Fractures and Dislocation of the Elbow

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Fractures and dislocations of the elbow joint in small animals can present in many combinations. In animals with open physes, fracture is more likely to occur than dislocation owing to the inherent weakness of the epiphyseal plate and soft bone of the epiphysis. Fractures of the elbow can include supracondylar fractures, transcondylar fractures, intercondylar fractures of the "T" or "Y" type, lateral condyle fractures, medial condyle fractures, and fractures of the articular surface of the humerus. In addition, elbow fractures can include fractures of the ulna, proximal olecranon, and the proximal radius or radial head. Fractures involving more than one bone are usually more serious and have a poorer prognosis in regard to elbow function.

FRACTURES OF THE DISTAL HUMERUS
SUPRACONDYLAR FRACTURES

Supracondylar fractures occur as either flexion or extension injuries. The position of the fragments as well as any obliquity of the fracture site may reveal the history of the fracture. With extension injuries the distal fragment sits posterior to the proximal fragment (most common), whereas with flexion injuries the distal fragment lies cranial to the shaft of the humerus.

CLOSED REDUCTION
Although reduction may be accomplished in a closed manner, it is usually less satisfactory than are open methods. Maintenance of reduction of closed fractures can sometimes be accomplished using immobilization with a Schroeder-Thomas splint in a right angle configuration to control rotation of the distal fragment.

OPEN REDUCTION

FIG. 23-1 A young bloodhound was hit by a car and sustained a supracondylar fracture of the humerus (A) Two Rush pins were used to stabilize the fracture following open reduction (B,C).
Open reduction and internal fixation is the most commonly accepted method of dealing with supracondylar fractures. Intramedullary pins can often be introduced from the epicondylar portion of the distal fragment. Rush pins, Steinmann pins used in a Rush fashion, or Steinmann pins as crossed pins can be used to stabilize the fracture against rotation and overriding (Fig. 23-1).

If small pieces of comminution have disturbed the anatomical reduction, cancerous bone grafting may be used to increase bone stock and hasten consolidation of the fracture. Open reduction of supracondylar fractures can be carried out through a lateral incision through the anconeus muscle at the level of the joint space which continues the incision proximally through the distal aspect of the lateral head of the triceps. (10,12) In difficult cases with comminution, olecranon osteotomy can be performed, allowing complete exposure on the lateral and posterior aspects of the distal humerus. (6) The medial intramedullary pin is placed through a small stab incision below the medial epicondyle. Care is taken to avoid the ulnar nerve, which lies lateral and caudal to this epicondyle.

TRANSCONDYLAR FRACTURES
Transcondylar fractures occur most commonly in young animals with open physes. They are uncommon in my experience. A transcondylar fracture differs from a supracondylar fracture in that it occurs within the joint capsule rather than above it. Most young animals with this fracture present with a physeal fracture (Salter type I or 11). If undisplaced or easily reduced, this fracture can be treated with external immobilization. If displaced, open reduction may be carried out through a lateral approach with small Kirschner wires used as cross pins for fixation. No external splint is used, but activity is limited for 3 to 4 weeks.

LATERAL CONDYLE FRACTURES
Lateral condyle fractures are common and result from the shearing of the lateral condyle from the shaft of the humerus by the radial head. The fracture usually occurs when the dog is dropped or hit by a car as the limb is extended during weight bearing. This fracture is seen in animals of all ages. When it occurs, the medial condyle, which is still attached to the humerus, moves medially and distally, thereby creating a moderate separation of the fracture fragments. Treatment of this injury should be aimed at restoration of the joint anatomy and function. Closed methods of reduction and immobilization with a Schroeder-Thomas splint have been used with moderate success. This closed method of treatment cannot usually reduce the fragments perfectly, and immobilization of the joint, which is necessary for fracture healing, may lead to continued joint stiffness following splint removal. Surprisingly good clinical results can occur with this method despite what appears to be a terrible result radiographically. However, the technique does not give uniformly good results and is not used as the method of choice. This Fracture is best handled through open reduction and internal fixation (Fig. 23-2). An intercondylar screw is used in an interfragmentary manner to compress the lateral condyle to the medial condyle. The lateral epicondyle is attached to the humeral shaft, with a small Kirschner wire or Steinmann pin to prevent rotation. Occasionally, if the fracture travels far enough up the shaft of the humerus on the lateral side, an interfragmentary screw can be used here as a second point of fixation. Reduction of this fracture must be exact if good results are to be expected. The procedure is usually done through a lateral approach to the elbow joint through the anconeus muscle. Manipulation of the fracture with reduction of the epicondylar segment usually allows perfect reduction. A small Kirschner wire or bone clamp can be used for temporary immobilization while inserting the lag screw.

