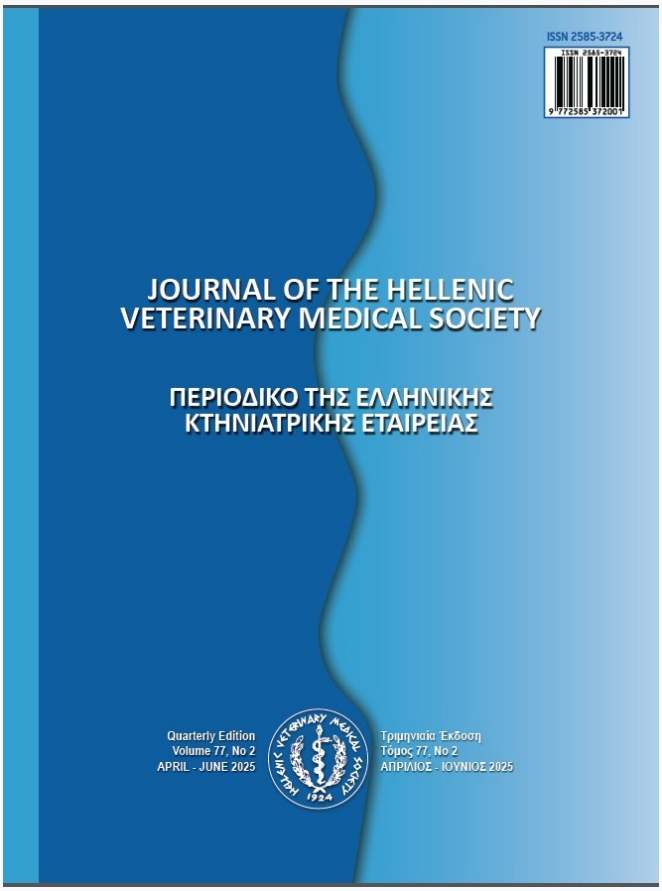
Journal of the Hellenic Veterinary Medical Society

Vol 76, No 2 (2025)



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doi: 10.12681/jhvms.37461

To cite this article:

Krystalli, A., Papaeuthymiou, S., Bairamis, T., Patsikas, M., & Prassinos, N. (2025). Humeral osteochondrosis in dogs: Long-term outcomes of 10 clinical cases. *Journal of the Hellenic Veterinary Medical Society*, *76*(2), 9391–9402. https://doi.org/10.12681/jhvms.37461

J HELLENIC VET MED SOC 2025, 77 (2): 9391-9402
ΠΕΚΕ 2025, 77 (2): 9391-9402

Case report
Κλινικό περιστατικό

Humeral osteochondrosis in dogs: Long-term outcomes of 10 clinical cases

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ABSTRACT: Humeral osteochondrosis (HO) is a complex growth cartilage disorder characterized by disruption in the process of endochondral ossification. This disorder, often seen in dogs, involves the separation of a segment of articular cartilage from the underlying bone, leading to degenerative joint disease and lameness. This retrospective study aims to compare the outcomes of conservative and surgical treatment of HO in ten instances. The study was conducted at the Surgery and Obstetrics Unit of the Companion Animal Clinic, Department of Veterinary Medicine, Aristotle University of Thessaloniki, Greece. Nine client-owned dogs of varying breeds, both sexes, aged 4–8 months, and weighing 10–35 kg participated in the study. The duration of lameness prior to their first consultation ranged from 1 to 3 months. All participants were thoroughly examined clinically, orthopaedically and radiographically. This helped in determining both the location of osteochondrosis, whether in the shoulder or elbow joint, and the degree of severity. One dog, diagnosed with bilateral HO, accounted for two of the ten cases. Nine cases exhibited lesions on the caudal aspect of the humeral head, whereas one showed them in the medial part of trochlea humeri. Six cases underwent surgical treatment, which included the removal of the cartilage flap, curettage, and drilling of the subchondral bed. The remaining four cases received conservative treatment such as activity restriction, weight reduction and administration of non-steroidal anti-inflammatory drugs. Progress was evaluated through a dog mobility questionnaire completed by the owners. Findings showed that 1-month post-operation, surgically treated dogs, except for two, returned to full activity. The two exceptions experienced low-grade lameness post-strenuous exercise. Dogs receiving conservative treatment were not restricted, and their response to medical therapy varied, showing degrees of lameness, especially when conditions were favorable for the manifestation of osteoarthritis. The results obtained suggest that dogs treated surgically demonstrated better long-term functional outcomes compared to those treated conservatively. Recurrent lameness in some of them appears to be due to the development of degenerative changes in the joint.

Keyword: Dog; Humeral; Osteochondrosis; Treatment.

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Date of initial submission: **16-4-2024**
Date of acceptance: **08-1-2025**

INTRODUCTION

Osteochondrosis is a condition caused by focal disturbance of the endochondral ossification in the growth plate and joint cartilage. The stage of the disease, resulting in an articular osteochondral flap accompanied by joint inflammation, is designated as osteochondritis dissecans (OCD) (LaFond et al., 2002). This condition predominantly affects rapidly growing male dogs of medium, large, and giant breeds, with clinical signs usually appearing between 4 and 7 months of age (Milton, 1983; Denny and Butterworth, 2000; LaFond et al., 2002; Vezzoni et al., 2020). Research strongly suggests that the disorder is initiated by failure of blood supply to the growth cartilage (Ytrehus et al., 2007), causing an increase in articular cartilage thickness and focal chondronecrosis (DeCamp et al., 2016). This leads to the loss of chondrocytes in the deeper layers of cartilage and the formation of cracks where calcified and non-calcified tissues meet. These cracks result in detached cartilage fragments, known as 'joint mice' (Harari, 1998; Kuroki et al., 2005; Ytrehus et al., 2007), which may be absorbed by synovium or remain loose within the joint. As these fragments can grow due to nourishment from synovial fluid (DeCamp et al., 2016), osteoarthritis and lameness might occur in dogs older than 2 years (Denny and Butterworth, 2000).

