

5. Discussion

1. Comparison of the diagnostic method between Radiography and Computer Tomography

Elbow dysplasia is a common cause of lameness in young large-breed dogs. The development of FMCP generally is at the lateral aspect of the medial coronoid process of the ulna in the region of the radio-ulnar articulation. Because the elbow joint is a complex and compound joint with multiple articulations, it is difficult to diagnose this disease by radiography. Early diagnosis is critical to provide optimal treatment before the development of degenerative joint disease. Although many projections of radiographic pictures were used for the diagnosis of Canine Elbow Dysplasia the accuracy and specificity did not differ greatly. The range of accuracy and specificity for radiography in all projections was 70-100%. In this study we used just two projections which are implemented regularly in the clinic, cost being the reason for choosing these two rather than three or four other possible projections. A combination of mediolateral and craniocaudal projection was chosen for several reasons. We used the craniocaudal projection because it is the best projection for the diagnosis of OCD and osteophytes which arise from the medial coronoid process of the ulna. The other projection is mediolateral, which is used for elbow dysplasia scoring accordance with the recommendations of the International Elbow Working Group. In one study they presented an evaluation of elbow joints in Bernese Mountain dogs that had a significantly higher risk for developing elbow dysplasia. The diagnosis was based on at least two radiographic projections (WIND and PACKARD, 1986, HAZEWINKLE et al., 1995). MIYABAYASHI et al. (1999) showed that the routine mediolateral projection is easier to take and it should be used as a survey. A 45° flexed mediolateral projection requires extra effort in positioning and the benefit of making this projection for diagnosing a fragmented

coronoid process is still questioned. Moreover, MORGAN (2000) stated that in the radiographic examination of an older clinically lame dog suspected of having elbow dysplasia, the diagnosis is made much easier than in young dogs, because the presence of advancing osteoarthritis and the sign of incongruity may not be clear. Both normal mediolateral and craniocaudal projections can clearly demonstrate the new bone formation associated with elbow dysplasia. In an examination of young dogs, the flexed 45° mediolateral projection can be valuable to confirm the presence of an ununited anconeal process. However, the mediolateral projection is the best picture for evaluating joint incongruity. In addition, the craniocaudal projection can allow recognition of joint incongruity and can differentiate between coronoid disease and OCD of the humeral condyle.

In our study, radiography had an accuracy of 86% and specificity of 88%. However, the sensitivity from radiography for the diagnosis of FMCP is only 57%. The most lesions that we had seen in radiographic pictures were periarticular new bone formations, specifically at the subtrochlear region of the ulna. Sixty-five percent (60/92) of all radiographic findings found lesions at this position. We could see fragments at the medial coronoid process just in 33% (20/59) of joints by radiograph technique because superimposition of the radial head over the medial coronoid process and the central radiographic beam rarely intersects the cleavage line in a parallel plane (ROBBINS, 1980; BERZON and QUICK, 1980; OLSSON, 1983). Previous reports have shown that the sensitivity from different projections for the diagnosis of FMCP is not much difference. WOSAR et al. (1999) reported that the sensitivity for identifying FMCP in the craniocaudal projection and flexed mediolateral projection is 33 and 44%. However, it is not much different in other projections; mediolateral, caudomedial-cranio-lateral oblique and cranio-lateral-caudomedial oblique are 50, 30 and 67%, respectively. The flexed mediolateral projection had the highest sensitivity (95%) for detecting osteophyte

on the dorsal aspect of the anconeal process. HAUDIQUET et al. (2002) studied the distomedial-proximolateral oblique projection in 53 dogs for the diagnosis of FMCP. His study showed, that no specificity and sensitivity difference existed between this projection and flexed mediolateral, and also found that the radiographic projections seem to be more helpful for the detection of abnormal MCP than fractured MCP. The first radiological evidence of fragmentation of the coronoid process is osteophytes on the proximal rim of its anconeal process (OLSSON, 1983). In our study, the location where we predominantly found osteophytes was at the subtrochlear region of the ulna (about 65%) and most of the dogs that exhibited this lesion were up to 12 months old. Besides osteophytes formation in characteristic sclerosis at subtrochlear region, we also found osteophytes at the proximal aspect of the medial coronoid process, proximal non-articular surface of the anconeal process, and at the dorso-proximal radial head in radiographic pictures about 45%, 21% and 20% respectively. In dogs older than sixty months osteophytes were seen mostly at subtrochlear regions of the ulna, and the proximal aspect of the medial coronoid process. Subtrochlear sclerosis has been described as a radiographic finding and is actually a combination of sclerosis of the underlying subchondral bone and periarticular osteophytes along the base of the trochlear notch of the ulna. Evaluation of this change is again subjective and its appearance is subject to the radiographic technique.

