Published online: 2019-06-11

Avulsion of the Accessory-Carpal Ligaments and Sagittal Fracture of the Ulnar Carpal Bone in a Foal

Dane M. Tatarniuk[1] Robin White[1] Rolf B. Modesto[2] Kristina G. Miles[1]

[1] Department of Veterinary Clinical Sciences, Iowa State University, Ames, Iowa, United States
[2] Brazos Valley Equine Hospitals, Navasota, Texas, United States

Address for correspondence Dane M. Tatarniuk, DVM, MS, DACVS-LA, Department of Veterinary Clinical Sciences, Iowa State University, 1725 S. Riverside Drive, Ames, IA 50011-2140, United States (e-mail: dtatar@iastate.edu).

VCOT Open 2019;2:e50–e54.

Abstract

A 45-day-old foal presented for weight bearing lameness. Radiography revealed an abnormal radiolucent line associated with the proximal ulnar carpal bone and a separate curvilinear mineral opacity palmaromedial to the distal radial epiphysis. Computed tomography illustrated a sagittal, biarticular, non-displaced fracture of the ulnar carpal bone with small separate fragments associated with the accessory-ulnar and accessory-radial carpal ligaments. The foal was treated conservatively with rest and adjunct intra-articular hyaluronic acid. The lameness resolved within 90 days. Full range of motion of the carpus returned within 120 days following an active rehabilitation protocol. This report details avulsion of the accessory-carpal ligaments and sagittal fracture of the ulnar carpal bone secondary to presumed hyperextension injury.

Keywords
- foal
- orthopaedics
- equine
- fracture
- carpus

Introduction

The accessory-carpal bone in the equid is united with the parent articulation via three short and individual accessory-carpal ligaments. Proximally, a short ligament extends from the lateral aspect of the accessory-carpal bone and extends to the distal end of the radius behind the groove for the lateral digital extensor (*accessory-radial ligament*). A middle ligament connects the accessory-carpal bone to the ulnar carpal bone (*accessory-ulnar ligament*). The distal ligament is composed of two distinct bands which pass from the distal margin of the accessory to the fourth carpal bone (*accessory-fourth carpal ligament*) and the proximal end of the fourth metacarpal bone (*accessory-fourth metacarpal ligament*).[1] Injury associated with the accessory-carpal ligaments has not been previously detailed in the veterinary literature.

Dane M. Tatarniuk's ORCID is https://orcid.org/0000-0002-1442-9129.

Case Description

A 45-day-old Paint colt (130 kg) presented for a weight bearing lameness on the left forelimb. The foal was brought in from pasture 10 days prior to presentation with a noticeable lameness and swelling surrounding the carpus. The foal was managed on-farm with cold hosing, support bandaging, stall confinement and flunixin meglumine (2.2 mg/kg, orally) for the first 3 days of the lameness. The lameness and carpal swelling did not improve, leading to orthopaedic examination.

On admission, the foal was bright, alert and responsive. Vital parameters were within normal limits. The colt foal was able to ambulate on all four limbs; however, a marked lameness was present when weight was placed on the left forelimb (AAEP Grade 4/5).[2] On musculoskeletal palpation, moderate effusion of the radiocarpal joint and slight effusion of the middle carpal joint were present. Additionally, subcutaneous oedema could be palpated diffusely surrounding the dorsal and lateral aspects of the carpal region. Hoof tester application to the foot was negative. Passive carpal flexion

received
March 19, 2019
accepted after revision
April 30, 2019

DOI https://doi.org/10.1055/s-0039-1692190.
ISSN 2625-2325.

was limited by a marked painful response by the foal. The remainder of the limbs, as well as the umbilicus, palpated within normal limits. Haematology was submitted with no abnormalities identified.

Arthrocentesis and Joint Cytology

The left front carpus was prepared with alternating chlorhexidine and alcohol antiseptics. Arthrocentesis of the radiocarpal joint was performed and approximately 1.5 mL of joint fluid was aspirated. Grossly, the joint fluid was orange to red in colour and turbid. Cytology was performed and characterized by a total nucleated cell count of 1,330 cells/μL, total protein (TP) of 3.8 g/dL and lactate of 3.1 mmol/L (normal total nucleated cell count range: <1000 cells/μL, normal TP range: < 2.0 g/dL, normal lactate: < 3.9 mmol/L).[3] Morphology identified a mixed collection of nucleated cells comprised of 87% large mononuclear cells (resembling quiescent macrophages), 8% lymphocytes and 5% non-degenerate neutrophils. No micro-organisms were identified. Based on cytology, joint sepsis as a differential was deemed unlikely. The middle carpal joint fluid was aspirated, and grossly the fluid appeared straw coloured and clear. Cytology of the middle carpal joint was not performed.

