## Contents

*Introduction*  xiii

**Part 1: Historical Signs**  1

1.1 General, systemic and metabolic historical signs  1
  1.1.1 Polyuria/polydipsia  1
  1.1.2 Weight loss  3
  1.1.3 Weight gain  4
  1.1.4 Polyphagia  5
  1.1.5 Anorexia/inappetence  6
  1.1.6 Failure to grow  8
  1.1.7 Syncope/collapse  9
  1.1.8 Weakness  13

1.2 Gastrointestinal/abdominal historical signs  16
  1.2.1 Ptyalism/salivation/hypersalivation  16
  1.2.2 Gagging/retching  18
  1.2.3 Dysphagia  19
  1.2.4 Regurgitation  20
  1.2.5 Vomiting  21
  1.2.6 Diarrhoea  26
  1.2.7 Melaena  31
  1.2.8 Haematemesis  33
  1.2.9 Haematochezia  34
  1.2.10 Constipation/obstipation  36
  1.2.11 Faecal tenesmus/dyschezia  38
  1.2.12 Faecal incontinence  39
  1.2.13 Flatulence/borborygmus  40

1.3 Cardiorespiratory historical signs  40
  1.3.1 Coughing  40
  1.3.2 Dyspnoea/tachypnoea  42
  1.3.3 Sneezing and nasal discharge  43
  1.3.4 Epistaxis  44
  1.3.5 Haemoptysis  46
  1.3.6 Exercise intolerance  47

1.4 Dermatological historical signs  48
  1.4.1 Pruritus  48

1.5 Neurological historical signs  51
  1.5.1 Seizures  51
  1.5.2 Trembling/shivering  55
1.5.3 Ataxia/conscious proprioceptive deficits
1.5.4 Paresis/paralysis
1.5.5 Coma/stupor
1.5.6 Altered behaviour – general changes
1.5.7 Altered behaviour – specific behavioural problems
1.5.8 Deafness
1.5.9 Multifocal neurological disease

1.6 Ocular historical signs
1.6.1 Blindness/visual impairment
1.6.2 Epiphora/tear overflow

1.7 Musculoskeletal historical signs
1.7.1 Forelimb lameness
1.7.2 Hind limb lameness
1.7.3 Multiple joint/limb lameness

1.8 Reproductive historical signs
1.8.1 Failure to observe oestrus
1.8.2 Irregular seasons
1.8.3 Infertility in the female with normal oestrus
1.8.4 Male infertility
1.8.5 Vaginal/vulval discharge
1.8.6 Abortion
1.8.7 Dystocia
1.8.8 Neonatal mortality

1.9 Urological historical signs
1.9.1 Pollakiuria/dysuria/stranguria
1.9.2 Polyuria/polydipsia
1.9.3 Anuria/oliguria
1.9.4 Haematuria
1.9.5 Urinary incontinence/inappropriate urination

Part 2: Physical Signs

2.1 General/miscellaneous physical signs
2.1.1 Abnormalities of body temperature – hyperthermia
2.1.2 Abnormalities of body temperature – hypothermia
2.1.3 Enlarged lymph nodes
2.1.4 Diffuse pain
2.1.5 Peripheral oedema
2.1.6 Hypertension
2.1.7 Hypotension

2.2 Gastrointestinal/abdominal physical signs
2.2.1 Oral lesions
2.2.2 Abdominal distension
2.2.3 Abdominal pain
2.2.4 Perianal swelling
2.2.5 Jaundice
2.2.6 Abnormal liver palpation
2.3 Cardiorespiratory physical signs

2.3.1 Dyspnoea/tachypnoea

2.3.2 Pallor

2.3.3 Shock

2.3.4 Cyanosis

2.3.5 Ascites

2.3.6 Peripheral oedema

2.3.7 Abnormal respiratory sounds

2.3.8 Abnormal heart sounds

2.3.9 Abnormalities in heart rate

2.3.10 Jugular distension/positive hepatojugular reflux

2.3.11 Jugular pulse components

2.3.12 Alterations in arterial pulse

2.4 Dermatological signs

2.4.1 Scaling

2.4.2 Pustules and papules (including miliary dermatitis)

2.4.3 Nodules

2.4.4 Pigmentation disorders (coat or skin)

2.4.5 Alopecia

2.4.6 Erosive/ulcerative skin disease

2.4.7 Otitis externa

2.4.8 Pododermatitis

2.4.9 Disorders of the claws

2.4.10 Anal sac/perianal disease

2.5 Neurological signs

2.5.1 Abnormal cranial nerve (CN) responses

2.5.2 Vestibular disease (head tilt, nystagmus, circling, leaning, falling, rolling)

2.5.3 Horner’s syndrome

2.5.4 Hemineglect syndrome

2.5.5 Spinal disorders

2.6 Ocular signs

2.6.1 Red eye

2.6.2 Corneal opacification

2.6.3 Corneal ulceration/erosion

2.6.4 Lens lesions

2.6.5 Retinal lesions

2.6.6 Intraocular haemorrhage/hyphaema

2.6.7 Abnormal appearance of anterior chamber

2.7 Musculoskeletal signs

2.7.1 Muscular atrophy or hypertrophy

2.7.2 Trismus (‘lockjaw’)

2.7.3 Weakness

2.8 Urogenital physical signs

2.8.1 Kidneys abnormal on palpation

2.8.2 Bladder abnormalities

2.8.3 Prostate abnormal on palpation
### Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8.4</td>
<td>Uterus abnormal on palpation</td>
<td>191</td>
</tr>
<tr>
<td>2.8.5</td>
<td>Testicular abnormalities</td>
<td>191</td>
</tr>
<tr>
<td>2.8.6</td>
<td>Penis abnormalities</td>
<td>192</td>
</tr>
</tbody>
</table>

**Part 3: Radiographic and Ultrasonographic Signs**

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Thoracic radiography</td>
<td>193</td>
</tr>
<tr>
<td>3.1.1</td>
<td>Artefactual causes of increased lung opacity</td>
<td>193</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Increased bronchial pattern</td>
<td>193</td>
</tr>
<tr>
<td>3.1.3</td>
<td>Increased alveolar pattern</td>
<td>195</td>
</tr>
<tr>
<td>3.1.4</td>
<td>Increased interstitial pattern</td>
<td>199</td>
</tr>
<tr>
<td>3.1.5</td>
<td>Increased vascular pattern</td>
<td>201</td>
</tr>
<tr>
<td>3.1.6</td>
<td>Decreased vascular pattern</td>
<td>202</td>
</tr>
<tr>
<td>3.1.7</td>
<td>Cardiac diseases that may be associated with a normal cardiac silhouette</td>
<td>203</td>
</tr>
<tr>
<td>3.1.8</td>
<td>Increased size of cardiac silhouette</td>
<td>203</td>
</tr>
<tr>
<td>3.1.9</td>
<td>Decreased size of cardiac silhouette</td>
<td>205</td>
</tr>
<tr>
<td>3.1.10</td>
<td>Abnormalities of the ribs</td>
<td>205</td>
</tr>
<tr>
<td>3.1.11</td>
<td>Abnormalities of the oesophagus</td>
<td>206</td>
</tr>
<tr>
<td>3.1.12</td>
<td>Abnormalities of the trachea</td>
<td>209</td>
</tr>
<tr>
<td>3.1.13</td>
<td>Pleural effusion</td>
<td>211</td>
</tr>
<tr>
<td>3.1.14</td>
<td>Pneumothorax</td>
<td>212</td>
</tr>
<tr>
<td>3.1.15</td>
<td>Abnormalities of the diaphragm</td>
<td>213</td>
</tr>
<tr>
<td>3.1.16</td>
<td>Mediastinal abnormalities</td>
<td>214</td>
</tr>
<tr>
<td>3.2</td>
<td>Abdominal radiography</td>
<td>217</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Liver</td>
<td>217</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Spleen</td>
<td>219</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Stomach</td>
<td>221</td>
</tr>
<tr>
<td>3.2.4</td>
<td>Intestines</td>
<td>224</td>
</tr>
<tr>
<td>3.2.5</td>
<td>Ureters</td>
<td>230</td>
</tr>
<tr>
<td>3.2.6</td>
<td>Bladder</td>
<td>230</td>
</tr>
<tr>
<td>3.2.7</td>
<td>Urethra</td>
<td>233</td>
</tr>
<tr>
<td>3.2.8</td>
<td>Kidneys</td>
<td>234</td>
</tr>
<tr>
<td>3.2.9</td>
<td>Loss of intra-abdominal contrast</td>
<td>236</td>
</tr>
<tr>
<td>3.2.10</td>
<td>Prostate</td>
<td>238</td>
</tr>
<tr>
<td>3.2.11</td>
<td>Uterus</td>
<td>239</td>
</tr>
<tr>
<td>3.2.12</td>
<td>Abdominal masses</td>
<td>239</td>
</tr>
<tr>
<td>3.2.13</td>
<td>Abdominal calcification/mineral density</td>
<td>240</td>
</tr>
<tr>
<td>3.3</td>
<td>Skeletal radiography</td>
<td>241</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Fractures</td>
<td>241</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Altered shape of long bones</td>
<td>242</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Dwarfism</td>
<td>243</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Delayed ossification/growth plate closure</td>
<td>243</td>
</tr>
<tr>
<td>3.3.5</td>
<td>Increased radiopacity</td>
<td>243</td>
</tr>
<tr>
<td>3.3.6</td>
<td>Periosteal reactions</td>
<td>244</td>
</tr>
<tr>
<td>3.3.7</td>
<td>Bony masses</td>
<td>245</td>
</tr>
<tr>
<td>3.3.8</td>
<td>Osteopenia</td>
<td>246</td>
</tr>
<tr>
<td>3.3.9</td>
<td>Osteolysis</td>
<td>247</td>
</tr>
<tr>
<td>3.3.10</td>
<td>Mixed osteolytic/osteogenic lesions</td>
<td>248</td>
</tr>
<tr>
<td>3.3.11</td>
<td>Joint changes</td>
<td>248</td>
</tr>
<tr>
<td>3.4</td>
<td>Radiography of the head and neck</td>
<td>251</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Increased radiopacity/bony proliferation of the maxilla</td>
<td>251</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Decreased radiopacity of the maxilla</td>
<td>251</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Increased radiopacity/bony proliferation of the mandible</td>
<td>252</td>
</tr>
<tr>
<td>3.4.4</td>
<td>Decreased radiopacity of the mandible</td>
<td>252</td>
</tr>
<tr>
<td>3.4.5</td>
<td>Increased radiopacity of the tympanic bulla</td>
<td>253</td>
</tr>
<tr>
<td>3.4.6</td>
<td>Decreased radiopacity of the nasal cavity</td>
<td>253</td>
</tr>
<tr>
<td>3.4.7</td>
<td>Increased radiopacity of the nasal cavity</td>
<td>254</td>
</tr>
<tr>
<td>3.4.8</td>
<td>Increased radiopacity of the frontal sinuses</td>
<td>255</td>
</tr>
<tr>
<td>3.4.9</td>
<td>Increased radiopacity of the pharynx</td>
<td>255</td>
</tr>
<tr>
<td>3.4.10</td>
<td>Thickening of the soft tissues of the head and neck</td>
<td>256</td>
</tr>
<tr>
<td>3.4.11</td>
<td>Decreased radiopacity of the soft tissues of the head and neck</td>
<td>257</td>
</tr>
<tr>
<td>3.4.12</td>
<td>Increased radiopacity of the soft tissues of the head and neck</td>
<td>257</td>
</tr>
<tr>
<td>3.5</td>
<td>Radiography of the spine</td>
<td>258</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Normal and congenital variation in vertebral shape and size</td>
<td>258</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Acquired variation in vertebral shape and size</td>
<td>259</td>
</tr>
<tr>
<td>3.5.3</td>
<td>Changes in vertebral radiopacity</td>
<td>261</td>
</tr>
<tr>
<td>3.5.4</td>
<td>Abnormalities in the intervertebral space</td>
<td>262</td>
</tr>
<tr>
<td>3.5.5</td>
<td>Contrast radiography of the spine (myelography)</td>
<td>263</td>
</tr>
<tr>
<td>3.6</td>
<td>Thoracic ultrasonography</td>
<td>265</td>
</tr>
<tr>
<td>3.6.1</td>
<td>Pleural effusion</td>
<td>265</td>
</tr>
<tr>
<td>3.6.2</td>
<td>Mediastinal masses</td>
<td>266</td>
</tr>
<tr>
<td>3.6.3</td>
<td>Pericardial effusion</td>
<td>266</td>
</tr>
<tr>
<td>3.6.4</td>
<td>Altered chamber dimensions</td>
<td>267</td>
</tr>
<tr>
<td>3.6.5</td>
<td>Changes in ejection phase indices of left ventricular performance</td>
<td>270</td>
</tr>
<tr>
<td>3.7</td>
<td>Abdominal ultrasonography</td>
<td>272</td>
</tr>
<tr>
<td>3.7.1</td>
<td>Renal disease</td>
<td>272</td>
</tr>
<tr>
<td>3.7.2</td>
<td>Hepatobiliary disease</td>
<td>274</td>
</tr>
<tr>
<td>3.7.3</td>
<td>Splenic disease</td>
<td>277</td>
</tr>
<tr>
<td>3.7.4</td>
<td>Pancreatic disease</td>
<td>279</td>
</tr>
<tr>
<td>3.7.5</td>
<td>Adrenal disease</td>
<td>279</td>
</tr>
<tr>
<td>3.7.6</td>
<td>Urinary bladder disease</td>
<td>280</td>
</tr>
<tr>
<td>3.7.7</td>
<td>Gastrointestinal disease</td>
<td>281</td>
</tr>
<tr>
<td>3.7.8</td>
<td>Ovarian and uterine disease</td>
<td>283</td>
</tr>
<tr>
<td>3.7.9</td>
<td>Prostatic disease</td>
<td>284</td>
</tr>
<tr>
<td>3.7.10</td>
<td>Ascites</td>
<td>285</td>
</tr>
<tr>
<td>3.8</td>
<td>Ultrasonography of other regions</td>
<td>288</td>
</tr>
<tr>
<td>3.8.1</td>
<td>Testes</td>
<td>288</td>
</tr>
<tr>
<td>3.8.2</td>
<td>Eyes</td>
<td>288</td>
</tr>
<tr>
<td>3.8.3</td>
<td>Neck</td>
<td>290</td>
</tr>
</tbody>
</table>

Part 4: Laboratory Findings | 292

4.1 | Biochemical findings | 292
4.1.1 | Albumin | 292
4.1.2 Alanine transferase 293  
4.1.3 Alkaline phosphatase 295  
4.1.4 Ammonia 296  
4.1.5 Amylase 297  
4.1.6 Aspartate aminotransferase 298  
4.1.7 Bilirubin 298  
4.1.8 Bile acids/dynamic bile acid test 299  
4.1.9 C-reactive protein 300  
4.1.10 Cholesterol 301  
4.1.11 Creatinine 301  
4.1.12 Creatine kinase 302  
4.1.13 Ferritin 303  
4.1.14 Fibrinogen 303  
4.1.15 Folate 304  
4.1.16 Fructosamine 304  
4.1.17 Gamma-glutamyl transferase 305  
4.1.18 Gastrin 306  
4.1.19 Globulins 306  
4.1.20 Glucose 307  
4.1.21 Iron 309  
4.1.22 Lactate dehydrogenase 310  
4.1.23 Lipase 311  
4.1.24 Triglycerides 312  
4.1.25 Trypsin-like immunoreactivity 313  
4.1.26 Urea 313  
4.1.27 Vitamin B₁₂ (cobalamin) 316  
4.1.28 Zinc 317  

4.2 Haematological findings 317  
4.2.1 Regenerative anaemia 317  
4.2.2 Poorly-/non-regenerative anaemia 320  
4.2.3 Polycythaemia 323  
4.2.4 Thrombocytopenia 324  
4.2.5 Thrombocytosis 327  
4.2.6 Neutrophilia 328  
4.2.7 Neutropenia 330  
4.2.8 Lymphocytosis 331  
4.2.9 Lymphopenia 332  
4.2.10 Monocytosis 333  
4.2.11 Eosinophilia 334  
4.2.12 Eosinopenia 335  
4.2.13 Mastocytthaemia 335  
4.2.14 Basophilia 335  
4.2.15 Increased buccal mucosal bleeding time (disorders of primary haemostasis) 336  
4.2.16 Increased prothrombin time (disorders of extrinsic and common pathways) 337  
4.2.17 Increased partial thromboplastin time or activated clotting time (disorders of intrinsic and common pathways) 338  
4.2.18 Increased fibrin degradation products 338
4.2.19 Decreased fibrinogen levels 338
4.2.20 Decreased antithrombin III levels 339

4.3 Electrolyte and blood gas findings 339
4.3.1 Total calcium 339
4.3.2 Chloride 342
4.3.3 Magnesium 343
4.3.4 Potassium 345
4.3.5 Phosphate 347
4.3.6 Sodium 348
4.3.7 pH 350
4.3.8 \( \text{paO}_2 \) 353
4.3.9 Total CO\(_2\) 354
4.3.10 Bicarbonate 354
4.3.11 Base excess 354

4.4 Urinalysis findings 354
4.4.1 Alterations in specific gravity 354
4.4.2 Abnormalities in urine chemistry 356
4.4.3 Abnormalities in urine sediment 360
4.4.4 Infectious agents 362

4.5 Cytological findings 364
4.5.1 Tracheal/bronchoalveolar lavage 364
4.5.2 Nasal flush cytology 366
4.5.3 Liver cytology 367
4.5.4 Kidney cytology 369
4.5.5 Skin scrapes/hair plucks/tape impressions 369
4.5.6 Cerebrospinal fluid (CSF) analysis 370
4.5.7 Fine needle aspiration of cutaneous/subcutaneous masses 372

4.6 Hormones/endocrine testing 373
4.6.1 Thyroxine 373
4.6.2 Parathyroid hormone 374
4.6.3 Cortisol (baseline or post-ACTH stimulation test) 375
4.6.4 Insulin 376
4.6.5 ACTH 376
4.6.6 Vitamin D (1,25 dihydroxycholecalciferol) 376
4.6.7 Testosterone 377
4.6.8 Progesterone 377
4.6.9 Oestradiol 378
4.6.10 Atrial natriuretic peptide 378
4.6.11 Modified water deprivation test (in the investigation of polyuria/polydipsia) 379

4.7 Faecal analysis findings 379
4.7.1 Faecal blood 379
4.7.2 Faecal parasites 380
4.7.3 Faecal culture 380
4.7.4 Faecal fungal infections 381
4.7.5 Undigested food residues 381
Part 5: Electrodiagnostic Testing

5.1 ECG findings
  5.1.1 Alterations in P wave
  5.1.2 Alterations in QRS complex
  5.1.3 Alterations in P-R relationship
  5.1.4 Alterations in S-T segment
  5.1.5 Alterations in Q-T interval
  5.1.6 Alterations in T wave
  5.1.7 Alterations in baseline
  5.1.8 Rhythm alterations
  5.1.9 Alterations in rate

5.2 Electromyographic findings

5.3 Nerve conduction velocity findings

5.4 Electroencephalography findings

Part 6: Diagnostic Procedures

6.1 Fine-needle aspiration (FNA)

6.2 Bronchoalveolar lavage

6.3 Gastrointestinal (GI) endoscopic biopsy

6.4 Electrocardiography (ECG)

6.5 Magnetic resonance imaging (MRI)
  6.5.1 Brain
  6.5.2 Spine
  6.5.3 Nasal passages

6.6 Ultrasound-guided biopsy

6.7 Cerebrospinal fluid (CSF) collection

6.8 Bone marrow aspiration

6.9 Thoraco-, pericardo-, cysto- and abdominocentesis
  6.9.1 Thoracocentesis
  6.9.2 Pericardiocentesis
  6.9.3 Cystocentesis
  6.9.4 Abdominocentesis/diagnostic peritoneal lavage

6.10 Blood pressure measurement
  6.10.1 Central venous pressure
  6.10.2 Indirect blood pressure measurement by Doppler technique

6.11 Dynamic testing
  6.11.1 ACTH stimulation test
  6.11.2 Low-dose dexamethasone suppression test (LDDST)
  6.11.3 Bile acid stimulation test

6.12 Haematological techniques
  6.12.1 In saline autoagglutination test
  6.12.2 Preparation of a blood smear
6.12.3 Buccal mucosal bleeding time 415
6.12.4 Arterial blood sampling 416

6.13 Water deprivation test 416
6.14 Serial blood glucose curve 418
6.15 Skin scraping 419
6.16 Schirmer tear test 419
6.17 Nasal flush cytology/nasal biopsy 420

6.18 Contrast radiography 421
   6.18.1 Barium meal/swallow 421
   6.18.2 Intravenous urography 422
   6.18.3 Contrast cystography 423
   6.18.4 Myelography 425

6.19 Contrast echocardiography 426
6.20 Cranial nerve (CN) examination 426

Part 7: Diagnostic Algorithms 429
7.1 Bradycardia 430
7.2 Tachycardia 431
7.3 Hypoalbuminaemia 432
7.4 Non-regenerative anaemia 433
7.5 Regenerative anaemia 434
7.6 Jaundice 435
7.7 Hypokalaemia 436
7.8 Hyperkalaemia 437
7.9 Hypocalcaemia 438
7.10 Hypercalcaemia 439
7.11 Systemic hypertension 440

Appendix A: History Record 441
Appendix B: Physical Examination Record 443
Appendix C: Neurological Examination Chart 445
Appendix D: Cardiology Consultation Form 448

Bibliography and Further Reading 451

Index 453

Colour plate section follows p. 240
To Naomi and Abigail, for their patience and support, and Mac, for a lifetime of companionship.
Introduction

This book was written to fill what I felt was a gap in the market. While working up difficult medical cases, I have often wanted a single ready reference to help me formulate a differential list from the clinical information I have available. Unfortunately, I found myself frequently having to consult multiple textbooks to bring all the information I needed together. I decided therefore to write a book that would serve as a ready reference for differential diagnoses of the majority of presentations that are encountered in practice, including both common and uncommon conditions. This text should be of use to veterinary students, general practitioners, university interns, residents and anyone who, like me, cannot fully carry these lists around in their heads. I hope other clinicians find it as useful as I do.

The differential diagnosis list is one of the most important aspects of the problem-oriented approach to clinical diagnosis. For those who are not familiar with the problem-oriented approach, a brief outline follows.

As the name implies, problem-oriented medical management (POMM), concentrates on the individual problems of a patient. A differential diagnosis list should be made for each and every problem that is found in a patient, whether in the history, the physical examination, imaging or clinicopathological tests. Although superficially this may not sound very ‘holistic’, in fact, if all the patient’s problems are considered individually, the whole patient will have been evaluated, without falling into the trap of presuming that all of the findings are caused by a single condition.

The problem-oriented approach starts with a detailed history, and it is important to discover what the owners perceive to be the main problems – after all, they usually know their animal better than the clinician does. However, there may be relevant historical signs that the owners had not considered significant, so failing to systematically ask all the questions which could be of importance in a case can lead to overlooking important information. Using a checklist or form, such as the one in Appendix A can be useful as an aide-memoire.

In every case, a detailed physical examination should be carried out, including body systems that are not apparently of immediate concern. Again, a checklist or form, such as the one in Appendix B, can help ensure a systematic approach.

Once the history has been taken and the physical examination has been completed, the clinician should list every problem that has been discovered. Problems may include such findings as exercise intolerance, pruritus, pyrexia or a heart murmur. A differential diagnosis list should then be created for every problem. The list should be appropriate to that animal. There is no point listing feline leukaemia virus as a likely diagnosis in a dog!

An attempt should also be made to categorise the conditions in order of likelihood, or at least into common and uncommon. Although the more common conditions have been indicated in this book with an asterisk (*), there are few objective data regarding the true incidence of conditions, and the estimate of incidence is largely subjective and influenced by the author’s geographical location and caseload. Familiarity with how
common conditions are and their local incidence will help prioritise differential lists. The clinician can then select diagnostic tests in a rough order of probability, although rarer but life-threatening conditions, such as hypoadrenocorticism, should also be ruled out early in the course of investigations. Some authorities rightly point out that emphasis should be placed on historical and physical signs, and that ‘over-investigating’ can be expensive and potentially detrimental to the patient (Chesney, 2003).

It is this author’s opinion, however, that it is possible to place too much importance on probabilities and how commonly a condition occurs. The newly-qualified veterinary surgeon will often look for the rare but exciting and memorable condition they learned about at college, while the experienced practitioner will often remind them that ‘common things are common’, and suggest they restrict their investigations only to commonly-encountered conditions. The ideal approach is probably somewhere in between.

Although it is self-evidently true that common things are common, it is also true that uncommon things are encountered relatively often. To take a hypothetical example: if a common problem is caused by common conditions A and B with a frequency of 80%, and by rare conditions C to Z the rest of the time, with conditions C to Z occurring with equal frequency, then each individual condition C to Z will be responsible for the problem approximately 0.9% of the time, making each individual condition quite uncommon. However, 1 in 5 presentations of this problem will be caused by an uncommon condition, and so uncommon conditions will be diagnosed commonly, provided they are looked for. The problem-oriented approach ensures that these uncommon conditions are not overlooked.

Some authorities prefer to categorise the initial approach to a case differently, and describe the subjective and objective assessment of a patient as part of the SOAP approach (Subjective, Objective, Assessment, Plan). The principle is the same however, in that a detailed history or physical examination is the basis of the initial differential list.

Once the differential diagnosis list has been formulated, the clinician is in a position to select appropriate tests to aid in making a definitive diagnosis. Prioritising the selection of diagnostic tests helps avoid placing undue financial strain on the client and inappropriate or unnecessary testing on the patient. Tests may be prioritised on such factors as: the number of conditions which will be ruled in and out; the sensitivity and specificity of the tests; the risk/benefit to the patient ratio; the financial cost/benefit to the client ratio; the incidence or prevalence of the condition being tested for; the importance of the condition being tested for (e.g. hypoadrenocorticism is uncommon, but the consequences of failing to diagnose it may be serious).

After the results of initial testing have been obtained the clinician may be in a position to make a definitive diagnosis. Often, however, it is necessary to refine the differential list and select further appropriate testing. The differential list may be reformulated as often as is necessary until a single diagnosis for that problem is made. Often, a single diagnosis will tie in all the problems satisfactorily. However, in many cases, particularly in geriatric patients, concurrent disorders will require multiple diagnoses.

For problem cases in which a clear diagnosis is not made, or the patient fails to respond to treatment as expected, returning to the beginning with the history and physical examination, with the condition often having progressed, can be helpful. However, very few tests are 100% sensitive and specific, and many ‘definitive’ diagnoses in fact leave room for some doubt. The clinician should never be afraid to revise the initial diagnosis if further evidence comes to light. Those who are concerned that failing to make the correct diagnosis in every case is somehow a sign of inferior clinical abilities
should take heart from a recent study from the School of Veterinary Medicine at the University of California (Kent et al., 2004). In this paper, clinical and post mortem diagnoses of 623 dogs treated between 1989 and 1999 at the Veterinary Teaching Hospital were compared. It was found that the post mortem diagnosis, presumed to be the correct diagnosis, differed from the clinical diagnosis in approximately 1/3 of cases.

This book is organised into seven parts. Part 1 deals with signs likely to be uncovered during history taking. Part 2 deals with signs encountered at the physical examination. Part 3 deals with imaging findings, Part 4 with clinicopathological findings, and Part 5 electrophysiological findings. Part 6 outlines the techniques involved in some common diagnostic procedures and Part 7 contains some algorithms to aid in the diagnosis of common clinical presentations. Four appendices, containing checklists for diagnostic investigations, and a bibliography follow.

The individual lists are categorised as I felt was logical, for example by the DAMNIT-V organisation. DAMNIT-V is a mnemonic for remembering the various pathological processes that may cause a disease:

D – degenerative
A – anomalous (usually listed as congenital in this book)
M – metabolic
N – nutritional, neoplastic
I – inflammatory, infectious, immune-mediated, iatrogenic, idiopathic
T – traumatic, toxic
V – vascular

This categorisation is not appropriate in all cases, however. The individual lists are largely organised alphabetically. The more common conditions are labelled with an asterisk, but, as stated above, whether or not a condition is considered to be common is largely a matter of subjective opinion. Those conditions that are predominantly or exclusively found only in dogs are marked with a (D) and those in cats are marked with a (C).

Sources for the information in this book are wide ranging. A large number of textbooks, listed in the bibliography, were consulted, but in most cases it was necessary to expand the lists found in these sources, using information from veterinary journals and conference proceedings.

Although there are undoubtedly omissions from some of the lists, encompassing as this book does virtually the whole of small animal veterinary medicine, I have tried to make it as comprehensive as possible. I would be happy to hear of any omissions, corrections or comments on the text, which can be e-mailed with any supporting references to alex.gough@btconnect.com.

I am grateful to Simon Platt BVM&S DipACVIM DipECVN MRCVS, Chris Belford BVSc DVSc FACVS MRCVS Specialist Pathologist Dip Wldl Mgt, Theresa McCann BVSc CertSAM MRCVS, Rosie McGregor BVSc CertVD CertVC MRCVS and Mark Bush MA VetMB CertSAM MRCVS for comments on the text. I am equally grateful to Alison Thomas BVSc CertSAM MRCVS, Mark Maltman BVSc CertSAM CertVC MRCVS, Panagiotis Mantis DVM DipECVDI MRCVS, Axiom Laboratories, Stuart Caton BA VetMB CertSAM MRCVS, Tim Knott BSc BVSc CertVetOphth MRCVS, Lisa Phillips CertVR BVetMed MRCVS, Roderick MacGregor BVM&S CertVetOphth CertSAM MRCVS and Mark Owen BVSc CertSAO MRCVS for their comments on the text. Any errors are of course mine and not theirs. I am also grateful to Samantha Jackson at Blackwell Publishing for her support in this project.
Introduction

**Key**

* = more common condition  
(D) = condition seen exclusively or predominantly in dogs  
(C) = condition seen exclusively or predominantly in cats  
q.v. = more information can be found on this condition elsewhere in this book – see Index

**References**

PART 1
HISTORICAL SIGNS

1.1 General, systemic and metabolic historical signs

1.1.1 Polyuria/polydipsia

Physiological
- Exercise
- High environmental temperature

Diet
- Increased salt intake
- Very low protein diet

Electrolyte disorders
- Hypercalcaemia *q.v.*
- Hypokalaemia *q.v.*
- Hypernatraemia *q.v.*

Endocrine disease
- Acromegaly
- Diabetes mellitus*
- Diabetes insipidus
  - Central
  - Nephrogenic
- Hyperadrenocorticism*
- Hyperthyroidism* (C)
- Hypoadrenocorticism (D)
- Insulinoma
- Phaeochromocytoma
- Primary hyperaldosteronism
- Primary hyperparathyroidism

Hepatobiliary disease, e.g.
- Hepatic neoplasia* *q.v.*
- Hepatitis/cholangiohepatitis* *q.v.*

Infectious disease, e.g.
- Toxaemia, e.g.
  - Pyometra
**Miscellaneous**
- Congenital lack of ADH receptors
- Hypothalamic disease
- Pericardial effusion
- Polycythaemia
- Psychogenic

**Neoplasia**

**Renal disorders**
- Acute renal failure* q.v.
- Chronic renal failure* q.v.
- Glomerulonephritis
- After urethral obstruction
- Primary renal glycosuria
- Pyelonephritis
- Renal medullary washout

**Drugs/toxins**
- Aminophylline
- Corticosteroids
- Delmadinone acetate
- Diuretics
- Ethylene glycol
- Indomethacin

---

**Fig. 1.1** Dorsal T1 weighted MR scan of the adrenal glands of a dog with pituitary-dependent hyperadrenocorticism, showing mild bilateral enlargement. Reproduced with permission of Downs Referrals, Bristol.
Lithium
NPK fertilisers
Paraquat
Phenobarbitone
Potassium bromide
Primidone
Proligestone
Terfenadine
Theophylline
Vitamin D rodenticides

Note: Polyuria and polydipsia are considered together here, since one will lead to the other, with only a few exceptions. These include polydipsia in the face of obstructive lower urinary tract disease or oliguric renal failure, and polyuria which is not matched by fluid intake, in which case dehydration will rapidly follow. None of these scenarios are encountered commonly in practice.

References

1.1.2 Weight loss

Decreased nutrient intake
Anorexia q.v.
Diet
• Poor-quality diet
• Underfeeding
Dysphagia q.v.

Increased nutrient loss
Burns
Chronic blood loss
• Epistaxis q.v.
• Haematemesis q.v.
• Haematuria q.v.
• Melaena q.v.
Diabetes mellitus*
Effusions q.v.
Fanconi syndrome (D)
Intestinal parasites*
Neoplasia
Protein-losing enteropathy*
Protein-losing nephropathy
**Increased nutrient use**

*Endocrine, e.g.*
- Hyperthyroidism* (C)

*Neoplasia*

*Physiological*
- Cold environment
- Exercise
- Fever *q.v.*
- Lactation
- Pregnancy*

**Malassimilation**
- Cardiac failure*
- Exocrine pancreatic insufficiency
- Hepatic failure/bile salt deficiency* *q.v.*
- Hypoadrenocorticism (D)
- Neoplasia*
- Renal failure* *q.v.*
- Small intestinal disease* *q.v.*

**Regurgitation and vomiting *q.v.***

**Reference**

---

**1.1.3 Weight gain**

**Fluid accumulation**
- Ascites* *q.v.*
- Peripheral oedema *q.v.*
- Pleural effusion

**Increased body fat**

*Overeating*
- Boredom
- Excessive appetite (normal in some breeds)*
- High-calorie diets
- Overfeeding*

*Endocrinopathies*
- Acromegaly
- Hyperadrenocorticism*
- Hypogonadism
- Hypothyroidism* (D)
- Insulinoma
Increased organ size
Hepatomegaly* q.v.
Renomegaly q.v.
Splenomegaly* q.v.
Uterine enlargement q.v.
  • Pregnancy*
  • Pyometra*

Neoplasia
Large abdominal mass (often associated with poor body condition)*
Drugs, e.g.
  • Corticosteroids

References

1.1.4 Polyphagia

Behavioural/psychological
Normal in some breeds*
  Boredom

Physiological
Cold environment
Increased exercise
Lactation*
  Pregnancy*

Malassimilation*

Increased nutrient loss

Increased nutrient use

Diet
Highly-palatable food*
  Poor-quality food

Endocrine
Diabetes mellitus*
Hyperadrenocorticism*
Hyperthyroidism* (C)
Insulinoma

Miscellaneous
Peritoneopericardial diaphragmatic hernia

Drugs/toxins
Aminophylline
Benzodiazepines
Cannabis
Cyproheptadine
Delmadinone acetate
Glucocorticoids
Phenobarbitone
Potassium bromide
Primidone
Proligestone

References

1.1.5 Anorexia/inappetence

**Difficulty with prehension**
Blindness *q.v.*

*Myopathy, e.g.*
Masticatory myositis
Tetanus

*Pain on opening jaw, e.g.*
Mandibular or maxillary fracture
Retrobulbar abscess
Skull fractures
Soft tissue trauma
Temporo-mandibular joint disease

*Trigeminal nerve disease, e.g.*
Neoplasia
Trigeminal neuritis

**Difficulty with mastication**
Dental disease*
Lingual disease
Oral neoplasia*
Oral ulceration, e.g.
  • Ingestion of caustic or acidic substances*
  • Renal disease

**Difficulty with swallowing**
*Pharyngeal disease*
Foreign body*
Neoplasia
Neurological disease
Ulceration
**Oesophageal disease, e.g.**
- Foreign body
- Neoplasia
- Ulceration
- Megaesophagus
- Stricture
- Vascular ring anomaly

**Primary anorexia**
Intracranial disease, e.g.
- Hypothalamic neoplasia

**Secondary anorexia**
Anosmia
- Chronic rhinitis *q.v.*
- Nasal neoplasia
- Other nasal disease
- Neurological disease

Endocrine disease, e.g.
- Diabetic ketoacidosis
- Hypoadrenocorticism (D)

Fever* *q.v.*

Gastrointestinal disease *q.v.*, e.g.
- Gastritis
- Inflammatory bowel disease*

Heart disease, e.g.
- Cardiac failure*

Hepatic disease* *q.v.*

Infection*

Metabolic abnormalities, e.g.
- Hypercalcaemia *q.v.*
- Hypokalaemia *q.v.*

Pain*

Pancreatic disease*, e.g.
- Pancreatitis

Respiratory disease, e.g.
- Airway disease* *q.v.*
- Diaphragmatic hernia
- Pleural effusion* *q.v.*
- Pneumonia *q.v.*

Renal disease* *q.v.*

Drugs
- Acetazolamide
- Amiodarone
- Amphotericin B
- Bethanechol
- Bromocriptine
- Butorphanol
- Cardiac glycosides
- Chlorambucil
- Diazoxide
- Doxorubicin
- Fentanyl
• Hydralazine
• Itraconazole
• Ketoconazole
• Melphalan
• Methimazole
• Mitotane
• Nicotinamide
• Oxytetracycline (C)
• Penicillamine
• Theophylline
• Trimethoprim/sulphonamide (C)

**Diet**
Recent dietary changes*
Unpalatable diet*

**Psychological/behavioural* factors**
Altered schedule
New family members
New house
New pets

**Reference**

### 1.1.6 Failure to grow

**With good body condition**
Chondrodystrophy (normal in many breeds)* (D)
Endocrine disorders
• Congenital hyposomatropism (pituitary dwarfism)
• Congenital hypothyroidism
• Hyperadrenocorticism

**With poor body condition**
Dietary intolerance
Exocrine pancreatic insufficiency*

**Inadequate nutrient intake**
Anorexia *q.v.*
Poor-quality diet
Underfeeding

**Cardiac disorders, e.g.**
Congenital
Endocarditis
Hepatic disorders, e.g.
  Hepatitis q.v.
  Portosystemic shunt

Oesophageal disorders, e.g.
  Megaoesophagus q.v.
  Vascular ring anomaly (e.g. persistent right aortic arch)

Gastrointestinal disease, e.g.
  Histoplasmosis
  Obstruction, e.g.
    • Foreign body*
    • Intussusception*
  Parasites*

Renal disease
  Congenital kidney disease
  Glomerulonephritis
  Pyelonephritis

Inflammatory disease

Endocrine disease
  Diabetes insipidus
  Diabetes mellitus*
  Hypoadrenocorticism (D)

Reference

1.1.7 Syncope/collapse (see Table 1.1)

Cardiovascular dysfunction
  Myocardial failure
  Myocardial infarction
  Shock q.v.

Bradyarrhythmias q.v., e.g.
  High grade second degree heart block
  Sick sinus syndrome (D)
  Third degree heart block

Tachyarrhythmias q.v.
  Supraventricular tachycardia*
  Ventricular tachycardia*
Table 1.1 Differentiating seizures from syncope. This table is a guide to the differentiation of generalised seizures from syncopal episodes. However, there is a lot of overlap between the two: syncopal episodes may involve convulsions; seizures may occur on exercise; tonic–clonic motions may not always be observed with seizures.

<table>
<thead>
<tr>
<th>Syncope</th>
<th>Seizure (generalised)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precipitating event/timing</strong></td>
<td>Exercise, excitement, stress, cough, urination, defecation</td>
</tr>
<tr>
<td><strong>Pre-event</strong></td>
<td>Acute weakness, staggering, vocalisation</td>
</tr>
<tr>
<td><strong>Event</strong></td>
<td>Usually flaccid limbs but may be rigid</td>
</tr>
<tr>
<td></td>
<td>Duration less than 1 minute</td>
</tr>
<tr>
<td></td>
<td>Rarely urination/defecation</td>
</tr>
<tr>
<td></td>
<td>Usually retain consciousness, but may lose consciousness</td>
</tr>
<tr>
<td></td>
<td>Abnormal heart rhythm or rate may or may not be palpated/ausculted</td>
</tr>
<tr>
<td><strong>Post-event</strong></td>
<td>Rapid recovery</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Obstruction to flow**
Congenital, e.g.
- Aortic stenosis (D)
- Pulmonic stenosis (D)

Hypertrophic obstructive cardiomyopathy
Pericardial effusion* (D)
Pulmonary hypertension
Arterial obstruction, e.g.
- Neoplasia
- Thrombosis

**Hypoxaemic disease**
Carboxyhaemoglobinaemia
Methaemoglobinaemia

**Respiratory disease**
Upper airway, e.g.
- Brachycephalic obstructive airway syndrome
- Laryngeal paralysis
- Tracheal collapse
- Tracheal obstruction

Lower airway, e.g.
- Pneumonia
- Small airway disease
Ventilation-perfusion mismatch, e.g.
- Lung collapse

Pleural/thoracic disorders, e.g.
- Pleural effusion
- Pneumothorax
- Rib fractures

*Right-to-left cardiac shunt, e.g.*
Reverse-shunting patent ductus arteriosus
Severe anaemia

**Neurological dysfunction**
- Brainstem disease
- Glossopharyngeal neuralgia
- Micturition-related collapse
- Narcolepsy/cataplexy
- Seizures *q.v.*
- Swallowing-related collapse

*Diffuse cerebral dysfunction, e.g.*
- Encephalopathy
- Haemorrhage
- Hydrocephalus
- Inflammation
- Oedema
- Space occupying lesion
- Trauma

*Lower motor neurone disorders*
- Endocrine neuropathies, e.g.
  - Diabetes mellitus*
  - Hyperadrenocorticism
  - Hypothyroidism* (D)
- Lumbosacral disease
- Paraneoplastic neuropathies, e.g.
  - Insulinoma
- Peripheral nerve neoplasia
- Polyneuropathy
- Polyradiculoneuropathy

*Neuromuscular junction disorders*
- Botulism
- Myasthenia gravis

*Upper motor neurone disorders*
- Central vestibular disease
- Cerebellar disease
- Cerebral disease
- Peripheral vestibular disease
- Spinal disease
Miscellaneous
Carotid sinus stimulation, e.g.
• Neoplasia
• Tight collar
Hyperventilation
Postural hypotension
Tussive syncope

Metabolic disorders
Diabetic ketoacidosis
Hypercalcaemia/hypocalcaemia q.v.
Hypernatraemia/hyponatraemia q.v.
Hyperthermia/hypothermia q.v.
Hypoglycaemia q.v.
Hypokalaemia q.v.
Severe acidosis q.v.
Severe alkalosis q.v.

Myopathies
Corticosteroid myopathy
Exertional myopathy
Hypocalcaemic myopathy
Hypokalaemic myopathy
Malignant hyperthermia
Mitochondrial myopathy
Muscular dystrophy
Polymyopathy
Polymyositis
Protozoal myopathy

Skeletal/joint disorders
Bilateral cranial cruciate disease
Bilateral hip disease
Discospondylitis
Intervertebral disc disease
Multiple myeloma
Osteoarthritis
Panosteitis
Patellar luxation
Polyarthritis

Drugs
Anti-arrhythmics, e.g.
• Atenolol
• Digoxin
• Propranolol
• Quinidine
Sedatives, e.g.
• Phenothiazines
Vasodilators, e.g.
• ACE inhibitors
• Hydralazine
• Nitroglycerine
References
Berendt, M. (2001) The diagnosis of epilepsy: seizure phenomenology and
39:368–72.
Cardiology*, 2002.
Wray, J. (2005) Differential diagnosis of collapse in the dog. 1. Aetiology and

### 1.1.8 Weakness

**Metabolic disease**
Renal failure* q.v.
Hepatic failure* q.v.
Hypoglycaemia q.v.
Electrolyte disorders*
  • Hypercalcaemia*/hypocalcaemia q.v.
  • Hyperkalaemia/hypokalaemia* q.v.
  • Hypernatraemia/hyponatraemia q.v.
Acid–base disorders
  • Acidosis q.v.
  • Alkalosis q.v.

**Infectious diseases**
Bacterial
Viral
Fungal
Rickettsial
Protozoal
Other parasitic diseases

**Immune-mediated/inflammatory diseases**
Chronic inflammatory conditions*
Immune-mediated haemolytic anaemia* q.v.
Immune-mediated polyarthritis

**Haematological diseases**
Anaemia* q.v.
Hyperviscosity syndrome

**Endocrine diseases**
Diabetes mellitus*
Hyperadrenocorticism
Hyperparathyroidism
Hypoadrenocorticism (D)
Hypoparathyroidism
Hypothyroidism* (D)
Insulinoma
**Cardiovascular diseases**

Bradyarrhythmias q.v., e.g.
- High grade second degree heart block
- Sick sinus syndrome (D)
- Third degree heart block
Congestive heart failure*
Pericardial effusion* q.v.
Hypertension* q.v.
Hypotension* q.v.
Tachyarrhythmias q.v., e.g.
  - Ventricular tachycardia*

**Respiratory diseases**

Airway obstruction, e.g.
- Feline asthma* (C)
- Foreign body*
- Neoplasia *
Intrathoracic neoplasia*
  - Pleural effusion*
  - Pulmonary hypertension
  - Pulmonary oedema* q.v.
  - Pulmonary thromboembolism
Severe pulmonary parenchymal disease

**Neuromuscular diseases**

Epilepsy* q.v.
Myasthenia gravis
Myopathies
Vestibular disease* q.v.

**Intracranial disease, e.g.**

Cerebrovascular accident
Infection
Inflammation
Space-occupying lesions

**Spinal cord disease q.v., e.g.**

Infection
Inflammation
Intervertebral disc disease* (D)
Neoplasia
Trauma*

**Peripheral polyneuropathies**

Endocrine disorders, e.g.
  - Diabetes mellitus*
  - Hyperadrenocorticism
  - Hypothyroidism* (D)
Polyradiculoneuritis
Paraneoplastic disorders
Drugs/toxins, e.g.
- Cisplatin
- Lead
- Vincristine

Infections
- Botulism
- Tick paralysis

Systemic disorders
- Dehydration*
- Fever* q.v.
- Neoplasia*

Nutritional disorders
Cachexia, e.g.
- Heart failure*
- Neoplasia*

Inadequate calorie intake, e.g.
- Anorexia* q.v.
- Poor-quality diet

Specific nutrient deficiencies, e.g.
- Minerals
- Vitamins

Physiological factors
- Over-exercise
- Pain*
- Stress/anxiety*

Drugs/toxins
- Alphachloralose
- Anticoagulant rodenticides
- Anticonvulsants
- Antihistamines
- Blue-green algae
- Cannabis
- Diclofenac sodium
- Glucocorticoids
- Hypotensive agents, e.g.
  - Beta-blockers
  - Vasodilators
- Ibuprofen
- Insulin overdosage
- Iron salts
- Mistletoe
- Opioids
Organophosphates
Petroleum distillates
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Sedatives

References

1.2 Gastrointestinal/abdominal historical signs

1.2.1 Ptyalism/salivation/hypersalivation

Physiological factors
Appetite stimulation
Fear
Stress

Oral cavity disease
Dental disease
Foreign body
Neoplasia

Inability to close mouth, e.g.
Mandibular trauma
Trigeminal nerve disease, e.g.
  • Idiopathic trigeminal neuritis
  • Infiltrating neoplasia, e.g.
    • Lymphoma
    • Nerve sheath tumours

Ulceration, e.g.
Immune-mediated disease
Ingestion of irritant substance
Renal failure

Inflammation
Faucitis
Gingivitis
Glossitis
Oesophagitis
Stomatitis
16

Historical Signs

Organophosphates
Petroleum distillates
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Sedatives

References

1.2 Gastrointestinal/abdominal historical signs

1.2.1 Ptyalism/salivation/hypersalivation

Physiological factors
Appetite stimulation*
Fear*
Stress*

Oral cavity disease
Dental disease*
Foreign body*
Neoplasia*

Inability to close mouth, e.g.
Mandibular trauma*
Trigeminal nerve disease, e.g.
  • Idiopathic trigeminal neuritis
  • Infiltrating neoplasia, e.g.
    • Lymphoma
    • Nerve sheath tumours

Ulceration*, e.g.
Immune-mediated disease
Ingestion of irritant substance
Renal failure*

Inflammation*
Faucitis*
Gingivitis*
Glossitis*
Oesophagitis*
Stomatitis*
**Neurological disease**
- Cataplexy/narcolepsy
- Hepatic encephalopathy
- Intracranial neoplasia
- Partial seizures

**Nausea/regurgitation/vomiting q.v.**

**Salivary gland disease q.v.**
- Salivary gland necrosis/sialadenitis
- Salivary mucocoele
- Sialadenosis

**Normal breed variation, e.g.**
- St Bernards

**Drugs/toxins**
- Adder bites
- Alphachloralose
- Baclofen
- Batteries
- Benzodiazepines
- Bethanechol
- Blue-green algae
- Cannabis
- Carbamate
- Chocolate/theobromine
- Cotoneaster
- Cyanoacrylate adhesives
- Daffodil
- Dieffenbachia
- Dinoprost tromethamine
- Glyphosate
- Horse chestnut
- Ivermectin
- Ketamine
- Laburnum
- Levamisole (C)
- Loperamide
- Metronidazole
- Mistletoe
- NPK fertilisers
- Organophosphates
- Paracetamol
- Paraquat
- Phenoxy acid herbicides
- Plastic explosives
- Pyrethrin/pyrethroids
- Pyridostigmine
- Rhododendron
- Rowan
Terfenadine
Toads
Trimethoprim/sulphonamide (C)
Xylazine

References

## 1.2.2 Gagging/retching

### Congenital disease
- Achalasia, e.g.
  - Cricopharyngeal achalasia (D)
- Cleft palate
- Hydrocephalus

### Neuromuscular disease
- Brainstem disease
- Cranial nerve defects (V, VII, IX, XII)
- Encephalitis
- Laryngeal paralysis*
- Muscular dystrophy
- Myasthenia gravis

### Immune-mediated and infectious disease
- Asthma* (C)
- Bacterial encephalitis
- Fungal disease
  - Granuloma complex
- Idiopathic glossopharyngitis
- Laryngitis*
- Pharyngitis*
- Rabies
- Rhinitis*
- Sialadenitis
- Viral encephalitis

### Systemic disorders
- Hypocalcaemia
- Renal failure*

### Trauma
- Foreign body*
- Pharyngeal haematoma
Historical Signs

- Styloid apparatus trauma
- Tracheal rupture

**Neoplasia**
- Central nervous system
- Epiglottis
- Inner ear
- Nasal
- Pharyngeal
- Tonsillar

**Nutrition**
- Food texture and size

**Respiratory disease (expectoration), e.g.**
- Bronchitis
- Haemorrhage
- Pulmonary oedema

**Toxic**
- Botulism
- Ingestion of irritant chemical
- Smoke

**Reference**

### 1.2.3 Dysphagia

**Infectious/inflammatory disease**

**Oral disease**
- Dental disease
- Osteomyelitis of jaw
- Periodontitis
- Pharyngitis
- Rabies
- Retrobulbar abscess
- Severe gingivitis
- Tooth root abscess
- Ulceration, e.g.
  - Ingestion of irritant substance
  - Renal disease

**Obstruction**
- Foreign body
- Granuloma
Neoplasia
Sialocele

**Trauma**
Fracture*
Haematoma
Laceration*

**Temporomandibular joint disease**

**Neuromuscular disease**
Cricopharyngeal achalasia
Myasthenia gravis
Myopathy, e.g.
  • Masticatory myopathy
Trigeminal nerve disease, e.g.
  • Intracranial disease
  • Trigeminal neuritis

**References**

**1.2.4 Regurgitation**

**Salivary gland disease**
Sialadenitis

**Oesophageal disease**
Foreign body*
Megaoesophagus
  • Idiopathic
  • Acquired
Neoplasia
Oesophageal diverticulum
Oesophageal fistula
Oesophageal inclusion cysts
Oesophagitis*
Stricture
Vascular ring anomaly, e.g.
  • Persistent right aortic arch

**Gastric disease**
Gastric dilatation-volvulus* (D)
Hiatal hernia
Pyloric outflow obstruction, e.g.
  • Foreign body*
  • Neoplasia
  • Pyloric stenosis
Neuromuscular disease

Peripheral neuropathies, e.g.
- Giant cell axonal neuropathy (D)
- Lead poisoning
- Polyneuritis
- Polyradiculoneuritis

Central nervous system disease, e.g.
- Brainstem disease
- Infection
- Inflammation
- Intracranial space occupying lesion
- Trauma

Neuromuscular junctionopathies, e.g.
- Acetylcholinesterase toxicity
- Botulism
- Myasthenia gravis
- Tetanus

Immune-mediated disease
- Dermatomyositis (D)
- Polymyositis
- Systemic lupus erythematosus

Endocrine disease
- Hypoadrenocorticism (D)
- Hypothyroidism* (D)

References

1.2.5 Vomiting

ACUTE VOMITING

Dietary
- Dietary indiscretion*
- Dietary intolerance*
- Sudden change in diet*
Gastrointestinal disease
Colitis
Constipation/obstipation * q.v.
Foreign body *
Gastric dilatation/volvulus *
Gastric or duodenal ulceration *
Gastritis/enteritis *
Haemorrhagic gastroenteritis *
Infection, e.g.
  • Bacterial *
  • Parasites *
  • Viral *
Inflammatory bowel disease *
Intestinal volvulus
Intussusception
Neoplasia *

Endocrine disease, e.g.
Diabetic ketoacidosis *
Hypoadrenocorticism (D)

Metabolic/systemic disease
Hypercalcaemia/hypocalcaemia q.v.
Hyperkalaemia/hypokalaemia * q.v.
Hyperthermia * q.v.
Liver disease * q.v.
Pancreatitis *
Peritonitis *
Prostatitis *
Pyometra * (D)
Renal disease * q.v.
Septicaemia *
Urinary obstruction *
Vestibular disease *

Miscellaneous conditions
Central nervous system disease
Diaphragmatic hernia
Motion sickness
Psychogenic

Drugs/toxins
Acetazolamide
Adder bite
Allopurinol
Alpha-2 agonists
Aminophylline
Amphotericin B
Apomorphine
Aspirin
Atipamezole
Atropine
Batteries
Benzalkonium chloride
Bethanechol
Blue-green algae
Borax
Bromocriptine
Calcium edetate
Carbimazole
Carboplatin
Cardiac glycosides
Cephalexin
Chlorambucil
Chloramphenicol
Chlorphenamine
Clomipramine
Colchicine
Cotoneaster
Cyclophosphamide
Cyclosporin
Cytarabine
Daffodil
Dichlorophen
Diclofenac sodium
Dinoprost tromethamine
Dopamine
Doxorubicin
Doxycycline
Dieffenbachia
Ethylene glycol
Erythromycin
Glipizide
Glucocorticoids
Glyphosphate
Honeysuckle
Horse chestnut
Hydralazine
Ibuprofen
Indomethacin
Ipecacuanha
Iron/iron salts
Ivermectin
Ketoconazole
Laburnum
Lead
Levamisole
Lignocaine
Loperamide
Medetomidine
Melphalan
Metaldehyde
Methimazole
Metronidazole
Mexiletine
Misoprostol
Mistletoe
Mitotane
Naproxen
Nicotinamide
Nitroscanate
NPK fertilisers
NSAIDs
Paracetamol
Paraquat
Penicillamine
Pentoxifylline
Petroleum distillates
Phenoxy acid herbicides
Phenytoin
Pimobendan
Piperazine
Plastic explosives
Poinsettia
Potassium bromide
Procainamide
Propantheline bromide
Pyracantha

Fig. 1.2 Lateral abdominal radiograph of a dog showing a mineral-density foreign body. Exploratory coeliotomy revealed this to be a large stone within the small intestine. Reproduced with permission of Downs Referrals, Bristol.
Pyrethrin/pyrethroids
Pyridostigmine
Rhododendron
Rowan
Salt
Selective serotonin reuptake inhibitors
Sildenafil
Sotalol
Strychnine
Sulphasalazine
Terfenadine
Tetracycline
Theobromine
Theophylline
Tricyclic antidepressants
Trimethoprim/sulphonamide
Ursodeoxycholic acid
Vitamin D rodenticides
Xylazine
Yew
Zinc

CHRONIC VOMITING

Gastrointestinal disease
Bacterial overgrowth
Colitis*
Constipation/obstipation* q.v.
Enterogastric reflux
Gastric motility disorders*
Gastric or duodenal ulceration*
Gastritis/enteritis*
Infection, e.g.
  • Bacterial
  • Fungal
  • Parasites*
  • Viral
Inflammatory bowel disease
  • Eosinophilic
  • Lymphocytic
  • Lymphoplasmacytic
  • Mixed
Irritable bowel syndrome
Neoplasia*
Obstruction, e.g.
  • Foreign body*
  • Inflammatory bowel disease (gastritis or enteritis)
  • Intussusception*
  • Neoplasia*
  • Pyloric stenosis
**Endocrine disease, e.g.**
- Diabetes mellitus*
- Hyperthyroidism* (C)
- Hypoadrenocorticism (D)

**Metabolic/systemic disease**
- Heartworm disease
- Hypercalcaemia/hypocalcaemia *q.v.*
- Hyperkalaemia/hypokalaemia *q.v.*
- Liver disease* *q.v.*
- Pancreatitis*
- Prostatitis
- Pyometra* (D)
- Renal disease* *q.v.*

**Miscellaneous conditions**
- Abdominal neoplasia
- Diaphragmatic hernia
- Sialadenitis

**References**

### 1.2.6 Diarrhoea

**Small intestinal diarrhoea**

**Diet**

*Dietary intolerance, e.g.*
- Food hypersensitivity*
- Food intolerance
- Gluten-sensitive enteropathy

**Extra-gastrointestinal disease**
- Exocrine pancreatic insufficiency*
- Hepatic disease* *q.v.*
- Hyperthyroidism* (C)
- Hypoadrenocorticism (D)
- IgA deficiency
- Nephrotic syndrome
- Pancreatic duct obstruction
- Pancreatitis*
- Renal disease* *q.v.*
- Right-sided congestive heart failure*
Systemic lupus erythematosus
Uraemia

**Infection**

**Bacterial**, e.g.
- *Campylobacter* spp
- *Clostridium* spp
- *E. coli*
- *Salmonella* spp
- *Staphylococcus* spp
- Small intestinal bacterial overgrowth

**Fungal**

**Helminths**
- Hookworm
- Roundworm
- Tapeworm
- Whipworm

**Protozoal**, e.g.
- Cryptosporidiosis
- *Giardia* spp

**Viral**, e.g.
- Coronavirus
- Feline leukaemia virus (C)
- Parvovirus

**Rickettsial**

**Inflammatory/immune-mediated disease**
- Basenji enteropathy (D)
- Duodenal ulceration
- Haemorrhagic gastroenteritis*
- Inflammatory bowel disease*
  - Eosinophilic
  - Granulomatous
  - Lymphoplasmacytic
- Protein-losing enteropathy and nephropathy of the Soft-Coated Wheaten Terrier (D)

**Idiopathic disease**
- Lymphangiectasia

**Neoplasia**, e.g.
- Adenocarcinoma
- Carcinoid tumours
- Leiomyoma
- Lymphoma
Mast cell tumours
Sarcoma

Partial obstruction*
Foreign body
Intussusception
Neoplasia
Stricture

Motility disorders, e.g.
Dysautonomia
Enteritis
Functional obstruction (ileus)
Hypoalbuminaemia
Hypokalaemia

Drugs/toxins (see Large intestinal diarrhoea, below)

LARGE INTESTINAL DIARRHOEA

Diet*
Dietary hypersensitivity
Dietary indiscretion

Extra-intestinal conditions
Metastatic neoplasia
Neurological disease leading to ulcerative colitis
Pancreatitis
Toxaemia
Uraemia

Infection
Bacterial*, e.g.
Campylobacter spp
Clostridium difficile
Clostridium perfringens
E. coli
Salmonella spp
Yersinia enterocolitica

Viral*
Coronavirus
Feline immunodeficiency virus (C)
Feline infectious peritonitis (C)
Feline leukaemia virus (C)
Parvovirus

Fungal, e.g.
Histoplasmosis
Protothecosis
Parasitic*, e.g.
- Amoebiasis
- *Ancylostoma* spp
- *Balantidium coli*
- Cryptosporidiosis
- *Giardia* spp
- *Heterobilharzia americana*
- Roundworm
- Tapeworm
- *Tritrichomonas foetus* (C)
- *Uncinaria* spp
- Whipworm

Protozoal, e.g.
- Toxoplasmosis

Immune-mediated/inflammatory disease
- Histiocytic ulcerative colitis of Boxers (D)
- Inflammatory bowel disease*

Idiopathic conditions
- Fibre-responsive large-bowel diarrhoea
- Irritable bowel syndrome

Neoplasia*

Benign, e.g.
- Adenomatous polyps
- Leiomyoma

Malignant, e.g.
- Adenocarcinoma
- Lymphoma

Obstruction (see Plate 1.2(a) in colour plate section)
- Caecal inversion
- Foreign body*
- Intussusception*
- Neoplasia
- Stricture

Miscellaneous
- Secondary to chronic small intestinal disease
- Stress

Drugs/toxins
- Acetazolamide
- Adder bite
- Allopurinol
Aminophylline
Amoxicillin
Amphotericin B
Ampicillin
Atenolol
Benzalkonium chloride
Bethanechol
Blue-green algae
Borax
Calcium edetate
Carbamate insecticides
Cardiac glycosides
Cephalexin
Chloramphenicol
Chlorphenamine
Colchicine
Cotoneaster
Cyclophosphamide
Cyclosporin
Cytarabine
Daffodil
Diazoxide
Diclofenac sodium
Dieffenbachia
Doxycycline
Glyphosphate
Honeysuckle
Horse chestnut
Ibuprofen
Indomethacin
Iron/iron salts
Laburnum
Lactulose
Levamisole
Lithium
Loperamide
Mebendazole
Metaldehyde
Methiocarb
Misoprostol
Mistletoe
Mitotane
Naproxen
Nicotinamide
NPK fertilisers
NSAIDs
Organophosphates
Oxytetracycline
Pamidronate
Pancreatic enzyme supplementation
Paracetamol
Paraquat
Pentoxifylline
Petroleum distillates
Phenoxy acid herbicides
Piperazine
Poinsettia
Procainamide
Pyracantha
Pyrethrin/pyrethroids
Pyridostigmine
Quinidine
Rhododendron
Rowan
Salt
Selective serotonin reuptake inhibitors
Sotalol
Theobromine
Theophylline
Vitamin D rodenticides
Yew
Zinc sulphate

Note: Perirectal diseases, e.g. anal sac disease, anal furunculosis, perineal hernia, rectal prolapse, perianal adenoma, may cause signs mimicking large-bowel disease (tenesmus, haematochezia, mucoid stool).

References

1.2.7 Melaena

Ingestion of blood

Nasal disease (see also epistaxis), e.g.
Coagulopathy* q.v.
Neoplasia*
Trauma*
Oropharyngeal haemorrhage
  Coagulopathy* q.v.
  Neoplasia*
  Trauma*

Respiratory disease (see also haemoptysis), e.g.
  Coagulopathy* q.v.
  Exercise-induced pulmonary haemorrhage
  Parasites
  Neoplasia*
  Ruptured aneurysm
  Trauma*

Gastrointestinal disease
  Enteritis*
  Gastritis*
  Oesophagitis
  Parasites*

Gastrointestinal ulceration*
  Gastrinoma
  Helicobacter infection
  Inflammatory gastroenteric disease*
  Neurological disease
  Post foreign body*
  Stress
  Uraemia* q.v.
  Drugs, e.g.
    • Glucocorticoids*
    • NSAIDs*

Ischaemia, e.g.
  Mesenteric avulsion
  Mesenteric thrombosis/infarction
  Mesenteric volvulus
  Post gastric-dilatation volvulus* (D)

Neoplasia*, e.g.
  Adenocarcinoma
  Leiomyoma
  Leiomyosarcoma
  Lymphoma

Extra-gastrointestinal disease
  Hypoadrenocorticism (D)
  Liver disease* q.v.
  Mastocytosis
  Pancreatitis*
  Septicaemia*
  Shock* q.v.
Systemic hypertension* q.v.
Uraemia* q.v.
Vasculitis, e.g.
  • Rocky Mountain Spotted Fever

Coagulopathy q.v., e.g.
  Anticoagulant toxicity* q.v.
  Congenital clotting factor deficiency q.v.
  Disseminated intravascular coagulation
  Thrombocytopenia q.v.
  von Willebrand’s disease (D)

References

1.2.8 Haematemesis

Ingestion of blood
Nasal disease (see also epistaxis), e.g.
  Coagulopathy* q.v.
  Neoplasia*
  Trauma*

Oropharyngeal haemorrhage
  Coagulopathy* q.v.
  Neoplasia*
  Trauma*

Respiratory disease (see also haemoptysis), e.g.
  Coagulopathy* q.v.
  Exercise-induced pulmonary haemorrhage
  Parasites
  Neoplasia*
  Ruptured aneurysm
  Trauma*

Gastrointestinal disease
  Gastritis*
  Haemorrhagic gastroenteritis
  Oesophagitis

Gastrointestinal ulceration*
  Gastrinoma
  Helicobacter infection*
Inflammatory gastroenteric disease
Neurological disease
Post foreign body
Stress
Systemic mastocytosis
Uraemia
Drugs, e.g.
  • NSAIDs
  • Glucocorticoids

Ischaemia, e.g.
Post gastric-dilatation/volvulus (D)
Neoplasia, e.g.
  • Adenocarcinoma
  • Lymphoma

Extra-gastrointestinal disease
Hypoadrenocorticism (D)
Liver disease q.v.
Mastocytosis
Septicaemia
Shock
Systemic hypertension q.v.
Uraemia q.v.

Coagulopathies q.v., e.g.
Anticoagulant toxicity
Congenital clotting factor deficiency
Disseminated intravascular coagulation
Thrombocytopenia
von Willebrand's disease (D)

Pancreatic disease, e.g.
Pancreatitis

Vasculitis, e.g.
Rocky Mountain Spotted Fever

Toxins, e.g.
Calcipotriol
Paraquat

Reference

1.2.9 Haematochezia

Extra-gastrointestinal disease
Neurological disease leading to ulcerative colitis
Coagulopathies q.v., e.g.
  Anticoagulant toxicity*
  Congenital clotting factor deficiency q.v.
  Disseminated intravascular coagulation
  Thrombocytopenia q.v.
  von Willebrand’s disease (D)

Perirectal disease, e.g.
  Anal furunculosis*
  Anal sac disease*
  Perianal adenoma*
  Perineal hernia*
  Rectal prolapse*

Gastrointestinal disease

Dietary
  Dietary hypersensitivity
  Dietary indiscretion

Bacterial*, e.g.
  Campylobacter spp
  Clostridium spp
  E. coli
  Salmonella spp

Viral*
  Coronavirus
  Feline immunodeficiency virus (C)
  Feline infectious peritonitis (C)
  Feline leukaemia virus (C)
  Parvovirus

Fungal, e.g.
  Histoplasmosis
  Protothecosis

Parasitic*, e.g.
  Amoebiasis
  Ancylostoma spp
  Balantidium coli
  Cryptosporidiosis
  Giardia spp
  Heterobilharzia americana
  Roundworm
  Tapeworm
  Tritrichomonas foetus (C)
  Uncinaria spp
  Whipworm
Protozoal, e.g.
Toxoplasmosis

**Immune-mediated/inflammatory disease**
Histiocytic ulcerative colitis of Boxers (D)
Inflammatory bowel disease*

**Idiopathic conditions**
Fibre-responsive large-bowel diarrhoea
Haemorrhagic gastroenteritis
Irritable bowel syndrome

**Neoplasia**

*Benign, e.g.*
Adenomatous polyps
Leiomyoma

*Malignant, e.g.*
Adenocarcinoma
Lymphoma

**Obstructive disease**
Foreign body*
Intussusception*

**Drugs**
Glucocorticoids

**References**

1.2.10 Constipation/obstipation

**Congenital conditions**
Atresia ani
Atresia coli

**Diet**
Ingestion of hair, bones and foreign material
Low-fibre diets

**Systemic disease**
Dehydration*
Hypercalcaemia *q.v.*
Hypokalaemia* *q.v.*
Hypothyroidism* (D)
**Neuromuscular disease**
- Feline dysautonomia (C)
- Lumbosacral disease*
- Pelvic nerve disease, e.g.
  - Traumatic*

**Obstructive disease** (see Plate 1.2(b) in colour plate section)

*Intraluminal/intramural*
- Diverticulum
- Foreign body*
- Neoplasia*, e.g.
  - Adenoma
  - Leiomyoma
  - Leiomyosarcoma
  - Lymphoma
- Stricture

*Extraluminal*
- Granuloma
- Neoplasia*
- Pelvic fracture*
- Perineal hernia*
- Prostatic disease (D)
  - Abscess
  - Benign prostatic hypertrophy*
  - Neoplasia
  - Prostatitis*
- Sublumbar lymph node disease

**Prolonged colonic distension, e.g.**
- Narrowing of pelvic canal post fracture*

**Painful conditions**
- Anal furunculosis*
- Anal or rectal inflammation*
- Anal or rectal mass*
- Anal or rectal stricture
- Anal sac disease*, e.g.
  - Abscess
  - Anal sacculitis
- Pelvic trauma (soft tissue or bony)*
- Spinal cord disease*

**Behavioural factors*, e.g.**
- Change of daily routine
- Dirty litter box
- Hospitalisation
- Novel litter substrate
Idiopathic conditions
Idiopathic megacolon*

Drugs/toxins
Aluminium antacids
Butylscopolamine (hyoscine)
Diphenoxylate
Diuretics
Loperamide
Opioids
Propantheline bromide
Sucralfate
Verapamil
Vincristine

References

1.2.11 Faecal tenesmus/dyschezia

Anal sac disease, e.g.
Abscess
Anal sacculitis*
Neoplasia

Constipation/obstipation q.v.

