Tieteellinen artikkeli

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Medial compartment disease in a canine elbow: Diagnosis and treatment by canine unicompartmental elbow surgery – Review and a case report

Koiran kyynärnivelen sisemmän nivelpinnan sairauden diagnosointi ja hoito canine unicompartmental elbow -leikkauksella – kirjallisuuskatsaus ja tapausselostus

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SUMMARY

Medial compartment disease is a recently identified manifestation of developmental elbow dysplasia in the dog. It is a common cause of front limb lameness and is associated with full-thickness cartilage loss in the medial compartment of the canine elbow: the medial coronoid process, the medial part of the humeral condyle and the medial part of the semilunar ulnar notch. These severe cartilage erosions may appear as the only pathologic finding in the elbow or together with fragmentation of the medial coronoid process or osteochondrosis of the medial part of the humeral condyle. The diagnosis of medial compartment disease is challenging. Radiography and computer tomography are commonly used for diagnosis of the different manifestations of elbow dysplasia, but for visualization of the joint cartilage, arthroscopy is required. The prognosis is guarded for medial compartment disease, and it often requires surgical treatment with load-shifting osteotomies or different elbow prostheses. In the Canine Unicompartmental Elbow (CUE) Arthroplasty System, the medial compartment of the elbow joint is partially resurfaced with humeral and ulnar implants to maintain physiologic load transmission and distribution in the joint. We describe CUE surgery in a 9-year-old Labrador Retriever with severe medial compartment cartilage lesions.

YHTEENVETO

Kyynärnivelen sisemmän nivelpinnan sairaus on hiljattain tunnistettu kyynärnivelen kasvuhäiriön ilmenemismuoto koiralla. Se on yleinen eturaajan ontuman syy ja kuvaa syvää nivelruston tuhoutumista kyynärluun sisemmän varislisäkkeen, olkaluun telan sisäpuolen nivelnastan ja semilunaariuurteen sisemmän osan nivelpinnoilla. Nämä pitkälle edenneet nivelruston eroosiot voivat esiintyä kyynärnivelen ainoana patologisena löydöksenä tai ne voivat esiintyä yhdessä sisemmän varislisäkkeen murtuman tai olkaluun osteokondroosin kanssa. Sairauden diagnosointi on haastavaa. Röntgen- ja tietokonetomografiatutkimusta käytetään kyynärniveldysplasian eri ilmenemismuotojen diagnosointiin, mutta nivelruston tarkasteluun tarvitaan artroskopiaa. Kyynärnivelen sisemmän nivelpinnan sairauden ennuste on varovainen ja se vaatii usein kirurgista hoitoa painorasitusta siirtävillä leikkaustekniikoilla tai erilaisilla proteeseilla. Canine unicompartmental elbow (CUE) -nivelenmuovausleikkauksessa osa kyynärnivelen sisemmästä nivelpinnasta pinnoitetaan olkaluuhun ja kyynärluuhun asetettavilla implanteilla, jolloin säilytetään nivelen fysiologinen voimansiirto ja jakautuma. Kuvaamme CUE-leikkauksen 9-vuotiaalla labradorinnoutajalla, jolla todettiin vakava-asteinen kyynärnivelen sisemmän nivelpinnan rustovaurio.

REVIEW

Developmental elbow dysplasia is a common cause of front limb lameness in dogs. According to the International Elbow Working Group, elbow dysplasia encompasses the following primary problems: ununited anconeal process, fragmented medial coronoid process (FMCP), osteochondrosis of the medial part of the humeral condyle and elbow joint incongruity alone or in combination.[1] Of these primary causes, FMCP is the most common cause of elbow dysplasia.[2,3]

Medial compartment disease (MCD) is a recently identified manifestation of canine elbow dysplasia. MCD refers to severe joint cartilage erosions (modified Outerbridge grades IV–V) (table 1)[4,5] in the medial compartment, including the medial coronoid process (MCP), the medial part of the humeral condyle and the medial part of the semilunar ulnar notch (figure 1).[5] The lateral compartment remains healthy.[2,5,6]

