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Review Articles

RADIOGRAPHIC, COMPUTED TOMOGRAPHIC AND ARTHROSCOPIC DIAGNOSIS OF THE MEDIAL CORONOID DISEASE

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SUMMARY

Medial coronoid disease (MCD), previously known as ununited or fragmented medial coronoid process (MCP) appears to be the most common component of elbow dysplasia in large breed dogs. Due to the late manifestation of the disease, the pathological findings obtained from clinical patients are usually complicated by degenerative and regenerative changes, with uncertainty whether the findings are causes by or consequences of MCD. And due to the complex articulation of the canine elbow joints, the ideal diagnostic approach for consistently and accurately determining the presence of MCD has yet to be established. Radiography has been used as the first line diagnostic modality to diagnose MCD, but most of the time, secondary changes, such as osteophytosis, ulnar subtrochlear sclerosis, and blunting or blurring of the cranial edge of the MCP, have been used to determine the likelihood of MCD. The use of computed tomography alleviates the problems of superimposition, which improves the examination of the lateral aspect of the MCP. However, both techniques are not allowed the assessment of the articular cartilage and its integrity. On the other hands, arthroscopy serve as both diagnostic and treatment tools and this technique has become more common in veterinary practice. This technique allows more specific, reliable evaluation of MCD lesions within the elbow joint.

Keywords: Medial coronoid disease; Radiography; Computed tomography; Arthroscopy

INTRODUCTION

Medial coronoid disease (MCD) (Figure 1) is known as one of the most frequently diagnosed heritable disorders of dogs and usually affects young, large breed dogs (Flückiger, 1992; Boulay, 1998; Janutta *et al.*, 2006; Burton *et al.*, 2008; Temwichitr *et al.*, 2010; Lavrijsen *et al.*, 2012). It has been described under a well-known umbrella disease i.e. elbow dysplasia (ED) together with entities such as ununited anconeal process (UAP), osteochondrosis (OC) or osteochondritis dissecans (OCD) of the humeral trochlea, and radioulnar joint incongruity (RUI).

This disease of the medial coronoid process (MCP) was first called *"ununited medial coronoid process"* of the canine elbow joint and was described as the presence of an ossified bone loosely attached to the medial coronoid process of the ulna (Tirgari, 1974). In later years, it became known as *"fragmented medial coronoid process"* (FMCP; Henry, 1984). The term "medial coronoid disease" was introduced in 2008 as being a more representative term for FMCP, as it encompasses lesions of both articular cartilage and subchondral bone (Moores *et al.*, 2008; Fitzpatrick *et al.*, 2009). The prevalence of MCD was found to be 11-50% in Labrador retrievers presenting with forelimb lameness (Ubbink *et al.*, 1998; Meyer-Lindenberg *et al.*, 2002; Fitzpatrick *et al.*, 2009), and 6% in a recent screened cohort of 2693 Dutch Labrador retrievers (Lavrijsen *et al.*, 2012). The first clinical signs of MCD usually occur between 4 and 8 months of age, although lameness has been reported as early as 3 months (Olsson, 1983; Voorhout and Hazewinkel, 1987; Fitzpatrick *et al.*, 2009); but there are also cases described where clinical signs become apparent much later in life (Henry, 1984; van Bruggen *et al.*, 2010).

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The dogs that are brought to veterinary clinics have usually developed an advanced stage of the disease because the early, mild signs of lameness are easily overlooked by the owner or confused with "growing pains".

Despite numerous studies and high prevalence of this disease among the large breed dogs, importance of noticing this disease is still lacking in Malaysia. The ability to recognize the lesions early is essential in order to start treatment before severe osteoarthritis develops, so as to optimize treatment outcomes. The following modalities have been used frequently in diagnosing MCD.

