Carpal hyperextension injuries

Author : Matt Matiasovic, Mark Bush

Categories : Companion animal, Vets

Date : June 13, 2016

ABSTRACT

Hyperextension is the most common injury to the canine carpus. It is mostly of traumatic origin, but non-traumatic causes are possible.

The carpus is a composite hinge joint composed of multiple bones, ligaments, an articular disc, palmar fibrocartilage and a joint capsule, and injuries can present at three levels of the joint. A thorough clinical examination and use of diagnostic imaging techniques are required for a final diagnosis of hyperextension. Conservative management of hyperextension injuries is rarely successful, so carpal arthrodesis is the recommended treatment. Pancarpal arthrodesis is most commonly performed by applying a dorsal plate to the carpus. Postsurgical coaptation of the arthrodesed carpus is not necessary, although application of a light bandage is recommended.

The most common complications after surgery are surgical site infection and implant infection. Provided the radiographic appearance of the arthrodesis site is satisfactory, return to normal activity levels can be expected 12 weeks after the procedure. Lameness, however, can be present at this time in up to half of cases.

Injuries of the distal antebrachium in dogs are common, typically as a result of trauma, and may result in fractures, ligamentous injuries and various combinations of these.

Hyperextension is the most common injury to the canine carpus. It occurs as a result of excessive loading of the limb and can be associated with a fall from a height, running or jumping[1].

Figure 1. Radiographic anatomy of the canine carpus.

A supraphysiological load causes damage to the palmar ligaments of the carpus with or without disruption of the joint capsule, resulting in hyperextension during weight bearing. Dogs can also present with hyperextension without any known history of trauma in cases of immune-mediated or metabolic arthropathies, or degenerative conditions of the ligaments, notably in rough collies[2-11]. In atraumatic cases, animals are usually bilaterally affected.

Anatomy

The carpus is a composite joint composed of seven carpal bones (**Figure 1**) arranged in two rows. The proximal row consists of the radial, ulnar and accessory carpal bones, and the distal row comprises four numbered carpal bones (I-IV).

Four levels to the joint exist:

- The antebrachiocarpal joint, between the distal radius and ulna, and the proximal row of carpal bones.
- The middle carpal joint, between the proximal and distal row of carpal bones.
- The metacarpophalangeal joint, between the distal row of carpal bones and the joint surface of the base of the metacarpal bones.
- The intercarpal joints form the communication between the individual bones of each row[12-14].

Hyperextension of the carpus may occur at the proximal (antebrachiocarpal), middle (intercarpal) or distal (carpometacarpal) level, or at more than one level.

The carpus, as a whole, acts as a hinge joint stabilised by short extra-articular and intra-articular ligaments, an articular disc (known as the radioulnar ligament, connecting the radius to the ulna), palmar fibrocartilage and the joint capsule[12,13]. The palmar fibrocartilage is attached to all the proximal carpal bones except the accessory carpal bone, all the numbered carpal bones and the proximal palmar aspect of the base of metacarpal bones III, IV and V[14].

With its fibrous, ligamentous and tendinous components, the carpus acts as a shock absorber for the forelimb during weight bearing. However, because of the lack of muscular support, it is prone to injury[2].

Ligamentous injuries

Ligamentous injuries are classified as sprains and can occur in the midsection of the ligament or at its attachment to the bone. Sprains are classified into three grades of severity[15]:

- Grade 1 sprains are mild and described as an overstretching of the ligament without disruption or loss of function of the ligament.
- Grade 2 sprains are moderate in severity and described as a partial tear of the ligament. The general continuity of the ligament is intact, though the strength of the ligament is significantly reduced.
- Grade 3 sprains are severe and result from complete disruption or tearing of the ligament, resulting in instability of the joint[15].

Luxations involve the disruption of multiple ligaments, as well as the joint capsule, and displacement of one or more bones[1]. Clinically, the grade of sprain is often irrelevant to the management of most cases of carpal hyperextension injury, as discussed in this article.

History and presentation

Figures 2a and b. A dog showing a hyperextended carpal stance (a, top) and a normal contralateral limb for comparison (b, above; image reversed).

Owners commonly report a history of a fall or jump from a height, although hyperextension can occur as a result of degenerative changes affecting the ligaments.

Following an acute injury, animals typically try to bear weight after five days to seven days[10]. Dogs often present with a characteristic palmigrade stance, but the presenting signs can be more subtle as, typically, after the acute phase of the injury, the signs of discomfort and lameness can be mild.

While some patients may be walking on their carpal pads, others may show only 20° to 30° of extension (**Figure 2**). Pressure and abrasion sores may exist in chronic cases.

