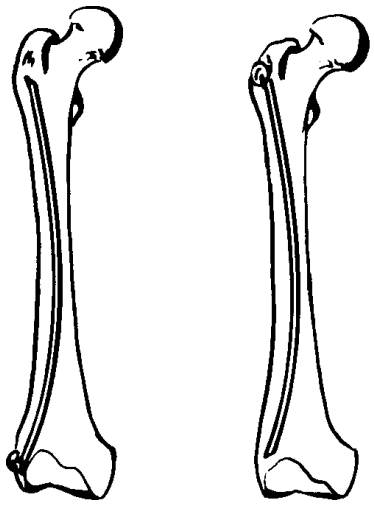
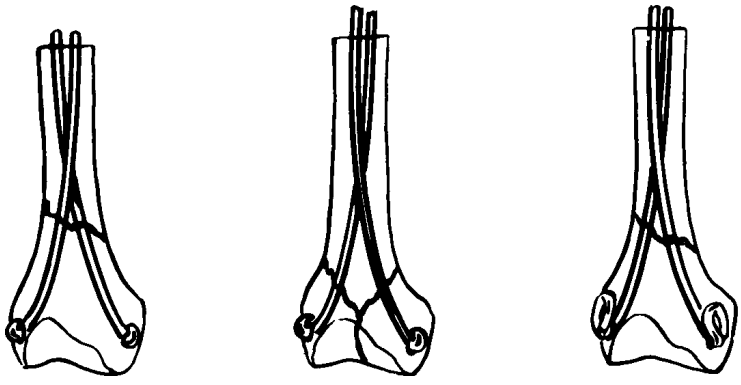
15
The Femur: Perspective



Pin options for shaft fractures.

Fractures of the shaft of the adult femur are transfixed with the curved pin one fourth inch in diameter. We have two basic options. The pin can be introduced via the greater trochanter and driven downward or through the external condyle and driven upward.

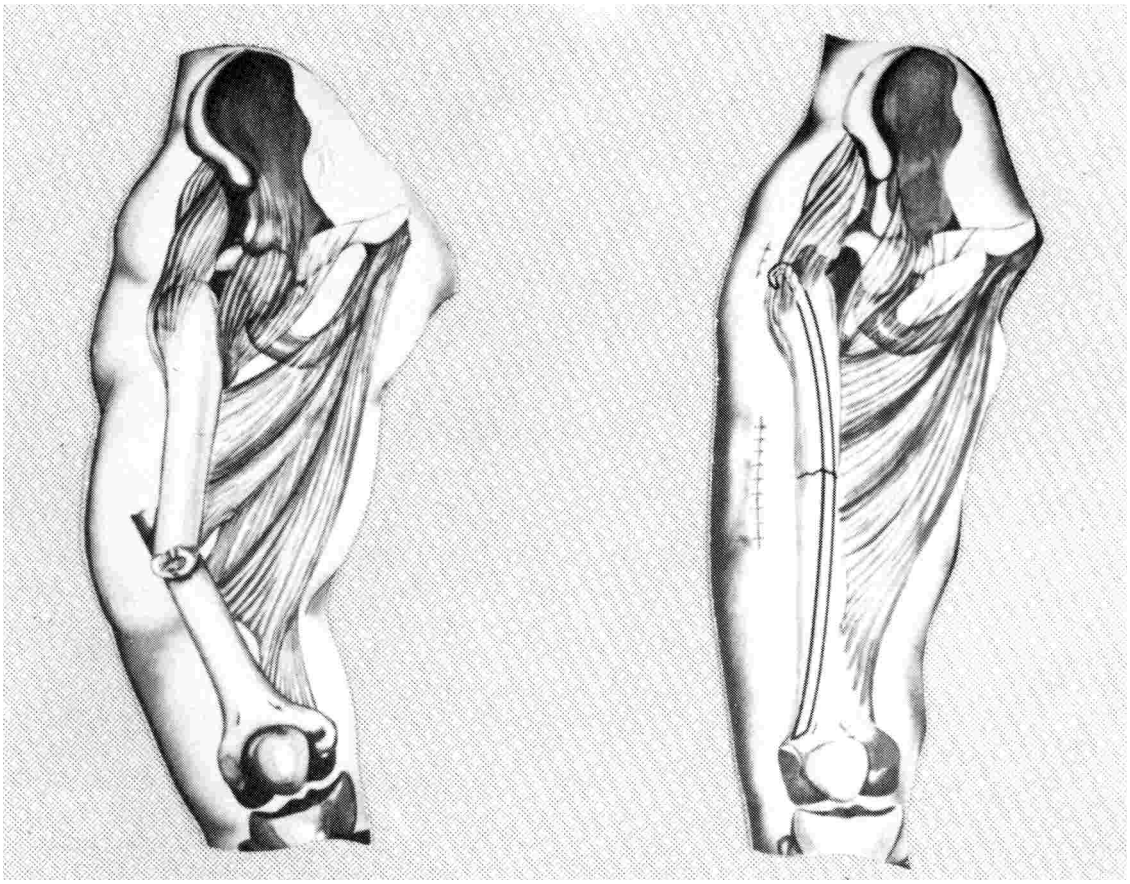
The greater trochanter is general preferable because it avoids the possibility of infection of the knee joint. Introduction of the pin through the supero-lateral cortex of the great trochanter is not difficult when semi-open reduction is elected because one can become oriented by palpating the distal end of the proximal fragment. However, in closed reduction and closed pinning of the femur shaft, we have found it much easier to pin the fracture via the external condyle.



Double pins for the supracondylar area.

The medullary cavity of the lower femoral shaft is trumpet shaped in contract to the tubular shaped medullary canal of the upper shaft. Double pins three sixteenths inch in diameter are utilized in this area via the condyles. In the intermediate region, the junction of the middle and lower thirds of the shaft, a combination of the two technics is used combining the curved one fourth inch as above with the small pin via the medial condyle.

The Femur: TECHNIC



Fractures of the shaft of the femur have a general tendency toward antero-lateral bowing because of the adductor muscle pull. A curved pin can resist this force to give stable fixation by three-point pressure. It is rarely necessary to see the bone to fix it properly. The pin can be inserted as a closed or semi-open procedure.

