Cone-Beam computed tomography in the diagnosis of atypical medial coronoid process lesions

Hnizdo J., Valasek P., Tikal L., Trapek M.
Veterinarstvi 2013, 63:813-820

Summary
The paper presents the use of a new imaging technology, cone beam computed tomography CBCT, for the diagnosis of atypical lesions in the medial coronoid process (MCP) in dogs. CT is a highly sensitive imaging modality for detection of subchondral fissures and MCP fragmentation, as well as for evaluation of joint incongruency. In this paper three cases are discussed. The first case report describes a six month old American Stafordshire Terrier with elbow pain and negative radiologic findings. A subchondral fissure of the MCP and incongruency was detected by CBCT. Even during the arthroscopic exam this lesion was not immediately visible. The second case report deals with a six year old Apenzeller Sennendog wizh acute onset of lameness and elbow joint pain, also with negative radiographic findings. First arthroscopy was inconclusive and only minimal cartilage changes were detected. Late fragmentation of MCP was diagnosed with CBCT months later. During the second look arthroscopy a subtotal coronoidectomy was performed. The third case report describes a seven years old Small Munsterlander with intermitent elbow pain and minimal radiographic changes. On CBCT a subchondral fissure was confirmed as well as changes in the bone density of MCP. Arthroscopy confirmed subchondral necrosis and a fissure. Abrasioplasty of the MCP was performed. The author´s recent experience confirm the value of CBCT in the diagnostic of MCP lesions that are otherwise difficult to detect. The diagnostic value is comparable to published data of spiral CT systems. Further studies are needed for classification of pathologic findings as well as morphologic variations.

Preface

Medial Coronoid Disease (MCD) is one of the well known forms of Elbow Dysplasia (ED) in dogs. ED syndrom includes Ununited Anconeal Process (UAP), Osteochondrosis Dissecans (OCD), incongruence (IC) and Incomplete Ossification of Humeral Condyle (IOHC).[1,2]
In many ED patients combinations of these conditions are present. These conditions lead to different development of joint disorders. Especially in MCD different morphological variants are distinguished. It depends on the fragment location. [3] Recently it is widely accepted that only large and giant dog breeds are predisposed to MCD. These problems are common even in small and medium breeds of dogs and their crossbreeds. Most affected patients are young, in the ages between 8 and 15 months. New studies show that about 12 % of patients with acute onset of MCD are older than 6 years. [4,5] Perhaps the MCD definition alone will need to be reconsidered in the future.

Medial coronoid processus fragmentation usually develops gradually. So it is not a result of a single injury. Traumatic MCP fracture is a very rare condition. [6] Even in early phases of disease microfissures in subchondral bone were histopathologicaly detected. In the course of time these lesions are spread to periferal tissue which lead to complete bone fragmentation.[6] The Medial coronoid apex (MCP=medial coronoid proccess) and its lateral side in incisura radialis ulnae are sites of predilection. Multiple kindes of damage and their combinations can lead to the fragmentation. [3,8]

- Static radioulnar incongruity (radius relative short to ulna)
- Dynamic radioulnar incongruity (laxity in radioulnar junction in concrete movement phases lead to cyclical MCP overload)
- Incongruity connected with incisura trochlearis shape
- Primary rotating instability of the ulna and the radius relative to the humerus
- Incisura radialis ulnae and capitus radii incongruity
- Musculotendineous mismatch (abnormal bicipital traction to MCP)

Until now the MCD diagnostic approach as well as ED evaluation for breeding purposes was based on X ray imaging. Evaluation is provided on standartized X-ray projections (medio-lateral, cranio-caudal, or Cr15oL-CdMO oblique projection).[9] In most cases (except in large dislocated fragments) it is not possible to display MCP fragmentation by these techniques . In the majority of cases it is typical to find just indirect indicators as unreadable cranial MCP edge in mediolateral projection, increased subchondral sclerotisation of the ulna in medial radial condylus or arthrotic changes in predilect areas (capitus radii, proximal processus anconaeus).[11,12] Recent studies show that more than 20 % of dogs with no or minimal X- ray changes showed up different forms of MCD during arthroscopy. [5,13,14] That is why new imaging technologies as arthroscopy or computed tomography are considered as more benefitial for ED evaluation.

Cone Beam CT (CBCT) is a quiet new imaging technology, which finds its use in veterinary medicine in past three years. In contrast with fan- beam CT reaches CBCT the image by rotation of one X-ray tube around the patient. Beams passing through the object are caught by dynamic flat - panel detector on the opposite side and data is processed for picture reconstruction by the computer. Like in a convetional CT transversal, sagital and dorsal reconstruction of the image are created. In addition, images can be processed to a 3D reconstruction (volume rendering). Low radiation exposure of the patient and low energy consumption is benefitial.[15] According to available information, there is still no publications dealing with CBCT use in veterinary ortopedic diadnostics.

