SUMMARY

CT is an imaging tool with many applications in various clinical disciplines that is becoming increasingly available to the veterinary profession. This imaging procedure is particularly valuable for the detection and diagnosis of brain diseases associated with mass lesions. The fact that some intracranial lesions may not be visible on CT is due to diffuse distribution, attenuation levels similar to those of the surrounding normal tissue, and minimal or absent contrast enhancement. In evaluating the localisation, extent and characterisation of lesions of the nasal cavities, paranasal sinuses, orbita, jaws, temporomandibular joints and tympanic bullae, CT is more accurate than conventional radiography. CT appears to be remarkably accurate in revealing the location, extent and origin of nasal diseases, and is superior to conventional radiography for detecting middle ear disease. In the investigation of spinal lesions in the event of doubtful radiographic and/or myelographic findings, CT is useful and can be of help in surgical planning. For the detection and description of masses, malformations and fluid collections in the thoracic cavity, CT is one of the best imaging modalities and is considered the most sensitive method for the detection of pulmonary metastases. CT of the abdomen gives excellent anatomic images of the organs and vessels, although the overall availability of ultrasound may have decreased the demand for abdominal CT studies. Skeletal CT may be helpful in clinical cases in which standard radiography is negative or inconclusive even though there is a high suspicion of pathology. In the diagnosis of fragmented coronoid process and other elbow joint pathology, CT has been proven to be superior to radiography.
INTRODUCTION

Computed tomography (CT) was introduced in the 1970s in human medicine, and since then it has become an established and important imaging procedure (Seeram, 2001). Although over the last decade CT has become more readily available to the veterinary profession, its general application is still limited. It requires animal patients to be anaesthetised for examination (Jeffery et al., 1992). Another disadvantage is the cost of purchasing and maintaining the equipment. Superior soft-tissue differentiation and the absence of superimposition are the major advantages of CT over conventional x-ray techniques (Hathcock and Stickle, 1993). The predominant emphasis is the evaluation of affections of the head and central nervous system, and orthopaedic disease. Besides its use in detecting abnormalities, CT is also used for better defining the extent and severity of lesions, all these features being useful for treatment planning. A thorough knowledge of the cross-sectional anatomy is required in examining each region of the body.

BRAIN AND SKULL

In cases of trauma, fractures of the cranium can be identified easily with CT because of its great sensitivity for bony tissue (Jeffery et al., 1992; Dennis, 1996). Computed tomography is particularly valuable for the detection and diagnosis of brain diseases. The first reports of CT scanning in small animals were published in the 1980s and concerned the normal brain anatomy as seen on CT (Fike et al., 1980; Fike et al., 1981a; Fike et al., 1984; Legrand and Carlier, 1986; Zook et al., 1981; George and Smallwood, 1992) and various types of tumours in dogs and cats (Fike et al., 1981b; LeCouteur et al., 1981; LeCouteur et al., 1983; Turrell et al., 1986; Lang et al., 1988). Intracranial masses and fluid-filled cavities are usually clearly demonstrated with CT (Stickle and Hathcock, 1993).