In dogs with FMCP or osteochondrosis, the mechanical irritation of an osteochondral fragment may aggravate joint cartilage erosion. Consequently, MCD is frequently diagnosed in older dogs with chronic elbow osteoarthritis.[2] However, MCD has recently also been recognized in older dogs without concomitant elbow lesions in young dogs and in dogs previously treated for FMCP.[2,5,7,8] The etiopathogenesis is not fully understood. It is suggested that elbow incongruity causes abnormal distribution of loads across the elbow joint surface, which ultimately results in these cartilage lesions, [3,9,10] as discussed by Tast and others.[11]

Clinical signs of the different manifestations of elbow dysplasia are similar. Differentiation of MCD on physical examination alone is not possible. Patients with MCD present with varying degrees of front limb lameness. On orthopedic examination, pain is elicited by full flexion of the elbow, by antebrachial supination in conjunction with moderate elbow flexion and by deep digital pressure adjacent

FIGURE 1 KUVA
CT scans provide three-dimensional and volume-rendering images of the elbow joint. The medial compartment is marked with blue arrows and the medial coronoid process with red arrows, while the site of the anconeal process is marked with a green arrow.
Tietokonetomografiatutkimuksella saadaan kyynärnivelestä kolmiulotteinen kuva. Kyynärnivelen sisäsivu on merkitty sinisillä nuolilla, sisempi varislisäke on merkitty punaisilla nuolilla ja kyynärpään uloke (processus anconeus) vihreillä nuolilla.

CENTRAL POINTS

- The term medial compartment disease is used to describe severe full-thickness cartilage loss in the medial coronoid process, the medial part of the humeral condyle and the medial part of the semilunar notch in the elbow joint.
- MCD is a common cause of front limb lameness.
- CUE surgery consists of two implants designed to resurface the medial compartment of the elbow joint: the ulna and the opposite site in the humerus.
- CUE surgery aims to maintain physiologic load transmission and transition in the elbow joint.

YDINKOHDAT

- Kyynärnivelen sisäsivun sairaus kuvaa vakavan rustovaurion esiintymistä sisemmässä varislisäkkeessä, sisemmässä olkaluun nivelnastassa ja semilunaariuurteen sisemmässä osassa.
- Kyynärnivelen sisäsivun sairaus on yleinen syy eturaajaontumaan.
- CUE-leikkauksessa käytetään kahta nastaa pinnoittamaan kyynärnivelen sisempi osa – kyynärluu ja vastapäinen olkaluu.
- CUE-leikkauksella pyritään säilyttää nivelen fysiologinen voiman siirto ja jakautuma.

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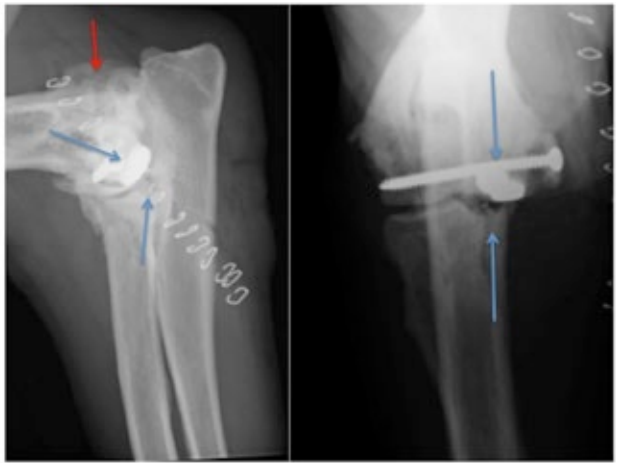

