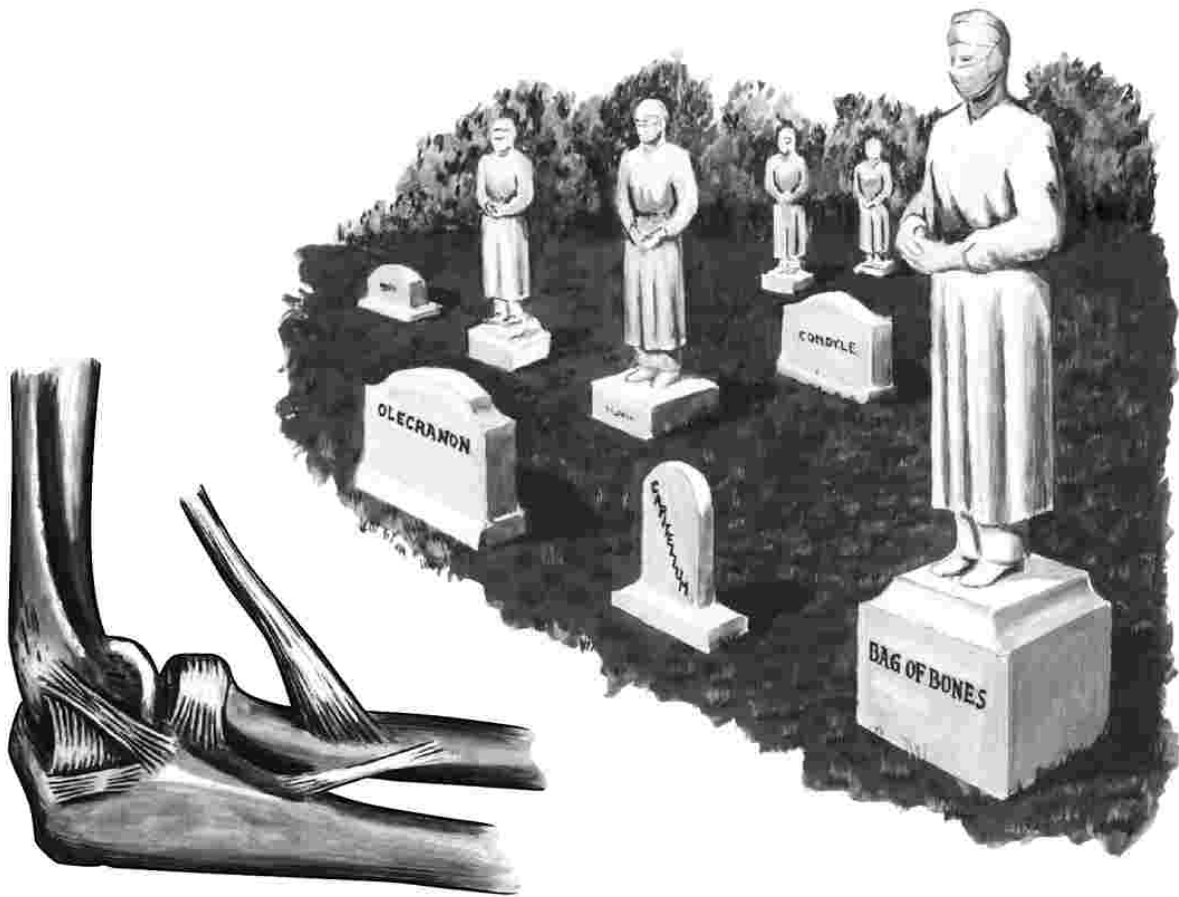


21 The Elbow



THE ELBOW: Proceed cautiously. This is the territory of "monuments" to surgical accomplishments and misadventures.

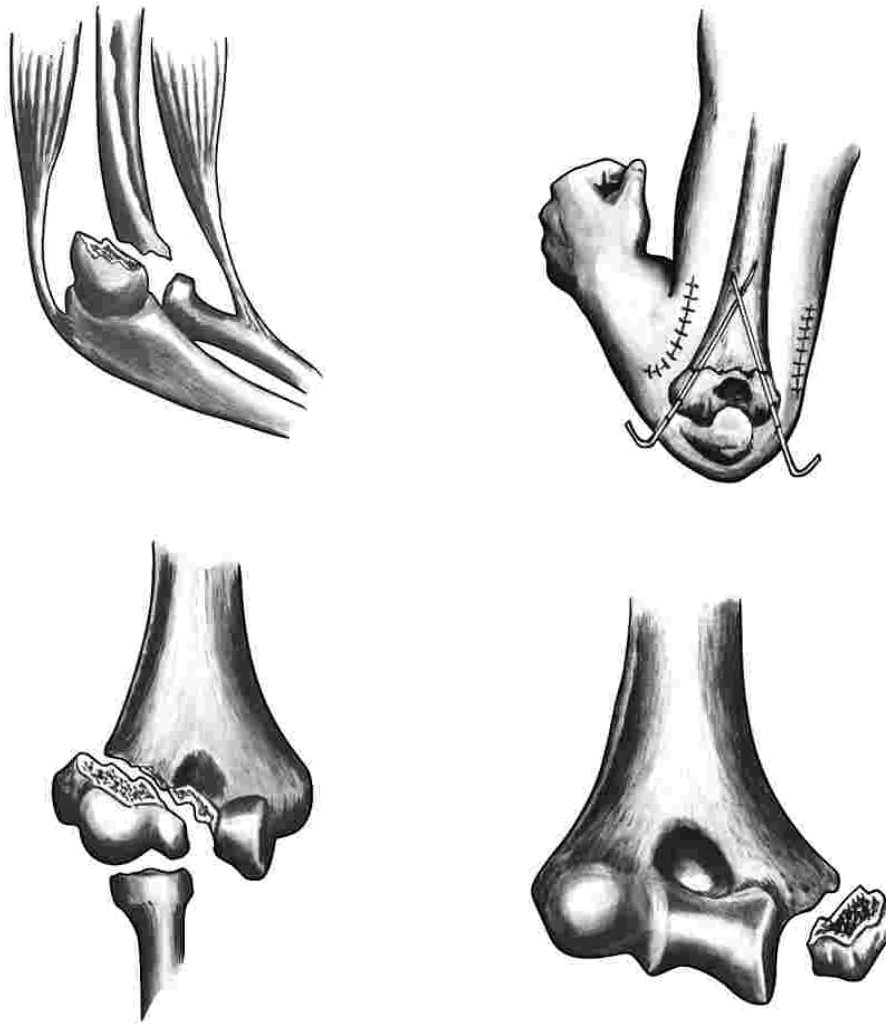
These are dangerous fractures and good results can not always be expected. They occur in a variety of forms, can be very complex and can tax the ingenuity of the surgeon to the utmost.

