Solid Humeral Nail (UHN) and Proximal Humeral Nail (PHN)

Surgical technique

SYNTHES®

Original Instruments and Implants of the Association for the Study of Internal Fixation – AO/ASIF

358.590 Radiographic Ruler for UHN

292.260 Kirschner Wire, 2.5mm dia., with trocar tip

351.120 Awl with T-Handle, cannulated

359.031 Drill Bit, 2.7mm dia., calibrated

315.330 Drill Bit, 3.2mm dia., calibrated

310.440 Drill Bit, 4.5mm dia.

312.460 Double Drill Sleeve 4.5/3.2

319.010 Depth Gauge for Screws

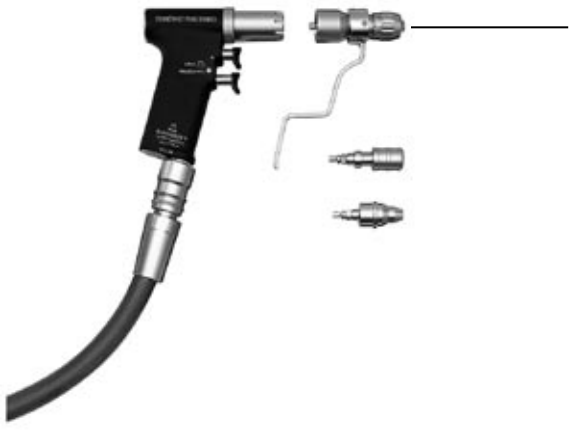
314.270 Screwdriver, hexagonal, large, with groove

314.570 Screwdriver, hexagonal, small

314.060 Holding Sleeve

358.682 Projectile Reamer, 10mm dia.

332.062 Router, length 130mm



511.790 Quick Coupling for Kirschner Wires

511.701 COMPACT™ AIR DRIVE II

511.760 Quick Coupling for DHS/DCS® Triple Reamer

511.750 Quick Coupling

321.200 Ratchet Wrench, 11mm

356.490 Impactor/Extractor
for UTN and UHN

332.200 Slotted Hammer

355.180 Driving Head

358.610 Compression Connecting
Screw

358.540 Connecting Screw
for UHN

358.600 Compression Device
for UHN

358.692 Insertion Handle
for UHN

359.021 Coupling Block
for extraction

355.750 Trocar, 8.0mm dia.

355.722 Drill Sleeve 8.0/3.2,
blue

359.026 Drill Sleeve 8.0/2.7,
pink

355.700 Protection Sleeve
11.0/8.0

358.689 Aiming Arm
for Standard Locking

358.686 Trocar, 2.0mm dia.

358.694 Drill Sleeve 4.5/2.0

358.688 Protection Sleeve 14.0/4.5

292.650 Guide Wire, 2mm dia.

358.691 Drill Bit, 4.5mm dia., cannulated

358.698 Measuring Device for UHN Spiral Blade

358.697 Connecting Screw for UHN Spiral Blade

358.679 Insertion Guide Attachment for Spiral Blade Locking

358.696 Inserter for UHN Spiral Blade

462.96x End Caps for UHN

462.66x End Caps for Spiral Blade

462.7xx Unreamed Humeral Nails (UHN)

462.9xx Proximal Humeral Nail

462.6xx Spiral Blade for 7.5mm/9.5mm UHN and PHN

462.6xx Spiral Blade for 6.7mm UHN

458.1xx 3.9mm Locking Bolt, self-tapping

462.4x 3.4mm Locking Bolt, self-tapping

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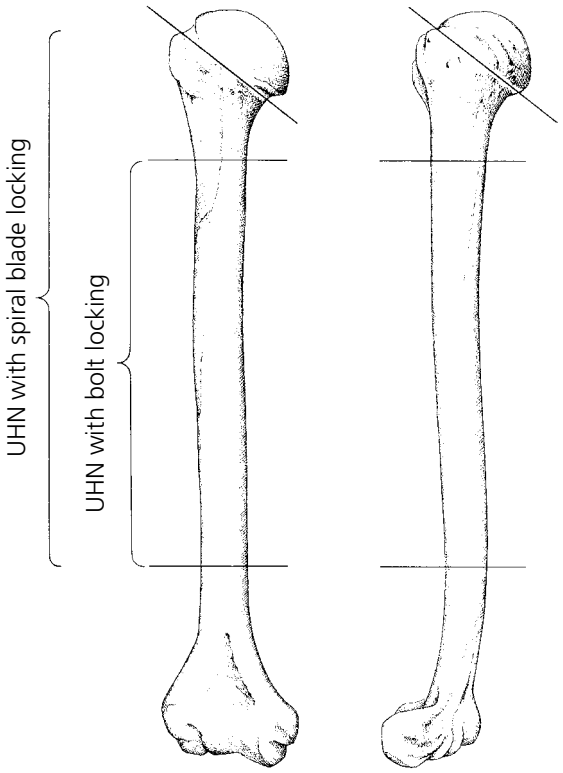
Image intensifier control

Warning:
This description is not sufficient for an immediate application of the instrumentation. Instructions by an experienced surgeon in handling this instrumentation are highly recommended.

Indications



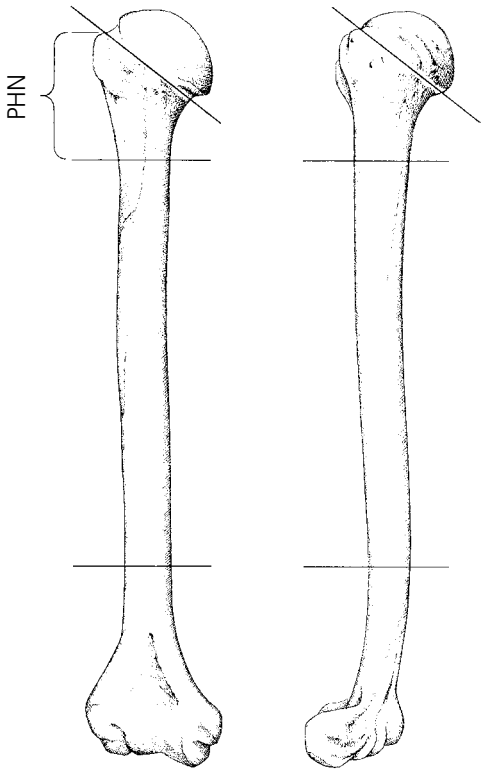
UHN – Locking with locking bolt or spiral blade

The «Solid Humeral Nail» UHN can be used for an antegrade or retrograde insertion in the humeral shaft, and can be employed universally for the left and right humeri.

In both surgical approaches, the special hole geometry of the nail ensures an optimal position of the locking holes. The numerous locking possibilities allow good fixation even of short distal or proximal fragments. In the antegrade procedure, proximal locking with the spiral blade ensures better fixation in osteoporotic bone. Locking with a locking bolt provides the possibility of interfragmentary compression, which improves stabilisation of transverse and short oblique fractures.

The indications of the UHN include humeral shaft fractures to approximately 5 cm proximal of the olecranon fossa in closed epiphyseal cartilages:

- Stable or unstable fresh fractures
- Pathologic fractures
- Refractures, delayed unions and pseudarthroses



PHN – Standard locking with spiral blade

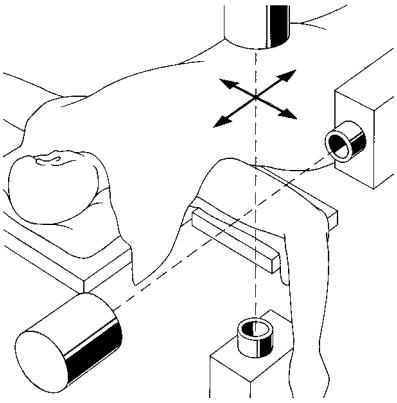
The «Proximal Humeral Nail» PHN has been designed for antegrade insertion into the proximal humeral shaft. It can be used universally for the left and right humeri. The standardised proximal spiral-blade locking ensures sufficient anchoring even in an osteoporotic humeral head.

In adults, the indications of the PHN include humeral fractures in the subcapital humerus region (AO/ASIF classification: A2, A3), or with simultaneous fracture of the trochiter (AO/ASIF classification: extra-articular, bifocal fractures B1, B2):

- Fresh stable or unstable fractures
- Pathologic fractures
- Refractures, delayed unions and pseudarthroses

In specific cases, even joint fractures of the humeral head can be treated (AO/ASIF classification: C fractures), if the head fragment is large enough and not fractured.

UHN – Retrograde insertion



1. Patient positioning

If possible, place the patient in a prone position at the ipsilateral edge of the table. Arrange the fractured upper arm on an armrest, fixed to the table. The elbow is in 90° flexion, and it should be possible to bend it up to approximately 120°, if required. This placement allows a good view of the operating field. Visualisation of the entire upper arm including elbow and humeral head must be possible in two planes in the image intensifier. The freely hanging lower arm normally achieves correct rotation without further manipulation.

If general conditions or the injuries do not allow a prone position, it is also possible to place the patient in a lateral or supine position.

In a lateral position, place the injured arm on a foam wedge. Make sure the elbow can be flexed to approximately 120°. Support the patient with sufficient bolstering.

With the patient in a supine position, try to achieve a nearly lateral position by means of padding. The assistant places the humerus under traction while bending the elbow.

Preoperatively, verify the complete visualisation of the humerus in the image intensifier, as the view is more difficult in a lateral and supine position than in a prone one.

2. Determine nail length

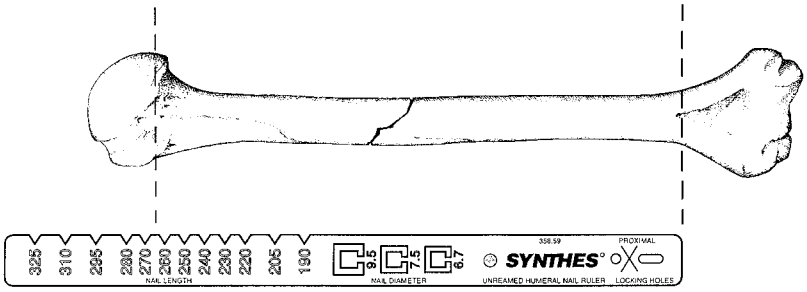
Determine the approximate nail length preoperatively by measuring the uninjured humerus from the top of the humeral head to the olecranon fossa, and subtracting 3 – 4cm from the measured length.

The correct length of the fractured arm can only be determined after correct reduction.

Position the image intensifier for an AP image of the distal humerus. Hold the Radiographic Ruler for UHN (358.590) parallel to the humerus, so that the locking holes symbolised on the ruler are at the appropriate location on the distal humerus. Mark the skin at the end of the ruler.

