Successful surgical management of a Salter-Harris type I fracture of the accessory carpal bone in a dog

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OBJECTIVE
To describe the successful surgical management of a previously unreported Salter-Harris type I fracture of the accessory carpal bone in a dog.

ANIMAL
An 11-week-old intact female Golden Retriever–Poodle cross presented with a history of a marked left forelimb lameness following a suspected fall from a height.

CLINICAL PRESENTATION, PROGRESSION, AND PROCEDURES
On physical examination, the patient demonstrated a severe left forelimb lameness and pain on palpation and range of motion of the left carpus. Orthogonal radiographs of the distal left forelimb demonstrated a type I Salter-Harris fracture of the accessory carpal bone with proximal displacement of the palmar fragment.

TREATMENT AND OUTCOME
The patient underwent open reduction and internal fixation wherein the fracture was reduced and stabilized with two 1.1-mm Kirschner wires. Postoperatively, the patient was initially managed with a carpal flexion bandage for 2 weeks and then a soft padded bandage was maintained until 4 weeks postoperatively. The patient recovered well and was walking and weight-bearing comfortably following removal of the carpal flexion bandage. Repeat radiographs performed 4 and 8 weeks postoperatively demonstrated adequate fracture healing but showed mild proximocaudal implant displacement. Implant removal was not performed, as the patient was doing well at home and the implant migration appeared static and was not causing clinical morbidity.

CLINICAL RELEVANCE
To the authors’ knowledge, this was the only reported case of a Salter-Harris fracture of the accessory carpal bone in a dog and the only described case of successful surgical stabilization.

Keywords: Salter-Harris, accessory carpal bone, fracture, trauma, avulsion
covel bone fracture. The patient was premedicated with IV fentanyl (3 µg/kg), dexmedetomidine (2 µg/kg), and midazolam (0.2 mg/kg) and induced with propofol (2 mg/kg, IV) and ketamine (2 mg/kg) to permit endotracheal intubation with a size 7.0 cuffed endotracheal tube. The patient was maintained on oxygen (100%) and sevoflurane (1% to 2%) and received IV fluids (5 mL/kg/h). Intraoperative analgesia was provided by a fentanyl constant rate infusion (3 to 6 µg/kg/h), ketamine boluses (1 mg/kg), and local analgesia through a radial, ulnar, median, and musculocutaneous local nerve block (bupivacaine [5 mg/kg], ketamine [1 mg/kg], and dexmedetomidine [0.85 µg/kg]). The patient remained stable throughout the anesthetic but developed transient hypotension corrected with a single crystalloid bolus (5 mL/kg) administered over 15 minutes.

The left accessory carpal bone was approached through a palmar-lateral incision, and the palmar fragment was reduced and stabilized with two 1.1-mm Kirschner wires (K-wires) placed palmar-dorsally across the fracture line. The lateral carpal retinaculum was noted to be traumatized and repaired with 3-0 polydioxanone cruciate sutures. Soft tissue closure was routine with 4-0 Monocryl simple continuous for the subcutaneous layer, 4-0 Monocryl intradermal sutures, and 3-0 Ethicon in a cruciate pattern for skin sutures. During closure, liposomal bupivacaine (Nocita; 2.7 mg/kg, SC) was infiltrated into the incision to provide ongoing local postoperative analgesia.

Postoperative radiographs showed appropriate implant positioning with mild over-reduction distally of the palmar fragment (Figure 2). The patient was placed in a carpal flexion bandage prior to recovery. Following surgery, the patient recovered well from general anesthesia and was stable overnight in hospital. The patient was discharged home 23 hours following recovery on PO medications including carprofen (2.1 mg/kg, PO, q 12 h for 10 days), gabapentin (8.5 mg/kg, PO, q 8 to 12 h for 10 days), and trazodone (4.2 mg/kg, PO, q 8 to 12 h for 10 days).

The patient presented 2 weeks postoperatively for removal of the carpal flexion bandage and skin sutures. The incision healed well without complications, and a soft padded bandage was placed that was removed 4 weeks postoperatively. Repeat radiographs were performed 5 weeks postoperatively that demonstrated static fracture reduction, adequate fracture healing, and callous formation as well as mild proximocaudal K-wire migration (Figure 3). The patient was ambulating well at this time and demonstrated no evidence of swelling, inflammation, lameness, or pain due to implant migration. Radiographs were repeated 8 weeks postoperatively and showed no further implant migration and identified mature bone union.

Long-term follow-up was acquired 8 months following fracture repair; the patient was doing well at home, and on physical examination no pain or instability was noted. Follow-up radiographs showed mature bone union with static implant positioning (Figure 4). Lucency around the K-wires was observed, but no further pin migration was noted. The owner reported the patient was running and behav-
ing normally at home with no evidence of lameness or pain. The owner was extremely satisfied with the operative outcome and classified the patient’s function as excellent.