Inherent dangers here are circulatory crippling with possible Volkmann's ischemia, nerve palsies, limitation of motion and anatomical deformity.

The most conservation treatment is that which safeguards the circulation and provides the most accurate anatomical reconstruction with early motion.

Some cases do not require open operation. When surgery is indicated it should be performed early. An early open reduction can be an arm saving procedure. Swelling can be terrific and traumatic blisters occur frequently.

The prognosis in elbow fractures should be guarded. Even with good anatomical restoration, a poor functional result might be obtained. Myositis ossificans can ruin an otherwise excellent result. Even when good function is secured, alteration of the carrying angle can be disagreeable.



The intramedullary pin is very rarely an advantage in fractures of the lower end of the humerus in children.

The Child's Elbow

SUPRA-CONDYLAR FRACTURE

This is an emergency. Closed reduction is usually indicated and should be performed immediately before swelling occurs. Swelling can occur very rapidly and can be extremely violent. These cases should be hospitalized for close scrutiny for possible circulatory impairment.

Emergency open reduction may be indicated in the event of violent swelling with embarrassment of circulation. Converging Kirschner wire may be preferable to pins in the child's elbow in some cases. The condyles are not well developed and this adds to the technical difficulty of medullary pinning. The cancellous bone here is firm so that short straight wires give satisfactory fixation.

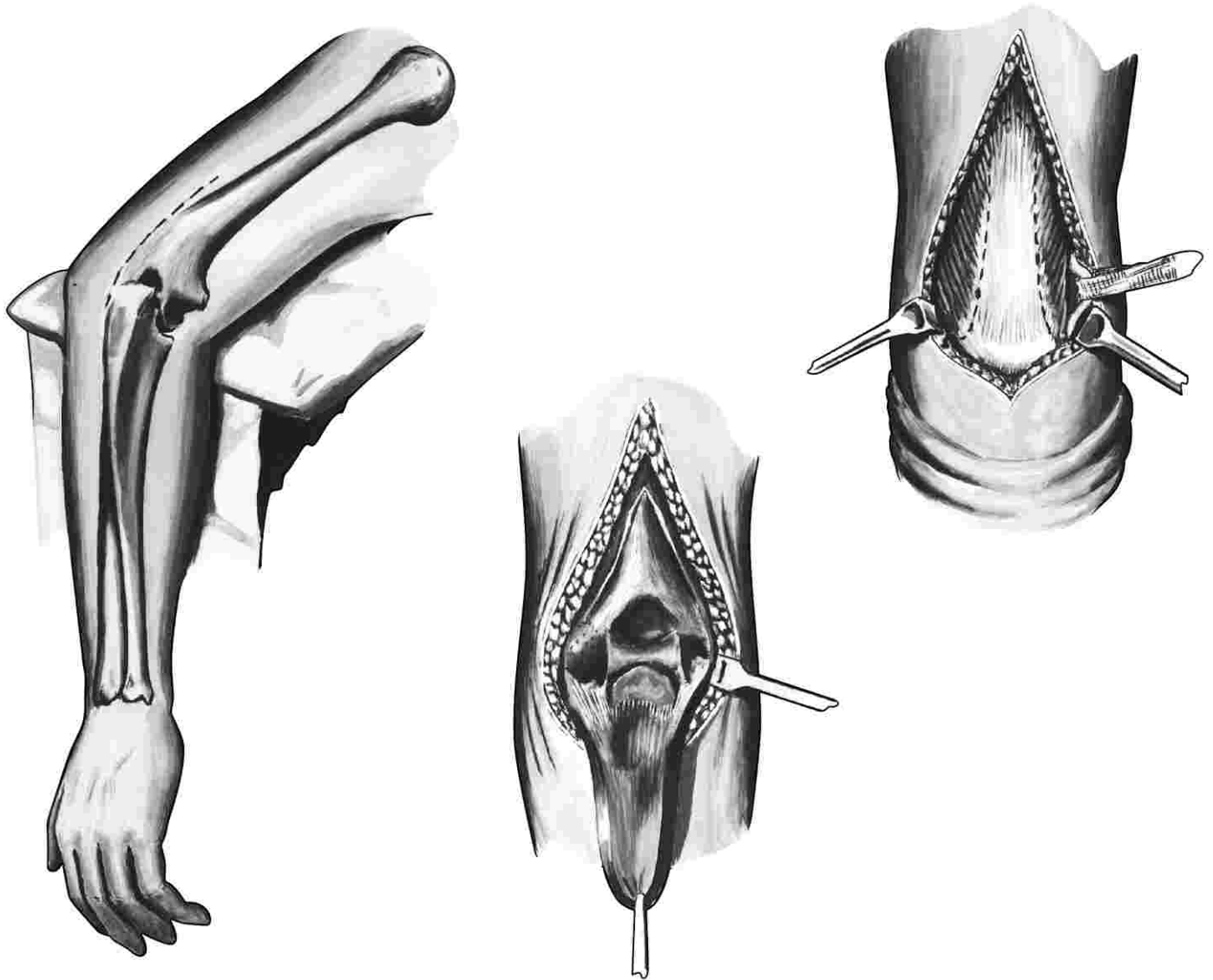
Since the fracture is securely healed in two or three weeks, the wires can be left extending through the skin to simplify removal.