Case Reports

Case 1

Patient: MARY, American Stafordshire Terrier, 6 months old, intact female, 19kg
History: Patient was referred in August 2013 because of a month long left forelimb limp with gradual onset. After nonsteroidal antiinfalmatory drugs, only transient improvement was observed. Lameness was more obvious after the rest period.

Physical examination

II/VI lameness degree on left forelimb, mild paw pronation, pain during left elbow pronation in semiflexion

Radiology:
No significant pathological findings and no secondary degenerative changes in both elbows

CBCT examination
Patient was in sternal recumbency with its head toward the gantry. Both forelimbs were in maximal extension. Head was elevated on the right side. (Scan parameters: half beam, 110kV, 31,0 mAs, 0,08 mAs/shot, total 59,6 mAs, standard reconstruction).

Findings: left elbow: significant radioulnar incongruity in MCP and humeral condylus contact point, significant subchondral ulnar sclerotisation in whole MCP area, rounded coronoid apex, subchondral fissure lesion of MCP in incisura radialis (pict. 2 and 3).
Rigt elbow: without radiological changes

Based on CBCT findings left elbow arthroscopy was performed (1,9 mm Storz, Hopkins Endoscope 30 degree).
Arthroscopically detected findings: significant static radioulnar incongruity and moderate synovitis was detected. Cartilage tissue in entire elbow and MCP surface appeared to be normal (pict 4). After gentle curettage of cartilage above expected fissure area a fragile and avascular subchondral bone was discovered. Next debridement confirmed deep fissure in 1,5mm depth extending from incisura to apex. Subtotal coronoidectomy to the vascular bone level was performed and biceps ulna release procedure (BURP) under endoscopical check was provided. Patient recovery was without any complications. Nonsteroidal antiflogistic drugs were administered for seven days and four weeks long leash walking was recommended. Patient is currently without any clinical problems.

Case 2
Patient: Vivien, Apenzeller Sennendog, intact female, 6 years, 23kg
History: in April 2012 patient was admited because of a few month duration of intermitent left forelimb lameness. Patient was evaluated as ED 0/0 in 2008.

Physical examination:
left elbow pain

Radiology:
X- rays showed minimal changes in MCP area. The whole elbow joint was without degenerative changes.

An arthroscopy was provided and a mild radiolulnar incongruity and surface chondromalacia of MCP with cartilage fibrilation in apical area was discovered. MCP was without fragmentation and stabile during palpation. Intraarticular injection of ultraviscose hyaluronate (Synvisc One, 2ml pro toto) was applied. Medial compartment syndrome (MCS) was diagnosed and Proximal Abducting Ulna Leveling osteotomy (PAUL) was recommended to the owner. The procedure was refused at that time.

07/2013
Patient admitted with acute worsening of left forelimb lameness.

Physical examination:
III/VI left forelimb lameness was obvious. Moderate pain during pronation in semiflexion and during maximal extension of elbow joint was present.

Radiology:
No progression of arthrosis was detected. MCP changes were still very mild. On cranial humeral condylar edge, proximal anconeal edge and on caudal lateral condylus minimal osteoarthrotic changes were visible.(pict. 6)

CBCT examination was provided in the same way like in case 1 (Scan parameters: extended beam, 110 kV, 31 mAs, 0,15 mAs/shot, .total 111, 75 mAs, standard reconstruction). The joint seemed to be mildly incongruent. Most of the MCP was separated by an oblique deep fissure along the incisura radialis ulnae to the apex of the hypodense MCP - subchondral necrosis and fragmentation (pict. 7 and 8).

Diagnosis: MCS, subchondral necrosis and MCP fissure

Arthroscopy of left elbow (1,9 mm Storz, Hopkins Endoscope 30^{o}) showed moderate synovitis and surface cartilage degeneration with subchondral bone eburnation (pict. 9). Most of MCP was separated by a deep fissure. Subchondral bone seemed to be avascular in entire MCP. Finally, a subtotal coronoidectomy was performed..

Patient is currently without any clinical problems.

Case 3
Patient: Dori, Small Munsterlander, intact female, 7 years old, 20 kg

History: in May 2011 arthroscopically assisted tenotomy because of partial bicipital tendin rupture was found. In June 2013 intermitent lameness on left forelimb was present. X - rays showed only increased subchondral sclerotization on MCP base. In that time increased antibody titer against Anaplasma phagocytophilum was detected incidentaly (1:3200)

Physical examination:
I/VI level of lameness , maximal extension and pronation in semiflexion seemed to be painful.

