CHAPTER

34

Surgical Resolution of Orthopedic Disorders

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Orthopedic injuries are common in pet bird practice. Some of the more common causes are falling, an impact with a window or ceiling fan, a crushing incident such as being stepped on, or an encounter with a dog or cat.

Definitive fixation of a fracture is rarely an emergency. Due to the traumatic nature of most of these injuries, first priority must be given to stabilizing the patient. Emergency treatment of shock, hemorrhage and sepsis are covered elsewhere. It is important to assess the patient holistically, including diet, husbandry and concurrent medical conditions, without focusing solely on the obvious injuries.

Prior to examination, obtain a thorough history from the owner. Upon initial examination of the patient, orthopedic problems may manifest as lameness, a wing droop, paresis, a swelling or an open wound. Following initial stabilization of the patient, further investigation of these abnormalities is warranted.

The initial orthopedic exam is generally performed with the bird awake. Prior to handling the bird, visually assess it in its cage:

- Does the bird bear weight equally on each leg?
- Are the wings held symmetrically and in the proper position?
- Does the bird grip a perch?
- Is the overall body posture correct?

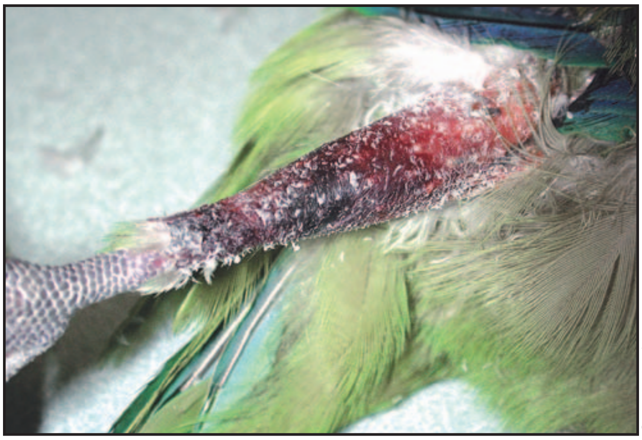


Fig 34.1 | Wetting with alcohol or removing feathers over a fracture site often reveals the contusion.

Following the initial visual examination, restrain the animal and systematically assess the skeletal system. The skull is palpated and the feathers covering the head parted to examine the head for hemorrhage or other injuries. In small birds, transillumination of the skull may identify intracranial bleeding. The keel is palpated for evidence of a fracture. Palpation and visualization of the entire length of the vertebral column may reveal deviations or swellings. Wings and legs are examined beginning at the proximal aspect and progressing distally. Long bones are assessed for fractures, deviations and swellings, and joints are assessed for appropriate range of motion. The contralateral appendage may be used as a normal for comparison. Be careful examining extended wings, as iatrogenic fractures may result from the bird trying to flap while improperly restrained.

Suspicion or identification of orthopedic injury requires further examination under anesthesia. Isoflurane or sevoflurane are the agents of choice. While under anesthesia, a more complete evaluation of suspicious areas may be performed, including investigation of masses, minor wound debridement and investigation, wetting or plucking of feathers for closer inspection (Fig 34.1), and radiographs may be made.

Radiographic technique and positioning are covered elsewhere. At a minimum, two orthogonal views are required for evaluation of a particular area. Radiographs of the non-affected contralateral limb are often helpful for comparison, especially as anatomy is quite variable between genera of birds.

Following identification of an orthopedic problem, a treatment plan must be formulated. Fractures should be temporarily immobilized with splints or bandages until the patient is otherwise stable enough to undergo surgery for repair.

One must keep in mind that splints and bandages are usually meant for temporary fixation only.

The selection of an appropriate technique for definitive repair will depend on several variables, including the size of the patient, the degree of postoperative return to function required, cost, the skill of the surgeon and concurrent medical conditions.

The importance of the first of these conditions, the size of the patient, is often underestimated. Many avian orthopedic techniques were developed for use in raptors weighing approximately 1 kg. While it is true that "tie-in" fixators (TIF) was developed on birds around 1 kg in weight, available hardware is such that it can be readily applied to birds 65-100 grams. These techniques may not be feasible in the 20-g canary. The reduction of load associated with smaller size and higher surgical morbidity and mortality of small patients often contribute to a decision to manage fractures more conservatively in small patients.

The goal of every surgeon should be to return each patient to the pre-injury level of activity; however, this is not always possible. Consideration must be given to the quality of life of a non-releasable wild bird postsurgically. Given the same circumstance, a pet parrot may have an excellent quality of life.

The ideal method of fixation must always be offered and recommended, but lower cost alternatives may have to be considered. A lower cost option may sacrifice postoperative return to function, but in a pet this may be an acceptable compromise. Preoperative communication with owners may be as important as the surgical fixation technique.

Finally, all surgeons do not possess the same skill and experience with avian fracture repair. Referral of orthopedic cases to a more experienced surgeon should be considered.

Principles of Orthopedic Repair

The basic fundamental principles of orthopedic repair are similar to other species. The repair technique should promote a functional union of the fragments, share the load on the bone during healing, allow early return to function and have a low morbidity. The ideal hardware for use in this repair would be versatile, effective, adjustable, lightweight, inexpensive and associated with minimal complications.

Although the principles of repair are the same as in other veterinary patients, some important differences exist:

- Bone cortices are thinner and more brittle, resulting in less holding power for hardware.

- There is less soft tissue covering the bones. As a result, blood and nerve supplies are commonly injured. Fracture segments tend to be unstable and commonly penetrate the skin, with bacterial contamination a common sequela. These fragments of exposed bone are non-viable and commonly form sequestra if incorporated into the repair.
- Bone grafting is not common, as there is little cancellous bone to harvest.
- Load bearing must be rapidly restored to the legs, as locomotion is bipedal.

The healing patterns of avian bone have been examined.[8,19] In adult birds, the amount of time needed for radiographic and histologic union of unilateral radius and ulna fractures in an experimental setting was 5 weeks with internal fixation and 8 weeks with external coaptation.[8] The majority of the callus tissue during healing is derived from the periosteal surface, and the blood supply to the periosteum from surrounding soft tissues is very important. The intramedullary circulation appears to be of less significance in avian bone healing than in mammals.[19]

General Methods of Fracture Fixation

CAGE REST

Very few avian fractures are satisfactorily treated with this method of repair. Fractures of the digits as well as greenstick fractures of young birds may be managed in this way. Cage rest also may be appropriate in the management of fractures of non-weight-bearing bones in very small birds such as canaries and finches. Consider decreasing light levels to decrease activity; however, adequate light must be provided at least twice daily for feeding. Also consider the use of smooth-sided cages without perches (eg, aquarium or plastic carrier) to prevent climbing.