THE CAPITELLUM

This fracture is difficult to reduce even by open reduction and non-union occurs frequently. The fragment may be reattached by a small pin or a Kirschner wire.

INTERNAL EPICONDYLE

This fragment displaces downward and anteriorly and tends to rotate markedly. It is difficult to reposition and hold accurately with the pin. Simple excision of the fragment with suture of the fascia appears to be the best treatment.



Surgical Exposure of Condyles

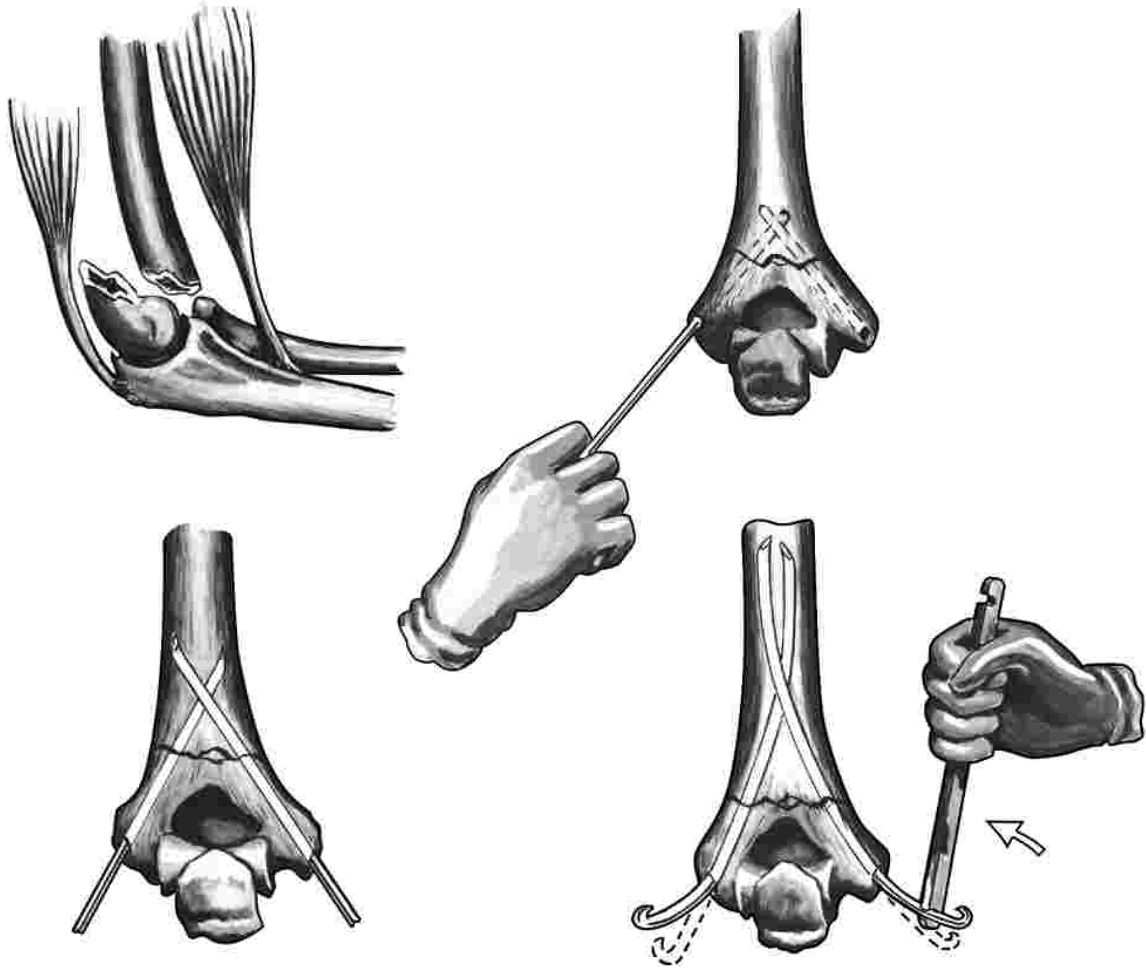
The medial and lateral incisions give sufficient exposure for the repair of many fractures of the condyles but in extensive injuries of this region, the posterior incision described by Van Gorder* is excellent.

The triceps tendon is exposed and is turned downward as a flap. The ulnar nerve is freed and retracted with a rubber tape to prevent its injury.