This bone is amenable to pinning from the subtrochanteric area (except in old people) to and including the condyles. There must be some variance of operative technic at different levels because of the bone structure and the differing muscle pulls at these levels.

Fracture of the mid-shaft is easiest to deal with and will be discussed first. The operation will then be modified for adaptation to other regions of the femur in a natural progression of technic.

To follow the orthodox textbook approach would but cause confusion. Fracture levels will be discussed in this order:

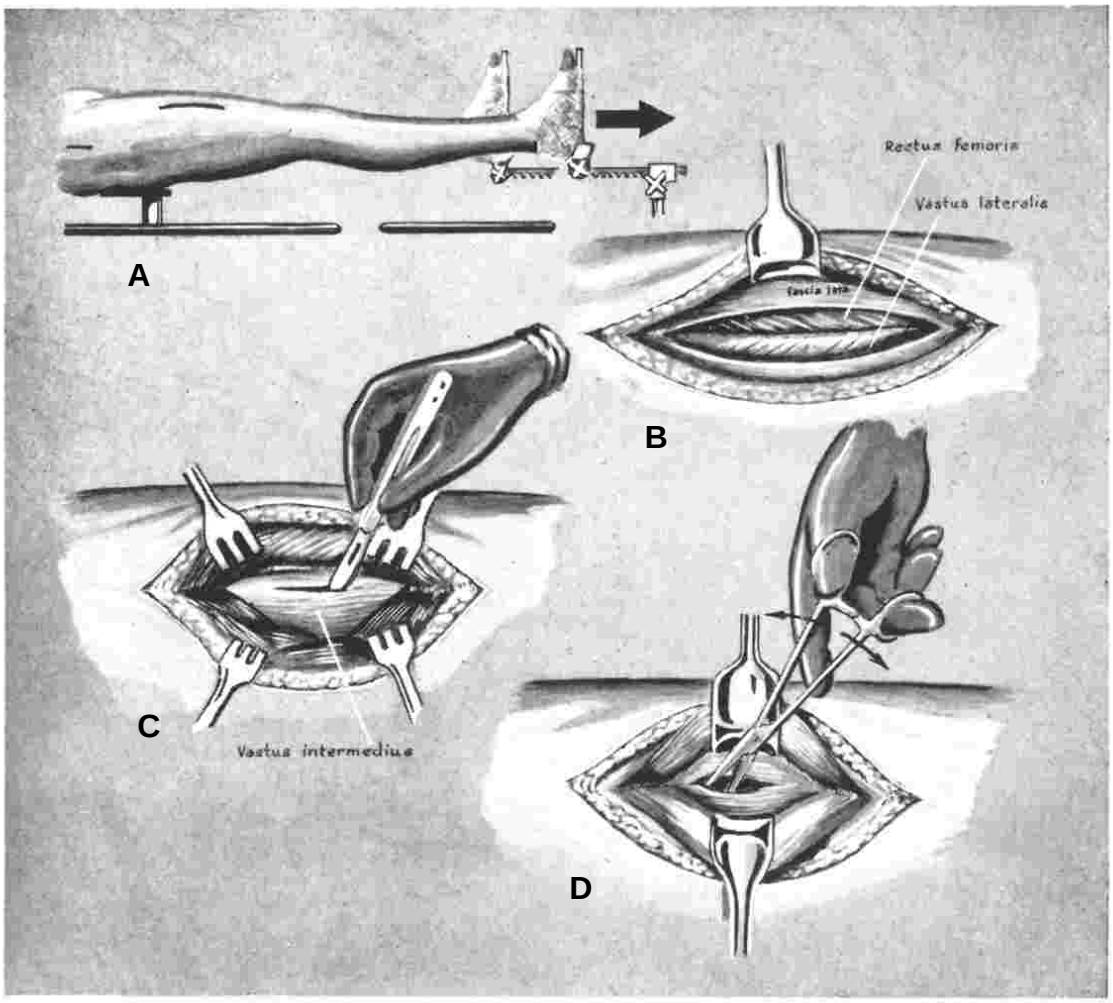
1. Mid-shaft.
2. Junction upper and middle thirds.
3. Subtrochanteric region.
4. Supra-condylar region.
5. Junction middle and lower thirds.
6. The condyles.

MID SHAFT

The deformity here results from the force of violence rather than muscle pull. Bones overlap markedly and may be displaced in any direction, but distal fragment is usually posterior.

Any fracture table is satisfactory. There is no necessity for the lateral position or for special attachments for the table.

The lateral incision can be used. The antero-lateral approach is almost bloodless and gives mechanical advantages for semi-open operation.



(A) POSITION OF PATIENT on fracture table. Simple recumbency, hip adducted and neutral as to rotation. Moderate, not strong, traction to overcome shortening. Incisions indicated.

(B-D) THE ANTERO-LATERAL INCISION for semi-open reduction

(B) SIX-INCH INCISION through skin, fat and fascia lata exposes cleavage line between rectus femoris and vastus lateralis muscles.

