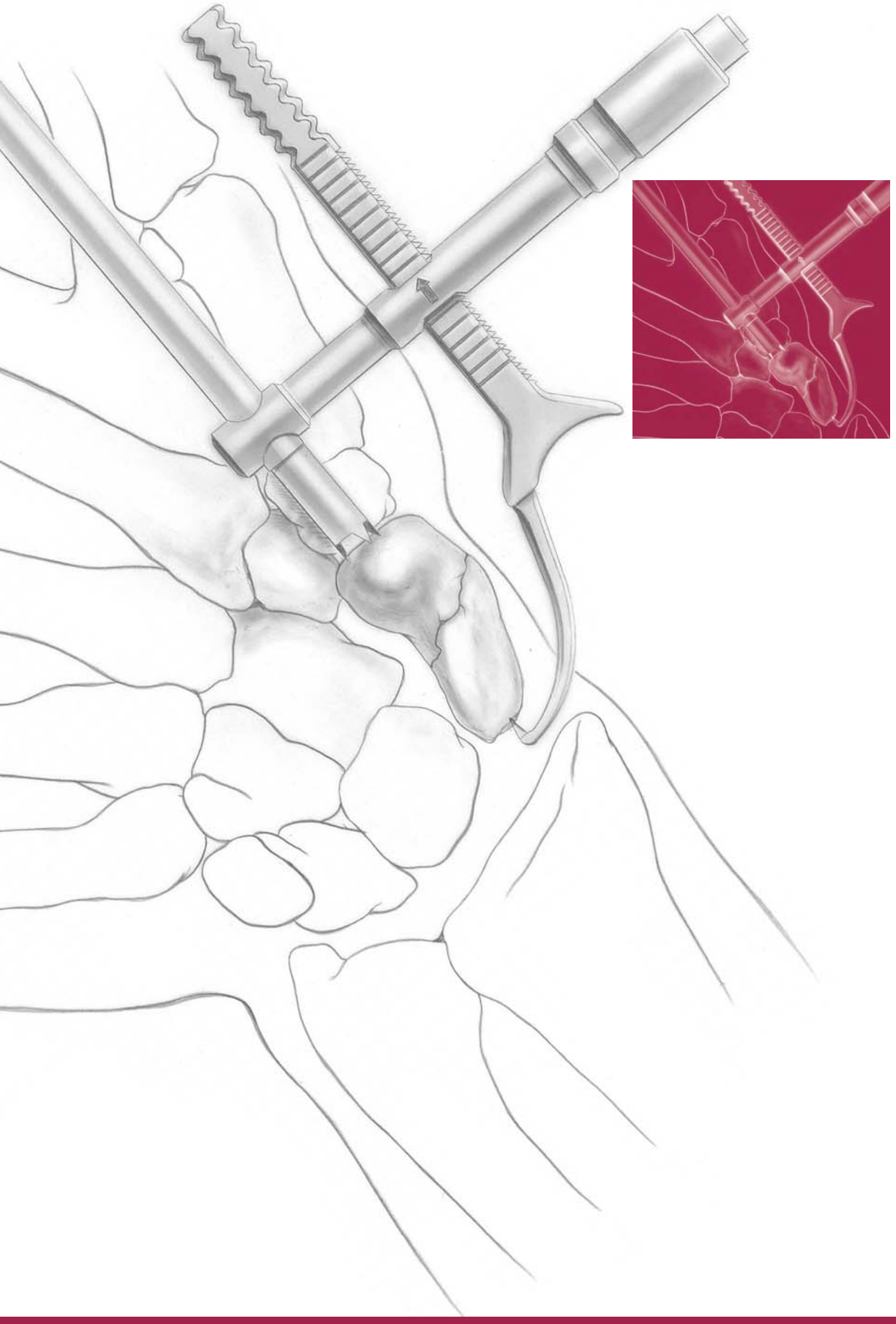

ZIMMER® HERBERT/ WHIPPLE® BONE SCREW SYSTEM

Surgical Techniques for Fixation of Scaphoid and Other Small Bone Fractures

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Confidence in your hands™

SURGICAL TECHNIQUES FOR FIXATION OF SCAPHOID AND OTHER SMALL BONE FRACTURES

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INTRODUCTION TO THE HERBERT/WHIPPLE BONE SCREW SYSTEM

The *Herbert/Whipple* Bone Screw has been developed in response to the demand for a cannulated screw similar in dimension to the standard *Herbert*™ Bone Screw, which has already proven itself invaluable for providing rigid fixation of small bone fragments. (Refer to the Suggested Readings on page 54.)

The *Herbert/Whipple* Cannulated Bone Screw System allows for accurate placement of the screw when inserted by the free-hand method, (i.e., without use of the Alignment Guide) and is particularly suited to arthroscopic surgery. At the same time, recognizing the advantages of an external guide control system in maintaining accurate reduction and controlling alignment, Dr. Whipple designed an Alignment Guide for the *Herbert/Whipple* Screw. This instrument offers several advantages over the conventional Huene Alignment Guide for scaphoid fractures, and can be applied under arthroscopic visualization for fixation of minimally displaced fractures. The *Herbert/Whipple* System is offered as an alternative for those surgeons who prefer to use a cannulated screw in conjunction with an external alignment guide system, or who are interested in primary internal fixation for certain acute fractures using minimally invasive techniques.

The two systems should be seen as complementary to each other, thus providing total flexibility for the surgeon.

INSTRUMENTATION

HERBERT/WHIPPLE INSTRUMENTS

Guide Wire

The 1mm Guide Wire (Fig. 1), manufactured from cobalt-chrome alloy for increased bending stiffness, has a trocar tip to facilitate drilling into the bone.
The cannulated screws and instruments are designed to fit over this wire. It is intended to be a single-use item.

NOTE: Guide Wires should be inserted at high RPMs, but with minimal axial pressure. Excessive pressure to speed the insertion compromises the cutting capability of the Guide Wire tip. This leads to bending in cortical bone, and can bend the cannulated instruments used subsequently.

Alignment Guide

The Alignment Guide has been designed to ensure accurate positioning of the *Herbert/Whipple* Bone Screw when it is used for internal fixation of scaphoid fractures. It may also be used in other sites where appropriate.

The *Herbert/Whipple* System ensures accurate insertion of the screw whenever the free-hand system is used.

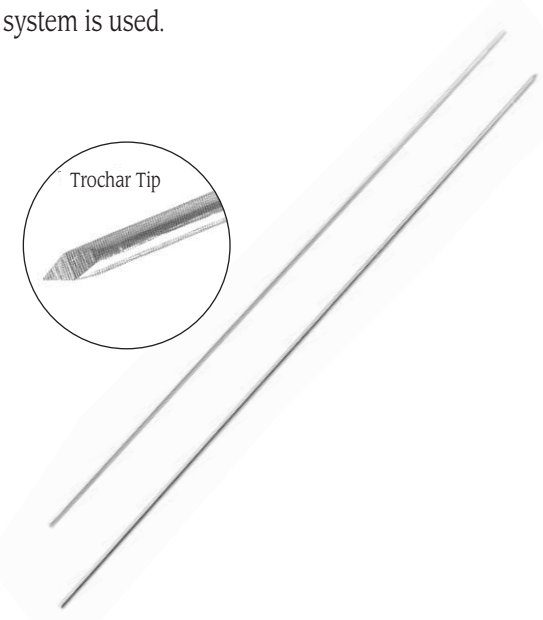


Fig. 1 – Guide Wire (1152-50)

Whenever possible, the screw is inserted through the Alignment Guide (Fig. 2), which is applied externally. This guide has a ratcheting mechanism and precision teeth to lock the two bone fragments together and ensure accurate positioning of the screw.

The barrel of the guide is designed to precisely direct the instrumentation. The blade slides through the body of the Alignment Guide, and is calibrated to indicate the appropriate screw length.

The tip of the blade is designed to hook around the proximal (or distal) end of the scaphoid bone or the external cortices of other small bones. The blade tip and the teeth on the barrel stabilize and compress the bone fragments when the Alignment Guide is tightened.

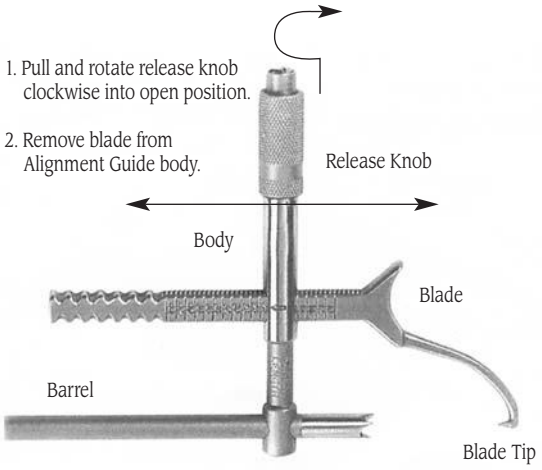


Fig. 2 – Alignment Guide (1152-06)

Calibration Check

The calibration of the Alignment Guide (Fig. 3) should be checked periodically as it is possible for the blade to become distorted with rough usage.

Assemble the Guide and insert the Drill or Tap through the barrel. Apply tension to the blade as shown. Check to be sure that the blade tip is centered on the tip of the Drill or Tap within a 1mm diameter range. When the blade is assembled to the barrel body, the distance between the tips of the barrel and blade should measure 2mm longer than the screw length read on the calibrated blade.

Depth Gauge

This instrument (Fig. 4) is used in conjunction with the Alignment Guide to ensure the proper insertion depth of the primary and accessory Guide Wires.

Free-Hand Guide and Insert Sleeve

This guide (Fig. 5) is used when a free-hand technique for screw insertion is preferred. It consists of a barrel with an attached handle and a Sleeve for insertion of the Guide Wire for the cannulated screw. This guide is useful for fixation of small proximal pole scaphoid fractures, intra-articular fractures, osteochondral fragments, and small joint fusions.

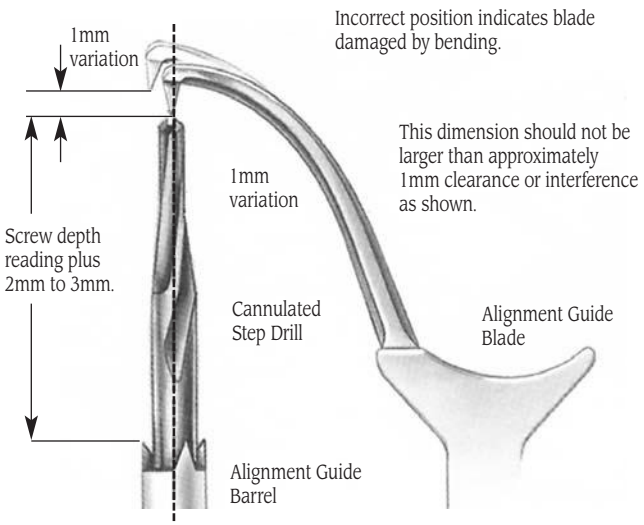


Fig. 3 – Calibration Check

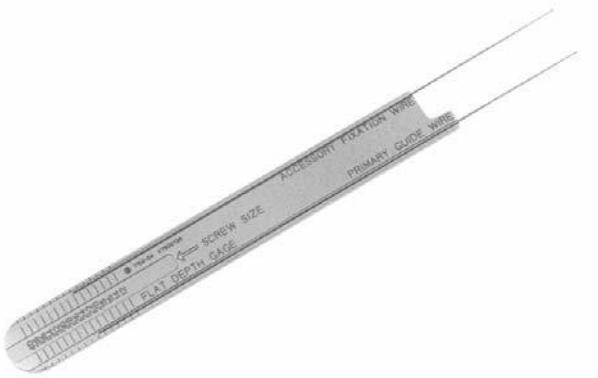


Fig. 4 – Flat Depth Gauge (1152-04)

Fig. 5 – Free Hand Guide (1154-92)

Free-Hand Depth Gauge

This gauge (Fig. 6) is used in the free-hand technique and with the Osteochrondritis Dissecans Cannula. It determines the appropriate length of the screw to be used. The gauge is designed to fit over the Guide Wire and into the appropriate guide.

Fig. 6 – Free-Hand Depth Gauge (1152-55)

Cannulated Cortical Broach

This instrument (Fig. 7) can be used to remove a small amount of bone from the cortical surface. This prepares the surface for the use of the remaining cannulated instruments. The broach has a built-in stop to limit the depth of penetration into the bone surface. It need not be used for soft bone, or when inserting the *Herbert/Whipple* Screw through articular cartilage.

Fig. 7 – Cannulated Cortical Broach (1152-02)

Cannulated Step Drill

This instrument (Fig. 8) has two drill diameters. The leading (smaller) diameter is used to prepare the bone for the leading threads of the screw. The trailing (larger) diameter is used to prepare the bone for the shank and trailing threads. The drill tip is provided sterile and recommended for single use. The drill shaft is reusable and has a quick- connect end for use with any standard Q-C handle or chuck adapter.

NOTE: Always test power drills to ensure there is no wobble in the spindle and that the drill bit is mounted centrally in the chuck to avoid wobble, which would "spread" the tip by applying lateral stresses to the Cannulated Step Drill when used over a Guide Wire.

This Step Drill should be used in conjunction with the optional Cannulated Cortical Broach or the Cannulated Gliding Hole Drill when hard cortical bone is encountered.

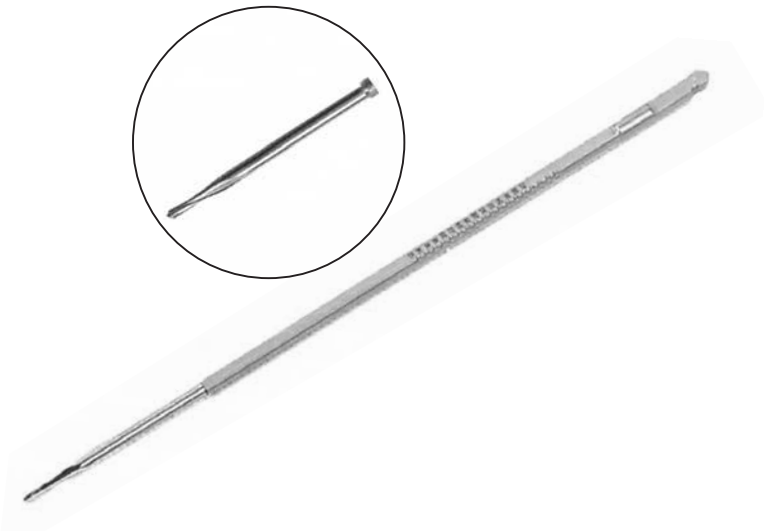


Fig. 8 – Cannulated Step Drill (1152-13, 15)

Cannulated Tap

This instrument (Fig. 9) is used to tap the hole to accept the leading threads of the screw. Tapping is usually optional as the leading screw threads are self-tapping. Tapping must be performed when the leading threads are penetrating dense cortical or cancellous bone. **It is important that the Tap be inserted to the full drill depth selected to avoid losing the compressive action of the screw.** Avoid turning the Tap once the stop hits the guide barrel. Further turning could result in stripping of the cancellous bone near the Tap.

Fig. 9 – Cannulated Tap (1152-05)

Modular Handle

This handle (Fig. 10) is used with the Cortical Broach, the Tap, and the Screwdriver. The Cortical Broach and Step Drill may also be used in a Jacob's Chuck if a power drill is used.

Fig. 10 – Modular Handle (1154-90)

Sleeve

The Sleeve is used as a stop mechanism for both the Step Drill and the Tap (Fig. 11). This quick-release stop features an internal spring which, when compressed, allows release of the locking mechanism. The Sleeve must be set at the chosen screw depth on both instruments to ensure correct function of the Step Drill and Tap. The depth is read at the tapered end of the Sleeve.

Fig. 11 – Sleeve (1152-60)

Screw Forceps

This instrument (Fig. 12) is used to remove screws from the screw case.

Fig. 12 – Screw Forceps (2313-11)

Cannulated Screwdriver

The tip of the Cannulated Screwdriver (Fig. 13) consists of two drive prongs which fit into the double holes of the screw. During screw insertion, the prongs **must** be inserted fully into the screw sockets to avoid damage to the screw or Screwdriver. This Screwdriver has a built-in stop to control the insertion depth of the screw into the bone.