CBCT examination:
Was provided the same way as in previous patients (scan parameters: half beam, 110 kv, 31 mAs, 0,08 mAs/shot, total 59,6 mAs, standard reconstruction). Joint was congruent and without degenerative changes. . MCP showed elevated subchondral sclerotisation and hypodense subchondral bone on its apex. A subchondral apical fissure was found. It was visible espicially in sagital reconstruction (pict 10 and 11).

Diagnosis:
MCP subchondral fissure and sclerotisation

Arthroscopy (1,9mm Storz, Hopkins endoscope 30o) observed surface chondromalacia with focal cartilage fibrilation (pict. 12). Fissure and necrotic part of MCP was removed by abrasioplastic procedure.
Patient has excellent outcome without any clinical problems.

Discussion
With the advent of new imaging techologies atypical forms of MCP become more common. In many cases patients do not have significant radiological changes on X ray images.[11,12] It usually is in small to medium breed dogs in which ED was seemingly irrelevant. Next group of patients with uncommon MCD is dogs older than four years. These patients are often presented with acute onset of lameness with no previous problems and have no X-ray detectable degenerative changes (jump down syndrom)[2] . Even our Case 2 and Case 3 belong to this group of patients. Onset of lameness was first observed at six or seven years of age.
Early diagnostic of subchondral lesions is complicated. In hard to examine patients and in unclear pain localiation cases (elbow vs shoulder) it could be helpful to use selective intraarticular anestesia and repeat ortopedic examination.[16] X ray findings are usually very minimal or none at all, especially in dogs younger than seven months.
In unclear cases nuclear scintigraphy is a very sensitive method. But positive findings in elbow joints are quiet nosnspecific - e.g. injury, infections, degenerative changes, neoplastic process (pict. 13).
CT is transectional imaging diagnostic which could eliminate superimposition artifacts which affect a diagnostic benefit to conventional X- ray images of MCP.[14,20,21] CT has become to be a more available method in general small animal clinical practices. This is due to more affordable devices such as CBCT being introduced to the veterinary market.
If compared to X- ray CT shows increased sensitivity for MCD detection. For MCD diagnostics the sensitivity rate of CT is 71 to 88.2 % and specifity rate is 84 to 86 %. In contrast X- ray imaging sensitivity rate for MCD is only 23 to 28 %.[2,21] Even arthroscopic visualisation shows lower sensitivity than CT (82 %).[2,14] In one recent study subchondral fissures from CT scans were endoscopically confirmed in only 34 % of cases . On the other side all arthroscopically found fissures were detected by CT imaging.[5] Arthroscopy revision is diagnostic in most patients with MCD, but in some cases could be insufficient for subchondral lesions, especially when the cartilage is intact (via case 1).[5,14,22]
Comparably sensitive to CT is magnetic resonance imaging (MRI).Sensitivity for MCD is 83.3 %. Some studies shows MRI sensitivity for fissures about 90 % or more.[2,24] But it is hard to detect early changes as subchondral sclerotisation on MRI. Diagnostic benefit of MRI is limited by the size of patient (small breeds), anestesia duration and financial constraints.[24] Some authors prefer the CT as the only diagnostic modality in MCD suspected cases. False negative results in CT occur in cases of early cartlige damage in MCP (25-29 %) without subchondral changes and nonmineralized cartlige fragments.[2,24] In these cases arthroscopy or MRI has a better diagnostic benefit .[14,21,25]

