

# Table of contents

## CHAPTER 1 BASIC PRINCIPLES OF RADIOGRAPHY

<b>Fundamentals of radiography .....</b>	1
Definition of X-rays.....	1
X-ray production .....	2
The parts of an X-ray machine.....	3
How X-rays interact with matter.....	4
Image formation.....	6
The cassette .....	12
Radiographic film .....	12
Image intensifying or strengthening screens.....	13
The development process.....	14
Negatoscope or X-ray film viewers .....	15
<b>Digital radiography .....</b>	15
Digital X-ray systems.....	15
Native data and image algorithms.....	17
DICOM format.....	17
Software.....	17
Viewing .....	17
Image archiving and management .....	17
Technical recommendations in digital radiography .....	19
Digital radiography image quality .....	19
<b>Radiation protection.....</b>	21
International Commission on Radiological Protection .....	22
Legal exposure limits.....	22
Training for exposed workers .....	22
Classification of work areas .....	23
Staff dosimetric control .....	23
General principles to limit radiation exposure .....	24
Radiation protection systems .....	24
<b>General principles of X-ray interpretation.....</b>	27

<b>Radiographic technique .....</b>	28
Radiograph identification .....	28
X-ray image quality .....	28
Radiographic density and contrast .....	28
Image geometry .....	29
Scatter or diffuse radiation .....	29
Radiographic patient positioning and projections .....	33
Technical artifacts and errors .....	35
<b>Radiology reports .....</b>	39
<b>Atlas of radiographic positioning and anatomy .....</b>	40
Abdomen .....	40
Neck .....	43
Thorax .....	44
Appendicular skeleton .....	48
Thoracic limb .....	48
Scapula .....	48
Shoulder .....	49
Humerus .....	50
Elbow .....	51
Radius-ulna .....	53
Carpus .....	54
Metacarpus-phalanges .....	55
Pelvic limb .....	56
Hip .....	56
Femur .....	58
Knee .....	59
Tibia-fibula .....	60
Tarsus .....	61
Metatarsus-phalanges .....	62
Spine .....	63
Head .....	69

## CHAPTER 2 ABDOMEN

<b>Principles of interpretation .....</b>	81
<b>Abdominal wall.....</b>	83
<b>Peritoneal cavity and retroperitoneal space.....</b>	85
Pneumoperitoneum.....	85
Free fluid.....	89
Peritonitis and retroperitonitis.....	90
Peritoneal carcinomatosis .....	92
Masses .....	92
<b>Liver, spleen and lymph nodes .....</b>	96
Liver .....	96
Spleen.....	99
Lymph nodes .....	103
<b>Urinary system.....</b>	103
Kidneys.....	103
Excretory urography.....	107
Percutaneous pyelography .....	108
Ureters.....	110
Bladder.....	114
Positive-contrast cystography.....	114
Negative-contrast cystography (pneumocystography) .....	114
Double-contrast cystography .....	114
Pathological alterations .....	115
Urethra .....	118
<b>Genital system.....</b>	124
Genital system of the female .....	124
Genital system of the male.....	128
<b>Stomach .....</b>	132
Gastrography using barium sulphate .....	132
Positive-contrast gastrography using iodinated contrast media.....	135
Negative-contrast gastrography .....	135
Double-contrast gastrography .....	135
Pathological alterations .....	136
<b>Small intestine .....</b>	142
<b>Large intestine.....</b>	149

