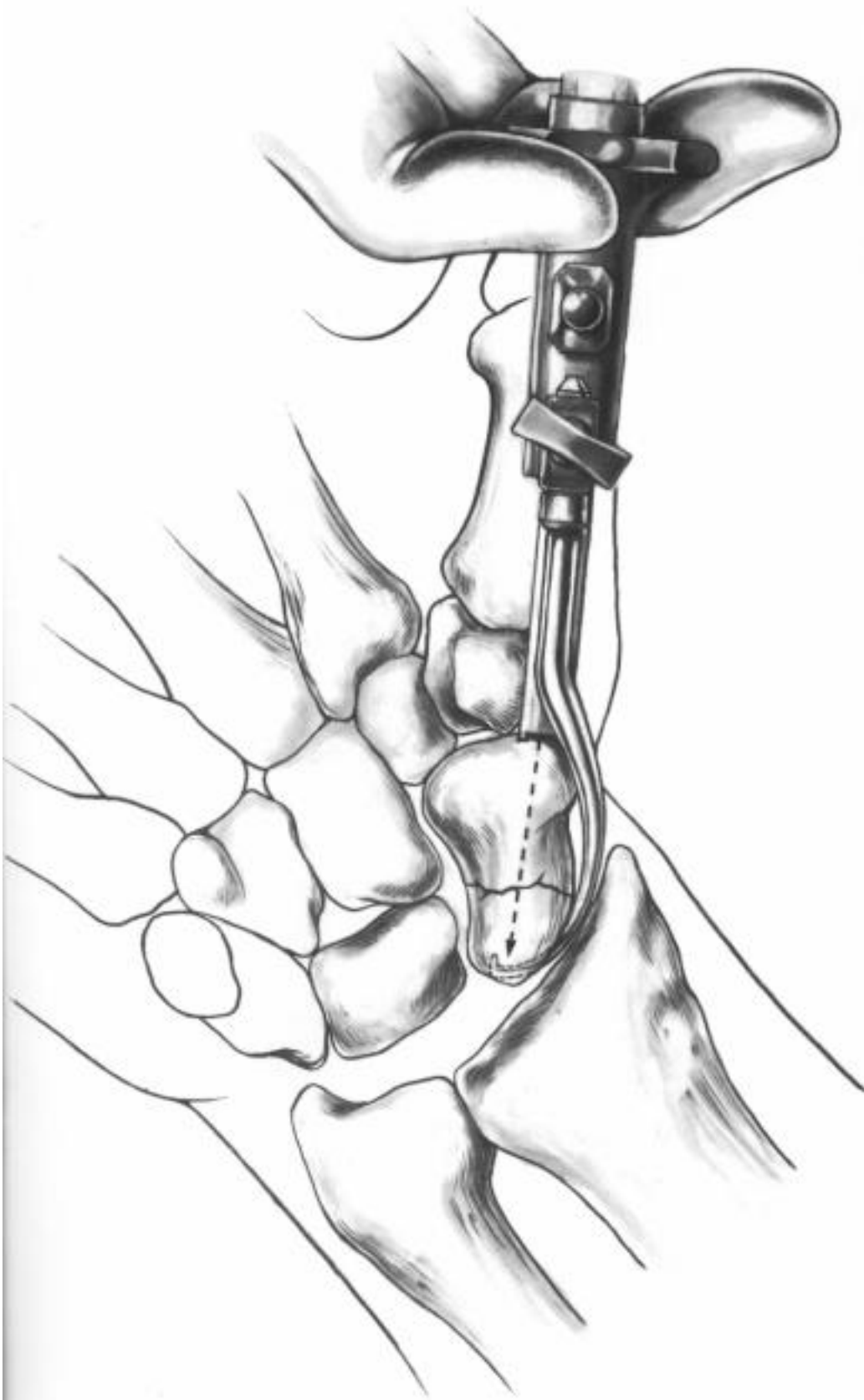


FRACTURE MANAGEMENT

Surgical  
Technique

*Herbert Bone Screw*

Scaphoid Fractures



# Scaphoid Fractures

## Indications for Surgery

It has been shown that rigid internal fixation maintains anatomical reduction of the scaphoid without the need for any external splintage. By avoiding the use of plaster, early (protected) joint motion is possible. This appears to accelerate bone healing and leads to rapid functional recovery. At the same time, the complications of plaster, such as joint stiffness, osteoporosis, and muscle wasting are avoided.

Thus, internal fixation using the *Herbert Bone Screw* is indicated in the treatment of all acute, unstable fractures (Type B) of the scaphoid, or whenever prolonged plaster immobilization is contraindicated.

Similarly, internal fixation has proven to be invaluable as an adjunct to bone grafting for scaphoid nonunion (Type C).

The decision to carry out internal fixation in the management of scaphoid fractures depends on the surgeon's assessment of the problems. Factors that should be taken into account include:

### A: The Patient

- Age
- Occupation
- General health
- Disability
- Expectations

### B: The Fracture

- Age
- Instability/deformity
- Bone stock
- Bone viability
- Associated conditions (e.g. other fractures, osteoarthritis)

### C: The Surgeon

- Internal fixation of the scaphoid is a difficult surgical procedure, demanding a sound understanding of the three-dimensional anatomy of the carpus.

Thus, contraindications include:

- Unsuitable patient
- Inadequate bone (e.g. complete avascular necrosis)
- Inexperienced surgeon

# Classification of Scaphoid Fractures

The following classification of scaphoid fractures is recommended:

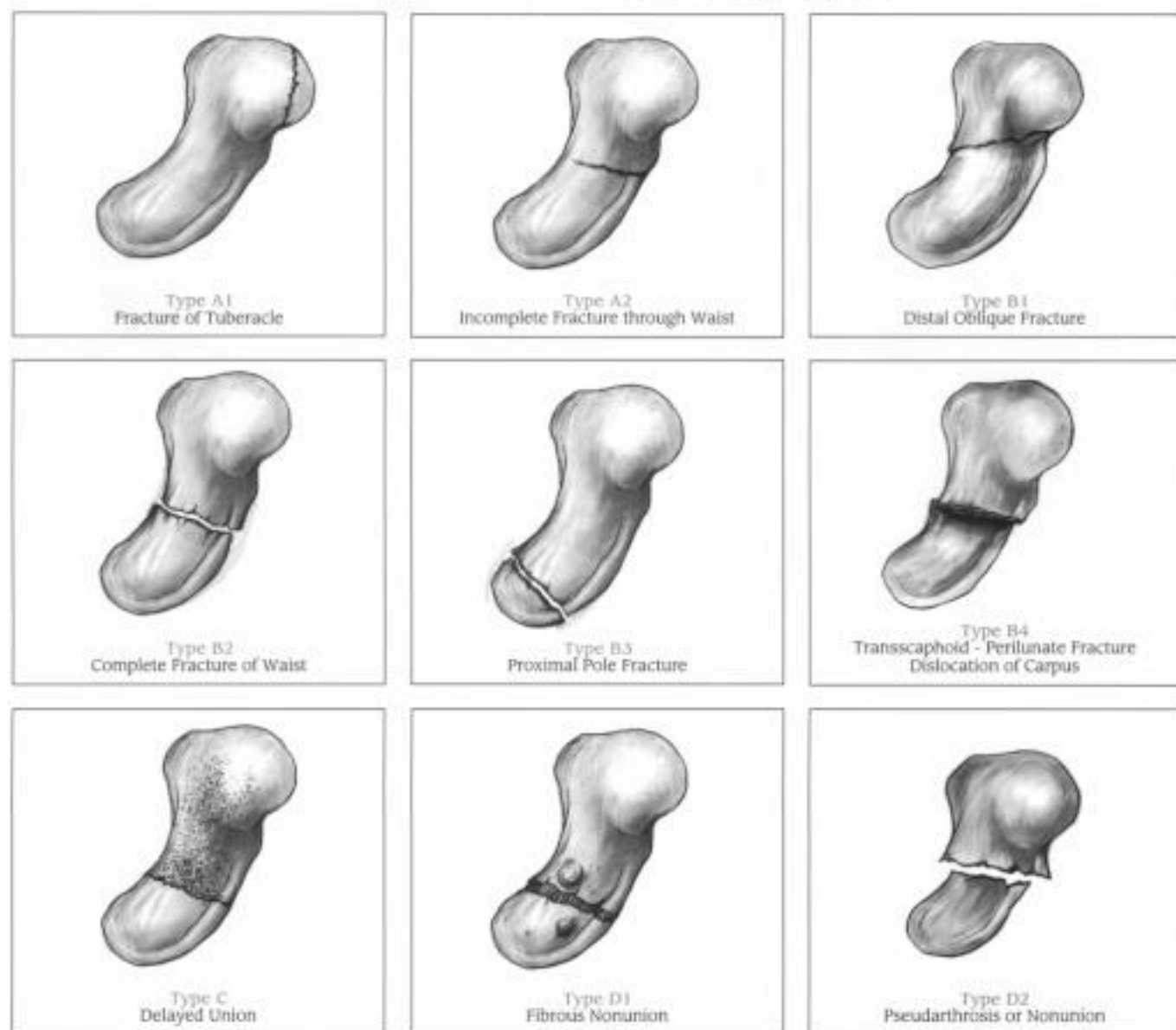
**Type A Acute, Stable**—Union may be expected after immobilization of the wrist for six weeks in a Colles-type plaster. However, internal fixation may be indicated when the patient prefers to avoid the use of plaster.

**Type B Acute, Unstable**—Open reduction and screw fixation are indicated. In comminuted fractures, supplementary bone grafting may be required. In oblique fractures, additional Kirschner wire fixation is sometimes necessary.

**Type C Delayed Union**—Screw fixation, with or without bone grafting, is indicated. However, it is advisable to leave the wrist free of plaster for a minimum period of two weeks prior to surgery.

**Type D1 Fibrous Nonunion**—The fibrous tissue should be completely excised and a suitable bone graft (cancellous or corticocancellous) inserted prior to screw fixation.

**Type D2 Pseudarthrosis**—Reconstruction of the scaphoid involves resection of the pseudarthrosis and correction of deformity, using a substantial corticocancellous bone graft from the iliac crest. Surgery is indicated only after careful assessment of the patient's disability and expectations.



# Scaphoid Fractures Standard Operating Procedure

## (Using Huene Alignment Guide—Volar Approach)

### Preparation

Use either regional block or general anesthesia. The operation must be done under pneumatic tourniquet technique using the appropriate hand operating table. Radiographic control, best done with a high resolution image intensifier, is essential. If bone grafting of the scaphoid is required, it is recommended that iliac bone be used because of its density and higher levels of bone cellular elements and bone morphogenic protein. Use of the contralateral iliac crest with a small roll under the hip facilitates grafting.

### Exposure

A volar approach is favored for all but the most proximal scaphoid fractures because of protection afforded the important and vulnerable scaphoid blood supply entering the bone and the dorsum. In addition, the Alignment Guide can only be used from the anterior approach. Its use allows safer precision placement of the screw entirely within the scaphoid bone, and ensures maximum precompression of the fracture and/or graft.

A dorsal or posterior approach is used for fractures whose proximal pole is equal or less than 25%. This approach requires free-hand insertion of the screw (see page 24 Dorsal Approach to the Scaphoid).

Once through the skin, the tendon sheath of the flexor carpi radialis tendon is carefully located and opened (Figure 1-3). Retract the FCR tendon ulnarly (using the small Retractor) and carefully carry the dissection distally until the superficial palmar branch of the radial artery (of variable caliber) is located. The skin incision shown in Figure 1-3 is centered over the tubercle of the scaphoid and extended distally and radially toward the base of the thumb. The proximal limb of the incision may be straight or zig-zag (for a more cosmetic scar). Cut and ligate this vessel and continue opening the sheath around the scaphoid tubercle. The floor of the tendon sheath provides a landmark for the joint arthrotomy. Directly in the floor



FIGURE 1-3 Volar approach — skin incision. The proximal limb of the incision may be straight or zig-zag