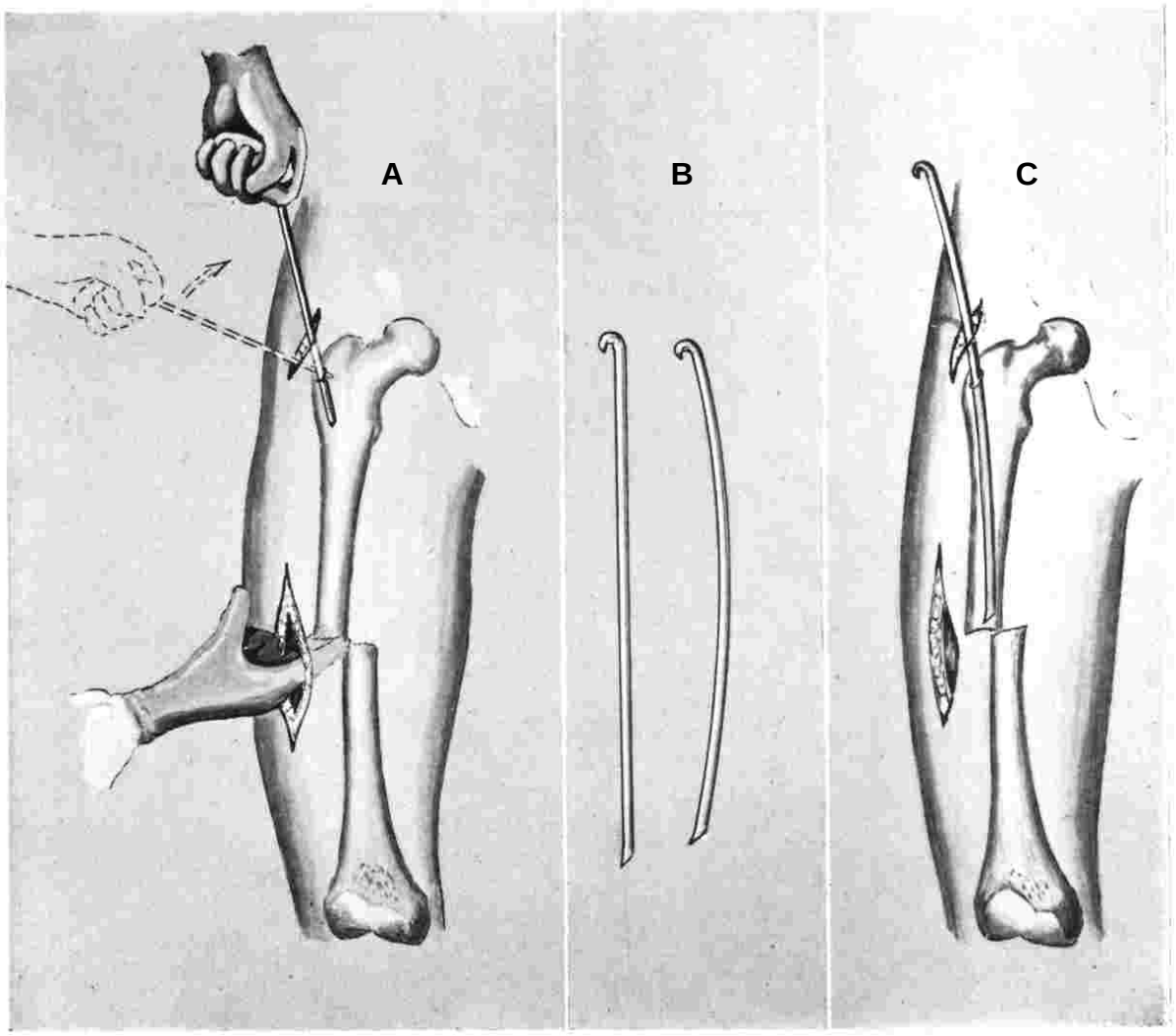
(C) RECTUS FEMORIS reflected medially exposing aponeurosis covering vastus intermedius. Small incision is made through aponeurosis only, not cutting muscle.

(D) ARTERY FORCEPS pushed through vastus intermedius into hematoma. Blades spread until opening admits two examining fingers.

Technic: Mid Shaft

The pin should be inserted and the point be palpable at the fracture line before bone manipulation begins. There is no point in manipulating the bone until the pin is ready to enter the distal fragment. By following this procedure it becomes necessary to hold the bone in the reconstructed position but a few seconds as the pin crosses the fracture line.

The muscles of the thigh are strong and manipulation time should be minimal because it is exhausting to the surgeon. For this reason the primary incision should be made first to identify the position of the proximal fragment by palpation. This orientation makes a simple procedure of inserting the pin in the proximal fragment.



The Proximal Fragment

(A) The proximal fragment does not rotate and the great trochanter is directly lateral. It is identified by palpation and exposed by a two-inch incision which extends through the fascia lata.

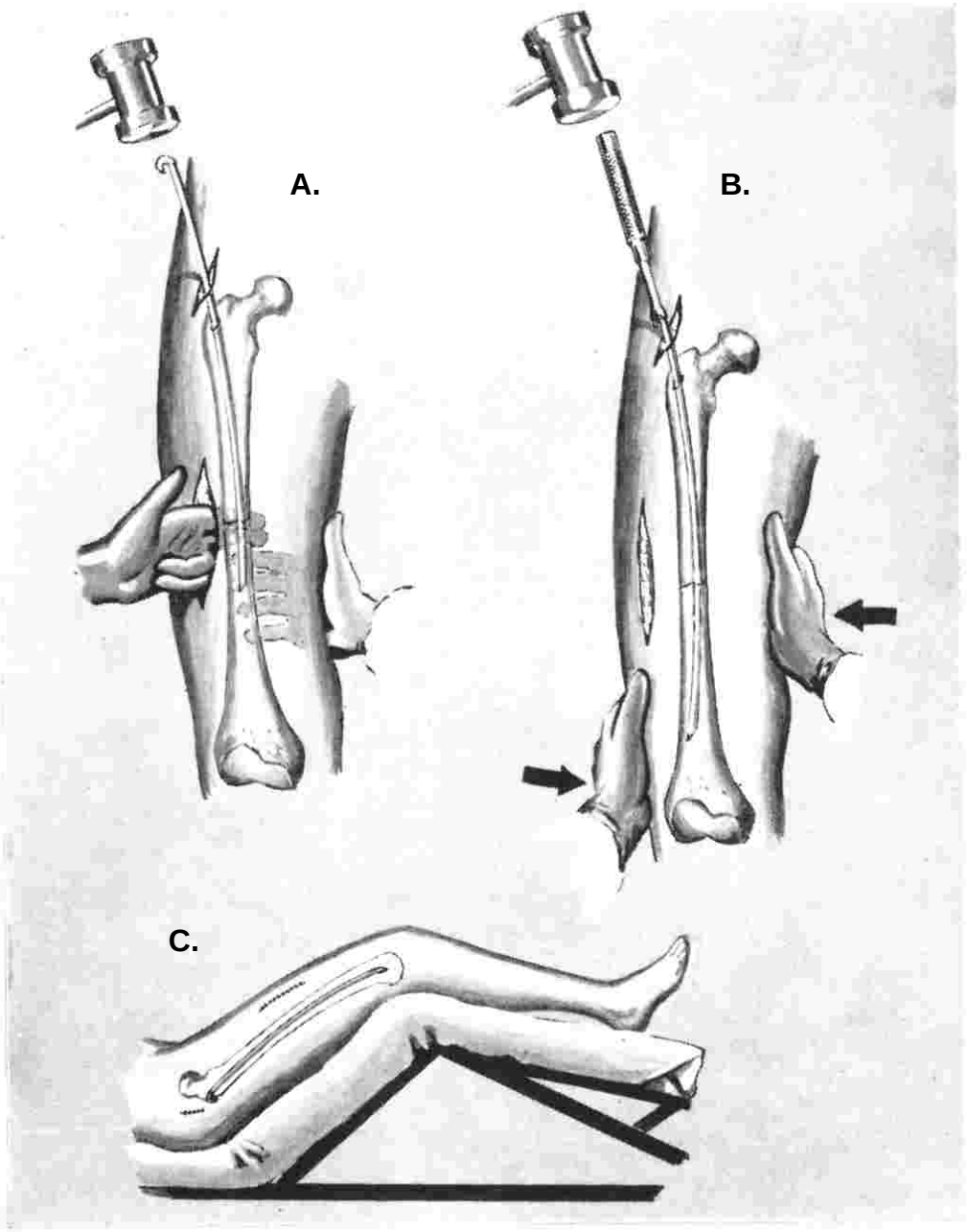
With fingers in each wound, line of proximal fragment is easily visualized mentally without actual exposure of the bone.