CBCT gives comparable imaging possibilities as commonly used spiral CT systems. Our experience shows CBCT more benefitial in intraarticular structures than arthroscopy in some cases. This is clearly described in our case reports.
Most authors recommened primary transversal reconstructions of elbow CT scan evaluation.[20,26] Recently there is no uniform examination protocol for ED evaluation in dogs recommended. Especially, the assesment of joint congruity is quite subjective and depends on patient positioning issues like incidental supination or pronation of the limb during examination.[26,27] In CBCT systems is a patient positioning different than in helical CT machines.[16]
Standard assessment of MCP surface is provided in transversal, sagital and dorsal reconstruction. The shape of processus, congruity to humeral and radial surface and fragment presentation is evaluated (pict 14).[26,28] Moreover, objective comparision of bone density is possible with this method. In recent studies during CT - Osteoabsorbtive Spectrometry (CT-OAM) it was observed that even in very early stages of joint disease signifficant changes in bone density are present.[29,30] More available than CT-OAM bone density measurement is using a Hounsfield scale.[5] Variations between individual breeds are present. There are differences of bone density between males and females of the same breed detected. In a Klumpp et. al. study comparing the bone density in healthy Labrador Retrievers and German Shepards it was found that there is a signifficant higher bone density of MCP in Labradors (1212-1554 HU) as compared with German Shepards (1126-1374 HU).[5] There are no objective referral ranges for densiometry in dogs and values can be considered as tentative. Recent studies suggest high level of importance of elevated subchondral MCP base density as the sign of early joint disease. Klumpp et al. found in 91 % of base MCP density elevated cases observed by CT even arthroscopically relevant changes.[5] Bone density measurement is possible in CBCT systems. The MCP shape is physiologically distinct in different breeds. Rounded apex was detected in 40 % of Labrador Retrievers in the study. German Shepards showed more often irregular or spiked apex of MCP.[5] More studies for physilological and pathological forms distinction are needed. Current evaluation of the CT findings is still partially subjective. The diagnosis is based on fissures or MCP fragmentation or elbow joint incongruity confirmation.[23-28] The elevated bone density as a subchondral sclerotisation symptom can be expected especially in the MCP base area, incisura trochlearis or medial humeral condylus. Transversal reconstructions seem to be most benefitial for detection of many MCP changes (pict 15).[21] In some cases sagital reconstruction can be suitable for fragment detection. This was confirmed by CBCT use in our practice. The cartilage is not visible on the CT.[21,24] New studies show high detection of relevant CT findings in patients with negative X- ray imaging (almost 33 %). Which is signifficantly important with regard to existing ED evaluation systems.[5,31] Past experiences show that even minimal (or no) radiologically detectable changes are connected with clinical relevant CT findings.

In our practice from February 2013 to September 2013 12 patients (overall 20 joints) with atypical MCP suspision (medium breeds, patients younger than 6 months or older than four years, with negative or ambigous X ray findings) was examined by the CBCT technique (Fidex, Animage USA). 13 joint was evaluated as positive in some MCP area changes. The most common findings were subchondral fissures, sclerotisation and fragmentation of MCP. In 10 cases the diagnosis was arhroscopically confirmed. Experience based on a small number of patients confirm the reports from recent literature.[2] For objective assesment of these conclusions more indepth studies are needed.

Conclusion

Use of CBCT for MCD diagnostics is still in its infancy. Reliable referral ranges for bone density and for MCP shape assesment are still needed. Physiological variability in single breeds is still a problematic issue. Our experience shows CBCT is a highly sensitive method for early detection of ED and minimal subchondral changes. It works especially in cases where conventional diagnostic technigues have no definitive conclusions. By using standard arthroscopic techniques it is possible to better understand to MCP formation which allows more effective treatment for affected patients. CT examinations followed by arthroscopy should be considered as a gold standard in ED diagnostics. Standardization in patients positioning in CBCT and dog elbow joint evaluation systems in exactly defined slices is a future goal for veterinary orthopedics.

CBCT is now available technology for specialized veterinary centers. These methods should be considered as standart diagnostic tools and could be used for post operative monitoring. In preoperative angular deformity assesment (3-D volume rendering) CBCT can be helpful for critical assesment before correction osteotomy in the elbow joint area (pict 16).[32] Our clinic uses CBCT in every elbow joint with MCP before unicompartmental arthroplasty procedure (Canine Unicompartmental Elbow CUE) for which the intact subchondral bone of MCP base is necessary for an ulnar implant anchor.

Reference:

1. Michelsen, J. Canine elbow dysplasia: aethiopathogenesis and current treatment recommendations. Vet J 2013;196(1):12-19.
2. Griffon, J. D. Surgical Diseases of the Elbow. In: Tobias, K. M., Johnston, S. A. (eds). Vet Surg Small Animal. Elsevier; St. Louis, 2012:724-751.
3. Fitzpatrick, N., Yeadon, R. Working algorythm for treatment decission making for developmental disease of the medial compartment of the elbow in dogs. Vet Surg 2009;5:285-300.
4. Vermote, K. , Bergenhuyzen, A., Gielen, I., van Bree, H et al. Elbow lameness in dogs of six years and older, arthroscopic and imaging findings of medial coronoid process in 51 dogs. Vet Comp Orthop Traumatol 2010;23(1):43-50.
5. Klumpp, S., Karpenstein, H., Tellhelm, B. Failing, K. et al. Die computertomographische morphologie und Anatomie des Ellbogengelenkes mit Schwerpunkt des Processus coronoideus medialis ulnae bei mit ED 0 beurteilten Hunden spezieller Rassen. Kleinterpraxis 2013;2:57-64.
6. Yovich, J. C., Read, R. A. Traumatic fracture of the medial coronoid process in two dogs. Vet Comp Orthop Traumatol 1994;7:173-176.
7. Danielson, K. C., Fitzpatrick, N., Muir, P., Manley, P. A. Histomorphometry of fragmented medial coronoid process in dogs: a comparison of affected and normal coronoid process. Vet Surg 2006;35:501-509.

