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Medial coronoid process disease in the course of elbow dysplasia in dogs

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Summary

Background: Medial coronoid process disease is one of the four primary causes of elbow dysplasia. Among common imaging techniques used to diagnose elbow dysplasia, X-ray examination and computed tomography are the most popular. The aim of the dissertation was to determine the incidence of medial coronoid process disease in dogs and to compare the diagnostic usefulness of computed tomography and X-ray examination in determining this primary cause of elbow dysplasia.

Material and methods: The research was conducted on 58 dogs, including 36 German Shepherds, 13 Labrador Retrievers, and 9 Golden Retrievers, of both sexes (28 males and 30 females), aged 3 to 15 months. All the dogs underwent X-ray examination and computed tomography.

Results: Based on X-ray examination, elbow dysplasia with a visible primary cause was diagnosed in 38 dogs, with medial coronoid process disease found in 20 cases. Medial coronoid process disease ulna was diagnosed in 12 German Shepherds, 3 Golden Retrievers and 5 Labrador Retrievers. Computed tomography of the elbow joints revealed dysplasia in 52 dogs, including medial coronoid process disease diagnosed in 44 cases. Medial coronoid process disease was diagnosed in 29 German Shepherds, 4 Golden Retrievers and 11 Labrador Retrievers. Comparing the results of X-ray examination with the results of computed tomography in dogs, a statistically significant difference was shown between the two diagnostic methods in diagnosing medial coronoid process disease ($p < 0.001$).

Conclusion: Based on this research, it was determined that medial coronoid process disease occurs much more frequently than osteochondritis dissecans of the medial condyle of the humerus or ununited anconeal process of the ulna, and is only slightly more frequent than incongruity. Fragmentation was the most commonly observed abnormality of the medial coronoid process. Moreover, computed tomography proved its diagnostic superiority over X-ray examination in detecting medial coronoid process disease in dogs.

Keywords: elbow dysplasia, medial coronoid process disease, dog, computed tomography, radiography

Elbow dysplasia (ED) is a consequence of primary diseases of the elbow joint, which may occur individually or in combination, causing the development of irreversible and progressive secondary degenerative joint disease (DJD) (10, 26, 31, 32, 36, 42, 45). Elbow dysplasia appears most frequently in young and quickly growing animals, aged 4-6 months, of medium, large and giant dog breeds, among which the most predisposed are German Shepherds, Golden Retrievers, Labrador Retrievers, Rottweilers, and Bernese Mountain Dogs (7, 15, 21, 22, 23, 26, 39, 44). This disease also occurs, although much less frequently, in small and miniature breeds (34). It has been found that, compared to females, males are twice as likely to develop elbow dysplasia, which is most probably related to their rapid growth rate and a gender-related factor (10, 26, 32).

Originally, the term „elbow dysplasia" referred to a generalized osteoarthritis of the elbow with or without a coexisting ununited anconeal process (UAP) (10,

24). At present, this term is used to describe a group of 4 diseases developing in the elbow. According to the International Elbow Working Group (IEWG), the primary causes of ED include medial coronoid process disease (MCPD), ununited anconeal process (UAP), osteochondritis dissecans (OCD), and incongruity of the articular surface or elbow incongruity (INC, IC, EI) (7, 9, 15, 35, 39).

At first, MCPD was called „ununited medial coronoid process" because it was primarily thought to develop from a separate ossification center. In subsequent years, the disease was known as „fragmented medial coronoid process" (FCP/FMCP), and since 2008, it has been known as „medial coronoid process disease." It results from the fact that the changes involve not only the fragmentation itself, but also damage to the articular cartilage and subchondral bone of the medial coronoid process (9, 10, 30, 33, 36, 44). Currently, the common name „medial coronoid process disease" comprises fragmented medial coronoid process (FCP) with partial or total fragmentation, presence of a fissure, primary subchondral bone lesions with secondary lesions of articular cartilage, and chondromalacia (softening of articular cartilage) (5, 15). It should be emphasized that the most frequently diagnosed lesion in medial coronoid process disease is a rupture of the medial coronoid process with complete fragmentation, which may occur even in the first few months of a dog's life. The separated fragments of the medial coronoid process may remain in place or be displaced within the joint cavity (10, 33, 37, 50, 41). According to some authors, apart from fragmentation, the frequently diagnosed abnormalities of the medial coronoid process include the presence of a fissure (visible in the CT image in the form of a hypoattenuating line) and chondromalacia (8).