EXTERNAL COAPTATION

The use of splints and bandages for fracture repair in the avian patient is limited. Bandages tend to be bulky and cumbersome. They require prolonged immobilization of joints and usually result in poor alignment of fracture fragments. Though this type of repair may be initially less expensive, return to function is typically prolonged and may not be as complete as with internal fixation. Coaptation may be considered if:

- Full return to function is not required.
- Fractures are pathologic as a result of metabolic bone diseases.
- Bones are too soft to hold hardware.
- The patient is too small for internal fixation alternatives.
- The surgical or anesthetic risk is judged to be too great.

Commonly used splints include the “figure-8” wrap, which may or may not include a body wrap, the Altman splint, and Robert-Jones bandages with the incorporation of splinting material. The application of the figure-8 wrap and the Robert-Jones bandage are covered in other texts.[7] A description of the application of the Altman splint is found below in Managing Fractures of the Specific Bones, Tibiotarsus.

The use of titanium IM pins may have advantages in comparison to the traditional stainless steel pin. Titanium has a “memory” and can be bent past 180° and spring back to its normal position (Fig 34.2). The titanium pin is measured against the radiograph of the fractured bone. The pin is inserted into the proximal or distal fragment (Fig 34.3). The pin is bent and inserted into the opposite fragment, thus avoiding the need to transgress a joint (Fig 34.4) (G. Harrison, personal communication, 2003). If a larger pin than shown in Fig 34.4 is needed for larger birds, a single titanium IM pin is not used, as the force to bend the larger pin will shatter the bone. Multiple smaller diameter pins are placed in stacking fashion to facilitate bending.

Orthodonture rubber-band impactions also have been used successfully on the tibiotarsus (Fig 34.5) (G. Harrison, personal communication, 2003) (see Chapter 14, Evaluating and Treating the Gastrointestinal System).

HYBRID FIXATORS

The use of both intramedullary (IM) pins and external skeletal fixators (ESF) has been well described for the management of avian fractures.[7] More recently, the use of hybrid fixators, or “tie-in” fixators (TIF), has become more popular. This technique combines an IM pin linked to an ESF (Fig 34.6). Advantages include the relative ease of application, use of a smaller diameter IM pin than would otherwise be used, which causes less damage to the intramedullary blood supply, an increase in resistance to bending forces compared to either ESF or IM pin alone,[1] a decrease in migration of the IM pin or the cross-pins, and the ability to gradually remove hardware over time, a process called dynamization, which gradually increases the load bearing of the bone.

The diameter of the IM pin should fill 50 to 60% of the medullary cavity. Following placement, the pin is bent at 90° where it exits the bone. Two or more threaded cross-pins are placed. Threaded pins have been demonstrated to have superior bone-holding strength in avian cortices when compared to non-threaded pins.[4] In one recent

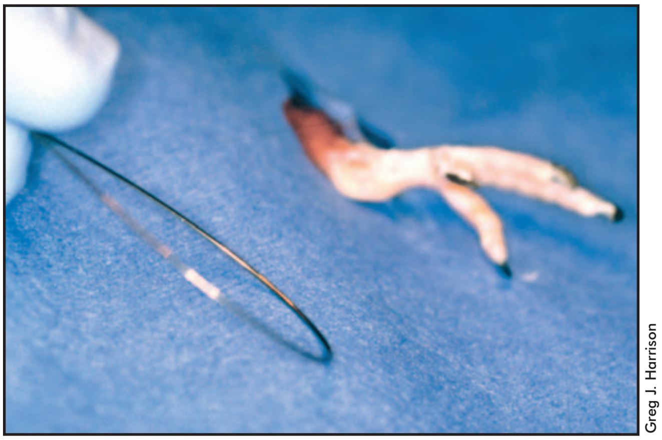


Fig 34.2 | Titanium pin bent past 180°.

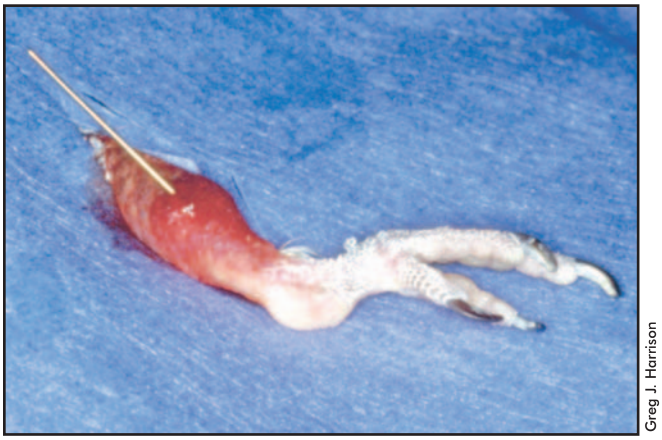


Fig 34.3 | Titanium pin, precut and placed in the distal fragment via the fracture site.

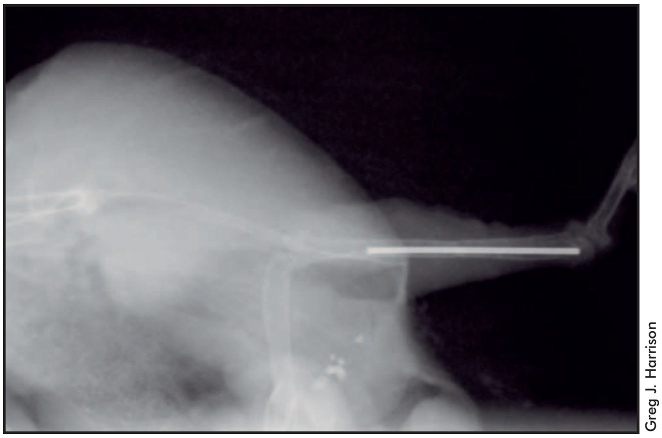


Fig 34.4 | Radiograph of a titanium pin in the marrow cavity, having never transversed a joint surface.