By extending the incisions downward and laterally through the tendinous structures and the capsule, wide exposure of the entire posterior surface of the condyles is gained.

At the upper angle of the incision, one must guard against injury to the musculo-spiral nerve which passes posteriorly at the junction of the middle and lower thirds of the humerus.

*Redrawn after Van Gorder, G. W.: J. Bone & Joint Surg. 22:278, 1940



Supra-Condylar Fracture

The technic here is but a modification of that used in the supra-condylar fracture of the femur with which one should be thoroughly familiar before embarking upon similar procedures in the elbow region. The elbow region is much more complex.

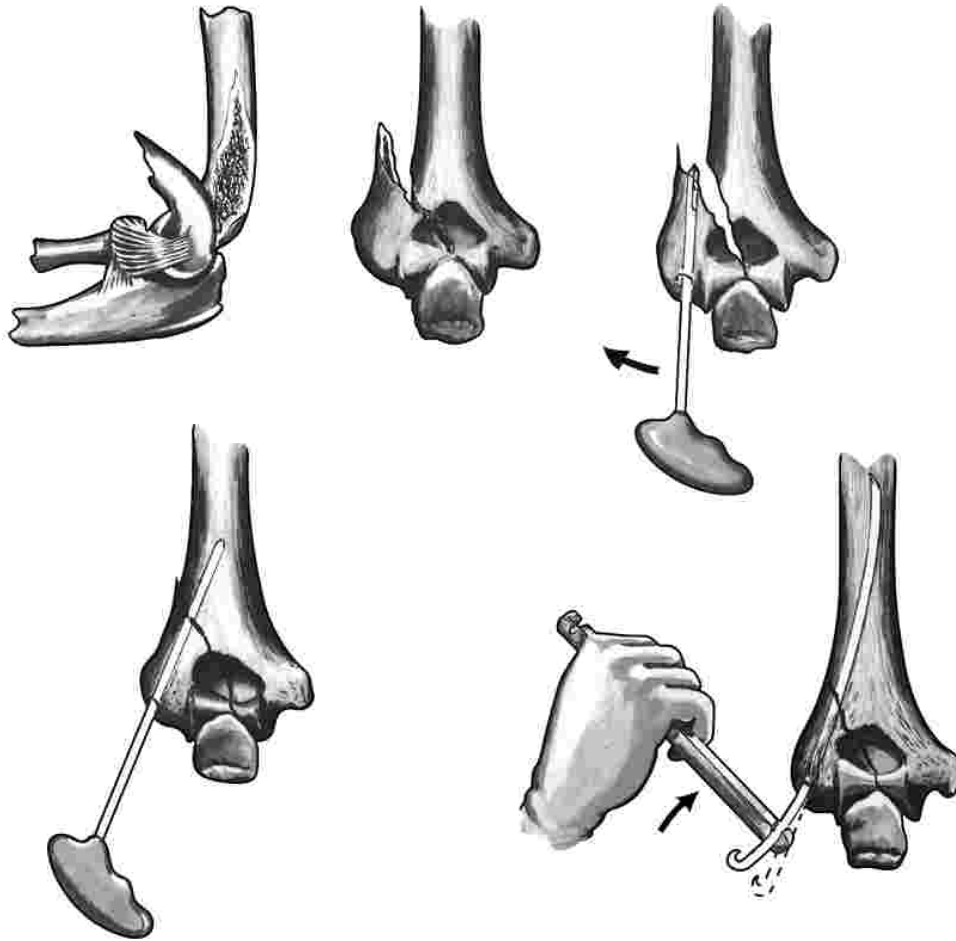
Technic: The fracture is reduced by open reduction and the fragment held in position manually. The pins used are 1/8 of an inch in diameter and of sufficient length to extend well up into the medullary canal of the shaft of the humerus. In the child, use pins 3/32 inch in diameter. The pins are straight when driven.

With the awl-reamer, of the same diameter as that of the pin to be used, opening is made first in the external condyle and a similar opening is made in the internal epicondyle, the direction of the instrument being such that the two openings

converge at a point in the shaft slightly above the fracture line.

The pins are driven through these openings, simultaneously, in such fashion that the sled runners of the points strike the opposite cortices, respectively, and are deflected upwards into the medullary canal of the shaft. As the pins are driven, the heads of the pins tend to swing medially, according to the vase of flowers principle, to compress the lower fragment.

It is then necessary to bend the proximal portions of the pins slightly with the bending iron to conform with the contour of the lower end of the humerus to avoid migration of the heads of the pins into the bone. The heads should be left prominent, but should not engage the capsule.



External Condyle

This fracture usually extends from the ridge above the external condyle and passes obliquely downward through the coronoid and olecranon fossae. There is a tendency for the fragment to rotate, to displace laterally and to move upward to produce some cubitus valgus deformity. Accurate reconstruction is essential to prevent disturbance of the carrying angle and a tendency to delayed ulnar palsy from stretching of the ulnar nerve.

Technic: Lateral incision. Sharp dissection is carried down to the lateral ridge of the humerus and the soft tissue is dissected from the bone anteriorly and posteriorly.

