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

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Abstract

Objective The aim of this study was to describe a novel minimally invasive surgical approach for the treatment of shoulder osteochondritis dissecans (OCD) in dogs and to retrospectively review our clinical cases treated with this approach.

Study Design The study describes a modification of Cheli surgical approach (1985), developed to reduce the degree of invasiveness as well as the incidence of postoperative complications observed in other surgical approaches to the shoulder joint. Medical records of dogs that underwent our minimally invasive approach to the scapulohumeral joint for treatment of OCD from May 2001 to May 2019 were retrospectively reviewed for intraoperative findings and complications. Clinical outcome and complications were also evaluated in the operated dogs with a minimum of a 2-month-follow-up evaluation.

Results A total of 164 shoulders in 141 dogs (23 bilateral), 103 males and 38 females, were examined and treated with our modified craniolateral approach for the treatment of OCD of the humeral head. In all cases, the modified craniolateral approach allowed visibility and adequate exposure of the caudal humeral head surface. Radiographic and clinical follow-up evaluations were available in 123/164 (75%) cases. The clinical outcome was consistent with other reports using different surgical approaches for OCD lesions of the humeral head in dogs.

Clinical Significance This technique provided a reliable approach for surgical treatment of canine shoulder OCD and can be considered a valid alternative to other surgical approaches including arthroscopy.

Keywords
- osteochondritis dissecans
- shoulder
- dog
- arthrotomy
- minimally invasive approach

Introduction

Osteochondritis dissecans (OCD) of the canine shoulder is a common cause of forelimb lameness in dogs and constitutes a disturbance of endochondral ossification resulting in focal thickening of the joint cartilage with subsequent dissection of a flap of this thickened cartilage away from the underlying subchondral bone.[1,2] The cartilaginous flap is most frequently located in the caudocentral or caudomedial region of the humeral head.[2] The exact aetiology of OCD is unknown, but there is evidence that some factors, such as heredity, rapid growth, trauma and poor diet, are essential for its occurrence.[3] The disease occurs mainly in large and giant breed male dogs, with 27 to 68% of patients having radiographic lesions bilaterally.[3–5] The onset of clinical signs (lameness and pain) generally occurs between 4 and 10 months of age.[3–5] Surgical treatment

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options include open arthrotomy or arthroscopic joint examination, with the subsequent removal of the elevated cartilage flap and the curettage of the underlying subchondral bone bed to stimulate fibrocartilage formation as well as infill the joint surface defect. The post-surgical recovery period is approximately 2 months compared with approximately 7 months following conservative treatment.[6] The prognosis following surgical recovery is good, with 75 to 91% of patients showing no lameness at a mean interval of 3 years after surgery.[7,8] Arthroscopic surgery is a minimally invasive approach that gives good overall joint visibility, allows intra-articular palpation, manipulation and resection of joint structures and when performed by experienced surgeons can result in low morbidity and good recovery.[7,9–11] The challenges inherent with its use are the need to invest in expensive instrumentation, the intensive training required to perform the procedure and the technical difficulty in removing large detached cartilage flaps from the caudolateral instrument portal. Open shoulder arthrotomy using various modifications of three standard approaches (craniolateral, caudolateral and caudal) provides adequate exposure of the joint surfaces without damaging the cartilage or compromising joint function, and results in minimal postoperative complications.[12–15] Generally, arthrotomy techniques requiring myotomy, tenotomy or osteotomy are considered to be more traumatic and result in more severe postoperative pain and lameness than those requiring only muscle separation.[15] In particular, a caudolateral approach with craniodorsal retraction of the teres minor muscle (no tenotomy) has been shown to result in increased joint extension and range-of-motion compared with a craniolateral approach with tenotomy of the infraspinatus muscle, but there was less exposure to the articular surface compared with a craniolateral approach.[13,16] In the early 1970s, Punzet was the first to describe an articular access between the distal segment of the supraspinatus muscle and the infraspinatus tendon.[17] A decade later, Cheli and colleagues proposed a modification of this original technique by positioning the shoulder in forced hyperflexion[18] (►**Fig. 1**). This resulted in caudal displacement

