Fracture Management in Birds

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Wild birds of prey are one of the commonest groups of birds presented for fracture repair. Previous surveys of wild raptors trauma cases (Howard and Redig 1993), have shown that 33% are likely to have suffered a fracture incident, of these 40% are likely to be euthanased on account of the fracture, 10% euthenased for other reasons, and 15% die spontaneously. The percentage of wild raptor fracture cases that are eventually released is 36% for closed fractures, but only 15% for open fractures. The author believes strongly that permanent flight impaired wild casualty birds, of any species, should not be maintained in captivity, but should instead be euthanased. Such release rates may initially seem low, however it should be realised that for a wild bird to allow itself to be caught, it must be either severely traumatised or significantly weakened as a consequence of fracture, such that it has been unable to feed for several days. Wild raptor fracture cases are made up of 86% wing fractures (Howard and Redig, 1994), whilst in captive raptors 82% are leg fractures (Forbes unpublished data). The success rate for full return of normal function in captive bird fracture cases is far greater, predominantly because less are compound fractures (firstly because they are presented more quickly but also because less involve the humerus, where fractures are typically open), but also because correct expedient therapy can usually be implemented.

The approach to an avian orthopaedic case, requires initial consideration of the following key factors, is it a wild or a captive bird, is complete repair and return of normal function possible, and what degree of functional disability is acceptable for the species and individual bird to live a compassionate future life.

In considering the likelihood of return to full normal function, the following factors should be considered. Through out the process, one should continue to ask oneself, if there is any reason why this bird will not be able to return to the wild, to hunt kill and survive in a wild environment. One the first and most important considerations is eyesight. Many thin birds are admitted, which gain weight rapidly, are released and subsequent starve again. Likewise it is known that 30% of raptor trauma cases have eye damage, of these the damage is only affecting the posterior chamber. Such damage is not apparent to the keeper, (or to the vet unless they pick up an ophthalmoscope). All raptor trauma or thin bird cases should have their eyes fully examined, and should preferably be flight trained and hunted prior to release, to ensure that they will be able to survive in the wild. Any bird who has lost an eye (or the use in it), a wing, leg, beak, 1st or hind talon, or who is imprinted should not be considered for release to the wild.

How did the fracture occur, consider trauma, pathological fracture due to neoplasia, metabolic bone disease, osteomyelitis (in particular *M avium*). If it arose subsequent to trauma, have other structures also been traumatised. Which bone is affected. Compound or closed, avian bones have a wide medulla and thin cortex (in order to minimise weight, in order to maximise flight ability). Avian bones are brittle, they are surrounded by only a small amount of soft tissue, hence many

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fractures are compound (62% of all wild raptor fracture cases) (Howard and Redig 1993), soft tissues, especially of the wing are prone to desiccation. If compound, how contaminated or devitalised is the potential surgical site. Is there significant soft tissue damage. Are nerve and vascular supply intact. Does the fracture involve a joint or is it close to a joint. After due consideration, if the case is to be treated, rather than euthanased, the condition of the bird must be assessed. Many birds which have undergone sufficient trauma to fracture bones will at the same time have suffered considerable other soft tissue damage. Pre anaesthetic screens performed and supportive care administered if appropriate (Redig, 1996). Fluid imbalances must be corrected, the patient stabilised, analgesia and antibiosis administered, prior to surgery.

The aims should then be to :-

- Treat contaminated or infected wounds.
- Preserve soft tissues, if necessary by applying splints or other dressings. In view of the extreme fragility of avian skin, and the small volume of soft tissue, special care is required in many cases to prevent desiccation of muscle and tendon tissues.
- To realign fractures or replace luxations.
- To rigidly stabilise the fracture site, preventing any movement or rotation, this may require a combination of surgical techniques together with a full understanding of the husbandry of the bird, such that it may be properly controlled during it's convalescent period.
- Maintain full early function of all joints and tendons.
- Return the limb to full normal function, without adversely affecting the healing process as quickly as possible.