During the examination the dog is best placed in prone position with the head extended. The head should be held with cushions to maintain a straight and symmetric position. A scout view is performed in the lateral and ventrodorsal planes. The area of interest extends from the cranial aspect of the first cervical vertebra to the cribriform plate and transverse slices are set perpendicular to the hard palate (Fike et al., 1981b; LeCouteur et al., 1981). The scan thickness is generally 5 mm for large dogs and 2 mm for small dogs and cats (Jeffery et al., 1992; Stickle and Hathcock, 1993). For brain scanning a window level of 50 Hounsfield units (HU) and a window width of 150 HU is routinely used in our department. A survey scan series is performed, followed by the IV administration of iodinated contrast medium and a second series of scans (Fike et al., 1981b). The falx cerebri, the tentoria cerebelli, and the ventricular system are readily visible on survey CT images (Figure 1) (Stickle and Hathcock, 1993; Jeffery et al., 1992). Intracranial mass lesions seen on CT scans are generally classified on the basis of a shift in the position of normal structures (mass effect) (Figure 2) (Fike et al., 1981b; Fike et al. 1986).
Oedema may be visible as an area of decreased density in the brain parenchyma (Plummer et al., 1992; Stickle and Hathcock, 1993). Both primary brain tumours and metastases can be identified. The visibility of intracranial lesions is enhanced on CT because of the leakage of contrast medium through a disrupted blood-brain barrier and/or an increase in vascularity (Fike et al., 1981b; Fike et al., 1986). Unfortunately, different types of lesions can have virtually identical characteristics on CT, making the differentiation between neoplastic and non-neoplastic diseases impossible (Plummer et al., 1992; Wolf et al., 1995). Nevertheless, certain tumour types, such as meningiomas can often be recognised. These are extra-axial lesions which appear to be hyperdense compared to the brain parenchyma. They may show areas of calcification and tend to have a homogeneous enhancement with sharp demarcation from normal tissue (Figure 3) (Lang et al., 1988; Turrell et al., 1986; Jeffery et al., 1992). In this type of tumour, hyperostosis is seen in 50% of the cats (Gordon et al., 1994).

Figure 1: Transverse CT image of the canine brain, made at the level of the fourth ventricle. The occipital region of the brain (A), tentoria cerebelli (B), cerebellum (C) and fourth ventricle (D) are easily visible on survey CT images.

Figure 2: Pre-contrast transverse CT image of the brain of a dog showing a mass-effect. A lateral displacement of the falx cerebri (white arrow on top) and the third ventricle (white arrow in the middle) towards the right is visible. There is a shift of the midline structures, probably due to an intracranial mass in the left hemisphere.
Astrocytomas and oligodendrogliomas are intra-axial lesions and typically show peripheral enhancement with central lucency or heterogeneous, non-uniform enhancement (LeCouteur et al., 1981; Turrel et al., 1986; Jeffery et al. 1992). However, ring-enhancement is a relatively non-specific sign and a brain abscess or inflammatory disease may also exhibit this feature (Turrel et al., 1986; Plummer et al., 1992; Wolf et al., 1995). Choroid plexus tumours typically are intra-ventricular, well defined hyperdense masses that enhance markedly after contrast administration (Figure 4).

Figure 3: Representative pre-and post-contrast transverse CT scan of the brain of a dog. The pre-contrast image (a) shows a normal symmetry of the brain parenchyma. The ventricles are not enlarged and there is no mass effect. On the corresponding post-contrast scan (b), intense contrast enhancement of a mass with a broad base on the dura (black arrow) is visible. This extra-axial mass lesion is suggestive of a meningioma.

Figure 4: Pre-contrast (a) and post-contrast (b) CT scan of the canine brain at the level of the lateral ventricles. The pre-contrast image shows asymmetry and a mass-effect of the left lateral ventricle (white arrow). After intravenous contrast administration (b) a well-defined hyperdense intraventricular mass is visible. This lesion is suggestive of a choroid plexus papilloma.
Large pituitary tumours may be recognised by their location at the level of the sella turcica and typically show uniform contrast enhancement (Figure 5) (Turrel et al., 1986.; Jeffery et al., 1992).

Several infectious and non-infectious inflammatory disorders can cause CT abnormalities in dogs. The presence of multifocal granulomatous lesions in more than one region of the brain is considered to be specific for primary inflammatory disease such as granulomatous meningoencephalitis (Figure 6) (Ducoté et al., 1999; Speciale, 1992; Plummer et al., 1992).

CT findings such as multifocal areas of decreased density have been found to be characteristic for necrotising encephalitis mostly seen in the Yorkshire Terrier (Ducoté et al., 1999). Although asymmetric enlargement of the lateral ventricles is often associated with this disease, this is also a common feature in normal dogs (Dennis, 1996).
Unfortunately, information about ventricle size and normal variation with regard to breed is still scarce. A recent study demonstrated a statistically significant difference between Yorkshire Terriers and German Shepherd dogs, but no age-related difference could be determined (Esteve-Ratsch, 2001).