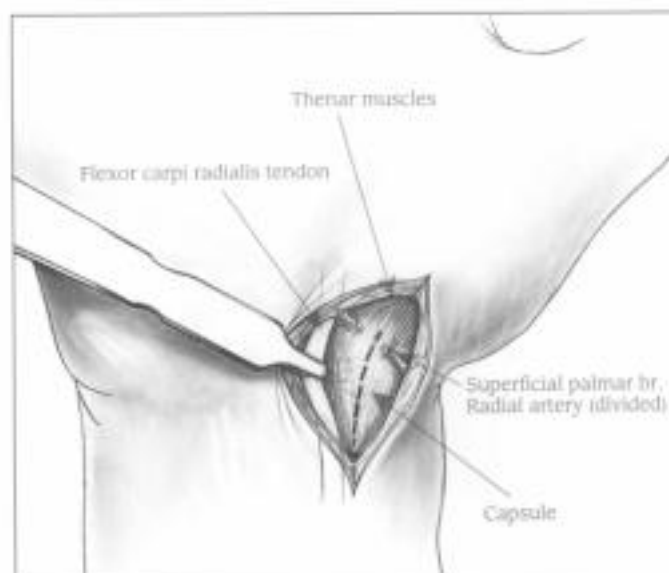


FIGURE 1-4 Volar approach — capsular incision

of the sheath, sharply incise the radioscaphocapitate ligament and the joint capsule (Figure 1-4). This will expose the anterior surface of the scaphoid. Insert the Self-Retaining Retractor. The fracture or nonunion can now be visualized. Extend the incision sharply slightly into the origin of the thenar muscles and over the center of the scaphoid tubercle. Peel off a cuff of the ligament on the tubercle radially and ulnarly, but do not dissect too far anteriorly, especially on the radial side because a small group of important vessels enters the scaphoid here. Unlike the Russe operative approach, the scapho-trapezial joint must be opened when fixing the scaphoid

with a *Herbert Bone Screw* (Figure 1-5). Mobilize this joint enough to allow the distal pole of the scaphoid to be elevated enough to permit proper placement of the barrel of the Alignment Guide on the distal pole of the scaphoid (Figure 1-6). Adequate mobilization of this joint is important, and when inadequate, is a cause of frustration for many inexperienced surgeons in proper placement of the Alignment Guide.

By pulling longitudinally on the index and long fingers and distracting the wrist, the dome of the proximal pole of the scaphoid and a portion of the scaphoid facet of the radius can be well-visualized.

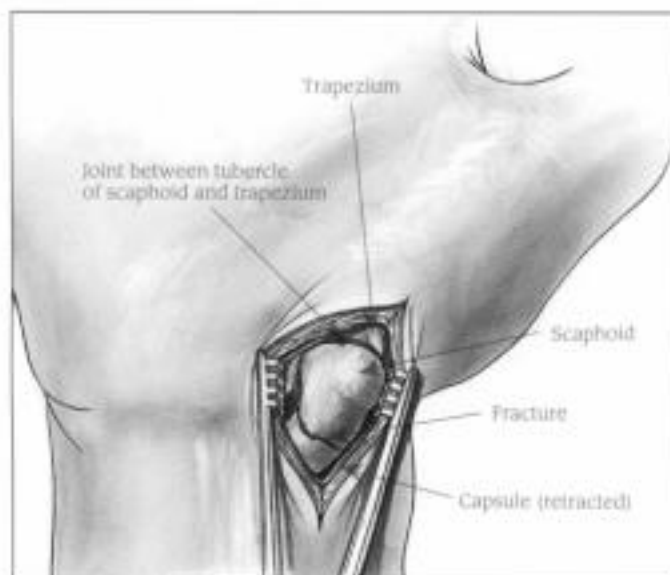


FIGURE 1-5 Volar approach — fracture exposed and scaphotrapezial joint opened

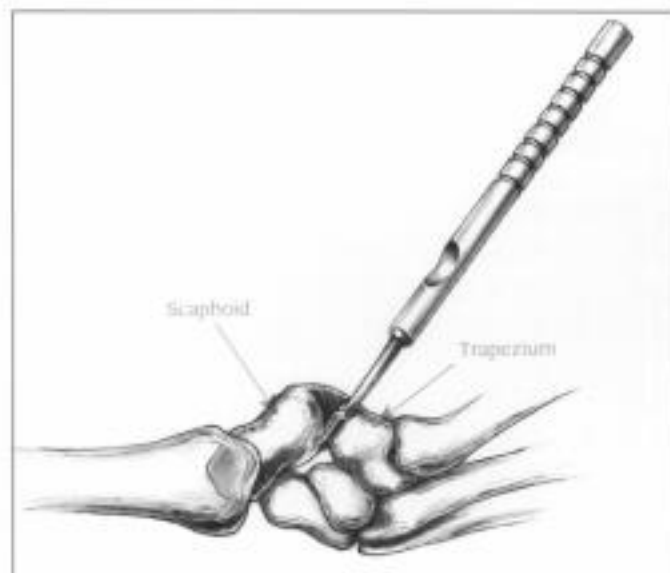


FIGURE 1-6 Use the Elevator (1154-09) to lift and mobilize the tubercle of the scaphoid away from the trapezium

## Fracture Reduction

Once the joint exposure described is completed, evaluation of the fracture can be accomplished. In older fractures, it may be necessary to divide adhesions at the fracture site in order to obtain adequate visualization. Movement at the fracture site may be demonstrated by moving the hand into the ulnar and radial deviation. The fracture may be hinged open by dorsiflexing the wrist.

In fresh fractures, perform a trial reduction of the fracture. In most acute fractures, a hemarthrosis is present and suction is required for adequate visualization of the fracture and adjacent joints. If the fracture is unstable because of comminution or compression of the volar cortex of the scaphoid, a bone graft is necessary to restore normal contour of the scaphoid and reconstitute the volar cortex. If the instability is due to the obliquity of the fracture, the Alignment Guide can be applied initially without compression and a small bone fracture clamp or hemostat can be used to compress and stabilize the fracture mediolaterally. Alternatively, a Kirschner wire may be used as temporary fixation. (This should be inserted along the ulnar border of the bone so as not to interfere with the insertion of the screw.) This provides additional stability as the Alignment Guide is tightened.

### Bone Grafting

In certain comminuted acute fractures the scaphoid may tend to collapse under compression. In such cases, it may be necessary to excise loose bone fragments and use a bone graft to stabilize the fracture and maintain length of the scaphoid when it is compressed with the Alignment Guide.