8. Hnízdo, J. Nové trendy v řešení medial compartment disease. Sborník XX výroční konference ČAVLMZ, 2012;7-89.
9. Carpenter, L. G., Schwarz, P. D., Lowry, J. E. Comparison of radiologic imaging techniques for the diagnosis of fragmented medial coronoid process of the cubital joint in dogs. J Am Vet med Assoc 1993;203:78-83.
10. Cook, C. R., Cook, J. L. Diagnostic imaging in the canine elbow dysplasia: a review. Vet Surg 2009;38:144-153.
11. Daffan, D., Carrera, I., Carmichael, S., Heller, J., Hammond, G. Radiographic analysis of trochlear notch sclerosis in the diagnosis of osteoarthritis secondary to medial coronoid disease. Vet Comp Orthop Traumatol 2009;22:7-15.
12. Hornoff, W. J., Wind, A. P., Wallack, S. T. et al. Canine elbow dysplasia. The early radiographic detection of fragmentation of the coronoid process. Vet Clin North Am Small Anim Pract 2000;30:257-267.
13. Fitzpatrick, N., Smith, T., Evans, R. B., Yedon, R. Radiographic and arthroscopic findings in the elbow joints of 263 dogs with medial coronoid disease. Vet Surg 2009;38:213-223.
14. Moores, A.P., Benigni, L., Lamb, C.R. Computed tomography versus arthroscopy for detection of canine elbow dysplasia lesions. Vet Surg 2008;37(4): 390-398.
15. Rigori, R., Hnízdo, J., Brunning, H. A Guide to Clinical Use of Fidex. Animage, Pleasanton 2013:1-90.
16. Van Vynckt, D., Verhoeven, G., Saunders, J. Polis, I. et al. Diagnostic intra-articular anaesthesia of the elbow in dogs with medial coronoid disease. Vet Comp Orthop Traumatol 2012;25(4):307-313.
17. Read, R. A., Armstrong, S. J., Black, A. P., MacPherson, G. C., Yovich, J., Davey, T. Relationship between physical signs of elbow dysplasia and radiographic score in growing Rottweilers. J Am Vet Med Assoc 1996;209:1427-1430.
18. Van Bruggen, L. W., Hazewinkel, H. A., Wolschrijn, C. F. , Voorhout, G. et al. Bone szintigraphy for the diagnosis of an abnormal medial coronoid process in dogs. Vet Radiol Ultrasound 2010;23(1):344-348.
19. Debruyn, K. Peremans, K., Vandermeulen, E, Van Ryssen, B. et al. Evaluation of semi-quantitative bone scintigraphy in canine elbows. Vet J 2013;196(3):424-430.
20. De Rycke, L. M., Gielen, I. M., van Bree, H. et al. Computed tomography of the elbow joint in clinically normal dogs. Am J Vet Res 2002;63(10):1400-1407.
21. Groth, A. M., Benigni, L., Moores, A. P. Spectrum of computed tomography findings in 58 canine elbows with fragmentation of the medial coronoid process. J Small Anim Pract 2009;50:15-22.
22. Van Ryssen, B., Van Bree, H. Arthroscopic findings in 100 dogs with elbow lameness Vet Rec 1997; 140:360-362
23. Reichle, J. K., Park, R. D., Bahr, A. M. Computed tomographic findings in dogs with cubital joint lameness. Vet Radiol Ultrasound 2000;41(2):125-130.
24. Klumpp, S. Ondreka, N. Amort, K. Zweick, M. et al. Diagnostische Wertigkeit von Computertomographie und Magnetresonanztomographie für die Diagnose einer Koronoiderkrankung beim Hund. Tierärztl Prax 2010;1:7-14.

