Carpal and pedal lameness in the dog

Carpal Anatomy

The carpus is a 3-level hinge joint composed of antebrachiocarpal joint, middle carpal joint and carpometacarpal joint. Radial carpal bone and ulna carpal bone comprise the proximal row. Second, third and fourth carpal bones comprise distal row. Accessory carpal bone positioned palmar to ulna carpal bone. The carpal joints are supported by numerous ligaments. The tough palmar fibrocartilage connecting the distal radius with carpal bones and metacarpal bones is important in stability.

Figure 1: Normal carpus

Localisation of an injury to the carpus is by the observation of soft tissue swelling, pain on manipulation, and abnormal range of motion. Diagnosis is aided by radiography and joint fluid analysis, but clinical examination will detect focal swellings and instabilities.

Sprains

A sprain is defined as a ligamentous injury. There are 3 degrees of severity: mild (haematoma), moderate (partial tearing of ligament), severe or complete (complete disruption of all of the fibres of the mid substance of the ligament or fracture of the bone at one of the insertions). Sprain injuries of the carpus are common and frequently due to falls. A wide variety of sprain injuries are possible. The most serious is sprain of the palmar ligaments causing hyperextension of the carpus.

Short radial collateral ligament rupture

The short radial collateral ligament has two components. The straight part has its origin on the prominent unnamed tubercle on the medial aspect of the distal radius, and its insertion on the most medial part of the palmar process of the radial carpal bone. It is intimately attached to the sheath of the abductor pollicus longus tendon on its dorsal aspect. The oblique part has its origin on the styloid process of the radius and runs obliquely to the palmaromedial surface of the
radial carpal bone. The short component is in tension during extension and the oblique component during flexion. The oblique part runs under the tendon sheath of the abductor pollicus longus muscle.

Rupture of these ligaments results in medial and dorsopalmar instabilities. Diagnosis is by stressed radiography. Treatment is by prosthetic ligament replacement or by prosthetic reattachment of the ligaments in which the remnant of the ligament is captured using a locking loop suture. The suture is then attached to the bone using the remaining soft tissues, a bone anchor, or a bone screw. It is imperative that additional support to the repair is given by external coaptation or by transarticular external fixation. The latter should be removed after three weeks by which time sufficient periarticular fibrous tissue will have formed. Further support dressings are necessary.

**Stenosing tenosynovitis of the abductor pollicus longus muscle**

This condition is reported to occur in the larger breeds of dog and is a cause of chronic lameness (Grundmann & Montavon 2001). There is a firm swelling over the medial aspect of the antebrachiocarpal joint and pain on hyperflexion of the joint. Radiography shows proliferative bone formation around the canal of the tendon of the abductor pollicus longus muscle on the dorsomedial aspect of the distal radius. This is seen on the dorsopalmar and mediolateral views.

The condition can be successfully treated by the injection of methylprednisolone acetate around the tendon sheath. If this fails to resolve the lameness then a dorsal release of the tendon with debridement of the fibrous and osseous tissues to allow the free movement of the tendon is necessary. The dog is placed in lateral recumbency. The exposure is and the tendon exposed by a longitudinal skin incision at the level of the styloid process of the radius. Blunt dissection allows exposure of the terminal tendon, and the thickened synovial sheath is incised longitudinally. The fibrous and osseous tissues are debrided until a free gliding movement of the tendon is achieved. A support bandage is applied for seven days and the exercise restricted for four weeks.

**Radiocarpal bone fracture (incomplete ossification)**

This condition seems to primarily affect Boxer dogs. The radiocarpal bone develops as two separate centres of ossification and this can leave a line of weakness in the sagittal plane. The injury appears to be spontaneous and can be bilateral. DP radiographs can demonstrate the fracture line but CT scanning may be preferred to fully evaluate the lesion. Treatment can involve primary fixation with a lag screw but it seems many cases require pancarpal arthrodesis (Li and others 2000).