In the case of fibrous nonunion (Type D1) carefully pry open the fracture and curette out all fibrous tissue and cysts. Prepare the bone surfaces so that healthy bone is apparent in both bone fragments. Tightly pack the resultant cavities with fresh cancellous bone, harvested from the iliac crest. (Radial bone is not normally suitable for this procedure.) Insert the graft

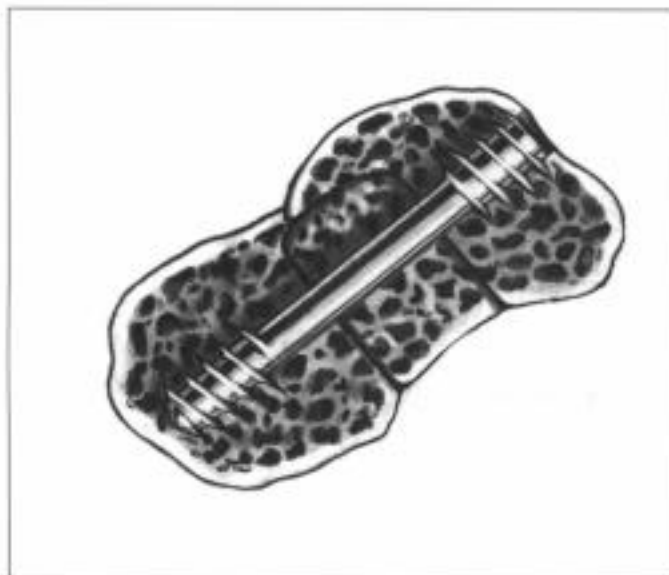


FIGURE 1-7 Reconstruction of scaphoid; following excision of pseudarthrosis, a corticocancellous block from the iliac crest has been firmly impacted with cortex flush anterior so that it remains stable in compression

in such a way that the scaphoid will be completely stable on compression with the Alignment Guide. If necessary, a corticocancellous wedge graft may be required.

In the case of an established pseudarthrosis (Type D2) the two fragments typically are completely mobile and unstable, and the bone faces are sclerotic. The goal of surgery is correction of associated carpal deformity while obtaining a sound bony union. Excise the sclerotic bone faces using a small osteotome. Make the cuts perpendicular to the long axis of the scaphoid so that the graft will be stable when inserted. An attempt should be made to preserve a soft tissue hinge posteriorly since this will contain the graft. Fill any residual cavities with cancellous bone chips.

Forcibly dorsiflex the wrist. This maneuver will tend to correct the carpal deformity and open the defect in the scaphoid to its full length. Remove a block of corticocancellous bone from the outer border of the iliac crest and carefully shape it to fit tightly within the resultant cavity (Figure 1-7). The graft should be wide enough to prevent any collapse when compression is applied. Use a small punch to firmly impact the graft. Then trim any protuberant graft after the screw has been inserted.



## Internal Fixation

### Step 1 — Apply Alignment Guide

Set the blade of the Alignment Guide for the appropriate hand and firmly tighten the locking screw. Set the barrel at 30mm and check the calibration.

Open the radiocarpal joint by firmly distracting the wrist. At the same time, use the curved end of the Dissector to locate the tip of the proximal pole of the scaphoid. Carefully insert the blade of the Alignment Guide around the proximal pole of the scaphoid. To avoid damage to the articular cartilage, initially point the hook anteriorly until it is around the proximal pole. Then swing it in an arc, medially and then posteriorly, until it is in a position to engage the proximal pole as deeply as possible. Aim the blade toward the *dorsum* of the proximal pole so that the angle of the Alignment Guide is approximately 45 degrees to the horizontal (Figure 1-8).

If the proximal pole fragment is very narrow, or if the fracture is oblique, engage the hook of the blade toward the radial surface of the proximal pole. This will ensure accurate alignment of the Guide perpendicular to the fracture and prevent medial penetration. Once the hook is engaged, hold it in position by maintaining traction on the handle of the Alignment Guide and release traction on the index and middle fingers.

Insert the special distal pole Elevator (1154-09) into the scaphotrapezial joint and gently lever the scaphoid tubercle anteriorly from the trapezium. Maintaining traction on the Alignment Guide, swing the barrel into position on the distal pole of the scaphoid, again aiming to be as perpendicular to the fracture as possible. When the line appears correct, push the Guide onto the bone using firm thumb pressure (Figure 1-9). Usually the barrel will be placed in the radial volar quadrant of the scaphoid just on the articular cartilage surface of the distal pole of the scaphoid.

### Technique Tips

**The Alignment Guide will normally ensure accurate positioning of the scaphoid screw, so that intraoperative radiographs are not mandatory.**

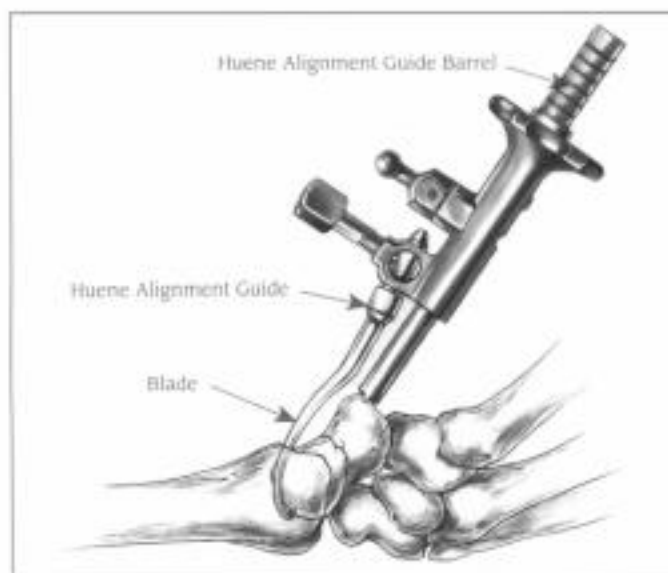


FIGURE 1-8 Correct positioning of the Alignment Guide along axis of scaphoid (approximately 45-degree angle to horizontal)