Diagnostic methods used in detecting medial coronoid process disease. Given that radiography is widely available, cheap, and, in most cases, does not require general anesthesia of the animal, this method is first used in the diagnostic procedure in the case of medial coronoid process disease in dogs. (7, 9, 11, 16, 25). It should be noted that the radiographic visualization of MCPD with complete fragmentation of the medial coronoid process is difficult. This is due to the following reasons: separation of a small fragment of the process, its partial fragmentation, minimal displacement of the fragment(s) of the process, and the location of the separated fragment(s) between the head of the radial bone and the intact part of the medial coronoid process (19, 26, 46). Another method used in diagnosing MCPD is computed tomography (CT). The abnormalities found in the computed tomography image indicating a disease of the medial coronoid process comprise fragmentation (with or without displacement of free fragments), abnormal shape of the process, sclerotization, the presence of a fissure and osteophytes, and altered radiological density of the process. These changes are best seen in the multiplanar reconstruction in a cross-section (4, 17). Another diagnostic method that is used in the diagnosis and treatment of MCPD is arthroscopy. Based on the endoscopic examination of the elbow, an MCPD classification has been developed which distinguishes 7 lesions of the medial coronoid process: 1 – fragmentation of the medial edge of the process, 2 – erosion of the cartilage of the lateral edge of the process, 3 – isolated process, 4 – rupture (fissure) of the process, 5 – differentiation of levels between the head of the radial bone and the process, 6 – osteophytes on the process, and 7 – loose pieces of the process bone and cartilage in the joint (1, 2). As a tool used in the diagnosis of MCPD, ultrasonography can only supplement the radiographic examination in the case of suspected fragmentation of the medial coronoid process, but only when computed tomography or magnetic resonance imaging is not possible. However, it depends on the size and location of the separated fragment. Moreover, dynamic ultrasound imaging may be helpful in visualizing the movement of the separated fragment of the coronoid process and secondary changes, such as the presence of exudate and degeneration (28). Scintigraphy is characterized by high diagnostic sensitivity, primarily in the diagnosis of secondary osteoarthritis of the elbow and the location of changes in this joint. However, it has a very low diagnostic value in identifying individual, primary causes of elbow dysplasia (6, 38). Nevertheless, some authors believe that scintigraphy can be used in identifying dysplastic changes of the elbow that are still invisible on radiographs, and particularly in diagnosing early abnormalities of the medial coronoid process (5, 6).

The aim of the study was to determine the incidence of medial coronoid process disease in dogs and to compare the diagnostic usefulness of computed tomography and X-ray examination in diagnosing this primary cause of elbow dysplasia.

Material and methods

The research was conducted on 58 dogs, including 36 German Shepherds, 13 Labrador Retrievers, and 9 Golden Retrievers, of both sexes (28 males and 30 females), aged 3 to 15 months, which were referred to the Imaging Diagnostics Laboratory of the Department and Clinic at the Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences, in order to perform imaging diagnostics of the elbows. All 58 dogs underwent X-ray and CT scans.

The following anesthetic regimen was used in the animals qualified for X-ray and computed tomography of the elbows:

1. sedation: medetomidine (prep. Cepetor, 1 mg/ml, ScanVet Poland) at a dose of 10-20 μg/kg b.w. and butorphanol (prep. Butomidor, 10 mg/ml, ORION PHARMA) at a dose of 0.1 mg/kg b.w. administered in one intramuscular injection;
2. if sedation was insufficient for the safe conduct of the above-mentioned examinations, the dogs were given

general anesthesia in which the following medicaments were used: for premedication – medetomidine (prep. Cepetor, 1 mg/ml, ScanVet Poland) at a dose of 10-20 µg/kg b.w. and butorphanol (prep. Butomidor, 10 mg/ml, ORION PHARMA) at a dose of 0.1 mg/kg b.w. administered as one intramuscular injection, and for the main anesthesia – propofol (prep. Propofol-Lipuro, 10 mg/ml, Braun) intravenously at an initial dose of 2-4 mg/kg bw and then according to the effect.

