Traumatic fragmented medial coronoid process in a Chihuahua

H. S. Hadley1; J. L. Wheeler1; P. A. Manley2

1 Wheat Ridge Veterinary Specialists, Wheat Ridge, Colorado, USA; 2University of Wisconsin, School of Veterinary Medicine, Madison, Wisconsin, USA

Keywords
Fragmented medial coronoid process, traumatic fracture, jump-down syndrome

Summary
Fragmented medial coronoid process (FMCP) is a disease process that has not previously been reported in toy-breed dogs. This report describes a presumptive case of FMCP in a 14-month-old Chihuahua that was presented for evaluation approximately four weeks following acute onset of moderate lameness in the left forelimb. Definitive diagnosis of a fragmented medial coronoid process was based upon computed tomography (CT) scan. A CT scan also demonstrated moderate joint incongruity in the affected elbow. Surgical removal of the fragment and subtotal coronoidectomy were performed via a medial arthrotomy. An ulnar ostectomy was also performed to address joint incongruity. Histology of specimens removed at surgery did not demonstrate evidence of microdamage as characteristic of FMCP in large breed dogs, and instead, suggested that the fracture was acute and traumatic in nature. Rapid return to function was observed following surgery.

Introduction
Fragmented medial coronoid process (FMCP) has traditionally been described as a developmental disease that most commonly affects the elbow joints of skeletally immature, rapidly-growing, large breed dogs (1–3). This disease process appears to be over-represented in Labrador Retrievers, Golden Retrievers, Rottweilers, Bernese Mountain Dogs, German Shepherds, Newfoundland, and Chow Chows (4–7). However, it has also been reported in some medium-size and chondrodystrophic breeds (8). Fragmented medial coronoid process is characterised by fissuring and fragmentation of the cartilage and bone over the craniolateral aspect of the medial portion of the coronoid process (9). Osteochondral fragments may remain in situ, or they may separate from the base of the coronoid process and become displaced, resulting in a free osteochondral fragment between the radius and ulna (1–3, 9, 10). Fragmented medial coronoid process consistently leads to lameness and secondary osteoarthritis in affected dogs (1, 7, 9).

The underlying pathophysiological mechanisms resulting in the development of FMCP are not well understood. However, proposed theories include osteochondrosis, elbow joint incongruity due to trochlear notch dysplasia or asynchronous growth of the radius and ulna, fatigue microdamage of the subchondral bone, and trauma (11, 12, 13).

Fragmentation of the medial coronoid process has been described in association with traumatic elbow injuries such as elbow luxation, distal humeral condyle fracture, and subluxation secondary to premature closure of the distal or proximal radial physis and/or distal ulnar physis (14, 15). However, acute traumatic fracture of the medial coronoid process without any other associated lesion is uncommon (16, 17, 18). Recently, ‘jump down syndrome’ (JDS), or traumatic FMCP, has been described as a common phenomenon in performance dogs (19). Unlike the classic condition of FMCP affecting the elbow joints of skeletally immature, large breed dogs, JDS appears to have no age or size limitations. Although the cause and pathogenesis of JDS have not yet been fully explained, Canapp proposed that abnormal repetitive loading, such as landing from a jump, may lead to fatigue microdamage in the subchondral bone and eventual fracture. He further reported that dogs with joint incongruity may be predisposed to this condition.

The purpose of this case report was to describe the diagnosis and treatment of traumatic fragmented medial coronoid process in an atypical breed (Chihuahua) and to discuss how these findings may or may not support current theories regarding pathogenesis of the disease.

Clinical report
A 14-month-old, spayed female Chihuahua, weighing 4.2 kg, was presented for evaluation approximately four weeks following acute onset of lameness in the left forelimb. There was no known history of traumatic injury. The lameness was intermittent, but appeared gradually progressive and worsened with exercise. Occasionally, the patient would become non-weight-bearing at a trot. On admission, a moderate weight-bearing lameness (grade 3/5) of the left forelimb was observed at a walk. Palpation of the left elbow did not demonstrate soft tissue swelling or joint effusion. However, significant discomfort was elicited upon full extension of the elbow, and when the elbow was flexed and the antebrachium was concurrently pronated or supinated. Range of motion in the left elbow joint appeared within normal limits and crepitus was not appreciated. The remainder of the physical examination was unremarkable.
Diagnostic imaging

Standard radiographic views (craniocaudal and flexed mediolateral) were obtained of the right and left elbow joints which demonstrated subtrochlear sclerosis of the left proximal ulna and a mild loss of clarity in the region of the medial portion of the coronoid process.