Identify point of insertion which is the supero-lateral surface of the great trochanter. Start opening in bone at this point with awl-reamer. Drill not deeper than one-half inch. During this procedure keep palpating fingers on end of proximal fragment for orientation. Direct the awl-reamer at a point just medial to finger tips and ream hole to depth of one and one-half inches. Leave reamer in place.

(B) Select pin from rack No. 1 (one fourth inch diameter) of proper length to reach into condyle. Allow one extra length for curve. Shape pin into slight curve (B) using bending iron.

(C) Remove reamer and insert pin into trochanter. As it is tapped with mallet, the sled runner will engage far cortex and ride it down to the fracture line. Continue driving until point can be palpated at fracture line. Allow pin to rotate. It guides itself in this manner.

In closed pinning of the femur shaft, we now find the pin can be introduced more easily through the lateral wall of the external condyle, driving it proximally into the region of the great trochanter.

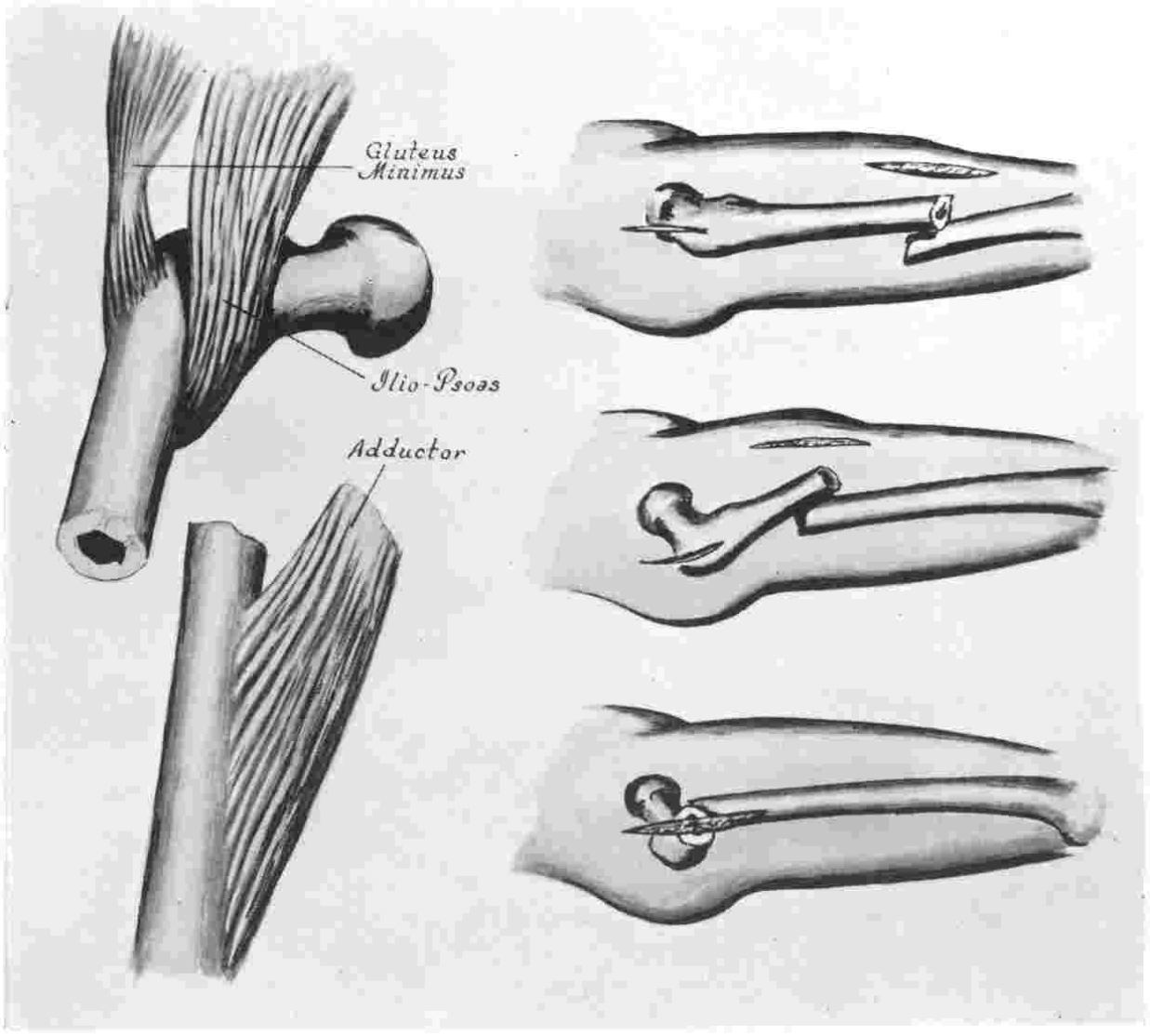


Transfixion

(A) Bone is realigned by manual and finger manipulation. The right hand is lifting the lower fragment forward. When fragments are in proper relationship, pin is driven short distance into distal fragment. Reduction must be good at this stage. It is difficult to make adjustments after pin has passed deeply into distal fragment.

(B) Note direction of pressure of hands as pin is driven home. This directs point toward lateral cortex and insures against medial angulation. Guide hooked head with pliers as it is set to be sure the hook is directed laterally.