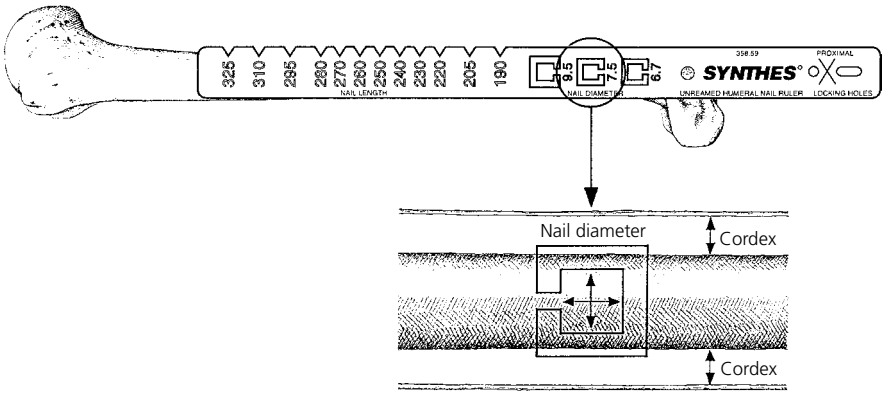
Move the image intensifier to the proximal humerus, position the distal end of the ruler at the skin mark, and take an AP image. Verify the position and read the nail length directly off the ruler.

Note: the nail tip should protrude only slightly into the humeral head.



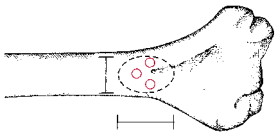
3. Determine nail diameter

Position the image intensifier for a lateromedial image of the distal humerus. Place the radiographic ruler in an either parallel or diagonal position on the humerus, so that the square marks «Nail diameter» (6.7, 7.5, 9.5) lie on the medullary canal. The inner square of this mark symbolises the nail diameter. Determine the correct nail diameter by checking under image intensification, if the transition between the medullary canal and the cortex is still visible on the lateral side of the square.

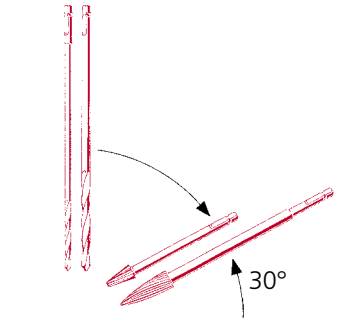


4. Open medullary cavity

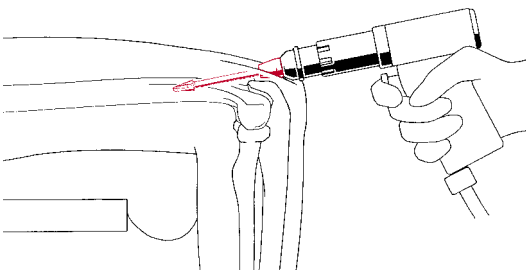
Begin the longitudinal skin incision slightly distal with respect to the olecranon, with the elbow in 90° flexion. Expose the distal humerus shaft with a triceps splitting incision. The incision should allow visualisation of the bone area, beginning at the superior edge of the olecranon fossa and extending approximately 25mm proximally. Do not open the elbow joint.



The entry point to the medullary cavity is in the centre of an imaginary triangle between the medial and lateral supracondylar edge and the roof of the olecranon fossa.



Drill three 3.2mm holes (3.2mm Drill Bit (315.330)) perpendicular to the medullary canal, forming a triangle. Overdrill these holes with the 4.5mm Drill Bit (310.440) and lower the drill bit about 30° (see figure). Use burrs to enlarge this opening until it is approximately 10mm wide and 20mm long. The conical 8.5/3.5mm Burr (358.681) allows rapid reaming of the opening, and the cylindrical Projectile Reamer (358.682) facilitates its modelling.

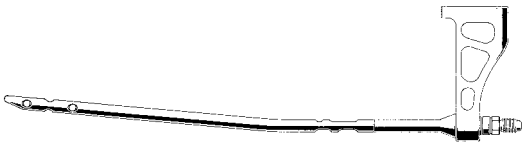


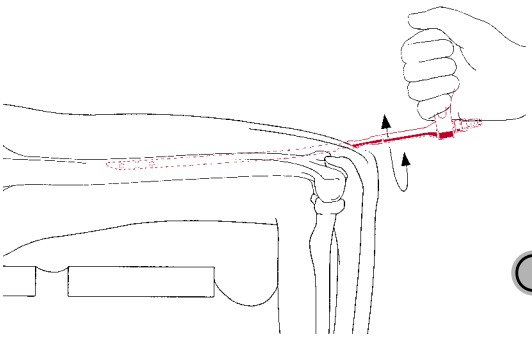
Chamfer and flatten the distal edge of the insertion hole to ensure unimpeded insertion of the nail.

5. Assemble insertion handle and nail

Mount the selected nail onto the Insertion Handle (358.692) making sure that the apex of the nail's curvature points away from the insertion handle. Thread the Connecting Screw for UHN (358.540) through the insertion handle into the nail, and tighten it with the 11.0mm Ratchet Wrench (321.200) or the 11.0mm Combination Wrench (321.160).

Note: should interfragmentary compression be desired to minimise a fracture gap in transverse or short oblique fractures, this is the moment to thread the Compression Device (358.600) and the Compression Connecting Screw (358.610) into the insertion handle (see page 15, Compression Device).



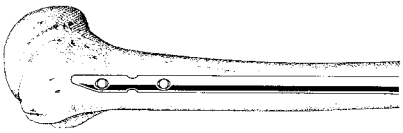


6. Insert nail

Insert the nail by slightly turning the insertion handle. Do not use the hammer to insert the UHN, as this would increase the risk of iatrogenic fissures or fractures at the insertion hole. Insert the nail to the fracture line, reduce the fracture, and monitor the passing of the fracture line with the image intensifier. Manipulate with care, especially in fractures in the region between the middle and the distal third of the shaft in order not to damage the radial nerve.

In case of a preoperative paresis of the radial nerve, an exploration of the nerve through a short anterolateral incision at the transition between the middle and the distal third of the shaft may be necessary.

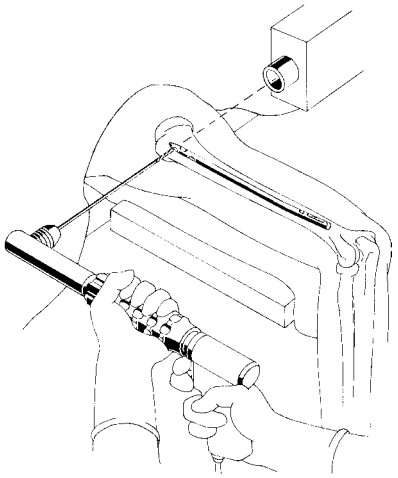
If the nail does not pass easily, it may be adequate to enlarge the medullary canal with the Hand Reamer (351.920, 351.930 or 351.940) in order to avoid the risk of iatrogenic fractures. Never insert the nail with the hammer.



Insert the nail until the nail tip protrudes only slightly into the humeral head. This allows the insertion of a lateromedial locking bolt into the humeral head distally to the rotator cuff.

Verify the position of the nail with the image intensifier.

Note: applying pressure on the humeral head while inserting the nail prevents diastasis and disturbances in the healing process possibly related to it.



7. Proximal locking

Once the nail tip is seated in the humeral head, lock proximally using the radiolucent drive (see page 23, steps 7 – 10) or the freehand locking technique.

Check the position of the proximal fragment, as the insertion of the nail may create a fracture line. Use the 3.2mm Drill Bit (315.330) for 3.9mm locking bolts or the 2.7mm Drill Bit (359.031) for 3.4mm locking bolts. Determine the length of the locking bolt with the Depth Gauge for Screws (319.010), the Depth Gauge for Locking Bolts (355.790) or read it directly off the calibrated drill bit.

Note: in order not to endanger the axillary nerve or its branches, bluntly dissect and carefully spread the underlying muscles after the skin incision.

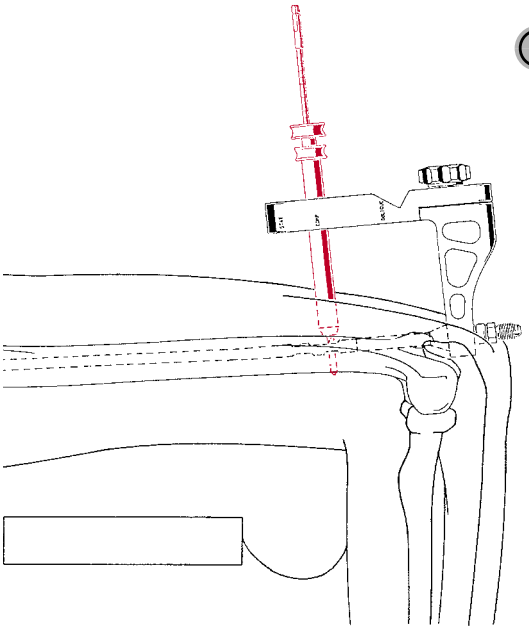
Distal locking
Lock distally by means of the insertion handle and the attached aiming arm. In standard cases, carry out double parallel distal locking, i.e. place a bolt in the static as well as in the dynamic hole.

8. Mount aiming arm and insert trocar assembly

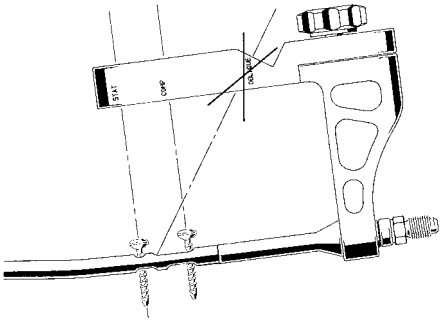
Secure the Aiming Arm for Standard Locking (358.689) to the insertion handle. Verify the connection between the insertion handle and the nail, and retighten the connecting screw, if necessary. Recheck the reduction.

Guide the two-part trocar assembly (Protection Sleeve 11.0/8.0 (355.700), 8.0mm Trocar (355.750)) through the selected hole of the aiming arm, and insert it through a stab incision to the bone. Remove the trocar and insert the drill sleeve corresponding to the locking bolt or drill bit diameter (Drill Sleeve 8.0/3.2 (355.722) for 3.9mm locking bolts, Drill Sleeve 8.0/2.7 (359.026) for 3.4mm locking bolts).

9. Drill and determine locking bolt length



Use the Drill Bit (3.2mm dia. for 3.9mm locking bolts and 2.7mm dia. for 3.4mm ones) to drill through both cortices until the tip of the drill bit just penetrates the anterior cortex. Read the required length of the locking bolt off the calibrated drill bit or determine it with the Depth Gauge for Screws (319.010) or the Depth Gauge for Locking Bolts (355.790). When using the depth gauge for screws or that for locking bolts, add 2mm to the measured length to ensure full engagement of the locking bolt in the opposite cortex.