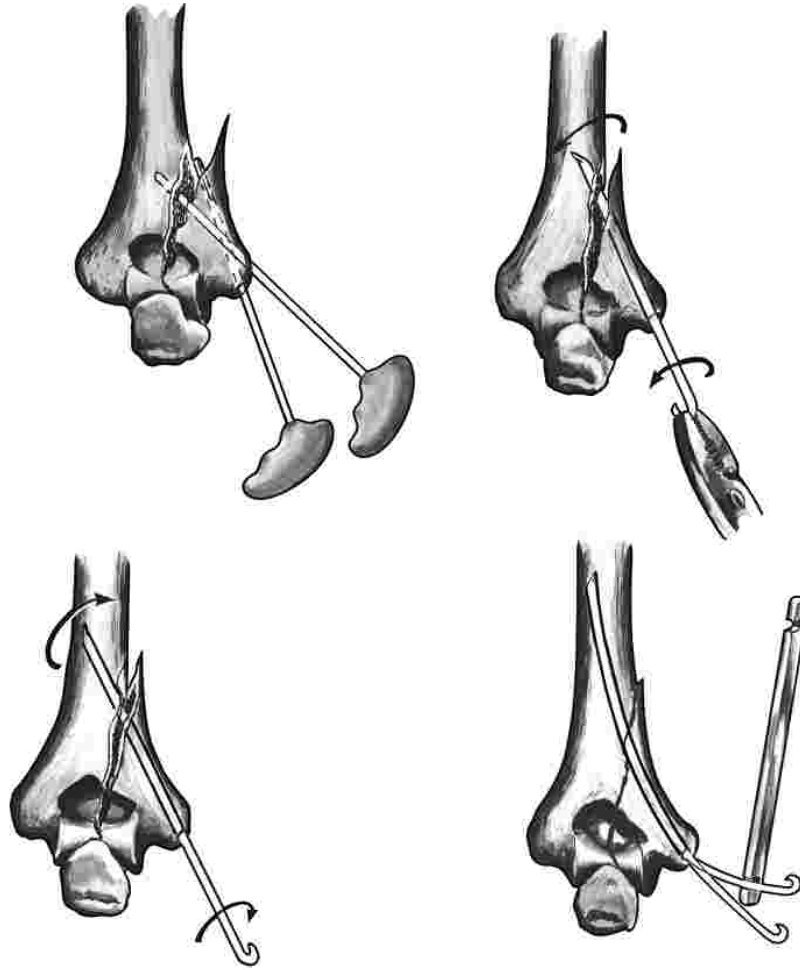
With the awl-reamer, the same diameter as that of the pin (1/8 inch), the opening for the pin is made, paralleling the cortex of the fragment as closely as possible. If this opening is made too obliquely, there will be tendency for the fragment to rotate laterally, opening the fracture line in the upper portion.

With the awl-reamer in the fragment, it is then manipulated into position and the opening continued for a short distance into the shaft of the bone.

The straight pin, 1/8 of an inch in diameter, is driven through this opening so that the sled runner surface of the point glides upon the far cortex of the shaft and is deflected upward into the medullary canal. When about 1 1/2 inches are still exposed, the proximal portion of the pin is given a curve with the bending iron to almost conform to the natural curve of the bone. This prevents angulation and distraction of the fragment.

Some spring pressure of the pin is necessary to compress the fracture surfaces.

The pin is then driven home leaving the head slightly prominent. The capsule is freed and sutured over the head of the pin to avoid compromising the motion of the joint.



The Internal Condyle

The fracture is very much like that of the external condyle. The fracture line begins at the ridge above the internal epicondyle passing downward and obliquely through the olecranon and coronoid fossae. Its displacement is similar to that of the external condyle, tending to give a cubitus varus deformity.

Technic: Medial Incision. Subperiosteal dissection. The ulnar nerve must be protected from harm.

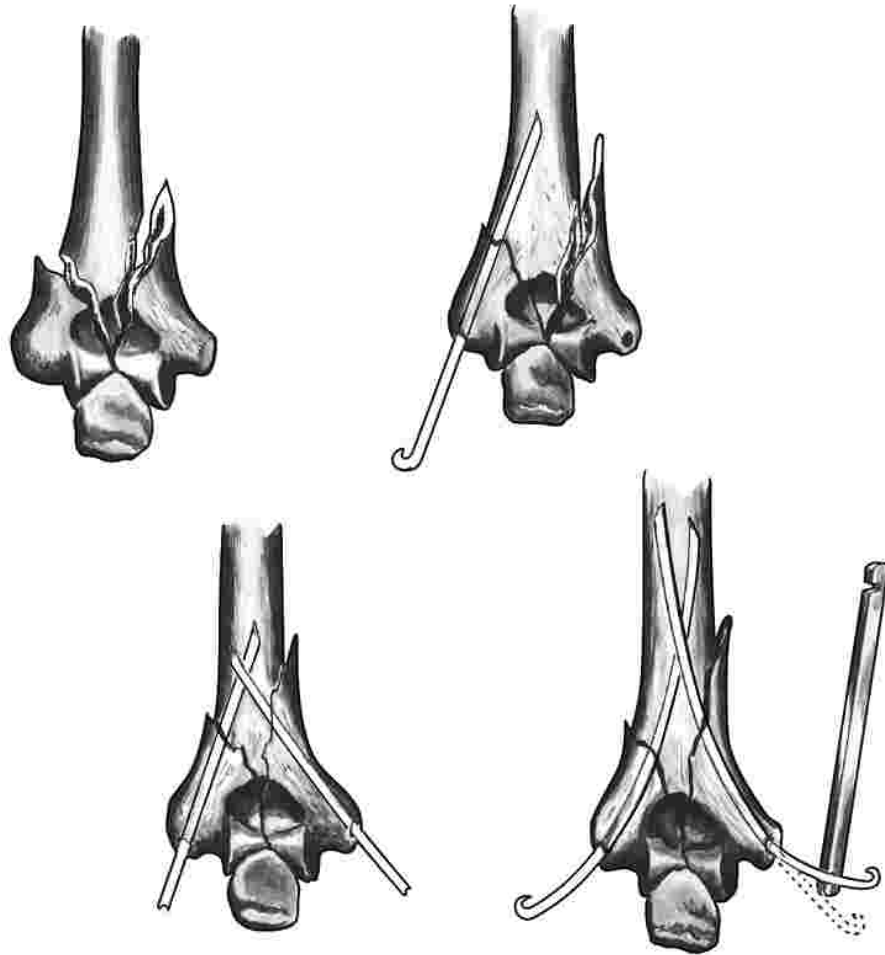
The bone has a much greater curve in the region of the internal condyle than that of the external condyle as a general thing, and there is considerable variation in the shape of the internal condyle in some individuals. The technic of pinning is very similar to that just described for the external condyle. It is sometimes difficult to direct the pin so that it will properly enter the vertical fracture surface of the shaft and it is frequently necessary

