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RADIOGRAPHIC AND COMPUTED TOMOGRAPHY FINDINGS IN DOGS WITH FRAGMENTED MEDIAL CORONOID PROCESS

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Abstract:

Fragmented medial coronoid process is part of the triad of developmental lesions causing elbow dysplasia, amongst ununited anconeal process and osteochondrosis of the distomedial aspect of the humeral trochlea, being the most common clinical entity that generates elbow pain and osteoarthrosis in dogs. In this study we compared computed tomography (CT) and radiological findings in 25 dogs presented with forelimb non-traumatic lameness, that were screened for elbow dysplasia and had a CT diagnosis of fragmented medial coronoid process. The radiographs were evaluated according to International Elbow Working Group guidelines and compared with CT images. A fragmented medial coronoid process was diagnosed in 6 dogs using radiographs and was visible in all dogs in the CT examinations. Because fragments are often poorly visualized on radiographic images, due to the fact that the medial coronoid process may remain cartilaginous, the fragment may not be completely detached or may superimpose on the radius, radiographic diagnosis is made mostly on secondary osteoarthritic changes. Thus, computed tomography examinations of the elbow joint have a much higher sensitivity in diagnosing this developmental lesion.

Key words: *computed tomography; dog; elbow dysplasia; fragmented medial coronoid process; radiography.*

INTRODUCTION

Elbow dysplasia is a developmental disorder, usually seen affecting young large breed dogs, with a complex genetic component involved, being a frequent cause of thoracic limb lameness (Hammond & McConnell, 2016).

Elbow dysplasia is a nonspecific term that encompasses a number of pathologic entities of the developing elbow, usually used for referring to a triad of developmental lesions that includes ununited anconeal process (UAP), fragmented medial coronoid process of the ulna (FMCP) and osteochondrosis or osteochondritis of the distomedial aspect of the humeral trochlea (OCD) (Pollard & Phillips, 2018).

Underlying causes for this disorder are not yet fully understood, but it is thought that genetics, nutrition, growth disturbances and trauma can all be part of the aetiologies of this condition (Wisner & Zwingenberger, 2015). One theory states that UAP, FMCP and OCD can be related to incongruity of the elbow joint (Wind, 1986).

Fragmentation of the medial coronoid process of the ulna is the most common disorder of the elbow joint in growing dogs, being also the most common clinical lesion that generates elbow pain and osteoarthrosis (Kirberger, 2016).

Fragmented medial coronoid process is a developmental disorder of the elbow joint, with clinical signs apparent as early as 4 to 6 months (La fond et al., 2002; Temwichitr et al., 2010).

In FMCP, some of the radiographic changes of the elbow joint can include flattening or rounding of the medial coronoid process, proliferation, distinct fragmentation or an ill defined margin in one or more projections (Hornof et al., 2000; Cook & Cook, 2009).

Due to the superimposition of the medial coronoid process on the radius, the fact that the fragment may still be cartilaginous, it may be fissured and not separated and there can be minimal or no fragment displacement the radiographic visualization of the fragmented medial coronoid process can be extremely difficult to detect (Pollard & Phillips, 2018).

Typically, a fragmented medial coronoid process is not seen as a separate fragment in radiographs. In fact, the absence of a normal appearing medial coronoid process on

mediolateral projections is a good indicator of affected MCP. In most instances actually, radiographic diagnosis of FMCP can be made indirectly, on the basis of secondary osteoarthritic changes, like sclerosis of the subchondral bone beneath the trochlear notch of the ulna and periarticular osteophyte formation of the distal humerus, proximal radius and proximal ulna (Berry, 1992; Hammond and McConnell, 2016).
The complexity of the elbow joint, the variation in radiographic appearance and the inability to directly assess articular pathology make radiography as a sole diagnostic modality incomplete, other modalities like computed tomography (CT), magnetic resonance (MRI), ultrasound and arthroscopy being necessary for a definitive diagnosis (Voorhout & Hazewinkel, 1987; Cook & Cook, 2009).
Studies regarding this condition that compare radiographic examinations with computed tomography show that CT has a sensitivity of 88.2%, compared with radiology, that has only one of 23.5% in identifying fragmented medial coronoid processes (Carpenter et al., 1993; Stickle & Hathcock, 1993; Braden et al., 1994; Reichle et al., 2000). There are multiple studies that state the value of CT for diagnostic imaging of the canine elbow (Reichle et al., 2000; De Rycke et al., 2002). This diagnostic imaging method allows for great delimitation and differentiation of the medial and lateral coronoid processes, the medial and lateral aspects of the humeral condyle and the radial incisure or head (Cook & Cook, 2009).
In CT, abnormalities of the medial coronoid process include abnormal shape, sclerosis, osteophytosis, fragments or fissures, hypo or hyperattentuation and associated radial irregularities or lucencies (Reichle & Snaps, 1999; Reichle et al., 2000).

