Less Invasive Stabilization System LISS.
Proximal Lateral Tibia.

Surgical Technique
### Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>Surgical technique</td>
<td>10</td>
</tr>
<tr>
<td>Product information</td>
<td>24</td>
</tr>
<tr>
<td>Additional features</td>
<td>27</td>
</tr>
</tbody>
</table>

**Warning!** This description is not sufficient for an immediate application of the instrumentation. An instruction by an experienced surgeon in handling this instrumentation is highly recommended.
Introduction

Fractures of the proximal tibia can provoke complex tissue injuries. Conservative treatment often results in malalignment or non-unions as well as stiffness of the knee. To reduce the occurrence of these problems, open reduction and internal fixation can be carried out. The AO/ASIF has developed the techniques and defined the following principles of internal fixation:

- Anatomical reduction
- Stable internal fixation
- Preservation of the blood supply
- Early active and pain-free mobilization

Combined with these principles, internal fixation with plates and screws has been a successful technique for the treatment of fractures.

However, additional vascular trauma resulting from extensive surgical exposure was typically caused by the need for precise reduction, implant placement and its fixation. Fracture fragments were also often stripped of their soft tissue envelope. As a result, bone healing was impaired and the risk of infection increased.

In the treatment of diaphyseal fractures, fracture healing and the clinical outcome were dependent on obtaining correct length, axis and rotation of the fractured bone, rather than on precise anatomical reduction and absolute stability. Intramedullary nails used in a closed technique in combination with indirect visualization (image intensifier) minimize the amount of additional vascular trauma and represent the current treatment of choice for diaphyseal fractures of femur and tibia. For the treatment of articular fractures, however, anatomical reduction is of paramount importance in ensuring restoration of articular surfaces and preventing post-traumatic arthrosis. Usually, open reduction is followed by internal fixation with plates and screws.

The combination of these two requirements, i.e. anatomical reduction of articular fractures and obtaining correct length, axis and rotation with minimal additional vascular trauma of the diaphysis, has led to the development of a new generation of implants and instruments for the treatment of meta- and epiphyseal fractures. Since it preserves bone perfusion much better than conventional plates, and it can be inserted in a closed way, this process is called the Less Invasive Stabilization Systems (LISS).

Foreword

Fractures of the proximal tibia can provoke complex tissue injuries. Conservative treatment often results in malalignment or non-unions as well as stiffness of the knee. To reduce the occurrence of these problems, open reduction and internal fixation can be carried out. The AO/ASIF has developed the techniques and defined the following principles of internal fixation:

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- Stable internal fixation
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Combined with these principles, internal fixation with plates and screws has been a successful technique for the treatment of fractures.

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The combination of these two requirements, i.e. anatomical reduction of articular fractures and obtaining correct length, axis and rotation with minimal additional vascular trauma of the diaphysis, has led to the development of a new generation of implants and instruments for the treatment of meta- and epiphyseal fractures. Since it preserves bone perfusion much better than conventional plates, and it can be inserted in a closed way, this process is called the Less Invasive Stabilization Systems (LISS).
The Less Invasive Stabilization Systems
The Less Invasive Stabilization Systems (LISS) combine a new concept of implants with instruments for the treatment of metaphyseal fractures of long bones.

The implant consists of a plate and locking head screws, which together act as an internal fixator. The internal fixator is a construct where the screws (pins), which are the principal load-transferring elements, are locked in the plate (frame). The forces are transferred from the bone to the plate across the threaded screw-plate connection. No compression of the plate onto the bone is required to achieve stability. The blood supply of the bone under the plate is therefore preserved as basically no (or only little) contact between the plate and the bone is needed.

For optimal stability and to preserve the soft tissues, the internal fixator has to be placed very close to the bone. The plates are therefore pre-shaped. Special instruments and insertion guides allow the plates to be slid under the muscle. The screws are inserted percutaneously via small stab incisions, in a technique similar to that used for Bridge Plating and for Minimally Invasive Plate Osteosyntheses (MIPO).