An important point to remember is that wing amputee male birds are highly unlikely to ever successfully copulate. Leg amputee birds over 150g, almost inevitably develop bumblefoot or arthritis in their remaining foot sooner or later.

Timing of surgery

- It is the author’s experience that all such orthopaedic cases should have surgery delayed by 24 hours. In the interim desiccation and further trauma should be prevented. The bird should be stabilised with fluid therapy, analgesia, antibiosis, parasiticides if necessary, and nutritional support.
- Timing and method should always be considered on an individual cases basis, decisions will very depending on the nature and life style of the bird, let alone the fracture and the state of the proximate tissues.

Methods of Fracture Repair

- External coaption (splints, extension splints, bandages etc.)
- Internal fixation (pins, wire, cement, etc), surgical intervention and trauma should be minimised
- External fixation (half or full pin, with lateral stabilising bars)
- Case and method selection should be made in consideration of the degree of perfection that that species requires in order to survive happily in the wild, or if a captive bird, for it to still be a functional bird for the owner in relation to its current or potential future uses. For example a hybrid 1 year old male bird, may be of very little use for anything apart from flying at game, whilst in contrast a female 6 year old pure bred gyr falcon, has great value and potential as a breeding bird, even if she cannot fly again.

Bone Healing

- In correctly aligned and opposed bones, repair is by endosteal callous
- If not rigidly fixed, periosteal callous will also form
- Stable properly aligned fractures heal more rapidly than in mammals typically being fully stable in 3 - 4 weeks

Techniques : Surgical approaches for avian fracture repair have been discussed by Orosz *et al* (1992), Harcourt-Brown (1994) and others. Orthopaedic techniques are very varied, depending on the bone, fracture type and the size and species involved. For surgical techniques the following references should be referred to (Howard and Redig, 1994; Hess, 1994; Coles, 1996; Harcourt-Brown, 1996).

The current recommendations, are in line with newer procedures in humans and domestic mammals. Surgical intervention, and in particular bone fragment manipulation at the fracture sight should be minimised or better still avoided. The aim should be to stabilise the fracture, in correct alignment and length, permitting full joint movements. This is often best achieved by the use of a hybrid or tie in fixator this involves the combination of a half pin external fixator, which is joined to a single intra-medullary pin (see later).

Thoracic Limb

Coracoid - these fractures are relatively common, and are most often seen in sparrow hawks following collision with French Windows and similar. Good quality xrays are required in order to exactly delineate the coracoid, furcula and scapula. Fracture of any of these may also result in disruption of the trioseum. Smaller species (<300g), generally respond well to immobilisation of the affected wing, and rest. (Northern Sparrow hawks in particular are very susceptible to stress, and the placement of bandages around the thorax can be deleterious. Larger species, especially those in which there is significant displacement, may benefit from fracture reduction and internal fixation. The cranial portion of the pectoral musculature is elevated, to expose the fractured croaked, a pin is passed retrograde, then after reduction of the fracture a blunt end is passed into the proximal fragment, the surgeon should be very careful not to advance the pin normograde too far, in view of the position of the heart in relation to the surgical field.

Proximal humerus - fractures commonly occur following similar injuries to those described above. Humerus fractures are the commonest type of fracture in wild raptors. The humerus is pneumatised, being joined to the clavicular air sac. Flushing of the proximal bone segment is dangerous in view of the possibility of encouraging infection to pass from the humerus into the air sac. These fractures are most commonly seen in the Northern Goshawk and Northern Sparrow hawk. These may be repaired by single IM pinning or stack pinning, although a hybrid fixture is generally preferable. The natural curve of the humorous, lends itself to pins being exited either proximally near the shoulder or distally near the elbow, without interference with the joints. The favored method in the US until recently has been the use of a threaded pin, in combination with methylmethacrylate.