Commonly suggested causes of osteochondrosis include heredity, rapid growth, anatomical structure, trauma, and dietary imbalances. However, the most compelling evidence supports only genetics and anatomic conformation, particularly the inheritance of specific joint shapes, as significant contributors to joint lesions (Grøndalen, 1974; Ytrehus et al., 2007). While there is little evidence to suggest that excess body weight directly causes osteochondrosis, it may influence its progression into osteoarthritis (Ytrehus et al., 2007). Early recognition of OCD (at 4 to 6 months old) can allow for conservative treatment, such as rest and a diet reduced in calories and calcium, with the goal of preventing the formation of flaps (DeCamp et al., 2016). Except for recommendations for restricted activity, it may sometimes be necessary to use non-steroidal anti-inflammatory drugs and painkillers to prevent excessive discomfort and lameness (Denny and Butterworth, 2000).

When diagnosed between 4 to 6 months of age, some syndromes in which flap has not been formed like osteochondritis dissecans of the shoulder may be treated with rest and a decreased caloric diet. Surgical treatment is indicated in any dog older than 6 months who has shown consistent lameness and displays a clear radiographic lesion (Milton, 1983; DeCamp et al., 2016). The surgery's objectives are the debridement of the flap or joint mice and of any cartilage which is not adhered to the underlying bed. In cases where the defect is surrounded by sclerotic borders abrasion arthroplasty, curettage, forage, or micropick treatment are chosen as palliative techniques (De Camp et al., 2016). Curettage or micropicking of the exposed subchondral bone to produce a bleeding bed and facilitate its repair through the formation of fibrocartilage is often advocated. The cells responsible for producing this fibrocartilage are pluripotential mesenchymal cells that migrate in from subchondral bone (Butterworth and Pettitt, 2018).

For chronic cases, removing osteophytes can be beneficial in alleviating symptoms (Milton, 1983). Bilateral radiographic shoulder OCD is reported in 27% to 68% of cases. However, surgical treatment in both sides is recommended only in cases of pain on shoulder hyperextension (DeCamp et al., 2016). This study's goal is to assess long-term outcomes for dogs receiving either surgery or conservative treatment for HO.

MATERIALS AND METHODS

We conducted a retrospective study of the clinical records from nine dogs diagnosed with HO at the Aristotle University of Thessaloniki's Companion Animal Clinic in Greece, within the Surgery and Obstetrics Unit, between 2006-2017. Dogs with pelvic limb lameness and with neurologic disease were excluded. Of the examined dogs presented with thoracic limb lameness, dogs were only included in the study if they exhibited typical OCD lesions located in the caudal central aspect of the humeral head or the medial part of trochlea humeri, as demonstrated through radiography.

The initial examination recorded the dog's history, including its nature, lameness occurrences and type, physical activity, pain presence, and food type and quantity. It also included a physical and orthopaedic examination of the affected thoracic limb, with findings documented in the clinical records. Each affected joint was assessed to identify any pain during hyperextension and hyperflexion. After the physical examination and while the dogs were anesthetized, a radiological examination using medio-lateral and ventro-dorsal views was conducted,

while in some cases computed tomography(CT) and magnetic resonance imaging (MRI) were also used.

For our study, we retrospectively graded the severity of lameness in limbs affected by HO, using information from clinical files. We classified lameness during standing, walking, and running into six grades (Table 1).

Group surgically treated

In all cases that received surgical treatment, the dogs were given general anesthesia and underwent aseptic preparation prior to the surgery. They were positioned in lateral recumbency with the affected limb uppermost in a neutral position.

The shoulder arthrotomy was performed using a caudo-lateral approach, while a medial approach was employed for the elbow arthrotomy. In the first case, a skin incision was made initially from the distal end of the scapular spine curving toward the mid humerus. After subcutaneous tissues and deep fascia are incised, blunt dissection of the omobrachial fascia to delimit the acromial and scapular portions of the deltoideus muscle. After their retraction, the joint capsule was incised and the humerus was internally rotated and the caudal aspect of the humeral head was examined. In the case of elbow OCD, a curved incision over the medial epicondyle extends from the distal third of the humerus to the proximal third of the antebrachium was performed. An L-shaped incision was made through the joint capsule and medial collateral ligament and the antebrachium was pronated and abducted. We detached the cartilage flap from the surrounding cartilage at the top or inner top part of the lesion (Fig. 1, 2). We removed the flap by inserting a freer periosteal elevator between the subchondral bed and the cartilage flap. Then, a twisting motion was applied.

The subchondral bed, left behind after the cartilage flap removal, underwent both visual inspection and probing. The cartilage flap was detected attached to the subchondral bone in 4 cases (No=4, No=6, No=7, No=10) and as joint mice in the caudal aspect of humeral head in the rest of them. All loose cartilage not firmly attached to the subchondral bone was discarded. Edges of the cartilage were neatly trimmed using

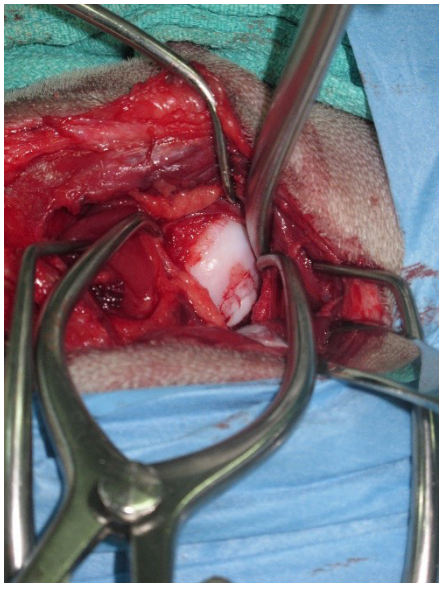

Figure 1. Intraoperative photograph of osteochondritis dissecans lesion in the humeral head.