**Hyperextension Injury**

Falls, particularly those from a height, such as off cliffs and over high fences, commonly result in hyperextension injuries of the carpus. Initially there is swelling of the carpus and pain on manipulation. As this acute inflammation resolves, then instability of the carpus with subluxation at the middle carpal joint, or carpometacarpal joint or both become evident. Subluxation is due to rupture of the palmar fibrocartilage and ligamentous support of the carpus. In addition, there may be disruption of the support for the accessory carpal bone.

Disruption of the antebrachiocarpal joint is less common. When it occurs, it may be a complete luxation of the joint, frequently in combination with fracturing of the radial or ulnar carpal bones.

Hyperextension injury is the primary indication for carpal arthrodesis. This can be pancarpal, incorporating the whole carpus, or partial involving fusion of the middle carpal and carpometacarpal joints. Arthrodesis of the antebrachiocarpal joint alone leads to the development of osteoarthritis in the more distal carpal joints.
The decision as to which type of arthrodesis is suitable must be made after a full evaluation of the injuries and if in doubt, a pancarpal arthrodesis should be performed.

Prognosis for both techniques is generally good but complications are common and are detailed below. A direct comparison of the techniques is complicated by disparate clinical results and lack of objective patient inclusion criteria for case selection.

Range of motion after partial carpal arthrodesis is reduced by approximately 50% but the dog has a more natural gait than with pancarpal arthrodesis and the technique is probably preferable in the athletic dog. However about 50% of these dogs will show mild lameness after heavy exercise. Radiographic signs of fusion with both procedures generally take from eight to ten weeks but are usually complete at 12 weeks.

Arthrodesis is the surgical fusion of a joint. This procedure is commonly performed for severe carpal injuries that cannot be reconstructed primarily. It is more commonly performed in the carpus than perhaps any other joint because the success rate is good with a good functional outcome. Arthrodesis is performed as a pancarpal arthrodesis of the entire carpal joint or a partial carpal arthrodesis of the middle carpal and carpometacarpal joints together. The decision between the two depends on the level of injury. Indications for arthrodesis include severe hyperextension injuries, luxations of the antebrachiocarpal joint and irreparable fractures of the carpal bones. Bony fusion of the arthrodesis takes 6-12 weeks. During this time the joint is protected with a splint.

**Pancarpal arthrodesis**

Important steps in performing arthrodesis include exposure of the joint cavity, removal of all of the articular cartilage to subchondral bone with an air driven bur or curette, autogenous cancellous bone grafting of the joint space, and internal fixation with a plate on the dorsal aspect of the carpus extending from the distal radius to the third metacarpal bone.

Pancarpal arthrodesis can be performed with round-hole, dynamic compression or hybrid bone plates. The hybrid plate is specifically designed for this procedure and allows for larger screw proximally and smaller screws distally as well as for appropriate screw hole location. The plates are available in several different sizes (detail sizes). The reduced thickness of the hybrid plate distally also allows for some inherent dorsal angulation of the metacarpus relative to the antebrachium. Whichever plate is selected, it should extend distally to cover more than 50% of the length of the metacarpus to avoid subsequent metacarpal bone fracture.

Bone grafting may involve autogenous cancellous graft, usually retrieved from the ipsilateral proximal humerus. However for the last two years, the author has routinely been using demineralised bone matrix (DBM). DBM is prepared from canine donor bone contains species specific growth factors such as BMP-2 for osteoinduction. Studies indicate that DBM delivers results comparable to autogenous graft but with reduced surgical prep and operative time along with reduced patient morbidity (Hoffer and others 2008). DBM may be combined with allograft cancellous chips if the joint space is large. Both products can be obtained from Veterinary Tissue Bank (www.vtbank.org).