FIG. 23-2 A lateral condylar fracture of the humerus (A), an example of shear mode failure, is treated with an interfragmentary screw and an antirotational wire (B). (Courtesy of R.B. Hohn, DVM)

MEDIAL CONDYLE FRACTURES
Fracture of the medial condyle is uncommon at our institution. When fracture does occur, usually a large fragment is the result. Open reduction and interfragmentary screw fixation is the treatment of choice. Two screws usually provide adequate stability (Fig. 23-3). A medial approach to the distal humerus is used for this procedure, taking care not to damage the ulnar nerve and collateral ulnar artery that are retracted caudally after incision through the fascia, just cranial to the medial head of the triceps. No external splint or bandage is used, but activity is restricted for 4 to 6 weeks.
INTERCONDYLAR FRACTURES
"T" or "Y" fractures of the humeral condyles are more difficult to deal with than are lateral or medial condyle fractures. The best results, again, are achieved through open reduction and internal fixation. Closed methods of fixation are similar to those described for lateral condyle fractures, and functional results are mixed. With open reduction and internal fixation of simple "T" or "Y" fractures, the lateral approach is combined with an osteotomy of the olecranon to give a posterior approach to the intercondylar Fracture. Usually the first step in repair of this fracture is to reduce the intercondylar fracture with an interfragmentary lag screw. The condyle is then attached to the shaft of the humerus (Fig. 23-4). In dogs, a cortical screw provides interfragmentary compression by overdrilling the lateral condyle and threading the medial one. Although commonly used, the cancerous screw is usually not necessary, and, in fact, the large cancerous screw may be detrimental, since it uses up a sizable amount of bone stock for its shaft, thereby acting more as a prosthesis than as fracture fixation. If the cancerous screw is removed, the void created by the threaded shaft can lead to refracture. It is important to achieve absolute reduction so that there is no step in the cartilaginous surface of the trochlea at the fracture site. Rotation of the fracture fragments must be positioned carefully. This is usually done by interlocking small defects in the cartilaginous surface of the trochlea to ensure a correct rotational position. In some cases the cartilaginous defects are not helpful in positioning the rotation of the fracture fragments, and reduction of the fracture must be carried out by anatomical reduction of the condyles to the shaft with visualization of the intercondylar fracture at the time of interfragmentary screw fixation. Following reduction and stable fixation of the intercondylar portion of the fracture, the condyle is attached to the shaft of the humerus. This is often accomplished with Steinmann pins used as Rush pins or with Steinmann pins used as cross pins. Occasionally a plate may be used on the caudal aspect of the medial condyle to provide anchorage to the humeral shaft. Sometimes bilateral plates are used posteriorly on the medial and lateral condyle to act in a buttress fashion to support the distal condylar fracture, a method used more commonly when dealing with comminuted fractures in which additional interfragmentary lag screws are used to stabilize the fracture. Occasionally the distal end of the humeral shaft is so comminuted that small Kirschner wires must be used to reestablish pieces that are large enough to reattach to the main shaft of the humerus. In these animals the postoperative radiographic appearance of a pin cushion in the distal end of the humerus is representative of the effort that was needed to reconstruct these severely comminuted fractures. When fracture fragments are large enough for screw fixation, superimposed plate fixation will give the desired stability necessary for early mobilization of the elbow joint. This early mobilization seems especially important with the severely traumatized soft tissues that are a part of comminuted fractures of the elbow.