25. Wagner, K., Griffon, D. J., Thomas, M. W. et al. Radiographic, computed tomographic and arthroscopic evaluation of experimental radio-ulnar incongruence in the dog. Vet Surg 2007;36:691-698.
26. Kramer, A. Holsworth, I. G., Wiesner, Kaas P. H. et al. Computed tomographic evaluation of canine radioulnar incongruence in vivo. Vet Surg 2006;35:24-29.
27. Gemill, T. J., Hammond, G., Mellor, D. et al. Use of computed tomography for the assesment of joint spaces in the canine elbow. J Small Anim Pract 2006;47(2):66-74.
28. Rovesti, G. L., Biasibetti, M., Schumacher, A., Fabiani, M. The use of the computed tomography in the diagnostic protocol of the elbow joint in the dog. Vet Comp Orthop Traumatol 2002;15:35-43.
29. Müller-Gerbl, M., Putz, R., Hodapp, N. et al. Die Darstellung der subarachnoidalen Dichtemuster mit CT-Osteoabsorbtiometrie (CT-OAM) zur Beurteilung der individuellen Gelenkbeanspruchung an Lebenden. Z Orthop Ihre Grenzgeb 1990;126:128-133.
30. Saimii, V. F. Les, C. M., Schulz, K. S. et al. Computed tomographic osteoabsorbtiometry of the elbow joint in clinically normal dogs. Am J Vet Res 2002;63:1159-1166.
31. Lappalainen, A. K., Mölsä, S. Laitinen-Vapaavuori, O. et al Radiographic and computed tomography findings in Belgian sheppard dogs with mild elbow dysplasia. Vet Radiol Ultrasound 2009;50(4):364-369.
32. Fitzpatrick, N., Caron, A. Solano. Bi-oblique Dynamic Proximal Ulnar Osteotomy in Dogs: Reconstructed Computed Tomographyc Assesment of Radioulnar Congruence over 12 weeks. Vet Surg 2013;42(6):727-738.

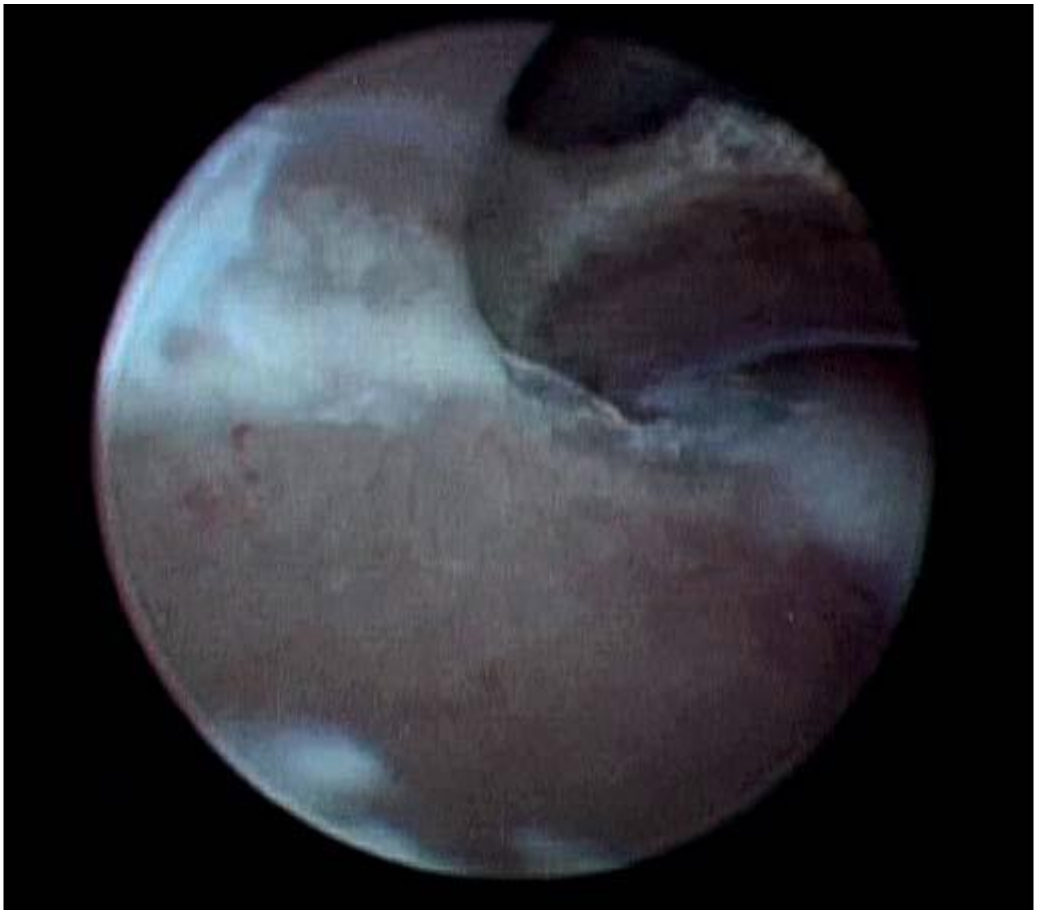
Adress:
MVDr. Jan Hnízdo
Animal Clinic, Bílá Hora
Čistovická 44
163 00 Praha 6
www.animalclinic.cz

Pict 1: X-Ray (LL projection) patient 1

Pict 2: CBCT radius/ulna transversal view of MCP area, MCP fissure (patient 1)

Pict 3: CBCT, dorsal view, radioulnar incongruity (patient 1)