Implants may need to be removed in some cases, if they are associated with skin irritation or infection. One can reinforce plate fixation with the addition of two cross pins (plate-rod fixation). In some instances this might abrogate the need for post-operative coaptation.
Post-operative complications are fairly common and the majority are resolved by plate removal. These include:

- Loosening of the distal metacarpal screws.
- Fracture of the third metacarpal bone from the stress riser at the distal end of the plate. Ideally the plate should cover more than 50% of the metacarpal bone.
- Infection. This can be iatrogenic or due to pressure necrosis of the skin pulled over the implants in thin-skinned breeds such as the Greyhound. Arthrodesis will still occur in the face of infection with good wound management and continuous antibacterial therapy.
- Thermal effects of the plate.

CONDITIONS OF THE MANUS

Introduction
The first digit or "dew claw" is a rudimentary structure with a shortened metacarpal bone and phalanges. The distal end, or head, is enlarged laterally with a single sessamoid located on the ventral aspect of the MCPJ. The weight-bearing digits are numbered II to IV from a medial to lateral direction. Each digit has the following joints: - The metacarpophalangeal (MCPJ), the proximal interphalangeal (PIPJ) and the distal interphalangeal (DIPJ). There is a pair of sessamoid bones located on the palmar surface of each MCPJ in each of the four weight bearing digits; they are numbered I-VIII from the medial to the lateral side. Each pair of sessamoids is embedded within the tendon of insertion of the interosseous muscle on the respective digit. They articulate primarily with the palmar aspect of the metacarpal head and secondarily with the first phalanx. Each pair of sessamoids is joined by a thick fibrous band, the intersessamoidean ligament, which forms a groove in which the superficial and deep digital flexor tendons run.

The two central digits, metacarpals III and IV, are longer than II and V, the sagittal ridge is better defined, and the two articular surfaces for the palmar sessamoids and more equal in size and shape. The medial and lateral metacarpals, digits II and V, diverge distally and posteriorly, the articular condyles are less well defined and the sagittal ridge does not equally divide the articular area. The distal metacarpals form a dorsally convex arcade. The distal divergence of the medial and lateral metacarpals also results in the deep flexor tendons of digits III and IV being placed centrally behind the sessamoids 3 to 6 respectively while the flexor tendon in digits II & V is eccentrically placed resulting in more pressure being applied to sessamoids II and VII.

The shape of the sessamoid bones varies; I and VIII are shorter and have a wider base than III, IV, V and VI. II and VII are also shorter and almost pear shaped. All sessamoids are supported on the palmar aspect of the metacarpal head by the sagittal ridge and multiple ligaments. There is also
an extension of the interosseous muscle tendon, which runs dorsally and attaches to the common digital extensor tendon in the distal third of the first phalanx.

The four weight-bearing MCPJs are compound saddle joints supported by a pair of medial and lateral collateral ligaments that arise from the distal end of the metacarpal bone and fan out to attach to the lateral or medial aspect of the first phalanx. The sessamoids are embedded in the interosseous muscle proximally and each pair is held in place by a complex series of ligaments. The intersessamoidean ligament consists of short transverse fibres, which join the two sessamoids together. The lateral and medial collateral sessamoidean ligaments form two parts, with the proximal ligament passing dorsally to attach just caudal to the MCP collateral ligament. The more distal component crosses the joint and attaches to the tubercle on the caudomedial or caudolateral aspect of the first phalanx. A pair of cruciate ligaments extends from the base of each sessamoid, crosses the MCP joint diagonally and attaches to the respective tubercles on the first phalanx. Covering the cruciate ligaments, the distal sessamoidean ligament is made up of a broad flat band, which attaches the distal end of the sessamoids to the first phalanx.

A small dorsal sessamoid is incorporated within the common digital flexor tendon as it crosses the dorsal aspect of the joint. It is held in place by the common digital extensor tendon dorsally, delicate fibres attached to extensions from the interosseous muscles and the joint capsule medially and laterally. The joint capsule encases these structures and the joint is supported by the medial and lateral collateral ligaments, which arise from the distal end of the metacarpus and pass distally to attach to the posterior aspect of the proximal end of the first phalanx.