Diet
Excess bone
Excess fibre

Perianal disease, e.g.
Anal furunculosis/perianal fistulas* (D)
Perianal adenoma*
Perineal hernia*
Rectal prolapse*

Caudal abdominal mass*

Pelvic narrowing

Prostatic disease (D)
Abscess
Benign prostatic hypertrophy*
Neoplasia
Prostatitis*
Trauma, e.g.
Pelvic fracture*

Urogenital disease*, e.g.
Lower urinary tract disease
Urethral obstruction

Colorectal disease, e.g.
Colitis q.v.
Congenital disease
Large intestinal neoplasia

References

1.2.12 Faecal incontinence

Anal sphincter incompetence
Myopathy
Neoplasia*
Trauma*

Neurological, e.g.
Cauda equina syndrome
Degenerative myelopathy/CDRM* (D)
Distemper encephalomyelitis
Dysautonomia
Lumbosacral stenosis
Myelodysplasia/spinal dysraphism
Peripheral neuropathy
Sacrocaudal dysgenesis
Spinal arachnoid cysts
Spinal trauma

Perianal disease, e.g.
Perianal fistula*

Iatrogenic disease, e.g.
Damage to anal sphincter during anal sacculectomy

Reservoir incontinence
Behavioural
CNS disease q.v.
Colitis*
Diet*
Neoplasia*
References

### 1.2.13 Flatulence/borborygmus

**Aerophagia**
Competitive/aggressive eating
Nervous animal

**Diet**
High fibre diets
Milk products/lactase deficiency
Spoiled food

**Maldigestion, e.g.**
Exocrine pancreatic insufficiency

**Malabsorption, e.g.**
Inflammatory bowel disease

**Drugs/toxins, e.g.**
Lactulose
Metaldehyde

References

### 1.3 Cardiorespiratory historical signs

#### 1.3.1 Coughing

**Infection**

*Bacterial, e.g.*
Bordetellosis*

*Fungal, e.g.*
Coccidioidomycosis

*Viral, e.g.*
Canine distemper*
References

1.2.13 Flatulence/borborygmus

**Aerophagia**
- Competitive/aggressive eating
- Nervous animal

**Diet**
- High fibre diets
- Milk products/lactase deficiency
- Spoiled food

**Malabsorption, e.g.**
- Exocrine pancreatic insufficiency

**Malabsorption, e.g.**
- Inflammatory bowel disease

**Drugs/toxins, e.g.**
- Lactulose
- Metaldehyde

References

1.3 Cardiorespiratory historical signs

1.3.1 Coughing

**Infection**

*Bacterial, e.g.*
- Bordetellosis*

*Fungal, e.g.*
- Coccidioidomycosis

*Viral, e.g.*
- Canine distemper*
Parasitic
  *Aelurostrongylus abstrusus* (C)
  *Angiostrongylus vasorum* (D)
  *Dirofilaria immitis*
  *Oslerus osleri* (D)
  Paragonimiasis

Immune-mediated/inflammatory disease
  Asthma* (C)
  Chronic bronchitis* (D)

Miscellaneous conditions
  Aspiration pneumonia
  Idiopathic pulmonary fibrosis
  Inhaled foreign body
  Laryngeal paralysis
  Left atrial enlargement*
  Lung lobe hernia
  Primary ciliary dyskinesia

Neoplasia
  Adenocarcinoma
  Alveolar carcinoma
  Bronchial gland carcinoma
  Metastatic disease
  Squamous cell carcinoma

Pulmonary haemorrhage
  Coagulopathy *q.v.*
  Exercise-induced
  Neoplasia*
  Traumatic

Pulmonary oedema
  Airway obstruction
  Cardiogenic*
  Electrocution
  Hypoglycaemia
  Hypoproteinaemia *q.v.*
  Iatrogenic
  Ketamine
  Neurological
    • Cranial trauma
    • Seizures
  Obstruction of lymphatic drainage
  Primary alveolar–capillary membrane injury
  Re-expansion

Drugs/toxins/irritants
  Benzalkonium chloride ingestion
Chemical fume inhalation
Potassium bromide (C)
Smoke inhalation

References

1.3.2 Dyspnoea/tachypnoea

See Section 2.3.1
1.3.3 Sneezing and nasal discharge

**Infection**

**Viral**
- Canine distemper virus* (D)
- Canine infectious tracheobronchitis* (D)
- Feline calicivirus* (C)
- Feline herpes virus* (C)
- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)
- Feline pox virus
- Feline reovirus (C)

**Fungal**
- Aspergillosis
- Cryptococcosis
- Exophiala jeanselmei
- *Penicillium* spp
- Phaeohyphomycosis
- Rhinosporidium seeberi

**Parasitic**
- *Cuterebra* spp
- *Eucoleus bœhmi*
- Linguatula serrata
- Pneumonyssoides caninum

**Bacterial/mycoplasmal**
- *Bordetella bronchiseptica* *
- *Chlamydophila* spp *
- Coliforms
- *Mycoplasma* spp
- *Pasteurella* spp
- *Staphylococcus* spp
- *Streptococcus* spp

**Inflammatory disease**
- Allergic rhinitis*
- Granulomatous rhinitis
- Lymphoplasmacytic rhinitis*
- Nasopharyngeal polyp* (C)

**Physical**
- Foreign body*
- Irritant gases
- Trauma

**Neoplasia**
- Adenocarcinoma*
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Lymphoma*
Mast cell tumour
Melanoma
Neuroblastoma
Osteosarcoma
Squamous cell carcinoma*
Transmissible venereal tumour
Undifferentiated carcinomas*

**Dental disease**
Tooth root abscess*

**Anatomical deformities**
Acquired nasopharyngeal stenosis
Cleft palate
Oronasal fistula

**Congenital disease**
Ciliary dyskinesia

**Systemic disease (see also epistaxis)**
Coagulopathy *q.v.*
Hypertension *q.v.*
Hyperviscosity syndrome
Vasculitis
  - Ehrlichiosis
  - Rocky Mountain Spotted Fever

**References**

1.3.4 **Epistaxis**

**Nasal disease**

*Physical*
Trauma*

*Neoplasia*
Adenocarcinoma*
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Lymphoma*
Mast cell tumour
Melanoma
Osteosarcoma
Squamous cell carcinoma*
Transmissible venereal tumour
Undifferentiated carcinomas*

Infection
Viral
• Canine distemper virus* (D)
• Canine infectious tracheobronchitis* (D)
• Feline calicivirus* (C)
• Feline herpes virus* (C)
• Feline immunodeficiency virus* (C)
• Feline leukaemia virus* (C)
Fungal
• Aspergillosis
• Cryptococcus spp
• Exophiala jeanselmei
• Penicillium spp
• Phaeohyphomycosis
• Rhinosporidium seeberi
Parasitic
• Cuterebra
• Eucoleus böehmi
• Linguatula serrata
• Pneumonyssoides caninum
Bacterial/mycoplasmal
• Mycoplasma spp*
• Pasteurella spp*

Inflammatory disease
Allergic rhinitis*
Lymphoplasmacytic rhinitis*

Dental disease
Oronasal fistula
Tooth root abscess*

Coagulopathies q.v.
Coagulation factor deficiency q.v.
Platelet disease
• Thrombocytopenia q.v.
• Thrombocytopenia q.v.

Miscellaneous conditions
Hyperlipidaemia
Hypertension \textit{q.v.}
Hyperviscosity syndrome
Increased capillary fragility
Thromboembolism

\textbf{References}

\section*{1.3.5 Haemoptysis}

\textbf{Pulmonary disease}
Pulmonary hypertension
Pulmonary thromboembolism

\textit{Infection}
Parasitic
\begin{itemize}
  \item \textit{Aelurostrongylus abstrusus} (C)
  \item \textit{Angiostrongylus} (D)
  \item \textit{Capillaria aerophila}
  \item \textit{Dirofilaria immitis}
  \item \textit{Paragonimus kellicotti}
\end{itemize}
Fungal
\begin{itemize}
  \item Blastomycosis
  \item Coccidioidomycosis
  \item Histoplasmosis
\end{itemize}
Viral
\begin{itemize}
  \item Infectious tracheobronchitis*
\end{itemize}
Bacterial
\begin{itemize}
  \item Nocardiosis
  \item Pneumonia*
  \item Pulmonary abscessation
\end{itemize}

\textit{Inflammatory}
Bronchiectasis
Chronic bronchitis* (D)
Pulmonary infiltrate with eosinophils

\textit{Neoplastic}
Adenocarcinoma
Chondrosarcoma
Metastatic tumours*
Squamous cell carcinoma
Physical
Bronchial gland carcinoma
Foreign body
Lung lobe torsion
Trauma

Cardiovascular disease
Arteriovenous fistula
Bacterial endocarditis
Dirofilaria immitis
Pulmonary oedema* q.v.

Systemic disease
Coagulation factor deficiency q.v.
Thrombocytopathia q.v.
Thrombocytopenia q.v.

Iatrogenic
Diagnostic procedures, e.g.
• Bronchoalveolar lavage
• Bronchoscopy
• Lung aspirate
• Trans-tracheal wash
Endotracheal intubation*

References

1.3.6 Exercise intolerance

Cardiovascular disease, e.g.
Arrhythmias
Congestive heart failure*
Cyanotic heart disease q.v.
Myocardial dysfunction
Obstruction to ventricular outflow

Respiratory disease q.v., e.g.
Idiopathic pulmonary fibrosis
Pleural effusion*
Pulmonary oedema*
Upper airway obstruction q.v.

Metabolic/endocrine disease, e.g.
Anaemia*
Hyperthyroidism* (C)
Hypoadrenocorticism (D)
Hypoglycaemia *q.v.*
Hypokalaemic polymyopathy
Hypothyroidism* (D)
Malignant hyperthermia

**Neuromuscular/musculoskeletal disease, e.g.**
Botulism
Cervical myelopathy (D)
Coonhound paralysis
Ischaemic neuromyopathy* (C)
Intermittent claudication
Lumbosacral pain
Myasthenia gravis
Myopathies
- Congenital
- Hypokalaemic
- Toxic
Peripheral neuropathy *q.v.*
Polyarthritis
Polymyositis
Protozoal myositis
Tick paralysis

**Drugs, e.g.**
Drugs causing hypotension

**References**

**1.4 Dermatological historical signs**

**1.4.1 Pruritus**

**Infection**

*Bacterial*
- Deep pyoderma*
- Surface pyoderma/wet eczema*
- Superficial bacterial folliculitis*

*Fungal*
- Candidiasis
- Dermatophytosis*
Historical Signs

Hyperthyroidism* (C)
Hypoadrenocorticism (D)
Hypoglycaemia *q.v.*
Hypokalaemic polymyopathy
Hypothyroidism* (D)
Malignant hyperthermia

**Neuromuscular/musculoskeletal disease, e.g.**
Botulism
Cervical myelopathy (D)
Coonhound paralysis
Ischaemic neuromyopathy* (C)
Intermittent claudication
Lumbosacral pain
Myasthenia gravis
Myopathies
  • Congenital
  • Hypokalaemic
  • Toxic
Peripheral neuromyopathy *q.v.*
Polyarthritis
Polymyositis
Protozoal myositis
Tick paralysis

**Drugs, e.g.**
Drugs causing hypotension

**References**

**1.4 Dermatological historical signs**

**1.4.1 Pruritus**

**Infection**

*Bacterial*
  • Deep pyoderma*
  • Surface pyoderma/wet eczema*
  • Superficial bacterial folliculitis*

*Fungal*
  • Candidiasis
  • Dermatophytosis*
Malassezia dermatitis*
Pythiosis

Parasitic
Cheyletiellosis
Demodicosis*
Dermanyssus gallinae
Dirofilariasis
Dracunculiasis
Fleas*
Hookworm dermatitis
Lynxacarus radovsky (C)
Notoedres cati (C)
Otobius megnini (D)
Otodectes cyanotis
Pediculosis
Pelodera dermatitis
Pneumonyssoides caninum (D)
Sarcoptic mange* (D)
Schistosomiasis
Trombiculiasis*

Immune-mediated disease
Drug eruptions
Discoid lupus erythematosus
Systemic lupus erythematosus

Allergy/hypersensitivity
Atopy*
Contact allergy*
Food hypersensitivity*
Hormonal hypersensitivity* (D)
Parasite hypersensitivity*, e.g.
  • Fleas
  • Mosquitoes

Pemphigus complex
Pemphigus erythematosus
Pemphigus foliaceus
Pemphigus vegetans
Pemphigus vulgaris
Bullous pemphigoid

Keratinisation disorders
Acne*
Idiopathic facial dermatitis
Primary seborrhoea
Vitamin A responsive dermatitis
Endocrine disorders
Calciossisis cutis*
Hyperthyroidism* (C)
Predisposing to pyoderma
- Hyperadrenocorticism
- Hypothyroidism* (D)

Environmental
Contact irritant dermatitis*
Sunburn/solar dermatitis*

Neoplasia
Cutaneous T cell lymphoma
Mast cell tumour*
Mycosis fungoides
Other neoplasia with secondary pyoderma
Paraneoplastic pruritus

Neurological, e.g.
Syringohydromyelia

Miscellaneous
Feline hypereosinophilic syndrome (C)
Idiopathic sterile granulomatous dermatitis
Sterile eosinophilic pustulosis
Subcorneal pustular dermatosis
Urticaria pigmentosa
Waterline disease of black Labradors (D)
Zinc responsive dermatosis

Drugs/toxins
Methimazole
Paracetamol

References
1.5 Neurological historical signs

1.5.1 Seizures

INTRACRANIAL

Idiopathic*

Congenital
Ceroid lipofuscinosis
Chiari-like malformation
Cortical dysplasia
Hydrocephalus
Intracranial arachnoid cysts
Lissencephaly
Lysosomal storage diseases
Organic acidurias, e.g.
• L-2-hydroxyglutaric aciduria

Infectious

Bacterial, e.g.
Nocardiosis
Pasteurella spp
Staphylococcus spp

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Mucormycosis

Parasitic
Aberrant migration of Cuterebra spp
Dirofilariasis

Protozoal, e.g.
Neosporosis (D)
Toxoplasmosis

Rickettsial encephalitis
Ehrlichiosis/anaplasmosis
Rocky Mountain Spotted Fever

Viral
Canine distemper* (D)
Canine herpes virus (D)
Eastern equine encephalitis
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Pseudorabies
Rabies

**Inflammatory/immune-mediated disease**
Breed-specific necrotising meningoencephalitis
Distemper-vaccine-associated (D)
Eosinophilic meningoencephalitis
Granulomatous meningoencephalomyelitis* (D)
Steroid-responsive meningoencephalitis

**Physical**
Trauma

**Neoplasia**

*Primary intracranial*
Astrocytoma
Choroid plexus tumours
Ependymoma
Ganglioblastoma
Glioma
Medulloblastoma
Meningioma
Neuroblastoma
Oligodendroglioma

*Local extension*
Middle-ear tumour
Nasal/paranasal sinus tumour
Pituitary tumour
Skull tumour

*Metastatic, e.g.*
Haemangiosarcoma
Lymphoma
Malignant melanoma
Mammary carcinoma
Prostatic carcinoma
Pulmonary carcinoma
Teratoma

**Vascular**

*Haemorrhage, e.g.*
Coagulopathy *q.v.*
Feline ischaemic encephalopathy (C)
Hypertension *q.v.*

Trauma

Infarction, e.g.

Thromboembolism

**EXTRACRANIAL**

**Metabolic**

Electrolyte imbalances*, e.g.

- Hypernatraemia *q.v.*
- Hypocalcaemia *q.v.*
- Hyponatraemia *q.v.*

Hepatic encephalopathy* *q.v.*

Hypoglycaemia *q.v.*

Renal failure* *q.v.*

**Nutritional**

Thiamine deficiency

**Drugs/toxins**

Alphachloralose

Arsenic

Baclofen

Blue-green algae

Borax

**Fig. 1.5(a)** Transverse T2 weighted MR scan of the brain of a Boxer with a suspected glioma (arrow). Reproduced with permission of Downs Referrals, Bristol.
Cannabis
Carbamate
Doxapram
Ethylene glycol
Glyphosate
Honeysuckle
Hymenoptera stings
Ibuprofen
Iodine-containing myelographic contrast media
Laburnum
Lead
Lignocaine
Metaldehyde
Metronidazole
Mexiletine
Mistletoe
Organophosphates
Paracetamol
Petroleum distillates
Phenoxy acid herbicides
Piperazine
Plastic explosives
Pyrethrin/pyrethroids
Risperidone
Salt
Selective serotonin reuptake inhibitors
Strychnine
Terfenadine
Theobromine
Theophylline
Tricyclic antidepressants
Vitamin D rodenticides
Yew

References

### 1.5.2 Trembling/shivering

**Physiological**
- Ballistocardiographic*
- Fatigue/weakness*
- Fear*
- Reduced environmental temperature*

**Neurological**
- Abiotrophies
- Cerebellar disease *q.v.*
- Central nervous system inflammatory disease
- Cerebrospinal hypomyelinogenesis and dysmyelinogenesis
- Corticosteroid responsive tremor syndrome (‘white dog shaker disease’)
- Idiopathic head nod of Dobermanns and bulldogs
- Lumbosacral disease, e.g.
  - Disc herniation
  - Discospondylitis
  - Neoplasia
  - Stenosis
- Lysosomal storage disease
- Neuroaxonal dystrophy (D)
- Nerve root compression
- Niemann-Pick disease (C)
- Peripheral neuropathies *q.v.*
- Primary orthostatic tremor
- Senility
- Spongiform encephalopathy

**Metabolic**
- Hepatic encephalopathy *q.v.*
- Hyperadrenocorticism/hypoadrenocorticism (D)
- Hyperkalaemia *q.v.*
- Hypocalcaemia *q.v.*
- Hypoglycaemia *q.v.*
- Primary hyperparathyroidism
- Uraemia *q.v.*
**Drugs/toxins**
- 5-fluorouracil
- Baclofen
- Benzodiazepines
- Blue-green algae
- Bromethalin
- Caffeine
- Carbamate
- Guarana
- Hexachlorophene
- Horse chestnut
- Ivermectin
- Macadamia nuts
- Metaldehyde
- Mexiletine
- Mycotoxins
- Risperidone
- Organochlorines
- Organophosphates
- Petroleum distillates
- Plastic explosives
- Piperazine
- Pyrethrin/pyrethroids
- Rhododendron
- Salbutamol
- Salt
- Strychnine
- Terbutaline
- Theobromine
- Theophylline
- Tricyclic antidepressants
- Yew
- Zinc phosphate

**References**


1.5.3 Ataxia/conscious proprioceptive deficits

FOREBRAIN

Degenerative
- Leukodystrophy
- Lysosomal storage disease
- Mitochondrial encephalopathy
- Multi-system neuronal degeneration
- Spongy degeneration

Congenital
- Dandy-Walker syndrome
- Hydrocephalus
- Intra-arachnoid cyst

Metabolic
- Electrolyte/acid–base disorders q.v.*
- Hepatic encephalopathy q.v.*
- Hypoglycaemia q.v.
- Uraemic encephalopathy q.v.*

Neoplasia
- Choroid plexus tumours
- Dermoid cyst
- Ependymoma
- Epidermoid cyst
- Glioma
- Lymphoma
- Medulloblastoma
- Meningioma
- Metastatic tumour

Immune-mediated disease/infection
- Encephalitis q.v.
- Feline spongiform encephalopathy

Vascular
- Cerebrovascular accident

BRAINSTEM/CENTRAL VESTIBULAR DISORDERS

Degenerative
- Lysosomal storage disorders

Congenital
- Chiari-like malformation
- Hydrocephalus
- Intra-arachnoid cysts
Metabolic
Electrolyte abnormalities* q.v.
Hepatic encephalopathy* q.v.
Uraemic encephalopathy* q.v.

Neoplastic
Choroid plexus tumours
Dermoid cyst
Epidermoid cyst
Glioma
Lymphoma
Medulloblastoma
Meningioma
Metastatic tumour

Nutritional
Thiamine deficiency

Immune-mediated/infectious
Feline spongiform encephalopathy (C)
Meningoencephalitis q.v.

Trauma

Vascular
Cerebrovascular accident

Drugs
Metronidazole

Fig. 1.5(b) Transverse T1 weighted MR scan of a dog showing a cystic tumour in the brain stem (arrow). The contralateral tympanic bulla is filled with a high signal material which in this case was an incidental finding. Reproduced with permission of Downs Referrals, Bristol.
CEREBELLUM (generally ataxia without conscious proprioceptive deficits)

**Degenerative**
- Cerebellar cortical degeneration
- Gangliosidosis
- Hereditary ataxia of Jack Russell and Smooth-coated Fox Terriers (D)
- Leukoencephalomalacia (D)
- Neuroaxonal dystrophy (D)
- Neuronal vacuolation and spinocerebellar degeneration (D)
- Storage diseases

**Congenital**
- Feline cerebellar hypoplasia (C)

**Metabolic**
- Thiamine deficiency

**Neoplastic**
- Choroid plexus tumours
- Dermoid cyst
- Epidermoid cyst
- Glioma
- Lymphoma
- Medulloblastoma
- Meningioma
- Metastatic tumour

**Immune-mediated/infectious q.v.**
- *In utero* infection with feline parvovirus (C)

**Vascular**
- Cerebrovascular accident *q.v.*

**Drugs/toxins**
- Heavy metals
- Organophosphates

**PERIPHERAL VESTIBULAR DISEASE**

**Congenital**
- Congenital vestibular disease, e.g.
  - Lymphocytic labyrinthitis
  - Non-inflammatory cochlear degeneration

**Metabolic**
- Hypothyroidism* (D)
**Neoplastic**

*Middle- or inner-ear tumours, e.g.*
- Adenocarcinoma
- Chondrosarcoma
- Fibrosarcoma
- Lymphoma
- Osteosarcoma
- Squamous cell carcinoma

**Immune-mediated/infectious**

- Nasopharyngeal polyps*
- Otitis media/interna*
  - Primary secretory otitis media in the Cavalier King Charles Spaniel
  - Secondary to otitis externa

**Idiopathic**

- Canine geriatric vestibular disease
- Feline idiopathic vestibular disease

**Traumatic**

**Drugs/toxins**

- Aminoglycosides
- Chlorhexidine
- Topical iodophores

---

**Fig. 1.5(c)** Sagittal T2 weighted MR scan of the head of a dog showing high signal material in the tympanic bulla due to otitis media (arrow). Reproduced with permission of Downs Referrals, Bristol.
SPINE

**Degenerative**
- Cervical fibrotic stenosis
- Cervical spondylomyelopathy
- Degenerative disc disease* (D)
- Degenerative myelopathy*
- Leukoencephalomalacia
- Lumbosacral disease
- Lysosomal storage disease
- Neuroaxonal dystrophy
- Neuronal vacuolation and spinocerebellar degeneration (D)
- Other leukodystrophies
- Synovial cysts

**Congenital**
- Atlanto-occipital dysplasia
- Atlantoaxial subluxation
- Cartilaginous exostoses
- Dermoid sinus
- Epidermoid cyst
- Hereditary myelopathy
- Meningoceles
- Sacral osteochondritis dissecans
- Sacrocaudal dysgenesis
- Spina bifida
- Spinal arachnoid cyst
- Spinal dysraphism
- Syringohydromyelia (D)
- Tethered cord syndrome
- Vertebral malformations *q.v.*

**Immune-mediated**
- Cauda equina neuritis
- Granulomatous meningoencephalomyelitis*
- Steroid-responsive meningitis-arteritis

**Infectious**
- Discospondylitis
- Foreign body
- Meningomyelitis
- Spinal epidural empyema

**Idiopathic**
- Calcinosis circumscripta
- Disseminated idiopathic skeletal hyperostosis

**Neoplastic**

*Extradural*
- Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Lipoma
Lymphoma
Malignant nerve sheath tumour
Meningioma
Metastatic disease
Myeloma
Osteosarcoma

**Intradural extramedullary**
Malignant nerve-sheath tumour
Meningioma
Metastatic

**Intramedullary**
Astrocytoma
Ependymoma
Metastatic tumour
Oligodendroglioma

**Nutritional**
Hypervitaminosis A
Thiamine deficiency

---

**Fig. 1.5(d)** Sagittal T1 weighted MR scan of the cervical spine of a dog showing a spinal meningioma (arrow). Reproduced with permission of Downs Referrals, Bristol.
**Traumatic**
- Brachial plexus avulsion
- Dural tear
- Fracture*
- Gunshot wound
- Luxation*
- Sacrocaudal injury
- Traumatic disc injury*

**Vascular**
- Fibrocartilaginous embolism*
- Fat graft necrosis
- Myelomalacia
- Spinal cord haematoma
- Spinal cord haemorrhage
- Vascular anomaly

**PERIPHERAL NERVES** (mono- or polyneuropathies)

**Degenerative**
- Birman cat distal polyneuropathy (C)
- Boxer dog progressive axonopathy (D)
- Giant axonal neuropathy of German Shepherds (D)
- Globoid cell leukodystrophy
- Golden Retriever hypomyelinating polyneuropathy (D)
- Hereditary/idiopathic polyneuropathy of Alaskan Malamutes (D)
- Hypertrophic neuropathy
- Hypomyelinating polyneuropathy
- Laryngeal paralysis–polyneuropathy complex
- Lysosomal storage diseases
  - Fucosidosis (D)
  - Globoid cell leukodystrophy
  - Glycogen storage disease type IV
  - Niemann-Pick disease (C)
- Mucopolysaccharidosis IIIA (D)
- Sensory neuropathy (D)

**Immune-mediated/infectious**
- Chronic inflammatory demyelinating polyneuropathy
- Feline leukaemia virus associated
- Polyradiculoneuritis
- Protozoal
- Sensory ganglioradiculoneuritis

**Neoplastic**
- Lymphoma
- Malignant nerve-sheath tumours
- Myelomonocytic neoplasia
- Paraneoplastic neuropathy
**Traumatic**
- Bite wounds*
- Iatrogenic
- Missile injuries
- Traction injuries

**Vascular**
- Ischaemic neuromyopathy*
- Neurogenic claudication

**SYSTEMIC**

**Metabolic**
- Electrolyte/acid–base disorders*
- Endocrine disease, e.g.
  - Diabetes mellitus*
  - Hypothyroidism* (D)
- Hepatic encephalopathy*
- Hyperadrenocorticoid neuropathy
- Hyperchylomicronaemia
- Insulinoma/hypoglycaemia

**Nutritional**
- Vitamin B₆ (pyridoxine) overdose

**Drugs/toxins**
- Alphachloralose
- Baclofen
- Benzodiazepines
- Blue-green algae
- Butorphanol
- Cannabis
- Carbamate
- Codeine
- Daffodil
- Dichlorophen
- Diclofenac
- Ethylene glycol toxicity
- Fentanyl and other sedatives and tranquillisers
- Glyphosate
- Horse chestnut
- Ivermectin
- Loperamide
- Metaldehyde
- Methiocarb
- Metronidazole
- Naproxen
- Nitroscanate (C)
- Organophosphates
- Paracetamol
Paraquat
Phenobarbitone
Phenoxy acid herbicides
Phenytoin
Piperazine
Plastic explosives
Potassium bromide
Primidone
Pyridoxine (Vitamin B₆)
Selective serotonin reuptake inhibitors
Terfenadine
Thallium
Theobromine
Tricyclic antidepressants
Vincristine
Walker Hound mononeuropathy
Yew

References
Veterinary Conference, 2002.
disease in young Rottweilers. JSAP, 44:388–94.
and factors influencing the recovery rate. JSAP, 44:76–80.
Stern-Bertholtz, W., et al. (2003) Primary secretory otitis media in the Cavalier King

1.5.4 Paresis/paralysis

SPINAL DISEASE

Degenerative
Afghan Hound hereditary myelopathy (D)
Calciosis circumspecta
Cervical spondylomyelopathy
Degenerative disc disease* (D)
Degenerative myelopathy* (D)
Labrador Retriever axonopathy (D)
Lumbosacral disease
Lysosomal storage disease
Neuronal vacuolation and spinocerebellar degeneration (D)
Rottweiler leukoencephalomyelopathy (D)
Other leukodystrophies
Synovial cysts

**Congenital**
- Atlantoaxial subluxation
- Atlanto-occipital dysplasia
- Cartilaginous exostoses
- Dermoid sinus
- Epidermoid cyst
- Hereditary myelopathy
- Meningoceles
- Osteochondromatosis
- Sacrocaudal dysgenesis
- Sacral osteochondritis dissecans
- Spina bifida
- Spinal arachnoid cyst
- Spinal dysraphism
- Syringohydromyelia (D)
- Vertebral malformations *q.v.*

**Immune-mediated**
- Cauda equina neuritis
- Epidural granuloma
- Granulomatous meningoencephalomyelitis*
- Steroid-responsive meningitis-arteritis

---

*Fig. 1.5(e)* Sagittal T1 weighted MR scan of the cervical spine of a dog showing an intervertebral disc protrusion (arrow). Reproduced with permission of Downs Referrals, Bristol.
**Infectious**
- Discospondylitis
- Infectious meningoencephalomyelitis
- Spinal epidural empyema

**Idiopathic**
- Calcinosis circumspecta
- Disseminated idiopathic skeletal hyperostosis

**Neoplastic**

*Extradural*
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Lipoma
- Lymphoma
- Malignant nerve-sheath tumour
- Meningioma
- Metastatic
- Multiple myeloma
- Osteosarcoma
- Plasma cell tumour

*Intradural extramedullary*
- Malignant nerve-sheath tumour
- Meningioma
- Metastatic

*Intramedullary*
- Astrocytoma
- Ependymoma
- Metastatic tumour
- Oligodendrogioma

**Nutritional**
- Hypervitaminosis A
- Thiamine deficiency

**Traumatic**
- Brachial plexus avulsion
- Dural tear
- Foreign body
- Fracture*
- Gunshot wound
- Luxation*
- Sacrocaudal injury
- Traumatic disc injury*
**Vascular**
- Fibrocartilaginous embolism*
- Fat-graft necrosis
- Ischaemic neuromyopathy*
- Myelomalacia
- Neurogenic claudication
- Spinal cord haematoma
- Spinal cord haemorrhage
- Vascular anomaly

**PERIPHERAL NERVES (MONO- OR POLYNEUROPATHIES)**

**Degenerative**
- Acute idiopathic polyneuropathy
- Adult onset motor neuron disease
- Birman cat distal polyneuropathy (C)
- Boxer dog progressive axonopathy (D)
- Chronic idiopathic polyradiculoneuropathy (C)
- Distal denervating disease (D)
- Giant axonal neuropathy of German Shepherds (D)
- Golden Retriever hypomyelinating polyneuropathy (D)
- Hereditary/idiopathic polyneuropathy of Alaskan Malamutes (D)
- Hypertrophic neuropathy
- Laryngeal paralysis–polyneuropathy complex
- Lysosomal storage diseases
  - Fucosidosis (D)
  - Globoid cell leukodystrophy
  - Glycogen storage disease type IV
  - Niemann-Pick disease (C)
- Mucopolysaccharidosis IIIA (D)
- Rottweiler distal sensorimotor polyneuropathy (D)
- Sensory neuropathy of longhaired Dachshunds (D)
- Spinal muscular atrophy

**Metabolic**
- Diabetic neuropathy*
- Hyperchylomicronaemia
- Hypothyroid neuropathy*
- Primary hyperoxaluria

**Immune-mediated/infectious**
- Acute idiopathic polyradiculoneuritis (Coonhound paralysis) (D)
- Brachial plexus neuritis
- Chronic inflammatory demyelinating polyneuropathy
- Protozoal polyradiculoneuritis
- Sensory ganglionic radiculoneuritis

**Neoplastic**
- Insulinoma
- Lymphoma
Malignant nerve-sheath tumours
Myelomonocytic neoplasia
Paraneoplastic neuropathy e.g.

**Traumatic**
Bite wounds*
Iatrogenic
Missile injuries
Traction injuries

**Vascular**
Arterial thromboembolism
Ischaemic neuromyopathy*
Traumatic ischaemic neuromyopathy associated with bottom-hung pivot windows and garage doors

**Drugs/toxins**
Baclofen
Blue-green algae
Cannabis
Daffodil
Horse chestnut
Ivermectin
Methiocarb
Organophosphate
Petroleum products
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Salinomycin toxicity (C)
Thallium
Vincristine
Vitamin K antagonists
Walker Hound mononeuropathy (D)

**References**
1.5.5 Coma/stupor (see Table 1.5)

**INTRACRANIAL DISEASE**

*(Note: Especially lesions of midbrain through medulla that impair the ascending reticular activating system.)*

**Degenerative**

Inherited neurodegenerative diseases
- Multisystem neuronal degeneration of Cocker Spaniels (D)
- Multisystemic chromatolytic neuronal degeneration
- Spongiform degenerations

**Congenital**

Hydrocephalus

---

**Table 1.5** Modified Glasgow Coma scale. Table reproduced, with permission, from: Platt, S. (2005) Evaluation and treatment of the head trauma patient. *In Practice, 27*:31–5.

<table>
<thead>
<tr>
<th>Sign</th>
<th>Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of consciousness</td>
<td>Occasional period of alertness and responsiveness</td>
<td>6</td>
</tr>
<tr>
<td>Depression or delirium, inappropriate response</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Semicomatose, responsive to visual stimuli</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Semicomatose, responsive to auditory stimuli</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Semicomatose, responsive only to noxious stimuli</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Comatose, unresponsive</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Motor activity**

- Normal gait and reflexes | 6 |
- Hemiparesis, tetraparesis | 5 |
- Recumbent, intermittent extensor rigidity | 4 |
- Recumbent, constant extensor rigidity | 3 |
- Recumbent, constant extensor rigidity, opisthotonus | 2 |
- Recumbent, hypotonia, depressed/absent spinal reflexes | 1 |

**Brainstem reflexes**

- Normal pupillary light reflexes/physiological nystagmus | 6 |
- Slow PLR/normal or reduced physiological nystagmus | 5 |
- Bilateral unresponsive miosis/normal or reduced physiological nystagmus | 4 |
- Pinpoint pupils/reduced or absent physiological nystagmus | 3 |
- Unilateral unresponsive mydriasis | 2 |
- Bilateral unresponsive mydriasis | 1 |

**Prognosis:**
- Score 3–8 = grave
- Score 9–14 = guarded
- Score 15–18 = good

Neoplastic

Primary
- Choroid plexus papilloma
- Glioma
- Meningioma
- Pituitary tumour

Metastatic
- Carcinoma
- Haemangiosarcoma
- Lymphoma

Local extension
- Nasal tumour
- Skull osteochondroma

Inflammatory/infectious q.v.

Trauma
- Head trauma
- Intracranial haemorrhage
- Subdural haematoma

Vascular
- Cerebrovascular accident
- Feline ischaemic encephalopathy (C)
- Hypertension q.v.
- Intracranial haemorrhage

EXTRACRANIAL DISEASE

Metabolic
- Electrolyte disturbances* q.v.
- Hepatic encephalopathy*
- Hypoglycaemia q.v.
- Hypothyroid myxoedema coma
- Uraemic encephalopathy* q.v.

CNS perfusion disturbances
- Anaemia* q.v.
- Cardiorespiratory disease*
- Haemoglobin-related toxicity
- Hyperviscosity
- Hypovolaemia*

Nutritional
- Thiamine deficiency
**Drugs/toxins**

Alphachloralose  
Baclofen  
Barbiturates  
Benzodiazepines and other sedatives/anaesthetic agents  
Blue-green algae  
Borax  
Cannabis  
Carbamate insecticides  
Diclofenac sodium  
Ethylene glycol  
Ibuprofen  
Indomethacin  
Iron  
Ivermectin  
Lead  
Loperamide  
Metaldehyde  
Methiocarb  
Metronidazole  
Naproxen  
Organophosphates  
Paracetamol  
Phenoxy acid herbicides  
Salt  
Tricyclic antidepressants  
Vitamin K antagonists  
Water  
Xylitol  
Yew

**References**


---

**1.5.6 Altered behaviour – general changes**

(e.g. disorientation, increased aggression, forgetfulness)

**INTRACRANIAL DISEASE** (see Plate 1.5(a) in colour plate section)

**Degenerative**

Cognitive dysfunction
**Congenital**
- Hydrocephalus
- Lissencephaly
- Lysosomal storage diseases

**Neoplastic e.g.**
- Glioma
- Lymphoma
- Meningioma
- Metastatic disease
- Pituitary

**Infectious**

**Viral**
- Canine distemper* (D)
- Feline immunodeficiency virus* (C)
- Feline infectious peritonitis* (C)
- Feline leukaemia virus* (C)

**Bacterial**

**Fungal**

**Protozoal**
- Neosporosis
- Toxoplasmosis

---

**Fig. 1.5(f)** Sagittal T1 weighted gadolinium-enhanced MR scan of a cat’s brain, showing a large, contrast-enhancing, pituitary tumour. Reproduced with permission of Downs Referrals, Bristol.
**Prion**
Feline spongiform encephalopathy

**Inflammatory/immune-mediated**
Granulomatous meningoencephalomyelitis*
Steroid-responsive meningitis-arteritis

**Physical**
Trauma

**EXTRACRANIAL DISEASE**

**Metabolic**
Hepatic encephalopathy *q.v.*
Hypocalcaemia *q.v.*
Hypoglycaemia *q.v.*
Renal failure *q.v.*
Thiamine deficiency

**Drugs/toxins**
Acepromazine
Benzodiazepines
Other sedatives/tranquillisers
Cannabis
Ibuprofen
Ivermectin
Petroleum distillates
Phenylpropanolamine
Risperidone
Salbutamol
Selective serotonin reuptake inhibitors
Selegiline
Terfenadine

### 1.5.7 Altered behaviour – specific behavioural problems

**Stereotypy/compulsive behaviour**
Boredom*
Frustration*
Genetic predisposition*
Physical triggers, e.g.
- Anal sac disease (tail chasing)*
- Dermatitis in (over-grooming)*
Neurological disease
- Brainstem lesions *q.v.*
- Forebrain disease *q.v.*
- Lumbosacral disease (tail chasing)
- Seizures* *q.v.*
- Sensory neuropathies (self-mutilation)
• Vestibular lesions (circling)*  *q.v.*  
Stress*  

**Aggression**  
Dominance*  
Fear*  
Hypcholesterolaemia  
Petting*  
Play*  
Possessive*  
Predatory*  
Territorial*  

**Inappropriate urination and defecation**  
Cognitive dysfunction  
Fear  
Gastrointestinal disease *q.v.*  
Hyperexcitability  
Litter-box related  
• Dirty litter  
• New location of litter box  
• Unfamiliar litter  
Separation anxiety  
Territorial marking  
Urinary tract disease (see Incontinence/inappropriate urination)  

**References**  

**1.5.8 Deafness**  

**Congenital conditions**  
Aplasia/hypoplasia of auditory receptors  
Hydrocephalus  

**Infection/inflammation**  
Otitis externa*  *q.v.*  
Otitis interna*  
Otitis media*
**Neoplasia**
Intracranial
Middle ear
Nasopharyngeal polyp*

**Mechanical**
Loud noise
Trauma

**Degenerative disease**
Presbycusis* (D)
- Cochlear conductive defects
- Senile ossicle or receptor degeneration

**Idiopathic**

**Drugs/toxins**

*Antibiotics*
- Aminoglycosides
- Amphotericin B
- Ampicillin
- Bacitracin
- Chloramphenicol
- Colistin
- Erythromycin
- Griseofulvin
- Hygromycin B
- Minocycline
- Polymixin B
- Tetracyclines
- Vancomycin

*Antiseptics*
- Benzalkonium chloride
- Benzethonium chloride
- Cetrimide
- Chlorhexidine
- Ethanol
- Iodine
- Iodophores

*Cancer chemotherapeutics*
- Actinomycin
- Cisplatin
- Cyclophosphamide
- Vinblastine
- Vincristine
Diuretics
- Bumetanide
- Ethacrynic acid
- Frusemide

Metals/heavy metals
- Arsenic
- Gold salts
- Lead
- Mercury
- Triethyl/trimethyl tin

Miscellaneous
- Ceruminolytic agents
- Danazol
- Detergents
- Digoxin
- Dimethylsulphoxide
- Diphenylhydrazine
- Insulin
- Potassium bromide
- Prednisolone
- Propylene glycol
- Quinidine
- Salicylates

Reference

1.5.9 Multifocal neurological disease

Degenerative
- Mitochondrial encephalopathies
- Organic acidurias
- Storage diseases

Congenital
- Hydrocephalus
- Syringohydromyelia

Metabolic
- Hepatic disease* q.v.
- Hyperosmolarity
- Hypoglycaemia q.v.
- Hypothyroidism* (D)
- Renal disease* q.v.
Neoplastic
Leukaemia
Lymphoma
Metastatic neoplasia

Nutritional
Thiamine deficiency

Infectious

Bacterial
Bacterial encephalitis/meningitis
Tetanus

Fungal
Aspergillosis
Blastomycosis
Candidiasis
Coccidioidomycosis
Cryptococcosis

Parasitic
Cuterebra spp
Toxocariasis

Protozoal
Neosporosis
Toxoplasmosis

Rickettsial
Ehrlichiosis/anaplasmosis
Protothecosis
Rocky Mountain Spotted Fever

Viral
Canine distemper virus (D)*
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Herpes virus
Parainfluenza virus
Parvovirus*

Immune-mediated disease
Granulomatous meningoencephalomyelitis
Necrotising encephalitis
Spinal cord vasculitis
Steroid-responsive meningitis-arteritis

Idiopathic conditions
Dysautonomia
**Vascular**

Intracranial haemorrhage
- *Angiostrongylus vasorum*
- Coagulopathy
- Trauma
- Vascular anomaly

Hypertension *q.v.*
Spinal haemorrhage
Thromboembolism

**Drugs/toxins**

Alphachloralose
Baclofen
Benzodiazepines
Blue-green algae
Borax
Cannabis
Carbamate
Daffodil
Dichlorophen
Diclofenac sodium
Ethylene glycol
Glyphosphate
Horse chestnut
Ibuprofen
Ivermectin
Laburnum
Loperamide
Metaldehyde
Methiocarb
Naproxen
Organophosphates
Paracetamol
Petroleum products
Piperazine
Plastic explosives
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Salt
Selective serotonin reuptake inhibitors
Terfenadine
Theobromine
Tricyclic antidepressants
Vitamin D$_2$/D$_3$
Vitamin K antagonists
Yew

See Plate 1.5(b) in colour plate section.
**References**

### 1.6 Ocular historical signs

#### 1.6.1 Blindness/visual impairment

**CENTRAL NERVOUS SYSTEM (CNS)**

**Optic nerve disease, e.g.**
- Optic nerve hypoplasia/aplasia
- Optic neuritis
- Space-occupying lesion compressing optic nerve
- Trauma

**Brain disease**

*Congenital, e.g.*
- Hydrocephalus

*Degenerative, e.g.*
- Neuronal ceroid lipofuscinosi
- Lysosomal storage diseases

*Immune-mediated/infectious, e.g.*
- Granulomatous meningoencephalomyelitis
- Toxoplasmosis

*Metabolic, e.g.*
- Hepatic encephalopathy *q.v.*

*Neoplastic, e.g.*
- Lymphoma
- Meningioma
- Pituitary tumour

**Trauma**

*Drugs/toxins, e.g.*
- Ivermectin
- Lead
- Levamisole
- Metaldehyde

*Vascular, e.g.*
- Cerebrovascular accident
References

1.6 Ocular historical signs

1.6.1 Blindness/visual impairment

CENTRAL NERVOUS SYSTEM (CNS)

Optic nerve disease, e.g.
- Optic nerve hypoplasia/aplasia
- Optic neuritis
- Space-occupying lesion compressing optic nerve
- Trauma

Brain disease

*Congenital, e.g.*
- Hydrocephalus

*Degenerative, e.g.*
- Neuronal ceroid lipofuscinosis
- Lysosomal storage diseases

*Immune-mediated/infectious, e.g.*
- Granulomatous meningoencephalomyelitis
- Toxoplasmosis

*Metabolic, e.g.*
- Hepatic encephalopathy *q.v.*

*Neoplastic, e.g.*
- Lymphoma
- Meningioma
- Pituitary tumour

*Trauma*

*Drugs/toxins, e.g.*
- Ivermectin
- Lead
- Levamisole
- Metaldehyde

*Vascular, e.g.*
- Cerebrovascular accident
INTRAOCULAR/PERIOCULAR

**Congenital**
- Ankyloblepharon
- Anophthalmia
- Anterior segment dysgenesis
- Collie eye anomaly
- Congenital vitreous opacification
- Corneal dermoid
- Entropion (severe)
- Microphthalmia
- Persistent hyperplastic primary vitreous
- Persistent hyperplastic tunica vasculosa lentis
- Persistent pupillary membranes
- Posterior segment coloboma
- Vitreo-retinal dysplasia

**Retinal disorders**
- Congenital retinal dystrophy
- Early onset photoreceptor dystrophies
  - Early retinal degeneration
  - Photoreceptor dysplasia
  - Rod–cone dysplasia
  - Rod dysplasia
- Hemeralopia
- Lysosomal storage diseases
- Primary retinal dysplasia
- Secondary retinal dysplasia
  - Idiopathic/inherited
  - Intra-uterine trauma
  - Maternal infections
  - Radiation
  - Vitamin A deficiency during pregnancy

**Lens disorders**
- Aphakia
- Cataracts
- Coloboma
- Lenticonus/lentiglobus
- Microphakia
- Spherophakia

**Acquired**
- Anterior uveitis
- Cataract* q.v.
- Chorioretinitis
- Chronic superficial keratitis/pannus*
- Chronic uveitis*
- Corneal lipid dystrophy/degeneration
- Corneal oedema and endothelial dysfunction*
- Endophthalmitis
- Entropion
- Generalised progressive retinal degeneration
- Glaucoma*
- Hypertensive ocular disease*
- Hyphaema
- Intraocular haemorrhage*
- Keratoconjunctivitis sicca*
Nutritional retinal degeneration
  • Taurine deficiency
  • Vitamin A deficiency
  • Vitamin E deficiency
Phthisis bulbi, e.g.
  • Secondary to ocular trauma or chronic uveitis
Pigmentary keratitis
Retinal degeneration
Retinal detachment* q.v.
Retinal haemorrhage
Retinal pigment epithelial cell dystrophy
Sudden acquired retinal degeneration
Superficial keratitis
Symblepharon
Trauma*
Ulcerative keratitis and corneal scarring
Vitreal haemorrhage

Sequelae to chronic uveitis*
  Corneal oedema
  Cyclitic membranes
  Exudative retinal detachment
  Hyphaema
  Intraocular adhesions
  Lens luxation
  Phthisis bulbi
  Secondary cataracts
  Secondary glaucoma
  Secondary retinal degeneration*

Reference

1.6.2 Epiphora/tear overflow

Impaired tear drainage
  Dacryocystitis
  Entropion
  Imperforate/obstructed punctum or canaliculus
  Lacrimal canicular aplasia
  Small lacrimal lakes

Painful/irritating ocular conditions

Eyelid conditions*
  Blepharitis
  Distichiasis/Ectopic cilia
  Entropion
  Facial nerve paralysis
  Lid laceration
  Neoplasia
  Trichiasis

Extraorbital conditions
  Diseases of paranasal sinuses
  Mechanical or olfactory stimulation of nasal mucosa
**Intraocular conditions**
- Acute uveitis
- Anterior lens luxation (D)
- Glaucoma
- Trauma

**Ocular surface conditions**
- Conjunctivitis*
- Corneal ulceration*
- Foreign body
- Keratitis*

**Third eyelid conditions***
- Lymphoid hyperplasia
- Neoplasia
- Prolapsed nictitans gland
- Scrolled third eyelid
- Trauma

### 1.7 Musculoskeletal historical signs

#### 1.7.1 Forelimb lameness

**Any site**
- Infection*
- Metaphyseal osteopathy
- Panosteitis
- Trauma*
  - Bruising or strain of soft tissues*
  - Laceration*
  - Penetrating wound*

**Shoulder**
- Brachial plexus avulsion
- Fracture of humerus*
- Fracture of scapula
- Haemarthrosis
- Joint capsule rupture
- Luxation (congenital or acquired)
- Medially displaced biceps tendon
- Osteochondrosis* (D)
- Septic arthritis*
- Shoulder dysplasia*
- Traumatic arthritis*

**Elbow**
- Avulsion of the medial epicondyle
- Collateral ligament rupture or avulsion
- Degenerative joint disease*
- Elbow incongruity
- Fracture of humerus*
- Fracture of radius*
**Intraocular conditions**
Acute uveitis
Anterior lens luxation (D)
Glaucoma
Trauma

**Ocular surface conditions**
Conjunctivitis
Corneal ulceration
Foreign body
Keratitis

**Third eyelid conditions**
Lymphoid hyperplasia
Neoplasia
Prolapsed nictitans gland
Scrolled third eyelid
Trauma

### 1.7 Musculoskeletal historical signs

#### 1.7.1 Forelimb lameness

**YOUNG ANIMALS**

**Any site**
Infection
Metaphyseal osteopathy
Panosteitis
Trauma
  - Bruising or strain of soft tissues
  - Laceration
  - Penetrating wound

**Shoulder**
Brachial plexus avulsion
Fracture of humerus
Fracture of scapula
Haemarthrosis
Joint capsule rupture
Luxation (congenital or acquired)
Medially displaced biceps tendon
Osteochondrosis (D)
Septic arthritis
Shoulder dysplasia
Traumatic arthritis

**Elbow**
Avulsion of the medial epicondyle
Collateral ligament rupture or avulsion
Degenerative joint disease
Elbow incongruity
Fracture of humerus
Fracture of radius
Fracture of ulna*
Growth plate disorders
Haemarthrosis
Luxation (congenital or acquired)
Osteochondrosis (D)*
  - Fragmented medial coronoid process
  - Osteochondritis dissecans of the medial condyle of the humerus
  - Ununited anconeal process
Septic arthritis
Traumatic arthritis*

**Carpus**

Carpal hyperextension
Collateral ligament rupture or avulsion
Degenerative joint disease*
Dysostosis
Flexor tendon contracture
Fracture of carpal bones*
Fracture of metacarpal bones*
Fracture of radius*
Fracture of ulna*
Growth plate disorders

---

**Fig. 1.7** Lateral condylar fracture of the humerus. Reproduced with permission of Downs Referrals, Bristol.
Luxation
Osteochondrosis
Septic arthritis
Shearing injury
Subluxation

Foot
Avulsion of deep digital flexor tendon
Avulsion of superficial digital flexor tendon
Claw disease q.v.*
Degenerative joint disease*
Fracture of distal metacarpal bones*
Fracture of phalanges*
Injury to integument, e.g.
  • Bite wound
  • Foreign body
  • Laceration
Other pathology of integument*
Luxation/subluxation
Septic arthritis
Sesamoid disease/fracture

ADULT ANIMALS

Any site
Infection*
Trauma*
  • Bruising or strain of soft tissues
  • Laceration
  • Penetrating wound

Shoulder
Biceps tendon rupture
Bicipital tenosynovitis (D)
Degenerative joint disease*
Fracture of humerus*
Fracture of scapula*
Haemarthrosis
Infraspinatus contracture/other muscle contractures
Joint capsule rupture
Luxation (congenital or acquired)*
Medially displaced biceps tendon
Neoplasia*, e.g.
  • Metastatic tumour
  • Nerve root tumour
  • Primary bone tumour
  • Soft tissue tumour
  • Synovial sarcoma
Osteochondrosis
Septic arthritis
Shoulder dysplasia
Traumatic arthritis*
Elbow
Collateral ligament rupture or avulsion
Degenerative joint disease*
Elbow incongruity
Fracture of humerus*
Fracture of radius*
Fracture of ulna*
Haemarthrosis
Incomplete ossification of humeral condyle
Luxation (congenital or acquired)
Medial spur
Neoplasia*
  • Bone
  • Metastatic
  • Soft tissue
Osteochondrosis
Septic arthritis
Traumatic arthritis*

Carpus
Carpal hyperextension
Degenerative joint disease*
Fracture of radius*
Fractures of carpal bones*
Fractures of metacarpal bones*
Haemarthrosis
Luxation or subluxation
Neoplasia*
  • Bone
  • Metastatic
  • Soft tissue
Septic arthritis
Shearing injury
Traumatic arthritis*

Foot
Avulsion of superficial or deep digital flexor tendon
Claw disease q.v.
Degenerative joint disease*
Fracture of distal metacarpal bones*
Fracture of phalanges*
Fracture of sesamoid bones*
Haemarthrosis
Injury to integument*, e.g.
  • Bite wound
  • Foreign body
  • Laceration
Other pathology of integument*
Luxation
Neoplasia
  • Bone
• Metastatic
• Soft tissue
Septic arthritis
Sesamoid disease
Traumatic arthritis*

References

### 1.7.2 Hind limb lameness

**YOUNG ANIMALS**

**Any site**
- Infection
- Metaphyseal osteopathy
- Panosteitis
- Trauma
  - Bruising or strain of soft tissues
  - Laceration
  - Penetrating wound

**Hip**
- Avascular necrosis of the femoral head (D)
- Fracture of acetabulum*
- Fracture of femur*
- Haemarthrosis
- Hip dysplasia*
- Luxation*
- Septic arthritis
- Traumatic arthritis*

**Stifle**
- Caudal cruciate ligament rupture or avulsion
- Cranial cruciate ligament rupture or avulsion*
- Femorotibial luxation
- Fracture of femur*
- Fracture of fibula*
- Fracture of patella*
- Fracture of tibia*
- Genu valgum
- Haemarthrosis
- Long digital extensor tendon avulsion
- Meniscal trauma*
- Osteochondrosis*
- Patellar ligament rupture or avulsion
- Patellar luxation*
Septic arthritis
Stifle hyperextension
Traumatic arthritis*

Hock
Calcanecal tendon rupture, laceration or avulsion
Collateral ligament avulsion
Congenital tarsal anomalies
Fracture of tibia*
Fracture of fibula*
Fractures of metatarsal bones*
Fractures of tarsal bones*
Gastrocnemius tendon rupture, laceration or avulsion
Growth plate disorders
Haemarthrosis
Luxation
Osteochondrosis*
Septic arthritis
Shearing injury
Tibial dysplasia
Traumatic arthritis*

Foot
Avulsion of the superficial or deep digital flexor tendon
Claw disease *q.v.*
Degenerative joint disease*
Fractures of distal metatarsal bones*
Fractures of phalanges*
Fractures of sesamoid bones
Haemarthrosis
Injury to integument*, e.g.
  • Bite wound
  • Foreign body
  • Laceration
Other pathology of integument*
Luxation
Septic arthritis
Sesamoid disease
Traumatic arthritis*

ADULT ANIMALS

Any site
Infection
Trauma
  • Bruising or strain of soft tissues
  • Laceration
  • Penetrating wound

Hip
Avascular necrosis of the femoral head*
Degenerative joint disease*
Fracture of acetabulum*
Fracture of femur*
Haemarthrosis
Hip dysplasia*
Luxation*
Myositis ossificans
Neoplasia*
• Bone
• Soft tissue
• Metastatic
Septic arthritis
Traumatic arthritis*

\textbf{Stifle}

Caudal cruciate ligament rupture or avulsion
Cranial cruciate ligament rupture or avulsion*
Degenerative joint disease*
Femorotibial luxation
Fracture of femur*
Fracture of fibula*
Fracture of patella*
Fracture of tibia*
Haemarthrosis
Long digital extensor tendon avulsion
Meniscal trauma*
Neoplasia*
• Bone
• Soft tissue
• Metastatic
Osteochondrosis*
Patellar ligament rupture or avulsion
Patellar luxation*
Septic arthritis
Stifle hyperextension
Traumatic arthritis*

\textbf{Hock}

Calcaneal tendon rupture, laceration or avulsion
Collateral ligament avulsion
Degenerative joint disease*
Fracture of fibula*
Fracture of tibia*
Fractures of metatarsal bones*
Fractures of tarsal bones*
Gastrocnemius tendon rupture, laceration or avulsion
Growth plate disorders
Haemarthrosis
Luxation
Neoplasia*
• Bone
• Soft tissue
• Metastatic
Osteochondrosis*
Septic arthritis
Shearing injury
Superficial digital flexor luxation
Tibial dysplasia
Traumatic arthritis*

Foot
Avulsion of the superficial or deep digital flexor tendon
Claw disease* q.v.
Degenerative joint disease*
Fractures of distal metatarsal bones*
Fractures of phalanges*
Fractures of sesamoid bones
Haemarthrosis
Injury to integument*, e.g.
• Bite wound
• Foreign body
• Laceration
Other pathology of integument*
Luxation*
Neoplasia*
• Bone
• Soft tissue
• Metastatic
Septic arthritis
Sesamoid disease
Traumatic arthritis*
Traumatic tenosynovitis

References

1.7.3 Multiple joint/limb lameness

Young animals
Borreliosis
Chondrodysplasia
Drug reaction
• Sulphonamide
• Vaccine
Excessive joint laxity
Collagen defect
• Dietary
• Traumatic
Haemarthroses
Metaphyseal osteopathy (D)
Nutritional secondary hyperthyroidism
Osteochondrosis*
Polyarthritis
Septic arthritis
Viral arthritis
**Adult animals**

Borreliosis  
Chondrodysplasia  
Degenerative joint disease*  
Drug reaction  
  • Sulphonamide  
  • Vaccine  
Excessive joint laxity  
  • Collagen defect  
  • Dietary  
  • Traumatic  
Haemarthroses  
Hyperparathyroidism  
Neuromuscular disease  
Osteochondrosis*  
Nutritional, e.g.  
  • Hypervitaminosis A  
  • Copper deficiency  
Periosteal proliferative arthritis  
Polyarthritis  
Septic arthritis  
Systemic lupus erythematosus  
Viral arthritis

**Reference**


---

**1.8 Reproductive historical signs**

**1.8.1 Failure to observe oestrus**

Abnormal sex chromosomes  
Early embryonic death *q.v.*  
Idiopathic  
Immune-mediated oophoritis  
Inadequate display of oestrus*  
Inadequate observation of oestrus*  
Inappropriate photoperiod (C)  
Lactational anoestrus*  
Panhypopituitarism  
Physical/athletic training  
Poor diet  
Prepuberty*  
Previous ovariectomy*
**Adult animals**

Borreliosis  
Chondrodysplasia  
Degenerative joint disease*  
Drug reaction  
  • Sulphonamide  
  • Vaccine  
Excessive joint laxity  
  • Collagen defect  
  • Dietary  
  • Traumatic  
Haemarthroses  
Hyperparathyroidism  
Neuromuscular disease  
Osteochondrosis*  
Nutritional, e.g.  
  • Hypervitomosis A  
  • Copper deficiency  
Periosteal proliferative arthritis  
Polyarthritis  
Septic arthritis  
Systemic lupus erythematosus  
Viral arthritis

**Reference**


### 1.8 Reproductive historical signs

#### 1.8.1 Failure to observe oestrus

Abnormal sex chromosomes  
Early embryonic death *q.v.*  
Idiopathic  
Immune-mediated oophoritis  
Inadequate display of oestrus*  
Inadequate observation of oestrus*  
Inappropriate photoperiod (C)  
Lactational anoestrus*  
Panhypopituitarism  
Physical/athletic training  
Poor diet  
Prepuberty*  
Previous ovariectomy*
Historical Signs

Pseudohermaphroditism
Pseudopregnancy*
Seasonal anoestrus (C)*
Social factors
Spontaneous ovulation
Sterile matings
True hermaphroditism

**Concurrent disease**
Hyperadrenocorticism
Hypoadrenocorticism (D)
Hypothyroidism* (D)
Poor body condition

**Iatrogenic**
Anabolic steroids
Androgens
Glucocorticoids
Progestogenes

**Ovarian disease**
Ovarian aplasia
Ovarian cysts and tumours
  • Granulosa-thecal cell tumours
  • Luteal cysts
  • Other neoplasms or cysts causing ovarian atrophy
Ovarian hypoplasia
Senile ovarian failure

**Stress**
Frequent showing
Frequent travel
Overcrowding
Temperature extremes

**References**

1.8.2 Irregular seasons

**Short pro-oestrus followed by anoestrus**
Poor diet
Shortened inter-pro-oestrus intervals (see below)
Stress
Reduced intensity of visible signs of oestrus

Concurrent disease*

Drugs*
  • Anabolic steroids
  • Androgens
  • Glucocorticoids
  • Progesterones

Prolonged pro-oestrus/oestrus

Excessive adrenal production of oestrogen (C)

Follicular cysts*

Hepatic disease

Merging of waves of follicular growth (C)

Normal in young females*

Iatrogenic

Drugs used to prevent pregnancy after mating

Exogenous gonadotrophins

Ovarian tumours

Adenocarcinoma

Cystadenoma

Granulosa cell tumour

Persistence of oestrus behaviour

Signs of oestrus in absence of true hormonal oestrus

Vaginal foreign body

Vaginal tumour

Vaginitis*

Vulvitis*

Shortened inter-pro-oestrus interval

Follicular cysts

Frequent episodes of pro-oestrus

Ovulatory failure

Short anoestrus

Split heats

Iatrogenic

Bromocriptine

Cabergoline

Prostaglandins

Prolonged inter-pro-oestrus interval

Normal in some breeds

Hypothyroidism* (D)

Idiopathetic

Ovarian cysts or neoplasia

Severe systemic disease

Silent heat
1.8.3 Infertility in the female with normal oestrus

Failure to achieve intromission
   Male factors* q.v.

Congenital defects of the vestibule and vagina
   Intersexes
   Vaginal septa
   Vestibulovaginal strictures
   Vulval constrictions

Acquired vaginal conditions
   Foreign body
   Post-partum fibrosis
   Transmissible venereal tumour
   Vaginal hyperplasia*
   Vaginal tumours
   Vaginal ulceration

Failure of ovulation
   Idiopathic (D)
   Inadequate number of matings (C)
   Incorrect timing of mating* (C)

Miscellaneous
   Cervical stenosis
   Cystic endometrial hyperplasia*
   Early embryonic loss q.v.
   Endometritis
   Herpes virus
   Hypoluteodism
   Incorrect timing of mating/insemination*
   Infertile male
   Non-patent oviducts or uterus
   Segmental aplasia of the paramesonephric duct
   Stress
   Uterine polyps
   Uterine tumours

References
1.8.4 Male infertility

Lack of libido

Age-related
- Prepubertal*
- Senility*

Behavioural
- Inexperience*
- Previous bad experience when mating*
- Training not to display sexual interest*

Management
- Overuse*

Concurrent/systemic disease*, e.g.
- Hypoadrenocorticism
- Hypogonadism
- Hypothyroidism* (D)

Testicular disease
- Idiopathic testicular degeneration
- Orchitis
- Sertoli cell tumour

Drugs
- Anabolic steroids
- Cimetidine
- Glucocorticoids
- Ketoconazole
- Oestrogens
- Overuse of testosterone
- Progestagens

Diet
- Malnutrition
- Obesity*

Inability to mount the female
- Prostatic disease q.v.

Orthopaedic disease*
- Hips
- Spine
- Stifle
**Failure to achieve intromission**
Female factors *q.v.*

**Congenital abnormalities, e.g.**
- Diphallus
- Penile hypoplasia
- Persistent penile frenulum
- Preputial stenosis
- Pseudohermaphroditism

**Acquired abnormalities**
- Neoplasia of the penis/prepuce
- Phimosis
- Trauma of the penis/prepuce
- Urethral obstruction and subsequent haematoma

**Miscellaneous**
- Incomplete erection
- Ineffective thrusting
  - Experience*
  - Poor socialisation*
  - Short os penis
  - Size discrepancy*
  - Trauma (desensitised glans)
- Premature full attainment of erection in inexperienced dog*
- Premature loss of erection*

**Lack of fertility where normal mating/s is/are achieved**

**Failure of/incomplete ejaculation**
- Discomfort or stress during mating*
- Inadequate tie*
- Retrograde ejaculation
  - Disorder of sympathetic nervous system
  - Urethral sphincter incompetence

**Low/absent sperm number or quality**

**Artefact**
- Poor collection technique/analysis*

**Congenital defects**
- Cryptorchidism
- Genetic abnormalities in spermatogenesis
  - Chromosomal abnormalities, e.g.
    - XXY syndrome (D)
    - 38,XY/57,XXY (C)
  - Immotile cilia (Kartagener’s syndrome)
- Segmental aplasia of the duct system
- Testicular hypoplasia
Acquired defects

Infections causing azoospermia or abnormal sperm/semen
- Balanoposthitis
- Epididymitis
- Orchitis
- Prostatitis
- Urethritis

Increases in testicular temperature
- Chemotherapeutics, e.g.
  - Chlorambucil
  - Cisplatin
  - Cyclophosphamide
- High environmental temperature
- Hyperthermia
- Iatrogenic
- Orchitis in contralateral testis
- Other drugs
  - Anabolic steroids
  - Androgens
  - Glucocorticoids
- Radiation therapy/excessive radiography
- Scrotal dermatitis

Local trauma
- Dog bites
- Kicks/blows
- Lacerations

Neoplasia of the testis
- Overuse*
- Pain*
- Prepuberty*
- Retrograde ejaculation
- Toxins

References
Axner, E., et al. (1996) Reproductive disorders in 10 domestic male cats. JSAP,
77:570–73.
38:45–9.
Olson, P. N., et al. (1992) Clinical and laboratory findings associated with actual or

1.8.5 Vaginal/vulval discharge

Pseudopregnancy*
Pyometra*
Stump pyometra
Vaginal or uterine neoplasia
Vaginitis
Vulvitis

1.8.6 Abortion

Infection
- Brucella canis (D)
- Canine adenovirus (D)
- Canine distemper virus (D)*
- Canine herpes virus (D)
- Chlamydia psittaci (C)
- Ehrlichiosis
- Feline herpes virus (C)*
- Feline infectious peritonitis (C)*
- Feline leukaemia virus (C)*
- Feline panleukopenia virus (C)*
- Leishmaniasis
- Toxoplasmosis

Habitual abortion
Abnormal uterine environment, e.g.
- Cystic endometrial hyperplasia
- Poor luteal function

Drugs, e.g.
- Cabergoline
- Corticosteroids
- Prostaglandins

References

1.8.7 Dystocia

MATERNAL CAUSES

Uterine inertia*
Primary uterine inertia
- Fatty infiltration of the myometrium
Hormonal deficiencies
Hypocalcaemia* q.v.
Inherited
Maternal systemic disease
Overstretching of myometrium, e.g.
  • Excessive intra-uterine fluids
  • Large foetuses*
  • Large litter*
Poor diet
Senile changes*
Single puppy syndrome*

Secondary uterine inertia
Exhaustion of myometrium*
  • Obstruction of birth canal*
  • Prolonged labour*

Obstruction of the birth canal
Congenital uterine malformations
  • Aplasia of cervix
  • Aplasia of corpus uteri
  • Aplasia of uterine horns
Fibrosis of the birth canal
Narrow pelvic canal
  • Congenital
  • Fracture*
  • Immaturity*
Neoplasia
Uterine malposition
Uterine rupture
Uterine torsion
Vaginal septa

FOETAL CAUSES

Oversized foetuses
Physically normal but large puppy*
Monstrosities
  • Duplications
  • Hydrocephalus
  • Oedema

Malpresentation*
Backward flexion of front legs
Breech
Lateral or downward deviation of the head
Posterior
Transverse
Two foetuses presenting simultaneously
1.8.8 Neonatal mortality

Congenital abnormalities*, e.g.
Congenital heart disease
Hydrocephalus
Hypothyroidism

Infections*, e.g.
Feline calicivirus*
Feline herpes virus*
Feline infectious peritonitis*
Feline parvovirus*
Septicaemia

Maternal/management factors*
Asphyxiation
Euthanasia for reasons of congenital deformities or undesirable cosmetic features
Hypoglycaemia q.v., e.g.
  • Secondary to sepsis
Hypothermia
Inadequate lactation
Poor environment, e.g.
  • Draughts
  • Heating
Poor hygiene
Poor mothering
Poor nutrition/health of breeding stock

Miscellaneous
Fading puppy syndrome*
Low birth weight
Neonatal isoerythrolysis
Stillbirth

References

## 1.9 Urological historical signs

### 1.9.1 Pollakiuria/dysuria/stranguria

**Normal urine**
- Behavioural*
- Idiopathic detrusor-urethral dyssynergia
- Neuromuscular

**With haematuria, pyuria or bacteriuria**
- Diabetes mellitus*
- Feline lower urinary tract disease* (C)
- Hyperadrenocorticism/costeroid treatment
- Iatrogenic disorders
- Infiltrative urethral diseases
- Neoplasia
- Neuromuscular disorders
- Prostatic disease
- Renal disease* q.v.
- Structural abnormalities
- Trauma/bladder rupture
- Urolithiasis*

**Infection**
- Bacterial
- Fungal
- Mycoplasmal
- Viral

### References


### 1.9.2 Polyuria/polydipsia (see 1.1.1 for full differentials)

- Diet
- Congenital lack of ADH receptors
- Electrolyte disorders
- Endocrine disease
- Hepatobiliary disease
- Hypothalamic disease

### 1.9 Urological historical signs

#### 1.9.1 Pollakiuria/dysuria/stranguria

**Normal urine**
- Behavioural*
- Idiopathic detrusor-urethral dyssynergia
- Neuromuscular

**With haematuria, pyuria or bacteriuria**
- Diabetes mellitus*
- Feline lower urinary tract disease* (C)
- Hyperadrenocorticism/costeroid treatment
- Iatrogenic disorders
- Infiltrative urethral diseases
- Neoplasia
- Neuromuscular disorders
- Prostatic disease
- Renal disease* q.v.
- Structural abnormalities
- Trauma/bladder rupture
- Urolithiasis*

**Infection**
- Bacterial
- Fungal
- Mycoplasmal
- Viral

### References


#### 1.9.2 Polyuria/polydipsia (see 1.1.1 for full differentials)

- Diet
- Congenital lack of ADH receptors
- Electrolyte disorders
- Endocrine disease
- Hepatobiliary disease
- Hypothalamic disease
Infectious disease
Neoplasia*
Pericardial effusion
Physiological
Polycythaemia
Psychogenic
Renal disorders
Drugs/toxins

1.9.3 Anuria/oliguria

Pre-renal
Dehydration*
Hypoadrenocorticism (D)
Shock *q.v.*

Renal
Acute renal failure *q.v.*
Chronic renal failure*
- Acute
- Chronic
- End-stage

Post-renal
Prostatic disease*
Urethral spasm

Neoplasia
Bladder
Extra-urinary tract
Urethra

Trauma
Avulsion of ureters
Ruptured bladder/urethra

Urolithiasis*
Nephroliths
Ureteroliths
Uroliths in bladder or urethra

1.9.4 Haematuria

Physiological
Pro-oestrus

Renal disease
Cysts
Glomerulonephritis
Iatrogenic
• Biopsy
• Fine needle aspirate
Idiopathic renal haematuria
Infarction, e.g.
• Disseminated intravascular coagulation
Neoplasia*
Parasites
• Dioctophyma renale
Pyelonephritis
Renal telangiectasia
Trauma
Uroliths*

Ureteral, urinary bladder and urethral disease
Feline lower urinary tract disease*
Iatrogenic
• Cystocentesis*
• Forceful catheterisation*
Neoplasia
Parasites
• Capillaria plica
Polyps
Trauma*
Urethritis
Uroliths*
Drugs
• Cyclophosphamide

Prostatic disease
Abscess
Benign prostatic hyperplasia* (D)
Cysts
Neoplasia
Prostatitis*

Uterine disease
Metritis
Neoplasia
Pyometra*
Sub-involution*

Vaginal disease
Neoplasia
Trauma

Penile disease
Neoplasia
Trauma
Extra-urogenital disease
Coagulopathy *q.v.*
Heatstroke
Drugs/toxins
  • Paracetamol

Pseudohaematuria (non-haematuria-related red urine)
Bilirubinuria *q.v.*
Food pigments
  • Blackberries
  • Beets
  • Rhubarb
Haemoglobinuria *q.v.*
Myoglobinuria *q.v.*
Phenazopyridine
Phenolphthalein
Phenothiazines

References

1.9.5 Urinary incontinence/inappropriate urination

With bladder distension
*Detrusor atony*
  Bladder over-distension
  Dysautonomia
  Lower motor neurone disease
  Neoplastic infiltration of bladder wall
  Upper motor neurone disease

*Partial physical obstruction*
  Granulomatous urethritis
  Neoplasia
  Prostatic disease
  Retroflexion of bladder into a perineal hernia
  Urethral fibrosis/stricture
  Urolithiasis
  Vestibulovaginal stenosis
**Functional obstruction**
- Reflex dyssynergia*
- Upper motor neurone disease
- Urethral inflammation*
- Urethral pain

**Without bladder distension**

**Bladder hypercontractility**
- Chronic partial obstruction*
- Detrusor instability
- Inflammation*
- Neoplasia

**Reduced bladder storage**
- Fibrosis
- Hypoplasia
- Neoplasia

**Urethral sphincter incompetence**
- Congenital
- Hormone responsive*
- Intersex
- Prostatic disease*
- Urethral inflammation*
- Urethral neoplasia
- Urinary tract infection*

**Miscellaneous**
- Ectopic ureters
- Ureterocele
- Urolithiasis
- Iatrogenic
  - Ureterovaginal fistulation
- Behavioural
- Secondary to polydipsia/polyuria

**References**
PART 2
PHYSICAL SIGNS

2.1 General/miscellaneous physical signs

2.1.1 Abnormalities of body temperature – hyperthermia

TRUE FEVER

Infection

Bacterial
Localised, e.g.
- Abscess*, e.g.
  - Dental
  - Lung
  - Retrobulbar
- Cellulitis*
- Cholangiohepatitis
- Cystitis
- Dental disease*
- Discospondylitis
- Endocarditis
- Gastrointestinal infection*
- Metritis*
- Osteomyelitis*
- Peritonitis*
- Pneumonia*
- Prostatitis*
- Pyelonephritis
- Pyometra/stump pyometra*
- Pyothorax*
- Septic arthritis*
- Urinary tract infection*

Generalised/multifocal, e.g.
- Bartonellosis
- Brucellosis (D)
- Leptospirosis*
- Lyme disease
- Mycobacterium spp
- Plague
- Septicaemia from septic focus
Fungal, e.g.  
Aspergillosis  
Blastomycosis  
Coccidioidomycosis  
Cryptococcosis  
Histoplasmosis

Parasitic, e.g.  
Aberrant helminth migration  
Babesiosis  
Chaga’s disease  
Cytauxzoon felis  
Dirofilaria immitis  
Haemobartonellosis  
Hepatozoonosis  
Leishmaniasis

Protozoal, e.g.  
Neosporosis (D)  
Toxoplasmosis

Rickettsial, e.g.  
Ehrlichiosis  
Rocky Mountain Spotted Fever (D)  
Salmon poisoning

Viral (many), e.g.  
Feline calicivirus* (C)  
Feline herpes virus* (C)  
Feline immunodeficiency virus* (C)  
Feline infectious peritonitis* (C)  
Feline leukaemia virus* (C)  
Feline panleukopenia virus* (C)  
Canine distemper virus* (D)  
Canine hepatitis virus* (D)  
Canine parainfluenza virus* (D)  
Canine parvovirus* (D)

Immune-mediated disease  
Autoimmune skin disease  
• Bullous pemphigoid  
• Discoid lupus erythematosus  
• Pemphigus erythematosus  
• Pemphigus foliaceus  
• Pemphigus vulgaris  
Drug reactions  
Evan’s syndrome  
Familial renal amyloidosis  
Granulomatous meningoencephalomyelitis  
Immune-mediated haemolytic anaemia*
Immune-mediated joint disease*
- Idiopathic
- Periosteal proliferative arthritis
- Polyarthritis/meningitis
- Polyarthritis/polymyositis
- Rheumatoid arthritis
- Systemic lupus erythematosus

Immune-mediated thrombocytopenia
Pemphigus
Plasmacytic-lymphocytic gonitis
Polyarteritis nodosa
Polymyositis
Systemic lupus erythematosus

**Immunodeficiency syndromes**

*Defects in specific immunity, e.g.*
- Agammaglobulinaemia
- C3 deficiency
- Canine leucocyte adhesion deficiency
- Lethal acrodermatitis
- Low immunoglobulins in Weimaraners (D)
- Neutrophil defect of Weimaraners (D)
- Pneumocystic pneumonia in miniature Dachshunds (D)
- Transient hypogammaglobulinaemia
- Selective IgA deficiency
- Selective IgM deficiency
- Severe combined immunodeficiency disease

*Defects in non-specific immunity*
- Bone marrow dyscrasia in Poodles (D)
- Canine cyclic haematopoiesis (D)
- Canine granulocytopathy syndrome (D)
- Chediak-Higashi syndrome (C)
- Complement deficiency (D)
- Hypotrichosis with thymic aplasia (C)
- Immotile cilia syndrome
- Pelger-Huet anomaly

*Secondary immunodeficiencies*
- Endocrine
  - Hyperadrenocorticism
- Infectious, e.g.
  - Canine distemper virus* (D)
  - Demodecosis*
  - Feline immunodeficiency syndrome* (C)
  - Feline leukaemia virus* (C)
  - Parvovirus
- Metabolic
  - Uraemia
Neoplastic
  • Haematopoietic
Nutritional
  • Zinc deficiency
Drugs
  • Corticosteroids
  • Immunosuppressive therapy

**Neoplasia**
  Lymphoma*
  Lymphoproliferative disease
  Malignant histiocytosis
  Myeloproliferative disease
  Solid tumours*

**Tissue damage**
  Surgery*
  Trauma*

**Miscellaneous**
  Metabolic bone disorders
    • Hypervitaminosis A (C)
    • Metaphyseal osteopathy
    • Nutritional secondary hyperthyroidism
    • Panosteitis
  Pansteatitis (C)
  Portosystemic shunt
  True pyrexia of unknown origin

**Inadequate heat dissipation**
  Heat stroke*
  Hyperpyrexic syndrome

**Increased muscular activity**
  Episodic myokymia
  Hypocalcaemic tetany *q.v.*
  Normal exercise*
  Pain
  Seizures* *q.v.*
  Stress

**Pathological hyperthermia**
  Hypermetabolic states
    • Hyperthyroidism* (C)
    • Phaeochromocytoma
  Hypothalamic lesions
  Malignant hyperthermia

**Drugs/toxins**
  Adder bites
Amphotericin B
Aspirin
Benzalkonium chloride
Benzodiazepines
Borax
Cannabis
Carbamate
Daffodil
Dichlorophen
Diclofenac sodium
Dinoprost tromethamine
Glyphosphate
Horse chestnut
Hymenoptera stings
Indomethacin
Ivermectin
Metaldehyde
Organophosphates
Oxytetracycline
Paracetamol
Paraquat
Penicillamine
Petroleum distillates
Phenytoin
Poinsettia
Procainamide
Pyrethrin/pyrethroids
Salbutamol
Theobromine
Yew

2.1.2 Abnormalities of body temperature – hypothermia

Drugs/toxins
Alphachloralose
Baclofen
Benzodiazepines
Cannabis
Daffodil
Ethylene glycol
General anaesthetics
Ivermectin
Loperamide
Paracetamol
Sedatives
Yew
Miscellaneous
Aortic thromboembolism* (C)
Cardiac disease* q.v.
Coma q.v.
Environmental cold*
Hypoadrenocorticism (D)
Hypothalamic disorders
Hypothyroidism* (D)
Loss of thermoregulatory abilities following heat stroke
Near drowning
Severe sepsis/endotoxaemia*

References

2.1.3 Enlarged lymph nodes

PROLIFERATION/INFLAMMATION

Infectious
Algal
Protothecosis
Bacterial
Actinomycosis
*Brucella canis* (D)
*Corynebacterium* spp
Localised infection
*Mycobacterium* spp
Nocardiosis
Septicaemia
*Streptococcus* spp
*Yersinia pestis*

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Phycomycosis
Sporotrichosis

Parasitic
Babesiosis
Cytauxzoonosis
Demodecosis
Hepatozoonosis
Leishmaniasis
Trypanosomiasis

Protozoal
Neosporosis (D)
Toxoplasmosis

Rickettsial
Ehrlichiosis
Rocky Mountain Spotted Fever
Salmon poisoning

Viral
Canine herpes virus* (D)
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Infectious canine hepatitis* (D)

Non-infectious
Dermatopathic lymphadenopathy
Drug reactions
Idiopathic
Immune-mediated
- Immune-mediated polyarthritis
- Mineral associated lymphadenopathy
- Puppy strangles* (D)
- Rheumatoid arthritis
- Systemic lupus erythematosus
Localised inflammation*
Post-vaccine

INfiltration

Neoplastic disease

Haemolymphatic
- Leukaemias
- Lymphoma*
- Lymphomatoid granulomatosis
- Malignant histiocytosis
- Multiple myeloma
- Systemic mastocytosis

Metastatic
- Adenocarcinomas
- Carcinomas
- Malignant melanomas
- Mast cell tumours
- Sarcomas

Non-neoplastic disease
- Eosinophilic granuloma complex
- Mast cell infiltration

References

2.1.4 Diffuse pain

Gastrointestinal disease, e.g.
- Cholecystolithiasis/cholecystitis*
- Gastrointestinal parasitism*
- Pancreatitis*

Musculoskeletal disease, e.g.
- Polyarthritis
- Polymyositis
Neurological disease, e.g.
Meningoencephalitis
Spinal disease* q.v.
Thalamic pain syndrome

Urological disease, e.g.
Prostatic disease*
Renal parasitism
Renal urolithiasis
Ureteral urolithiasis
Urethral tumour

Other causes of abdominal pain q.v.

