Traumatic craniolateral shoulder luxation and fracture of the lesser tubercle of the humerus in a dog

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Summary
A five-year-old, spayed female, Bearded Collie was presented with a 24-hour history of non-weight-bearing lameness of the right thoracic limb after sustaining vehicular trauma. Radiographs revealed a craniolateral scapulohumeral luxation and a distally and medially displaced fracture of the lesser tubercle of the humerus. Open reduction and internal fixation of the fracture was achieved with lag screw fixation and an anti-rotational Kirschner wire. Surgical repair resulted in compression across the fracture line, anatomic reduction of the articular surface, and a stable scapulohumeral joint following reduction of the humeral head in the glenoid. Six weeks post-operatively, the patient exhibited no evidence of pain or lameness on the right thoracic limb and radiographs revealed complete healing of the fracture and normal articulation of the scapulohumeral joint. This is the first report of a lesser tubercle fracture associated with a craniolateral shoulder luxation. Surgical intervention resulted in the return of full shoulder joint function in this dog.

Case report
A five-year-old, spayed female, Bearded Collie, weighing 14.4 kg, was presented with a 24-hour history of non-weight bearing lameness of the right thoracic limb after sustaining vehicular trauma. Initial evaluation by the local veterinarian revealed signs of pain on manipulation of the right shoulder. A mediolateral radiographic image of the right shoulder revealed a cranial scapulohumeral luxation. Medications administered to the patient included dexamethasone (12 mg IV), prednisolone sodium succinate (500 mg IV), and buprenorphine (0.23 mg IV) prior to referral for additional treatment at our veterinary medical teaching hospital.

On presentation through our emergency service, mentation and vital parameters were assessed to be within normal limits. Mucous membranes were pink and moist with a capillary refill time of two seconds. A body condition score of 3/9 was assigned (4). Bilateral conjunctival chemosis was observed with the right eye more affected. The patient exhibited a non-weight bearing lameness of the right thoracic limb. Swelling was present and signs of pain were elicited on palpation and extension and flexion of the scapulohumeral joint. Upon palpation, the greater tubercle was displaced cranial to the glenoid of the scapula, consistent with the diagnosis of scapulohumeral luxation. No crepitus was appreciated. The neurologic examination and remainder of the orthopaedic examination were within normal limits.

A complete blood count was performed revealing an inflammatory leukogram (25.3 x 10³/ul, range: 6–17 x 10³/ul) characterized by a mature neutrophilia (23.4 x 10³/ul, range: 3.0–11.4 x 10³/ul) and lymphopenia (0.94 x 10³/ul, range 1.0–4.8 x 10³/ul) and a mild thrombocytopenia without evidence of clumping (141,000/ul, range 200–500,000/ul). Serum chemistry results were within normal limits with the exception of an elevated alkaline phosphatase value at 181 IU/L (range, 20–150 IU/L). These changes were considered to be consistent with administration of corticosteroids and the known history of trauma. Numerous pulse oximetry readings were

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Introduction
Scapulohumeral luxation is uncommon in dogs and can be associated with congenital joint laxity or trauma (1). While both medial and lateral luxations are reported, lateral luxations are more commonly associated with trauma and are typically a result of damage to the soft tissue supporting structures of the joint (1–3). In this case report, a traumatic cranial lateral shoulder luxation is described in conjunction with a complete fracture of the lesser tubercle of the humerus. Open reduction and internal fixation were performed and full function was regained.

* Dexamethasone: Bimeda-MTC Animal Health Inc., Cambridge, Ontario, Canada
* Prednisolone Sodium Succinate: Pharmacia and Upjohn Co., Kalamazoo, Michigan, USA
* Buprenorphine: Reckitt-Benckiser Health Care, Hull, England
taken with all values being greater than 95%. No arrhythmias were observed on continuous electrocardiogram readings that were monitored for 24 hours.

Abdominal, thoracic and right scapulohumeral radiographs were obtained. A left pneumothorax was observed on thoracic images and the right scapulohumeral joint was luxated in a craniolateral direction (Fig. 1A). Additionally, a complete fracture of the lesser tubercle of the right humerus and associated soft tissue swelling were identified on the craniocaudal view of the shoulder joint (Fig. 1B). The mediolateral width of the lesser tubercle fragment was 9 mm. It was displaced distally and medially with respect to the humeral head. There were no radiographic abnormalities seen on the abdominal images.

The patient was treated overnight with intravenous fluids containing 16 mEq/L KCl at a rate of 1 ml/kg/hr and hydromorphone was administered at a dose of 0.05 mg/kg every six hours as needed for pain. Based on the patient’s stable respiratory status, no specific treatment was initiated for the mild pneumothorax.

