Less Invasive Stabilization System (LISS)

TECHNIQUE GUIDE

Distal Femur

SYNTHES®

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

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Foreword

Plate osteosynthesis in accordance with AO ASIF principles has resulted in improved restoration of full function to the injured limb and mobility to the patient. Infection, refracture, delayed union, and the need for bone graft are not uncommon, although the majority of fractures heal without complication. These complications may be the result of surgical techniques which impair the normal blood supply to bone and soft tissue (see "References," p. 37). Developments such as closed, indirect reduction techniques; implants with minimal bone contact; development of internal fixators; and further advances in the area of extramedullary force carriers have evolved in order to limit soft tissue disruption and preserve the blood supply.

The Less Invasive Stabilization System (LISS) is an extramedullary, internal fixation system that has been developed to incorporate these technical innovations and surgical techniques. Its main features are an atraumatic insertion technique, minimal bone contact, and a locked, fixed-angle construct.

Biomechanics of Unicortical, Locked Screws

Traditional Compression Plating

Traditional bone screws in plates have relied on two forces to create stable fixation: compression between opposing cortices and friction between the plate and bone caused by the screw. A tensile force is generated along the axis of the screw. This tensile force relies on the shear strength of the bone at the screw-thread interface. In particularly hard bone, higher forces can be generated, whereas in softer, osteopenic bone, the shear strength is lower and more susceptible to stripping.

As the screw is tightened, its increasing tensile force creates increasing compressive force between the plate and bone. This compression generates a friction force between the bone and plate. Applied load is transferred from the bone to the plate, across the fracture, and back to the bone. A tight frictional interface is key to the load transmission. As long as the applied (patient) load is less than the frictional force, the construct will remain stable.

Although a bicortical screw has inherent angular stability, when the patient load exceeds the maximum friction available, some collapse across the fracture gap results. This collapse is due to the lack of angular stability between the plate and the screw.

Locked Screw-Plate Constructs

Traditional unicortical bone screws have lower load carrying capability than bicortical screws. However, if a unicortical screw is locked to the plate, its load carrying capacity increases due to the angular stability. This locked screw-plate connection provides the path for load transmission to the plate. When comparing the load applied to a locked screw with a conventional screw, both screws are subjected to the same patient load. However, load on the bicortical, non-locked screw is always higher due to the initial tightening required to generate friction between the plate and the bone, which ensures stability of the construct.

In conventional plating, even though the bone fragments are correctly reduced prior to plate application, if the plate does not fit the bone, the result will be fracture dislocation. If a locked internal fixator is applied to a reduced long bone fracture, the alignment is maintained by the locked screw construct. A locked internal fixator functions as a splint, which relies on relative stability for secondary healing and callus formation. However, this implant does not inherently reduce or align the fracture during its placement (as with a nail). The implant locks the bone segments in their relative positions regardless of how they are reduced. Preshaping the plate minimizes the gap between the plate and the bone, but an exact fit is not necessary for implant stability.

A conventional plate must be tightened against the bone in order to generate the frictional forces needed for stability. This compresses the periosteum between the plate and the bone and theoretically compromises blood flow in the area of plate contact. With a locked internal fixator, the plate is not compressed against the bone, thus reducing or avoiding constriction of the local blood supply.

LISS offers a locking internal fixator construct for use in the distal femur. In addition, the availability of an Insertion Guide allows percutaneous targeting of screws through stab incisions. The Insertion Guide also ensures that all screws will be properly inserted and locked to the plate.

Traditional Plating and Locked Internal Fixators Comparison

Traditional Plating	Locked Internal Fixators
• Screws tighten plate to bone to generate compression	• Screws lock to the plate
• Screw threads in bone are under a load applied intraoperatively	• Screws inserted into bone with minimal axial preload
• Patient loads (weight and movement) add to the amount of preload on the bone/plate/screw construct	• No stress in the system (bone or plate) prior to patient loads

Indications

For fixation of fractures in the distal femur:

- Extra-articular or distal diaphyseal fractures
- Complete intra-articular fractures including those with associated coronal fractures
- Periprosthetic fractures

Distal diaphyseal fracture (AO 33-C3), AP, preoperative

Distal diaphyseal fracture (AO 33-C3), lateral, preoperative

Intra-articular fracture (AO 33-C3), AP, preoperative

Intra-articular fracture (AO 33-C3), lateral, preoperative. Medial and lateral Hoffa fractures are nondisplaced.

Supracondylar periprosthetic fracture (AO 33-C3) AP, preoperative

Supracondylar periprosthetic fracture (AO 33-C3) lateral, preoperative

Case Examples

CASE 1

Complex articular fracture

Female, 47 years old, AO classification 33-C3 with pulmonary contusion and contralateral traumatic knee arthrotomy.

Preoperative frontal plane CT of distal femur demonstrates intercondylar notch fragment.

Preoperative AP

Preoperative oblique demonstrates multiplane articular involvement.

Three-month postoperative AP shows callus formation. Patient begins weight bearing at this time.

Three-month postoperative lateral

Case Examples (continued)

CASE 2

Periprosthetic fracture

Female, 62 years old, AO classification 33-A2 above a total knee arthroplasty.

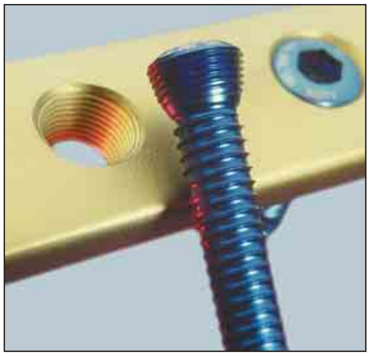
Preoperative traction AP

Preoperative traction lateral; no signs of femoral component loosening

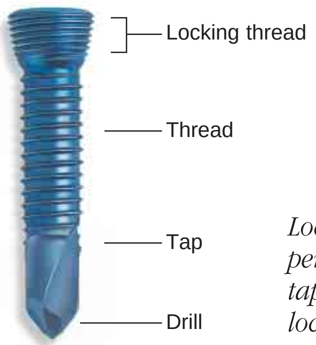
Three-month postoperative AP with significant fracture consolidation. Patient begins weight bearing at this time.

Three-month postoperative lateral

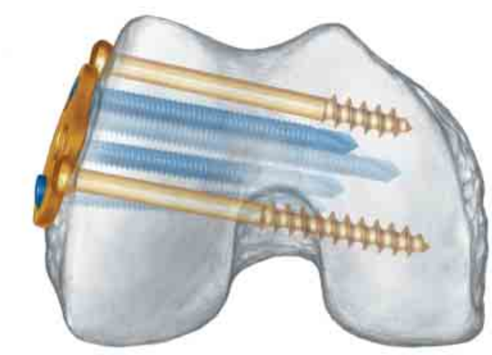
System Features



Unicortical locking screws offer angular stability for optimal purchase and reduced stress on the bone.



Locking screws perform drilling, tapping and locking to the plate.

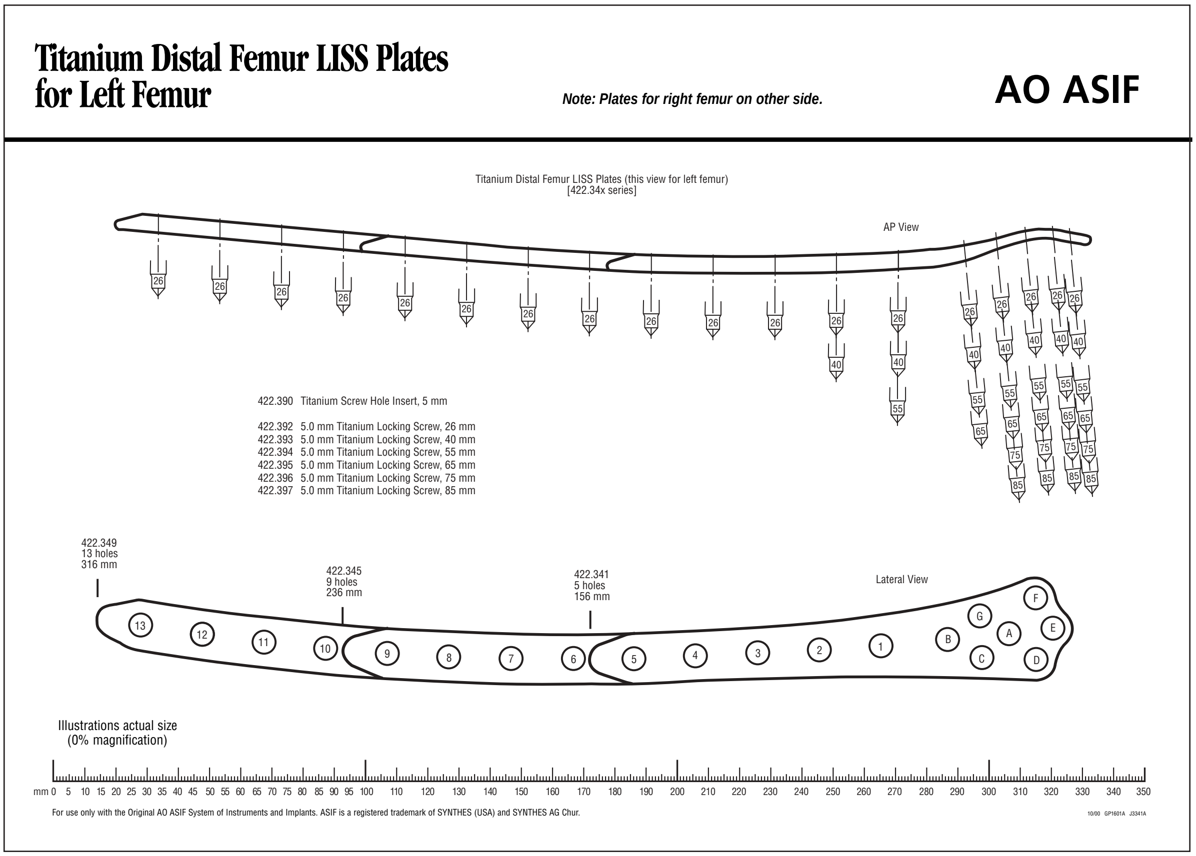


Optimized screw position in the condyles to avoid intercondylar notch and patellofemoral joint and maximize bone purchase.