## CHAPTER 3 NECK AND THORAX

<b>Principles of interpretation .....</b>	155
Neck .....	155
Thorax.....	155
<b>Thoracic wall .....</b>	161
Ribs .....	161
Sternum.....	163
<b>Pharynx, larynx and trachea.....</b>	164
Pharynx and larynx.....	164
Trachea.....	168
<b>Oesophagus .....</b>	174
<b>Pleural space .....</b>	182
Pleural effusion .....	182
Pneumothorax .....	185
Pleural masses .....	188
Pleural thickenings .....	188
<b>Mediastinum.....</b>	188
Mediastinal effusion .....	191
Pneumomediastinum .....	191
Mediastinal masses .....	193
Displacement of the mediastinum .....	198
<b>Heart.....</b>	198
Size of the cardiac silhouette .....	199
Position of the cardiac chambers and great vessels.....	203
Radiographic signs of enlargement of the heart chambers.....	205
Great vessels.....	208
Acquired heart diseases .....	209
Acquired valvular disease.....	209
Cardiomyopathies .....	209
Dirofilariasis .....	209
Congenital cardiac diseases.....	214
Patent ductus arteriosus .....	214
Pulmonary stenosis .....	215
Aortic stenosis .....	216
Ventricular septal defect.....	216
Tetralogy of Fallot .....	217
Diseases of the pericardium .....	217
Cardiac tumours .....	217
Microcardia.....	217
Cor pulmonale .....	220

<b>Lung.....</b>	220
Abnormal lung patterns .....	224
Bronchial pattern .....	224
Vascular pattern.....	226
Alveolar pattern.....	230
Interstitial pattern .....	237
Mixed pattern .....	244
Lung hypertranslucency .....	244
Pulmonary neoplasia .....	245
Lung lobe torsion .....	245
Pulmonary thromboembolism .....	246

## CHAPTER 4 APPENDICULAR SKELETON

<b>Principles of interpretation .....</b>	249
Ossification and closure of growth plates .....	249
Osteolysis and osteogenesis.....	250
Patterns of osteolysis .....	250
Patterns of osteogenesis.....	252
Aggressive bone lesions versus non-aggressive .....	252
Soft tissues.....	253
Other imaging diagnostic techniques.....	255
<b>Congenital, hereditary and developmental abnormalities .....</b>	256
Chondrodysplasia .....	256
Epiphyseal chondrodysplasia.....	257
Physeal chondrodysplasia .....	257
Metaphyseal chondrodysplasia .....	257
Retained core of growth cartilage.....	257
Polymelia .....	257
Ectrodactyly .....	257
Hemimelia .....	257
Osteochondrosis and osteochondritis dissecans.....	257
Elbow dysplasia .....	260
Hip dysplasia .....	260
Hypertrophic osteodystrophy .....	264
Panosteitis .....	265
Femoral head avascular necrosis.....	266
Incomplete ossification of the humeral condyle .....	266
Spontaneous capital femoral physeal fracture in cats.....	266
Mucopolysaccharidosis.....	266

<b>Fractures.....</b>	267
<b>Deformities due to growth plate alteration .....</b>	272
<b>Bone tumours and osteomyelitis.....</b>	273
Bone tumours.....	273
Osteomyelitis.....	275
<b>Nutritional and metabolic alterations .....</b>	278
Secondary nutritional hyperparathyroidism.....	278
Secondary renal hyperparathyroidism .....	278
Hypophyseal dwarfism.....	278
Hypervitaminosis A .....	278
<b>Joint disease.....</b>	280
Radiographic signs of joint disease .....	280
Increased synovial volume.....	280
Altered thickness of the joint space .....	280
Decreased subchondral bone opacity .....	281
Increased subchondral bone opacity .....	281
Osteophytes and enthesophytes.....	281
Soft tissue calcification.....	282
Intra-articular bodies (arthroliths) .....	283
Joint incongruence.....	283
Joint malformation.....	283
Intra-articular gas .....	283
Ligament injuries .....	285
Tendon lesions.....	286
Sesamoids .....	288
Luxations and subluxations.....	294
Degenerative joint disease .....	294
Infection .....	295
Immune-mediated polyarthropathy .....	295
Joint tumours.....	296
<b>Other appendicular skeleton abnormalities.....</b>	296
Pulmonary hypertrophic osteopathy .....	296
Circumscribed calcinosis .....	297
Multiple cartilaginous exostoses.....	297