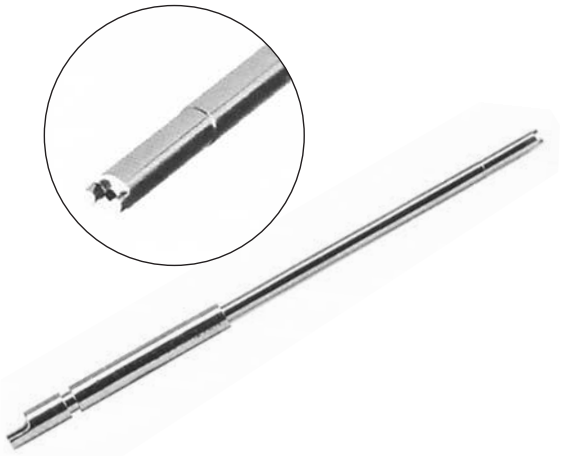


Fig. 13 – Cannulated Screwdriver (1152-01)

OCD Cannula

The Osteochondritis Dissecans (OCD) Cannula (Fig. 14) is used to protect soft tissue and as a guide for the cannulated instruments during arthroscopic procedures.

Fig. 14 – OCD Cannula (1152-70)

OCD Obturator

The OCD Obturator (Fig. 15) is used for inserting the Guide Wire during arthroscopic procedures.

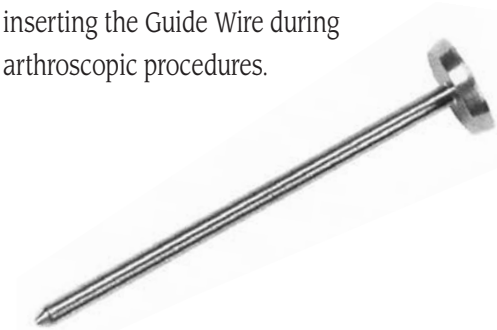


Fig. 15 – OCD Obturator (1152-71)

Cleaning Tools

To optimize intraoperative efficiency, these instruments are designed to unclog small cannulae, cutting edges, and flutes.

Small-Cannula Cleaner

The small shaft of the 7-inch-long Cannula Cleaner (Fig. 16) is used to dislodge tightly held fragments of soft tissue and bone from within the Cortical Broach, Screwdriver, Step Drill and Tap. This is a fragile instrument and it should be inspected periodically for bends. **Severe bending of the small rod could inhibit function. Bent components should be replaced.**

Pencil-End Brush

The stiff bristles of this brush (Fig. 17) will easily dislodge bone, cartilage, and other debris from the flutes, barbs, and cutting edges of the *Herbert/Whipple* instruments.

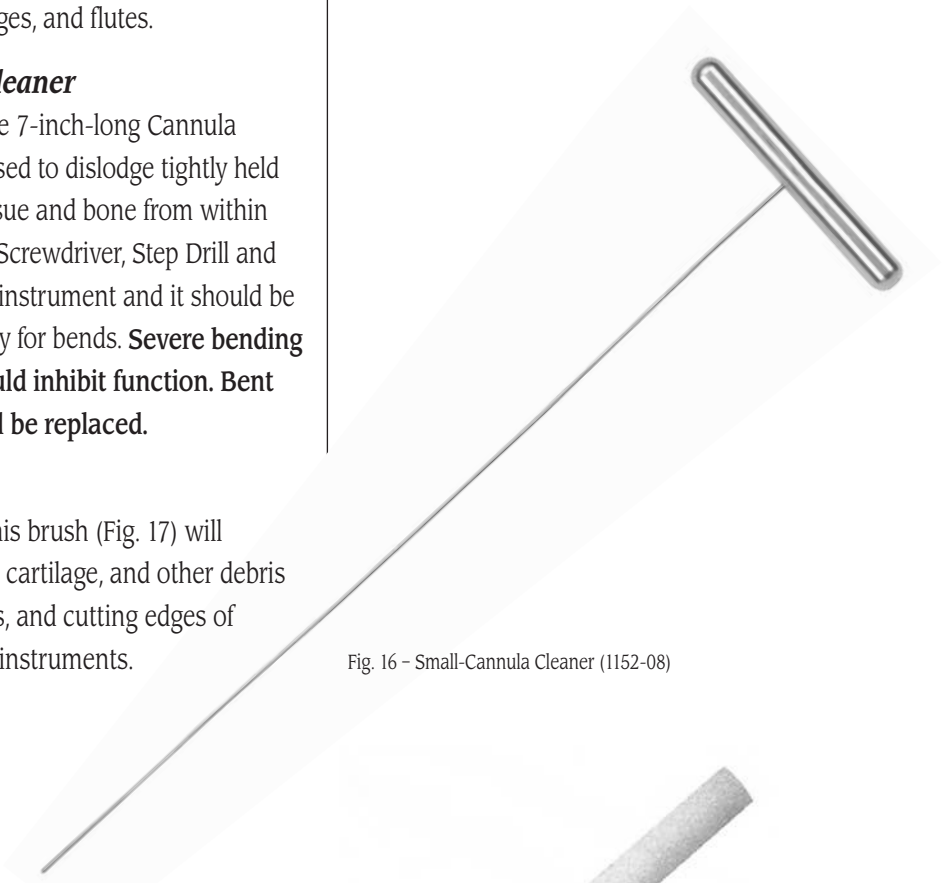


Fig. 16 – Small-Cannula Cleaner (1152-08)

Fig. 17 – Pencil-End Brush (1152-09)

GENERAL INSTRUMENTATION

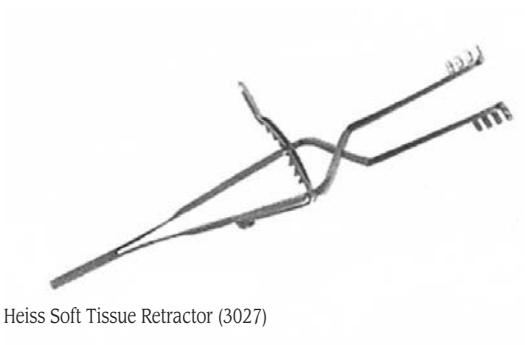
A set of General Instruments is available to facilitate operative technique. These instruments have been found to be of considerable assistance when carrying out internal fixation of small bone fragments.

Retractors

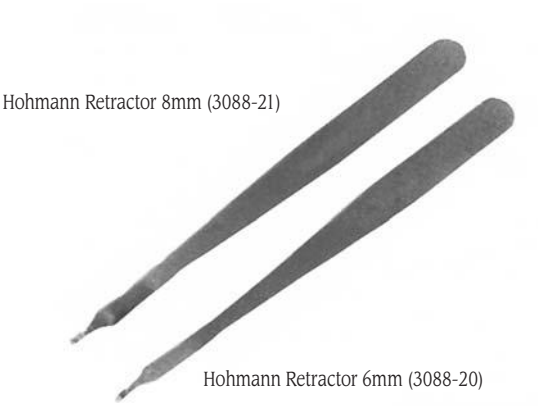
The General Instrument Set contains a Small Retractor, a Soft Tissue Retractor, two Double-Ended Retractors, and 6mm and 8mm Hohmann Retractors (Fig. 18). These are specifically designed for soft tissue retraction during small bone procedures.

Small Herbert Retractor (1154-78)

Double-Ended Herbert Bone Screw Retractor (1154-40)



Heiss Soft Tissue Retractor (3027)



Hohmann Retractor 8mm (3088-21)

Hohmann Retractor 6mm (3088-20)

Fig. 18 – General Instrument Set Retractors

Periosteal Elevator

This instrument (Fig. 19) is used to elevate the periosteum and muscle from the bone surface.

Dissector

The sharp end of the Dissector (Fig. 20) may be used to open the fracture prior to reduction or grafting. The blunt (curved) end is useful in wrist surgery, particularly when opening the radioscaphoid joint before application of the Alignment Guide around the proximal pole of the bone.

Trephine—Graft Cutter

If you decide to remove a well-fixed screw, use the Trephine (Fig. 21) to resect bone around the external diameter of the trailing threads. Then use the Screwdriver to back out the screw. The screw may be removed through the center of the Trephine. Experience has shown that this instrument may also be used to harvest a limited amount of bone graft from the iliac crest.

Fig. 19 – Periosteal Elevator (2910-02 – 2910-08)

Fig. 20 – Herbert Bone Screw Dissector (1154-08)

Fig. 21 – Use the Trephine to free the trailing threads from surrounding bony tissues prior to extraction.

Sharp Hook

The Sharp Hook (Fig. 22) may be used to remove soft tissue from the bone. This will allow accurate placement of the Alignment Guide. The hook is also useful to extract bone from the screw drive to facilitate insertion of the Screwdriver during removal.

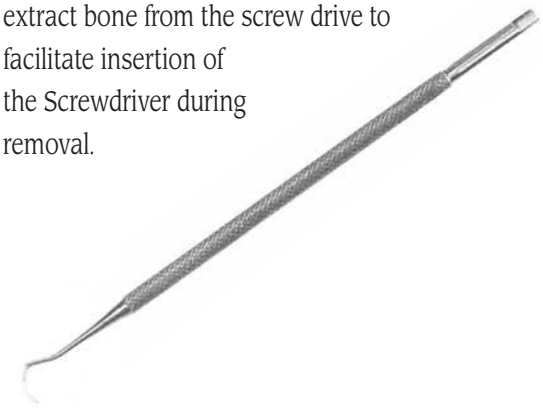


Fig. 22 – Sharp Hook (2446-39)

Bone-Holding Forceps

This instrument (Fig. 23) is used to reduce small fragments, as well as to grasp the bone and hold it firmly in place during the procedure.

Fig. 23 – Reduction Forceps (2446-07)

OPTIONAL INSTRUMENTATION

Hand Rasp (Pencil-Shaped Rasp)

This instrument (Fig. 24) is used to remove fibrous tissue and cysts from cancellous bone before bone grafting. It's especially useful for scaphoid nonunions.

Fig. 24 – Hand Rasp (Pencil-Shaped Rasp) (1154-77)

Gliding Hole Drill

The Gliding Hole Drill (Fig. 25) cuts more efficiently than the smaller-diameter Step Drill and is significantly stronger in bending. This Drill is .5mm larger in diameter than the largest portion of the Step Drill.

In thick regions of hard bone, the Gliding Hole Drill should be used in place of the Cortical Broach. Over-drilling for the core diameter of the trailing threads facilitates burying the *Herbert/Whipple* Bone Screws in dense bone.

Simply set the Stop Sleeve on the Gliding Hole Drill at the measured screw length. Drill over the K-wire and through the appropriate Alignment Guide until the stop bottoms on the guide barrel.

NOTE: The smaller-diameter Step Drill is appropriate for drilling cancellous bone. The Gliding Hole Drill should not be used in cancellous bone.

All smaller-diameter cannulated drill bits are delicate. Excessive thrust and all bending should be avoided.

Fig. 25 – Gliding Hole Drill (1152-17)

INDICATIONS AND USAGE

Indications for use of the *Herbert/Whipple* Bone Screw in the management of scaphoid fractures include:

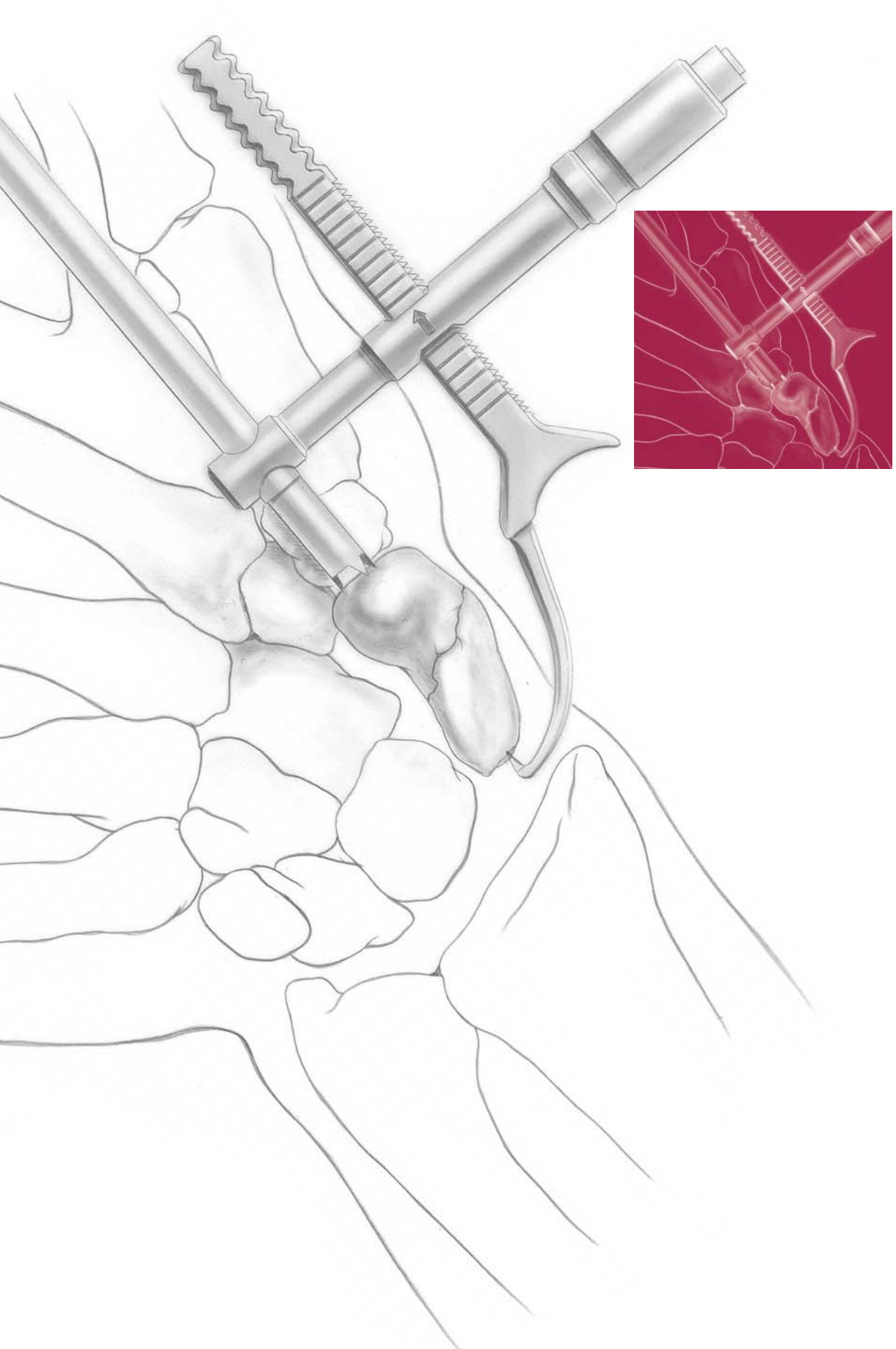
Unstable acute fractures.

1) Displaced or mobile fractures of the waist (recognized by angulation displacement or mobility at the fracture site).
2) Fractures associated with dislocations of the carpus.
3) Oblique fractures of the distal third.
4) Fractures of the proximal pole.
5) Comminuted fractures.
6) "Late fractures" presenting for primary treatment some weeks after the original injury (experience shows a high incidence of nonunion in this group).

Fractures showing evidence of delayed union after an initial period of treatment in plaster (such cases should be left free of plaster for a minimum period of two weeks prior to screw fixation).

Patients with symptomatic nonunion, when screw fixation is combined with excision of the pseudarthrosis and bone grafting.

The *Herbert/Whipple* Bone Screw may also be indicated whenever it is desirable to obtain rigid internal fixation of small bone fragments, in particular those where a protrusive screw head would be undesirable, e.g.



ZIMMER® HERBERT/ WHIPPLE® BONE SCREW SYSTEM

Open Reduction and Fixation of Scaphoid Fractures and Nonunions

zimmer

Confidence in your hands™

OPEN REDUCTION AND FIXATION OF SCAPHOID FRACTURES AND NONUNIONS

Preparation

Use either regional or general anesthesia. Apply a tourniquet, and prepare and drape the limb in the standard fashion. The use of an arm extension table and a hand support is recommended. If bone grafting will be necessary, prepare and drape the opposite iliac crest.