MATERIALS AND METHODS

This study was made retrospectively, over the years 2015-2018. The medical records of twenty-five canine patients admitted to the Faculty of Veterinary Medicine in Perugia, Italy, diagnosed with fragmented medial coronoid process on CT examinations were reviewed. All dogs underwent, prior to the CT scan, clinical and radiological examinations. On physical examination, lameness was detected in one or both elbow joints. In some dogs, clinical findings were supported by radiographic ones. Radiographic examination of both elbows was performed and neutral mediolateral, flexed mediolateral, craniocaudal and oblique craniolateral- 15^0caudomedial views were obtained.
Afterwards, all dogs underwent general anesthesia and complete transverse CT examinations of both elbows. Patients were positioned in sternal recumbency, with the forelimbs parallel and pulled cranially. Acquisition of CT data was performed on a multislice helical CT scanner (Siemens^{TM}), using a small field of view and a filter for bone and soft tissue reconstruction.
All examinations were reviewed by two different examiners and a consensus opinion was made. Normal elbow images in transverse and sagittal planes are shown in Figure 1A, B.

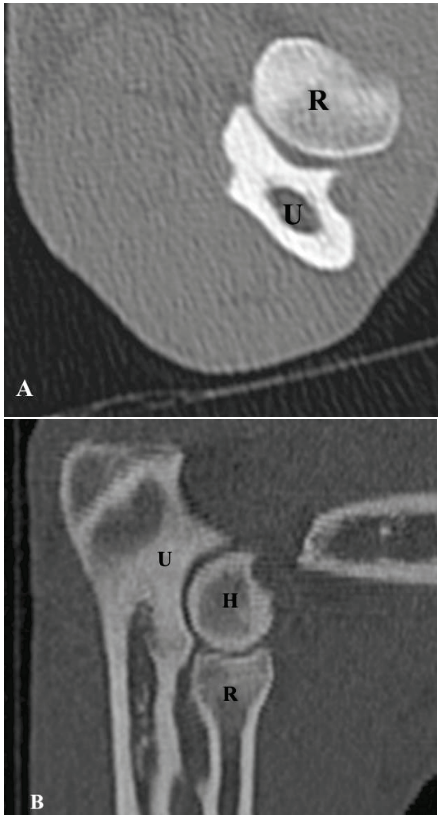

Figure 1. **(A)** Transverse CT image of a normal canine elbow at the level of the radius (R) and ulna (U). **(B)** Sagittal CT image of a normal canine elbow; R-radius, U-ulna, H-humerus.

RESULTS AND DISCUSSIONS

The breeds of the 25 dogs are represented in Table 1. Age at the time of the examination ranged between 6 months and 7 years, with a mean age of 2.24 years. There were examined 8 intact females, 5 neutered females, 10 intact males and 2 neutered males and a total of 50 elbows.

Table 1. Breed distribution and number of dogs that underwent radiologic and CT examinations due to lameness attributed to the elbow joint

Breed	**Number**
Labrador Retriever	6
German Shepherd	5
Golden Retriever	3
Bernese Mountain Dog	3
Border Collie	3
Irish Setter, Weimaraner, Bull Terrier, Dachshund, American Bulldog	1 each