(C) Proper bed position to minimize swelling and to avoid rotary strain. This position applicable to all femoral fractures.



Upper Third

DISPLACEMENT

The upper fragment becomes the problem. It has been shown that the shorter the fragment, the less stable becomes the fixation. Here, also, the shorter the fragment, the greater the displacement.

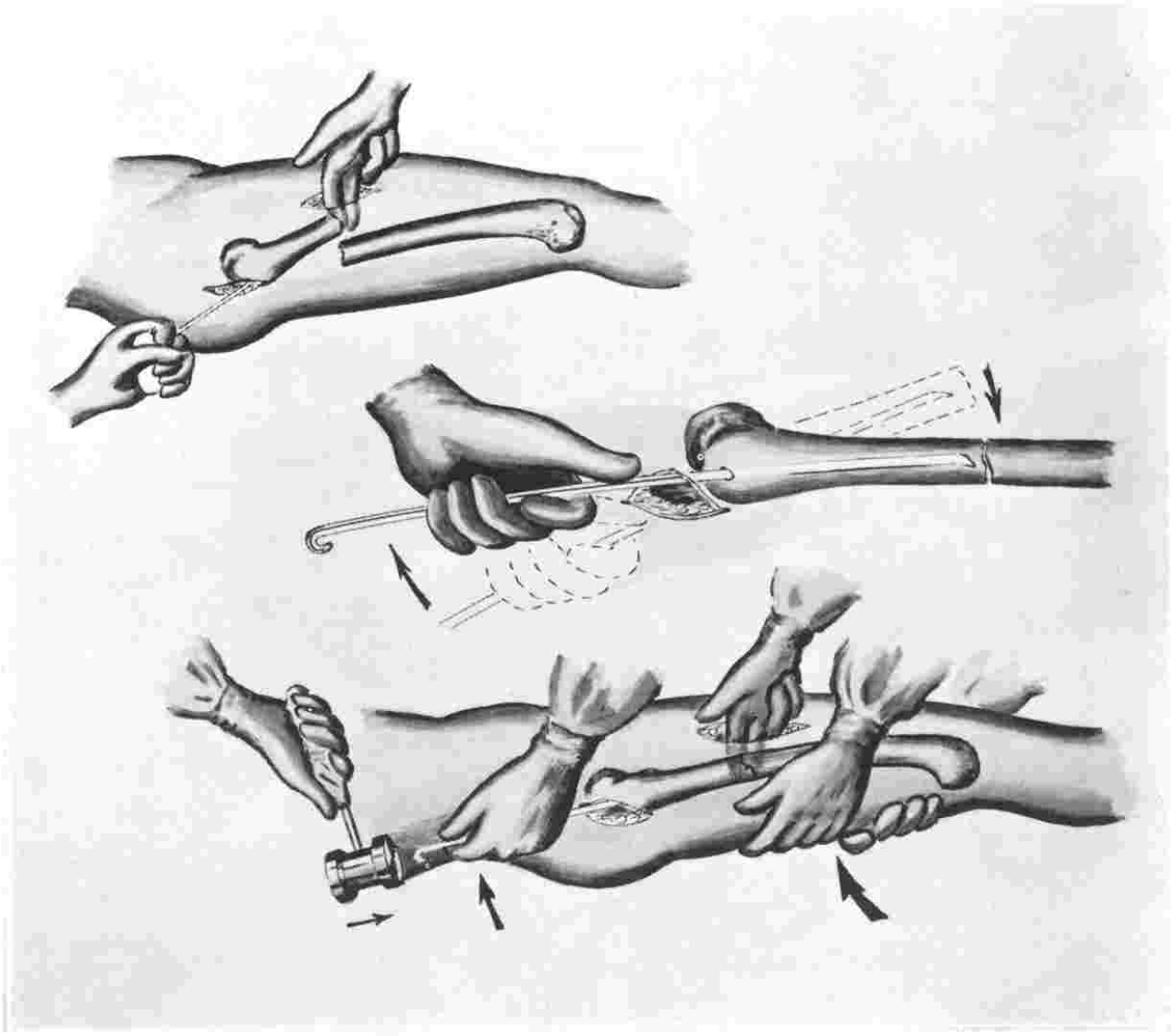
The upper fragment is flexed by the iliopsoas, and abducted and externally rotated by the rotators of the hip. The higher the fracture, the more effectively this muscle action is exerted upon the bone so that great deformity can occur at the subtrochanteric area. There is marked tendency to anterolateral angulation.

COMPARATIVE DISPLACEMENTS

Mid-shaft: Little displacement proximal fragment. Great trochanter remains lateral and is easy to enter with pin.

Upper third: Great trochanter more posterior, proximal fragment flexed and abducted. Incision must be more posterior, and the direction of awl-reamer must be adjusted to axial line of upper shaft.

Subtrochanteric region: Fragment still more violently displaced and is difficult to manipulate. Opening for pin is best made using awl-reamer or drill in retrograde fashion.



Technic: Junction Upper and Middle Thirds

The procedure here is the same as that of the mid-shaft except that the proximal fragment is more cantankerous.