The following morning, surgical repair of the fracture and open reduction of the scapulohumeral joint was achieved through a craniomedial approach to the joint and craniomedial arthrotomy. The fracture extended through the medial 15–20% of the articular surface, extending through the intertubercular groove. The transverse ligament was intact and appeared grossly normal. Exposure of the fracture plane revealed entrapment of the biceps tendon within the fracture gap. Evaluation of the glenoid fossa, joint capsule and medial glenohumeral ligament did not reveal gross abnormalities. The biceps tendon was replaced within the intertubercular groove and the fracture reduced. Anatomic reduction of the fracture was visually confirmed. Interfragmentary compression was achieved with the use of a 4.0 mm fully threaded cancellous screw and stainless steel washer, placed in lag fashion across the fracture plane. An anti-rotational 1.6 mm Kirschner wire was placed caudal and parallel to the screw, across the fracture line. The wire was bent away from the joint surface and cut. The humeral head was reduced into the glenoid and the shoulder was palpated for stability through a full range-of-motion. The shoulder joint was assessed to be stable. The arthrotomy, muscle fascia, and skin were closed routinely. Postoperative craniocaudal and mediolateral shoulder radiographs were obtained with the patient under anesthesia. They revealed anatomic reduction of the fracture and reduction of the scapulohumeral luxation (Fig. 2A and 2B). The right forelimb was placed in a Spica splint prior to anaesthetic recovery. Following surgery, the patient was treated with intravenous fluids containing 16 mEq/L KCl and hydromorphone (0.08 mg/kg IV every 4 hours as needed for pain). One day post-

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Fig. 1: A) Craniocaudal and B) lateral radiographs of the right shoulder. The lesser tubercle fracture fragment (asterisk) is displaced medially and distally on the craniocaudal view but is not visible on the lateral view. Craniolateral luxation of the shoulder is apparent.

Fig. 2: Immediate postoperative A) craniocaudal and B) lateral radiographs of the right shoulder. The shoulder is reduced and anatomic reduction of the fracture is observed with only a faint fracture line identified on the craniocaudal view.
operatively, the patient was comfortable and was partially weight bearing on the right forelimb. Oral pain medication (tramadol 3 mg/kg orally every 8 hours) was administered for continued analgesia and the patient was discharged from the hospital 36 hours following surgery.

The Spica splint was maintained for two weeks with weekly bandage evaluation to ensure adequate perfusion to the digits and cleanliness of the bandage. The owners were instructed to restrict the dog’s activity by means of cage confinement and short leash walks for urination and defecation purposes only. Feeding instructions based on the caloric content of the dog’s normal diet were provided to the owner to promote weight gain. At the two-week postoperative recheck, the Spica splint was removed. After five to 10 minutes, normal foot placement was observed during weight bearing. No neurological deficits were appreciated and sensation to the medial and lateral right thoracic limb digits was intact. Moderate atrophy of the biceps, triceps and supraspinatus and infraspinatus musculature was observed. No instability of the right scapulohumeral joint was appreciated although extremes of joint flexion and extension were not tested. Range-of-motion in the shoulder joint was pain-free. Four weeks of additional crate rest and leash walks were prescribed.

At the six week postoperative recheck, the owners were pleased with their dog’s progress and reported no evidence of lameness or pain. Body condition score was normal at 4/9 (4). Physical and orthopaedic examination findings were consistent with the owners’ observations with no visible lameness of the right thoracic limb during the walk and trot. The range-of-motion in the scapulohumeral joint was normal; there was no crepitus, pain, or instability present. The shoulder musculature had increased in size, but remained mildly atrophied compared to the contralateral limb. The patient was sedated with dexmedetomidine (0.65 mg IV) and butorphanol (2.6 mg IV) and mediolateral and craniocaudal radiographs of the right shoulder were obtained. The radiographs revealed stable implants, normal scapulohumeral alignment, and a healed fracture of the lesser tubercle with contiguous remodelled cortical bone (Fig. 3A and 3B). No osteoarthritis was present. Based on the radiographs and clinical examination, a gradual return to normal activity over a period of three to four weeks was recommended for the patient. Telephone communication with the owner six months postoperatively revealed that the patient had returned to normal function without any evidence of lameness or pain.

Discussion

Traumatic shoulder luxations are uncommon in dogs and cats (1, 2, 8). While medial luxations are reported to occur most commonly, trauma may result in luxation in any direction. Lateral luxations may occur more commonly in large breed dogs and are theorized to be a result of extreme adduction of the limb (1, 3). In this unique case, a combination of fracture and luxation may have occurred due to limb adduction in combination with a significant distal-to-proximal force through the mechanical axis of the forelimb, resulting in impaction of the medial aspect of the humeral head on the glenoid.