Areas of acute haemorrhage appear as homogenous, hyperdense areas associated with oedema and mass-effect (LeCouteur et al., 1981; Jeffery et al., 1992; Stickle and Hathcock, 1993). Other intracranial lesions that are well visualised are those related to the fluid filled spaces of the brain. The appearance of hydrocephalus can be detected (Figure 7) and the aetiology can sometimes be demonstrated.

Some intracranial lesions may not be visible on CT probably due to diffuse distribution, attenuation similar to that of the surrounding normal tissue and minimal or absent contrast enhancement (LeCouteur, 1999).

A definitive diagnosis of intracranial diseases and lesions can only be reached by obtaining a tissue sample for histological examination. Pre-operative biopsy of a lesion may provide information needed to establish a treatment protocol and to give prognostic information to the owner. One report describes the use of CT guided free-hand needle biopsy to perform brain biopsies in dogs. The success rate was rather low due to the inadequate sample size. Clinical complications after biopsy were also reported (Harari et al., 1994). The most accurate method for obtaining samples of a cerebral mass in dogs is CT-guided stereotactic biopsy. This technique uses a frame to hold the head in place while the orientation and insertion of the biopsy needle is guided using coordinates derived from imaging data. Different stereotactic CT-guided devices for dogs and cats have been modified and developed (Coffey and Lunsford, 1987; LeCouteur et al., 1998; Koblik et al., 1999a; Moissonnier et al., 2000; Flegel et al., 2002; Giroux et al., 2002). With the required instrumentation, small brain lesions exceeding 6-9 mm in diameter can be biopsied (Koblik et al., 1999b; Moissonnier et al., 2000; Moissonnier et al., 2002).
The diagnostic information obtained using CT concerning localisation, extent and characterisation of lesions of the nasal cavities, paranasal sinuses, orbit, jaws, temporomandibular joints and tympanic bulla, is more accurate than conventional radiography (Feeney et al., 1991b; Stickle and Hathcock, 1993; Dennis, 1996). Patients are positioned in sternal recumbency and horizontally in the CT gantry. Symmetric positioning of the patient is critical for acquiring images in which the left and right side can be compared (Losonsky, 1997).

Commonly, multiple window levels and widths are used for the evaluation of bony and soft tissue structures (Stickle and Hathcock, 1993). All nasal structures can be made clearly visible by manipulation of the grey scale. CT appears to be remarkably accurate in revealing the location and extent of chronic nasal diseases (Codner et al., 1993; Forrest, 1999, Saunders et al., 2003).

All commonly seen nasal disorders have their typical CT features. The CT features of canine nasal aspergillosis are destruction of the turbinates producing cavitating lesions, and a rim of soft tissue along the frontal bone (Figure 8) (Burk, 1992a; Codner et al., 1993; Schwartz, 1995; Saunders et al., 2002).

The CT features of nasal neoplasm include space-occupying lesions associated with bone destruction, patchy areas of increased soft-tissue density, and destruction of the ethmoid bone (Figure 9). The extent to which a nasal neoplasm has destroyed the frontal bone and extended into the orbit can be established very accurately (Thrall et al., 1989; Burk, 1992a; Park, 1992; Codner et al., 1993; Schwartz, 1995). The CT features of non-specific rhinitis include non-destructive processes that spare the paranasal sinuses and affect most often both nasal cavities (Codner et al., 1993).
CT also provides accurate information on the extension of the process for treatment, surgery planning and radiation therapy of nasal lesions (McEntee et al., 1991, Codner et al., 1993; Mathews et al., 1996).

Studies are available on the normal nasal cavity and paranasal sinuses in the dog and cat to assist in interpretation of CT images (Burk, 1992b; Losonsky et al., 1997).

Because radiographic examination rarely is conclusive in orbital diseases, CT is increasingly being used for the investigation of orbital lesions and the detection and involvement of retrobulbar masses (Figure 10) (Feeney et al., 1991b; Calia et al., 1994; LeCouteur et al., 1982). Exophthalmus and soft tissue swelling associated with the orbit or calvaria can be evaluated using CT. Multilobular tumours and their bone involvement in the zygomatic arch and in the rostral and frontal bone can best be visualised on non-contrast CT images using a bone window (Hathcock and Newton, 2000).