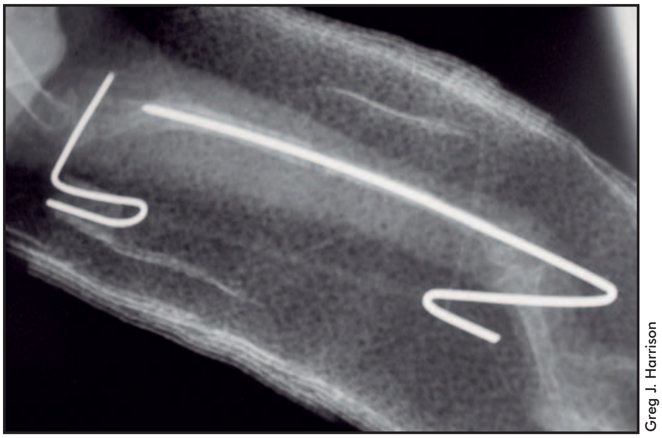


Fig 34.5 | Bending a hook shape into the distal end of a stainless steel transverse pin and the distal end of the distal fragment pin can allow a periodontal rubber band to be used to apply traction to a fracture. A topical bandage covering helps prevent the rubber band from being removed inadvertently.

study, a significant difference in pull-out strength was not demonstrated when comparing positive profile threaded pins vs. negative profile threaded pins.[4] However, positive profile pins have a higher locking strength at the pin-bone interface and may be considered advantageous in larger bones. The cross-pins are linked to the IM pin with either a metal or acrylic bar. Several ways have been described for linking the pins including rubber tubing (ie, Penrose drain, IV tubing, PVC tubing) that is filled with methylmethacrylate (ie, hoof repair material[a]) or car body filler. Also available is a methylmethacrylate putty[b] that is semi-solid. This material is kneaded and applied without the need for any tubing. The fumes emitted from this product are significantly less than the hoof repair material.

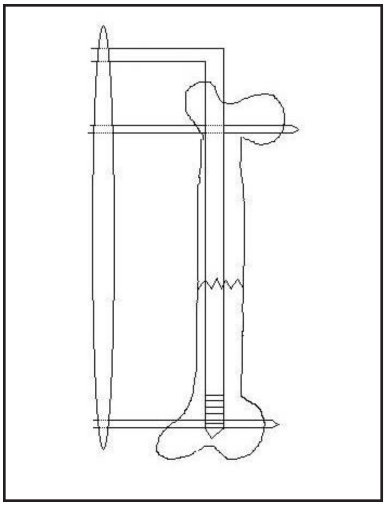


Fig 34.6 | Schematic of a tie-in fixator (TIF) comprising an IM pin linked to two cross-pins.

Managing Fractures of Specific Bones

THORACIC LIMB

Fractures of the scapula, coracoid and clavicle are managed conservatively in all sizes of birds. Figure-8 bandages with body wraps are left in place for approximately 3 weeks, then radiographs are made for reevaluation. Previous recommendations for internal fixation of coracoid fractures, compared to bandaging, resulted in lower success rates in birds of prey, even when severe displacement of fragments existed.[16]

Luxations of the elements of the shoulder girdle also are managed conservatively, with the exception of subluxation of the proximal end of the coracoid from the cranial aspect of the sternum. Open reduction of these subluxations is performed via a standard approach to the coracoid. The musculature of the keel is detached and reflected laterally to expose the proximal coracoid. An elevator or osteotome is used for reduction. Transarticular cerclage wire or pins may be placed if instability persists. The wing is bandaged for 3 weeks postoperatively with physical therapy beginning about 10 days postoperatively.

Patagium

The patagium is a soft tissue structure comprising muscular, elastic and tendinous tissues that extends from the shoulder to the metacarpus. This structure forms the leading edge of the wing during flight. Injury to the patagium may result in perforation or tearing. Healing of these injuries often results in contraction of the web, altering the conformation and restricting extension of the wing.

Sutures do not hold well in patagial tissue. This can be overcome by suturing a piece of cardboard slightly larger than the defect over the area. The splint should be replaced every 7 to 10 days until the defect is healed. The support of the cardboard allows extension of the wing during healing.

Humerus

Fractures of the humerus are classified anatomically into one of three zones: (1) The proximal zone, which extends from the tubercles to the pectoral crest, (2) the diaphyseal zone extending from just distal to the pectoral crest to the apex of the distal curvature of the bone, and (3) the distal zone, which is the curved portion of the bone adjacent to the elbow.

Proximal humeral fractures that are minimally displaced often heal well with a figure-8 wrap combined with a wrap to immobilize the wing against the body wall. However, in order to maximize postoperative flight chances, or in cases of displacement, internal fixation is required. Generally the proximal fragment is too small to drive two cross-pins for external fixation, and there is insufficient purchase for an IM pin. A tension band method of fixation has been described as the most effective technique in the management of these fractures.[16]

The proximal humerus is approached from the dorsal aspect. The major pectoral muscle and the deltoid muscle are elevated from their attachments to the pectoral crest. Two small-diameter pins are driven to exit at the dorsal and ventral aspects of the pectoral crest. Following fracture reduction, the pins are driven into the distal fragment, which results in tension exerted against the medullary cavity. This advancement can be difficult, as the pins bend against the bone and each other. The pins should be driven in an alternating fashion, advancing each only a small amount at a time. The wires are left projecting from the head of the humerus for future removal. This fixation, in addition to wrapping the wing to the body for approximately 1 week, is sufficient in birds under 300 g.

In larger birds, following placement of the cross-pins, a hole is drilled approximately 1 cm distal to the fracture site and another just caudal to the exit point of the wires. A wire is passed through these holes and tightened in a figure-8 pattern to complete the tension band.

Fractures of the humeral diaphysis tend to be oblique and are best managed with a TIF device. The radial nerve, which must be identified and preserved, crosses the dorsal aspect of the humerus at approximately one half of its length.

There are two methods of placing the IM pin in the humerus: 1) the retrograde (ie, away from the fracture site) method that is generally used for fixation of open fractures, and 2) the normograde (ie, toward the fracture site) method for closed fractures.

For retrograde IM pin insertion, the patient is placed in ventral recumbency and the humerus is approached from the dorsal aspect. The diameter of the IM pin should be slightly larger than 50% of the diameter of the marrow cavity. The pin is introduced at the fracture site and driven retrograde, exiting the proximal humerus just distal to the shoulder. The bone chuck is then attached to the free end of the pin and the pin withdrawn until the interval end is flush with the fracture site. The fracture is reduced and the pin driven into the distal fragment. Care must be taken not to penetrate the distal end of the humerus, as damage to the triceps tendon and joint damage are common sequelae.