Reference

2.1.5 Peripheral oedema

Generalised
Hypoalbuminaemia* q.v.
Increased central venous pressure
  • Central venous occlusion
    • Neoplasia
    • Thrombosis
  • Congestive heart failure*
Vasculitis

Regional
Bilateral forelimb oedema/head and neck oedema
Cranial vena cava syndrome
  • Compression of cranial vena cava, e.g. by mediastinal mass
  • Granuloma of cranial vena cava
  • Neoplasia of cranial vena cava
  • Thrombosis of cranial vena cava

Bilateral hind limb oedema
Budd-Chiari-like syndrome
Obstruction of sublumbar lymph nodes, e.g. neoplasia

Increased central venous pressure
Central lymph obstruction
Central venous occlusion, e.g.
  • Mediastinal mass
  • Thrombosis
**Localised**
- Arteriovenous fistula
- Cellulitis*
- Inflammation*
- Lymphangitis
- Lymphoedema
- Neurogenic or hormonal vasoactive stimuli
- Proximal venous obstruction
- Vascular trauma
- Vasculitis
- Drugs/toxins
  - Alphaxalone/alphadolone
  - Paracetamol
  - Salbutamol

**References**

### 2.1.6 Hypertension

**Adrenal disease**
- Hyperadrenocorticism
- Hyperaldosteronism
- Phaeochromocytoma

**Anaemia* q.v.**

**CNS disease q.v.**

**Endocrine disease**
- Acromegaly
- Diabetes mellitus* (D)
- Hyperoestrogenism
- Hyperthyroidism* (C)

**Hyperviscosity**
- Hyperglobulinaemia *q.v.*
- Polycythaemia *q.v.*

**Iatrogenic**
- Overzealous fluid administration

**Idiopathic**
- Essential/primary hypertension

**Renal disease**
- Renal arterial disease
Renal parenchymal disease
- Amyloidosis
- Chronic interstitial nephritis*
- Glomerulonephritis
- Glomerulosclerosis
- Pyelonephritis

**Thyroid disease**
Hyperthyroidism* (C)

**Drugs/toxins**
- Corticosteroids
- Cyclosporin A
- Dobutamine
- Dopamine
- Doxapram
- Erythropoietin
- Fludrocortisone
- Phenylpropanolamine
- Theobromine

**References**

### 2.1.7 Hypotension

**Decreased preload**
- Heatstroke*
- Hypoadrenocorticism (D)
- Hypovolaemia*
  - Blood donation
  - Burns
  - Effusions *q.v.*
  - Diarrhoea *q.v.*
  - Haemorrhage *q.v.*
  - Polyuria without polydipsia *q.v.*
  - Vomiting *q.v.*

**Decreased venous return**
- Cardiac tamponade
- Caval syndrome/heartworm disease
- Gastric dilatation/volvulus*
- Pneumothorax* *q.v.*
Positive pressure ventilation
Restrictive pericarditis

**Decreased cardiac function**
Arrhythmias* q.v.
Cardiomyopathy*
Congenital heart disease
Electrolyte/acid–base disorders* q.v.
Hypoxia
Valvular disease*

**Decreased vascular tone**
Anaphylaxis
Babesiosis
Electrolyte/acid–base disorders* q.v.
Hypoxia
Neurological disease q.v.
Systemic inflammatory response syndrome

**Drugs/toxins**
ACE inhibitors
Adder bites
Amiloride
Amiodarone
Daffodil
Diazoxide
Dopamine
General anaesthetics and sedatives
Hydralazine
Hymenoptera stings
Indomethacin
Isosorbide dinitrate
Lignocaine
Medetomidine
Mexiletine
Midazolam
Mistletoe
Nitroprusside
Oxytetracycline (intravenous)
Phenoxybenzamine
Prazosin
Procainamide
Propofol
Pyridostigmine
Quinidine
Ranitidine (intravenous)
Rhododendron
Snake venom
Sotalol
Terbutaline
Terfenadine
1.18 Physical Signs

Tricyclic antidepressants
Verapamil
Xylazine
Yew

References

2.2 Gastrointestinal/abdominal physical signs

2.2.1 Oral lesions

Congenital deformities

Neoplasia

Oropharyngeal tumours
- Extramedullary plasmacytoma
- Fibroma/fibrosarcoma
- Fibropapilloma
- Granular cell tumour
- Haemangiosarcoma
- Histiocytoma
- Lymphoma
- Mast cell tumour
- Melanoma*
- Mixed mesenchymal sarcoma
- Papilloma (D)
- Rhabdomyosarcoma
- Squamous cell carcinoma
- Transmissible venereal tumour (D)

Odontogenic tumours
- Acanthomatous epulides
- Ameloblastic adenomatoid
- Ameloblastoma
- Calcifying epithelial odontogenic tumour
- Cementoma
- Dentinoma
- Fibromatous epulides
- Fibromyxoma
- Hamartoma
- Inductive fibroameloblastoma (C)
Tricyclic antidepressants
Verapamil
Xylazine
Yew

References

2.2 Gastrointestinal/abdominal physical signs

2.2.1 Oral lesions

Congenital deformities

Neoplasia

Oropharyngeal tumours
- Extramedullary plasmacytoma
- Fibroma/fibrosarcoma
- Fibropapilloma
- Granular cell tumour
- Haemangiosarcoma
- Histiocytoma
- Lymphoma
- Mast cell tumour
- Melanoma
- Mixed mesenchymal sarcoma
- Papilloma (D)
- Rhabdomyosarcoma
- Squamous cell carcinoma
- Transmissible venereal tumour (D)

Odontogenic tumours
- Acanthomatous epulides
- Ameloblastic adenomatoid
- Ameloblastoma
- Calcifying epithelial odontogenic tumour
- Cementoma
- Dentinoma
- Fibromatous epulides
- Fibromyxoma
- Hamartoma
- Inductive fibroameloblastoma (C)
Keratinising ameloblastoma (C)
Odontogenic fibroma
Odontoma
Ossifying epulides

**Inflammatory masses, e.g.**
Feline eosinophilic granuloma complex*

**Oral ulceration**
Immune-mediated/inflammatory, e.g.
  • Eosinophilic granuloma complex*
  • Lymphoplasmacytic*
Infectious, e.g.
  • Feline calicivirus
Ingestion of irritant substances*
Metabolic, e.g.
  • Uraemia* q.v.
Traumatic*

**Periodontitis/gingivitis**
Bacterial infection*
Diabetes mellitus*
Diet (non-abrasive)*
Immune deficiency, e.g.
  • Feline immunodeficiency virus* (C)
  • Feline leukaemia virus* (C)
Immune-mediated disease, e.g.
  • Lymphoplasmacytic*
Periodontal foreign material*, e.g.
  • Grass
  • Hair
Tooth abnormalities*, e.g.
  • Crowding
  • Malocclusion
  • Rough surfaces

**Salivary gland enlargement**
Infarction
Infection
Neoplasia
  • Acinic cell tumour
  • Adenocarcinoma
  • Monomorphic adenoma
  • Mucoepidermoid tumour
  • Pleomorphic adenoma
  • Undifferentiated carcinoma
Sialadenitis
Sialadenosis
Sialocele
Stomatitis
Immune-mediated/inflammatory, e.g.
- Eosinophilic stomatitis
- Lymphoplasmacytic stomatitis* 
Infection, e.g.
- *Bartonella henselae*
- Feline calicivirus* (C)
- Feline herpes virus* (C)
Ingestion of irritant substances
Metabolic, e.g. uraemia*
Traumatic*

Tooth disease
- Caries
- Feline odontoclastic resorptive lesions* (C)
- Trauma*

References

2.2.2 Abdominal distension
- Abdominal neoplasia*
- Ascites* q.v.
- Bladder distension* q.v.
- Gastric dilatation*
- Gastric distension*
- Obstipation* q.v.
- Organomegaly*
  - Enlarged kidney q.v.
  - Enlarged uterus q.v.
  - Hepatomegaly q.v.
  - Splenomegaly q.v.
- Pneumoperitoneum
- Weakness of abdominal musculature
  - Hyperadrenocorticism
  - Ruptured prepubic tendon

2.2.3 Abdominal pain
Gastrointestinal disease
- Colitis*
- Constipation* q.v.
Enteritis*  
Gastric dilatation/volvulus* (D)  
Gastric foreign body*  
Gastric ulceration*  
Gastritis*  
Intestinal volvulus  
Neoplasia*  
Small intestinal foreign body*  

**Hepatobiliary disease**  
Cholangitis  
Cholecystitis*  
Cholelithiasis  
Gall bladder obstruction  
Hepatitis*  
Liver lobe torsion  
Portal hypertension  

**Mechanical factors**  
*Dilatation of a hollow viscus*  
Bladder distension* *q.v.*  
Gastric dilatation/volvulus* (D)  
Intestinal dilatation, e.g.  
- Foreign body  
- Volvulus  

*Obstruction of outflow*  
Obstruction of bile outflow  
Urinary tract obstruction  

**Mesenteric tension/traction/torsion**  
Abscess  
Bowel incarceration in hernia or mesenteric tear  
Cryptorchid testicular torsion  
Foreign body*  
Haematoma  
Intestinal volvulus  
Gastric dilatation/volvulus* (D)  
Intussusception*  
Neoplasia  
Splenic torsion  
Stenosis/stricture  
Uterine torsion  

**Musculoskeletal pain**  
Abdominal muscle rupture  
Referred spinal pain*  

**Organ rupture**  
Bile duct  
Gall bladder
Intestine
Spleen
Stomach
Urinary tract
Uterus, e.g.
  • Pyometra

**Pancreas**
Pancreatic abscess
Pancreatitis*

**Peritoneal cavity**
Ascites *q.v.*

**Haemoabdomen**
Coagulopathy *q.v.*
Neoplasia*
Trauma*

**Peritonitis**
Blunt trauma*
Feline infectious peritonitis* (C)
Iatrogenic, e.g.
  • Post-surgical*
Pancreatitis*
Penetrating trauma
Prostatitis*
Rupture or penetration of gastrointestinal tract
Ruptured pyometra

**Uroabdomen**
Rupture of urinary tract

**Reproductive system**
Labour/dystocia*
Metritis*
Prostatic disease
Pyometra*

**Miscellaneous**
Sterile nodular panniculitis and pansteatitis in Weimaraners

**Trauma**
Fractures*
Ruptured viscus

**Urinary system**
Cystitis*
Lower urinary tract obstruction*
Nephritis
Pyelonephritis
Ureteral obstruction

**Drugs/toxins**
- Allopurinol
- Blue-green algae
- Borax
- Daffodil
- Diclofenac sodium
- Dieffenbachia
- Horse chestnut
- Ibuprofen
- Indomethacin
- Itraconazole
- Loperamide
- Metaldehyde
- Misoprostol
- Naproxen
- NPK fertilisers
- Paracetamol
- Paraquat
- Petroleum distillates
- Phenoxy acid herbicides
- Poinsettia
- Rhododendron
- Theobromine
- Zinc sulphate

**References**

**2.2.4 Perianal swelling**

**Anal/rectal prolapse**
- Faecal tenesmus

**Anal sac disease**
- Anal sac abscess
- Anal sac adenocarcinoma
- Anal sac impaction
- Anal sacculitis
Neoplasia
Perianal adenoma*
Other perianal neoplasia

Perineal hernia*
Idiopathic
Secondary to causes of tenesmus q.v.

2.2.5 Jaundice

PRE-HEPATIC
Haemolytic anaemia q.v.
Increased haem liberation
• Congenital porphyria
• Ineffective erythropoiesis
• Internal haemorrhage
• Severe myolysis

HEPATIC

Intrahepatic cholestasis
Hepatic necrosis, e.g.
Infections
Toxins

Infection
Bacterial*
Fungal
Viral
• Adenovirus* (D)
• Feline immunodeficiency virus* (C)
• Feline infectious peritonitis* (C)
• Feline leukaemia virus* (C)

Inflammation
Cholangitis/cholangiohepatitis*

Miscellaneous
Amyloidosis
Cirrhosis
Hepatic erythrohaemaphagic syndrome
Hepatic lipidosis
Polycystic kidney disease (C)

Neoplasia, e.g.
Lymphoma*
Mast cell tumour
Myeloproliferative disease
Drugs/toxins
Barbiturates
Blue-green algae
Carbimazole
Diazepam
Glipizide
Glucocorticoids
Glyphosphate
Griseofulvin
Ketoconazole
Methimazole
Methimazole
Methyldopa
Methimazole
Metronidazole
Mexiletine
NSAIDS, e.g.
• Carprofen
• Ibuprofen
• Paracetamol
• Phenylbutazone
Phenobarbitone
Plastic explosives
Primidone
Salicylates
Sulphasalazine
Tetracycline

POST-HEPATIC

Bile duct occlusion

Extraluminal
Choledochal cysts (C)
Duodenal disease
Pancreatic neoplasia
Pancreatitis*
Polycystic disease (C)
Secondary to peribiliary disease
Stricture at porta hepatis

Intramural
Cholangitis
Cholecystitis*
Cholelithiasis
Gall bladder/duct neoplasia

Intraluminal
Choledochal cysts (C)
Cholelithiasis
Gall bladder mucocoele
Haemobilia
Inspissated bile
Polycystic kidney disease (C)
References

2.2.6 Abnormal liver palpation

Generalised enlargement

Endocrine disease
- Diabetes mellitus*
- Hyperadrenocorticism

Inflammation/infection, e.g.
- Abscess*
- Cholangiohepatitis*
- Feline infectious peritonitis* (C)
- Fungal infection
- Granuloma
- Hepatitis*
- Lymphocytic cholangitis

Miscellaneous
- Amyloidosis
- Cholestasis (see Jaundice q.v.)
- Cirrhosis (early)
- Hepatic lipidosis
- Nodular hyperplasia*
- Storage diseases

Neoplasia*, e.g.
- Lymphoma
- Malignant histiocytosis

Venous congestion
- Caudal vena cava occlusion (post caval syndrome)
  - Adhesions
  - Cardiac neoplasia
  - Congenital cardiac disease
  - Diaphragmatic rupture/hernia*
  - Dirofilariasis
• Pericardial disease
• Thoracic mass*
• Thrombosis
• Trauma
Right sided congestive heart failure, e.g.
• Dilated cardiomyopathy*
• Pericardial effusion

Drugs
Glucocorticoids

Focal enlargement
Abscess*
Biliary pseudocyst
Cyst
Granuloma
Haematoma*
Hepatic arteriovenous fistula
Hyperplastic/regenerative nodule*
Liver lobe torsion

Neoplasia
Adenocarcinoma*
Biliary cystadenoma
Haemangiosarcoma*
Hepatocellular carcinoma*
Hepatoma
Lymphoma*
Malignant histiocytosis
Metastatic*

Reduced liver size
Cirrhosis*
Diaphragmatic rupture/hernia*
Hypoadrenocorticism (D)
Idiopathic hepatic fibrosis
Portosystemic shunt
• Acquired
• Congenital

References
2.3 Cardiorespiratory physical signs

2.3.1 Dyspnoea/tachypnoea

Physiological causes
Exercise
Fear
High ambient temperature
Pain

Upper airway disorders

Cervical tracheal disease
Extraluminal compression
Foreign body
Hypoplasia/stenosis
Neoplasia
- Extraluminal
- Intraluminal
  - Adenocarcinoma
  - Chondroma
  - Chondrosarcoma
  - Leiomyoma
  - Lymphoma
  - Osteochondroma
  - Osteosarcoma
  - Plasmacytoma
  - Polyps
  - Rhabdomyosarcoma
  - Squamous cell carcinoma
Tracheal collapse*
Trauma

Pharyngeal disease
Elongated or oedematous soft palate* (D)
Enlarged tonsils*

Laryngeal disease
Everted saccules* (D)
Laryngeal paralysis* (D)
Neoplasia
Oedema*

Nasal disease, e.g.
Aspergillosis
Foreign body*
Inflammatory disease*
Nasopharyngeal polyp
Neoplasia
Stenotic nares

**Lower airway disorders**

*Thoracic tracheal disease, e.g.*
- Extraluminal compression
- Foreign body
- Hypoplasia/stenosis
- Neoplasia (extra- or intraluminal)
- Tracheal collapse*
- Trauma

*Bronchial disease*
- Bronchiectasis
- Broncho-oesophageal fistula
- Chronic bronchitis* (D)
- Cystic-bullous lung disease, e.g. secondary to emphysema
- Eosinophilic bronchitis*
- Extraluminal compression
  - Enlarged left atrium
  - Hilar lymphadenopathy, e.g.
    - Fungal disease
    - Granulomatous disease
    - Neoplasia
  - Neoplasia
- Feline asthma* (C)
- Foreign body
- Lungworm
- Neoplasia
- Primary ciliary dyskinesia

*Pulmonary parenchymal disease*
- Foreign body
  - Abscess
  - Chronic pulmonary fibrosis
  - Eosinophilic bronchopneumonopathy
  - Eosinophilic pneumonitis
  - Eosinophilic pulmonary granulomatosis
  - Hilar lymph node enlargement
  - Inhalation pneumonia
- Idiopathic pulmonary fibrosis
- Inflammatory disease
- Irritating gases
- Near drowning
- Neoplasia*
- Paraquat toxicity
- Pneumonia/infectious disease*
  - Bacterial, e.g.
    - *Bordetella bronchiseptica*
    - *Chlamydophila psittaci*
• *E. coli*
• *Klebsiella pneumoniae*
• *Mycobacterium* spp
• *Mycoplasma pneumoniae*
• Pasteurellosis
• Endogenous lipid pneumonia
• Fungal, e.g.
  • Aspergillosis
  • Blastomycosis
  • Coccidioidomycosis
  • Cryptococcosis
  • Histoplasmosis
  • *Pneumocystis*
• Parasitic, e.g.
  • *Aelurostrongylus abstrusus*
  • *Angiostrongylus vasorum*
  • *Capillaria aerophila*
  • *Crenosoma vulpis*
  • *Oslerus* spp
  • *Paragonimus kellicotti*
  • Visceral larva migrans
• Protozoal, e.g.
  • Toxoplasmosis
• Rickettsial
• Viral, e.g.
  • Canine distemper virus* (D)
  • Feline calicivirus* (C)
  • Feline immunodeficiency virus* (C)
  • Feline leukaemia virus* (C)

Pulmonary oedema *q.v.*
Pulmonary thromboembolism, e.g.
• Cardiac disease
• Heartworm disease
• Hyperadrenocorticism

Smoke inhalation

Trauma, e.g.
• Pulmonary contusions
• Pulmonary haemorrhage

**Restrictive disorders**

Diaphragmatic hernia, e.g.
• Peritoneopericardial diaphragmatic hernia
• Traumatic*

Large intra-abdominal mass

Neoplasia
• Mediastinal
• Thoracic wall

Pickwickian syndrome (extreme obesity)
Pleural effusion* *q.v.*
Pneumothorax* *q.v.*
Severe ascites *q.v.*
Severe gastric distension
Severe hepatomegaly *q.v.*
Thoracic wall abnormalities, e.g.

**Fig. 2.3(a)**  Dorsoventral radiograph showing an adenocarcinoma of the lung. Reproduced with permission of Downs Referrals, Bristol.

**Fig. 2.3(b)**  Ultrasonogram of a disseminated thoracic thymoma. Reproduced with permission of Downs Referrals, Bristol.
• Neoplasia
• Pectus excavatum
• Trauma*

Systemic and miscellaneous disorders
Anaemia* q.v.
Central neurological disease causing damage to respiratory centres, e.g.
• Head trauma
• Hyperthermia* q.v.
• Hyperthyroidism* (C)
• Hypoxia*
• Metabolic acidosis q.v.
• Neuromuscular weakness, e.g. polyradiculoneuritis
• Shock/hypovolaemia* q.v.

Acute respiratory distress syndrome
Aspiration of acidic substances
Drug reaction
Inhalation injury
Lung lobe torsion
Multiple transfusions
Pancreatitis
Sepsis
Shock
Surgery
Trauma

Drugs/toxins
Benzalkonium chloride
Blue-green algae
Dichlorophen
Ibuprofen
Metaldehyde
Naproxen
Paracetamol (methaemoglobinaemia)
Paraquat
Salbutamol
Strychnine
Terfenadine

References
2.3.2 Pallor

Anaemia q.v.

Decreased peripheral perfusion
  Shock q.v.

Drugs/toxins
  Adder bites
  Baclofen
  Diclofenac sodium
  Ibuprofen
  Ivermectin
  Metaldehyde
  Naproxen
  Paracetamol
  Vitamin D rodenticides

2.3.3 Shock

Cardiogenic

Decreased systolic function
  Dilated cardiomyopathy* (C)
  Myocardial infarction
  Myocarditis
  Drugs/toxins, e.g.
    • Doxorubicin

Decreased ventricular filling
  Hypertrophic cardiomyopathy* (C)
  Pericardial effusion/tamponade*
  Restrictive cardiomyopathy* (C)
  Restrictive pericarditis

Obstruction
  Heartworm disease
  Intracardiac masses
  Thrombosis

Severe arrhythmia q.v.

Valve disease
  Severe myxomatous degeneration of mitral valve* (D)
Distributive
Anaphylactic
Septic

Hypoxaemic
Anaemia* q.v.
Respiratory disease* q.v.
Toxins
• Carbon monoxide
• Paracetamol

Metabolic
Heat stroke*
Hypoglycaemia
Sepsis*
Toxins, e.g.
• Cyanide

Hypovolaemic
Haemorrhage* q.v.
Hypoadrenocorticism (D)

Dehydration, e.g.
Diabetes mellitus*
Diarrhoea* q.v.
Prolonged use of diuretics
Renal failure* q.v.
Vomiting* q.v.

Hypoproteinaemia/plasma loss, e.g.
Abdominal surgery
Ascites q.v.
Burns
Peripheral oedema q.v.
Pleural effusion

Neurogenic
Acute central nervous system disease
Electric shock
Heat stroke

References
### 2.3.4 Cyanosis

**PERIPHERAL**

**Vasoconstriction**
- Hypothermia* q.v.
- Reduced cardiac output*
- Shock* q.v.

**Venous obstruction, e.g.**
- Right-sided heart failure*
- Thrombophlebitis
- Tourniquet

**Arterial obstruction, e.g.**
- Aortic thromboembolism* (C)

**CENTRAL**

**Hypoxaemia**

**Respiratory disease***
- Hypoventilation
  - Pleural effusion* q.v.
  - Pneumothorax* q.v.
  - Respiratory muscle failure
  - Toxicity

**Obstruction**
- Brachycephalic obstructive airway syndrome
- Foreign body
  - Laryngeal
  - Tracheal
- Large airway mass, e.g.
  - Abscess
  - Neoplasia
  - Parasite
- Laryngeal paralysis*

**Ventilation–perfusion mismatch**
- Acute respiratory distress syndrome
- Chronic obstructive pulmonary disease*
- Pneumonia
- Pulmonary inflammatory conditions
- Pulmonary neoplasia*
- Pulmonary oedema* q.v.
- Pulmonary thromboembolism

**Reduced inspired oxygen**
- Altitude
- Anaesthetic
Physical Signs

**Cardiovascular disease (anatomic shunts), e.g.**
- Pulmonary arteriovenous fistula
- Reverse-shunting patent ductus arteriosus
- Reverse-shunting ventricular septal defect
- Tetralogy of Fallot

**Haemoglobin abnormalities**

**Drugs/toxins**
- Baclofen
- Blue-green algae
- Loperamide
- Metaldehyde
- Paracetamol (methaemoglobinaemia)
- Paraquat
- Theobromine

**References**

### 2.3.5 Ascites (see 3.7.10 for full listing)
- Bile
- Blood
- Chyle
- Exudate
- Transudate/modified transudate
- Urine

### 2.3.6 Peripheral oedema

**Generalised**
- Hypoalbuminaemia* q.v.
- Increased central venous pressure
  - Central venous occlusion
  - Neoplasia
  - Thrombosis
  - Congestive heart failure*

**Regional**
**Bilateral forelimb oedema/head and neck oedema**
- Compression of cranial vena cava, e.g.
  - Mediastinal mass
  - Thrombosis of cranial vena cava
Bilateral hind limb oedema
Budd-Chiari-like syndrome
Obstruction of sublumbar lymph nodes, e.g.
  • Neoplasia

Increased central venous pressure
Central venous occlusion, e.g.
  • Mediastinal mass
  • Thrombosis
Central lymph obstruction

Localised
Arteriovenous fistula
Cellulitis*
Inflammation*
Lymphoedema
Neurogenic or hormonal vasoactive stimuli
Proximal venous obstruction
Vascular trauma
Vasculitis
Drugs/toxins
  • Alphaxalone/alphadolone
  • Paracetamol
  • Salbutamol

References

2.3.7 Abnormal respiratory sounds

Stridor

Upper airway obstruction
Brachycephalic obstructive airway syndrome
Laryngeal obstruction, e.g.
  • Foreign body
  • Laryngospasm
  • Neoplasia
  • Oedema
  • Paralysis*
Tracheal obstruction, e.g.
  • Collapse*
  • Extraluminal compression
• Exudate
• Foreign body
• Haemorrhage
• Neoplasia
• Stenosis

**Sertor**

*Nasopharyngeal obstruction, e.g.*
- Brachycephalic obstructive airway syndrome
- Foreign body
- Neoplasia

**Crackles**
- Exudate in airways
- Haemorrhage in airways
- Pulmonary fibrosis
- Pulmonary oedema *q.v.*

**Wheeze**s

*Airway narrowing, e.g.*
- Bronchoconstriction
- Extraluminal compression
- Exudate in airways
- Masses in airways

**Reference**

### 2.3.8 Abnormal heart sounds

**Transient heart sounds (Heart sounds of short duration)**

**Loud S1**
- Anaemia *q.v.*
- Intensity varies with arrhythmias, e.g.
  - Atrial fibrillation
  - Heart block
  - Sinus arrhythmia
  - Ventricular premature depolarisations
- High sympathetic tone
- Mitral insufficiency
- Systemic hypertension *q.v.*
- Tachycardia *q.v.*
- Thin animals
- Young animals
**Quiet S1**
Decreased myocardial contractility, e.g.
- Dilated cardiomyopathy
Diaphragmatic hernia
Emphysema
First degree heart block
Obesity
Pericardial effusion *q.v.*
Pleural effusion *q.v.*
Shock *q.v.*

**Split S1**
Bundle branch block
Cardiac pacing
Ectopic beats
Physiological in healthy large-breed dogs

*Note:* A split S1 should be differentiated from presystolic gallop, ejection sounds and diastolic clicks.

**Loud S2**
Anaemia *q.v.*
Fever *q.v.*
Hyperthyroidism *q.v.* (C)
Intensity varies with arrhythmias, e.g.
- Atrial fibrillation
- Heart block
- Sinus arrhythmia
- Ventricular premature depolarisations
Tachycardia *q.v.*
Thin animals
Young animals

**Quiet S2**
Decreased myocardial contractility, e.g.
- Dilated cardiomyopathy
Diaphragmatic hernia
Emphysema
Obesity
Pericardial effusion *q.v.*
Pleural effusion *q.v.*
Thoracic masses
Shock *q.v.*

**Split S2**
Physiological in healthy large-breed dogs

Aortic valve closure follows pulmonic valve closure (A2 follows P2)
Aortic stenosis
Left bundle branch block
Systemic hypertension
Ventricular ectopic beats*

**Pulmonic valve closure follows aortic valve closure (P2 follows A2)**
Left to right intracardiac shunt (atrial septal defect)
Pulmonary hypertension, e.g.
- Heartworm disease
Pulmonic stenosis
Right bundle branch block
Ventricular ectopic beats*

**Gallop rhythms**

**Accentuated S₃ (protodiastolic)**
Occasionally noted in healthy animals on phonocardiography
Anaemia* q.v.
Hyperthyroidism* (C)
Mitrail regurgitation*
Myocardial dysfunction*
Patent ductus arteriosus
Septal defects

**Accentuated S₄ (presystolic)**
Inaudible in healthy animals, but may be noted on phonocardiography
Hyperthyroidism* (C)
Hypertrophic cardiomyopathy* (C)
Marked left ventricular hypertrophy
Profound heart failure following rupture of chordae tendinae

**Early diastolic sounds**
Opening snaps (rare)
- Mitral valve stenosis
Pericardial knocks
- Constrictive pericarditis
Plops
- Mobile atrial tumours

**Ejection sounds (high frequency sounds in early diastole)**
Aortic stenosis
Dilatation of the great vessels
Heartworm disease
Hypertension* q.v.
Opening of abnormal semilunar valves
Pulmonic stenosis
Tetralogy of Fallot

**Systolic clicks (short, mid- to high-frequency sounds in mid to late systole)**
Early degenerative valvular disease
MURMURS (HEART SOUNDS OF LONGER DURATION ARISING FROM TURBULENT BLOOD FLOW)

Innocent murmurs*

Physiological murmurs
Anaemia* q.v.
Fever* q.v.
Hypertension* q.v.
Hyperthyroidism* (C)
Pregnancy*

Murmurs associated with cardiovascular disease

Systolic
Holosystolic plateau-shaped
- Mitral regurgitation*
- Tricuspid regurgitation*
- Ventricular septal defect
Holosystolic crescendo–decrescendo
- Aortic stenosis
- Pulmonic stenosis
- Ventricular septal defect

Diastolic
Aortic insufficiency (congenital or associated with bacterial endocarditis)
Mitral stenosis

Fig. 2.3(c) Diagrammatic representation of heart murmur shapes.
Continuous
Coronary arteriovenous fistula
Coronary artery or ruptured sinus aneurysm communicating directly with right atrium
Patent ductus arteriosus
Pulmonary arteriovenous fistula

Fig. 2.3(d) Dorsoventral thoracic radiograph of a West Highland White terrier with pulmonic stenosis. Right-sided heart enlargement is evident. Reproduced with permission of Downs Referrals, Bristol.

Fig. 2.3(e) Lateral thoracic radiograph of the same dog as in Figure 2.3(d). Note the lung fields appear underperfused. Reproduced with permission of Downs Referrals, Bristol.
References

2.3.9 Abnormalities in heart rate

BRADYCARDIA
Normal in athletic dogs, during rest/sleep
Cardiac disease/arrhythmias q.v.
CNS disease
Hypothermia
Severe systemic disease

Increased vagal tone*, e.g.
Gastrointestinal disease* q.v.
Respiratory disease* q.v.

Metabolic disease
Hyperkalaemia q.v.
Hypoglycaemia q.v.
Hypothyroidism*
Uraemia*

Drugs/toxins
Adder bites
Amiodarone
Anti-dysrhythmics, e.g. beta blockers
Atenolol
Baclofen
Bethanechol
Cannabis
Carbamate
Clonidine
Daffodil
Diltiazem
Fentanyl
Glyphosphate
Hypertonic saline
Ivermectin
Lignocaine
Loperamide
Medetomidine
Mexiletine
Organophosphates
Paraquat
Phenoxy acid herbicides
Propranolol
Pyridostigmine
Rhododendron
Sotalol
Theobromine
Timolol maleate
Verapamil
Vitamin D rodenticides
Xylazine
Yew

TACHYCARDIA

Sinus tachycardia

Physiological
   Excitement*
   Exercise*
   Fear*
   Pain*

Pathological
   Heart failure*
   Respiratory disease*
   Shock*
   Systemic disease
   • Anaemia* q.v.
   • Fever* q.v.
   • Hyperthyroidism (C)*
   • Hypoxia*
   • Sepsis*

Other supraventricular tachycardias* q.v.

Ventricular tachycardias* q.v.

Drugs/toxins
   Adder bites
   Adrenaline
   Atropine
   Baclofen
   Blue-green algae
   Cannabis
   Dinoprost tromethamine
   Dobutamine
   Dopamine
   Doxapram
   Doxorubicin
   Ethylene glycol
   Glycerol trinitrate
   Glycopyrronium bromide
   Glyphosphate
Hydralazine
Ibuprofen
Isosorbide dinitrate
Ketamine
Levothyroxine
Metaldehyde
Paracetamol
Paraquat
Petroleum distillates
Phenoxy acid herbicides
Phenoxybenzamine
Propantheline bromide
Pyrethrins/pyrethroids
Salbutamol
Selective serotonin reuptake inhibitors
Terbutaline
Terfenadine
Theobromine
Theophylline
Tricyclic antidepressants
Verapamil
Vitamin D rodenticides

References

2.3.10 Jugular distension/positive hepatojugular reflux
Cardiac disease resulting in right-sided heart failure*
Fluid volume overload, e.g.
  • Iatrogenic*
Pericardial disease

2.3.11 Jugular pulse components

Cannon a waves
Atrioventricular dissociation, e.g.
  Third-degree heart block

Exaggerated a waves
Decreased right ventricular compliance, e.g.
  Constrictive pericarditis
  Restrictive right ventricular disease
  Right ventricular hypertrophy
Prominent v waves
Tricuspid regurgitation

2.3.12 Alterations in arterial pulse

Hypokinetic (weak) pulse
Aortic stenosis
Increased peripheral resistance
Regional loss of pulse (see below)
Small stroke volume, e.g.
  • Hypovolaemia* q.v.
  • Left-sided heart failure*
Tachycardia q.v.
Toxins
  • Alphachloralose
  • Anticoagulant rodenticides

Hyperkinetic (bounding) pulse
Anaemia* q.v.
Arteriovenous fistula
Bradycardia* q.v.
Decreased diastolic blood pressure
  • Aortic insufficiency
  • Shunting lesions, e.g.
    • Increased stroke volume
    • Increased systolic blood pressure
    • Patent ductus arteriosus
Fever* q.v.
Hyperthyroidism* (C)

Pulsus paradoxus
Exaggerated in pericardial tamponade
Physiological

Pulsus alternans
Myocardial failure
Tachyarrhythmias q.v.

Pulsus bigeminus
Ventricular bigeminy

Pulse deficits
Tachyarrhythmias q.v.

Regional loss of pulse
Infectious embolus
Neoplastic embolus
Thromboembolism*
2.4 Dermatological signs

2.4.1 Scaling

Primary/inherited disorders of keratinisation

- Acne*
- Canine primary idiopathic seborrhoea (D)
- Ear margin dermatosis
- Epidermal dysplasia (Armadillo Westie syndrome) (D)
- Feline idiopathic facial dermatitis (C)
- Feline primary idiopathic seborrhoea (C)
- Follicular dysplasia
- Follicular hyperkeratosis
- Follicular parakeratosis
- Footpad hyperkeratosis

Fig. 2.3(f) Arterial pulse patterns. Modified from Fox, P. R., Sisson, D. & Moise, N. S. (1999) Textbook of Canine and Feline Cardiology: Principles and Clinical Practice, 2nd edn. W.B. Saunders, Philadelphia.
2.4 Dermatological signs

2.4.1 Scaling

Primary/inherited disorders of keratinisation

Acne*
Canine primary idiopathic seborrhoea (D)
Ear margin dermatosis
Epidermal dysplasia (Armadillo Westie syndrome) (D)
Feline idiopathic facial dermatitis (C)
Feline primary idiopathic seborrhoea (C)
Follicular dysplasia
Follicular hyperkeratosis
Follicular parakeratosis
Footpad hyperkeratosis
Ichthyosis
Lethal acrodermatitis
Lichenoid psoriasiform dermatosis
Nasal hyperkeratosis*
Nasodigital hyperkeratosis
Schnauzer comedo syndrome (D)
Sebaceous adenitis
Tail gland hyperplasia*
Vitamin A responsive dermatosis
Zinc responsive dermatosis

Exfoliative dermatoses
Contact dermatitis*
Drug eruption
Epitheliotrophic lymphoma
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Parapsoriasis
Pemphigus foliaceus
Systemic lupus erythematosus
Thymoma
Toxic epidermal necrolysis

Secondary scaling
Allergic/immune-mediated
Atopy*
Contact hypersensitivity
Drug hypersensitivity
Food hypersensitivity*
Hormonal hypersensitivity
Pemphigus foliaceus

Environmental
Low humidity
Physical/chemical damage

Infectious/parasitic
Bacterial pyoderma
Cheyletiellosis*
Cowpox virus (C)
Demodecosis*
Dermatophytosis*
Endoparasites*
Fleas*
Leishmaniasis
Malassezia spp*
Pediculosis*
Pyoderma*
Scabies* (D)
Metabolic/endocrine
  Diabetic dermatopathy
  Growth hormone-responsive dermatosis
  Hepatic disease
  Hyperadrenocorticism
  Hyperandrogenism
  Hyperthyroidism* (C)
  Hypopituitarism
  Hypothyroidism* (D)
  Idiopathic male feminising syndrome
  Intestinal disease
  Necrolytic migratory erythema
  Oestrogen-responsive dermatosis
  Pancreatic disease
  Renal disease
  Sertoli cell tumour
  Sex hormone abnormalities
  Superficial necrolytic dermatitis
  • Glucagonoma
  • Hepatocutaneous syndrome
  Testosterone-responsive dermatosis

Neoplastic
  Epitheliotrophic lymphoma

Nutritional
  Dietary deficiency of essential fatty acids
  Malabsorption/malnutrition of essential fatty acids

References

2.4.2 Pustules and papules (including miliary dermatitis)

Primary immune-mediated
  Bullous pemphigoid
  Pemphigus erythematosus
  Pemphigus foliaceus
Pemphigus vegetans
Pemphigus vulgaris
Systemic lupus erythematosus

**Immune-mediated diseases causing secondary pyoderma**
- Atopy*
- Contact allergy*
- Food hypersensitivity*
- Hypereosinophilic syndrome

**Infectious/parasitic diseases causing secondary pyoderma**
- Cheyletiellosis
- Demodecosis*
- Dermatophilosis
- Dermatophytosis*
- External parasite bites*, e.g.
  - Fleas
  - Mosquitoes
- Feline immunodeficiency virus*
- Feline leukaemia virus*
- *Lynxacarus radovsky*
- *Malassezia* spp
- *Notoedres cati*
- Pediculosis*
- Sarcoptic mange*
- Superficial pustular dermatitis*
- Trombiculiasis*

**Miscellaneous**
- Canine linear IgA pustular dermatosis (D)
- Contact irritation*
- Drug eruptions
- Juvenile cellulitis
- Sterile eosinophilic pustular dermatosis
- Subcorneal pustular dermatosis

**Neoplasia**
- Epitheliotrophic lymphoma
- Mast cell tumour*

**Nutritional**
- Biotin deficiency
- Essential fatty acid deficiency

**References**
### 2.4.3 Nodules

**Inflammation**

Angiogenic oedema  
Calcinosiis circumscripta  
Calcinosiis cutis  
Infectious  
  - Bacterial*  
  - Fungal  
  - Parasitic  
Granuloma, e.g.  
  - Eosinophilic*  
  - Insect bite*  
Histiocytosis  
Nodular cutaneous amyloidosis  
Nodular dermatofibrosis  
Sterile nodular granuloma  
Urticaria*  
Xanthoma

**Panniculitis**

Idiopathic  
  - Sterile nodular  
Immune-mediated  
  - Discoid lupus erythematosus  
  - Systemic lupus erythematosus  
  - Vasculitis  
Infectious  
  - Bacteria  
  - Fungi  
  - Mycobacteria  
  - Parasites, e.g. insect bites  
Pancreatic disease  
Physical  
  - Foreign body  
  - Post-injection  
  - Trauma  
Vitamin E deficiency

**Neoplasia**

**Epithelial**

Apocrine adenoma/carcinoma*  
Basal cell tumour*  
Ceruminous adenoma/carcinoma*  
Keratoacanthoma*  
Papilloma*  
Perianal gland adenoma/carcinoma*  
Pilomatrixoma*
Sebaceous adenoma/carcinoma*
Squamous cell carcinoma*
Sweat gland tumours*
Trichoepithelioma*

Melanocyte
Melanoma

Round cell
Lymphoma
  • Epitheliotrophic
  • Lymphomatoid granulomatosis
  • Non-epitheliotrophic
Histiocytic sarcoma
Histiocytoma*
Mast cell tumour*
Plasmacytoma*
Transmissible venereal tumour

Mesenchymal
Benign fibrous histiocytoma
Dermatofibroma
Fibrolipoma
Fibroma
Fibropapilloma
Fibrosarcoma
Haemangioma/sarcoma
Haemangiopericytoma
Leiomyoma/sarcoma
Lipoma/sarcoma*
Lymphangioma/sarcoma
Myxosarcoma
Schwannoma

Metastatic

Non-neoplastic, non-inflammatory
Benign nodular sebaceous hyperplasia
Cysts*
  • Dermoid
  • Epidermoid
  • Follicular
Fibroadnexal dysplasia
Haematoma*
Naevi/hamartoma
  • Collagenous
  • Follicular
  • Sebaceous
  • Vascular
Seroma*
Skin polyp*
Urticaria pigmentosa

References

2.4.4 Pigmentation disorders (coat or skin)

Hypopigmentation

Generalised
Age-related greying*
Albinism
Canine cyclic haematopoiesis (D)
Chediak-Higashi syndrome (C)
Mucocutaneous hypopigmentation
Nutritional deficiencies
  • Copper
  • Lysine
  • Pantothenic acid
  • Protein
  • Pyridoxine
  • Zinc
Oculocutaneous albinism
Piebaldism
Tyrosinase deficiency
Waardenburg syndrome
Drugs

Localised
Trauma
  • Burns
  • Chemical
  • Physical*
  • Radiation
  • Surgical*

Immune-mediated
  • Sutton’s halo
  • Uveodermatological syndrome
  • Vitiligo
**Post-inflammatory**
- Bullous pemphigoid
- Inflammatory dermatitis* q.v.
- Lupus erythematosus

**Infectious**
- Aspergillosis
- Leishmaniasis

**Idiopathic**
- Periocular leukotrichia/Aguirre’s syndrome
- Seasonal nasal hypopigmentation*

**Neoplastic**
- Basal cell tumour
- Epitheliotrophic lymphoma
- Gastric carcinoma
- Mammary adenocarcinoma*
- Melanoma
- Squamous cell carcinoma

**HYPERPIGMENTATION**

**Generalised/diffuse**
- Alopecia X
- Demodecosis*
- Endocrine disease
  - Adrenal sex-hormone dermatosis
  - Growth hormone-responsive dermatosis
  - Hyperadrenocorticism
  - Hyperoestrogenism
  - Hypothyroidism* (D)
- Iatrogenic
  - Prolonged glucocorticoid administration
- *Malassezia* spp*
- Recurrent flank alopecia
- Ultraviolet irradiation of alopecic regions

**Multifocal**
- Bowen’s disease (C)
- Demodecosis*
- Dermatophytosis*
- Lentigines
- Melanoderma
- Naevus
- Post-inflammatory
- Pyoderma*
- Tumours*
- Urticaria pigmentosa
Focal
Acanthosis nigrans
Demodecosis*
Dermatophytosis*
Lentigo
Naevus
Neoplasia*
Post-inflammatory
Pyoderma*
Trauma*
Drugs
  • Minocycline
  • Mitotane

References

2.4.5 Alopecia (see Plate 2.4 in colour plate section)

Failure of hair growth
Paraneoplastic alopecia

Endocrine disease
Diabetes mellitus*
Hyperadrenocorticism
Hypothyroidism* (D)

Systemic diseases
Chronic hepatic disease q.v.
End-stage renal disease q.v.
Feline immunodeficiency virus (C)
Feline leukaemia virus (C)

Follicular diseases
Anagen defluvium
  • Cancer chemotherapy
  • Endocrine disease*
  • Infection
  • Metabolic disease*
Colour-dilution alopecia
Congenital follicular dysplasias
Congenital hypotrichosis
Dark hair follicular dystrophy

Hair cycle arrest alopecia
Endocrine disease
- Alopecia X
  - Adrenal sex hormone-responsive dermatosis
  - Castration-responsive dermatosis
  - Growth hormone-responsive dermatosis
  - Oestrogen responsive dermatosis
  - Testosterone responsive dermatosis
- Hyperadrenocorticism
- Hyperoestrogenism
- Hypothyroidism* (D)

Idiopathic cyclic flank alopecia
Pattern baldness
Post-clipping
Telogen defluvium*
  - Stress, e.g.
    - Anaesthesia
    - Pregnancy
    - Shock *q.v.*
    - Surgery
    - Systemic illness

**Damage to hair follicle**
Secondary to pruritus* *q.v.*

**Follicular infections**
Bacterial folliculitis*
Demodecosis*
Dermatophytosis*

**Immune-mediated disease**
Alopecia areata
Idiopathic lymphocytic mural folliculitis
Pseudopelade
Sebaceous adenitis

**Neoplasia***

**Trauma/physical**
Injection site reaction
Over-grooming
Sensory neuropathy
Traction alopecia
Trichoepitheliosis
Tricornerhexis nodosa

**Nutritional**
Zinc deficiency
Zinc responsive dermatosis

**Miscellaneous**
Alopecia mucinosis
Feline acquired symmetric alopecia (C)
Feline pinnal alopecia* (C)
Feline pre-auricular alopecia (normal)
Follicular lipidosis of Rottweilers (D)
Medullary trichomalacia
Psychogenic alopecia*
Short hair syndrome of Silky breeds (D)
Drugs
• Carbimazole

References

2.4.6 Erosive/ulcerative skin disease

Immune-mediated
Bullous pemphigoid
Discoid lupus erythematosus
Epidermolysis bullosa acquisita
Erythema multiforme
Mucous membrane pemphigoid
Perianal fistulae
Plasma cell pododermatitis
Systemic lupus erythematosus
Toxic epidermal necrolysis
Ulcerative disease of Shetland Sheepdog and Rough Collie (D)

Idiopathic
Feline idiopathic ulcerative dermatosis

Infection
Antibiotic responsive ulcerative dermatoses
Cowpox virus (C)

Neoplasia*

Physical
Burns
Frostbite
Radiation
Trauma

Vasculitis
Idiopathic
Immune-mediated
Infectious
Drugs/toxins
ACE inhibitors
Diuretics
Fenbendazole
Imodium
Itraconazole
Ivermectin
Metoclopramide
Metronidazole
Phenobarbitone
Phenylbutazone
Thallium

References

2.4.7 Otitis externa

Primary causes

Hypersensitivity
- Atopy*
- Contact allergy*
- Drug reactions
- Food hypersensitivity*

Infection
- Fungal
  - Dermatophytosis*
  - *Sporothrix schenckii*
- Parasites
  - Demodecosis*
  - Fleas*
  - *Otodectes cyanotis*
  - Pediculosis*
  - Sarcoptic mange* (D)
  - Trombiculosis*
- Pyoderma

Endocrine, e.g.
- Hyperadrenocorticism
- Hypothyroidism* (D)

Physical
- Foreign body*
Immune-mediated
- Bullous pemphigoid
- Cold agglutinin disease
- Drug eruption
- Erythema multiforme
- Lupus erythematosus
- Pemphigus erythematosus
- Pemphigus foliaceus
- Vasculitis

Disorders of keratinisation
- Primary seborrhoea
- Sebaceous adenitis
- Vitamin A responsive dermatosis

Miscellaneous
- Abnormal cerumen production
- Juvenile cellulitis

Neoplasia
- Adenocarcinoma
- Adenoma
- Papilloma
- Squamous cell carcinoma

Predisposing factors
- Systemic immunosuppression

Ear conformation/structure
- Ear canal stenosis
  - Acquired*
  - Inherited
- Hypertrichosis*
- Neoplasia
- Pendulous pinnae* (D)
- Polyps*

Excessive moisture
- Humidity
- Swimming

Iatrogenic
- Irritant ear cleaning products
- Overuse of cleaning products
- Trauma

Perpetuating factors
- Acquired changes secondary to chronic ear disease
  - Fibrosis*
  - Hyperplasia*
• Mineralisation*
• Oedema*
• Ulceration*

Bacterial infection*
• *Enterobacter* spp
• *Proteus* spp
• *Pseudomonas* spp
• *Staphylococcus intermedius*
• *Streptococcus* spp

Candidiasis*
*Malassezia* spp

Otitis media

References

2.4.8 Pododermatitis

Asymmetric pododermatitis
Foreign body*
Irritant*
Neoplasia
Trauma

Infection
Bacterial*
• *Actinomyces* spp
• *Nocardia* spp
• *Proteus* spp
• *Pseudomonas* spp
• *Staphylococcus intermedius*

Fungal
• Blastomycosis
• Candidiasis
• Cryptococcosis
• Dermatophytosis*
• Eumycotic mycetoma
• *Malassezia* spp

Parasitic, e.g.
• Demodecosis*

Miscellaneous
Acral lick dermatitis*
Arteriovenous fistula
Calcinosis circumspecta
Osteomyelitis
Sensory neuropathy
**Symmetric pododermatitis**

*Congenital*
- Acrodermatitis of Bull Terriers (D)
- Familial hyperkeratosis in Irish Terriers (D)
- Familial vasculopathy of German Shepherd (D)
- Idiopathic footpad hyperkeratosis
- Tyrosinaemia
- Vasculitis of Jack Russell Terriers (D)

*Immune-mediated/allergic*
- Atopy*
- Bullous pemphigoid
- Cold agglutinins
- Contact allergy*
- Dermatomyositis (D)
- Drug eruption
- Food allergy*
- Pemphigus foliaceus
- Pemphigus vulgaris
- Plasma cell pododermatitis (C)
- Sterile granuloma/pyogranuloma
- Systemic lupus erythematosus
- Vasculitis

*Immunodeficiencies*
- Acquired
- Congenital

*Infection*
- Bacterial, e.g.
  - *Staphylococcus intermedius*
- Fungal, e.g.
  - *Malassezia* spp
- Parasitic, e.g.
  - Demodecosis
  - Hookworm
  - Leishmaniasis
  - Pelodera

*Irritant*

*Metabolic*
- Calcinosis circumspecta
- Superficial necrolytic dermatitis

*Miscellaneous*
- Dermatofibrosis
- Distemper* (D)

*Neoplasia*
Nutritional
Zinc responsive dermatosis

Psychogenic/neurogenic
Acral mutilation of German Short-Haired Pointers (D)
Sensory neuropathy

References

2.4.9 Disorders of the claws

Idiopathic conditions
Idiopathic onychodystrophy
Idiopathic onychogryphosis
Idiopathic onychomadesis

Immune-mediated disease
Bullous pemphigoid
Cryoglobulinaemia
Discoid lupus erythematosus/Symmetric lupoid onychodystrophy
Drug eruption
Eosinophilic granuloma complex
Pemphigus complex
Systemic lupus erythematosus
Vasculitis

Infection
Bacterial
• Secondary to trauma or virus*
Fungal
• Blastomycosis
• Candidiasis
• Cryptococcosis
• Dermatophytosis
• Geotrichosis
• *Malassezia* spp
• Sporothricosis
Parasitic
• Ascarids
• Demodecosis
• Hookworm dermatitis
Protozoal
• Leishmaniasis
Viral
• Canine distemper virus* (D)
• Feline immunodeficiency virus* (C)
• Feline leukaemia virus* (C)

Inherited/primary disease
Anonychia
Dermatomyositis
Epidermolysis bullosa
Naevus
Primary seborrhoea
Supernumerary claws

Metabolic/endocrine disease
Acromegaly
Diabetes mellitus*
Hyperadrenocorticism
Hyperthyroidism* (C)
Hypothyroidism* (D)
Necrolytic migratory erythema

Neoplasia, e.g.
Metastatic lung carcinoma
Squamous cell carcinoma

Nutrition
Lethal acrodermatitis
Zinc responsive dermatosis

Drugs/toxins
Thallotoxicosis

Trauma
Irritant chemical*
Physical injury*

Vascular
Disseminated intravascular coagulation
Raynaud-like disease

References

2.4.10 Anal sac/perianal disease

Perianal/caudal pruritus
Anal sac impaction*
Anal sacculitis*
Atopy*
Flea bite hypersensitivity* 
Food hypersensitivity*
Intertrigo*
  • Perineal 
  • Tail fold 
  • Vulval fold
Parasitism*, e.g.
  • Cheyletiellosis 
  • Sarcoptic mange

**Perianal swelling**
Anal sac abscess*
Anal sac neoplasia*
Perianal adenoma*
Other perianal neoplasia
Perineal hernia*
Rectal prolapse*

**Perianal fistula**
Anal furunculosis*
Ruptured anal sac abscess*

**Reference**

---

**2.5 Neurological signs**

**2.5.1 Abnormal cranial nerve (CN) responses**

The anatomical localisation of lesions associated with the abnormal test are listed, together with other disorders that can produce alterations in the cranial nerve tests. Differentiating intracranial disease from peripheral neuropathy can be aided by the fact that intracranial disease is more likely to involve multiple cranial nerves and other neurological signs are usually present. Specific disorders of selected cranial nerves are also listed below.

**Anisocoria** (see Plate 2.5(a) in colour plate section)

*Abnormal pupil—constricted*
  • Corneal ulcers/lacerations 
  • Horner’s syndrome 
  • Posterior synechiae 
  • Previous inflammation 
  • Uveitis*
164 Physical Signs

Anal sacculitis*
Atopy*
Flea bite hypersensitivity*
Food hypersensitivity*
Intertrigo*
  • Perineal
  • Tail fold
  • Vulval fold
Parasitism*, e.g.
  • Cheyletiellosis
  • Sarcoptic mange

Perianal swelling
Anal sac abscess*
Anal sac neoplasia*
Perianal adenoma*
Other perianal neoplasia
Perineal hernia*
Rectal prolapse*

Perianal fistula
Anal furunculosis*
Ruptured anal sac abscess*

Reference

2.5 Neurological signs

2.5.1 Abnormal cranial nerve (CN) responses

The anatomical localisation of lesions associated with the abnormal test are listed, together with other disorders that can produce alterations in the cranial nerve tests. Differentiating intracranial disease from peripheral neuropathy can be aided by the fact that intracranial disease is more likely to involve multiple cranial nerves and other neurological signs are usually present. Specific disorders of selected cranial nerves are also listed below.

Anisocoria (see Plate 2.5(a) in colour plate section)

Abnormal pupil-constricted
  Corneal ulcers/lacerations
  Horner’s syndrome
  Posterior synechiae
  Previous inflammation
  Uveitis*


Drugs, e.g.
- Pilocarpine

Abnormal pupil–dilated
- Iris, retina, CN II, CN III
  - Chorioretinitis
  - Glaucoma
  - Iris atrophy/hypoplasia
  - Iris trauma
  - Posterior synechiae
  - Unilateral blindness
  - Drugs, e.g.
    - Atropine
    - Phenylephrine

Auditory response reduced
- CN VIII
- External auditory canal*
- Middle* or inner ear

Corneal reflex reduced
- Brainstem
- CN V
- CN VII

Gag reflex reduced
- Brainstem
- CN IX
- CN X

Facial asymmetry (see Plate 2.5(b) in colour plate section)
- Facial paralysis
  - CN VII
  - Idiopathic neuritis
  - Neoplasia of the middle ear
  - Otitis media*
- Masticatory muscle wastage
  - CN V
    - Idiopathic trigeminal neuritis
    - Malignant trigeminal nerve sheath tumour
    - Masticatory myositis

Jaw tone reduced/inability to close jaw
- CN V
  - Idiopathic trigeminal neuritis
  - Lymphoma*
  - Neosporosis

Lack of response to non-irritant smell
- CN I
- Nasal disease
Menace response reduced
Brainstem
Cerebellum
CN II
CN VII
Forebrain
Immature animal
Retina

Palpebral reflex reduced
Brainstem
CN V
CN VII

Pupillary light reflex reduced
Brainstem
CN II
CN III
Retina

Response to stimulation of nasal mucosa reduced
Brainstem
CN V
Forebrain

Response to vagal manoeuvres reduced
CN X

Spontaneous nystagmus
Brainstem
CN VIII
Toxic, e.g.
• Cannabis
• Metaldehyde
Vestibular disease q.v., e.g.
• Canine idiopathic geriatric vestibular disease
• Congenital vestibular disease
• Middle ear disease

Strabismus
Ventrolateral
CN III

Dorsolateral
CN IV

Medial
CN VI

Vestibulo-ocular reflex reduced
Brainstem
Diseases of CN V
Idiopathic trigeminal neuritis
Infiltrating neoplasia, e.g.
- Lymphoma
- Nerve sheath tumours

Diseases of CN VII
Idiopathic
Insulinoma
Otitis media/interna
Trauma of middle ear
Tumour of middle ear

References:

2.5.2 Vestibular disease
(Signs include: head tilt, nystagmus, circling, leaning, falling, rolling)

PERIPHERAL VESTIBULAR SYSTEM

Congenital vestibular disease

Metabolic disease
Hypothyroidism* (D)

Neoplasia
Ceruminous gland adenocarcinoma
Chondrosarcoma
Fibrosarcoma
Osteosarcoma
Schwannoma
Squamous cell carcinoma

Idiopathic conditions
Idiopathic geriatric vestibular disease*
**Infection**

- Extension of otitis externa* q.v.
- Foreign bodies*
- Haematogenous spread of infection
- Otitis media/interna*
- Polyps*

**Trauma**

**Drugs/toxins**

**Antibiotics**

- Aminoglycosides
- Amphotericin B
- Ampicillin
- Bacitracin
- Chloramphenicol
- Colistin
- Erythromycin
- Griseofulvin
- Hygromycin B
- Metronidazole
- Minocycline
- Polymixin B
- Tetracyclines
- Vancomycin

**Antiseptics**

- Benzalkonium chloride
- Benzethonium chloride
- Cetrimide
- Chlorhexidine
- Ethanol
- Iodine
- Iodophores

**Cancer chemotherapeutics**

- Actinomycin
- Cisplatin
- Cyclophosphamide
- Vinblastine
- Vincristine

**Diuretics**

- Bumetanide
- Ethacrynic acid
- Frusemide

**Metals/heavy metals**

- Arsenic
- Gold salts
Lead
Mercury
Triethyl/trimethyl tin

**Miscellaneous**
- Ceruminolytic agents
- Danazol
- Detergents
- Digoxin
- Dimethylsulphoxide
- Diphenylhydrazine
- Insulin
- Mexiletine
- Potassium bromide
- Prednisolone
- Propylene glycol
- Quinidine
- Salicylates

**CENTRAL VESTIBULAR SYSTEM**

**Trauma**

**Degeneration**
- Lysosomal storage disorders

**Congenital conditions**
- Chiari-like malformation
- Hydrocephalus

**Fig. 2.5(a)** Transverse T1 weighted MR scan of the head of a dog, showing a large neoplasm in the middle ear. Reproduced with permission of Downs Referrals, Bristol.
**Metabolic disease**
- Electrolyte abnormalities\* q.v.
- Hepatic encephalopathy\* q.v.
- Uraemic encephalopathy\* q.v.

**Neoplasia**
- Choroid plexus tumours
- Dermoid cyst
- Epidermoid cyst
- Glioma
- Lymphoma
- Medulloblastoma
- Meningioma
- Metastatic tumour

**Nutrition**
- Thiamine deficiency

**Immune-mediated/Infection**
- Feline spongiform encephalopathy (C)
- Meningoencephalitis

**Idiopathic conditions**
- Arachnoid cysts

**Drugs/toxins**
- Metronidazole

---

*Fig. 2.5(b)* Sagittal T1 weighted MR scan of the brain and cervical spine of a Cavalier King Charles Spaniel, showing syringohydromyelia (arrow). Reproduced with permission of Downs Referrals, Bristol.
Vascular disorders
Cerebrovascular accident

References:

2.5.3 Horner’s syndrome

1st order (hypothalamus, rostral midbrain, spinal cord to T3)
Intracranial disease, e.g.
• Neoplasia
Spinal disease q.v.
Thoracic disease, e.g.
• Cranial mediastinal mass

2nd order (pre-ganglionic) (T1–T3, vagosympathetic trunk, caudal and cranial cervical ganglia)
Brachial plexus avulsion
Cervical soft tissue disease, e.g.
• Mass
• Neoplasia
• Trauma
Cervical surgery, e.g.
• Thyroidectomy

3rd order (post-ganglionic) (middle ear, cranial cavity, eye)
Feline immunodeficiency virus* (C)
Iatrogenic, e.g.
• Bulla osteotomy
Idiopathic*
Middle ear
• Mass
• Neoplasia
Otitis media/interna*
• Under middle ear
Retrobulbar
• Injury
• Mass*
• Neoplasia

Reference
2.5.4 **Hemineglect syndrome** (Forebrain dysfunction *q.v.*).

2.5.5 **Spinal disorders** (see Fig. 2.5(c) for neurolocalisation).

**C1–C5**

*Acute*
- Atlantoaxial subluxation
- Cervical spondylomyelopathy (D)
- Degenerative disc disease* (D)
- Discospondylitis
- Fibrocartilaginous embolism*
- Fracture*
- Granulomatous meningoencephalomyelitis
- Haematoma
- Ischaemic myelopathy
- Luxation
- Neoplasia

*Chronic*
- Atlanto-occipital dysplasia
- Atlantoaxial subluxation
- Calcinosis circumscripta
- Cervical fibrotic stenosis
- Cervical spondylomyelopathy* (D)
- Feline infectious peritonitis (C)
- Hypervitaminosis A
- Neoplasia

<table>
<thead>
<tr>
<th>L4-S3</th>
<th>T3-L3</th>
<th>C6-T2</th>
<th>C1-C5</th>
<th>Brain</th>
</tr>
</thead>
<tbody>
<tr>
<td>T/L LMN</td>
<td>T/L Normal</td>
<td>T/L LMN</td>
<td>T/L UMN</td>
<td>T/L UMN</td>
</tr>
<tr>
<td>P/L LMN</td>
<td>P/L UMN</td>
<td>P/L UMN</td>
<td>P/L UMN</td>
<td>P/L UMN</td>
</tr>
</tbody>
</table>

**Key**
- T/L - Thoracic limb
- P/L - Pelvic limb
- UMN - Upper motor neurone
- LMN - Lower motor neurone

*Fig. 2.5(c) Localisation of spinal lesions.*
Spinal arachnoid cysts
Synovial cysts
Syringohydromyelia*

C6–T2

Acute
Brachial plexus avulsion
Cervical spondylomyelopathy* (D)
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism*
Fracture*
Granulomatous meningoencephalomyelitis
Haematoma
Luxation
Neoplasia

Chronic (see Plate 2.5(c) in colour plate section)
Cervical spondylomyelopathy* (D)
Dermoid sinus
Neoplasia
Spinal arachnoid cysts
Synovial cysts

T3–L3

Acute
Ascending myelomalacia
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Luxation
Neoplasia

Chronic
Calcinosis circumscribed
Degenerative disc disease* (D)
Degenerative myelopathy*
Neoplasia
Spinal arachnoid cyst
Synovial cysts

L4–S3

Acute
Ascending myelomalacia
Cauda equina neuritis* (D)
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Ischaemic neuromyopathy
Luxation
Neoplasia
Psoas muscle injury

Chronic
Degenerative myelopathy*
Dermoid sinus
Lumbosacral disc disease* (D)
Neoplasia
Sacral osteochondritis dissecans
Sacrocaudal dysgenesis
Spina bifida
Tethered cord syndrome

References

### 2.6 Ocular signs

#### 2.6.1 Red eye

CONJUNCTIVITIS

Chemical
- Acid
- Alkali
- Antiseptics
- Shampoos

Immune-mediated
- Allergic
- Arthropod bites*
- Atopy*
- Drug reaction
- Food hypersensitivity*
- Idiopathic
- Keratoconjunctivitis sicca*
Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Ischaemic neuromyopathy
Luxation
Neoplasia
Psoas muscle injury

Chronic
Degenerative myelopathy*
Dermoid sinus
Lumbosacral disc disease* (D)
Neoplasia
Sacral osteochondritis dissecans
Sacrocaudal dysgenesis
Spina bifida
Tethered cord syndrome

References

2.6 Ocular signs

2.6.1 Red eye

CONJUNCTIVITIS

Chemical
Acid
Alkali
Antiseptics
Shampoos

Immune-mediated
Allergic
Arthropod bites*
Atopy*
Drug reaction
Food hypersensitivity*
Idiopathic
Keratoconjunctivitis sicca*
**Infectious**

Bacterial*  
Fungal, e.g.  
  • Blastomycosis  
Mycoplasmal  
Parasitic, e.g.  
  • Thelazia spp  
Rickettsial  
Viral, e.g.  
  • Canine distemper virus* (D)

**Neurological**

Lack of blink reflex  
  • Lesions of facial nerve *q.v.*  
  • Lesions of trigeminal nerve *q.v.*  
Lack of tear production  
  • Neurogenic keratoconjunctivitis sicca

**Physical**

Cilia*  
Dust*  
Foreign body*  
Masses*  
Poor eyelid anatomy*  
  • Ectropion  
  • Entropion

**Radiation therapy**

**Neoplastic, e.g.**  
Mast cell tumour  
Melanoma  
Squamous cell carcinoma

**Systemic diseases**

Hepatozoonosis  
Leishmaniasis  
Listeriosis  
Multiple myeloma  
Systemic histiocytosis  
Tyrosinaemia (D)

**ANTERIOR UVEITIS**

Idiopathic

**Ionising radiation**

**Infection**

*Algae*  
Protothecosis
**Bacteria**
- Bartonella
- Borrellosis
- Brucellosis (D)
- Leptospirosis
- Septicaemia
  - Abscesses*
  - Bacterial endocarditis
  - Dental infections*
  - Neonatal umbilical infections
  - Prostatitis*
  - Pyelonephritis
  - Pyometra*
  - Pyothorax

**Fungal**
- Blastomycosis
- Candidiasis
- Coccidioidomyocosis
- Cryptococcosis
- Histoplasmosis

**Parasitic**
- Angiostrongylosis
- *Baylisascaris procyonis*
- *Diptera*
- Dirofilariasis
- Toxocariasis

**Protozoa**
- Leishmaniasis
- Neosporosis (D)
- Toxoplasmosis

**Rickettsia**
- Ehrlichiosis
- Rocky Mountain Spotted Fever

**Viruses**
- Canine adenovirus-1 (D)
- Canine distemper virus
- Canine herpes virus (D)
- Feline immunodeficiency virus (C)*
- Feline infectious peritonitis (C)*
- Feline leukaemia virus (C)*
- Rabies

**Neoplasia**
- Adenocarcinomas
- Ciliary body
- Ciliary body adenoma
- Medulloepitheliomas
- Melanoma
- Metastatic neoplasia, especially
• Haemangiosarcoma
• Lymphoma
Sarcoma
Systemic histiocytosis

**Non-infectious inflammatory**
Lens-associated anterior uveitis
• Cataract*
• Luxation*
• Penetrating trauma*
Granulomatous meningoencephalomyelitis
Idiopathic
Immune-mediated vasculitis
Pigmentary uveitis
Uveodermatological syndrome

**Systemic, e.g.**
Coagulopathy
Hyperlipidaemia *q.v.*
Systemic hypertension* *q.v.*
Toxaemia

**Trauma**
Blunt trauma*
Penetrating trauma*/Intraocular foreign bodies
Drugs, e.g.
• Miotics

**BULBAR HYPERAEMIA/VASCULAR CONGESTION**
Anterior scleritis
Trauma*

**Episcleritis**
Nodular
Simple

**Glaucoma**
*Primary*
Goniodygenesis
Primary open angle glaucoma

*Secondary*
Cataract* *q.v.*
Intraocular haemorrhage* *q.v.*
Lens luxation*
Neoplasia
Neovascular tissue overlying pectinate ligament
Pigmentary glaucoma
Trauma
Uveitis* q.v.
Vitreous prolapse post-lentectomy

Drugs
- Atropine
- Sildenafil

**INSIDE RED EYE**
- Anterior uveitis
- Hyphaema
- Iris mass
- Retinal detachment
- Vitreal haemorrhage

**CORNEA RED**
- Neovascularisation
- Granulation tissue
- Haemorrhage

**References**

**2.6.2 Corneal opacification**

**Corneal oedema**
- Anterior uveitis* q.v.
- Canine adenovirus-1 (D)
- Corneal ulceration* q.v.
- Endophthalmitis
- Endothelial dystrophy
- Glaucoma q.v.
- Historic use of canine adenovirus-1 live vaccine
- Intraocular neoplasia
- Mechanical trauma*/iatrogenic
- Neovascularisation
- Persistent pupillary membranes
- Drugs/toxins
  - Tocainide

**Pigmentation**
- Anterior synechiae
- Chronic corneal insult*
- Congenital endothelial pigmentation
- Corneal sequestrum
- Limbal melanoma
- Persistent pupillary membranes
- Pigmentary glaucoma

**Corneal vascularisation**
- Endophthalmitis
- Glaucoma q.v.
- Intraocular neoplasia
- Keratitis*
- Pannus*
- Uveitis* q.v.
**Miscellaneous**
- Calcium deposition
- Cellular infiltration
- Degenerative changes
- Foreign bodies*
- Lipid deposition
- Neoplastic infiltration
- Scarring*
- Xerosis

**References**

---

**2.6.3 Corneal ulceration/erosion**

**Degeneration**
- Corneal calcific degeneration
- Lipid keratopathy

**Dystrophic**
- Bullous keratopathy
- Corneal endothelial dystrophy
- Corneal sequestrum (C)
- Epithelial basement membrane dystrophy (indolent ulcer)

**Infection**

**Bacterial (secondary invaders)**
- *Bacillus* spp
- *Corynebacterium* spp
- *Escherichia coli*
- *Pseudomonas* spp
- *Staphylococcus* spp
- *Streptococcus* spp

**Fungal**
- *Acremonium* spp
- *Alternaria* spp
- Aspergillosis
- Candidiasis
- *Cephalosporium* spp
- *Curvulcia* spp
- *Pseudallescheria* spp
- *Scedosporium* spp
Protozoal

Viral
  Feline herpes virus* (C)

Inflammation/immune-mediated
  Feline eosinophilic keratitis
  Keratoconjunctivitis sicca*
  Punctate keratopathy (D)

Mechanical/irritant trauma
  Aberrant hairs*
  Distichiasis*
  Ectopic cilia*
  Eyelid abnormalities*
    • Ectropion
    • Entropion
  Heat
  Irritant chemicals
  Self-trauma*
  Shampoos
  Smoke*
  Trichiasis*
  Ultraviolet light*

Neurological conditions
  Ionising radiation
  Lack of blink reflex
    • Lesions of facial nerve q.v.
    • Lesions of trigeminal nerve q.v.
  Lack of tear production
    • Neurogenic keratoconjunctivitis sicca

References

2.6.4 Lens lesions

Cataract
  Age-related*
  Electrocution
  Glaucoma q.v.
  Lens luxation (see below)
  Non-hereditary developmental
  Post-inflammation
  Radiation
  Retinal degeneration
**Hereditary, e.g.**
- Congenital with microphthalmos and rotatory nystagmus
- Early onset and progressive
- Posterior polar subcapsular cataract

**Metabolic**
- Diabetes mellitus*
- Hypocalcaemia
- Nutritional secondary hyperparathyroidism

**Nutritional**
- Hand rearing on milk substitutes

**Traumatic***
- Blunt
- Penetrating

**Drugs/toxins**
- Diazoxide
- Dimethyl sulfoxide
- Dinitrophenol
- Hydroxymethylglutaryl-coenzyme A reductase inhibitors
- Ketoconazole
- Pefloxacin
- Phenylpiperazine
- Progesterone-based contraceptives
- Sulfonylurea glimepiride
- Topical dexamethasone

**Luxation/subluxation**

**Primary**

**Secondary**
- Chronic uveitis *q.v.*
- Glaucoma *q.v.*
- Lens shape/size abnormalities
- Trauma

**References**
2.6.5 Retinal lesions

Retinal detachment
Fibrous vitreoretinal adhesions
Trauma*

Congenital, e.g.
Collie eye anomaly
Persistent hyperplastic primary vitreous and retinal dysplasia

Iatrogenic
Complication of lens surgery

Space-occupying lesions
Extraocular
Intraocular

Systemic disease
Hypertension* q.v.
Severe systemic inflammatory disease
Uveodermatological syndrome

Swollen optic disc
Papilloedema, e.g.
Acute glaucoma
Hypertension q.v.
Neoplasia of optic nerve
Orbital space-occupying lesion
Raised intracranial pressure
  • Brain tumours
  • Intracranial haemorrhage

Optic neuritis
Inflammatory
  • Granulomatous meningoencephalomyelitis
Infectious
  • Blastomycosis
  • Canine distemper virus* (D)
  • Cryptococcosis
  • Histoplasmosis
  • Toxoplasmosis
Idiopathic
Local disease
  • Orbital abscess*
  • Orbital cellulitis*
Neoplasia
Trauma*
Toxins

Pseudopapilloedema
Congenital defects
Disc oedema
- Glaucoma *q.v.*
- Post-operative hypotony
- Uveitis *q.v.*

Neoplasia
- Metastatic
- Primary

Retinal haemorrhage*, e.g.*
- Coagulopathy
- Hypertensive retinopathy
- Hyperviscosity
- Inflammatory/infectious chorioretinitis
- Neoplastic chorioretinitis

References

2.6.6 Intraocular haemorrhage/hyphaema

Chronic glaucoma

Coagulopathy

Congenital disease
- Collie eye anomaly
- Persistent hyaloid artery
- Persistent hyperplastic primary vitreous
- Vitreoretinal dysplasia

Hyperviscosity syndrome
- Hyperglobulinaemia
- Polycythaemia *q.v.*

Iatrogenic
- Post surgery

Inflammation, e.g.
- Uveitis

Neoplasia

Neovascularisation
- Retinal
- Uveal
Retinal detachment q.v.