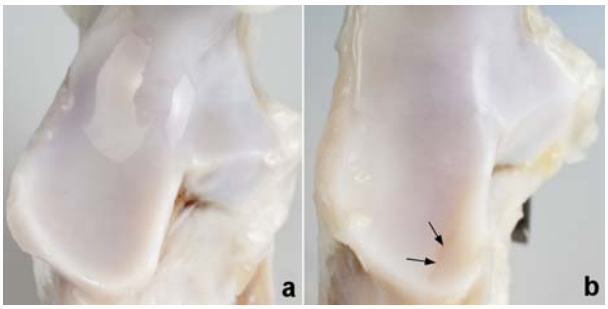

Figure 1. Left MCPs from (a) a healthy dog and (b) a dog with MCD; complete fissure across from the apex to the base of MCP (arrows)

Radiography

Radiography is usually used to diagnose MCD with a sensitivity of 10–62% (Carpenter *et al.*, 1993; Wosar *et al.*, 1999). Radiography typically detects advanced disease, with diagnostic criteria often being based on secondary changes caused by degenerative joint changes (Figure 2), such as osteophytosis at the proximal anconeal process and cranioproximal radial head, and the medial

part of humeral condyle, and ulnar subtrochlear sclerosis (STS), and blunting or blurring of the cranial edge of the MCP (Keller *et al.*, 1997; Hornof *et al.*, 2000; Mason *et al.*, 2002). In some cases, the primary lesion (i.e., fragmentation of MCP) can be seen concomitantly with other components of ED, such as indentation of the medial part of humeral condyle in the case of OCD-like lesions, UAP, and the presence of RUI (Hornof *et al.*, 2000; Meyer-Lindenberg *et al.*, 2002; Lavrijsen *et al.* 2012). It is often difficult to make a definitive radiographic diagnosis because of the superimposition of the radial head over the MCP and the tight fit between the ulnar trochlear notch and the humeral condyle.

Differences in positioning the limb during radiographic examination also has been studied and reported in order to optimise the visualisation of the lesion of MCD (Voorhout and Hazewinkel, 1987; Miyabayashi *et al.*, 1995; Wosar *et al.*, 1999; Hornof *et al.*, 2000; Haudiquet *et al.*, 2002). Multiple views, including mediolateral (ML) view with the elbow joint maximally extended and antebrachium supinated at 15° (Voorhout and Hazewinkel, 1987), and mediocaudal-laterocranial oblique radiographs (Miyabayashi *et al.*, 1995) has been described. International Elbow Working Group (IEWG) required minimum one view and recommended few more extra views in order to minimise the effect of the superimposition (Tellhelm, 2012; Flückiger, 2012). Differences between screening protocols are largely dependent on the presence of technicians during radiography and financial ability. Four views, namely, ML, craniocaudal, craniolateral-caudomedial oblique, and extended supinated ML views would be recommended in order to optimise the interpretation. The craniolateral-caudomedial oblique view is an excellent projection for detecting contact lesions at the humeral trochlea (Chanoit *et al.*, 2010), and the extended supinated ML view is considered the best projection for showing the outline of the cranial edge of the MCP (Miyabayashi *et al.*, 1995).

In previous longitudinal study (Lau *et al.*, 2013a) involved growing Labrador retrievers, a breed with a high prevalence of MCD (Ubbink *et al.*, 2000; Lavrijsen *et al.*, 2012), we studied growing dogs in an attempt to identify

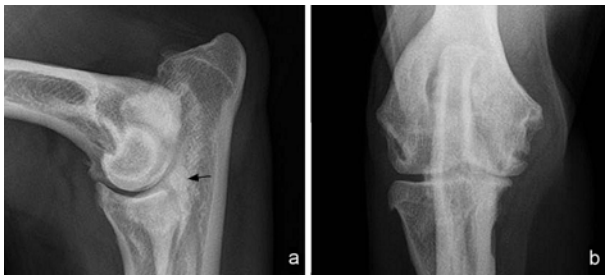

Figure 2. (a) Mediolateral and (b) craniocaudal projections of an elbow obtained from a 2-year-old Labrador Retriever diagnosed with MCD demonstrating a spectrum of findings. Degenerative joint changes such as obvious ulnar subtrochlear sclerosis (arrow), abnormal cranial edge of MCP and periarticular osteophytosis were identified on radiographic images

lesions at an early age, knowledge that in turn might help optimise treatment outcomes. The MCP was abnormal in 50% of the dogs (five of nine males, two of five females) based on the necropsy examination and micro-computed tomographic findings. Despite the relatively high prevalence of MCD, none of the dogs showed abnormalities in daily activities or on physical examination. Radiographically, none of the elbow joints showed signs of MCD: there was no evidence of osteophytosis, ulnar STS, blurring of the cranial edge of the MCP, or primary lesions indicative of MCD. In contrary to the incipient MCD, radiography has approximately 93.8% of sensitivity in detecting advanced MCD (Lau *et al.*, 2013d) based on the IEWG guidelines (Table 1; Tellhelm, 2011).

