OPERATING MANUAL AND TECHNIQUE GUIDE FOR TITANIUM FEMORAL AND TIBIAL NAILING SYSTEMS
ORTHOMEDICAL GMBH TITANIUM FEMORAL NAIL
OPERATIVE TECHNIQUE

Introduction: Why a new type of femoral nail?

The latest standard in treating femoral fractures as a result of evolution in the
types of fracture (ever-increasing trend towards proximally and distally located
femoral fractures, and also for conventional shaft fractures).

Objective: Improved clinical outcome in the minimally invasive treatment of
femoral fractures and great cost-efficiency thanks to its versatility.

· More interlocking options, both proximal and distal
· Anatomically compatible design (continuous nail curvature)
· Locking of a straight (first proximal) interlocking screw at a fixed angle
· High central load-bearing stability
· Can be implanted both antegrade and retrograde
· Short learning curves and minimum investment, as 90% of the existing standard
  instruments for femoral and tibial nails from the basic standard instrument set
  are compatible. Only the proximal femoral targeting jig, which is also new, is
  additionally required (a new, additional instrument). No new adapter is necessary
  to connect up the distal targeting device; the existing femoral adapter block is
  compatible with the new proximal femoral targeting jig. Connection is done in
  the conventional way.
INDICATIONS

- Open and closed conventional shaft fractures
- Pertrochanteric fractures
- Intertrochanteric fractures
- High subtrochanteric fractures
- Low subtrochanteric fractures
- Distal shaft fractures
- Condylar fractures

![Fig. 1](image)

For the diameter and lengths of the nails and interlocking screws and associated instrument set, see the titanium nail brochure!

Advantages

- Open and closed shaft fractures
- Unreamed insertion
- Proximal fractures
- Distal shaft and condylar fractures
- Minimally invasive
- Dynamisation
- Option of inserting either antegrade or retrograde
- Highly economical
Positioning the patient

Positioning for antegrade indication

Place the patient in the supine position on a traction table or a radiolucent operating table. The X-ray image intensifier is positioned in such a way that it gives a clear view from AP and lateral.

The position of the patient depends on the injury and the physical condition of the patient.

Positioning for retrograde indication

Place the patient in the supine position on a radiolucent operating table. Flex the knee to an angle of 45° with the aid of a leg support placed under the thigh. Alternatively, an X-ray positioning table can be used, which enables alignment of the leg and good visualisation.

Reduction

Reduce the fracture. To do so, you can use a large distractor or the internal aligner from the basic instrument set (if the fracture pattern permits this).

Using a large distractor applying the standard method for reductions:

With many fracture patterns or if the assistant surgeon lacks practice, the use of a distractor can be helpful. If this approach is taken, use the standard technique.

Warning:

When using distractors in conjunction with Schanz screws, the screws must be placed in such a way that the nail can be inserted without complication. The screws must not block the medullary cavity! Insertion is only possible at the distal extremity of the condyle or at the proximal extremity of the pertrochanteric area.
Selecting the right implant

Determining the nail length for antegrade insertion

Position the image intensifier in such a way to enable a view from AP of the proximal femur. Using long forceps, hold the ruler against the outside of the thigh in parallel level with the femur. Place the image intensifier in such a position that the beam is orientated between femur and ruler, in order to avoid incorrect size ratios. Slide the ruler until the end of it is level with the greater trochanter. Mark the tissue at the end of the ruler.

Position the image intensifier above the distal femur, place the proximal end of the ruler at the mark on the skin again; take an image of the distal femur from AP and check the reduced fracture. The length of the nail can now be read straight off the X-ray image. Select the measurement that lies right on or just proximal of the epiphyseal line or the insertion depth.

Determining the nail length for retrograde insertion

Follow the procedure for antegrade insertion in reverse order!
Determining the nail diameter

The diameter of the medullary cavity can be determined using the markings on the ruler. Position the mark above the isthmus. When the transition to the cortical bone is just visible to the left and right of the mark, the corresponding nail can be used.

Determining the insertion point for antegrade insertion

Flexion and adduction of the hip joint eases access, even in adipose patients, and allows a minimum incision to be made. Palpate the greater trochanter, the lateral condyle and, if possible, the femoral shaft. Mark the points with a pen and then extend the line in a gentle curve toward proximal (following the anatomical femoral curvature). Make a stab incision of approx. 3 cm in length in the direction of the tip of the trochanter approx. 10-15 cm above the tip of the trochanter.