Pict. 4: Arthroscopy finding (patient 1), macroscopicall intact MCP

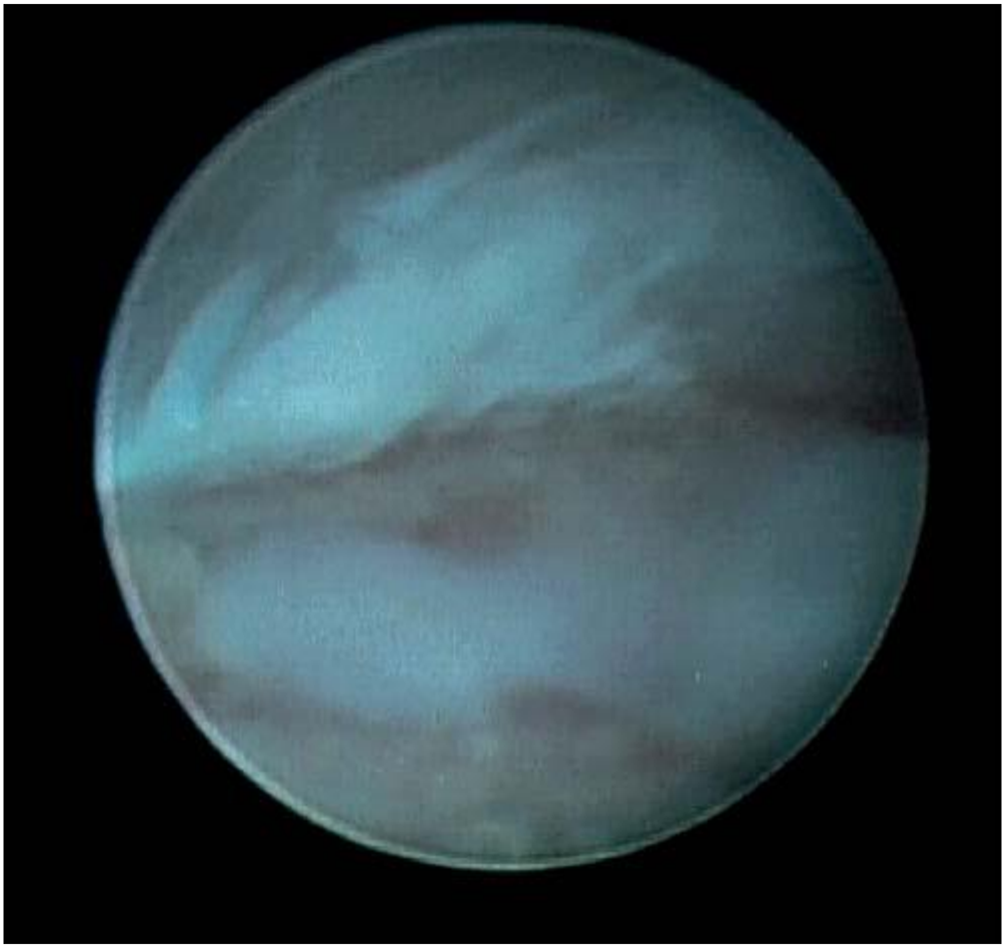


Pict. 5: Atrhroscopy finding (patient 1) subchondral bone necrosis

Pict. 6: RTG (LL projection) patient 2

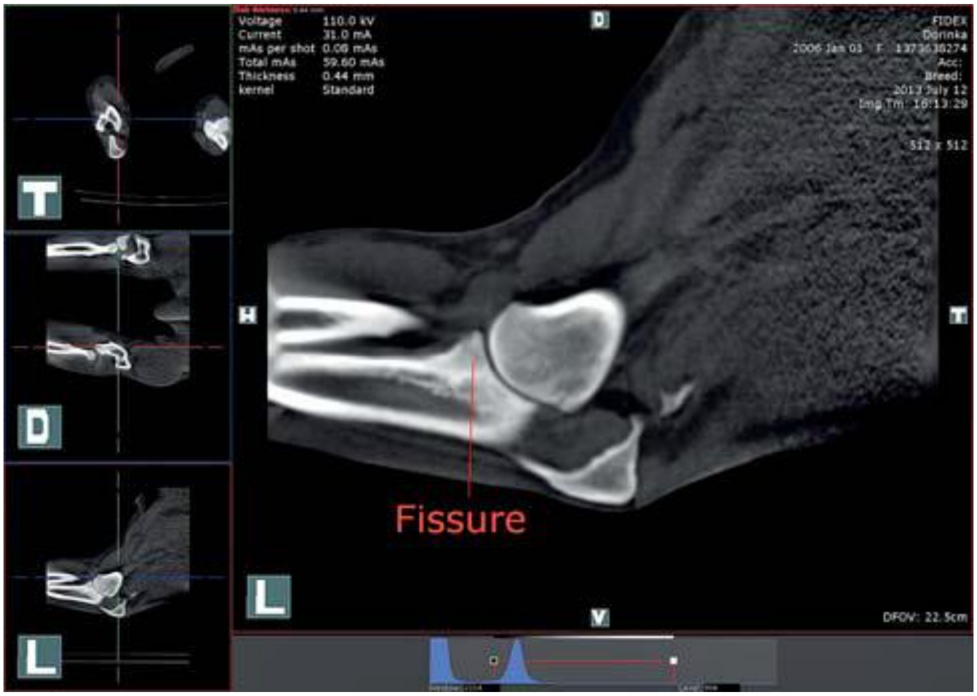
Pict. 7: CBCT radius/ulna transversal view of MCP area, MCP fissure, hypodense and deformed MCP (patient 2)