FIGURE 2 KUVA
Mediolateral and craniocaudal radiographs of the elbow of a 9-year-old Labrador Retriever after CUE surgery. The humeral implant and ulnar implant are marked with blue arrows. The UHMWPE ulnar implant is not visible in radiography, but can be identified due to a small marker. Adequate exposure to the elbow joint was achieved after osteotomy of the anconeal process (red arrow). The osteotomy of the medial epicondyle was reduced with a positional bone screw and a plastic washer.
Mediolateraalinen ja kraniokaudaalinen röntgenkuva 9-vuotiaan labradorinnoutajan kyynärnivelestä CUE-leikkauksen jälkeen. Olkaluun ja kyynärluun implantit on merkitty sinisillä nuolilla. Kyynärnivelen implantti ei ole röntgentiivis, mutta pienen tunnistimen avulla identifioitavissa. Riittävä nivelen avaus saatiin kyynärluun ulokkeen osteotomian jälkeen (punainen nuoli). Mediaalisen epikondyylin osteotomia redusoitiin positionaalisella ruuvilla ja muovisella aluslevyllä.

TABLE 1 TAULUKKO

The modified Outerbridge classification system is used for arthroscopic evaluation of cartilage lesions.[4,5]
Modifioitua Outerbridge-luokitusta käytetään nivelrustoleesioiden arvosteluun niveltähystyksen yhteydessä.[4,5]

Modified Outerbridge Score Modifioitu Outerbridge-luokka	Description of the appearance of cartilage findings. Rustolöydösten ulkonäön kuvailu.
0	Normal cartilage. Normaali rusto.
1	Condromalacia; softening and swelling of the cartilage. Kondromalasia; pehmeä ja turvonnut rusto.
2	Fibrillation; superficial cartilage erosion that does not reach the subchondral bone; villous-like cartilaginous flakes. Fibrillaatiota; pinnallista ruston kulumaa, joka ei ulotu rustonalaiseen luuhun asti; villus-tyyppisiä rustohiutaleita.
3	Deep ulceration that does not reach the subchondral bone. Syvää kulumaa, joka ei ulotu rustonalaiseen luuhun asti.
4	Full thickness cartilage loss; exposure of the subchondral bone. Täyssyvä nivelruston tuhoutuminen rustonalaiseen luuhun asti.
5	Extensive exposure of the subchondral bone with bone eburnation. Laaja rustonalaisen luun paljastus ja luun eburnaatio (luu kulunut norsunluun näköiseksi)

to the medial coronoid process.[10,12] Joint effusion may be palpable. Chronic cases may present with generalized muscle atrophy, periarticular fibrosis, and a decreased range of motion.[7]

DIAGNOSTIC APPROACHES

Radiography is affordable and accessible, and is considered important for initial assessment of the elbow joint. Ununited anconeal process and osteochondrosis can generally be diagnosed with radiography, whereas elbow incongruity and FMCP often require advanced imaging. [13] Ulnar subtrochlear sclerosis and blurring at the cranial edge of the medial coronoid process need to be considered as better indicators of FMCP than a radiopaque area on the anconeal process.[14,15] However, there may be severe cartilage erosions without osteophyte development.[16] Radiography cannot be relied on as a diagnostic modality for MCD.[9]

Computed tomography provides complete imaging of articular subchondral bone, but not of cartilage.[17] Osteophyte size, FMCP, and irregular radial incisure of the ulna are associated with arthroscopic features of MCD in dogs.[17] However, the absence of computed tomography findings does not rule out elbow cartilage lesions. [17]

The gold standard for MCD diagnosis is arthroscopy, which allows direct visualization of the cartilage lesion.[2,7] The degree of cartilage lesions is graded using the modified Outerbridge classification system (table 1).[2,4,5] Subchondral fissures of the medial coronoid process may be missed on arthroscopy alone if the overlying cartilage appears healthy.[17] Together, CT and arthroscopy ideally provide information on the quality of both joint cartilage and subchondral bone.[2,17]

TREATMENT

A variety of treatment options have been reported for MCD, but no ideal regime has yet been developed for this debilitating disease.[5]

Conservative management for MCD is similar to that for osteoarthritis. Diet, controlled exercise and physical rehabilitation are emphasized.[18] Medical treatment consists of nonsteroidal anti-inflammatory drugs, chondroprotectants and adjunct medications.[18,19] Regenerative methods and commonly used nutraceuticals lack evidence-based efficacy.[18,19] Medical treatment alone does not usually provide a good treatment response for MCD.[19]