Fig 34.7 | Dorsal view of the correct introduction site for normograde placement of an IM pin in the humerus. Skin has been removed for illustration purposes.

Fig 34.8 | Dorsal view of the correct sites for placement of cross-pins in the humerus. Skin has been removed for illustration purposes.

Normograde pin insertion is often possible in closed diaphyseal fractures (Fig 34.7). A small skin incision is made on the dorsal aspect of the distal humerus just proximal to the lateral (or dorsal) humeral condyle. Following caudal retraction of the triceps tendon, a non-threaded pin is introduced. The fracture is reduced and the pin is driven proximally to engage the cortex of the proximal humerus in the midsection of the pectoral crest.

Regardless of the manner of IM pin insertion, positive profile interface K-wires are placed at the proximal and distal aspects of the humerus to link externally to the IM pin (Fig 34.8). The distal pin is placed first. A small skin incision is made just proximal to the highest point of the lateral (or dorsal) condyle and aimed toward the ventral condyle. The pin is driven until a full thread extends through the opposite cortex. Prior to placing the proximal pin, the wing is folded against the body to properly align the rotation of the fragments. The midsection of the free edge of the pectoral crest is palpated and fingers walked along it until the high point is reached. The pin is driven, parallel to the distal one, until both cortices are engaged. The free end of the IM pin is bent at 90° approximately 2 cm from the skin. The three pins are attached as previously described. It is not recommended to place the distal ESF pin directly through the condyles in fractures of either the distal humerus or the distal tibiotarsus. In many species the intercondylar sulcus is sufficiently deep that the pin will skewer the tendon (triceps or gastrocneumius) that rides in that sulcus. The pin is placed in a slightly proximal position: at the humeral epicondyle to which the tendon of the common digital extensor and supinator muscle arise and in the tibiotarsus, proximal to the supratendinal ridge.

Fractures of the distal humerus (ie, those that occur within 2 to 3 bone diameters of the distal humeral condyles) are problematic, as there is insufficient space for an IM pin to gain purchase in the distal fragment. A cross-pinning technique for these supracondylar fractures has been described.[16]

A skin incision is made dorsally to approach the fracture. The distal fragment is isolated and elevated while protecting the soft tissues and avoiding the separation of comminuted fragments from their soft tissue attachments. Two K-wires are placed in retrograde manner, at an angle such that they exit the fragment on the opposite side of the marrow cavity. When pin ends are flush with the fracture line, the fracture is reduced and the pins are driven into the proximal fragment. Movement is alternated between the pins, advancing about 0.5 cm at a time until properly seated. Pins are placed in the proximal and distal humerus as previously described and the elements attached to form a hybrid fixator device.

Radius and Ulna

The method of repair of fractures of the radius and ulna will depend upon the integrity of the other bone of the pair. External coaptation is a viable option in small companion birds when either the radius or the ulna is fractured and the displacement of fragments is minimal. Potential complications include patagial contraction as a result of prolonged immobilization and the formation of synostosis between any displaced fragments and the other bone. This significantly affects the bird's ability to fly, as both lift and descent require the radius to rotate about the ulna.

Internal fixation of the radius and/or ulna may be accomplished with ESF, IM pins, or a combination forming a TIF. The prognosis for diaphyseal fractures is good; however, some very proximal radius and ulna fractures may be managed only by transarticular ESF, with a very poor prognosis for return to flight. Repair of avulsion fractures of the olecranon has not been reported.

In cases of fracture of both the radius and ulna, fixation

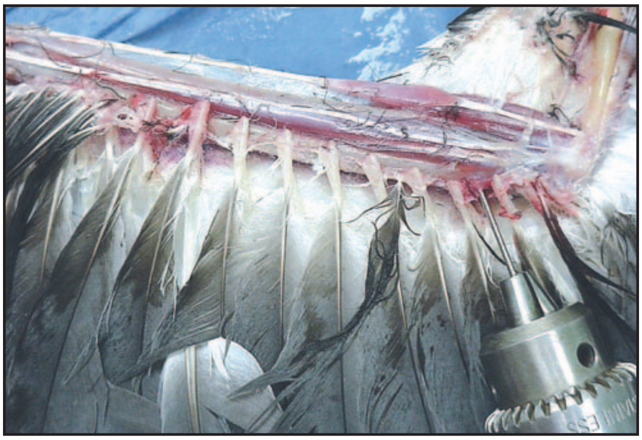


Fig 34.9 | Dorsal view of the correct introduction site for normograde placement of an IM pin in the ulna. Skin removed for illustration purposes.

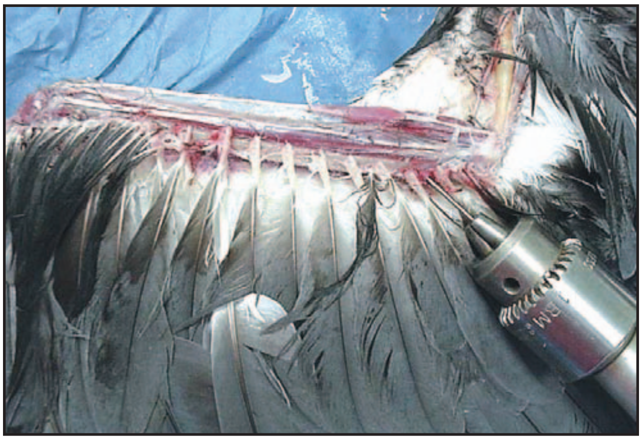


Fig 34.10 | Dorsal view of the normograde placement of an IM pin in the ulna: gradually reducing the angle of introduction. Skin removed for illustration purposes.

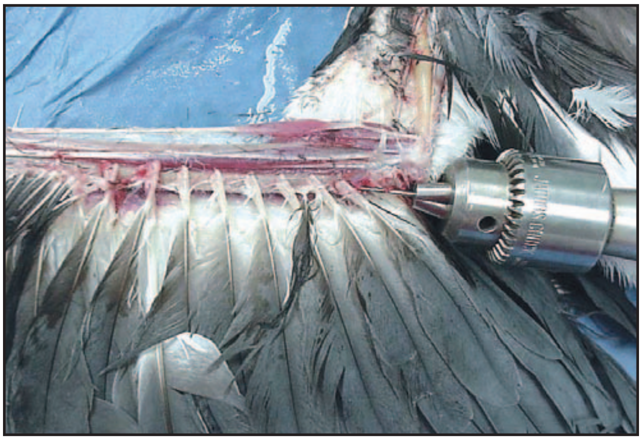


Fig 34.11 | Dorsal view of the normograde placement of an IM pin in the ulna: final alignment. Skin removed for illustration purposes.

of the radius is mandatory, while repair of the ulna is somewhat optional. Given the greater rigidity obtained and the shorter healing time, ulnar fixation is generally recommended. A combination of IM pin fixation of the radius and TIF fixation of the ulna is effective.