Exposure

An anterior incision is typically recommended (Fig. 1-1). It should be centered over the tubercle of the scaphoid which is palpable with the wrist in full radial deviation. Gently curve the distal end of the incision toward the base of the thumb. Extend the proximal end for approximately 3cm along the radial border of the flexor carpi radialis (F.C.R.) tendon.

Ligate and divide the superficial palmar branch of the radial artery (variable) as it crosses into the palm just proximal to the tubercle of the scaphoid. Incise the sheath of the F.C.R. tendon and retract the tendon toward the ulna to expose the anterior capsule of the wrist over the scaphoid bone (Fig. 1-2).

Incise the capsule longitudinally along the line of the tendon to expose the palmar surface of the scaphoid bone and the fracture (Fig. 1-3). This incision completely transects the volar radioscaphocapitate ligament. Be sure to repair this ligament when the incision is closed.

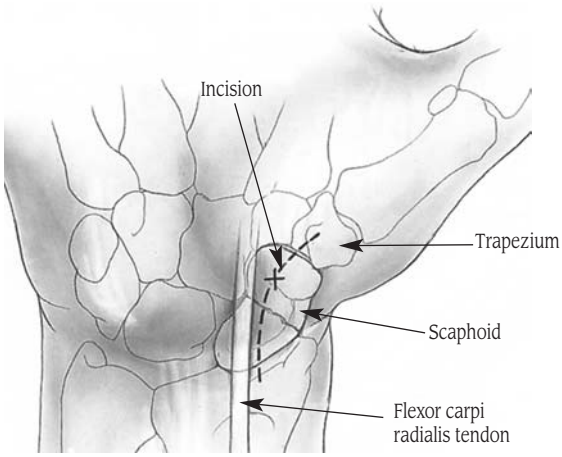


Fig. 1-1 – Anterior approach–skin incision

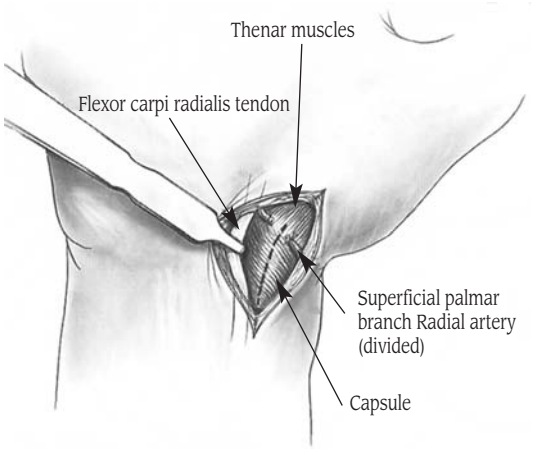


Fig. 1-2 – Anterior approach–capsular incision

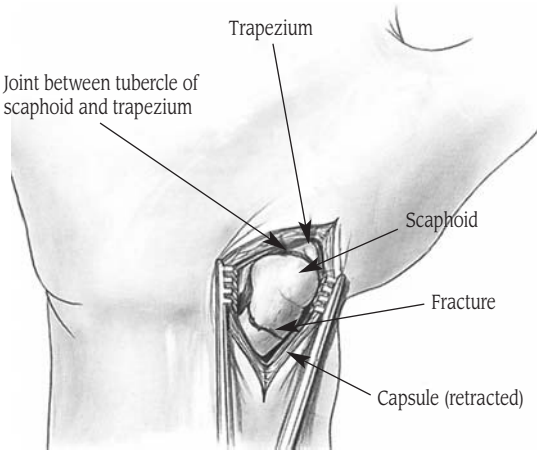


Fig. 1-3 – Anterior approach–fracture exposed and scaphotrapezial joint opened

Deepen the incision distally, dividing the origin of the thenar muscles in line with their fibers, along the anterior surface of the trapezium. The joint between the scaphoid and the trapezium can then be identified.

Incise the joint capsule transversely, starting medially at the border of the F.C.R. tendon and sweeping the knife blade radially around the tubercle of the scaphoid. Although this dissection should not be carried too proximal (in order to avoid damage to the blood supply), **it is important that the joint is mobilized sufficiently to allow the distal pole of the scaphoid to be lifted forward** with the special Elevator contained in the set.

With a 5mm osteotome, resect a portion of the volar tubercle of the trapezium after opening the scaphotrapezial joint transversely to gain adequate exposure for the barrel of the Alignment Guide.

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 ulnar and radial deviation. The fracture may be hinged open by dorsiflexing the wrist. In the case of fibrous union, use the sharp end of the Dissector to pry open the fracture.

Fracture Reduction

Perform a trial reduction of the fracture. If the fracture is very unstable due to comminution or compression of the volar cortex of the scaphoid, then a bone graft is recommended to restore the normal contour of the scaphoid and reconstitute the volar cortex. A cortiocancellous graft should be harvested and shaped before applying the Alignment Guide. If, however, the instability is due to the obliquity of the fracture, then the Alignment Guide should be applied initially **without compression** and a small bone clamp or hemostat should be used to compress the fracture mediolaterally, thereby providing additional stability while the Alignment Guide is tightened.

In most acute fractures, a hemarthrosis is present and suction is required for adequate visualization of the fracture and the adjacent joints. **Once the fracture has been accurately reduced, apply the Alignment Guide to maintain the reduction while inserting the Guide Wires and screw.**

If there has been a dislocation of the midcarpal joint, open the carpal tunnel and decompress the median nerve. Reduce the dislocation under direct vision, and carefully repair the transverse tear in the anterior wrist capsule using fine, non-absorbable sutures.

Associated fractures of the radius or other carpal bones may need to be fixed. In these cases a dorsal incision may be required.

Bone Grafting

In certain **multi-fragmentary acute fractures** the scaphoid may tend to collapse under compression. In such cases, it may be necessary to excise loose bone fragments and insert sufficient cancellous bone graft to ensure stability under compression.

In the case of the **fibrous union**, carefully pry open the fracture and curette out all fibrous tissue and cysts. The pencil-shaped Hand Rasp in the set is especially useful for removing fibrous or cystic material. Prepare the bone cavities so that healthy bone is apparent in both bone fragments. Tightly pack the cavities with fresh cancellous bone. Insert the graft in such a way that the scaphoid will be completely stable when compression is applied with the Alignment Guide. If there is a humpback deformity of the scaphoid or loss of cortical bone support on the volar side, a cortiocancellous wedge graft may be required.

In the case of an **established pseudarthrosis** 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 or small power burr. 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 dorsally to contain the graft. Curette the proximal and distal fragments with the Hand Rasp. Fill any residual cavities with cancellous bone chips.

Hyperextend 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 (Fig. 1-4). The graft should be wide enough to prevent collapse of the fracture fragments when compression is applied. Use a small punch to firmly impact the graft. Then trim any protuberant graft after the screw has been inserted.

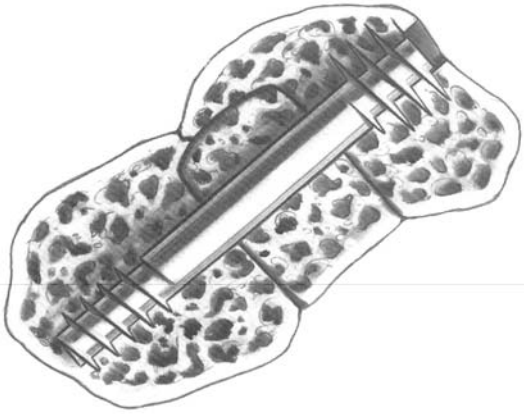


Fig. 1-4 – Reconstruction of scaphoid; following excision of pseudarthrosis, a corticocancellous block from the iliac crest has been firmly impacted with cortex flush anterior so that it remains stable in compression.

SCREW INSTALLATION

Step 1—Alignment Guide Application

Set the screw depth on the Alignment Guide at approximately 30mm. Distract the wrist by pulling on the index and long fingers. Use a curved mosquito, or other clamp to develop the 1-2 portal from the inside out, adjacent to the extensor carpi radialis longus tendon. The 1-2 portal is located between the first and second extensor compartments in the dorsal aspect of the snuff box. Introduce the blade of the Alignment Guide through this portal. Advance the blade in an ulnar direction to the level of the scapholunate ligament with the hook facing "volarward".

Then sweep the hook dorsally and seat it into the articular surface of the proximal pole of the scaphoid. Optimal placement is essential to avoid the Guide Wire or screw penetrating either the volar or ulnar concave surfaces of the scaphoid. To insert the Guide Wire more centrally in the cancellous bone, the target hook of the Alignment Guide should engage the proximal pole adjacent to the widest part of the lunate facet, 1mm to 2mm radial to the scapholunate ligament. This position requires a familiarity with the three-dimensional shape of the scaphoid and may not be as far dorsal as expected (Fig. 1-5). When the hook is engaged, hold it in position with traction on the handle of the Alignment Guide.

Preoperative A/P—Acute compressed fracture of the volar cortex

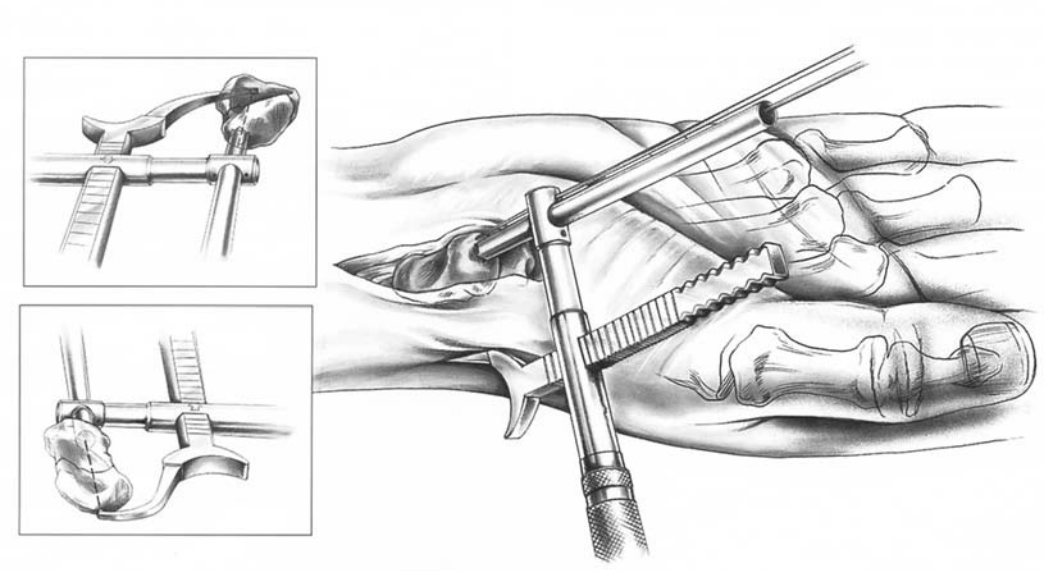


Fig. 1-5 – Showing correct alignment of Alignment Guide perpendicular to fracture

Hyperextend the thumb to move the trapezium dorsally. Maintaining traction on the Alignment Guide, compress the barrel portion of the Alignment Guide against the distal pole of the scaphoid just above the volar scaphoid tubercle. The most dorsal tooth of the guide barrel **must** engage articular cartilage, ideally about mid-width on the distal pole. Try to be as perpendicular to the fracture as possible. When the line appears to be correct, squeeze the blade toward the barrel to push the teeth of the barrel onto the bone.

Check the reduction of the fracture and make any necessary adjustments (Fig. 1-6). When bone grafting, be sure that the graft remains in position while the Alignment Guide is compressed as tightly as possible.

Step 2—Determine Screw Length

Read the screw length from the calibrations on the Alignment Guide (Fig. 1-6 Inset). Be sure that the screw depth is read from the correct portion of the Alignment Guide as illustrated.

Step 3—Insert Wires

NOTE: It is imperative that only the Guide Wires included with the set are used to perform this procedure. These wires are sized precisely for the depth gauges and cannulated instruments. Guide Wires should be inserted at high RPMs, but with minimal axial pressure. Excessive pressure to speed the insertion compromises the cutting capability of the Guide Wire point. This leads to bending in cortical bone.

Insert the Free-Hand Guide Insert Sleeve (Guide Sleeve) into the barrel of the Alignment Guide. Wire penetration can be controlled using the Depth Gauge to insert the primary Guide Wire into a wire driver at the correct depth (Fig. 1-7). Drive the wire into the bone through the Guide Sleeve until the wire driver bottoms out on the Guide Sleeve (Fig. 1-8). Remove the wire driver and Guide Sleeve.

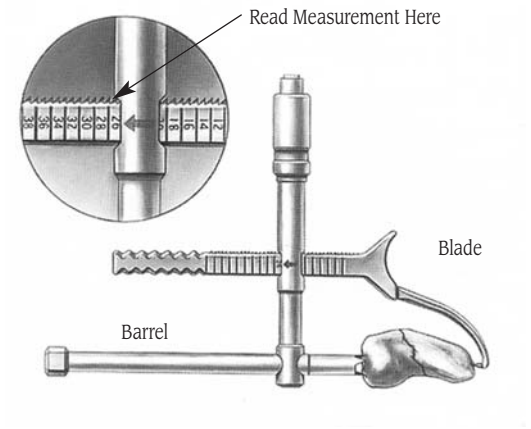


Fig. 1-6 – Positioning of Alignment Guide

Fig. 1-7 – Depth Gauge showing primary Guide Wire measurement

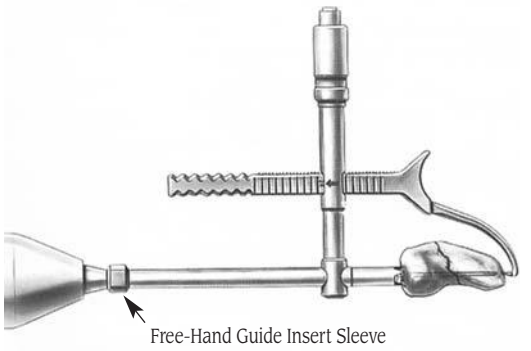


Fig. 1-8 – Primary Guide Wire Placement

Use an x-ray or image intensifier to verify the positions of both the Alignment Guide and the primary Guide Wire. There should be at least 2mm of bone on each side of the wire in every projection. If necessary, withdraw the wire, reposition the Alignment Guide, and reinsert the Guide Sleeve and the wire.

Remove the Guide Sleeve. Use the Depth Gauge to measure the accessory Guide Wire in a wire driver for the same depth as the primary Guide Wire (Fig. 1-9). Place this wire parallel to the primary wire through one of the two holes adjacent to the barrel of the Alignment Guide (Fig. 1-10). This will help prevent fragment rotation during screw insertion. Drive the wire until the wire driver bottoms out on the end of the Alignment Guide barrel. Then bend the accessory wire away from the Alignment Guide barrel slightly to move it from the path of the instruments.

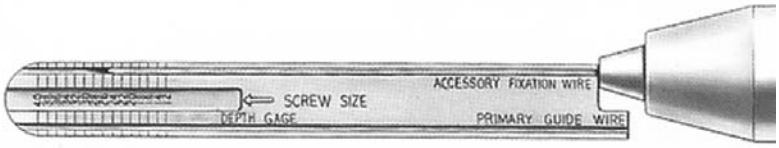


Fig. 1-9 – Depth Gauge showing accessory Guide Wire measurement

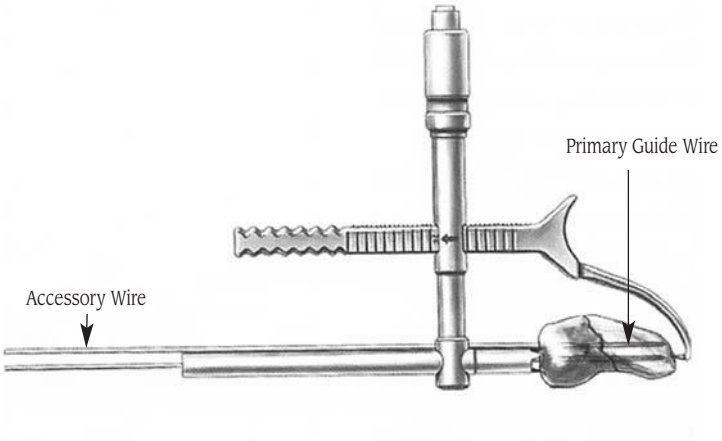


Fig. 1-10 – Accessory Guide Wire placement

Step 4—Broach the Cortex

For most scaphoid bones, this step is not necessary. For extremely hard bone, attach the Cannulated Cortical Broach to the Modular Handle and slide it over the primary Guide Wire (Fig. 1-11). Turn the handle clockwise and advance the broach until it bottoms out on the end of the Alignment Guide barrel. This will remove a small amount of bone from the cortical surface and facilitate the use of additional instrumentation. Alternatively, power instruments may be used to drive this broach.