Radiographic technique. In all the dogs, X-ray examination of the elbows was performed with the use of an indirect digital radiography system, using a Vertix IID X-ray machine with a Siemens Polydoros LX 30 lamp. The exposure parameters were selected depending on the thickness of the X-rayed tissue and were as follows: lamp voltage from 60 to 70 kV and the product of time and amperage from 6.8 to 7.1 mAs. Taking images did not require the use of an anti-scatter grid.

Fig. 1. Positioning the animal for X-ray examination of the elbow joint in a) mediolateral projection in the extended position, b) mediolateral projection in flexion, c) cranio-caudal projection, d) oblique projection in the anterolateral to posteromedial direction (15°)

Each elbow joint was screened separately. Radiological projections of the elbows were made in accordance with the guidelines of the International Elbow Working Group (2008) and comprise: a) mediolateral projection in an extended elbow position, b) mediolateral projection in flexion, c) craniocaudal projection, d) oblique projection from anterolateral to posteromedial direction (15°) (Fig. 1).

CT technique. Computed tomography of the elbows was performed using a 16-slice Siemens Somatom Emotion Computed Tomograph. The examination was performed with the dogs in the sternal recumbency in line with the long axis of the CT table. In addition, the animal was stabilized in a non-shadowing sponge positioner, and its head was tilted to the side and also stabilized with special belts of the CT table. In order to maximize the exposure of the elbows, the thoracic limbs were pulled out in the cranial direction and placed parallel to each other. Scanning was carried out along the long axis of the elbows, first in the cranial direction and then in the caudal direction. Both elbow joints were scanned simultaneously. The CT examination of the elbows was performed using the following exposure parameters: 60 mAs and 130 kV; the displacement coefficient was 0.75; the cross-section images were obtained using the bone filter: W 1400, C 300. The image of the elbows was obtained using the Siemens sybgoMMWP software. Additionally, the function of the multiplanar reconstruction image in the sagittal, dorsal and transverse sections and the three-dimensional image function were used.

Results and discussion

Elbow dysplasia is a disease that often reduces the motor activity of dogs. It is associated with pathological changes in the components that build the elbow. The consequence is the occurrence of the following clinical symptoms: one-sided or bilateral lameness (observed most frequently), soreness of the elbow, edema, reduced mobility and deformation of the elbow joint area, temperature increase in this area, muscle atrophy, and crepitation observed in elbow bending and straightening (14, 20, 25, 44).

Based on X-ray examination, elbow dysplasia with a visible primary cause was diagnosed in 38 dogs from the experimental group (25 German Shepherds, 9 Labrador Retrievers, and 4 Golden Retrievers), including the diagnosis of medial coronoid process disease in 20 cases, incongruity in 30 cases, osteochondrosis dissecans of the medial condyle of the humerus in 10 cases, and ununited anconeal process in 9 cases (Tab. 1). Among the animals examined, 17 dogs had ED in both elbows, and in 21 animals only one elbow was affected. Based on the presence of radiological signs of secondary degenerative disease, 15 dogs were diagnosed with elbow dysplasia without a visible primary cause. In 8 out of the 15 cases, dysplasia affected only one elbow joint, and in 7 cases it affected both. In 5 dogs, no radiological signs of elbow dysplasia were revealed.

Among animals with medial coronoid process disease, diagnosed by X-ray examination in 52.63% of cases, 8 dogs were diagnosed to have both elbows affected, and in 12 dogs the disease was one-sided. MCPD was diagnosed in 14 dogs on the basis of the irregular contour of the medial coronoid process and increased sclerotization in the area of the ulnar trochlear notch, and only in 6 dogs was it diagnosed on the basis of its fragmentation (Fig. 2).

Tab. 1. Incidence of primary lesions of elbow dysplasia in dogs based on X-ray and computed tomography

	Number of animals with elbow dysplasia			
	medial coronoid process diseases	incongruity	osteochondrosis dissecans of the medial condyle	ununited anconeal process
X-ray	20 (52%)	30 (78%)	10 (25%)	9 (23%)
CT	44 (84%)	41 (78%)	15 (28%)	9 (17%)