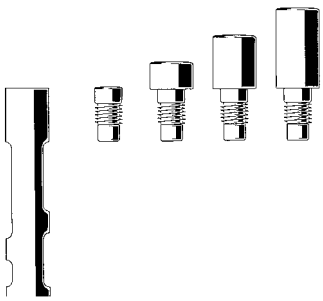
10. Insert locking bolt

Use the large hexagonal Screwdriver (314.270) to insert the locking bolt through the protection sleeve until the bolt head rests on the posterior cortex. The tip of the locking bolt should protrude 1-2mm above the anterior cortex.

Insert the second locking bolt as described.

Note: insert two locking bolts in each main fragment, especially in short ones.

The placement of a locking bolt in the oblique locking hole makes it impossible to place a second bolt through the transverse holes and to achieve compression.



11. Insert end cap

The end cap protects the inner thread of the nail from tissue ingrowth, and facilitates subsequent implant removal. End caps are provided in four lengths (with 0, 5, 10, or 15mm extension), allowing an extension of the nail, if required. This permits free positioning of the locking holes in areas with good bone quality.

Insert the end cap with the hexagonal screwdriver (use the small hexagonal Screwdriver (314.240) for 0mm extension, and the large hexagonal Screwdriver (314.270) for all other extensions).

12. Postoperative care

After the intervention, apply a sterile, padded bandage; additional splinting of the arm is not necessary.

Verify the function of the radial nerve as soon as the anaesthetic wears off.

Remove the Redon drain on the second postoperative day.

Begin immediately with active and passive mobilisation of the shoulder and elbow. Do not carry out any internal or external rotations against resistance before fracture healing.

13. Radiographic control

Make radiographic controls immediately after the intervention. Follow-up controls should be carried out after two, six, and twelve weeks; further controls according to the healing process.

Compression (optional)

As opposed to the femur and tibia, the humerus is less exposed to pressure loads than to rotation ones. This is why the dynamisation of fracture types leading to fragment adaptation in the femur and tibia, might cause healing problems in the humeral shaft.

The compression device allows controlled compression of the fragments in order to eliminate an existing diastasis of the fracture or to achieve interfragmentary compression.

Interfragmentary compression is indicated in the following humeral shaft fractures:

- Transverse fractures
- Short oblique fractures

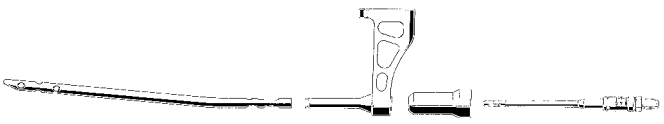
Compression is contraindicated in the following fracture types, because of loss of length and possible dislocations involved:

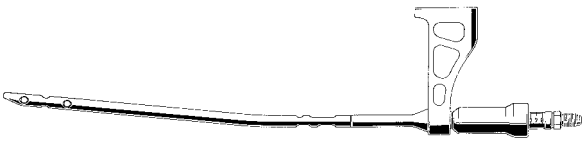
- Spiral fractures
- Long oblique fractures
- Fractures unstable in length

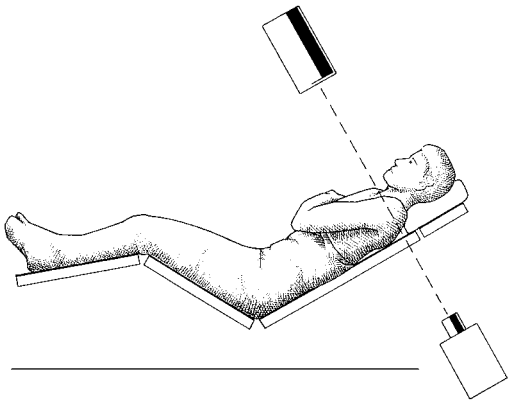
Achieve compression

Use the 11.0mm Ratchet Wrench (321.200) or the 11.0mm Combination Wrench (321.160) to attach the Compression Device (358.600) with the Compression Connecting Screw (358.610) and the insertion handle to the nail. Insert the nail into the medullary canal and lock it distally in the dynamic compression hole. Then perform locking in the proximal fragment under image intensification. By tightening the nut of the compression connecting screw, both the bolt in the compression hole and the distal fragment move proximally (a maximum of 8mm). Use the image intensifier to check the closing of the fracture line. Take into consideration that the nail basis shifts distally when the fragments meet (risk of impingement).

To hold the achieved reduction, introduce an additional bolt in the static locking hole. Remove the compression device and insert an end cap into the nail end.







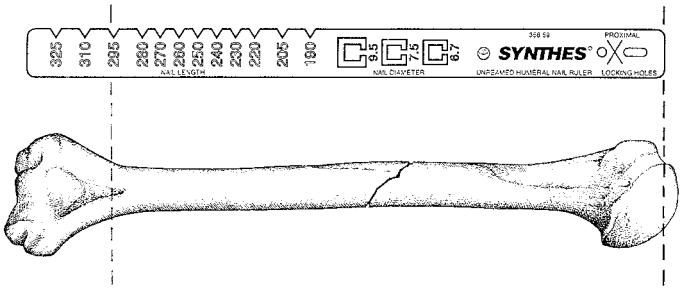
1. Patient positioning

Place the patient supine in a 30° semi-reclined position with a bolster under the shoulder. The operating table has to be radiolucent in the shoulder area or the corresponding part of the table should be removed. Visualisation of the entire humerus including elbow and humeral head must be possible in two planes of the image intensifier. Place the arm on a lateral support.

2. Determine nail length

Determine the approximate nail length preoperatively by measuring the uninjured humerus from the humeral head to the olecranon fossa and subtracting 3 – 4cm from the measured length.

The correct implant length can only be determined after the correct reduction of the fractured arm.



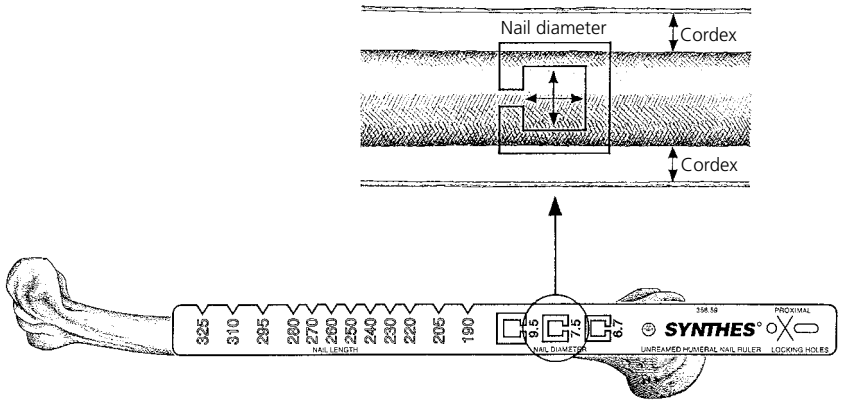
Position the image intensifier for an AP view of the proximal humerus. Hold the Radiographic Ruler for UHN (358.590) parallel to the humerus, so that the symbolised locking holes are at the appropriate location on the proximal humerus. Mark the skin at the end of the ruler.

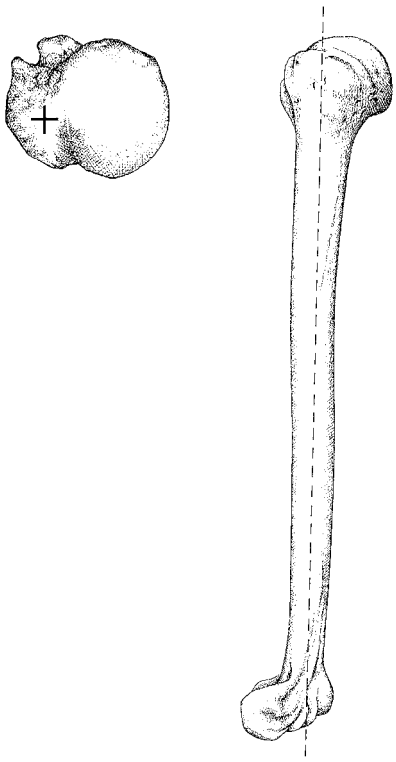
Move the image intensifier to the distal humerus, reposition the proximal end of the ruler at the skin mark, and take an AP image. Verify the reduction, and read the nail length directly from the ruler.

Note: the nail tip should rest no more than 20mm before the cranial aspect of the olecranon fossa.

3. Determine nail diameter

Position the image intensifier for a lateromedial view of the distal humerus. Place the ruler in an either parallel or diagonal position on the humerus so that the square marks «Nail diameter» (6.7, 7.5, 9.5) lie on the medullary canal. The inner square symbolises the nail diameter. Determine the nail diameter by checking under image intensification, if the transition between the medullary canal and the cortex is still visible on the lateral side of the square.

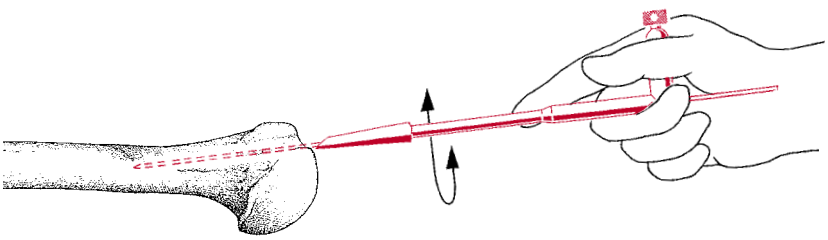




4. Open medullary cavity

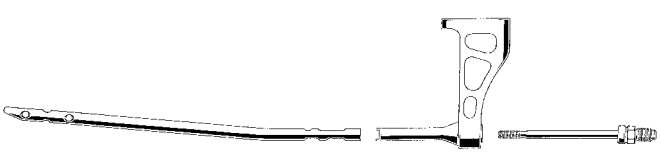
Make an anterolateral incision towards the acromion, and split the deltoid muscle in line with its fibres. Palpate the trochiter, identify the supraspinatus tendon without exposing it, and split the mid-tendon in line with its fibres. Be careful not to damage the rotator cuff. The arm can be adducted across the chest to gain better access to the proximal humerus.

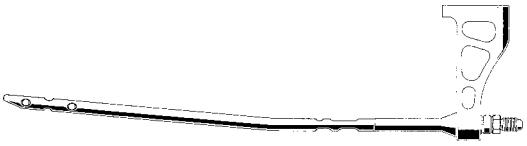
In the antegrade insertion, the insertion point for the UHN is in the extension of the central humeral shaft axis at the bone-cartilage transition of the humeral head and not at the trochiter, as this would interfere with the insertion zone of the supraspinatus tendon. If the humeral head is in its correct position, the point is just before or below the tip of the acromion. Pass a 2.5mm Kirschner Wire with trocar tip (292.260) under image intensification to this point. The intersection point between the line of the humeral head and the Kirschner wire will show whether the Kirschner wire's position is too ventral or too dorsal. If the position of the Kirschner wire is correct, it lies in the centre of the humeral head.