The description of lameness given by most owners was consistent with published reports of lameness caused by a fragmented coronoid process of the ulna. The dogs were stiff when rising from rest as well as following vigorous exercise. The lameness can be unilateral or bilateral (LANG et al., 1998). For our patients, almost all had lameness for between three weeks and one year, and as is also reported in the literature most of the dogs had lameness when rising from rest and pain when we examined their elbow joints. In dogs up to 12

months old, signs of pain were predominant on extension and flexion, whereas old age dogs mostly had joint thickening and sometimes had no signs of pain during physical examination. The average age of dogs in this study was 33 months, which reflects the function of small animal veterinary teaching hospital of Free University of Berlin as a referral center so that most dogs had previously been seen by other veterinarians and were referred when the lameness persisted. Correlation between lameness and osteophytes in radiographic pictures has been published by many researchers. READ et al. (1996) studied the relationship between physical signs of elbow dysplasia and radiographic score in growing Rottweiler and found that evidence of radiographic signs of elbow dysplasia at the age of six months old was a poor predictor of clinical disease. Radiographic changes at 12 months were a more accurate guide to elbow function. STUDDER et al. (1991) stated that 66 percent were found with radiographic signs of elbow osteochondritis dissecans without lameness; similar to GRONDALEN (1982) who found that 68 percent of non-lame Rottweiler had osteophytes in the elbow. For our study, signs of pain and visualization of osteophytes were the criteria used in the diagnosis of a fragmented coronoid process of the ulna.

TROSTEL et al. (2003) stated that for suspected osteochondritis dissecans, positive contrast arthrography may be used to determine the size of subchondral defects, the presence of a radiolucent flap, and unmineralized free joint bodies. Computer Tomography (CT) and Magnetic Resonance Imaging (MRI) are extremely helpful in the diagnosis of elbow dysplasia. CT has more accuracy, specificity and sensitivity than radiography for identifying the presence of FMCP. Our results showed this with values of 87%, 100% and 86%, respectively. Standard transverse CT images allow excellent visualization of the coronoid process without superimposition of adjacent bony structure (GEMMILL et al., 2006). Therefore, in our certified study 100% (59/59) of fracture medial coronoid process was found

by CT. In examination by computer tomography, we positioned dogs in dorsal recumbency with both elbows extended cranially, since the scanner operates with an x-ray tube rotating through 360°. Placing dogs in lateral, ventral or dorsal recumbency should have no effect on image gain. Further small variations in the degree of extension or rotation of the elbow do not influence joint space measurement as defined in this study (GEMMILL et al., 2005). To avoid any inter-observer variation, the scans were reviewed by a single observer and 0.1 mm thickness slices were obtained to assure high quality images.

The diagnosis of a fragmented coronoid process of the ulna is based on the finding of a separate opaque fragment or fragments adjacent to the medial coronoid process, best identified on transverse and sagittal images. An additional and similar CT finding of an incomplete fragment of the medial coronoid process is also known as a fissure or in situ fragment. Some investigators reported that fissures in the articular cartilage of the medial coronoid process were found at necropsy in 50% of the elbows of dogs with elbow dysplasia (KELLER et al., 1997); GRONDALEN (1981) reported that in a gross anatomic study of young rapidly growing dogs, this type of lesion was found in 26% of the elbow joints. Another reporter showed that abnormal shapes of MCP were significantly related to lameness localized to the affected cubital joint. Sclerosis most likely indicates stiffened subchondral bone, as seen with osteoarthritis. The stiffened, sclerotic bone may predispose the overlying cartilage to damage, similar to exercise-related sclerosis in the third carpal bone of the thoroughbred racehorse. Sclerosis of the notch was found in 94% of the elbows of the dogs with the lameness attributed to the elbow on CT examination, and was significantly associated with lameness in that joint (REICHEL et al., 2000).