Diagnosis

Diagnosis is based on comprehensive clinical evaluation and diagnostic imaging techniques.

Palpation may reveal soft tissue swelling as a result of joint effusion, fibrous tissue formation, or

both. Manipulation of the affected joint can elicit discomfort, show crepitus or alter the range of motion in flexion and extension. Palpation of the contralateral joint can be useful for comparing abnormal motion in unilaterally affected cases.

After obtaining standard dorsopalmar and mediolateral views of both carpi, a mediolateral exposure is made with the manus stressed to maximal carpal extension using tape/ties and heavy sandbags.

For patient safety, the animal should be anaesthetised during stress radiography. It is helpful to obtain radiographs of both carpi in normal and extended positions for comparison.

A diagnosis of hyperextension can be made when the joint angle exceeds 15° to 20° during stress radiography (**Figure 3**). In addition, other radiographic evidence of hyperextension may exist.

When the injury is at the middle carpal level, the palmar process of the ulnar carpal bone becomes separated from the base of metacarpal V; this process is easily identified (**Figure 3**). The accessory carpal bone may show evidence of subluxation and proximal angulation. With carpometacarpal injury, the proximal carpal bones override the distal row (**Figure 4**).

In chronic injuries at all levels, varying degrees of bony proliferation may exist where the proximal bones override the distal bones[10].

It should be noted, in cases of more subtle hyperextension injuries where uncertainty exists about the presence of a hyperextension injury, the appearance of the carpus while the animal is loading the limb at rest can often be diagnostic. Animals often subject their own thoracic limbs to a greater load than a cautious vet is willing to attempt (**Figure 2**).

Treatment

Numerous conservative treatment options have been described for carpal sprains and strains; however, in nearly all cases, the forces generated during loading will exceed the restorative capacity of the healing tissue[2]. As a result, surgical management is indicated.

Conservative therapy is almost invariably unsuccessful and will delay appropriate treatment, potentially cause dressing sores, and exhaust the financial and emotional reserves of the owner[16-19].

Figure 3. Mediolateral stressed radiography of a canine carpus. Arrows indicate the direction of stress applied to the limb. The top image shows a normal limb undergoing stress radiography. In the affected contralateral limb, the resultant angle of extension is greater than 20°.

Arthrodesis is the recommended treatment for carpal hyperextension injuries[19]. Two types – partial carpal and pancarpal – can be performed.

Pancarpal arthrodesis (PCA) involves surgical fusion of all three joint levels – the antebrachiocarpal, the middle carpal and the carpometacarpal joints. It is indicated when the antebrachiocarpal joint is involved, or when middle carpal or carpometacarpal joint involvement causes damage to the accessory carpal ligaments, the palmar fibrocartilage and the palmar ligaments[6,7,9,20].

Partial carpal arthrodesis involves fusion of only the middle and distal joints. It can be performed when the antebrachiocarpal joint is not involved and no displacement of the accessory or ulnar carpal bones exists. This should be advantageous as the preserved antebrachiocarpal joint accounts for 85% of the range of motion of the carpus, but in practice, it can be difficult to accurately assess and exclude the presence of injury to the palmar soft tissues of the antebrachiocarpal joint. As a result, ongoing hyperextension may be seen following partial carpal arthrodesis, necessitating a complex revision surgery. Additionally, the evidence for the clinical benefit of partial carpal arthrodesis versus PCA is not overwhelming[6,7,9,20].

Pancarpal arthrodesis

In addition to its use in carpal hyperextension injury, PCA is a salvage procedure for managing other end-stage carpal conditions, such as degenerative joint disease, congenital malformations, and intra-articular/juxta-articular fractures and luxations where conservative management has either failed or is inappropriate.

Surgical techniques used to achieve carpal arthrodesis include application of a plate to the dorsal, medial or palmar surfaces, or external skeletal fixation, with or without crossed Kirschner wires[4-6,21,22].

Dorsally applied plate fixation is the most common technique. After a dorsal approach, sectioning the insertion of the extensor carpi radialis tendons and removal of the dorsal joint capsule with a scalpel blade, the antebrachiocarpal, middle carpal and carpometacarpal joints are visualised. Subsequently, the articular cartilage is meticulously removed to the level of the subchondral bone by means of a high-speed burr and lavage. Care should be taken to ensure all the articular cartilage has been removed.

The palmar aspect of the radiocarpal bone may commonly be missed, potentially resulting in a failure of the arthrodesis. A small-tipped Hohmann retractor, or small-pointed reduction forceps, can be used to manipulate the carpal bones to ensure all the surfaces of the bones are attended to. Cancellous autograft or allograft is placed in the joint spaces before applying the plate.