Determining the insertion point for retrograde insertion

A median incision and a medial patellar capsular incision are made. The entry point lies in the notch just anterior of the femoral point of attachment of the posterior cruciate ligament.
Opening the medullary cavity for antegrade insertion

Determine the insertion point in accordance with Fig. 6 and open with a curved awl

Opening the medullary cavity for retrograde insertion

Determine the insertion point in accordance with Fig. 7 and open with a curved awl

Inserting the nail guide wire

Insert the nail guide wire, 3.0 mm in diameter, in conjunction with the T-handle, and advance steadily towards distal for antegrade insertion and toward proximal for retrograde insertion (fragments are threaded on in the process).

Note:

The nail guide wire must always be inserted first, even with the non-cannulated solid femoral nails with diameters of 9 mm and 10 mm. After threading on the fragments the nail guide wire is left in the medullary cavity, as for subsequent enlargement of the medullary cavity (enlargement for the larger proximal femoral nail with a diameter of 13 mm and a length of 85 mm) will be performed over the nail guide wire with a cannulated reamer diameter 13.5 mm
Presetting for distal interlocking with distal targeting device:

Setup 1.

Femoral nail / proximal targeting device and femoral adapter block

Setup 2.

Preset to distal screw holes with accessories – green drill sleeve, gold drill sleeve and 4 mm drill for nail diameters 10 and 11 mm. For nails with diameters of 8 und 9 mm, the black drill sleeve and the 3.5 mm drill are used for presetting!

The horizontal / vertical axis of the targeting device must be aligned in such a way that the drill goes through both distal drill holes!
Presetting for distal interlocking with distal targeting device:

Setup 3.

Insert hook arm into the distal targeting device, insert silver 8 mm drill sleeve / blue drill sleeve and 4.8 mm drill into the anterior opening on the hook arm (presetting for fixation hook insertion). The 4.8 mm drill must be between the two distal screw holes and touch the nail shaft laterally!

Setup 4.

Insert fixation hook into the anterior opening on the hook arm and adjust it so that it touches the back of the nail but does not apply pressure (presetting for nail fixation hook). For femoral nails the 20 mm fixation hook is used!
Enlarging the proximal medullary cavity:

Feed in cannulated 13.5 mm reamer over the guide wire and then enlarge the proximal medullary cavity (ream up to the anterior reamer mark).

Insertion:

Feed in nail over the guide wire and insert by hand into the medullary cavity as far as it will go (remove guide wire beforehand for non-cannulated nails of 8 and 9 mm).
Insertion:
After insertion into the medullary cavity, attach impactor and sliding hammer, and hammer in the nail to the distal end of the medullary cavity (hold the targeting jig parallel while hammering in the nail to prevent rotation).

Remove impactor, sliding hammer and guide wire (guide wire does not have to be removed when inserting non-cannulated nails of 8 and 9 mm). Once the hammer components have been removed the connection between the nail and proximal targeting device is retightened with a universal socket wrench (the hammering action can loosen the connection, making it necessary to check the connection after insertion).
Positioning the nail:

Determine the position of the nail according to the first proximal nail hole. Under image intensifier control, a 1.8 mm drill wire is inserted over the green drill sleeve and silver 2.1 mm drill sleeve to determine the position.

Measuring the length of the first proximal interlocking screw:

Place the length gauge against the collar of the silver drill sleeve and read off the length. To get the actual screw length, subtract 10 mm from the measured length (given a measured length of 85 mm the actual screw length is 75 mm). This step is only for the first proximal screw!
Drilling for the first proximal interlocking screw:

Remove the silver drill sleeve; insert the gold drill sleeve into the green drill sleeve and, over the drill wire, insert the 4 mm cannulated drill into the gold drill sleeve and drill to the actual measured screw length (read length from the drill calibration, flush with the collar of the gold drill sleeve).

Insertion of the first proximal interlocking screw:

Remove drill wire and gold drill sleeve, and screw in the 5 mm interlocking screw using a 3.5 mm hexagonal screwdriver until it is flushed with the mark on the collar of the green drill sleeve. Proximal interlocking is achieved with 5 mm interlocking screws!
Insertion of the first proximal interlocking screw:

Insert green and gold drill sleeve; drill with non-cannulated 4 mm drill via the medial cortical bone.