The results of our study indicate that by the use of CT, not only bony structures can be evaluated, but also with the correct window settings, a detailed observation of muscular, tendinous and vascular structures is possible. By studying the axial computed tomographic images, the complexity of the radiographic images can be reduced, although some familiarization with this type of imaging is necessary. The use of CT offers the advantage of evaluating the medial coronoid process and the medial part of the humeral condyle (Trochlear humeri) in detail and without superimposition of bony structures (DE RYCKE et al., 2002). Computer tomography can make a distinction between displaced and non-displaced fragments of a medial coronoid process. The diagnosis of non-displaced mineralized fragments is based on an irregular outline and signifies degenerative joint disease. Fragmentation does not occur despite mechanical abnormalities of the joint (SNAPS et al., 1997). CT scan was able to detect fragments of MCP as small as 1x2 mm, when the fragments are smaller or non-calcified fragments, it is not possible to determine accuracy of CT. However, cartilaginous fragments can be missed by CT (ROVESTI et al., 2002). From CT pictures we found 38 in 41 joints which have in situ fragments. Displaced fragments were found in 24 joints by CT examination, but when compared with arthroscopy we found displaced fragments only in 18 joints. This result was considered highly reader-dependent. Periarticular new bone formation was found in more than 80% of joints, which had fragments. From studying the sagittal and dorsal reconstructions, the entire humero-radio-ulnar joint surface could be studied. We can see three bone structures (Humerus, Radius and Ulna) in three dimensions without superimposition by the other bony structure, so we can evaluate this complex joint clearly. In the evaluation of incongruity, the information gained by CT could be more objective than findings obtained by radiography. Major incongruity is easy to evaluate radiographically, but minor incongruity can be hard to recognize. For the detection of minor incongruity, comparative studies on clinically normal dogs are also

prerequisite. The main disadvantages of CT are the low number of CT in real clinical situation, experience and accuracy of the observer, the patients need for general anesthesia and the purchase and maintenance costs of the equipment.

The development of arthroscopy in veterinary surgery evolved in the early 1970s. The first report of arthroscopic surgery in a small animal was in 1978. After reports of successful use of the arthroscope to treat joint pathology in dogs of VAN BREE and VAN RYSSSEN in 1999, arthroscopy gained widespread popularity among small animal orthopedists (BEALE et al., 2003). The diagnosis of a fragmented coronoid process of the ulna in dogs younger than seven to eight months by radiographic picture is always difficult because most of them have no abnormality finding. These dogs should be reevaluated for progression of degenerative change in four to five weeks. Osteophytes formation can be minimal when the medial coronoid process is fissured (GRONDALEN, 1979). CT and arthroscopy allow visualization of the fragment and may show the abnormally shaped of the medial coronoid process (CALPADO et al., 2005). The arthroscopic treatment of a fragmented coronoid process is not difficult, but it is often complicated because the elbow joint has a narrow joint space, and can be limited by the size of instruments (VAN RYSSSEN and VAN BREE, 2003). Different types of lesions in the area of coronoid process can be seen by arthroscopy: chondromalacia, fissures of the articular cartilage, non-displaced and displaced fragments, and full-thickness cartilage loss. In the area of medial humeral condyle (Trochlear humeri): kissing lesion and osteochondritis dissecans (OCD) can be distinguished. From our study it has been shown that 59 of 92 (64%) joints which were examined by arthroscopy had fragments of the medial coronoid process and cartilage erosion appeared in almost all patients who had FMCP. CT and arthroscopic findings usually concur, in this study we proved that non-displaced and displaced fragmentation of a medial coronoid process can be seen easily in CT and

arthroscopy. No significant differences in statistics between the two methods were seen. In each diseased joint, inflammation of the synovial membrane and arthrosis can be evaluated by arthroscopy (VAN RYSSSEN and VAN BREE, 2003). More than 50% of affected joints had synovitis in our study. Forty percent of them just had moderate synovitis and twenty percent had severe synovitis. Most of them had an irregular surface of the radial head, eroded, or fibrillated. These signs were seen in chronic inflamed joints, as well as in the patients in our study. They had chronically lameness before they came to our hospital. In incongruent joints, the level of the radial head is deeper than the level of the medial coronoid process. In this study we can evaluate joint incongruence by arthroscopy: 13 in 92 joints (14%). In comparison with CT, this can detect joint incongruence in 8%. Therefore, we can assume that for diagnosing joint incongruence, arthroscopy can be more clearly evaluated than CT. The advantages of arthroscopic surgery include decreasing scarring, decreasing risk of infection, less post-operative pain, and possibly a more thorough visualization of the elbow joint than arthrotomy during some procedure. There were data indicating that elbow arthroscopy could be used successfully to remove osteophytes, to perform synovectomy in inflammatory osteoarthritis, to evaluate patients with chronic elbow pain and to treat patients with osteochondritis dissecans (KELLY et al., 2001). Cartilage lesion can be easily visualized by arthroscopy. In comparison with CT, arthroscopy allows a far more detailed picture of elbow joints. We can evaluate the lesion of cartilage, which can be missed by CT, and intraarticular pathology such as synovialitis or joint incongruence. Arthroscopy is not only the diagnostic method for elbow disorder but also the treatment. The greatest disadvantages of arthroscopy are the cost and care of the equipment and required training and experience of surgeons.