Surgical treatments for MCD include arthroscopic debridement and lavage, load-shifting osteotomies, total joint replacement and unicompartmental resurfacing.[5]

ARTHROSCOPY

During arthroscopy, coronoid fragments may be removed, pathologic cartilage burred and the elbow joint lavaged to prevent the progression of mild elbow disease to MCD.[8,10] While arthroscopic treatment is commonly used for FMCP, its benefits have recently been questioned.[20,21] Arthroscopy does not address underlying incongruity, and for patients with MCD and severe cartilage lesions, debridement may not give long-term improvement, since the regeneration capacity of cartilage is limited.[20,21]

LOAD-SHIFTING OSTEOTOMIES

Load-shifting osteotomies aim to reduce load bearing in the medial compartment.[5,22-29] Ulnar osteotomies are commonly used in young, growing dogs with FMCP or incongruency to prevent mild chondromalasia progressing to MCD, as described by Tast and coworkers[11] and others.[22-24] In the proximal abducting ulnar osteotomy, a custom-designed locking plate (Advanced Locking Plate System, ALPS PAUL, KYON Veterinary Surgical Products, Boston, MA) with a step is applied to a proximal ulnar osteotomy, which reduces the load in the medial compartment.[25,26] In sliding humeral osteotomy , which is considered technically challenging, a plate with a 7.5 mm to 10 mm step is applied on the medial aspect of the humerus after humeral osteotomy.[27]

TOTAL JOINT REPLACEMENT

Total elbow replacement surgery is extensive. Complete excision of the joint is required. The necessary synostosis of the radius and ulna affects physiologic joint

kinematics and may predispose to implant failure. Total elbow replacement remains an option for patients with full-thickness cartilage loss throughout the joint surface.[31-33]

UNICOMPARTMENTAL RESURFACING

In the Canine Unicompartmental Elbow (CUE) Arthroplasty System (Arthrex Vet Systems, Naples, Florida, USA), only part of the affected medial compartment of the elbow is resurfaced.[6] CUE consists of two prostheses: a figure-eight-shaped implant of CoCr bonded to titanium is placed within the humeral trochlea and a cylindrical implant of ultra-high molecular weight polyethylene is placed within the base of the medial coronoid process.[6] The implants are slightly dome shaped to mimic the articular surface and to re-establish the medial joint space for physiologic load transmission through the implants. [6] Clinical mid- to long-term outcomes after CUE surgery have been evaluated.[34] CUE has provided significant improvement, with 47.6% of cases returning to full function and 43.7% to acceptable function.[34] The complication rate for CUE has been small.[34]

CASE REPORT

A 9-year-old male Labrador Retriever, weighing 42 kg, was referred to Univet Espoo Animal Hospital (currently Evidensia Finnoo) because of right forelimb lameness, which had persisted over several years. Since 1 year of age, the dog had been treated for elbow dysplasia multiple times and over long periods with nonsteroidal anti-inflammatory drugs, chondroprotectants and adjunct medications.

At the age of 7, severe osteoarthritis in the right elbow was identified on radiographs. At the time of presentation, the dog was treated with carprophen 3.5 mg/ kg once daily (Dolagis 120 mg, Sogeval Laboratories) and gabapentin 3.5 mg/ kg twice daily (Neurontin 600 mg, Pfizer). Significant lameness persisted despite medical treatment.

The dog presented with significant weight-bearing right forelimb lameness. The right elbow was thick and had a decreased range of motion. Standard radiographs using mediolateral and craniocaudal projections were obtained for both elbows. Signs of severe osteoarthritis in the right elbow with multiple osteophytes, narrowing of the joint space in the medial compartment and sclerosis at the semilunar ulnar notch were identified on the radiographs. Osteoarthritic findings were milder in the left elbow.

Arthroscopy was suggested to verify suspicion of MCD, but was declined by the owner due to financial issues.