Fracture reduction and fixation proceed in two distinct steps. First, the reduction of the fracture has to be performed. Anatomical reduction and internal fixation with compression screws is mandatory in articular fractures. In the metaphysis and the shaft area, the indirect reduction is preferred. However, care has to be taken to ensure that length, rotation, and axial alignment of the main fragments are correct. The reduction must then be securely held to allow the reduced fragments to be bridged with the LISS fixator.

The first LISS was developed for the treatment of distal femoral fractures (LISS DF). The second LISS was developed for the treatment of proximal tibial fractures, using a lateral approach. It is called LISS Proximal Lateral Tibia (LISS PLT).

Beside important benefits in direct high-energy injuries, the clinical results as well as biomechanical studies have shown that the features of LISS become particularly beneficial in osteoporotic bone and in periprosthetic fractures (1–5).
Case examples

Case 1:
40-year-old female,
single fracture,
AO 41 C3

Preoperative  Postoperative

3 months follow-up  5 months follow-up
Case 2:
61-year-old male,
fragmented wedge fracture,
AO 42 B3

Case examples

Less Invasive Stabilization System LISS.
Proximal Lateral Tibia.
Case examples

Case 3:
45-year-old male, single fracture
AO41C3

Preoperative

Postoperative

10 months follow-up
Preoperative selection of the implants

Use an anterio-posterior as well as a lateral x-ray picture of the injured limb and a picture of the knee joint. X-ray pictures of the other limb might be useful for comparison.

Use the AO/ASIF Preoperative Planning Template (nos. 034.000.135 and 034.000.136) to determine the length of the LISS plate and the position of the screws (see page 10). Both template images are enlarged 10% to account for average radiograph magnification. However, magnification may vary.

Note that the screws in holes A and C point towards the articular surface of the knee. For hole A, the tip of a 40 mm long screw and for hole C, the tip of a 75 mm long screw will lie approximately at the same level as the top of the plate. The screws used in the tibial shaft will normally be locking head screws of 26 mm or 18 mm length.

If required, the use of lag screws should be planned.

Positioning of the patient

Position the patient supine on a radiolucent table. The leg should be freely movable. The contralateral leg can be placed in an obstetric leg holder.

Ensure that both a lateral and AP x-ray of the proximal tibia can be obtained in this position.

Use bumps made with towels to flex the knee in the appropriate position.

The use of a fracture table did not prove to be very helpful.
LISS Proximal Lateral Tibia, right

- **Titanium Description**
  - 422.300 LISS-PLT Plate, right 5 140
  - 422.302 LISS-PLT Plate, right 7 180
  - 422.304 LISS-PLT Plate, right 9 220
  - 422.306 LISS-PLT Plate, right 11 260
  - 422.308 LISS-PLT Plate, right 13 300

- **Screw Hole Insert**
  - 422.390 Screw Hole Insert
  - 422.391 5.0 mm Locking Screw 18
  - 422.392 5.0 mm Locking Screw 26
  - 422.393 5.0 mm Locking Screw 40
  - 422.394 5.0 mm Locking Screw 55
  - 422.395 5.0 mm Locking Screw 65
  - 422.396 5.0 mm Locking Screw 75
  - 422.397 5.0 mm Locking Screw 85

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For use only with the Original AO/ASIF System of Instruments and Implants

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Eimattstrasse 3
CH-4436 Oberdorf
www.synthes.com
**Instruments for the insertion of LISS**

Insertion Guide left (324.003)
Insertion Guide right, not illustrated (324.004)

<table>
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<th>Pin Wrench (321.170)</th>
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<th>Drill Sleeve (324.022)</th>
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Assembly of the insertion instruments

Insert the Fixation Bolt (324.043) through hole A of the insertion guide.
Place the insertion guide on the three-point locking mechanism of the LISS.

Thread the fixation bolt into the LISS.
Thread the nut of the fixation bolt and lightly tighten it with the pin wrench (~10°).

For a more stable fixation of the LISS to the insertion guide during insertion, introduce the Stabilization Bolt (324.044) with the Drill Sleeve (324.022) through hole C and thread it into the LISS.

