Partial scapulectomy for treatment of an articular fracture of the scapula in a cat

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Summary
A seven-month-old cat was referred, after having been missing for one week, for evaluation and treatment of a right forelimb injury and facial fractures. On physical examination, a moderate partial weight-bearing lameness of the right forelimb was present, with palpable crepitus in the glenohumeral joint. Dental radiographs revealed a midline palatal fracture and rostral fractures of the left maxillary canine alveolar bone. Radiographs of the right shoulder revealed a Type III or intra-articular fracture of the scapula with moderate displacement of the fracture at the articular surface. Early fibrous healing of the fracture was observed and the causal aspect of the medial glenohumeral ligament was ruptured. Due to the chronicity, reduction and stabilization was not attempted. Instead, the causal aspect of the medial glenohumeral ligament was incised along its origin and approximately 30% of the glenoid was removed. The causal glenohumeral ligament was attached to the subscapularis muscle. Three years after surgery, the owner reported that the cat continued to experience no visible lameness and led an active lifestyle. This case report demonstrates that a partial caudal scapulectomy can result in full return of function of the forelimbs in cats with scapular fractures, especially when joint involvement is severe and the articular cartilage is affected. To the authors’ knowledge, this is the first report of a partial scapulectomy, utilized for fracture management, in the veterinary literature.

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Introduction
Fractures of the scapula account for 0.5% to 2.4% of all fractures observed in small animals (1–3). Typically, the thoracic limbs are protected by the extrinsic muscles, contributing to the low incidence (1). In the majority of cases, scapular fractures are the result of vehicular trauma, accounting for 68% to 95% of canine cases in one study (2). Concurrent injuries are often noted in animals with scapular fractures, reportedly observed in 56% to 70% of cases due to the anatomic location of the scapula and the large force required to fracture the scapula (1–3). Fractures involving the scapula can either be medically or surgically managed depending upon the type of fracture. Those fractures that involve the articular surface, the neck of the scapula, the acromion process, and some displaced body fractures are typically surgically repaired via internal fixation (4).

Partial scapulectomy procedures have been previously reported in the veterinary and human literature (5–7). Subtotal scapulectomy procedures are utilized in humans as a method for primary bone and soft tissue tumour removal, and have also been described in veterinary literature for bone tumours (5–8). This case report describes a technique for management of intra-articular fractures of the causal aspect of the scapula, especially if fibrous non-union and articular cartilage damage are present.

Case report
A seven-month-old spayed 2.56 kg female cat was referred for evaluation and treatment of a right forelimb injury and facial fractures. The cat had been missing outdoors for one week, returning home with a right forelimb lameness and significant facial trauma. A physical examination performed by the referring veterinarian revealed caudal deviation of the left maxilla and mandible, haemorrhagic nasal discharge, epiphora of the right eye, and palpable crepitus of the right shoulder and scapular region, indicating a fracture was likely to be present. Intravenous fluid therapy was initiated by the referring veterinarian at 1.5 times maintenance. Ampicillin* (20 mg/kg, IV every 8 hours) and hydromorphone* (0.1 mg/kg, IV as needed every 4 to 6 hours) were administered intravenously. Oral examination revealed a symphyseal separation of the mandible and a caudolaterally deviated left maxilla. All of the left maxillary incisors were absent.

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A complete blood count revealed a moderate to marked anaemia (hematocrit 22.2%; reference range 30.0–45.0%) with mild regeneration (reticulocyte count 0.9%). A marked leukocytosis (38.76 x 10⁹ WBC/L; reference range, 5.5–19.50 x 10⁹ WBC/L) characterized by a marked neutrophilia (31.63 x 10⁹ /L; reference range, 2.50–12.50 x 10⁹ /L) with a mild left shift (20% bands), mild monocytes (2.04 x 10⁹ /L; reference range 0.15–1.70 x 10⁹/L), mild eosinophilia (1.89 x 10⁹ /L; reference range 0.10–0.79 x 10⁹ /L), and mild basophilia (0.25 x 10⁹ /L; reference range 0.00–0.10 x 10⁹ /L) were present. A pre-anaesthetic serum biochemistry panel showed a mildly decreased creatinine (62 μmol/L; reference range 71–212 μmol/L).