NOTE: Use the Cortical Broach prior to drilling with the Step Drill when any hard cortical bone is encountered.

NOTE: Many scaphoid non-unions develop sclerotic bone at the pseudarthrosis. In such a case, the optional Gliding Hole Drill should be used in place of the Cortical Broach.

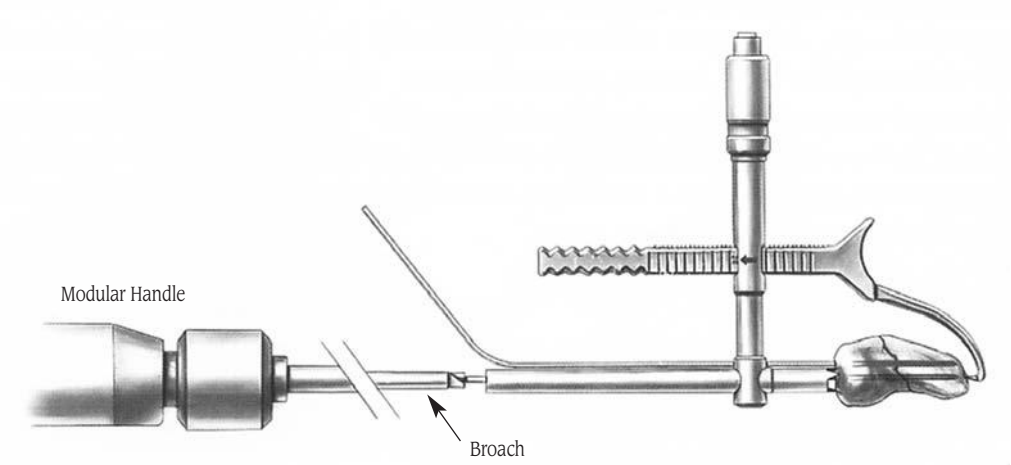


Fig. 1-11 – Broach

Step 5—Drill

Use the Cannulated Step Drill over the primary Guide Wire to drill the pilot hole (Fig. 1-12). Slide the adjustable stop Sleeve onto the Drill and set it for the appropriate screw length (Fig. 1-12 Inset). The hole should be drilled using a cannulated Jacob's Chuck and power drill. Alternatively, for soft bone, the Step Drill can be attached to the Modular Handle for manual drilling. The small diameter of this Drill is for the leading threads of the screw, while the larger diameter is for the trailing threads and shank. Drill until the Sleeve bottoms out on the end of the Alignment Guide barrel.

NOTE: Never drill over a bent K-wire. Drilling of hard cortical bone should be done at high RPMs (700 to 1,500), but with minimal axial pressure and minimal bending force on the drill bit. Never force the drill bit through the bone. Remove it periodically for cleaning and cooling if necessary. If the drill bit seems to stick, remove the bit and clean debris from the flutes with the brush provided. Rinse the bit and the bone with cool saline solution. Repeat as necessary.

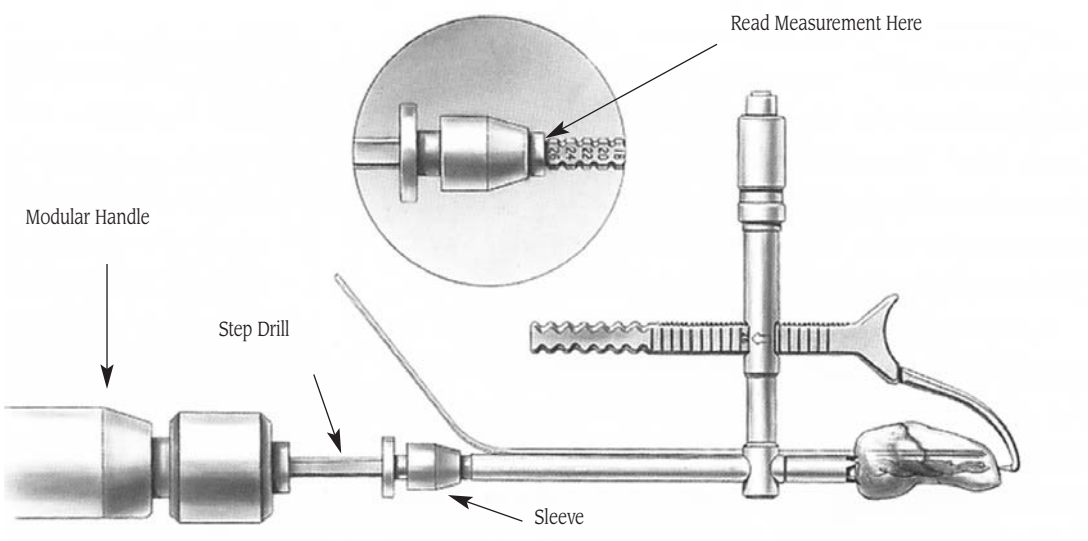


Fig. 1-12 – Drill pilot hole

Step 6—Tap (Recommended only for sclerotic bone)

Attach the Tap to the Modular Handle. Slide the adjustable stop Sleeve onto the Tap and set it for the appropriate screw length (Fig. 1-13 Inset). Tap the hole for the leading threads of the screw (Fig. 1-13). This is an optional step recommended **only for sclerotic bone** because the leading and trailing threads of the implant are self-tapping. Tap until the Sleeve bottoms out on the end of the Alignment Guide barrel. **The Tap must not be turned beyond the depth of the Sleeve or the bone threads will be stripped.**

NOTE: If at any time during the procedure, a Guide Wire is found to be bent, the wire must be removed and a new wire inserted. The 1mm Guide Wires are intended to be single-use items. Do not use Guide Wires that are bent, cracked, or otherwise damaged. Check each Guide Wire prior to use to assure that it has not been damaged. Bent wires will cause the cannulated instruments to bind or break.

If the Guide Wire is removed with the Cannulated Drill, the wire can be reinserted by first inserting the Guide Sleeve into the barrel and then reinserting the wire, blunt end first. Tap the wire once or twice to anchor it in the bone.

The shafts and tips of the Drill bit and Tap should be evaluated periodically for straightness. A bent tip could lead to oversizing the hole or fracture of the tip. A bent shaft could cause impingement in the guide barrel and hinder the surgical procedure.

The Drill and Tap shafts should pass freely through the guide barrel. Carefully inspect these tools for bends, cracks, and dulling. Replace worn or damaged items.

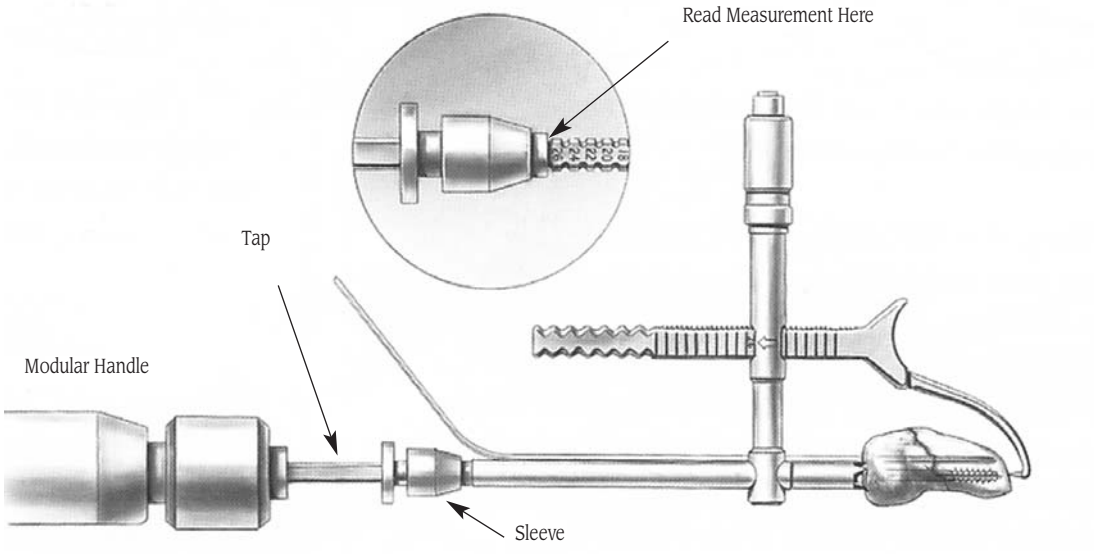


Fig. 1-13 – Tap

Step 7—Insert the Screw

Attach the Screwdriver to the Modular Handle. Insert the screw and Screwdriver over the Guide Wire and into the barrel of the Alignment Guide. Turn the Screwdriver until the stop bottoms out on the end of the guide barrel as shown (Fig. 1-14). The Screwdriver should be advanced a few more turns to further bury the screw head below the bone surface. The advancing screw will "walk" off the end of the Screwdriver as it is seated.

When the screw is fully seated, remove the Screwdriver, primary Guide Wire, and Alignment Guide. The accessory Guide Wire can be removed, or, if desired, it can be left in place for two weeks to help control rotation of the fragments during initial healing. If the accessory wire is bent, it must be cut before removing the Alignment Guide. To ensure that the screw head is completely buried, inspect the entry point on the distal pole of the scaphoid. If necessary, reapply the Screwdriver and rotate the screw one more revolution.

Put the wrist joint through a full range of movements to check the security of fixation and to ensure that the screw has not penetrated proximally. This can also be checked by feeling around the proximal pole of the screw with the curved blade of the Dissector or with a repeat x-ray image. Carefully trim off any protuberant bone graft.

SPECIAL NOTE: Although the Alignment Guide will normally ensure accurate positioning of the screw, intraoperative radiographs are suggested. 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 with this procedure on cadaver wrists is strongly recommended. Intraoperative radiographs should also be made to confirm satisfactory reduction of the fracture and placement of the screw.

The most common error is to apply the barrel of the Alignment Guide either too volar so that the screw exits anteriorly, or too medially so that the screw penetrates the scaphocapitate joint. This can be prevented by carefully checking the position of the Guide Wire before drilling and is an important failsafe of the *Herbert/Whipple* design.

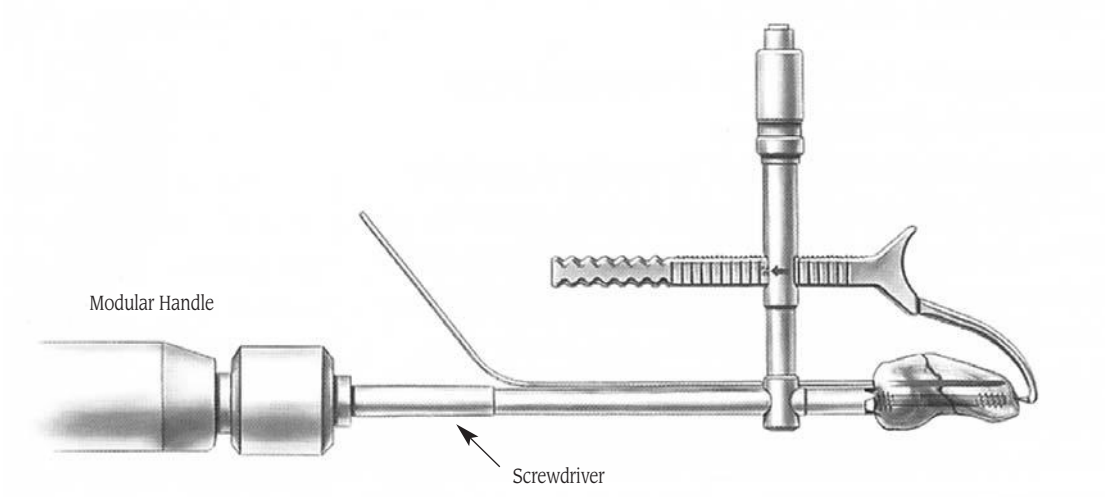


Fig. 1-14 – Insert Screw

OPTIONAL TECHNIQUE

Retrograde Fixation of Proximal Pole Scaphoid Fractures

To expose the proximal pole of the scaphoid, mark the anatomic landmarks (Fig. 1-15). Make a 15mm to 20mm longitudinal incision between the third and fourth extensor compartments, ending proximally at Lister's tubercle.

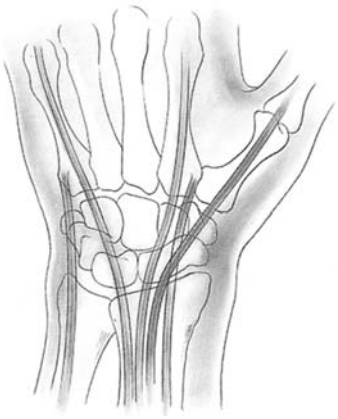


Fig. 1-15 – Anatomic landmarks

Incise the subcutaneous tissue and open the extensor retinaculum to expose the extensor pollicis longus tendon, which crosses the extensor carpi radialis brevis tendon.

Retract the extensor pollicis longus tendon, and incise the dorsal capsule to expose the proximal pole of the scaphoid (Fig. 1-16).

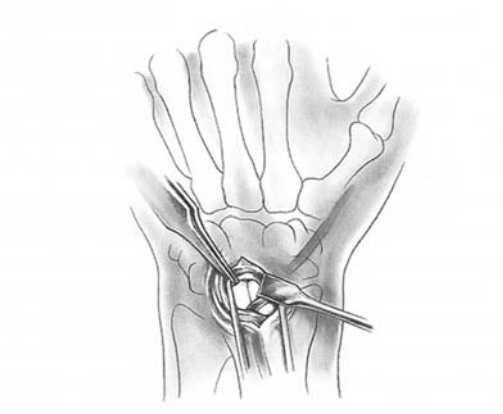


Fig. 1-16 – Exposing the proximal pole of the scaphoid

incision can be extended at an angle toward the thumb if necessary.

The Alignment Guide is placed with the guide barrel on the proximal pole. The target hook is placed on the skin at the volar tubercle of the trapezium. There is no need to engage the distal pole of the scaphoid. The hook should simply impale the skin, and the guide is compressed and locked (Fig.1-17).

NOTE: The screw size calibrations on the Alignment Guide cannot be used for this procedure. Instead, the primary Guide Wire should be inserted through the scaphoid to the distal cortex, but not more than 20mm.

Use image intensification to ensure that the wire has reached the far cortex. Use the Cannulated Depth Gauge to determine screw length.

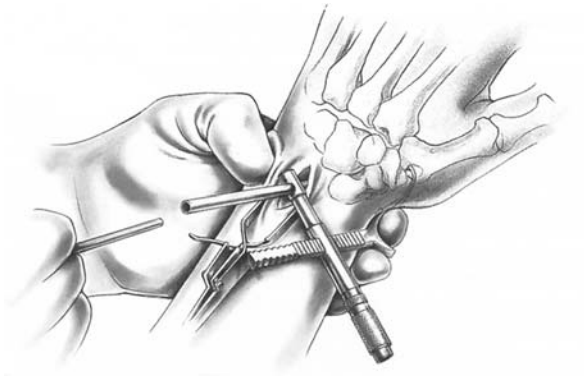


Fig. 1-17 – The Alignment Guide is placed with the guide barrel on the proximal pole

CLOSURE AND POSTOPERATIVE MANAGEMENT

Closure

Use a suitable fine, nonabsorbable suture (e.g., 4/0 ETHIBOND) to close the wrist capsule securely. Be sure to repair the radioscapho-capitate ligament crossing the waist of the scaphoid. 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.