Mid shaft Humeral Fractures - these fractures frequently become grossly displaced and often (59%, Redig 1993) result in compound fractures, with exposed necrotic bone. For closed simple fractures of the mid shaft any of the techniques mentioned above may be employed. During surgery great care must be taken not to traumatise the radial nerve which is located just

beneath the skin on the dorsal aspect. During repair great care must be taken to ensure the correct alignment of the humerus, mal-rotations can easily occur. As with many other long bones in avians, there is a great propensity for longitudinal cracking. Such cracks should be evident on xray (if of sufficient quality), so that circlage wires may be placed before i/m devices or external fixators are applied. In cases of comminuted mid shaft fractures, so long as the radial nerve is functional, a half pin external fixator, on the dorsal or lateral aspect of the wing may be used, although when combined with an intra medullary devise the result is significantly improved. Care must be taken not to damage the radial nerve.

Distal Humeral Fractures - the same devices as above may be used, or if the fracture is very close to the joint a trans-articular external fixator may be used, in which case at least 5 pins must be used, two in the proximal humerus, one in the distal humerus, and two in the proximal ulna.

Dislocation of the Elbow - this injury, carries a poor prognosis for a post operative return to normal flight. Martin *et al*. (1993) described a a half pin trans-articulation technique, which is applied for 7 - 15 days only, which achieved a fifty percent release rate in wild injured birds, this author has achieved similar success rates with the same technique.

Fractures of the Ulna & Radius - 30% fracture only the ulna, 60% suffer fracture of the ulna and radius and 10% fracture only the radius (Redig 1993). These bones have little soft tissue support, the soft tissue being prone to desiccation. In birds with a fracture only the ulna if there is not significant displacement, then cage rest alone, (on occasions with bandage support - to maintain the wing in a natural position) is sufficient. In such cases the bird should be maintained in a 'night quarter' eg. tea chest, so that it can move its wings but not extend or flap them fully, for a period of 2-3 weeks. If the radius is fractured, this does generally need to be stabilised by internal fixation with a single fine i/m pin. When repairing the radius the pin may be placed retrograde or normograde, as it can be passed out to the carpus without undue morbidity to the joint. If the ulna requires repair, a single pin is generally inserted in the proximal ulna just beyond the point of attachment of the triceps tendon ie gaining entry from the level of the 2nd or 3rd last secondary feather, on the dorso-caudal aspect of the wing. Circlage wires may also be necessary. In larger birds, especially if there is contamination of the wound, an external fixator may be used.

During healing of fractures where the ulna and radius are involved, a synostosis may develop, careful surgery with an air drill to remove this and the placement of a fat pad between the bones will often be effective in preventing reoccurrence. Such a fat pad is readily harvest (in most species) from the subcutaneous site in the ventral abdominal midline.

Fractures of the metacarpals - these are often challenging as they are typically high impact injuries, with significant concomitant soft tissue damage. They may usually be repaired by external support (splints and bandages). Load bearing post repair (of primary feather forces when wing flapping) is demanding a considerable stability of repair. A single i/m pin may be placed, plus external support, and the prevention of wing flapping for 2-3 weeks is to be encouraged.

Angel wing is a condition seen most commonly in grazing waterfowl (eg. geese), where excessive protein levels have been fed. This results in a dorso-lateral rotation along the longitudinal axis of the primary metacarpal bone. This may be corrected by cutting of the bone, placement of a single i/m pin and correction of the rotation.

Pelvic Limb

Fractures of the Femur - these typically require surgical repair. The femur is pneumatised. Although 'Schroeder-Thomas' extension splints have been used in raptors, they are not well suited to them, and surgery represents a better method of repair. Femoral fractures most commonly occur, in flying accidents, when the bird is stooping at quarry which either goes through a fence or down a hole (eg. rabbit). If there is subluxation of the coxofemoral joint, this will inevitably involve the femoral head, an arthroplasty should be performed. Proximal femoral fractures may be repaired with a tension band technique. Proximal to mid shaft fractures may be repaired using single or multiple stacked intramedullary pins. The standard technique involves retrograde pin insertion at the fracture site, exiting at the trochanteric fossa, prior to realignment, and insertion of the pin or pins with or without the added support of hemicerclage or cerclage wires. Distal fractures of the femur may be repaired using crossed pins in a 'Rush Pin' technique. If this method is used, the technique is facilitated by placing the pins from the fracture site in a normograde direction. Alternatively external fixation using half pin, full pin with or without cross pin and transarticular fixation may be employed. Intramedullary threaded pins may be used in combination with methylmethacrylate, as described above for the humerus.