Ultrasound Examination

Under sedation, ultrasound identified increased joint fluid with proliferative synovium within the radiocarpal joint and irregular bone margins associated with the distal aspect of the cranial radius. Generalized hypoechogenicity and increased thickness of the subcutaneous tissue overlying the carpus were also noted. The middle carpal joint on ultrasound imaged within normal expectations.

Radiographs

A complete radiographic series of the left front carpus was obtained. The cuboidal bones were observed to be normal in shape and ossification. On the dorsopalmar projection and superimposed with the accessory-carpal bone, an abnormal radiolucent line associated with the proximal articular margin of the ulnar carpal bone was observed extending distal and laterally (►**Fig. 1A**). Additionally, a separate mineralized curvilinear structure was noted palmaromedial to the distal radial epiphysis (►**Fig. 1B**). The dorsolateral margin of the distal radial epiphysis and proximal aspect of the radial carpal bone were also discontinuous with well-defined separate mineral fragments present dorsally.

Computed Tomography and Contrast Arthrography

Based on suspicion of a traumatic insult, and the difficulty characterizing the injury from radiographs alone, computed tomography (CT) of the carpus was performed. In preparation for the procedure, the colt foal was sedated with xylazine (50 mg) intravenously and induced with ketamine (300 mg) intravenously. The foal was placed in a sternal position on the CT table and held in place using a combination of rope ties and white adhesive tape. The CT field of view of both forelimbs extended from the distal aspect of the radial diaphysis to the proximal metaphysis of the third metacarpal bone. Before and after positive contrast arthrography was performed using iohexol (diluted in a 1:1 ratio with saline, 6 mL volume injected into the left radiocarpal joint) for both bone and soft tissue algorithms. Transverse images were reconstructed in dorsal and sagittal planes for analysis.

Fig. 1 (**A**) Dorsopalmar radiograph illustrating a radiolucent line associated with the proximal articular margin of the ulnar carpal bone extending distal and laterally (circled); (**B**) Palmarolateral–dorsomedial radiograph illustrating faintly mineralized curvilinear focus palmaromedial to the distal radial epiphysis (palmarolateral–dorsomedial projection, abnormality circled) and osteochondral fragmentation off the dorsolateral aspect of the distal radial epiphysis and proximal aspect of the radial carpal bone. DLPMO, dorsolateral palmaromedial oblique.

Best appreciated on the transverse images, a sagittally oriented hypoattenuating linear defect was noted in the midbody of the ulnar carpal bone (►**Fig. 2**). The defect was wider at the palmar margin and tapered dorsally. Several separate mineral foci were noted on the palmar aspect of the ulnar carpal bone in the region of the accessory-ulnar ligament. Additionally, the articular margins of the palmar aspect of the ulnar carpal bone and dorsal aspect of the accessory-carpal bone were moderately discontinuous with irregular margins. Multiple small separate fragments were also visualized associated with the dorsal radial epiphysis (in the region of the accessory-radial ligament), intermediate carpal bone and medial and lateral styloid processes.

Diagnosis

Based on clinical examination and collective diagnostic imaging, the final diagnosis was a biarticular, non-displaced sagittal plane fracture of the ulnar carpal bone with microcomminution and associated avulsion fragments originating from the accessory-ulnar and accessory-radial ligaments and dorsal recess of the radiocarpal joint in the left front.

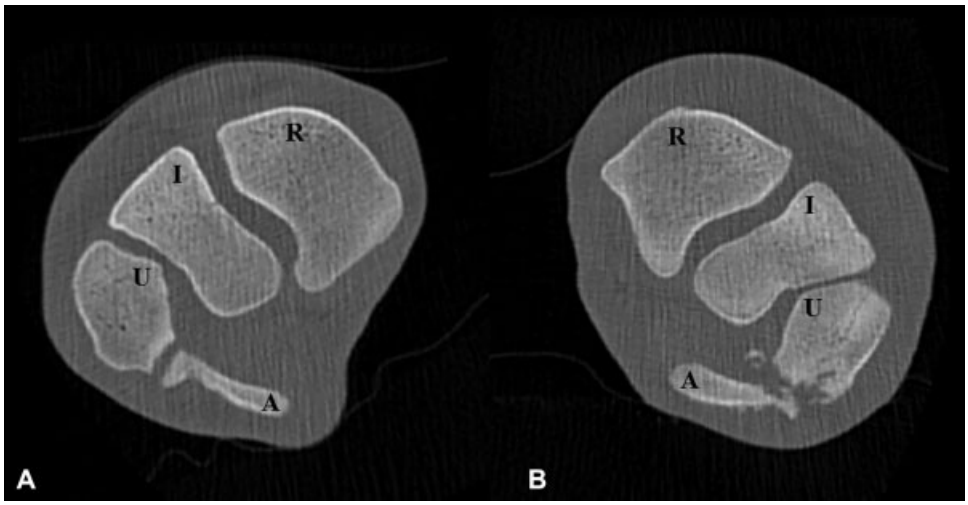

Fig. 2 Transverse slice of proximal row of carpal bones demonstrating (**A**) normal right proximal row; and (**B**) sagittally oriented hypoattenuating linear defect in the midbody of the left ulnar carpal bone (A = accessory carpal, U = ulnar carpal, I = intermediate carpal, R = radial carpal).