Table 1. Lameness scale (Krystalli et al., 2023).

Degree of Lameness	Limb's Weight Bearing				Characterization of Lameness
	Description	Stance	Walk	Run	
0	Full (normal) weight bearing	.....	.....	.....	Absence
1	Partial weight bearing: hardly visible	.....	.....	.....	Light
2	Partial weight bearing: easily visible	.....	.....	.....	Mild
3	No weight bearing: intermittent, sporadic (≤1:5) *	.....	.....	.....	Moderate
4	No weight bearing: intermittent, frequent (>1:5) *	.....	.....	.....	Severe
5	No weight bearing: continuous	.....	.....	.....	Not functional
Degree of lameness = (S + W + R)/3					

*: limb lift frequency per 5 steps.

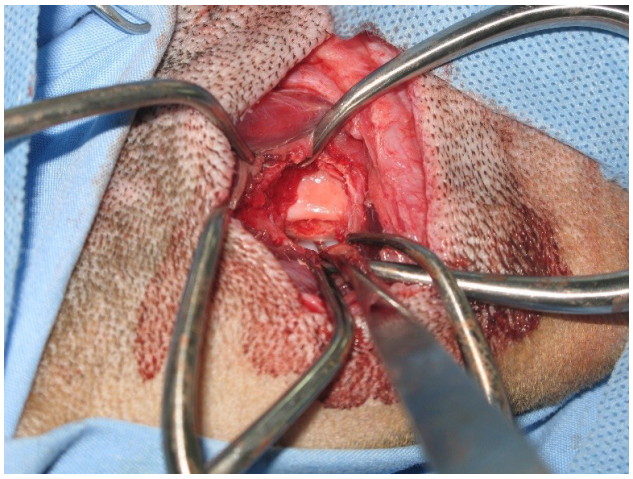

Figure 2. Osteochondritis dissecans lesion of the medial humeral condyle exposed by medial approach with transection of the pronator teres muscle and medial collateral ligament.

a small bone curette at a 90° angle with respect to the cartilage.

When the lesions were covered by seemingly normal fibrocartilage the disruption of the subchondral bed was deemed unnecessary. On the other hand, those lesions partially covered by regenerating fibrocartilage were pricked with small holes using Steinmann pins (1.2-1.5 mm diameter) until the bone bled and the edges were also trimmed. Lesions, where only subchondral bone was present, were gently curetted until bleeding occurred.

During the postoperative period, NSAIDs, like firocoxib (5 mg kg^{-1} sid) (Previcox, Boehringer Ingelheim Vetmedica GmbH, Germany) and carprofen (4 mg kg^{-1} sid) (Rimadyl, Zoetis, London, UK), were administered for a duration of 7 to 10 days. Rest and restriction of physical activity were advised for a period of 4 to 6 weeks.

Group conservatively treated

For conservative treatment cases, a combination of rest and regulated exercise was employed. Pain and lameness were alleviated using analgesics and anti-inflammatory drugs like carprofen and firocoxib. Additionally, dogs were put on a restrictive diet comprising a well-balanced dog cereal diet, with a lowered caloric intake and cessation of calcium supplements.

Owner questionnaire

Dog owners were asked to complete a mobility questionnaire for their pets. They were required to assess and grade their dogs' lameness after treatment and after periods of extended rest or activity, using a 6-point scoring system. They were also asked to evaluate the efficacy of pain relief and the level of their dogs' activity compared to before the onset of lameness. The questionnaire concluded with inquiries about exercise restrictions for the dogs and the owner's satisfaction with the results (Table 2 and 3).

RESULTS

The study group comprised 9 dogs aged 4 to 8 months (median: 8). The body weight of treated animals ranged from 10 to 35 kg (median: 24.95). Our study encompassed various dog breeds, most commonly the English Setter (Table 4).

The rest of dogs' breeds were Labrador, Cane Corso, Dogue de Bordeaux, Pitbull and Mongrel. The group consisted of 4 females and 5 males. Eight dogs were diagnosed with unilateral HO and one with bilateral shoulder OCD. However, surgical intervention was performed only on one limb. This dog was counted as two cases and thus the final cases turned into ten (six surgically treated and four conservatively).

The majority of cases reported a gradually increasing lameness that was exacerbated by physical activity. Only two examples (No=1, No=10) cited a major trauma event as the cause of sudden lameness. In all instances, the reported lameness lasted from 1 to 3 months prior to the dog's first veterinary clinic visit. While three dogs (No=2, No=5, No=6) were fed only dry food, four (No=1, No=4, No=8, No=9) had a mixed diet of dry and homemade food, and one (No=7) was exclusively given homemade food. Five of the dogs (No=1, No=7, No=8, No=9, No=10) received dietary supplements, such as high-calcium and Bones And Raw Food (BARF) diets, cod liver oil, multivitamins, and chondroprotective supplements, for a single month.

The gait evaluation revealed grade 1 (No=2, No=3, No=7, No=9, No=10) and grade 2 lameness (No=1, No=4, No=5, No=6, No=8). The dogs showed considerable pain during the orthopedic assessment of their affected joints. Muscle atrophy in the impacted limb was noted in two instances (No=2, No=10). Crepitus could be felt in four cases (No=2, No=5, No=8, No=9). Subchondral bone lesions were detected on the medial humeral condyle in one case (No=4) (Fig. 3) and at the rear of the humeral head in the remaining cases (Fig. 4).