**Interphalangeal Joint Anatomy**

Each proximal interphalangeal joint (PIPJ) consists of the convex head of the first phalanx articulating with the proximal fossa of the second phalanx. These two surfaces are enclosed in a joint capsule, which has considerable inherent strength. This joint capsule is thickened dorsally and closely adherent to the extensor tendon. There is a small dorsal sessamoid embedded within this dorsal thickening. The joint capsule is also thickened ventrally and involves the insertion of the superficial digital flexor. There is also a medial and lateral collateral ligament, which attach to the anterior distal surface of the proximal phalanx and fan out as they extend distocaudally to attach to the posterior aspect of the proximal end of the distal phalanx. These collateral ligaments have a vertical orientation in the normal weight bearing position and are relatively lax until the toe is extended. The joint capsule provides significant stability when the joint is flexed.

**Physical Examination**

It should be remembered that fractures and luxations can occur in the first digit or "dew claw" so it is essential that it should be included when examining the extremities. The normal MCP joint should flex to approximately 90 degrees. However, individual variation is common and loss of range of motion is not necessarily indicative of disease provided that the joint is not painful when flexed. The joint should be pain free and stable in flexion, extension, rotation and when stressed mediolaterally. Assessment of the collateral ligaments in digits III and IV is more difficult because of the adjacent digit. The palmar aspect of the distal metacarpal bone and its associated sessamoids should be palpated for pain, swelling and crepitus. The dorsal sessamoid should also be checked for soft tissue swelling, joint effusion, instability or pam.

Physical examination of the PIPJ involves careful examination of each individual digit. The joint should be observed grossly for the presence of any swelling or deformity. The stability of the dorsal sessamoid should be assessed and any evidence of joint effusion noted. Pain on full extension of the joint may indicate ventral joint capsule injuries or injury to the insertion of the superficial digital flexor tendon. Pain on full flexion may involve the dorsal sessamoid. The collateral ligaments should be assessed in full extension, as there is considerable laxity in these
joints in the normal or flexed position. Any dog, which has suffered a collateral ligament injury and is clinically lame, should be assessed radiographically because of the high incidence of intra-articular and avulsion fractures associated with these injuries. Dogs, particularly the racing Greyhound, which have had a cast fitted incorporating the foot often have pain on extension of the PIPJ after exercise for some 6-8 weeks, after the cast is removed.

**Radiographic Examinations of the Distal Limb.**
All radiographs of the distal limbs and digits should be taken using either high detail digital or single emulsion mammography screens. Multiple views are often necessary and it may also be necessary to use soft and hard tissue settings. A bright light and magnifier are also essential for proper interpretation of radiographs of the digits. When reviewing these radiographs, variation in the contrast settings is recommended.

**Metacarpophalangeal luxations**
MCP luxations may be single or multiple. Due to the complex arrangement of the various sessamoidean ligaments an injury to a single ligament is unlikely therefore these injuries are, by definition, complex. Radiographic examination is necessary to rule out intra-articular avulsion fractures associated with the collateral ligaments or fractures of the sessamoids. The prognosis for return to function is good although MCP luxations carry a guarded prognosis for return to successful competitive racing. Chronic instability or osteoarthritis may be treated by sesamoidectomy, excision arthroplasty of the head of the proximal phalanx, arthrodesis of
the MCPJ or digital amputation at the distal metacarpal level. Arthrodesis of single or multiple metacarpophalangeal joints is an effective salvage procedure for chronic or debilitating osteoarthritis. The normal angle of arthrodesis will be between 100-120 degrees. Arthrodesis may cause a slight change in gait but should be well tolerated by a pet. Chronic lameness after arthrodesis surgery is usually an indication of either infection or the development of a non-union. Digital amputation can also be performed for chronic MCPJ disease.

**Diseases of the Sessamoids**

The pathogenesis of the various forms of sessamoid disease is poorly understood.