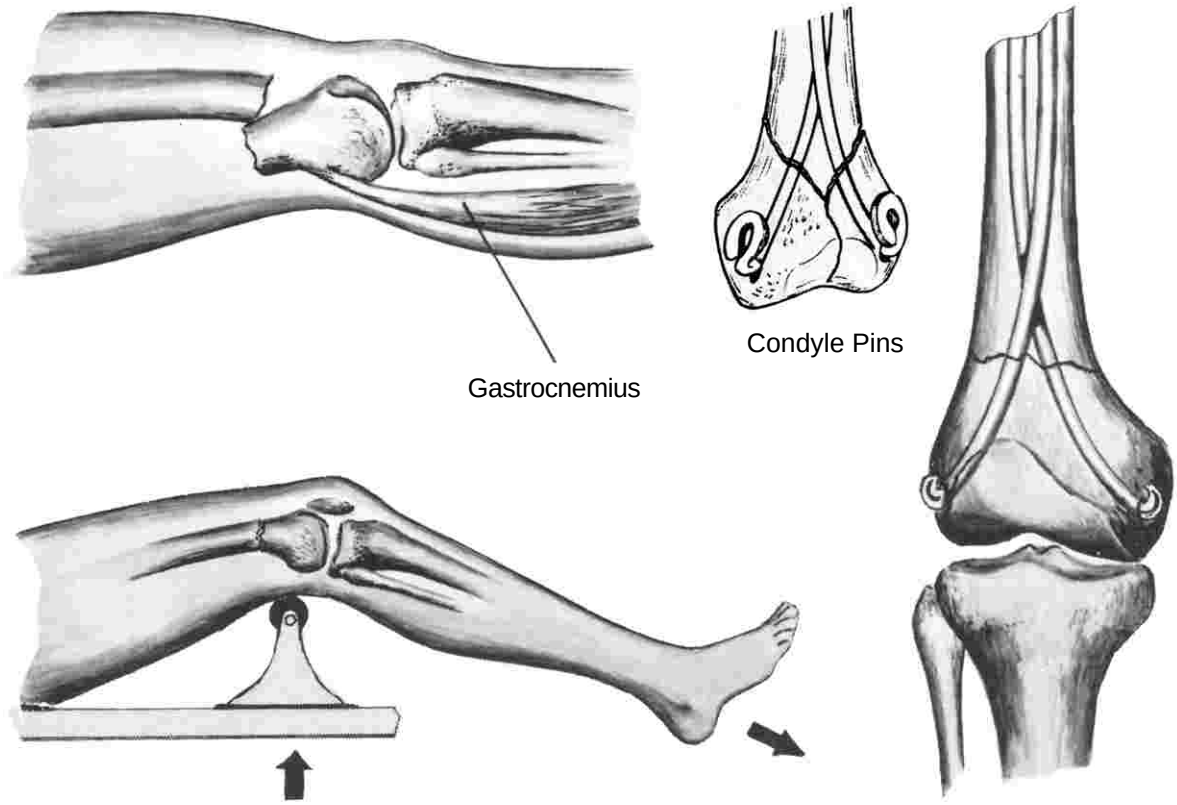
The incision over the trochanter must be placed more posteriorly. Since the proximal shaft is in partial flexion, the direction of the awl-reamer must be altered to a more obliquely anterior one to conform.

When the pin has been driven to the fracture line, it can be manipulated to move the proximal fragment into position. The palpating fingers in the primary wound guide the procedure, and an assistant makes upward traction to lift the lower fragment.

The surgeon here has two fingers of the right hand in the primary incision to align the bones. The left hand is maneuvering the proximal fragment by the pin.

One assistant is lifting up on distal fragment as second assistant taps pin with the mallet.

The pin used here is curved as before, and the operation is completed as in mid-shaft.



Supra-Condylar Fracture

Here the lower fragment becomes the problem. It displaces and tends to rotate backward because of the pull of the gastrocnemius muscle.

Reduction and pinning can usually be accomplished as a closed procedure. For reduction, moderate flexion of the knee relaxes the gastrocnemius pull. Upward pressure is made beneath the condyles as traction is exerted on the foot. This may be done with or without the fracture table.

This is the original fracture for which the present Rush Pin was designed. Here, two pins are used, each three-sixteenths inch in diameter and nine to twelve inches long.

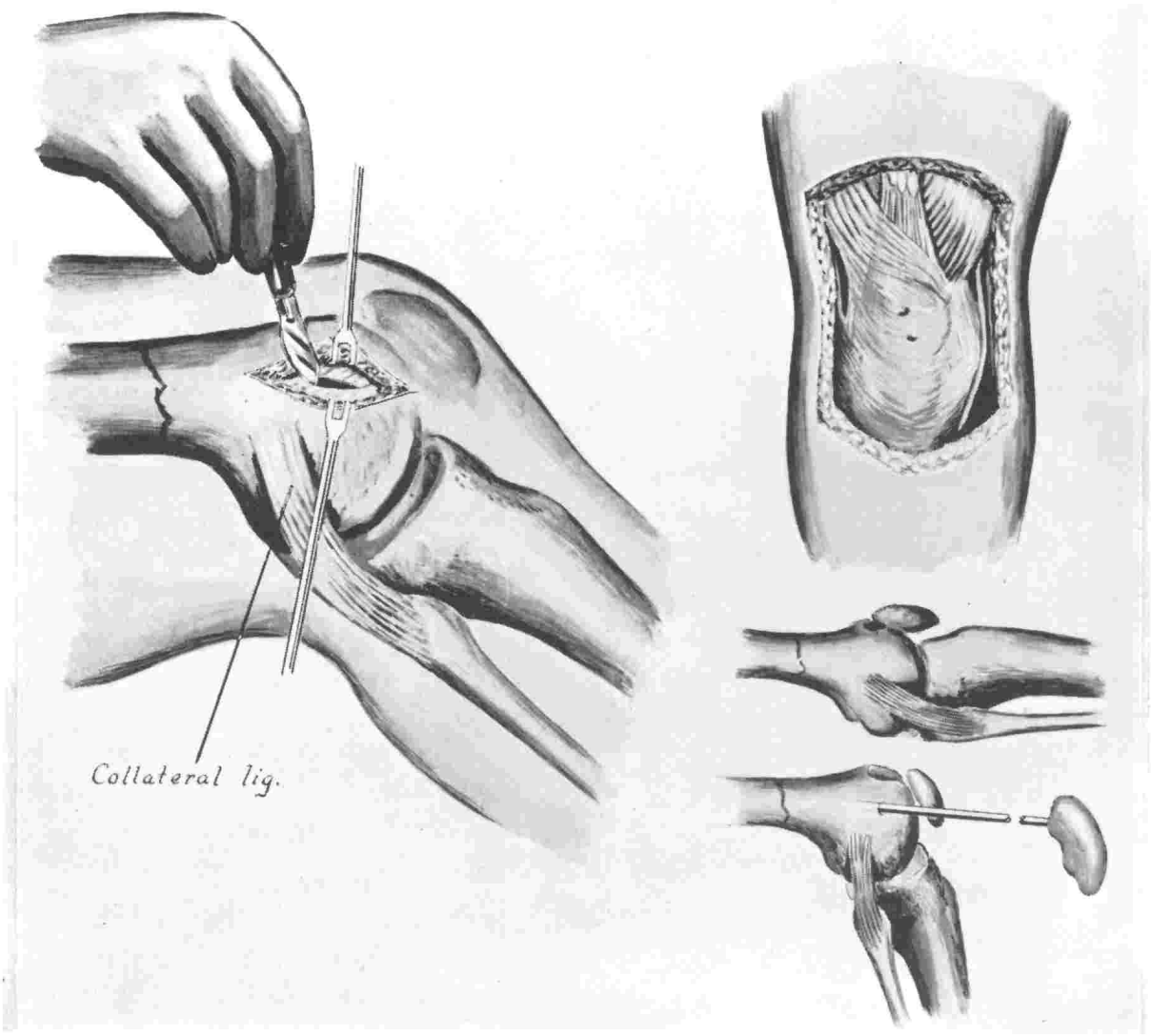
It might be well for the reader to review the chapters on “Dynamic Factors” and “Stability of Fixation” at this point.