CT provides excellent image detail of bony changes and small fractures of the temporomandibular joint in dogs and cats (Schwarz et al., 2002). The IV injection of contrast medium enhancing the pathologically affected zone in the area of the mandibula or zygomatic arch was noticed in some cases seen in our department. This finding appeared useful to determine the borders of non-mineralised soft tissue masses (Figure 11).

Figure 9: CT image of the nasal cavity of a dog with nasal neoplasia. A low density mass fills both sides of the nasal cavity. Nasal turbinate destruction and lysis of the nasal septum is present. Note the lytic areas in the maxilla (arrow on top) and a defect in the hard palate (vertical arrow).

Figure 10: Transverse CT scan of a dog at the level of mid-zygomatic arch. A diffuse mass is present in the right orbit (asterisk), displacing the globe laterally and rostrally.
CT imaging allows clear visualisation of the base of the skull and tympanic bullae without superimposed structures creating confusion (Hoskinson, 1993; Seitz, 1996) and can accurately enable the diagnosis of otitis media in dogs and cats in the early stages of the condition (Hoskinson, 1993; Love, 1995; Seitz, 1996; Forrest 1999). CT can detect subtle increases in soft tissue densities (fluid or mass) in the tympanic bulla and is therefore superior to conventional radiography for detecting middle ear disease (Love et al., 1995) (Figure 12). One must be aware that on CT images there is an apparent increase in thickness of the tympanic bulla wall when it is filled with fluid. A window of +2000 and a small slice thickness must be used to reduce this volume average artefact (Barthez et al., 1996). CT is also valuable in evaluating the external ear canals, the inner ear, the nasopharyngeal area and the extent of osseous bulla involvement in inflammatory polyps in cats (Seitz, 1996).

Figure 11: Pre-contrast (a) and post-contrast (b) transverse CT image of the head of a dog. The pre-contrast image (bone window) displays lysis of the right mandibula (white arrow). On the corresponding post-contrast image (soft tissue window) peripheral enhancement of the soft tissue of the mass is clearly visible.

Figure 12: CT image at the mid-tympanic bulla. The tympanic bulla (white arrow) and ear canal are filled with soft tissue density. There is no osseous thickening of the wall of this tympanic bulla. The tympanic bulla at the other side is normal and filled with air.
Good knowledge of the normal anatomy of the middle and inner ear is mandatory for optimal interpretation of clinical CT images (Russo et al., 2002).

**SPINE**

For a CT examination of the spine, the patient is positioned in sternal recumbency. Gantry tilt is used so that the scan plane through the primary site of interest is nearly perpendicular to the long axis of the spinal canal. In cats and small dogs, sagittal CT images for visualising the entire thoracic and lumbar spine can be acquired after positioning the animal in ventral recumbency across the table with the long axis of the spine transverse to the direction of table movement (Kneissl and Schedbauer, 1997). The interpretation of spinal and vertebral CT images is performed in both a bone and soft tissue window (Stickle and Hathcock, 1993).

CT examination of the spinal cord should be performed post-myelography (Drost et al., 1996). CT is useful in the investigation of spinal lesions in the event of doubtful radiographic and/or myelographic findings (Stickle and Hathcock, 1993; Drost et al., 1996). With CT, the localisation and extent of spinal lesions can be accurately evaluated, which is of help in surgical planning. The spinal cord, the intervertebral discs and the vertebrae can be visualised. Spinal cord and nerve root compression can also be demonstrated (Dennis, 1996).

Spinal cord compression can be more accurately assessed with CT than with standard radiographs (Stickle and Hathcock, 1993). In spinal arachnoid cysts, CT provides additional information to myelography by improving visualisation of the caudal limits of the cyst and eventual topographic position. The degree of spinal cord compression can accurately be measured using CT (Galloway et al., 1999).