**Acute fractures**

These are usually in racing, working or very active pets and occur during periods of excessive activity. They can affect any sessamoid although II and VII are most commonly affected. The dog is acutely lame and there is swelling of the affected digit with pain and loss of flexion. Radiographs will confirm the presence of a fracture. The fracture fragments should have a sharp distinct outline. Treatment involves the surgical excision of either the smaller fragment or the entire sessamoid. The foot should be supported in a padded dressing for 7-10 days post operatively and the dog only allowed leash exercise for this time. It is then allowed increasing amounts of controlled exercise over the next 2-3 weeks. Postoperative physiotherapy in the form of ultrasound or laser acupuncture helps to decrease any loss of mobility.

**Bi- or tripartite sessamoid**

Bi- or tripartite sessamoids are a well recognised condition and have reported in several breeds. In particular, the racing Greyhound, Rottweiler and other giant breeds. Sessamoids II and VII are most commonly, but not exclusively, affected. They are usually clinically silent and are an incidental finding on radiographic examination. 27% of racing greyhounds in one survey were affected. (Eaton-Wells unpublished data) In this series, there was no evidence to suggest a traumatic aetiology, although the method of rearing young greyhounds, allowing free exercise in large paddocks, may subject the sessamoids to chronic trauma. There may be some swelling of the effected digit with loss of flexion but no pain on palpation. No treatment is necessary.

**Sessamoid disease of young dogs**

In some breeds, the Rottweiler and Australian cattle dog in particular, there is a readily recognised syndrome of chronic pain associated with the metacarpal phalangeal joints of all digits. The dog’s present with either an acute, or acute on chronic forelimb lameness. There is a shortened posterior phase of the stride when the dog is gaited and the lameness is worse when walking on “stony” surfaces. Clinically there is varying degrees of decreased ROM and joint effusion in the effected joints. Subclinical cases can often be detected by holding the MCP joints flexed for a couple of minutes then allowing the dog to walk, there is an obvious lameness which decreases or disappears after a few steps.

The pathogenesis and likely aetiology of the “young dog sessamoid disease” is still unclear. Factors hypothesised to be involved include osteochondrosis, degeneration, trauma and vascular compromise but the exact aetiology is still to be elucidated. Multiple authors have reported varying incidences of subclinical sessamoid changes. Robins & Read, Mathews et al, The clinical incidence of sessamoid disease is recognised to be more common in large breeds such as the Rottweiler but smaller breeds such as the Australian Cattle Dog, Australian Kelpie and the Staffordshire Terrier also have a high incidence of both clinical and subclinical disease. (Robins & Read 1993).

The occurrence of clinical signs of sessamoiditis in dogs which also have a high incidence of
osteochondral disease lead to the hypothesis that osteochondrosis could be a contributing factor but this was not supported histopathologically. It has been reported that diseased sessamoid bones showed various stages of fracture repair, that there were extensive areas of bone necrosis associated with this healing process, and that the extent of the necrosis appeared to be inversely correlated to the stage of fracture repair (Robins and Read 1993). In dogs with a history of acute onset of disease there was evidence of cartilage regeneration and extensive areas of bone necrosis. This is supported by the radiographic appearance of porotic sessamoids during the acute phase of the disease. In cases with a more chronic history the histological picture was one of extensive fibrous callus formation with cartilage proliferation and osteoclastic activity in the adjacent bone. These authors concluded that vascular compromise was part of the aetiology of this disease, but were unable to establish whether trauma to the vasculature and subsequent avascular necrosis caused the bone to weaken and fracture or whether a primary fracture resulted in vascular compromise. Subsequent work demonstrated abundant but variable blood supply (Cake and Read). The blood supply to the sessamoid in the human big toe is a singular artery, which is easily disrupted and leads to osteonecrosis.