ANESTHESIA

The owner gave the dog 2 mg/ kg carprophen (Dolagis 120 mg tablet, Sogeval Laboratories) in the morning before surgery. The dog was premedicated intramuscularly with 7 µg/ kg dexmedetomidine hydrochloride (Dexdomitor 0.5 mg/ ml, Orion) and 0.07 mg/ kg butorphanol (Torphasol 10 mg/ ml, aniMedica). General anesthesia was induced intravenously with propofol (PropoVet Multidose 10 mg/ ml, Zoetis) to effect until the dog could be intubated. Anesthesia was maintained with sevoflurane (SevoFlo 100%, Zoetis). Pain was controlled with a constant rate infusion: fentanyl 5 µg/ kg/ h (Fentanyl Hameln 50 µg/ ml, Hameln Pharma Plus), lidocaine 2mg/ kg/ h (Lidocain 20 mg/ ml, Orion), and ketamine 0.3 mg/ kg/ h (Ketaminol vet 50 mg/ ml, Intervet) with prior loading doses (2 µg/ kg fentanyl, 1 mg/ kg lidocaine and 0.5 mg/ kg ketamine). Twenty-two mg/ kg cephazolin (Kefzol 1 g, Lilly) was given intravenously 30 minutes before surgery and again 2 hours later.

SURGERY

The right elbow was approached medially. Access to the elbow joint was gained by osteotomy of the medial epicondyle. Before the osteotomy, a tunnel from the medial to the lateral epicondyle was drilled for later reduction. The joint was subluxated and osteophytes on the medial humeral condyle were removed. Exposure was not considered sufficient and required a further osteotomy of the tip of the anconeal process. The joint surface was inspected and the MCD diagnosis was confirmed.

The implant size was determined intraoperatively using the ulnar drill guide with the same diameter as the ulnar implant. A Beath pin (guide pin) was driven through the ulnar drill guide, which then was substituted with a cannulated reamer. The reamer was used to drill a cylindrical socket in the medial coronoid process.

The elbow was flexed and extended from 100° to 140°, the stance-phase range of motion. A humeral implant that maximized contact with the ulnar component at this stance-phase range of motion was chosen. The shape of the humeral implant resembles a figure eight, and two Beath pins were thus driven through the humeral drill guide. To form a figure eight hole, the reamer was successively inserted over each Beath pin.

Matching trials for both the humeral and the ulnar implants were used to confirm that the top ridge of the prosthesis protruded 1 mm from the socket. The prosthesis was then implanted and seated. The elbow joint was reduced and put through a full range of motion to ensure that the implants were flush and properly seated.

The previously osteotomized epicondyle was reduced and stabilized with a positional screw and a washer. Closure of the surgical wound was routine. Craniocaudal, extended lateral and flexed lateral radiographs of the right elbow were obtained postoperatively.

POSTOPERATIVE TREATMENT

Postoperative pain was controlled intravenously with 0.02 mg/ kg buprenorfine (Vetergesic, 0.3 mg/ ml, Sogeval), and 0.2 µg / kg dexmedetomidine was administered intravenously for the dog to be tranquil during the car trip home. A soft-padded, full-limb bandage was applied and maintained for 2 days.

Carprophen was continued orally at 2 mg/ kg twice a day for a week and then 1 mg/ kg twice a day continuously. Gabapentin was discontinued. Cephalexin (Kefavet 500mg, Orion Oyj) at 24 mg/ kg was prescribed twice daily for a week. The owner was instructed to start rehabilitation at home with an assisted range of motion and advised to initiate a physiotherapy program for the dog. The dog was kept on restricted leash walks for 6 weeks.

Re-evaluations were made at the referring clinic. The dog gradually improved and carprophen could be discontinued 4 months postoperatively. At 8 months after the operation, the dog was more eager to exercise, although a mild degree of lameness persisted. Daily activities included 3 daily 30-minute walks. Pain medication was needed only occasionally.