The lesser tubercle serves as the point of insertion of the subscapularis tendon. This muscle, along with the infraspinatus, teres minor, and supraspinatus muscles work in conjunction with the joint capsule and medial and lateral glenohumeral ligaments to stabilize the glenohumeral joint (6). The biceps brachii tendon has also been shown to play a significant role in the stability of the shoulder joint with transection of the tendon resulting in increased cranial and lateral translation when the shoulder is in either a neutral or flexed position (7). Experimentally and clinically, disruption of the lateral joint capsule, the associated lateral glenohumeral ligament, and the infraspinatus tendon are required for a lateral shoulder luxation (6, 8). No defects were observed in these structures at the time of surgery in this case. It is possible that the uncommon combination of forces that were applied on the scapulohumeral joint caused fracture of the bone rather than rupture of supporting soft tissue structures. Thus, displacement of the fracture segment and the biceps brachii tendon into
the fracture gap ultimately allowed cranio-lateral luxation of the humeral head. This theory is supported by the intra-operative findings that repair of the fracture and replacement of the biceps tendon within the intertubercular groove resulted in a stable reduction of the glenohumeral joint. Additionally, underlying shoulder instability was unlikely to play a role in this dog’s injury as there was no evidence of mal-formation of the glenoid cavity or flattening of the humeral head that may have contributed to lateral shoulder instability (9).

To the authors’ knowledge, this injury has not been reported in other quadrupeds. Lesser tubercle avulsion fractures have been reported in people and are theorized to be a result of forceful contraction of the subscapularis muscle in an attempt to resist sudden external rotation. This injury is thought to be associated with abduction of the humerus, resulting in increased contact forces between the lesser tubercle and the edge of the glenoid (10). Surgical repair may not always be recommended in human patients with a sedentary lifestyle, as conservative management is reported to lead to an acceptable functional outcome in many of these cases (11).

Multiple findings prompted the recommendation for surgical intervention in this case. First, the fracture occurred in combination with shoulder luxation. Due to the significant role that the supraspinatus tendon, medial glenohumeral ligament, and joint capsule play in stability of the shoulder joint, and the large degree of fracture displacement, conservative management would have likely resulted in delayed healing, soft tissue laxity, and continued shoulder instability. Second, based on the preoperative radiographs we suspected that the fracture line involved the articular surface of the proximal humerus. Principles of articular fracture repair include early anatomic reduction, rigid fixation, and early return to function. Following these principles minimizes trauma to the articular cartilage, joint incongruity, and subsequent osteoarthritis (12). Lastly, the proximity of the fracture to the intertubercular groove raised concerns about injury to the transverse ligament and the biceps tendon. At the time of surgery we identified entrapment of the biceps tendon in the fracture plane. Left untreated, this injury may have resulted in continued lameness and dysfunction of the forelimb. Thus for these reasons, closed reduction of the shoulder and conservative management of the fracture was neither attempted nor recommended.

A Spica splint was placed postoperatively to limit motion in the scapulohumeral joint during the initial phase of postoperative healing. Spica splints are preferred for treatment of lateral scapulohumeral luxation, as they prevent limb adduction better than other slings or bandages (1, 3). They should be used cautiously in patients with thoracic trauma as excessively tight bandages can impede thoracic wall expansion. The potential benefits of the Spica splint for the treatment of scapulohumeral luxation were weighed against the potential risks when used in combination with the articular fracture. Joint immobilization is discouraged during the treatment of articular fractures as fibrosis and contracture of the periarticular tissues may progress rapidly and result in a decreased range-of-motion. Joint mobility plays a very important role in cartilage health, healing, and nutrition, and thus immobilization may subsequently lead to suboptimal healing and osteoarthritis (12). A non-weight bearing sling such as a carpal flexion bandage could also have been considered in this case, and it may have allowed for adequate periarticular healing without strict scapulo-humeral immobilization. Given the stability that was palpated in the shoulder joint after fracture repair, a Spica splint may not have been truly necessary in this case. However, no morbidity resulted from the use of the Spica splint and the shoulder joint regained full function despite its use.

This is the first report of a lesser tubercle fracture of the humerus associated with a traumatic scapulohumeral luxation in a dog. This case demonstrates the importance of orthogonal radiographic evaluation, including assessment for the presence of fracture in conjunction with traumatic shoulder luxation. In this case, the fracture was intra-articular and contributed to the joint instability. Repair of this fracture promoted normal joint congruity and a complete return to function.

**Conflict of interest**
None declared.

**References**