CT myelography is an additional diagnostic procedure in dogs with cervical spondylomyelopathy, this technique provides extra information on the exact location and degree of compression (Sharp et al., 1995). In dogs with cervical intervertebral disc protrusion, CT myelography performed pre- and postoperatively has proved also to be quite useful in planning the surgical technique and in establishing the prognosis (Hara et al., 1994).

Mineralised intervertebral disc material in the vertebral canal can also be detected using CT without myelography. However, herniated disc material with soft tissue attenuation may not be visible on non-contrast images. The accuracy of CT in diagnosing and localising herniated disc material compares favourably with myelography (Olby et al., 2000). The incidence and extent of acute haemorrhage in the vertebral canal can be also identified using CT. CT has proved to be superior when bony changes are involved. However, in one study, spinal cord lesions (intradural/extradural and intramedullary) were less correctly classified using CT than using myelography (Drost et al., 1996).

Gas between vertebrae and in the vertebral canal (the “vacuum phenomenon”), which is a sign of disc degeneration, can be identified with computed tomography (Hathcock, 1994). CT can also be of great value in the diagnosis and evaluation of lumbosacral lesions (Feeney et al., 1991c; Jones et al., 1994; Jones et al., 1995; Jones et al., 1996; Feeney et
For this examination, the dogs are positioned in dorsal recumbency with the hind limbs entering the gantry first. This position allows consistent neutralisation of lumbosacral lordosis (Jones et al., 1994; Jones et al., 1995). Bone remodelling, evidence of cauda equina compression, articular process joints, sacroiliac joints and the invertebral foramina can be evaluated without superimposition (Stickle and Hathcock, 1993; Jones et al., 1995). Structures visible on CT include disc margin bulging, nerve tissue displacement, degenerative articular process joint disease and idiopathic or developmental stenosis (Figure 13) (Jones et al., 1996; Ramirez and Thrall, 1998).

Epidural injection of contrast medium tends to cause uneven accumulations and hinders the interpretation of CT images (Stickle and Hathcock, 1993). When using intravenous contrast, however, the positive predictive value for compressing soft tissues involving the spinal canal was quite high (Jones et al., 1999). The individual L5-S3 nerve roots can be visualised and traced to the point of exit from their corresponding foramina because of the inherent contrast provided by abundant epidural fat (Jones et al., 1995; Jones et al., 1996). Where there is an increase in soft tissue density in the absence of epidural fat, cauda equina compression should be suspected, even if degenerative changes appear mild (Jones et al., 1996). CT findings in older dogs, especially stenosis and loss of epidural fat, indicate that some lumbosacral abnormalities are clinically insignificant (Jones, 2000).

CT can also be used to define the extent of a lumbosacral plexus nerve sheath tumour in a dog. A soft tissue mass can be identified ventral to the sacrum, following the course of the lumbosacral trunk and sciatic nerve (Figure 14) (Niles et al., 2001).
CT provides excellent visualisation of brachial plexus tumours, but it is difficult to determine the exact origin of the nerve sheath involved. The administration of contrast medium intravenously helps to identify vascular structures (Figure 15) (McCarthy et al., 1993).

Avulsion of the nerve roots of the brachial plexus, which can be demonstrated using CT after myelography, results in an improved prognostic assessment of brachial plexus paralysis (Forterre et al., 1998).

CT anatomic studies of the normal canine spine and lumbosacral region have been described (Jones 1995; Feeney et al., 1991c; Smallwood and George, 1993; Feeney et al. 1996).
Sternal recumbency is preferable for imaging the thoracic cavity, as it allows more normal positioning of the heart and other mediastinal structures. CT images obtained in ventral recumbency can help to avoid overlooking a mass in the pulmonary parenchyma (Ahlberg et al., 1985). Again, symmetrical positioning of the patient allows better visualisation and evaluation of the structures in the thorax. Breathing and cardiac pulsation are the main causes of motion artefacts. These artefacts can be suppressed using single CT slices, short scan time and artificial respiration with breathholds (Fike et al., 1980).