DISCUSSION

MCD is a debilitating disease with a guarded prognosis. The etiopathogenesis is unclear, but there is a consensus that underlying elbow incongruity appears to be the cause of abnormal load distributions ultimately leading to severe cartilage erosion.[3,9,10] This humeroulnar conflict may be caused by static radioulnar length discrepancy, dynamic radioulnar longitudinal incongruency or underdevelopment of the ulnar trochlear notch.[10,35] It has been suggested that even a transient lag in growth may be an aggravating factor.[10] In order to prevent progression to MCD, we need to address the underlying cause, elbow incongruity, with load-shifting osteotomies.[22-30] However, some dogs present with MCD at a later age, sometimes with severe osteoarthritis.[2] For these patients, the CUE arthroplasty system appears to be an appropriate treatment.[6,34]

Our case study describes CUE surgery in a canine elbow with severe medial compartment disease and osteoarthritis. The dog benefitted from CUE by achieving a higher activity level. CUE surgery improved the use of the affected limb and alleviated pain. Surgery was performed without complications. Anatomical landmarks were less distinctive due to the severe osteoarthritis and periarticular fibrosis, which made osteotomy of the medial humeral epicondyle more demanding. Gaining adequate exposure to the elbow joint for fitting of the ulnar drill guide flush with the articular surface of the medial coronoid process was also challenging.

We recommend computed tomography and arthroscopy for patients with early signs of elbow dysplasia to diagnose MCD. For older patients with severe osteoarthritis findings on radiography, arthroscopy alone may be sufficient to visualize the medial compartment of the elbow for MCD diagnosis. We suspected MCD in our patient based on the history, radiographical findings and clinical signs. To verify our suspicions, we recommended arthroscopy, which the owner declined.

Because of our patient's advanced stage of osteoarthritis, less invasive regimes such as arthroscopic debridement or ulnar osteotomy were not considered.[10] According to the manufacturer, proximal abducting ulnar osteotomy is especially beneficial in young dogs prior to severe osteoarthritis and was accordingly rejected.[25] Recent studies have not registered an associated increase in pressure in the lateral compartment following proximal abducting ulnar osteotomy. Further investigations are needed to identify how the remaining forces are shifted.[26] Another surgical option our patient may have benefitted from is sliding humeral osteotomy.[27,31-33] Reported results on sliding humeral osteotomy are contradictory. Quinn et al used it as a treatment modality for humeral osteochondrosis. The surgical intervention proved unsuccessful and MCD developed in the treated elbows.[28] Other studies have demonstrated that sliding humeral osteotomy for dogs with MCD improves the use of the affected limb and alleviates pain.[27,29] The high complication rate has led to modifications of the implants.[29] The joint surface contact area is reduced after surgery. This concentration of loads may lead to iatrogenic cartilage damage.[30] Because CUE requires exposure of the elbow joint, the diagnosis could be confirmed during surgery in contrast to sliding humeral osteotomy, in which the approach is to the humeral diaphysis.[27] CUE surgery strives to maintain physiologic load transmission and transition in the elbow joint, mitigating lateral compartment failure addressed to load-shifting osteotomies.[5,27] In this respect, CUE differs, for example, from sliding humeral osteotomy and proximal abducting ulnar osteotomy.[25-29]

Total elbow replacement was discussed with the owner and declined. CUE surgery is less extensive than TER and, in contrast to TER, allows supination and pronation of the radius and ulna.[5,31-33] In case of implant failure, the options for coronoidectomy and TER remain open.

The size of the implants only allows CUE to be performed on large breed dogs and on a limited portion of the joint surface. Reported complications in CUE surgery include osteotomy of the medial humeral epicondyle, implant malposition, and incisional infections.[27] No evidence of implant failure has been reported.[27] We suggest there may be a risk of a fracture of the medial coronoid process at the edges surrounding the ulnar implant, as well as between the humeral implant and the osteotomy of the epicondyle.

We conclude that CUE surgery was an appropriate treatment for our patient. We have used CUE surgery for other patients with MCD with advanced stages of osteoarthritis, and our experiences with this surgical procedure are positive.

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