Figure 4. Mediolateral stressed radiograph of canine carpal hyperextension at the intercarpal and carpometacarpal level. Note how the proximal carpal bones override the distal row in this case and how the palmar process of the ulnar carpal bone is displaced from the distal row of carpal bones

and the base of the metacarpal bones.

The pre-contoured PCA plates provide 10° to 12° of extension [1]. Hybrid dynamic compression plates allow the application of screws of different diameter to the limb – larger screws in the radius and smaller screws in the metacarpal bones. These plates may be applied to a single metacarpal bone (III). Alternatively, larger, dedicated PCA plates allow screw application to two metacarpal bones (III and IV).

Applying the plate to two metacarpal bones will provide a more robust construct, which should, in theory, reduce the incidence of complications including plate failure and metacarpal fractures. However, a recent review of PCA cases found this was not the case. Plate failure was a rare event and a greater number of metacarpal fractures were seen with the larger plate versus the single metacarpal plate[22]. No discernible advantage was found in using the double metacarpal plate versus the single metacarpal plate and, in the authors' experiences, the double metacarpal plate is more time consuming to apply and harder to align on the manus.

The authors place one or two washers between the plate and the radiocarpal bone to prevent dorsal displacement of the radiocarpal bone during screw tightening. This helps to maintain the alignment of the radiocarpal joint (**Figure 5**). A 4mm cancellous screw is used in place of a 3mm cortical screw in the distal radius as, often, limited cortical bone stock exists at this point.

Postoperative bandaging

A multi-centre study found the addition of long-term external coaptation, in the form of a splint or cast, is not advisable. The dressing does not significantly improve the stability of the construct and can increase the complication rate due to dressing-associated complications, some of which may be more debilitating and harder to manage than the initial injury[10,22].

However, in the immediate postoperative period, application of a modified Robert Jones bandage or light dressing is recommended, mainly to control postoperative swelling to prevent a biological tourniquet effect and decrease the risk of wound infection and dehiscence.

Complications

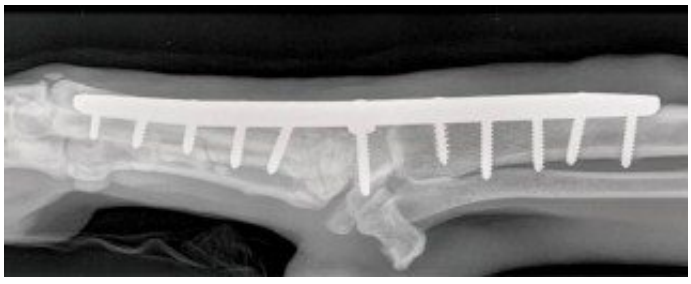

Figure 5. Mediolateral radiograph of a pancarpal arthrodesis using a dorsal plate. Note the washer between the plate and the radiocarpal bone, and the use of a cancellous screw in the distal radius.

Fracture or fissure of the metacarpal bones during screw application is the most common intraoperative complication in plated PCA[22].

The risk of intraoperative metacarpal fracture can be mitigated by carefully contouring the plate to the metacarpal bone(s) prior to application and ensuring the plate is correctly aligned over the metacarpal. Ensuring the plate covers more than 50% of the length of the metacarpal bone[23] reduces the risk of postoperative metacarpal fracture.

Surgical site infection or implant infection are the most commonly reported postoperative complications for dorsally plated PCA and are seen or suspected in more than one-third of cases. This high rate of infection may be partly due to the presence of a large metal implant just below the skin incision, with little interposed soft tissue coverage to prevent bacterial colonisation of the implants[22].

Outcomes

Assessing radiographic healing after PCA can be challenging because the plate obscures the surgical site in dorsoplantar images. Follow-up radiographs should be taken at six weeks to eight weeks postoperatively to assess early signs of radiographic fusion.

Return to normal activity levels is anticipated 12 weeks after the procedure, provided the radiographic appearance is satisfactory. However, half of cases still show mild/moderate lameness[22]. Radiographic union is expected four months to six months postsurgery[11].

References

1. Kapatkin AS, Garcia-Nolen T and Hayashi K (2012). Carpus, metacarpus and digits. In Tobias K and Johnston S (eds), *Veterinary Surgery: Small Animal*, Saunders, St Louis: 785-800.
2. Canapp SO and Kirkby K (2013). Diseases of the canine forelimb: veterinary diagnosis and treatment. In Zink C and Van Dyke J (eds), *Canine Sports Medicine and Rehabilitation*, Wiley, West Sussex: 223-249.
3. Milgram J, Milshtein T and Meiner Y (2012). The role of the antebrachiocarpal ligaments in the prevention of hyperextension of the antebrachiocarpal joint, *Veterinary Surgery* **41**(2): 191-199.
4. Lotsikas PJ and Radasch RM (2006). A clinical evaluation of pancarpal arthrodesis in nine dogs using circular external skeletal fixation, *Veterinary Surgery* **35**(5): 480-485.
5. Guerrero TG and Montavon PM (2005). Medial plating for carpal panarthrodesis, *Veterinary Surgery* **34**(2): 153-158.