Three cases (No=7, No=8, No=9) were diagnosed

Table 2. Questionnaire for conservative treatment

Registration number:…….....
Presentation date:……
Owner:……
Phone number:……
Dog's characteristics: Male ☐ Female ☐ Neutered☐
Age……..……Breed……
Name……..……Weight……..…
Disease:
Osteochondrosis of humeral head ☐
Osteochondrosis of medial part of humerus trochlea ☐
Completed questionnaire: Yes☐ No ☐
1. Nutrition
1.1. Kind of nutrition
DF ☐ CF ☐……
Barf ☐ Other ☐.....
1.2. Dietary supplements
Yes ☐ No ☐
Formulation……..
Duration of administration……
2. Lameness
2.1. Duration……
2.2. Grade: ⓪ ① ② ③ ④ ⑤
3. Analgesia
3.1. Yes ☐ No ☐
3.2. Drug……..
3.3. Administration's duration……
3.4. Was analgesia useful? Yes ☐ No ☐ Possibly ☐
4. Restriction
4.1. Yes ☐ No ☐
4.2. Duration……
4.3. Restriction's kind:……
4.4. Was restriction useful? Yes ☐ No ☐ Possibly ☐
5. Physical therapy
5.1. Yes ☐ No ☐
5.2. Kind: Passive movements ☐ Swimming ☐ Bathtub ☐
5.3. Frequency……
5.4. Duration……
5.5. Was analgesia beneficial? Yes ☐ No ☐ Maybe☐
6. Does the dog appear lame after exercise?
6.1. Yes ☐ No ☐
6.2. Grade: ⓪ ① ② ③ ④ ⑤
6.3. Does the lameness reduce after rest? Yes ☐ No ☐
7. What kind of exercise do you use to keep your dog active?
Walking on a leash ☐
Free running ☐
Swimming ☐
Other ☐ ……
8. Assessment of dog's postoperative clinical condition
1. Worsening ☐
2. Stable ☐
3. Small improvement ☐
4. Great improvement ☐
5. Full recovery ☐
9. If you had to decide again, would you choose conservative treatment?
Yes ☐ No ☐
Why……

Table 3. Questionnaire for surgical treatment

Registration number:……..……
Presentation date:…… **Surgery's date:**……..…..
Owner:……
Phone number:……
Dog's characteristics: Male ☐ Female ☐ Neutered☐
Age……..……Breed…….
Name……..……Weight……..…
Disease:
Osteochondrosis of humeral head ☐
Osteochondrosis of medial part of humerus trochlea ☐
Completed questionnaire: Yes☐ No ☐
1. Nutrition
1.1. Kind of nutrition
DF ☐ CF ☐……
Barf ☐ Other ☐.....
1.2. Dietary supplements
Yes ☐ No ☐
Formulation……..
Duration of administration……
2. Preoperative Lameness
2.1. Duration……
2.2. Grade: ⓪ ① ② ③ ④ ⑤
3. Post-operative lameness
Time & lameness grade
- 1st week: ⓪ ① ② ③ ④ ⑤
- 1st month: ⓪ ① ② ③ ④ ⑤
- 6th month: ⓪ ① ② ③ ④ ⑤

4. Analgesia
4.1. Yes ☐ No ☐
4.2. Drug……..
4.3. Administration's duration……
4.4. Was analgesia useful? Yes ☐ No ☐ Possibly ☐
5. Restriction
5.1. Yes ☐ No ☐
5.2. Duration……
5.3. Restriction's kind:……
5.4. Was restriction useful? Yes ☐ No ☐ Possibly ☐
6. Physical therapy
6.1. Yes ☐ No ☐
6.2. Kind: Passive movements ☐ Swimming ☐ Bathtub ☐
6.3. Frequency……
6.4. Duration……
6.5. Was analgesia beneficial? Yes ☐ No ☐ Maybe ☐
7. Does the dog appear lame after exercise?
7.1. Yes ☐ No ☐
7.2. Grade: ⓪ ① ② ③ ④ ⑤
7.3. Does the lameness reduce after rest? Yes ☐ No ☐
8. What kind of exercise do you use to keep your dog active?
Walking on a leash ☐
Free running ☐
Swimming ☐
Other ☐ ……
9. Assessment of dog's postoperative clinical condition
1. Worsening ☐
2. Stable ☐
3. Small improvement ☐
4. Great improvement ☐
5. Full recovery ☐

Table 4. Summary of treated animals

Ordinal Number (n)	Treated animals							
	Breed	Age (months)	Gender	Weight (kg)	Limb	Grade of lameness	Duration of lameness (months)	Method of treatment
1	English Setter	8	Male	18.5	Right	2	2	Conservative
2	English Setter	8	Male	20	Left	1	1	Conservative
3	Mongrel	4	Male	10	Left	1	1	Conservative
4	Dogue de Bordeaux	8	Male	31	Right	2	1.5	Surgical
5	Pitbull	8	Male	29.9	Right	2	2.5	Surgical
6	Cane Corso	7,5	Female	35	Right	2	1	Surgical
7	English Setter	7	Female	13	Left	1	1	Surgical
8	Labrador	8	Female	30	Left	2	2	Surgical
9	Labrador	8	Female	30	Right	1	26	Conservative
10	English Setter	7	Female	15.6	Left	1	3	Surgical

Figure 3. Craniocaudal radiograph of elbow showing a large lateral condylar lucent defect (white arrow) with a sclerotic margin.

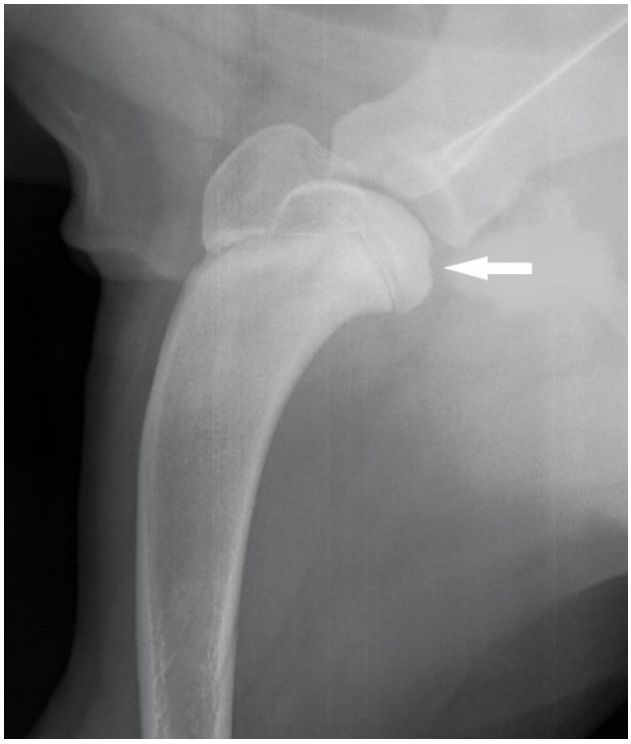

Figure 4. Lateral radiograph of the shoulder joint showing an oval radiolucent area (white arrow) measuring on the caudal aspect of the humeral head.

