Fracture or dislocation of the carpus usually results from automobile trauma or falling from a height. The axial loading of the joint is most likely to result in fractures, whereas trauma with the joint in extension is likely to result in carpal luxation or accessory carpal bone luxation. Owing to the anatomical complexity of the carpus, a thorough review of the bony and ligamentous structures of the area is in order before discussion of fracture or dislocation repair.

ANATOMY

The carpus is composed of seven major bony structures: the radial carpal bone, ulnar carpal bone, accessory carpal bone, first carpal bone (I), second carpal bone (II), third carpal bone (III), and fourth carpal bone (IV) (Fig. 25-1). These seven bones form a very complex set of joints. Essentially three major articulations are present. The antebrachio-carpal joint is formed between the distal radius and ulna and the radial and ulnar carpal bones. This joint is stabilized primarily by a radial (medial) collateral ligament and an ulnar (lateral) collateral ligament (Fig. 25-2). The antebrachio-carpal joint has the capacity for the greatest amount of carpal motion. Approximately 80% to 90% of carpal motion occurs through this joint.

The middle carpal joint is formed between the radial and ulnar carpal bones and carpal bones 1, 11, 111, and IV. Numerous short ligaments reinforce this joint by passing between the rows of bones as well as between the bones of each row.(3) The middle carpal joint is responsible for approximately 10% to 15% of carpal motion.

The carpometacarpal joint is formed between carpal bones 1, 11, 111, and IV and the base of metacarpal bones 1, II, III, IV, and V. This joint is supported by numerous short ligaments, as is the middle carpal joint.(3) The carpometacarpal joint is
responsible for approximately 5% of carpal motion.

The carpus is also made up of numerous intercarpal joints, that is, joints between bones within the rows of carpal bones. Additionally the accessory carpal bone lies on the caudal lateral surface of the joint. Short ligaments to the ulnar carpal bone and long ligaments to the base of metacarpal bones IV and V hold the bone in place (Figs. 25-3 and 25-4).

Distal to the radius, the term dorsal replaces cranial and palmar (or volar) replaces caudal.

SURGICAL ANATOMY
Surgical approaches to the carpus usually necessitate complete dorsal exposure of one or more bones or one or more joints. This is best accomplished using a dorsal skin incision over the carpus extending from the distal radius to the metacarpal bones. Deeper dissection of this incision will expose and allow for retraction of the tendon of the common digital extensor muscle and the tendon of the extensor carpi radialis muscle. Transverse arthrotomy incisions into the antebrachiocarpal joint will allow exposure of the radial and ulnar carpal bones. Transverse arthrotomy into the middle carpal joint allows visualization of carpal bones I, II, III, and IV (3)

Surgical exposure of the accessory carpal bone requires a lateral incision directly over the accessory carpal bone. The incision runs to the base metacarpal bone V. The incision is continued along the dorsal border of the abductor digiti quinti muscle, which is retracted palmarly to expose the accessory carpal bone.(4)

FRACTURES OF THE CARPUS
RADIAL CARPAL BONE FRACTURE
TYPES OF FRACTURES
Fracture of the radial carpal bone can take many forms. Fractures occurring with the joint in hyperextension may result in chip fractures of the proximal dorsal border of the bone. More typically the radial carpal bone is crushed when loaded axially in a fall from a height. Transverse fractures with a major medial and lateral fragment can occur, however, they are uncommon.

CLINICAL PRESENTATION
Most carpal problems present similarly. The dog or cat carries the limb with the carpus flexed. It is rare for any weight bearing to occur. Palpation will demonstrate swelling, crepitus, and possible laxity associated with loss of ligamentous support.

Radiography in two views is essential to demonstrate the extent of bony fragmentation. Since fragments are often very small, fine detail film may be necessary, as well as sedation of the animal to prevent motion.

Soft tissue injury associated with carpal fractures is usually confined to the local area. Supporting ligaments or transversing tendons may be damaged but rarely are. Likewise injury to the cephalic vein or the branches of the superficial radial nerve
are possible but occur only rarely.

**FRACTURE REDUCTION AND FIXATION**

Most small-fragment fractures or massively crushed fractures are handled by conservative means. Reduction is not possible; therefore, the carpus is immobilized externally in full extension. External immobilization should be for 2 to 4 weeks only, since excessive fixation may result in severe loss of range of motion. Small chip fragments that do not unite or continue to cause clinical discomfort should be excised.