Systemic hypertension* q.v.

Trauma*

References

2.6.7 Abnormal appearance of anterior chamber

Anterior synechia

Anterior uveitis q.v.

Congenital lesions
Coloboma
Iris cysts
Persistent pupillary membranes

Hyphaema q.v.

Hypopyon
Deep corneal ulceration
Uveitis q.v.

Infiltration by neoplastic cells

Lipaemic aqueous

Masses
Foreign body*
Iris cysts
Luxated lens
Organised fibrin post inflammation*
Uveal tumours
• Adenocarcinoma
• Adenoma
• Medulloepithelioma
• Melanoma
• Metastatic

References
2.7 Musculoskeletal signs

2.7.1 Muscular atrophy or hypertrophy

ATROPHY

Disuse atrophy
- Orthopaedic disease q.v.
- Restricted exercise

Metabolic/endocrine/systemic disease
- Cardiac disease
- Neoplasia
- Glycogen storage diseases
- Hyperadrenocorticism
- Hyperthyroidism (C)
- Hypothyroid myopathy (D)
- Lipid storage myopathy
- Mitochondrial myopathy
- Poor nutritional states
  - Gastrointestinal disease q.v.
  - Inadequate protein-calorie intake

Myopathies

Degenerative/inherited
- Distal myopathy of Rottweilers (D)
- Fibrotic myopathy
- Labrador Retriever myopathy (D)
- Merosin-deficient myopathy
- Muscular dystrophy
- Nemaline myopathy

Inflammatory/infectious
- Bacterial
- Dermatomyositis
- Extra-ocular myositis
- Leptospirosis
- Masticatory myositis
- Polymyositis
- Protozoal
  - Neosporosis (D)
  - Toxoplasmosis
- Tetanus

### 2.7 Musculoskeletal signs

#### 2.7.1 Muscular atrophy or hypertrophy

**ATROPHY**

**Disuse atrophy***
- Orthopaedic disease* *q.v.*
- Restricted exercise*

**Metabolic/endocrine/systemic disease**
- Cachexia*
  - Cardiac disease*
  - Neoplasia*
- Glycogen storage diseases
- Hyperadrenocorticism
- Hyperthyroidism* (C)
- Hypothyroid myopathy (D)
- Lipid storage myopathy
- Mitochondrial myopathy
- Poor nutritional states
  - Gastrointestinal disease *q.v.*
  - Inadequate protein-calorie intake

**Myopathies**

*Degenerative/inherited*
- Distal myopathy of Rottweilers (D)
- Fibrotic myopathy
- Labrador Retriever myopathy (D)
- Merosin-deficient myopathy
- Muscular dystrophy
- Nemaline myopathy

*Inflammatory/infectious*
- Bacterial
- Dermatomyositis
- Extra-ocular myositis
- Leptospirosis
- Masticatory myositis
- Polymyositis
- Protozoal
  - Neosporosis (D)
  - Toxoplasmosis
- Tetanus
**Neurogenic**

Neoplasia, e.g.
- Malignant nerve sheath tumour
Peripheral neuropathies *q.v.*
Spinal cord disease *q.v.*

**HYPERTROPHY/MUSCULAR SWELLING**

Athletic training*
Breed related*
Myositis ossificans
Myotonia (D)
Muscular dystrophy
Traumatic ischaemic neuromyopathy associated with bottom-hung pivot windows and garage doors (C)

**References**


### 2.7.2 Trismus (‘lockjaw’)

**Temporomandibular joint ankylosis**

Infection
Systemic arthropathies
Trauma*
Tumours

**Pain on opening jaw**

Foreign body*
Retrobulbar cellulitis or abscess*
Temporomandibular joint arthritis*
Tooth root abscess*
Trauma to buccal cavity or temporomandibular joint*

**Inflammatory**

Dermatomyositis
Granulomatous meningoencephalomyelitis
Infectious
- Neosporosis
- Tetanus
- Toxoplasmosis
Masticatory myositis
Trigeminal neuritis
**Mechanical**
- Foreign body
- Malicious, e.g. placement of rubber band
- Neoplasia
  - Mandibular
  - Maxillary
  - Oral
  - Orbital
  - Retrobulbar

**Drugs/toxins, e.g.**
- Cocaine

**References**

**2.7.3 Weakness** (see 1.1.8 for full listings)
- Cardiovascular disease*
- Endocrine disease*
- Haematological disease*
- Immune-mediated disease
- Infectious disease*
- Metabolic disease
- Neuromuscular disease
- Nutritional disorders
- Physiological
- Respiratory disease
- Systemic disorders*
- Drugs/toxins

**2.8 Urogenital physical signs**

**2.8.1 Kidneys abnormal on palpation**

**Enlarged kidneys** (see Plate 2.8 in colour plate section)
- *Irregular surface*
  - Feline infectious peritanitis (C)
  - Infarcts
  - Neoplasia*
  - Pericapsular abscess
  - Pericapsular haematoma
**Mechanical**
Foreign body
Malicious, e.g. placement of rubber band
Neoplasia
- Mandibular
- Maxillary
- Oral
- Orbital
- Retrobulbar

**Drugs/toxins, e.g.**
Cocaine

**References**

### 2.7.3 Weakness (see 1.1.8 for full listings)

- Cardiovascular disease*
- Endocrine disease*
- Haematological disease*
- Immune-mediated disease
- Infectious disease*
- Metabolic disease
- Neuromuscular disease
- Nutritional disorders
- Physiological
- Respiratory disease
- Systemic disorders*
- Drugs/toxins

### 2.8 Urogenital physical signs

#### 2.8.1 Kidneys abnormal on palpation

**Enlarged kidneys** (see Plate 2.8 in colour plate section)

- *Irregular surface*
  - Feline infectious peritonitis (C)
  - Infarcts
  - Neoplasia*
  - Pericapsular abscess
  - Pericapsular haematoma
Polycystic kidney disease
Renal cyst

**Smooth surface**
Acute renal failure *q.v.*
Amyloidosis
Compensatory hypertrophy
Hydronephrosis
Neoplasia*
Perinephric pseudocyst
Polycystic kidney disease
Pyelonephritis
Pyogranulomatous nephritis
Renal cyst

**Normal-sized kidneys – irregular surface**
Infarcts
Neoplasia*
Pericapsular haematoma
Polycystic kidney disease
Renal cyst
Subcapsular haematoma

---

**Fig. 2.8** Dorsoventral abdominal radiograph of a dog with right-sided renomegaly, due to a suspected renal adenocarcinoma. Reproduced with permission of Downs Referrals, Bristol.
Small kidneys

Irregular surface
  Chronic generalised glomerulo- or tubulo-interstitial disease* q.v.
  Hypoplastic kidneys
  Multiple infarcts

Smooth surface
  Hypoplasia

Absent kidneys
  Aplasia
  Nephrectomy

References

2.8.2 Bladder abnormalities

Palpable mass
  Neoplasia*
  Urolith*

Large bladder, difficult to express

Mechanical obstruction
  Matrix-crystalline plugs*
  Neoplasia*
    • Bladder
    • Urethra
  Prostatomegaly*
  Urethral stricture
  Uroliths*
    • Bladder neck
    • Urethra

Functional obstruction
  Neurological disease
    • Upper motor neurone bladder*
      • Spinal disorders cranial to L7 q.v.
Psychogenic*
  • Pain
  • Stress

Reflex dyssynergia

Drugs/toxins, e.g.
  • Atropine
  • Glycopyrronium bromide
  • Propantheline bromide
  • Tricyclic antidepressants

**Large bladder, easy to express**
Normal

**Neurological disease, e.g.**
Dysautonomia
Lower motor neurone bladder*
  • Cauda equina syndrome
  • Lesion of sacral spinal cord
  • Lesions of pelvic/lumbosacral plexus

**Small/difficult to palpate bladder**
Congenital hypoplasia
Ectopic ureters
Non-distensible bladder
  • Diffuse bladder-wall neoplasia
  • Severe cystitis, e.g.
    • Calculi
    • Infection
    • Trauma

Oliguric/anuric renal failure *q.v.*
Recent voiding*
Ruptured bladder
Ruptured ureters

**2.8.3 Prostate abnormal on palpation**

**Enlargement**

*Diffuse*
  - Bacterial prostatitis
  - Benign prostatic hyperplasia*
  - Neoplasia

*Focal lesions*
  - Abscess
  - Cysts
    • Paraprostatic
    • Prostatic
  - Neoplasia
2.8.4 Uterus abnormal on palpation

**Enlargement on palpation**
- Haemometra
- Hydrometra
- Mucometra
- Neoplasia*
  - Adenocarcinoma
  - Adenoma
  - Leiomyoma
  - Leiomyosarcoma
- Post partum*
- Pregnancy*
- Pyometra*

2.8.5 Testicular abnormalities

**Single palpable testis**
- Castration of single descended testis with subsequent descent of unilateral cryptorchid testis
- Unilateral cryptorchid*
- Unilateral testicular agenesis

**No palpable testis**
- Bilateral cryptorchid*
- Bilateral testicular agenesis
- Intersex abnormalities
- Previous castration*

**Large testis**
- Acute infection
- Inguinoscrotal hernia
- Neoplasia
- Sperm granuloma
- Testicular torsion

**Small testis**
- Chronic inflammation
- Cryptorchidism
- Degeneration
- Hypoplasia
- Intersex
- Sertoli cell tumour in contralateral testis

**Reference**
2.8.6 Penis abnormalities

Paraphimosis
Chronic balanoposthitis
Foreign bodies in prepuce
Fracture of the os penis
Idiopathic
Obstruction of the preputial opening by long hair*
Small preputial opening
  • Congenital
  • Post-surgical
  • Traumatic
Soft tissue trauma*
Spinal lesions

Penile bleeding
Haematuria* q.v.
Herpes virus
Transmissible venereal tumour
Other tumours
Trauma

Prostatic disease, e.g.
Benign hyperplasia

Urethral disease, e.g.
Urethral prolapse

Reference
PART 3
RADIOGRAPHIC AND ULTRASONOGRAPHIC SIGNS

3.1 Thoracic radiography

3.1.1 Artefactual causes of increased lung opacity

Chemical stains/dirty cassettes
Dirty or wet fur
Forelimbs not pulled sufficiently forward
Movement blur
Obesity
Poorly inflated lungs
• Abdominal distension
• Expiratory film
• Upper airway obstruction
Underdevelopment
Underexposure

3.1.2 Increased bronchial pattern

Normal variation*
Chondrodystrophic breeds
Older dogs

Bronchial wall oedema, e.g.
Congestive heart failure*

Bronchiectasis

Chronic bronchitis*
Primary ciliary dyskinesia (D)

Infection
Bacterial*
Fungal, e.g.
• Pneumocystis carinii
Parasitic, e.g.
• Crenosoma vulpis (D)
Protozoal, e.g.
• Toxoplasmosis
Viral

Copyright © 2007 by Alex Gough
Inflammation, e.g.
Eosinophilic bronchopneumonopathy (Pulmonary infiltrate with eosinophils) (D)
Feline asthma (C)

Endocrine
Hyperadrenocorticism

Figure 3.1(a)  Dorsoventral thoracic radiograph of a cat with feline asthma, showing a predominantly bronchial pattern. A microchip is also visible. Reproduced with permission of Downs Referrals, Bristol.

Figure 3.1(b)  Lateral thoracic radiograph of the same case as in Figure 3.1(a). Reproduced with permission of Downs Referrals, Bristol.
Neoplasia
Bronchogenic carcinoma
Lymphoma

References

3.1.3 Increased alveolar pattern

Atelectasis
Airway obstruction
Chronic pleural or pulmonary disease
Collapse of lung lobes under general anaesthesia
Extra-pulmonary thoracic mass
Feline asthma (C)
Lack of surfactant (newborn, acute respiratory distress syndrome)
Lung lobe torsion
Pleural effusion q.v.
Pneumothorax q.v.
Recumbency

Neoplasia
Malignant histiocytosis
Primary lung tumour, e.g.
• Bronchoalveolar carcinoma
Pulmonary lymphomatoid granulomatosis

Pulmonary oedema
Acute dyspnoea in Swedish Hunting Dogs
Acute pancreatitis
Airway obstruction
Brain trauma
Congestive heart failure
Electrocution
Hypoalbuminaemia
Hypostatic congestion
Iatrogenic
• Aspired hypertonic contrast media
• IV contrast media
• Overhydration
Inhalation of irritant gases/smoke
Lung lobe torsion
Near drowning
Obstruction of pulmonary drainage mechanisms, e.g.
  • Hilar mass
Post-ictal
Re-expansion, e.g.
  • Post pneumothorax
Seizures
Other CNS disease
Uraemia q.v.

**Acute respiratory distress syndrome**
Iatrogenic, e.g.
  • Overhydration
  • Oxygen therapy
Infection
Inhalation pneumonia
Pancreatitis
Trauma

**Toxins**
Alphanaphylthiourea
Endotoxin
Ethylene glycol
Paracetamol
Snake venom

**Pneumonia**

**Aspiration pneumonia**
Aspirated foreign body*
Cleft palate
Gastrobronchial fistula
Generalised weakness
Iatrogenic, e.g.
  • Anaesthetic complication
  • Force feeding
  • Incorrectly placed stomach tube
Oesophagotracheal/bronchial fistula
Regurgitation, e.g.
  • Megaesophagus
Swallowing disorders
Vomiting

**Bronchopneumonia, e.g.**
Canine distemper virus with secondary bacterial infection* (D)
Tracheobronchitis*
Bacterial, e.g.
- Tuberculosis
- Tularaemia

Fungal, e.g.
- Pneumocystis carinii

Parasitic, e.g.
- Aelurostrongylus abstrusus (C)
- Angiostrongylus vasorum (D)
- Dirofilaria immitis
- Oslerus osleri (D)

Miscellaneous
- Kartagener’s syndrome
- Primary ciliary dyskinesia
- Radiation therapy

**Pulmonary haemorrhage**
- Coagulopathy q.v.
- Exercise-induced
- Idiopathic
- Neoplasia*
- Trauma*

**Inflammation/immune-mediated**
- Eosinophilic bronchopneumonopathy (Pulmonary infiltrate with eosinophilia)

**Pulmonary thromboembolism**

![Lateral thoracic radiograph showing an alveolar pattern due to pulmonary oedema. The enlarged cranial lobar pulmonary veins suggest that this is secondary to left-sided congestive heart failure.](image)

**Figure 3.1(c)** Lateral thoracic radiograph showing an alveolar pattern due to pulmonary oedema. The enlarged cranial lobar pulmonary veins suggest that this is secondary to left-sided congestive heart failure. Reproduced with permission of Downs Referrals, Bristol.
Figure 3.1(d)  Dorsoventral thoracic radiograph of a cat with chylothorax. A microchip is present. Reproduced with permission of Downs Referrals, Bristol.

Figure 3.1(e)  Lateral thoracic radiograph of the same cat as in Fig. 3.1(d). Reproduced with permission of Downs Referrals, Bristol.

References


### 3.1.4 Increased interstitial pattern

**Nodular**

**Artefact**
- End-on view of blood vessels
- Nipples
- Objects adhering to coat
- Ossification of costochondral junctions
- Thoracic wall nodules

**Infection**
- Abscesses
- Feline infectious peritonitis* (C)
- Granulomata
  - Bacterial
  - Foreign body*
  - Fungal
- Hydatid cysts
- Parasitic
  - *Aelurostrongylus abstrusus* (C)
  - *Crenosoma vulpis* (D)
  - *Oslerus osleri* (D)
  - *Paragonimus kellicotti* (D)
  - Tularaemia
  - Visceral larva migrans
- Pneumonia
  - Fungal pneumonia
  - Haematogenous bacterial pneumonia
  - Mycobacterial pneumonia
- Protozoal, e.g.
  - Toxoplasmosis

**Neoplasia**
- Lymphoma*
- Metastatic tumours*
- Primary lung tumours

**Miscellaneous**
- Calcified pleural plaques*
- Disseminated intravascular coagulation
Haematomata
Idiopathic mineralisation
Pulmonary osteomata (heterotopic bone)*

**Diffuse/unstructured**
Artefact, e.g.
- Expiratory film
Neoplasia
Oedema (early) *q.v.*

**Endocrine**
Hyperadrenocorticism

**Infection**
Bacterial
Fungal, e.g.
- Blastomycosis
- Coccidioidomycosis
- Cryptococcosis
- Histoplasmosis
- *Pneumocystis carinii* (D)
Mycoplasmosis
Parasitic
- *Aelurostrongylus abstrusus* (C)
- *Angiostrongylus vasorum* (D)
- Babesiosis
- Dirofilariasis
Protozoal, e.g.
Rickettsial, e.g.
- Rocky Mountain Spotted Fever (D)
Toxoplasmosis
Viral, e.g.
- Canine distemper virus* (D)
- Feline infectious peritonitis* (C)

**Inhalation**
Dust
Irritant gases

**Pulmonary fibrosis**
Idiopathic
Secondary to chronic respiratory disease

**Pulmonary haemorrhage**
Coagulopathy *q.v.*
Exercise-induced
Idiopathic
Neoplasia
Trauma
Miscellaneous
- Acute respiratory distress syndrome
- Pancreatitis
- Pulmonary thromboembolism
- Radiation therapy
- Uraemia* q.v.
- Very old animals
- Very young animals

Drugs/toxins
- Chronic glucocorticoid administration
- Paraquat

Reticular pattern
- Normal ageing*
- Chronic fibrosis
- Fungal pneumonia
- Lymphoma*
- Metastatic neoplasia*

References

3.1.5 Increased vascular pattern

Increased size of pulmonary arteries
Aelurostrongylus abstrusus (C)
Angiostrongylus vasorum (D)
Dirofilariasis
Large left-to-right shunts, e.g.
- Atrial septal defect
- Endocardial cushion defects
- Patent ductus arteriosus
- Ventricular septal defect
Pulmonary hypertension
Pulmonary thromboembolism
**Increased size of pulmonary veins**
Left-sided heart failure
Left-to-right shunts, in some cases

**Increased size of pulmonary arteries and veins**
Left-to-right shunts, e.g.
- Atrial septal defect
- Endocardial cushion defects
- Patent ductus arteriosus
- Ventricular septal defect

**References**

### 3.1.6 Decreased vascular pattern

**Generalised**

*Pericardial disease, e.g.*
- Pericardial effusion* q.v.
- Restrictive pericarditis

*Pulmonary hypoperfusion*
- Hypoadrenocorticism (D)
- Localised hypoperfusion due to pulmonary thromboembolism
- Pulmonic stenosis
- Severe dehydration*
- Shock*
- Tetralogy of Fallot

*Pulmonary over-inflation*
- Air trapping
  - Chronic bronchitis* (D)
  - Feline asthma* (C)
  - Upper respiratory tract obstruction, e.g.
    - Foreign body*
    - Nasopharyngeal polyp* (C)
- Compensatory
  - Following lobectomy
  - Secondary to atelectasis of another lobe
  - Secondary to congenital lobar atresia/agenesis
- Emphysema
- Iatrogenic
  - Anaesthesia
Right-to-left cardiac shunts, e.g.
- Atrial septal defect
- Reverse-shunting patent ductus arteriosus
- Tetralogy of Fallot
- Ventricular septal defect

**Localised**
- Emphysema
- Pulmonary thromboembolism

**Reference**

### 3.1.7 Cardiac diseases that may be associated with a normal cardiac silhouette

- Bacterial endocarditis
- Congestive heart failure overzealously treated with diuretics
- Constrictive pericarditis
- Functional murmurs*
- Hypertrophic cardiomyopathy* (C)
- Neoplasia
- Small atrial septal defect
- Small ventricular septal defect

### 3.1.8 Increased size of cardiac silhouette

#### Generalised cardiomegaly
- Normal variation, e.g.
  - Greyhound*
- Artefact
  - Bacterial endocarditis
  - Bradycardia* q.v.
  - Chronic anaemia* q.v.
  - Concurrent mitral and tricuspid valve deficiency
  - Dysplasia
  - Intrapericardial fat
  - Mediastinal fat
  - Myxomatous degeneration* (D)
- Congenital cardiac disease, e.g.
  - Peritoneopericardial diaphragmatic hernia
- Enlargement of specific chamber sizes q.v.
- Pericardial effusion* q.v.

#### Myocardial disease
- Inflammatory
  - Immune-mediated, e.g. rheumatoid arthritis
• Infectious, e.g.
  • Bacterial
  • Fungal
  • Parvovirus
  • Protozoal

Ischaemic
• Arteriosclerosis

Non-inflammatory
• Dilated cardiomyopathy*
• Hypertrophic cardiomyopathy (C)*
• Restrictive cardiomyopathy (C)

Secondary
• Acromegaly
• Amyloidosis
• End-stage mitral valve insufficiency* (D)
• Glycogen storage disease
• Hypertension* q.u.
• Hyperthyroidism* (C)
• Mucopolysaccharidosis
• Neoplasia
• Neuromuscular disease
• Nutrition
  • L-carnitine deficiency
  • Taurine deficiency
• Trauma
• Drugs/toxins
  • Doxorubicin
  • Heavy metals

Volume overload
Iatrogenic
Left-sided heart failure

Figure 3.1(f) Dorsoventral thoracic radiograph of a dog, demonstrating a very large cardiac silhouette due to pericardial effusion. Reproduced with permission of Downs Referrals, Bristol.
• Bacterial endocarditis
• Dilated cardiomyopathy
• Mitral valve dysplasia
• Myxomatous degeneration of the mitral valve (D)

References

3.1.9 Decreased size of cardiac silhouette

Atrophic myopathies
Constrictive pericarditis
Hypoadrenocorticism (D)
Post thoracotomy

Artefact
Deep-chested dogs
Deep inspiration
Heart displaced from sternum, e.g.
  • Mediastinal shift
  • Pneumothorax
Pulmonary over-inflation, e.g.
  • Emphysema
  • Hyperventilation

Decrease in muscle mass
Chronic systemic disease
Malnutrition
Myopathies

Shock* q.v., e.g.
  Hypovolaemia, e.g.
    • Blood loss
    • Severe dehydration

Reference

3.1.10 Abnormalities of the ribs

Congenital disorders
  Absence of xiphisternum
  Agenesis/hypoplasia of 13th rib
  Pectus excavatum
  Supernumerary ribs
### New bone
- Cartilaginous exostoses
- Healed fractures
- Mineralisation of the costal cartilages*
- Neoplasia
- Non-union fractures
- Periosteal reaction to soft tissue mass

### Osteolysis
- Metastatic tumours
- Osteomyelitis
- Primary tumours
  - Chondrosarcoma
  - Fibrosarcoma
  - Haemangiosarcoma
  - Multiple myeloma
  - Osteoma
  - Osteosarcoma

### Thoracic wall trauma*

### References

### 3.1.11 Abnormalities of the oesophagus

#### Oesophageal dilatation

#### Generalised

*Transient megaoesophagus*
- Hiatal hernia
- Respiratory infection
- Sedation/anaesthesia*

*Acquired megaoesophagus*
- Idiopathic
- Immune-mediated myopathies
  - Myasthenia gravis
  - Polymyositis
  - Polyradiculoneuritis
  - Systemic lupus erythematosus
- Metabolic/endocrine
  - Diabetes mellitus*
  - Glucocorticoid administration*
  - Hyperadrenocorticism*
• Hypoadrenocorticism (D)
• Hypothyroidism* (D)
• Insulinoma
• Renal failure* q.v.

Miscellaneous
• Dysautonomia
• Gastric dilatation/volvulus*
• Hypertrophic muscular dystrophy
• Oesophageal foreign body
• Reflux oesophagitis
• Thiamine deficiency

Toxic
• Botulinum toxin
• Chlorinated hydrocarbons
• Heavy metals
• Herbicides
• Organophosphates
• Snake venom
• Tetanus

**Congenital megaoesophagus**
Canine giant axonal neuropathy (D)
Glycogen storage disease
Hereditary megaoesophagus
Hereditary myopathy
Vascular ring anomaly, e.g.
• Double aortic arch
• Normal aorta with aberrant right subclavian artery
• Persistent right aortic arch
• Persistent right ductus arteriosus
• Right aortic arch with aberrant right subclavian artery

**Localized**
Redundant oesophagus

**Transient**
Aerophagia*
Dyspnoea*
Swallowing*

**Congenital**
Dilatation cranial to a congenital stenosis
Dilatation cranial to oesophageal hiatal hernia
Segmental oesophageal hypomotility
Vascular ring anomaly, e.g.
• Double aortic arch
• Normal aorta with aberrant right subclavian artery
• Persistent right aortic arch
• Persistent right ductus arteriosus
• Right aortic arch with aberrant right subclavian artery
• Oesophageal diverticulum
Acquired
Dilatation cranial to a gastro-oesophageal intussusception
Dilatation cranial to acquired stricture, e.g.
• Extraluminal compression
• Granuloma
• Mucosal adhesion
• Neoplasia
• Post general anaesthesia
Dilatation cranial to an oesophageal foreign body*
Oesophagitis
Scar tissue post trauma

INCREASED OESOPHAGEAL OPACITY

Soft tissue density
Megaesophagus with collection of food/water
Normal variation, e.g.
• Fluid in oesophagus*
• Superimposition of trachea*

Soft tissue mass
Intraluminal
• Food-containing oesophageal diverticulum
• Foreign body*
• Gastro-oesophageal intussusception
• Oesophageal hiatal hernia
Intramural
• Abscess
• Foreign body
• Granuloma, e.g.
  • Spirocerca lupi (D)
• Neoplasia
  • Metastatic
  • Primary oesophageal, e.g.
    • Leiomyoma/sarcoma
    • Squamous cell carcinoma
  • Secondary to Spirocerca lupi (D)
Extraluminal
• Abscess
• Neoplasia
• Paraoesophageal hiatal hernia

Bony density
Foreign body*
Megaesophagus with collection of food
Osteosarcoma, e.g.
• Secondary to Spirocerca lupi (D)

References

### 3.1.12 Abnormalities of the trachea

#### Dorsal displacement

Artefact
- Expiration
- Rotation
- Ventroflexion

Breed variation*
Cardiomegaly*
Cranioventral mediastinal mass
Heart base tumour
Tracheobronchial lymphadenopathy*

#### Ventral displacement

Craniodorsal mediastinal mass
Megaesophagus
Oesophageal foreign body*
Post-stenotic aortic dilatation
Vertebral spondylosis

#### Lateral displacement

Artefact
- Expiration
- Rotation
- Ventroflexion

Breed variation*
Cranial mediastinal mass
Heart base tumour
Mediastinal shift *q.u.*
Megaesophagus
Vascular ring anomaly

#### Narrowing

Congenital hypoplasia

#### Artefact

Hyperextension of neck
Superimposition of muscle/oesophagus
External compression
- Cranial mediastinal mass
- Megaoesophagus
- Oesophageal foreign body*
- Vascular ring anomaly

Mucosal thickening
- Feline infectious peritonitis* (C)
- Inflammation, e.g.
  - Allergy*
  - Infection*
  - Irritant gases
- Submucosal haemorrhage, e.g.
  - Coagulopathy

Stricture/stenosis
- Congenital
- Excessive pressure from the cuff of endotracheal tube
- Focal intramural mass
- Post-traumatic injury

Tracheal collapse*
- Acquired, e.g.
  - Secondary to chronic bronchitis
- Congenital

Opacification of lumen
- Abscess
- Aspiration of positive contrast agents
- Foreign body*
- Granuloma
- Oslerus osleri
- Polyp

Neoplasia
- Adenocarcinoma
- Chondrosarcoma
- Leiomyoma
- Lymphoma
- Mast cell tumour
- Osteochondroma
- Osteosarcoma

References
  JAVMA, 201:768–72.
3.1.13 Pleural effusion

**Bile pleuritis**
Ruptured biliary tree with diaphragmatic hernia

**Blood**
Autoimmune disorders, e.g.
- Immune mediated thrombocytopenia
Coagulopathy
Neoplasia, e.g.
- Haemangiosarcoma
Trauma

**Chyle**
Congenital duct malformation (D)
Constrictive pleuritis
Cranial mediastinal mass
Diaphragmatic rupture*
Feline dirofilariasis (C)
Idiopathic*
Lung lobe torsion
Neoplasia
Peritoneopericardial diaphragmatic hernia
Post pacemaker implantation (C)
Rupture of thoracic duct

**Heart disease***
Dilated cardiomyopathy (C)
Hypertrophic cardiomyopathy (C)*
Pericardial disease
Right-sided heart failure (C)

**Obstruction of thoracic duct**
Intraluminal
- Granuloma
- Neoplasia
Extraluminal
- Increased intrathoracic pressure

**Exudate**
Actinomycosis
Autoimmune disorders, e.g.
- Rheumatoid arthritis
- Systemic lupus erythematosus
Feline infectious peritonitis* (C)
Fungal infection
Neoplasia*
Nocardiosis
Pneumonia*
Pyothorax*  
- Foreign body  
- Haematogenous spread  
- Penetrating thoracic wound  
- Penetration of trachea/oesophagus

Tuberculosis

Transudate/modified transudate
Congestive heart failure*  
Diaphragmatic rupture*  
Foreign body  
Hyperthyroidism* (C)  
Hypoproteinaemia q.v.*  
- Liver disease*  
- Protein-losing enteropathy*  
- Protein-losing nephropathy*

Idiopathic  
Lung lobe torsion  
Neoplasia, e.g.  
- Lymphoma*  
Pneumonia*  
Thromboembolism

References

3.1.14 Pneumothorax

Artefact
- Overdevelopment  
- Overexposure*  
- Overinflation of the lungs  
- Skin folds*  
- Undercirculation

Iatrogenic
- Cardiopulmonary resuscitation  
- Leaking chest drain  
- Lung aspiration/biopsy  
- Thoracocentesis  
- Thoracotomy

Spontaneous
- Bacterial pneumonia  
- Parasites
- Dirofilariasis
- *Oslerus osleri*
- *Paragonimus*

Pleural adhesions
Rupture of congenital or acquired bullae, cysts or blebs
Tumours*

**Trauma**
Perforation of lung*
Perforation of oesophagus
Perforation of thoracic wall*
Perforation of trachea/bronchi*

**References**

### 3.1.15 Abnormalities of the diaphragm

**Cranial displacement**
Diaphragmatic rupture/hernia*

**Abdominal causes**
- Abdominal neoplasia*
- Ascites*
- Gastric dilatation*
- Obesity*
- Organomegaly*, e.g.
  - Liver
  - Spleen
- Pneumoperitoneum
- Pregnancy*
- Pyometra*

**Thoracic causes**
- Atelectasis
- Diaphragmatic paralysis
- Diaphragmatic tumour
- Expiratory film*
- Lung lobectomy
- Pleural adhesions
- Pulmonary fibrosis

**Caudal displacement**

**Abdominal causes**
- Abdominal body wall rupture/hernia leading to abdominal organ displacement
- Poor body condition
**Thoracic causes**
- Chronic dyspnoea*
- Deep inspiration*
- Intrathoracic mass*
- Pleural effusion*
- Pneumothorax*

**Irregular diaphragmatic contour**
- Diaphragmatic rupture/hernia*
- Hypertrophic muscular dystrophy
- Pleural masses, e.g.
  - Granuloma
  - Neoplasia
- Severe lung hyperinflation

**Lack of visualisation of diaphragmatic border**
- Artefact, e.g.
  - Expiratory film
- Diaphragmatic hernia*
- Increased lung density, e.g.
  - Alveolar pattern*
- Neoplasia adjacent to diaphragm*
- Peritoneopericardial diaphragmatic hernia
- Pleural effusion*

**References**

### 3.1.16 Mediastinal abnormalities

**Mediastinal shift**

**Away from affected hemithorax**
- Diaphragmatic rupture/hernia*
- Lobar emphysema
- Lung mass*
- Oblique view
- Pleural mass*
- Unilateral pleural effusion*
- Unilateral pneumothorax*

**Towards affected hemithorax**
- Atelectasis
  - Feline asthma* (C)
• Foreign body*
• Mass*
• Radiation

Hypostatic congestion*, e.g.
• General anaesthesia
• Illness resulting in prolonged lateral recumbency

Lobar agenesis/hypoplasia
Lobectomy
Lung lobe torsion
Oblique view
Radiation-induced fibrosis
Unilateral phrenic nerve paralysis

**Pneumomediastinum**
Emphysematous mediastinitis
Iatrogenic
Secondary to severe dyspnoea*

**Air from neck**
Gas-forming bacteria
Trauma*, e.g.
• Jugular venipuncture
• Oesophagus
• Pharynx
• Soft tissue
• Trachea

**Air from bronchi/lungs, e.g.**
Lung lobe torsion
Spontaneous
Trauma*

**Widened mediastinum**
Normal variation*
• Bulldogs
Abscess
• Foreign body
Masses (see below)
Megaoesophagus *q.v.*
Obesity*

**Mediastinal effusions, e.g.**
Chylomediastinum
Haemorrhage
• Coagulopathy
• Neoplasia
• Trauma*

**Mediastinitis/mediastinal abscess**
Feline infectious peritonitis (C)
Lymphadenitis
Oesophageal/tracheal perforation
Penetrating neck wound*
Pleuritis*
Pneumonia*

Oedema*
Congestive heart failure*
Hypoproteinaemia* q.v.
Neoplasia*
Trauma*

**Mediastinal masses**
Aortic aneurysm
Cyst
Granuloma
  - Actinomycosis
  - Nocardiosis
Haematoma
Hiatal hernia
Oesophageal dilatation
Oesophageal foreign body*
Oesophageal granuloma
  - *Spirocerca lupi* (D)
Thymus

Artefact
Left or right atrial enlargement
Lung lobe tip
Pleural fluid
Post-stenotic dilatation of aorta or pulmonary artery

**Lymphadenopathy**
Neoplasia
  - Lymphoma*
  - Malignant histiocytosis
  - Metastatic neoplasia*
Bacterial
  - Actinomycosis
  - Nocardiosis
  - Tuberculosis
Eosinophilic pulmonary granulomatosis
Fungal
  - Blastomycosis
  - Coccidioidomycosis
  - Cryptococcosis
  - Histoplasmosis

**Neoplasia**
Ectopic parathyroid tumour
Ectopic thyroid tumour
Fibrosarcoma
Heart base tumours
Lipoma*
Lymphoma*
Malignant histiocytosis
Rib tumour
Thymoma

References

3.2 Abdominal radiography

3.2.1 Liver

Generalised enlargement

Endocrine disease
  Diabetes mellitus*
  Hyperadrenocorticism

Infection/inflammation
  Abscess
  Feline infectious peritonitis* (C)
  Fungal infection
  Granuloma
  Hepatitis*
  Lymphocytic cholangitis*

Neoplasia, e.g.
  Haemangiosarcoma
  Lymphoma*
  Malignant histiocytosis
  Metastatic tumours*

Venous congestion
  Caudal vena cava occlusion (post caval syndrome)
  • Adhesions
  • Cardiac neoplasia
  • Congenital cardiac disease
  • Diaphragmatic rupture/hernia*
  • Dirofilariasis
  • Pericardial disease
Fibrosarcoma
Heart base tumours
Lipoma*
Lymphoma*
Malignant histiocytosis
Rib tumour
Thymoma

References

3.2 Abdominal radiography

3.2.1 Liver

Generalised enlargement
Endocrine disease
Diabetes mellitus*
Hyperadrenocorticism

Infection/inflammation
Abscess
Feline infectious peritonitis* (C)
Fungal infection
Granuloma
Hepatitis*
Lymphocytic cholangitis*

Neoplasia, e.g.
Haemangiosarcoma
Lymphoma*
Malignant histiocytosis
Metastatic tumours*

Venous congestion
Caudal vena cava occlusion (post caval syndrome)
• Adhesions
• Cardiac neoplasia
• Congenital cardiac disease
• Diaphragmatic rupture/hernia*
• Dirofilariaisis
• Pericardial disease
• Thoracic mass
• Thrombosis
• Trauma*

Right-sided congestive heart failure, e.g.
• Dilated cardiomyopathy*
• Pericardial effusion *q.v.*
• Tricuspid regurgitation

**Miscellaneous**
Amyloidosis
Cholestasis *q.v.*
Cirrhosis (early)*
Hepatic lipidosis (C)
Nodular hyperplasia*
Storage diseases

**Drugs**
Glucocorticoids

**Focal enlargement**

**Infection/inflammation**
Abscess
Granuloma

**Neoplasia***
Biliary cystadenoma
Haemangiosarcoma
Hepatocellular carcinoma*
Hepatoma

---

**Figure 3.2(a)** Lateral abdominal radiograph of a young Labrador demonstrating hepatomegaly. Cytology revealed this to be due to hepatic lymphoma. Reproduced with permission of Downs Referrals, Bristol.
Lymphoma*
Malignant histiocytosis
Metastatic*

Miscellaneous
Biliary pseudocyst
Cyst
Haematoma
Hepatic arteriovenous fistula
Hyperplastic/regenerative nodule*
Liver lobe torsion

Reduced liver size
Cirrhosis
Diaphragmatic rupture/hernia*
Hypoadrenocorticism (D)
Idiopathic hepatic fibrosis
Portosystemic shunt
  • Acquired
  • Congenital

References

3.2.2 Spleen

Enlargement
Normal, e.g.
  Breed related*

Congestion
  Gastric dilatation/volvulus*
  Portal hypertension
  Right-sided congestive heart failure
  Sedation and general anaesthesia*
  Splenic thrombosis
  Splenic torsion

Haematoma*
  Idiopathic
  Secondary to neoplasia
  Trauma
Hyperplasia*
  Chronic anaemia *q.v.*
  Chronic infection
  Lymphoid

Inflammation/immune-mediated
  Hypereosinophilic syndrome
  Immune-mediated haemolytic anaemia
  Systemic lupus erythematosus

Infection
  Abscess
  Babesiosis
  Bacteraemia
  Ehrlichiosis
  Feline infectious peritonitis* (C)
  Fungal infections
  Haemobartonellosis
  Infectious canine hepatitis (D)
  Leishmaniasis
  Mycobacteria
  Toxoplasmosis
  Salmonellosis
  Septicaemia*

Neoplasia
  Fibrosarcoma
  Haemangioma
  Haemangiosarcoma*
  Leiomyosarcoma
  Leukaemia
  Lymphoma*
  Malignant histiocytosis
  Multiple myeloma
  Systemic mastocytosis

Miscellaneous
  Amyloidosis
  Extramedullary haematopoiesis*
  Infarction
  Splenic myeloid metaplasia

Trauma
  Foreign body
  Penetrating wound

Reduction in size
  Dehydration*
  Shock* *q.v.*
Absence
Artefact
Displacement though hernia/rupture
Splenectomy

References

3.2.3 Stomach

Cranial displacement
Diaphragmatic hernia/rupture*
Hiatal hernia
Late pregnancy*
Microhepatica
Neoplasia/mass, e.g.
• Colonic
• Mesenteric
• Pancreatic
Peritoneopericardial diaphragmatic hernia

Caudal displacement
Enlargement of thoracic cavity, e.g.
• Overinflation of lungs
• Pleural effusion* q.v.
Hepatomegaly* q.v.

Distended
Acute gastritis*
Gastric dilatation volvulus*
Pancreatitis*

Aerophagia*
Bolting food
Dyspnoea
Pain

Iatrogenic
Anticholinergic drugs
Endoscopic inflation
Misplaced endotracheal tube
Stomach tube
Outflow obstruction
- Fibrosis/scarring
- Foreign body
- Granuloma
- Muscular or mucosal hypertrophy
- Neoplasia
- Pylorospasm
- Ulceration

Abnormal contents

Gas
- Aerophagia
- Gastric dilatation/volvulus

Mineral opacity
- Foreign body
- Gravel sign (outflow obstruction)
- Iatrogenic
  - Barium
  - Bismuth
  - Kaolin

Soft tissue opacity
- Blood clot
- Food/ingested liquid
- Foreign body
- Intussusception
- Neoplasia
- Polyp

Increased wall thickness (contrast radiography)

Focal
- Artefact
  - Empty stomach
- Hypertrophy
  - Mucosal
  - Muscular
- Inflammation
  - Eosinophilic
  - Fungal infection
  - Granulomatous
- Neoplasia
  - Adenocarcinoma
  - Leiomyoma
  - Leiomyosarcoma
  - Lymphoma
**Diffuse**

Inflammation
- Chronic gastritis*
- Eosinophilic gastritis*

Neoplasia
- Lymphoma
- Pancreatic tumour

Chronic hyperplastic gastropathy

**Delayed gastric emptying**

Gastritis*
General anaesthesia/sedation*

**Functional disorders**

Adynamic ileus*
Dysautonomia
Pancreatitis*
Primary dysmotilities
Uraemia* q.v.

**Pylorospasm**

Anxiety
Stress

**Pyloric outflow obstruction**

Chronic hyperplastic gastropathy
Fibrosis/scar tissue
Foreign body*
Granuloma

Neoplasia
- Biliary
- Duodenal
- Gastric
- Pancreatic

Pyloric hypertrophy
- Mucosal
- Muscular

Ulceration

**Ulceration**

Duodenal
Gastric

**References**


3.2.4 Intestines

SMALL INTESTINE

**Increased number of small intestinal loops visible**

- Normal distension with fluid, food or gas
- Abdominal pain
- Acute gastroenteritis
- Adynamic ileus/pseudo-obstruction
- Amyloidosis
- Neurogenic disease
- Oedema
- Post surgery
- Vascular disease
- Drugs

**Physical obstruction**

- Adhesions
- Foreign body
- Intussusception
- Localised inflammation
- Neoplasia

**Decreased number of small intestinal loops visible**

- Body wall/diaphragmatic hernia/rupture
- Enterectomy
- Intussusception
- Linear foreign body
- Loss of serosal detail q.v.
- Normal empty small intestine
- Obesity

**Displacement**

**Diaphragmatic disorders**

- Peritoneopericardial diaphragmatic hernia
- Rupture/hernia

**Cranial displacement**

- Empty stomach
- Enlarged urinary bladder q.v.
- Enlarged uterus
  - Pregnancy
  - Pyometra
- Microhepatica

**Caudal displacement**

- Distended stomach
Empty urinary bladder
Hepatomegaly \( q.v. \)
Hernias
- Inguinal
- Perineal

**Lateral displacement**
Hepatomegaly \( q.v. \)
Prolonged lateral recumbency
Renomegaly \( q.v. \)
Splenomegaly \( q.v. \)

**Bunching**
Adhesions
Linear foreign body
Obesity

**Increased width of small intestinal loops**

**Artefact**
Mistaking colon for small intestine

**Mechanical obstruction**
Abscess
Adhesions
Caecal impaction
Constipation
Foreign body
Granuloma
Intestinal volvulus
Intussusception
Neoplasia, e.g.
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma
Polyps
Strangulation in hernia/mesenteric tear
Stricture

**Functional obstruction**
Dysautonomia
Electrolyte imbalances \( q.v. \)
Pancreatitis
Peritonitis
Recent abdominal surgery
Secondary to chronic mechanical obstruction
Severe gastroenteritis
Variation in small intestinal contents

Gas density
Normal*
Adhesions*
Aerophagia*
Enteritis*
Functional obstruction
• Dysautonomia
• Electrolyte imbalances* q.v.
• Pancreatitis*
• Peritonitis*
• Recent abdominal surgery*
• Secondary to chronic mechanical obstruction*
• Severe gastroenteritis*
Mechanical obstruction
• Abscess
• Adhesions
• Caecal impaction
• Constipation*
• Foreign body*
• Granuloma
• Intestinal volvulus
• Intussusception
• Neoplasia, e.g.
  • Adenocarcinoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma
• Polyps
• Strangulation in hernia/mesenteric tear
Partial obstruction*
Prolonged recumbency*

Fluid/soft tissue density
Normal*
Diffuse infiltrative neoplasia
Functional obstruction
• Dysautonomia
• Electrolyte imbalances* q.v.
• Pancreatitis*
• Peritonitis*
• Recent abdominal surgery*
• Secondary to chronic mechanical obstruction*
• Severe gastroenteritis*
Mechanical obstruction
• Abscess
• Adhesions*
• Caecal impaction
• Constipation*
• Foreign body*
• Granuloma
• Intestinal volvulus
• Intussusception
• Neoplasia, e.g.
  • Adenocarcinoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma
• Polyps
• Strangulation in hernia/mesenteric tear
  Mistaking colon or enlarged uterus for small intestine

Bony/mineral density
  Food*
  Foreign body*
  Iatrogenic
  • Contrast media
  • Medications

Delayed intestinal transit time
  Diffuse neoplasia
  Enteritis*
  Inflammatory bowel disease*
  Sedation/general anaesthesia*

Functional obstruction
  Dysautonomia
  Electrolyte imbalances* q.v.
  Pancreatitis*
  Peritonitis*
  Recent abdominal surgery*
  Secondary to chronic mechanical obstruction*
  Severe gastroenteritis*

Mechanical obstruction (partial)
  Abscess
  Adhesions*
  Caecal impaction
  Constipation*
  Foreign body*
  Granuloma
  Intussusception
  Neoplasia, e.g.
  • Adenocarcinoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma
Polyps
Strangulation in hernia/mesenteric tear

**Luminal filling defects on contrast radiography**
Foreign body*
Intussusception
Neoplasia
Parasitism*
Polyp

**Increased wall thickness (contrast radiography)**
Inflammatory bowel disease*
Fungal infections
Lymphangiectasia
Neoplasia, e.g.
  • Adenocarcinoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma

**LARGE INTESTINE**

**Displacement**

*Ascending colon*
Adrenal mass
Duodenal dilatation*
Hepatomegaly* q.v.
Lymphadenopathy* q.v.
Pancreatic mass
Renomegaly q.v.

*Transverse colon*
Diaphragmatic rupture/hernia*
Dilatation of stomach*
Enlarged bladder* q.v.
Enlarged uterus*
Hepatomegaly* q.v.
Lymphadenopathy* q.v.
Microhepatica q.v.
Mid-abdominal mass*
Pancreatic mass

*Descending colon*
Adrenal mass
Enlarged bladder* q.v.
Enlarged uterus* q.v.
Hepatomegaly* q.v.
Lymphadenopathy* q.v.
Prostatomegaly*
Renomegaly* q.v.
Retroperitoneal fluid
Splenomegaly* q.v.

**Rectum**
- Paraprostatic cyst
- Perineal hernia*
- Prostatomegaly*
- Sacral or vertebral mass
- Urethral mass
- Vaginal mass
- Other pelvic/intrapelvic mass

**Dilatation**
- Constipation/obstipation* q.v.

**Variation in contents**

**Empty**
- Normal
- Caecal inversion
- Enema
- Gastric/small intestinal obstruction* q.v.
- Large intestinal diarrhoea* q.v.
- Intussusception
- Neoplasia
- Typhlitis

**Soft tissue/mineral density**
- Caecal impaction
- Constipation/obstipation* q.v.
- Undigested dietary material*

**Luminal filling defects on contrast radiography**
- Caecal inversion
- Faeces*
- Foreign body*
- Intussusception
- Masses
  - Neoplasia
  - Polyps

**Increased wall thickness (contrast radiography)**
- Colitis*
- Fibrosis from previous trauma/surgery
- Neoplasia

**References**

### 3.2.5 Ureters

**Dilated**
- Ascending infection
- Ectopic ureter
  - Congenital
  - Iatrogenic, e.g.
    - Post ovariohysterectomy
- External compression, e.g.
  - Abdominal mass*
- Hydroureter
  - Iatrogenic
  - Neoplasia
  - Stricture following ureterolith or other trauma
- Ureterolith
- Ureteral diverticula
- Ureterocele

**Reference**

### 3.2.6 Bladder

**Non-visualisation**
- Ascites
- Bladder hypoplasia
- Bladder rupture
- Empty bladder
  - Bilateral ectopic ureters
  - Cystitis*
  - Post voiding*
- Lack of abdominal fat
- Positioning fault

**Displacement**
- Abdominal hernia/rupture*
- Constipation/obstipation* *q.v.*
- Enlarged uterus* *q.v.*
- Lymphadenopathy* *q.v.*
Obesity
Perineal hernia
Prepubic tendon rupture
Prostatomegaly
Short urethra
Traumatic urethral injury

**Enlarged bladder**
- Normal

**Functional obstruction**
- Neurological
  - Cauda equina syndrome
  - Dysautonomia
  - Upper motor neurone spinal cord lesion *q.v.*, *e.g.*
    - Intervertebral disc disease *(D)*
    - Trauma
    - Tumour
- Psychogenic
  - Lack of outside/litter access
  - Pain
  - Stress

**Mechanical obstruction**
- Crystalline–matrix plugs
- Neoplasia
  - Bladder
  - Urethra
- Prostatomegaly
- Urethral stricture
- Uroliths
  - Bladder neck
  - Urethra

**Small bladder**
- Anuria
- Congenital hypoplasia
- Ectopic ureters
- Non-distensible bladder
  - Diffuse bladder-wall neoplasia
  - Severe cystitis, *e.g.*
    - Calculi
    - Infection
    - Trauma
- Recent voiding
- Ruptured bladder
- Ruptured ureters

**Abnormal shape**
- Diverticula
Herniation
Neoplasia
Patent urachus
Positioning errors
Rupture

**Increased opacity**
- Chronic cystitis
- Foreign body
- Neoplasia
- Radio-opaque calculi
  - Oxalate
  - Silica
  - Struvite
- Superimposition of other organs

**Decreased opacity**
- Emphysematous cystitis
- Iatrogenic

**Abnormal bladder contents (contrast cystography)**

*Filling defects*
- Artefact
  - Air bubbles
- Blood clots
- Calculi
- Neoplasia
- Polyps
- Severe cystitis

*Increased opacity*
- Blood clots
- Neoplasia
- Polyps
- Uroliths

**Thickening of bladder wall (contrast cystography)**
- Chronic cystitis
- Chronic outflow obstruction
- Polyps
- Small bladder

**Neoplasia**
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Metastatic neoplasia
Rhabdomyosarcoma
Squamous cell carcinoma
Transitional cell carcinoma

**Failure of bladder to distend (contrast radiography)**
Congenital defects, e.g.
- Ectopic ureters
- Hypoplasia
Cystitis*
Neoplasia
Rupture

**References**

### 3.2.7 Urethra

**Filling defects (contrast urethrography)**
- Air bubbles*
- Blood clots
- Neoplasia
- Uroliths*

**Strictures/irregular surface**
- Neoplasia
- Previous surgery
- Previous uroliths
- Prostatic disease*
- Urethritis*

**Displacement**
- Adjacent neoplasia
- Bladder displacement
- Prostatic disease*

**Contrast medium leakage**
- Hypospadia
- Normal
- Previous urethrotomy/urethrostomy
- Prostatic disease*
- Urethral rupture
  - Iatrogenic
  - Trauma

**Reference**
### 3.2.8 Kidneys

**Non-visualisation**
- Artefact/technical factors
- Nephrectomy
- Obscured by gastrointestinal tract contents* 
- Reduced intra-abdominal contrast* * q.v.
- Retroperitoneal effusion
  - Haemorrhage
  - Urine
- Unilateral renal agenesis
- Very small kidneys

**Enlargement**

*Smooth outline*
- Acute pyelonephritis
- Acute renal failure * q.v.
- Amyloidosis
- Compensatory renal hypertrophy
- Congenital conditions
  - Ectopic ureter
  - Ureterocoele
- Feline infectious peritonitis* (C)
- Hydronephrosis
  - Extrinsic mass
  - Neoplasia, e.g.
    - Bladder
    - Prostate
    - Trigone
  - Paraureteral pseudocyst
  - Ureteral blood clot
  - Ureteral inflammation
  - Ureterolith
  - Ureteral stricture
- Neoplasia, e.g.
  - Lymphoma*
- Nephritis*
- Perirenal pseudocysts
- Portosystemic shunts
- Subcapsular abscess
- Subcapsular haematoma

*Irregular outline*
- Abscess
- Cyst
- Granuloma
- Haematoma
- Infarction
- Neoplasia
  - Adenoma
  - Anaplastic sarcoma
- Cystadenocarcinoma
- Haemangioma
- Metastatic neoplasia
- Nephroblastoma
- Papilloma
- Renal cell carcinoma
- Transitional cell carcinoma
- Polycystic kidney disease

**Small kidneys**
- Chronic glomerulonephritis
- Chronic interstitial nephritis*
- Chronic pyelonephritis

**Increased radio-opacity**
- Nephroliths

**Artefact**
- Superimposition

**Dystrophic mineralisation**
- Abscess
- Granuloma
- Haematoma
- Neoplasia
- Osseous metaplasia

**Nephrocalcinosis**
- Chronic renal failure* *q.v.*
- Ethylene glycol toxicity
- Hyperadrenocorticism
- Hypercalcaemia *q.v.*
- Nephrotoxic drugs
- Renal telangiectasia

**Figure 3.2(b)** Dorsoventral abdominal radiograph taken during intravenous urography. The right kidney is enlarged, and the ureter fails to opacify, due to a right ureterolith. Reproduced with permission of Downs Referrals, Bristol.
Dilatation of the renal pelvis (contrast radiography)
- Chronic pyelonephritis
- Diuresis
- Ectopic ureter
- Nephrolithiasis
- Renal neoplasia

Hydronephrosis
- Extrinsic mass
- Neoplasia
  - Bladder
  - Prostate
  - Trigone
- Paraureteral pseudocyst
- Ureteral blood clot
- Ureteral inflammation
- Ureteral stricture
- Ureterolith

Renal pelvic blood clot
- Coagulopathy
- Iatrogenic (post biopsy)
- Idiopathic renal haemorrhage
- Neoplasia
- Trauma

References

3.2.9 Loss of intra-abdominal contrast

Artefact
- Ultrasound gel on coat*
- Wet hair coat*

Ascites/peritoneal fluid

Bile
- Ruptured biliary tract
  - Neoplasia
  - Post surgery, e.g.
    - Cholecystectomy
  - Severe cholecystitis
  - Trauma
Blood
Coagulopathy *q.v.*
Neoplasia*, e.g.
  • Haemangiosarcoma
Trauma

Chyle
Lymphangiectasia
Ruptured cisterna chyli
  • Neoplasia
  • Trauma

Exudate
Feline infectious peritonitis* (C)
Septic peritonitis, e.g.
  • Iatrogenic/nosocomial
  • Neoplasia*
  • Pancreatitis*
  • Penetrating wound
  • Ruptured viscus
    • Neoplasia*
    • Post surgery, e.g.
      Enterotomy wound dehiscence*
    • Trauma*

Transudate/modified transudate, e.g.
Cardiac tamponade
Caudal vena caval obstruction
Hepatic disease
  • Cholangiohepatitis*
  • Chronic hepatitis*
  • Cirrhosis*
  • Fibrosis*
Hypoalbuminaemia* *q.v.*
Neoplasia
Portal hypertension
Right-sided heart failure*

Urine
Lower urinary tract rupture
  • Bladder
  • Ureter
  • Urethra

Diffuse peritoneal neoplasia

Lack of abdominal fat
Emanvation*
Immaturity*

Peritonitis
Neoplasia*
Irritant
Bile
Urine

Septic
Bile leakage
Gastrointestinal tract leakage
• Devitalisation
  • Foreign body*
  • Gastric dilatation/volvulus*
  • Intestinal volvulus
  • Intussusception
• Perforation
  • Enterotomy wound dehiscence*
  • Gastroduodenal ulceration
  • Penetrating wound
Hepatic abscess
Ruptured prostatic abscess
Ruptured uterus
Septicaemia*
Splenic abscesses
Urinary tract disruption

Viral
Feline infectious peritonitis* (C)

Miscellaneous
Pancreatitis*

References

3.2.10 Prostate

Displacement
Abdominal weakness
Full bladder*
Perineal hernia*
Prostatomegaly*

Enlargement
Benign prostatic hyperplasia*
Paraprostatic cysts
Prostatic cysts
Prostatic neoplasia
Prostatitis
Testicular neoplasia

Reference

3.2.11 Uterus

Enlargement
Haemometra
Hydrometra
Mucometra
Neoplasia
Post partum
Pregnancy
Pyometra
Torsion

3.2.12 Abdominal masses

Cranial abdomen
Adrenal mass
Hepatomegaly/hepatic mass *q.v.*
Pancreatic mass
Stomach distension/mass

Mid abdomen
Cryptorchidism
Mesenteric lymphadenopathy
Ovarian masses
Renomegaly/renal mass *q.v.*
Small intestine
• Foreign body
• Neoplasia
• Obstruction
Splenomegaly/splenic mass *q.v.*

Caudal abdomen
Distended urinary bladder *q.v.*
Enlarged uterus *q.v.*
Large intestine
• Foreign body
• Neoplasia
• Obstruction
Prostatomegaly
3.2.13 Abdominal calcification/mineral density

**Abdominal fat**
- Idiopathic
- Pansteatitis

**Adrenal glands**
- Idiopathic
- Neoplasia

**Arteries**
- Arteriosclerosis

**Gastrointestinal tract**
- Foreign bodies and ingesta* 
- Iatrogenic
  - Contrast media
  - Medication
- Uraemic gastritis* q.v.

**Genital tract**
- Chronic prostatitis *
- Cryptorchidism *
- Neoplasia
- Ovarian neoplasia
- Ovarian or prostatic cyst *
- Pregnancy *

**Liver**
- Abscess
- Cholelithiasis
- Chronic cholecystitis *
- Chronic hepatopathy *
- Cyst
- Granuloma
- Haematoma
- Neoplasia
- Nodular hyperplasia *

**Lymph nodes**
- Inflammation *
- Neoplasia *

**Pancreas**
- Chronic pancreatitis *
- Fat necrosis
- Neoplasia
- Pancreatic pseudocyst
Plate 1.2(a) An intussusception in a cat. Reproduced with permission of Downs Referrals, Bristol.

Plate 1.2(b) A large perineal hernia in a dog, causing chronic constipation. Reproduced with permission of Downs Referrals, Bristol.

Plate 1.5(a) A Dalmatian dog showing head pressing behaviour due to an intracranial space occupying lesion. Reproduced with permission of Downs Referrals, Bristol.

Plate 1.5(b) Post-mortem dissection of the brain of a dog that showed multiple intracranial neurological signs. There is massive dilation of the lateral ventricle and a very thin cerebral cortex. Reproduced with permission of Downs Referrals, Bristol.
Plate 2.4  Alopecia secondary to a severe flea infestation.

Plate 2.5(a)  Anisocoria in a cat. Reproduced with permission of Downs Referrals, Bristol.

Plate 2.5(b)  Unilateral masticatory muscle atrophy due to a malignant nerve sheath tumour of the trigeminal nerve. Reproduced with permission of Downs Referrals, Bristol.

Plate 2.5(c)  A Dermoid sinus in a Rhodesian Ridgeback. Reproduced with permission of D. Bush, Downs Referrals, Bristol.
Plate 2.8 Post-mortem dissection of the kidneys of a Persian cat with polycystic kidney disease.

Plate 4.1(a) Peripheral oedema in a dog, secondary to hypoalbuminaemia, demonstrating pitting. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.1(b) Abdominal distension in a dog, due to ascites caused by cirrhosis of the liver. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.1(c) Skin tenting in a severely dehydrated cat. Reproduced with permission of Downs Referrals, Bristol.
Plate 4.3  A parathyroid adenoma in a dog with hypercalcaemia. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.5  A large number of eosinophils detected in a bronchoalveolar lavage from a dog with eosinophilic bronchitis. Reproduced with permission of Abbey Veterinary Services.

Plate 6.12  Measuring buccal mucosal bleeding time.
Spleen
Abscess
Haematoma*
Histoplasmosis

Urinary tract
Chronic inflammation*
Neoplasia
Nephrocalcinosis
  • Chronic renal failure* q.v.
  • Hyperadrenocorticism
  • Hypercalcaemia* q.v.
  • Nephrotoxic drugs q.v.
Urolithiasis*

Miscellaneous
Calciosis cutis
Chronic hygroma
Foreign body*
Mammary gland neoplasia*
Myositis ossificans

References

3.3 Skeletal radiography

3.3.1 Fractures
Congenital/inherited weakness, e.g.
  Incomplete ossification of the humeral condyle

Pathological
  Bone cyst
  Osteopenia q.v.

Neoplasia
  Chondrosarcoma
  Fibrosarcoma
  Haemangiosarcoma
  Metastatic neoplasia
  Multilobular osteochondrosarcoma
  Multiple myeloma
  Osteosarcoma*
Spleen
Abscess
Haematoma*
Histoplasmosis

Urinary tract
Chronic inflammation*
Neoplasia
Nephrocalcinosis
  • Chronic renal failure* q.v.
  • Hyperadrenocorticism
  • Hypercalcaemia* q.v.
  • Nephrotoxic drugs q.v.
Urolithiasis*

Miscellaneous
Calciosis cutis
Chronic hygroma
Foreign body*
Mammary gland neoplasia*
Myositis ossificans

References

3.3 Skeletal radiography

3.3.1 Fractures

Congenital/inherited weakness, e.g.
Incomplete ossification of the humeral condyle

Pathological
Bone cyst
Osteopenia q.v.