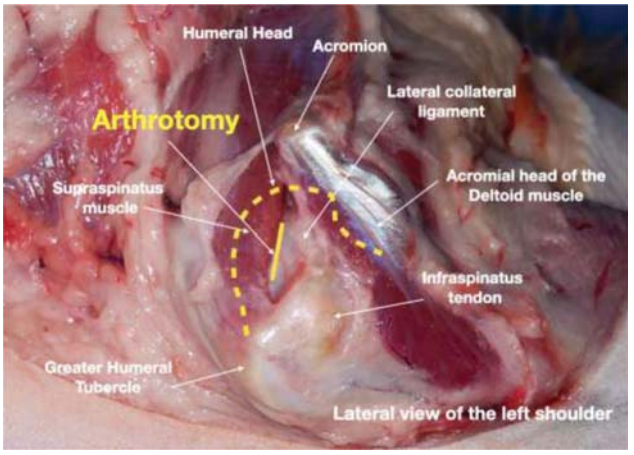

Fig. 2 Anatomical specimen showing how forced hyperflexion of the shoulder results in caudal displacement of the acromial head of the deltoid and infraspinatus muscles, providing exposure of the joint capsule without the need for myotomy or tenotomy.

of the acromial deltoid and infraspinatus muscles, which improved exposure of the joint surfaces without the need for myotomy or tenotomy (►**Fig. 2**). The original Cheli craniolateral approach was further modified by Vezzoni in 1986 to create a limited open approach for the debridement of OCD lesions of the caudal humeral head without humeral head luxation as proposed by Cheli.[19]

The aim of this study was to describe a modification of the Cheli approach for minimally invasive treatment of shoulder OCD in dogs. A retrospective review of clinical cases treated with this novel surgical technique is presented in this study.

Materials and Methods

Case Selection

Medical records of dogs that underwent treatment of OCD using this modified Cheli approach from May 2001 to May 2019

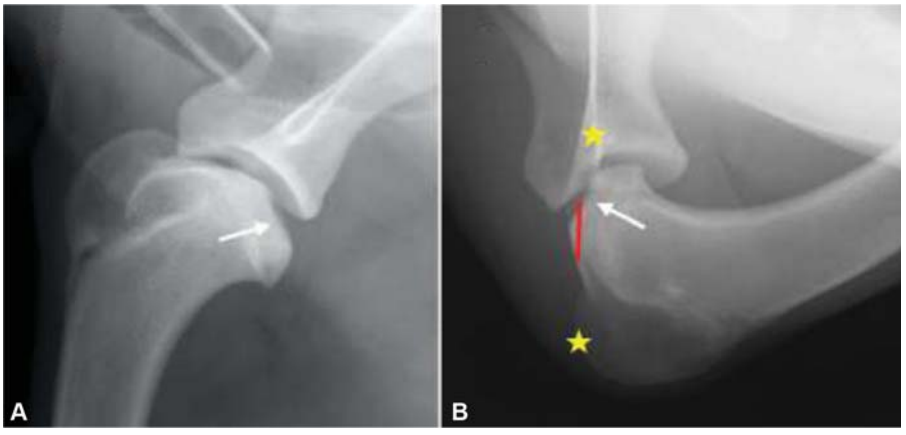

Fig. 1 (**A**) Neutral radiographic view of the shoulder of an English Setter with osteochondrosis dissecans (OCD) showing the lesion on the caudal surface of the humeral head (white arrows). (**B**) Forced hyperflexion of the shoulder joint, as proposed by Cheli in 1984, moves the caudal surface of the humeral head cranially. The yellow stars indicate the landmarks for the direction of the skin incision, approximately midway between the cranial edge of the acromion process and the proximal greater humeral tubercle. The red line indicates the joint approach for direct access to the OCD lesion.

at the Clinica Veterinaria Vezzoni, Cremona, Italy, were retrospectively searched for clinical results and complications. All surgeries were performed by one of two surgeons (A.V., L.V.). For inclusion in the retrospective study, a complete patient medical record with preoperative radiographs of both shoulder joints and a minimum clinical follow-up period of 2 months was required for all dogs.