Postoperative Management

Apply a postoperative dressing with a short arm cast or volar plaster splint for about two weeks to protect the RSC ligament.

Elevate the limb and make routine observations. Active finger exercises are encouraged immediately, but the wrist is normally supported until the wound has healed.

At two weeks, apply a cockup wrist splint at least eight inches in length. It should remain in place for about four weeks, except for short periods of gentle ROM exercises.

After week six, use the cockup wrist splint for stressful activities only. Avoid pushing and load bearing, hammering, or other impact loading and excessive power grip.

At 12 weeks, only strenuous activities should be restricted. 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 such risk.

Contact sports normally should be avoided for up to three months after surgery and should be resumed only with the protection of spica wrist taping. It is recommended that all patients be reviewed after one year for final clinical and radiological assessment.

Take follow-up x-ray films at six-week 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.

ZIMMER® HERBERT/ WHIPPLE® BONE SCREW SYSTEM

Athroscopically Assisted Reduction and Fixation of Acute Scaphoid Fractures

zimmer

Confidence in your hands™

ARTHROSCOPICALLY ASSISTED REDUCTION AND FIXATION OF ACUTE SCAPHOID FRACTURES

PREPARATION

Use either regional or general anesthesia. Apply a tourniquet, and prepare and drape the limb in the standard fashion. The use of an arm extension table and Traction Tower (Linvatec, Largo, FL), or similar traction arrangement, is recommended.

Exposure

Make a 12mm to 15mm radially curved incision, centered over the volar tubercle of the trapezium just radial to the flexor carpi radialis tendon (Fig. 2-1). Identify and open the scaphotrapezial joint through a transverse capsulotomy. Make a T-shaped incision in the capsule and periosteum over the trapezium, meeting the transverse capsulotomy (Fig. 2-2). Turn the capsular flaps distally by subperiosteal dissection.

Excise the volar tubercle on the trapezium with a 5mm osteotome. Remove enough of the tubercle to expose a portion of the distal articular surface of the scaphoid when the first metacarpal is hyperextended. Place a small Self-Retaining Retractor in the incision (Fig. 2-3).

Position the forearm vertically in the Traction Tower with 10 pounds of axial traction applied to the index and long fingers.

Fracture Reduction

Gently introduce the arthroscope through the radial midcarpal (RMC) portal. To avoid applying excessive pressure during insertion of the arthroscope sheath and trocar, spread the subcutaneous tissue and lance the capsule with a No. 11 scalpel. Briefly flush the joint.

Insert an inflow cannula in the ulnar midcarpal (UMC) portal. Be sure it will not interfere with instrumentation. Clear the hemarthrosis, if present, and examine the scaphoid fracture line for any evidence of displacement or angulation.

If the degree of angulation or displacement is small, reduce the fracture by placing the wrist in extension or supination. This should reverse the humpback deformity and close the fracture line.

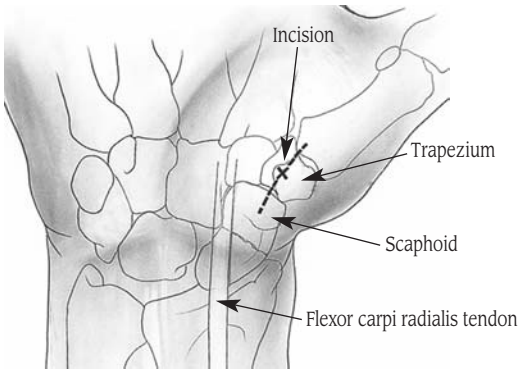


Fig. 2-1 – Anterior approach–skin incision

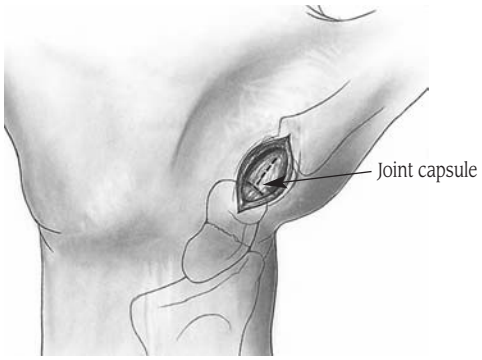


Fig. 2-2 – Expose the scaphotrapezial joint

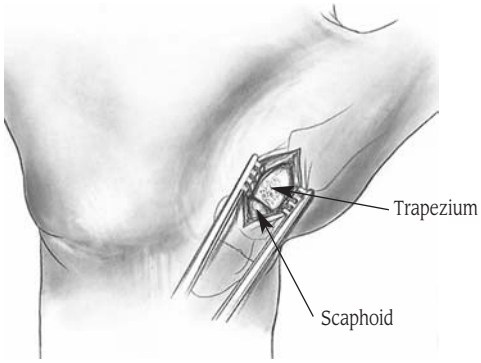


Fig. 2-3 – Excise the volar tubercle, retract the incision

If the fracture line remains open, insert a 1mm K-wire percutaneously into both the scaphoid tubercle volarly and the proximal pole dorsally. Use these wires to manipulate the fracture fragments. Confirm the reduction using a radiograph or fluoroscope.

SCREW INSTALLATION

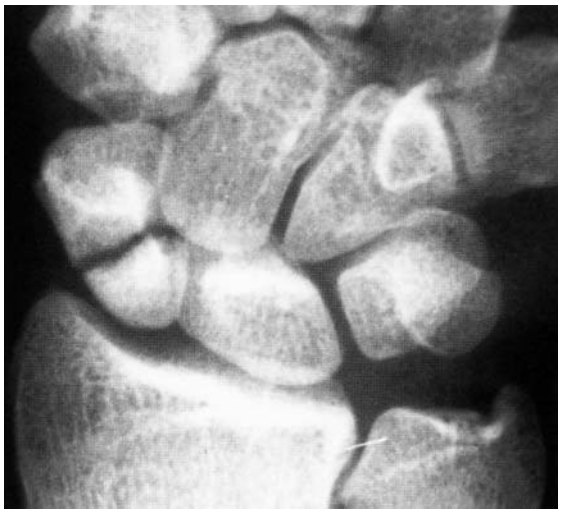
Step 1—Insert Alignment Guide

Transfer the arthroscope to the 4-5 portal and move the inflow cannula to the arthroscope sheath or the 6-U portal. Establish a 1-2 portal and dilate it to admit the target hook of the Alignment Guide. The 1-2 portal is located between the first and second extensor compartments in the dorsal aspect of the snuff box. Introduce the blade of the Alignment Guide through this portal. Advance the blade in an ulnar direction to the level of the scapholunate ligament with the hook facing dorsally. Then sweep the hook dorsally and seat it into the articular surface of the proximal pole of the scaphoid. Optimal placement is essential to avoid the Guide Wire or screw penetrating either the volar or ulnar concave surfaces of the scaphoid.

Ideal placement is approximately 1mm to 2mm from the scapholunate ligament just dorsal to the most proximal point of the scaphoid. Rotate the target hook so that its angle accommodates the convex contour of the scaphoid and embed it into the articular cartilage at the target point. The handle of the target hook should be nearly perpendicular to the palm with the wrist slightly extended. Use slight traction to hold the target hook in place while the Alignment Guide barrel is attached.

Hyperextend the thumb to move the trapezium dorsally. Maintaining traction on the Alignment Guide, compress the barrel portion of the Alignment Guide against the distal pole of the scaphoid just above the volar scaphoid tubercle. The most dorsal tooth of the guide barrel **must** engage articular cartilage, ideally about mid-width on the distal pole. Try to be as perpendicular to the fracture as possible. When the line appears to be correct, squeeze the blade toward the barrel to push the teeth of the barrel onto the bone.

Check the reduction of the fracture and make any necessary adjustments (Fig. 2-4).



Preoperative A/P—Two-part nonunion of the scaphoid

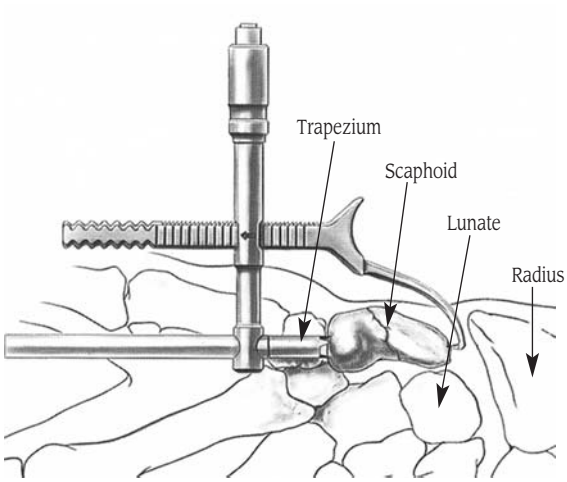


Fig. 2-4 – Showing correct positioning of the Alignment Guide along axis of scaphoid (approximately 45-degree angle to horizontal)

Step 2—Determine Screw Length

Read the screw length from the calibrations on the Alignment Guide (Fig. 2-5). Be sure that the screw depth is read from the correct portion of the Alignment Guide as illustrated.

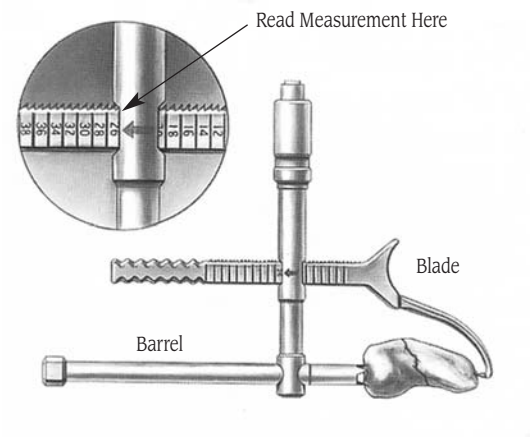


Fig. 2-5 – Positioning of Alignment Guide

Step 3—Insert Wires

NOTE: It is imperative that only the Guide Wires included with the set are used to perform this procedure. These wires are sized precisely for the depth gauges and cannulated instruments. Guide Wires should be inserted at high RPMs, but with minimal axial pressure. Excessive pressure to speed the insertion compromises the cutting capability of the Guide Wire point. This leads to bending in cortical bone.

Insert the Free-Hand Guide Insert Sleeve (Guide Sleeve) into the barrel of the Alignment Guide. Wire penetration can be controlled using the Depth Gauge to insert the primary Guide Wire into a wire driver at the correct depth (Fig. 2-6). Drive the wire into the bone through the Guide Sleeve until the wire driver bottoms out on the Guide Sleeve (Fig. 2-7). Remove the wire driver and Guide Sleeve.

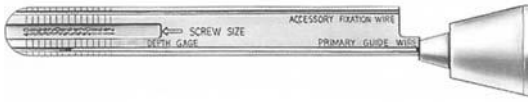


Fig. 2-6 – Depth Gauge showing primary Guide Wire measurement

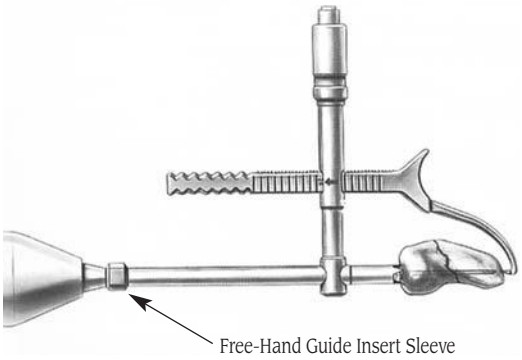


Fig. 2-7 – Primary Guide Wire placement

Use an x-ray or image intensifier to verify the positions of both the Alignment Guide and the primary Guide Wire. There should be at least 2mm of bone on each side of the wire in every projection. If necessary, withdraw the wire, reposition the Alignment Guide, and reinsert the Guide Sleeve and the wire.

Remove the Guide Sleeve. Use the Depth Gauge to measure the accessory Guide Wire in a wire driver for the same depth as the primary Guide Wire (Fig. 2-8). Place this wire parallel to the primary wire through one of the two holes adjacent to the barrel of the Alignment Guide (Fig. 2-9). This will help prevent fragment rotation during screw insertion. Drive the wire until the wire driver bottoms out on the end of the Alignment Guide barrel. Then bend the accessory wire away from the Alignment Guide barrel slightly to move it from the path of the instruments.

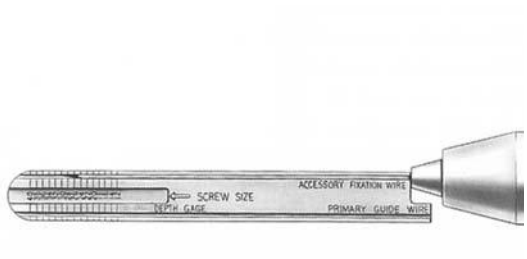


Fig. 2-8 – Depth Gauge showing accessory Guide Wire measurement

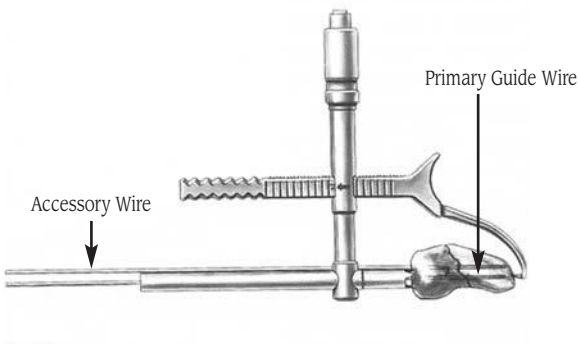


Fig 2-9 – Accessory Guide Wire placement

Step 4—Broach the Cortex

For most scaphoid bones, this step is not necessary. For extremely hard bone, attach the Cannulated Cortical Broach to the Modular Handle and slide it over the primary Guide Wire (Fig. 2-10). Turn the handle clockwise and advance the broach until it bottoms out on the end of the Alignment Guide barrel. This will remove a small amount of bone from the cortical surface and facilitate the use of additional instrumentation. Alternatively, power instruments may be used to drive this broach.

NOTE: Use the Cortical Broach prior to drilling with the Step Drill when any hard cortical bone is encountered.

NOTE: Many scaphoid nonunions develop sclerotic bone at the pseudarthrosis. In such a case, the optional Gliding Hole Drill should be used in place of the Cortical Broach.

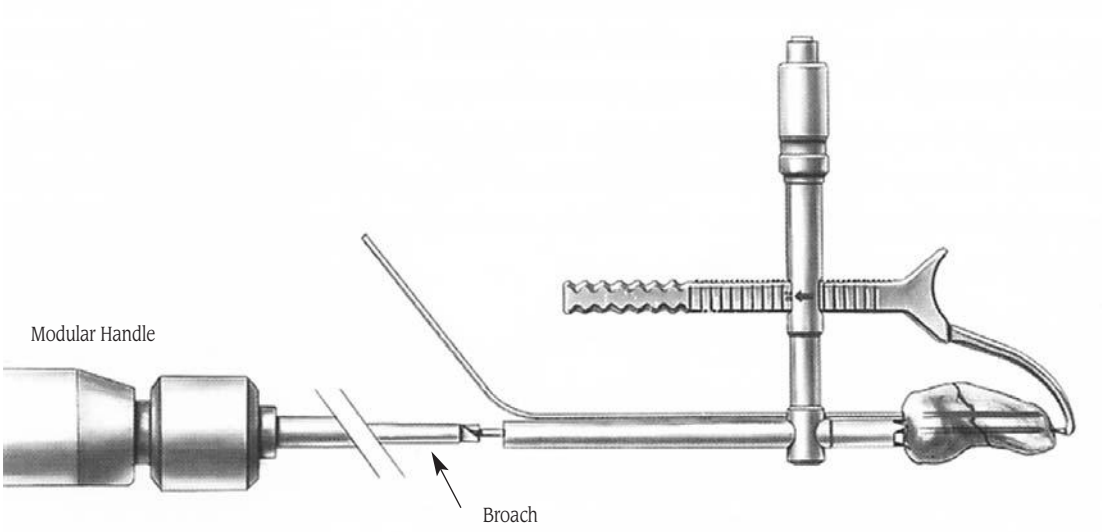


Fig. 2-10 – Broach

Step 5—Drill

Use the Cannulated Step Drill over the primary Guide Wire to drill the pilot hole (Fig. 2-11). Slide the adjustable stop Sleeve onto the Drill and set it for the appropriate screw length (Fig. 2-11 Inset). The hole should be drilled using a cannulated Jacob's Chuck and power drill. Alternatively, for soft bone, the Step Drill can be attached to the Modular Handle for manual drilling. The small diameter of this Drill is for the leading threads of the screw, while the larger diameter is for the trailing threads and shank. Drill until the Sleeve bottoms out on the end of the Alignment Guide barrel.