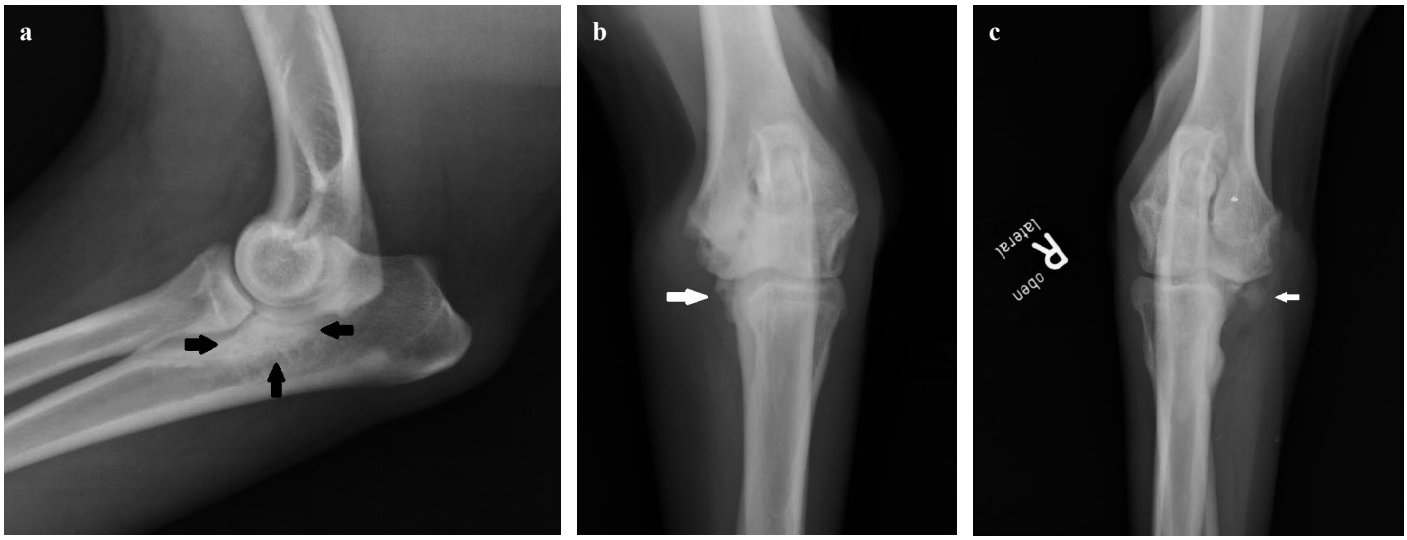

Fig. 2. Radiograph of the elbow: a) in the mediolateral projection in the extended position showing increased sclerotization in the area of the ulnar trochlear notch, b) in an oblique projection in the anterolateral to posteromedial (15°) direction showing an irregular outline of the medial coronoid process, c) in an oblique projection from the anterolateral to posteromedial (15°) direction showing the free fragment of the medial coronoid process

However, in 33 dogs, no medial coronoid process disease was found in the X-ray examination. In a study of 90 dogs, Villamonte-Chevalier et al. (48) found that the incidence of MCPD in X-ray examination of the elbows was 84% of cases. Fitzpatrick et al. (9) showed a similar incidence of the disease (83.07% of cases) in X-ray examination Such a difference in the disease incidence may have resulted from the fact that the two authors included dogs with MCPD in the group of animals in which no other concurrent primary cause of elbow dysplasia was found, which was related to the presence of secondary osteoarthritis. Medial coronoid process disease was diagnosed in 12 German Shepherds, 3 Golden Retrievers and 5 Labrador Retrievers (Tab. 2). In a study carried out on German Shepherds, Remy et al. (40) diagnosed MCPD in 50% of dogs. The incidence of MCPD in German Shepherds in studies conducted by the authors of this paper was consistent with that reported by Remy et al. (40) for this breed of dogs and amounted to 60% of cases. On the other hand, the results of our research for Labrador Retrievers, 25% of which were diagnosed with MCPD, were very different from the findings of Fitzpatrick et al. (9). In their studies, the incidence of MCPD in this breed was 50.2%, which most likely resulted from a large number of Labrador Retrievers in the group of dogs diagnosed with medial coronoid process disease. With regard to Golden Retrievers, we diagnosed MCPD in only 15% of these dogs.