**Comments**

The canine carpus is a highly complex hinged joint consisting of multiple bones, joints, ligaments, and tendons to provide stability and facilitate locomotion. Numerous injuries have been reported within the carpus including traumatic fractures of the radial, ulnar, and accessory carpal bones; luxations of the radial and accessory carpal bones; and ligamentous injuries. Fractures of the accessory carpal bone are well documented within the veterinary literature but are almost exclusively reported in adult racing Greyhounds, and to date, no reports of Salter-Harris type fractures have been described.3,4

Accessory carpal bone fractures in adult Greyhounds are classified into 5 main types: type I fractures are avulsion fractures at the attachment of the ligament connecting the accessory to the ulnar carpal bones, and type II fractures occur at the origin of the ligaments connecting to the distal radius and ulna.3,4 Type III fractures occur at the origin of the ligaments attaching to the fourth and fifth metacarpal bones, type IV fractures are avulsion fractures at the tendon of insertion of the flexor carpi ulnaris muscle, and type V fractures are comminuted fractures.3,4

The accessory carpal bone acts as a fulcrum to prevent carpal hyperextension during weight-bearing in dogs.3,4 In skeletally mature Greyhounds, fractures of the accessory carpal bone are thought to occur during racing from significant tensile loading from the flexor tendons and ligamentous structures.3,4 In this case, this patient was suspected to have fallen down a flight of stairs, likely landing on its outstretched forepaw, resulting in hyperextension of the carpus and critical failure of the physis. This resulted in a traumatic type I Salter-Harris fracture of the accessory carpal bone without compromising the flexor carpi ulnaris tendon proximally or the ligaments attaching to the fourth and fifth metacarpal bones distally.3

Trauma to the lateral carpal retinaculum anchoring the accessory carpal bone to the styloid process of the ulna was observed intraoperatively and likely permitted the proximal displacement of the palmar fragment. The carpal retinaculum forms the carpal tunnel, through which the superficial and deep digital flexor tendons run. Surgical repair was performed to provide axial stability to the palmar fragment and maintain normal positioning of the flexor tendons.

The accessory carpal bone possesses a single epiphysis that typically closes between 2.5 and 5 months of age and is one of the first growth plates to fuse.3 The early age at which this epiphysis fuses combined with the relatively small size of the insertions...
ing musculature is likely responsible for the paucity of described cases. This report details the surgical management and outcome of a Salter-Harris type I avulsion fracture of the accessory carpal bone in a skeletally immature dog, a previously unreported injury within the veterinary literature.1 Traditional management of fractures of the accessory carpal bone depend on location, fracture type, and owner goals and can include rigid internal fixation with bone screws, fragment removal, and external coaptation.3,4

Surgical stabilization was indicated in this case due to the marked displacement of the palmar fragment, severe non-weight-bearing lameness, and poor limb function (Figure 1). Conservative management through activity restriction and external coaptation would have been unlikely to facilitate a clinical union in this case and would have resulted in a prolonged recovery, premature growth plate closure, and a poor clinical outcome.

As a result, surgical stabilization was pursued through the placement of paired K-wires across the fracture line. This was designed to minimize the damage to the accessory carpal bone epiphysis while providing rigid internal fixation to maintain fragment position and resist the pull of the flexor carpi ulnaris muscle. The exact clinical impact of premature fusion of the accessory carpal bone epiphysis is unknown; however, permitting ongoing growth in young animals with significant growth potential is a key goal of Salter-Harris fracture repair. The utilization of potentially more secure constructs, such as positional or lag screws or a pin and tension band wire was considered in this case. However, the increased security provided through interfragmentary compression was more likely to cause premature growth plate closure. As a result, these methods were rejected in favor of paired K-wires due to theoretical ability for ongoing bone growth following fracture stabilization.

During the procedure, optimal reduction through direct visualization was impaired, as aggressive soft tissue exposure was avoided to minimize iatrogenic trauma. This resulted in mild over-reduction of the palmar fragment but appeared to have no long-term effect on return to function (Figure 2). The use of intraoperative fluoroscopy would have facilitated more accurate anatomic reduction and implant positioning.

Initial follow-up radiographs demonstrated successful bone union but did note mild implant migration (Figure 3). Repeated tension on the fracture line likely exerted repeated bending forces on the K-wires, resulting in motion that led to motion migration. Kirschner wires are typically removed following the formation of a bony union if they are causing clinical morbidity. In this case, further follow-up radiographs showed static position of the pins and the patient was asymptomatic (Figure 3). As a result, the pins were left in place.

Long-term follow-up was obtained 8 months following surgery and showed no further implant-associated complications and mature bone union (Figure 4). The owner reported no visible lameness and categorized the surgical outcome as excellent. This represented the first reported case of a type I Salter-Harris fracture of the accessory carpal bone in a dog, as well as the successful surgical management of this injury.

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References