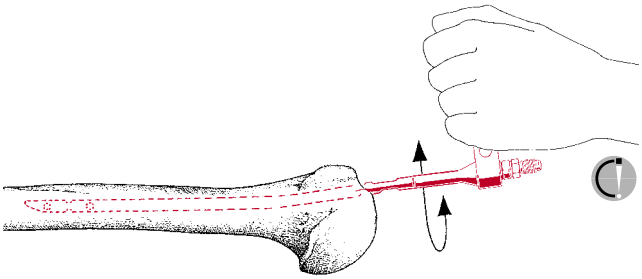
5. Assemble insertion handle and nail

Mount the selected nail on the Insertion Handle (358.692), making sure that the apex of the nail's curvature points away from the insertion handle. Thread the Connecting Screw for UHN (358.540) through the insertion handle into the nail, and tighten it with the Ratchet Wrench (321.200) or the Combination Wrench (321.160).





Note: should interfragmentary compression be desired to minimise a fracture gap in transverse or short oblique fractures, this is the moment to thread the Compression Device (358.600) and the Compression Connecting Screw (358.610) onto the insertion handle (see page 29, Compression Device).



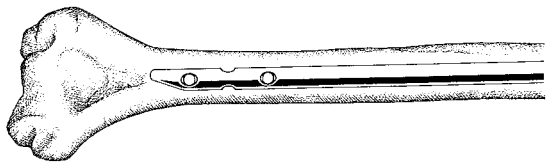
6. Insert nail

Manually insert the nail by slightly turning the insertion handle. Advance the nail to the fracture line, reduce the fracture, and monitor the passing of the fracture line with the image intensifier. Manipulate with care especially in fractures of the middle to distal third of the shaft in order not to damage the radial nerve.

In case of a preoperative paresis of the radial nerve, an exploration of the nerve through a short anterolateral incision at the transition of the middle and the distal shaft third may be necessary.

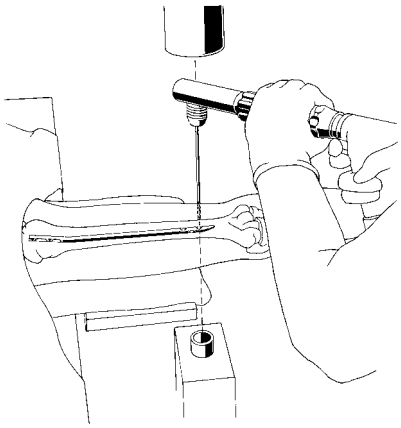
Do not use the hammer to insert the UHN, as it increases the risk of iatrogenic fissures or fractures at the insertion hole.

Verify the position of the nail with the image intensifier.



Notes

- If advancing the nail is difficult, it may be adequate to enlarge the medullary canal with the Hand Reamer (351.920, 351.930 or 351.940) in order to avoid the risk of iatrogenic fractures. Never use the hammer to insert the nail.
- Applying pressure on the olecranon while inserting the nail prevents diastasis and disturbances in the healing process possibly related to it. Bury the nail completely into the humeral head to avoid subsequent irritation of the shoulder structures, even when the arm is abducted (impingement syndrome).



Locking
Once the fracture gap is well closed, lock first proximally and then distally. If the nail tip has reached its final position, it is recommended to lock distally first, to push back the nail, and conclude by locking proximally.

When using the spiral blade, always lock proximally first to ensure optimal placement of the spiral blade.

Distal locking
Lock distally using a normal double parallel locking by means of the radiolucent drive or the freehand locking technique.

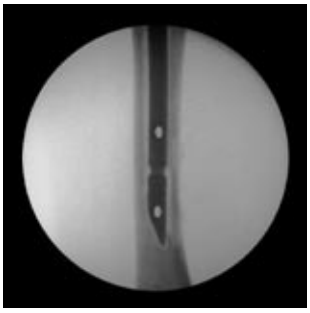
Distal locking with the Radiolucent Drive (511.300) is described below.

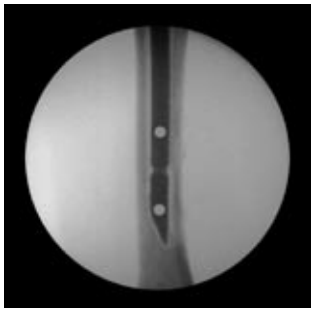
7. Position insertion handle and align image

Verify the connection between the insertion handle and the nail, and retighten the connecting screw, if necessary. In case of proximal spiral blade locking, swivel the insertion guide with the attachment approximately 20° ventrally in order to respect the humeral head's retroversion. The spiral blade rests now in the centre of the humeral head.

Verify the position of the proximal fragment, as the insertion of the nail may create a fracture line.

Align the image intensifier with the distal hole of the nail so that the hole is visible as a perfect circle in the image.

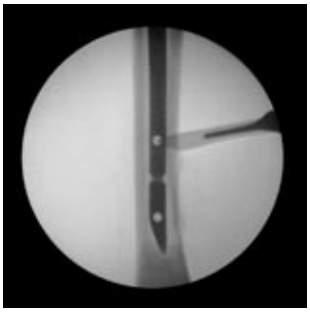




8. Make incision

Determine the incision point on the skin and use a scalpel to make a stab incision.

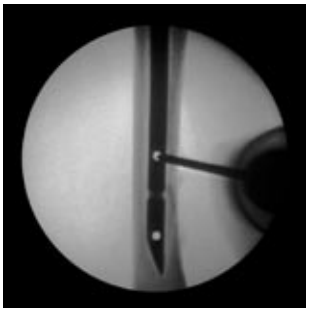
Note: make a blunt dissection down to the bone in order avoid damaging the brachial artery and the median nerve.

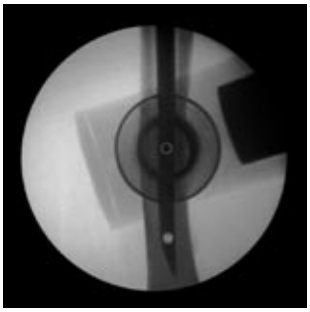


9. Drill

Under image intensification, use the radiolucent drive to insert the 3.2mm Drill Bit (315.330) for 3.9mm locking bolts or the 2.7mm Drill Bit (359.031) for 3.4mm locking bolts through the incision to the bone.

Tilt the drive until the tip of the drill bit appears centred in the locking hole. The drill bit will nearly fill out the locking hole image. Holding the drill bit in this position, drill through both cortices until the tip of the drill bit just penetrates the posterior cortex.





10. Determine locking bolt length and insert locking bolt

When using the calibrated drill bit, read the correct bolt length directly off the drill bit or determine the length with the Depth Gauge for Screws (319.010) or the Depth Gauge for Locking Bolts (355.790). When using the depth gauge for screws or that for locking bolts, add 2mm to the measured length to ensure full engagement of the bolt in the opposite cortex.

Proximal locking with locking bolt (standard locking)

Lock proximally with the insertion handle and the attached aiming arm, which should be positioned exactly in the mediolateral plane.

Standard locking for the antegrade insertion is simple oblique locking as it does not interfere with the head of the humerus and ensures better hold in the stronger medial cortex.

For proximal locking with the spiral blade see page 31 ff., steps 11b – 17b.

11a Mount aiming arm and insert trocar assembly

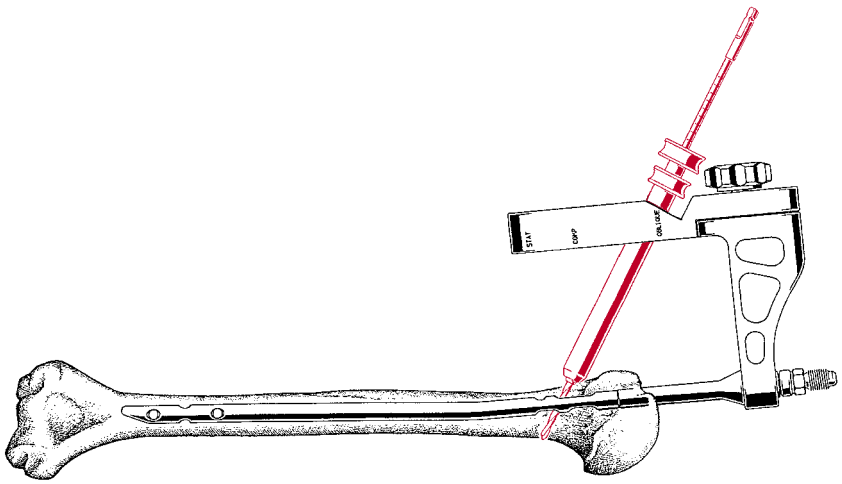
Attach the Aiming Arm for Standard Locking (358.689) to the insertion handle and recheck the reduction.

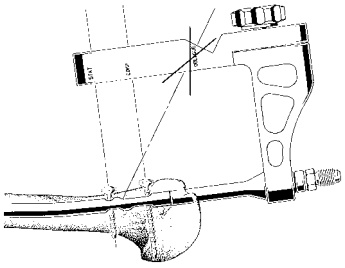
Guide the two-part trocar assembly (Protection Sleeve 11.0/8.0 (355.700), 8.0mm Trocar (355.750)) through the selected hole of the aiming arm, make a stab incision and insert the assembly to the bone. Remove the trocar and insert the drill sleeve corresponding to the bolt or drill bit diameter (Drill Sleeve 8.0/3.2 (355.722) for 3.9mm locking bolts, Drill Sleeve 8.0/2.7 (359.026) for 3.4mm locking bolts).

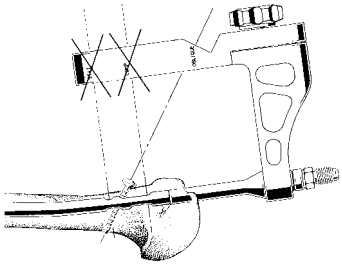
Note: incise only the skin; perform a deep blunt dissection to avoid damaging the axillary nerve and its branches.

12a Drill and determine locking bolt length

Use the drill bit (3.2mm dia. for 3.9mm locking bolts or 2.7mm dia. for 3.4mm locking bolts) to drill through both cortices until the tip of the drill bit just penetrates the medial cortex. Read the appropriate length of the locking bolt either directly off the calibrated drill bit or determine it with the Depth Gauge for Screws (319.010) or the Depth Gauge for Locking Bolts (355.790). When using the depth gauge for screws or that for locking bolts, add 2mm to the measured length to ensure full engagement of the bolt in the opposite cortex.