to rotate the pin as shown in the drawings to engage the point in the opening in the shaft. It will be noted from the drawing that the awl-reamer has been removed from the fracture fragment in order to make this separate opening in the shaft.

The internal condyle is technically more difficult to transfix than the external condyle. Skillful use of the awl-reamer and of the bending iron is essential to success. The proximal portion of the pin must be given a greater curve here than in the external condyle.

In all fractures of this region, the pins must be long enough to extend well into the medullary canal, else, they migrate backward with loosening of fixation.

The heads must not be set too deeply because they can migrate into the bone.



Comminuted Condyles

These fractures are usually of the T or Y type but may be severely comminuted to produce a bag-of-bones fracture. All of the factors previously mentioned will apply here, in aggregate.

Technic: Posterior incision. The technic of reconstruction here is a combination of those technics described for supra-condylar fracture, the external condyle and the internal condyle fractures.

The operation is somewhat difficult but a splendid reconstruction can frequently be accomplished. In a bag-of-bones type fracture, it may be wise to remove some of the fragments from the mid-portion of the bone being careful to preserve the articular surfaces and the fragments of the internal and external condyles.

In fractures of this type, nature often throws down an overgrowth of bone and the olecranon and coronoid fossae become filled with new bone

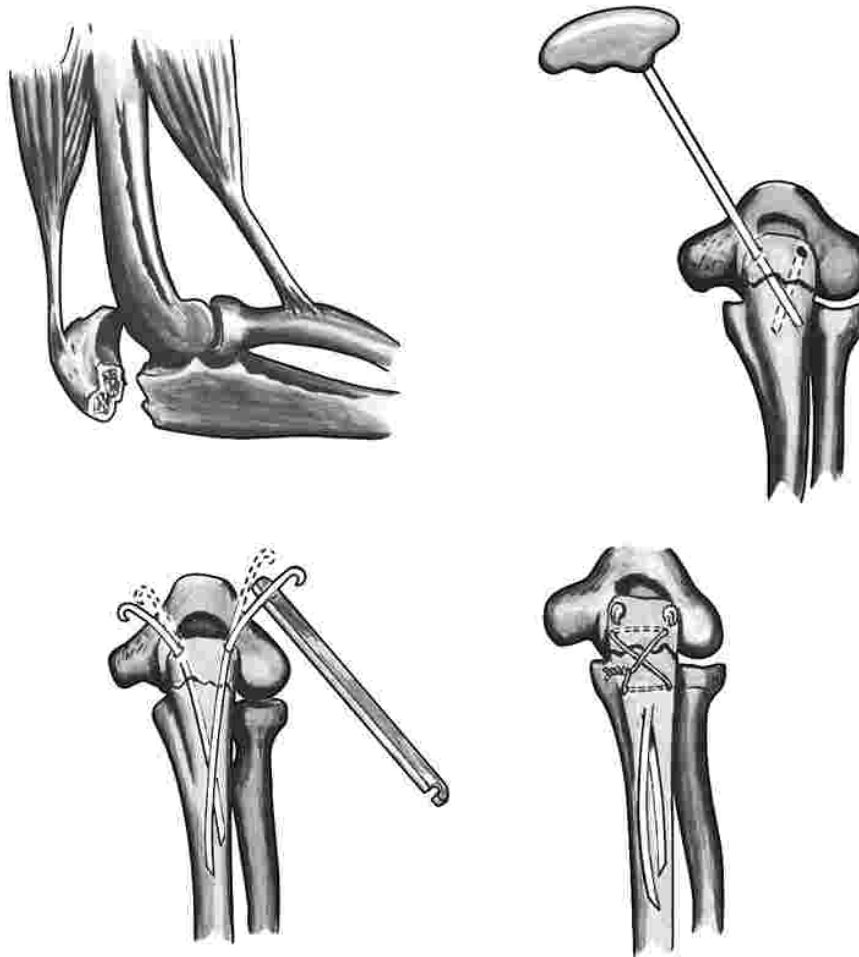
formation, so that ultimately limitation of motion might be expected.

The external condyle fragment is usually the most substantial and is best attacked first. The internal epi-condyle fragment is frequently a long narrow spike and can be very troublesome to deal with.

Once the fragments have been repositioned and transfixed by the pins and the points of the pins have entered the shaft, both pins should be driven simultaneously to avoid displacement of the freshly reconstructed condyle fragments.