Anatomic shape of the plate and locked construct makes intraoperative contouring unnecessary. Percutaneous, submuscular insertion of the plate does not disrupt the cortical blood supply.

Preoperative Planning

Use the AO ASIF Preoperative Planning Template to determine length of the plate and position of the screws. In general, LISS plate length and screw positions are selected similarly to external fixator determinations. At least four (4) screws should be placed in the intact shaft proximal to the fracture. The selected LISS plate should be longer than a traditional plate.

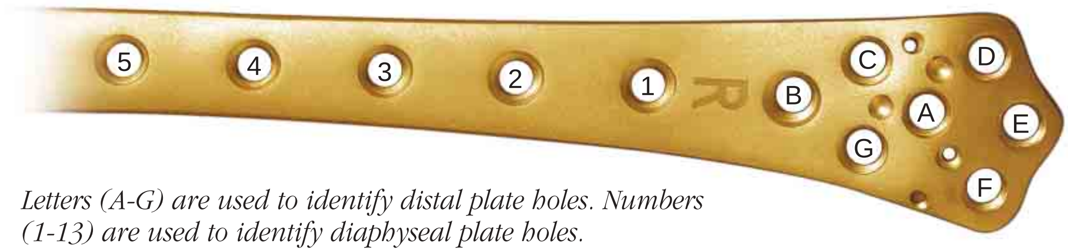


Screw Hole Inserts

The Preoperative Planning Template is also used to determine which plate holes will be located at the fracture site. To prevent tissue in-growth and facilitate implant removal, 5.0 mm Screw Hole Inserts [422.390] may be used to fill plate holes that will not be used. Screw Hole Inserts should be placed prior to plate insertion and the corresponding Insertion Guide [324.011 or 324.012] holes marked with Stoppers [324.019]. If a screw must replace a screw hole insert intraoperatively, the insert can easily be removed through an Insertion Sleeve [324.022].

Screw Selection

Plate shape, and screw angles and lengths were developed from Computerized Tomography (CT) of cadaver bones. As a result, a reference measurement guide for distal screws, below, was developed. Alternately, screw lengths may be determined by measurement over a Kirschner wire (see “Measuring for distal screw length” on page 25) or direct measurement from X-ray.



Letters (A-G) are used to identify distal plate holes. Numbers (1-13) are used to identify diaphyseal plate holes.

Determining distal screw lengths (alpha holes A–G)

Measure the maximum condyle width in AP projection of the uninjured limb. This can be measured directly from an X-ray or using a 2.0 mm Kirschner Wire, 280 mm [292.699] through the 2.0 mm Kirschner Wire Insertion Sleeve [324.055] and the 2.0 mm Kirschner Wire Measuring Device [324.037]. If injured femoral condyles are not intact, a measurement can be obtained from the contralateral femur.

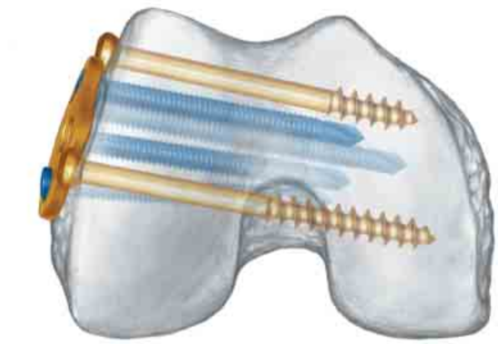
Alternate: Use the additionally available X-Ray Calibrator [324.056] to determine magnification factor. The X-Ray Calibrator is 50 mm wide and can be used as a reference measurement to determine X-ray magnification. With the calculated magnification factor, a measurement from an X-ray can be used more accurately to calculate the actual width of the condyles.

Select condylar screw lengths (A-G) from the chart below.

Width of Condyles	60–80 mm	81–87 mm	88–95 mm	96–110 mm
Screw Selection for	**Screw Length (mm)**			
Hole A	65	75	75	85
Hole B	40	40	55	65
Hole C	40	55	65	75
Hole D	55	65	65	75
Hole E	65	75	75	75
Hole F	65	75	75	85
Hole G	55	65	75	85

Screw Selection (continued)

The recommended distal screw lengths and angles ensure that screws do not penetrate the far cortex or the intercondylar notch when the plate is placed properly. The screw lengths may be adjusted as necessary based on plate position and patient anatomy.



Proper placement of the LISS plate on the lateral condyle is essential for correct length and position of locking screws.

In the diaphysis, 26 mm screws are generally used. If the plate is off the bone by more than a few millimeters, 40 mm screws may be necessary. In the case of very thick or dense cortical bone, refer to page 32 for additional screw insertion information.

Patient Positioning

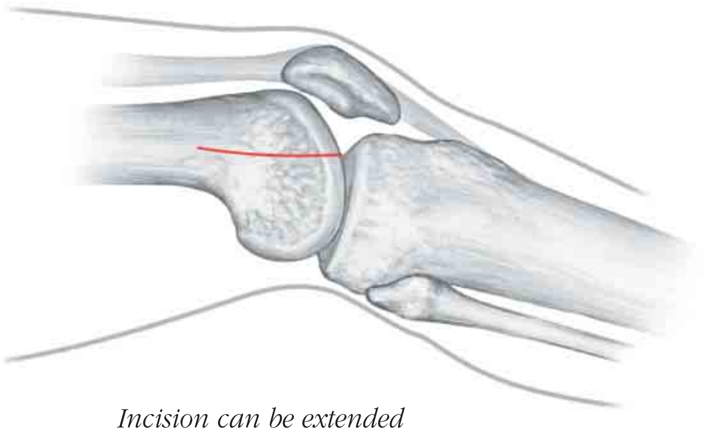
Place the patient in supine position on a radiolucent table. Adequately support the knee, but allow the leg to move freely. It may be helpful to place a small bump under the patient's buttock on the injured side. It is also important to ensure a true lateral fluoroscopy of the femur can be obtained in this position.

Avoid strong traction and a fully extended knee because forces of the gastrocnemius muscle will create recurvatum of the distal fragment. To reduce the muscle forces of the gastrocnemius, flex the leg approximately 20–40°. (See "Reduction" section for more information.)

Incision

Lateral Incision

A lateral incision is recommended when a simple articular (AO classification 33-C1) or extra-articular fracture (AO classification 32 or 33A) is present. Skin incision starts at Gerdy's tubercle and extends about 80 mm in a proximal direction.



Incision can be extended distally if necessary.

Lateral Parapatellar Incision

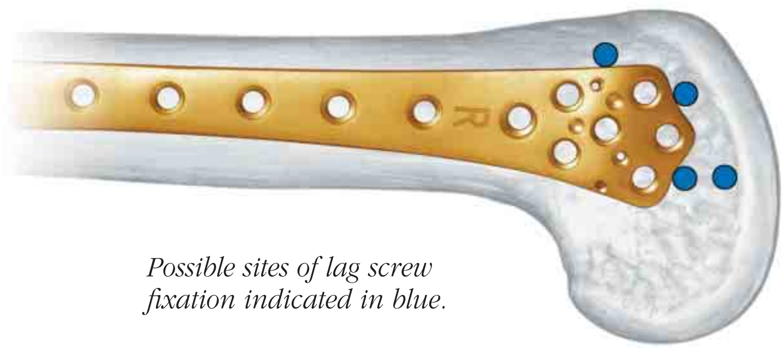
In the presence of a complex intra-articular fracture (AO classifications 33-C2 or C3), perform a lateral parapatellar approach. Perform arthrotomy to expose joint for reduction. Evert the patella and extend incision for adequate exposure of the joint for reduction and anatomic fixation.

Split the iliotibial band in line with the fibers. Define the distal margin of the vastus lateralis muscle. Open the space between the vastus lateralis and the periosteum. The plate is inserted into the virtual space between the periosteum and the muscle.

Note: *In rare instances, it may be determined that a closed insertion procedure is not appropriate. The LISS plate may be applied in an open procedure to take advantage of the low-contact plate and fixed-angle construct. This is also a useful technique when reduction cannot be achieved otherwise.*

Reduction

Articular fracture reduction must be complete prior to placement of the LISS plate. Lag screws are used to reduce the articular surface. Screw placement should take the preoperative plan for LISS plate and locking screw locations into account. The figure below shows possible sites for lag screws placed around the LISS plate. (These screws may also be placed medially to laterally.)



Possible sites of lag screw fixation indicated in blue.

Before locking screws are placed in each main fragment, length, rotation, varus-valgus and recurvatum correction should be achieved. Extra-articular reduction is accomplished by indirect means (e.g., external fixator, distractor, traction, joysticks, bumps, etc.). The metaphyseal/diaphyseal component of the fracture can be aligned by manual traction, a knee-bridging fixator, or a distractor. Anteromedial insertion of a Schanz screw can help manipulate the distal fragment as a "joystick." (The use of two Schanz screws will prevent fragment rotation.) The Pull Reduction Instrument [324.033] is available to aid in minor varus-valgus and translation corrections prior to screw placement. (See "Final Adjustment of Extra-articular Reduction.")