To prevent tissue ingrowth and facilitate implant removal, close the unoccupied screw holes by means of Screw Hole Inserts (422.390) prior to inserting the LISS plate. Use the torque-limiting screwdriver until clicking occurs.
**Reduction**
If the fracture is intra-articular, first reconstruct and stabilise the whole joint. Use lag screws to achieve compression between the articular fragments. Cannulated screws proved to be very convenient for this.

Take care to ensure that these additional screws do not collide with the locking head screws inserted through the insertion guide. The figure shows the possible zone for lateral lag screws in the condyle.

The fracture can be aligned manually by traction, with a temporary knee-bridging external fixator or with a distractor.

Intra-operative x-ray or image-intensifier control is recommended to check reduction.

**Surgical approaches**
Depending on the need, it is possible to perform either a curved (120° hockey stick) or a straight skin incision from Gerdy's tubercle about 50 mm in distal direction (see figure below). Approximately half a centimetre from the tibial ridge, detach the anterior tibial muscle from the bone, retract it and insert the LISS in the space between the periosteum and the muscle. To allow correct positioning of the proximal part of the LISS, it is important to adequately dissect the muscle attachment site.

For complex intra-articular fractures, an anterolateral arthrotomy that provides good control of the reduction may be preferred.
**Insertion of LISS**

Insert the internal fixator between the anterior tibial muscle and the periosteum.

Slide the LISS plate in the distal direction with its distal end in constant contact with the bone. Position the proximal end of the fixator against the lateral condyle. Carefully find the correct position of the LISS on the condyle.

Check that the LISS is positioned properly, distally on the anterolateral side of the tibia and proximally on the lateral condyle. The plate must lie flat against the condyle. Due to its weight, the insertion guide has a tendency to tilt dorsally. Should it be problematic to find the correct position of the LISS on the condyle, then further release the proximal soft tissues by increasing the opening.

**Important note!** The screw in hole D is oriented towards the posterior side of the medial condyle. Excessive internal rotation of the insertion guide must therefore be avoided as this screw might endanger the popliteal artery.
Once the LISS is properly aligned with the bone, remove the drill sleeve and the stabilization bolt from hole C. Insert the Trocar (324.027) in the Drill Sleeve (324.022) through the most distal hole of the plate (5, 9 or 13).

Perform a stab incision and insert the drill sleeve and the trocar down to the LISS plate.

**Important note!** If you use a 13 hole LISS plate, before inserting the trocar and drill sleeve, perform a careful soft tissue dissection down to the plate in order to visualize the superficial peroneal nerve (n. peroneus superficialis). Secure the position of the drill sleeve with the insertion guide’s fixation screw. Replace the trocar with the Stabilization Bolt (324.044). Thread the stabilization bolt into the LISS plate to close the frame.

Note that once the bolt has been inserted, it becomes difficult to change the position of the plate/handle assembly, due to the soft tissues around the stabilization bolt.

Check the correct position of the distal part of the plate, either with the image intensifier or by direct palpation.

**Preliminary fixation of LISS**

For the preliminary fixation of the internal fixator, use 2.0 mm Kirschner wires through the most proximal K-wire hole of the insertion guide (guided only through the aluminium foot part of the insertion handle) and through the stabilization bolt. Carefully check the position of the LISS plate and the reduction (length!) of the injured limb.

Alternatively, use the Aiming Device for Kirschner wires (324.048 see page 24) to insert the wires on the ventral and dorsal side of the fixator.

Insert the initial screws as soon as the reduction has been successfully completed and the internal fixator is in the correct position.
Instruments to determine screw length

Compact Air Drive II (511.701)

Quick Coupling for Kirschner Wires (511.790)

Drill Sleeve (324.022)

Guide Sleeve for Kirschner Wire (324.055)

Measuring Device (324.037)

Kirschner Wire, 2 mm dia. × 280 mm (292.699)
Instruments for screw insertion

Compact Air Drive II (511.701)

Quick Coupling (510.750)

Torque-limiting Screwdriver (324.052)

Drill Sleeve (324.022)

Trocar (324.027)

Screwdriver Shaft (324.050)
Insertion of the self-drilling screws

The placement of the screws will depend on the fracture type. Choose the screw sites in accordance with established biomechanical principles for internal fixation. The screws should be close to and remote from the fracture gap on the main fragments. Use at least four screws per fracture side.