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia
Multilobular osteochondrosarcoma
Multiple myeloma
Osteosarcoma*
Osteomyelitis
Bacterial*
Fungal
Protozoal, e.g.
• Leishmaniasis

Iatrogenic
Bone biopsy
Complication of orthopaedic surgery

Traumatic*

References

3.3.2 Altered shape of long bones

Abnormally straight
Premature closure of growth plate

Angulation
Fractures*

Bowling
Asymmetric growth plate bridging
• Iatrogenic, e.g.
  • Plating
  • Metaphyseal osteopathy
Chondrodysplasia
Chondrodystrophy
• May be normal breed variation*
Congenital hypothyroidism
Rickets
Tension
• Quadriceps contracture
• Shortening of ulna

Irregular margination
Calcifying tendinopathy
Bone cyst
• Enchondromatosis
Metaphyseal osteopathy
Neoplasia
• Chondrosarcoma
- Multiple cartilaginous exostoses
- Osteosarcoma*
Periosteal remodelling *q.v.*

### Reference

#### 3.3.3 Dwarfism

**Proportionate**
- Hypothyroidism (D)
- Pituitary dwarfism

**Disproportionate**
- Chondrodysplasia
- Hypervitaminosis A
- Hypothyroidism (D)
- Mucolipidosis type II
- Mucopolysaccharidosis
- Rickets

### Reference

#### 3.3.4 Delayed ossification/growth plate closure

- Chondrodysplasia
- Copper deficiency
- Early neutering
- Hypervitaminosis D
- Hypothyroidism (D)
- Mucopolysaccharidosis
- Pituitary dwarfism

#### 3.3.5 Increased radiopacity

- Artefact
- Bone infarcts
- Folding fractures*
- Growth arrest lines
- Lead poisoning
- Metaphyseal osteopathy
- Neoplasia
- Panosteitis
- Skeletal immaturity* (metaphyseal condensation)
Osteomyelitis
Bacterial*  
Fungal  
Protozoal, e.g.  
• Leishmaniasis

Osteopetrosis
Acquired
• Chronic excess dietary intake of calcium  
• Chronic hypervitaminosis D  
• Feline leukaemia virus* (C)  
• Idiopathic  
• Myelofibrosis  
Congenital

Reference

3.3.6 Periosteal reactions

Craniomandibular osteopathy  
Hip dysplasia*  
Hypertrophic osteopathy  
Hypervitaminosis A  
Metaphyseal osteopathy  
Mucopolysaccharidosis  
Neoplasia  
Panosteitis  
Trauma*

Infection
Bacterial*  
Fungal  
Protozoal  
• Hepatozoonosis  
• Leishmaniasis  
Tuberculosis

References
3.3.7 Bony masses

Neoplasia

Benign
- Chondroma
- Endochondroma
- Monostotic osteochondroma
- Multiple osteochondroma (C)
- Osteoma
- Polyostotic osteochondroma/multiple cartilaginous exostoses

Malignant
- Locally invasive soft tissue
  - Malignant melanoma of digit
  - Soft tissue sarcomas
  - Squamous cell carcinoma of digit
- Primary bone
  - Chondrosarcoma
  - Fibrosarcoma
  - Giant cell tumour
  - Haemangiosarcoma
  - Liposarcoma
  - Lymphoma
  - Multiple myeloma
  - Multilobular osteochondrosarcoma
  - Osteosarcoma
  - Parosteal osteosarcoma
  - Plasma cell tumour
  - Undifferentiated sarcoma
- Tumours which metastasise to bone
  - Mammary carcinoma
  - Prostatic carcinoma
  - Pulmonary carcinoma
  - Sarcomas of rib/chest wall

Proliferative joint disease
- Disseminated skeletal hyperostosis
- Feline periosteal proliferative polyarthropathy (C)
- Hypervitaminosis A
- Osteoarthritis*

Trauma
- Callus*
- Hypertrophic non-union
- Periosteal reaction

Miscellaneous
- Craniomandibular osteopathy
- Enthesiopathies
3.3.8 Osteopenia

Artefact

Disuse
- Fracture*
- Lameness*
- Paralysis

Iatrogenic
- Chronic anticonvulsant therapy, e.g.
  - Phenobarbitone
  - Phenytoin
  - Primidone
- Chronic glucocorticoid administration
- Stress protection from plating/casting

Metabolic/endocrine/systemic
- Diabetes mellitus*
- Hyperadrenocorticism
- Hyperthyroidism* (C)
- Lactation*
- Mucopolysaccharidosis
- Pregnancy*
- Primary hyperparathyroidism
- Renal secondary hyperparathyroidism*

Neoplasia
- Multiple myeloma
- Pseudohyperparathyroidism (see below)

Nutrition
- Chronic protein malnutrition
- Hypervitaminosis A
- Hyper-/hypovitaminosis D
- Nutritional secondary hyperparathyroidism
- Pseudohyperparathyroidism
  - Adenocarcinoma of apocrine glands of anal sacs
  - Gastric squamous cell carcinoma
  - Lymphoma*
  - Mammary adenocarcinoma
  - Multiple myeloma

References
- Testicular interstitial cell tumour
- Thyroid adenocarcinoma

**Miscellaneous**
- Ageing changes
- Osteogenesis imperfecta
- Panosteitis

**Toxins**
- Lead poisoning

**References**

### 3.3.9 Osteolysis

Avascular necrosis of the femoral head* (D)
- Bone cysts
- Feline femoral metaphyseal osteopathy (C)
- Fibro-osseous dysplasia
- Fibrous dysplasia
- Infarct
- Intraosseous epidermoid cysts
- Metaphyseal osteopathy
- Pressure atrophy
- Retained cartilaginous core
- Trauma*

**Infection**

- **Bacterial**
  - Bone abscess
  - Iatrogenic, e.g. around surgical implants*
  - Osteomyelitis*
  - Sequestra
- **Fungal**
- **Protozoal**
  - Leishmaniasis

**Neoplasia**

- Enchondroma
- Malignant soft tissue tumour
- Metastatic tumour
- Multiple myeloma
- Osteochondroma/multiple cartilaginous exostoses
- Osteoclastoma
Reference

3.3.10 Mixed osteolytic/osteogenic lesions

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Liposarcoma
Malignant soft tissue tumour*
Metastatic*
Osteosarcoma*

Infection
Bacterial
Osteomyelitis*
Sequestrum

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis

Protozoal
Leishmaniasis

Reference

3.3.11 Joint changes

Soft tissue swelling – joint effusion
Haemarthrosis
Ligament injury
Osteoarthritis
Osteochondrosis
Shar Pei fever (D)
Soft tissue callus
Synovial cyst
Trauma*
Villonodular synovitis
Arthritis

Iatrogenic
- Drugs, e.g.
  - Sulphonamides
  - Vaccine reactions

Idiopathic polyarthritis

Immune-mediated disease
- Arthritis of the Akita (D)
- Gastrointestinal disease associated
- Idiopathic
- Neoplasia associated
- Polyarteritis nodosa
- Polyarthritis/meningitis
- Polyarthritis/polymyositis
- Systemic lupus erythematous
- Vaccine reaction

Infection
- Borrellosis
- Ehrlichiosis
- Sepsis (bacterial)^

Periarticular swelling
- Abscess^®
- Cellulitis^
- Haematoma
- Neoplasia
- Oedema^

Reduced size of joint space
- Degenerative joint disease^
- Erosive rheumatoid arthritis
- Erosive septic arthritis
- Periarticular fibrosis
- Positioning artefact^

Increased size of joint space
- Degenerative joint disease
- Intra-articular soft tissue mass
- Joint effusion^
- Juvenile animal
- Positioning artefact/traction
- Subluxation

Epiphyseal dysplasia
- Chondrodysplasia
- Congenital hypothyroidism
- Mucopolysaccharidosis
- Pituitary dwarfism

Subchondral osteolysis
- Neoplasia
Osteochondrosis
Rheumatoid arthritis
Septic arthritis*

**Osteolytic joint disease**
Avascular necrosis of the femoral head* (D)
Chronic haemarthrosis
Epiphyseal dysplasia causing apparent osteolysis
Incomplete ossification in juveniles
Osteochondrosis
Osteopenia *q.v.*
Rheumatoid arthritis
Subchondral cysts
Villous nodular synovitis

**Infection**
Feline tuberculosis (C)
Leishmaniasis
Mycoplasmosis
Septic arthritis*

**Neoplasia**
Metastatic digital carcinoma
Synovial sarcoma
Other soft tissue neoplasia

**Proliferative joint disease**
Disseminated idiopathic skeletal hyperostosis
Enthesiopathies
Hypervitaminosis A
Mucopolysaccharidosis
Systemic lupus erythematosus

**Neoplasia**
Osteoma
Osteosarcoma*  
Synovial osteochondroma

**Osteoarthritis**
Ageing*
Angular limb deformities
Chondrodysplasia
Elbow dysplasia*
Hip dysplasia*
Post articular fractures*
Post surgery*
Other chronic joint stresses
Repeated haemarthroses
Soft tissue damage, e.g.
  * Ruptured cranial cruciate ligament*
**Mixed osteolytic/proliferative joint disease**
- Avascular necrosis of the femoral head* (D)
- Feline periosteal proliferative polyarthritis (C)
- Feline tuberculosis (C)
- Leishmaniasis
- Neoplasia
- Non-infectious erosive polyarthritis
- Osteochondromatosis
- Periosteal proliferative polyarthritis
- Repeated haemarthroses
- Rheumatoid arthritis
- Septic arthritis*
- Villonodular synovitis

**References**

### 3.4 Radiography of the head and neck

#### 3.4.1 Increased radiopacity/bony proliferation of the maxilla
- Healing/healed fracture*
- Neoplasia
- Osteomyelitis*

#### 3.4.2 Decreased radiopacity of the maxilla
- Granuloma
- Nasolacrimal duct cysts

**Hyperparathyroidism**
- Nutritional secondary
- Primary
- Renal secondary*

**Neoplasia**
- Fibrosarcoma
- Local extension of tumour, e.g.
  - From nasal cavity*
- Malignant melanoma
- Osteosarcoma*
- Squamous cell carcinoma

**Odontogenic cysts**
- Adamantinoma
Mixed osteolytic/proliferative joint disease
Avascular necrosis of the femoral head* (D)
Feline periosteal proliferative polyarthropathy (C)
Feline tuberculosis (C)
Leishmaniasis
Neoplasia
Non-infectious erosive polyarthritis
Osteochondromatosis
Periosteal proliferative polyarthritis
Repeated haemarthroses
Rheumatoid arthritis
Septic arthritis*
Villonodular synovitis

References

3.4 Radiography of the head and neck

3.4.1 Increased radiopacity/bony proliferation of the maxilla

Healing/healed fracture*
Neoplasia
Osteomyelitis*

3.4.2 Decreased radiopacity of the maxilla

Granuloma
Nasolacrimal duct cysts

Hyperparathyroidism
Nutritional secondary
Primary
Renal secondary*

Neoplasia
Fibrosarcoma
Local extension of tumour, e.g.
• From nasal cavity*
Malignant melanoma
Osteosarcoma*
Squamous cell carcinoma

Odontogenic cysts
Adamantinoma
Ameloblastoma
Complex odontoma
Dentigerous cyst

**Periodontal disease**

**Reference**

### 3.4.3 Increased radiopacity/bony proliferation of the mandible

Acromegaly
Canine leukocyte adhesion deficiency (D)
Craniomandibular osteopathy
Healing/healed fracture*
Neoplasia
Osteomyelitis*

**Reference**

### 3.4.4 Decreased radiopacity of the mandible

Granuloma
Periodontal disease

**Hyperparathyroidism**
Nutritional secondary
Primary
Renal secondary*

**Neoplasia**
Fibrosarcoma
Malignant melanoma
Osteosarcoma*
Squamous cell carcinoma

**Odontogenic cysts**
Adamantinoma
Ameloblastoma
Complex odontoma
Dentigerous cyst

**Reference**
3.4.5 Increased radiopacity of the tympanic bulla

Positioning artefact

Abnormal contents
- Cholesteatoma
- Granuloma
- Neoplasia
- Otitis media *
- Polyp *

Thickening of bulla wall
- Canine leukocyte adhesion deficiency (D)
- Craniomandibular osteopathy
- Neoplasia
- Otitis media *
- Polyp *

References

3.4.6 Decreased radiopacity of the nasal cavity

Artefact

Turbinate destruction
- Aspergillosis
- Congenital defect of hard palate
- Destruction of palatine or maxillary bone, e.g.
  - Neoplasia *
- Foreign body *
- Previous rhinotomy
- Viral rhinitis *

References
3.4.7 Increased radiopacity of the nasal cavity

Artefact

Epistaxis q.v.

Neoplasia

Nasal cavity*
- Adenocarcinoma*
- Chondrosarcoma
- Esthesioneuroblastoma
- Fibrosarcoma
- Haemangiosarcoma
- Histiocytoma
- Leiomyosarcoma
- Liposarcoma
- Lymphoma*
- Malignant fibrous histiocytoma
- Malignant melanoma
- Malignant nerve sheath tumour
- Mast cell tumour
- Myxosarcoma
- Neuroendocrine tumours
- Osteosarcoma
- Paranasal meningioma
- Rhabdomyosarcoma
- Squamous cell carcinoma*
- Transitional cell carcinoma
- Transmissible venereal tumour
- Undifferentiated carcinomas*
- Undifferentiated sarcoma

Nasal planum
- Cutaneous lymphoma
- Fibroma
- Fibrosarcoma
- Haemangioma
- Mast cell tumour*
- Melanoma
- Squamous cell carcinoma

Miscellaneous
- Foreign body
- Hyperparathyroidism
- Kartagener’s syndrome
- Polyp
- Primary ciliary dyskinesia
Rhinitis* q.v.

Reference

3.4.8 Increased radiopacity of the frontal sinuses

Neoplasia
Carcinoma*
Local extension, e.g.
• Nasal tumour*
Osteoma
Osteosarcoma

Obstruction of drainage
Neoplasia*
Trauma*

Sinusitis
Allergic*
Bacterial*
Fungal
Kartagener’s syndrome
Viral*

Miscellaneous
Canine leukocyte adhesion deficiency (D)
Craniomandibular osteopathy

3.4.9 Increased radiopacity of the pharynx

Foreign body*
Mineralisation of laryngeal cartilages
Nasopharyngeal stenosis
Obesity*
Pharyngeal paralysis
Salivary calculi

Pharyngeal soft tissue mass
Abscess*
Granuloma
Nasopharyngeal polyp*
Neoplasia
• Carcinoma
• Lymphoma
Retropharyngeal mass
Abscess*
Enlarged lymph nodes*
Neoplasia, e.g.
• Lymphoma*

Soft palate thickening
Brachycephalic obstructive airway syndrome* (D)
Mass
• Cyst
• Granuloma
• Neoplasia

3.4.10 Thickening of the soft tissues of the head and neck

Focal
Abscess*
Cyst*
Foreign body*
Granuloma
Haematoma*
Iatrogenic, e.g.
• Subcutaneous fluid administration*
Neoplasia*

Figure 3.4 Transverse T2 weighted MR scan of a dog with a large facial sarcoma. Reproduced with permission of Downs Referrals, Bristol.
Diffuse
Acromegaly
Cellulitis*
Cranial vena cava syndrome
Neoplasia*
Obesity*
Oedema*

Reference

3.4.11 Decreased radiopacity of the soft tissues of the head and neck

Gas
Abscess*
Perforation
• Oesophagus
• Pharynx
• Skin
• Trachea
Pneumomediastinum

Fat
Lipoma*
Obesity*

3.4.12 Increased radiopacity of the soft tissues of the head and neck

Artefact

Calcification
Calcinosi
circumscripta
Calcinosi
cutis

Calcification of:
Abscess
Granuloma
Haematoma
Tumour

Foreign body*

Neoplasia

Iatrogenic
Barium
Microchip
3.5 Radiography of the spine

3.5.1 Normal and congenital variation in vertebral shape and size

Normal variation
- C7 may be shorter than adjacent vertebrae
- L7 may be shorter than adjacent vertebrae
- Ventral L3 and L4 may be poorly defined

Congenital variation
- Abnormal dorsal angulation of the dens of C2
- Agenesis/incomplete development of dens of C2
- Anomalous development of a transverse process of a lumbar vertebra
- Block vertebrae
- Butterfly vertebrae
- Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
- Chondrodystrophic dwarfism
- Congenital metabolic disease
  - Congenital hypothyroidism
  - Pituitary dwarfism
- Fused dorsal spinal processes
- Hemivertebrae
- Mucopolysaccharidosis
- Narrowed vertebral canal
  - Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome) (D)
  - Congenital lumbosacral stenosis
  - Secondary to hemivertebrae or block vertebrae
  -Thoracic stenosis
- Occipital dysplasia
- Perocormus
- Sacrococcygeal dysgenesis
- Scoliosis
- Shortened dens of C2
- Spina bifida
- Spinal stenosis
- Transitional vertebrae

References
References

3.5 Radiography of the spine

3.5.1 Normal and congenital variation in vertebral shape and size

Normal variation
- C7 may be shorter than adjacent vertebrae
- L7 may be shorter than adjacent vertebrae
- Ventral L3 and L4 may be poorly defined

Congenital variation
- Abnormal dorsal angulation of the dens of C2
- Agenesis/incomplete development of dens of C2
- Anomalous development of a transverse process of a lumbar vertebra
- Block vertebrae
- Butterfly vertebrae
- Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
- Chondrodystrophic dwarfism
- Congenital metabolic disease
  - Congenital hypothyroidism
  - Pituitary dwarfism
- Fused dorsal spinal processes
- Hemivertebrae
- Mucopolysaccharidosis
- Narrowed vertebral canal
  - Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome) (D)
  - Congenital lumbosacral stenosis
  - Secondary to hemivertebrae or block vertebrae
  - Thoracic stenosis
- Occipital dysplasia
- Perocormus
- Sacrococcygeal dysgenesis
- Scoliosis
- Shortened dens of C2
- Spina bifida
- Spinal stenosis
- Transitional vertebrae
3.5.2 Acquired variation in vertebral shape and size

**Altered vertebral shape**
- Hyperparathyroidism
  - Nutritional secondary
  - Primary
  - Renal secondary*
- Hypervitaminosis A
- Mucopolysaccharidosis
- Spondylosis deformans
- Trauma
  - Fracture*

**Neoplasia**
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Metastatic neoplasia*, e.g.
  - Haemangiosarcoma
  - Lymphosarcoma
  - Prostatic carcinoma
- Multiple cartilaginous exostoses
- Multiple myeloma
- Osteochondroma
- Osteosarcoma*

**Increased vertebral size**
- Baastrup’s disease
- Bone cyst
- Callus formation secondary to trauma/pathological fracture
- Disseminated idiopathic skeletal hyperostosis
- Hypervitaminosis A
- Mucopolysaccharidosis

**Neoplasia**
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Metastatic neoplasia*, e.g.
  - Haemangiosarcoma
  - Lymphosarcoma
  - Prostatic carcinoma
- Multiple cartilaginous exostoses
- Osteochondroma
- Osteosarcoma*

**Spondylitis**
- Bacterial, e.g.
  - Foreign body*
• Haematogenous
• Puncture wound
Fungal, e.g.
• Actinomycosis
• Aspergillosis
• Coccidioidomyocosis
Parasitic, e.g.
• Spirocerca lupi
Protozoal, e.g.
• Hepatozoonosis

**Spondylosis deformans**
Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Chronic disc disease* (D)
Degeneration of annulus fibrosis
Discospondylitis
Hemivertebrae
Post surgery
Trauma*

**Decreased vertebral size**
Discospondylitis
Fracture* 
Intervertebral disc herniation* (D)
Mucopolysaccharidosis
Nutritional secondary hyperparathyroidism

**Vertebral canal changes**

*Widened*
• Arachnoid cyst
• Syringohydromyelia
• Tumour

*Narrowed*
•Adjacent bone pathology, e.g.
• Callus
Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Lumbosacral stenosis

**References**
3.5.3 Changes in vertebral radiopacity

**Generalised decrease in radiopacity**
- Disuse atrophy
- Hyperadrenocorticism
- Hyperparathyroidism
  - Nutritional secondary
  - Primary
  - Pseudohyperparathyroidism
  - Renal secondary
- Hyperthyroidism* (C)
- Hypothyroidism* (D)
- Osteogenesis imperfecta
- Senile osteoporosis

**Generalised increase in radiopacity**
- Osteopetrosis

**Focal or multifocal decrease in radiopacity**
- Discospondylitis
- Osteomyelitis*
- Vertebral physitis

**Neoplasia**
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Metastatic neoplasia
- Multiple myeloma
- Osteochondroma
- Osteosarcoma*

**Focal or multifocal increase in radiopacity**

**Neoplasia**
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Metastatic neoplasia*, e.g.
  - Haemangiosarcoma
  - Lymphosarcoma
  - Prostatic carcinoma
- Osteochondroma
- Osteosarcoma*

**References**
3.5.4 Abnormalities in the intervertebral space

**Widened disc space**
- Normal variation
- Adjacent to hemivertebra
- Artefact (traction)
- End-plate erosion
  - Discospondylitis
  - Neoplasia
- Mucopolysaccharidosis
- Trauma
  - Luxation
  - Subluxation

**Decreased size of disc space**
- Adjacent hemivertebra
- Adjacent neoplasia
- Artefact
  - Divergence of X-ray beam at periphery of radiograph
  - Positioning artefact
- Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
- Degenerative canine lumbosacral stenosis
- Discospondylitis
- Hansen type I disc extrusion* (D)
- Hansen type II disc protrusion* (D)
- Post surgery
- Spondylosis deformans*
- Subluxation
- Within block vertebra

**Irregular margination of disc space**
- Ageing in cats
- Degenerative intervertebral disc disease
- Discospondylitis
- Mucopolysaccharidosis
- Nutritional secondary hyperparathyroidism
- Spondylosis deformans*

**Increased radiopacity of disc space**
- Artefact
  - Superimposition of normal bone/soft tissue
- Incidental mineralisation
- Intervertebral disc disease* (D)
Reference

3.5.5 Contrast radiography of the spine (myelography)

Artefact
- Contrast medium in soft tissues outside vertebral canal
- Contrast medium in spinal parenchyma
- Epidural leakage
- Injection of contrast into central canal
- Injection of gas into subarachnoid space
- Subdural injection

Extradural lesions
- Congenital abnormalities
- Foreign body
- Neoplasia

Degenerative
- Hansen type I disc extrusion* (D)
- Hansen type II disc protrusion* (D)
- Hansen type III disc high velocity low volume extrusion
- Hypertrophied ligamentum flavum
- Arachnoid cysts

Inflammatory
- Abscess
- Granuloma

Trauma
- Fracture*
- Luxation*

Vascular
- Haematoma
- Haemorrhage

Intradural/extradural

Degenerative
- Disc disease

Neoplasia
- Lymphoma
- Meningioma
- Nerve root tumour
- Nerve sheath tumour
Idiopathic
  Intra-arachnoid cyst

Inflammatory
  Subdural granuloma

Vascular
  Subarachnoid haematoma
  Subarachnoid haemorrhage

Intramedullary

Degenerative
  Disc disease* (D)

Congenital
  Syringohydromyelia* (D)

Neoplastic
  Ependymoma
  Glioma
  Lymphoma
  Metastatic tumours

Figure 3.5(a) Dorsoventral myelogram of the thoracolumbar spine of a dog, demonstrating loss of contrast at T13–L1, suggesting a prolapsed intervertebral disc. Reproduced with permission of Downs Referrals, Bristol.
Inflammatory
   Granulomatous meningoencephalomyelitis

Traumatic
   Cord swelling
      • Concussion
      • Disc extrusion

Vascular
   Ischaemic myelopathy*
   Myelomalacia secondary to infarction

Contrast column splitting
   Lateralised extradural compression(s)
   Midline extradural compression

References

3.6 Thoracic ultrasonography

3.6.1 Pleural effusion

(See 3.1.13 for full listings)
   Bile pleuritis
   Blood
   Chyle
   Exudate
   Transudate/modified transude
Inflammatory
Granulomatous meningoencephalomyelitis

Traumatic
Cord swelling
• Concussion
• Disc extrusion

Vascular
Ischaemic myelopathy*
Myelomalacia secondary to infarction

Contrast column splitting
Lateralised extradural compression(s)
Midline extradural compression

References

3.6 Thoracic ultrasonography

3.6.1 Pleural effusion

(See 3.1.13 for full listings)
Bile pleuritis
Blood
Chyle
Exudate
Transudate/modified transudate
3.6.2 Mediastinal masses

Granuloma
Idiopathic mediastinal cysts
Neoplasia
  • Lymphoma*
  • Mast cell tumour
  • Melanoma
  • Thymoma*
  • Thyroid carcinoma
Reactive lymphadenopathy*
Thymic branchial cysts

Reference

3.6.3 Pericardial effusion

Secondary to cardiomyopathy (C)*

Haemorrhagic
  Coagulopathy q.v.
  Left atrial rupture

Idiopathic*(D)

Neoplastic*
  Haemangiosarcoma
  Heart base tumours
    • Chemodectoma
    • Metastatic parathyroid tumour
    • Metastatic thyroid tumour
    • Other metastatic tumours*
    • Nonchromaffin paraganglioma
  Lymphoma
  Mesothelioma

Pericarditis
  Bacterial
    • Bite wounds
    • Extension of pulmonary infection
    • Foreign bodies
    • Oesophageal perforation
  Fungal
  Uraemic
  Viral
    • Feline infectious peritonitis* (C)
References

3.6.4 Altered chamber dimensions

**LEFT HEART**

**Enlarged left atrium**
- Chronic bradycardia
- Dilated cardiomyopathy*
- Hyperthyroidism* (C)
- Hypertrophic cardiomyopathy* (C)
- Left-to-right shunt
- Mitral dysplasia
- Myxomatous degeneration of the mitral valve* (D)
- Primary atrial disease
- Restrictive cardiomyopathy (C)

**Left ventricle**

*Dilatation*
- Anaemia
- Arteriovenous fistula
- Chronic bradycardia *q.v.*
- Chronic tachyarrhythmia *q.v.*
- Dilated cardiomyopathy
• Idiopathic*
• Parvovirus
• Taurine deficiency
• Drugs/toxins, e.g.
  • Doxorubicin
High output states
• Anaemia* q.v.
• Hyperthyroidism* (C)
Myocarditis
Volume overload
• Aortic insufficiency
• Left-to-right shunts
  • Arteriovenous fistulas
  • Atrial septal defects
  • Patent ductus arteriosus
  • Ventricular septal defects
• Mitral regurgitation, e.g.
  • Mitral dysplasia
  • Myxomatous degeneration of the mitral valve* (D)

**Hypertrophy**
Cardiomyopathy
• Hypertrophic* (C)
Coarctation of the aorta
Endomyocardial fibrosis
Hyperthyroidism* (C)
Infiltrative cardiac disease, e.g.
• Lymphoma

**Figure 3.6(b)** Right parasternal short axis view of the left atrium at the level of the aortic valve, showing left atrial dilation and an atrial thrombus. Reproduced with permission of Downs Referrals, Bristol.
Pressure overload
• Aortic/subaortic stenosis
• Systemic arterial hypertension*
Pseudohypertrophy from volume depletion*

Reduction
Hypovolaemia q.v.*

Wall thinning
Aneurysm
Dilated cardiomyopathy*
Infarction
Prior myocarditis

RIGHT HEART

Right atrium
Anaemia q.v.
Arteriovenous fistula
Atrial septal defect
Chronic bradycardia
Cor pulmonale
Dilated cardiomyopathy*
Heartworm disease
Hyperthyroidism* (C)
Hypertrophic cardiomyopathy* (C)
Myxomatous degeneration of the tricuspid valve* (D)
Primary atrial myocardial diseases
Pulmonary hypertension
Restrictive cardiomyopathy (C)
Right-to-left shunts
Tricuspid dysplasia
Tricuspid stenosis/atresia

Right ventricle

Dilatation
Right ventricular volume overload
• Atrial septal defects
• Cardiomyopathy
  • Dilated cardiomyopathy* (D)
  • Hypertrophic cardiomyopathy* (C)
  • Restrictive cardiomyopathy (C)
• Pulmonic insufficiency
• Tricuspid insufficiency
  • Myxomatous degeneration of the tricuspid valve* (D)
  • Tricuspid dysplasia

Hypertrophy
Hypertrophic cardiomyopathy* (C)
Pressure overload
- Cor pulmonale
- Heartworm disease
- Large ventricular septal defect
- Pulmonary hypertension
- Pulmonary thromboembolism
- Pulmonic stenosis
- Tetralogy of Fallot
Restrictive cardiomyopathy (C)

Reduction
Cardiac tamponade
Hypovolaemia* q.v.

References

3.6.5 Changes in ejection phase indices of left ventricular performance (fractional shortening – FS%, ejection fraction – EF)

Apparent reduced performance (decreased FS%, decreased EF)

Decreased preload, e.g.
Hypovolaemia* q.v.
Increased afterload, e.g.
- Aortic stenosis
- Systemic arterial hypertension* q.v.

Reduced systolic function
- Canine X-linked muscular dystrophy
- Chronic valvular heart disease* (D)
- Dilated cardiomyopathy*

Apparently increased performance (increased FS%, increased EF)

Decreased afterload, e.g.
- Hypotension
- Mitral valve regurgitation*

Increased preload, e.g.
- Iatrogenic fluid overload*

Myocardial disease, e.g.
- Hypertrophic cardiomyopathy* (C)

Reference
3.7 Abdominal ultrasonography

3.7.1 Renal disease

Diffuse abnormalities
Renomegaly *q.v.*
Small kidneys *q.v.*

*Increased cortical echogenicity with normal or enhanced corticomedullary definition*
- End-stage renal disease* *q.v.*
- Ethylene glycol toxicity
- Fat in cortex*
- Feline infectious peritonitis* (C)
- Glomerulonephritis
- Interstitial nephritis*
- Nephrocalcinosis
- Renal lymphoma
- Squamous cell carcinoma

*Medullary rim sign*
- May be normal*
- Chronic interstitial nephritis*
- Ethylene glycol toxicity
- Feline infectious peritonitis* (C)
- Hypercalcaemic nephropathy
- Idiopathic acute tubular necrosis
- Leptospirosis*

*Increased cortical echogenicity with reduced corticomedullary definition*
- Chronic inflammatory disease*
- Congenital renal dysplasia
- End-stage kidneys*

Reduced cortical echogenicity
- Lymphoma

Focal abnormalities

Anechoic/hypoechoic lesions
- Abscess
- Acquired cysts secondary to nephropathies
- Congenital cysts
- Cystadenocarcinoma
- Haematoma
- Lymphoma
- Perirenal pseudocyst
- Polycystic kidney disease*
- Tumour necrosis
Hyperechoic lesions
- Calcified abscess
- Calcified cyst wall
- Calcified haematoma
- Calculi
- Chronic renal infarcts
- Fibrosis
- Gas
- Granuloma
- Neoplasia
  - Chondrosarcoma
  - Haemangioma
  - Haemangiosarcoma
  - Metastatic thyroid adenocarcinoma
  - Osteosarcoma

Mixed echogenicity lesions
- Abscess
- Acute infarct
- Granuloma
- Haematoma
- Neoplasia
  - Adenocarcinoma
  - Haemangioma
  - Lymphoma

Pelvic dilatation
- Contralateral renal disease/absence (mild dilatation)
- Polyuria/diuresis
- Pyelonephritis
- Renal neoplasia

Congenital conditions
- Ectopic ureter
- Ureterocoele

Hydronephrosis
- Extrinsic mass
- Neoplasia
  - Bladder
  - Prostate
  - Trigone
- Paraureteral pseudocyst
- Ureteral blood clot
- Ureteral inflammation
- Ureteral stricture
- Ureterolith
274 Radiographic and Ultrasonographic Signs

References

3.7.2 Hepatobiliary disease

Focal or multifocal hepatic parenchymal abnormalities
Nodular hyperplasia (D)*

Abscess
- Biliary disease*
- Chronic glucocorticoid administration
- Diabetes mellitus*
- Liver lobe torsion
- Neoplasia*
- Pancreatitis*
- Penetrating foreign body

Cysts
- Acquired cysts
  - Biloma
  - Polycystic renal disease*
- Congenital cysts

Figure 3.7(a) Renal ultrasonogram. The kidney is enlarged, and the renal architecture is disrupted by a presumed neoplastic lesion. Reproduced with permission of Downs Referrals, Bristol.
Cyst-like masses
- Biliary pseudocyst
- Inflammation
- Necrosis
- Neoplasia*
- Trauma

Haematoma
- Coagulopathy *q.v.*
- Trauma*

Hepatic necrosis
- Chemical insult
- Immune-mediated*
- Infection*
- Toxin

Neoplasia
- Biliary cystadenoma
- Cholangiocellular adenocarcinoma
- Cholangiocellular adenoma
- Hepatocellular adenocarcinoma*
- Hepatocellular adenoma*
- Lymphoma*
- Metastatic tumours*

Diffuse hepatic disease
- Hepatomegaly *q.v.*
- Microhepatica *q.v.*

Decreased echogenicity
- Amyloidosis
- Congestion*
- Hepatitis*
- Leukaemia
- Lymphoma*

Increased echogenicity
- Chronic hepatitis*
- Cirrhosis*
- Fatty infiltration
  - Diabetes mellitus*
  - Obesity*
- Lymphoma*
- Steroid hepatopathy*

Mixed echogenicity
- Cirrhosis*
- Diffuse neoplasia*
- Hepatocutaneous syndrome
Biliary obstruction (see also Jaundice)
Abscess
Biliary calculi
Gastrointestinal disease* q.v.
Granuloma
Hepatobiliary disease* q.v.
Lymphadenopathy* q.v.
Neoplasia*
Pancreatitis*

Focal/multifocal increased echogenicity of gall bladder
Biliary calculi
Gall bladder mucocoele
Gall bladder sludge*
Neoplasia
Polyp

Gall bladder wall thickening
Acute hepatitis* q.v.
Cholangiohepatitis*
Cholecystitis* q.v.
Chronic hepatitis* q.v.
Gall bladder mucocoeles
Hypoalbuminaemia* q.v.
Neoplasia*
Right-sided congestive heart failure*
Sepsis*

Dilatation of caudal vena cava and hepatic veins
Haematological disorders
Systemic infection*

Obstruction of caudal vena cava/hepatic veins
Budd-Chiari syndrome
Liver disease* q.v.
Neoplasia*
Strictures
Thrombosis
Trauma*

Right-sided heart failure*
Cardiac tamponade
Dirofilariasis
Myocardial disease
Pulmonary hypertension
Pulmonic stenosis
Tricuspid insufficiency
Figure 3.7(b)  Hepatic ultrasonogram showing a hypoechoic mass. Cytology revealed this to be a lymphoma. Reproduced with permission of Downs Referrals, Bristol.

References

3.7.3 Splenic disease

Diffuse splenic disease – splenomegaly
Abscess
Amyloidosis
Extramedullary haematopoiesis
Immune-mediated disease*
Infarction
Parenchymal necrosis
Portal hypertension
Splenic vein thrombosis

Congestion
Anaesthetic agents*
Haemolytic anaemia*
Portal vein obstruction
Right-sided heart failure*
Torsion of splenic pedicle
• Gastric dilatation/volvulus
• Isolated
Toxaemia*
Tranquillizers*
Infection
Bacterial
Fungal

Neoplasia
Lymphoma
Lymphoproliferative disease
Malignant histiocytosis
Mastocytosis
Myeloproliferative disease

Parasites
Babesiosis
Ehrlichiosis
Haemobartonellosis

Focal or multifocal splenic disease
Abscess
Fat deposits
Nodular hyperplasia

Haematoma
Abdominal trauma
Coagulopathy

Infarcts
Cardiovascular disease
Hyperadrenocorticism
Hypercoagulability
Inflammatory diseases
  • Endocarditis
  • Pancreatitis
  • Septicaemia
Liver disease q.v.
Neoplasia
  • Fibrosarcoma
  • Haemangioma
  • Haemangiosarcoma
  • Leiomyosarcoma
  • Lymphoma
Renal disease q.v.

Neoplasia
Chondrosarcoma
Fibrosarcoma
Fibrous histiocytoma
Haemangioma
Haemangiosarcoma
Leiomyosarcoma
Liposarcoma
Lymphoma
Metastatic tumours
Myxosarcoma
Osteosarcoma
Rhabdomyosarcoma
Undifferentiated sarcoma

References

3.7.4 Pancreatic disease

Focal pancreatic lesions
Abscess (D)
Cyst-like structures
• Congenital cysts
• Pseudocysts
• Retention cysts
Neoplasia
Nodular changes

Diffuse enlargement
Pancreatic neoplasia
Pancreatic oedema
Pancreatitis

References

3.7.5 Adrenal disease

Adrenomegaly

Unilateral
Adrenal tumour
• Adrenocortical adenocarcinoma
• Adrenocortical adenoma
• Blastoma
• Metastatic tumours
• Phaeochromocytoma
Bilateral

Adrenal tumours
  • Adrenocortical adenocarcinoma*
  • Adrenocortical adenoma*
  • Metastatic tumours

Hyperplasia

Pituitary dependent hyperadrenocorticism*

Stressful non-adrenal illness*

Drugs
  • Trilostane

References


3.7.6 Urinary bladder disease

Increased wall thickness

Diffuse
  Chronic cystitis*
  Emphysematous cystitis
    • Clostridial infection
    • Diabetes mellitus

Empty bladder*

Fibrosis/calcification of bladder wall

Focal or multifocal

Mural haematomas
  • Coagulopathies q.v.
  • Iatrogenic
  • Infection
  • Neoplasia
  • Trauma

Neoplasia
  • Adenocarcinoma
  • Chemodectoma
  • Fibroma
  • Fibrosarcoma
  • Haemangioma
  • Haemangiosarcoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma
  • Myxoma
  • Rhabdomyosarcoma
  • Squamous cell carcinoma
• Transitional cell carcinoma
• Undifferentiated carcinoma

**Focal wall defects**
- Acquired diverticulum
- Patent urachus
- Urachal diverticulum
- Ureterocoele

**Intraluminal lesions**, e.g.
- Blood clots*
- Foreign bodies
- Gas bubbles
- Sediment*
- Uroliths*

**References**

### 3.7.7 Gastrointestinal disease

**Increased wall thickness**

*Diffuse*
- Acute haemorrhagic gastroenteritis*
- Colitis* q.v.
Gastritis*
  • Dietary*
  • Infectious*
    ◦ Parvovirus*
  • Inflammatory*
  • Uraemic* q.v.

Inflammatory bowel disease*

Neoplasia
  • Lymphoma*

Focal/multifocal
  Benign adenomatous polyps
  Chronic hypertrophic gastropathy
  Congenital hypertrophic pyloric stenosis
  Inflammatory bowel disease*
  Intussusception (apparent)

Neoplasia
  • Adenocarcinoma
  • Adenoma
  • Carcinoid tumours
  • Carcinoma
  • Leiomyoma
  • Leiomyosarcoma
  • Lymphoma
  • Neurilemmoma

Decreased intestinal motility (ileus)

Functional
  Abdominal pain*
  Acute gastroenteritis*
  Amyloidosis

Figure 3.7(d) Abdominal ultrasonogram of a palpable abdominal mass (arrowed). Exploratory coeliotomy revealed the mass to be a retained swab from previous abdominal surgery. Reproduced with permission of Downs Referrals, Bristol.
Neurogenic disease
Oedema
Postoperative abdomen*
Vascular disease
Drugs

Mechanical
Adhesions*
Foreign body*
Intussusception
Localised inflammation*
Neoplasia

References

3.7.8 Ovarian and uterine disease

Ovarian masses
Ovarian stump granuloma
Cysts*  
  Follicular  
  Luteinising

Neoplasia  
  Adenoma  
  Adenocarcinoma  
  Dysgerminoma  
  Granulosa cell tumour  
  Luteoma  
  Teratoma  
  Thecoma

Uterine enlargement  
  Haemometra  
  Hydrometra  
  Mucometra  
  Post partum*  
  Pregnancy*  
  Pyometra*

Uterine wall thickening  
Neoplasia  
  Adenocarcinoma  
  Adenoma  
  Fibroma  
  Fibrosarcoma  
  Leiomyoma  
  Leiomyosarcoma  
  Lymphoma

References  

3.7.9 Prostatic disease

Prostatic enlargement  
Diffuse  
  Bacterial prostatitis*  
  Benign prostatic hyperplasia*  
  Neoplasia  
  Squamous metaplasia
Focal lesions
Abscessation
Cysts
- Paraprostatic
- Prostatic
Neoplasia
- Adenocarcinoma
- Fibroma
- Leiomyoma
- Leiomyosarcoma
- Squamous cell carcinoma
- Transitional cell carcinoma
- Undifferentiated carcinoma

References

3.7.10 Ascites

Bile – ruptured biliary tract
Neoplasia
Post surgery, e.g.
- Cholecystectomy
Severe cholecystitis*
Trauma

Blood
Coagulopathy
Neoplasia, e.g.
  • Haemangiosarcoma*
Organ or major blood vessel rupture
Thrombosis
Trauma
Vasculitis

Chyle
Congestive heart failure
Feline infectious peritonitis (C)
Lymphangiectasia
Lymphangiosarcoma
Lymphoma
Mesenteric root strangulation
Ruptured cisterna chyli
  • Neoplasia
  • Trauma
Steatitis

Exudate
Diaphragmatic hernia
Feline infectious peritonitis* (C)
Hepatitis
Neoplasia
Organ torsion
Pancreatitis
Pericardiophragmatic hernia

Septic peritonitis
Abscess
Haematogenous spread
Iatrogenic/nosocomial
Local extension of infection from elsewhere
Migrating foreign body
Neoplasia*
Pancreatitis*
Penetrating wound
Ruptured viscus, e.g.
  • Neoplasia
  • Post surgery, e.g.
    ○ Enterotomy wound dehiscence*
  • Pyometra
  • Trauma
Steatitis

Transudate/modified transudate
Cardiac tamponade *q.v.*
Caudal vena caval obstruction
Hepatic disease
  • Cholangiohepatitis* *q.v.*
• Chronic hepatitis® * q.v.
• Cirrhosis®
• Fibrosis®
• Portal hypertension
Hypoalbuminaemia® * q.v.

Inflammation
• Feline infectious peritonitis

Neoplasia®
Portal hypertension
Right-sided heart failure®
Ruptured cyst
Splenic disease

Urine – lower urinary tract rupture
Bladder
Ureter
Urethra

References
3.8 Ultrasonography of other regions

3.8.1 Testes

Enlargement
- Neoplasia*
- Orchitis
- Torsion

Focal lesions – neoplasia
- Interstitial cell tumour*
- Seminoma*
- Sertoli cell tumour*

Reference

3.8.2 Eyes

Intraocular masses
- Foreign body*
- Inflammation*

Infection*
- Bacteria
- Fungi
  - Blastomycosis
  - Coccidioidomycosis
  - Cryptococcosis
  - Histoplasmosis
- Viral
  - Feline infectious peritonitis* (C)

Neoplasia
- Ciliary body adenocarcinoma
- Ciliary body adenoma
- Lymphoma
- Medulloepithelioma
- Melanoma
- Metastatic cancer
- Squamous cell carcinoma

Organised haemorrhage*
- Chronic glaucoma
- Coagulopathy *q.v.*
- Diabetes mellitus*
Hypertension* q.v.
Neoplasia
Neovascularisation
Persistent hyaloid artery
Trauma*
Vitreoretinal disease

Point-like and membranous lesions of vitreous chamber
Asteroid hyalosis
Endophthalmitis
Foreign body
Haemorrhage (see above)
Persistent hyperplastic primary vitreous
Posterior vitreal detachment
Vitreous floaters
Vitreous membrane formation

Retinal detachment q.v.

Retrobulbar masses
Abscess/cellulitis*
Extension from nasal cavity
Extension from paranasal sinuses
Extension from tooth-root infection*
Extension from zygomatic salivary gland
Foreign body
Haematogenous spread
Oral inflammatory disease
Penetrating wound

Neoplasia
Metastatic tumours
• Chondrosarcoma
• Haemangiosarcoma
• Lacrimal gland tumour
• Lymphoma
• Meningioma
• Nasal adenocarcinoma
• Neurofibrosarcoma
• Osteosarcoma
• Rhabdomyosarcoma
• Squamous cell carcinoma
• Zygomatic gland tumour
Primary epithelial and mesenchymal tumours

References
3.8.3 Neck

Enlarged parathyroid gland(s)

Neoplasia
- Adenocarcinoma
- Adenoma

Hyperplasia
- Nutritional secondary hyperparathyroidism
- Renal secondary hyperparathyroidism

Enlarged thyroid gland(s)

Neoplasia
- Adenocarcinoma*
- Adenoma*

Miscellaneous
- Thyroid cyst
- Thyroiditis

Lymph node enlargement

Inflammation/infection
- Abscess*
- Inflammation*

Neoplasia
- Lymphoma*
- Metastatic neoplasia*

Salivary gland enlargement

Salivary cysts
- Retention cyst
- True cyst
Salivary gland abscess*
Salivary gland neoplasia
Sialitis
Sialocele*
Sialolithiasis

Neck masses at other sites

Inflammation/infection
- Abscess*
- Cellulitis
- Granuloma

Neoplasia
- Lipoma*
Metastatic neoplasia
Primary neoplasia

Miscellaneous
Arteriovenous malformation
Cyst*
Haematoma*

References
In order to avoid repetition, ‘laboratory error’ has been omitted from the differential diagnoses in this chapter. However, it should always be borne in mind that factors such as mislabelling or misidentification of samples, errors introduced by the laboratory machinery (especially certain in-house laboratories where quality control is inadequate), errors due to ageing samples or incorrect collection techniques can all cause apparent abnormalities. Where a test result is unexpectedly abnormal it should be repeated, preferably by a different method. It is also important to remember that normal ranges are usually based on the values into which 95% of the healthy population would fall, so small changes outside these values may not be significant. Finally, different laboratories use different reference ranges, due to differences in testing methodology.

## 4.1 Biochemical findings

### 4.1.1 Albumin

**Increased**

- Artefact
  - Lipaemia
  - Haemoconcentration*
  - Dehydration

**Decreased**

- Relative (dilutional)

**Decreased protein intake**

- Malabsorption*
- Maldigestion
- Malnutrition

**Decreased production**

- Chronic inflammatory disease*
- Hepatic failure* _q.v._

**Increased loss**

- Cutaneous lesions, e.g.
  - Burns
- External haemorrhage*, e.g.
  - Coagulopathy _q.v._
  - Gastrointestinal neoplasia
• Gastrointestinal ulceration
• Trauma

Protein-losing enteropathy*
• Acute viral infection
• Cardiac disease
• Inflammatory bowel disease
• Gastrointestinal neoplasia
• Gastrointestinal parasitism
• Gastrointestinal ulceration
• Lymphangiectasia
  • Intestinal inflammation
  • Intestinal neoplasia
  • Lymphangitis
  • Primary/congenital
  • Venous hypertension

Protein-losing nephropathy *q.v.*

**Sequestration**

Body cavity effusion* *q.v.*

See Plate 4.1(a) in colour plate section.

**References**


### 4.1.2 Alanine transferase

**Decreased** *(see Plate 4.1(b) in colour plate section)*

- Chronic liver disease
- Normal variation*
- Nutritional deficiency
  - Vitamin B$_6$
  - Zinc

**Increased**

- Artefact
  - Haemolysis
  - Lipaemia

**Liver disease**

- Cholangiohepatitis* *q.v.*
- Cholangitis* *q.v.*
- Chronic hepatitis* *q.v.*
- Cirrhosis*
Copper storage disease (D)
Feline infectious peritonitis* (C)
Hapatotoxin
Neoplasia, e.g.
• Hepatocellular adenocarcinoma*
• Lymphoma*
Trauma*

Extrahepatic disease
Anoxia
Endocrine disease, e.g.
• Hyperadrenocorticism
• Hyperthyroidism (C)
Inflammatory disease, e.g.
• Pancreatitis

Drugs/toxins
Barbiturates
Cimetidine
Colchicine
Cyclophosphamide
Danazol
Diazepam (C)
Glucocorticoids
Griseofulvin
Itraconazole
Ketoconazole
Methamizole
Methotrexate
Metronidazole
Mexiletine
Nandrolone
NSAIDs, e.g.
• Ibuprofen
• Paracetamol
• Phenylbutazone
Oxytetracycline
Phenobarbitone
Phenylbutazone
Phenytoin
Primidone
Procainamide
Salicylates
Tetracycline
Trimethoprim/sulphonamide

References
4.1.3 Alkaline phosphatase

**INCREASED**
Normal in young growing animals*

**Artefact**
Haemolysis
Hyperbilirubinaemia
Lipaemia

**Hepatic disease**
Cholangiohepatitis* q.v.
Chronic hepatitis* q.v.
Cirrhosis* q.v.
Copper storage disease (D)
Feline infectious peritonitis* (C)
Hepatic lipidosis (C)
Hepatic neoplasia*, e.g.
- Haemangiosarcoma
- Hepatocellular carcinoma
- Lymphoma
- Metastatic carcinoma

**Extrahepatic disease**
Bile duct neoplasia
Bone disease, e.g.
- Fracture
- Osteomyelitis
Cholecystitis*
Cholelithiasis
Diabetes mellitus*
Diaphragmatic hernia*
Ehrlichiosis
Gall bladder mucocoele
Hyperadrenocorticism
Hyperthyroidism (C)*
Pancreatic neoplasia
Pancreatitis*
Right-sided congestive heart failure*
Septicaemia*

**Drugs/toxins**
Aflatoxin
Barbiturates
Cimetidine
Colchicine
Cyclophosphamide
Danazol
Diazepam (C)
Glucocorticoids
Griseofulvin
Itraconazole
Ketoconazole
Methamizole
Methotrexate
Metronidazole
Mexiletine
Nandrolone
NSAIDs, e.g.
  • Ibuprofen
  • Paracetamol
  • Phenylbutazone
Oxytetracycline
Phenobarbitone
Phenoxy acid herbicides
Phenylbutazone
Phenytoin
Primidone
Procainamide
Salicylates
Trimethoprim/sulphonamide

References

4.1.4 Ammonia

Decreased

Drugs
  • Diphenhydramine
  • Enemas
  • Lactulose
  • Oral antibiotics, e.g.
    • Aminoglycosides
    • Probiotics

Increased

Artefact
  • Delay in sample analysis
  • Fluoride/oxalate anti-coagulants
  • Strenuous exercise
**Hepatic insufficiency, e.g.**
- Acquired portosystemic shunt
- Congenital portosystemic shunt

**Miscellaneous**
- High protein diet
- Intestinal haemorrhage
- Portosystemic shunts
- Urea cycle disorders

**Drugs**
- Ammonium salts
- Asparaginase
- Diuretics

**Reference**

---

**4.1.5 Amylase**

**INCREASED**

**Intestinal disease**

**Pancreatic disease**
- Necrosis
- Neoplasia
- Pancreatic duct obstruction
- Pancreatitis

**Reduced glomerular filtration q.v.**
- Pre-renal disease
- Renal disease
- Post-renal disease

**Drugs/toxins**
- Azathioprine
- Carbamate
- Diazoxide
- Frusemide
- Glucocorticoids
- L-asparaginase
- Metronidazole
- Oestrogens
- Potassium bromide
- Sulphonamides
- Tetracyclines
- Thiazide diuretics

**Reference**
4.1.6 Aspartate aminotransferase

INCREASED

Artefact
Haemolysis
Lipaemia

Haemolysis*

Hepatic disease* q.v.

Muscle damage*
Exercise
Inflammation
Intramuscular injection
Ischaemia
Necrosis
Neoplasia
Trauma

Drugs/toxins
Barbiturates
Carbamate
Glucocorticoids
Griseofulvin
Ketoconazole
NSAIDs, e.g.
• Ibuprofen
• Paracetamol
• Phenobarbitone
• Phenylbutazone
• Primidone
• Salicylates

Reference

4.1.7 Bilirubin

Decreased

Artefact
Prolonged exposure to sunlight or fluorescent light

Increased (see also Jaundice)

Artefact
Haemolysis
Lipaemia
Pre-hepatic
Haemolysis*

Hepatic, e.g.
Cholestatic liver disease* q.v.

Post-hepatic, e.g.
Biliary obstruction* q.v.

Drugs/toxins
Barbiturates
Blue-green algae
Glucocorticoids
Glyphosphate
Griseofulvin
Ketoconazole
Metronidazole
Phenobarbitone
Plastic explosives
Primidone
NSAIDs, e.g.
  • Ibuprofen
  • Paracetamol
  • Phenylbutazone
Salicylates

References

4.1.8 Bile acids/dynamic bile acid test

Failure to stimulate
Cholestyramine
Delayed gastric emptying
Failure to feed a sufficiently high fat meal for bile acid stimulation test
Malabsorption
Rapid intestinal transit time
Normal

Increased
Artefact
  • Haemolysis
  • Lipaemia
Cholestatic disease* q.v.
Hepatic parenchymal disease* q.v.
300 Laboratory Findings

Portosystemic shunt
- Acquired
- Congenital
Secondary hepatic disease*
Drugs
- Ursodeoxycholic acid

References

4.1.9 C-reactive protein

Increased
- Inflammation*
- Neoplasia*
- Parturition*
- Tissue trauma*

Reference

Fig. 4.1 Ventrodorsal radiograph of an intraoperative mesenteric venogram, showing an extrahepatic portosystemic shunt. Reproduced with permission of Downs Referrals, Bristol.
4.1.10 Cholesterol

Decreased

Artefact
Intravenous dipyrone

Gastrointestinal
Hepatic insufficiency* q.v.
Maldigestion/malabsorption* q.v.
Protein-losing enteropathy* q.v.

Drugs
Azathioprine
Oral aminoglycosides

Increased
Idiopathic hyperlipidaemia
Postprandial hyperlipidaemia

Artefact
Hyperbilirubinemia
Lipaemia

Breed-related
Hypercholesterolaemia of the Briard, Rough Collie, Shetland Sheepdog (D)

Secondary hyperlipidaemia
Cholestatic disease* q.v.
Diabetes mellitus*
Hyperadrenocorticism
Hyperthyroidism* (D)
Nephrotic syndrome

Drugs
Corticosteroids
Phenytoin
Thiazide diuretics

References

4.1.11 Creatinine

Decreased
Poor body condition
Increased
Heavily muscled dogs
Pre-renal azotaemia*
Renal failure*
  • Acute renal failure
  • Chronic renal failure
  • Post-renal failure*
(see urea, *q.v.*)

Reference

4.1.12 Creatine kinase

Mild increases
Intramuscular injections*
Muscle biopsy
Muscle damage
Physical activity*
Prolonged recumbency*
Restraint*

Moderate increases
Anorexia
Convulsions*
Masticatory myopathy
Muscle damage
Neuropathies
Trauma*
Tremors/shivering *q.v.*
Toxins, e.g.
  • Carbamate
  • Lily poisoning
  • Phenoxy acid herbicides

Marked increases
Feline obstructive urethral syndrome*
Thromboembolic disease

Inherited myopathies
  Hereditary Labrador Retriever myopathy
  Muscular dystrophy
  Myotonia

Myositis
  Infectious
    • Neurosporosis
    • Toxoplasmosis
  Immune-mediated
    • Polymyosistis

Endocrine
  Hyperadrenocorticism
  Hypothyroidism* (D)

Toxic
  Monensin
**Nutritional myopathy**

- Selenium deficiency
- Vitamin E deficiency

**References**


**4.1.13 Ferritin**

**Decreased**

- Iron deficiency disorders *q.v.*

**Increased**

- Haemolysis*
- Inflammation*
- Liver disease*
- Neoplasia*
  - Lymphoma
  - Repeated blood transfusions

**References**


**4.1.14 Fibrinogen**

**Decreased**

- Artefact
  - Clot
  - Incorrect anticoagulant
- Disseminated intravascular coagulation*
- Excessive blood loss*
- Hereditary fibrinogen deficiency
- Severe hepatic insufficiency

**Increased**

- Breed
  - Cavalier King Charles Spaniels
Inflammation
Parturition
Pregnancy
Renal disease

References

4.1.15 Folate

**Decreased**
- Dietary deficiency
- Proximal small intestinal disease

**Increased**
- Dietary supplementation
- Exocrine pancreatic insufficiency
- Small intestinal bacterial overgrowth

**Reference**

4.1.16 Fructosamine

**Decreased**
- Hyperthyroidism (C)
- Insulin overdosage
- Persistent hypoglycaemia *q.v.*, e.g.
  - Insulinoma

**Increased**
- Hypothyroidism (D)
- Persistent hyperglycaemia, e.g.
  - Diabetes mellitus

**References**
4.1.17 Gamma-glutamyl transferase

INCREASED

Artefact
Lipaemia

Hepatic disease
Cholangiohepatitis* q.v.
Chronic hepatitis* q.v.
Cirrhosis* q.v.
Copper storage disease (D)
Feline infectious peritonitis* (C)
Hepatic lipidosis (C)
Hepatic neoplasia*, e.g.
• Haemangiosarcoma
• Hepatocellular carcinoma
• Lymphoma
• Metastatic carcinoma

Extrahepatic disease
Bile duct neoplasia
Cholecystitis*
Cholelithiasis
Diabetes mellitus*
Diaphragmatic hernia*
Gall bladder mucocoele
Hyperadrenocorticism
Hyperthyroidism (C)*
Pancreatic neoplasia
Pancreatitis*
Right-sided congestive heart failure*
Septicaemia*

Drugs
Barbiturates
Glucocorticoids
Griseofulvin
Ketoconazole
NSAIDs, e.g.
• Ibuprofen
• Paracetamol
• Phenylbutazone
Phenobarbitone
Primidone
Salicylates

Reference
4.1.18 Gastrin

Increased
- Antral G-cell hyperplasia
- Atrophic gastritis
- Chronic omeprazole administration
- Gastric outlet obstruction
- Gastrinoma
- Hyperparathyroidism
- Renal failure* q.v.
- Short bowel syndrome

Reference

4.1.19 Globulins

INCREASED

Polyclonal
Dehydration

Infectious
- Bacterial disease*, e.g.
  - Bacterial endocarditis
  - Brucellosis
  - Pyoderma*
- Fungal disease, e.g.
  - Blastomycosis
  - Coccidiodomycosis
  - Histoplasmosis
- Parasitic disease*, e.g.
  - Demodicosis*
  - Dirofilariasis
  - Scabies*
- Protozoal disease
- Rickettsial disease, e.g.
  - Ehrlichiosis
- Viral disease*, e.g.
  - Feline immunodeficiency virus* (C)
  - Feline infectious peritonitis* (C)
  - Feline leukaemia virus* (C)

Immune-mediated/inflammatory
Acute inflammatory response, e.g.
- Hepatitis*
- Nephritis *
- Suppurative diseases*
Allergies*
Autoimmune polyarthritis
Bullous pemphigoid
Immune-mediated haemolytic anaemia
Immune-mediated thrombocytopenia
Pemphigus complex
Systemic lupus erythematosus

Neoplasia
Lymphoma

Monoclonal/Oligoclonal
Cutaneous amyloidosis
Idiopathic
Macroglobulinaemia
Plasmacytic gastroenterocolitis

Infectious
Ehrlichiosis
Leishmaniasis

Neoplastic
Extramedullary plasmacytoma
Lymphoma*
Multiple myeloma

DECREASED
Normal in greyhounds
External haemorrhage, e.g.
• Coagulopathy *q.v.*
• Gastrointestinal neoplasia
• Gastrointestinal ulceration
• Trauma*
Hepatic insufficiency* q.v.
Neonate*
Protein-losing enteropathies* q.v.

References

4.1.20 Glucose

Decreased
Polycythaemia *q.v.*
Renal failure* q.v.
Sepsis*

**Artefact**
Prolonged contact of serum/plasma with erythrocytes

**Endocrine**
Hypoadrenocorticism (D)
Hypopituitarism
Insulinoma

**Hepatic**
Hepatic failure
  - Cirrhosis*
  - Hepatic necrosis, e.g.
    - Infection
    - Toxin
    - Trauma
  - Portosystemic shunts (acquired or congenital)

**Idiopathic**
Juvenile
Neonatal

**Neoplastic***
Hepatic leiomyoma/leiomyosarcoma
Hepatic/splenic haemangiosarcoma
Hepatocellular carcinoma
Pancreatic

**Substrate deficiency**
Glycogen storage disease
Hunting dog hypoglycaemia
Juvenile hypoglycaemia
Neonatal hypoglycaemia
Reduced dietary intake of glucose or its precursors

**Drugs/toxins**
Anabolic steroids
Beta blockers, e.g.
  - Propranolol
Ethanol
Ethylene glycol
Insulin
Salicylates
Sulfonylurea
Xylitol

**Increased**
- Pancreatitis*
- Parenteral nutrition
- Post-prandial
- Renal insufficiency* *q.v.*
- Stress hyperglycaemia*

**Artefact**
- Azotaemia

**Endocrine**
- Acromegaly
- Diabetes mellitus*
- Hyperadrenocorticism
- Phaeochromocytoma

**Progesterone-induced*, e.g.**
- Dioestrus
- Lactation
- Pregnancy

**Drugs/toxins**
- Daffodil
- Glucocorticoids
- Hydrochlorothiazide
- Megestrol acetate
- Oestrogens
- Phenytoin
- Progestagens
- Snake venom
- Thiazide diuretics
- Xylazine

**References**


**4.1.21 Iron**

**Decreased**
- Acute phase inflammatory reactions*
- Chronic inflammatory disease*
- Hypothyroidism (D)
Portosystemic shunt
Renal disease* q.v.

**Chronic external blood loss***
Chromically bleeding external masses*
External parasites, e.g.
  • Heavy flea burden*
Gastrointestinal*, e.g.
  • Clotting disorder q.v.
  • Neoplasia
  • Parasitism
  • Ulceration

**Decreased intake**
Milk-only diet in immature animals

**Neoplasia**
Lymphoma
Osteosarcoma

**Increased**
Haemolysis* q.v.
Ingestion of iron supplements/parental overdose
Liver disease* q.v.
Refractory anaemia

**References**

4.1.22 Lactate dehydrogenase

**INCREASED**

**Artefact**
Haemolysis
Sample ageing

**Cardiac muscle disorders**
Degeneration
Ischaemia
  • Aortic thromboembolism*
  • Bacterial endocarditis
  • Dirofilariasis
  • Myocardial infarction
Neoplasia
Trauma

**Respiratory disease***
Necrosis
Thromboembolism
Skeletal muscle disorders
Exertional rhabdomyolysis
Neoplasia*
Seizures*
Trauma*

Endocrine
Hyperadrenocorticism*
Hypothyroidism* (D)

Inflammatory/infectious
Bacterial*
Protozoal*

Idiopathic
Idiopathic polymyositis
Masticatory myopathy

Inherited myopathies
Hereditary Labrador Retriever myopathy
Muscular dystrophy
Myotonia

Metabolic
Glycogen storage diseases
Mitochondrial myopathy

Nutritional
Vitamin E deficiency

Vascular
Aortic thromboembolism* (C)

Miscellaneous
Hepatocellular damage* q.v.
Hyperthyroidism* (C)

References

4.1.23 Lipase

Decreased
Artefact
Haemolysis
Hyperbilirubinaemia
Lipaemia
Increased

Pancreatic disease
- Necrosis
- Neoplasia
- Pancreatic duct obstruction
- Pancreatitis*

Reduced glomerular filtration
- Pre-renal disease* q.v.
- Renal disease* q.v.
- Post-renal disease* q.v.

Drugs
- Azathioprine
- Diazoxide
- Frusemide
- Glucocorticoids
- L-asparaginase
- Metronidazole
- Oestrogens
- Potassium bromide
- Sulphonamides
- Tetracyclines
- Thiazide diuretics

References

4.1.24 Triglycerides

Decreased
- Artefact
  - Intravenous dipyrone
- Hyperthyroidism* (C)
- Protein-losing enteropathy*
- Drugs
  - Ascorbic acid therapy

Increased
- Artefact
  - Hyperbilirubinaemia
- Post-prandial*

Primary/idiopathic hyperlipidaemia
- Familial hyperchylomicronaemia in the cat
Idiopathic hyperchylomicronaemia of the Miniature Schnauzer
Idiopathic hypertriglyceridaemia
Lipoprotein lipase deficiency (C)
Transient hyperlipidaemia and anaemia in kittens (C)

*Secondary hyperlipidaemia*
  
  Acute pancreatitis*
  Cholestasis*
  Diabetes mellitus*
  Hepatic insufficiency* q.v.
  Hyperadrenocorticism
  Hypothyroidism* (D)
  Nephrotic syndrome

*Drugs*
  
  Glucocorticoids
  Megestrol acetate

*References*


**4.1.25 Trypsin-like immunoreactivity**

*Decreased*
  Exocrine pancreatic insufficiency
  Very low protein diet

*Increased*
  High-protein diet
  Pancreatitis*
  Post-pancreatic obstruction
  Reduced glomerular filtration rate

*References*


**4.1.26 Urea** (see Plate 4.1(c) in colour plate section)

*INCREASED*

*Pre-renal*
  Dehydration*
Gastro-intestinal haemorrhage
Heart failure*
High protein diet*
Hypoadrenocorticism (D)
Increased catabolic state, e.g.
• Fever*
Shock* q.v.
Tetracyclines

Renal (see Table 4.1)

Acute renal failure
Diabetes mellitus*
Hypercalcaemia
Immune-mediated diseases, e.g.
• Glomerulonephritis
• Systemic lupus erythematosus
Infection, e.g.
• Leptospirosis
• Pyelonephritis
Ischaemia
• Decreased cardiac output*
• Extensive burns
• Hyper-/hypothermia* q.v.
• Prolonged anaesthesia*
• Renal vessel thrombosis
• Shock, e.g.
  • Hypovolaemia
  • Sepsis*

Table 4.1 Differentiating acute and chronic renal failure.

<table>
<thead>
<tr>
<th></th>
<th>Acute</th>
<th>Chronic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signalment</strong></td>
<td>Any age, breed.</td>
<td>Usually older, unless breed predisposed to congenital kidney disease.</td>
</tr>
<tr>
<td><strong>History</strong></td>
<td>Toxin exposure, trauma, ischaemic insult, acute course.</td>
<td>PUPD, weight loss, chronic course.</td>
</tr>
<tr>
<td><strong>Physical findings</strong></td>
<td>Normal or large kidneys; other clinical signs often more severe than in CRF.</td>
<td>Often small irregular kidneys. Oral ulceration, mucous membrane pallor.</td>
</tr>
<tr>
<td><strong>Clinical pathology</strong></td>
<td>Hyperkalaemia may be seen, especially in oliguric or obstructed cases.</td>
<td>Potassium may be normal or low; non-regenerative anaemia often present; PTH may be elevated.</td>
</tr>
<tr>
<td><strong>Urinalysis</strong></td>
<td>Proteinuria, glucosuria, granular casts may be seen; may be anuric, oliguric or polyuric.</td>
<td>May be bacterial infection; polyuria usually seen unless ‘acute on chronic’</td>
</tr>
</tbody>
</table>
• Transfusion reactions
• Trauma*
Urinary tract obstruction*
Drugs/toxins
• ACE inhibitors
• Anaesthetics
• Antibiotics, e.g.
  • Aminoglycosides
  • Amphotericin B
  • Cephalosporins
  • Tetracyclines
• Borax
• Calcium edetate
• Chemotherapeutics, e.g.
  • Cisplatin
• Cimetidine
• Corticosteroids
• Dipyrone (metamizole)
• Heavy metals, e.g.
  • Arsenic
  • Lead
  • Mercury
• Hymenoptera stings
• Intravenous radiographic contrast agents
• Iron/iron salts
• Methylene blue
• NSAIDs
• Organic compounds, e.g.
  • Ethylene glycol
  • Herbicides
  • Pesticides
• Pigments, e.g.
  • Myoglobin/haemoglobin
  • Paraquat
  • Plastic explosives
  • Salt
  • Snake venom

**Chronic renal failure, e.g.**
Subsequent to acute renal failure
Glomerulonephritis*
Interstitial nephritis*
Nephrotoxins

**Post-renal**
Bladder obstruction*, e.g.
• Blood clot
• Neoplasia
• Polyp*
• Urolith*
Bladder trauma
Ureteral obstruction (may need to be bilateral to cause azotaemia)
Urethral obstruction, e.g.
  • Neoplasia
  • Urolith
Urethral trauma
Uroabdomen

**DECREASED**
Normal in neonates*
Dialysis/over-hydration
Diuresis, e.g.
  • Fluid and drug therapy*
Liver failure, e.g.
  • Cirrhosis
  • Portosystemic shunt*
Low-protein diet/malnutrition*
Polyuria _q.v._, e.g.
  • Diabetes insipidus
  • Hyperadrenocorticism
Pregnancy*
Urea cycle enzyme deficiency

**References**

**4.1.27 Vitamin B12 (cobalamin)**

**Increased**
Vitamin B12 supplementation

**Decreased**
Exocrine pancreatic insufficiency
Hepatic lipidosis (C)
Inflammatory biliary tract disorders
Inherited defect of absorption
Intestinal mucosal disease*
Pancreatitis

**Reference**
4.1.28 Zinc

**Decreased**
- Decreased dietary intake
- Zinc-responsive dermatosis

**Increased**
- Ingestion of zinc-containing objects, e.g.
  - Coins

**Reference**

4.2 Haematological findings

4.2.1 Regenerative anaemia (see Table 4.2(a))

HAEMORRHAGE

**Internal**
- Bleeding tumour*
- Coagulopathy *q.v.*
- Traumatic injury*

**External**
- Bleeding tumour*
- Coagulopathy *q.v.*
- Epistaxis *q.v.*

<table>
<thead>
<tr>
<th>Table 4.2(a)</th>
<th>Differentiating regenerative from non-regenerative anaemia.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regenerative</td>
</tr>
<tr>
<td>MCV</td>
<td>N/†</td>
</tr>
<tr>
<td>MCHC</td>
<td>‡</td>
</tr>
<tr>
<td>RPI</td>
<td>&gt;2</td>
</tr>
</tbody>
</table>

Key:
- MCV = Mean corpuscular volume
- MCHC = Mean corpuscular haemoglobin concentration
- RPI = Reticulocyte production index
- RPI is calculated according to the following formula:
  \[
  \text{RPI} = \frac{\text{ [% reticulocytes } \times (\text{patient haematocrit/species haematocrit})]}{\text{correction factor}}
  \]
-Species haematocrit: 45% (dog), 35% (cat)
-Correction factor: PCV > 35% = 1; PCV 25 – 35% = 1.5; PCV 15 – 25% = 2; PCV < 15% = 2.5
4.1.28 Zinc

**Decreased**
- Decreased dietary intake
- Zinc-responsive dermatosis

**Increased**
- Ingestion of zinc-containing objects, e.g.
  - Coins

**Reference**

### 4.2 Haematological findings

#### 4.2.1 Regenerative anaemia
(see Table 4.2(a))

**HAEMORRHAGE**

**Internal**
- Bleeding tumour*
- Coagulopathy *q.v.*
- Traumatic injury*

**External**
- Bleeding tumour*
- Coagulopathy *q.v.*
- Epistaxis *q.v.*

<table>
<thead>
<tr>
<th>Table 4.2(a)</th>
<th>Differentiating regenerative from non-regenerative anaemia.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regenerative</td>
</tr>
<tr>
<td>MCV</td>
<td>$N/\uparrow$</td>
</tr>
<tr>
<td>MCHC</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>RPI</td>
<td>$&gt;2$</td>
</tr>
</tbody>
</table>

Key:
- $MCV =$ Mean corpuscular volume
- $MCHC =$ Mean corpuscular haemoglobin concentration
- $RPI =$ Reticulocyte production index

RPI is calculated according to the following formula:

$$RPI = \left(\frac{\text{% reticulocytes} \times (\text{patient haematocrit}/\text{species haematocrit})}{\text{correction factor}}\right)$$

Species haematocrit: 45% (dog), 35% (cat)
Correction factor: $\text{PCV} > 35\% = 1$; $\text{PCV} 25 – 35\% = 1.5$; $\text{PCV} 15 – 25\% = 2$; $\text{PCV} < 15\% = 2.5$
Haematemesis *q.v.*
Haematuria *q.v.*
Intestinal blood loss *q.v.*
Traumatic injury*

**Parasitism**
- *Ancylostoma* spp
- Fleas
- Lice
- Ticks
- *Uncinaria* spp

**HAEMOLYSIS**

**Immune-mediated**
- Primary (auto-immune haemolytic anaemia)*

**Immunological**
- Anti-lymphocyte globulin therapy
- Neonatal isoerythrolysis
- Systemic lupus erythematosus
- Transfusion reactions

**Infectious**
- *Ancylostoma* spp
- Babesiosis
- Cytauxzoonosis
- Dirofilariasis
- Ehrlichiosis
- Feline leukaemia virus* (C)
- Haemobartonellosis
- Leishmaniasis
- Leptospirosis*
- Trypanosomiasis (D)
- *Uncinaria* spp

**Neoplastic**
- Haemangiosarcoma
- Lymphoproliferative disease, e.g.
  - Leukaemia
  - Lymphoma*

**Drugs/toxins**
- Antiarrhythmics
- Anticonvulsants
- Cephalosporins
- Chlorpromazine
- Copper
- Dipyrone
- Levamisole
Methimazole
Methylene blue
NSAIDs, e.g.
  • Paracetamol
Penicillins
Propylthiouracil
Quinidine
Trimethoprim/sulphonamide

**Mechanical injury of red cells**
Dirofilariasis
Disseminated intravascular coagulation*
Enlarged spleen
Glomerulonephritis
Haemolytic–uraemic syndrome
Neoplasia causing microangiopathic haemolytic anaemia, e.g.
  • Splenic haemangiosarcoma*
Patent ductus arteriosus
Vasculitis

**Genetic defects of red cells**
Feline porphyria
Hereditary elliptocytosis
Hereditary haemolysis in Abyssinian and Somali cats (C)
Hereditary stomatocytosis
Methaemoglobin reductase deficiency
Non-spherocytic haemolytic anaemia of Beagles (D)
Phosphofructokinase deficiency (D)
Pyruvate kinase deficiency

**Acquired defects of red cells**
Hypophosphataemia

**Chemical damage**
Copper
Cyclic hydrocarbons
Heavy metals
Propylene glycol

**Oxidative damage (Heinz body anaemia)**
Benzocaine toxicity
D-L methionine toxicity
Garlic toxicity
Glycol toxicity
High doses of vitamin K
Lymphoma
Metabolic disease
  • Diabetes mellitus*
  • Hyperthyroidism* (C)
  • Renal failure*
Methylene blue
Onion toxicity
Paracetamol toxicity
Phenazopyridine (C)
Phenolic-compound toxicity, e.g.
  • Mothballs
Propylene toxicity
Vitamin K\textsubscript{3} toxicity
Zinc toxicity

References

4.2.2 Poorly-/non-regenerative anaemia (see Table 4.2(a))

Normal
Young animals

Acute, pre-regenerative anaemia

Anaemia of chronic disease/associated with systemic disease
  Chronic inflammatory disease\textsuperscript{*}
  Chronic renal failure\textsuperscript{*} *q.v.*
  Cytauxzoonosis
  Feline immunodeficiency virus\textsuperscript{*} (C)
  Feline infectious peritonitis\textsuperscript{*} (C)
  Feline leukaemia virus\textsuperscript{*} (C)
  Hepatic disease\textsuperscript{*} *q.v.*
  Histoplasmosis
  Hypoadrenocorticism (D)
  Hypothyroidism\textsuperscript{*} (D)
  Leishmaniasis
  Malignant neoplasia
  Trypanosomiasis (D)

Bone marrow disorders – reduced red cell production

Aplastic anaemia
  Hyperoestrogenism, e.g.
    • Iatrogenic
    • Sertoli cell tumour
Infection
  • Ehrlichiosis
  • Viruses, e.g.
• Feline leukaemia virus* (C)
• Parvovirus*

Irradiation

Drugs/toxins
• Albendazole
• Anti-cancer chemotherapeutics
• Chloramphenicol
• Cyclic hydrocarbons
• DDT
• Diazoxide
• Oestrogens
• Phenylbutazone
• Sulpha drugs
• Trichloroethylene
• Trimethoprim-sulphadiazine

Myelodysplasia
Primary
Secondary
• Cobalamin or folate deficiencies
• Drug-induced toxicosis
• Immune-mediated diseases
• Neoplastic diseases

Myelophthisis
Granulomatous inflammation
• Fungi
• Histoplasmosis
• Tuberculosis

Myelofibrosis
• Idiopathic
• Lymphoproliferative
• Myeloproliferative
• Other types of neoplasia
• Prolonged marrow stimulation, e.g.
  • Chronic haemolytic anaemia
• Radiation

Neoplasia
• Leukaemia
• Metastatic neoplasia, e.g.
  • Carcinoma
  • Melanoma

Pure red cell aplasia
Feline leukaemia virus* (C)
Immune-mediated

Haematopoietic neoplasia
Lymphoproliferative
• Lymphoid leukaemia
• Acute lymphoblastic leukaemia
• Chronic lymphocytic leukaemia
• Granular lymphocytic leukaemia
• Multiple myeloma

Myeloproliferative
• Acute monocytic leukaemia
• Acute myeloid leukaemia
• Acute myelomonocytic leukaemia
• Chronic myeloid/granulocytic leukaemia

**Defects in haemoglobin synthesis**
- Copper deficiency
- Erythropoietic porphyria
- Hereditary porphyria
- Iron deficiency anaemia *q.v.*
- Lead poisoning
- Vitamin B₆ deficiency

**Defects in nucleotide synthesis**

*Nutrient deficiencies*
- Cobalt
- Folic acid
- Vitamin B₁₂

**Erythropoietin deficiency**
- Chronic renal failure* *q.v.*

**Iron deficiency**

*Inadequate intake*
- Dietary deficiency, e.g.
  - Milk diet

*Inadequate stores*
- Neonates*

**Chronic external haemorrhage**
- Bleeding tumour*
- Coagulopathy *q.v.*
- Epistaxis *q.v.*
- Haematemesis *q.v.*
- Haematuria *q.v.*
- Intestinal blood loss *q.v.*
- Parasitism*
  - *Ancylostoma* spp
  - Fleas
  - Lice
  - Ticks
  - *Uncinaria* spp
Rapid erythropoiesis
Erythropoietin therapy of anaemia
Neonates

Repeat phlebotomy
Blood donors*
Frequent blood sampling of small patients*
Therapeutic phlebotomy, e.g.
• Polycythaemia

Traumatic injury

Sideroblastic anaemia

References

4.2.3 Polycythaemia

Relative polycythaemia
Dehydration*
• Burns
• Diarrhoea
• Heat stroke
• Polyuria without matching polydipsia
• Vomiting
• Water deprivation

Spleenic contraction*
• Excitement
• Exercise
• Stress

Primary polycythaemia
Myeloproliferative disease (polycythaemia vera)

Secondary polycythaemia
Physiologically appropriate
• Altitude
• Chronic respiratory disease, e.g.
  • Feline asthma*
  • Neoplasia*
Haemoglobinopathies
Right-to-left congenital cardiac shunt, e.g.
• Atrial septal defect with pulmonic stenosis
• Pulmonary arteriovenous fistula
• Reverse-shunting patent ductus arteriosus
• Reverse-shunting ventricular septal defect
• Tetralogy of Fallot

Physiologically inappropriate
Extra-renal neoplasia
• Caecal leiomyosarcoma
• Hepatic carcinoma
• Hepatoblastoma
• Nasal fibrosarcoma
Hyperadrenocorticism
Hyperthyroidism* (C)
Non-neoplastic renal diseases
• Fatty infiltration of the kidney
• Hydronephrosis
• Renal capsular effusion
• Renal cysts
Renal neoplasia
• Adenocarcinoma
• Fibrosarcoma
• Lymphoma
• Nephroblastoma
Toxins, e.g.
• Carbamate

References

4.2.4 Thrombocytopenia

Decreased production
Bone marrow neoplasia, e.g.
• Lymphoproliferative disease
• Metastatic disease
• Myeloproliferative disease
Infection

Bacterial
• Endotoxaemia*

Fungal
• Blastomycosis
• Coccidioidomycosis
• Cryptococcosis
• Histoplasmosis

Parasitic
• Cytauxzoonosis
• Hepatozoonosis

Rickettsial
• Ehrlichiosis
• Rocky Mountain Spotted Fever

Viral
• Canine distemper virus* (D)
• Canine parvovirus* (D)
• Feline immunodeficiency virus* (C)
• Feline infectious enteritis* (C)
• Feline leukaemia virus* (C)

Drugs

Albendazole

Antibiotics, e.g.
• Chloramphenicol
• Trimethoprim/sulphonamide

Chemotherapeutic/cytotoxic drugs

Chloramphenicol

Diazoxide

Griseofulvin

Methimazole

Oestrogens

Phenylbutazone

Phenytoin

Propylthiouracil

Ribavirin

Thiazide diuretics

Miscellaneous

Haemophagocytic syndrome

Myelofibrosis
• Idiopathic
• Neoplasia, e.g.
• Myeloproliferative disease
• Prolonged marrow stimulation
• Secondary to sepsis

Immune-mediated destruction

Primary immune-mediated thrombocytopenia

Concurrent immune-mediated thrombocytopenia and immune-mediated haemolytic anaemia (Evans’s syndrome)
Secondary immune-mediated thrombocytopenia

Infections
- Babesiosis
- Dirofilariasis
- Ehrlichiosis
- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)
- Leptospirosis

Neonatal alloimmune thrombocytopenia

Neoplasia, e.g.
- Lymphoma*
- Solid tumours

Systemic lupus erythematosus

Transfusion reactions

Drugs/toxins
- Cephalosporins
- Chlorpromazine
- Colchicine
- Cytotoxic drugs
- Dipyrrone
- Heparin
- Levamisole
- Methimazole
- Modified live vaccines
- NSAIDs
- Oestrogens
- Penicillins
- Propylthiouracil
- Quinidine
- Trimethoprim/sulphonamide

Increased utilisation/non-immune destruction
- Disseminated intravascular coagulation
- Haemolytic uraemic syndrome
- Microangiopathic destruction
- Septicaemia
- Snake venom

Chronic/severe haemorrhage
- Coagulopathy
- Neoplasia

Vasculitis
- Canine adenovirus-1
- Canine herpes virus
- Dirofilariasis
- Ehrlichiosis
- Feline infectious peritonitis* (C)
- Neoplasia
Polyarteritis nodosa
Rocky Mountain Spotted Fever
Septicaemia
Systemic lupus erythematosus

Sequestration
Hepatomegaly* q.v.
Sepsis*

Splenomegaly* q.v.
Chronic infection*
Haematoma*
Immune-mediated haemolytic anaemia*
Neoplasia
• Haemangioma
• Haemangiosarcoma
• Mast cell
• Metastatic
Portal hypertension
Splenic torsion
Splenitis
Systemic lupus erythematosus

References

4.2.5 Thrombocytosis

Normal
May be normal in older animals

Splenic contraction
Excitement*
Exercise*
Stress*

Post splenectomy

Primary
Essential thrombocytosis
**Reactive**

- Bradycardia *q.v.*
- Chronic haemorrhage* *q.v.*
- Fractures*
- Gastrointestinal disease* *q.v.*
- Hyperadrenocorticism
- Hypercoagulability/disseminated intravascular coagulation
- Hyperviscosity syndromes
- Hypotension*
- Infection
- Inflammation/immune-mediated disease*
- Metastatic carcinoma
- Non-specific bone marrow stimulation
- Paraneoplastic
  - Bronchoalveolar carcinoma
  - Chronic myeloid leukaemia
  - Gingival carcinoma
  - Metastatic squamous cell carcinoma
  - Osteosarcoma
- Polycythaemia *q.v.*
- Shock* *q.v.*

**Rebound**

Secondary to resolution of previous thrombocytopenia

**References**


**4.2.6 Neutrophilia**

**Immunodeficiency syndromes**

- Canine leukocyte adhesion deficiency (D)
- Weimaraner immunodeficiency (D)
Inflammatory conditions – acute or chronic*, e.g.
   Chemical exposure

Immune-mediated disease*, e.g.
   Haemolytic anaemia*
   Polyarthritis
   Systemic lupus erythematosus

Infections
   Bacterial*
   Fungal
   Protozoal
   Viral*

Neoplasia
   Necrosis*
   Secondary bacterial infection*
   Ulceration*

Tissue necrosis, e.g.
   Large tumours*
   Pancreatitis*
   Pansteatitis

Toxins
   Endotoxin*
   Snakebite

Physiological
   Stress
     • Adrenaline release
     • Corticosteroid (endogenous or exogenous)

Reactive
   Haemolysis* q.v.
   Haemorrhage*
   Neoplasia*
   Oestrogen toxicity
   Recent surgery*
   Trauma*

Primary
   Myeloproliferative disease
     • Acute myeloid leukaemia
     • Chronic myeloid leukaemia

References
4.2.7 Neutropenia

Decreased neutrophil survival
Haemophagocytic syndromes
Immune-mediated neutropenia (D)
Parvovirus enteritis*

Sepsis/endotoxaemia*, e.g.
Acute salmonellosis*
Aspiration pneumonia*
Peritonitis*
Pyometra*
Pyothorax*

Reduced neutrophil production
Canine cyclic haematopoiesis

Acute viral infections*
Canine parvovirus* (D)
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Feline panleukopenia virus* (C)
Infectious canine hepatitis* (D)

Bone marrow disease
Aplastic anaemia
• Ehrlichiosis
• Idiopathic
• Toxicity
  • Oestrogen
  • Phenylbutazone
Bone marrow neoplasia, e.g.
• Lymphoproliferative disease
• Metastatic neoplasia
• Myeloproliferative disease
Disseminated granulomatous disease
Immune-mediated destruction of neutrophil precursors
Myelodysplasia
Myelophthisis

Bone marrow suppression
Oestrogen toxicity, e.g.
• Iatrogenic
• Sertoli cell tumour

Radiation therapy

Drugs
• Albendazole
• Azathioprine
• Busulphan
• Carbimazole
• Carboplatin
• Chlorambucil
• Chloramphenicol
• Cyclophosphamide
• Cytarabine
• Diazoxide
• Doxorubicin
• Frusemide
• Griseofulvin
• Hydroxyurea
• Lomustine
• Melphalan
• Methimazole
• Phenobarbitone
• Phenylbutazone
• Trimethoprim/sulphonamide (C)
• Vinblastine

References

4.2.8 Lymphocytosis

Physiological*
• Excitement*
• Exercise*
• Immature animal*
• Post vaccination*
• Stress (adrenaline response)*

Neoplasia
Leukaemia
• Acute lymphoblastic leukaemia
• Chronic lymphocytic leukaemia
Stage V lymphoma

Miscellaneous
Chronic infection*
Hypoadrenocorticism (D)
Recent vaccination*

References
blood: frequency and associations in 1022 samples. JSAP, 45:343–9.