Fig. 3 Palmarolateral–dorsomedial radiograph taken at day 140 post-injury illustrating mature sclerosis associated with the previously demarcated radiolucent line within the proximal articular margin of the ulnar carpal bone (circled).

Secondary non-septic synovitis of the radiocarpal joint and subcutaneous oedema was also present.

Treatment

Surgical fixation of the ulnar carpal bone utilizing internal lag screw fixation in conjunction with arthroscopic surgery of the dorsal recess of the joint was offered. The ability to perform palmar carpal arthroscopy in a foal to remove palmar-based fragments was anticipated to be difficult. Conservative management was also offered and forecasted to have a fair prognosis for athleticism. The potential for radiocarpal osteoarthritis developing and requiring future joint support was discussed with the owner during consideration of how to manage the injury. The owner elected conservative management.

Under sedation, the radiocarpal joint was flushed with 3 L of sterile saline to remove inflammatory mediators and micro-debris present within the articulation. Two 14-gauge needles were placed along the lateral and medial aspects of the extensor carpi radialis tendon, and a third 18-gauge needle was placed into the palmar recess of the carpus from a lateral approach. Following conclusion of joint lavage, 44mg of hyaluronic acid was administered intra-articularly in conjunction with 80mg of gentamicin. A firm cotton bandage was placed overlying the carpus to provide stiffness and maintain the carpus in extension.

The foal was placed on a 14-day course of oral firocoxib (0.1 mg/kg per os Semel in Die). The owner was instructed to keep the foal on strict stall rest for a total of 3 months from time of presumed injury. Starting at 2 weeks post-injury, range of motion exercises were performed daily by the owner by passively flexing the carpus to the point of physical resistance and/or aversion response from pain. This was continued as a daily exercise for ~90 days.

Outcome

The owner was contacted by phone at 4 weeks post-examination. The foal was showing improvement in comfort, although lameness was not fully resolved. Range of motion during flexion of the carpus, as estimated by the owner, was ~30 degrees (0 degrees indicating carpus in normal extension while weight bearing). At 60 days, the range of motion during flexion of the carpus, as estimated by the owner, was ~90 degrees. The foal was noted to be sound at the walk at 60 days. At 140 days, the range of motion during flexion of

carpus was considered normal during veterinary examination. Comfort had improved such that the owner had initiated training on the lunge-line. Recheck radiographs at 140 days demonstrated moderate-to-severe subchondral sclerosis in the region of the accessory-ulnar joint and enthesis of the accessory-ulnar ligament as best noted on the dorsolateral palmaromedial oblique view (►**Fig. 3**). The previously defined mineralized feature palmaromedial to the distal radial epiphysis was superimposed with the palmarodistal aspect of the radius and exhibited smooth margins. The previously noted mineral features along the dorsolateral distal radius and proximal radial carpal bone were no longer identified.

Discussion

The carpus is a complex articulation composed of multiple cuboidal bones supported by various carpal ligaments. The tendons of the ulnaris lateralis and flexor carpi ulnaris insert along the proximal aspect of the accessory-carpal bone. Three short ligaments support the accessory-carpal bone with the dorsal radial–cuboidal articulation. Proximally, a short ligament extends from the lateral aspect of the accessory-carpal bone and extends to the distal end of the radius behind the groove for the lateral digital extensor (*accessory-radial ligament*). A middle ligament connects the accessory-carpal bone to the ulnar carpal bone (*accessory-ulnar ligament*). The distal ligament is composed of two distinct bands which pass from the distal margin of the accessory to the fourth carpal bone (*accessory-fourth carpal ligament*) and the proximal end of the fourth metacarpal bone (*accessory-fourth metacarpal ligament*) (►**Fig. 4**).[1]