A more complete exposure to the elbow joint can be accomplished by a lateral approach, which includes ulnar diaphyseal osteotomy. This allows complete visualization of the radial head joint surface, the entire ulnar joint surface including the coronoid process, as well as both humeral condyles. With this approach the ulna is osteotomized just proximal to the interosseous ligament, and the annular ligament is transected laterally to allow the proximal ulna to be displaced medially, exposing the humeral condyles. This approach may make practical the reassembly of a comminuted distal humeral fracture with very little manipulation (Fig. 23-5). Upon closure the osteotomy is fixed with an intramedullary pin or pins in the ulna and a local tension band wire anchored through the bone approximately 1 cm to each side of the osteotomy. No postoperative immobilization is used but activity is restricted until radiographic union of the osteotomy is substantiated.

FIG. 23-3 A medial condyle fracture of the humerus (A) is fixed with a combination of two lag screws (B).

FIG. 23-4 A comminuted intercondylar fracture of the humerus (A). A transolecranon approach was employed, with a single lag screw and a Kirschner wire used to stabilize the intercondylar fracture and a caudal plate to connect the condyles with the humeral shaft (B,C).
FRACTURE OF THE PROXIMAL ULNA
Fractures of the olecranon are usually seen in young dogs and represent apophyseal separations of the olecranon. When they are found in older dogs, they may actually enter the joint or may be comminuted. Generally fractures of the olecranon are handled through tension band wiring techniques, which will adequately stabilize the fracture and allow full immediate weight bearing (Fig. 23-6). When tension band wires are applied to the olecranon, there is some disagreement in the literature as to the position that the wire should take in relationship to the triceps tendon. There is concern by some that the wire might cut through the tendinous portion of this attachment above the pins used for fixation. It would appear that the wire can be placed cranially or caudally to this tendon of attachment with a high rate of success. No case of rupture of this tendon has occurred in our clinic, and we routinely place the wire on the caudal surface of the tendon right above the Kirschner wires or Steinmann pins. It is important to use two pins in stabilization, even in small animals such as cats, to prevent rotation of the fragment, which will cause fatigue fracture of the tension band wire. Severely comminuted fractures of the olecranon and proximal portion of the ulna may require interfragmentary screw fixation along with plate fixation to adequately rebuild and stabilize this bone. This plate is usually placed on the caudal aspect of the bone but may be tucked under the extensor carpi ulnars or flexor carpi ulnaris if desired.

When dealing with physeal injuries (olecranon apophysis), closure of this growth plate is certain if removal of the tension band wire does not occur on schedule. Removal is scheduled for 4 weeks in young growing animals. The two Kirschner wires or Steinmann pins can be left in place an additional 4 to 6 weeks.

Refracture has not been a problem with this method of timed removal of the fixation. When the growth plate is closed, the internal fixation is removed only if problems develop such as pain or open wounds associated with the fixation.

Chip fractures of the ulna are uncommon. Ununited coronoid process of the ulna is not considered a fracture in this context and is dealt with elsewhere (Chapter 85); likewise, fracture or nonunion of the anconeal process is discussed under ununited anconeal process ((Chapter 85).

FRACTURES OF THE HEAD OF THE RADIUS
Fractures of the head of the radius are uncommon and when they occur are usually associated with fractures of other bones, which makes the situation rather serious. Although radial head resection has been reported in the literature, it is not a useful technique and should not be used if function is expected.’ Most radial head fractures can be reduced and stabilized with small Kirschner wires. The rest of the fracture is then treated accordingly and mobilization begun as soon as possible. Chip fractures of the radial head are treated by removal when indicated. Care must be taken not to confuse the small ectopic bones around the radial head for fractures. Radiographs of the opposite side should always be taken if in doubt.