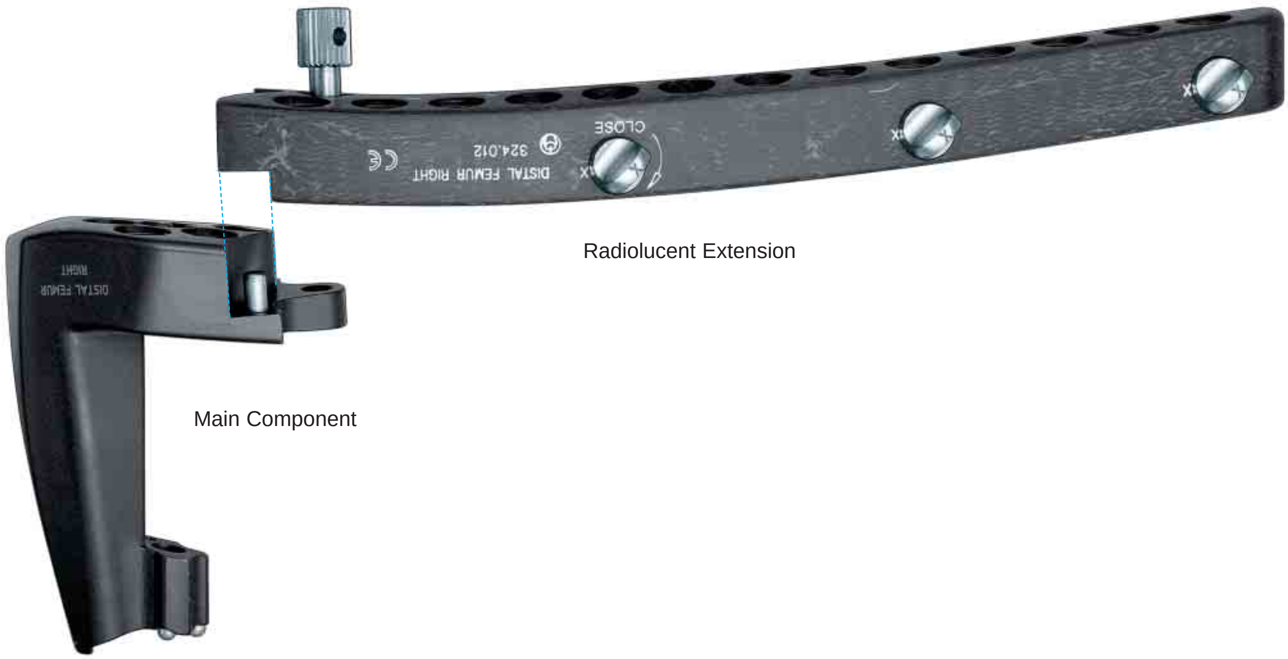
Perform reduction under C-arm guidance and assess in both the AP and lateral views. Confirm reduction prior to plate insertion. Because of the gastrocnemius muscle's pull, the distal fracture fragment may be in hyperextension on the lateral projection. If distal fragment orientation is not confirmed, the fixation may be inadvertently malpositioned. Bumps placed under the distal femur are useful in counteracting this hyperextension deformity.

An external fixator can serve as preliminary fixation. This will not only make operative reduction easier, but the fixator can also be used as a tool intraoperatively.

Example of a possible external fixator frame to facilitate reduction of length, rotation, recurvatum, and varus-valgus.

Instrument Assembly for Insertion

1 Assemble Distal Femur LISS Insertion Guide [324.011] left, or [324.012] right, main component and radiolucent extension.



2 Insert the Fixation Bolt [324.043] through hole A of Insertion Guide by advancing the knurled nut on the Fixation Bolt fully against the knurled head of the bolt.

Note: *Letters (A-G) are used to identify distal plate holes and numbers (1-13) are used to identify diaphyseal plate holes.*

3 Align the three points of the Insertion Guide with the corresponding three points on the plate.

4 Screw the Fixation Bolt into the LISS plate using top segment of bolt. Final tightening is completed with a quarter turn of the Pin Wrench [321.17].

5 Screw the nut on the Fixation Bolt toward the Insertion Guide to stabilize the attachment between guide and LISS plate. Final tightening is completed with a quarter turn of the Pin Wrench.

6 If desired, insert a Stabilization Bolt [324.044] with Insertion Sleeve for 5.0 mm screws [324.022] into an adjacent alpha (B–G) hole for a more stable attachment of plate to Insertion Guide. This offers greater stability if there is resistance from soft tissue or fracture fragments during insertion.

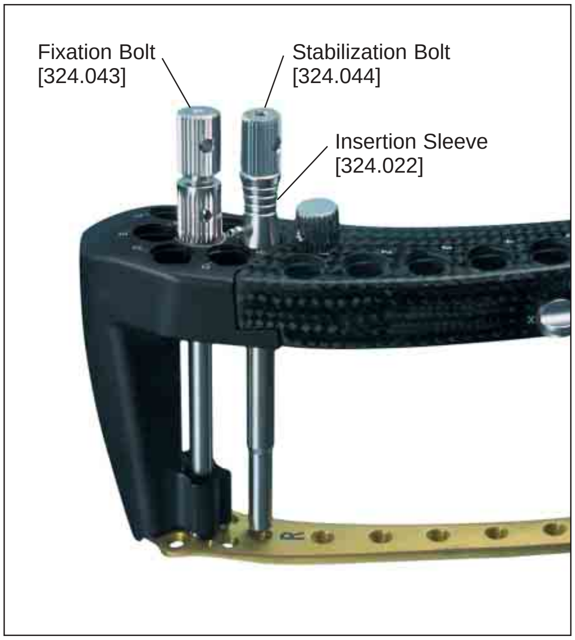
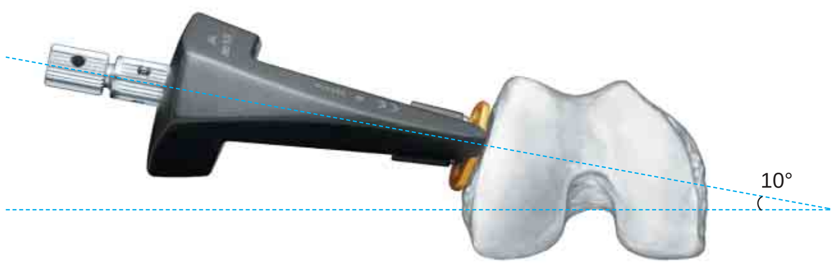


Plate Insertion

1 Insert the plate

Insert the plate between vastus lateralis muscle and periosteum. Keep the proximal end of plate in constant contact with bone during insertion. Place the distal end of the plate against lateral condyle.

The Insertion Guide may interfere with the soft tissues when using a 5-hole plate or in large patients. In such cases, remove the proximal, radiolucent portion of the guide to aid insertion.

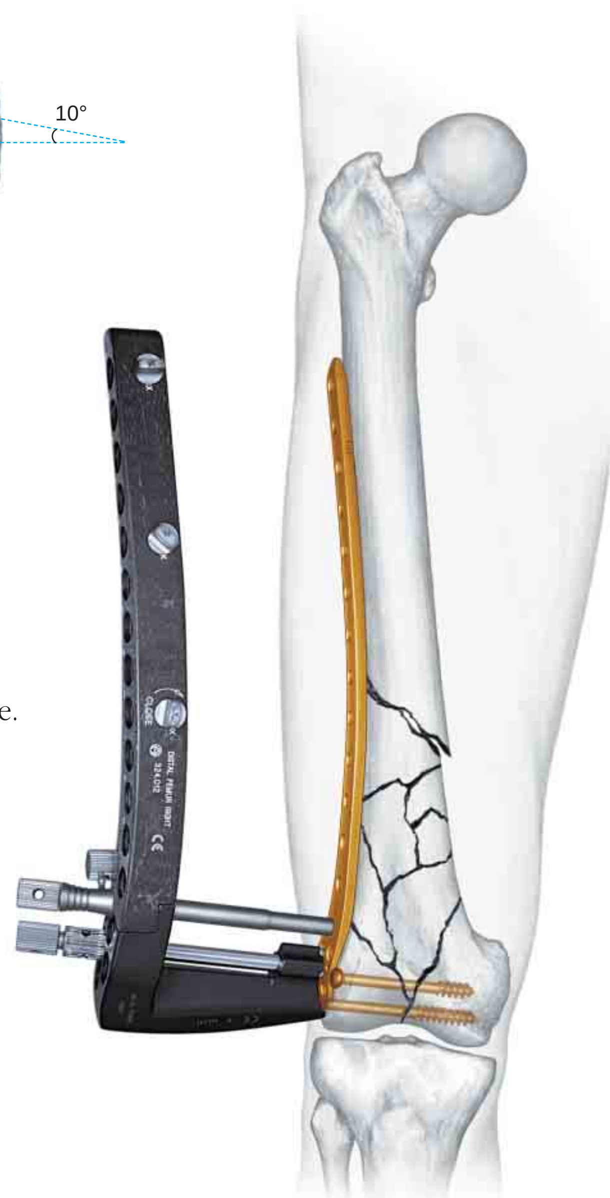


2 Check plate orientation

Due to its weight, the Insertion Guide has a tendency to tilt toward the floor (i.e., externally rotate). When the Insertion Guide is positioned properly on the lateral condyle, the guide will be internally rotated approximately 10° to the femoral shaft.

3 Adjust plate position if necessary

To find proximal-distal plate placement, slide the plate proximally and then distally. Tactile feedback will indicate proper plate placement on the flange of the lateral condyle.



4 Insert K-wire through Fixation Bolt

Insert a 2.0 mm Kirschner Wire [292.699] through the cannula of the Fixation Bolt to provide preliminary fixation of plate.

Notes:

A K-wire placed through the Fixation Bolt will be parallel to the joint in AP view when the fracture is reduced. Due to the type of fixation, if the wire is not parallel, the implant will not affect the existing reduction.