NOTE: Never drill over a bent K-wire. Drilling of hard cortical bone should be done at high RPMs (700 to 1,500), but with minimal axial pressure and minimal bending force on the drill bit. Never force the drill bit through the bone. Remove it periodically for cleaning and cooling if necessary. If the drill bit seems to stick, remove the bit and clean debris from the flutes with the brush provided. Rinse the bit and the bone with cool saline solution. Repeat as necessary.

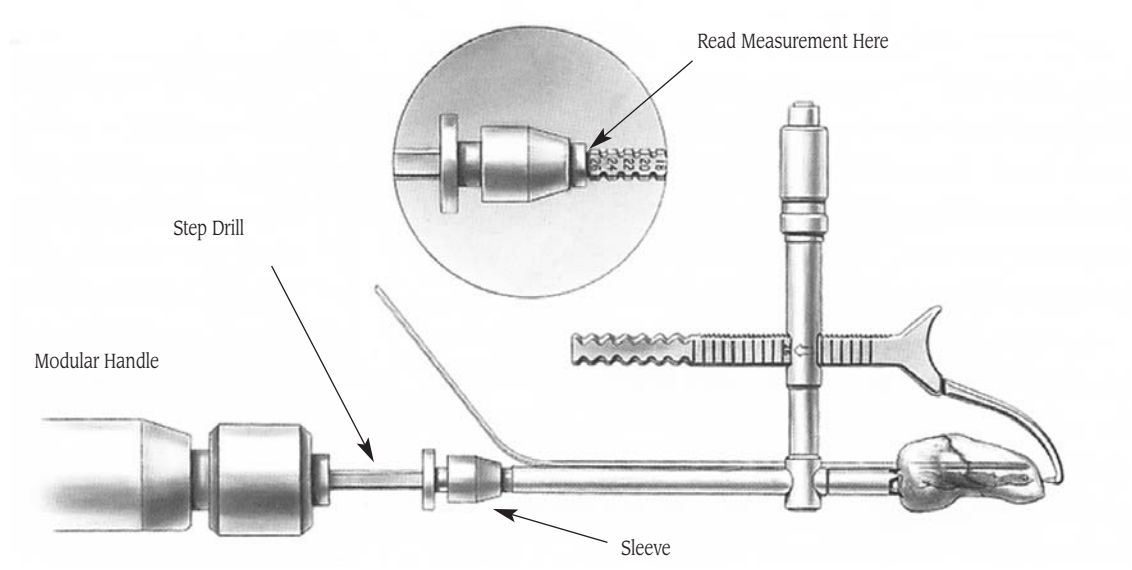


Fig. 2-11 – Drill pilot hole

Step 6—Tap (Recommended only for sclerotic bone)

Attach the Tap to the Modular Handle. Slide the adjustable stop Sleeve onto the Tap and set it for the appropriate screw length. Tap the hole for the leading threads of the screw (Fig. 2-12). This is an optional step recommended **only for sclerotic bone** because the leading and trailing threads of the implant are self-tapping. Tap until the Sleeve bottoms out on the end of the Alignment Guide barrel. **The Tap must not be turned beyond the depth of the Sleeve or the bone threads will be stripped.**

NOTE: If at any time during the procedure, a Guide Wire is found to be bent, the wire must be removed and a new wire inserted. The 1mm Guide Wires are intended to be one-time-use items. Do not use Guide Wires that are bent, cracked, or otherwise damaged. Check each Guide Wire prior to use to assure that it has not been damaged. Bent wires will cause the cannulated instruments to bind or break.

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The shafts and tips of the drill bit and Tap should be evaluated periodically for straightness. A bent tip could lead to oversizing the hole or fracture of the tip. A bent shaft could cause impingement in the guide barrel and hinder the surgical procedure. The Drill and Tap shafts should pass freely through the guide barrel. Carefully inspect these tools for bends, cracks, and dulling. Replace worn or damaged items.

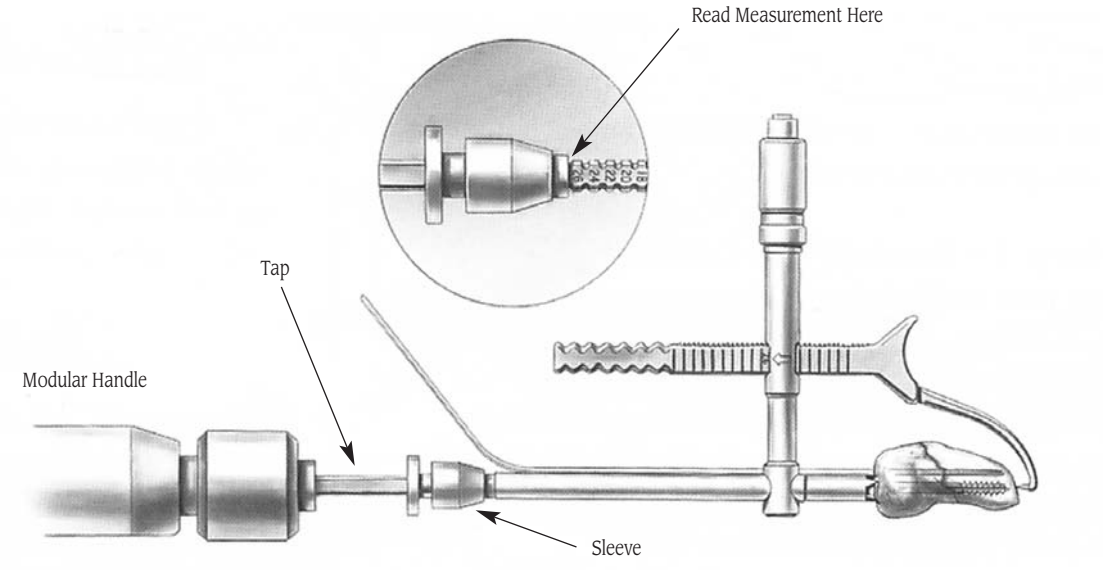

Fig. 2-12 – Tap

Step 7—Insert the Screw

Attach the Screwdriver to the Modular Handle. Insert the screw and Screwdriver over the Guide Wire and into the barrel of the Alignment Guide. Turn the Screwdriver until the stop bottoms out on the end of the guide barrel as shown (Fig. 2-13). The Screwdriver should be advanced a few more turns to further bury the screw head below the bone surface. The advancing screw will "walk" off the end of the Screwdriver as it is seated.

Postoperative Lateral and A/P—Fixation of two-part nonunion of the scaphoid

When the screw is fully seated, remove the Screwdriver, primary Guide Wire, and Alignment Guide. The accessory Guide Wire can be removed, or if desired, it can be left in place for two weeks to help control rotation of the fragments during initial healing. If the accessory wire is bent, it must be cut before removing the Alignment Guide. To ensure that the screw head is completely buried, inspect the entry point on the distal pole of the scaphoid. If necessary, reapply the Screwdriver and rotate the screw one more revolution.

Put the wrist joint through a full range of movements to check the security of fixation and to ensure that the screw has not penetrated proximally.

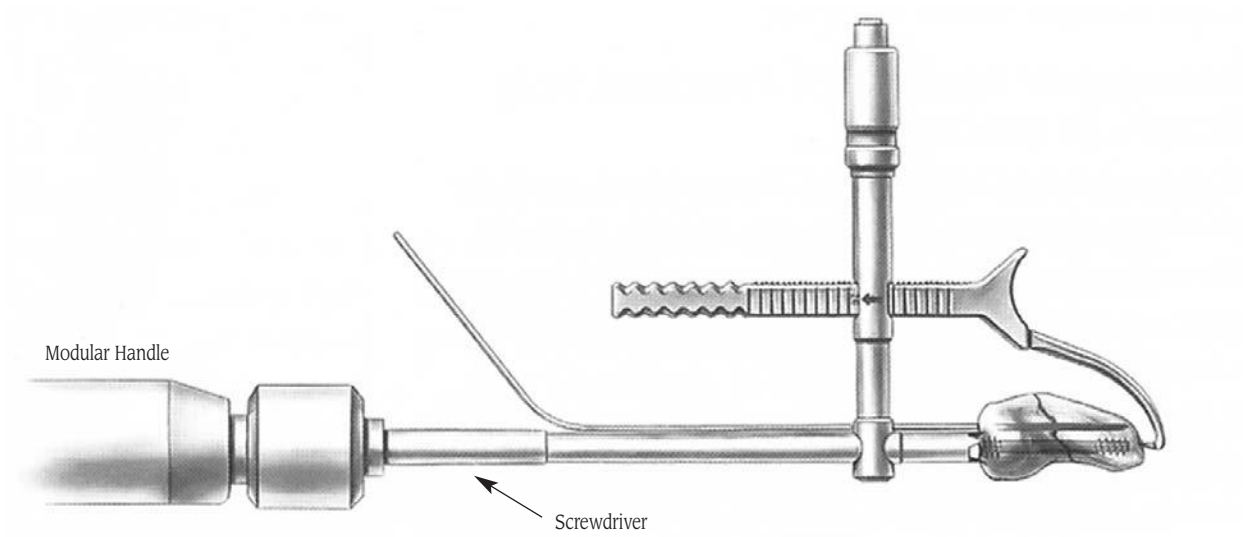

Fig. 2-13 – Insert screw

SPECIAL NOTE: Although the Alignment Guide will normally ensure accurate positioning of the screw, intraoperative radiographs are suggested. 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 with this procedure on cadaver wrists is strongly recommended. Intraoperative radiographs should also be made to confirm satisfactory reduction of the fracture and placement of the screw.

The most common error is to apply the barrel of the Alignment Guide either too volar so that the screw exits anteriorly, or too medially so that the screw penetrates the scaphocapitate joint. This can be prevented by carefully checking the position of the Guide Wire before drilling and is an important failsafe of the *Herbert/Whipple* design.

CLOSURE AND POSTOPERATIVE MANAGEMENT

Close the volar capsulatomy with absorbable sutures. Skin and subcutaucaus layers should be closed routinely and a volar splint should be incorporated into the dressings for three to four weeks. Thereafter motion can be allowed but impact loading and severe stress should be avoided until x-ray evidence of fracture union.

ZIMMER® HERBERT/ WHIPPLE® BONE SCREW SYSTEM

Internal Fixation of Fractures and Fusions with Free-Hand Guide

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INTERNAL FIXATION OF FRACTURES AND FUSIONS WITH FREE-HAND GUIDE

In some instances, a free-hand technique is preferential to use of the Alignment Guide. This technique is appropriate for small proximal pole fractures of the scaphoid, fixation of other intra-articular fractures, fixation of osteochondral fragments, and small joint fusions where it is not possible to apply the Alignment Guide.

When using this technique, use the Free-Hand Guide and Guide Sleeve to direct the Guide Wire, cannulated instruments, and screw.

It is imperative that the bone fragments are held firmly together during free-hand insertion of the screw. This can usually be achieved by applying manual pressure on the handle of the guide.

Preoperative A/P—Chauffeur's Distal Radius fracture

SCREW INSTALLATION

Step 1—Apply Free-Hand Guide

Insert the Guide Sleeve into the Free-Hand Guide and apply the assembly to the bone (Fig. 3-1). Be certain all soft tissue is cleared to allow the guide to seat securely on the bone surface.

Step 2—Insert Wires

Insert the primary Guide Wire through the Guide Sleeve (Fig. 3-2). The appropriate depth can be estimated, then adjusted after x-ray assessment. After the wire is securely in place, remove the Guide Sleeve while maintaining pressure on the bone.

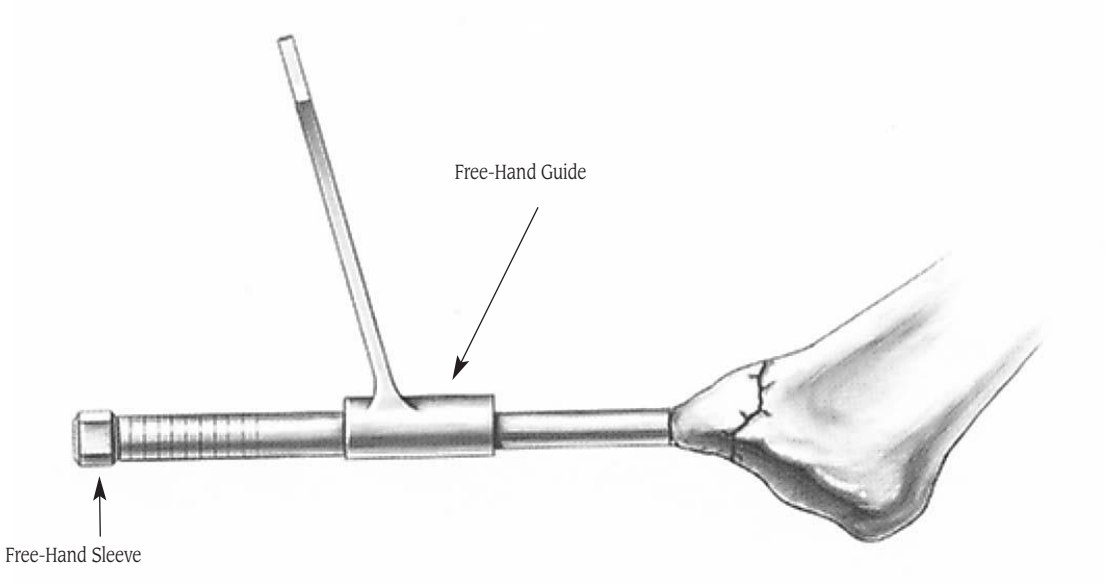

Fig 3-1 – Positioning of Free-Hand Guide and Free-Hand Guide Insert Sleeve

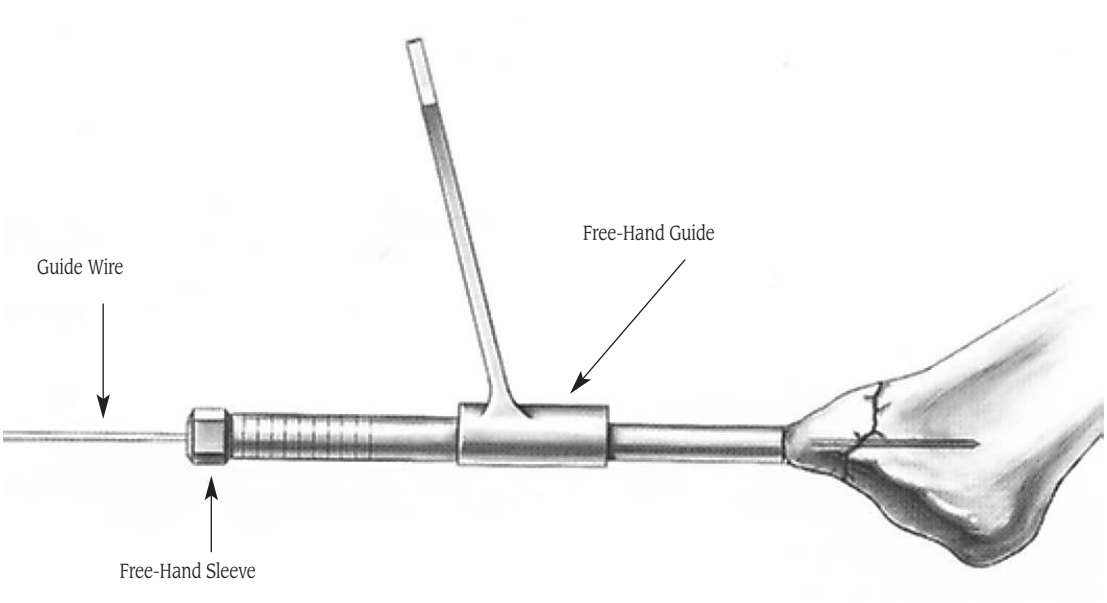

Fig. 3-2 – Placement of primary Guide Wire

Whenever possible, place a second accessory wire through the alignment holes on the Free-Hand Guide to further secure the bone fragments (Fig. 3-3). This will prevent any displacement or fragment rotation during the procedure. Use of these guide holes will ensure that the Guide Wires are parallel. Confirm proper fracture or fusion reduction and the appropriate depth of the Guide Wire with image intensification. Make any necessary adjustments at this stage. Be certain that the Guide Wire is not bent inside the bone.