Ulnar STS appears to be the most common findings (87.6%) in Labrador retrievers <12 months. Blunting or blurring of the cranial edge of the MCP was detected in 75.0% of the elbow joints and periarticular osteophytosis

Table 1: Elbow dysplasia (ED) evaluation according to the guidelines used in the International Elbow Working Group (IEWG) Elbow Screening Scheme (Tellhelm, 2011)

Elbow dysplasia scoring		Radiographic findings
0	Normal elbow joint	● Normal elbow joint ● No evidence of incongruence, sclerosis, or osteophytosis
1	Mild arthrosis	● Presence of osteophytes < 2 mm high ● Minor sclerosis of the base of the coronoid process
2	Moderate arthrosis or suspect primary lesion	● Presence of osteophytes of 2 - 5 mm high ● Obvious sclerosis of the base of the coronoid process ● Step of 3-5 mm between radius and ulna (RUI) ● Indirect signs for a primary lesion (UAP, FCP/ Coronoid disease, OCD)
3	Severe arthrosis or evident primary lesion	● Presence of osteophytes of > 5 mm high ● Step of > 5 mm between radius and ulna (obvious RUI) ● Obvious presence of a primary lesion (UAP, FCP, OCD)

Legends: RUI, radioulnar joint incongruity; UAP, ununited anconeal process; FCP, fragmented coronoid process; OCD, osteochondritis dissecans

was detected in 56.3% of the elbow joints, with the most common site being the medial edge of the MCP. All these animals were presented to the veterinary clinic with a complaint of forelimb lameness. Crepitus and pain reactions were elicited during joint manipulation. Generally, radiography is not an optimal tool to diagnose incipient MCD, in which the secondary changes are absent. Fissures and fragmentation of the MCP can occur without significant lameness and abnormal findings during physical examination. Hence, it is difficult to diagnose incipient MCD based solely on radiograph. Radiographic findings associated with MCD should be carefully investigated on multiple projections. However, the recognition of incipient MCD is possible with computed tomography.

Computed tomography

Computed tomography (CT) is a better diagnostic technique as images are not superimposed and can be evaluated in different reconstructed views (Reichle *et al.*, 2000; Holsworth *et al.*, 2005; Kramer *et al.*, 2006; Samoy *et al.*, 2006; Wagner *et al.*, 2007). CT is superior to plain film radiography, xeroradiography, linear tomography, and arthrography in detecting MCD, having the highest accuracy (86.7%), sensitivity (88.2%), and negative predictive value (84.6%; Carpenter *et al.*, 1993). Reichle *et al.* (2000) reported the most common CT finding to be abnormal shape of MCP (97%), sclerosis of the MCP (95%), followed by irregularity of the radial incisures (83%), osteophytosis (74%), fragmentation of the MCP (28%), fissures of the MCP (27%), and humeral trochlear subchondral lucency (16%).

In previous longitudinal study (Lau *et al.*, 2013a), we demonstrated that the earliest age MCD could be detected by CT was at 14 weeks of age, with a mineralised bone fragment detected at the base of the MCP subchondral bone, which did not extend to the apex of the MCP. This finding was further confirmed by microCT and histological findings (Lau *et al.*, 2013b; 2013c). Similar findings were described as radial incisure fragmentation in a microCT study in clinical patients (Fitzpatrick *et al.*, 2011). In this study, we also demonstrated that CT had sensitivity of 30.8% and negative predictive value of 62.5% in detecting the incipient MCD. In the advanced MCD in dogs <12 months (Lau *et al.*, 2013d), the most common CT finding was 'obvious' fragmentation of MCP, which was found in 93.8% of the elbow joints. Osteophytosis was detected in 75.0% of the elbow joints. In 56.2% of the elbow joints, sclerosis of the MCP was detected. Cyst-like lesions were found on the radial incisure of the ulna and humeral trochlea in 56.2% of the elbow joints, an OCD-like lesion was detected on the humeral trochlear in 50.0% of the elbow joints, and RUI was detected in 18.8% of the elbow joints. Change in MCP contour and structure was detected in 6.2% of the elbow joint. CT images showed 'obvious' fragmentation of MCP in a dog that had negative radiographic findings. Radiographic signs relying on secondary lesions should not be used as the sole criterion for diagnosing early-stage MCD, because this might lead to false negative results, especially in young dogs.