The large medullary cavity and the trumpet shape of the lower end of the femur preclude satisfactory fixation by pin or nail driven downward from above.

The pins here literally “turn a corner”, the sled-runner points being deflected from the far cortices travel up the medullary canal. The straight pin being forced into a curve exerts pressure at three points — and the two pins oppose each other to give stability by six points of pressure.

Several points previously mentioned are well repeated here:

1. Pins should be driven simultaneously to prevent displacing the shaft.
2. Pins should not be too long. They can impinge in a small medullary cavity above to give distraction and non-union. The proximal cortex can be split by such a procedure if the medullary cavity is very small.
3. Pins too short will migrate backwards.
4. The heads of the pins can migrate into the bone from dynamic force unless stress is relieved with the bending iron.



Anatomy

The condyles of the femur are enveloped in an aponeurotic capsule. On flexion and extension of the knee this capsule glides obliquely over the condyles. If this capsule is compromised by the pin, it will adhere to the bone to give limitation of motion at the knee.

The collateral ligaments must not be injured by the surgical procedure. Partially flexing the knee carries them backward out of harm's way.

These ligaments are not infrequently torn in injuries of this and are best repaired immediately. After the bone has been transfixed, it is possible to test the ligaments for laxity (lateral mobility of the knee).

The point of entrance for the pin is about one inch central to the periphery or articular margin of the condyle. This can be determined by palpation when the knee is flexed. The reamer must be inserted, in the lateral plane, so that it will approximate the long axis of the shaft. If the point of insertion is too far posteriorly or at the wrong angle, the condyle will angulate as the pin enters the medullary canal.

A one-inch incision is sufficient for inserting the pin and must extend through the capsule.

Double Pinning

For this procedure the pins should not be pre-curved but should be driven straight. The pin develops the curve from pressure within the bone.

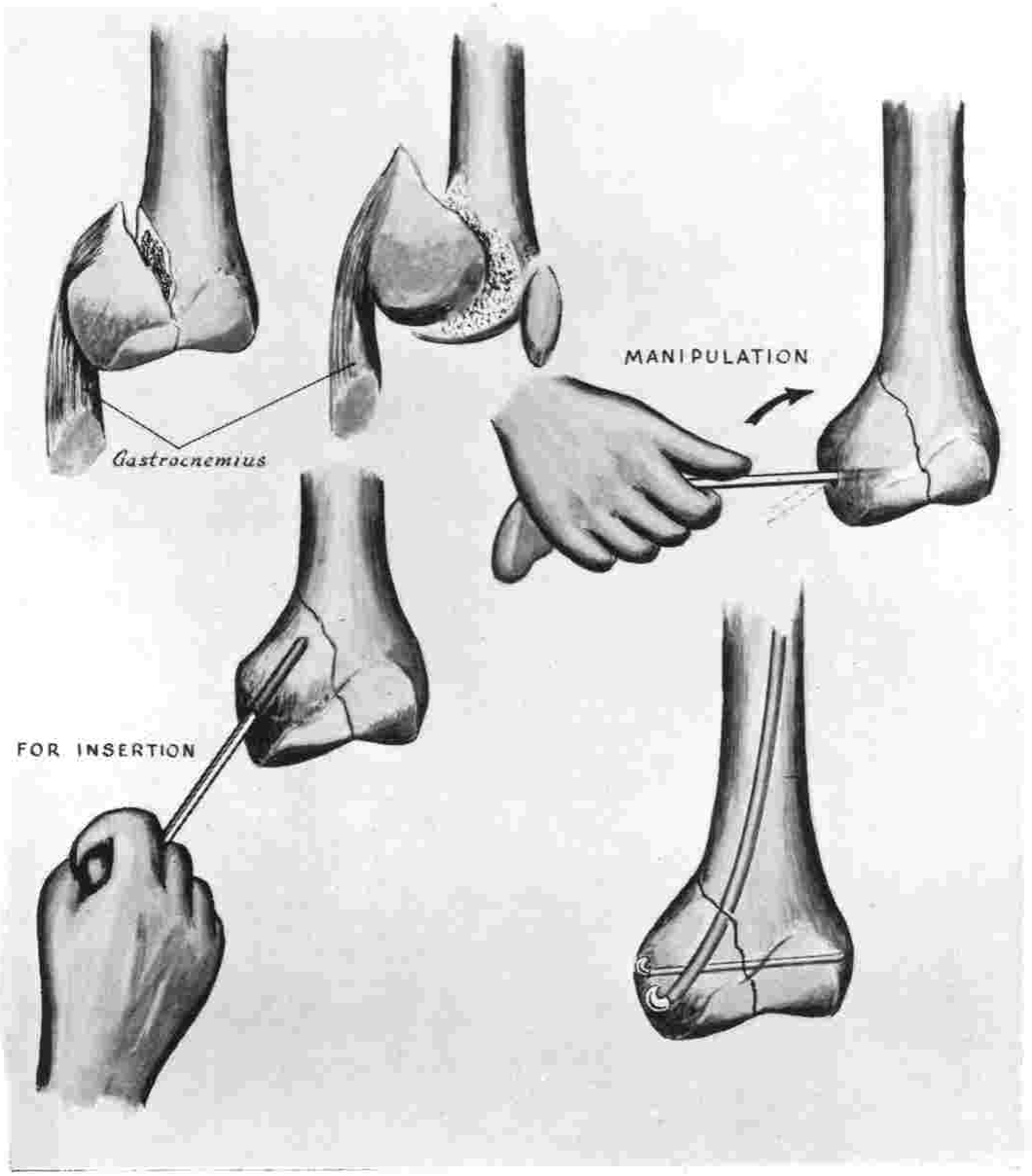
In the front view the two pins enter the condyle at such an angle that they cross at a point about four inches above the insertion points. The openings for the pins must be accurate and can be directed much more simply with the awl-reamer than with the drill.