Length and rotation are defined as soon as one screw has been inserted in each main fragment. Ante- and recurvatum deformities can still be adjusted, but varus or valgus deformities can hardly be corrected. For this reason, it is recommended to start inserting the first screw in the proximal fragment.

Important note! If a screw has to be removed and reinserted, use the Torque-limiting Screwdriver (324.052) by hand and not the power tool.

Start making a stab incision and insert the trocar through the drill sleeve.

To determine the length of the condylar screws, use the Measuring Device (324.037) with a 2.0 mm Kirschner wire, length 280 mm, placed through the Centering Sleeve (324.055) in the drill sleeve. Using image intensification, place the Kirschner wire to the desired depth leaving at least 5 mm between the tip of the Kirschner wire and the medial cortex. Measure the screw length with the measuring device over the Kirschner wire until it bottoms on the drill sleeve and round down to the nearest screw length. This will ensure that the tip of the screw will not protrude through the medial cortex.

Important note! To improve the visualization of the condyle, the drill sleeves for the two most proximal holes (holes D and E) are guided through the aluminium foot part of the insertion guide only. To prevent rotation of the drill sleeve, it is therefore necessary to hold it with two fingers (not shown on the drawing!) during insertion – or removal! – of the Kirschner wire as well as during insertion – or removal! – of the two most proximal screws.

Orient the C-arm obliquely in order to visualize correctly where the K-wire exits from the anteromedial or posteromedial cortex.
Insertion of the self-drilling screws

Use screws of 26 mm or 18 mm length in the shaft region. When using a 13 hole LISS plate, perform a careful soft tissue dissection down to the plate for holes 10 to 13 before inserting the trocar and drill sleeve, in order to visualize the superficial peroneal nerve. Alternatively, it is also possible to perform a blunt dissection from ventral to dorsal to avoid the superficial peroneal nerve.

Insert the self-drilling and self-tapping screws using a battery or compressed air tool. It is important to cool the screw during the drilling procedure with saline solution through to prevent the risk of thermal necrosis. The insertion sleeves have a side nipple for irrigation. Use standard tubing and syringe with saline solution.

Advance the screws into the bone until the second bulge of the screwdriver disappears in the drill sleeve (see picture).

Important note! To complete locking of the screws, use the Torque-limiting Screwdriver (324.052) until clicking occurs at the recommended tightening moment of 4Nm. Check that the screw head sits completely in the LISS plate. Soft tissues entrapped between the screw head and the plate might prevent the screw head from being flush with the plate. In such cases, use the long Hexagonal Screwdriver (314.260) from the pelvic instrument set to complete tightening.

If the screw is difficult to insert or stops advancing prior to locking to the plate, remove the screw and clean the cutting flutes using a Kirschner wire. The screw can be re-used if the hexagonal socket has not been damaged.

Use the pulling device to pre-drill in a very thick cortex.

If it is difficult to remove the screwdriver from the screw after insertion, disconnect the screwdriver from the power tool and remove the drill sleeve. Then withdraw the screwdriver from the screw.
**Insertion of the self-drilling screws**

The insertion of the initial screw tends to push the bone medially, especially in cases of dense bone and/or unstable reductions. The Pulling Device (324.033) helps to solve this problem.

**Important note!** Insert the pulling device without the knurled nut through the drill sleeve into the neighbouring hole of the first permanent screw. Stop the power tool before the entire threaded part of the pulling device has been inserted. Remove the power tool and the drill sleeve. Threading the knurled nut on the pulling device pulls the bone towards the LISS plate. As the tip of this instrument has a diameter of 4.0 mm, replacing it with a 5.0 mm LISS screw still ensures good purchase in the bone.
Postoperative treatment
Postoperative treatment should proceed as in conventional internal fixation procedures; basically functional, with free mobilisation of the knee joint and partial weight bearing. Physical rehabilitation should be started immediately postoperative including range-of-motion exercises. Restrictions may be appropriate in special cases.