## CHAPTER 5 SPINE

<b>Principles of interpretation .....</b>	299
<b>Myelography .....</b>	301

<b>Congenital disorders .....</b>	304
Hemivertebra .....	304
Block vertebra .....	305
Transitional vertebra .....	305
Spina bifida .....	306
<b>Instability syndromes .....</b>	306
Atlantoaxial instability .....	306
Cervical instability .....	306
Lumbosacral instability .....	308
<b>Degenerative intervertebral disc disease .....</b>	309
<b>Other disorders of the spine .....</b>	312
Scoliosis, kyphosis and lordosis .....	312
Spondylosis deformans .....	314
Dural ossification .....	314
Spondyloarthritis .....	314
Diffuse idiopathic skeletal hyperostosis .....	314
Inflammation and infection .....	315
Fractures and luxations .....	320
Tumours .....	320
Hypervitaminosis A .....	321
Mucopolysaccharidosis .....	321
Osteopetrosis .....	321
Multiple cartilaginous exostoses .....	321

## CHAPTER 6 HEAD

<b>Principles of interpretation .....</b>	327
<b>Cranial vault .....</b>	328
Congenital hydrocephalus .....	328
Occipital dysplasia .....	328
Fractures .....	328
Infection .....	328
Tumours .....	328
<b>Nasal cavity and sinuses .....</b>	330
Fractures .....	331
Rhinitis .....	332
Foreign bodies .....	334
Tumours .....	334

<b>Mandible, maxilla and temporomandibular joint .....</b>	337
Fractures .....	337
Temporomandibular joint luxation.....	337
Temporomandibular dysplasia.....	339
Temporomandibular joint ankylosis .....	339
Degenerative joint disease .....	340
Infection .....	340
Tumours .....	340
Craniomandibular osteopathy .....	340
Secondary renal hyperparathyroidism .....	340
<b>Teeth.....</b>	343
Periodontal disease.....	345
Periapical abscess .....	345
Tooth resorption .....	345
Tumours .....	348
<b>Auditory system .....</b>	348
Otitis externa .....	349
Otitis media.....	349
Tumours .....	351
Cholesteatoma .....	352

## CHAPTER 7 | MOST COMMON DIAGNOSTIC ERRORS

<b>Abdomen .....</b>	353
Lack of abdominal fat, wet hair .....	353
Underexposure and overexposure.....	353
Caudal hepatic border depending on thoracic conformation .....	354
Physiological organomegaly in young animals .....	354
False impression of splenomegaly .....	354
Gestation before foetal mineralisation .....	354
Superimposition of the prepuce and os penis.....	355
“Pseudomasses” .....	355
False thickening of the gastric or intestinal wall .....	355
Increase in the amount of gastric and intestinal fluid/gas .....	355
Anatomical variations of the gastrointestinal tract in cats .....	356
Intestinal particularities in dogs.....	356
Peristaltic waves.....	356
Inappropriate doses of contrast agent.....	356
Patterns of contrast medium accumulation .....	357
Presence of gas bubbles.....	357
Contrast diffusion .....	357

<b>Neck and thorax .....</b>	358
Confusion of the hyoid apparatus with foreign bodies.....	358
Cricopharyngeal sphincter .....	358
Cutaneous nodules and nipples .....	358
Calcification associated with age.....	358
Folds of skin.....	359
Rib curvature and costal cartilage calcification .....	359
False alterations of the trachea .....	359
False alterations of the oesophagus .....	359
Mediastinum in brachycephalic breeds and obese animals .....	360
False impression of cardiomegaly .....	360
Thymus.....	360
Coronary vessels .....	360
False pleural effusion .....	360
False pulmonary alterations .....	360
<b>Appendicular skeleton.....</b>	363
Radiographic technique.....	363
Age and breed .....	363
Incorrect positioning of the patient.....	363
Clavicle and sesamoid bones.....	364
<b>Spine .....</b>	365
Incorrect positioning of the patient.....	365
Overexposure and underexposure .....	365
Superimposed structures.....	365
Normal anatomical variations.....	366
Contrast medium in extradural space .....	366
<b>Head .....</b>	367
Incorrect positioning of the patient.....	367
<b>Digital imaging .....</b>	368
Greater definition of the elements of the lung .....	368
Higher pulmonary radiopacity.....	368
Higher tissue contrast .....	368
Overexposure.....	368
Metallic implants.....	368
Excessive post-processing .....	368
Excessive zooming.....	368
<b>RECOMMENDED READING LIST .....</b>	371