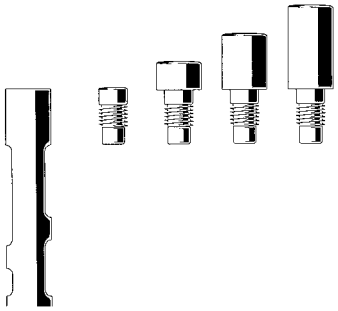


13a Insert locking bolt

Use the large hexagonal Screwdriver (314.270) to insert the locking bolt through the protection sleeve until the bolt head rests on the lateral cortex. The tip of the locking bolt should protrude 1-2mm above the medial cortex.

Insert further locking bolts as described.

Note: placement of a locking bolt in the oblique locking hole makes it impossible to place a second locking bolt through the transverse holes and to achieve compression.



14a Insert end cap

The end cap protects the inner thread of the nail from tissue ingrowth and facilitates subsequent implant removal. End caps are provided in four lengths (with 0, 5, 10, or 15mm extension), allowing an extension of the nail, if required. This permits free positioning of the locking holes in areas with good bone quality.

Insert the end cap with the hexagonal screwdriver (use the small hexagonal Screwdriver [314.240] for the 0mm extension, and the large hexagonal Screwdriver [314.270] for all other extensions).

Make sure to bury the nail and the end cap completely in the humeral head to ensure unhindered function of the shoulder, even in abduction. For this reason, use the end cap without extension, if possible.

Note: when using the compression device, take into consideration that the nail basis will approach the head surface. It is recommended to bury the nail basis deeper in the humeral head, and to use an appropriate end cap to balance too great a distance to the head surface. It is important to avoid nail protrusion, as it might cause impingement.

15a Postoperative care

After the intervention, apply a sterile, padded bandage; additional splinting of the arm is not necessary.

Verify the function of the radial nerve as soon as the anaesthetic wears off.

Remove the Redon drain on the second postoperative day.

Begin immediately with active and passive mobilisation of the shoulder and elbow. Do not carry out any internal or external rotations against resistance before fracture healing.

16a Radiographic control

Make radiographic controls immediately after the intervention. Follow-up controls should be carried out after two, six, and twelve weeks; further controls according to the healing process.

Compression (optional)

As opposed to the femur and tibia, the humerus is less exposed to pressure loads than to rotation ones. This is why the dynamisation of fracture types leading to fragment adaptation in the femur and tibia, might cause healing problems in the humeral shaft.

The compression device allows controlled compression of the fragments in order to eliminate an existing fracture gap or to achieve interfragmentary compression.

Interfragmentary compression is indicated in the following humeral shaft fractures:

- Transverse fractures
- Short oblique fractures

Compression is contraindicated in the following fracture types, because of loss of length and possible dislocations involved:

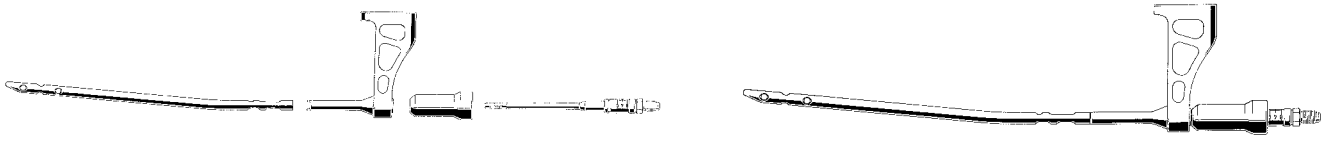
- Spiral fractures
- Long oblique fractures
- Fractures unstable in length

The compression device has been primarily designed for the retrograde procedure, as it requires two parallel locking bolts at the nail basis. In the antegrade procedure, simple oblique locking is usual. However, it is possible to use the compression device in the antegrade procedure. It must be considered though that these two now parallel bolts do not hold very firmly in the minimal thickness of the cortex and that, compared to the retrograde procedure, the compression bolt transfers some compression in cancellous bone.

Achieve compression

Use the 11.0mm Ratchet Wrench (321.200) or the 11.0mm Combination Wrench (321.160) to attach the Compression Device (358.600) with the Compression Connecting Screw (358.610) and the insertion handle to the nail. Insert the nail into the medullary canal and lock it proximally in the dynamic compression hole. Then lock in the distal fragment under image intensification. By tightening the nut of the compression connecting screw, the nail and with it the entire distal fragment move distally. Use the image intensifier to check the contact of the fragments. Take into consideration that the nail basis shifts proximally when the fragments meet (risk of impingement).

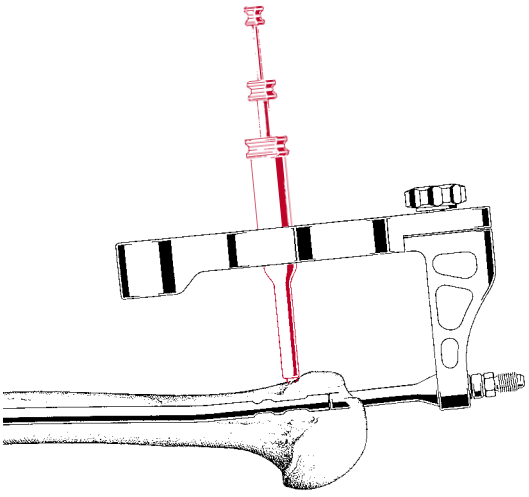
To hold the achieved reduction, introduce an additional bolt in the static locking hole. Remove the compression device and insert an end cap into the nail end.



Proximal locking with spiral blade

Spiral-blade instead of locking-bolt locking provides higher stability in the proximal fragment, particularly in very proximal shaft fractures or in shaft fractures involving an ipsilateral subcapital humeral fracture, but also in osteoporotic bone.

11b Mount insertion guide attachment and insert trocar assembly



Attach the Insertion Guide Attachment for Spiral Blade Locking (358.679) to the insertion handle.

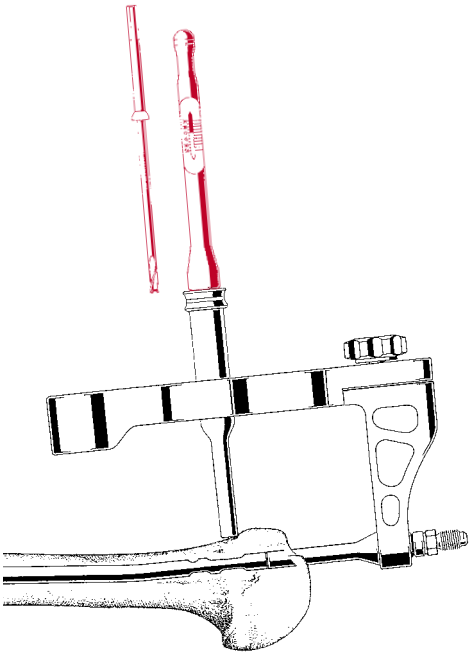
When starting with proximal locking, verify the connection between the insertion handle and the nail, and retighten the connecting screw, if necessary. Recheck the reduction.

Swivel the insertion guide with the attachment approximately 20° ventrally, in order to respect the retroversion of the humeral head. The spiral blade rests now in the centre of the humeral head.

After the skin incision, insert the three-part trocar assembly (Protection Sleeve 14.0/4.5 (358.688), Drill Sleeve 4.5/2.0 (358.694), 2.0mm Trocar (358.686)) through the hole of the attachment marked «Spiral Blade» to the bone.

Remove the trocar.

Note: incise only the skin; perform a deep blunt dissection to avoid damaging the axillary nerve and its branches.



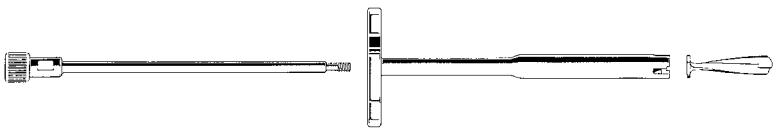
12b Determine spiral blade length and drill

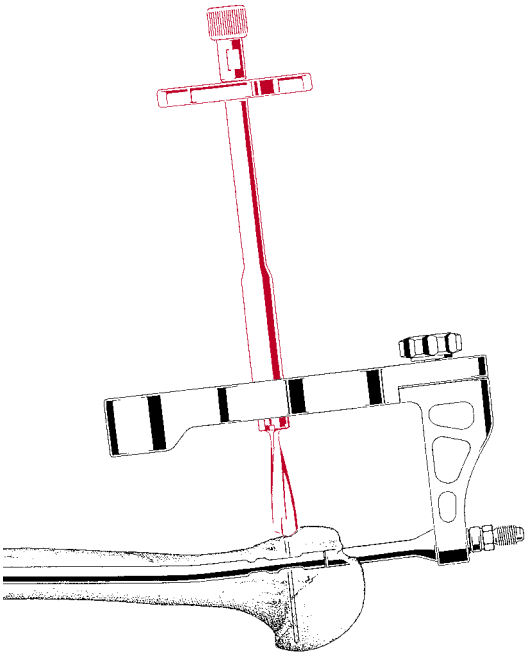
Insert a 2.0mm Guide Wire (292.650) through the Drill Sleeve 4.5/2.0 (358.694) into the humeral head, and use image intensification to verify the final position at the transition of the medial and lower third of the humeral head. The wire will almost reach the opposite cortex, but should not enter the subchondral cortex. Push the Measuring Device for Spiral Blade (358.698) over the Kirschner wire, and read the spiral-blade length off the scale. Remove both drill sleeve and measuring device; the Kirschner wire remains in the bone.

Push the cannulated 4.5mm Drill Bit (358.691) over the Kirschner wire, and drill to the automatic stop under image intensification.

13b Attach spiral blade to inserter

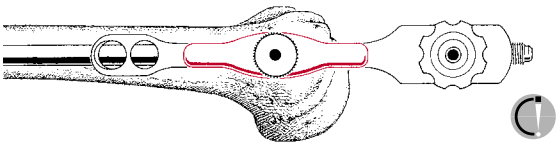
Insert the Connecting Screw for Spiral Blade (358.697) in the Inserter for Spiral Blade (358.696), attach the golden Spiral Blade (462.634–654) for 7.5/9.5mm UHN and 7.5/8.0mm PHN or the pink Spiral Blade (462.672–688) for 7.6mm UHN of determined length to the cams of the inserter, and tighten the connecting screw. Make sure the spiral blade is firmly attached.





14b Insert spiral blade

Insert the spiral blade and the inserter over the Kirschner wire through the insertion guide attachment to the lateral cortex.