Data retrieved from the medical record included breed, gender, age at diagnosis, body weight, limb affected, unilateral or bilateral lesions, lameness score at diagnosis, surgery duration, intraoperative observations and intraoperative and postoperative complications. Postoperative complications were defined as any unexpected event that occurred after surgery. Clinical follow-up observations at various time periods greater than 2 months were required for each dog.

Anaesthesia

All dogs were premedicated with morphine (0.15 mg/kg intramuscular [IM]) or methadone (0.1–0.2 mg/kg IM) and acepromazine (0.01 mg/kg IM). General anaesthesia was induced using propofol (3–6 mg/kg) administered via a peripheral venous catheter and maintained using isoflurane (1–1.5% in 80% oxygen) after endotracheal intubation. Intraoperative analgesia was provided by a constant rate infusion of fentanyl (10 µg/kg/hr). Cefazolin sodium (22 mg/kg IV) was only administered at the time of anaesthetic induction. Postoperative analgesia consisted of a single intra-articular injection of lidocaine 1% (1 mg/kg) and morphine (0.1 mg/kg) after closure of the joint capsule.

Fig. 3 Position of the dog in lateral recumbency with the surgical limb uppermost. The shoulder joint is held in maximum hyperflexion and the elbow joint in hyperextension using a surgical positioning device secured to the surgical table, and the distal aspect of the limb is positioned close to the abdomen,

Surgical Technique

Standard surgical instrumentation was augmented with pointed Mayo forceps, two small Gelpi retractors with overlapping deep arms, a 4 mm blunt Langenbeck periosteal elevator, a 1.5 mm blunt meniscal probe, a 3 mm sharp periosteal elevator, 2 mm curette and a microfracture awl. Dogs were positioned in lateral recumbency with the surgical limb uppermost. The shoulder joint was held in maximum hyperflexion and the elbow joint in hyperextension using a surgical positioning device secured to the surgical table and the distal aspect of