Fractures of the Tibiotarsus - these are by far the commonest fracture of captive birds of prey. The fracture usually occurs within the first week that the bird is every restrained on a perch by the use of 'Jessies' (leather anklets). The fracture occurs at the junction of the first and second third of the tibiotarsus, within 3mm of the fibula crest. Repair is most commonly achieved with either single or multiple intramedullary stacked pins, inserted retrograde, exiting at the anterior aspect of the stifle joint. If a single pin is used, this may either be a single large pin, (this is not ideal as the diameter of the medullary cavity tapers to the distal end, or a single smaller pin, which is held in a rigid position within the medulla by a hemicerclage figure of eight wire. These do not interfere with the joint, as long as they are removed once the fracture has healed. Post operatively the chance of rotation about the longitudinal axis may be reduced by applying a box splint (made of foam backed aluminum finger splint), which is applied around the dorsal aspect of the distal femur, lateral and medial to the tibiotarsus, and ventral to the proximal metatarsus. Alternatively a half or full pin technique, with or without polypropalene intramedullary devices, will stabilise the leg fully whilst at the same time allowing full normal joint mobility. The latter is particularly important if both legs are simultaneously affected. There is the potential for damage to branches of the tibialis nerve, namely the tibialis medialis medially or the fibularis and suralis lateralis laterally, during pin placement.

If half or full pin techniques are used at all in birds, careful radiography is required first to ensure that there are no longitudinal cracks in the affected bone. Pins should always be inserted with a power drill, placing those nearest the fracture first, and spacing others out along the length of the bone, in order to maximise the spread of any tension that may be placed via the pins. Following surgery to this bone, venous congestion of the distal limb is not uncommon. The author advises applying elastoplast on the distal limb at the time of surgery to prevent swelling.

Fractures of the distal Tibiotarsus - these may be repaired using the above technique or a cross pin method, as described above for the distal femur. the surgeon should be aware of the position of the extensor canal in the distal tibiotarsus. If this structure has potentially been damaged, it is important that intertarsal joint movement is maintained during healing.

Subluxation of the tibial cartilage - can occur as a consequence of trauma or secondary to growth abnormalities, which may result in bowing of the tibiotarsus, or longitudinal rotation.

Fractures of the Tarso-metatarsus - these most frequently occur, when nesting material catches under an oversize ring in a young bird whilst still in the nest. The tarsometatarsus is made up of the distal row of tarsal bones, plus metatarsae 2, 3 & 4. Metatarsus 1 forms the proximal section of the hind talon. Hawks have no intramedullary cavity, whilst falcons have one in the distal half of the bone only. The posterior aspect of the tarsometatarsus is concave , (containing the flexor tendons), and hence care must be taken in using half or full pin techniques, not to trap these tendons. Alternatively a padded aluminum finger splint may be placed down the lateral side of the leg, and under the ball of the foot. Fractures of the distal tarsometatarsus, may involve the interosseal canal.

Chip fractures on the medial or lateral aspect of the distal tarso-metacarpus are not uncommon, the bird should be restrained in a dark small enclosure (eg Tea chest), but the foot and leg should not be dressed, as the tendons may become involved in the callous if the limb is immobilised. Clinically these will look similar to avulsion of the first metatarsus, or oedema following local trauma when first jessed up.

In severe bumblefoot cases, bacterial infection may lead to osteomyelitis, resulting in loss of bone density of the trochlea. All severe cases should be xrayed for these signs and if present the bird should be euthanased.

Phalanges - any significant swelling should be considered serious and the foot should be xrayed and compared with the opposite foot. Osteomyelitis is common as are fractures. Fractures may be treated with rest alone, or the foot may be placed in a ball bandage for the first 7 days only. Any lengthened period of immobilisation, or attempted immobilisation of only one toe will end in a disaster.