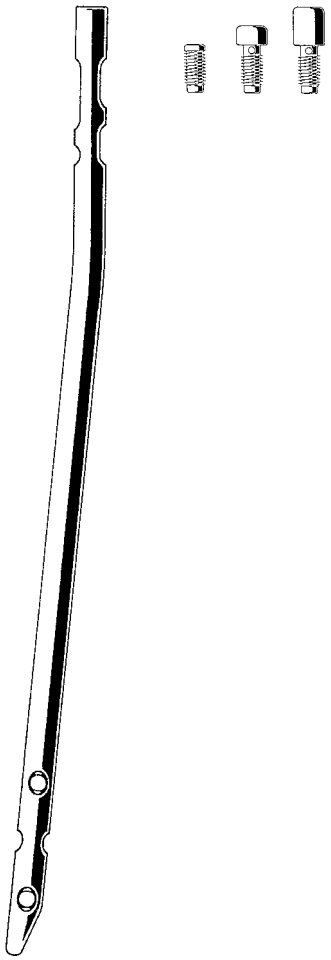
Align the T-handle of the inserter parallel with the insertion guide attachment. Use gentle hammer taps on the connecting screw to advance the blade to the desired position. During insertion, the T-handle will turn 90°. Verify the position of the spiral blade with the image intensifier.

Remove the insertion instruments for spiral blade and the Kirschner wire.

It is also possible to insert a transverse locking bolt through the second proximal hole, if required.

Remove the insertion handle.

Note: in fractures involving fragments of the trochiter (B fractures), always reduce and fix the tuberosity. This can be performed either by closed reduction or by enlarging the cranial incision. Perform fracture fixation using either a cannulated 4.0mm titanium screw or the tension band principle. When using the tension band fixation, anchor a suture or wire loop in the spiral-blade holes intended for this or on the most proximal locking bolt.



15b Insert end cap

The end cap protects the inner thread of the nail from tissue ingrowth and facilitates subsequent implant removal. The special golden End Cap for UHN Spiral Blade (462.660, 462.665 or 462.666) locks the spiral blade. The last tightening turns will offer some resistance caused by a groove in the thread, which prevents the screw from loosening. Firmly tighten the end cap. End caps are provided in three lengths (with 0, 5, or 15mm extension), allowing an extension of the nail, if required. This permits free positioning of the locking holes in areas with good bone quality.

Make sure to bury the nail and the end cap completely in the humeral head to ensure unhindered function of the shoulder, even in abduction. For that reason, use the end cap without extension whenever possible.

Note: when using a spiral blade, always insert the End Cap for UHN Spiral Blade (462.660, 462.665 or 462.666) into the nail, otherwise the spiral blade will not lock.

16b Postoperative care

After the intervention, apply a sterile, padded bandage; additional splinting of the arm is not necessary.

Verify the function of the radial nerve as soon as the anaesthetic wears off.

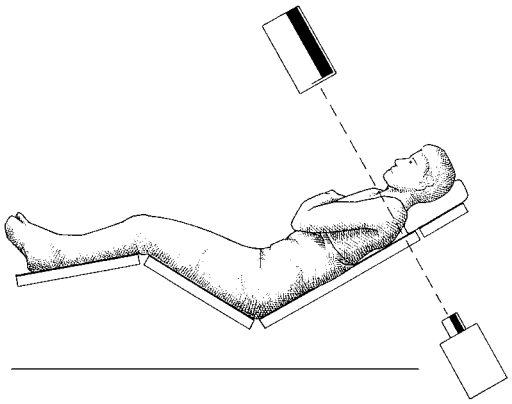
Remove the Redon drain on the second postoperative day.

Begin immediately with active and passive mobilisation of the shoulder and elbow. Do not carry out any internal or external rotations against resistance before fracture healing.

17b Radiographic control

Make radiographic controls immediately after the intervention. Follow-up controls should be carried out after two, six, and twelve weeks; further controls according to the healing process.

PHN – Antegrade insertion

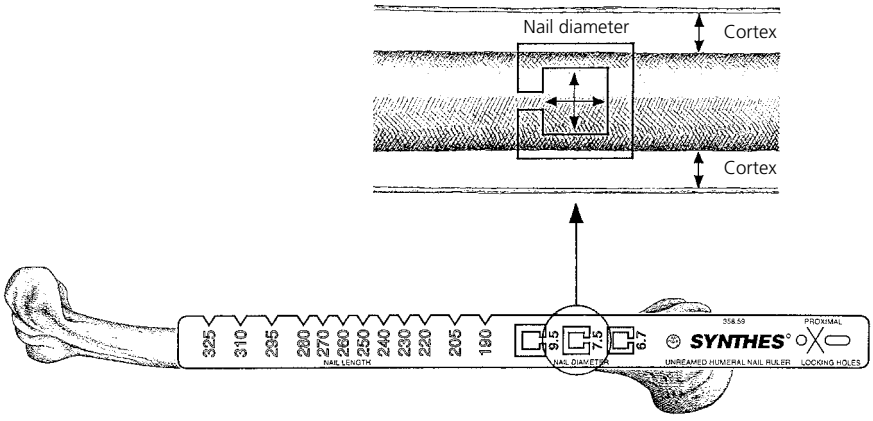


1. Patient positioning

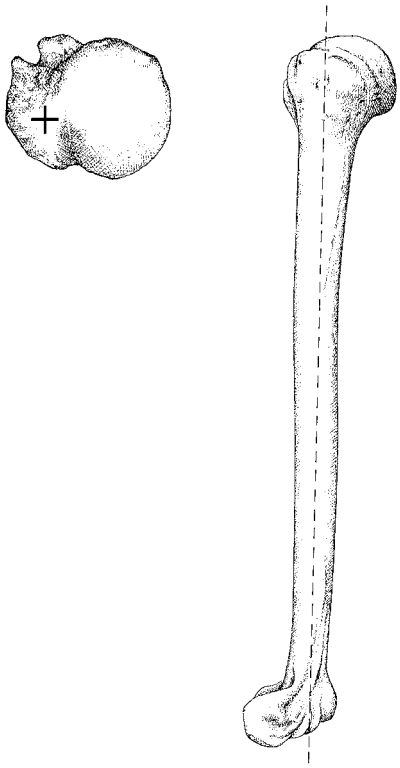
Place the patient supine in a 30° semi-reclined position with a bolster under the shoulder. The operating table has to be radiolucent in the shoulder area or the corresponding part of the table has to be removed. Visualisation of the entire humerus including elbow and humeral head must be possible in two planes in the image intensifier. Place the arm on a lateral support.

2. Determine nail diameter

Due to its short length, the PHN has a relatively wide medullary canal at its disposal. The 7.5mm PHN is therefore used as standard nail and the 8.0mm PHN in osteoporotic bone with a very large medullary canal. If the selection of the nail diameter is problematic, refer to the measuring method of the UHN.



Position the image intensifier for a lateromedial view of the proximal humerus. Place the Radiographic Ruler for UHN (358.590) in an either parallel or diagonal position on the humerus, so that the square marks «Nail diameter» (7.5 or 9.5 (corresponding to the 8.0mm PHN)) lie on the medullary canal. The inner square of this mark symbolises the nail diameter. Select the nail whose transition between the medullary canal and the cortex is still visible on the lateral side of the square under image intensification.

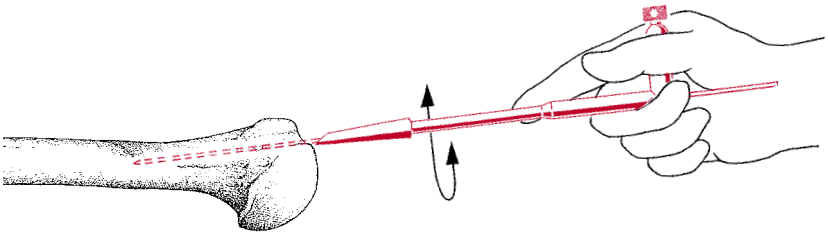


3. Open medullary canal

After a closed reduction, certain cases require a temporary fixation of the humeral head using a periosteal elevator or a wire. The correct focus of the head appears in the AP view of the largest humeral head diameter.

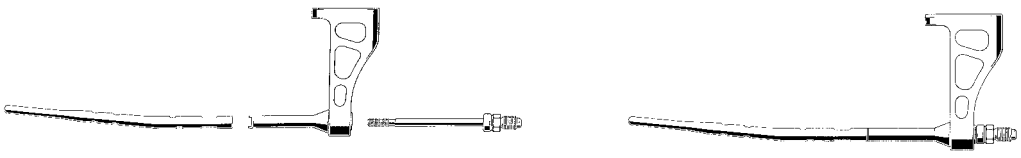
Make an anterior incision in the acromion region, split the deltoid muscle and the rotator cuff, and fix the latter.

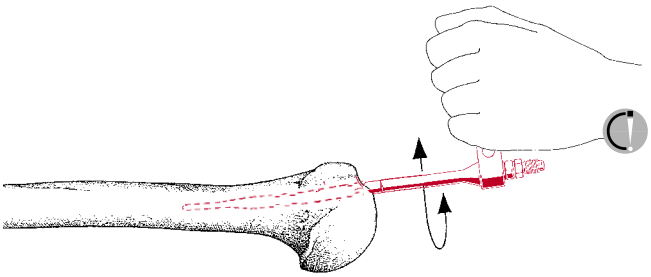
Use the cannulated Awl with T-Handle (351.120) to insert a Kirschner wire through the correct entry point into the proximal humerus, and advance it in the medullary canal. Use the image intensifier to verify the position of the Kirschner wire in both frontal and sagittal planes. Unlock the fixing device of the Kirschner wire, and open the medullary canal with the awl.



4. Attach insertion handle to nail

Mount the selected nail onto the Insertion Handle (358.692), making sure that the apex of the nail's curvature points away from the insertion handle. Manually thread the Connecting Screw for UHN (358.540) into the nail, and tighten it with the 11.0mm Ratchet Wrench (321.200) or the 11.0mm Combination Wrench (321.160).



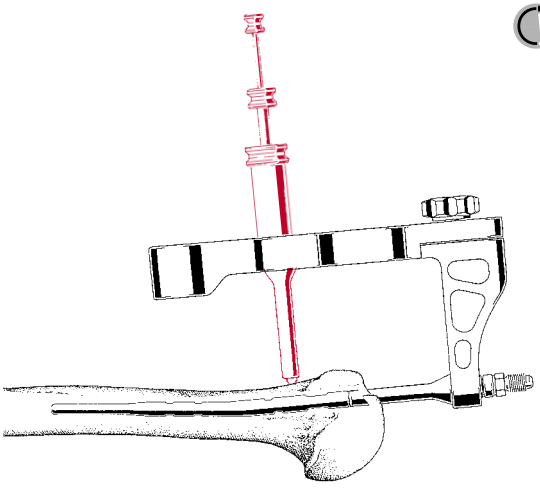


5. Insert nail

Manually insert the nail by slightly turning the insertion handle, and monitor the nail tip passing of the fracture line under image intensification.