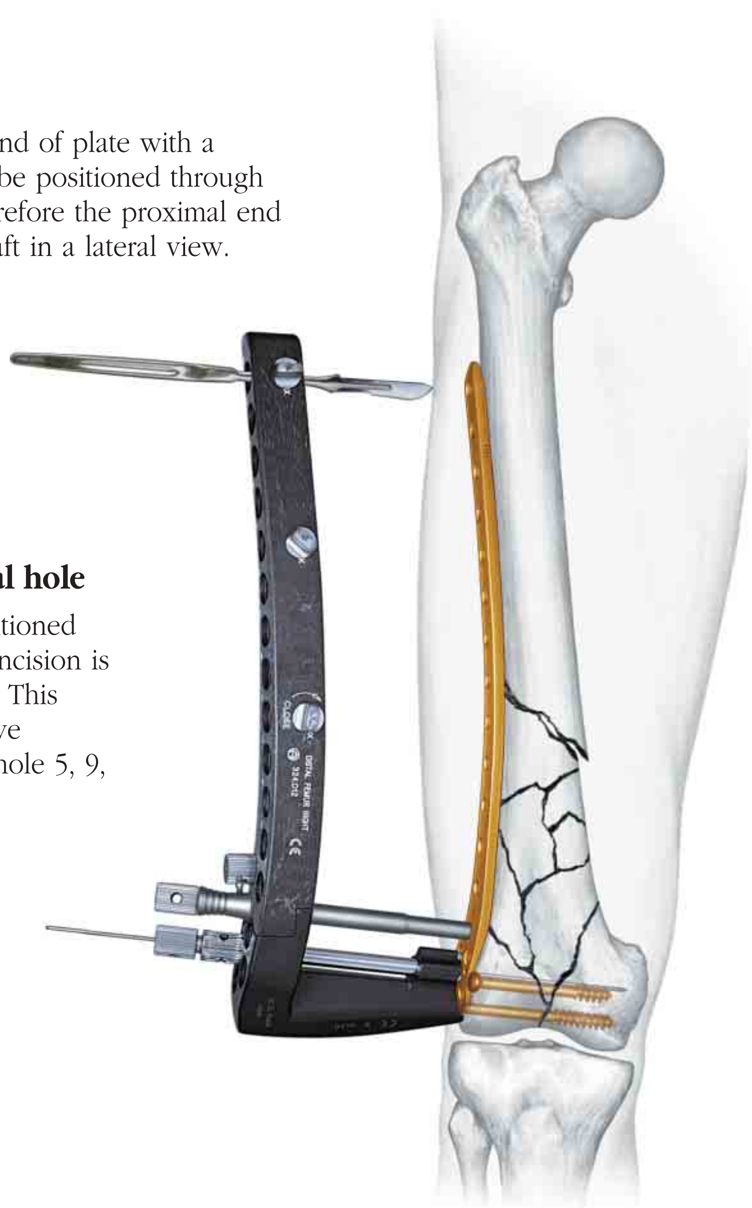
A K-wire placed through hole E can be used to check proximal-distal location of plate in relation to condylar notch.

5 Confirm plate position

Confirm proper position of the proximal end of plate with a lateral X-ray. The diaphyseal screws must be positioned through the center of the intramedullary canal; therefore the proximal end of the plate should be centered on the shaft in a lateral view.

Alternate:

Direct palpation through a slightly elongated proximal incision or probing with a K-wire can also be used to check plate location.



6 Make incision at most proximal hole

Once the plate has been inserted and positioned properly, with reduction reconfirmed, an incision is necessary at the most proximal plate hole. This location is marked using an Insertion Sleeve [324.022] with 5.0 mm Trocar [324.027] in hole 5, 9, or 13. Make an incision at this location.

Plate Insertion (continued)

7 Replace Insertion Sleeve and trocar

Through this stab incision, replace the Insertion Sleeve and trocar. Ensure that the Insertion Sleeve is fully seated in guide to avoid interposed soft tissue, which can keep the bolt from engaging with the plate. Secure the sleeve by tightening the nut on side of guide.

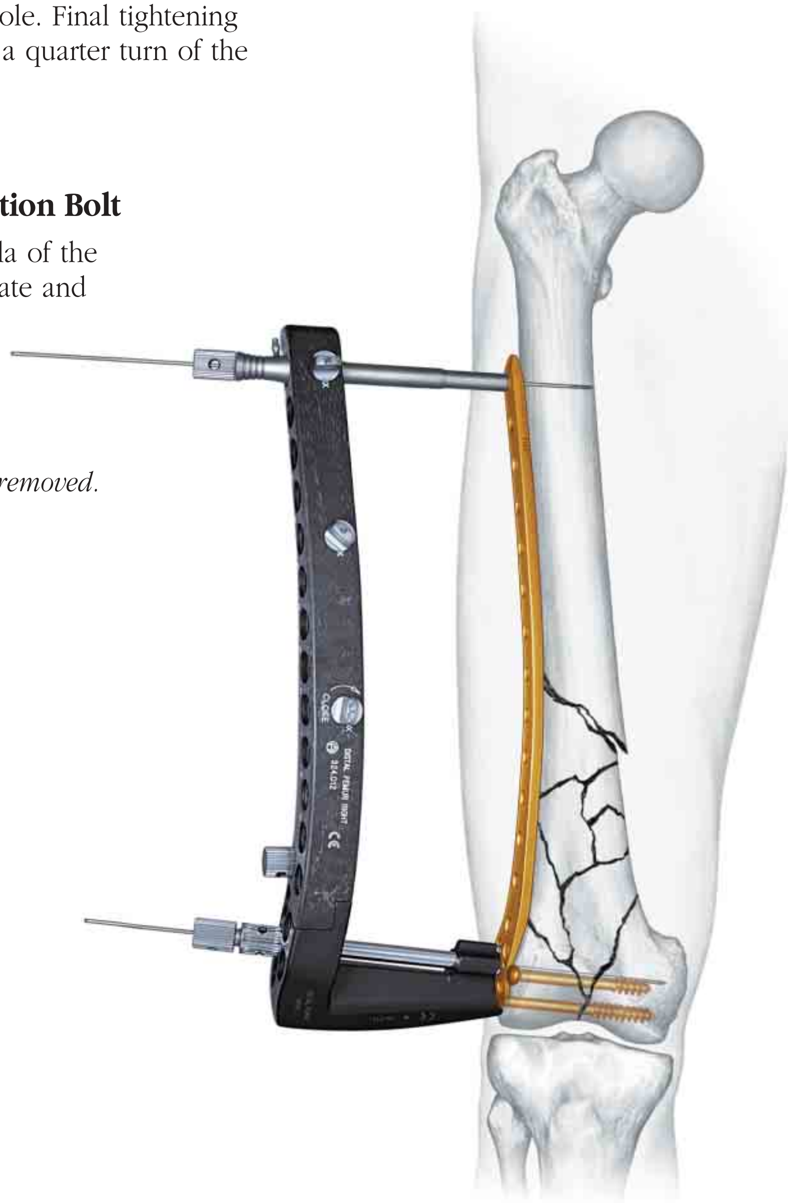
8 Remove trocar; tighten Stabilization Bolt

Remove trocar and close plate insertion frame by threading the Stabilization Bolt into the proximal plate hole. Final tightening of the Stabilization Bolt is completed with a quarter turn of the Pin Wrench.

9 Insert K-wire through Stabilization Bolt

Insert a 2.0 mm K-wire through the cannula of the Stabilization Bolt. Check position of the plate and reduction of injured limb. Complete reduction and confirm plate position prior to placing initial screws.

Note: *If a supplementary Stabilization Bolt was inserted in a distal hole, it may now be removed.*



Use of Pull Reduction Instrument

Additional varus-valgus correction can be completed prior to placement of locking screws in both main fracture fragments. The Pull Reduction Instrument [324.033] with quick coupling, is placed through guide and plate holes to pull or push bone fragments in relation to plate. This instrument can be used for:

- Minor varus-valgus adjustment (approximately 2–4°)
- Translational adjustments
- Stabilization of plate-bone orientation during insertion of the first screws
- Alignment of segmental fragments
- Predrill dense or thick cortical bone before placing a 5.0 mm locking screw to prevent screw drilling flutes from filling before the screw is fully inserted. (For options in dealing with dense or thick cortices, see page 32.)

Three Insertion Sleeves [324.022] are available in the set. The Stabilization Bolt [324.044] must be used with an insertion sleeve, and one must be reserved for locking screw insertion. If more than one Pull Reduction Instrument is used, insert the reduction instrument without the nut attached. The sleeve can be removed for use elsewhere, and the nut placed to tighten against guide.

1 Create a stab incision

Place the Insertion Sleeve and trocar in the Insertion Guide. Mark the location with skin impression. Remove the sleeve and trocar to create a stab incision.

2 Reinsert sleeve with trocar

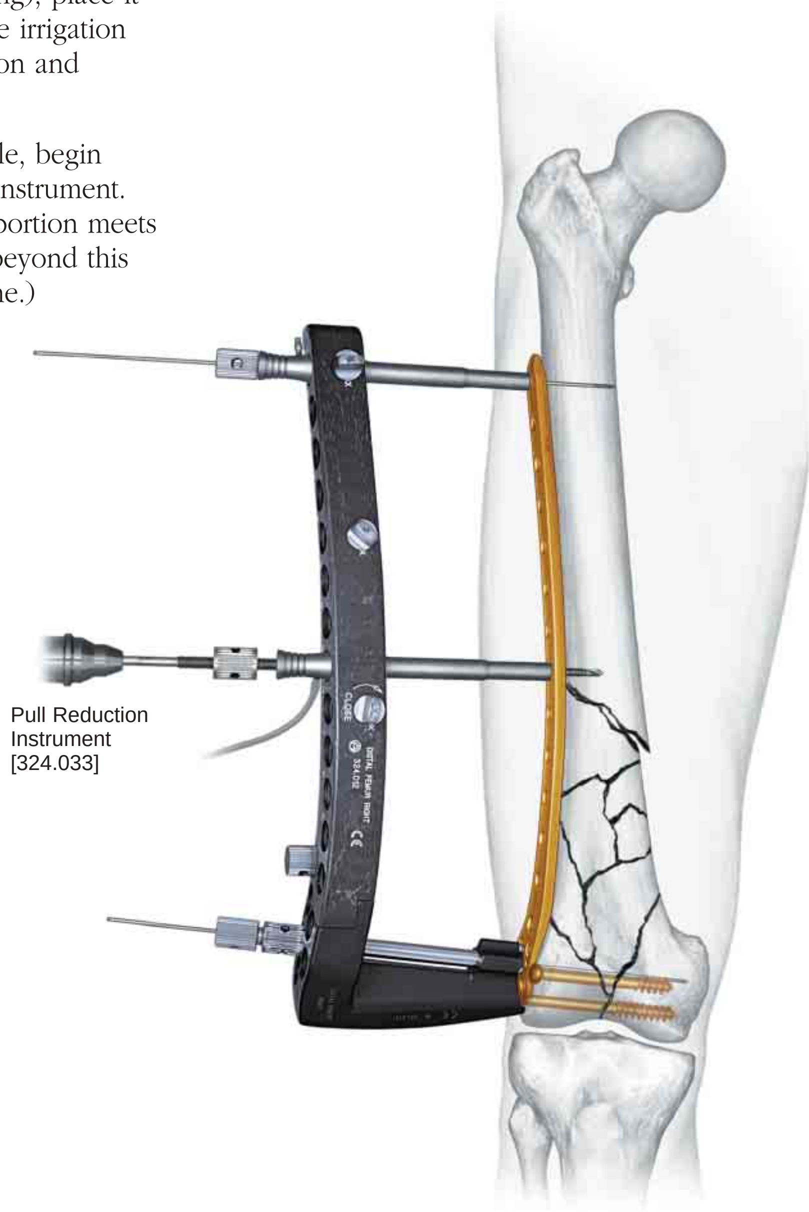
Reinsert the sleeve with trocar until it is fully seated to ensure that no soft tissue is interposed. Remove the trocar.