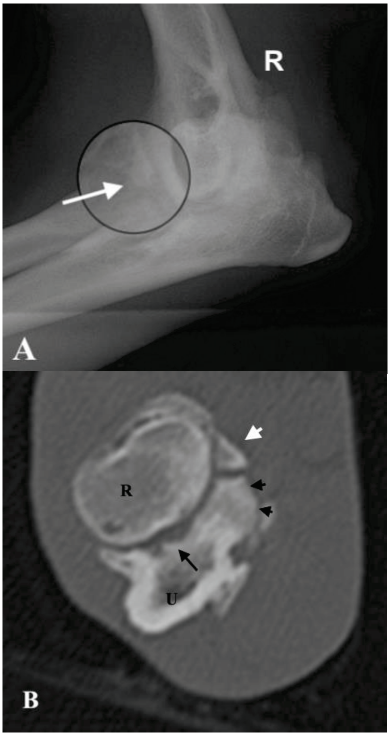

Figure 2. **(A)** Mediolateral right (R) elbow projection in which a fragment of the medial coronoid process can be seen (white arrow). **(B)** Transverse CT image of the same elbow through the radius (R) and the ulna (U); There is a distinctly separate fragmented MCP (arrowhead), abnormal shaped coronoid process (black arrowheads), sclerosis and radial incisure irregularity (black arrow)

Clinical orthopedic examination revealed lameness of one or both elbows for every dog. A number of 8 elbows (16%) presented slightly adducted and with a lateral rotation of the antebrachium. Twenty out of 50 elbows (40%) presented with pain on manipulation and palpation and in 9 elbows (18%) pain was elicited after maximal flexion of the elbow joint, combined with lateral rotation of the affected limb.

For all patients, the following changes were described as present or absent, in both CT and radiographic images: distinct fragment of medial coronoid process (Figure 2A and B), fissure or in situ fragmented MCP (Figure 3A, B and C), abnormally shaped MCP, sclerosis of the MCP and osteophyte of the MCP (Figure 4A and B). Radiographic fragments/fissures at the level of the MCP were identified only in 6 of the dogs examined (4 males and 2 females) (Figure 2A; Figure 3A).

For the remaining 19 dogs, the radiographic signs of fragmented or fissured MCP were not as visible and the diagnosis was suspicioned considering observable secondary osteoarthritic changes, like sclerosis of the MCP or medial humeral condyle, presence of ostephytes at the site of the ulna, radius or humerus, irregularity or abnormal shape (blunting/flattening) of the MCP, making necessary the CT examination.

On the CT images, the MCP was considered affected if there were fragments, fissures or sclerosis present or if it had an abnormal shape. All dogs in this study had a diagnosis of fragmented or fissured medial coronoid process.

Fragments of the medial coronoid process have been divided in two groups (large fragments, > 5 mm and small fragments, < 5 mm) (Figure 5A, B, C, D). Fragments are observed at the top of the MCP, while fissures or in situ fragments are parallel to the radial incisure. Sclerosis of the MCP was observed in 27 (54%) of the 50 elbows examined, while osteophytes of the ulna were present only in 12 (24%) of them. Other abnormalities observable in CT examinations are represented in Table 2 (abnormalities of the MCP, of the radial incisure of the ulna, the medial aspect of the humeral condyle and osteophytes of the ulna, radius and humerus).

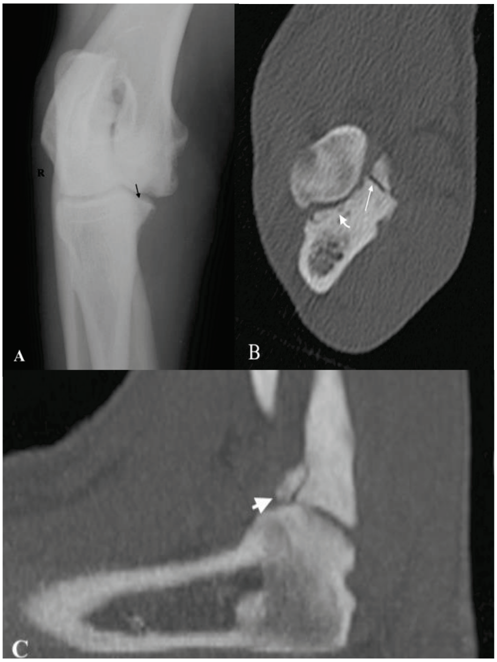

Figure 3. **(A)** Craniocaudal projection of the right elbow in a dog presenting with forelimb lameness; slightly visible MCP fissure line (black arrow). **(B)** Transverse CT image of the same elbow; visible fissure of the MCP (white arrow) and irregular radial incisure (curved arrow). **(C)** Sagittal CT image of the same elbow as in **(A)** and **(B);** visible fissure line of the MCP