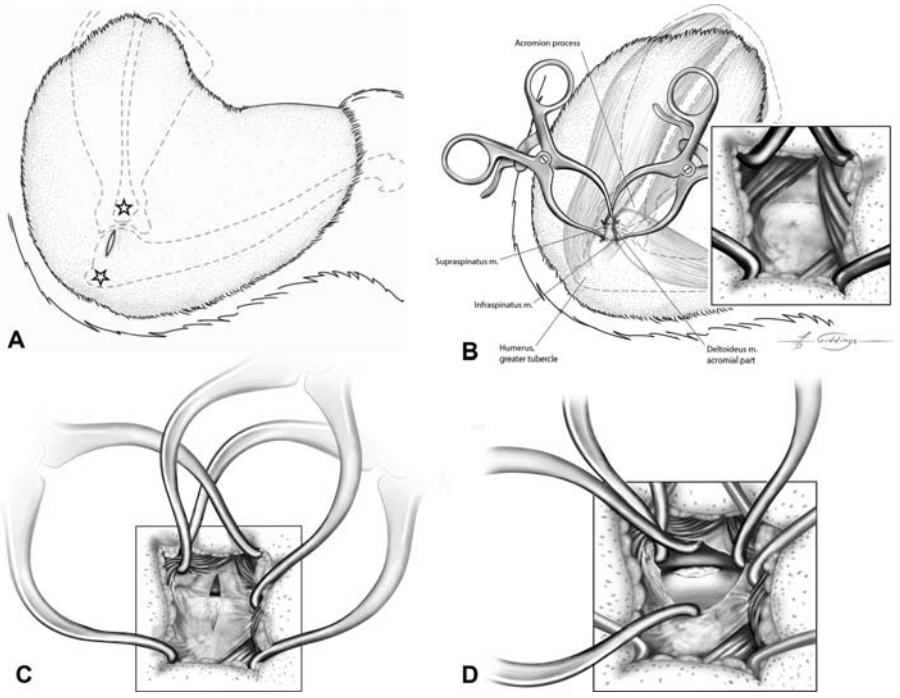

Fig. 4 (**A**) A longitudinal 1 to 1.5 cm skin incision is made on the craniolateral aspect of the shoulder, midway between the cranial edge of the acromion process and the proximal greater tubercle (stars). (**B**) The cranial margin of the acromial head of the deltoid muscle is identified below the subcutaneous tissue layer, and the intermuscular septum between the caudal margin of the supraspinatus muscle belly and the acromial deltoid muscle is identified and bluntly separated to expose the joint capsule beneath. (**C**) Two small self-retaining Gelpi retractors are positioned perpendicularly to each other to keep the muscles separated and gain adequate joint capsule exposure which is incised in a proximal to distal plane to mimic the intermuscular septum dissection. (**D**) The Gelpi retractors are then placed in the joint and the joint capsule arthrotomy is divaricated to expose the articular surface of the humeral head.

the limb was positioned close to the abdomen (►**Fig. 3**). The shoulder area was aseptically prepared. The acromion process and the greater tubercle were used as anatomical landmarks. A longitudinal 1 to 1.5 cm skin incision was made on the craniolateral aspect of the shoulder, approximately midway between the cranial edge of the acromion process and the proximal greater tubercle (►**Fig. 4A**). The cranial margin of the acromial head of the deltoid muscle was identified below the subcutaneous tissue layer, and the intermuscular septum between the caudal margin of the supraspinatus muscle belly and the acromial deltoid muscle was identified and bluntly separated to expose the joint capsule beneath (►**Fig. 4B**). Two small self-retaining Gelpi retractors were positioned perpendicularly to each other to keep the muscles separated and gain adequate joint capsule exposure (►**Fig. 4C**). The fibrous joint capsule was incised in a proximal to distal plane to mimic the intermuscular septum dissection. The arthrotomy was adjacent and cranial to the lateral collateral ligament. The Gelpi retractors were then placed in the joint to retract the joint capsule arthrotomy and expose the articular surface of the humeral head (►**Fig. 4D**). The humeral head was then inspected by gentle probing with a meniscal probe to identify the osteochondral flap, which was exposed by shoulder hyperflexion. The flap was carefully elevated from its peripheral attachment using a sharp periosteal elevator and removed with grasping forceps (►**Fig. 5**). Cartilage remnants were removed from the margins of the lesion while pushing the humeral head distally with the blunt Langenbeck elevator (►**Fig. 6**). The meniscal probe was then used to evaluate the margins of the OCD lesion to determine the completeness of flap removal. Microfracture was performed when sclerotic bone was found underneath the flap to promote vascular ingrowth and subsequent fibrocartilage formation by migrating mesenchymal cells.[20]

When significant fibrocartilage tissue was identified on the OCD lesion bed after flap removal, saline lavage of the area was done rather than curettage or microfracture. In patients with detached OCD flaps that were not visible, joint lavage under pressure was performed and the tip of a 19 G venous catheter was directed medially, caudally and cranially to mobilize and remove the detached flap. To facilitate effective flushing of the joint at the end of the procedure, the limb was positioned in a neutral standing position, and gentle distal traction was used to distract the joint surfaces from each other.

The joint capsule was closed with one or two interrupted sutures using absorbable suture material with a small diameter needle (Vicryl EP 1.5 mounted on a 10 mm 1/3 circle needle). The intermuscular septum, subcutaneous tissues and skin were closed routinely.

Postoperative Care

Dogs were discharged the same day and received amoxicillin/clavulanic acid (12.5 mg/kg per os) for 5 days and meloxicam (0.1 mg/kg per os) once daily for 5 days postoperatively and then every other day for another 7 days. Restricted exercise in the form of short controlled leash walks was advised for the first month postoperatively. The duration and intensity of the walks were gradually increased in the second month with return to normal activity 3 months postoperatively.