Proximal locking
After inserting the nail, always lock proximally first. Bury the nail under the humeral head surface so that it does not protrude above the head even with an inserted end cap, but still ensures that the spiral blade will not be positioned too distally.

6. Mount insertion guide attachment and insert trocar assembly



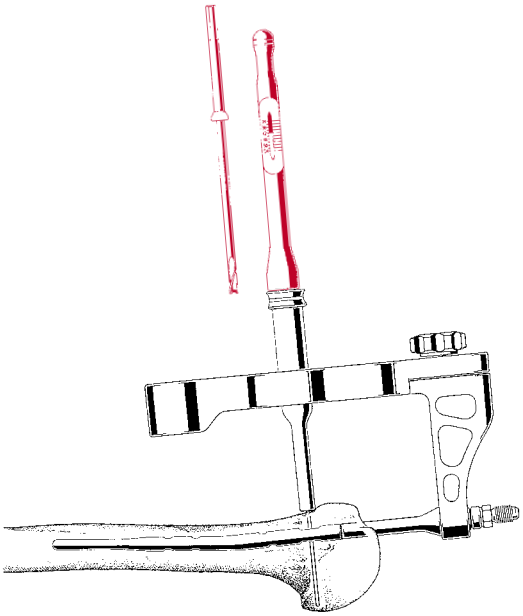
Attach the Insertion Guide Attachment for Spiral Blade Locking (358.679) to the insertion handle and turn it until it rests exactly in the mediolateral plane. Verify the connection between the insertion handle and the nail, and retighten the connecting screw, if necessary. Recheck the reduction.

Swivel the insertion guide with the attachment approximately 20° ventrally in order to respect the retroversion of the humeral head. The spiral blade rests now in the centre of the humeral head.

After the skin incision, insert the three-part trocar assembly (Protection Sleeve 14.0/4.5 (358.688), Drill Sleeve 4.5/2.0 (358.694), 2.0mm Trocar (358.686)) through the hole of the attachment marked «Spiral Blade» to the bone.

Remove the trocar.

Note: incise only the skin; perform a deep blunt dissection to avoid damaging the axillary nerve and its branches.



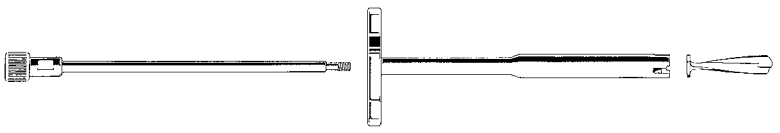
7. Determine spiral blade length and drill

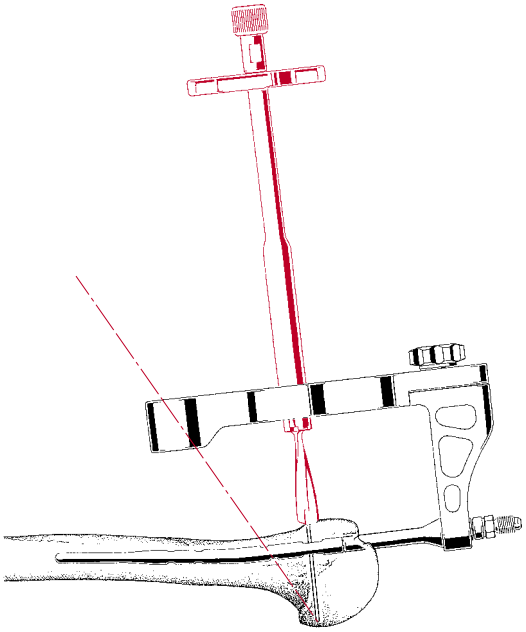
Insert a 2.0mm Guide Wire (292.650) through the Drill Sleeve 4.5/2.0 (358.694) into the humeral head, and use image intensification to verify the final position at the transition of the medial and lower humeral-head third. The wire will almost reach the opposite cortex, but should not enter the subchondral cortex. Push the Measuring Device for Spiral Blade (358.698) over the Kirschner wire, and read the spiral-blade length off the scale. Remove both drill sleeve and measuring device; the Kirschner wire remains in the bone.

Push the cannulated 4.5mm Drill Bit (358.691) over the Kirschner wire, and drill to the automatic stop under image intensification.

8. Attach spiral blade to inserter

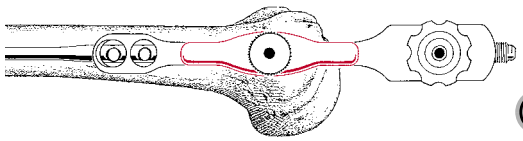
Insert the Connecting Screw for Spiral Blade (358.697) into the Inserter for Spiral Blade (358.696), attach the selected golden Spiral Blade (462.634–654) to the cams of the inserter, and tighten the connecting screw. Make sure the spiral blade is firmly attached.





9. Insert spiral blade

Insert the spiral blade and the inserter over the Kirschner wire through the insertion guide attachment to the lateral cortex.



Align the T-handle of the inserter parallel with the insertion guide attachment. Use gentle hammer blows on the connecting screw to advance the blade to the desired position. During insertion, the T-handle will turn 90°. Verify the position of the spiral blade with the image intensifier.

Remove the insertion instruments for spiral blade and the Kirschner wire.

Use an oblique locking bolt to additionally fix the lateral cortex fragment. Insert the bolt according to the steps 10 – 12, pages 42 to 43.

Make sure that the drill bit does not touch the spiral blade.

Important: the obliquely inserted bolt should not be longer than **50mm**; otherwise it will touch the spiral blade.

Note: in fractures involving fragments of the trochiter (B fractures), always reduce and fix the tuberosity. This can be performed either by closed reduction or by enlarging the cranial incision. Perform fracture fixation using either a cannulated 4.0mm titanium screw or the tension band principle. When using the tension band fixation, anchor a suture or wire loop in the spiral-blade holes intended for this or on the most proximal locking bolt.

Distal locking

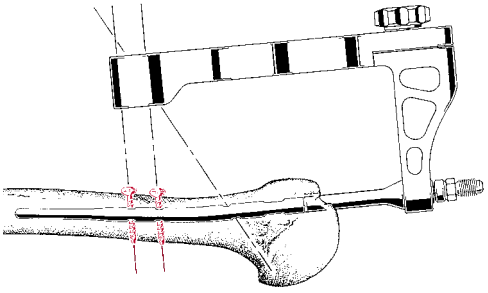
Verify the reduction and close the fracture gap by impaction, if necessary. Lock using the Insertion Guide Attachment for Spiral Blade Locking (358.679).

10. Insert trocar assembly

Guide the two-part trocar assembly (Protection Sleeve 11.0/8.0 (355.700), 8.0mm Trocar (355.750)) through the selected hole of the insertion guide attachment, and insert it through a stab incision to the bone. Remove the trocar and insert the Drill Sleeve 8.0/3.2 (355.722).

11. Drill and determine locking bolt length

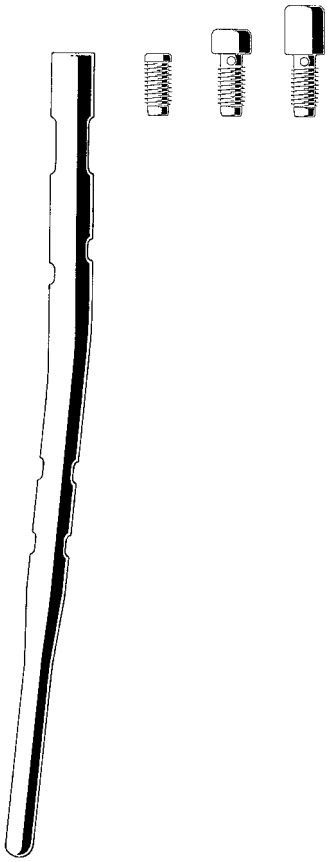
Use the 3.2mm Drill Bit (315.330) to drill through both cortices until the tip of the drill bit just penetrates the anterior cortex. Read the required length of the locking bolt off the calibrated drill bit or determine it with the Depth Gauge for Screws (319.010) or the Depth Gauge for Locking Bolts (355.790). When using the depth gauge for screws or that for locking bolts, add 2mm to the measured length to ensure full engagement of the locking bolt in the opposite cortex.



12. Insert locking bolt

Use the large hexagonal Screwdriver (314.270) to insert the locking bolt through the protection sleeve until the bolt head rests on the posterior cortex. The tip of the locking bolt should protrude 1-2mm above the anterior cortex.

Insert the second locking bolt as described.



13. Insert end cap

The end cap protects the inner thread of the nail from tissue ingrowth and facilitates subsequent implant removal. The special golden End Cap for UHN Spiral Blade (462.660, 462.665 or 462.666) locks the spiral blade. The last tightening turns will offer some resistance caused by a groove in the thread, which prevents the screw from loosening. Firmly tighten the end cap.

End caps are provided in three lengths (with 0, 5, or 15mm extension), allowing an extension of the nail, if required. This permits free positioning of the locking holes in areas with good bone quality.

Make sure to bury the nail and the end cap completely in the humeral head to ensure unhindered function of the shoulder even in abduction.

Remove the connecting screw, but leave the insertion handle on the nail. Use the small hexagonal Screwdriver (314.570) to place the End Cap with 0mm extension (462.660) through the insertion handle into the proximal nail end. If an end cap with extension is required, use the large hexagonal Screwdriver (314.270) to insert it.

Note: always insert the end cap into the nail; otherwise the spiral blade will not lock.

14. Postoperative care

Postoperatively, apply a sterile, padded bandage. Stable conditions (A fractures) do not require immobilisation. Mobilisation should start immediately. Rotation exercises should begin after the third week only. In fractures involving the trochiter (B and C fractures) and/or in poor bone quality, immobilisation for three weeks is recommended.

15. Radiographic control

Make radiographic controls immediately after the intervention. Follow-up controls should be carried out after two, six, and twelve weeks; further controls according to the healing process.

Implant removal

Normally, the removal of the nail is not necessary, as the used titanium alloy (TAN = TiAl6Nb7) is not subject to corrosion.

Experience shows that the insertion hole and the nail are covered by callus. If, however, removal of the nail is still desired, this callus formation requires careful dissection.

1. Remove end cap and locking implants

Remove the ingrown tissue from the hexagonal socket of the end cap, the locking bolts or the spiral blade. Use the small hexagonal Screwdriver (314.570) to remove the end cap with 0mm extension. Remove end caps with 5mm to 15mm extension with the large hexagonal Screwdriver (314.270). Use the large hexagonal Screwdriver and the Holding Sleeve (314.280) to remove all locking bolts or spiral blades, except one.

To extract the spiral blade, firmly attach the inserter with the connecting screw for spiral blade to the spiral blade, and use the hammer to remove the blade.