Tab. 2. Incidence of medial coronoid process diseases in dogs based on X-ray examination

Number of animals with MCPD (n = 38)	20 (52.63%)
bilateral occurrence	8 (40%)
one-sided occurrence	12 (60%)
Number of German Shepherds (n = 25)	12 (60%)
Number of Labrador Retrievers (n = 9)	5 (25%)
Number of Golden Retrievers (n = 4)	3 (15%)

Based on the results of computed tomography of the elbow joints, 52 dogs from the experimental group (34 German Shepherds, 13 Labrador Retrievers, and 5 Golden Retrievers) were diagnosed with elbow dysplasia with a visible primary cause, including medial coronoid process disease in 44 cases, incongruity in 41 cases, osteochondrosis dissecans of the medial condyle of the humerus in 15 cases, and ununited anconeal process in 9 cases (Tab. 1). Among these animals, ED was found in both elbows in 28 cases, and in 24 cases, only one elbow was affected. However, in 6 dogs from that group, elbow dysplasia was diagnosed with no apparent primary cause: in both elbow joints in 5 dogs, and in one elbow joint in one dog.

Among animals with medial coronoid process disease, diagnosed in 84.61% of dogs based on CT scans: 18 dogs had bilateral disease and 26 dogs had one-sided disease, whereas in 14 dogs no MCPD was found in CT. In dogs diagnosed with MCPD, fragmented medial coronoid process was found in 28 cases (including 14 cases without displacement and 14 cases with displacement), and the presence of a fissure was found in 5 cases. In 11 cases, there was no fragmented medial coronoid process, and the disease was diagnosed on the basis of the irregular shape and heterogeneous subchondral bone of the process (Fig. 3). In studies conducted by the authors, MCPD was diagnosed by the CT of the elbow in 84.61% of dogs. These findings are confirmed by studies conducted by Villamonte-Chevalier et al. (48), Groth et al. (12) and Griffon et al. (11), in which this disease was diagnosed in 78%,

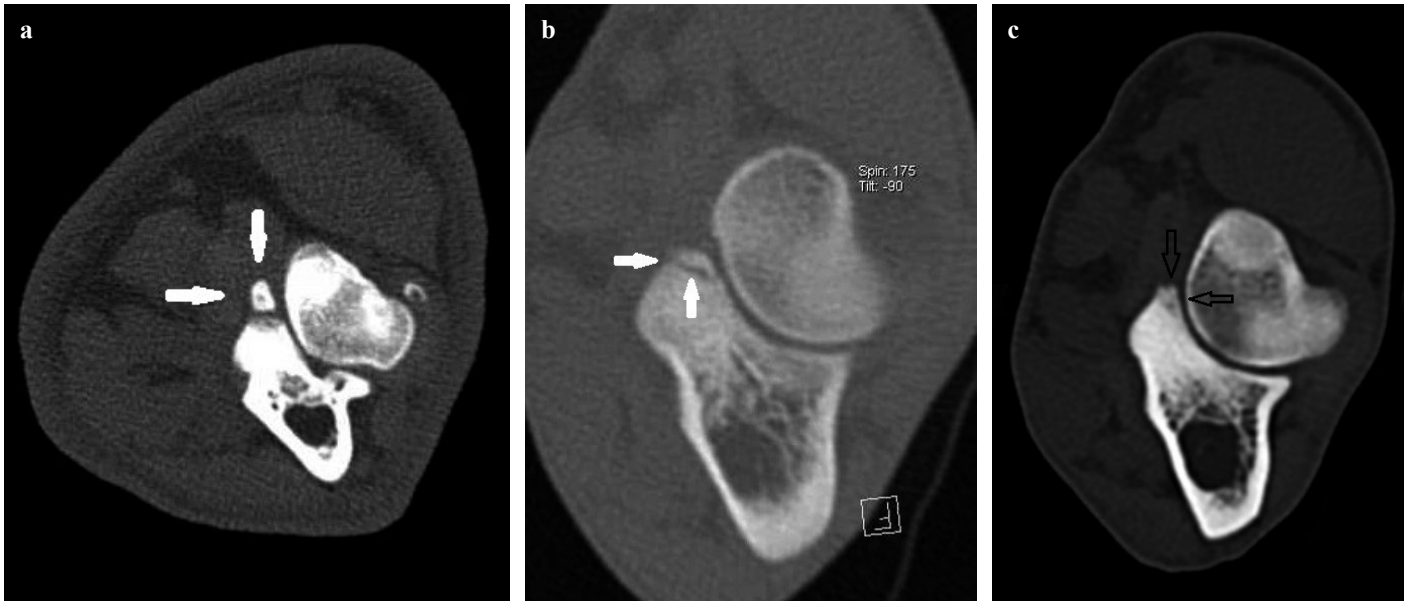

Fig. 3. Image of the multiplanar computed tomography reconstruction of the elbow in a cross-section. A visible dysplasia of the elbow on account of medial coronoid process disease: a) with its fragmentation, which is marked with a yellow arrow, b) with the presence of a fissure, which is marked with a blue arrow, and c) with a changed shape and heterogeneous subchondral bone of the process, which is marked with a green arrow