Infection in the tip of a toe, just ventral to the junction of the toe with the claw, can easily lead to infection of the distal interphalangeal joint, at the site of the insertion of the flexor tendon, which will lead to the necessity for partial or complete toe amputation.

Hybrid fixator (ESF-IM tie-in)

As mentioned above this is the newest and most widely recommended technique for many avian fracture cases. Any device inserted should promote load sharing. as healing progresses, parts of the fixator may be removed, a process referred to as dynamic destabilisation (Redig 2000).

The technique has been present in various forms for a number of years. It was refined and further developed (Redig 2000), as an answer to provide longitudinal and rotational stability to humeral fractures, without having to resort to total wing fixation. With good fixation and good overall vascular condition at the fracture site, healing will often be achieved in 2.5 - 3.5 weeks. However on many occasions when vascular function is impaired, or there is significant trauma related tissue damage, full repair may take several weeks. Loosening of pins should not occur, and the use of positive profile pins greatly assists in prevention.

In simplistic terms, a single i/m pin is placed along the full length of the bone, but avoiding any damage to or full functioning of the joints. External fixator pins are then placed in safe sites (to avoid major blood vessels and nerves or contusion of tissues in subsequent limb movements), with at least two other side of the fracture, spread out as far as possible along the length of the

bone. The free end of the intra medullary is bent through 90º and attached to a bar which in turn joins with all the external fixator pins, there by linking i/m and ESF.

Developmental Problems - rickets is still common and is always associated with a Ca:P:D_3 imbalance.

The bones affected will be dependent on the age of the chick at the time of deficiency. Chicks may hatch and be deficient. This occurs if the hen laid a deficient egg, as a result of dietary (or ultraviolet light) deficiency, renal or parathyroid disease. These chicks are weak, may have a defective hyoid apparatus, and have swollen epiphysis. Bowing is most often present in the tibiotarsus at the level of the fibular crest, although in severe cases, the femur, ulnar, radius, humerus, ribs and pelvis may be affected. Cases with marked clinical signs are generally hopeless. Others may have less severe signs which may comprise tarsal valgus or varus, tibial head dyschrondoplasia, or longitudinal rotation around the length of the tibiotarsus.

Long bone deviations should be corrected as soon as possible. When very young and the bones are still soft this is best achieved with closely applied aluminum finger splints. These should be applied under ga. The clinician must be mindful of the very fast growth rates achieved at this stage of life, and such splints will need to be changed every 2-3 days. Typically 1-2 changes are all that are required, as bone healing is rapid. Growth restriction (through controlled food intake), Ca & D_3 supplementation is crucial. Once splints are applied, the chick must be restrained so that undue pressures do not develop at the end of the splint (this is not uncommon). Young chicks may be suspended in a plastic box filled with wood shavings, until such age as they attempt to crawl out of this all the time. Slinging or suspending a slightly older parrot is another option, although not all parrots will tolerate this.

If a juvenile bird is presented with deviations of long bones (distal tibiotarsus is one of the commonest sites), then all bones should be assessed in relation to their longitudinal alignment and correct alignment. surgery is typically indicated, but before embarking on this one must assess how many bones will require correction, and if any can be performed simultaneously. One should consider the welfare aspects to the bird of repeated surgeries, the likely final outcome and the costs before one commences.
Xrays of young birds may prove confusing and difficult to interpret. The epiphysis are cartilagenous, and do not become radio lucent until growth has stopped at which point they mineralise. The distal tibiotarsus and proximal tarso-metatarsus may look as though they have a mammalian growth plate but it is in fact only the tarsal bones giving this deception.

Tarsal varus or vulgus, may also occur after damage to the growth plate of one of the metatarsae, but not the others. Treatment comprises removal of the damaged cartilage, correction of the angulation of the bone and restraint in a cast for 10 days.

Osteoarthritis - is rare in birds, usually following chronic inflammatory joint disease caused by untreated conditions such as femoral head fractures, pins left in joints or developmental / growth abnormalities. If mal-alignment is present, ten one should consider if this should be corrected.

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