Computed tomography (CT) examination was performed. Consecutive 1 mm transversal images of the right and left antebrachium and elbow joints were obtained. The scan revealed a 2.0 x 2.5 mm non-displaced fragment associated with the left medial coronoid process (Fig. 1) and moderate incongruity of the left elbow, with widening of the proximal humeral-ulnar joint and widening of the humeral-radial joint.

There was a step between the proximal radius and ulna, with the radius displaced slightly distally (Fig. 2). Sclerosis of the subtrochlear region of the left ulna was also observed. Examination of the right elbow revealed mild incongruity, with mild widening of the proximal aspect of the humeral-ulnar joint and a step between the proximal radius and ulna. There was bilateral radius curvus and mild carpal valgus.

Surgical procedure

The dog was anaesthetised and positioned in dorsal recumbency. The left forelimb was clipped and prepared in an aseptic manner. A 3 cm incision was made over the medial aspect of the left elbow joint and a standard arthrotomy was performed. A visible fissure line on the medial coronoid process was identified and the fragmented portion was removed using a small rongeur. A subtotal coronoidectomy was performed 2 mm caudal to the existing fissure line using an osteotome and mallet. Following debridement, the subchondral bone appeared to be healthy and was observed to be bleeding. The joint capsule, overlying musculature, and subcutaneous tissue were closed routinely with absorbable suture in a simple continuous pattern. The skin was closed with non-absorbable suture in a simple continuous pattern.

Histopathology

The fragmented coronoid process and excised subchondral bone were submitted for histological examination. The fully mineralised specimens were specifically stained for microdamage with 1% basic fuchsin in a graded series of alcohols, before embedding in polymethylmethacrylate. Sections were cut transversely to the long axis of the MCP at a thickness of 130 μm and were mounted on glass slides. The histological characteristics of the cartilage and subchondral bone were compared to those of classical fragments of the medial coronoid process as defined by

4–0 Biosyn™: Covidien Synecture™, Norwalk, CT, USA
3–0 Surgipro™: Covidien Synecture™, Norwalk, CT, USA

Fig. 1 A transverse computed tomographic reconstruction of the left elbow joint demonstrating a 2.0 x 2.5 mm non-displaced fragment (arrowhead) associated with the left medial coronoid process.

Fig. 2 Sagittal computed tomographic reconstruction of the left elbow joint demonstrating incongruity with a clear `step' between the radial head and the trochlear notch.

Fig. 3 Mediolateral radiographic view of the left forelimb following proximal ulnar ostectomy and intramedullary pin placement.
Danielson et al (13). The cartilage was evaluated for thickening, fissuring, and degeneration. The subchondral bone was examined for diffuse damage, micro-cracks, decreased osteocyte density, and porosity. The articular cartilage in the specimens was of normal thickness when compared to reference specimens of FMCP. There was no evidence of diffuse damage, micro-cracks, or decreased osteocyte density as in the subchondral bone of typical FMCP specimens (13). However, the specimens did demonstrate an increase in porosity when compared to archived specimens of FMCP (Fig. 4).

**Outcome**

At four weeks post-operatively, the lameness at a walk and trot had completely resolved. Physical examination revealed only minimal discomfort on manipulation of the left elbow. Range of motion continued to be within normal limits. Radiographs showed failure of the intramedullary pin at the ostectomy site. Moderate callus was evident on each side of the ostectomy, however, the ostectomy was still visible. At four months post-operatively, the owners reported that the dog had continued to do well. No lameness had been observed with activity, however, the dog did occasionally hold the leg up when sitting.

**Discussion**

Fragmented medial coronoid process is a known developmental disorder that occurs most commonly in young, large-breed dogs (1, 2, 3). It is rarely reported in small breeds (4), and to our knowledge, has not been previously reported in a Chihuahua. Therefore, this case serves as an important reminder that FMCP can occur in atypical breeds of dogs and should not be disregarded as a possible cause of forelimb lameness in toy and small-breed dogs.