Use of Pull Reduction Instrument (continued)

3 Insert Pull Reduction Instrument through sleeve

When the Pull Reduction Instrument has been attached to a power tool (quick coupling), place it in desired position through sleeve. (Use irrigation method illustrated on page 31, "Irrigation and Cooling").

With the nut in highest position possible, begin power insertion of the Pull Reduction Instrument. Stop insertion before end of threaded portion meets plate surface. (Attempting to advance beyond this point may cause threads to strip in bone.)

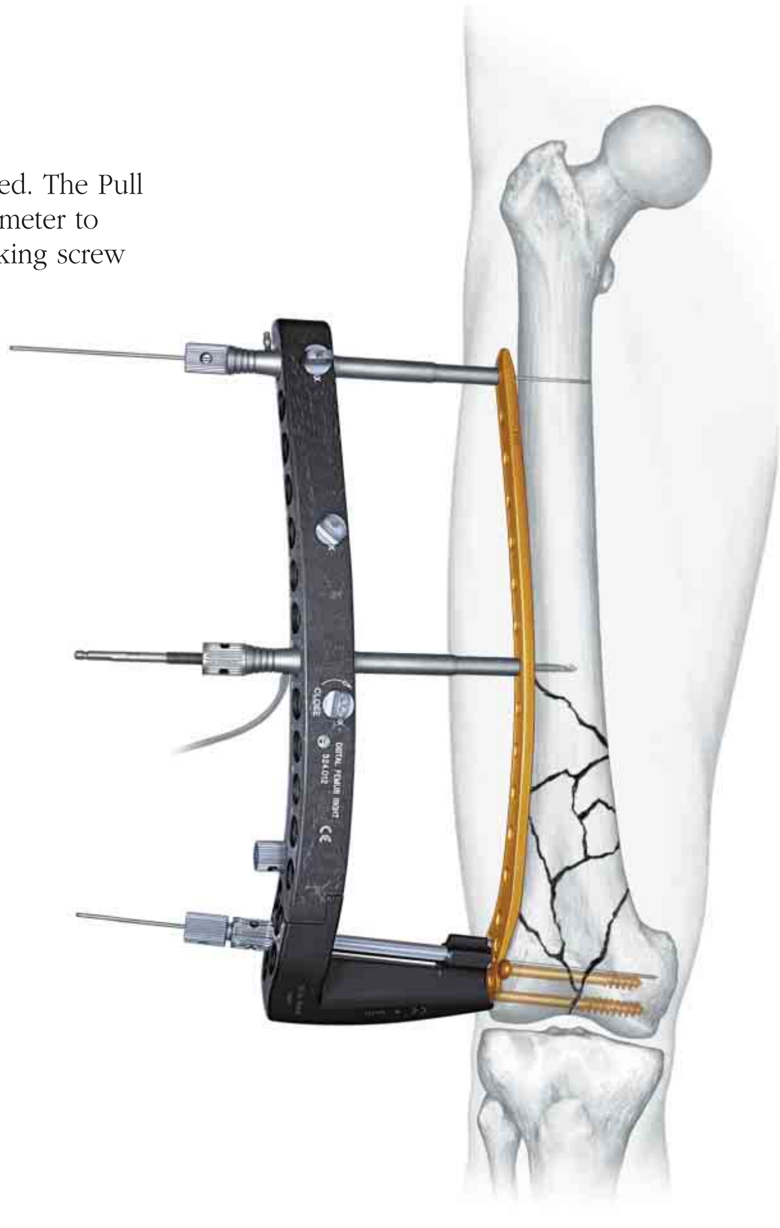


4 Remove power tool

Remove the power tool and begin tightening the nut toward the sleeve (or guide) while monitoring progress under C-Arm.

5 Reduce the fracture

Stop when desired reduction is achieved. The Pull Reduction Instrument is 4.0 mm in diameter to allow later placement of a 5.0 mm locking screw in the same hole.



Insertion of Locking Screws

Proper screw placement depends upon fracture type. Choose screw sites in accordance with biomechanical principles for external fixation: screws should be placed close to and away from the fracture. A minimum of four (4) screws is recommended in each main fracture fragment. (More screws may be appropriate in osteopenic bone.)

First, insert 5.0 mm Titanium Locking Screws (422.391–.397) distally, recheck reduction, and then place proximal screws. As with conventional distal femur plate fixation, check to ensure that the initial locking screws in the condyles (B–G) are parallel to the joint as seen in AP view. After final fracture alignment is confirmed, proceed with inserting the remaining locking screws as planned.

Note: *In the case of thick or dense cortical bone, refer to page 32.*

1 Make a stab incision

Place the insertion sleeve and trocar into the Insertion Guide. Mark location with skin impression. Remove the sleeve and trocar to create a stab incision.

2 Reinsert sleeve with trocar

Reinsert the sleeve with trocar to ensure that no soft tissue is interposed between the locking screw and plate hole. Remove the trocar.

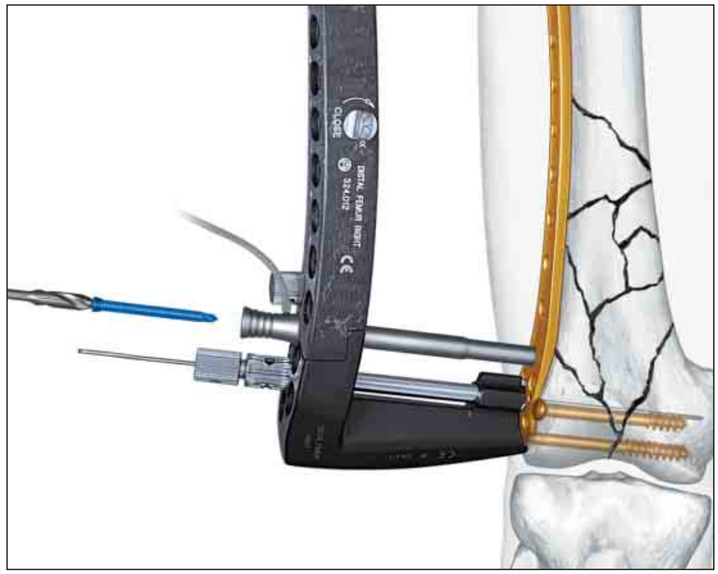
3 Attach 5.0 mm locking screw

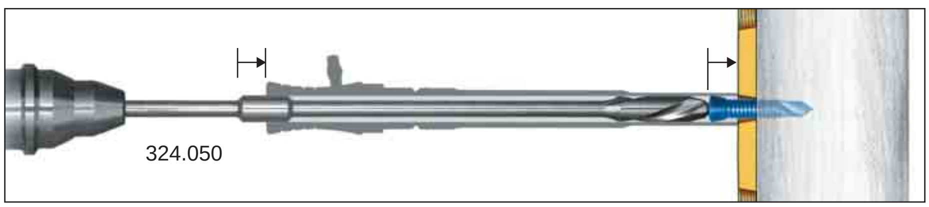
Attach a 5.0 mm locking screw to the 3.5 mm Hexagonal Screwdriver Shaft [324.050] until it snaps securely into place.

4 Insert 5.0 mm locking screw

Insert a 5.0 mm locking screw with high-speed power and limited axial pressure. Use irrigation method illustrated on page 31, “Irrigation and Cooling.”

Note: *Do not lock screws with power tools. Threaded plate-screw connections should be completed by hand.*



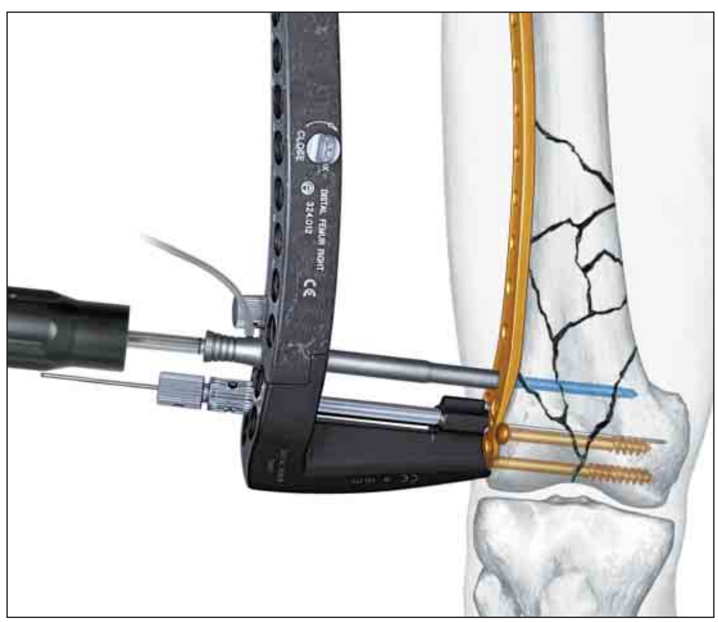


The shoulder of the hexagonal screwdriver shaft indicates the distance of the screw head from the plate. Stop power insertion before screw locks to plate.