CT is the best imaging modality for the detection and description of masses, malformations and fluid collections in the thoracic cavity (Burk, 1991; Samii et al., 1998). It can be used to determine the exact size and shape of a mass, the presence of early mass mineralisation (indicating neoplastic transformation), and the occurrence of any changes in the surrounding structures (Stickle and Hathcock, 1993). Because of the high tissue-air contrast, lung structures are delineated with a very high degree of detail, especially when window width (WW) and window level (WL) are adjusted to lung tissue (-700 HU). Changes of the pleura and changes on the medial aspect of the ribs can also be evaluated (Burk, 1991). Soft tissue evaluation of the mediastinum, body wall and bone is performed using multiple window levels (Stickle and Hathcock, 1993). Thoracic masses can be differentiated from accumulations of mediastinal or pleural fluid (Feeney et al., 1991d; Samii et al., 1998) and can be characterised as areas of calcification, as cavitations or as solid masses (Fike et al., 1980). Through the use of intravenous contrast medium, the vasculature of the mediastinum can be distinguished from structures of similar appearance on pre-contrast CT (Figure 16) (Stickle and Hathcock, 1993; Marincheck and Young, 1980).

CT is considered the most sensitive method for detecting pulmonary metastases (Figure 17), but there are limitations in the detection capacity. Lesions smaller than 5 mm are often not demonstrated, and micro-metastases, the most common type, are usually overlooked (Waters et al., 1998).

**Figure 16: CT scan of the thorax after IV administration of contrast. In the cranial mediastinum a large heterogeneous enhanced mass is visible (arrow). Histological examination confirmed a thymoma.**
CT enables improved detection of small pulmonary nodules and hilar or mediastinal lymphadenopathy. Large bullae and cavitated neoplasms can be revealed, but small (less than 3 mm) peripheral bullae are difficult to detect (Burk, 1991).

CT is also used to define the extent and the definition of contours of masses, information which is useful for planning surgery (Burk, 1991; Smallwood and George, 1993).

Descriptions of normal canine and feline cross-sectional anatomy of the thorax, including correlative CT images, are available (Assheuer and Sager, 1997a; Feeney et al., 1991d; Fike et al., 1980; Samii et al., 1998; Smallwood and George, 1993; Zook et al., 1989).

ABDOMEN

CT of the abdomen gives excellent anatomic images of the organs and vessels. The relative lack of CT imaging in abdominal disease in animals may be due to the need for anaesthesia and artefacts due to respiratory motion. In addition, the availability of ultrasound may have decreased the demand for CT. Abdominal images usually are evaluated using a window level of 40 and a window width of 350 to 500 (Stickle and Hathcock, 1993). Usually CT scans are requested for the purpose of better defining the relationship of a known abdominal mass to adjacent vital structures or for evaluating known or suspected lesions involving the spine and pelvic canal.

CT examination is very useful for the early detection of renal carcinomas and for differentiating between cysts and solid tumours (Figure 18) (Moe and Lium, 1997).
A bolus injection of contrast medium increases the possibility of differentiating a solid vascular renal mass from an avascular cyst (Evill et al., 1988; Moe and Lium, 1997; Yamazoe et al., 1994).

The imaging of adrenal glands and the evaluation of the assessment of size, shape and topography of adrenal masses is another important indication for CT (Figure 18) (Bailey, 1986; Emms et al., 1986; Rosenstein, 2000; Voorhout, 1990; Voorhout et al., 1990). When used to evaluate canine hyperadrenocorticism, this technique provides good differentiation between unilateral adrenal masses and bilateral adrenal gland enlargement (Emms et al., 1986; Voorhout et al., 1988). Fine-needle aspiration of an adrenal mass using CT guidance can be performed in dogs (Rosenstein, 2000).

CT images at maximum expiration allow a detailed view of the normal pancreatic parenchyma, whereas normal pancreatic and bile ducts cannot be visualised. The main technical problem in CT imaging of the pancreas is its demarcation from adjacent organs, especially liver, spleen, and stomach (Probst and Kneissl, 2001). Contrast-enhanced CT offers a combination of topographic and functional assessment of the spleen and is an accurate method for diagnosing splenic torsion in a dog (Patsikas et al., 2001).