Large fracture fragments may be reduced by open reduction and fixation. Fragment alignment is accomplished using a small boneholding forceps and fixation is applied. Internal fixation may be either an interfragmentary cortical lag screw or multiple Kirschner wires. Postoperative management may include a soft support dressing for a few days, but firm external fixation should be avoided. Passive and active manipulation of the joint should be encouraged soon after surgery if a good range of motion is to remain.

**COMPLICATIONS**

As with any intra-articular fracture, secondary degenerative joint disease with loss of motion is to be expected. The best method to minimize this complication is to encourage early weight bearing and activity aimed at restoring as full a range of motion as possible.

**PROGNOSIS**

The prognosis for radial carpal fractures in most animals is good. Most animals will return to near normal function. However, intermittent lameness associated with the process of degenerative joint disease can be expected.

**ULNAR CARPAL BONE FRACTURE**

Fracture of the ulnar carpal bone is very rare. When encountered, it is handled the same way as radial carpal bone fracture. Chip fractures, or massively comminuted fractures, are treated by external fixation. Bipartite fractures, if reducible, are fixed by open reduction and use of multiple Kirschner wires or a single small cortical interfragmentary lag screw.

**ACCESSORY CARPAL BONE FRACTURE**

Most fractures of the accessory carpal bone are avulsion fractures seen in racing greyhounds. Fracture through the body of the accessory carpal bone has not been reported. For a more complete discussion of this topic see Chapter 35.

**FRACTURES OF CARPAL BONES 1,11,111, or IV**

Fractures of the numbered carpal bones are very rare. They are generally chip fractures associated with hyper extension injuries and are most often seen in racing or working dogs. Chip fragments may be removed if it is felt they pose problems to joint function. External fixation usually allows for union without the necessity of intra-articular surgery. Most animals will have a satisfactory return of function if treated in this fashion.

**DISLOCATION OF THE CARPUS**

**CARPAL SUBLUXATION OR LUXATION**

FIG. 25-5 Dorsopalmar (A) and medial-lateral (B) radiographic views of carpal subluxation secondary to canine rheumatoid arthritis.

Carpal subluxation or luxation occurs commonly following automobile trauma, jumping from a height, or jumping over a
barrier. While most animals are normal prior to the injury, it must be remembered that animals with underlying disease processes, such as rheumatoid arthritis or systemic lupus erythematosus, may require less trauma to cause an injury than normal dogs (Fig. 25-5).

ANTEBRACHIOCARPAL LUXATION OR SUBLUXATION
Most antebrachiocarpal subluxations or luxations are palmar (Fig. 25-6). The injury occurs with the carpus in an extended or hyperextended position and results in partial or complete tears of the medial palmar fibrocartilage. While palmar dislocation is most common, the displacement may also be dorsal, medial, or lateral. If only one collateral ligament is affected, the displacement may also be valgus or varus.

FIG. 25-6 Medial-lateral radiograph demonstrates palmar luxation of the antebrachiocarpal joint.

CLINICAL PRESENTATION
Most animals present carrying the affected limb, if the injury is acute, or walking on the limb in a plantigrade fashion if chronic. Soft tissue swelling and tenderness are to be expected. Radiography may not adequately demonstrate the lesion unless the joint is stressed during the exposure. Only if complete dislocation is present will a dorsopalmar view show abnormal bony alignment.

REDUCTION AND FIXATION
Reduction of antebrachiocarpal subluxation or luxation can usually be accomplished easily. The joint realigns readily but dislocates as easily. Maintenance of the joint in external fixation may allow for soft tissue healing and scarring, which will support the joint and maintain a normal position. This technique is successful less than 25% of the time.

In cases of complete dislocation, surgical reconstruction of the medial and lateral collateral ligaments followed by external fixation may result in success 50% of the time (see Chapter 69 for details of reconstruction). Most animals with antebrachiocarpal subluxation or luxation require joint arthrodesis. It is probably unnecessary in most cases to arthrodese the middle carpal joint and carpometacarpal joint; therefore, the animal will have 15% to 20% of carpal motion following repair. For technique of antebrachiocarpal arthrodesis see Chapter 46.

Dogs or cats with antebrachiocarpal subluxation or luxation that is untreated will continue to bear weight on the deformed lower limb. With chronicity the joint will become progressively more arthritic and will probably require arthrodesis to control pain and discomfort.