5 Final tightening

For final tightening, use the Torque Limiting Screwdriver [324.052] to ensure torque applied reaches the minimum level necessary for locking. Screw heads should be flush with the plate surface.

Note: *In some instances, bone density or interposed soft tissue provides greater resistance to screw insertion than is normally expected. In order to ensure the screw head is flush with the plate and the screw is locked, additional tightening may be performed using the Large Hexagonal Screwdriver, [314.26 or 317.75].*



Insertion of Locking Screws (continued)

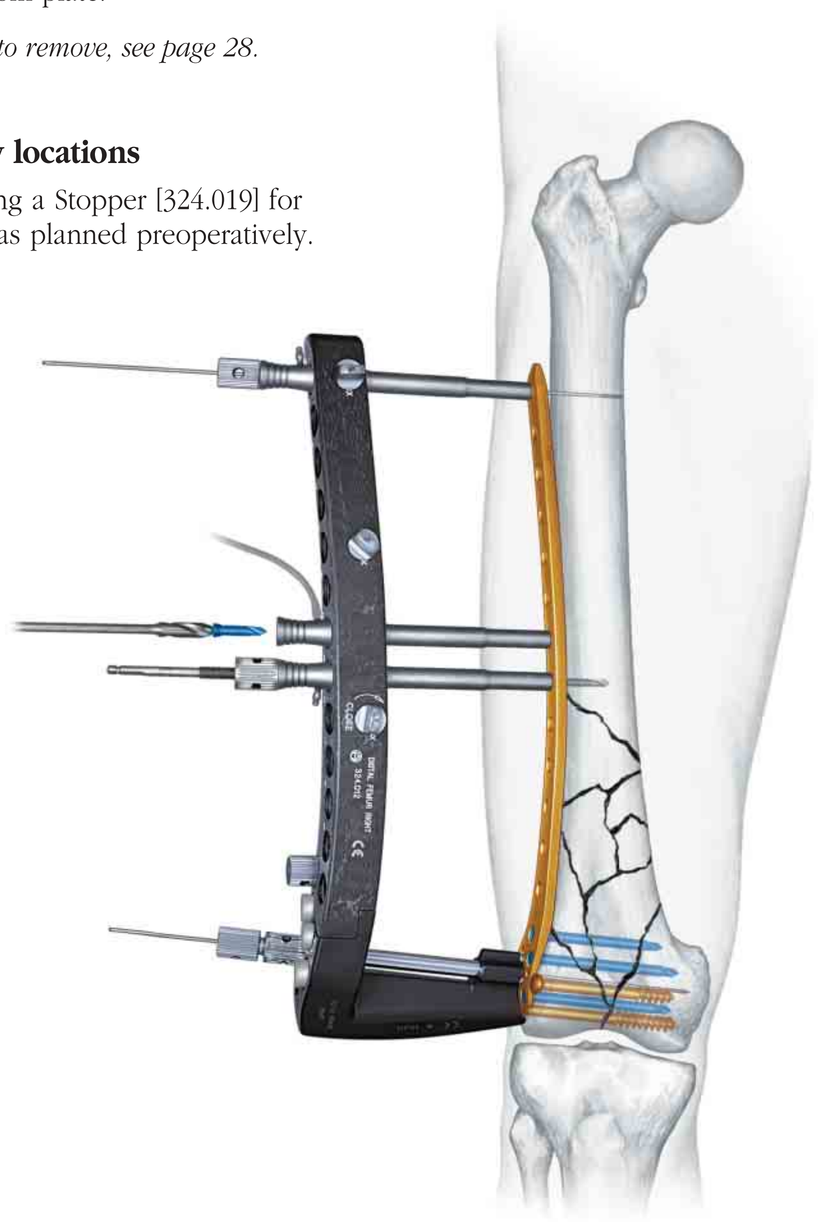
6 Insert diaphyseal screws

Place diaphyseal screws so that the drill tip passes through the center of intramedullary canal. (See page 30 for more information). It may be necessary to use the Pull Reduction Instrument to maintain plate-bone distance (see page 19). In dense bone, drilling action of initial screw will push bone away from plate.

Note: *If the screwdriver shaft is difficult to remove, see page 28.*

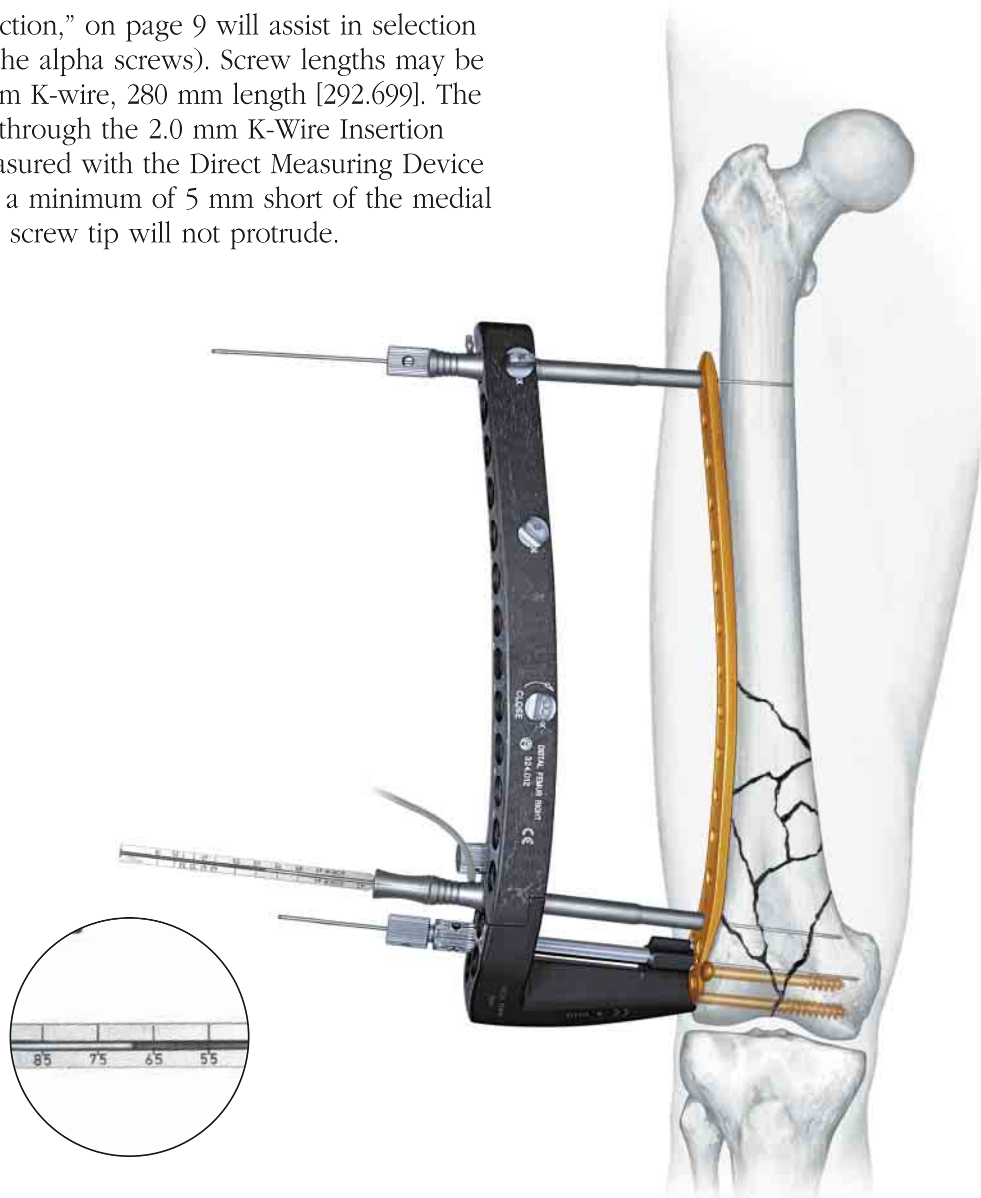
7 Use Stoppers to mark screw locations

Mark each screw location in guide using a Stopper [324.019] for reference as screw insertion proceeds as planned preoperatively.



Measuring for distal screw length

The chart in “Screw Selection,” on page 9 will assist in selection of distal screw lengths (the alpha screws). Screw lengths may be confirmed using a 2.0 mm K-wire, 280 mm length [292.699]. The wire should be inserted through the 2.0 mm K-Wire Insertion Sleeve [324.055] and measured with the Direct Measuring Device [324.037]. Wire is placed a minimum of 5 mm short of the medial cortex to ensure that the screw tip will not protrude.



Insertion of Locking Screws (continued)

Insertion of screws at locations of fixation or Stabilization Bolt

If preoperative planning determined that the proximal end hole or hole A requires a locking screw, follow instructions below. These steps ensure that the Insertion Guide remains aligned with the LISS plate for final screw insertion. When used, hole A must always be the last hole filled with a locking screw.

If a locking screw is not planned for hole A, it is recommended that a Titanium Screw Hole Insert [422.390] be inserted. This ensures that the guide can be reattached for implant removal.

Screw placed in most proximal hole

- The Stabilization Bolt is used in the proximal hole to stabilize the Insertion Guide and plate. Removal of the Stabilization Bolt disrupts orientation with remaining plate holes; therefore, this should be the last screw placed in the diaphysis.
- To insert the screw, remove the K-wire and then Stabilization Bolt with the Insertion Sleeve remaining. Without applying pressure to the Insertion Guide, insert a 5.0 mm locking screw. (For 9- or 13-hole plates, the Stabilization Bolt and insertion sleeve may be placed in holes 5 and 9 to stabilize the frame, if these holes are free of screws.)

Screw placed in hole A (always inserted last)

- The Fixation Bolt is the most important connection in stabilizing the Insertion Guide and plate. Once removed, it is difficult to reattach the guide to the plate and, therefore, orientation between plate and guide is lost. As a result, insert this screw last.
- Before removing the Fixation Bolt, place Stabilization Bolts with Insertion Sleeves in two (2) adjacent, open holes (B-G). Remove the K-wire and Fixation Bolt. Place the insertion sleeve and then locking screw.