IM pins may be placed in the radius and the ulna, however, the method and location of placement is very different. In the radius, the pin is introduced at the site of the fracture and driven retrograde to exit at the distal end of the bone as the carpus is held in flexion. The pin will exit cranial to the carpal joint as the distal radius curves caudally. The fracture is reduced and the pin driven into the proximal fragment. Blunting the proximal tip of the pin may aid in avoiding penetration into the elbow joint.

The ulna is pinned in normograde fashion. Retrograde placement is contraindicated, as it risks exiting the pin at the olecranon and damaging the joint. The covert and down feathers are plucked from the dorsal and caudal aspects of the wing distal to the olecranon. Secondary flight feathers are left untouched. The pin insertion point is on the caudal aspect of the ulna between the shafts of the second- and third-to-last secondary feathers. A small skin incision is made and the pin introduced at nearly a right angle to the caudal bone cortex. As the pin is slowly driven through the cortex, the angle is gradually reduced to become aligned with the long axis of the ulna (Figs 34.9-34.11). The fragments are manipulated into reduction and the pin is seated in the distal aspect of the bone. The proximal ulnar cross-pin is placed between the proximal end of the ulna and the IM pin. It should not impinge upon the elbow joint. The carpal joint must be avoided when placing the distal cross-pin.

Elbow Luxations

Moderate success has been reported in the surgical repair of caudodorsal luxations of the elbow with the following technique.[16] A skin incision is made over the dorsal surface of the wing, and the distal end of the humerus and the proximal antebrachium are exposed. Exposure of the joint is improved by transecting the tendon of origin of the supinator muscle if it remains intact. The proximal end of the ulna is levered into place by inserting a flat periosteal elevator between the proximal ulna and the dorsal (or lateral) humeral condyle and levering the ulna distally until it aligns with the humeral condyle. Application of traction to the distal ulna may be beneficial. The cut ends of the supinator muscle are resutured and a pseudocollateral ligament is made by suturing the edge of the triceps tendon to the common digital extensor tendon. Following closure, a transarticular ESF is placed for 7 to 10 days.

Carpal and Metacarpal Bones

Factors that complicate the management of these fractures include the paucity of soft tissue structures around these bones to protect them and provide blood supply as well as the high incidence of open comminuted fractures

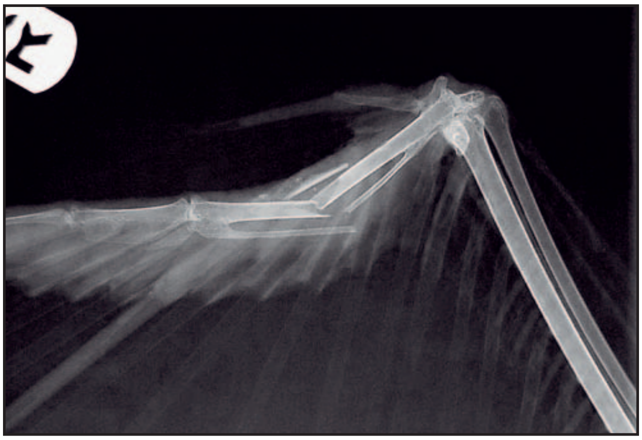


Fig 34.12 | Preoperative view of a fracture of the major and minor metacarpal bones.

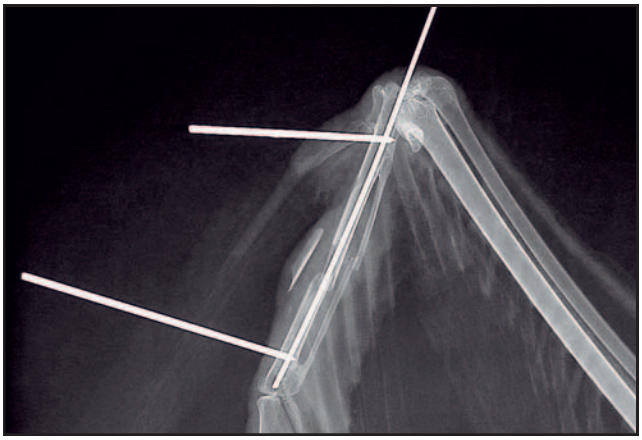


Fig 34.13 | Postoperative view of a reduced fracture of the major and minor metacarpal bones. The IM pin has not yet been bent nor attached to the cross-pins.

as a result of high-energy collisions with wires or projectile impacts. Fractures of the metacarpal bones have a lower rate of successful fixation than other avian fractures.

There are two main techniques used in the management of metacarpal and carpal bone fractures: the curved-edge sandwich splint, and ESF (Type I). The later has yielded the best overall results.

Curved-edge sandwich splints are suitable for stabilizing closed, easily reduced metacarpal fractures. These splints are formed with a right-angle bend in the edge of the splint that runs along the leading edge of the wing. The splint material is cut to a length equal to the distance from the cranial edge of the metacarpus to the distal phalanx and wide enough to cover five to six primary feather bases. The material is laid on the ventral surface of the wing, and the cranial edge is bent at 180° and trimmed flush with the dorsal wing surface. Overlapping adhesive tape strips are applied lengthwise to the dorsal and ventral surfaces of the feather shafts to keep the splint in place. Tape edges are pressed together to provide strength.

ESF are ideal for highly comminuted fractures of the metacarpal bones with extensive soft tissue damage. The fragments can be reduced with minimal soft tissue manipulation.

TIF are not ideal due to the great care that must be taken when placing the IM pin, as there is significant risk of injury to the distal radius. For placement, the pin is introduced at the fracture site and driven proximally while the carpal joint is held in flexion. Following reduction of the fragments, the pin is seated in the distal fragment and bent at 90° to attach to the fixator **(Figs 34.12, 34.13)**. IM pins alone are unsuitable options for metacarpal fracture fixation due to the risk of injury to the radius, coupled with the need for supplemental external coaptation to control rotation forces.