Diagnosis of FMCP can be challenging when based on radiographs alone as visualisation of the medial coronoid process is difficult (21). In typically affected breeds, a presumptive diagnosis is often based upon the radiographic presence of osteophytes and the absence of other components of elbow dysplasia. However, in this case involving an unexpected breed of dog, physical examination findings and advanced imaging were integral to the diagnosis of FMCP. Clinical signs of FMCP often include a gradual and progressive lameness that is heightened after exercise, shortened strides, difficulty in rising or lying down, adduction of the affected elbow, and pain upon elbow extension and/or flexion with concurrent pronation or supination (8). In the Chihuahua, thorough orthopaedic examination demonstrated several signs consistent with FMCP, which increased the suspicion of elbow disease. Although radiographs demonstrated mild pathological changes in the elbow joint, a definitive diagnosis could not be made from these images alone. Therefore, a CT scan was performed. Computed tomography has become a well-established tool for the diagnosis of coronoid disease as displaced fragments can be easily identified (22). Some forms of elbow incongruity can also be identified with transverse images alone (23). A CT scan confirmed the diagnosis of left FMCP and moderate elbow incongruity, presumably due to asynchronous growth of the radius and ulna.

Animals affected by FMCP are often candidates for surgery when they are persistently lame and have only mild degenerative changes. Surgical treatment has traditionally consisted of fragment excision, either by open arthrotomy or arthroscopy (9). Due to the size of the patient, a medial arthrotomy was selected to allow fragment removal and subtotal coronoidectomy. A variety of osteotomies have been described to address incongruities associated FMCP, and have been reported to offer good results (24). Previous studies have described a proximal ulnar osteotomy that is stabilised with an intramedullary pin to address joint incongruity induced by radial shortening (25). The rationale for this technique is that the osteotomy allows shortening and rotation of the proximal ulna, which relieves abnormal loading on the medial coronoid process (24). A proximal ulnar shortening osteotomy was performed in this case to address moderate elbow joint incongruity.

Incongruity of the elbow joint surfaces, due to asynchronous growth of the radius and ulna may lead to disproportionate loading through the medial compartment and subsequent coronoid process fracture (26, 27). According to Burr and others, repeated abnormal loading of bone leads to formation of microdamage within the mineralised tissue. If this damage is not repaired, the weakened bone may fracture (13, 28). Assuming that FMCP is indeed a result of accumulated microdamage and subsequent fracture, it would be expected that FMCP specimens would have more evidence of microdamage than normal specimens. Danielson et al. confirmed these expectations and concluded that fatigue of the subchondral bone is important in the pathogenesis of FMCP (13).

As a result of fatigue, bone sustains microdamage, which is then repaired by bone remodeling processes (29). Therefore, we...
would have expected the FMCP specimens from the Chihuahua to have demonstrated evidence of diffuse damage and perhaps micro-cracks (direct measures of microdamage), osteocyte loss (indirect measure of microdamage), and increased porosity (indirect indicator of remodeling) as previously defined. However, only one of these variables, increased porosity, was found to be present (and increased compared to archived specimens of classic FMCP) upon histological examination. Porosity is a measure of bone remodeling. Bone remodeling is a dynamic process that initiates the repair of damaged bone by first revascularizing the damaged area, then by resorbing the damaged bone, and finally by replacing the damaged bone with new bone. The process of bone remodeling is usually coupled so that bone resorption and formation are in balance (30).

Given the absence of microdamage on histological review, we concluded that the accumulation of damage from chronic abnormal loading was not the cause of fracture in this case, as it appears to be in typical FMCP (13). Moreover, osteochondrosis was not observed to be an underlying cause as there were no signs of abnormal cartilage thickening, fissuring, or degeneration. Histology instead suggested that the fracture of the medial coronoid process was acute and traumatic in nature, similar to that described in JDS (19).

Studies have shown that bone porosity continuously increases between one and six weeks following fracture (31) and may be associated with disuse as the normally coupled remodeling process that initiates the repair of damaged bone is usually coupled so that bone resorption and formation are in balance (30). In conclusion, this case likely represents an example of JDS, or acute traumatic fracture of the medial coronoid process in a Chihuahua. Although the fracture did not appear to be due to the accumulation of microdamage, it is possible that elbow incongruity, and subsequent increased loading of the medial coronoid process, had played a contributing role in the fracture.

References