It is also possible to insert this screw freehand, but only insertion through the handle ensures that the screw and plate are aligned, to provide a locked construct.

Postoperative Treatment

Postoperative treatment with LISS does not differ from conventional internal fixation procedures. Range of motion of the knee joint and partial weight bearing to at least 10 kg is appropriate. Restrictions may be appropriate in special cases. The presence of callus formation on X-ray indicates indirect or secondary bone healing.

Implant Removal

Remove the implant only after complete consolidation of the fracture and remodeling of the medullary canal. Remove the implant in reverse order to implantation. First, make the incision to fit the Insertion Guide. Make stab incisions and use the Torque Limiting Hexagonal Screwdriver to remove the screws by hand. (The Large Hexagonal Screwdriver [314.26 or 314.75] can be used, but each lacks the self-retaining mechanism to aid in screw removal through a stab incision.) After explantation of all screws, remove the plate. If the plate is still not easily removed, detach the Insertion Guide and use only the Fixation Bolt. Loosen the plate by applying reciprocating movements to the Fixation Bolt.

Note: *Use the additionally available Cleaning Instrument [324.053], as necessary, to remove tissue from the hexagonal socket of the screw head to facilitate removal.*

Troubleshooting

If screw head is not flush with the plate level:

- The screw may not be fully locked. Use the 3.5 mm Torque Limiting Screwdriver [324.052], turning until it clicks.
- Soft tissue may be interposed between plate and screw head. If the screw head is not flush after use of the Torque Limiting Screwdriver, use a Large Hexagonal Screwdriver [314.26 or 314.75] to complete tightening. To help avoid this problem, use the trocar prior to screw insertion.

If the power screwdriver jams in the screw head at insertion, the driver may be off center in the sleeve:

- Release the quick coupling from the driver and loosen or remove drill sleeve, or
- Back up the screw slightly and perform final tightening by hand with the Torque Limiting Screwdriver, or
- If other options do not work, hold onto the chuck end with pliers to pull the screwdriver shaft out.

If the locking screw is difficult to insert or stops advancing prior to locking to the plate:

- The screw should be removed and the flutes cleaned with a K-wire. The screw can be reused if its hexagonal socket is undamaged. This condition may be caused by unusually dense or thick cortical bone (see page 32).

Tips and Tricks

Reduction and Fixation

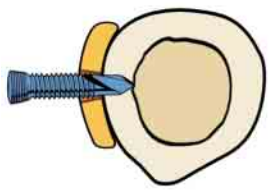
- To avoid interfering with placement of the LISS plate on the lateral side, lag screws can be placed percutaneously from the medial side.
- If an extension table is used, careful traction should be applied to prevent the gastrocnemius muscle from pulling the distal fragment posteriorly or into hyperflexion. Posterior support of the distal fragment could facilitate reduction.
- Flexion-extension reduction of the distal fragment may be facilitated using a Schanz screw in the femoral condyle as a joystick. Insertion of a Schanz screw or Pull Reduction Instrument [324.033] into the proximal fragment may also be helpful. Should it still be impossible to achieve fracture reduction, extend incision to improve access.
- Bumps made of 8, 10, 12, or 15 towels can be used under the distal metaphyseal area to help reduce the fracture in the lateral view. These help to counteract the forces of the gastrocnemius. Small adjustments in these bumps can make marked changes in the reduction.
- Varus-valgus can be checked using C-Arm and a cautery cord from the femoral head to the center of the ankle joint on an AP view. Use C-Arm at the knee to check that the cord passes 10 mm medially to the center of the knee joint. Adjustment to varus-valgus reduction can be performed with the Pull Reduction Instrument prior to locking screw placement in the malaligned fragment, or with manual pressure on the Insertion Guide opposed by pressure on the medial aspect of the distal femur.
- A distractor or large external fixator is a useful tool in gaining reduction. Proximal Schanz screw(s) should be placed anteriorly, and distal Schanz screws placed anteromedially and anterolaterally.
- Two distractors may also be used to gain reduction. One is applied medially and the second anterolaterally to minimize malreduction due to uneven distraction.
- Fractures not treated acutely should be placed in a spanning external fixator to maintain length until LISS fixation can be performed. This frame can also be used intraoperatively to assist in fracture reduction.
- For articular visualization, a Hohmann retractor can be used over the medial femoral condyle from a lateral incision. Flexion of the knee also offers visualization of a Hoffa fracture.

Tips and Tricks (continued)

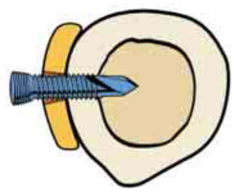
Plate Placement

Should the plate be positioned too far anteriorly or posteriorly, the screws may not be centered on the bone. This position is not sufficient to ensure a stable fixation and can cause loss of fixation.

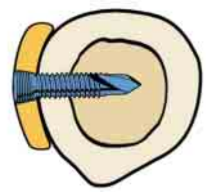
Correct plate placement



Drill

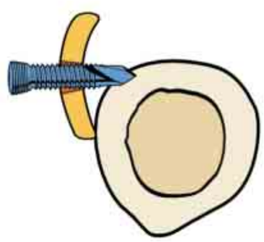


Tap

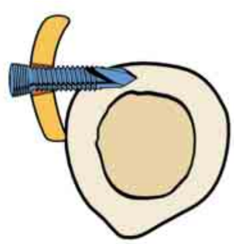


Screw locks plate to bone

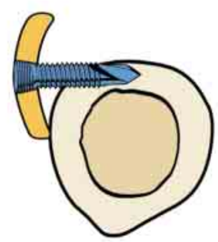
Incorrect plate placement



Drill



Threads strip and do not tap



Screw locks to plate but has inadequate purchase in bone

To ensure proper plate placement, these techniques may be used:

- Direct palpation through a slightly elongated incision for the Stabilization Bolt can be used to confirm the position of the proximal end of the plate.
- The Insertion Guide holes may be aligned with the plate holes under C-Arm to confirm central location of the plate on the femoral shaft.

To check the position of the most distal screw, hole E, place a K-wire with the guide wire sleeve and check the position relative to the intercondylar notch.

Irrigation and Cooling

- The LISS Insertion Sleeve has a side port to allow irrigation. This is useful in cooling self-drilling locking screws or the Pull Reduction Instrument during drilling. It is important to prevent thermal necrosis during the drilling step.
- Use standard IV tubing and a 60 cc syringe filled with sterile, physiologic saline solution. Attach the Luer lock to the syringe and cut the opposite end of the tubing. Slide the cut end of the tubing onto the port of the insertion sleeve.

Tips and Tricks (continued)

Screw Insertion

- Use power tools for screw insertion to ensure adequate performance of the self-drilling screw tip. The ease with which the screws advance into the bone will depend on several factors, such as bone density and power output of the tools. The screws should be advanced into the bone until the screw head locks in the plate.
- The screw's drilling tip has been dimensioned according to an average cortex thickness. If, during preoperative planning, it is determined that the cortex is 7 mm thick or more, predrill the cortex using the Pull Reduction Instrument, which is 4.0 mm in diameter.
- If a standard locking screw is inserted and the drill tip flutes fill with bone chips, the screw will stop advancing. In this case, the screw should be removed and the flutes cleaned with a K-wire. The screw can be reused if its hexagonal socket is undamaged.
- Both the Hexagonal Screwdriver Shaft and the Torque Limiting Screwdriver are equipped with a self-retaining mechanism. Slight pressure should be used to ensure that the screwdriver shaft penetrates the socket of the screw head on pick-up. This retaining feature is key during a closed implant insertion.
- If necessary, bicortical 4.5 mm cortex screws may be used through the plate. These screws should be used prior to placement of any locking screws in that fracture fragment.

  Note: *Heads will be prominent.*

- In the presence of a fracture around a prosthesis or IM nail, 4.5 mm cortex screws may be used, with the screws angled past the shaft of the prosthesis or nail.

Implant Removal

If the additionally available Cleaning Instrument [324.053] is employed during implant removal, it should be used through the Insertion Guide. Inspect the Cleaning Instrument after every use.

Plate Contouring

The fixator's stability is not dependent on the plate matching the contour of the bone exactly, as in standard compression plating.

Bending and twisting of the LISS plate is not recommended because it results in misalignment of the holes of the Insertion Guide and corresponding plate holes. This will make locking screws to the plate difficult or impossible.

Temporary Fixation with Kirschner Wires

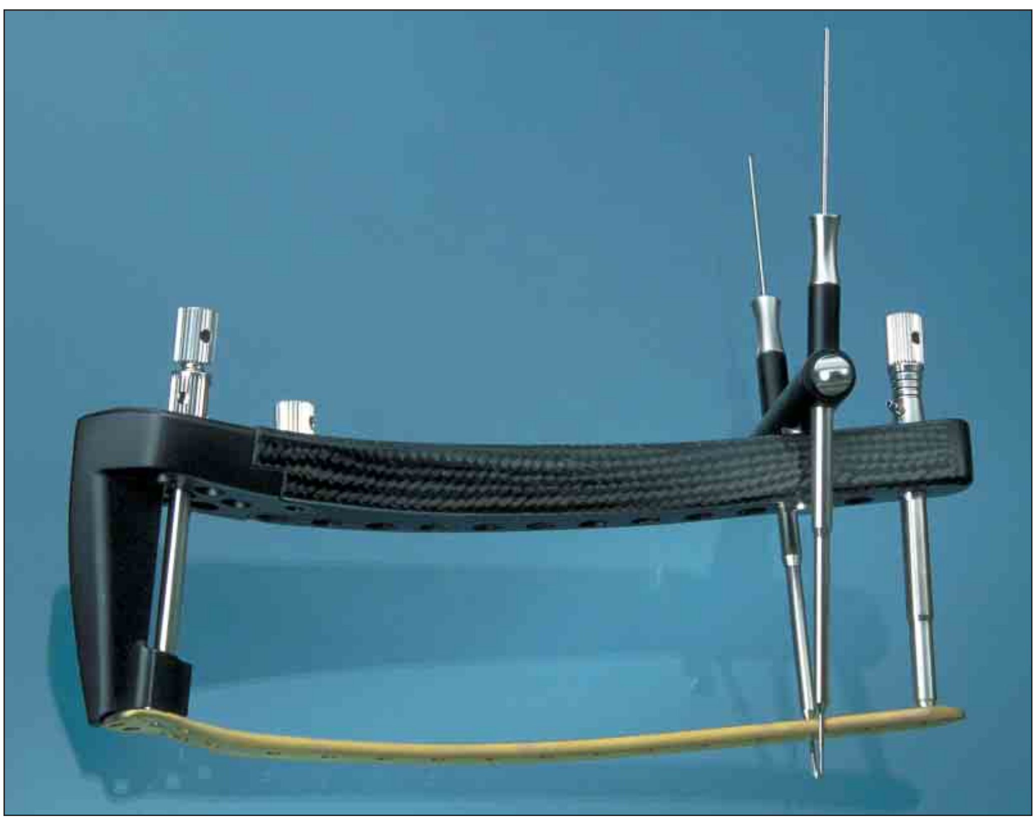
The system offers the ability to maintain central alignment of the plate on the femoral shaft while still allowing adjustment proximally or distally. This can be useful if length reduction adjustment is necessary after placement of locking screws in the distal femur, but before diaphyseal screws are placed.