4.2.9 Lymphopenia

Physiological
Stress (corticosteroid response)*

Hyperadrenocorticism

Immunodeficiency syndromes

Loss of lymph
Chylothorax
Lymphangiectasia
Protein-losing enteropathy* q.v.

Infectious/inflammatory
Septicaemia*

Viral infections, e.g.
Canine distemper virus* (D)
Coronavirus*
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Infectious canine hepatitis* (D)
Parvovirus

Drugs/therapy
Albendazole
Azathioprine
Busulphan
Carbimazole
Carboplatin
Chlorambucil
Chloramphenicol
Corticosteroids
Cyclophosphamide
Cyclosporine
Cytarabine
Diazoxide
Doxorubicin
Frusemide
Griseofulvin
Hydroxyurea
Lomustine
Melphalan
Phenylbutazone
Trimethoprim/sulphonamide (C)
Vinblastine

References

4.2.10 Monocytosis

Chronic inflammation
Granulomatous inflammation
Pyogranulomatous inflammation
Suppuration *
Tissue necrosis *

Corticosteroids
Hyperadrenocorticism
Iatrogenic
Stress

Infections
Viral, e.g.
Feline immunodeficiency virus * (C)

Fungal, e.g.
Coccidioidomycosis

Parasitic, e.g.
Leishmaniasis

Haemolytic/haemorrhagic diseases * q.v.

Immune-mediated disease, e.g.
Immune-mediated haemolytic anaemia *
Immune-mediated polyarthritis
**Neoplasia**
- Tumours with necrotic centres*
- Monocytic leukaemia
- Myelomonocytic leukaemia

**References**

### 4.2.11 Eosinophilia

**Immune-mediated**
- Allergies *
  - Atopy*
  - Feline asthma* (C)
  - Flea allergy*
  - Food allergies*
- Canine panosteitis (D)
- Eosinophilic gastroenteritis*
- Eosinophilic granuloma complex*
- Eosinophilic myositis
- Feline hypereosinophilic syndrome (C)
- Pemphigus foliaceus
- Pulmonary infiltrate with eosinophilia (D)

**Infection**

- *Bacterial*
  - *Fungal, e.g.*
    - Aspergillosis
    - Cryptococcosis

- *Parasites*, e.g.
  - *Aelurostrongylus abstrusus*
  - *Ancylostoma spp*
  - *Angiostrongylus vasorum*
  - *Capillaria aerophila*
  - *Dirofilaria immitis*
  - *Oslerus osleri*
  - *Pneumonyssoides caninum*
  - *Trichuris vulpis*

**Hormonal**
- Oestrus in some bitches

**Neoplastic**
- Eosinophilic leukaemia
**Tumour-associated eosinophilia**

- Fibrosarcoma
- Myeloproliferative disease
- Lymphoma
- Mast cell tumour
- Mucinous carcinomas
- Transitional cell carcinoma

**References**


---

**4.2.12 Eosinopenia**

- Acute infection*
- Acute inflammation*
- Glucocorticoid therapy*
- Hyperadrenocorticism
- Stress*

**Reference**


---

**4.2.13 Mastocythaemia**

- Disseminated mast cell neoplasia
- Mast cell leukaemia
- Mast cell tumour*, e.g.
  - Intestinal tract
  - Spleen
- Severe inflammation

**Reference**


---

**4.2.14 Basophilia**

- Chronic granulocytic leukaemia
- Hyperlipoproteinaemia
- Hypersensitivity reactions
- Lymphoma
- Lymphoplasmacytic gastroenteritis
- Mast cell tumours*
- Parasitism, especially dirofilariasis

**Reference**

4.2.15 Increased buccal mucosal bleeding time (disorders of primary haemostasis) (see Table 4.2(b))

Thrombocytopenia q.v.

Thrombocytopenia

Inherited
- Basset Hound thrombopathy (D)
- Canine thrombasthenic thrombopathy of Otter Hounds and Great Pyrenees (D)
- Chediak-Higashi syndrome (C)
- Cocker Spaniel bleeding disorders (D)
- Glanzmann’s thrombasthenia (D)
- von Willebrand’s disease* (D)

Acquired
- Chronic anaemia
- Disseminated intravascular coagulation
- Hepatic disease*
- Infection
  - Ehrlichiosis
  - Feline leukaemia virus* (C)
- Neoplasia*, e.g.,
  - Lymphocytic leukaemia
  - Multiple myeloma
- Paraproteinaemias
  - Benign macroglobulinaemia
  - Polyclonal gammopathies
- Uraemia* q.v.
- Drugs/toxins
  - Antibiotics
  - Barbiturates
  - Calcium channel blockers
  - Heparin
  - Hetastarch
  - NSAIDS, especially aspirin
  - Propranolol
  - Theophylline
  - Snake venom

References
4.2.16 Increased prothrombin time (disorders of extrinsic and common pathways) (see Table 4.2(b))

Artefact, e.g.
Deficiency of Factor II, V, VII or X
Disseminated intravascular coagulation
Hypo- or dysfibrinogenaemia
Liver disease*, e.g.
  • Portosystemic shunt
  • Vitamin K antagonism*

References


<table>
<thead>
<tr>
<th>Condition</th>
<th>PC</th>
<th>BMBT</th>
<th>ACT</th>
<th>PTT</th>
<th>PT</th>
<th>TCT</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin K antagonism</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>N</td>
<td>PIVKA</td>
</tr>
<tr>
<td>Immune-mediated thrombocytopenia</td>
<td>↓</td>
<td>↑</td>
<td></td>
<td></td>
<td>N↑</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Disseminated intravascular coagulation</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>FDPs</td>
</tr>
<tr>
<td>Platelet dysfunction</td>
<td>N</td>
<td>↑</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Deficiencies of FVIII, FIX, FXI, FXII</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>↑</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Deficiency of FVII</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Deficiencies of FII, FX</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Deficiency of FI</td>
<td>N</td>
<td>N</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>von Willebrand’s disease</td>
<td>N</td>
<td>↑</td>
<td>N/↑</td>
<td>N/↑</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

Key:
PC = platelet count
BMBT = buccal mucosal bleeding time
ACT = activated clotting time
PTT = partial thromboplastin time
PT = prothrombin time
TCT = thrombin clotting time
PIVKA = proteins induced by vitamin K antagonism
FDPs = fibrin degradation products
4.2.17 Increased partial thromboplastin time or activated clotting time (disorders of intrinsic and common pathways) (see Table 4.2(b))

Colloid administration
Disseminated intravascular coagulation
Factor II, V, X, XI or XII deficiency
Haemophilia A (Factor VIII deficiency)
Haemophilia B (Factor IX deficiency)
Haemorrhage
Hypo- or dysfibrinogenaemia
Liver disease* q.v.
Vitamin K antagonism*
Vitamin K-dependent coagulopathy

References

4.2.18 Increased fibrin degradation products

Disseminated intravascular coagulation
Hepatic disease* q.v.
Internal haemorrhage
Thrombosis*
Vitamin K antagonism*

References

4.2.19 Decreased fibrinogen levels

Artefact
- Clot
- Incorrect anticoagulant
Disseminated intravascular coagulation*
Excessive blood loss*
Hereditary fibrinogen deficiency
Immune-mediated haemolytic anaemia
Severe hepatic deficiency

Reference

4.2.20 Decreased antithrombin III levels

Heparin therapy
Hepatic disease* q.v.
Hypercoagulability, e.g.
  • Disseminated intravascular coagulation
Protein-losing enteropathy* q.v., e.g.
  • Parvovirus enteritis
Protein-losing nephropathy* q.v.

Reference

4.3 Electrolyte and blood gas findings

4.3.1 Total calcium

Increased (Table 4.3)
Acute renal failure q.v.
Artefact
  • Lipaemia


<table>
<thead>
<tr>
<th></th>
<th>PTH</th>
<th>PTHRP</th>
<th>iCa(^{2+})</th>
<th>1,25DHCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary hyperparathyroidism</td>
<td>↑/N</td>
<td>↓/N</td>
<td>↑</td>
<td>↑/N</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Chronic renal failure</td>
<td>↑/N</td>
<td>↑/N</td>
<td>↓/N</td>
<td>↓</td>
</tr>
<tr>
<td>Apocrine gland tumour of the anal sac</td>
<td>↓</td>
<td>↑</td>
<td>↑/N</td>
<td>↓</td>
</tr>
<tr>
<td>Hypervitaminosis D</td>
<td>↓</td>
<td>↓/N</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

Key:
PTH = parathyroid hormone
PTHRP = parathyroid hormone related peptide
iCa\(^{2+}\) = ionised calcium
1,25DHCC = 1,25 dihydroxycholecalciferol (Vitamin D)
Hereditary fibrinogen deficiency
Immune-mediated haemolytic anaemia
Severe hepatic deficiency

Reference

4.2.20 Decreased antithrombin III levels

Heparin therapy
Hepatic disease* q.v.
Hypercoagulability, e.g.
  • Disseminated intravascular coagulation
Protein-losing enteropathy* q.v., e.g.
  • Parvovirus enteritis
Protein-losing nephropathy* q.v.

Reference

4.3 Electrolyte and blood gas findings

4.3.1 Total calcium

Increased (Table 4.3)
Acute renal failure q.v.
Artefact
  • Lipaemia


<table>
<thead>
<tr>
<th></th>
<th>PTH</th>
<th>PTHRP</th>
<th>iCa²⁺</th>
<th>1,25DHCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary hyperparathyroidism</td>
<td>↑/N</td>
<td>↓/N</td>
<td>↑</td>
<td>↑/N</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Chronic renal failure</td>
<td>↑/N</td>
<td>↑/N</td>
<td>↓/N</td>
<td>↓</td>
</tr>
<tr>
<td>Apocrine gland tumour of the anal sac</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Hypervitaminosis D</td>
<td>↓</td>
<td>↓/N</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

Key:
PTH = parathyroid hormone
PTHRP = parathyroid hormone related peptide
iCa²⁺ = ionised calcium
1,25DHCC = 1,25 dihydroxycholecalciferol (Vitamin D)
Chronic renal failure* q.v.
Dehydration/hyperalbuminaemia* q.v.
Granulomatous disease
Hypervitaminosis A
Hypervitaminosis D
Hypoadrenocorticism (D)
Idiopathic hypercalcaemia of cats (C)
Physiological
  • Post prandial
  • Young dog*
Tertiary hyperparathyroidism

Hypercalcaemia of malignancy (Fig. 4.3)
Carcinoma
  • Bronchogenic
  • Mammary
  • Nasal cavity
  • Prostatic
  • Squamous cell
  • Thyroid
Haematological malignancies
  • Lymphoma*
  • Multiple myeloma
  • Myeloproliferative disease

Fig. 4.3 Transverse T2 weighted MR scan of the neck of a dog, showing a thyroid carcinoma (arrow). Reproduced with permission of Downs Referrals, Bristol.
Metastatic or primary bone neoplasia *q.v.*
Pseudohyperparathyroidism
  • Apocrine gland adenocarcinoma*
  • Lymphoma*

**Primary hyperparathyroidism**
Hereditary neonatal hyperparathyroidism
Multiple endocrine neoplasia
Parathyroid gland adenoma
Parathyroid gland carcinoma
Primary hyperplasia of the parathyroid glands

**Skeletal lesions**
Bone metastases
Hypertrophic osteodystrophy
Osteomyelitis
Systemic mycoses

**Drugs/toxins**
Anabolic steroids
Calcipotriol
Cholecalciferol rodenticides
Hydralazine
Jasmine
Oestrogen
Oral or intravenous calcium
Oral phosphate binders
Paracetamol
Parenteral calcium administration
Progesterone
Testosterone
Trilostane
Vitamin D analogues

**Decreased** (see Plate 4.3 in colour plate section)
Acute pancreatitis*
Acute renal failure *q.v.*
Canine distemper virus* (D)
Chronic renal failure* *q.v.*
Hypalbuminaemia* *q.v.*
Hypomagnesaemia *q.v.*
Hypoproteinaemia
Iatrogenic (post thyroidectomy)*
Idiopathic
Infarction of parathyroid gland adenomas
Intestinal malabsorption*
Medullary carcinoma of the thyroid (C-cell tumour)
Nutritional secondary hyperparathyroidism
Primary hypoparathyroidism
Puerperal tetany (eclampsia)*
Rhabdomyolysis
Tumour lysis syndrome

**Artefact**
Haemolysis
Incorrect anticoagulant

**Drugs/toxins**
Anticonvulsants
EDTA
Ethylene glycol
Frusemide
Glucagon
Intravenous phosphate administration
Mithramycin
Pamidronate
Phosphate-containing enemas
Sodium bicarbonate
Transfusion using citrated blood

**References**

**4.3.2 Chloride**

*Note:* Most causes of hyperchloraemia also cause concurrent hypernatraemia, and if changes are proportionate it is usually easier to look for causes of hypernatraemia. Formulae to correct chloride to account for sodium changes have been suggested as follows:

**Dogs:**  
\[ \text{Cl}^- \text{(corrected)} = \text{Cl}^- \text{(measured)} \times \frac{146}{\text{Na}^+ \text{(measured)}} \]  
Reference ranges: \( \text{Cl}^- \text{(measured)} = 100 - 116 \text{mmol/l} \)  
\( \text{Cl}^- \text{(corrected)} = 107 - 113 \text{mmol/l} \)

**Cats:**  
\[ \text{Cl}^- \text{(corrected)} = \text{Cl}^- \text{(measured)} \times \frac{156}{\text{Na}^+ \text{(measured)}} \]  
Reference ranges: \( \text{Cl}^- \text{(measured)} = 100 - 124 \text{mmol/l} \)  
\( \text{Cl}^- \text{(corrected)} = 117 - 123 \text{mmol/l} \)

*Note:* Reference ranges may vary depending on the instruments used to perform the measurement.
Increased

**Artefact**
- Hypotonic water loss
- Lipaemia
- Potassium bromide therapy
- Pure water loss

**Corrected hyperchloraemia**
- Chronic respiratory alkalosis *q.v.*
- Diabetes mellitus*
- Fanconi syndrome
- Hyperaldosteronism
- Hypoadrenocorticism (D)
- Renal failure* *q.v.*
- Renal tubular acidosis
- Small intestinal diarrhoea*

**Drugs/toxins**
- Acetazolamide
- Fluid therapy with saline
- Potassium chloride supplementation
- Salt poisoning
- Spironolactone
- Total parenteral nutrition
- Urinary acidifiers, e.g. ammonium chloride

Decreased

**Artefact**
- Lipaemia

**Corrected hypochloraemia**
- Chronic respiratory acidosis *q.v.*
- Exercise*
- Hyperadrenocorticism
- Vomiting*

**Drugs**
- Frusemide
- Sodium bicarbonate
- Thiazide diuretics

References


4.3.3 Magnesium

Increased

**Artefact**
- Sample haemolysis
Haemolysis
Hypoadrenocorticism (D)
Obstructive uropathy*
Renal failure* q.v.
Thoracic neoplasia/pleural effusion (C)
Drugs
- Oral antacids
- Parenteral administration
- Progesterones

**Decreased**
Acute pancreatitis*
Cholestasis* q.v.
Decreased intake
Hypercalcaemia q.v.
Hypokalaemia q.v.

**Artefact**
Haemolysis

**Endocrine**
Diabetic ketoacidosis*
Hyperthyroidism* (C)
Hypoparathyroidism (ionised hypomagnesaemia)
Primary hyperaldosteronism
Primary hyperparathyroidism

**Intestinal loss**
Bowel resection
Enteropathies*

**Redistribution**
Hypothermia* q.v.
Sepsis*
Trauma*

**Renal**
Acute tubular necrosis
Drug-induced tubular injury
- Aminoglycosides
- Cisplatin
Post-obstructive diuresis*

**Drugs/iatrogenic**
Amino acids
Aminoglycosides
Blood transfusion
Cisplatin
Digitalis
Diuretics, e.g.
- Frusemide
- Thiazides
Haemodialysis
Insulin
Nasogastric suction
Pamidronate
Peritoneal dialysis
Prolonged intravenous fluid therapy
Total parenteral nutrition

References

4.3.4 Potassium

Increased

Artefact/pseudohyperkalaemia
Contamination of sample with potassium EDTA
Haemolysis (especially Japanese Akita)
Marked leukocytosis/thrombocytosis with delay in separating serum
Thrombocytosis

Decreased urinary excretion
Acute renal failure *q.v.*
Chylothorax with repeated drainage
Gastrointestinal diseases *
• Perforated duodenal ulcer
• Salmonellosis
• Trichuriasis
Hyporeninaemic hypoaldosteronism
Post-renal failure* *q.v.*
Ruptured bladder/uroperitoneum
Hypoadrenocorticism (D)

Increased intake
Iatrogenic

Translocation
Acidosis *q.v.*
Diabetes mellitus/diabetic ketoacidosis *
Reperfusion injury, e.g.
• Aortic thromboembolism
• Crush
Tumour lysis syndrome
**Drugs/toxins**
- ACE inhibitors
- Amiloride
- Beta blockers
- Cardiac glycosides
- Ethylene glycol
- NSAIDs
- Oral or parenteral potassium supplementation
- Paraquat
- Prostaglandin inhibitors
- Salbutamol
- Spironolactone
- Succinylcholine
- Tricyclic antidepressants
- Trilostane

**Decreased**

**Diet**
- Decreased dietary intake
- High protein acidifying diets

**Endocrine**
- Diabetes mellitus*
- Hyperadrenocorticism
- Mineralocorticoid excess
- Primary hyperaldosteronism

**Increased loss**
- Chronic renal failure* *q.v.*
- Diuresis, e.g.
  - Diabetes mellitus*
  - Diuretic therapy
- Gastrointestinal loss (vomiting, diarrhoea)* *q.v.*
- Post obstructive diuresis*
- Renal tubular acidosis

**Translocation**
- Alkalosis
- Hypothermia* *q.v.*
- Idiopathic hypokalaemia of Burmese cats (C)

**Drugs/iatrogenic**
- Albuterol
- Amphotericin B
- Catecholamines
- Dialysis
Diuretics, e.g.
- Frusemide
- Mineralocorticoids
- Penicillins
- Thiazides
Fludrocortisone
Frusemide
Glucose
Hydrochlorothiazide
Inadequate potassium supplementation during fluid therapy
Insulin
Terbutaline
Total parenteral nutrition

References

4.3.5 Phosphate

Decreased
Decreased dietary intake
Decreased intestinal absorption
Diarrhoea* q.v.
Eclampsia*
Hypercalcaemia of malignancy*
Hypothermia* q.v.
Hypovitaminosis D
Increased urinary excretion*
Metabolic acidosis* q.v.
Renal tubular defects, e.g.
- Fanconi syndrome
Respiratory alkalosis q.v.
Vomiting* q.v.

Endocrine disorders
Diabetic ketoacidosis*
Hyperadrenocorticism
Hyperinsulinism/insulinoma
Primary hyperparathyroidism

Drugs/iatrogenic
Bicarbonate
Diuretics
Fluid therapy
Glucocorticoids
Glucose
Insulin
Pamidronate
Phosphate binding antacids
Salicylates
Vitamin D deficiency

**Increased**
Acute or chronic renal failure* q.v.
Haemolysis* q.v.
Metabolic acidosis* q.v.
Muscle trauma/necrosis*
Normal juvenile animal
Osteolytic bone lesions
Pre-renal failure* q.v.
Post-renal failure q.v.
Tumour lysis syndrome

** Artefact**
Haemolysis

**Endocrine disorders**
Acromegaly
Hyperthyroidism* (C)
Nutritional secondary hyperparathyroidism
Primary hypoparathyroidism
Renal secondary hyperparathyroidism*

**Drugs/toxins**
Cholecalciferol rodenticides
Hypervitaminosis D
Jasmine toxicity
Phosphate-containing enemas
Phosphate supplementation

**References**

**4.3.6 Sodium**

**Decreased**
Congestive heart failure with effusion*
Diarrhoea*
Hyperglycaemia* q.v.
Hyperlipidaemia q.v.
Hypoadrenocorticism (D)
Liver disease with ascites* q.v.
Marked hyperproteinaemia q.v.
Nephrotic syndrome with effusion
Over-hydration
Pancreatitis*
Renal failure* q.v.
Vomiting* q.v.

**Effusions**
Peritonitis*
Pleural effusion* q.v.
Uroabdomen

**Dehydration/hypovolaemia**
Cutaneous loss, e.g.
- Burns
Gastrointestinal loss*
Hypoadrenocorticism (D)

**Third space loss**
Chylothorax with repeated drainage
Pancreatitis*
Peritonitis*
Uroabdomen

**Normal hydration**
Inappropriate antidiuretic hormone secretion
Inappropriate fluid therapy
Myxoedema coma of hypothyroidism
Psychogenic polydipsia*

**Drugs**
Cyclophosphamide
Diuretics, e.g.
- Amiloride
- Frusemide
- Mannitol
- Spironolactone
- Thiazides
NSAIDs
Vincristine

**Increased**

**Hypotonic fluid loss**
Cutaneous, e.g.
- Burns
Diabetes mellitus (secondary to osmotic diuresis)*
Gastrointestinal (vomiting, diarrhoea, small intestinal obstruction)* q.v.
Post-obstructive diuresis*
Renal failure* q.v.
Third space loss, e.g.
• Pancreatitis*
• Peritonitis*

**Increased intake**
- Hyperadrenocorticism
- Hyperaldosteronism
- Iatrogenic
- Salt poisoning

**Pure water loss**
- Hypodypisia or adipsia, e.g.
  - Cranial trauma
  - Diabetes insipidus
  - Inflammatory brain disease
  - Intracranial neoplasia
- Hyperthermia *q.v.*
- Lack of free access to water with normal or increased insensible losses

**Drugs/toxins**
- Fludrocortisone
- Salt-containing products, e.g.
  - Playdough
- Sodium bicarbonate
- Sodium phosphate enemas

**References**

**4.3.7 pH**

**ACIDAEMIA**

**Metabolic acidosis**
- Diabetic ketoacidosis*
- Hypoadrenocorticism (D)
- Post-hypocapnic metabolic acidosis
- Renal failure* *q.v.*
- Renal tubular acidosis

**Lactic acid production**
- Diarrhoea* *q.v.*
- Hypoxaemia
- Pancreatitis*
- Sepsis*
- Shock* *q.v.*
Drugs/toxins
- Acetazolamide
- Ammonium chloride
- Ethylene glycol
- Methanol
- Methionine
- Paraldehyde
- Salicylic acid

Respiratory acidosis
Cardiopulmonary arrest

CNS disease (brain stem/high cervical spinal lesion), e.g.
- Intracranial space occupying lesion
- Trauma

Neuromuscular defects
- Botulism
- Idiopathic hypokalaemia of Burmese (C)
- Myasthenia gravis
- Polymyositis
- Polyradiculoneuritis
- Tetanus
- Tick paralysis

Severe respiratory disease
- Acute respiratory distress syndrome
- Airway obstruction*
- Aspiration pneumonia
- Chest wall trauma
- Diaphragmatic hernia*
- Haemothorax*
- Neoplasia*
- Pleural effusion* q.v.
- Pneumonia* q.v.
- Pneumothorax* q.v.
- Pulmonary fibrosis
- Pulmonary oedema* q.v.
- Pulmonary thromboembolism
- Pyothorax*
- Smoke inhalation

Iatrogenic respiratory depression
- Anaesthesia
- Opiates
- Organophosphates
- Pancuronium
- Succinylcholine
ALKALAEUNIA

Metabolic alkalosis
- Hyperadrenocorticism
- Post hypercapnia
- Primary hyperaldosteronism
- Vomiting

Drugs
- Acetate
- Bicarbonate
- Citrate
- Diuretics
- Exogenous steroid therapy
- Gluconate
- Lactate

Respiratory alkalosis
Overzealous ventilator therapy

Hypoxaemia, e.g.
- Congestive heart failure
- High altitude
- Pulmonary disease
- Right-to-left cardiac shunts
- Severe anaemia

Panting/hyperventilation
- Anxiety
- Fever
- Heat stroke
- Hyperthyroidism (C)
- Pain

Direct stimulation of medullary respiratory centre (neurogenic hyperventilation)
- CNS disease
- Hepatic disease
- Sepsis
- Drugs
  - Methyl xanthines
  - Salicylate intoxication

References
Decreased

CNS disease (brain stem/high cervical spinal lesion), e.g.
- Intracranial space occupying lesion
- Trauma

Heart disease
- Pulmonary oedema* q.v.
- Right-to-left shunting

Iatrogenic respiratory depression
- Anaesthesia
- Opiates
- Organophosphates
- Pancuronium
- Succinylcholine

Inadequate oxygen in inspired air
- Failure of oxygen supply during anaesthesia
- High altitude

Neuromuscular defects
- Botulism
- Idiopathic hypokalaemia of Burmese cats (C)
- Myasthenia gravis
- Polymyositis
- Polyradiculoneuritis
- Tetanus
- Tick paralysis

Severe respiratory disease
- Acute respiratory distress syndrome
- Airway obstruction*
- Aspiration pneumonia*
- Chest wall trauma*
- Diaphragmatic hernia*
- Haemothorax*
- Neoplasia*
- Pleural effusion* q.v.
- Pneumonia* q.v.
- Pneumothorax* q.v.
- Pulmonary fibrosis
- Pulmonary oedema* q.v.
- Pulmonary thromboembolism
- Pyothorax*
- Smoke inhalation
**Increased**
- Oxygen supplementation

**Reference**

### 4.3.9 Total CO₂

**Increased**
- Respiratory acidosis *q.v.*

**Decreased**
- Respiratory alkalosis *q.v.*

### 4.3.10 Bicarbonate

**Increased**
- Metabolic alkalosis *q.v.*

**Decreased**
- Metabolic acidosis *q.v.*

### 4.3.11 Base excess

**Increased**
- Metabolic alkalosis *q.v.*

**Decreased**
- Metabolic acidosis *q.v.*

### 4.4 Urinalysis findings

#### 4.4.1 Alterations in specific gravity

**Hyposthenuria**

**Increased water loss but no increased loss of solutes**

*Polyuria due to decreased ADH secretion*
- Insulinoma
- Overhydration
- Phaeochromocytoma
- Primary central diabetes insipidus
**Increased**
Oxygen supplementation

**Reference**

---

**4.3.9 Total CO₂**

**Increased**
Respiratory acidosis *q.v.*

**Decreased**
Respiratory alkalosis *q.v.*

**4.3.10 Bicarbonate**

**Increased**
Metabolic alkalosis *q.v.*

**Decreased**
Metabolic acidosis *q.v.*

**4.3.11 Base excess**

**Increased**
Metabolic alkalosis *q.v.*

**Decreased**
Metabolic acidosis *q.v.*

---

**4.4 Urinalysis findings**

**4.4.1 Alterations in specific gravity**

**HYPOSTHENURIA**

**Increased water loss but no increased loss of solutes**

*Polyuria due to decreased ADH secretion*
- Insulinoma
- Overhydration
- Phaeochromocytoma
- Primary central diabetes insipidus
Psychogenic polydipsia*  
Drugs, e.g.  
- Adrenaline  
- Phenytoin

Polyuria due to ADH inhibition/resistance  
- Hyperadrenocorticism  
- Hypercalcaemia* q.v.  
- Hyperthyroidism* (C)  
- Hypokalaemia* q.v.  
- Liver disease* q.v.  
- Primary hyperparathyroidism  
- Primary nephrogenic diabetes insipidus  
Toxaemia, e.g.  
- Pyometra*

Drugs  
- Anticonvulsants  
- Carbonic anhydrase inhibitors  
- Corticosteroids  
- Frusemide  
- Spironolactone  
- Thiazide diuretics

Inability of kidneys to concentrate urine  
- Acute renal failure q.v.  
- Chronic renal failure* q.v.  
- Pyelonephritis

HYPERSTHENURIA

Polyuria with excess solute loss  
- Acromegaly  
- Diabetes mellitus*  
Diet  
- High protein  
- High salt  
- Fanconi syndrome  
- Hyperviscosity  
- Osmotic diuretics  
- Dextrose  
- Mannitol  
- Primary renal glucosuria

Decreased loss of water and no decreased loss of solutes  
- Cardiac failure*  
- Dehydration*  
- Haemorrhage*  
- Renal infarction  
- Shock* q.v.
References

### 4.4.2 Abnormalities in urine chemistry

**Glucose – increased**

Hyperglycaemia q.v.
- Diabetes mellitus*
- Hyperadrenocorticism
- Iatrogenic
- Phaeochromocytoma
- Primary hyperaldosteronism
- Stress*

Renal tubular disorders
- Fanconi syndrome
- Primary renal glucosuria

Urinary tract haemorrhage with mild hyperglycaemia

References

**Blood**

See Haematuria q.v.

**Haemoglobin**

Haematuria q.v.

**Haemolysis** q.v.
- Disseminated intravascular coagulation
- Haemoplasmosis
- Immune-mediated haemolytic anaemia*
- Incompatible blood transfusion
- Neonatal isoerythrolysis
- Physical causes
  - Burns
  - Intravenous hypotonic solutions
  - Radiation
- Splenic torsion
Toxins
- Benzocaine
- Chlorate
- Dimethyl sulphoxide
- Nitrate
- Paracetamol
- Propylthiouracil
- Snake venom

Reference

Bilirubin
False positive, e.g. pigmenturia
Fever* q.v.
Hyperbilirubinaemia* q.v.
Normal in small quantities in dogs*
Starvation*

Myoglobin – muscle injury/necrosis
Athletic performance
Exercise-induced rhabdomyolysis
Heat stroke*
Ischaemia, e.g.
  - Aortic thromboembolism*
Trauma
  - Crush injury*
Toxins
  - Snake bites

Reference

Urobilinogen
*(Note: Of limited use in veterinary medicine.)*
Re-establishment of bile flow after an episode of biliary obstruction

Reference

Nitrite
*(Note: Many false negatives in dogs and cats.)*
Gram negative bacteriuria

Reference
**Protein – increased**

*False positives (strip test)*
- Contamination, e.g.
  - Benzalkonium Chloride
  - Cetrimide
  - Chlorhexidine
- Stale urine

*False positives (20% sulphosalicylic acid test)*
- Cephalosporins
- Penicillins
- Radiographic contrast media
- Sulphafurazole
- Thymol
- Tolbutamide

**Pre-renal**
- Haemoglobinuria, e.g.
  - Haemolytic anaemia
- Hyperproteinaemia *q.v.*
- Myoglobinuria, e.g.
  - Muscle trauma
  - Rhabdomyolysis
- Physiological, e.g.
  - Exercise
  - Stress

**Renal**
- Mild to moderate
  - Acute renal failure *q.v.*
  - Amyloidosis
  - Breed-associated nephropathy (D)
  - Chronic renal failure *q.v.*
  - Fanconi syndrome
  - Glomerulonephritis
  - IgA nephropathy
  - Primary renal glucosuria
  - Secondary glomerular disease
    - Bacterial endocarditis
    - Borreliosis
    - Brucellosis
    - Chronic bacterial infection
    - Chronic skin disease *q.v.*
    - Diabetic glomerulosclerosis
    - Dirofilariasis
    - Ehrlichiosis
    - Feline infectious peritonitis *q.v.* (C)
    - Feline leukaemia virus *q.v.* (C)
    - Hyperthermia *q.v.*
• Hypothermia* q.v.
• Immune-mediated haemolytic anaemia*
• Infectious canine hepatitis* (D)
• Inflammatory bowel disease*
• Leishmaniasis
• Leptospirosis*
• Mycoplasma polyarthritis
• Pancreatitis*
• Polyarthritis
• Prostatitis*
• Pyometra*
• Pyrexia* q.v.
• Rocky Mountain Spotted Fever (D)
• Septicaemia*
• Sulphonamide hypersensitivity
• Systemic lupus erythematosus

Severe
• Amyloidosis
• Glomerulonephritis

Post-renal
Genital tract inflammation
• Prostatitis*
• Vaginitis*
Genital tract secretions
Urinary tract inflammation
• Trauma*
• Urinary tract infection*
• Urolithiasis*
Urogenital neoplasia
• Bladder neoplasia
• Ureteral neoplasia
• Urethral neoplasia
• Vaginal or prostatic neoplasia

References
Jacob, F., et al. (2005) Evaluation of the association between initial proteinuria and morbidity rate or death in dogs with naturally occurring chronic renal failure. JAVMA, 226:393–400.

pH

DECREASED (<7)
• Acidifying diets*
• Metabolic acidosis* q.v.
• Respiratory acidosis* q.v.
• Drugs
• Ammonium chloride
• Frusemide
• Methionine
• Sodium acid phosphate
• Sodium chloride

**INCREASED**

**Diet**
• Low protein*
• Post-prandial alkaline tide*

**Metabolic alkalosis q.v.**

**Urinary tract disease**
• Proximal renal tubular acidosis
• Urinary retention*
• Urinary tract infection with urea-producing bacteria*

**Drugs**
• Acetazolamide
• Chlorthiazides
• Potassium citrate
• Sodium bicarbonate
• Sodium lactate

**Artefact**
Contamination with ammonia, detergents
Old sample

**Reference**

**Ketones – shift of energy production from carbohydrate to fat**

Hypoglycaemia, e.g.
• Insulinoma q.v.

Low carbohydrate, high fat diet
Starvation
Uncontrolled diabetes mellitus/diabetic ketoacidosis*

**Reference**

**4.4.3 Abnormalities in urine sediment**

**Increased white blood cells**
Low numbers normal
Neoplasia
Urinary tract infection*
Urinary tract inflammation*
Urolithiasis*
**Increased red blood cells**
Haematuria *q.v.*

**Casts**
Bilirubin
- Bilirubinuria

Broad casts
- Chronic pyelonephritis
- Dilated renal tubules

Epithelial cell, fatty, granular and waxy casts
- Acute renal failure *q.v.*
- Chronic renal failure* *q.v.*
- Degeneration/necrosis of tubular epithelial cells
- Degeneration of white cells
- Glomerulopathy

Haemoglobin
- Haemoglobinuria *q.v.*

Hyaline
- Associated with proteinuria *q.v.*

Myoglobin
- Myoglobinuria *q.v.*

Red blood cell
- Renal tubular haemorrhage

White cell
- Tubulointerstitial inflammation

**Reference**

**Crystals (predisposing factors)**

*Bilirubin*
(see Bilirubinuria, Hyperbilirubinaemia)

**Calcium oxalate**
Diet
- Excess calcium
- Excess oxalic acid
- Excess Vitamin C
- Excess Vitamin D

Ethylene glycol poisoning
Hyperadrenocorticism
Hypercalciuria
- Hypercalcaemia *q.v.*

**Calcium phosphate**
Alkaline urine
Primary hyperparathyroidism
Renal tubular acidosis
Cystine
Acid pH
Inherited defect of renal tubular cells

Silica
Dietary
• Gluten
• Soya bean hulls
Soil ingestion

Xanthine
Allopurinol administration
Hereditary

Struvite
Alkaline urine*
Urinary bladder foreign body
Urinary tract infection*

Urate
Acid urine
Breed-associated
• Dalmatian*
• English Bulldog
Portosystemic shunts
Urinary tract infection*

References

4.4.4 Infectious agents

Bacteria
Contamination*
• Catheterised sample*
• Failure of sterile collection technique
• Voided sample*
Urinary tract infection*

Fungi
Blastomycosis
Candidiasis
Contaminants*
Cryptococcosis
Prolonged antibiotic therapy

**Parasites**
*Capillaria ova*
*Diocophyma renale ova*
*Dirofilaria microfilaria*
Faecal contamination*

**Predisposing factors to urinary tract infection**

*Alteration of urothelium*
Changes in normal flora of distal urogenital tract
Metaplasia
- Oestrogens
  - Exogenous
  - Sertoli cell tumours*
Neoplasia*
Trauma
- External*
- Iatrogenic, e.g.
  - Catheterisation*
  - Palpation
  - Surgery*
- Urolithiasis*
Drugs
- Cyclophosphamide
- Oestrogens

*Alterations in urine*
Decreased frequency of urination
- Involuntary retention*
- Voluntary retention*
Decreased volume
- Decreased water consumption*
- Increased fluid loss*
- Oliguric/anuric renal failure *q.v.*
Dilute urine*
Glucosuria*

*Anatomic defects*
Acquired
- Chronic lower urinary tract disease*
- Secondary vesicoureteral reflux
- Surgical procedures
Congenital
- Ectopic ureters
- Persistent urachal diverticula
- Primary vesicoureteral reflux
- Urethral
Immunodeficiency
Congenital diseases
Hyperadrenocorticism
Iatrogenic, e.g.
  • Corticosteroids*
Uraemia* q.v.

Interference with normal micturition
Outflow obstruction
  • Neoplasia*
  • Prostatic disease*
  • Strictures
  • Urinary bladder herniation
  • Urolithiasis*
Incomplete emptying of bladder
  • Anatomic defects
    • Diverticula
    • Vesicoureteral reflux
  • Neurogenic
    • Reflex dyssynergia*
    • Spinal disease

References

4.5 Cytological findings

4.5.1 Tracheal/bronchoalveolar lavage

Increased neutrophils
Aspiration pneumonia*
Bacterial bronchitis*
Bronchopneumonia*
Canine tracheobronchitis* (D)
Chronic bronchitis*
Foreign body*
Parasites, e.g.
  • Angiostrongylus vasorum

Increased eosinophils (see Plate 4.5 in colour plate section)
Drugs
  • Potassium bromide (C)T
Eosinophilic bronchitis*
Feline asthma* (C)
### Immunodeficiency

Congenital diseases  
Hyperadrenocorticism  
Iatrogenic, e.g.  
- Corticosteroids*  
Uraemia* \(q.v.\)

### Interference with normal micturition

Outflow obstruction  
- Neoplasia*  
- Prostatic disease*  
- Strictures  
- Urinary bladder herniation  
- Urolithiasis*

Incomplete emptying of bladder  
- Anatomic defects  
  - Diverticula  
  - Vesicoureteral reflux  
- Neurogenic  
  - Reflex dyssynergia*  
  - Spinal disease

### References


---

### 4.5 Cytological findings

#### 4.5.1 Tracheal/bronchoalveolar lavage

**Increased neutrophils**  
Aspiration pneumonia*  
Bacterial bronchitis*  
Bronchopneumonia*  
Canine tracheobronchitis* \(D\)  
Chronic bronchitis*  
Foreign body*  
Parasites, e.g.  
- *Angiostrongylus vasorum*

**Increased eosinophils (see Plate 4.5 in colour plate section)**  
Drugs  
- Potassium bromide \(C\)\(T\)  
Eosinophilic bronchitis*  
Feline asthma* \(C\)
Parasites

- *Aelurostrongylus abstrusus*
- *Angiostrongylus vasorum*
- *Capillaria aerophila*
- *Crenosoma vulpis*
- *Oslerus* spp

Pulmonary infiltrate with eosinophils/eosinophilic bronchopneumonopathy

**Organisms visible on microscopy/detectable on culture**

**Upper respiratory tract**
- *Aelurostrongylus abstrusus*
- *Bordetella bronchiseptica*
- *Capillaria aerophila*
- *Malassezia pachydermatis*
- *Mycobacteria* spp
- *Mycoplasma* spp
- *Oslerus osleri*

**Lower respiratory tract**
- *Aelurostrongylus abstrusus*
- *Aspergillus* spp
- *Blastomyces dermatitidis*
- *Bordetella bronchiseptica* *
- *Capillaria aerophila*
- *Coccidioides immitis*
- *Crenosoma vulpis* (D)
- *Cryptococcus neoformans*
- *Eucoleus aerophilus*
- *Haemophilus felis*
- *Histoplasma capsulatum*
- *Mycobacteria* spp
- *Mycoplasma* spp
- Opportunistic bacteria *
  - *Pasteurella* spp
  - *Pseudomonas* spp
  - *Salmonella* Typhimurium
- *Oslerus* spp
- *Paragonimus kellicotti* (D)
- *Penicillium* spp
- *Pneumocystis carinii* (D)
- *Toxocara canis*
- *Toxoplasma gondii*
- *Yersinia pestis*

**References**


4.5.2 Nasal flush cytology

Neoplasia
- Adenocarcinoma*
- Chondrosarcoma
- Esthesioneuroblastoma
- Fibrosarcoma
- Haemangiosarcoma
- Histiocytoma
- Leiomyosarcoma
- Liposarcoma
- Lymphoma*
- Malignant fibrous histiocytoma
- Malignant melanoma
- Malignant nerve sheath tumour
- Mast cell tumour
- Myxosarcoma
- Neuroendocrine tumour
- Osteosarcoma
- Paranasal meningioma
- Rhabdomyosarcoma
- Squamous cell carcinoma*
- Transitional cell carcinoma
- Transmissible venereal tumour
- Undifferentiated carcinoma*
- Undifferentiated sarcoma

Inflammation
- Acute or chronic inflammation secondary to foreign body or dental disease*
- Allergic rhinitis*
- Granulomatous rhinitis
- Lymphoplasmacytic rhinitis*
- Nasopharyngeal polyp*
- Oronasal fistula

Organisms visible on microscopy/detectable on culture

Fungal disease
- Aspergillosis
- Cryptococcosis
- Penicillium spp
- Rhinosporidium spp

Bacterial/mycoplasmal disease
- Bordetella bronchiseptica*
- Chlamydophila felis* (C)
Parasites

- *Haemophilus felis*
- *Mycoplasma spp*
- *Capillaria aerophila*
- *Cuterebra spp*
- *Eucoleus böehmi*
- *Linguatula serrata*
- *Pneumonyssoides caninum* (D)

References


4.5.3 Liver cytology

Amyloidosis

Hyperplasia

- Nodular hyperplasia*

Increased bile pigment

- Cholestasis* q.v.

Increased copper

- Copper-associated hepatopathy

Infectious hepatopathies

- Babesiosis
- *Bacillus piliformis*
- Bacterial cholangiohepatitis*
- Canine adenovirus-1* (D)
- Canine herpes virus (D)
- *Capillaria hepatica*
- Cytauxzoonosis
- Ehrlichiosis
- Extrahepatic sepsis
- Feline coronavirus* (C)
- *Hepatozoon canis*
- Leishmaniasis
- Leptospirosis*
- Liver abscess
- *Metorchis conjunctus*
- Mycobacteriosis
- Neosporosis
- *Opisthobothris felineus*
Rhodococcus equi
Toxoplasmosis
Yersiniosis

**Inflammatory hepatopathies**
Cholangiohepatitis* q.v.
Chronic hepatitis* q.v.
Copper retention/storage disease
Granulomatous hepatitis
  - *Bartonella henselae*
  - Fungal disease
  - Intestinal lymphangitis/lymphangiectasia
  - Leishmaniasis
Idiosyncratic drug reaction
Lobular dissecting hepatitis
Drugs
  - Anticonvulsants
  - NSAIDs

**Neoplastic cells, e.g.**
Bile duct carcinoma
Haemangiosarcoma
Hepatocellular adenocarcinoma*
Leiomyosarcoma
Lymphoma*
Mast cell
Metastatic tumour*

**Vacuolar hepatopathies**
Chronic infections, e.g.
  - Dental disease*
  - Pyelonephritis
Diabetes mellitus*
Exogenous glucocorticoid administration*
Hyperadrenocorticism
Hyperlipidaemia
Hypothyroidism* (D)
Inflammatory bowel disease*
Lipid storage disease
Neoplasia*
Pancreatitis*

**References**
4.5.4 Kidney cytology

Neoplastic cells
Adenocarcinoma
Chondrosarcoma
Haemangioma
Haemangiosarcoma
Lymphoma*
Metastatic thyroid adenocarcinoma
Osteosarcoma

Inflammatory cells
Chronic interstitial nephritis*
Glomerulonephritis
Leptospirosis*
Neoplasia
Pyelonephritis
Renal abscess

Reference

4.5.5 Skin scrapes/hair plucks/tape impressions

Parasites
Cheyletiella spp*
Demodex spp*
Felicola subrostratus
Heterodoxus spiniger
Larval ticks*
Linognathus setosus*
Lynxacarus radovsky
Notoedres cati
Otodectes cynotis*
Sarcoptes scabiei* (D)
Tricodectes canis
Trombiculid mites*

Fungi
Dermatophytosis
Malassezia spp

Reference
4.5.6 Cerebrospinal fluid (CSF) analysis

RAISED CSF WHITE CELL COUNT AND/OR MICROPROTEIN LEVELS

Infectious

Algal
Protothecosis

Bacterial
Leptospirosis
Various aerobes and anaerobes, e.g.
- *Escherichia coli*
- *Klebsiella* spp
- *Streptococcus* spp

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Hyalohyphomycosis
Phaeohyphomycosis

Parasitic
*Ancylostoma caninum*
*Angiostrongylus cantonensis*
*Cuterebra* spp
*Dirofilaria immitis*
*Toxocara canis*

Protozoal
Acanthamoebiasis
Babesiosis
Encephalitozoonosis
Neosporosis
*Sarcocystis*-like organism
Toxoplasmosis
Trypanosomiasis

Rickettsial
Ehrlichiosis
Rocky Mountain Spotted Fever (D)
Salmon poisoning disease (D)

Viral
Borna disease virus
Canine distemper* (D)
Canine herpes virus (D)
Canine parainfluenza (D)
Canine parvovirus* (D)
Central European tick-borne encephalitis
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Infectious canine hepatitis* (D)
Pseudorabies
Rabies

**Non-infectious** (Fig. 4.5)
Eosinophilic meningoencephalitis
Fibrocartilaginous embolism
Fucosidosis
Globoid cell leukodystrophy
Granulomatous meningoencephalomyelitis
Idiopathic tremor syndrome
Intervertebral disc disease
Meningoencephalomyelitis in Pointers
Necrotizing encephalitis
Neoplasia
Periventricular encephalitis
Polioencephalomyelitis
Pug and Maltese encephalitis
Pyogranulomatous meningoencephalomyelitis
Steroid responsive meningoencephalomyelitis and polyarteritis
Yorkshire Terrier encephalitis

---

**Fig. 4.5**  Transverse T2 weighted MR scan of the brain of a dog with suspected granulomatous meningoencephalomyelitis, showing a high signal around the right lateral ventricle (arrow). Reproduced with permission of Downs Referrals, Bristol.
References

4.5.7 Fine needle aspiration of cutaneous/subcutaneous masses

Neoplasia

Epithelial
- Basal cell tumour
- Papilloma
- Perianal adenoma*
- Sebaceous adenoma/hyperplasia*
- Sebaceous gland tumours*
- Squamous cell carcinoma*
- Sweat gland tumours

Round cell
- Histiocytoma* (D)
- Lymphoma
- Mast cell tumour*
- Plasmacytoma
- Transmissible venereal tumour (D)

Mesenchymal
- Haemangiopericytoma
- Lipoma*
- Melanoma
- Sarcoma*, e.g.
  - Chondrosarcoma
  - Fibrosarcoma
  - Haemangiosarcoma
  - Osteosarcoma

Inflammatory cells
- Abscess*
- Cellulitis*
- Panniculitis
- Pyoderma*

Reference

# 4.6 Hormones/endocrine testing

## 4.6.1 Thyroxine

### Increased

**Diet**
- Soy
**Hyperthyroidism** (C)
**Juvenile dogs**
**Obesity**
**Pregnant bitches**
**Strenuous exercise**
**Total T4 autoantibodies**
**Thyroid carcinoma**

**Drugs**
- Excessive thyroid hormone supplementation
- Ipodate

### Decreased

**Neonatal cats**
Normal value is lower in sight hounds

### Primary hypothyroidism

- Acquired
- Congenital

### Non-thyroidal illness (Sick euthyroid syndrome), Many conditions, e.g.

**Acute diseases**
- Acute hepatitis *q.v.*
- Acute pancreatitis *
- Acute renal failure *q.v.*
- Autoimmune haemolytic anaemia *
- Bacterial bronchopneumonia *
- Canine distemper virus (D)
- Intervertebral disc disease (D)
- Polyradiculoneuritis
- Sepsis *
- Systemic lupus erythematosus

**Chronic diseases**
- Cachexia
  - Cardiac *
  - Neoplasia *
- Chronic renal failure *q.v.*
- Congestive heart failure *
- Dermatological disease *q.v.*
- Diabetes mellitus *

### 4.6 Hormones/endocrine testing

#### 4.6.1 Thyroxine

**Increased**

- Diet
  - Soy
- Hyperthyroidism* (C)
- Juvenile dogs*
- Obesity*
- Pregnant bitches*
- Strenuous exercise*
- Total T4 autoantibodies
- Thyroid carcinoma

**Drugs**

- Excessive thyroid hormone supplementation
- Ipodate

**Decreased**

- Neonatal cats*
- Normal value is lower in sight hounds

**Primary hypothyroidism**

- Acquired*
- Congenital

**Non-thyroidal illness (Sick euthyroid syndrome)*, Many conditions, e.g.**

**Acute diseases**

- Acute hepatitis* *q.v.*
- Acute pancreatitis*
- Acute renal failure *q.v.*
- Autoimmune haemolytic anaemia*
- Bacterial bronchopneumonia*
- Canine distemper virus* (D)
- Intervertebral disc disease* (D)
- Polyradiculoneuritis
- Sepsis*
- Systemic lupus erythematosus

**Chronic diseases**

- Cachexia
  - Cardiac*
  - Neoplasia*
- Chronic renal failure* *q.v.*
- Congestive heart failure*
- Dermatological disease* *q.v.*
- Diabetes mellitus*
374 Laboratory Findings

- Gastrointestinal disease* q.v.
- Hyperadrenocorticism
- Hypoadrenocorticism (D)
- Liver disease* q.v.
- Lymphoma*
- Megaoesophagus
- Systemic mycoses

Drugs
- Amiodarone
- Anabolic steroids
- Anaesthetics
- Anticonvulsants
  - Phenobarbitone
  - Phenytoin
- Frusemide
- Glucocorticoids
- Iodine supplementation
- Methimazole
- NSAIDs
  - Carprofen
  - Flunixin
  - Phenylbutazone
  - Salicylates
- Progestagens
- Propanolol
- Propylthiouracil
- Sulphonamides

References

4.6.2 Parathyroid hormone

Increased
- Hyperadrenocorticism
- Non-parathyroid causes of hypocalcaemia q.v.
- Nutritional secondary hyperparathyroidism
- Primary hyperparathyroidism
- Renal secondary hyperparathyroidism*
- Drugs that decrease serum calcium (see Hypocalcaemia)

Decreased
- Artefact
  - Prolonged storage/transport above freezing
- Hypervitaminosis D
- Non-parathyroid causes of hypercalcaemia
Primary hypoparathyroidism
Drugs that increase serum calcium (see Hypercalcaemia)

References

4.6.3 Cortisol (baseline or post-ACTH stimulation test)

Increased
Severe/chronic illness*
Stress*

Artefact
Cross-reaction with glucocorticoids (but not Dexamethasone)
- Cortisone
- Hydrocortisone
- Methylprednisolone
- Prednisolone
- Prednisone

Hyperadrenocorticism
Adrenal dependent
Pituitary dependent

Drugs
Anticonvulsants

Decreased

Artefact
Prolonged/improper storage

Hypoadrenocorticism (D)
Primary
Secondary

Drugs
Chronic androgen administration
Chronic glucocorticoid administration
Chronic progestagen administration
Megestrol acetate
4.6.4 Insulin

With concurrent hyperglycaemia

*Increased*
- Insulin-binding antibodies
- Insulin resistance*

*Decreased*
- Diabetes mellitus*

With concurrent hypoglycaemia

*Increased*
- Insulinoma

Reference

4.6.5 ACTH

*Increased*
- Ectopic ACTH secretion
- Insulin administration
- Pituitary-dependent hyperadrenocorticism
- Primary hypoadrenocorticism

*Decreased*
- Adrenal-dependent hyperadrenocorticism
- Iatrogenic hyperadrenocorticism
- Spontaneous secondary hyperadrenocorticism

*Artefact*
- Collecting into glass containers
- Storing above freezing

Reference

4.6.6 Vitamin D (1,25 dihydroxycholecalciferol)

*Increased*
- Exogenous administration
Granulomatous disease
Humoral hypercalcaemia of malignancy
Primary hyperparathyroidism
Vitamin D based rodenticides

**Decreased**
Chronic renal failure
Lymphoma
Primary hyperparathyroidism
Vitamin D deficient diet

**References**

**4.6.7 Testosterone**

**Increased (post GnRH or hCG)**
Functional testicular tissue
Ovarian thecoma

**Decreased**
Castrated male
Sertoli cell tumour*
Drugs
- Exogenous androgen treatment

**Artefact**
Collection into EDTA
Storage at room temperature
Storage with red blood cells

**References**

**4.6.8 Progesterone**

**Increased**
Adrenocortical carcinoma
Granulosa cell tumour
Luteal cysts
Normal luteal function
Ovarian remnant syndrome
Prostaglandin therapy
Recent ovulation

**Decreased**
Artefact
• Storage at room temperature
• Storage in whole blood
Exogenous progestagen administration
Failure to maintain normal luteal function
Failure to ovulate
Imminent parturition
Normal anoestrus

Reference

4.6.9 Oestradiol

Increased
Follicular ovarian cysts
Ovarian remnant syndrome
Seminoma*
Sertoli cell tumour*

Reference

4.6.10 Atrial natriuretic peptide

Increased
Atrial stretch
• Congenital diseases
• Dilated cardiomyopathy* (C)
• Hypertrophic cardiomyopathy* (C)
• Myxomatous degeneration of the AV valves* (D)
• Other cardiomyopathies
Congestive heart failure*
Fluid overload
Renal failure* q.v.

Reduced
Dehydration*

References
4.6.11 Modified water deprivation test (in the investigation of polyuria/polydipsia)

**Urine fully concentrated post water deprivation (see 6.13 for technique)**
- Normal
- Psychogenic polydipsia

**Urine mildly submaximally concentrated post water deprivation**
- Normal
- Partial diabetes insipidus
- Psychogenic polydipsia

**Urine submaximally concentrated post water deprivation and fully concentrated following DDAVP administration**
- Central diabetes insipidus

**Urine submaximally concentrated following water deprivation and DDAVP administration**
- Hyperadrenocorticism
- Medullary washout

**Nephrogenic diabetes insipidus**
- Primary
- Secondary
  - Acromegaly
  - Hyperadrenocorticism
  - Hypercalcaemia
  - Hyperthyroidism (C)
  - Hypoadrenocorticism (D)
  - Hypokalaemia
  - Liver disease
  - Pyelonephritis
  - Pyometra
  - Renal failure
  - Very low protein diet

**Reference**

4.7 Faecal analysis findings

4.7.1 Faecal blood

(See Haematochezia *q.v.* and Melaena *q.v.*)

*Note:* Tests for occult blood may be positive if red meat has been fed in the previous five days.
4.6.11 Modified water deprivation test (in the investigation of polyuria/polydipsia)

Urine fully concentrated post water deprivation (see 6.13 for technique)
  Normal*
  Psychogenic polydipsia*

Urine mildly submaximally concentrated post water deprivation
  Normal*
  Partial diabetes insipidus
  Psychogenic polydipsia*

Urine submaximally concentrated post water deprivation and fully concentrated following DDAVP administration
  Central diabetes insipidus

Urine submaximally concentrated following water deprivation and DDAVP administration
  Hyperadrenocorticism
  Medullary washout

Nephrogenic diabetes insipidus
  Primary
  Secondary
  • Acromegaly
  • Hyperadrenocorticism
  • Hypercalcaemia*
  • Hyperthyroidism* (C)
  • Hypoadrenocorticism (D)
  • Hypokalaemia*
  • Liver disease*
  • Pyelonephritis
  • Pyometra*
  • Renal failure*
  • Very low protein diet

Reference

4.7 Faecal analysis findings

4.7.1 Faecal blood

(See Haematochezia q.v. and Melaena q.v.)
Note: Tests for occult blood may be positive if red meat has been fed in the previous five days.
4.7.2 Faecal parasites

Flukes
Alaria spp

Hookworms
Ancylostoma* spp
Uncinaria* spp

Protozoa
Cryptosporidium* spp
Giardia* spp
Toxoplasma gondii
Tritrichomonas foetus

Respiratory parasites shed in faeces
Aelurostrongylus abstrusus
Capillaria aerophila
Crenosoma vulpis (D)
Eucoleus boehmi
Paragonimus kellicotti (D)

Roundworms
Toxascaris leonina
Toxocara canis
Toxocara cati

Tapeworms
Taenia* spp

Threadworm
Strongyloides spp

Whipworms
Trichuris vulpis*

References

4.7.3 Faecal culture

Culture for specific enteropathogenic bacteria
Campylobacter spp*
Clostridium difficile*
Clostridium perfringens*
**Non-selective culture**

Non-selective culture is thought to be of limited diagnostic use.

**Reference**


### 4.7.4 Faecal fungal infections

*Histoplasma capsulatum*

**Reference**


### 4.7.5 Undigested food residues

*Note:* Trypsinogen-like immunoreactivity is a more sensitive test for exocrine pancreatic insufficiency than is the presence of undigested food residues.

**Fat**

- Bile acid deficiency
- Exocrine pancreatic insufficiency
- Malabsorption*

**Starch**

- Exocrine pancreatic insufficiency
- High starch diet
- Increased intestinal transit time
5.1 ECG findings

Note: Changes in ECG measurements are relatively insensitive indicators of chamber size.

5.1.1 Alterations in P wave

**Tall P wave (P pulmonale)**
Right atrial enlargement, e.g.
- Chronic respiratory disease*
- Dilated cardiomyopathy*
- Tricuspid regurgitation*

**Wide P wave (P mitrale)**
Left atrial enlargement*, e.g.
- Dilated cardiomyopathy*
- Mitral regurgitation*

**Variable height of P wave (wandering pacemaker)**
Increased vagal tone*

**Absent P wave**

*atrial fibrillation*
- Acute atrial stretch
  - Volume overload
- Atrial pathology
- Excessive vagal stimulation
- Large atria*

**Persistent atrial standstill**
- Artefact
- Atrial pathology
- Hyperkalaemia

**Sinus arrest/sinoatrial block**
- Normal in brachyccephalics
- Atrial disease, e.g.
  - Cardiomyopathy*
  - Dilation*
• Fibrosis
• Hypertrophy
• Necrosis
Electrolyte imbalances*
Increased vagal tone
  • Chronic respiratory disease*
  • Gastrointestinal disease*
Sick sinus syndrome
Stenosis of bundle of His
Drugs, e.g.
  • Beta blockers
  • Calcium channel blockers
  • Digitalis glycosides

References

5.1.2 Alterations in QRS complex

**Tall R waves**
Left ventricular enlargement, e.g.
  • Cardiomyopathy*
  • Hyperthyroidism* (C)
  • Mitral regurgitation*

**Small R waves**
Acute haemorrhage
Pericardial effusion

**Wide QRS**
*Supraventricular*
Left bundle branch block
  • Cardiomyopathy*
  • Subaortic stenosis*
  • Drugs/toxins, e.g.
    • Doxorubicin
    • Tricyclic antidepressants
Right bundle branch block
  • Occasionally seen in normal animals
  • Cardiac neoplasia
  • Heartworm disease
  • Inherited
  • Post cardiac arrest
  • Ventricular septal defect
Left ventricular hypertrophy*
Microscopic intramural myocardial infarction
Quinidine toxicity
Severe ischaemia

**Ventricular**
Accelerated idioventricular rhythm*
Ventricular ectopy*
Ventricular escape complexes
Ventricular premature complexes*
Ventricular tachycardia*

**Slurred upstroke**
Ventricular pre-excitation/Wolff-Parkinson-White syndrome
- Acquired heart defects, e.g.
  - Feline hypertrophic cardiomyopathy
- Congenital
- Idiopathic

**Electrical alternans**
Pericardial effusion

**Deep S waves** (Fig. 5.1(a–f))
Right ventricular enlargement, e.g.
- Pulmonary hypertension
- Pulmonic stenosis
- Reverse-shunting patent ductus arteriosus
- Tricuspid regurgitation

**References**

### 5.1.3 Alterations in P-R relationship

**Prolonged P-R interval (first degree atrioventricular block)**
Occasionally seen in normal animals*
Age-related degeneration of atrioventricular conduction system
Feline dilated cardiomyopathy (C)
Heart disease*
Hyperkalaemia *q.v.*
Hypokalaemia* q.v.
Increased vagal tone*
Drugs/toxins
- Beta-blockers
- Calcium channel blockers
Figure 5.1(a–f) Electrocardiogram, showing deep S waves suggestive of right ventricular enlargement: (a) lead I; (b) lead II; (c) lead III; (d) aVF; (e) aVL; (f) aVR (25 mm/s, 10 mm/mV). Reproduced with permission of Downs Referrals, Bristol.
• Cardiac glycosides
• Quinidine
• Tricyclic antidepressants
• Vitamin D rodenticides

**Short P-R interval**
Ventricular pre-excitation/Wolff-Parkinson-White syndrome
• Acquired heart defects, e.g.
  • Feline hypertrophic cardiomyopathy
• Congenital
• Idiopathic

**Intermittent failure of atrioventricular conduction (second degree atrioventricular block)**
May be seen in normal animals
Juvenile puppies at rest
Physiological when seen associated with supraventricular tachycardia
Electrolyte imbalances* *q.v.*, e.g.
• Hyperkalaemia *q.v.*
Hyperthyroidism* (C)
Increased vagal tone, e.g.
• Chronic respiratory disease* *q.v.*
• Gastrointestinal disease* *q.v.*
Microscopic idiopathic fibrosis
Myocardial diseases
Stenosis of bundle of His
Drugs, e.g.
• Alpha-2 agonists
• Atropine
• Beta blockers
• Calcium channel blockers
• Cardiac glycosides

**Complete atrioventricular block (third degree atrioventricular block)**
Idiopathic
Bacterial endocarditis
Congenital heart defects, e.g.
• Aortic stenosis
• Ventricular septal defect
Hyperkalaemia
Isolated congenital atrioventricular block
Myocardial diseases including infiltrative disorders
Myocardial infarction
Myocarditis
Severe drug intoxication, e.g.
• Beta blockers
• Calcium channel blockers
• Cardiac glycosides
**5.1.4 Alterations in S-T segment**

S-T segment depression/slur
- Acute myocardial infarction
- Cardiac trauma
- Digitalis toxicity
- Electrolyte disturbances* q.v.
- Myocardial ischaemia

S-T segment elevation
- Myocardial hypoxia
- Myocardial infarction
- Myocardial neoplasia
- Pericarditis

Secondary changes to S-T segment following QRS abnormalities
- Bundle branch block
- Ventricular hypertrophy
- Ventricular premature complexes*

Pseudo-depression of S-T segment (prominent atrial repolarisation wave)
- Pathological atrial changes
- Tachycardia q.v.