NOTE: It is imperative that only the Guide Wires included with the set are used to perform this procedure. These wires are sized appropriately for the depth gauges and cannulated instruments. Guide Wires should be inserted at high RPMs, but with minimal axial pressure. Excessive pressure to speed the insertion compromises the cutting capability of the Guide Wire point. This leads to bending in cortical bone, especially when approached tangentially.

Step 3—Determine Screw Length

Use the Free-Hand Depth Gauge to determine the proper screw length. Insert the gauge over the primary Guide Wire and into the barrel of the Free-Hand Guide until the tip touches the surface of the bone (Fig. 3-4). Then read the screw length directly from the calibrations on the Depth Gauge (Fig. 3-4 Inset). This reading is the longest possible screw that should be used. If a shorter screw can be chosen without leaving threads crossing the fracture site, selection of the shorter screw will reduce the risk of penetration and the chance of removal of the Guide Wire with the Cannulated Step Drill.

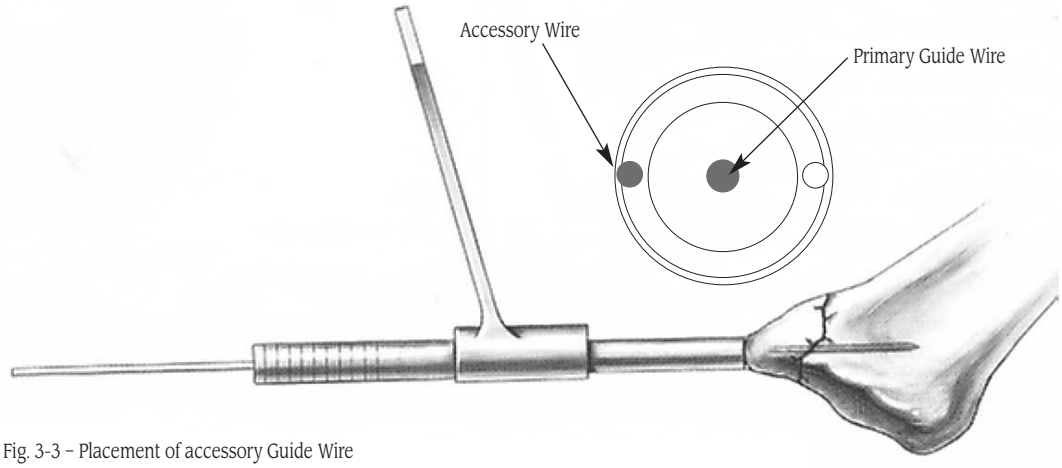

Fig. 3-3 – Placement of accessory Guide Wire

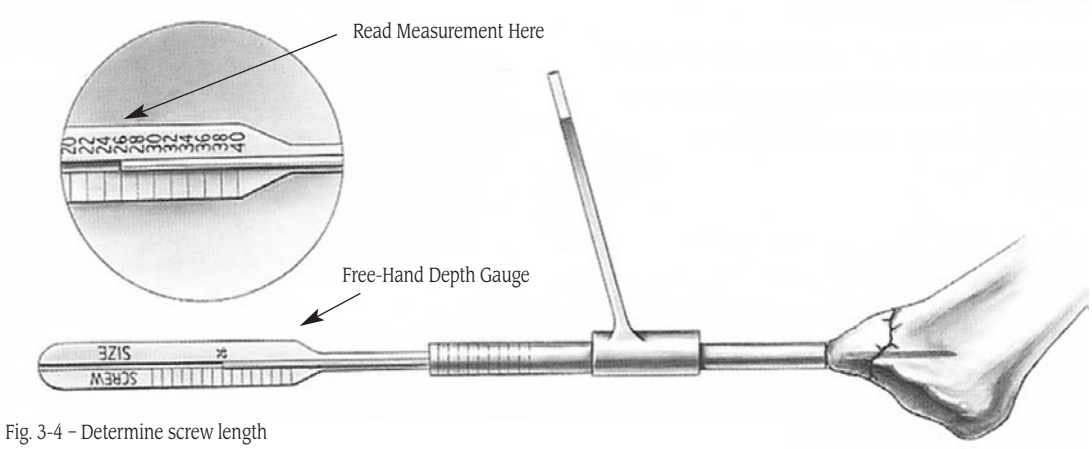

Fig. 3-4 – Determine screw length

Step 4—Broach the Cortex

Attach the Cannulated Cortical Broach to the Modular Handle and slide it over the primary Guide Wire. Turn the handle clockwise and advance the broach until it bottoms out on the end of the Free-Hand Guide (Fig. 3-5). This will remove a small amount of bone from the cortical surface and facilitate the use of additional instrumentation. Alternatively, power instruments may be used to drive this broach.

NOTE: Use the Cannulated Cortical Broach prior to drilling with the Step Drill when hard cortical bone is drilled.

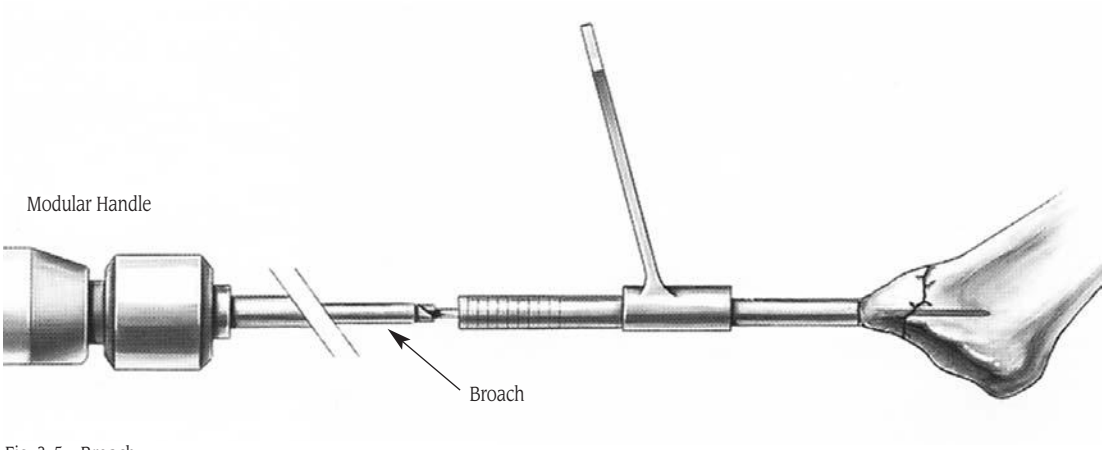

Fig. 3-5 – Broach

Step 5—Drill

Use the Cannulated Step Drill over the primary Guide Wire to drill the pilot hole. Slide the adjustable stop Sleeve onto the Drill and set it for the appropriate screw length (Fig. 3-6). The hole can be drilled manually using the Modular Handle, but a power drill and a cannulated Jacob's Chuck are preferred. The small diameter of this Drill is for the leading threads of the screw, while the larger diameter is for the trailing threads and shank. Drill until the Sleeve bottoms out on the end of the Free-Hand Guide. This Step Drill should be used in conjunction with the optional Gliding Hole Drill when very thick, hard cortical bone is encountered.

NOTE: Be careful when using the Drill with the Free-Hand Guide. Any movement or angling of the guide could cause the drill tip to fail. Never drill over a bent Guide Wire. Drilling of hard cortical bone should be done at high RPMs (700 to 1,500), but with minimal axial pressure and no bending force on the drill bit. Never force the drill bit through the bone. Remove it periodically for cleaning and cooling if necessary. If the drill bit seems to stick, remove the bit and clean debris from the flutes with the brush provided. Rinse the bit and the bone with cool saline solution. Repeat as necessary.

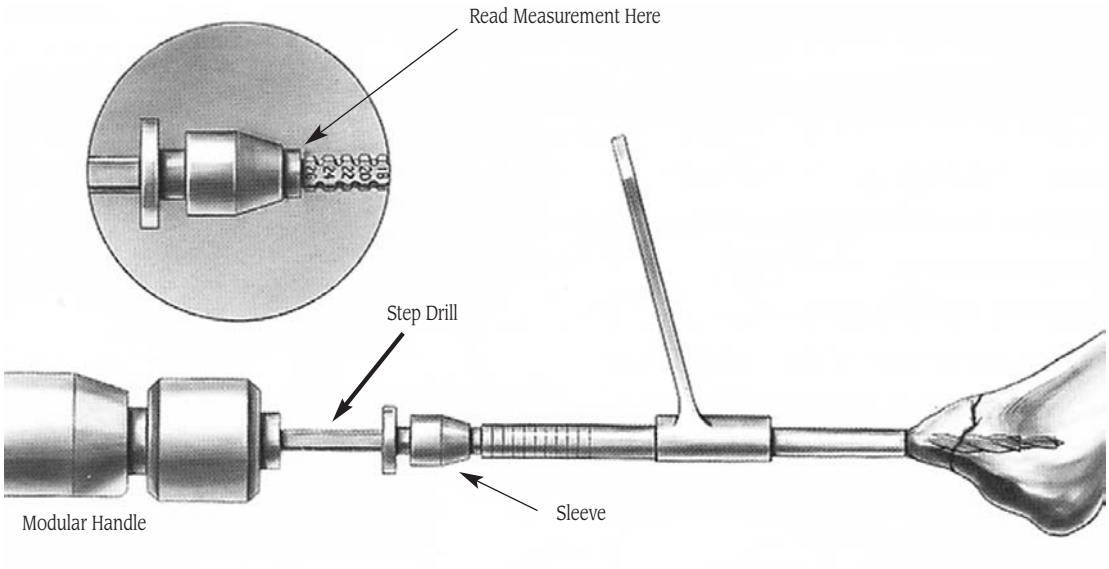

Fig. 3-6 – Drill pilot hole

Step 6—Tap (Recommended only for sclerotic bone)

Attach the Cannulated Tap to the Modular Handle. Slide the adjustable stop Sleeve onto the Tap and set it for the appropriate screw length. Tap the hole for the leading threads of the screw (Fig. 3-7). This is an optional step recommended **only** for sclerotic or cortical bone because the leading and trailing threads of the implant are self-tapping. Tap until the Sleeve bottoms out on the end of the Free-Hand Guide. The Tap must not be turned beyond the depth of the Sleeve or the bone threads will be stripped.

NOTE: If at any time during the procedure, a Guide Wire is found to be bent, the wire must be removed and a new wire inserted. The 1mm Guide Wires are intended to be one-time-use items. Do not use Guide Wires that are bent, cracked, or otherwise damaged. Check each Guide Wire prior to use to assure that it has not been damaged.

If the Guide Wire is removed with the Cannulated Drill, the wire can be reinserted by first inserting the Guide Sleeve into the barrel and then reinserting the wire, blunt end first. Tap the wire once or twice to anchor it in bone.

The shafts and tips of the drill bit and the Tap should be evaluated periodically for straightness. A bent tip could lead to oversizing the hole or fracture of the tip. A bent shaft could cause impingement in the guide barrel and hinder the surgical procedure. The Drill and Tap shafts should pass freely through the guide barrel. Carefully inspect these tools for bends, cracks, and dulling. Replace worn or damaged items.

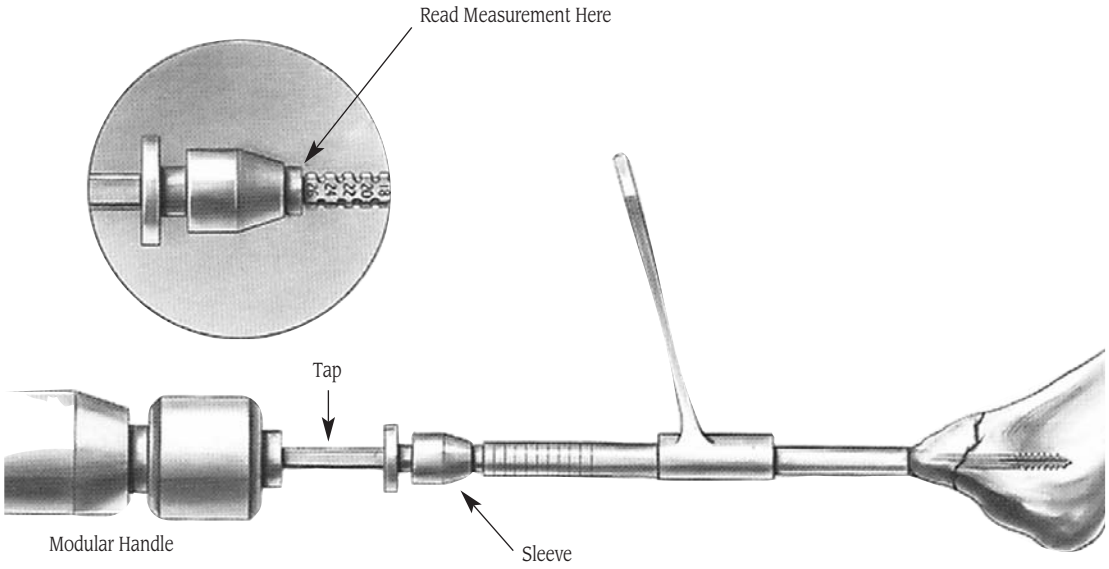

Fig. 3-7 – Tap

Step 7—Insert the Screw

Attach the Cannulated Screwdriver to the Modular Handle. Insert the screw and Screwdriver over the Guide Wire and into the barrel of the Free-Hand Guide. Turn the Screwdriver until the stop bottoms out on the end of the Free-Hand Guide as shown (Fig. 3-8). The Screwdriver should be advanced a few more turns to further bury the screw head below the bone surface.

When the screw is fully seated, remove the Screwdriver, the primary Guide Wire, and the Free-Hand Guide. The accessory Guide Wire can be removed, or if desired, it can be left in place for the first two weeks to help control rotation of the fragments until the initial consolidation of the fracture occurs. If desired, reapply the Screwdriver and rotate the screw one or two more revolutions to ensure that the screw head is completely buried and to produce satisfactory reduction and compression at the fracture site. An x-ray to check for positioning of the screw is recommended at this stage.

Postoperative A/P—Fixation of Chauffeur's distal radius fracture

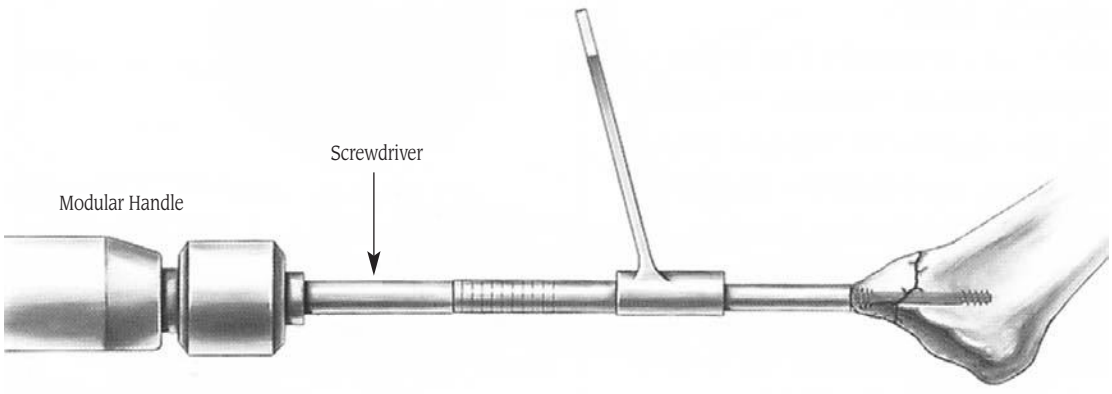

Fig. 3-8 – Insert screw

ZIMMER® HERBERT/ WHIPPLE® BONE SCREW SYSTEM

Arthroscopic Fixation of Osteochrondritis Dissecans or Osteochondral Fractures

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ARTHROSCOPIC FIXATION OF OCD OR OSTEOCHONDRAL FRACTURES

Where appropriate, the *Herbert/Whipple* Bone Screw may be inserted arthroscopically using cannula provided for this purpose. The example shown here demonstrates arthroscopic fixation of an osteochondral fragment in the knee.