PELVIC LIMB

The femoral head is connected to the acetabulum by the femoral capital ligament and supported by thickenings of the joint capsule. Traumatic rupture of the femoral capital ligament results in dislocation of the joint.

In small birds, closed reduction and strict cage rest may be effective in the management of coxofemoral luxations; however, in larger species an open reduction is preferred. A cranio-dorsal approach to the joint avoiding the antitrochanter is favored, as exposure is increased. The femoral head is replaced in the acetabulum and soft tissues repaired. Strict cage rest for 3 weeks postoperatively is necessary.

Pins should not be used to fix the femoral head into the acetabulum, as there is a high risk of damaging the kidney and its blood supply on the medial aspect of the pelvis. Additionally, only the rim of the acetabulum is bony in birds; the rest of the structure is fibrous.

Femur

The femur is surrounded by the *iliotibialis* and *femorotibialis medius* muscles cranially, the body wall medially, and the *flexor cruris* and *puboischiofemoralis pars medialis* muscles caudally. The ischiatic vein, artery and nerve are identified caudolaterally proximally and pass more laterally toward the distal femur. The surgical approach to the femur is made from the lateral aspect.

Fractures of the proximal femur are managed with a tension band apparatus similar to that described for the proximal humerus. The cross-pin technique described for fixation of supracondylar fractures of the humerus is well suited for distal femoral fractures.

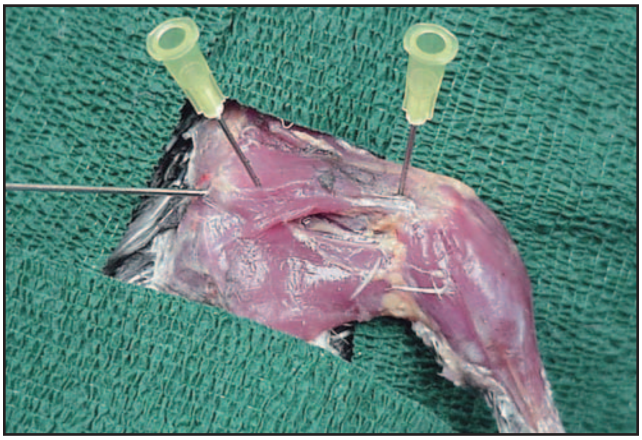


Fig 34.14 | Lateral view of the placement of an IM pin and cross-pins (hypodermia needles) in the femur. Note the neurovascular bundle coursing caudal to the bone. Skin removed for illustration purposes.

Diaphyseal fractures are best managed with a TIF. The IM pin is introduced at the fracture site and retrograded to exit at the hip. Following fracture reduction, the pin is driven into the distal fragment. The cross-pins are placed from slightly craniolateral to caudomedial to best avoid the neurovascular bundle (Fig 34.14). The proximal pin is placed through the femur just distal to the dorsal acetabular rim. The distal pin is placed through the condyles. IM pins alone are often sufficient in birds under 100 g.

Luxations of the Stifle

Luxations of the stifle or femorotibial joint may be managed using one of several methods. One recently reported method involves the placement of IM pins into the femur and the tibiotarsus at the stifle.[3] The free ends of these pins, projecting at the stifle, are bent parallel to each other, and with the leg in normal perching position, the pins are held together with a small amount of acrylic. Transarticular ESF placement, with threaded pins placed in the femur and tibiotarsus and connected with acrylic, has also been described.[6] Ruptured cruciate and collateral ligaments may be repaired using PTFE (Teflon) suture material as a replacement. Hypodermic needles are used to drill holes in the bone and the suture material is then threaded through the needles.

Tibiotarsus

Tibiotarsal fractures are very common in pet birds and in falconry birds. Psittacines tend to have mid- to distal diaphyseal fractures, whereas proximal-third fractures are more common in the raptors used in falconry. Tibiotarsal fractures are usually closed and the prognosis for repair is good. Damage to the tibial and or fibular nerves is not uncommon and must be evaluated. Also, particularly in raptors, bumblefoot of the opposing limb is a concern.

Patients under 300 g will heal very well with a combination of an IM pin or K-wire and external coaptation in the form of an Altman splint. Hypodermic needles make excellent IM pins, and a 22-gauge needle works very well in budgerigars, cockatiels and similar-sized birds. The pin is introduced into the cranial aspect of the proximal tibiotarsus, avoiding the patellar ligament, and following fracture reduction, advanced into the distal fragment. This is easily accomplished without a chuck, using the plastic hub of the needle to grasp. The hub is then trimmed off the needle. This IM pin technique is combined with an Altman splint to control rotation forces.

To place an Altman splint (Figs 34.15a-d), the bird is placed in lateral recumbency. Overlapping strips of adhesive tape are placed laterally and medially in a horizontal fashion, with the sticky side toward the limb, beginning just proximal to the stifle and continuing distally to immobilize the hock. The sticky sides of the tape are pressed together with hemostats on the cranial and caudal aspects of the limb. The limb should be splinted in a normal perching position. Several layers may be necessary to give strength to the splint, or the tape may be coated with a small amount of cyanoacrylic glue to strengthen it. As an alternative to white adhesive tape that can be difficult to remove, self-adhering bandage material[c] can be used in much the same way. Healing takes approximately 3 weeks.