using CT (Fig. 5), while MRI revealed a significant subchondral bone defect in the humeral head's caudal-medial area and minor left shoulder joint effusion in the final case (Fig. 6). Four cases underwent surgery, while six others were treated conservatively. We recommended surgery in the following situations: 1) Pain elicited on shoulder extension or flexion. 2) No other radiographic lesions of the forelimb were found. 3) The shoulder lameness had persisted after 6 1⁄2 months of age. 4) A cartilage flap or "joint mouse" was confirmed radiographically. Postoperative outcomes were gathered through phone interviews with the pet owners. However, two dogs (No=3, No=5) could not be tracked due to outdated contact information.

Two dog owners who opted for conservative treatment noticed an improvement in their dogs' lameness following anti-inflammatory medication (No=2, No=9). However, they did not restrict their dogs' physical activities. In two instances (No=1, No=9), grade 2 lameness was noticeable post-exercise and in one of them (No=9) exhibited grade 2 lameness during periods of high humidity. The owners chose different exercise routines for their dogs: two allowed their dogs to run freely (No=1, No=2), while one preferred walking their dog on a leash combined with running (No=9). All of them favored conservative treatment again, praising the effectiveness of analgesics or the dogs' purpose for hunting and competition.

In the group that underwent surgery, the dogs refrained from using the affected limb for one week after the operation. In four cases, the dogs returned to full activity within a month, except for one that exhibited grade-1 lameness (No=8). Six months postoperative, all dogs showed no signs of lameness. The owners expressed satisfaction with the pain medication, and they found it helpful to restrict their dogs' postoperative activities to short, leashed walks with running and jumping limitations. However, for two instances, these restrictions were applied differently; in one case, activity was limited only for 2 weeks (No=5), and another dog was not restricted at all (No=8).

Figure 5. CT image of shoulder joints reveals an empty ovoid defect of the humeral head (yellow arrows) with a displaced loose osteochondral fragment.

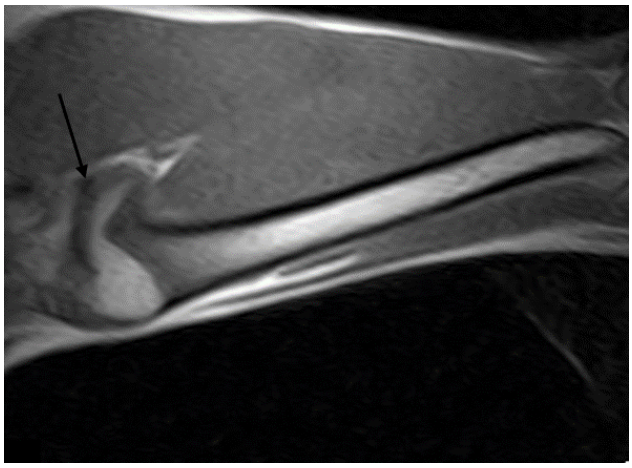

Figure 6. A typical appearance of an osteochondritis dissecans lesion on MRI. The black arrow delineates the associated hyperintense bone marrow lesion of the caudal part of humeral head.

These restrictions were reportedly beneficial for dogs' mobility. Three dogs were exercised with free running (No=4, No=7, No=10), one with leashed walks (No=6), and one dog used a combination of both methods (No=8). Following the exercise, one case showed a grade 2 lameness (No=8) and another a grade 1 (No=10). Rest alleviated the lameness in both cases.

According to the owners' assessment, the outcomes of surgically treated dogs were excellent for four dogs (No=4, No=6, No=7, No=8) and very good for one (No=10). For the conservatively treated dogs there was no improvement in one dog (No=1), a little improvement in another one (No= 2) and big improvement in one (No=9). Interestingly, during orthopedic re-examination at 1 and 3 months post-operatively for one dog (No=5), crepitus was detected during hyperextension of the affected shoulder joint. Six months after the operation, this same dog

exhibited crepitus and low-grade pain, identifiable by dilated pupils and elevated heart and respiratory rates may be because of the developed secondary osteoarthritis. Despite this, all gait evaluations yielded no signs of lameness. However, the owner described occasional lameness, notably after lengthy periods of rest, that lessened after walking.

The dog previously treated for bilateral shoulder OCD (No=8, No=9) was re-examined 6 years postoperative. The dog showed grade 1 lameness in its right conservatively treated thoracic limb. Upon palpation, crepitus was detected in the right thoracic limb, and pain was observed during hyperextension and hyperflexion in both thoracic limbs; however, the pain was more severe in the right thoracic limb, as indicated by increased muscle tone and resistance to examination. Contrastingly, symptoms in the left thoracic limb included dilated pupils (mydriasis) and an elevated heart and respiratory rate. The dog weighed 46 kg at the time of the follow-up examination. Radiologic findings showed a cartilage flap and osteosclerosis of the shoulder's articular surfaces of the limb treated conservatively (Fig. 7), and osteophytes in the limb that underwent surgery (Fig. 8).