Each sled-runner point glides up the opposite cortex directing the pin into the medullary canal.

Before the pins are driven completely home, the heads should be stress relieved (bent) with the bending iron to prevent their cutting into the bone.

The capsule of the joint must be sutured over the heads of the pins, and the knee should be tested to be sure there is full range of motion at completion of the operation. This can save later embarrassment.

Splinting is usually unnecessary but might be needed in comminuted fractures or in elderly patients where fixation is not stable. Double pins of three-sixteenths diameter do not nearly possess the strength of a single one-fourth inch pin. If there is doubt as to stability, splint!



Femur: Condyle

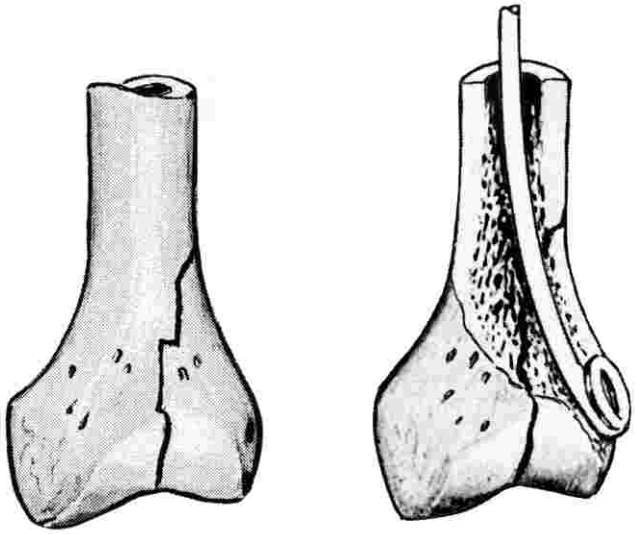
This type fracture results in widening. The fragment moves up, out and is rotated backward by the pull of the gastrocnemius muscle.

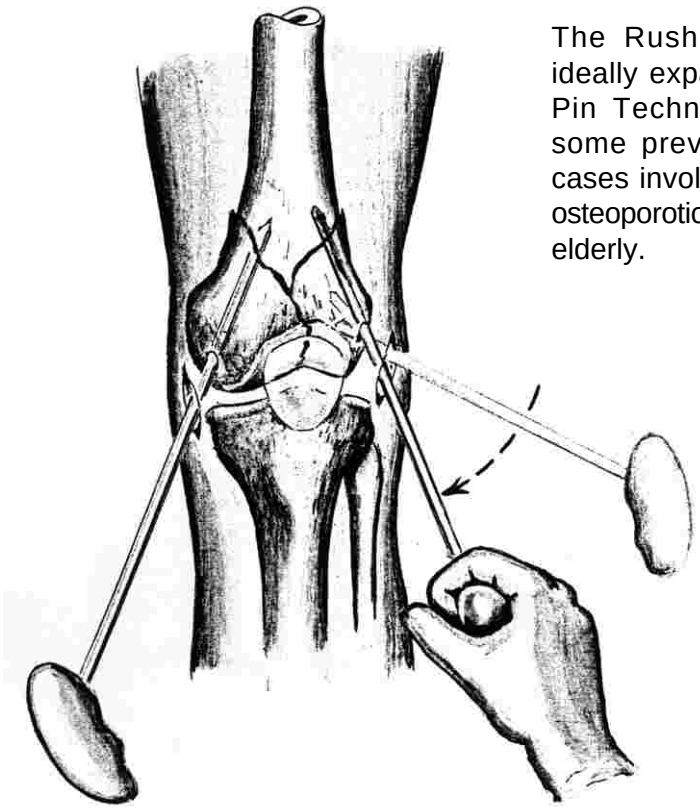
The medullary pin (3/16 inch) when properly placed will compress the fracture to give stable fixation and rapid healing.

This fracture must be accurately reduced even if it requires an incision. Closed reduction might be accomplished by the same procedure used in the supracondylar region — traction on foot with the knee moderately flexed and with counter traction upward beneath condyles.

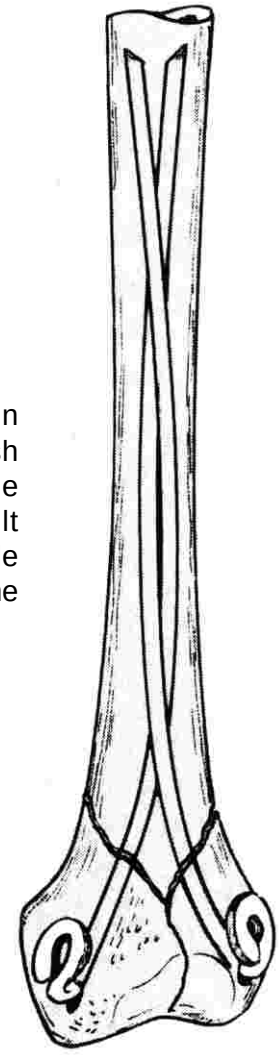
The awl-reamer might be used to lever the fragment into better position. The small transverse pin safeguards the integrity of the articular surface but is not always essential.

The single larger intramedullary pin is introduced just as for the supracondylar fracture. Individual judgment will have to be used as to how much to stress-relieve the head of the pin with the bending iron. Here a limited amount of pin pressure is necessary.





The Rush Condyle Pin ideally expands the Rush Pin Technics to include some previously difficult cases involving the friable osteoporotic condyles in the elderly.



Rush Condyle Pin

Special Condyle Pin

The technics previously described for the lower femur give very good fixation in young adults but the elderly can present quite a problem. They tend to comminute violently because the cortex of the bone is thin and there is little cancellous bone and the condyles are like egg shells. The pins are prone to migrate into the bone with loss of fixation.

The loop head condyle pin obviates this to a great degree. These fractures are usually pinned as closed procedures allowing a little telescoping of the fragments to encourage union. A long KES dressing is essential when the bone is osteoporotic.