Radiographs are necessary to confirm the presence of sessamoid abnormalities. Care should be taken in chronic cases, and it may be advisable to assess both left and right feet for the presence of subclinical abnormalities. Evidence of sessamoid changes on physical examination, such as palmar swelling and loss of flexion of the metacarpal/tarsal phalangeal joint without the pain or discomfort are more likely to indicate the presence of single or multiple bi or tri partite sessamoids which can be readily identified on radiographic examination. Their smooth rounded edges indicating that they are a chronic process. Radiographs should always be taken of both feet to check for multiple digit involvement. Young dogs with chronic sessamoid disease will usually have varying degrees of joint effusion. This effusion is particularly noticeable on the dorsal aspect of the joint. Cytology of these joints shows varying degrees of lymphocytic/plasmacytic cellularity and pain on flexion. Radiographs of these MCPJs may reveal some or all of the following changes: - Enlarged sessamoids, partial or gross lysis, multiple fragments contained within the enlarged sessamoid and early signs of degenerative joint disease.

Treatment of both young dog and chronic sessamoid disease should initially be conservative with NSAIDs. Other possible treatments include nutraceuticals and the many physiotherapy modalities available e.g. ultrasound, laser or magnetic field therapy. Intra-articular or systemic use of corticosteroids has also produced excellent results in cases which have become refractory to NSAIDs. Sessamoid disease, which does not respond to conservative treatment, may be treated by surgical excision of either the affected bone only, both sessamoids, or arthrodesis.

**Interphalangeal Joints**

*Proximal interphalangeal luxations*

Luxation or subluxations of the PIPJ may involve single or multiple joints with varying degrees of ligament failure. The injuries may involve the dorsal sessamoid, the collateral ligaments, the joint capsule or the insertion of the superficial digital flexor either singularly or in various combinations. Luxations of the dorsal sessamoid only will result in disruption of the joint capsule. This minor injury will result in weakening of the joint’s inherent stability and may lead to failure of a collateral ligament. Collateral ligament injuries may be associated with small avulsion fractures and the prognosis for full return to function if these fractures are not treated is reduced if the problem is not addressed at the time of initial injury. Disruption or avulsion of either one or both collateral ligaments, luxation of the dorsal sessamoid in the tendon of the common digital extensor tendon and avulsion injuries associated with the insertion of the superficial digital flexor tendon should be detected on physical examination. All
these injuries may be repaired surgically.

**Distal interphalangeal joint (DIPJ) injuries**

**Traumatic luxation**

Physical examination will reveal loss of stability in extension with varying degrees of pain and swelling. The dog may also be presented with gross displacement of the joint; remarkably this does not appear to be unduly painful and is readily replaced. In fact the toe may totally luxate on physical examination. Traumatic luxation of the DIPJ in the racing Greyhound may result in the distal end of the second phalanx being forced through the skin. On presentation, there is usually only a small laceration over the joint which bleeds profusely; occasionally, the bone will be protruding though the skin. These small lacerations should always be considered to be grade 1 open collateral ligament injuries until proved otherwise. Radiographs will reveal any fractures or ligament avulsions. Surgical exploration directly over the ruptured ligament will reveal if the joint is salvageable. The ligament and associated soft tissues may be reconstructed and the toenail amputated. If the joint is not salvageable amputation of the joint including the distal end of the second phalanx will be necessary. In the racing Greyhound repair of the ligament and toe nail amputation will allow the dog to return to racing in approximately 4-6 weeks. Digital amputation however will require approximately 10-12 weeks before the dog is returned to racing. This loss of racing time should always be considered when treating Greyhound toe injuries. Gross disruption of the DIPJ should be treated by amputation.

**Failure of the deep digital flexor tendon ("knocked up" toe).**

This appears to present as two separate entities. The acute sprain/rupture associated with athletic dogs and the apparent weakening of the tendon seen in older dogs. Complete rupture as seen in athletic dogs, results in the dog being marginally painful for a few days, then the pain disappears and the dogs return to normal. In those cases where the tendon has not completely ruptured it may be necessary to exercise the dog, while being treated with an anti inflammatory agent to ensure that the tendon does rupture, this often provides a more rapid resolution of the problem. Care should also be taken when examining dogs which spend a lot of time inside on slippery surfaces as they appear to have developed "flat feet" which is totally pain free. Treatment involves conservative treatment with NSAIDs.

**References**


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