Implant removal
Remove the implant only after complete consolidation of the fracture. The removal is in reverse order to the implantation. First make the incision for the insertion guide in the old scar and mount the insertion guide onto the plate.

Important note! Make stab incisions and use the torque-limiting screwdriver to remove the screws by hand. Complete the removal of the screws with a power tool. If a 13 hole LISS plate has to be removed, perform a careful soft-tissue dissection down to the plate for holes 10 to 13 before inserting the trocar and drill sleeve, in order to visualise the superficial peroneal nerve.

The Cleaning Tool (324.053 see page 25) is useful to clean the hexagonal recess of the screw head. After removal of all screws, remove the internal fixator. If the internal fixator remains fixed after having removed all screws, remove first the insertion guide, and use only the fixation bolt for the subsequent loosening of the plate.
Set overview

LISS PLT Plates and Insertion Guide, in SYNCASE (171.290)

LISS Set for Screws and additional Instruments, in SYNCASE (171.270)
Implants

LISS Plates: Proximal Lateral Tibia
- Right, 5 holes, length 140 mm (422.300)
- Right, 7 holes, length 180 mm (422.302)
- Right, 9 holes, length 220 mm (422.304)
- Right, 11 holes, length 260 mm (422.306)
- Right, 13 holes, length 300 mm (422.308)

Left, 5 holes, length 140 mm (422.301)
- Left, 7 holes, length 180 mm (422.303)
- Left, 9 holes, length 220 mm (422.305)
- Left, 11 holes, length 260 mm (422.307)
- Left, 13 holes, length 300 mm (422.309)

5.0 mm Locking Head Screws
- Screw-Hole Insert, L 5 mm (422.390)
- LISS Screw, L 18 mm (422.391), not illustrated
- LISS Screw, L 26 mm (422.392)
- LISS Screw, L 40 mm (422.393)
- LISS Screw, L 55 mm (422.394)
- LISS Screw, L 65 mm (422.395)
- LISS Screw, L 75 mm (422.396)
- LISS Screw, L 85 mm (422.397)
Instruments

Insertion Guide for Proximal Lateral Tibia, left (324.003)
Insertion Guide for PLT, right (324.004)
Not illustrated

Torque-limiting Screwdriver (324.052)

Stabilization Bolt for Insertion Guide (324.044)

Aiming Device for 2.0 Kirschner Wires (324.048)
with two sleeves (324.034)

Guide Sleeve for Kirschner Wires (324.055)
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<tr>
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<tbody>
<tr>
<td>Trocar for 5 mm Screws (324.027)</td>
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<td>Drill Sleeve for 5 mm Screws (324.022)</td>
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<td>Screwdriver Shaft (324.050)</td>
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<td>Fixation Bolt for Insertion Guide (324.043)</td>
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<td>Measuring Device for Kirschner Wires (324.037)</td>
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<td>Pin Wrench (321.170)</td>
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<td>Cleaning Tool for Screw Head (324.053)</td>
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<td>Pulling Device (324.033)</td>
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<td>Stopper for Insertion Guide holes (324.019)</td>
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Less Invasive Stabilization System LISS.
Proximal Lateral Tibia.
Temporary fixation with Kirschner wires
If necessary, it is possible to use 2.0 mm Kirschner wires for the preliminary fixation on both sides of the internal fixator. Use the aiming device for Kirschner wires to insert the wires on the ventral and dorsal side of the fixator. The aiming device can be used from hole 3 to hole 13. The distance between bone and fixator should be kept as short as possible when inserting the wires, as they are arranged convergently. After the insertion of the Kirschner wires, the distance between fixator and bone can no longer be reduced.