Table 2. Abnormal CT findings and percentage of the affected limbs in 50 examined elbows of dogs with unilateral or bilateral forelimb lameness

Abnormal CT finding	Percentage of affected limbs (%)
MCP of the ulna	
Abnormal shape	77
Sclerosis	54
Osteophyte	24
Distinct fragment	75
Fissure/in situ fragment	25
Radial incisure of the ulna	
Irregularity	40
Medial aspect of the humeral condyle	
Sclerosis	55
Flattening	45
Osteophytes	
Ulna	24
Radius	22
Humerus	35

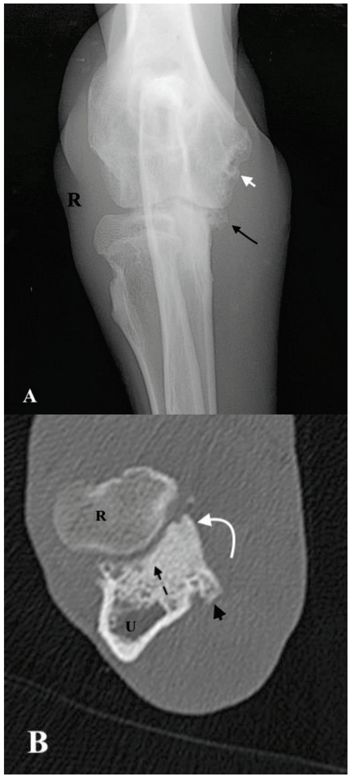

Figure 4. **(A)** Craniocaudal projection of the right elbow (R) in a dog presenting with mild forelimb lameness. Sclerosis and abnormal shape of the MCP (black arrow) and humeral condyle (white arrow) are present. **(B)** Transverse CT image at the level of the radius (R) and ulna (U) of the same elbow. Sclerosis (black arrowhead), abnormal shape (curved white arrow) of the MCP and irregular radial incisure (dotted black arrow) are present

In Table 3 are presented the main radiological changes associated with fragmented medial coronoid disease. Radiological diagnosis of the medial coronoid process is difficult, due to the fact that MCP can not be visualized without interference of bony structures (Cook & Cook, 2009). The presence of any of the signs from Table 3 is suggestive of elbow dysplasia, but identification of several changes increased the examiner's indirect diagnosis of FMCP.
Sclerosis of the subchondral bone of the MCP, seen as an area of increased opacity at the trochlear notch, was the main sign of a possible fragmentation of the coronoid process, being present in 30 (60%) of the elbows examined (Figure 6A, B, C).