Despite CT has higher sensitivity than radiography in detecting MCD, there are certain limitations that need to be taken into consideration during interpretation. Like radiography, CT is unable to assess cartilage integrity, and because animals are not in weight-bearing positions during both radiography and CT investigations (De Rycke *et al.*, 2002; Mason *et al.*, 2002), physiological incongruities due to ground reaction forces and muscular activity might be missed (Preston *et al.*, 2000; House *et al.*, 2009).

Arthroscopy

Arthroscopy serves as both diagnostic and treatment tools in MCD (Van Ryssen and van Bree, 1997; Hazewinkel *et al.*, 1998; Meyer-Lindenberg *et al.*, 2003; Wagner *et al.*, 2007; Fitzpatrick *et al.*, 2009; Punke *et al.*, 2009; Vermote *et al.*, 2009). This technique contributes to the early diagnosis of the MCD and allows removal of loose bodies in the elbow joint and the lesions in which the overlying cartilage is frayed can be treated by curettage. Arthroscopy is preferred than exploratory arthrotomy because of its shorter convalescence period and minimally invasive nature (van Bree and Van Ryssen, 1995; Meyer-Lindenberg *et al.*, 2003). Arthroscopy has a sensitivity of 94% and a specificity of 81.9% for diagnosing elbow pathology (Wagner *et al.*, 2007). It has a higher diagnostic value than radiography or CT because of its high specificity, reproducibility, and the ability to visualize cartilage lesions. Pathological changes of the cartilage at the ulnar joint surface of the MCP and humeral trochlea are normally graded using a 5-point ordinal scale based on Modified Outerbridge Scores (Table 2; Schulz, 2003; Goldhammer *et al.*, 2010).

Table 2. Modified Outerbridge Scoring (MOS) System (Schulz, 2003; Goldhammer *et al.*, 2010) used to evaluate articular cartilage of the medial coronoid process and humeral trochlea during arthroscopy

MOS	Description of cartilage
0	Normal cartilage appearance
1	Chondromalacia (softening and swelling of the cartilage)
2	Partial thickness fibrillation and fissuring of the cartilage
3	Full thickness cartilage fissuring
4	Full thickness cartilage erosion with exposure of the subchondral bone

Osteomalacia and chondromalacia were defined as softening of the subchondral bone and cartilage, which is easily removed by probing and curettage. Synovitis was normally assessed subjectively according to the appearance of the synovium, with erythematous discoloration of the synovial membrane and in more severe cases, a large number of villous protrusions.

In the previous study involved the advanced MCD in dogs <12 months (Lau *et al.*, 2013d), a displaced fragment was found in 68.8% of the elbow joints, fragment in situ in 18.8% of the elbow joints, and osteochondromalacia in

12.5% elbow joints. The median Modified Outerbridge score of the MCP was 2, and it was 4 for the humeral trochlea. Only 12.5% of the elbow joints were diagnosed as having RUI during arthroscopy.

Recognition of MCD lesions during the surgical procedures is limited by several technical problems. For instance, the limited window of view might not allowed sufficient inspection of the medial compartment of the joint, and vision might be obscured by severe protrusion of synovial villi and hemorrhages. These limitations, together with joint manipulation during the surgical procedure, complicate the assessment of joint congruency (Van Ryssen and van Bree, 1997; Meyer-Lindenberg *et al.*, 2003). The use of arthroscopy is limited by the need for expensive equipment and specialised training of personnel (van Bree and Van Ryssen, 1995). Arthroscopy are more invasive than radiography and CT, and post-operative potential complications such as joint infections, wound dehiscence, and damage to the cartilage need to be taken into consideration.

CONCLUSION

Currently in Malaysia, there is still room to improve in musculoskeletal diagnostic imaging due to lack of sophisticated diagnostic tools and expertise. In the future, how does this move forward? Correlative approach of radiographic and other imaging modalities with physical examination is essential to provide optimal outcomes and the best possible patient care.

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