Upon presentation to the clinic, an avulsion of the left canine tooth was observed. The left maxillary incisors and supporting bone were displaced into the left nasal passage. The right maxillary incisors were also displaced and palpably loosened. The two hemimandibles were separated at the symphysis and the left temporomandibular joint was luxated. Dental radiographs revealed a midline palatal fracture and rostral fractures of the left maxillary canine alveolar bone, both mesially and distally. In addition, a moderate partial weight-bearing lameness of the right forelimb was present, with palpable crepitus in the gleno-humeral joint. The neurological status of the cat was normal. Radiographs of the right scapula revealed a Type III or intra-articular fracture of the scapula, extending along the long axis (from the articular surface to the dorsal border) immediately ventral to the spine of the scapula (Fig. 1A and 1B) (2, 3). There was moderate caudo-distal displacement of the fracture at the articular surface. The shoulder joint space was wide and gas was superimposed in the thoracic inlet. Thus, a traumatic fracture of the right scapula was diagnosed.

The cat was hospitalized and intravenous fluids⁴ at maintenance rate and clindamycin⁵ (6.9 mg/kg, IV every 12 hours) were commenced. Four hours after admission, pre-anaesthetic sedation in preparation for repair of the facial fractures was achieved with hydromorphone⁶ (0.1 mg/kg, IV) and midazolam⁷ (0.1 mg/kg, IV). Anaesthesia was induced with propofol⁸ (4 to 6 mg/kg, IV, titrated to effect) and maintained with isoflurane⁹ (1.5%) in 100% oxygen. Intravenous fluids¹⁰ (10 ml/kg/hr, IV) were administered during the procedure. A dextran bolus (5 ml/kg, IV) was administered over 15 minutes as a means of treating perioperative hypotension (mean blood pressure 55 mmHg). Analgesia was achieved with a constant rate infusion of fentanyl¹¹ (2 μg/kg/hr, IV titrated according to the patient response under general anaesthesia). Local anaesthesia was achieved with bupivacaine hydrochloride injection 0.75%¹², 0.1 ml bilaterally at the intraorbital and mental foramina. The mandible was stabilized with a 24 gauge (0.511 mm) wire in a figure-of-eight pattern around the mandibular canines and supported with a splint formed from bis-acrylic composite crown and bridge material¹³. The left maxillary canine was surgically extracted. The incisor and alveolar bone fragment were anatomically reduced. Incisors 101, 102 and 103 were extracted to accommodate the right mandibular canine cusp and because they were assessed to be nonviable. The temporomandibular joint and the left maxillary fracture fragment could not be reduced due to fibrosis. All lacerations and open wounds within the oral cavity were apposed with 4–0 polyglactin 910 in a simple interrupted pattern. Due to suspected infection as a result of the open oral fracture, the scapular repair was delayed. Upon recovery, medetomidine¹⁴ (2 μg/kg, IV) was administered for sedation. A transdermal fentanyl patch¹⁵ (25 μg) was placed during the postoperative period. Meloxicam¹⁶ (0.1 μg/kg, SC) was administered daily for two days.

Following surgical repair of the facial fractures, the cat was syringe-fed orally. Clindamycin (6.9 mg/kg, IV every 12 hours) was continued for a total of eight days. Five days after the repair of the facial fractures, pre-anaesthetic sedation was achieved with hydromorphone (0.1 mg/kg, IV) and midazolam (0.1 mg/kg, IV) in

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⁴ Plasmalyte 148: Baxter Corporation, Mississauga, Ontario, Canada
⁵ Protemp Plus temporization material: 3M ESPE, St. Paul, MN, USA
⁶ Bonealive: Abbott Laboratories, North Chicago, IL, USA
⁷ Astrazeneca Canada Inc., Mississauga, Ontario, Canada
⁸ Marcaine®: Hospira Healthcare Corporation, Montreal, Quebec, Canada
⁹ Protemp Plus temporization material: 3M ESPE, St. Paul, MN, USA
¹⁰ Abbott Animal Health, Abbott Laboratories, North Chicago, IL, USA
¹¹ Domitor: Pfizer Animal Health, Pfizer Canada Inc, Kirkland, Quebec, Canada
¹² Fentanyl transdermal system: Novopharm Ltd, Toronto, Ontario, Canada
¹³ Boehringer Ingelheim Canada Ltd., Burlington, Ontario, Canada
¹⁴ Monocryl: Ethicon, Johnson & Johnson, Markham, Ontario, Canada
¹⁵ Fentanyl transdermal system: Novopharm Ltd, Toronto, Ontario, Canada
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excised (the caudal glenoid cavity). The ventral portion of the right scapula has been excised. Immediately caudal to the spine of the scapula, the caudal fragment of the fracture is evident and the distal aspect has been excised (the caudal glenoid cavity).