Tab. 3. Incidence of medial coronoid process disease in dogs based on computed tomography

Number of animals with MCPD (n = 52)	44 (84.61%)
bilateral occurrence	18 (41%)
one-sided occurrence	26 (59%)
Number of German Shepherds (n = 36)	29 (67%)
Number of Labrador Retrievers (n = 13)	11 (23%)
Number of Golden Retrievers (n = 9)	4 (10%)

68.96%, and 77.08% of cases, respectively. In addition, it was shown that in medial coronoid process disease, its fragmentation is the most common case, which was found in 63.63% of animals. On the other hand, other features on the basis of which it is possible to diagnose this disease, i.e. a fissure and an irregular shape of the radial notch of the ulna and the heterogeneous subchondral bone of the medial coronoid process, were much less frequent. It is confirmed by other authors (3, 11, 12, 29, 47). Only in studies conducted by Reichle et al. (39) were dogs with MCPD more often diagnosed with an abnormal shape of the medial coronoid process (97% of cases) than they were with its fragmentation (28% of cases). Medial coronoid process disease was diagnosed in 29 German Shepherds, 11 Labrador Retrievers, and 4 Golden Retrievers (Tab. 3).

Comparing the results of X-ray examination with the results of computed tomography in dogs, a statistically significant difference ($p < 0.001$) was reveled between the two diagnostic methods in recognizing medial coronoid process disease, as shown in Figure 4. This is confirmed by other authors (18, 27, 45, 49). It results from the fact that CT examination eliminates the phenomenon of overlapping shadows of different bones, which occurs in X-ray examination, and thus it is possible to more accurately visualize the medial coronoid process (43). Only studies by Villamonte-Chevalier et al. (48) showed a slight diagnostic superiority of X-ray examination over computed tomography in detecting MCPD. However, it was due to the fact that in

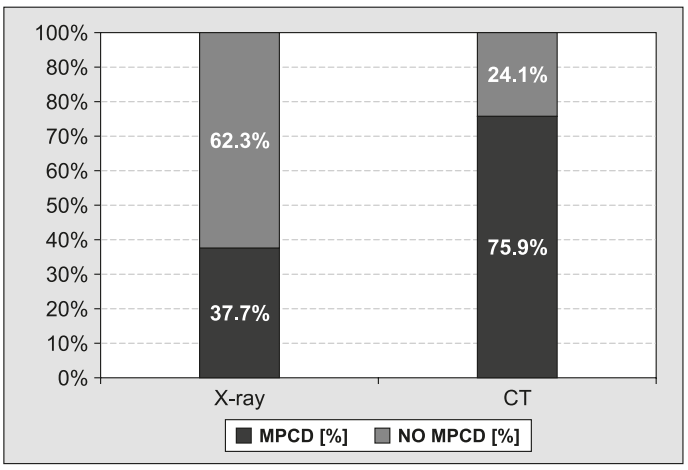

Fig. 3. Comparison of the incidence of medial coronoid process disease (MCPD) in X-ray and CT examinations

the above studies, the authors obtained a false positive result in as many as 7 cases of MCPD diagnosed by X-ray examination. Wosar et al. (51) and Haudiquet et al. (13) estimate the diagnostic sensitivity of X-ray in the diagnosis of MCPD as 10 to 62%. In our research, X-ray examination yielded a false negative result for MCPD in 24 cases, which amounted to 54.54% of all animals.

The study showed, on the basis of CT scans, that medial coronoid process disease occurred much more frequently than osteochondrosis dissecans of the medial condyle of the humerus or ununited anconeal process, and only slightly more frequently than incongruity. Fragmentation was the most common among abnormalities of the medial coronoid process. Moreover, computed tomography proved to be of higher diagnostic utility than X-ray examination in the diagnosis of medial coronoid process disease in dogs.

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