1 Insert K-wires to mark screw locations

Place the K-wire Aiming Attachment [324.048] into the desired hole in the Insertion Guide (holes 3 through 13 can be used). Insert 2.0 mm K-wire Centering Sleeves [324.034] to mark locations.

2 Make stab incision(s)

Remove sleeves and make stab incision(s) at these locations. The stab incision must be large enough to accommodate adjustment in reduction.



3 Reinsert sleeves and insert K-wires

Reinsert sleeves and place K-wires in each. Note that the distance between bone and plate should be kept to a minimum because the wires converge as they are inserted. After insertion of K-wires, the distance between plate and bone can no longer be reduced.

4 Remove sleeves

Remove sleeves and then the aiming attachment. Additional length reduction may now be achieved.

Kirschner Wire Positioning

The photo below shows K-wire positioning at the distal end of the LISS plate. The lateral K-wires prevent the plate from migrating in the AP plane while still allowing for proximal/ distal displacement and adjustment. When correct position is determined, the plate can be temporarily locked with a K-wire through the Fixation Bolt.

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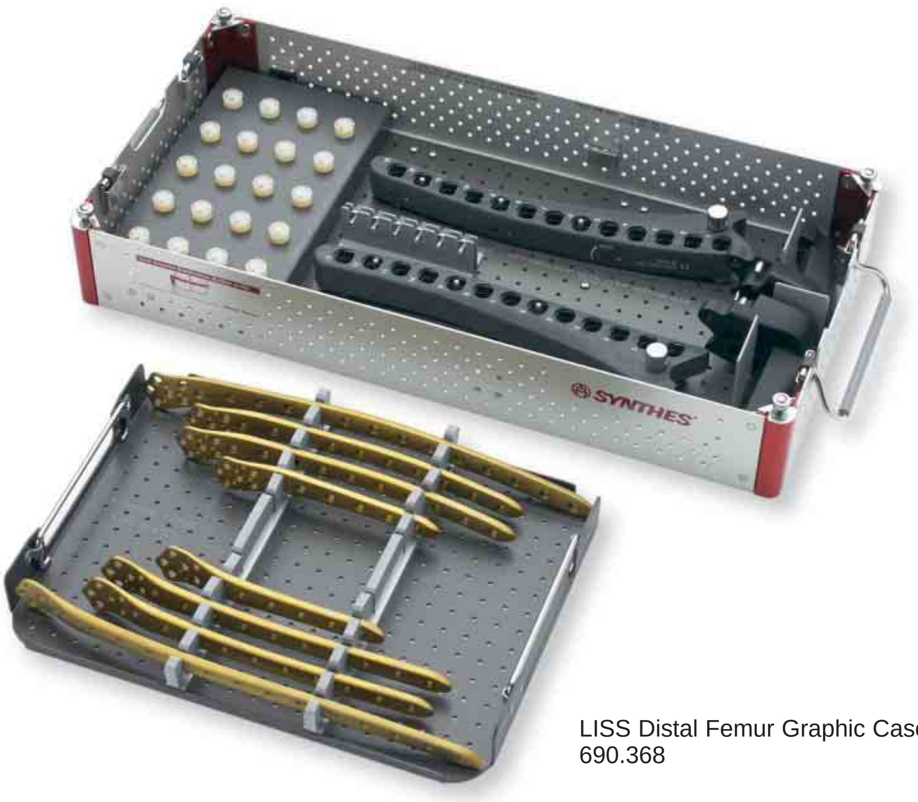
Distal Femur LISS Titanium Implant and Insertion Guide Set [145.473]



LISS Distal Femur Graphic Case
690.368

Implants

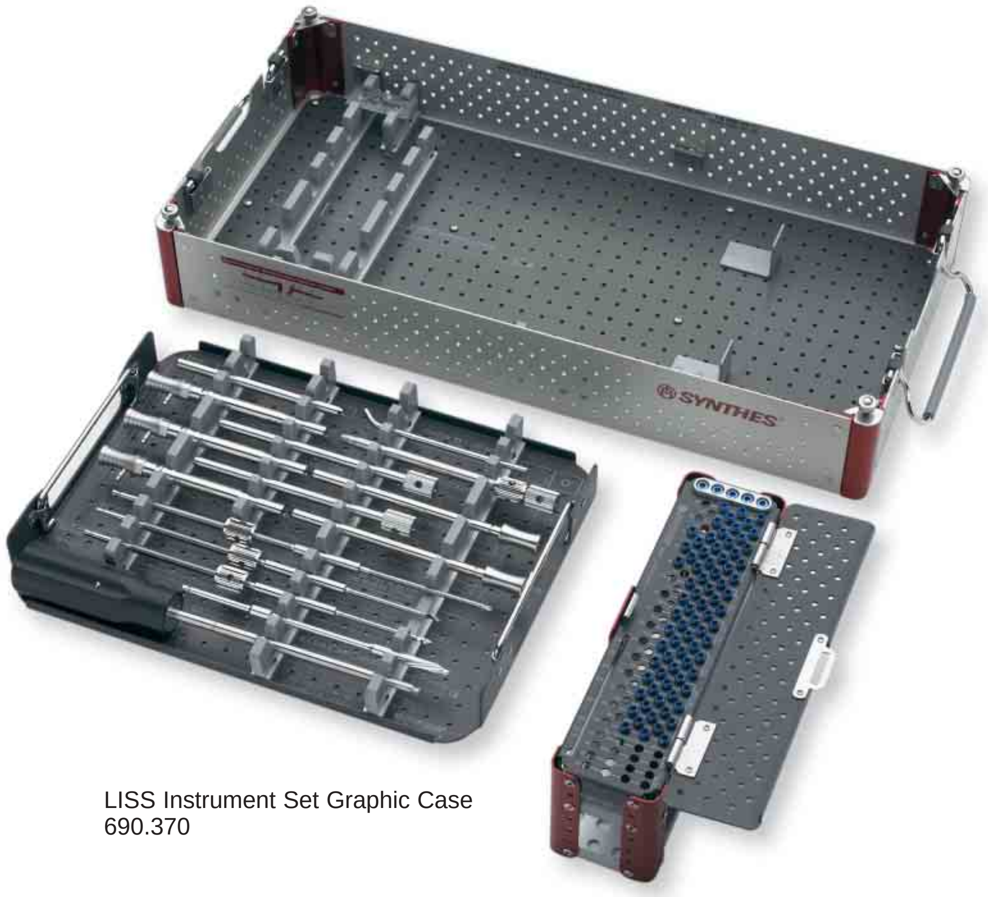
Titanium Distal Femur LISS Plates

422.340	5 holes, right, 156 mm
422.341	5 holes, left, 156 mm
422.344	9 holes, right, 236 mm, 2 ea.
422.345	9 holes, left, 236 mm, 2 ea.
422.348	13 holes, right, 316 mm, 2 ea.
422.349	13 holes, left, 316 mm, 2 ea.

Instruments

324.011	Distal Femur LISS Insertion Guide, left
324.012	Distal Femur LISS Insertion Guide, right
324.019	Stopper for LISS Insertion Guides, 5 mm, 20 ea.

LISS Instrument and 5.0 mm Titanium Locking Screw Set [145.471]



LISS Instrument Set Graphic Case
690.370

Implants

422.390	Titanium Screw Hole Insert, 5 ea.

5.0 mm Titanium Locking Screw, self-drilling

422.391	18 mm, 10 ea.
422.392	26 mm, 20 ea.
422.393	40 mm, 10 ea.
422.394	55 mm, 10 ea.
422.395	65 mm, 10 ea.
422.396	75 mm, 10 ea.
422.397	85 mm, 10 ea.

Instruments

292.699	2.0 mm Kirschner Wire, threaded trocar tip, 280 mm, 10 ea.
321.17	4.5 mm Pin Wrench, 120 mm
324.022	Insertion Sleeve for 5.0 mm Titanium Locking Screws, 3 ea.
324.027	5.0 mm Trocar
324.033	Pull Reduction Instrument, 2 ea.
324.037	2.0 mm Kirschner Wire Measuring Device
324.043	Fixation Bolt for LISS Insertion Guides
324.044	Stabilization Bolt for LISS Insertion Guides, 2 ea.
324.050	3.5 mm Hexagonal Screwdriver Shaft, self-retaining
324.052	3.5 mm Torque Limiting Screwdriver, self-retaining
324.055	2.0 mm Kirschner Wire Insertion Sleeve

Additionally Available

324.034	2.0 mm Kirschner Wire Centering Sleeve
324.048	Kirschner Wire Aiming Attachment
324.053	Cleaning Instrument for 3.5 mm Hex for 5.0 mm Locking Screws
324.056	X-Ray Calibrator for Distal Femur LISS

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