preparation for surgical repair of the scapular fracture. Anaesthesia was induced with propofol (4 to 6 mg/kg, IV, titrated to effect) and maintained with isoflurane (2%) in oxygen. Intravenous fluids (10 ml/kg/hr, IV) and cefazolin1 (22 mg/kg, IV) were administered perioperatively. Analgesia was achieved with a constant rate infusion of fentanyl (2 μg/kg/hr, IV titrated according to the patient response under general anaesthesia). Hypotension and bradycardia were managed with dextrans (10 ml/kg bolus, IV, given over 15 minutes), glycopyrrolateb (0.01 mg/kg, IV), and a dobutamineb constant rate infusion (5 μg/kg/hr, IV).

The fractured scapula was exposed through a caudolateral approach (9). The articular cartilage of the humerus was damaged. The pattern of cartilage lesions were consistent with chronic incongruity, however they may also have been secondary to the original trauma. Early fibrous healing of the fracture was observed and the caudal aspect of the medial glenohumeral ligament was partially ruptured. Because of the chronicity of the fractures and the ligament injury, reduction and stabilization was not attempted. The caudal aspect of the medial glenohumeral ligament was incised along its origin and the caudodistal portion of the scapula was excised using rongeurs. The shoulder joint was placed through a normal range-of-motion during surgery and there was not any crepitation detectable by palpation. The caudal glenohumeral ligament was attached to the subscapularis muscle using 3–0 polydioxanone in a locking-loop pattern. The joint capsule was apposed using 3–0 polydioxanone in a cruciate pattern. The fascia was closed with 3–0 polydioxanone in a simple continuous pattern. The subcutaneous tissue was apposed in a simple continuous pattern with 4–0 polydioxanone. Skin was apposed with 4–0 polydioxanone in an intradermal pattern. Orthogonal postoperative radiographs of the right shoulder showed a partial scapulectomy of the caudoventral portion of the right scapula (Fig. 2A and 2B). Caudal to the spine of the scapula, a fragment of the fracture was present and the distal aspect had been excised (the caudal glenoid cavity). In total, approximately 30% of the glenoid was removed. Medetomidine (3 μg/kg, IV) was administered upon recovery for sedation. A transdermal fentanyl patch (25 μg) was placed following surgery. Hydromorphone (0.05 mg/kg, IV, PRN) was administered for pain management postoperatively.

The cat was discharged with meloxicam for analgesia five days after surgery. The owner was instructed to keep the cat confined in a crate for four or five days immediately following discharge, and then to a small room for a minimum of two weeks. Passive range-of-motion exercises were recommended following the two week healing period.

Two weeks after discharge, the cat was readmitted to the hospital for removal of the dental appliance. At that point in time, the cat was doing well at home and was eating the soft canned diet readily. The cat was anaesthetized using the same protocol as previously described, and the dental appliance was removed.

One year after surgery, the owner reported that the cat experienced no visible lameness and had resumed normal activity. On physical examination (performed by PBR), all the joints in the right forelimb had normal range-of-motion and no palpable crepitis of the right shoulder was present. Neurological examination of the cat was normal. The facial fractures had healed and the cat had good occlusion of the mandible and maxilla. Full range-of-motion of the temporomandibular joint was not achieved, however the cat was able to eat well. Orthogonal radiographs of the right shoulder (Fig. 3A and 3B) revealed a small defect in the articular surface of the caudal aspect of the glenoid. The caudal aspect of the glenoid had a smoothly margined area of new bone formation, forming a relatively normal glenoid cavity. On the ventral aspect of the scapula, new bone formation was present and the scapular body fracture was healed. Minimal periarticular new bone formation on the caudal aspect of the humeral head was observed. Thus, the right scapular fracture had healed and mild osteoarthritis of the right shoulder was observed.

Three years after surgery, the owner reported that the cat continued to experience no visible lameness, even when playing with a new kitten in the household. Unfortunately the cat was unable to examined by a veterinarian at this time.