Attach the Coupling Block for extraction (359.021) with the Connecting Screw for UHN (358.540) to the nail before removing the remaining locking bolt or spiral blade. This prevents the nail from rotating or slipping.

Thread the Impactor/Extractor for UTN/CTN and UHN (356.490) into the connecting screw.

2. Remove nail

Remove the remaining locking bolt or spiral blade, and extract the nail using light hammer blows with the Slotted Hammer (332.200).

Case examples

1.

a Short oblique fracture of the humerus, AP and lateral

b Retrograde insertion of a 7.5mm UHN, interfragmentary compression, static locking, postoperative, AP and lateral

c Consolidation of the bone after 13 weeks, AP and lateral

a

b

c

2.

a Spiral fracture of the humerus after trivial trauma in a patient with years of cortisone therapy, conspicuously large medullary cavity, AP and lateral

b Retrograde insertion of a 9.5mm UHN, static locking, postoperative, AP and lateral

c Consolidation of the bone after 16 weeks, AP and lateral

a

b

c

3.

a Pathologic fracture of the humerus shaft in metastatic spreading due to mammary carcinoma, AP

b Antegrade insertion of a 7.5mm UHN, proximal oblique static locking, AP and lateral

c Situation after 6 months, AP and lateral

a

b

c

4.

a Proximal spiral fracture of the humerus shaft involving the trochiter - preoperative images

b Treatment using 7.5mm UHN and spiral blade, immediately postoperative x-ray images

c X-ray images after 5 months show fracture consolidation.

a

b

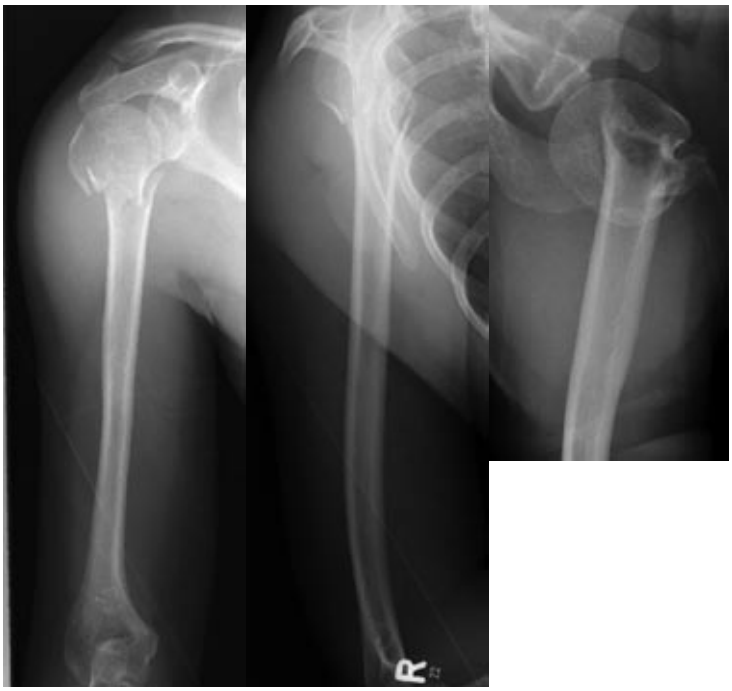
c

5.

a Subcapital humerus fracture - preoperative images

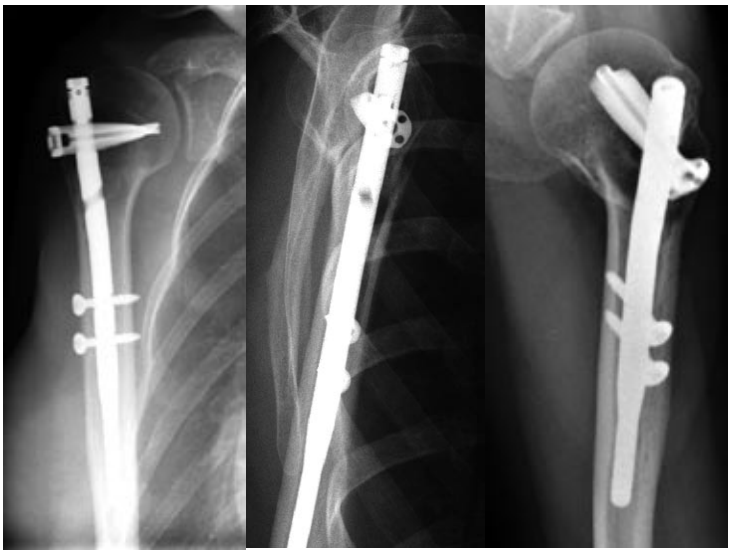
b Treatment with PHN and spiral blade - postoperative images

c X-ray images after 3 months with fracture consolidation



a

b



c

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175.430 Humeral Nail Instrument Set in SYNCASE

			Number of units in 175.430:
	292.260	**Kirschner Wire, 2.5mm dia., with trocar tip,** length 280mm	4
	292.650	**Guide Wire, 2.0mm dia., with threaded tip**	1
	310.440	**Drill Bit, 4.5mm dia.,** length 145/120mm, 2-flute, for quick coupling	2
	**312.460**	**Double Drill Sleeve 4.5/3.2**	1
	**314.060**	**Holding Sleeve** for end caps with 0mm extension	1
	**314.270**	**Screwdriver, hexagonal, large, with groove,** length 240mm, for locking bolts	1
	**314.570**	**Screwdriver, hexagonal, small** for end caps with 0mm extension	1
	315.330	**Drill Bit, 3.2mm dia., calibrated,** length 210/185mm, 3-flute, for quick coupling	3
	**319.010**	**Depth Gauge for screws**	1
	**321.200**	**Ratchet Wrench, 11mm**	1

			Number of units in 175.430:
	**332.062**	**Router, length 130mm** for quick coupling	1
	**332.200**	**Slotted Hammer**	1
	**351.120**	**Awl with T-Handle, cannulated,** straight	1
	**355.700**	**Protection Sleeve 11.0/8.0**	1
	**355.722**	**Drill Sleeve 8.0/3.2, blue**	1
	**355.750**	**Trocar, 8.0mm dia.**	1
	**355.180**	**Driving Head**	1
	**356.490**	**Impactor/Extractor for UTN and UHN**	1

			Number of units in 175.430:
	**358.540**	**Connecting Screw for UHN**	1
	**358.590**	**Radiographic Ruler for UHN**	1
	**358.600**	**Compression Device for UHN**	1
	**358.610**	**Compression Connecting Screw**	1
	**358.679**	**Insertion Guide Attachment for Spiral Blade Locking**	1
	**358.682**	**Projectile Reamer, 10mm dia.** for quick coupling	1
	**358.686**	**Trocar, 2.0mm dia.**	1
	**358.688**	**Protection Sleeve 14.0/4.5**	1
	**358.689**	**Aiming Arm for Standard Locking**	1
	358.691	**Drill Bit, 4.5mm dia., cannulated**	1

			Number of units in 175.430:
	**358.692**	**Insertion Handle for UHN**	1
	**358.694**	**Drill Sleeve 4.5/2.0**	1
	**358.696**	**Inserter for UHN Spiral Blade**	1
	**358.697**	**Connecting Screw for UHN Spiral Blade**	1
	**358.698**	**Measuring Device for UHN Spiral Blade**	1
	**359.021**	**Coupling Block for extraction**	1
	**359.026**	**Drill Sleeve 8.0/2.7, pink**	1
	359.031	**Drill Bit, 2.7mm dia., calibrated**	2

SYNCASE

675.430 SYNCASE for Humeral Nail Instrument Set, without contents

675.431 Tray, bottom,
for Humeral Nail Instruments

675.432 Tray, top,
for Humeral Nail Instruments

675.433 SYNCASE Lid,
for Humeral Nail Instruments

675.440 SYNCASE for Humeral Nail Implants, without contents

675.441 Tray, bottom,
for Humeral Nail Implants

675.442 Tray, top,
for Humeral Nail Implants

675.443 SYNCASE Lid,
for Humeral Nail Implants

Implants

Unreamed Humeral Nails, blue, TAN

6.7mm dia.	7.5mm dia.	9.5mm dia.	
Item no.	**Item no.**	**Item no.**	**Length**
462.619	462.719	462.919	190mm
462.620	462.720	462.920	205mm
462.622	462.722	462.922	220mm
462.623	462.723	462.923	230mm
462.624	462.724	462.924	240mm
462.625	462.725	462.925	250mm
462.626	462.726	462.926	260mm
462.627	462.727	462.927	270mm
462.628	462.728	462.928	280mm
462.629	462.729	462.929	295mm
462.631	462.731	462.931	310mm
462.632	462.732	462.932	325mm

3.4mm Locking Bolts, self-tapping, pink, TAN

Item no.	**Length**	**Item no.**	**Length**
462.416	16mm	462.440	40mm
462.418	18mm	462.442	42mm
462.420	20mm	462.444	44mm
462.422	22mm	462.446	46mm
462.424	24mm	462.448	48mm
462.426	26mm	462.450	50mm
462.428	28mm	462.452	52mm
462.430	30mm	462.454	54mm
462.432	32mm	462.456	56mm
462.434	34mm	462.458	58mm
462.436	36mm	462.460	60mm

3.9mm Locking Bolt, self-tapping, blue, titanium alloy

Item no.	Length	Item no.	Length
458.160	16mm	458.400	40mm
458.180	18mm	458.420	42mm
458.200	20mm	458.440	44mm
458.220	22mm	458.460	46mm
458.240	24mm	458.480	48mm
458.260	26mm	458.500	50mm
458.280	28mm	458.520	52mm
458.300	30mm	458.540	54mm
458.320	32mm	458.560	56mm
458.340	34mm	458.580	58mm
458.360	36mm	458.600	60mm
458.380	38mm		

End Cap for UHN, blue, titanium alloy

Item no.	Extension
462.950	0mm
462.955	5mm
462.960	10mm
462.965	15mm

End Cap for Spiral Blade, golden, titanium alloy

Item no.	Extension
462.660	0mm
462.665	5mm
462.666	10mm

Proximal Humeral Nail, titanium alloy

7.5mm dia. reddish yellow	8.0mm dia. reddish yellow	
Item no.	**Item no.**	**Length**
462.969	462.971	150mm

Spiral Blade for 7.5mm/9.5mm UHN and 7,5mm/8,0mm PHN, golden, titanium alloy

Item no.	Length
462.634	34mm
462.636	36mm
462.638	38mm
462.640	40mm
462.642	42mm
462.644	44mm
462.646	46mm
462.648	48mm
462.650	50mm
462.652	52mm
462.654	54mm

Spiral Blade for 6.7mm UHN, pink, titanium alloy

Item no.	Length
462.672	32mm
462.674	34mm
462.676	36mm
462.678	38mm
462.680	40mm
462.682	42mm
462.684	44mm
462.686	46mm
462.688	48mm

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