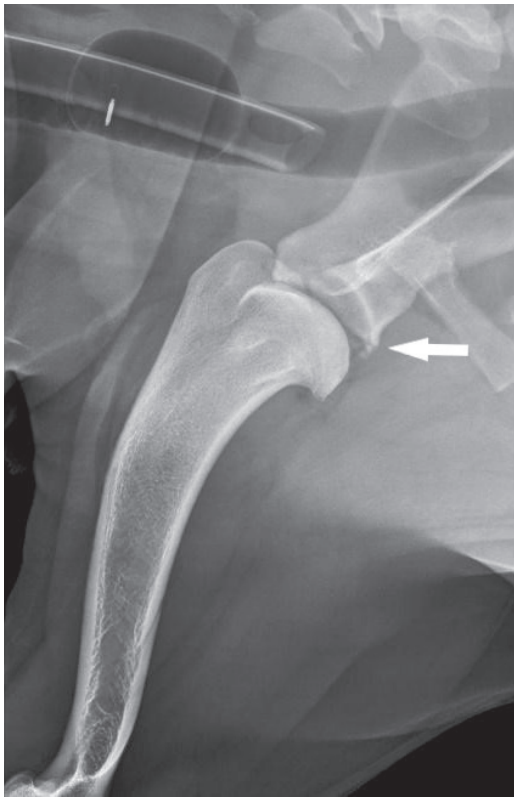

Figure 7. Secondary degenerative changes (osteophytes) were observed on a surgically treated shoulder.

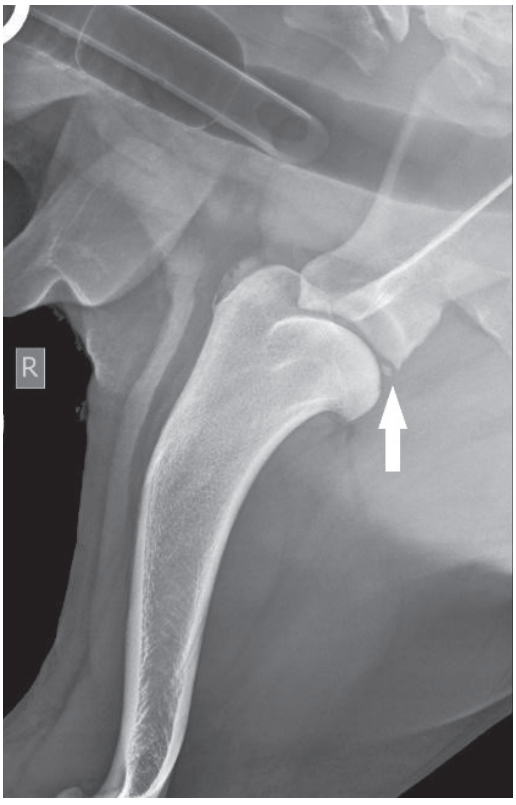

Figure 8. Cartilage flap and articular surface's osteosclerosis in the shoulder joint of a conservative treated limb.

DISCUSSION

HO is relatively infrequent in the broader scope of orthopedic diseases. Bieżyński et al. (2012) confirmed this fact. Out of 2000 surgeries conducted over 2 years, only 36 were for OCD treatment. Literature suggests various risk factors, with hereditary and anatomical conformation appearing as significant contributors to osteochondrosis. Its prevalence varies across different breeds (Ytrehus et al., 2007), with large and giant breeds – specifically Labrador Retrievers, Newfoundlands, and Rottweilers – being most at risk (Slater et al., 1991).

Our findings correlate with literature data, with 50% of incidents relating to large-breed dogs. However, our study also reinforces the minority of literature which mentions that medium breeds are also susceptible to HO (Biezyński et al., 2012). In a previous retrospective case-control study on OCD by Slater et al. (1991), male dogs had increased vulnerability to shoulder joint pathology due to the influence of sex hormones (Milton, 1983). Nevertheless, our study did not find a significant discrepancy between male and female patients, possibly due to the limited sample size.

Nutritional factors that cause an imbalance in calcium-phosphorus ratios have been implicated as significant contributors. Five cases involved dietary supplements (No=1, No=7, No=8, No=9, No=10). Ytrehus et al. (2007) propose that increased body weight may hasten the transition from osteochondrosis to osteoarthritis, as observed in our study in the case of bilateral HO. The histories of two cases showed links to an injury, which, according to Ytrehus, does not seem to be a crucial factor in etiopathogenesis. In these cases, trauma could cause a vertical fracture of abnormal articular cartilage and the formation of the cartilage flap. In most cases, lameness gradually worsened over time, particularly after intense exercise. This supports the findings of Vaughan and Jones (1968), who studied 22 dogs with shoulder OCD.

For diagnostic purposes, our patients primarily underwent clinical and radiological examinations. In four specific cases where survey radiography did not reveal cartilage lesions, we used MRI and CT scans. MRI was employed in one case, and CT scans were used in three. The inability of mediolateral views to detect the flap has already been reported and for this reason the supinated-mediolateral one has been recommended for the visualization of the caudal and central portion of the humeral head (Callahan and Ackerman, 1985).

Our study involved performing caudolateral arthrotomy with the objective of segmenting and eradicating the affected articular cartilage piece while also invigorating the tissue within the injured area to promote fibrocartilage growth. Generally, both of three basic arthrotomy techniques (craniolateral, caudolateral and caudal) require myotomy and tenotomy and are considered to be more traumatic resulting in longer recovery time and in more intense analgesic forms. When the caudolateral approach with the retraction of the teres minor muscle compared with a craniolateral approach with tenotomy of the infraspinatus muscle, an increased joint extension and range of motion and a better visualization of the articular surface was observed in the first one (McLaughlin and Roush, 1995; Amsellem, 2011). Punzet et al. (1974) described an approach providing an articular access between the distal segment of the supraspinatus muscle and the infraspinatus tendon. One decade later, Cheli et al. (1985) proposed a modification of this approach by positioning the shoulder in hyperflexion. The original Cheli approach was further modified by Vezzoni creating a limited open approach without humeral head luxation. However, shoulder's hyperflexion leads to collapse of the caudal portion of the joint. For this reason, the repositioning of the shoulder into a neutral position and the application of distal traction while flushing the caudal joint space was suggested in order to mobilize and collect detached flaps (Vezzoni et al., 2021). Due to the limited quantity and quality of newly formed fibrocartilage, restorative methods like osteochondral autograft implantation are being advanced (Adamiak et al., 2007). However, this method is restricted by donor site availability and morbidity (Cook et al., 2008; Fitzpatrick et al., 2012; Cinti et al., 2022). Synthetic osteochondral resurfacing implants is another technique indicated for large shoulder and stifle OCD lesions in dogs with the limitation of the size and shape of commercially available implants (Murphy et al., 2019). The idea of patient-specific implant was developed and implemented with the use of 3-D printed surgical guides (Mosser et al., 2023; Schmierer and Böttcher, 2023; Sutalo et al., 2024). As part of the effort to form hyaline or hyaline-like cartilage, the intraarticular injection of platelet-rich plasma (PRP) or mesenchymal stem cells (MSCs) or their combination has been proposed in both human and veterinary medicine as an adjunct modality of the conservative and surgical treatment (Franklin et al., 2018; Sharma et al., 2018; Sánchez et al., 2019; Sasaki et al., 2019; Domaniza et al., 2023).