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b PDS II®: Ethicon, Johnson & Johnson Medical, Markham, Ontario, Canada

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Fig. 2 Immediate A) craniocaudal and B) mediolateral postoperative radiographs of the right forelimb of the cat. The ventral portion of the right scapula has been excised. Immediately caudal to the spine of the scapula, the caudal fragment of the fracture is evident and the distal aspect has been excised (the caudal glenoid cavity).
Discussion

To the author’s knowledge, this is the first report of a partial scapulectomy utilized to treat an intra-articular scapular fracture in a cat. As previously noted, concurrent injuries are often noted in animals with scapular fractures. One study reported that 70% of cases examined had concurrent injuries, with thoracic trauma and fractures of other bones most commonly observed (3). In this case, concurrent skull fractures were present. Thoracic trauma has been reported to be present in 32% to 72% of cases, and pulmonary contusions, rib fractures and pneumothorax most commonly observed (1, 2). In this case, no thoracic trauma was observed at the time of presentation. However, the cat had been missing for a week prior to presentation.

Fractures of the scapula can be classified in several ways. The first is according to their anatomical location. Four common locations exist, including: the neck, the acromion process, the body and spine, as well as the glenoid and supraglenoid tuberosity (4, 10). The traditional scapular fracture scheme has three classifications and is based upon anatomic location (3). Type I scapular fractures include all those involving the scapular body (3). Type II fractures involve the scapular spine and the acromion process (3). Type III fractures involve the scapular neck, supraglenoid tubercle and glenoid cavity (3). The described fracture in this cat is classified as a Type III fracture according to this scheme. However, this scheme does not account for biomechanical principles that may become important in determining the appropriate treatment (3). As a result, another classification scheme has also been proposed. In this scheme, scapular fractures are classified as either stable extra-articular fractures, unstable extra-articular fractures, or intra-articular fractures (2, 3). Stable extra-articular fractures include fractures of the body of the scapula that are minimally displaced and noncomminuted (2, 3). Also included in this category are fractures of the scapular spine and nondisplaced, noncomminuted neck fractures (2, 3). Unstable extra-articular fractures include neck fractures that are either displaced or comminuted, as well as comminuted or displaced body fractures (2, 3). Avulsion fractures of the acromion process are included in this category (2, 3). Intra-articular fractures are those fractures involving the glenohumeral joint and supraglenoid tubercle (2, 3). According to this fracture classification scheme, the scapular fracture described in this cat is classified as an intra-articular fracture.

Fractures involving the scapula can either be medically or surgically managed depending upon the type of fracture. Conservative management is recommended for those fractures in the stable extra-articular fracture category (2, 3). Fractures involving the articular surface, the neck of the scapula, the acromion process, and some displaced body fractures are typically surgically repaired via internal fixation (4). Fractures in the unstable extra-articular fracture and intra-articular fracture categories are recommended to be anatomically reduced and stabilized (2, 3). Fractures of the body can be repaired with either interfragmentary wiring of the body and tension band wiring of the spine, or with a bone plate (4). Fractures of the caudovernal angle of the glenoid are typically repaired with lag screw fixation (4). In this case report, the fracture extended along the caudal aspect of the spine from the glenohumeral joint to the dorsal aspect of the scapula. Given that the fracture was moderately displaced, intra-articular, and chronic, this fracture was classified as either a type III or intra-articular fracture and surgical intervention was indicated.

Excision arthroplasty has been described in veterinary medicine for treatment of other types of conditions. For example, femoral head and neck excision is one method of treating fractures of the femoral neck, femoral head or acetabulum (11). Additionally, luxation and subluxation of the shoulder can be treated via glenohumeral excision arthroplasty (12). Given the degree of articular damage in this case it was elected to remove the caudal aspect of the scapula via partial scapulectomy. Partial scapulectomy procedures have been previously reported in the veterinary and human literature (5–7). The first description of the scapulectomy procedure in the human literature was in 1894 by Syme (13). Subtotal scapulectomy procedures are utilized in humans, as a method for primary bone and soft tissue tumour removal (7). In humans, total scapulectomy results in severe functional impairment of the limb since little rotation control is maintained. However, with partial scapulectomy, a portion of the glenohumeral