In-Clinic Follow-Up Examination

Clinical and radiographic postoperative re-examinations were done 2 to 5 months (short-term) and in some dogs 6 to 12 months (medium-term) and > 12 months (long-term) postoperatively.[21] At each follow-up examination, the gait and presence and degree of lameness were assessed via video recordings in all dogs. The presence of complications was also noted.

Data Analysis

Descriptive statistical analysis (median, range, percentage) was used to report data.[21]

Results

A total of 164 shoulders in 141 dogs (23 bilateral), consisting of 103 males and 38 females, were examined and treated with our modified technique for the treatment of OCD of the humeral head. Breeds included Border Collie ($n = 23$), Italian Cane Corso ($n = 13$), Golden Retriever ($n = 10$), mixed-breed ($n = 9$) Bernese Mountain dog ($n = 8$), Great Swiss Mountain dog ($n = 8$), Boxer ($n = 7$), English Setter ($n = 6$), German Shorthaired Pointer ($n = 6$), Rottweiler ($n = 6$) Belgian Shepherd dog ($n = 5$),

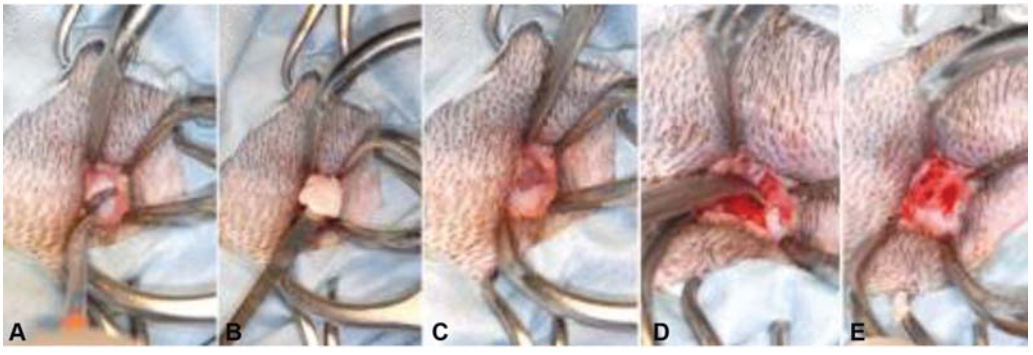

Fig. 5 The flap is carefully elevated from its peripheral attachment using a sharp periosteal elevator (**A**) and removed (**B**). The margins of the osteochondritis dissecans lesion are inspected to determine the completeness of flap removal (**C**). Microfracture is performed when sclerotic bone is found underneath the flap (**D**) to promote vascular ingrowth and subsequent fibrocartilage formation by migrating mesenchymal cells (**E**).

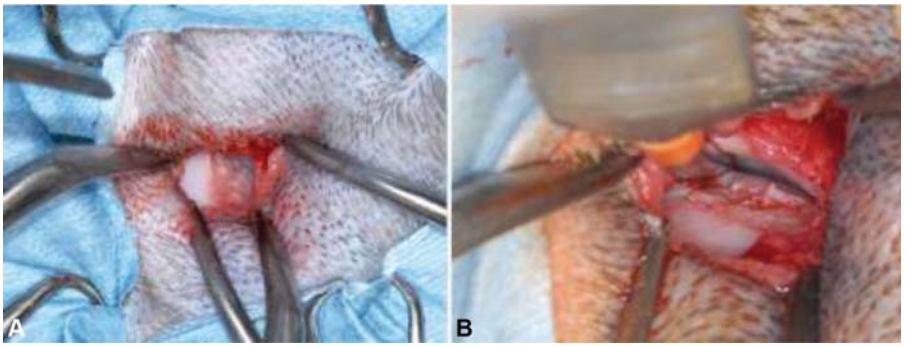

Fig. 6 When significant fibrocartilage tissue is identified on the osteochondritis dissecans lesion bed after flap removal, curettage or microfracture is not done (**A**). Cartilage remnants are removed from the margins of the lesion while pushing the humeral head distally with a blunt Langenbeck elevator (**B**).