In our group that underwent surgery, lameness was no longer an issue 6-month post-operation. However, one overweight dog that was not given restrictions showed grade 2 lameness after exercise, and another displayed mild, barely noticeable lameness. In both instances, the lameness receded after rest. It is worth noting that according to the literature the limb's function is not fully restored after surgical treatment in the cases of elbow OCD. This is explained by the inevitable development of osteoarthritis in this joint (DeCamp et al., 2016; Fossum, 2019).

Non-surgical treatments for joint discomfort include exercise restriction, rest, and the use of anti-inflammatory medications. Some suggest liberal activity to encourage the detachment of cartilage flaps, which could initiate healing. However, the presence of these flaps in the joint might lead to secondary osteoarthritis. It is generally recommended that conservative treatment be used for patients under 6 months with small lesions, minimal lameness,

and no loose bodies (Milton, 1983). If "joint mice" develop, pain relief typically occurs within a 1 or 2 weeks. Conservative medical therapy is also suggested in these situations (Novotny and Runyon, 1986). In our study, we assigned exercise restrictions, but dog owners did not consistently implement these. The dogs' lameness improved with anti-inflammatory medication, but symptoms remained perceptible after intense exercise or during periods of high humidity, likely due to degenerative joint disease.

Different surgical techniques are currently utilized to treat articular cartilage defects. Traditional methods, including cartilage flap removal and the drilling of the subchondral bone plate, intend to promote fibrocartilage growth, which is incapable of withstanding ongoing stress, often resulting in secondary degenerative joint disease. New promising methods are under development for the treatment of articular cartilage lesions related to OCD. Nevertheless, due to the limited number of clinical publications that employ objective measures when reporting outcomes, additional research is required.

CONCLUSIONS

In conclusion, in our Clinic, HO mainly affected dogs of medium and large breeds. The diagnosis was based on orthopedic and radiographic examinations of the affected shoulder or elbow joints. We have found surgical treatment to be more effective for our patients, while conservative methods have yielded less satisfactory results for lameness in dogs. In most cases, lameness recurs under favorable conditions due to osteoarthritis.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES

Adamiak Z, Nowicki M (2007) Implementation of osteochondral autografting for the treatment of osteochondritis dissecans of the canine stifle joint. A case report. Bull Vet Inst Pulawy 51: 705-708.

Amsellem P (2011) Complications of reconstructive surgery in companion animals. Vet Clin North Am Small Anim Pract 41(05): 995–1006.

Bieżyński J, Skrzypczak P, Piatek A, Kościółek N, Drozdzyńska M (2012) Assessment of treatment of Osteochondrosis dissecans (OCD) of shoulder joint in dogs - The results of two years of experience. Pol J Vet Sci 15(2): 285–290.

Butterworth SJ, Pettitt R (2018) The shoulder. In: BSAVA Manual of Canine and Feline Musculoskeletal Disorders A practical guide to lameness and joint disease. Gareth Arthurs G, Brown G, Pettitt R (eds). 2nd ed, BSAVA, Gloucester: pp 252-286.

Callahan TF, Ackerman N (1985) The supinated mediolateral radiograph for detection of humeral head osteochondrosis in the dog. Vet Radiol Ultrasound 26: 144–148.

Cheli R, Mortellaro CM, Fonda D (1985) Nuovo accesso cranio-laterale per l'artrotomia scapolo-omerale nel cane. Summa (Milano) 2: 91–94.

Cinti F, Vezzoni L, Vezzoni A (2022) A new generation of osteochondral autograft transfer system for the treatment of osteochondritis dissecans of the femoral condyle: clinical experience in 18 dogs. Vet Comp Orthop Traumatol 35(03): 198–204.

Cook JL, Hudson CC, Kuroki K (2008) Autogenous osteochondral grafting for treatment of stifle osteochondrosis in dogs. Vet Surg 37 (04): 311–321.

Decamp CE, Johnston SA, Dejardin LM, Schaefer SL(2016). Arthrology. In: Brinker, Piermattei, and Flo's Handbook of Small Animal Orthopedics and Fracture Repair. 5th ed, Elsevier, St. Louis: pp 180–210.

Denny HR, Butterworth SJ (2000) Osteochondrosis. In: A Guide to Canine and Feline Orthopedic Surgery. 4th ed, Blackwell, Oxford: pp 41-51.

Domaniza M, Hluchy M, Cizkova D, Humenik F, Slovinska L, Hudakova N, Hornakova L, Vozar J, Trbolova A (2023) Two Amnion-Derived Mesenchymal Stem-Cells Injections to Osteoarthritic Elbows in Dogs—Pilot Study. *Animals* 13(13): 2195.

Ekman S, Carlson CS (1998) The pathophysiology of osteochondrosis. Vet Clin North Am Small Anim Pract 28(1): 17–32.