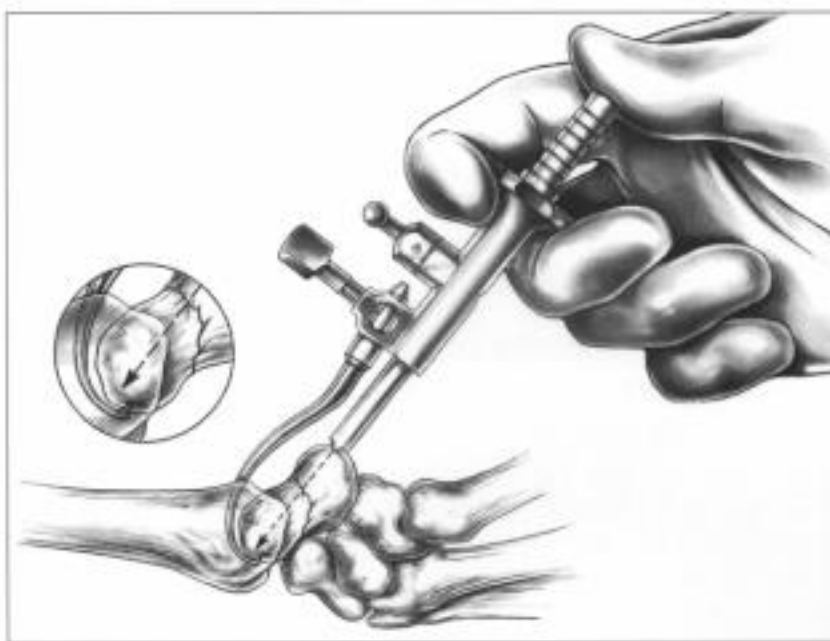


FIGURE 1-9 The fracture is compressed by using firm thumb pressure applied to the Alignment Guide. Note that the Alignment Guide lies at an angle of at least 45 degrees to the long axis of the limb

However, it does take practice to become familiar with the application of the Alignment Guide and the use of an image intensifier may be helpful. (Familiarization on cadaver wrists is strongly recommended.)

The most common error is to apply the Alignment Guide too superficially (screw penetrates scapho-capitate joint). This can be prevented by carefully checking the alignment of the Alignment Guide before drilling. Mark the most narrow part of the bone medially and position the Alignment Guide so its line is lateral to

this. If the Alignment Guide is incorrectly placed, it will become apparent during instrumentation. Penetration normally can be recognized during insertion of the long drill. If the Tap fails to advance during insertion, or if increased resistance is not apparent in the proximal pole, penetration is likely to have occurred and the Alignment Guide should be repositioned.

## Step 2 — Check Alignment

Visually check the alignment of the Guide to ensure that the screw will lie in the optimum position. Also, check the reduction of the fracture and make any necessary adjustments. With a bone graft, be sure that the graft remains in position while the Alignment Guide is compressed as tightly as possible (Figure 1-10). This position of the Alignment Guide can be checked with the image intensifier.

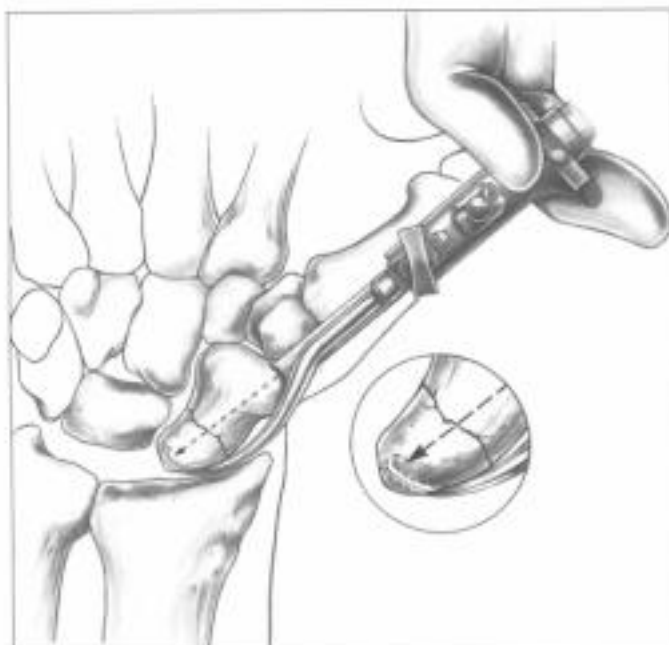


FIGURE 1-10 Correct alignment of Alignment Guide perpendicular to fracture

## Alignment Check with Guide Wire (Optional)

Insert the Sleeve (1152-52) into the barrel of the Alignment Guide. Drive a Guide Wire through the Insert Sleeve (Figure 1-11), and verify the position by x ray or image intensifier. Remove the Guide Wire and Insert Sleeve.

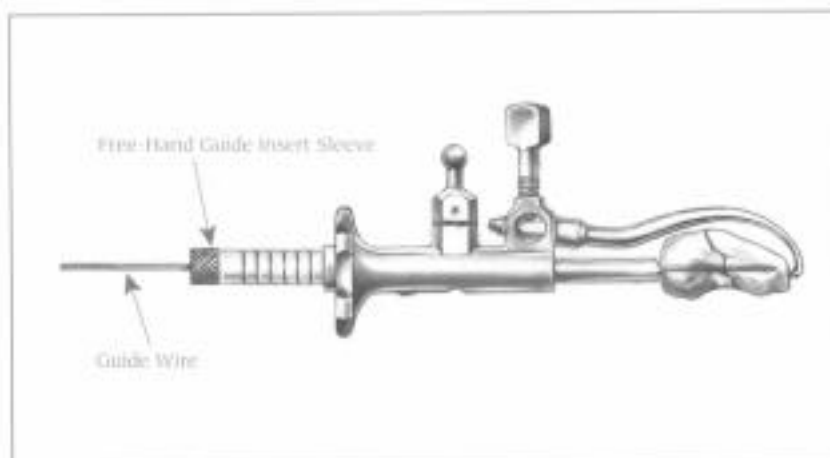


FIGURE 1-11 Optional use of the Free-Hand Guide Insert Sleeve and a K-wire to verify correct alignment of the Guide

## Step 3 — Drill the Pilot Hole

Insert the Pilot Drill into the barrel of the Alignment Guide. Turn the handle and advance the Drill until it bottoms out (Figure 1-12). Continue to turn the Drill in a clockwise direction during removal as this will remove bone and facilitate further instrumentation.