The same precautions must be taken by curving the proximal parts of the pins as in the previously described technics.

The elbow should be immobilized at a right angle for approximately three weeks or until there is x-ray evidence of good callus formation.



The Olecranon

This fracture is usually vertical or oblique and sometimes comminuted. The fragment is rotated and displaced violently upward by the pull of the triceps muscle.

Fixation by a single pin through the olecranon is unsatisfactory because of the continuous pull of the triceps muscle which tends to angulate and distract the fragment in such fashion that non-union or fibrous union can occur.

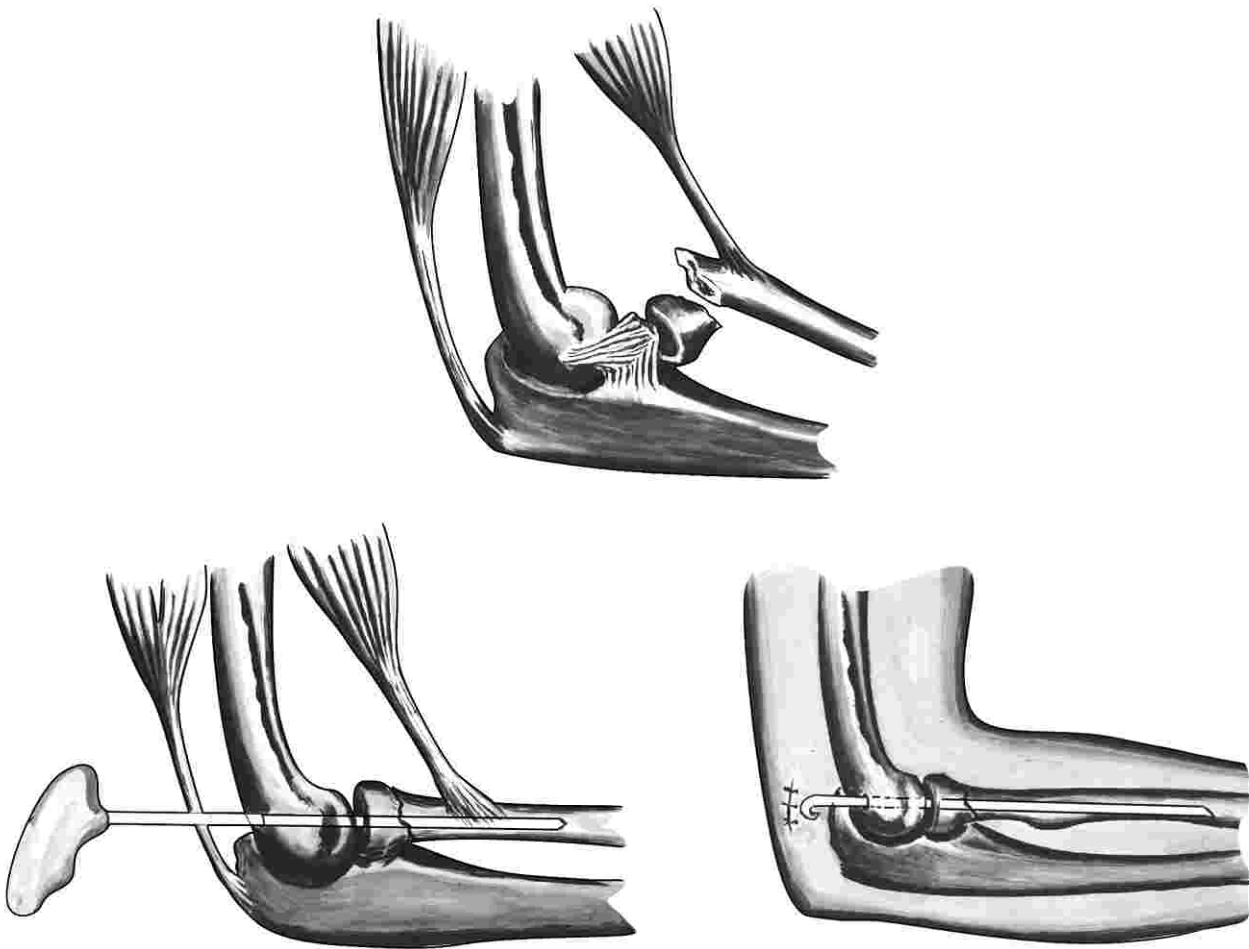
This fracture can often be securely and stably fixed by the use of two pins introduced from the sides of the olecranon. The single pin passed through the tip of the olecranon has to depend solely upon the cancellous bone for fixation. When two pins are passed from the sides of the bone, the cortical bone of the lateral surfaces of the olecranon provides a much stronger purchase for

the pins. Fixation is frequently so stable that no external immobilization is needed and immediate function can be permitted.

Before pinning, careful inspection of the roentgenogram should be made to determine the size of the medullary canal of the ulna as it is very rarely large enough to accommodate two pins of 1/8 inch diameter.

It is usually necessary to resort to pins of 3/32 of an inch in diameter and of sufficient length to extend well down into the medullary cavity.

Occasionally, despite the fixation of the double pins there will be some tendency to distraction. The complementary use of the tension band wiring usually enhances the stability to such a degree that external immobilization is not necessary.