DISLOCATION OF THE ELBOW
Complete traumatic disruption of the elbow joint usually results in the radius and ulna being displaced laterally to the humerus (lateral luxation) (Fig. 23-7). This occurs because the medial condyle of the distal humerus is larger, preventing
the radius and ulna from moving medially. The clinical picture is that of complete instability of the joint with deformity. The animal holds the leg in abduction with external rotation. The level of pain evidenced by the animal is quite variable but seems to diminish with time. Palpation of the limb reveals a large prominent medial condyle with loss of normal features on the lateral aspect. Radiographs in two views prove the diagnosis and may rule in or out additional fractures.

CLOSED REDUCTION
Reduction of a dislocated elbow may be difficult. Knowledge of the normal bony anatomy is necessary to reestablish an intact joint. Closed manipulation will often lead to successful reduction if swelling is not too severe. Prolonged manipulation is not beneficial to the patient's joint, and open reduction should be considered if closed manipulation is not successful in a short time. To accomplish a closed reduction of a lateral luxation of the elbow joint, the joint is flexed to 90° and the anconeal process is rotated medially (internal rotation of the radius and ulna) to interdigitate into the supratrochlear foramen. The leg is gradually extended with a lateral to medial force applied to the radial head while a medial to lateral force is applied to the medial condyle of the humerus. Simultaneously with these medial and lateral forces and gradual extension of the limb, the radius and ulna are internally rotated after hooking the beak of the anconeal process into the trochlear groove to snap the joint back into position. If successful in reduction, the joint should be carried through a full range of motion. If completely stable at this time, a soft bulky bandage can be applied to the elbow joint to ensure continued extension. If unstable in flexion, the joint should be immobilized in a Schroeder-Thomas splint in extension for 10 to 14 days. Occasionally the joint will be completely unstable, requiring open reduction with soft tissue reconstruction.

FIG. 23-7 Lateral (A) and cranial-caudal (B) views of a lateral luxation of the elbow joint.

OPEN REDUCTION
Open reduction of elbow luxations is usually carried out through a lateral incision through the anconeus muscle. Following debridement of the joint, reduction is carried out via the method described for closed reduction. A bone elevator may be used carefully within the joint surface if necessary. Rarely open reduction is not successful through this approach. To obtain reduction, the lateral approach is combined with proximal ulnar diaphyseal osteotomy, which allows the luxation to be reduced easily. Special attention to closure of the soft tissues will result in good stability of the joint. Postoperative immobilization, usually in extension, is necessary for 10 to 14 days.

CONGENITAL AND DEVELOPMENTAL DISLOCATION OF THE ELBOW
Congenital luxation of the elbow usually occurs in the smaller breeds of dogs. The dislocation may occur as a complete luxation, as is seen with traumatic luxation, or may be found with luxation of the radial head with an intact ulnar articulation or with ulnar subluxation. Congenital dislocation can also be seen with an intact radial humeral articulation with subluxation or dislocation of the ulna. The ulnar subluxation in these cases has only a rotatory component that is the cause of the dislocation.

Congenital luxation of the elbow in the dog is reported to be associated with aplasia or hypoplasia of the medial collateral ligament as well as a functionally annular ligament.(1) It has been suggested but not proven that this condition is heritable.

The treatment of these problems is often based on the general wellbeing of the animal and on expectatation for reasonable function of the involved limb.(2,5) Often the anatomical bony structures are changed in such a way that the joints are incongruent when reduced. The absence of associated soft tissues may make reconstruction impossible, as is often the case with complete dislocation. Although not reported, arthrodesis might be a method that would allow functional stabilization of the elbow.

With an intact radial humeral joint, the ulna can be repositioned following proximal ulnar diaphyseal osteotomy and reduced into position. Stabilization is accomplished by attachment of the ulnar segment to the proximal radius using pins or small screws for fixation. When the radial head is luxated, appropriate treatment depends on the radiographic appearance of the
proximal radius and ulna. Correction must be achieved, trying to maintain leg length. If the diaphysis of the radius is straight, proximal ulnar osteotomy is performed. If deviation occurs in the radius, only osteotomy of the proximal radius is carried out at the level of the curvature, and the radial head is repositioned properly after shortening the segment to allow it to be inserted properly. In most cases of radial head luxation, the radial head will have a spherical joint surface. This surface will not maintain proper congruency with the humeral condyles and will have to be contoured appropriately. This reshaping of the radial head will remove joint cartilage and may have a marked effect on the outcome of the procedure.