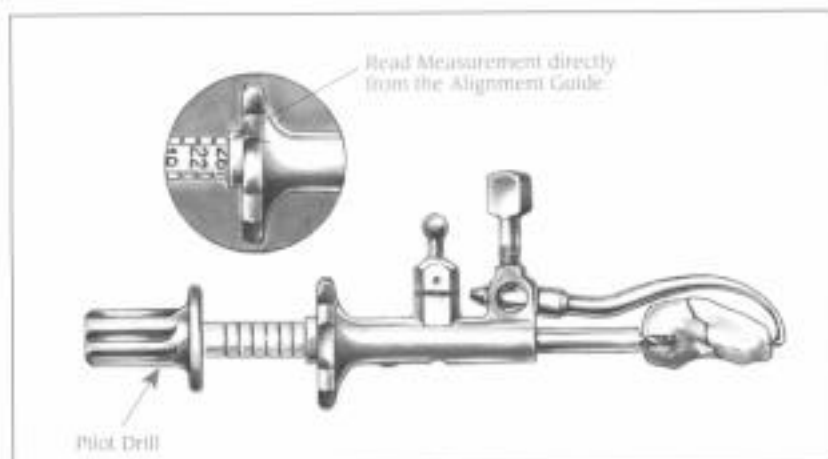


FIGURE 1-12 Determine the screw length from the calibrations on the Alignment Guide, and drill the pilot hole for the trailing threads



#### Step 4 — Drill the Main Hole

Insert the Main Drill into the Alignment Guide. Turn the Drill in a clockwise direction to maximize efficiency in cutting and chip removal. Advance the Drill until it bottoms out (Figure 1-13). If the bone is hard, withdraw the Drill periodically in a clockwise direction to remove bone fragments.

#### Step 5 — Tap

Tap the leading screw threads, especially when performing bicortical fixation. Insert the Tap using a clockwise movement until it bottoms out (Figure 1-14). Remove the Tap by turning in a counter-clockwise direction. It is essential that the Tap be inserted to the full drill depth in order to achieve the full compressive action of the screw.

#### Step 6 — Read Calibration

The screw length can be read directly from the calibrations on the Alignment Guide (Figure 1-14 Inset). This reading is the longest possible screw which should be used. If a shorter screw can be chosen without having threads present across the fracture site, selection of the shorter screw will reduce the risk of penetration. This is the reason for the preoperative calibration check recommended and described on page 5. However, too short a screw selection will result in threads present across the fracture line especially if the fracture is a proximal one. Screw threads across the fracture line can distract the bone fragments and contribute to failure of the device.

#### Step 7 — Insert Screw

Select the appropriate length screw and lift it out of the sterilization rack with the Screwdriver (Figure 1-15). Check the length of the screw against the calibrated scale located in the screw rack. (Packaged bone screws are presterilized.)

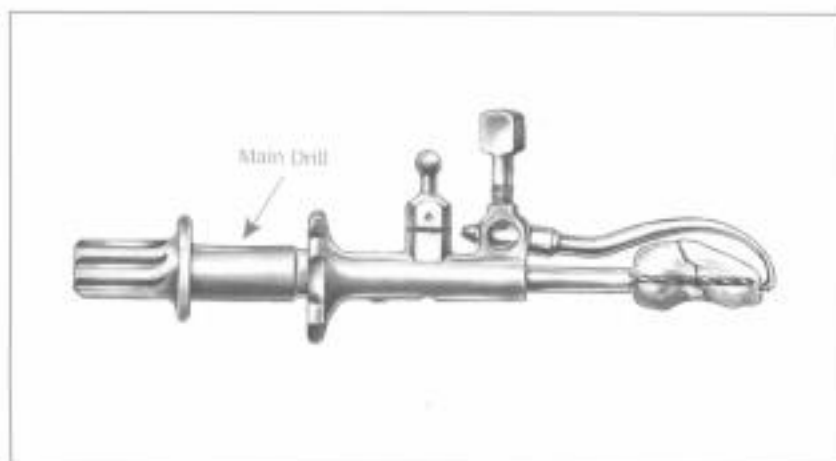


FIGURE 1-13 Drill the main hole for the leading threads, and the shaft of the bone screw

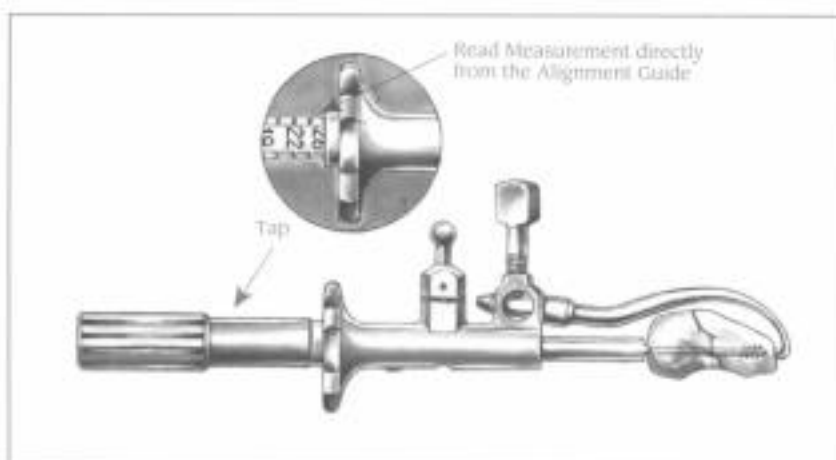


FIGURE 1-14 Tap the full depth of the main drill hole for the leading threads

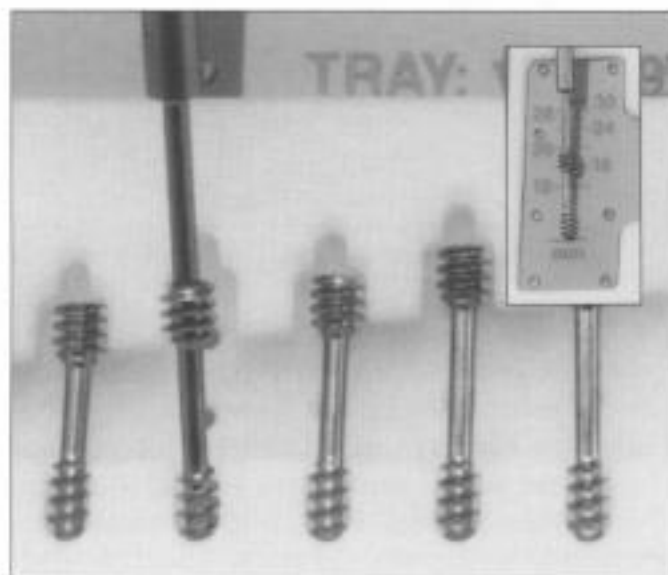


FIGURE 1-15 Lift the Herbert Screw from rack, Screwdriver fully engaged in hexagonal socket