6. Parker RB, Brown SG and Wind AP (1981). Pancarpal arthrodesis in the dog: a review of forty-five cases, *Veterinary Surgery* **10**(1): 35-43.
7. Denny HR and Barr ARS (1991). Partial carpal and pancarpal arthrodesis in the dog: a review of 50 cases, *Journal of Small Animal Practice* **32**(7): 329-334.
8. Li A, Gibson N, Carmichael S and Bennett D (1999). Thirteen pancarpal arthrodeses using 2.7/3.5mm hybrid dynamic compression plates, *Veterinary and Comparative Orthopaedics and Traumatology* **12**(3): 7-12.
9. Willer RL, Johnson KA, Turner TM and Piermattei DL (1990). Partial carpal arthrodesis for third degree carpal sprains: a review of 45 carpi, *Veterinary Surgery* **19**(5): 334-340.
10. Piermattei DL, Flo GL and DeCamp C (2006). Fractures and other orthopedic conditions of the carpus, metacarpus and phalanges, *Brinker, Piermattei and Flo's Handbook of Small Animal Orthopedics and Fracture Repair* (4th edn), Saunders Elsevier, St Louis: 382-428.
11. Guillard M (2006). The carpus. In Houlton J, Cook J, Innes J and Langley-Hobbs S (eds), *BSAVA Manual of Canine and Feline Musculoskeletal Disorders*, BSAVA, Gloucester: 281-291.
12. Mikic ZD, Ercegan G and Somer T (1992). Detailed anatomy of the antebrachiocarpal joint in dogs, *The Anatomical Record* **233**(2): 329-334.
13. Nordberg CC and Johnson KA (1999). Magnetic resonance imaging of normal canine carpal ligaments, *Veterinary Radiology and Ultrasound* **40**(2): 128-136.
14. Evans HE and Christensen GC (1979). *Miller's Anatomy of the Dog* (2nd edn), WB Saunders, Philadelphia.
15. Canapp SOJ, Campana D and Fair LM (2012). Orthopedic coaptation devices and small-animal prosthetics. In Tobias K and Johnston S (eds), *Veterinary Surgery: Small Animal*, Saunders, St Louis: 628-646.
16. Gambardella PC and Griffiths RC (1982). Treatment of hyperextension injuries of the canine carpus, *Compendium: Continuing Education for Veterinarians* **4**(2): 127-131.
17. Johnson AL and Houlton JEF, (2005), Arthrodesis of the carpus. In Johnson AL, Houlton JEF and Vannini R (eds), *AO Principles of Fracture Management in the Dog and Cat*, AO Publishing, Davos, Switzerland: 446-457.
18. Johnson KA and Piras A (2005). Fractures of the carpus. In Johnson AL, Houlton JEF and Vannini R (eds), *AO Principles of Fracture Management in the Dog and Cat*, AO Publishing, Davos, Switzerland.
19. Probst CW and Millis DL (2002). Carpus and digits. In Slatter D (ed), *Textbook of Small Animal Surgery* (3rd edn), WB Saunders, Philadelphia: 1,974-1,988.
20. Haburjak JJ, Lenehan TM, Davidson CD, Tarvin GB, Carlson KR and Hayes A (2003). Treatment of carpometacarpal and middle carpal joint hyperextension injuries with partial carpal arthrodesis using a cross pin technique: 21 cases, *Veterinary and Comparative Orthopaedics and Traumatology* **16**(2): 105-111.
21. Chambers JN and Bjorling DE (1982). Palmar surface plating for arthrodesis of the canine carpus, *Journal of the American Animal Hospital Association* **18**: 875-882.
22. Bristow PC, Meeson RL, Thorne RM, Butterworth SJ, Rutherford S, Renwick AI, Wustefeld-Janssens B, Witte PG, Woods S, Parsons KJ, Keeley BJ, Owen MR, Li A and Arthurs GI

(2015). Clinical comparison of the hybrid dynamic compression plate and the castless plate for pancarpal arthrodesis in 219 dogs, *Veterinary Surgery* **44**(1): 70-77.
23. Whitelock RG, Dyce J and Houlton JE (1999). Metacarpal fractures associated with pancarpal arthrodesis in dogs, *Veterinary Surgery* **28**(1): 25-30.