Reference

**5.1.5 Alterations in Q-T interval**

Prolonged Q-T interval
- Central nervous system disease q.v.
- Exercise*
- Hypocalcaemia q.v.
- Hypokalaemia* q.v.
- Hypothermia* q.v.
- Drugs/toxins
  - Amiodarone
  - Ethylene glycol
• Quinidine
• Tick toxicity
• Tricyclic antidepressants

Shortened Q-T interval
Hypercalcaemia *q.v.*
Hyperkalaemia *q.v.*
Drugs/toxins
• Cardiac glycosides

Reference

5.1.6 Alterations in T wave

Tall T waves
Anaesthetic complications
Bradycardia *q.v.*
Heart failure*
Hyperkalaemia *q.v.*
Hyperventilation during heat stroke
Left bundle branch block
Myocardial hypoxia
Myocardial infarction
Right bundle branch block

Small T waves
Hypokalaemia* *q.v.*

T wave alternans
Hypercalcaemia *q.v.*
Increased circulating catecholamines
Increased sympathetic tone

5.1.7 Alterations in baseline

Atrial fibrillation
Atrial flutter
Movement artefact*
Ventricular fibrillation
Ventricular flutter

References
5.1.8 Rhythm alterations

**Atrial fibrillation**
Anaesthesia
Gastrointestinal disease*
Hypothyroidism* (D)
Primary/‘lone’
Rapid, large-volume pericardiocentesis
Severe atrial enlargement, e.g.
  - Dilated cardiomyopathy*
  - Mitral regurgitation*
  - Patent ductus arteriosus
Volume overload

**Atrial flutter**
Cardiomyopathy
Iatrogenic
  - Cardiac catheterisation
Severe atrial enlargement, e.g.
  - Dilated cardiomyopathy*
  - Mitral regurgitation*
  - Patent ductus arteriosus
Drugs
  - Quinidine

**Atrioventricular block q.v.**

**Parasystole**
Atrial
Ventricular

**Persistent atrial standstill**
Artefact
Atrial pathology
Hyperkalaemia

**Sinus block/arrest**
Atrial disease, e.g.
  - Cardiomyopathy*
  - Dilation*
  - Fibrosis
  - Hypertrophy
  - Necrosis
Electrolyte imbalances* q.v.
Increased vagal tone
  - Chronic respiratory disease*
  - Gastrointestinal disease*
Sick sinus syndrome
Stenosis of bundle of His
Drugs, e.g.
- Beta blockers
- Calcium channel blockers
- Digitalis glycosides

**Supraventricular premature complexes/supraventricular tachycardia (sinus, atrial or junctional tachycardia)**
May be normal

**Structural cardiac disease, e.g.**
- Atrial enlargement*
- Myocardial disease

**Systemic disease, e.g.**
- Hyperthyroidism* (C)
- Inflammation*
- Neoplasia*
- Sepsis*
- Drugs, e.g.
  - Digoxin
  - General anaesthesia

**Ventricular premature complexes/ventricular tachycardia**

[Fig. 5.1(g–i)]

**Cardiac disease**
- Congestive heart failure*
- Endocarditis, e.g.
  - Bacterial
- Inherited, e.g.
  - German Shepherd Dogs
- Myocardial infarction
- Myocarditis, e.g.
  - Idiopathic
  - Traumatic
  - Viral
- Neoplasia
- Pericarditis

![Electrocardiogram showing ventricular tachycardia in a dog (lead II, 25 mm/s, 5mm/mV). Reproduced with permission of Downs Referrals, Bristol.](image)
Extra-cardiac disease

Anaemia* q.v.
Autonomic imbalances* 
Coagulopathies q.v.
Disseminated intravascular coagulation
Endocrinopathies*
Gastric dilatation/volvulus*
Hypoxia
Nutritional deficiencies
Pancreatitis*
Sepsis*
Uraemia* q.v.

Drugs/toxins
• Atropine
• Anti-dysrhythmics, e.g.
  • Amiodarone
  • Digoxin
  • Lignocaine
  • Sotalol
• Dobutamine
• Dopamine
• Glycopyrronium bromide
• Halothane

Figure 5.1(h) Electrocardiogram showing intermittent ventricular premature complexes (lead II, 25mm/s, 5mm/mV). Reproduced with permission of Downs Referrals, Bristol.

Figure 5.1(i) Electrocardiogram showing ventricular trigeminy in a Boxer with arrhythmogenic right ventricular cardiomyopathy (lead II, 25mm/s, 5mm/mV). Reproduced with permission of Downs Referrals, Bristol.
• Propantheline bromide
• Theobromine
• Tricyclic antidepressants
• Xylazine
• Vitamin D rodenticides

**Ventricular flutter/fibrillation**

**Ventricular asystole**
Electrolyte/acid–base disorders
Severe sinoatrial block
Terminal systemic disease
Third degree atrioventricular block

**References**

### 5.1.9 Alterations in rate

**Tachycardia**

*Supraventricular tachycardia*
  - Atrial fibrillation
  - Atrial flutter
  - Ectopic atrial tachycardia
  - Junctional tachycardia
    - Automatic junctional tachycardia
    - AV nodal re-entrant tachycardia
    - Bypass-tract-mediated macro-re-entrant tachycardia
  - Sinus nodal re-entrant tachycardia
  - Ventricular pre-excitation/Wolff-Parkinson-White syndrome
  - Ventricular tachycardia *q.v.*

*Sinus tachycardia*
  - Physiological
    - Excitement*
    - Exercise*
    - Fear*
    - Pain*
  - Pathological
    - Heart failure*
    - Respiratory disease*
    - Shock*
- Systemic disease
  - Anaemia* q.v.
  - Fever* q.v.
  - Hyperthyroidism* (C)
  - Hypoxia
  - Sepsis*

Drugs/toxins
- Adder bites
- Baclofen
- Blue-green algae
- Cannabis
- Ethylene glycol
- Glyphosphate
- Ibuprofen
- Metaldehyde
- Paracetamol
- Paraquat
- Petroleum distillates
- Phenoxy acid herbicides
- Pyrethrins/pyrethroids
- Salbutamol
- Selective serotonin reuptake inhibitors
- Terfenadine
- Theobromine
- Tricyclic antidepressants
- Vitamin D rodenticides

**Bradycardia**
Atrial standstill
- Atroventricular myopathy
- Dilated cardiomyopathy*
- Hyperkalaemia q.v.

Heart block q.v.
Sick sinus syndrome
Sinus arrest

**Sinus bradycardia**
Normal in athletic dogs, during rest/sleep
Cardiac disease
- End-stage heart failure*
- Feline dilated cardiomyopathy (C)

Hypoglycaemia q.v.
Hypothyroidism*
Increased vagal tone, e.g.
- Gastrointestinal disease* q.v.
- Respiratory disease* q.v.

Neurological disease, e.g.
- Coma
Severe systemic disease*
Drugs/toxins
- Adder bites
Antidysrhythmics
  - Beta blockers
  - Calcium channel blockers
  - Digoxin
Baclofen
Cannabis
Carbamate
Daffodil
Glyphosphate
Ivermectin
Loperamide
Organophosphates
Paraquat
Phenoxy acid herbicides
Rhododendron
Theobromine
Vitamin D rodenticides
Yew

References

5.2 Electromyographic findings

**Spontaneous activity**
- Normal end-plate noise
- Electrode-insertion artefact
- Fibrillation potentials
  - Denervation
- Myotonic potentials (dive bomber sound)
  - Myotonia
- Pseudo-myotonic potentials
  - Polymyositis
  - Primary myopathies
  - Steroid myopathy

**Evoked activity**

*Decreased muscle action potential*
- Junctionopathies
  - Botulism
  - Tick paralysis
- Neuropathies
- Primary myopathies
Antidysrhythmics
- Beta blockers
- Calcium channel blockers
- Digoxin

Baclofen
Cannabis
Carbamate
Daffodil
Glyphosate
Ivermectin
Loperamide
Organophosphates
Paraquat
Phenoxy acid herbicides
Rhododendron
Theobromine
Vitamin D rodenticides
Yew

References

5.2 Electromyographic findings

Spontaneous activity
Normal end-plate noise
Electrode-insertion artefact
Fibrillation potentials
- Denervation
Myotonic potentials (dive bomber sound)
- Myotonia
Pseudo-myotonic potentials
- Polymyositis
- Primary myopathies
- Steroid myopathy

Evoked activity
Decreased muscle action potential
Junctionopathies
- Botulism
- Tick paralysis
Neuropathies
Primary myopathies
Increased muscle action potential
  Aged animals
  Chronic neuropathies

Decremental decrease after repeated stimulation
  Myasthenia gravis
  Re-innervation

References

5.3 Nerve conduction velocity findings

Increased velocity
  Proximal part of extremity

Decreased velocity
  Demyelinating neuropathies
  Distal part of extremity
  Hypothermia of adjacent tissues
  Protein malnutrition
  Very old/young animals

Reference

5.4 Electroencephalography findings

High voltage slow activity
  Brain oedema
  Chronic inflammatory conditions
  Hepatic encephalopathy
  Hydrocephalus
  Hypocalcaemia q.v.
  Idiopathic epilepsy
  Lead poisoning
  Space occupying lesions
  Trauma

Low voltage fast activity
  Acute inflammatory conditions, e.g.
    • Bacterial encephalitis
    • Canine distemper (D)
Increased muscle action potential
Aged animals
Chronic neuropathies

Decremental decrease after repeated stimulation
Myasthenia gravis
Re-innervation

References

5.3 Nerve conduction velocity findings

Increased velocity
Proximal part of extremity

Decreased velocity
Demyelinating neuropathies
Distal part of extremity
Hypothermia of adjacent tissues*
Protein malnutrition
Very old/young animals*

Reference

5.4 Electroencephalography findings

High voltage slow activity
Brain oedema
Chronic inflammatory conditions
Hepatic encephalopathy*
Hydrocephalus
Hypocalcaemia q.v.
Idiopathic epilepsy
Lead poisoning
Space occupying lesions
Trauma*

Low voltage fast activity
Acute inflammatory conditions, e.g.
• Bacterial encephalitis
• Canine distemper* (D)
Increased muscle action potential
Aged animals
Chronic neuropathies

Decremental decrease after repeated stimulation
Myasthenia gravis
Re-innervation

References

5.3 Nerve conduction velocity findings

Increased velocity
Proximal part of extremity

Decreased velocity
Demyelinating neuropathies
Distal part of extremity
Hypothermia of adjacent tissues*
Protein malnutrition
Very old/young animals*

Reference

5.4 Electroencephalography findings

High voltage slow activity
Brain oedema
Chronic inflammatory conditions
Hepatic encephalopathy*
Hydrocephalus
Hypocalcaemia q.v.
Idiopathic epilepsy
Lead poisoning
Space occupying lesions
Trauma*

Low voltage fast activity
Acute inflammatory conditions, e.g.
• Bacterial encephalitis
• Canine distemper* (D)
Low voltage slow activity
Ischaemic encephalopathy

References
Once a differential diagnosis list has been formulated, further diagnostic procedures are usually indicated in order to make a definitive diagnosis. The descriptions below give an overview of common diagnostic procedures, together with indications and guides to interpretation. However, many diagnostic procedures entail some risk to the animal, and the amount of diagnostic information that is obtained with some tests varies with the clinician’s ability and experience. It is recommended, therefore, that clinicians not experienced in a procedure obtain experience or training with a more experienced colleague, on courses and/or by practising on cadavers. Of the tests described below, those incurring particularly significant risks to the patient are:

- Bronchoalveolar lavage
- Cerebrospinal fluid (CSF) tap
- Myelography
- Pericardiocentesis
- Peritoneal lavage
- Thoracocentesis
- Ultrasound-guided biopsy

### 6.1 Fine-needle aspiration (FNA)

#### Indications
Cytological diagnosis of accessible masses or organs

#### Equipment
- 5 or 10 ml syringe
- 21–25g needle of a length suitable to reach the site of interest
- Several slides
- Surgical scrub

#### Technique

**Restraint**
For superficial lesions, sedation is not usually required. For deeper lesions, where it is vital that the animal does not move during the procedure, e.g. kidney and liver biopsies, sedation or general anaesthesia is recommended.

**Special precautions**
For aspiration of vascular organs such as kidney and liver, a pre-procedural coagulation profile is recommended. For deeper lesions, ultrasound guidance should be used wherever possible, in order to ensure that vital or vascular structures are not penetrated, and that the area of interest is sampled. More detailed texts on ultrasonography should be consulted for details of ultrasound-guided fine needle aspiration.
**Procedure**
The skin over the area of interest should be clipped and aseptically prepared. For superficial lesions, the mass should be fixed in position, with the fingers if possible. The syringe is emptied of air and attached to the appropriate needle. The mass should be punctured with a brisk motion. The syringe plunger is then withdrawn to apply 3–5 ml of vacuum. The needle should be moved while vacuum is applied. For a superficial or non-vascular mass, the needle can be partially withdrawn (making sure the tip stays beneath the skin so the vacuum is maintained), and redirected within the lesion several times. For vascular organs, the needle can be moved in and out along the same track it entered in. The plunger is then advanced to 0 ml to release the vacuum and the needle is withdrawn.

The needle is removed, and the plunger of the syringe is withdrawn until the syringe contains 3 ml of air. The needle is reattached, and the air in the syringe is expelled by sharply depressing the plunger, with the needle directed obliquely towards a slide. A preparation is immediately made of the sample, by the blood smear technique (q.v.) or by the pull-apart method. In the pull-apart method, a clean glass slide is placed on top of and at right angles to the slide onto which the aspirate has been expelled. The slides are then gently pulled apart horizontally. Slides should be air dried immediately.

**Risk**
Risks of this procedure include dissemination of infection or neoplasia, and haemorrhage.

**Interpretation**
Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

### 6.2 Bronchoalveolar lavage

**Indications**
Diagnosis of chronic lower respiratory tract disease

**Equipment**
- Endoscope
- Sterile bronchoalveolar lavage or other suitable catheter
- Sterile saline
- Syringe
- Sterile collection container

**Technique**

**Restraint**
The animal is anaesthetised.

**Special precautions**
Attention should be paid to the oxygenation status of the animal by appropriate monitoring during this procedure, and the procedure paused or discontinued if it is suspected that oxygen saturation is dropping. A jet of oxygen supplied via the biopsy port can help maintain oxygen saturation.
**Procedure**

The skin over the area of interest should be clipped and aseptically prepared. For superficial lesions, the mass should be fixed in position, with the fingers if possible. The syringe is emptied of air and attached to the appropriate needle. The mass should be punctured with a brisk motion. The syringe plunger is then withdrawn to apply 3–5 ml of vacuum. The needle should be moved while vacuum is applied. For a superficial or non-vascular mass, the needle can be partially withdrawn (making sure the tip stays beneath the skin so the vacuum is maintained), and redirected within the lesion several times. For vascular organs, the needle can be moved in and out along the same track it entered in. The plunger is then advanced to 0 ml to release the vacuum and the needle is withdrawn.

The needle is removed, and the plunger of the syringe is withdrawn until the syringe contains 3 ml of air. The needle is reattached, and the air in the syringe is expelled by sharply depressing the plunger, with the needle directed obliquely towards a slide. A preparation is immediately made of the sample, by the blood smear technique (q.v.) or by the pull-apart method. In the pull-apart method, a clean glass slide is placed on top of and at right angles to the slide onto which the aspirate has been expelled. The slides are then gently pulled apart horizontally. Slides should be air dried immediately.

**Risk**

Risks of this procedure include dissemination of infection or neoplasia, and haemorrhage.

**Interpretation**

Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

---

**6.2 Bronchoalveolar lavage**

**Indications**

Diagnosis of chronic lower respiratory tract disease

**Equipment**

- Endoscope
- Sterile bronchoalveolar lavage or other suitable catheter
- Sterile saline
- Syringe
- Sterile collection container

**Technique**

**Restraint**

The animal is anaesthetised.

**Special precautions**

Attention should be paid to the oxygenation status of the animal by appropriate monitoring during this procedure, and the procedure paused or discontinued if it is suspected that oxygen saturation is dropping. A jet of oxygen supplied via the biopsy port can help maintain oxygen saturation.
**Procedure**

An endoscope is passed into the trachea. The airways should be examined in a systematic manner for lesions, masses and foreign bodies, as well as to enable assessment of the level of mucosal hyperaemia and mucus.

Once the airways are examined, the endoscope is advanced to a region of interest, until it is gently wedged in a small bronchus. The sterile catheter is then advanced so it protrudes into the airway. Care should be taken not to advance the catheter too far blindly, as it is possible to penetrate the airway and cause a pneumothorax. Flush 0.5 ml/kg of saline down the catheter, following this by 3 ml of air to clear the tubing. Firm coupage is applied to the animal’s chest and the fluid is then aspirated. Commonly only 20–30% of the saline is recovered. The procedure should be repeated 2–3 times, in different areas of the lungs if diffuse disease is suspected.

The fluid is placed in sterile containers. Samples are centrifuged and direct smears of the sediment are made, usually by the pull apart method (see Section 6.1) as the sediment is often very mucoid. The supernatant can be submitted for bacteriology.

**Risks**

Risks include iatrogenic pneumothorax and hypoxia due to the presence of the endoscope, the lavage fluid or the disease process itself.

**Interpretation**

Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

---

**6.3 Gastrointestinal (GI) endoscopic biopsy**

**Indications**

Investigation of chronic vomiting or diarrhoea

**Equipment**

- Flexible endoscope of suitable size and length
- Endoscopic biopsy forceps
- Pots containing 10% buffered formal saline

**Technique**

**Prior preparation**

Food is withheld for 24 hours. For colonoscopy, it is essential to prepare the colon adequately prior to the procedure. This involves withholding food for 24 hours and administering a human oral bowel-cleansing solution 18 hours prior to the procedure. On the morning of the procedure, two warm water enemas should be given.

**Restraint**

The animal is anaesthetised.

**Upper GI tract**

*Note:* The reader is advised to consult specific texts on endoscopy for more detail on these procedures.
Procedure
An endoscope is passed into the trachea. The airways should be examined in a systematic manner for lesions, masses and foreign bodies, as well as to enable assessment of the level of mucosal hyperaemia and mucus.

Once the airways are examined, the endoscope is advanced to a region of interest, until it is gently wedged in a small bronchus. The sterile catheter is then advanced so it protrudes into the airway. Care should be taken not to advance the catheter too far blindly, as it is possible to penetrate the airway and cause a pneumothorax. Flush 0.5 ml/kg of saline down the catheter, following this by 3 ml of air to clear the tubing. Firm coupage is applied to the animal’s chest and the fluid is then aspirated. Commonly only 20–30% of the saline is recovered. The procedure should be repeated 2–3 times, in different areas of the lungs if diffuse disease is suspected.

The fluid is placed in sterile containers. Samples are centrifuged and direct smears of the sediment are made, usually by the pull apart method (see Section 6.1) as the sediment is often very mucoid. The supernatant can be submitted for bacteriology.

Risks
Risks include iatrogenic pneumothorax and hypoxia due to the presence of the endoscope, the lavage fluid or the disease process itself.

Interpretation
Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

6.3 Gastrointestinal (GI) endoscopic biopsy

Indications
Investigation of chronic vomiting or diarrhoea

Equipment
- Flexible endoscope of suitable size and length
- Endoscopic biopsy forceps
- Pots containing 10% buffered formal saline

Technique

Prior preparation
Food is withheld for 24 hours. For colonoscopy, it is essential to prepare the colon adequately prior to the procedure. This involves withholding food for 24 hours and administering a human oral bowel-cleansing solution 18 hours prior to the procedure. On the morning of the procedure, two warm water enemas should be given.

Restraint
The animal is anaesthetised.

Upper GI tract
Note: The reader is advised to consult specific texts on endoscopy for more detail on these procedures.
Place the animal in left lateral recumbency. A dental gag is placed in the mouth to prevent damage to the endoscope, which is advanced into the stomach. The stomach is insufflated slightly with air, the endoscope is advanced into the pylorus and from there into the duodenum. It should be advanced down the small intestine as far as possible.

Biopsies are taken from any visible lesions. If no focal lesions are observed, multiple mucosal biopsies are taken. Endoscopic biopsy forceps are advanced down the biopsy channel. The forceps are opened as soon as they exit the instrument channel, and advanced to the mucosal surface, altering the angle of the scope so they are perpendicular to the surface. The forceps are gently pressed to the mucosa and closed. They are then withdrawn with a sharp tugging motion, avulsing a small piece of mucosa, and removed from the instrument channel.

There are several methods of transferring the biopsy sample. The author’s preferred method is to use a needle to tease the sample gently into the pot, but it is possible to cause artefactual damage with this method. Others prefer to liberate the sample directly into the formalin by immersing the open forceps, but they must be rinsed thoroughly before being used again in order to avoid iatrogenic chemical damage to the gastrointestinal tract.

After obtaining multiple small-intestinal samples, the endoscope is withdrawn into the stomach and the stomach is fully insufflated with air. All regions of the stomach are carefully examined for lesions, masses and foreign bodies. Biopsies of lesions are taken, and if no lesions are seen, several gastric mucosal samples are taken from different stomach regions, as described above.

Colonoscopy
Biopsies can be collected during colonoscopy as above.

Risks
Risks include those associated with general anaesthesia, perforation of the gastrointestinal tract and aspiration of the oral cleansing preparation.

Interpretation
The samples should be submitted for histopathological examination by a pathologist experienced in examining gastrointestinal samples.

6.4 Electrocardiography (ECG) (see Fig. 6.4)

Indications
- Detection of arrhythmias on auscultation
- Syncope/collapse
- Evaluation of congenital heart disease
- Part of database for general cardiac investigations

Equipment
- Electrocardiograph
- Surgical spirit or coupling gel

Technique
The animal is placed in right lateral recumbency. The leads are connected to the animal in the following way: red lead on the right elbow, yellow lead on the left elbow, green
Place the animal in left lateral recumbency. A dental gag is placed in the mouth to prevent damage to the endoscope, which is advanced into the stomach. The stomach is insufflated slightly with air, the endoscope is advanced into the pylorus and from there into the duodenum. It should be advanced down the small intestine as far as possible.

Biopsies are taken from any visible lesions. If no focal lesions are observed, multiple mucosal biopsies are taken. Endoscopic biopsy forceps are advanced down the biopsy channel. The forceps are opened as soon as they exit the instrument channel, and advanced to the mucosal surface, altering the angle of the scope so they are perpendicular to the surface. The forceps are gently pressed to the mucosa and closed. They are then withdrawn with a sharp tugging motion, avulsing a small piece of mucosa, and removed from the instrument channel.

There are several methods of transferring the biopsy sample. The author’s preferred method is to use a needle to tease the sample gently into the pot, but it is possible to cause artefactual damage with this method. Others prefer to liberate the sample directly into the formalin by immersing the open forceps, but they must be rinsed thoroughly before being used again in order to avoid iatrogenic chemical damage to the gastrointestinal tract.

After obtaining multiple small-intestinal samples, the endoscope is withdrawn into the stomach and the stomach is fully insufflated with air. All regions of the stomach are carefully examined for lesions, masses and foreign bodies. Biopsies of lesions are taken, and if no lesions are seen, several gastric mucosal samples are taken from different stomach regions, as described above.

Colonoscopy
Biopsies can be collected during colonoscopy as above.

Risks
Risks include those associated with general anaesthesia, perforation of the gastrointestinal tract and aspiration of the oral cleansing preparation.

Interpretation
The samples should be submitted for histopathological examination by a pathologist experienced in examining gastrointestinal samples.

### 6.4 Electrocardiography (ECG) (see Fig. 6.4)

**Indications**
- Detection of arrhythmias on auscultation
- Syncope/collapse
- Evaluation of congenital heart disease
- Part of database for general cardiac investigations

**Equipment**
- Electrocardiograph
- Surgical spirit or coupling gel

**Technique**
The animal is placed in right lateral recumbency. The leads are connected to the animal in the following way: red lead on the right elbow, yellow lead on the left elbow, green
lead on the left stifle, black lead on the right stifle. Spirit or coupling gel is applied to each clip. ECG pads can be used on animals that resent the application of crocodile clips. A diagnostic ECG may also be obtained by attaching the crocodile clips to the fur close to the skin and liberally applying coupling medium.

Care should be taken not to use so much electrical coupling medium that a short circuit is created, and also that the lead clips are not touching each other. A standard trace should include 10 seconds at 25 mm/s and 10 mm/mV on leads I, II, III, aVR, aVL and aVF, and then 30 seconds at 50 mm/s on lead II. It may be necessary to alter the vertical scale depending on the complex sizes.

**Interpretation**

The clinician should analyse the ECG in a systematic manner. The heart rate should be calculated. The pattern of complexes should be examined to ascertain whether the rhythm is regular or irregular. The complexes should be examined to ascertain whether they are supraventricular (narrow, tall) or ventricular (wide, bizarre) in origin. Complex sizes and intervals should be measured. The mean electrical axis can also be calculated. A sample ECG recording chart can be found within the cardiac record chart in Appendix D.

### 6.5 Magnetic resonance imaging (MRI)

#### 6.5.1 Brain

**Indications**

Suspected intracranial lesion

**Technique**

2.5–3 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes
lead on the left stifle, black lead on the right stifle. Spirit or coupling gel is applied to each clip. ECG pads can be used on animals that resent the application of crocodile clips. A diagnostic ECG may also be obtained by attaching the crocodile clips to the fur close to the skin and liberally applying coupling medium.

Care should be taken not to use so much electrical coupling medium that a short circuit is created, and also that the lead clips are not touching each other. A standard trace should include 10 seconds at 25 mm/s and 10 mm/mV on leads I, II, III, aVR, aVL and aVF, and then 30 seconds at 50 mm/s on lead II. It may be necessary to alter the vertical scale depending on the complex sizes.

**Interpretation**

The clinician should analyse the ECG in a systematic manner. The heart rate should be calculated. The pattern of complexes should be examined to ascertain whether the rhythm is regular or irregular. The complexes should be examined to ascertain whether they are supraventricular (narrow, tall) or ventricular (wide, bizarre) in origin. Complex sizes and intervals should be measured. The mean electrical axis can also be calculated. A sample ECG recording chart can be found within the cardiac record chart in Appendix D.

---

**6.5 Magnetic resonance imaging (MRI)**

**6.5.1 Brain**

**Indications**

Suspected intracranial lesion

**Technique**

2.5–3 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes

---

**Fig. 6.4** Measurement of the normal P-QRS-T complex.
**6.5.2 Spine**

**Indications**
Suspected spinal lesion

**Technique**
Use neurological examination to localise region of interest
2.0mm to 3mm slices with 0.2 to 0.3mm gap
Repeat in tranverse and sagittal planes

**Series to run:**
- T1W
- T2W
- T1 with gadolinium

---

**6.5.3 Nasal passages**

**Indications**
Suspected nasal disease, e.g.
- Mass
- Foreign body

**Technique**
2.5 to 3.0mm slices with 0.3mm gap
Repeat in tranverse and sagittal planes

**Series to run:**
- T1W
- T2W
- T1 with gadolinium

---

**6.6 Ultrasound-guided biopsy**

**Indications**
Histological examination of deep organs or masses

**Equipment**
- Ultrasound machine
- Trucut biopsy needle
- Pots containing 10% buffered formal saline
Series to run

- T1W
- T2W
- FLAIR
- T1 with gadolinium

6.5.2 Spine

Indications
Suspected spinal lesion

Technique
Use neurological examination to localise region of interest
2.0mm to 3mm slices with 0.2 to 0.3mm gap
Repeat in tranverse and sagittal planes

Series to run:
- T1W
- T2W
- T1 with gadolinium

6.5.3 Nasal passages

Indications
Suspected nasal disease, e.g.
- Mass
- Foreign body

Technique
2.5 to 3.0mm slices with 0.3mm gap
Repeat in tranverse and sagittal planes

Series to run:
- T1W
- T2W
- T1 with gadolinium

6.6 Ultrasound-guided biopsy

Indications
Histological examination of deep organs or masses

Equipment
- Ultrasound machine
- Trucut biopsy needle
- Pots containing 10% buffered formal saline
**Scalpel blade**

**Surgical scrub**

**Technique**

**Prior preparation**
A coagulation profile is performed, including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time (BMBT).

**Restraint**
The animal is sedated or anaesthetised.

**Procedure**
The region to be biopsied is identified by ultrasound examination, clipped and surgically prepared. Firm transducer pressure can be used to displace superficial visci, such as bowel loops, and bring the region to be biopsied closer to the surface. The clinician should ensure that the planned needle track will not disrupt major vessels or other vital structures.

The biopsy needle is inserted at an oblique angle to the probe, but within the plane of its field of view, so it can be visualised by the ultrasound image. Once it has been advanced to the region to be biopsied, the needle is triggered and withdrawn. It is then opened, and a scalpel blade can be used to liberate the sample gently into formalin. The biopsied area should be re-examined with ultrasound to ensure that no major haemorrhage has occurred. A small amount of self-limiting haemorrhage may be expected from vascular organs such as kidney and liver.

**Risks**
Risks include haemorrhage, dissemination of neoplasia or infection or rupture of a viscus. The reader is advised to consult specific texts on ultrasonography for more detail on this procedure.

**Interpretation**
Samples should be submitted for histopathological examination.

---

**6.7 Cerebrospinal fluid (CSF) collection**

**Indications**
- Suspected central nervous system disease
- Infection
- Inflammation

**Equipment**
- 20–22g spinal needle
- Surgical scrub
- Sterile collection pots

**Technique**
Two assistants will be need for this procedure.
Scalpel blade
Surgical scrub

**Technique**

**Prior preparation**
A coagulation profile is performed, including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time (BMBT).

**Restraint**
The animal is sedated or anaesthetised.

**Procedure**
The region to be biopsied is identified by ultrasound examination, clipped and surgically prepared. Firm transducer pressure can be used to displace superficial visci, such as bowel loops, and bring the region to be biopsied closer to the surface. The clinician should ensure that the planned needle track will not disrupt major vessels or other vital structures.

The biopsy needle is inserted at an oblique angle to the probe, but within the plane of its field of view, so it can be visualised by the ultrasound image. Once it has been advanced to the region to be biopsied, the needle is triggered and withdrawn. It is then opened, and a scalpel blade can be used to liberate the sample gently into formalin. The biopsied area should be re-examined with ultrasound to ensure that no major haemorrhage has occurred. A small amount of self-limiting haemorrhage may be expected from vascular organs such as kidney and liver.

**Risks**
Risks include haemorrhage, dissemination of neoplasia or infection or rupture of a viscus. The reader is advised to consult specific texts on ultrasonography for more detail on this procedure.

**Interpretation**
Samples should be submitted for histopathological examination.

### 6.7 Cerebrospinal fluid (CSF) collection

**Indications**
- Suspected central nervous system disease
  - Infection
  - Inflammation

**Equipment**
- 20–22g spinal needle
- Surgical scrub
- Sterile collection pots

**Technique**
Two assistants will be need for this procedure.
Special precautions
Ideally, magnetic resonance imaging (MRI) of the brain is performed prior to CSF collection, to rule out the presence of raised intracranial pressure, which may lead to fatal cerebellar herniation on performing the tap. Raised intracranial pressure may be suspected clinically in the absence of brain imaging by a decreasing state of consciousness, head pressing, anisocoria and papilloedema.

Restraint
The animal is anaesthetised.

Procedure
The animal is placed in right lateral recumbency for a right-handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal’s head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed. The needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

Once cerebrospinal fluid is obtained, a second assistant should hold a collection pot beneath the hub of the needle, taking care not to touch the needle or the clinician, and the fluid is allowed to drop into the pot. One ml of CSF per 5 kg body weight can be collected safely.

Sample handling
The cells in cerebrospinal fluid are generally few in number and fragile. Centrifugation at normal speeds may cause cell rupture. Various techniques have been described for CSF cytology. One recommendation is to divide the sample into two: one sample is sent in a plain tube and one in a tube containing one drop of formalin. Alternatively, in-house preparations can be made using sedimentation chambers, constructed from the barrel of a syringe placed upright on a slide, secured in place with bulldog clips and sealed with vaseline or candle wax. Spare fluid, or supernatant, can be used for bacteriology, viral titres and PCRs.

Risks
Risks include iatrogenic damage to the spinal cord and cerebellar herniation.

Interpretation
The samples can be submitted for examination by a cytologist.

6.8 Bone marrow aspiration

Indications
Haematological diseases, e.g.
- Unexplained cytopenias
Special precautions
Ideally, magnetic resonance imaging (MRI) of the brain is performed prior to CSF collection, to rule out the presence of raised intracranial pressure, which may lead to fatal cerebellar herniation on performing the tap. Raised intracranial pressure may be suspected clinically in the absence of brain imaging by a decreasing state of consciousness, head pressing, anisocoria and papilloedema.

Restraint
The animal is anaesthetised.

Procedure
The animal is placed in right lateral recumbency for a right-handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal’s head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed. The needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

Once cerebrospinal fluid is obtained, a second assistant should hold a collection pot beneath the hub of the needle, taking care not to touch the needle or the clinician, and the fluid is allowed to drop into the pot. One ml of CSF per 5 kg body weight can be collected safely.

Sample handling
The cells in cerebrospinal fluid are generally few in number and fragile. Centrifugation at normal speeds may cause cell rupture. Various techniques have been described for CSF cytology. One recommendation is to divide the sample into two: one sample is sent in a plain tube and one in a tube containing one drop of formalin. Alternatively, in-house preparations can be made using sedimentation chambers, constructed from the barrel of a syringe placed upright on a slide, secured in place with bulldog clips and sealed with vaseline or candle wax. Spare fluid, or supernatant, can be used for bacteriology, viral titres and PCRs.

Risks
Risks include iatrogenic damage to the spinal cord and cerebellar herniation.

Interpretation
The samples can be submitted for examination by a cytologist.

6.8 Bone marrow aspiration

Indications
Haematological diseases, e.g.
- Unexplained cytopenias
• Thrombocytosis
• Leukocytosis
• Polycythaemia
Hypercalcaemia
Hypergammaglobulinaemia
Multifocal lytic bone lesions
Pyrexia of unknown origin

**Equipment**
Jamshidi biopsy needle (12 g for large dogs, 14 g for small dogs and cats)
Surgical scrub
10 ml syringe
Local anaesthetic
Scalpel handle and blade

**Technique**

*Restraint*
The animal is sedated or anaesthetised.

*Procedure*
Sites for aspiration and biopsy include the wing of the ilium, the proximal humerus and the greater trochanter of the femur.

The chosen site is clipped and aseptically prepared. Local anaesthetic is infiltrated into the skin and periosteum. A small stab incision is made through the skin at the site of the needle entry and the Jamshidi biopsy needle is advanced into the marrow cavity with a firm twisting motion. Immediately the needle is anchored in the cavity, the stylet is withdrawn, and the syringe attached. Bone marrow is aspirated with several firm suction on the syringe plunger. The needle and syringe are then immediately removed, and the marrow is expelled onto slides.

*Sample preparation*
There are several techniques for preparing bone marrow aspirates for cytological examination, but in all cases rapid preparation and rapid air drying are vital, as the samples clot quickly and slow drying can lead to artefact. Techniques recommended include the blood-smear technique (q.v.) and the pull-away technique (q.v.). Another technique is to place a drop of aspirate at the top of a vertically placed slide, allowing the fluid to drain down the slide before making a squash preparation. If sufficient aspirate is obtained, a combination of preparations may be desirable.

*Interpretation*
After air drying, the samples can be submitted for staining and examination by a cytologist.
6.9 Thoraco-, pericardio-, cysto- and abdominocentesis

6.9.1 Thoracocentesis

Indications
Presence or suspicion of pleural fluid or pneumothorax
- Diagnosis
- Therapy

Equipment
- 22–24g butterfly needle
- 20ml syringe
- 3-way tap
- Sterile collection containers
- Surgical scrub

Technique

Special precautions
A dyspnoeic animal should be stabilised with five minutes of oxygen therapy prior to any stressful handling or procedures.

Restraint
Sedation and/or local anaesthesia is provided where it is necessary and safe to do so.

Procedure
The animal is placed in sternal recumbency and, where possible, the thorax is clipped and surgically prepared from intercostal spaces 5–11.

The butterfly needle, 3 way tap and syringe are connected. For suspected fluid, the needle is inserted just cranial to the 8th rib at a point low on the chest wall. For suspected air, the needle is inserted just cranial to the 9th rib, about 1/3 of the way down the chest wall. Negative pressure is maintained on the syringe by an assistant, so that as soon as the pleura are punctured, air or fluid will be aspirated. Samples of fluid should be placed in sterile collection pots for cytology and culture.

Risks
There is a risk with this technique of iatrogenic laceration of the lungs, and once the presence of pleural effusion or pneumothorax is confirmed, it is usually safer to place a chest drain in order to remove significant amounts of fluid or air.

Interpretation
Cytological and bacteriological analysis will be helpful in differentiating neoplastic, infectious, cardiac and other causes of pleural effusion (q.v.).
6.9.2 Pericardiocentesis

Indications
Drainage of a pericardial effusion
- Diagnosis
- Therapy

Equipment
Chest drain
Pericardiocentesis catheter or 14–16g intravenous catheter
20ml syringe
3-way tap
Sterile collection containers
Lignocaine without adrenaline

Technique
Special precautions
Connect an ECG monitor and provide supplemental oxygen if necessary.

Restraint
Provide sedation if necessary, e.g. with acepromazine and pethidine.

Procedure
Clip and surgically prepare both sides of the thorax. Place the animal in left lateral recumbency. Infiltrate the 5th intercostal space approximately 2/3 of the way down the thorax with 1% lignocaine. Maintaining sterile conditions, place a 3-way tap and 30 ml syringe on the syringe adaptor end of the chest drain or pericardiocentesis catheter. Pulling the skin laterally prior to the procedure can help to seal the entrance wound once the procedure is finished.

Make a stab incision at the site of the local anaesthesia, through the skin and partially through the intercostal muscle. Have an assistant maintain negative pressure as you advance the catheter through the chest wall. The first fluid retrieved may be pleural effusion. This can be drained at this stage, but if the animal is in cardiogenic shock/tamponade, continuing on to drain the pericardial space is preferable, with the pleural effusion being drained after the pericardiocentesis.

Continue to advance the needle perpendicular to the pericardium until the pericardial sac is felt. This may feel like an increase in resistance, or often a scratching sensation is felt as the needle tip contacts the pericardium. Advance the needle through the pericardial sac. Ultrasound guidance is helpful at this stage, but performing the procedure blind is appropriate in emergency situations.

Monitor the ECG. Ventricular premature complexes (VPCs) or changes in the S-T segment commonly occur if the needle contacts the myocardium, and if this occurs the needle should be withdrawn. Lignocaine may occasionally be required for the treatment of ventricular dysrhythmias.

Aspirate fluid. Benign pericardial effusions are usually port wine colour. Advance the needle a further 5 mm, then advance the sheath into the pericardial space. Continue to aspirate. Pausing at this stage to assess whether the fluid being aspirated is clotting is useful to confirm the heart has not been tapped accidentally. Comparing the packed cell
volume of the effusion to that of the blood is also useful in case of doubt. Continue to aspirate until no further fluid can be retrieved. Withdraw the catheter. The pleural space can be drained at this point if you have not previously done so. Suture the skin incision. Record the volume, colour and consistency of the fluid. Measure its PCV and submit to a cytologist for evidence of neoplasia.

**Risks**
Risks include puncturing the heart and causing arrhythmias.

**Interpretation**
Cytology and culture can be useful to assess for causes of the effusion. However, many tumours do not exfoliate, leading to false negatives on cytology. It has previously been suggested that pH can be useful to differentiate neoplastic from idiopathic effusions, but this test is too non-specific to be diagnostically useful. Echocardiography prior to drainage of the effusion is the best non-invasive way to diagnose pericardial tumours, although cardiac MRI may become more widely available in the future. Pericardial infections are rare in small animals.

### 6.9.3 Cystocentesis

#### Indications
- Sampling for suspected urinary tract infection
- Sampling for urinalysis
  - Dipstick
  - Specific gravity
  - Sediment examination
  - Cytology

#### Equipment
- 21g–23g needle
- 10ml syringe
- Sterile collection pots

#### Technique

**Restraint**
Sedation is not usually required except for fractious animals.

**Procedure**
The animal is placed in lateral or dorsal recumbency. The caudal ventral abdomen is clipped and surgically prepared. The bladder is palpated and digitally fixed in position. If the bladder is not palpable, then ultrasound guidance should be used.

The needle with syringe attached is angled caudally, at approximately 45°, and advanced into the bladder with a firm smooth motion. The puncture site should be 3–5cm cranial to the trigone area. If the bladder apex is used as the puncture site, then the needle will come out of the bladder lumen as the bladder deflates.

**Risks**
Cystocentesis is generally a safe technique, provided the bladder can be palpated and fixed easily, and that the animal is not suffering from a bleeding disorder.
Interpretation
Provided aseptic precautions have been taken, growth of a pathogenic organism from a cystocentesis sample is indicative of urinary tract infection. This is not necessarily the case for catheterised and free-catch samples, which can be contaminated with bacteria from the skin, genital tract, gastrointestinal tract and environment.

6.9.4 Abdominocentesis/diagnostic peritoneal lavage

Indications
- Evaluation of free peritoneal fluid
- Diagnosis of suspected peritonitis

Equipment
- Scalpel blade
- Chest drain or peritoneal dialysis catheter
- Warmed sterile isotonic saline
- 10 or 20 ml syringe
- Surgical scrub

Technique
The ventral abdomen is clipped and surgically prepared. If a large quantity of abdominal fluid is suspected or diagnosed with ultrasonography, abdominocentesis alone is a sufficient diagnostic test. If only a small amount of fluid or a localised peritonitis is suspected, then diagnostic peritoneal lavage is preferable.

Abdominocentesis
For abdominocentesis, a 1.5 inch 21–23g needle attached to a 10–20 ml syringe is inserted into the ventral abdomen, just to the right of the umbilicus, and fluid is aspirated. If no fluid is obtained, despite knowing or strongly suspecting its presence, the needle may have been entrapped by omentum, and placing the needle elsewhere may be productive. If several ‘dry’ taps are obtained, it should be definitively confirmed that fluid is present by ultrasound. If so, ultrasound guidance can be used to obtain a fluid sample.

Diagnostic peritoneal lavage
For diagnostic peritoneal lavage, local anaesthetic is infiltrated into the site of catheter placement and sedation may also be required in some cases.

A stab incision is made into the skin with the scalpel blade, and the catheter/chest drain is advanced into the abdomen. The stylet is removed, and the syringe attached. If a large amount of fluid can be aspirated, lavage is probably not required. If not, 20 ml/kg of warmed, sterile, isotonic saline is connected to the catheter by an intravenous giving set and instilled into the abdomen by gravity flow or pressure on the bag. The animal is gently rolled and the abdomen balloted. As much fluid as possible is then withdrawn, and placed in a sterile collection pot.

Risks
Risks are minimal, but include haemorrhage and accidental viscus penetration.
Interpretation
A PCV of lavaged fluid greater than 5% is suggestive of significant haemorrhage. Cloudiness suggests peritonitis. Increased creatinine may suggest urinary tract rupture and uroabdomen. Increased bilirubin may suggest biliary tract rupture and bile peritonitis. Increased amylase may suggest pancreatitis.

Samples should also be submitted for bacteriology and cytology.

6.10 Blood pressure measurement

6.10.1 Central venous pressure

Indications
Monitoring fluid therapy
- Where large volumes are being used, e.g. shock
- Where urine production is poor, e.g. acute oliguric or anuric renal failure
Monitoring critical care and poor-anaesthetic risk patients
Monitoring animals with heart failure

Equipment
16–18g jugular catheter
3-way tap
1m ruler
Intravenous giving set
Intravenous extension tubing
500ml normal saline

Technique
The animal is placed in lateral recumbency. The skin over the jugular vein is clipped and surgically prepared.

Maintaining strict asepsis, the jugular catheter is placed and advanced to the third intercostal space, which is roughly the level of the right atrium. The catheter is sutured or taped securely in place, with the hub of the catheter at the base of the ear. The 3-way tap is attached to the catheter, and the intravenous giving set, with bag of fluid, is connected to one of the 3-way tap ports, first ensuring that all the air has been flushed out of the tubing.

The extension tubing is attached to the last of the 3-way tap ports, taped vertically to a pole, and left with its upper end open, to create a manometer. The ruler is placed next to it, with the 0 mark at the midpoint of the trachea at the thoracic inlet. The stopcock on the 3-way tap is turned to connect the manometer to the saline bag, so that saline runs into the manometer to a level of 15cm. The stopcock is then turned so the manometer is connected to the jugular catheter. The fluid in the manometer will then fall until it reflects the central venous pressure, measured in cm of water.

The jugular catheter can remain in place, and can be used for fluid administration, and administration of drugs for which central venous administration is recommended. Regular flushing with heparinised saline helps to maintain patency.

Risks
Risks are minimal.
Interpretation
A PCV of lavaged fluid greater than 5% is suggestive of significant haemorrhage. Cloudiness suggests peritonitis. Increased creatinine may suggest urinary tract rupture and uroabdomen. Increased bilirubin may suggest biliary tract rupture and bile peritonitis. Increased amylase may suggest pancreatitis.
Samples should also be submitted for bacteriology and cytology.

6.10 Blood pressure measurement

6.10.1 Central venous pressure

Indications
Monitoring fluid therapy
- Where large volumes are being used, e.g. shock
- Where urine production is poor, e.g. acute oliguric or anuric renal failure
Monitoring critical care and poor-anaesthetic risk patients
Monitoring animals with heart failure

Equipment
- 16–18g jugular catheter
- 3-way tap
- 1m ruler
- Intravenous giving set
- Intravenous extension tubing
- 500ml normal saline

Technique
The animal is placed in lateral recumbency. The skin over the jugular vein is clipped and surgically prepared.
Maintaining strict asepsis, the jugular catheter is placed and advanced to the third intercostal space, which is roughly the level of the right atrium. The catheter is sutured or taped securely in place, with the hub of the catheter at the base of the ear. The 3-way tap is attached to the catheter, and the intravenous giving set, with bag of fluid, is connected to one of the 3-way tap ports, first ensuring that all the air has been flushed out of the tubing.
The extension tubing is attached to the last of the 3-way tap ports, taped vertically to a pole, and left with its upper end open, to create a manometer. The ruler is placed next to it, with the 0 mark at the midpoint of the trachea at the thoracic inlet. The stopcock on the 3-way tap is turned to connect the manometer to the saline bag, so that saline runs into the manometer to a level of 15cm. The stopcock is then turned so the manometer is connected to the jugular catheter. The fluid in the manometer will then fall until it reflects the central venous pressure, measured in cm of water.
The jugular catheter can remain in place, and can be used for fluid administration, and administration of drugs for which central venous administration is recommended. Regular flushing with heparinised saline helps to maintain patency.

Risks
Risks are minimal.
**Interpretation**
Central venous pressure that is greater than 10 cm of water is abnormally elevated e.g. by overzealous fluid administration. Measurements over 15 cm of water may be seen in congestive heart failure.

---

**6.10.2 Indirect blood pressure measurement by Doppler technique**

**Indications**
- Screening for hypertension in associated diseases (*q.v.*)
- Assessing degree of hypotension
  - Shock
  - General anaesthesia
  - Other associated conditions (*q.v.*)
- Assessing success of treatment of hypertension or hypotension

**Equipment**
- Doppler ultrasound unit
- Ultrasound gel
- Sphygmomanometer with various cuff sizes
- Tape

**Technique**

*Prior preparation*
The animal is left to acclimatise to its surroundings for as long as possible. It is vital it is kept in as stress free an environment as possible, and that it is handled calmly and gently.

*Procedure*
Arteries that are suitable to detect with the Doppler ultrasound unit are the digital artery of any foot or the coccygeal artery. The pulse is palpated and the area of skin over it is clipped. In some sparsely haired animals, wetting down with spirit may be sufficient. This reduces the stress associated with the procedure and hence reduces false positive diagnosis of hypertension.

A cuff of the appropriate width (approximately 40% of the circumference of the selected limb), is placed proximally on the limb and inflated several times to ensure a secure and comfortable fit, and to ensure that there are no leaks in the cuff.

The selected limb is raised or lowered to heart level to prevent artefactual reductions or elevations in the readings. Ultrasound gel is applied to the probe. The probe is applied gently to the pulse and moved to obtain a good signal. The use of headphones can help reduce stress to the animal.

Once the pulse has been detected by the ultrasound unit, the probe is taped or held in place. The cuff is inflated until the signal is lost, then slowly deflated. The reading at which the signal is first re-obtained is the systolic blood pressure. Five readings should be obtained, the highest and lowest discarded and a mean taken of the other three.
Interpretation
Systolic blood pressure values greater than 180 mmHg are suggestive of systemic hypertension, provided the animal is not unduly stressed. Serial measurements and retinal examinations are recommended to confirm the presence of hypertension.

6.11 Dynamic testing

6.11.1 ACTH stimulation test

Indications
Diagnosis of suspected hypo- or hyperadrenocorticism
Monitor response to therapy of hyperadrenocorticism
Differentiate iatrogenic from naturally occurring hyperadrenocorticism

Equipment
ACTH
Needle and syringe
Plain blood tubes

Technique
Prior preparation
Withhold glucocorticoids for at least 24 hours prior to this test to avoid cross-reaction. Note however, that glucocorticoid administration in the previous two weeks, even topically, can suppress the pituitary–adrenal axis.

Procedure
Collect 3 ml of plasma or serum and label the tubes with the time. Inject ACTH (e.g. Synacthen) intravenously, 250 μg for most dogs, 125 μg for dogs weighing less than 5 kg and cats. In dogs, 3 ml of plasma or serum are collected 120 minutes after administration of the ACTH. In cats, samples are collected 60 and 180 minutes after administration of the ACTH. The tubes are again labelled with the time. The plasma or serum is separated, and submitted for cortisol assay.

Note: Different laboratories recommend different protocols regarding timing of samples. Check with your laboratory for their preferred protocol.

Interpretation
In hyperadrenocorticism, post-ACTH administration cortisol levels greater than 600 nmol/l are expected. In hypoadrenocorticism, pre- and post-ACTH administration cortisol levels should be less than 15 nmol/l.

False positives for hyperadrenocorticism commonly occur in the presence of non-adrenal illness. The test is 85% sensitive for pituitary-dependent hyperadrenocorticism and 50% sensitive for adrenal-dependent hyperadrenocorticism. The test is highly specific and sensitive for hypoadrenocorticism. ACTH stimulation results should be interpreted in the light of other clinical findings before making a definitive diagnosis of hyperadrenocorticism.
**Interpretation**
Systolic blood pressure values greater than 180 mmHg are suggestive of systemic hypertension, provided the animal is not unduly stressed. Serial measurements and retinal examinations are recommended to confirm the presence of hypertension.

---

**6.11 Dynamic testing**

**6.11.1 ACTH stimulation test**

**Indications**
- Diagnosis of suspected hypo- or hyperadrenocorticism
- Monitor response to therapy of hyperadrenocorticism
- Differentiate iatrogenic from naturally occurring hyperadrenocorticism

**Equipment**
- ACTH
- Needle and syringe
- Plain blood tubes

**Technique**

**Prior preparation**
Withhold glucocorticoids for at least 24 hours prior to this test to avoid cross-reaction. Note however, that glucocorticoid administration in the previous two weeks, even topically, can suppress the pituitary-adrenal axis.

**Procedure**
Collect 3 ml of plasma or serum and label the tubes with the time. Inject ACTH (e.g. Synacthen) intravenously, 250 μg for most dogs, 125 μg for dogs weighing less than 5 kg and cats. In dogs, 3 ml of plasma or serum are collected 120 minutes after administration of the ACTH. In cats, samples are collected 60 and 180 minutes after administration of the ACTH. The tubes are again labelled with the time. The plasma or serum is separated, and submitted for cortisol assay.

*Note:* Different laboratories recommend different protocols regarding timing of samples. Check with your laboratory for their preferred protocol.

**Interpretation**
In hyperadrenocorticism, post-ACTH administration cortisol levels greater than 600 nmol/l are expected. In hypoadrenocorticism, pre- and post-ACTH administration cortisol levels should be less than 15 nmol/l.

False positives for hyperadrenocorticism commonly occur in the presence of non-adrenal illness. The test is 85% sensitive for pituitary-dependent hyperadrenocorticism and 50% sensitive for adrenal-dependent hyperadrenocorticism. The test is highly specific and sensitive for hypoadrenocorticism. ACTH stimulation results should be interpreted in the light of other clinical findings before making a definitive diagnosis of hyperadrenocorticism.
6.11.2 Low-dose dexamethasone suppression test (LDDST)

**Indication**
Screening for suspected hyperadrenocorticism

**Equipment**
- Dexamethasone
- Plain blood tubes
- Needle and syringe

**Technique**
A basal sample of 3ml of plasma or serum is collected and labelled with the time. Dexamethasone is injected intravenously: 0.01mg/kg for dogs; 0.1mg/kg for cats. Blood samples are collected at 4 and 8 hours post administration, and labelled with the time. All samples are then submitted for cortisol assay.

**Interpretation**
The LDDST has a high sensitivity in dogs for both pituitary- and adrenal-dependent hyperadrenocorticism. As with the ACTH stimulation test, false positives can occur in non-adrenal illness. A cortisol concentration at 8 hours post dexamethasone administration of greater than 40nmol/l is suggestive of hyperadrenocorticism. A cortisol concentration at 4 or 8 hours that declines by more than 50% from the pre-dexamethasone-administration level, combined with failure to suppress at 8 hours, is suggestive of pituitary-dependent hyperadrenocorticism.

6.11.3 Bile acid stimulation test

**Indication**
Assessment of liver function

**Equipment**
- Plain blood sample tubes
- Sunflower oil and dog or cat food
- Needle and syringe

**Technique**
**Prior preparation**
The animal is fasted for 12 hours.

**Procedure**
A base level sample of 3ml of serum is obtained, the tubes labelled with the time and the animal is fed a fatty meal to stimulate gall bladder contraction. The addition of sunflower oil to tinned pet food will usually provide adequate stimulation. Another 3ml of serum are obtained 2 hours after feeding and the tubes labelled with the time. The tubes are then submitted for bile acid assay.
Interpretation
Normal values for the post-prandial sample in dogs and cats are 0–15 μmol/l. Values over 30 μmol/l are more consistent with hepatic dysfunction.

Bile acids are also elevated where there is hepatocellular disease (primary or secondary) or portosystemic shunting (acquired or congenital). Elevations due to secondary hepatic disease are usually mild, whereas elevations due to liver failure and portosystemic shunting are usually marked.

Bile acids will be elevated in icteric animals, and in these cases do not provide information on hepatic function.

6.12 Haematological techniques

6.12.1 In saline autoagglutination test

Indication
Suspected immune-mediated haemolytic anaemia

Equipment
- Glass slide
- Isotonic saline
- Blood sample in EDTA

Technique
One drop of blood is placed in the middle of a clean glass slide and one drop of saline is added. The blood and saline are mixed by rocking the slide in a circular motion.

Interpretation
Addition of saline to a drop of blood interferes with rouleaux formation (which is normal) grossly and microscopically, but does not disrupt clumping caused by autoagglutination. (Rouleaux are chains of red blood cells resembling stacks of coins.) Clumping macroscopically is suggestive of autoagglutination. Examination under the microscope confirms that the clumping is not due to rouleaux formation.

6.12.2 Preparation of a blood smear

Indications
A blood smear should be examined whenever a blood sample is taken for a full blood count:
- Confirmation of haematological values from automated counting equipment
- Assess red and white cell morphology
- Assess presence of circulating neoplastic cells

Equipment
- Two glass slides
- EDTA anticoagulated blood
**Interpretation**
Normal values for the post-prandial sample in dogs and cats are 0–15 μmol/l. Values over 30 μmol/l are more consistent with hepatic dysfunction.

Bile acids are also elevated where there is hepatocellular disease (primary or secondary) or portosystemic shunting (acquired or congenital). Elevations due to secondary hepatic disease are usually mild, whereas elevations due to liver failure and portosystemic shunting are usually marked.

Bile acids will be elevated in icteric animals, and in these cases do not provide information on hepatic function.

### 6.12 Haematological techniques

#### 6.12.1 In saline autoagglutination test

**Indication**  
Suspected immune-mediated haemolytic anaemia

**Equipment**  
- Glass slide  
- Isotonic saline  
- Blood sample in EDTA

**Technique**  
One drop of blood is placed in the middle of a clean glass slide and one drop of saline is added. The blood and saline are mixed by rocking the slide in a circular motion.

**Interpretation**  
Addition of saline to a drop of blood interferes with rouleaux formation (which is normal) grossly and microscopically, but does not disrupt clumping caused by autoagglutination. (Rouleaux are chains of red blood cells resembling stacks of coins.) Clumping macroscopically is suggestive of autoagglutination. Examination under the microscope confirms that the clumping is not due to rouleaux formation.

#### 6.12.2 Preparation of a blood smear

**Indications**  
A blood smear should be examined whenever a blood sample is taken for a full blood count:  
- Confirmation of haematological values from automated counting equipment  
- Assess red and white cell morphology  
- Assess presence of circulating neoplastic cells

**Equipment**  
- Two glass slides  
- EDTA anticoagulated blood
The corner of one glass slide is broken off after pre-scoring with a glass cutter, to create a spreader slide. A small drop of EDTA anticoagulated blood is placed near one end of the slide. The spreader slide is placed on the other slide in front of the drop at an angle of 20–40°. The spreader slide is slid backwards until it just touches the drop of blood. The blood spreads along the edge of the spreader slide, but as the spreader slide is narrower than the sample slide, it will not go over the edge. The spreader slide is advanced briskly and smoothly, leaving a smear with a feathered edge. The smear is rapidly air dried. If it is to be examined in the clinic, it should be stained, for example with one of the rapid staining kits available.

The feathered edge should be examined with the 100 × oil immersion objective lens. White cell and red cell morphology should be assessed, platelet count subjectively evaluated and a differential white cell count performed. At least 100 white cells should be counted, and the percentages of neutrophils, lymphocytes, monocytes, eosinophils and basophils should be calculated. Note that platelets tend to clump towards the feathered edge of the smear.

**6.12.3 Buccal mucosal bleeding time (see Plate 6.12 in colour plate section)**

**Indications**
Assessment of primary haemostasis
- Animals with suspected thrombocytopenia or thrombocytopathia
- Animals with unexplained bleeding disorders
- Pre-operative assessment for animals undergoing surgery
  - Conditions that may predispose to bleeding disorders
  - Breeds predisposed to von Willebrand’s disease

**Equipment**
- Bleeding time device, e.g. Simplate II
- Stopwatch
- Filter paper
- Gauze bandage

*Note: A scalpel blade can be used instead of the specific bleeding time device, but deeper-than-standard cuts may lead to overestimation of the bleeding time and shallower cuts may lead to underestimation.*

**Technique**

*Restraint*
Sedation may be required in fractious animals.

*Procedure*
The animal is placed in lateral recumbency. The lateral part of the maxillary lip is reflected upwards and tied with bandage to produce moderate venous engorgement.
The bleeding time device is placed over an area of buccal mucosa that appears free of superficial vessels. The device is triggered, and a stopwatch started. The device produces two parallel cuts, of a standard size and depth, into the mucosa, triggering bleeding. Blood is blotted from beneath the cuts with the filter paper, taking care not to touch the incisions, thereby dislodging a forming clot. The time taken for bleeding to stop is recorded.

**Interpretation**
Normal times for dogs are 1.4–3.5 minutes, and for cats 1.5–2.5 minutes.

### 6.12.4 Arterial blood sampling

**Indications**
- Arterial blood gas analysis
- Assessment of acid–base status

**Equipment**
- 23g needle
- Pre-heparinised 1–2ml syringe
- Surgical scrub

**Technique**
The femoral artery can be used in dogs and cats, or the dorsal pedal or metatarsal arteries in dogs.

The area over the chosen artery is clipped and surgically prepared. The skin is stretched and the artery palpated. A 23g needle with pre-heparinised 1–2ml syringe attached is advanced into the artery with the bevel up. After the sample is obtained, pressure is applied to the artery with a sterile swab for 3–5 minutes.

If the sample is not to be used for immediate analysis, the needle end should be sealed with a rubber stop, and the sample packed in ice.

**Interpretation**
See Section 4.3 for blood gas and acid–base differentials.

### 6.13 Water deprivation test

**Indications**
Differentiation between:
- Diabetes insipidus
  - Central
  - Nephrogenic
- Psychogenic polydipsia

The test is contraindicated in known or suspected renal disease, and should only be performed after a thorough investigation of other causes of polyuria and polydipsia (*q.v.*). If the animal is already clinically dehydrated, with a low urine specific gravity, then it has already proven unable to concentrate its urine and the test is unnecessary.
The bleeding time device is placed over an area of buccal mucosa that appears free of superficial vessels. The device is triggered, and a stopwatch started. The device produces two parallel cuts, of a standard size and depth, into the mucosa, triggering bleeding. Blood is blotted from beneath the cuts with the filter paper, taking care not to touch the incisions, thereby dislodging a forming clot. The time taken for bleeding to stop is recorded.

**Interpretation**
Normal times for dogs are 1.4–3.5 minutes, and for cats 1.5–2.5 minutes.

### 6.12.4 Arterial blood sampling

**Indications**
- Arterial blood gas analysis
- Assessment of acid–base status

**Equipment**
- 23g needle
- Pre-heparinised 1–2ml syringe
- Surgical scrub

**Technique**
The femoral artery can be used in dogs and cats, or the dorsal pedal or metatarsal arteries in dogs.

The area over the chosen artery is clipped and surgically prepared. The skin is stretched and the artery palpated. A 23g needle with pre-heparinised 1–2ml syringe attached is advanced into the artery with the bevel up. After the sample is obtained, pressure is applied to the artery with a sterile swab for 3–5 minutes.

If the sample is not to be used for immediate analysis, the needle end should be sealed with a rubber stop, and the sample packed in ice.

**Interpretation**
See Section 4.3 for blood gas and acid–base differentials.

### 6.13 Water deprivation test

**Indications**
Differentiation between:
- Diabetes insipidus
  - Central
  - Nephrogenic
- Psychogenic polydipsia

The test is contraindicated in known or suspected renal disease, and should only be performed after a thorough investigation of other causes of polyuria and polydipsia (*q.v.*). If the animal is already clinically dehydrated, with a low urine specific gravity, then it has already proven unable to concentrate its urine and the test is unnecessary.
**Equipment**
- Refractometer
- Scales
- Urinary catheter
- Desmopressin
- Needle and syringe

**Technique**

**Prior preparation**
Water should be restricted gradually over the three days prior to the procedure (in order to prevent medullary washout from influencing the test) to 120 ml/kg, 90 ml/kg and 60 ml/kg on days −3, −2, and −1 respectively. Food is withheld from the night before, and water is withheld from the starting time of the test.

**Procedure**
The bladder is catheterised and emptied and the urine specific gravity is recorded. A blood sample is taken to check urea, creatinine and electrolytes. The patient is accurately weighed. The following measurements are made every 60 minutes: urine samples are taken and tested for specific gravity; blood samples are taken and tested for urea, creatinine and electrolytes; the animal is observed for signs of depression and dehydration. Measurement of serum osmolality is useful if available.

The test should be ended if urine specific gravity exceeds 1.030 or the animal shows signs of clinical dehydration or illness. If the animal loses greater than 5% of its body weight without showing a urine specific gravity greater than 1.030, a blood sample can be obtained for vasopressin concentration.

Aqueous desmopressin is then given at a dose of 2–5 units intramuscularly. Urine samples for specific gravity and blood samples for urea, creatinine and electrolytes are taken every 15–30 minutes for up to 2 hours or until the urine concentrates.

Once the test has finished, introduce small amounts of water every 30 minutes for 2 hours and monitor for vomiting, dehydration and depression. If the animal is well after 2 hours, it can be returned to ad lib water.

**Risks**
Dehydration and its consequences are risks for this test, but if the patient has previously been worked up correctly for polyuria and polydipsia, and hydration is monitored closely during the procedure, risks are low.

**Interpretation**
If a urine concentration of >1.035 is obtained prior to desmopressin administration, central or nephrogenic diabetes insipidus can be ruled out, and, assuming a thorough pre-procedure work up, the likely diagnosis is psychogenic polydipsia. A urine concentration of >1.030 prior to desmopressin administration is also likely to be consistent with psychogenic polydipsia, although partial diabetes insipidus is possible.

If the animal becomes 5% dehydrated without concentrating the urine to >1.030, then diabetes insipidus is likely. If urine specific gravity of >1.030 is achieved only after desmopressin administration, then central diabetes insipidus is likely. If urine specific gravity of >1.030 is not achieved despite desmopressin administration, then primary nephrogenic diabetes insipidus is likely. This result will also be seen with conditions such
as hyperadrenocorticism, medullary washout and renal dysfunction, but these conditions should have been ruled out prior to commencing the test.

### 6.14 Serial blood glucose curve

#### Indications
- Investigation of causes of apparent insulin resistance in diabetes mellitus
- Determination of correct timing and dosage of insulin

#### Equipment
- Glucometer or point-of-care blood glucose analyser
- Needle and syringe

#### Technique
Insulin is administered at the normal dose, and the animal follows its normal schedule of feeding. Blood samples are taken hourly, and the glucose concentration recorded on a chart and/or graph. If the animal receives insulin twice daily, the test should be continued for 12 hours. If the animal is dosed once daily, then ideally the test should be continued for 24 hours. The glucose curve can be generated by the owner at home with a portable glucometer, using the ear prick technique to obtain blood samples. This has the advantage of replicating the animal’s normal daily routine.

#### Interpretation

**Value of glucose curves**
Note that a recent study showed significant variation in the findings of glucose curves on subsequent days in the same animals, casting doubt on the utility of glucose curves for determining the correct dosage of insulin. They are, however, important for: ruling out Somogyi overswing as a cause of apparent insulin resistance; assessing whether there is any significant response to insulin; assessing the duration of action of the administered insulin.

**Specific interpretation of results**
- If hypoglycaemia, or a rapid decrease in glucose level, is followed by a rapid elevation of glucose level, then insulin overdosage leading to Somogyi overswing is likely.
- If the duration of action of the insulin is less than 10 hours, then dosing three times daily or using a longer-acting insulin should be considered.
- If the duration of action is over 14 hours, then once daily dosing or a shorter-acting insulin should be considered.
- If the insulin did not significantly affect the glucose concentration, and the dosage is more than 1–2IU/kg, then consideration should be given to finding a cause of true or apparent insulin resistance.

#### Reference
as hyperadrenocorticism, medullary washout and renal dysfunction, but these conditions should have been ruled out prior to commencing the test.

### 6.14 Serial blood glucose curve

**Indications**
- Investigation of causes of apparent insulin resistance in diabetes mellitus
- Determination of correct timing and dosage of insulin

**Equipment**
- Glucometer or point-of-care blood glucose analyser
- Needle and syringe

**Technique**
Insulin is administered at the normal dose, and the animal follows its normal schedule of feeding. Blood samples are taken hourly, and the glucose concentration recorded on a chart and/or graph. If the animal receives insulin twice daily, the test should be continued for 12 hours. If the animal is dosed once daily, then ideally the test should be continued for 24 hours. The glucose curve can be generated by the owner at home with a portable glucometer, using the ear prick technique to obtain blood samples. This has the advantage of replicating the animal’s normal daily routine.

**Interpretation**

**Value of glucose curves**
Note that a recent study showed significant variation in the findings of glucose curves on subsequent days in the same animals, casting doubt on the utility of glucose curves for determining the correct dosage of insulin. They are, however, important for: ruling out Somogyi overswing as a cause of apparent insulin resistance; assessing whether there is any significant response to insulin; assessing the duration of action of the administered insulin.

**Specific interpretation of results**
- If hypoglycaemia, or a rapid decrease in glucose level, is followed by a rapid elevation of glucose level, then insulin overdosage leading to Somogyi overswing is likely.
- If the duration of action of the insulin is less than 10 hours, then dosing three times daily or using a longer-acting insulin should be considered.
- If the duration of action is over 14 hours, then once daily dosing or a shorter-acting insulin should be considered.
- If the insulin did not significantly affect the glucose concentration, and the dosage is more than 1–2IU/kg, then consideration should be given to finding a cause of true or apparent insulin resistance.

**Reference**
6.15 Skin scraping

**Indications**
Diagnosis of suspected mite infections e.g.
- Pyoderma
- Scaling
- Follicular disorders

**Equipment**
- Liquid paraffin
- Scalpel blade
- Clean glass slides

**Technique**

*Demodex mites*
A drop of liquid paraffin is placed on the skin in the region of a new lesion. The skin is squeezed to extrude mites from the hair follicles. The skin is scraped with the scalpel blade until capillary bleeding is seen.

*Sarcoptes mites*
*Sarcoptes* mites are much harder to find than *Demodex* mites. Multiple scrapings are necessary. Emphasis should be placed on the predilection sites of the pinnal margins and the elbows. More scrapings increase the chances of a positive result, with 15 scrapings being recommended by some dermatologists.

**Interpretation**
The slides are examined under the microscope using the low power lens.

**Reference**

6.16 Schirmer tear test

**Indications**
Assessment of tear production

**Equipment**
- Stopwatch
- Schirmer tear test paper strips

**Technique**
The paper strip is folded at the level of the notch to an angle of 90°, and the folded part is placed beneath the lower eyelid. The number of millimetres the tear film has advanced down the strip after one minute is recorded.
6.15 Skin scraping

Indications
Diagnosis of suspected mite infections e.g.
- Pyoderma
- Scaling
- Follicular disorders

Equipment
- Liquid paraffin
- Scalpel blade
- Clean glass slides

Technique
Demodex mites
A drop of liquid paraffin is placed on the skin in the region of a new lesion. The skin is squeezed to extrude mites from the hair follicles. The skin is scraped with the scalpel blade until capillary bleeding is seen.

Sarcoptes mites
Sarcoptes mites are much harder to find than Demodex mites. Multiple scrapings are necessary. Emphasis should be placed on the predilection sites of the pinnal margins and the elbows. More scrapings increase the chances of a positive result, with 15 scrapings being recommended by some dermatologists.

Interpretation
The slides are examined under the microscope using the low power lens.

Reference

6.16 Schirmer tear test

Indications
Assessment of tear production

Equipment
- Stopwatch
- Schirmer tear test paper strips

Technique
The paper strip is folded at the level of the notch to an angle of 90°, and the folded part is placed beneath the lower eyelid. The number of millimetres the tear film has advanced down the strip after one minute is recorded.
Interpretation
Readings of less than 15 mm may be indicative of reduced tear secretion.

6.17 Nasal flush cytology/nasal biopsy

Indications
Investigation of chronic nasal discharge or sneezing

Equipment
- Moistened gauze swabs
- Collection pots
- Sterile saline
- 60ml syringe
- 10F polyethylene catheter or protective outer sheath of an intravenous catheter

Nasal flush

Restraint
The animal is anaesthetised, an endotracheal tube is placed and the cuff inflated.

Procedure
The table is tilted so the animal’s head is downwards. Two gauze swabs are placed at the back of the pharynx behind the soft palate. A 10F catheter is inserted into the nose. The saline is forcefully injected into the catheter, then suction is applied. Fluid is collected into sterile pots.

The gauze swabs are removed, and impression or squash smears of any dislodged material are made.

Nasal biopsy

Prior preparation
Prior to nasal biopsy, it is sensible to take a coagulation profile including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time.

Procedure
Nasal biopsy may be performed subsequent to a nasal flush. The 10F polyethylene catheter or protective outer sheath of an intravenous catheter is cut at an angle to produce a sharp bevelled point. If a mass has been identified on endoscopy, radiography or MRI, then the catheter is advanced to the level of the mass. Otherwise it is first measured from the external nares so it is just short of the medial canthus of the eye, to avoid penetrating the cribriform plate. A syringe is attached and forcefully suctioned. Samples obtained can be made into squash preparations or placed in formalin.

Risks
Risks include haemorrhage, aspiration of flush fluids and accidental penetration of the cribriform plate.

Interpretation
Samples from both techniques can be submitted for cytological, histological and bacteriological examination.
Interpretation
Readings of less than 15 mm may be indicative of reduced tear secretion.

6.17 Nasal flush cytology/nasal biopsy

Indications
Investigation of chronic nasal discharge or sneezing

Equipment
- Moistered gauze swabs
- Collection pots
- Sterile saline
- 60 ml syringe
- 10F polyethylene catheter or protective outer sheath of an intravenous catheter

Nasal flush

Restraint
The animal is anaesthetised, an endotracheal tube is placed and the cuff inflated.

Procedure
The table is tilted so the animal’s head is downwards. Two gauze swabs are placed at the back of the pharynx behind the soft palate. A 10F catheter is inserted into the nose. The saline is forcefully injected into the catheter, then suction is applied. Fluid is collected into sterile pots.

The gauze swabs are removed, and impression or squash smears of any dislodged material are made.

Nasal biopsy

Prior preparation
Prior to nasal biopsy, it is sensible to take a coagulation profile including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time.

Procedure
Nasal biopsy may be performed subsequent to a nasal flush. The 10F polyethylene catheter or protective outer sheath of an intravenous catheter is cut at an angle to produce a sharp bevelled point. If a mass has been identified on endoscopy, radiography or MRI, then the catheter is advanced to the level of the mass. Otherwise it is first measured from the external nares so it is just short of the medial canthus of the eye, to avoid penetrating the cribriform plate. A syringe is attached and forcefully suctioned. Samples obtained can be made into squash preparations or placed in formalin.

Risks
Risks include haemorrhage, aspiration of flush fluids and accidental penetration of the cribriform plate.

Interpretation
Samples from both techniques can be submitted for cytological, histological and bacteriological examination.
6.18 Contrast radiography

6.18.1 Barium meal/swallow

Indications
Suspected oesophageal disease
Suspected functional or mechanical upper gastrointestinal (GI) obstruction

Equipment
Barium suspension
- 60% for oesophagogram
- 20% for upper GI series

Technique

Prior preparation
The animal’s coat should be free of dirt and foreign material. Survey abdominal and thoracic radiographs are taken first, if this has not already been done.