EXPOSURE AND FRACTURE REDUCTION

Visualize the fracture site and assess the fragment to be certain that it is reimplantable. Determine the amount of bone surface beneath the articular cartilage on the fragment. Then reduce the fragment to be sure that it will fit back into its crater of origin.

SCREW INSTALLATION

Step 1—Insert the Obturator and Cannula

Introduce the OCD Cannula and the OCD Obturator through the anterolateral portal for medial femoral condyle OCD lesions. Select an appropriate portal for the fracture that will give a direct approach to the fragment. Place the tapered portion of the Obturator against the articular surface of the fragment (Fig. 4-1).

Preoperative A/P—Osteochrondritis Dissecans (OCD)

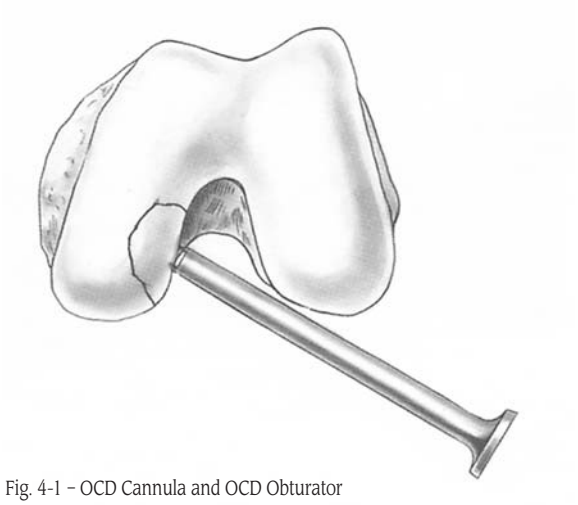


Fig. 4-1 – OCD Cannula and OCD Obturator

Step 2—Insert Wire

Insert the Guide Wire through the OCD Obturator and drill it through the fragment and into the cancellous bone of the medial femoral condyle (Fig. 4-2). The depth of penetration should be at least 15mm.

NOTE: It is imperative that only the Guide Wires included with the set are used to perform this procedure. These wires are sized appropriately for depth gauges and cannulated instruments. Guide Wires should be inserted at high RPMs, but with minimal axial pressure. Excessive pressure to speed insertion compromises the cutting capability of the Guide Wire point. This leads to bending in cortical bone, especially when approached tangentially.

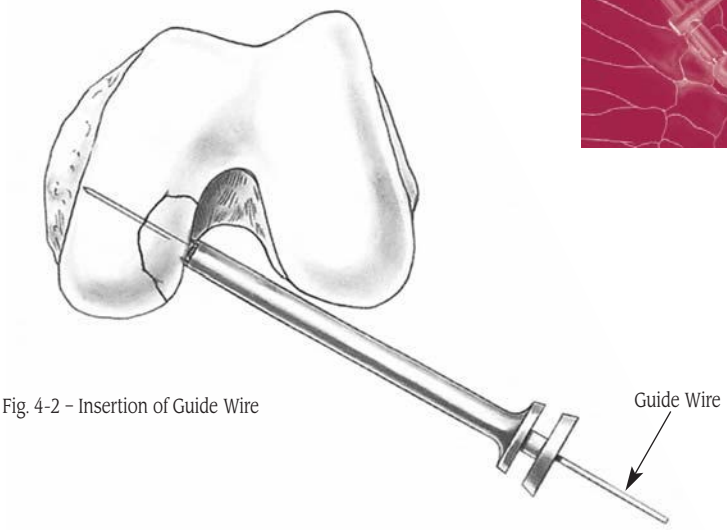


Fig. 4-2 – Insertion of Guide Wire

Step 3—Determine Screw Length

Slide the OCD Cannula down to the articular surface so the two sharp pegs seat into the articular cartilage of the defect. Remove the OCD Obturator. The Cannula should remain firmly seated with the Guide Wire centered within the Cannula. Insert the Free-Hand Depth Gauge into Cannula and read the screw length from the calibrations on the guide (Fig. 4-3). A shorter screw may be selected, but longer screws give better purchase in the condyle.

Use image intensification to check the location of the Guide Wire. It should be deep enough to provide good screw capture in the cancellous bone. However, the wire should not penetrate the posterior femoral condyle, or be embedded in any structure posterior to the joint capsule. Be certain the Guide Wire is not bent. If two wires are used, be sure they are not crossing each other.

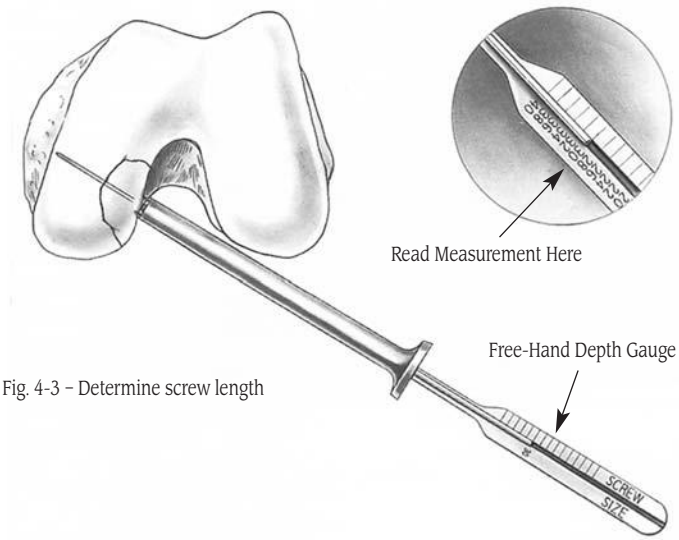


Fig. 4-3 – Determine screw length

Step 4—Drill

Use the Cannulated Step Drill over the Guide Wire to drill the pilot hole (Fig. 4-4). Do not use the Cortical Broach on articular cartilage. Slide the adjustable stop Sleeve onto the Drill and set it for the appropriate screw length. The stop can be set at a shorter drill length to avoid pulling the Guide Wire out of the condyle, but should not be less than 14mm. Then drill until the stop of the Sleeve bottoms out on the Cannula.

NOTE: For extremely hard bone, the optional Gliding Hole Drill should be used before the Step Drill. It is not necessary to tap cancellous bone in the femur. **The self-tapping screw threads are strong enough for secure bone purchase.**

If the Guide Wire comes out with the drill bit, hold the Cannula in place, drop the Obturator back into the Cannula and replace the Guide Wire, blunt end first. Tap the wire once or twice to seat it in bone. Be careful when using the Drill with the Cannula. Any movement or angling of the guide could cause the drill tip to bind on the Guide Wire and fail. Never drill over a bent Guide Wire. Drilling of hard cortical bone should be done at high RPMs (700 to 1,500), but with minimal axial pressure and minimal bending force on the drill bit. Never force the drill bit through the bone. Remove it periodically for cleaning and cooling if necessary. If the drill bit seems to stick, remove the bit and clean debris from the flutes with the brush provided. Rinse the bit and the bone with cool saline solution. Repeat as necessary.

NOTE: If at any time during the procedure, a Guide Wire is found to be bent, the wire must be removed and a new wire inserted. The 1mm Guide Wires are intended to be one-time-use items. Do not use Guide Wires that are bent, cracked, or otherwise damaged.

The shafts and tips of the drill bit and Tap should be evaluated periodically for straightness. A bent tip could lead to oversizing the hole or fracture of the tip. A bent shaft could cause impingement in the Cannula and hinder the surgical procedure. The Drill and Tap shafts should pass freely through the Cannula. Carefully inspect these tools for bends, cracks, and dulling. Replace worn or damaged items.

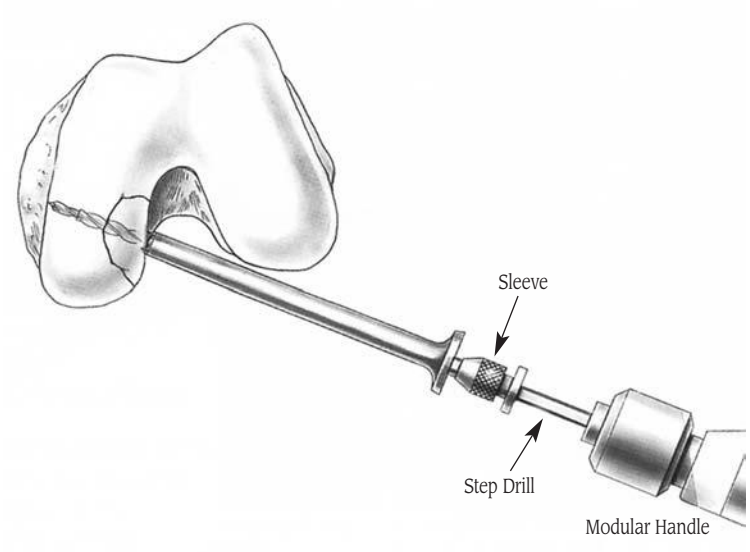


Fig. 4-4 – Drill pilot hole

Step 5—Insert the Screw

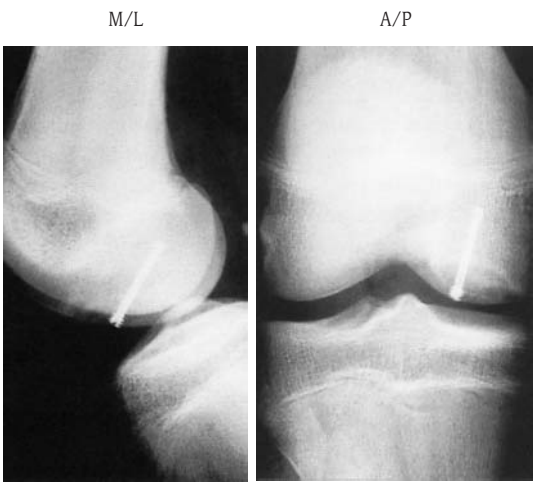
Attach the Cannulated Screwdriver shaft to the Modular Handle. Insert the screw and Screwdriver over the Guide Wire and into the Cannula (Fig. 4-5). While applying pressure to the cannula to compress the fragment into its bed, turn the Screwdriver until the stop bottoms out on the end of the Cannula. The Screwdriver should be advanced a few more turns to further bury the screw head below the bone surface. The screw will "walk" off the end of the Screwdriver.

When the screw is fully seated, remove the Cannulated Screwdriver, Guide Wire, and Cannula. If desired, reapply the Screwdriver and rotate the screw one or two more revolutions to ensure that the head is completely buried and to produce compression across the fracture site, but do not advance the trailing threads past the bony portion of the loose fragment.

SPECIAL NOTE: Although the OCD Cannula and Obturator will normally ensure accurate positioning of the screw, intraoperative radiographs are suggested.

Step 6—Prepare for Second Screw (Optional)

If it is determined that the fragment will require a second screw for fixation, repeat Steps 1-5. It may be helpful to slightly flex or extend the knee when selecting the point of entry for the second screw.



Postoperative M/L and A/P—Fixation of Osteochrondritis Dissecans

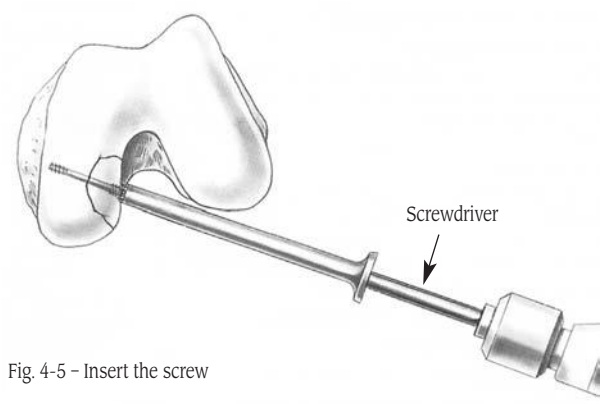


Fig. 4-5 – Insert the screw

TECHNIQUE VARIATIONS

Hard Bone Fixation

The *Herbert/Whipple* Bone Screws were designed for use in both cancellous and cortical bone; however, alternate surgical steps are required to optimize use in hard bone (cortical bone, dense cortical/cancellous bone or sclerotic bone).

In small bones subject to high loads, e.g. metatarsals, it is best to capture cortical bone on both ends of the screw because cortical bone provides stronger fixation and the resistance to fracture gap motion will be greater. Situations include:

- Interphalangeal fusion of the digits
- Fixation of oblique metatarsal osteotomies
- Fixation of certain carpal or tarsal fractures

The *Herbert/Whipple* instrumentation (Fig. 4-6, 7, 8) has been calibrated to assure that the bone screw will be buried 1.6mm below the near cortex. If the bone screw is being inserted obliquely, a shorter length bone screw may be selected to allow further burying of the trailing threads. (Refer to the bunionectomy illustrations.)

Fig. 4-6 – Showing correct method of drilling through cortical bone (power may be preferred) with the Free-Hand Guide located in a "hollow" created in the cortex with a rongeur or large drill.

Fig. 4-7 – Placement of the screw across the modified osteotomy. The screw is placed more dorsal to plantar, which is easy to reproduce, causes less stress riser formation, and allows the trailing threads to be well-seated in dense bone. The increased amount of bone comprising the plantar shelf of the osteotomy provides easy placement of the leading threads across the osteotomy to sufficiently anchor the fixation.

Fig. 4-8 – *Herbert/Whipple* Bone Screw placement across the conventional osteotomy. This requires a very oblique angle of screw placement. It is difficult to perform, leaving very little room for error, and decreasing the chances of correctly placing the leading threads across the osteotomy line. The obliquity of the screw results in greater shearing stress on the dorsal cortex (top arrow) and less dense bone supporting the trailing threads (bottom arrow), which favors migration of the screw.

These techniques may require selection of a bone screw which is 2mm to 6mm shorter than the number read on the instruments.

Conversely, when attempting to maximize cortical fixation on both ends of the *Herbert/Whipple* Bone Screw, a screw 2mm longer than indicated by the guide calibrations should be selected. Note that one end of the screw could protrude beyond the cortical surface by approximately 1mm.

Alternate steps:

1. If bone is too hard for the points of the drill guides to engage, gouge out a small hollow to assist in location of the guide.
2. Overdrill the trailing thread core diameter with the Gliding Hole Drill. Then drill completely through any hard bone in the far fragment with the Step Drill.
3. Tap for the leading threads through all predrilled hard bone.

Drilling and tapping bicortically prevents the leading threads of the *Herbert/Whipple* Bone Screws from abutting against the inner cortical wall and accidentally stripping the cancellous thread purchase. Use of the Gliding Hole Drill completely through the near cortex and any sclerotic bone prevents the trailing thread from abutting against the near cortex.

Warnings:

1. Failure to properly drill cortical bone can generate high compression forces and high torques which can cause failure of the drive mechanisms.
2. The Screwdriver tip must always be fully engaged in the drive socket of the screws to transmit loads properly and to prevent failures. However, stop turning the driver handle if the mechanism begins to slip or deform. Remove the screw. Use the appropriate Gliding Hole Drill or Cortical Broach to overdrill the near cortex and reinsert the bone screw.
3. We do not recommend use of the cortical size drills when attempting cancellous bone fixation. Overdrilling in cancellous bone can significantly reduce the fixation capabilities of the *Herbert/Whipple* Bone Screws in this weaker material.

Screw Removal

Because the screw is completely buried within the bone, removal is not usually indicated. However, should removal become necessary, use the Trephine to cut the bone around the trailing thread of the screw. Remember to remove all soft tissue from the sockets of the screw so the Screwdriver drive prongs can be fully engaged. Then insert a Guide Wire in the screw and place the Screwdriver over the Guide Wire to remove the screw.

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Warning: *This device is not approved for screw attachment or fixation to the posterior elements (pedicles) of the cervical, thoracic or lumbar spine.*

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