After removing the K-wire sleeves and the aiming device, carry out the proximal/distal displacement and adjustment of the LISS plate’s position. At the same time, the lateral Kirschner wires prevent the internal fixator from migrating in the sagittal plane. Once the correct position is determined, the plate can be temporarily locked using a Kirschner wire through the fixation bolt.
Instruments required for the placement of Kirschner wires

Compact Air Drive II (511.701)

Quick Coupling for Kirschner Wires (511.790)

1 Kirschner Wire, 2.0 mm dia., length 280 mm (292.699)
2 Aiming Device for Kirschner Wires, 2.0 mm dia. (324.048) with two sleeves (324.034)
**Tips and tricks**

- Improve the access by increasing the soft-tissue opening, should it still be impossible to perform a correct reduction.

- While inserting the pulling device, it is important to carefully monitor the advancing of the screw tip. Stop the power tool before the entire threaded part of the pulling device is inserted, thus preventing stripping of the thread in the bone.

- Bending and twisting of the LISS plate is not recommended as this would result in a misalignment between the holes of the insertion guide and the corresponding plate holes.

- Should the plate lie too ventral or too dorsal, the screws will not be centred in the medullary canal. This position may compromise the screw purchase.

- To guarantee the stability of the construct, the most distal screw of the fixator should be inserted last, just before removal of the insertion guide. Remove the stabilization bolt and insert the screw through the drill sleeve.

- To facilitate the application of the insertion guide during implant removal, close hole A with a screw-hole insert if no screw has been inserted in this hole.

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**Tips and tricks**

- Both the screwdriver shaft and the torque-limiting screwdriver are equipped with a self-holding mechanism. Use slight pressure to ensure that the screwdriver shaft fully penetrates the socket of the screw head.

- A standard 4.5 mm cortex screw can be used through the fixator, if required. Note, however, that the 4.5 mm cortex screw cannot be inserted through the drill sleeve.

- Hole A serves to lock the insertion guide to the implant. This hole can therefore not be used to insert a screw while the fixation bolt is attached. If a screw is required in hole A, remove the fixation bolt – with the stabilization bolt still in place! – and refix it in an adjacent available hole. Place the drill sleeve in hole A and insert the appropriate screw.

- If a screw has been placed in every hole, use the free-hand method to insert the screw in hole A. Use the direction given by the fixation bolt prior to removal or use another plate and screw to determine the correct direction for insertion.

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**Drilling**  
**Tapping**  
**Correct placement**

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**Drilling**  
**Tapping**  
**Compromised screw purchase**
**Additionally available**

LISS Distal Femur Set for Plates and Insertion Guides, in SYCASE (171.280)

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Locking Head Screw, length 35 mm, with longer drill tip for extra thick cortex (422.398)

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Special for periprosthetic fractures:
Drill bit, 4.3 mm dia., length 280 mm (310.423)

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Drill Guide for 4.3 mm drill bit (324.007) and Locking Head Screws for periprosthetic fractures, length 14 and 18 mm (422.402 and 422.404)

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Less Invasive Stabilization System LISS.
Proximal Lateral Tibia.
Suggested readings

2 P. Schandelmaier et al., „LISS-Osteosynthese von distalen Femurfrakturen” [Internal fixation of distal femoral fractures using LISS], Trauma Berufskrankh 1 (1999), 392–397.

3 T.J. Hockertz et al., „Die Versorgung von periprothetischen Femurfrakturen bei liegender Kniegelenkprothese mit dem LIS-System” [Treatment of periprosthetic femoral fractures with knee prosthesis using the LISS system], Der Unfallchirurg 10 (1999), 811–814.


5 P. Schandelmaier et al., „Distale Femurfrakturen” [Distal femoral fractures], Unfallchirurg 70 (2000), 428–436.

Indications
The Less Invasive Stabilization System for Proximal Lateral Tibia (LISS PLT) is indicated for the stabilisation of fractures of the proximal tibia.

– Proximal shaft fractures
– Metaphyseal fractures
– Intra-articular fractures
Less Invasive Stabilization System LISS.
Proximal Lateral Tibia.