Insert the screw through the Alignment Guide and turn the Screwdriver clockwise (Figure 1-16). As the trailing thread enters the bone, increased resistance will be felt and further reduction at the fracture site will be visible. Remove the Alignment Guide and **turn the screw an additional one or two turns. This will apply additional reduction and/or compression at the fracture site and completely bury the screw head.**

Put the wrist joint through a full range of movements to confirm secure fixation and to ensure that the screw has not penetrated proximally. This can also be checked by feeling around the proximal pole of the scaphoid with the curved blade of the Dissector. Carefully trim off any protuberant bone. A check with the image intensifier at this stage verifies the position of the screw on the radiograph at the termination of the operative procedure.

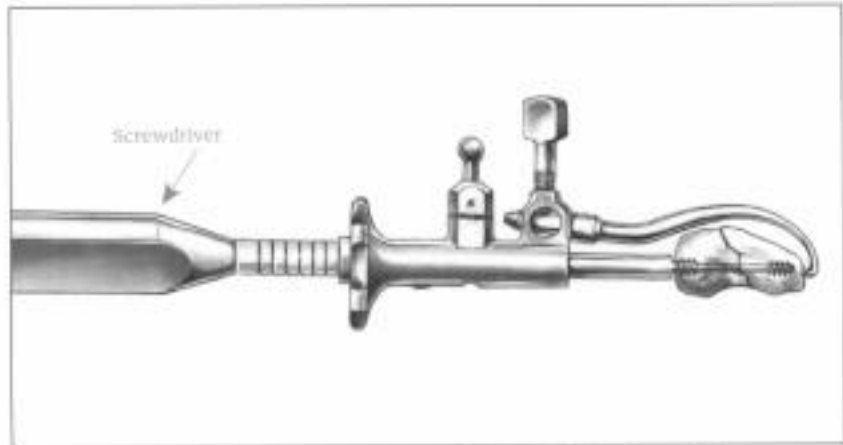


FIGURE 1-16 Insert the Herbert Bone Screw into the scaphoid bone through the Alignment Guide

## Closure

Use a suitable fine, nonabsorbable suture (e.g., 4/0 Ticron) to close the wrist capsule securely. Loosely suture the thenar muscles and the underlying joint capsule across the distal end of the scaphoid. Secure hemostasis as necessary prior to skin closure. Apply a firm bandage to support the wrist until the sutures are removed.

## Radiographs

As mentioned previously, intraoperative x ray films are not normally required, although image intensification screening may be useful. Take postoperative x rays to confirm satisfactory placement of the screw and reduction of the fracture (Figure 1-17).

## Postoperative Management

Elevate the limb and carry out routine observations. Encourage active finger exercises immediately, but the wrist should be supported until the wound has healed.

When the wound is healed, begin active wrist mobilizing exercises. If fixation is secure, no further splintage is required. However, the patient should be warned against further trauma to the wrist, and a removable wrist support should be worn if there appears to be any risk of this.

Take follow-up x rays at regular intervals until the outcome is clear. Most acute fractures should be united by six weeks, whereas reconstructions, particularly when there is a small proximal pole fragment, may take considerably longer. Failure of union becomes apparent if there are signs of loosening of the screw, such as a "halo" appearance around either screw thread.

Normally, contact sports should be avoided for up to three months after surgery, and it is recommended that all patients are reviewed after one year for final clinical and radiological assessment.

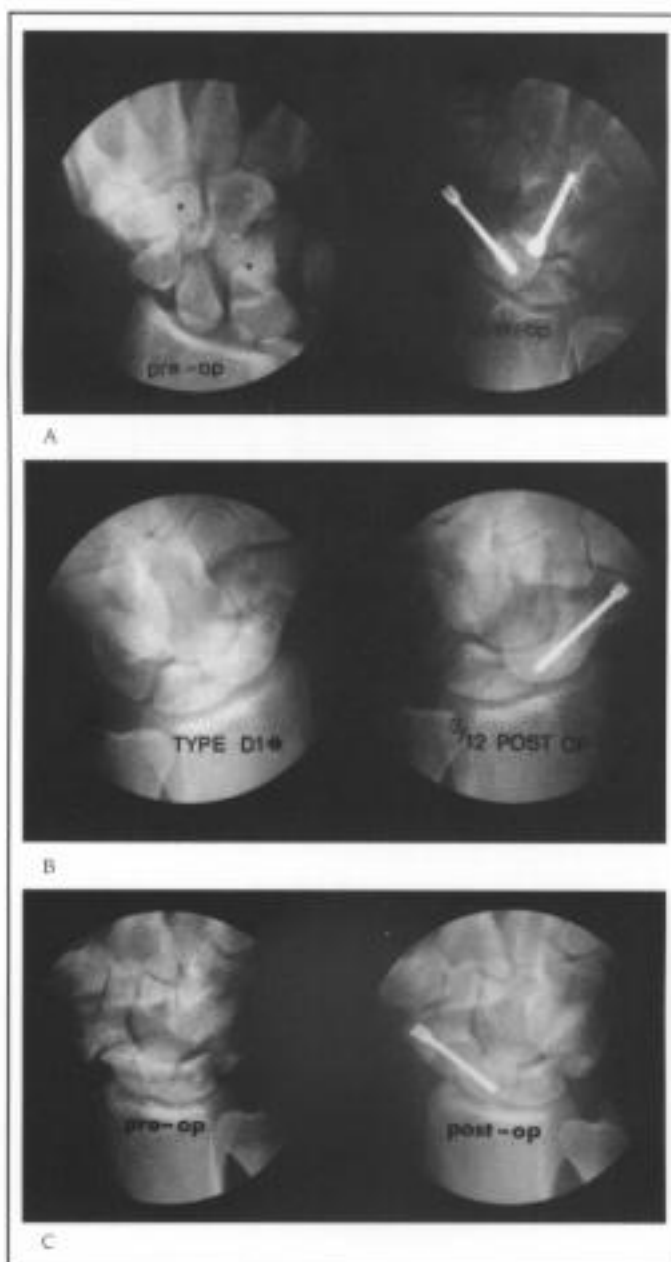


FIGURE 1-17 — Radiographs showing:

- A. Acute fracture dislocation (Type B5); note accurate reduction and fixation of scaphoid fracture, together with capitate fracture fixed by "free-hand" screw insertion
- B. Fibrous nonunion (Type D1) [left] treated by cancellous bone graft and screw fixation to attain union [right]
- C. Pseudarthrosis (Type D2) treated by reconstruction with corticocancellous bone graft and screw fixation

All these fractures united without the need for any postoperative plaster immobilization of the wrist.