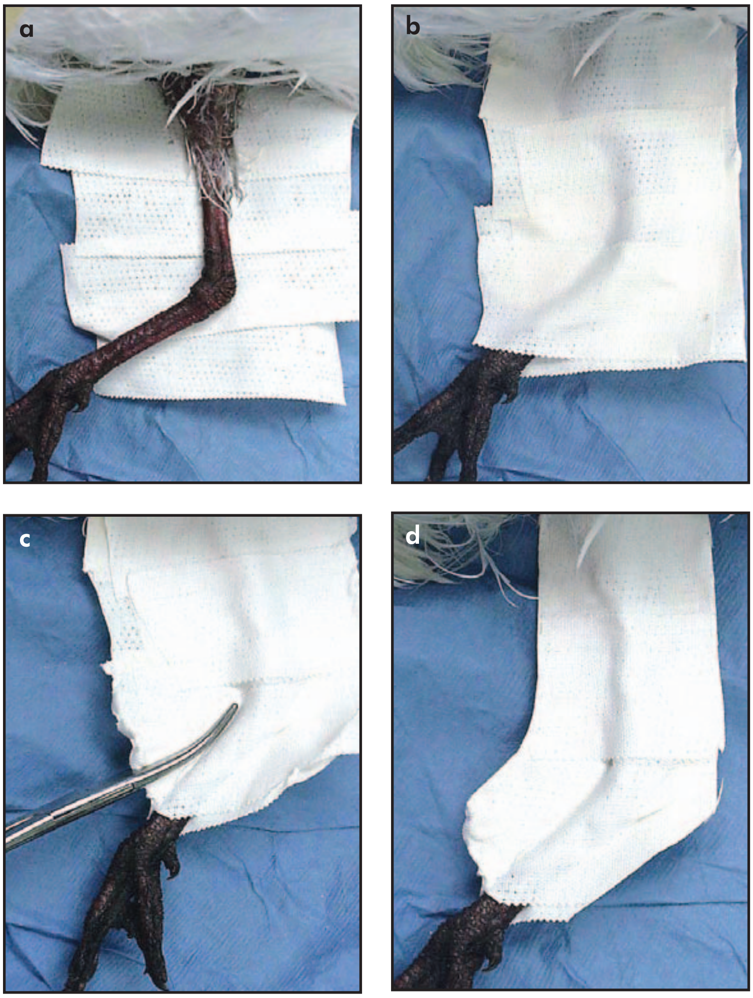
In larger birds, a TIF is the fixation method of choice (Figs 34.16, 34.17). The IM pin may be placed in a normograde fashion as previously described or in retrograde fashion from the fracture site. Pins should not exit into the intertarsal joint, as the tendons of the digital flexor muscles pass through the tibial cartilage in this area and may be damaged.

In planning a surgical approach or placement of the cross-pins, the fibula and neurovascular bundle laterally, and the gastrocnemius muscle caudally, dictate a craniomedial approach. The distal cross-pin is placed from lateral to medial through the condyles. The proximal cross-pin should be introduced on the craniolateral aspect just distal to the tibial plateau and cranial to the fibula. The pin is directed caudomedially. These pins are attached to the IM pin to form the fixator. Type II ESF fixators also have been used with great success in the management of tibiotarsal fractures.

Rotational or angular deformities may be corrected with an osteotomy and either ESF or a TIF.[6]

Tarsometatarsus

The shape of the tarsometatarsus varies among families of birds. The tarsometatarsus of hawks has a flat, C-shaped cross-section with little medullary cavity, whereas in parrots, the bone is rounder with a larger cavity. IM



Figs 34.15a-d | Step-by-step application of an Altman splint.

Fig 34.16 | Preoperative view of the fracture of the tibiotarsus and fibula.

Fig 34.17 | Postoperative view of a reduced fracture of the tibiotarsus and fibula. The IM pin has not yet been attached to the cross-pins.

pins are not recommended, as the flexor tendons that run on the caudal aspect of the bone are affected. ESF cross-pins must be placed with caution to avoid the metatarsal artery and extensor tendons running dorsally, and the flexor tendons ventrally. Splinting of tarsometatarsal fractures with an L-shaped metal splint works well. The toes should be allowed to function freely during recovery to avoid immobilization of the flexor tendons during callus formation.

Phalanges

Closed phalangeal fractures are left unsupported and treated with cage rest. The flexor tendons and their sheaths provide good support. Splinting results in the formation of adhesions and a stiff toe. Compound fractures commonly result in osteomyelitis, and amputation should be considered. Dislocations of phalangeal joints may be reduced under anesthesia without the need for external support. Damaged collateral ligaments may be repaired with 3-0 or 4-0 polyglactin suture.

POSTOPERATIVE CARE

Gauze sponges are applied between the connecting bar and the skin to provide mild compression and to absorb fluids exuding around the pins. These should be changed daily. Pain is managed with opioids or NSAIDs. Analgesia is discussed in Chapter 8, Pain Management and elsewhere in this book. Perioperative antibiotic therapy with bactericidal antibiotics such as cefotaxime[d], enrofloxacin[e], or clavulanated amoxicillin[f] is warranted. In patients where osteomyelitis is a concern, clindamycin[h] is indicated. The use of antibiotic-impregnated polymethylmethacrylate (AIP-MMA) beads (also called MMP beads) should be considered in patients with open, contaminated fractures with infected bone.

Postoperative radiographs are always indicated to assess the alignment and apposition of the reduction, regardless of the fixation technique used. Radiographs should be repeated in 10 to 14 days to assess healing. Fractures will often heal with significant fibrous callus that will not be initially evident radiographically. Palpation of the fracture site yields additional information regarding fracture stability.

Complications

AMPUTATION

The ability of an individual bird to deal with either thoracic or pelvic limb amputation depends on the bird's size, demeanor and required return to function. Amputation through bone is preferred to disarticulation. The bone end will atrophy and maintain adequate soft tissue coverage.[18]

Wing amputations are quite feasible in most parrots, though balance is significantly affected. Most birds will learn to adapt. The wing is generally amputated at the junction of the proximal and middle thirds of the humerus, leaving sufficient soft tissue for closure.

Pelvic limb amputation always carries with it the concern of development of bumblefoot on the opposing limb. Parrots, especially the smaller varieties, fed formulated diets and offered appropriate perches, tolerate pelvic limb amputation well. There are two common sites for amputation: the proximal tarsometatarsus and midfemoral. The advantage of a tarsometatarsal amputation is the creation of a weight-bearing stump covered by the thick, scaly skin in the area. Some birds will traumatize this stump, and a midfemoral amputation site is cosmetic as well as leaving adequate soft tissue for closure. Postoperatively, birds often benefit from wider, padded perches until they regain their balance.

MALUNION/NON-UNION

Malunions and non-unions are the results of instability at the fracture site. Management includes ensuring adequate immobilization of the fracture, which may include additional apparatus, additional coaptation or a decrease in the activity level of the bird. If a callus is present, this material may be removed and packed into the defect as a graft. In more long-standing cases, bone grafting may be required. A piece of bone from the carina may be harvested, chopped into small pieces and packed into the defect. This is cortical bone and may become a sequestrum.

OSTEOMYELITIS

As previously mentioned, many avian fractures are open and contaminated. Routine antibiotic therapy is instituted as discussed. Cases of postoperative osteomyelitis are managed with surgical debridement and antibiotic therapy based on culture and sensitivity. Lincomycin[i] and clindamycin[h] are generally the drugs of choice.