German Shepherd dog ($n = 5$), Saint Bernard dog ($n = 5$), Great Dane ($n = 4$), Labrador Retriever ($n = 4$), Dogue de Bordeaux ($n = 3$), Newfoundland dog ($n = 3$), Australian Shepherd dog ($n = 2$), Pyrenean Mountain dog ($n = 2$) and one each of the following 12 different breeds: Beauceron, Bouvier des Flandres, Briard, Central Asia Shepherd dog, Dalmatian, Dobermann, Lagotto, Leonberger, Pit Bull, Rhodesian, Shar-pei and Vizsla. Median body weight was 23.4 kg (range, 14–65 kg) and median age was 9.5 months (range, 6–27 months). Bilateral OCD lesions were seen radiographically in 23 (16%) dogs; in 11 of these, both shoulders were operated in the same surgical session, and in 12, the operations were staged 3 to 5 weeks apart. In the remaining 118 dogs (84%), the modified arthrotomy approach was performed on 65 left shoulders and on 53 right shoulders.

Intraoperative Data

In all cases, our novel modified craniolateral approach allowed visual inspection and adequate exposure of the caudal surface of the humeral head. Flaps of cartilage still attached to the humeral head were detected in 148 of 164 shoulders (90%) and removed (►**Fig. 7**). Microfracture was performed in 116 of 164 (71%) shoulders, and reparative fibrocartilage was present in 42/164 (27%). Detached cartilage flaps occurred in 4 of the 164 (2.4%) shoulders and were removed with the assistance of saline joint lavage (►**Fig. 7**).

In 10 patients (6%), cartilage flaps were not present on the visible subchondral OCD bone bed and detached flaps could not be collected via joint lavage.

In another two cases (1.2%), a definitive cartilage flap was not detected at the site of the radiographic lesion. In one of those, an 8-month-old Dogue de Bordeaux, the cartilage flap was found and removed 4 months later. In the second case, a 7-month-old Dogue de Bordeaux, no progression of osteochondrosis to OCD was seen. Intraoperative complications consisting of moderate intraoperative bleeding occurred in three cases (1.8%) and were readily stopped via electrocautery. Median surgery duration was 32 minutes (range, 20–50 minutes).

Postoperative Outcome

The results of radiographic and clinical follow-up examinations were available in 123 of 164 (75%) dogs. Early postoperative complications included two cases (1.2%) of mild seroma formation. At the first follow-up examination 2 to 3 months after surgery, eight dogs (6.5%) had persistent mild lameness (grade 2 of 4). In five of these, clinical signs disappeared within the following 3 months and the remaining two cases underwent a second surgery. The first was a Border Collie, which had been treated for bilateral OCD at 9 months of age and had persistent lameness in one limb. At the time of the first surgery, both osteochondral flaps were found and removed and the lesion beds were microfractured. Arthroscopy done 7 months postoperatively showed subtotal biceps rupture, which was treated with tendon release, resulting in complete resolution of lameness at the 2-month-follow-up examination. The second case was a Dogue de Bordeaux in which an elevated flap had not been identified in the initial surgery. In this case, a second surgery performed 2 months later allowed identification and removal of the cartilage flap with subsequent microfracture. The results of follow-up examinations were not available for this dog. The results of medium-term follow-up, that is, 6 to 12 months after surgery, were available in 70 cases (57%): one dog showed persistent mild lameness and another had intermittent lameness after exercise. The results of long-term follow-

INTRAOPERATIVE FINDINGS

Total cases. 164	Number	%
Cartilage flap in situ and removed	148	90
Cartilage flap dislodged and removed	4	2
Cartilage flap dislodged and not found	10	6
Cartilage lesion not found	2	1
Microfracture performed	116	71