PROGNOSIS
The prognosis following arthrodesis is excellent. Most active dogs will return to near normal function and perform well. Hunting animals will return to function but have some limitations resulting from lack of flexion in the carpus. Dogs needing bilateral arthrodesis will perform with less ability than those with a single surgery; however, they also will do well.

Cats lose much dexterity of their paws following antebrachiocarpal arthrodesis; however, they can walk and perform most functions well.

MIDDLE CARPAL LUXATION OR SUBLUXATION
Most subluxation or luxation through the middle carpal joint mimics problems of the radiocarpal joint. Most luxations occur in a palmar direction; however, they may also be dorsal, and subluxation may occur medially or laterally (Fig. 25-7).
Closed reduction and external fixation rarely results in success. There are major ligaments spanning this joint that can be reconstructed. The best results are achieved by arthrodesis.

Arthrodesis of middle carpal subluxation or luxation should involve only the middle carpal joint and carpometacarpal joint. There is no reason to arthrodese the antebrachio-carpal joint. If arthrodesis is successful, the animal will have 80% to 90% normal carpal movement by sparing the antebrachio-carpal joint. For technique see Chapter 46.

The prognosis in middle carpal subluxation or luxation is very good. By not involving the antebrachio-carpal joint in the arthrodesis most animals will appear and perform normally. Cats will have no noticeable loss of dexterity.

Carpometacarpal Luxation or Subluxation
Carpometacarpal luxation or subluxation mimics luxation of the middle carpal joint. Any direction of placement is possible, but palmar is the most common (Figs. 25-8 and 25-9). External fixation in a reduced position is rarely successful, whereas arthrodesis is very successful. Arthrodesis should involve only the carpometacarpal joint. If it is successful the affected animal will have near normal function following surgery.

Multiple Level Luxation
It is not uncommon for luxation or subluxation to occur at various levels of the carpus simultaneously. In these cases panarthrodesis of the entire joint should be performed.

Subluxation or Luxation of Individual Carpal Bones
Individual bones of the carpus may luxate partially or completely. The bones most commonly involved are the radial carpal bone or carpal bones I and II. Usually they displace dorsally.

Closed reduction may be possible followed by external immobilization for 2 to 4 weeks. While reduction is possible, good results are unlikely. Most reductions do not have good soft tissue healing and the bone continually subluxates. The end result is joint instability and degenerative joint disease followed by joint discomfort and pain. Most require carpal arthrodesis to reach a satisfactory end.

Open reduction and fixation is possible. Once the bone has been reduced, it is fixed in place by using a screw, multiple pins,
or wires. This technique usually results in failure, however. The motion between carpal bones eventually loosens the metal and it migrates or breaks. Arthrodesis results in success.

LUXATION OF THE ACCESSORY CARPAL BONE
Luxation and proximal displacement of the accessory carpal bone occurs when the two ligaments attaching the bone distally to the base of metacarpals IV and V tear or avulse. This is commonly found in association with palmar luxation or subluxation of the antebrachiocarpal joint. Tears of the palmar carpal fibrocartilage and palmar transverse carpal ligament often occur simultaneously.

CLINICAL PRESENTATION
Animals demonstrate a plantigrade posture, there is no accessory carpal bone prominence, and there is muscular laxity in the flexor carpi ulnaris muscle. Deep palpation will demonstrate soft tissue swelling and tenderness.

Radiography shows proximal displacement of the accessory carpal bone. It is rare for the bone to distract proximally away from the carpus; rather, it seems to "hinge" on its dorsal-proximal edge.

REDUCTION AND FIXATION
External immobilization of the limb does not relocate the bone and therefore does not result in success.

Open surgical reduction has been attempted. Reduction is performed with the carpus slightly flexed. Surgical repair may involve suture of the palmar carpal fibrocartilage, wiring the caudal tip of the accessory carpal bone to the base of metacarpal V, or both. The results of such surgery are mixed: some surgeons usually have good results with these techniques while others do not(2) (Fig. 25-10).

FIG. 25-10 (A) Medial lateral radiographic view of a dog carpus demonstrates subluxation of the accessory carpal bone and loss of palmar carpal support. (B) Postoperative radiograph following realignment and stabilization of the accessory carpal bone using a screw and orthopaedic wire.

If corrective surgery fails, arthrodesis of one or all levels of the carpus is necessary to stabilize the joint.

REFERENCES

All rights reserved. This document is available on-line at www.ivis.org. Document No. B0026.0685.