Restraint
Sedatives are best avoided, as they can alter intestinal transit times and delay gastric emptying. If necessary, a low dose of acepromazine can be given for dogs, or diazepam/ketamine for cats, with minimal effects on motility.

Oesophagogram
For an oesophagogram (barium swallow), the barium should be thick and pasty.

The patient is positioned for radiography, and a tablespoonful of barium is given by mouth. The exposure is made after the animal takes its second swallow. If megaoesophagus is diagnosed, the animals are monitored closely and kept upright following the procedure to avoid aspiration.

Upper GI tract
For an upper GI series, the animal is fasted for 12–24 hours prior to the procedure.

A colonic enema is given 2–4 hours before the study is to be started. A 20% suspension of barium suspension is given by mouth or by stomach tube at a dose of 10ml/kg. Right lateral and ventrodorsal radiographs are taken at 0, 5, 15, 30 and 60 minutes, then hourly until the end of the study. The study is terminated when the stomach is empty of barium (the gastric emptying time) and the leading edge has reached the colon (the intestinal transit time).

Interpretation
For an oesophagogram, the oesophagus is evaluated for dilation, strictures and luminal or mucosal filling defects.

For an upper GI series, the radiographs are examined for luminal or mucosal filling defects or evidence of obstruction. A significant amount of barium remaining in the stomach after two hours for cats and four hours for dogs is suggestive of delayed gastric emptying. Contrast has usually reached the large intestine by 3–5 hours after administration.
**Risk**
The use of barium suspension is contra-indicated where intestinal perforation is suspected, and there is a risk of inhalation of contrast in the presence of a megaoesophagus.

### 6.18.2 Intravenous urography

**Indications**
- To ascertain or confirm the presence, size and shape of the kidneys
- To provide information about the internal renal architecture
- To provide information on the patency and location of the ureters

**Equipment**

*Note: Non-ionic contrast agents are recommended in the presence of significant renal compromise.*
- Iodine-based contrast agent
- Needle and syringe

**Technique**

**Prior preparation**
The patient is fasted for 12 hours. The animal’s fluid intake is limited in the 12 hours prior to radiography if it is safe to do so. However, it is important that the animal is adequately hydrated prior to administering intravenous contrast medium.

A high colonic enema is administered at least two hours prior to the procedure. If there is dirt or debris on the animal’s coat it is cleaned or bathed. The animal’s bladder is emptied immediately prior to the procedure.

If plain survey radiographs have not already been taken, they should be taken now.

**Restraint**
The patient is anaesthetised and an intravenous catheter is placed into a peripheral vein. The animal is positioned in dorsal recumbency, prepared for a ventrodorsal (VD) radiograph.

**High concentration, low volume (bolus)**
An iodine preparation with a concentration of 300–400mg/ml is used, at a dose rate of 850mg iodine/kg. The dose rate should be doubled in the presence of significant azotaemia. Warming the iodine to blood temperature assists with rapid administration.

The iodine is injected rapidly via the intravenous catheter. A VD radiograph is taken immediately injection has finished, and VD and lateral radiographs are taken at 1, 3, 5, 10, 20 and 40 minutes post injection.

**Low concentration, high volume (infusion)**
This technique may give superior visualisation of the ureters.

An iodine preparation with a concentration of 150mg/ml is used, at a dose rate of 1200mg iodine/kg. The dose rate should be doubled in the presence of significant azotaemia. The iodine is injected slowly over 5–10 minutes. Radiographs are taken as required.
Risks
Risks are minimal, but include risks due to anaesthesia, radiography and reactions to the intravenous contrast agent.

Interpretation
Four phases are seen: the arteriogram, the nephrogram, the pyelogram and the cystogram. The arteriogram demonstrates renal blood flow, the nephrogram is used to evaluate the renal parenchyma, the pyelogram evaluates the urinary collecting system and ureters and the cystogram outlines the bladder (although other techniques are preferable for examining the bladder – see Section 6.18.3 below).

Note: The arteriogram and nephrogram phases are not seen with the low concentration high volume technique.

6.18.3 Contrast cystography

Indication
To examine the lower urinary tract
- Vagina/penis
- Urethra
- Bladder
- Distal ureters

Equipment
- Foley catheter
- Urinary catheter
- Water soluble (iodine-based) contrast medium
- 50ml syringe
- 3-way tap
- KY jelly
- Bowel clamps

Technique

Patient preparation
The patient is fasted for 12 hours.
A high colonic enema is administered at least 2 hours prior to the procedure, and if there is dirt or debris on the animal’s coat it is cleaned or bathed. The animal’s bladder is emptied immediately prior to the procedure.
If plain survey radiographs have not already been taken, they should be taken now.

Restraint
The patient is anaesthetised or sedated.

Pneumocystography
The bladder is catheterised and completely drained. Air is injected into the urinary catheter slowly using the syringe and 3-way tap. The abdomen is palpated periodically and air injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount injected is usually 4–10ml/kg. Ventrodorsal and lateral radiographs are taken.
There is a theoretical risk of causing an air embolus with this technique, and carbon dioxide can be used instead of air to avoid this.

**Positive contrast cystography**
The bladder is catheterised and completely drained. Water-soluble iodine contrast medium, with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected, using a syringe and 3-way tap. The abdomen is palpated periodically, and injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount injected is usually 4–10 ml/kg. Ventrodorsal and lateral radiographs are taken.

**Double contrast cystography**
The bladder is catheterised and completely drained. A small amount of water-soluble iodine contrast medium (2–20 ml, depending on the size of the animal), with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected, using a syringe and 3-way tap. The abdomen is massaged and/or the animal rolled to distribute the contrast medium.

Air is then injected via the syringe and 3-way tap. The abdomen is palpated periodically, and injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount of air injected is usually 4–10 ml/kg. Ventrodorsal and lateral radiographs are taken.

**Retrograde urethrography (males)**
A pneumocystogram is first performed to provide back pressure, which will distend the urethra. The urethra is catheterised with the widest possible urinary catheter. The tip is advanced so that it is distal to the area under investigation, or to the distal end of the os penis. A contrast agent is prepared consisting of 150–200 mg iodine/ml, diluted 1:1 with sterile lubricating jelly. The sheath is held tightly around the catheter, and 1 ml/kg of the prepared contrast medium is injected, using a syringe and 3-way tap. Lateral and slightly oblique VD radiographs are taken immediately after injection.

**Retrograde vaginourethrography (females)**
A pneumocystogram is first performed to provide back pressure, which will distend the urethra. The end of a Foley catheter is cut off beyond the inflatable bulb and the catheter is inserted just beyond the vulval lips. The vulva is closed around the catheter using bowel clamps and the bulb is inflated. Water-soluble iodine contrast medium, with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected gently over 5–10 seconds, at a dose of 1 ml/kg, using a syringe and 3-way tap. Lateral and slightly oblique VD radiographs are taken immediately.

**Risks**
Risks are minimal, but include introduction of infection and a theoretical risk of air embolus.

**Interpretation**
- Pneumocystography (negative contrast) is used to identify the position of the bladder.
- Positive contrast cystography is used to identify bladder ruptures.
- Double contrast cystography is useful in identification of calculi and mucosal lesions.
• Retrograde urethrography or vaginourethrography is used to assess vaginal and urethral lesions.

### 6.18.4 Myelography

#### Indications
Investigation of suspected spinal disease

#### Equipment
- Non-ionic intravenous contrast medium
- 22g spinal needle
- Surgical scrub
- Sterile collection pots
- Diazepam

#### Technique

**Restraint**
The animal is anaesthetized.

**Procedure**
Survey spinal radiographs are taken, if this has not already been done.

For *cisternal myelography*, the animal is then placed in right lateral recumbency, for a right handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal's head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed and the needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

For *lumbar myelography*, L4–5 or L5–6 can be used. Lumbar myelography is safer than cisternal myelography and may be superior at delineating severe compressive lesions, but is technically harder.

CSF is collected for analysis as described in Section 6.7. A test injection of a small amount (0.5 to 1.0ml) of the contrast medium may be given and a radiograph taken to ensure the contrast is in the subarachnoid space, if there is any doubt of this. For a full spinal study, 0.3 to 0.5ml/kg of a 240mg/ml iodine preparation is injected. The contrast is injected slowly over several minutes.

Lateral and VD radiographs are taken as soon as possible after the injection has finished. It may be necessary to take oblique, contralateral and dynamic views (eg traction) to provide as much detail as possible. Tilting the animal may help pool the contrast medium in an area of interest if filling is inadequate. However, care should be taken to keep the head elevated to avoid contrast medium entering the brain.

Following the procedure, the animal should be observed carefully for evidence of fitting while it recovers, and diazepam should be readily available.
**Interpretation**
Four basic myelographic patterns seen. A normal pattern shows the contrast flowing in uninterrupted columns. Abnormal patterns are extradural, intradural/extramedullary and intramedullary.

### 6.19 Contrast echocardiography

**Indications**
Detection of a right-to-left cardiac shunt
- Intracardiac
- Extracardiac

**Equipment**
- 0.9% saline or a colloid
- 2 × 5 ml syringes
- 3-way tap
- Intravenous catheter

**Technique**
An intravenous catheter is placed in a peripheral vein.

The medium that will bear the bubbles that provide the positive contrast can be saline, a colloid, 5% dextrose or saline mixed with a small amount of the patient’s own blood.

The two syringes, one containing 3 ml of the medium and the other containing 1 ml of air, are connected to each other via the 3-way tap. The medium is then passed rapidly from one syringe to the other several times, producing a solution containing microbubbles.

A right parasternal long axis view of the heart is obtained by echocardiography. The medium is then injected (although any superficial froth, should not be injected) into the intravenous catheter, and the passage of contrast in the right heart, and any presence of contrast in the left heart, is observed.

The procedure is then repeated, but the descending aorta (best imaged dorsal to the bladder) is examined at the time of injection.

**Interpretation**
In a normal heart, the lungs remove the microbubbles, so contrast is seen only in the right heart and not the left. In a right-to-left intracardiac shunt, such as a ventricular septal defect, contrast bypasses the lungs and is seen in the left heart. If contrast is not seen in the left heart but is present in the descending aorta, an extracardiac shunt such as a patent ductus arteriosus, is suspected.

### 6.20 Cranial nerve (CN) examination

**Indication**
To assist in neurolocalisation of suspected intracranial disease

**Equipment**
- Bright light source
- Haemostats
**6.19 Contrast echocardiography**

**Indications**
- Detection of a right-to-left cardiac shunt
- Intracardiac
- Extracardiac

**Equipment**
- 0.9% saline or a colloid
- 2 × 5 ml syringes
- 3-way tap
- Intravenous catheter

**Technique**
An intravenous catheter is placed in a peripheral vein.

The medium that will bear the bubbles that provide the positive contrast can be saline, a colloid, 5% dextrose or saline mixed with a small amount of the patient’s own blood.

The two syringes, one containing 3 ml of the medium and the other containing 1 ml of air, are connected to each other via the 3-way tap. The medium is then passed rapidly from one syringe to the other several times, producing a solution containing microbubbles.

A right parasternal long axis view of the heart is obtained by echocardiography. The medium is then injected (although any superficial froth, should not be injected) into the intravenous catheter, and the passage of contrast in the right heart, and any presence of contrast in the left heart, is observed.

The procedure is then repeated, but the descending aorta (best imaged dorsal to the bladder) is examined at the time of injection.

**Interpretation**
In a normal heart, the lungs remove the microbubbles, so contrast is seen only in the right heart and not the left. In a right-to-left intracardiac shunt, such as a ventricular septal defect, contrast bypasses the lungs and is seen in the left heart. If contrast is not seen in the left heart but is present in the descending aorta, an extracardiac shunt such as a patent ductus arteriosus, is suspected.
**Interpretation**

Four basic myelographic patterns seen. A normal pattern shows the contrast flowing in uninterrupted columns. Abnormal patterns are extradural, intradural/extramedullary and intramedullary.

---

### 6.19 Contrast echocardiography

**Indications**

Detection of a right-to-left cardiac shunt

- Intracardiac
- Extracardiac

**Equipment**

- 0.9% saline or a colloid
- 2 × 5 ml syringes
- 3-way tap
- Intravenous catheter

**Technique**

An intravenous catheter is placed in a peripheral vein.

The medium that will bear the bubbles that provide the positive contrast can be saline, a colloid, 5% dextrose or saline mixed with a small amount of the patient’s own blood.

The two syringes, one containing 3 ml of the medium and the other containing 1 ml of air, are connected to each other via the 3-way tap. The medium is then passed rapidly from one syringe to the other several times, producing a solution containing microbubbles.

A right parasternal long axis view of the heart is obtained by echocardiography. The medium is then injected (although any superficial froth, should not be injected) into the intravenous catheter, and the passage of contrast in the right heart, and any presence of contrast in the left heart, is observed.

The procedure is then repeated, but the descending aorta (best imaged dorsal to the bladder) is examined at the time of injection.

**Interpretation**

In a normal heart, the lungs remove the microbubbles, so contrast is seen only in the right heart and not the left. In a right-to-left intracardiac shunt, such as a ventricular septal defect, contrast bypasses the lungs and is seen in the left heart. If contrast is not seen in the left heart but is present in the descending aorta, an extracardiac shunt such as a patent ductus arteriosus, is suspected.

---

### 6.20 Cranial nerve (CN) examination

**Indication**

To assist in neurolocalisation of suspected intracranial disease

**Equipment**

- Bright light source
- Haemostats
Tests

Smelling non-irritant substance (CN I)
The animal is blindfolded or its vision obscured with a hand, and a strong-smelling substance such as food is placed near the nose. The animal is observed for sniffing movements. Note that an irritant substance may stimulate the nasal mucosal sensation, which is mediated by CN V.

Pupil size/anisocoria (retina, CNs II, III)
The sizes of the pupils and any difference between them are noted.

Pupillary light reflex (CNs II, III, sympathetic, retina)
The animal is placed in a darkened room and allowed to acclimatise. A bright light is then shone into one eye and the response of both pupils observed. This is repeated with the other eye.

Menace (retina, CNs II, VII, forebrain, cerebellum)
One eye is covered and a threatening movement is made towards the other eye. Care should be taken to avoid causing a draught which might stimulate the corneal reflex. The blink response is observed. The test is then repeated for the other eye.

Corneal reflex (CNs V, VI, VII)
Taking care not to touch the eyelids, the cornea is touched with a moistened cotton bud. The globe should retract and the third eyelid come across the eye.

Throw cotton wool (CN II)
Cotton wool balls should be thrown in front of the patient. A normal animal will follow their motion with head or eye movements. An assistant or a blindfold can cover one eye to test the vision of each eye individually.

Auditory response (CN VIII)
A loud clap or whistle from outside the animal’s visual field is performed. The animal should start or look round.

Strabismus (permanent: CNs III, IV, VI; temporary: CN VIII)
Deviation of one or both eyes may indicate a deficit in one of the above cranial nerves.

Spontaneous nystagmus (horizontal, vertical, rotatory)
The eyes of the animal are observed for a drifting motion, while the head is in a neutral position. The direction of the fast phase is recorded.

Positional nystagmus (CNs III, VIII)
Placing the head in different positions, e.g. tilting it vertically, or placing the animal in dorsal recumbency, may elicit a nystagmus.

Oculovestibular reflex (CNs III, IV, VI, VIII)
Moving the head laterally left and right should elicit a nystagmus with the fast phase in the direction of the head’s rotation.
**Facial sensation, nasal stimulation (CN V, forebrain)**
The eyes are covered by a hand or blindfolded and a blunt probe, such as a haemostat is used to touch the nasal mucosa. A normal animal will withdraw its head. Pinching the upper lip with haemostats will lead to a CN-VII-mediated facial twitch or lip curl.

**Facial paralysis (CN VII)**
Drooping of and inability to move the ear and lip, a widened palpebral fissure, absent blinking, absent abduction of the nostril during inspiration and deviation of the nose towards the normal side are consistent with motor dysfunction of CN VII.

**Masticatory muscle atrophy (CN V)**
The masticatory muscles are observed and palpated for atrophy and asymmetry.

**Palpebral (CNs V, VII)**
The medial and lateral canthus of each eye is touched lightly with a finger. A blink reflex is seen in a normal animal.

**Swallowing/gag (CNs IX, X)**
The left or right side of the caudal pharyngeal wall is stimulated with a finger or an applicator. A normal animal should elevate its palate and contract its pharyngeal muscles. However, some normal animals will not demonstrate this response. An asymmetric response is abnormal.

**Tongue (CN XII)**
The tongue is visually assessed and palpated for atrophy, asymmetry or deviation. A normal animal will also often lick its nose after the gag reflex is assessed. Observing an animal drinking will help assess tongue function.

**Oculocardiac (CNs V, X)**
The heart is auscultated and the rate taken. The eyes are retropulsed, and the heart rate is immediately taken again. The expected response in a normal animal is for the heart to slow down, but many normal animals will not show this response.

**Jaw tone (CN V)**
The jaw is opened and assessed for normal tone.
7.1 Bradycardia

BRADYCARDIA

R/o Drugs, toxins

Neurological signs

R/o CNS disease

History, physical examination

Breed-related

R/o Atrial standstill of Springer Spaniels

Haematology, biochemistry and electrolytes

R/o Hyperkalaemia, hypocalcaemia

R/o Hypothyroidism, normal

Sinus arrest and tachycardia

Sinus arrest

Ventricular

ECG

Sinus bradycardia

Heart block

1st degree, 2nd degree type I

2nd degree type II, 3rd degree

May be normal

Thoracic radiography, echocardiography

Abnormal

R/o Congestive heart failure, aortic stenosis, ventricular septal defect, atrial mass, cardiomyopathy

Normal

R/o Sick sinus syndrome, hypothyroidism, CNS disease
7.2 Tachycardia

TACHYCARDIA

- Neurological signs
- History, physical examination
  - Pallor, collapse
  - Check arterial blood pressure
  - Tachypnoea, dyspnoea
- ECG
  - Low
  - Irregular rhythm
  - Regular rhythm
  - Sinus tachycardia
- Rule out causes of shock and hypotension
- Other supraventricular tachycardia
- R/o Ventricular tachycardia, ventricular premature complexes
- R/o Respiratory disease, cardiac disease
- R/o CNS disease
- Haematology, biochemistry, electrolytes, ultrasonography, radiography, T4
- Cardiac disease
  - R/o Hypertrophic cardiomyopathy, restrictive cardiomyopathy, dilated cardiomyopathy, valvular disease, congenital cardiac disease, pericardial disease, infiltrative disease
- Extra-cardiac disease
  - R/o splenic tumour, electrolyte/acid–base abnormalities, sepsis, renal insufficiency, hyperthyroidism, phaeochromocytoma

Differential Diagnosis in Small Animal Medicine
Alex Gough
Copyright © 2007 by Alex Gough
7.3 Hypoalbuminaemia

**History, physical examination**
- R/o low dietary intake, external blood loss, burns

**Biochemistry, haematology, urinalysis**
- Increased liver enzymes
  - Bile acid stimulation test
    - Elevated
    - R/o Hyperbilirubinaemia, liver failure
  - Normal

- Proteinuria
  - Urine protein:creatinine ratio
    - Normal
    - Elevated

- Ultrasonography, radiography

- Normal
  - Renal ultrasound and biopsy
    - Normal
    - Sediment analysis
  - Elevated

- TLI/B₁₂/folate, faecal analysis, gastrointestinal endoscopy and biopsy

- R/o Protein-losing enteropathy
- R/o Urinary tract inflammation
- R/o Protein-losing nephropathy
7.4 Non-regenerative anaemia

Non-regenerative anaemia

History, physical examination

- History, physical examination
- Biochemistry, full blood count, serology, electrolytes, urinalysis, T4
- R/o FIV, FeLV, chronic renal failure, liver disease, chronic inflammation, hypothyroidism
- R/o Pure red cell aplasia, myelofibrosis, myelodysplasia, neoplasia
- Bone marrow biopsy
- R/o Iron deficiency
- RBC morphology
- Hypochromic, microcytic
- Normal
- ACTH stimulation test
- R/o Hypoadrenocorticism
- Na:K ratio <27
- R/o Acute blood loss, pre-regenerative anaemia
- Pre-existing chronic disease
- R/o Anaemia of chronic disease
- R/o Toxins/drugs
- Less than 5 days chronicity
- R/o Pure red cell aplasia, myelodysplasia, neoplasia

7.5 Regenerative anaemia

REGENERATIVE ANAEMIA

- Toxins
  - R/o Copper, zinc, lead

- History, physical examination
  - External blood loss
  - R/o Copper, zinc, lead

- Biochemistry, urinalysis
  - Hypoproteinaemia
  - Hypophosphataemia
  - Melaena, haematochezia, haematemesis, faecal occult blood, haematuria, parasitism, trauma

- Hyperbilirubinuria, haemoglobinuria

- Normal
  - Ultrasound, radiology
  - R/o Internal blood loss

- Blood film examination
  - Heinz bodies
  - Schistocytes
  - Parasites
  - Spherocytes

- Coombs test
  - Positive
    - R/o Immune-mediated haemolytic anaemia
  - Negative
    - R/o Microangiopathic haemolytic anaemia

- R/o Heinz body anaemia

- R/o Immune-mediated haemolytic anaemia

- Neonatal isoerythrolysis, hereditary non-spherocytic haemolytic anaemia, phosphofructokinase deficiency, pyruvate kinase deficiency
7.6 Jaundice

JAUNDICE

R/o Drugs/toxins

Hepatomegaly

History, physical examination

Ultrasound, biopsy

R/o Hepatitis, neoplasia

Haematology

Anaemia

Normal

Regenerative, pre-regenerative

Non-regenerative

R/o Haemolysis

Biochemistry

Increased liver enzymes

Normal

Increased amylase, lipase, pancreatic lipase

Abdominal ultrasonography and radiography

Diffuse liver abnormality

Coagulation profile and liver biopsy

R/o Hepatitis, cirrhosis, neoplasia, FIP, hepatic lipidosis

Focal liver abnormality

Gall bladder abnormality

Coagulation profile and liver biopsy

R/o Neoplasia, abscess, granuloma

R/o Pancreatitis

Pancreatic abnormality

R/o Cholecystitis, choledolithiasis, neoplasia, mucocoele
**7.7 Hypokalaemia**

HYPOKALAEMIA

- R/o Anorexia, dietary deficiency, potassium-deficient fluid therapy, drugs/toxins, dialysis, recent urinary tract obstruction
- Breed-related
- Hypokalaemic periodic paralysis of Burmese cats

History, physical examination

Biochemistry, haematology, electrolytes, blood gases, urinalysis

- Increased ALKP
- Increased sodium
- Azotaemia
- R/o Alkalosis

ACTH stimulation test

- R/o Hyperadrenocorticism

R/o Primary hyperaldosteronism

R/o Renal insufficiency

Hyperglycaemia, glycosuria

R/o Diabetes mellitus
7.8 Hyperkalaemia

Hyperkalaemia

- History, physical examination
  - PUPD
  - R/o Diabetic ketoacidosis
  - Anuria
  - R/o Acute renal failure, urinary obstruction
- Biochemistry, haematology, urinalysis
  - Hyponatraemia
  - Hyperglycaemia, glycosuria, ketonuria
  - R/o Diabetic ketoacidosis
  - Normal
  - Azotaemia, decreased urine specific gravity
  - R/o Renal failure
- ACTH stimulation test
  - R/o Hyperkalaemic periodic paralysis, pseudohyperkalaemia
- R/o Drugs/toxins
  - Soft tissue injury, ischaemic injury
  - R/o Reperfusion injury/massive soft tissue damage
  - Vomiting, diarrhoea, bradycardia, collapse
  - R/o Diabetic ketoacidosis
  - R/o Acute renal failure, urinary obstruction
  - R/o Reperfusion injury/massive soft tissue damage
7.9 **Hypocalcaemia**

**Differential Diagnosis in Small Animal Medicine**
Alex Gough
Copyright © 2007 by Alex Gough

**HYPOCALCAEMIA**

- History, physical examination
- **R/o Ethylene glycol poisoning**
- Pregnancy/lactation
- **R/o Eclampsia**
- Diet
- **R/o Nutritional secondary hyperparathyroidism**
- Recent thyroidectomy
- **R/o iatrogenic hypoparathyroidism**

**Biochemistry**

- Hypoalbuminaemia
  - Ionised calcium/corrected calcium
    - Normal
    - Low
    - Investigate causes of hypoalbuminaemia
  - Normal
  - Investigate causes of hypoalbuminaemia
  - Low
  - Investigate causes of hypoalbuminaemia

- Azotaemia
  - Increased amylase, lipase, pancreatic lipase
  - Increased
  - R/o Renal secondary hyperparathyroidism
  - Normal
  - Investigate causes of hypoalbuminaemia
  - Low
  - Investigate causes of hypoalbuminaemia
  - Normal
  - Investigate causes of hypoalbuminaemia
  - Low
  - Investigate causes of hypoalbuminaemia

- PTH assay
  - Increased/normal
  - Decreased
  - **R/o Primary hypoparathyroidism**
  - Normal
  - Investigate causes of hypoalbuminaemia
  - Low
  - Investigate causes of hypoalbuminaemia
  - Normal
  - Investigate causes of hypoalbuminaemia
  - Low
  - Investigate causes of hypoalbuminaemia

- **R/o Primary hypoparathyroidism**
7.10 Hypercalcaemia

**HYPERCALCAEMIA**

- R/o Immaturity
- Toxicity
  - R/o Vitamin D rodenticides
- History, physical examination
  - Splenomegaly, hepatomegaly, lymphadenopathy
  - Bony mass
  - Anal sac mass
  - FNA
  - R/o Lymphoma
  - R/o Anal sac adenocarcinoma
- Bone biopsy
  - R/o Bone pathology
- Biochemistry, haematology, electrolytes
  - Increased albumin
  - Check ionised calcium
    - Normal
    - Increased
    - R/o Renal insufficiency
      - R/o Renal insufficiency
    - R/o Dehydration
  - Normal
  - Azotaemia
  - Na:K ratio less than 27
  - PTH and PTHRP assays
    - Increased PTHRPs
    - Normal PTH and PTHRPs
    - Increased PTH
  - ACTH stimulation test
    - R/o Hypoadrenocorticism
  - R/o Renal secondary hyperparathyroidism, primary hyperparathyroidism
- Survey radiography and ultrasonography
  - R/o Granulomatous disease, fungal disease, localised bone lesions
  - R/o Lymphoma, skeletal lesions
- R/o Lymphoma, skeletal lesions
7.11 **Systemic hypertension**

**SYSTEMIC HYPERTENSION**

- Polyuria, polydipsia
  - R/o Renal insufficiency, hyperadrenocorticism
    - Stress
      - History, physical examination
        - Ventral cervical mass
          - R/o Hyperthyroidism
        - Haematology, biochemistry, electrolytes, urinalysis
          - Increased T4
            - R/o Hypothyroidism
            - R/o Hyperthyroidism
          - Decreased T4
            - Haematology, biochemistry, electrolytes, urinalysis
              - Hyperproteinaemia and/or polycythaemia
                - R/o Hyperviscosity syndrome
              - R/o Hypothyroidism
          - Repeat in quiet environment
            - R/o Cardiac disease
              - Heart murmur
                - R/o CNS disease
        - Hyperproteinaemia and/or polycythaemia
          - R/o Hypothyroidism
          - R/o Primary hyperaldosteronism
          - R/o Diabetes mellitus
          - R/o Proteinlosing nephropathy
          - Increased ALKP
            - Decreased potassium
              - Hyperglycaemia, glycosuria
            - R/o Hyperadrenocorticism
          - Decreased ALKP
            - Urine protein: creatinine ratio
              - R/o Chronic renal failure
            - R/o Hyperadrenocorticism
              - R/o Primary hyperaldosteronism
Appendix A: History Record

<table>
<thead>
<tr>
<th>Animal</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Breed</td>
<td>Age</td>
</tr>
<tr>
<td>Length of time in owner’s possession</td>
<td></td>
</tr>
</tbody>
</table>

Main presenting problem

Duration of problem

Weight loss/gain

Demeanor

Appetite/prehension/swallowing

Drinking (quantify)

Urination
- Dysuria
- Pollakiuria
- Haematuria
- Polyuria

Respiratory signs
- Cough
  - Character (harsh, soft)
  - Frequency
  - When occurring (night, excitement, exercise)

Vomiting/regurgitation
- Frequency
- True vomiting or regurgitation?
- How long after feeding?
- Fresh blood? Haematemesis?

Diarrhoea
- Frequency
- Consistency
- Volume
- Mucus
- Blood/melaena

Reproductive status/length and cycle of seasons

Exercise tolerance
Collapsing/fitting episodes
Prodromal and aural behaviour
Frequency
- Clustering?
- History of status epilepticus?
Type
- Generalised (tonic-clonic, clonic, myoclonic, atonic)
- Focal (sensory, motor)
Urination/defecation
Loss of consciousness
Timing and relationship to feeding and exercise

Behavioural changes

Previous drug/anaesthetic reactions

Worming history

Vaccination history

Diet

History of exposure to toxins

Any recent changes in environment

History of travel abroad

Previous medical problems

Previous or current drug therapy

History of similar problems in littermates/housemates
Appendix B: Physical Examination Record

**Vital signs**
- Temperature
- Pulse
- Respiration

**Demeanour**

**Hydration status**

**Mucous membranes**
- Cyanosis
- Pallor
- Hyperaemia

**Oral examination**
- Gums
- Teeth
- Other lesions

**Eyes**
- Conjunctiva
- Eyelids
- Pupils
- Anterior chamber
- Lens
- Iris
- Posterior chamber
- Retina

**Ears**
- Auditory canal
- Tympanic membrane

**Nose**
- Discharge
- Pigmentation changes
- Airflow
- Upper respiratory noise

**Cervical palpation**
- Ventral cervical mass
- Tracheal pinch

**Skin**
- Alopecia
- Pyoderma
Skin tumours
Other lesions

Lymph nodes
Enlargement – generalised, regional or single node

Abdominal palpation
Pain
Liver
Spleen
Kidneys
Bladder
Abdominal masses
Ascites

Thoracic auscultation
Heart rhythm
Murmurs
• Grade
• Timing
• Intensity
• Localisation
• Character
• Radiation
Gallop sounds
Lung sounds

Pulse
Strength
Pulse deficits

Rectal
Anal glands
Prostate

Urogenital
Penis/prepuce/testes
Vulva/vagina

Musculoskeletal
Lameness
Muscular atrophy – generalised/localised

Neurological
See Appendix C

Other findings
Appendix C: Neurological Examination Chart

<table>
<thead>
<tr>
<th>Animal</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Breed</td>
<td>Age</td>
</tr>
<tr>
<td>Length of time in owner’s possession</td>
<td></td>
</tr>
</tbody>
</table>

Key:
− = reflex or sign absent
+ = reflex or sign reduced
++ = reflex or sign normal
+++ = reflex or sign exaggerated

History

Owner’s main complaint
Date of onset
Speed of onset
Evolution (progressive, waxing/waning, regressive, static, episodic)

Collapsing/fitting episodes?
Prodromal and aural behaviour
Frequency
• Clustering?
• History of status epilepticus?
Type
• Generalised (tonic–clonic, clonic, myoclonic, atonic)
• Focal (sensory, motor)
Urination/defecation
Loss of consciousness
Timing and relationship to feeding and exercise

Abnormal behaviour
Head pressing
Dementia
Circling
Other

Ataxia

Exercise tolerance

General medical history
Note: A full general history should be taken (see Appendix A).
Observation

**Mental status (normal, confused, depressed, stuporous, comatose)**

<table>
<thead>
<tr>
<th>Limbs</th>
<th>LF</th>
<th>RF</th>
<th>LH</th>
<th>RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paresis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paralysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thoracic limb</td>
<td>C1–C5</td>
<td>C6–T2</td>
<td>T3–L3</td>
<td>L4–L7</td>
</tr>
<tr>
<td>Pelvic limb</td>
<td>UMN</td>
<td>LMN</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

**Posture**
- Head tilt (left or right)
- Stance
- Circling

**Lameness**

**Ataxia**

**Paresis**

**Gait**

**Involuntary movement**

**Palpation/manipulation**

**Pain**
- Spinal – localise
- Joints
- Muscle

**Neck movement**

**Postural reactions**

<table>
<thead>
<tr>
<th>LF</th>
<th>RF</th>
<th>LH</th>
<th>RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopping</td>
<td>Knuckling</td>
<td>Wheelbarrowing</td>
<td>Hemiwalking</td>
</tr>
<tr>
<td>Extensor postural thrust</td>
<td>Placing (tactile)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Cranial nerves** – Normal? Reduced? Absent? Left or right?

- Smelling non-irritant substance (I)
- Pupil size/anisocoria (retina, II, III)
- PLR (II, III, sympathetic, retina)
- Menace (retina, II, VII, forebrain, cerebellum)
- Corneal reflex (V, VI, VII)
- Throw cotton wool (II)
- Auditory response (VIII)
- Strabismus (permanent: III, IV, VI; temporary: VIII)
- Spontaneous nystagmus (horizontal, vertical, rotatory)
- Positional nystagmus (III, VIII)
- Oculovestibular (III, IV, VI, VIII)
- Facial sensation, nasal stimulation (V, forebrain)
- Facial paralysis (VII)
- Masticatory muscle atrophy (V)
- Palpebral (V+VII)
- Swallowing/gag (IX and X)
- Tongue (XII)
- Oculocardiac (V, X)
- Jaw tone (V)

**Spinal reflexes**

- Thoracic withdrawal (C6–T2)
- Pelvic withdrawal (L6–T2)
- Patellar (L4–6)
- Gastrocnemius (L6–S1)
- Perineal (S1–S2)
- Extensor carpi radialis (C7–T2)
- Tail movement?
- Panniculus

**Urinary function**

- Voluntary urination?
- Full bladder?
- Easily expressed?
Appendix D: Cardiology Consultation Form

Note: For history-taking see Appendix A, and physical examination see Appendix B.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Result</th>
<th>Normal value canine</th>
<th>Normal value feline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhythm</td>
<td>70–160</td>
<td>120–240</td>
<td></td>
</tr>
<tr>
<td>Rate</td>
<td>&lt;0.4</td>
<td>&lt;0.2</td>
<td></td>
</tr>
<tr>
<td>P height (mV)</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
<td></td>
</tr>
<tr>
<td>P width (s)</td>
<td>&lt;2.5–3.0</td>
<td>&lt;0.9</td>
<td></td>
</tr>
<tr>
<td>R height (mV)</td>
<td>&lt;0.06</td>
<td>&lt;0.06</td>
<td></td>
</tr>
<tr>
<td>QRS width (s)</td>
<td>0.06–0.13</td>
<td>0.05–0.09</td>
<td></td>
</tr>
<tr>
<td>Q-T interval (s)</td>
<td>0.15–0.25</td>
<td>0.12–0.18</td>
<td></td>
</tr>
<tr>
<td>T height (mV)</td>
<td>&lt;1/4 height of R</td>
<td>&lt;0.3 mV</td>
<td>no marked depression</td>
</tr>
<tr>
<td>S-T segment</td>
<td>depression &lt;0.2 mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P for every QRS?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QRS for every P?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other comments on trace

ECG diagnosis

Radiography

Non-heart/lung structures

Lateral
- Vertebral heart score
- Cardiac silhouette width
- Cardiac silhouette height
- Chamber enlargement
- Lung pattern
- Cranial lobar arteries
- Cranial lobar veins
- Caudal vena cava width and position
- Tracheal elevation
- Mainstem bronchial splitting
Dorsoventral
Heart width
Chamber enlargement
Splitting of bronchi (cowboy sign)
Lung pattern
Caudal lobar arteries
Caudal lobar veins

**Echocardiography**
(Consult published tables for weight-adjusted normal values)

**2D**
IVSd
IVSs
LVd
LVs
LVFWd
LVFWs
LA
Ao
LA:Ao

**Systolic function**
FS%
EF
EPSS
PEP
LVET
PEP:LVET
Index of sphericity

**Diastolic function**
Mitral inflow velocities
E peak
A peak

**Valvular velocities**
Mitral regurgitation
Tricuspid regurgitation
Aortic outflow
Pulmonic outflow

**Colour Doppler**
LA regurgitation
RA regurgitation
ASD?
VSD?
Contrast (‘Bubbleogram’) findings

Pericardial effusion
  Tamponade?
  Neoplasia?
  Other findings
Bibliography and Further Reading

The following texts were used as sources of information, and are also recommended for further reading on the diseases listed in this book.


Note: this website provides large numbers of differential diagnoses – categorised in alphabetical order – for many common historical and physical signs.

Index

abdominal calcification, 240–41
abdominal distension, 120
abdominal masses, 239
abdominal pain, 114, 120–23
abdominal radiography
  abdominal calcification, 240–41
  abdominal masses, 239
  bladder, 230–33
  kidneys, 234–6
  large intestine, 228–9
  liver, 217–19
  loss of intra-abdominal contrast, 236–8
  prostate, 238–9
  small intestine, 224–8
  spleen, 219–21
  stomach, 221–3
  ureters, 230
  urethra, 233
  uterus, 239
abdominal ultrasonography
  ascites, 285–7
  gastrointestinal disease, 281–3
  hepatobiliary disease, 274–7
  ovarian disease, 283–4
  prostatic disease, 284–5
  renal disease, 272–4
  splenic disease, 277–9
  urinary bladder disease, 280–81
  uterine disease, 284
abdominocentesis, 409–10
abortion, 98
acidaemia, 350–51
acid–base disorders, 57, 117
  see also acidosis; alkalosis
acidosis, 13, 345
  see also metabolic acidosis; respiratory acidosis
ACTH, 376
ACTH stimulation test, 412
acute respiratory distress syndrome, 132, 196
adrenal disease/disorder, 2, 115, 279–80
aggression, 75
airway disease/disorder, 7, 129–30
alanine transferase, 293–4
albumin, 292–3
algae infection, see text under named signs
alkalaemia, 352
alkaline phosphatase, 295–6
alkalosis, 13
  see also metabolic alkalosis; respiratory alkalosis
alopecia, 155–7
ammonia, 296–7
amylase, 297
amyloidosis, 124, 126
anaemia
  abnormal heart sounds, 138–41
  aplastic, 320–21
  bone marrow disorders, 320–22
  bounding pulse, 146
  chronic disease, 320
  coma/stupor, 71
differentiating regenerative from non-regenerative, 317
dyspnoea/tachypnoea, 132
erythropoietin deficiency, 322
haematopoietic neoplasia, 321–2
haemoglobin synthesis defects, 322
haemolytic, 13, 124
hypertension, 115
iron deficiency, 322–3
left ventricle dilation, 268
myelodysplasia, 321
myelophthisis, 321
non-regenerative, 320–23
  diagnostic algorithm, 433
nucleotide synthesis defects, 322
pallor, 133
red cell aplasia, 321
regenerative, 317–20
  diagnostic algorithm, 434
respiratory alkalosis, 352
right atrium, 269
shock, 134
sinus tachycardia, 144, 393
spleen enlargement, 220
systemic disease, 320
ventricular tachycardia, 391
weakness, 13
anal sac disease, 123, 163–4
anisocoria, 164–5
anorexia/inappetence, 3, 6–8, 15
antithrombin III, decreased, 339
anuria/oliguria, 102
arterial blood sampling, 416
arthritis, 249
ascites, 136
  abdominal distension, 120
  abdominal pain, 122
  abdominal ultrasonography, 285–7
dyspnœa/tachypnoea, 131
  loss of intra-abdominal contrast, 236–7
  shock, 134
  weight gain, 4
aspartate aminotransferase, 298
ataxia/concious proprioceptive deficits, 57–65
atelectasis, 195
atria
  dimension alterations, 267, 269–70
  rhythm alterations, 389
atrial natriuretic peptide, 378
atrioventricular block, 389
auditory response, reduced, 165
blood, in urine, 362
bacterial infection, see text under named signs
bicarbonate, 354
bile acids, 299–300
bile acid stimulation test, 413–14
bile salt deficiency, 4
biliary obstruction, 125, 276, 299
bilirubin, 104, 298–9, 357
bladder, see urinary bladder
blindness/visual impairment, 6, 80–82
blood, in urine, 356
blood glucose curve, 418
blood pressure measurement, 410–12
blood smear preparation, 414–15
bone, skeletal radiography, 243–5
bone marrow aspiration, 404–5
bradyarrhythmias, 9, 14
bradycardia, 143–6, 393–4
  diagnostic algorithm, 430
  ECG findings, 388
  heart block, 393
  left ventricle dilation, 267
  reactive thrombocytosis, 328
  brainstem disorders, 57–8, 74
bronchial wall oedema, 193
bronchiectasis, 193
bronchitis, 193–5
bronchoalveolar lavage, 397–9
buccal mucosal bleeding time, 336, 415–16
calcium, 339–42
  see also hypercalcaemia; hypocalcaemia
calcium salts in urine, 361
Cannon a waves, 145
carbon dioxide (CO₂), 354
cardiac arrhythmias, 117, 133, 143, 389
cardiac disease, 47, 111, 143, 353
cardiac tamponade, 286
cardiogenic shock, 133
cardiology consultation form, 448–50
cardiomegaly, 203–5
cardiomyopathy, 271, 310
cardiovascular disease/dysfunction
  cyanosis, 136
  exercise intolerance, 47
  haemoptysis, 47
  syncope/collapse, 9–10
  weakness, 14
carpus disorders, 84–6
casts in urine, 361
cataract, 81, 177, 180–81
caudal vena cava, dilatation, 276
central nervous system disease
  blindness/visual impairment, 80
  coma/stupor, 71
  decreased paO₂, 353
  ECG findings, 387
  faecal incontinence, 39
  hypertension, 115
  neurogenic hyperventilation, 352
  respiratory acidosis, 351
central venous pressure measurement, 410–11
cerebellar disease, 55, 59
cerebrospinal fluid analysis, 370–72, 397, 403–4
chloride, 342–3
cholangiohepatitis
  increased alanine transferase, 293
  increased alkaline phosphatase, 295
  increased gamma-glutamyltranspeptidase, 305
  liver cytology, 368
  polyuria/polydipsia, 1
  ultrasonography, 286
cholangitis, 293
cholecytis, 276
cholestasis
  abnormal liver palpation, 126
  hypomagnesaemia, 344
  increased bile acids, 299
  increased bilirubin, 299
  increased cholesterol, 301
liver cytology, 367
liver enlargement, 218
cholesterol, 301
cirrhosis, 124, 126, 295, 305
claw disorders, 85–6, 88, 90, 162–3
coagulopathy
  abdominal pain, 122
coughing, 41
decreased albumin, 292
decreased globulins, 307
decreased iron, 310
epistaxes, 45
haematemesis, 33–4
haematochezia, 35
haematuria, 104
haemoptysis, 47
hepatic parenchymal abnormalities, 275
intraocular haemorrhage, 183, 288
iron deficiency anaemia, 322
loss of intra-abdominal contrast, 237
melaena, 31–3
pericardial effusion, 266
regenerative anaemia, 317
seizures, 52
sneezing/nasal discharge, 44
thoracic radiography, 200
urinary bladder disease, 280
ventricular tachycardia, 391
colitis, 22, 39, 281
coma/stupor, 70–72, 111
congenital conditions, see text under named signs
conjunctivitis, 174–5
constipation/obstipation, 36–8
  abdominal distension, 120
  abdominal pain, 120
  bladder displacement, 230
  large intestine contents, 229
  large intestine dilatation, 229
  vomiting, 22, 25
contrast cystography, 423–5
contrast echocardiography, 426
contrast radiography, 228–9, 233, 236, 263–5, 421–6
corneal abnormalities, 165, 178–80
cortisol, 375
coughing, 40–42
cranial nerves, 164–7
  examination, 426–8
C-reactive protein, 300
creatine kinase, 302–3
creatinine, 301–2
cyanoectasis, 135–6
cystine in urine, 362
cytocectesis, 408–9
deafness, 75–7, 165
degenerative conditions, see text under named signs
dermatological disease, 373
dermatoses, scaling, 148
diagnostic algorithms, 430–40
diaphragm abnormalities, 213–14
diarrhoea, 26–31
  hypernatraemia, 349
  hypophosphataemia, 347
  hypotension, 116
  large intestine contents, 229
  metabolic acidosis, 350
  shock, 134
differentiating seizures from syncope, 10
disuse muscular atrophy, 185
Doppler technique for blood pressure measurement, 411–12
drugs/toxins, see text under named signs
dwarfism, skeletal radiography, 243
dysphagia, 3, 19–20
dyspnoea/tachypnoea, 128–32
dystocia, 98–9
dysuria, 116
early embryonic death, 91, 94
ECG findings, 382–94
effusions, 3, 116, 266, 293
  see also pleural effusion
elbow disorders, 83–4, 86
electrocardiography, 400–01
  see also ECG findings
electroencephalography findings, 395–6
electrolyte disorders
  ataxia/conscious proprioceptive deficits, 57–8
  coma/stupor, 71
  ECG findings, 386–7
  hypotension, 117
  polyuria/polydipsia, 1
  sinus block, 389
  small intestine, 225–7
  vestibular disease, 170
electromyographic findings, 394–5
encephalitis, 57
endocrine disorders, see text under named signs
eosinopenia, 335
eosinophilia, 334–5
epilepsy, 14
epiphora/tear overflow, 82–3
epiphyseal dysplasia, 249
episcleral congestion, 177–8
epistaxis, 3, 44–6, 254, 317, 322
erosive/ulcerative skin disease, 157–8
erthropoietin deficiency, 322
exercise intolerance, 47–8
eyes
  anterior chamber, abnormal appearance, 184
  lens lesions, 180–81
  ultrasonography, 288–9
see also named disorders
facial asymmetry, 165
facial nerve lesions, 175, 180
faecal analysis, 379–81
faecal blood, 379
faecal incontinence, 39
faecal parasites, 380
faecal tenesmus/dyschezia, 38–9
female infertility, 91–4
ferritin, 303
fever
  abnormal heart sounds, 139, 141
  anorexia/inappetence, 7
  bounding pulse, 146
  hyperproteinuria, 359
  pyrexia of unknown origin, 109
  sinus tachycardia, 144, 393
  urine bilirubin, 357
  weakness, 15
  weight loss, 4
  see also hyperthermia
fibrin degradation products, increased, 338
fibrinogen, 303–4, 338–9
fine needle aspiration, 372, 397–8
flatulence/borborygmus, 40
folate, 304
foot disorders, 85–8, 90
forebrain dysfunction, 57, 74, 172
forelimb
  lameness, 83–7
  oedema, 114, 136
fractures, 241–2
frontal sinuses, 255
fructosamine, 304
fungal infection, see text under named signs
fungi in urine, 362–3
gag reflex, reduced, 165
gall bladder, ultrasonography, 276
gamma-glutamyl transferase, 305
gastric emptying, delayed, 223
gastrin, 306
gastrointestinal disease
  abdominal pain, 120–21
  abdominal ultrasonography, 281–3
  anorexia/inappetence, 7
  biliary obstruction, 276
  bradycardia, 143
decreased thyroxine, 374
diffuse pain, 113
ECG findings, 386
haematemesis, 33–4
haematochezia, 35
inappropriate urination and defecation, 75
melaena, 32
muscular atrophy, 185
reactive thrombocytosis, 328
regurgitation, 20
sinus bradycardia, 393
vomiting, 22, 25
gastrointestinal endoscopic biopsy, 399–400
gastrointestinal loss, 346
gingivitis, 119
Glasgow Coma scale, 70
glaucoma, 177–8, 180–81, 182, 183
globulins, 306–7
glomerular filtration, reduced, 297, 312
glucose, 307–9, 418
  in urine, 356
  see also hyperglycaemia; hypoglycaemia
growth failure, 8–9
growth plate closure, delayed, 243
haematemesis, 3, 33–4, 318, 322
haematochezia, 34–6
haematuria, 3, 102–4, 192, 318, 322, 356, 361
haemoglobinuria, 104, 356, 361
haemolysis, 318–20, 356
  hyperphosphataemia, 348
  increased aspartate aminotransferase, 298
monocytosis, 33
neutrophilia, 329
haemoptyisis, 46–7
haemorrhage
  hypotension, 116
  reactive thrombocytosis, 328
  regenerative anaemia, 317–18
  shock, 134
haemorrhagic disease, monocytosis, 333
haemorrhagic pericardial effusion, 266
hair growth, failure of, 155–7
hair plucks, 369
head and neck oedema, 114, 136
head and neck radiography, 251–7
heart
  abnormal rate, 143–5
  abnormal sounds, 138–43
  altered chamber dimensions, 267–70
  disease, 47, 111, 143, 353
  see also cardiac; cardio-
hepatic disease
  alopecia, 155
  anaemia, 320
Index

anorexia/inappetence, 7
diarrhoea, 26
diffuse, 275
hypoglycaemia, 308
increased alkaline phosphatase, 295
increased aspartate aminotransferase, 298
increased gamma-glutamyl transpeptidase, 305
multifocal neurological disease, 77
neurogenic hyperventilation, 352
see also liver; liver disease
hepatic encephalopathy
altered behaviour, 74
ataxia/conscious proprioceptive deficits, 57–8
blindness/visual impairment, 80
seizures, 53
trembling/shivering, 55
vestibular disease, 170
hepatic failure, 4, 13, 292
hepatic insufficiency
decreased cholesterol, 301
decreased globulins, 307
increased ammonia, 297
increased triglycerides, 313
hepatic jaundice, 124–5
hepatic lipidosis, 124, 126
hepatic parenchymal disease, increased bile acids, 299
hepatitis
decreased thyroxine, 373
gall bladder thickening, 276
growth failure, 9
increased alanine transferase, 293
increased alkaline phosphatase, 295
increased gamma-glutamyl transpeptidase, 305
liver cytology, 368
polyuria/polydipsia, 1
ultrasonography, 287
hepatobiliary disease
abdominal pain, 121
abdominal ultrasonography, 274–7
biliary obstruction, 276
polyuria/polydipsia, 1
hepatocellular damage, increased lactate dehydrogenase, 311
hepatojugular reflux, positive, 145
hepatomegaly
abdominal distension, 120
abdominal radiography, 239
dyspnoea/tachypnoea, 131
large intestine displacement, 228
small intestine displacement, 225
stomach displacement, 221
thrombocytopenia, 327
ultrasonography, 275
weight gain, 5
hind limb
lameness, 87–9
oedema, 114, 137
history record, 441–2
hock disorders, 88–90
Horner’s syndrome, 171
hydronephrosis, dilatation of renal pelvis, 236
hyperalbuminaemia, 340
hyperbilirubinaemia, 357
hypercalcemia, 339–41, 361
abdominal calcification, 241
anorexia/inappetence, 7
constipation/obstipation, 36
decreased specific gravity of urine, 355
diagnostic algorithm, 439
ECG findings, 388
hypomagnesaemia, 344
polyuria/polydipsia, 1
vomiting, 22, 26
weakness, 13
hyperchloaemia, 343
hyperglobulinaemia, 115
hyperglycaemia, 356, 348
hyperkalaemia, 345–6
bradycardia, 143, 393
diagnostic algorithm, 437
ECG findings, 384, 386–8
trembling/shivering, 55
vomiting, 22, 26
weakness, 13
hyperlipidaemia, 177, 348
hypermagnesaemia, 343–4
hypernatraemia, 1, 342, 349–50
seizures, 53
weakness, 13
hyperparathyroidism, 90, 251–2, 341
hyperphosphataemia, 348
hyperpigmentation, 154–5
hyperproteinaemia, 343, 348, 358
hyperproteinuria, 358–9
hypertension, 115–16
abnormal heart sounds, 138, 140–41
coma/stupor, 71
diagnostic algorithm, 440
epistaxis, 46
haematemesis, 34
intraocular haemorrhage, 184, 289
left ventricular performance indices, 271
melaena, 33
retinal detachment, 182
sneezing/nasal discharge, 44
thoracic radiography, 204
hypertension contd.
  uveitis, 177
  weakness, 14
hyperthermia, 107–10
  dyspnoea/tachypnoea, 132
  hypernatraemia, 350
  hyperproteinuria, 359
  increased urea, 314
  see also fever
hyperventilation, 352
hyperviscosity, 115, 183
hypochaemia, 81, 184
hypoalbuminaemia
  diagnostic algorithm, 432
  gall bladder thickening, 276
  hypocalcaemia, 341
  loss of intra-abdominal contrast, 237
  peripheral oedema, 114, 136
  ultrasonography, 287
hypocalcaemia, 341–2
  altered behaviour, 74
  diagnostic algorithm, 438
  dystocia, 99
  ECG findings, 387–8
  electroencephalography findings, 395
  seizures, 53
  trembling/shivering, 55
  vomiting, 22, 26
  weakness, 13
hypochloraemia, 343
hypoglycaemia
  altered behaviour, 74
  ataxia/conscious proprioceptive deficits, 57
  bradycardia, 143
  coma/stupor, 71
  decreased fructosamine, 304
  exercise intolerance, 48
  multifocal neurological disease, 77
  seizures, 53
  sinus bradycardia, 393
  syncope/collapse, 12
  trembling/shivering, 55
  weakness, 13
hypokalaemia, 346–7
  anorexia/inappetence, 7
  constipation/obstipation, 36
  decreased specific gravity of urine, 355
  diagnostic algorithm, 436
  ECG findings, 384, 387–8
  hypomagnesaemia, 344
  syncope/collapse, 12
  vomiting, 22, 26
  weakness, 13
hypomagnesaemia, 341, 344
hypoponatremia, 348–9
  seizures, 53
  weakness, 13
hypophosphataemia, 347–8
hypopigmentation, 153–4
hypoprothrombinaemia
  coughing, 41
  decreased iron, 309
  pleural effusion, 212
  shock, 134
hypopyon, 184
hypotension, 14, 116–18
hypothermia, 110–11
  cyanosis, 135
  ECG findings, 387
  hyperproteinuria, 359
  hypomagnesaemia, 344
  hypophosphataemia, 347
  increased urea, 314
  potassium translocation, 347
hypovolaemia
  dyspnoea/tachypnoea, 132
  left ventricle reduction, 269
  left ventricular performance indices, 270
  right atrial reduction, 270
  shock, 134
  thoracic radiography, 205
  weak pulse, 146
hypoxaemia
  central cyanosis, 135–6
  respiratory alkalosis, 352
  shock, 134
  syncope/collapse, 10–11
ileus, 282–3
immune-mediated disease, see text under named signs
immunodeficiency syndromes, 108–9, 161, 328
inappropriate urination and defecation, 75
increased central venous pressure, 114, 137
infection, see text under named signs
inflammatory disease, see text under named signs
in saline autoagglutination test, 414
insulin, 376
insulinoma, ketones in urine, 360
intervertebral space abnormalities, 262
intestinal blood loss, 318, 322
intestinal parasites, 4
intra-abdominal contrast, loss of, 236–8
intraocular disease, see text under named signs
intraocular haemorrhage, 177, 183–4
intravenous urography, 422–3
iron, 309–10
iron deficiency disorders, 303, 322–3
jaundice, 124–6
  diagnostic algorithm, 435
jaw, 165, 186, 251–2
joint changes, 248–51
keratinisation disorders, 49, 147–8, 159
kidneys
  abdominal radiography, 234–6
  abdominal ultrasonography, 272–3
  abnormal on palpation, 187–9
  contrast radiography, 236
  cytology, 369
  dilatation of renal pelvis, 236, 273
  enlarged, 120, 187–8, 234–5
  polycystic, jaundice, 124
  small, 189, 233, 272
  see also entries under ‘renal’, ‘reno-

lactate dehydrogenase, 310–11
large intestine, 228–9
lipase, 311–12
liver
  abdominal calcification, 240
  abdominal radiography, 217–19
  abnormal palpation, 126–7
  cytology, 367–8
  enlargement, 126–7, 217–19
  reduced size, 127, 219
liver disease
  ascites, 348
  decreased specific gravity of urine, 355
  decreased thyroxine, 374
  haematemesis, 34
  increased alanine transferase, 293–4
  jaundice, 124
  melaena, 32
  splenomegaly, 278
  vascular obstruction, 276
vomiting, 22, 26
  see also entries under ‘hepatic’, ‘hepato-
lockjaw, 186–7
long bones, skeletal radiography, 242–3
low-dose dexamethasone suppression test, 413
lungs, see entries under ‘pulmonary’
lymphadenopathy, 113, 216, 228, 230, 276
lymph nodes, 111–13, 240, 290
lymphocytosis, 331–2
lymphopenia, 332–3
magnesium, 341, 343–5
magnetic resonance (MR) imaging, 401–2
magnetic resonance scans
  adrenal glands, 2
  glioma, 53
  granulomatous meningoencephalomyelitis, 371
intervertebral disc protrusion, 66
middle-ear neopasm, 58, 169
otitis media, 60
pituitary tumour, 73
spinal meningoima, 62
thyroid carcinoma, 256, 340
male infertility, 95–7
mediastinal abnormalities, 214–17
mediastinal shift, 209, 214–15
melaena, 3, 31–3
menace response, reduced, 166
meningoencephalitis, 58
mesenteric tension/traction/torsion, 121
metabolic acidosis, 350–51, 359
  decreased bicarbonate, 354
  dyspnoea/tachypnoea, 132
  hyperphosphataemia, 348
  hypophosphataemia, 347
metabolic alkalosis, 352, 354, 360
metabolic disorders, see text under named signs
microhepatica, 228, 275
miliary dermatitis, 149–50
monocytosis, 333–4
multifocal neurological disease, 77–9
multiple joint/limb lameness, 90–91
muscular disorders, 185–6
musculoskeletal disease, 48
musculoskeletal pain, 113, 121
mycoplasmal infection, see text under named signs
myelogram, prolapsed intervertebral disc, 264–5
myelography, 263–5, 397, 425–6
myocardial disease, 203–4
myoglobinuria, 104, 357, 361
myopathies, 12, 185–6, 298
nasal biopsy, 420
nasal cavity, head and neck radiography, 253–5
nasal disease, 31, 33, 44–5, 128–9
nasal flush cytology, 366–7, 420
nasal mucosa stimulation, reduced response to, 166
neck, ultrasonography, 290–91
neonatal mortality, 100
neoplasia, see text under named signs
nephrocalcinosis, 235
nerve conduction velocity findings, 395
neurological disease/dysfunction
  conjunctivitis, 175
  corneal ulceration/erosion, 180
  diffuse pain, 114
  hypotension, 117
  pharyngeal disease, 6
neurological disease/dysfunction contd.
pruritus, 50
ptyalism/salivation/hypersalivation, 17
syncope/collapse, 11
trembling/shivering, 55
neurological examination, 445–7
neuromuscular disease/dysfunction
constipation/obstipation, 37
decreased paO₂, 353
dysphagia, 20
exercise intolerance, 48
gagging/retching, 18
lameness, 91
respiratory acidosis, 351
weakness, 14
neutropenia, 330–31
neutrophilia, 328–9
nitrite in urine, 357
nodules, 151–3
nutritional disorders, see text under named signs
nystagmus, spontaneous, 166
obstipation, see constipation/obstipation
obstruction, 28–9, 36–7, 138, 229
odontogenic cysts, 251–2
oesophageal abnormalities, 206–9
oestradiol, 378
oestrus, irregularities, 91–3
optic disc, oedema, 182–3
optic nerve disease, 80
oral lesions, 16, 19, 118–20, 252
organ rupture, 121–2
orthopaedic disease, 185
ossification, delayed, 243
osteolysis, 206, 247–8
osteolytic/proliferative joint disease, 250–51
osteomyelitis, 242, 244
osteopenia, 241, 246–7, 250
osteopetrosis, 244
otitis externa, 75, 158–60, 168
ovarian disease, 92, 283–4
pain, 113–14, 120–23, 128–9
pallor, 133
palpebral reflex, reduced, 166
pancreatic disease
  abdominal calcification, 240
  abdominal pain, 122
  increased amylase, 297
  increased lipase, 312
  ultrasonography, 279
paO₂, 353–4
paraphimosis, 192
parasitic infection, see text under named signs
pericardiocentesis, 397, 407–8
periosteal reactions, 244
peripheral neuropathies, 48, 55, 63–4, 68–9, 186
peripheral oedema, 4, 114–15, 136–7
peritoneal fluid, loss of intra-abdominal contrast, 236–7
peritoneal lavage, 397, 409–10
peritonitis, 237–8, 286
pH, 350–52
  of urine, 359–60
pharynx, head and neck radiography, 255–6
phosphate, 347–8
pigmentation disorders, 153–5
pleural effusion
  abnormal heart sounds, 139
  anorexia/inappetence, 7
cyanosis, 135
decreased paO₂, 353
dyspnoea/tachypnoea, 130
fluid accumulation, 4
hyponatraemia, 349
respiratory acidosis, 351
stomach displacement, 221
thoracic radiography, 195, 211–12
thoracic ultrasonography, 265
pneumomediastinum, 215
pneumonia
  anorexia/inappetence, 7
decreased paO₂, 353
respiratory acidosis, 351
thoracic radiography, 196–7
pneumothorax
cyanosis, 135
decreased paO₂, 353
dyspnoea/tachypnoea, 130
hypotension, 116
respiratory acidosis, 351
thoracic radiography, 195, 212–13
pododermatitis, 160–62
pollakiuria/dysuria/stranguria, 101
polycythaemia, 115, 307, 323–4, 328
polyphagia, 5–6
polyuria/polydipsia, 1–3, 101–2, 105, 316, 379
polyuria without polydipsia, hypotension, 116
post-renal disease, 312, 315–16
post-renal failure, 345, 348
potassium, 345–7
  see also hyperkalaemia; hypokalaemia
pre-renal disease, 312–14
pre-renal failure, 348
prion infection, 74
progesterone, 377–8
proliferative joint disease, 245, 250
prostate, 190, 238–9
prostatic disease
abdominal ultrasonography, 284–5
faecal tenesmus/dyschezia, 38
male infertility, 95
penile bleeding, 192
pollakiuria/dysuria/stranguria, 101
protein-losing enteropathies, 301, 307
protein-losing nephropathy, 293, 307
proteinuria, 361
prothrombin time, increased, 337
protozoal infection, see text under named signs
pruritis, 48–50, 163–4
pseudohyperkalaemia, 345
psychogenic disorders, 162, 190
ptyalism/salivation/hypersalivation, 16–18
pulmonary artery size, increased, 201–2
pulmonary disease, haemoptysis, 46–7
pulmonary fibrosis, 200
pulmonary haemorrhage, 41, 197, 200
pulmonary hypoperfusion, 202
pulmonary oedema
abnormal respiratory sounds, 138
cough, 41
cyanosis, 135
decreased paO₂, 353
dyspnoea/tachypnoea, 130
haemoptysis, 47
respiratory acidosis, 351
thoracic radiography, 195–6
weakness, 14
pulmonary over-inflation, 202
pulmonary thromboembolism, 197
pulmonary vein size, increased, 202
pulse, alterations in arterial, 146–7
pupillary light reflex, reduced, 166
pustules and papules, 149–50
pyloric outflow obstruction, 223
pyrexia, see fever

radiographs
adenocarcinoma of lung, 131
chylolithorax, 198
extrahepatic portosystemic shunt, 300
feline asthma, 194
foreign body, 24
fracture of humerus, 84
hepatomegaly, 218
pericardial effusion, 204
pulmonary oedema, 197
pulmonary stenosis, 142
pulmonic stenosis, 42
renomegaly, 188
ureterolith, 235
radiography, see named body regions
red eye, 174–8
regurgitation, 4, 7
renal disease
abdominal ultrasonography, 272–4
alopecia, 155
anorexia/inappetence, 7
decreased iron, 310
diarrhoea, 26
hypertension, 115–16
hypomagnesaemia, 344
increased lipase, 312
increased urea, 314–15
multifocal neurological disease, 77
pollakiuria/dysuria/stranguria, 101
polyuria/polydipsia, 2
spleenomegaly, 278
vomiting, 22, 26
see also kidneys
renal failure, 190
abdominal calcification, 241
altered behaviour, 74
anaemia, 320
anuria/oliguria, 102
casts in urine, 361
decreased glucose, 308
decreased specific gravity of urine, 355
decreased thyroxine, 373
differentiating acute and chronic, 314
hypercalcaemia, 340
hyperchloroaemia, 343
hyperkalaemia, 345
hypermagnesaemia, 344
hypernaatraemia, 350
hyperphosphataemia, 348
hyperproteinuria, 358
hypocalcaemia, 341
hyponatraemia, 349
increased atrial natriuretic peptide, 378
increased creatinine, 302
increased gastrin, 306
increased glucose, 309
increased radio-opacity of kidneys, 235
increased urea, 314–15
megaoesophagus, 206
metabolic acidosis, 350
polyuria/polydipsia, 2
predisposing factor to urinary tract infection, 363
seizures, 53
shock, 134
weakness, 13
weight loss, 4
renomegaly
abdominal radiography, 239
abdominal ultrasonography, 272
large intestine displacement, 228–9
renomegaly contd.
  small intestine displacement, 225
  weight gain, 5
reproductive signs, 91–100
respiratory acidosis, 343, 351, 354, 359
respiratory alkalosis, 343, 347, 352, 354, 360
respiratory disease
  bradycardia, 143
decreased paO2, 353
ECG findings, 386
exercise intolerance, 47
gagging/retching, 18
haematemesis, 33
increased lactate dehydrogenase, 310
melaena, 32
respiratory acidosis, 351
shock, 134
sinus bradycardia, 393
weakness, 14
respiratory sounds, abnormal, 137–8
retinal degeneration, 82, 180
retinal detachment, 82, 182, 184, 289
retinal haemorrhage, 82, 183
retinal lesions, 182–3
retrobulbar masses, ultrasonography, 289
retrophyryngeal mass, 256
rhinitis, 7, 255
rib abnormalities, 205–6
rickettsial infection, see text under named signs
right-to-left cardiac shunts, 202
salivary gland disease, 17, 20, 119, 290
scaling, 147–9
Schirmer tear test, 419–20
seizures, 51–4
  hyperthermia, 109
  stereotypy/compulsive behaviour, 74
syncope/collapse, 11
sepsis, 330, 332, 352
shock, 133–4
  abnormal heart sounds, 139
anuria/oliguria, 102
cyanois, 135
dyspnorea/tachypnoea, 132
increased specific gravity of urine, 355
increased urea, 314
melaena, 32
metabolic acidosis, 350
reactive thrombocytosis, 328
spleen reduction in size, 220
syncope/collapse, 9
thoracic radiography, 205
shoulder disorders, 83, 85
silica in urine, 362
sinus block, 389–90
sinus bradycardia, 393–4
sinusitis, 255
sinus tachycardia, 10, 144, 392–3
skeletal/joint disorders, 12
skeletal muscle disorders, 311
skeletal radiography
  altered shape of long bones, 242–3
  bony masses, 245
  delayed growth plate closure, 243
  delayed ossification, 243
dwarfism, 243
  fractures, 241–2
  increased radiopacify of bone, 243–4
  joint changes, 248–51
osteolysis, 247
osteolytic/ostogeneic lesions, 248
osteopenia, 246–7
perioseal reactions, 244
skin disease, 358
  skin scraping, 369, 419
small intestine disorders, 4, 224–8, 349
smell response, lack of, 165
sneezing/nasal discharge, 43, 44
sodium, 348–50
  see also hypernatraemia; hyponatraemia
soft palate thickening, 256
specific gravity of urine, 354–6
spinal disorders, 61–3, 172–4
  bladder obstruction, 189
  diffuse pain, 114
  Horner’s syndrome, 171
  muscular atrophy, 186
  paresis/paralysis, 65–8
  weakness, 14
spinal radiography, 258–62
  contrast radiography, 263–5
spleen, 219–21, 241, 277–9
splenomegaly, 220, 277–8
  abdominal distension, 120
  abdominal radiography, 239
  large intestine displacement, 229
  small intestine displacement, 225
  thromboctyopenia, 327
weight gain, 5
spondylitis, 259–60
stereotypy/compulsive behaviour, 74–5
stertor, 138
stifle disorders, 87–9
stomach, 221–3
stomatitis, 120
strabismus, 166
stridor, 137–8
struvite in urine, 362
supraventricular tachycardia, 144, 390
syncope/collapse, 9–13
synechia, anterior, 184
systemic disorders, see text under named signs
systolic function, decreased, 133
tachyarrhythmias, 9, 14, 146, 267
tachycardia, 144–6, 392–3
abnormal heart sounds, 138–9
diagnostic algorithm, 431
tape impressions, 369
tenesmus, 124
testes, ultrasonography, 288
testicular abnormalities, 191
testosterone, 377
thoracic radiography
acute respiratory distress syndrome, 196
atelectasis, 195
bronchial wall oedema, 193
bronchitis, 193–5
cardiac shunts, 202
cardiac silhouette, 203–5
diaphragm abnormalities, 213–14
hypovolaemia, 205
infection, 199–200
mediastinal abnormalities, 214–17
myocardial disease, 203–4
neoplasia, 195, 200
oesophageal abnormalities, 206–9
osteolysis, 206
pleural effusion, 211–12
pneumonia, 196–7
pneumothorax, 201
pulmonary fibrosis, 200
pulmonary haemorrhage, 197, 200
pulmonary hypoperfusion, 202
pulmonary oedema, 195–6
pulmonary over-inflation, 202
pulmonary thromboembolism, 197
rib abnormalities, 205–6
thoracic wall trauma, 206
tracheal abnormalities, 209–10
vascular pattern, 201–3
volume overload, 204–5
thoracic ultrasonography, 265–71
altered heart chamber dimensions, 267–70
left ventricular performance indices, 270–71
mediastinal masses, 266
pericardial effusion, 266
pleural effusion, 265
thoracocentesis, 397, 406
thrombocytopathia, 45, 47, 336
thrombocytopenia, 324–7
epsitaxis, 45
haematochezia, 35
haemoptysis, 47
increased buccal mucosal bleeding time, 336
melaena, 33
thrombocytosis, 327–8
thyroid disease, 116
thyroid glands, ultrasonography, 290
thyroxine, 373–4
tracheal abnormalities, 209–10
tracheal/bronchoalveolar lavage, 364–5
trembling/shivering, 55–6
trigeminal nerve lesions, 175, 180
triglycerides, 312–13
trismus, 186–7
tryptsin-like immunoreactivity, 313
tympanic bulla, head and neck radiography, 253
ultrasonograms
abdominal mass, 282
atrial thrombus, 268
dilated cardiomyopathy, 271
disseminated thoracic thymoma, 131
inflammatory bowel disease, 283
hepatic lymphoma, 277
kidney, 274
left atrial dilation, 268
pericardial effusion, 267
prostatic adenocarcinoma, 285
pulmonic stenosis, 270
ultrasonography, see named body regions
ultrasound-guided biopsy, 397, 402–3
uraemia
delayed gastric emptying, 223
haematemesis, 34
melaena, 32–3
oral lesions, 119
predisposing factor to urinary tract infection, 364
thoracic radiography, 201
trembling/shivering, 55
ventricular tachycardia, 391
uraemic encephalopathy, 57–8, 71, 170
uraemic gastritis, 240, 282
urate in urine, 362
urea, 313–16
ureters, 230
urethra, 233
urinalysis, 354–64
see named contents of urine
urinary bladder
abdominal radiography, 230–33, 239
abdominal ultrasonography, 280–81
abnormalities, 189–90, 224, 230–2
contrast radiography, 233
distension, 120–21
urinary incontinence/inappropriate urination, 104–5
urinary system, 122–3, 241
urinary tract infection, predisposing factors to, 363–4
urobilinogen in urine, 357
urological disease, 114
uterus
abdominal radiography, 239
abdominal ultrasonography, 284
abnormal on palpation, 191
enlarged, 5, 120, 228, 230
uveitis, 175–8
abnormal appearance of anterior chamber of eye, 184
blindness/visual impairment, 81–2
lens lesions, 181
vagal manoeuvres, reduced response to, 166
vaginal/vulval discharge, 97–8
vascular disorders
ataxia/conscious proprioceptive deficits, 57–9, 63–4
blindness/visual impairment, 80
claw disorders, 163
coma/stupor, 71
multifocal neurological disease, 79
paresis/paralysis, 68–9
seizures, 52–3
vestibular disease, 171
vascular tone, decreased, 117
vasculitis, 157, 326–7
venous congestion, 126–7, 217–18
ventricles
dimension alterations, 267–71
rate abnormalities, 144
rhythm alterations, 390–92
vertebrae, 258–61
vertebral malformations, 61
vestibular disease, 14, 167–71
vestibulo-ocular reflex, reduced, 166–7
viral infection, see text under named signs
vitamin B12, 316
vitamin D, 376–7
volume overload, 204–5
vomiting, 4, 17, 21–6, 116, 134, 347–9
water deprivation test, 379, 416–18
weakness, 13–16, 187
weight gain, 4–5
weight loss, 3–4
xanthine in urine, 362
zinc, 317