Franklin SP, Stoker AM, Bozynski CC, Kuroki K, Clarke KM, Johnson JK, Cook JL (2018) Comparison of Platelet-Rich Plasma, Stromal Vascular Fraction (SVF), or SVF with an Injectable PLGA Nanofiber Scaffold for the Treatment of Osteochondral Injury in Dogs. J Knee Surg 31(7): 686-697.

Fitzpatrick N, Yeadon R, van Terheijden C, Smith TJ (2012) Osteochondral autograft transfer for the treatment of osteochondritis dissecans of the medial femoral condyle in dogs. Vet Comp Orthop Traumatol 25(02): 135–143.

Fossum TW (2019) Diseases of the joints. In: Small animal surgery. 5th ed, Elsevier, Philadelphia: pp 1134–1279.

Grøndalen T (1974) Osteochondrosis, arthrosis and leg weakness in pigs. Nord Vet Med 26(9): 534-537.

Harari J (1998) Osteochondrosis of the femur. Small Anim Pract 28: 87-94.

Johnston SA(1998) Osteochondritis dissecans of the humeral head. Small Anim Pract 28(1): 33-49.

Krystalli A, Sideri A, Kazakos MG, Anatolitou A, Prassinos NN (2023) Contribution to the study of perioperative factors affecting the restoration of dog's mobility after femoral head and neck excision. A clinical study in 30 dogs. Animals 13(14): 2295. DOI:10.3390/ani13142295

Kuroki K, Cook JL, Stoker AM, Turnquist SE, Kreeger JM, Tomlinson JL (2005) Characterizing osteochondrosis in the dog: potential roles for matrix metalloproteinases and mechanical load in pathogenesis and disease progression. Osteoarthr Cartil 13(3): 225-234.

LaFond E, Breur GJ, Austin CC (2002) Breed susceptibility for developmental orthopedic diseases in dogs. J Am Anim Hosp Assoc 38(5): 467–477.

Milton JL (1983) Osteochondritis dissecans in the dog. Vet Clin North Am Small Anim Pract 13(1): 117–134.

McLaughlin R Jr, Roush JK (1995) A comparison of two surgical approaches to the scapulohumeral joint in dogs. Vet Surg 24(03): 207–214.

Moser J, Haimel G, Barker-Benfield K, Leschnik K, Böttcher P (2023) Fully guided synthetic osteochondral resurfacing of a large stifle OCD lesion using a patient specific implant and drill guides. VCOT Open 6(1): e8-e13.

Murphy SC, Egan PM, Fitzpatrick NM (2019) Synthetic osteochondral resurfacing for treatment of large caudocentral osteochondritis dissecans lesions of the humeral head in 24 dogs. Vet Surg 48(5): 858-868.

Novotny D, Runyon CL (1986) Osteochondritis Dissecans in the Dog. Iowa State University Digital Repository 48(1): 46-50.

Olivieri M, Ciliberto E, Hulse DA, Vezzoni A, Ingravalle F, Peirone B

(2007) Arthroscopic treatment of osteochondritis dissecans of the shoulder in 126 dogs. Vet Comp Orthop Traumatol 20(1): 65-69.
Olsson SE (1987) General and aetiologic factors in canine osteochondrosis. Vet Q 9(3): 268-278.
Punzet G (1974) Klinik und chirurgische behandlung der osteochondrosis dissecans des humeruskopfes beim Hund. Wien Tierarztl. Mschr 24: 75-82.
Sánchez M, Delgado D, Garate A, Sánchez P, Padilla S, Azofra J (2019) Platelet-rich plasma combined with allograft to treat osteochondritis dissecans of the knee: a case report. *J Med Case Rep* **13(1):** 105.
Sasaki A, Mizuno M, Mochizuki M, Sekiya I (2019) Mesenchymal stem cells for cartilage regeneration in dogs. World J Stem Cells 11(5): 254-269.
Sharma DK, Kumar N, Lal H, Sahu BK, Saikia SS (2018) Osteochondritis dissecans-Does platelet rich plasma really help. J Clin Orthop Trauma 9(2): 153-156.
Schmierer PA, Böttcher P (2023) Patient specific, synthetic, partial unipolar resurfacing of a large talar osteochondritis dissecans lesion in a dog. Vet Surg 52(5): 731-738.
Slater MR, Scarlett JM, Kaderly RE, Bonnett B (1991) Breed, Gender, and Age as Risk Factors for Canine Osteochondritis Dissecans. Vet Comp Orthop Traumatol 4: 40-46.
Stokes R, Dycus D (2021) The Shoulder Joint and Common Abnormalities. Small Anim Pract 51(2): 323-341.
Sutalo S, Kühn M, Böttcher P Patient-Specific Synthetic Osteochondral Resurfacing of an Extensive Shoulder OCD Lesion in a Dog (2024) VCOT Open 7: e11–e16.
van der Peijl GJM, Schaeffer IGF, Theyse LFH, Dijkshoorn NA, Schwencke M, Hazewinkel HAW (2012) Osteochondrosis dissecans of the tarsus in Labrador Retrievers: clinical signs, radiological data and force plate gait evaluation after surgical treatment. Vet Comp Orthop Traumatol 25(2): 126-134.
Vaughan LC, Jones DGC (1968) Osteochondritis Dissecans of the Head of the Humerus in Dogs. Small Anim Pract 9(6): 283-294.
Vezzoni A (1986) A new antero-lateral approach to the shoulder joint of the dog. Proceedings XI WSAVA Congress, Paris 61.
Vezzoni A, Vezzoni L, Boiocchi S, Miolo A, Holsworth IG (2021) A Modification of the Cheli Craniolateral Approach for Minimally Invasive Treatment of Osteochondritis Dissecans of the Shoulder in Dogs: Description of the Technique and Outcome in 164 Cases. Vet Comp Orthop Traumatol 34(2): 130–136.
Ytrehus B, Carlson CS, Ekman S (2007) Etiology and pathogenesis of osteochondrosis. Vet Pathol 44(4): 429–448.