Pict. 8 CBCT MIP reconstruction sagital view (patient 2), deep bone fissure



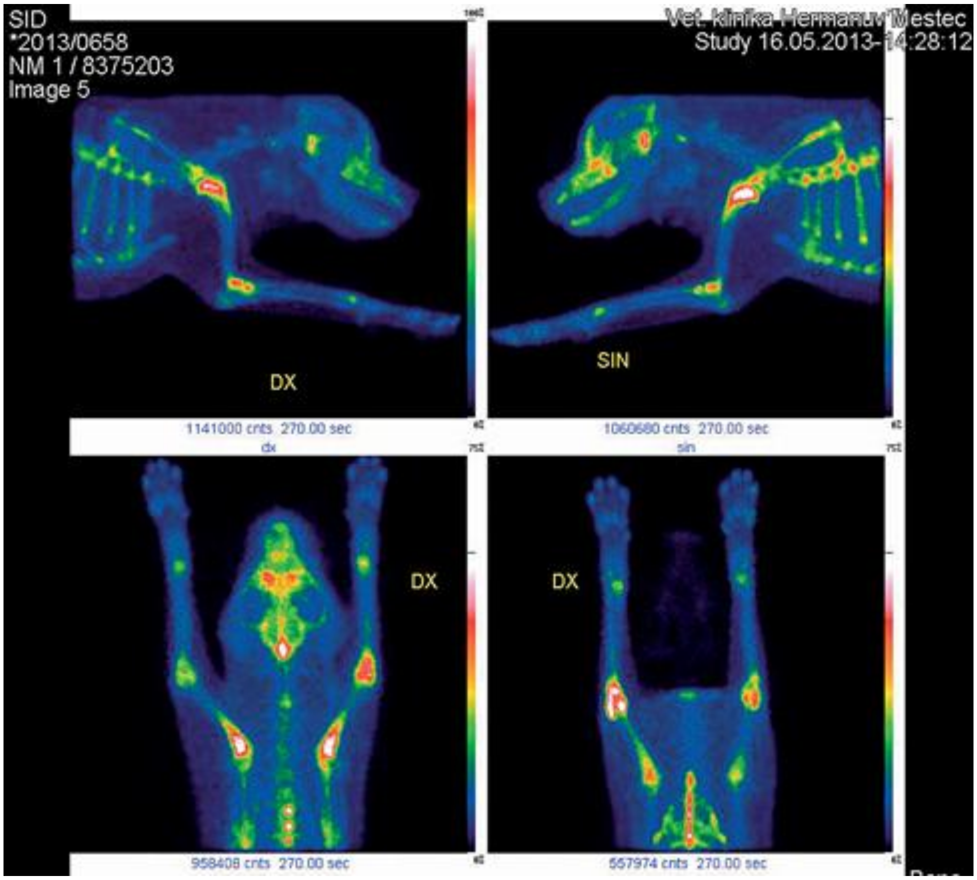
Pict 9. Arhroscopic finding: subchondral bone eburnation and a rest of MCP cartilage fibrilation (patient 2)

Pict. 10 – CBCT radius/ulna transversal view (patient 3): poor visible subchondral fissure



Pict.11 – CBCT sagital view (patient 3): visible subchondral fissure

Pict. 12 – Artrhroscopy finding (patient 3): MCP fibrilation and chondromalatia



Pict. 13 – Nuclear scintigraphy, right MCP disease
(Courtesy: Veterinary Clinic Heřmanův Městec)

Pict. 14 – CBCT radius/ulna transversal view: huge isolated fragmentation of MCP (German Shepard, 4 years, lameness for last 4 months)

Pict. 15 – CBCT radius /ulna transversal view: multiple fragmentations MCP (chow chow, 6 years, intermitent lameness for last 14 days)

Pict. 16 – CBCT volume rendering, angular deformity (Bernese Mountain Dog, 5 momths, inkongruity, short ulna syndrom
right)