Head of the Radius

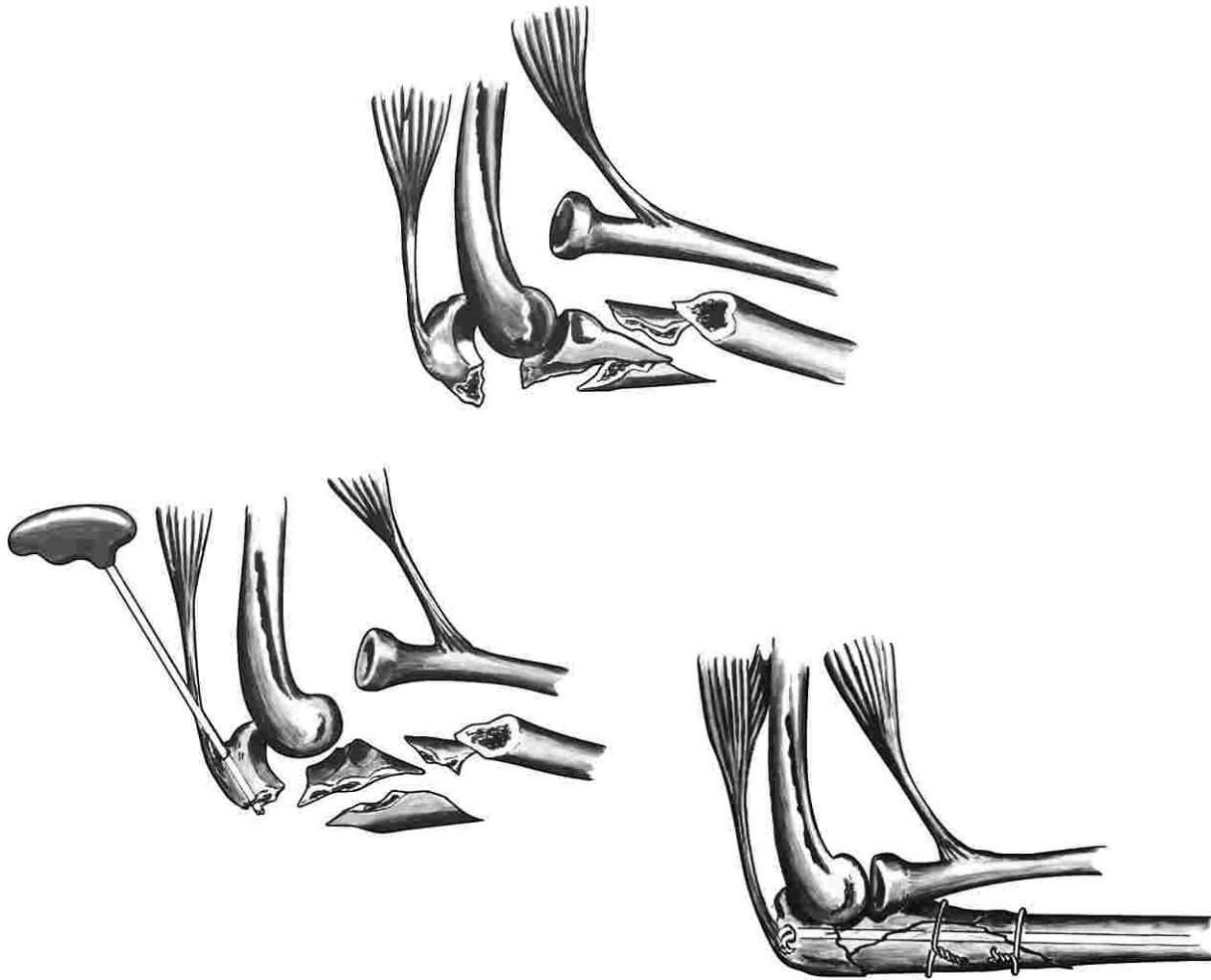
On several occasions, the head of the radius has been transfixed by a pin passed through the external condyle of the humerus, as shown above, without apparent ill-effect, to the elbow joint.

The operation is carried out through a posterolateral incision taking care that the profunda branch of the radial nerve is not injured at the lower angle of the incision.

When the reconstruction at the head of the radius has been accomplished the elbow is held at a right angle. A pin one-eighth inch in diameter and of sufficient length to extend well into the medullary

cavity of the shaft of the radius, is chosen. The awl-reamer is passed through the external condyle of the humerus and axially through the head and proximal shaft of the radius. Through this opening, the intramedullary pin is driven, leaving the head of the pin prominent posterior to the external condyle, but buried beneath the skin. By leaving the head of the pin prominent, it can be palpated in the soft tissue so that its removal is a very simple procedure.

The elbow is immobilized with plaster for approximately 4 weeks at which time the pin is usually removed.



Monteggia Fracture

This is the fracture which precipitated this work on intramedullary fixation. It is caused by direct violence and results in fractures of the upper shaft of the ulna and anterior dislocation of the head of the radius.

Technic: Incision is made over the proximal ulna, deflecting the extensor muscles laterally. The pin 1/8 of an inch in diameter is used, of sufficient length to extend almost to the styloid end of the ulna.

The comminuted fragments of the ulna are at first ignored. With the awl-reamer an axial opening is

made through the olecranon process. The intramedullary pin is passed through this opening and threaded into the medullary canal of the shaft. The comminuted fragments are then gathered about the pin and fixed with encircling wires of type 316 stainless steel. Fixation is usually stable, but if the head of the radius does not remain in position, it also is pinned according to the technic just described.

In fractures of this type, soft tissue injury is usually violent and it is wise to immobilize the elbow at a right angle at least for two to three weeks until the soft tissue is well healed.