# Technique Variations

## 1 Dorsal Approach to the Scaphoid

(For the *Herbert* and *Herbert Mini Bone Screws*)

As mentioned previously, in the case of a very small proximal pole fracture, it may be preferable to insert the *Herbert Bone Screw* in a retrograde fashion via a dorsal approach, so that the shorter trailing thread engages the small bone fragment (Figure 1-18).

Similarly, in the case of an unusually oblique fracture, it may not be possible to obtain a satisfactory direction for the screw from the volar approach and a dorsal approach may be preferred. With this approach, it is not possible to use the Alignment Guide, and fixation is carried out using the free-hand technique (see page 27).

In such cases, expose the scaphoid via a gently curved longitudinal incision over the back of the wrist centered to the ulnar side of Lister's tubercle. When using this approach, be sure to protect the superficial branches of the radial nerve.

Retract the extensor pollicis longus (E.P.L.) tendon after freeing it from beneath the extensor retinaculum. Incise the capsule longitudinally, just to the radial side of the extensor carpi radialis longus tendon (Figure 1-19).

This approach gives direct access to the proximal pole of the scaphoid. After reducing and/or grafting the fracture, use a K-wire to provide temporary fixation. Then fully flex the wrist, position the Free-hand Drill Guide on the apex of the proximal pole and apply firm pressure on the Guide to compress the fracture (Figure 1-20). Take care to ensure that the drill passes up the middle of the bone. (The axis of the scaphoid is roughly in line with the patient's thumb. This topographical fact can be used as an aiming guide for the surgeon. However, with the wrist flexed maximally, this axis is almost perpendicular—90 degrees—to the long axis of the forearm.) A 16mm or 18mm screw normally is sufficient to ensure good fixation, and the head should be buried completely beneath the articular surface.



FIGURE 1-18 Radiograph to show correct positioning of screw following retrograde, free-hand insertion via dorsal approach to a small proximal pole fracture



FIGURE 1-19 Dorsal approach to the scaphoid

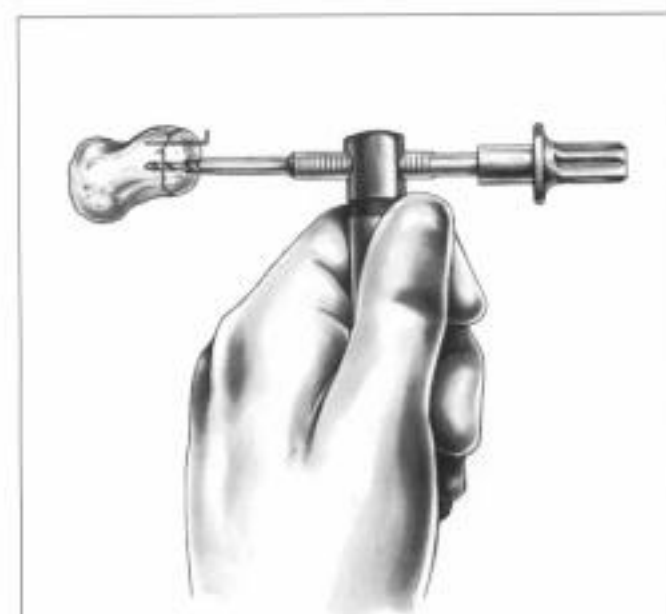


FIGURE 1-20 Free-Hand Drill Guide used to provide manual compression during instrumentation

Intraoperative x ray control is recommended to ensure correct positioning of the screw. Carefully repair the wrist capsule with fine, nonabsorbable sutures, and relocate the E.P.L. tendon in its dorsal compartment. Begin active wrist mobilizing exercises as soon as possible after surgery to encourage healing of the articular cartilage.

## 2 Transcaphoid Perilunate Fracture Dislocation

After perilunate or midcarpal dislocations, a much more extensive exposure is required (Figure 1-21). Stabilizing the scaphoid in these cases may be technically demanding when the scaphoid fracture is very unstable. A second dorsal exposure may be required and temporary K-wire fixation helpful. Decompression of the median nerve is necessary and snug repair of the large transverse tear of the anterior wrist ligaments is essential (Figure 1-22). When associated fractures of the radius or compartment syndromes are present, appropriate repair and fasciotomies are done.



FIGURE 1-21 Transcaphoid Perilunate incision

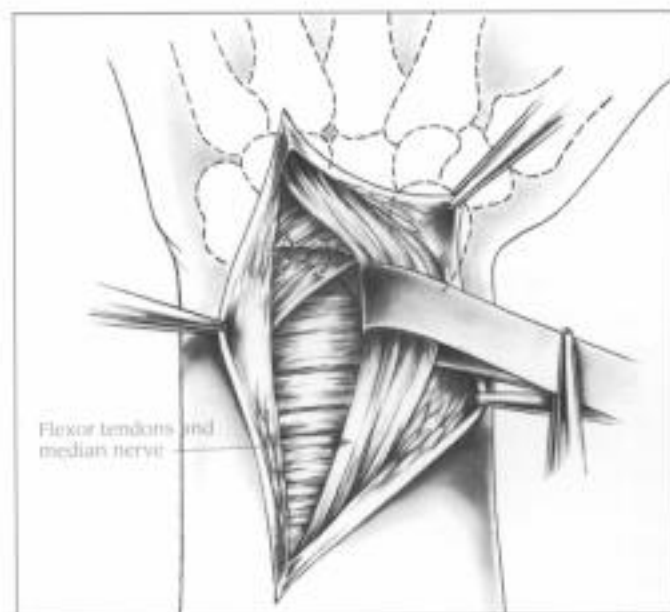


FIGURE 1-22 Suture repairs of ligaments