2.2 Evaluation of the joint space of Canine Elbow Dysplasia by using reconstructed computer tomography

Elbow incongruity was considered to result from the combined effects of several abnormalities. Two forms have been proposed in association with FMCP. Increasing humero-ulnar joint space developed when humeral condyle became displaced toward the cranial border of the proximal radius, and increasing humero-radial joint space developed after elevation of the medial coronoid process of the ulna and subsequent elevation of the humeral condyle. The elevated medial coronoid process of the ulna forced the humeral condyle against the anconeal process, which caused trauma to that process (TROSTEL et al., 2003).

Radiography is the standard imaging technique for the diagnosis of elbow joint incongruence. However, the elbow joint is a complex joint because it is composed of three bones and numerous articulations in multiple planes. By radiography, it is infeasible to have both the humero-radial and humero-ulnar joint in line with the radiographic beam for the same exposure (MASON et al., 2002). BLOND et al. (2005) stated that radiology is a sensitive and specific test to detect moderate to severe radio-ulnar incongruence (2 mm to greater than 4 mm), the same as MURPHY et al. (1998) and MASON et al. (2002), they conclude that radiology is less sensitive to evaluate subtle incongruence. Computer tomography may be a good method for evaluating radio-ulnar incongruence because we can visualize a three dimensional structure, and thin-slice projection may provide a more accurate image to evaluate the radio-ulnar joint (MASON et al., 2002). In our study, we scanned elbows in pairs and in maximum extension to cranial. Seventy-nine elbows have been diagnosed with elbow dysplasia and fifty seven elbows were normal. We measured joint space between humero-radial and humero-ulna in both groups and in multi points; therefore we could reduce errors

associated with the variance of the measuring method. Our results indicated increasing humero ulna and humero radial joint space in groups which had elbow dysplasia in sagittal plane. Coronal plane had no significant difference between two groups in both joint spaces. GEMMILL et al. (2005) studied forty-two FMCP cases and twenty-nine normal ones in Glasgow, he found the FMCP group had increasing humero radial joint space. However, our result has shown that the FMCP group had widening both humero-ulnar and humero-radial joint space. This result supported theories of WIND and PACKARD (1986), who stated elbow joint incongruity was considered to result in asynchronous growth of the radius and ulna. BIENZ (1985) found that fragmented medial coronoid process of ulna dogs had a shorter radius than the paired ulna. He also described dogs with FMCP had proportionately longer ulna than normal dogs. As a result of discordant length of paired radius and ulna elevated the medial coronoid process of the ulna, which caused that articular process to overload and defect. The result of this study implies that elbow joint space may vary between different areas of joint similar to DE RYCKE et al.'s (2002) study, and this variation could be a consequence from plane of reconstructed image. Data from our study show that measuring joint space in sagittal plane had different significance but in coronal plane we had no difference between two groups, although we used a standard transverse CT to be template and measuring in many levels to minimize errors.

Correlation from Spearman's rank order test signifies good agreement between multiple points which should be measured in sagittal plane. This suggested that the point of measuring in sagittal plane had minimal effect in detecting joint incongruence. Versus to coronal plane, we had low correlation between two formats. This implies that the good reconstructed images for measuring incongruence joint should be sagittal. The differentiation of both joint spaces between two groups in our study approximates 0.2 mm. Our results suggest that CT has a

sensitivity to detect subtle radio-ulnar incongruence (0.2-0.8 mm). However, until now we have had no standard protocol to detect joint incongruence by CT. We try to minimize any errors as much as possible. The development of accurate CT protocols for evaluating radio-ulnar incongruence will allow to improve therapy methods for dog that have true incongruence.

The end result of any disease of joint is arthritis. Arthritis in the elbow joint can lead to intermittent or chronic pain because dogs carry more their weight on their forelimbs. Although many researchers have investigated new methods for treatment of elbow dysplasia, a cure treatment is still questioned. The results of our studies may permit early detection or develop screening techniques for elbow dysplasia to aid in the elimination of disease or enable rapid management that may reduce the severity of the disease in clinical situation.