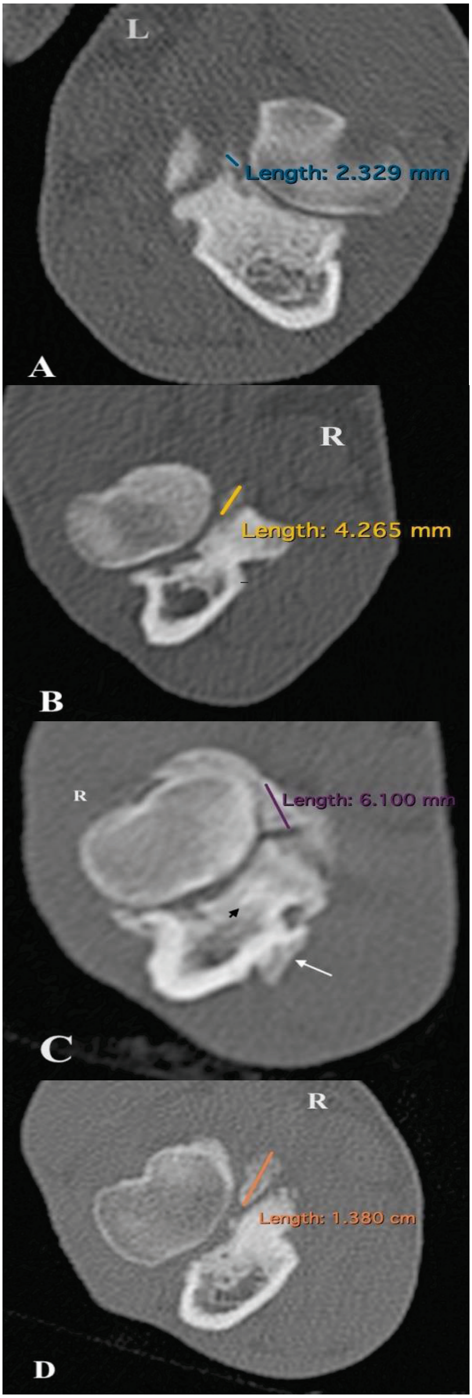

Figure 5. Transverse CT images of right (R) and left (L) elbows with different sizes of large and small fragments of medial coronoid processes. **(A)** Small FMCP fragment, of 0.23 cm; **(B)** Small FMCP fragment of 0.42 cm; **(C)** Large FMCP fragment of 0.61 cm; **(D)** Large FMCP fragment of 1.3 cm

Table 3. Abnormal radiological findings and percentage of the affected limbs in 50 examined elbows of dogs with unilateral or bilateral forelimb lameness

Main radiological sign	**Percentage of affected limbs (%)**
Sclerosis	60
Fragment of MCP	14
Articular incongruence	20
Blunted / convex shape of MCP	24
Periarticular osteophytes	30

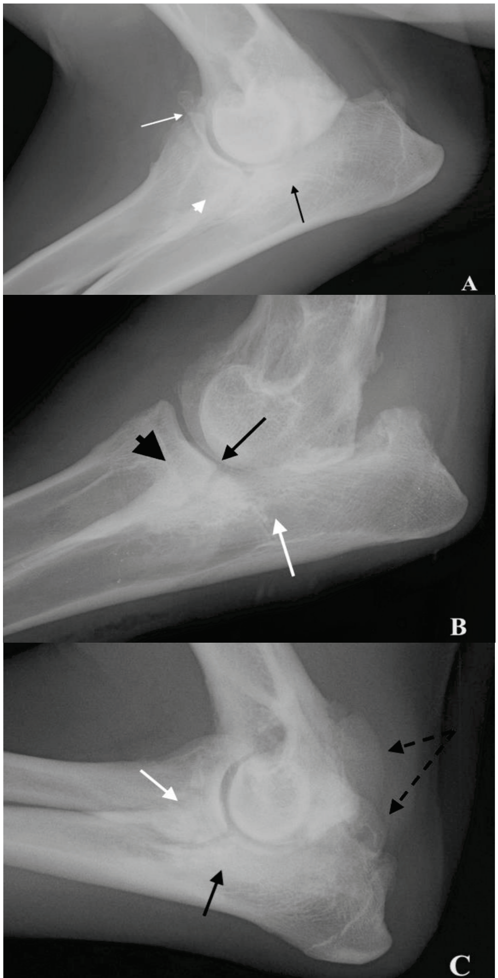

Figure 6. Changes associated with the medial coronoid process. **(A)** Subtrochlear sclerosis (black arrow), abnormally shaped MCP (white arrowhead) and periarticular osteophytes (white arrow; **(B)** Subtrochlear sclerosis (white arrow), abnormally shaped MCP (black arrowhead) and articular incongruence (black arrow); **(C)** Subtrochlear sclerosis (black arrow), abnormally shaped MCP (white arrow) and proliferation of the humeral condyle and anconeal process of the ulna (dotted black arrows)

CONCLUSIONS

The elbow joint is a complex articulation and diseases of the medial coronoid process of the ulna may be difficult to assess using only survey radiographs, until secondary changes are relatively marked.

A diagnosis of fragmented medial coronoid process was established after direct radiographic visualization of the fragment in 6 dogs and an equivalent of 14% of the elbows examined.

In fragmented medial coronoid disease, the most common radiographic sign of abnormality was sclerosis of the subchondral bone (in 60% of the examined elbows).

Computed tomography has the ability of evaluating the whole joint, highly differentiating and delimitating fragments or fissures of the medial coronoid process, making the establishing of a diagnosis possible before osteoarthritic changes become severe.

The most common CT findings in dogs with fragmented medial coronoid process were abnormal shape of the medial condyle, seen in 77% of the examined limbs and sclerosis of the subchondral bone, in 54% of them.

As a main conclusion, this retrospective paper shows confirms the fact that computed tomography offers visualization without superimposition, having a higher sensitivity for detecting fragmented medial coronoid process disease, compared with the radiological examination.

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