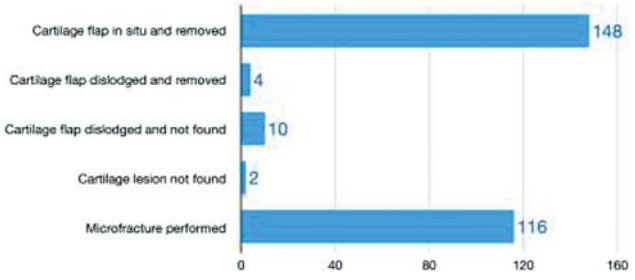

Fig. 7 Intraoperative findings.

up examination, that is, > 1 year after surgery, were available in 16 cases (9.7%) and none were lame on gait evaluation.

Discussion

In this retrospective study, our minimally invasive craniolateral surgical approach to the shoulder joint allowed adequate exposure of the humeral head including the caudal aspect in dogs with OCD. Accessing detached flaps in the caudal portion of the joint was difficult at first, and in two cases the flaps could not be removed. A more reliable method was subsequently developed to mobilize and collect lodged detached flaps by repositioning the shoulder into a neutral position and applying gentle distal traction while flushing the caudal joint space. Hyperflexion of the shoulder joint leads to collapse of the caudal portion of the joint and prevents lavage fluid from mobilizing free flaps. In addition, cartilaginous flaps firmly attached to the synovial membrane in the caudal joint recess cannot be mobilized using joint lavage. When free flaps are seen in the caudal joint recess on preoperative radiographs, an arthroscopic approach should be considered. In the two dogs with intraoperative bleeding, the surgical approach was more proximal than desired and bleeding was secondary to omobrachial vein injury. Thus, careful planning of the location of the initial incision is required to avoid this complication. Seroma formation is the most common postoperative complication after shoulder arthrotomy. In the present study, only two cases had mild, self-limiting, seroma formation in the postoperative period. The low number was likely attributable to the nature of the procedure, which minimized periarticular iatrogenic trauma and the creation of dead space. In two patients, one with lameness caused by subtotal biceps rupture and a second with progression of osteochondrosis to OCD, the need for further treatment was not attributable to the surgical technique. Of the 123 cases in which the results of follow-up examination were available, 72 (97.3%) had complete resolution of lameness. The results of range-of-motion and palpation of the shoulder joint and data on the ability to exercise in a normal, sustained, high-intensity fashion were not included in this series. The long-term clinical outcome of shoulder OCD surgery is likely related to many other factors including the location, diameter and depth of the lesion and the presence and severity of concurrent osteoarthritis.[2,4,6,8,10,22]

Our surgical approach can be considered a moderately challenging, minimally invasive, efficient and inexpensive alternative to other surgical approaches including arthroscopy for treatment of OCD of the humeral head. The surgical instrumentation required is commonly available and inexpensive in relation to arthroscopic equipment. The use of Gelpi retractors was adequate for retraction of the muscles and joint capsule. The short time required for surgery was favourable in terms of anaesthesia duration and complications related to more prolonged surgery.

In conclusion, this technique could be considered a reliable approach for surgical treatment of shoulder OCD even though the joint cannot be completely evaluated for other diseases. The majority of dogs with OCD could be successfully treated. In dogs with very large or deep lesions, the Cheli approach can be used to increase exposure of the humeral head and allow autogenic or allogenic osteochondral grafting or placement of a synthetic resurfacing implant. For the latter procedures, the surgical approach is expanded; wider incision of the lateral joint capsule is performed with care not to damage the lateral collateral ligament unduly. Fine-tuning of the shoulder flexion and humeral rotation along with careful intra-articular placement of a small Hohmann retractor is helpful in increasing humeral head access.

Authors' Contributions

A.V. contributed to conception of study, study design and acquisition of data. L.V. designed the study and acquired the data. All authors did data analysis and interpretation. They drafted, revised and approved the submitted manuscript. A.V. is publically accountable for relevant content.

Conflict of Interest

None declared.

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