The initial injury was not observed; however, hyperextension injury is presumed when evaluating diagnostic images and understanding limb biomechanics. Specifically, carpal hyperextension induces compression dorsally and places the palmar soft tissue structures under tensile forces. In this case, compression dorsally manifested as osteochondral crushing within the radiocarpal joint is evident along the cranial-distal radius and dorsal-proximal radial carpal bone. A similar manifestation occurs in racehorses that sustain osteochondral fragmentation from carpal hyperextension during high-speed racing.[4] When the palmar carpus is placed under tension, distracting forces are applied to the accessory-carpal bone. In this instance, avulsion fragmentation was evident at the interface of the accessory-ulnar and accessory-radial ligament. Furthermore, propagation of forces secondary to ligament avulsion presumably created a complete, non-displaced sagittal plane fracture of the ulnar carpal bone. To our knowledge, accessory-carpal ligament avulsions have not been previously reported in the horse. Hyperextension of the carpus can create frontal, transverse or comminuted fractures of the accessory-carpal bone itself in adult horses. These primary accessory-carpal bone fractures also occur secondary to the high tensile forces exerted through the *flexor carpi ulnaris* and *ulnaris lateralis* insertions during carpal hyperextension.[5]

Surgical stabilization, using lag screw fixation, is considered the best treatment option for the management of articular, non-displaced carpal bone fractures in adult horses.[6] Neonates have a tremendous ability to create bone callus, and have capacity for further growth of the entire osseous articulation. Conservative management was forecasted to result in a fair prognosis for healing and future athleticism, as it was hypothesized that the non-displaced fracture of the ulnar carpal bone would heal via secondary bone healing. Stabilization of the avulsed accessory-carpal ligaments was predicted possibly via fibrosis. As such, passive range of motion exercises were considered paramount for rehabilitation to ensure that restriction of joint capsule movement did not develop as a sequela.

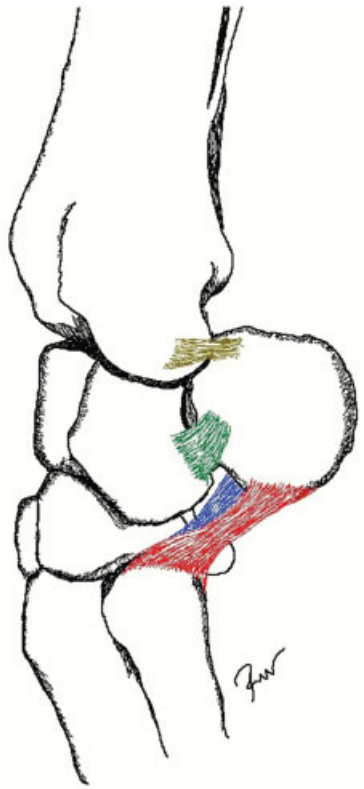

Fig. 4 Anatomical illustration of the accessory-ulnar (proximal ligament, yellow), accessory-carpal (middle ligament, green) and accessory-fourth metacarpal ligaments (distal ligaments, blue and red) that support the accessory-carpal bone to the remainder of the carpus (Illustration by Dr. R.B. Modesto).

Other diagnostic imaging modalities, such as magnetic resonance imaging, could have better characterized soft tissue injuries. However, the duration of anaesthesia required for magnetic resonance imaging is prolonged compared with CT, wherein the entire procedure was achieved via one dose of intravenous anaesthesia. Ultrasound was not repeated following CT. Potentially, ultrasound examination of the palmar and lateral aspect of the joint would have demonstrated avulsion injury associated with the accessory-carpal bone ligaments.

In conclusion, this case report highlights an unusual traumatic carpal bone injury secondary to presumed carpal hyperextension in a neonatal foal. Computed tomography was essential in fully understanding the location and extent of osseous injury. This report supports conservative management in foals as a therapeutic option for non-displaced cuboidal bone fractures, as well as avulsion injuries associated with

the ligamentous attachments of the accessory-carpal bone itself.

Note
All authors adhered to AVMA Principles of Ethics.

Author Contribution
All authors contributed to clinical management of this case. All authors contributed to drafting, revising and finally approving this manuscript.

Funding
None.

Conflict of Interest
None declared.

References

1 Sisson S, Grossman JD. Equine thoracic limb. In: Anatomy of Domestic Animals. 4th ed. London: Saunders; 1953:222–225
2 Anon. Definition and classification of lameness. In: Guide for Veterinary Service and Judging of Equestrian Events. 1st ed. Lexington, Kentucky: AAEP; 1991:19
3 Tulamo RM, Bramlage LR, Gabel AA. Sequential clinical and synovial fluid changes associated with acute infectious arthritis in the horse. . Equine Vet J 1989;21(05):325–331
4 McIlwraith CW, Yovich JV, Martin GS. Arthroscopic surgery for the treatment of osteochondral chip fractures in the equine carpus. . J Am Vet Med Assoc 1987;191(05):531–540
5 Minshall GJ, Wright IM. Frontal plane fractures of the accessory carpal bone and implications for the carpal sheath of the digital flexor tendons. . Equine Vet J 2014;46(05):579–584
6 Kraus BM, Ross MW, Boston RC. Surgical and nonsurgical management of sagittal slab fractures of the third carpal bone in racehorses: 32 cases (1991-2001). . J Am Vet Med Assoc 2005; 226(06):945–950