Implantation of AIPMMA beads may be beneficial, as high concentrations of antibiotic are reached in their surrounding area. Consider *Aspergillus* sp. and *Mycobacterium* spp. as etiologic agents in unresponsive cases.

SEPTIC ARTHRITIS

Joints may become infected through a direct penetrating wound or via the hematogenous route. Clinical signs include lameness and swelling of the joint. Diagnosis is obtained through radiographs, cytology and culture of the joint fluid. Radiographic signs of septic arthritis include increased radiodensity of the subchondral bone and osteolysis as the disease progresses. Treatment combines daily irrigation of the joint with saline and an antibiotic, in conjunction with oral antibiotics based on culture and sensitivity. Radiographic bone changes are a poor prognostic indicator. Although the infection may be controlled, a decrease in the range of motion of the joint should be anticipated.

BUMBLEFOOT

Bumblefoot, a combination of pressure sores and infection of the plantar aspect of the foot, is a common condition of captive birds of prey and waterfowl and also is seen in psittacines, primarily cockatiels and Amazon parrots. Predisposing factors include obesity, poor diet, inactivity, inappropriate perches and uneven weight bearing, as is often the case in pelvic limb injuries.

Initial lesions are recognized as hyperemia and flattening of the skin of the digital and metatarsal pads, the sites of maximum weight bearing (Type I) **(Figs 34.18, 34.19)**. These lesions progress if untreated and bacterial invasion of the subcutis occurs, resulting in a scab and mild swelling (Type II) **(Figs 34.20, 34.21)**. Some may further progress to form a caseous abscess with marked swelling and pain (Type III) **(Fig 34.22)**. Infection of the tendon sheaths results in an infection and corresponding cellulitis tracking toward the intertarsal joint and the digits, flexor tendon rupture (Type IV) **(Fig 34.23)**, osteoarthritis of the sesamoid bone ventral to digit II, and septic arthritis of the tarsometatarsal-phalangeal joints (Type V) **(Fig 34.24)**.

Treatment and prognosis depend on the degree of disease, but all birds with lesions should have the following changes made:

- Correct dietary deficiencies. In parrots, it is crucial to convert to a formulated diet.
- Alter perching surfaces to allow more even weight bearing. Wrapping wood perches with bandaging material[c] or covering perches with artificial turf or other carpeting material will result in a different weight distribution each time the bird perches. Cement and sandpaper-covered surfaces must be eliminated.
- Reduce the bird's weight. This will often accompany conversion to a formulated diet from a high-fat seed diet.

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Fig 34.18 | Early Type I bumblefoot in a parrotlet (*Forpus* sp.) that selected only oats from a seed/pellet diet.

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Fig 34.19 | Advanced Type I bumblefoot in a budgerigar (*Melopsittacus undulatus*) on an all-seed diet.

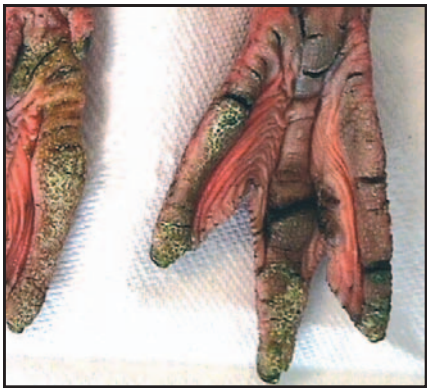

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Fig 34.20 | Type II bumblefoot in a flamingo fed an all-grain diet and housed on a poor floor surface.

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Fig 34.21 | Type II bumblefoot in a mynah bird (*Gracula religiosa*) with iron storage disease.

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Fig 34.22 | Advanced Type III bumblefoot in a cockatiel (*Nymphicus hollandicus*) fed an all-seed diet.

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Fig 34.23 | Type IV bumblefoot in a 20-year-old cockatiel (*Nymphicus hollandicus*) with deformed bones, tendons and ligaments fed an all-seed diet.

- Increase exercise. Pets should be encouraged to walk around on various surfaces and must be let out of their cage. Allow flight.

The above changes are usually sufficient for treatment of Type I disease. Refractory cases should be evaluated for other systemic disease that may be decreasing perfusion to the foot or otherwise delaying healing.

All birds with Type II-V bumblefoot should be managed with antibiotics. The choice of drugs is based on culture and sensitivity testing. Good initial choices include the amoxicillin/clavulanic acid[f] combinations, enrofloxacin[e], or Lincocin[i].

Type II bumblefoot may be treated with thorough cleaning of the feet and application of medication to soften the scab, such as hydrocolloidal wound dressing material or sodium fusidate[j] ointment. Once the scab is removed, the underlying wound is sutured and bandaged.

More advanced cases (Types III, IV, V) require surgical intervention. Treatment is aimed at wound debridement and re-epithelialization. AIPMMA beads may be left in the wound to increase antibiotic levels locally.[5] Large wounds are managed with a purse-string suture and allowed to granulate in. A rigid foot cast is made to support the foot and raise the plantar surface to avoid contact with the perch.

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Fig 34.24 | Type V bumblefoot in an American bald eagle (*Haliaeetus leucocephalus*) with improper diet and housing.

Prognosis for Types IV and V bumblefoot is guarded to poor. The disease often results in deformity and dysfunction of the toes.

Products Mentioned in the Text

a. Technovit, Jorgensen Laboratories Inc, Loveland, CO, USA www.jorvet.com, www.3m.com/us/healthcare/professionals/animalcare
b. ESF putty, Jorgensen Laboratories Inc, Loveland, CO, USA www.jorvet.com
c. Vetrap Bandaging Tape, 3M Animal Care Products, St. Paul, MN, USA
d. Claforan, cefotaxime, Hoechst-Roussel Pharmaceuticals, Kansas City, MO, USA www.aventis- us.com/PIs/claforan_TXT.html
e. Baytril, Bayer, Shawnee Mission, KS, USA www.bayeranimalhealth.com
f. Clavamox, Pfizer Animal Health, Exxon, PA, USA www.pfizer.com/ah
g. Suitably sized IM pins are available in the US from IMEX Veterinary Inc, Longview, TX, USA , www.imexvet.com
h. Clindamycin- Antirobe - Upjohn, Kalamazoo, MI. 616-329-8244
i. Lincomycin- Lincocin Upjohn, Kalamazoo, MI. 616-329-8244
j. Sodium fusidate ointment, Fusidic acid www.drugs.com/xq/cfm/pageID_0/search_fusidic%20Acid/start_31

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