It has been reported that contrast-enhanced CT is useful for the diagnosis of portosystemic shunt (Kleiter et al., 1999).

Contrast enhancement is needed to differentiate mesenteric masses from normal bowel or vascular structures. The clear visualisation of gastric detail, both in the small and in the large intestine, indicates that CT could effectively be used to evaluate gastrointestinal pathology (Fike et al., 1980). However, the application of CT to gastrointestinal imaging is limited in the dog. CT has great localising value, but it cannot assess dynamic activity of the bowel (Feeney et al., 1991a).

Because of high contrast resolution and lack of superposition, CT is valuable for the evaluation of the ureters and the ureterovesicular junction; with IV administration of contrast medium, it also makes it possible to diagnose the presence of an ectopic ureter (Figure 19) (Barthez et al., 1998).
Descriptions of the normal canine and feline cross-sectional anatomy of the abdomen and pelvis are available, with correlative CT images (Assheuer and Sager, 1997b; Feeney et al., 1991a; Fike et al., 1980; Samii et al., 1998; Smallwood and George, 1992; Smallwood and George, 1993).

MUSCULOSKELETAL SYSTEM

CT is widely used to evaluate the musculoskeletal system in human medicine (Dalinka, 1989; Erickson, 1997; Pettersson, 1998; Feldman, 2000). It is often used for the examination of acute and chronic injuries involving the articular surfaces (Newberg, 1990; Pretorius and Fishman, 1995). Nowadays, the technique is increasingly being used by veterinarians for the diagnosis of orthopaedic disorders in small animals (Hoskinson and Tucker, 2001; van Bree et al., 2002). Despite the growing availability, reports on its use in small animal orthopaedics are still infrequent (Fitch et al., 1997). Skeletal CT may be helpful in clinical cases in which standard radiography is negative or inconclusive and when there is a high suspicion of pathology (Hoskinson and Tucker, 2001). Radiographic identification of the cause of lameness localised in the joints of small animals may be difficult, especially considering the complex radiographic anatomy of some joints and the superimposition of the bony structures. CT enables more detailed and specific morphological diagnosis than radiography (Kippenes and Johnston, 1998) and facilitates the examination of complex joint structures such as the elbow and tarsus by eliminating superimposed structures (Reichle and Snaps, 1999). Osteolysis, sclerosis and new bone formation can be detected in the very early stages due to the extreme sensitivity of CT for bone and calcified tissue. CT enables the detection of density differences as low as 0.5%, as opposed to the lower limits of approximately 30% that are possible with conventional radiography (Hoskinson and Tucker 2001). Therefore CT is most accurate in evaluating the extent of an osteosarcoma in dogs prior to limb-sparing osteotomy (Davis et al., 2002).

CT has been proved to be superior to radiography in the diagnosis of fragmented coronoid process of the elbow joint (Figure 20) (Carpenter, 1993; van Bree and Van Ryssen, 1994; Reichle et al., 2000). Its use in the diagnosis of elbow incongruity has also been reported (Figure 21) (Gielen et al., 2001).
CT is superior in the diagnosis of incomplete ossification of the humeral condyle (Figure 22) (Marcellin-Little et al., 1994; Brunnberg, 2001; Meyer-Lindenberg et al., 2002).

In the treatment of hip dysplasia, CT can be used to check the status of the dorsal acetabular rim which is an important criterion when triple pelvic osteotomy (TPO) is being considered (van Bree et al., 2002).

In addition to purely diagnostic imaging, CT is a valuable tool in orthopaedic research. For example, CT offers the ability to non-invasively quantify volume, density and angles of long bones (Markel et al., 1990; Fitch et al., 1996; Johnson et al., 2001; Dueland et al., 2001).

Conventional arthrography techniques with negative or positive contrast agents can be used in combination with CT scanning. High-resolution thin-slice arthrogram images
produced by CT may demonstrate lesions undetected on standard contrast radiography
(Davies and Cassar-Pullicino, 1989; Hoskinson and Tucker, 2001). The ability to view images in several image planes may help to better delineate fracture orientation and to plan the repair process. It may also reveal articular involvement unrecognised with standard radiographs.