The ease with which little dogs manage to get around on three legs makes the corrective procedures uncommon, but the successes seen encourage further experience with surgical reconstruction.

Developmental dislocation may be difficult to separate from congenital dislocation except in relation to the age of onset. Animals may be of any size and develop subluxations first. If unchecked, dislocation of the elbow occurs later, usually following some form of traumatic insult to the growth physes of the proximal or distal radius and ulna.(4,7,5)

Premature arrest of ulnar growth is usually associated with lateral deformity of the forepaw but may be associated with luxation of the elbow or possible fracture of the anconeal process. In these cases, the ulna stops growing while the radius may continue to grow, actually pushing the humeral condyles out of position caudally, or the radial head may slip laterally and luxate in this manner.

Treatment is most easily accomplished by proximal ulnar diaphyseal osteotomy reducing the luxation and stabilizing the ulna to the radius. Destruction of the proximal radial physis is carried out at this time and the gap created in the ulna is left untreated. If this lesion is treated after 4 months of age, a successful outcome can be expected. Limb shortening will occur, but joint motion and function are preserved. If the dislocation occurs before 4 months of age, second surgeries may be necessary, and good results should not be expected.

With injuries to the proximal or distal radial growth plates, subluxation followed by dislocation of the elbow occurs distally. In these animals the ulna continues to grow but the radius does not. The humeral condyles anchored to the radial head by the collateral ligaments stay with the radius as the ulna grows away. Thus, proximal dislocation of the ulna results. With subluxations in growing dogs, the treatment is radial osteotomy and dynamic spreading of the osteotomy site to reduce the radial humeral subluxation. This is usually done with external skeletal fixation and periodic spreading of the fracture site. This spreading can continue for 4 to 5 weeks before bony union will occur.

In dogs with untreated subluxations, frank dislocation occurs. The end-stage dislocation is not amenable to stretching of soft tissues for reduction unless the subluxation is still mild. Although gradual stretching of the soft tissues is accomplished in limb-lengthening procedures in humans, the limits have not been delineated in the dog. Severe discrepancies in length associated with dislocation of the elbow in the dog have been treated by shortening osteotomy of the proximal ulna diaphysis.

Good joint function can be established, but loss of length will cause a mechanical limp. However, the animals may appear normal while running (galloping).

MONTEGGIA'S FRACTURE
The cranial dislocation of the head of the radius with fracture of the upper one-third of the shaft of the ulna is commonly referred to as a Monteggia fracture. This condition is seen infrequently and occurs when a blow is struck to the posterior aspect of the proximal ulna during weight bearing. The end result of a Monteggia fracture is usually good if the diagnosis is made promptly and adequate treatment carried out. In some instances a radial head luxation goes unnoticed, and treatment is instituted for the fracture of the ulna alone. In these cases it is very difficult to reduce the radial head at a later time when open reduction is required. Most Monteggia fractures are treated with open reduction and internal fixation. The internal fixation used is usually that of intramedullary rods in the ulna (fig. 23-8). Sometimes screws or pins are used to form a synostosis between the ulna and the radius to prevent the radius from popping out anteriorly. In some Monteggia fractures, closed reduction may be accomplished and external fixation used. A Schroeder-Thomas splint can be applied in this instance, with the bands securing the radial head in position. Most often, whether open reduction or closed reduction is used, it is necessary to stabilize the radius to the ulna. External fixation is recommended for temporary immobilization.
FIG. 23-8 Lateral view of a Monteggia's fracture (A) An intramedullary rod was used for fixation of the ulna after open reduction was accomplished (B). One month follow-up examination revealed a synostosis developing between the proximal radius and the ulna (C) Although fracture healing was still incomplete at this time, the animal was using the leg with only a slight limp.

REFERENCES


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