Fig. 3 Follow-up A) craniocaudal and B) mediolateral radiographs of the right forelimb of the cat, taken one year after the initial partial scapulectomy. At the caudal aspect of the glenoid there is an area of new bone formation, resulting in a relatively normal glenoid cavity. New bone formation is present on the ventral aspect of the scapula and the fracture of the body of the scapula is healed. Mild osteoarthritis is observed.
Joint is preserved, allowing for limited function of the limb (7). In one study, 14 patients had a subtotal scapulectomy, nine of whom had 80% or more of the scapula removed (7). Of those patients, twelve returned to the same level of activity or occupation after the operation as before (7). The main complications were reduced shoulder flexion and overhead strength, and brachial neuropathy (7). Animals, unlike humans, must bear weight on their forelimbs, requiring different type of movement than that observed in humans. Three veterinary reports describe a partial scapulectomy procedure as an alternative treatment for neoplastic lesions of the spine (5, 6, 8). In one case, three of the five animals maintained excellent limb function for eight, 18 and 24 months, respectively, following the surgical procedure (6). The fourth animal experienced good limb function for three months and the fifth, poor limb function, likely due to local metastatic disease (6). In another case, three of four dogs had excellent limb function postoperatively (8).

Prognosis for intra-articular fractures is guarded. In one study, long-term follow up of 20 animals with articular fractures found that 85% of the animal displayed variable degrees of lameness, while 15% were free from clinical symptoms of lameness (1, 2). Previous recommendations for articular fractures were to stabilize and anatomically reconstruct the fracture in order to minimize degenerative changes (1). In general, scapular fractures heal quickly due to the large surrounding musculature, good blood supply, high degree of myoperiosteal attachment and high ratio of cancellous to cortical bone (1, 3). Commonly observed complications of scapular fracture repair include: nonunion, delayed union, malunion, infection, osteoarthritis and abnormal postoperative cosmetic appearance (2). Complications are usually the result of inadequate fracture reduction, instability of the fracture repair, poor aseptic technique or impaired blood supply (2). Physical therapy, starting within two weeks of scapular fracture repair is encouraged, especially for articular fractures (2). Physical therapy can involve light massage, passive range-of-motion exercises and gentle active exercise (2). In this case, the cat was clinically normal one year postoperatively.

Despite radiographic evidence of osteoarthritis, the cat showed no evidence of lameness and was comfortable upon palpation of the limb at the time of follow-up. It is unknown how the osteoarthritis will affect this cat and long-term follow-up of the case would be required to assess this. However, the partial scapulectomy procedure described here for fractures of the caudal glenoid eliminates possible complicating factors such as delayed union, malunion or nonunion.

In this case, the caudal aspect of the medial glenohumeral ligament was ruptured. The medial glenohumeral ligament is a ‘Y’-shaped ligament (14). It extends from the medial surface of the glenoid tubercle across the shoulder joint and attaches to the articular capsule at the junction of the humeral neck and lesser tubercle (14, 15). There are two bands, the caudal band and cranial band. The cranial band is narrower, and attaches in two places: proximally on the corocoid process, and below the process of the supraglenoid tubercle (15). The caudal band attaches proximally on the medial side of the glenoid cavity (14). Both the medial and the lateral glenohumeral ligaments provide support to the joint, enter into the joint cavity, and are covered with synovial membranes on their periphery (15, 16). Luxation of the humerus is only possible if these ligaments are severed (16). Repair of the ligaments is difficult, usually because they are shredded when they tear (15). Plication of the joint capsule can provide adequate repair for the medial and lateral glenohumeral ligaments (16). In one study, the severity of the medial glenohumeral ligament lesion was related to the severity and degree of osteoarthritis (14). In this case, the caudal glenohumeral ligament was attached to the subscapularis muscle. Follow-up examination of the cat showed that although osteoarthritis was present, the cat had good range of motion and no there were no functional signs of glenohumeral instability.

This case report describes a novel technique for repair of intra-articular fractures of the caudal aspect of the scapula, especially if a fibrous union and articular cartilage damage are present. To the authors’ knowledge, no previous scapulectomy reports exist for fracture repair in the veterinary literature. In the present case a partial caudal scapulectomy offered excellent function of the forelimb following scapular fracture, especially when joint involvement was severe and the articular cartilage was affected. This technique is an alternative treatment to reduction and stabilization of articular scapular fractures. Possible complications, although not observed in this case, might include shoulder luxation. In this case, approximately 30% of the glenoid was removed, however it is unknown how much of the glenoid can be removed before the risk of complications, such as luxation, increases.

One limitation of this case report is that force plate analysis was not completed. Although the cat displayed no signs of discomfort or lameness, long-term follow-up would be required to determine the significance of the osteoarthritis and efficacy of treatment.

Conflict of interest
None declared.

References