Insertion of the second proximal interlocking screw:

Insert green and gold drill sleeve; drill with non-cannulated 4 mm drill via the medial cortical bone.
Measuring the length of the second proximal interlocking screw:

After drilling, remove drill and gold drill sleeve, and insert length gauge with hook into the green drill sleeve via the opposing cortical bone, and hook in place. At the collar of the green drill sleeve read off the actual measured screw length from the large calibration.

Insertion of the second proximal interlocking screw:

Steps for inserting the screw as in Fig. 21 and Fig. 22.
Insertion of the third and fourth interlocking screw:

The third interlocking screw can be statically or dynamically locked (see mark on proximal targeting device). The fourth interlocking screw is statically locked; steps for the third and fourth interlocking screw as in Fig. 21 and Fig. 22. How many interlocking screws are inserted proximally depends on the fracture types (however, at least two interlocking screws should be inserted proximally to give optimal rotational stability!).

Once proximal interlocking is complete, remove the upper part of the proximal targeting device by opening the adaptor screw with a wrench from the basic instrument set.
Distal interlocking with distal targeting device:

Setup as for presetting in Fig. 10. *(When using drill sleeves and drills, follow procedure for presetting as in Fig. 11!)*

Inserting hook arm into the distal targeting device:
Preparing insertion of the fixation hook:

Insert silver 8 mm drill sleeve and gold drill sleeve with T-handle and 4 mm trocar into the anterior opening on the hook arm.

Lateral perforation, ventral insertion hole for fixation hook:

For this operation the leg must be held in position by an assistant, to allow true lateral insertion at the correct point of entry. This also goes for the following steps.
Ventral drilling for fixation hook insertion:

Remove gold drill sleeve and trocar, insert blue drill sleeve and 4.8 mm drill; drill hole in ventral cortical bone.

Insert drill wire into ventral hole:

Remove blue drill sleeve and drill, insert silver 2.1 mm drill sleeve, then insert 1.8 mm drill wire via the silver drill sleeve, so that it lies in the ventral hole.
Preparing canal for insertion of fixation hook:

The assistant surgeon can now release the leg; remove drill sleeves; drill wire is left in position. The assistant surgeon holds the drill wire in position while the hook arm is removed; but do not change the presetting for further use.

Preparing canal with hook awl:

Take the drill wire from the assistant surgeon and insert the hook awl on the drill wire into the ventral insertion hole, set up, and prepare the canal using a gentle rotating motion. Once the hook awl is inserted, the drill wire is removed, and before the hook awl is removed it is inserted again and held in position by the assistant surgeon.
Preparing canal with hook awl:

Inserted hook awl in position, fully prepared canal.

Removed hook awl after preparation. Canal with positioned drill wire for insertion of the fixation hook, which is once again held in this position by the assistant surgeon.
Insertion of the fixation hook:

The sequence of steps for inserting the fixation hook is based on the same steps for the hook awl.

After insertion, the assistant surgeon holds the fixation hook in position, keeping it in contact with the ventral aspect of the nail. Insert hook arm into the distal targeting device once more, and fix. Now insert the fixation hook into the anterior opening on the hook arm, and fix. During the following steps, the fixed fixation hook must be held in position by the assistant surgeon, who must keep it in contact (without applying pressure) with the back of the nail. Contact between the fixation hook and back of the nail must not be broken!
Insertion of the distal interlocking screws:

The subsequent steps for distal interlocking are the same as for the proximal second, third and fourth interlocking screws (see Fig. 23 to Fig. 26). To find out which drill sleeves and drills to use, and also interlocking screws, see Presetting setup 2. Fig. 11.
Insertion of the distal interlocking screws:
Completion of distal interlocking:

Once insertion of the distal interlocking screws is complete (always two of them) the hook arm is removed first of all, followed by the fixation hook and the distal targeting device with femoral adapter block.

Note:
The function of distal interlocking with the distal targeting device is only guaranteed when all steps are followed exactly. The components must always be firmly fixed as a unit with the right locking screws (this must be observed closely, including for presetting)!
Note:
After distal interlocking an AP and LM image intensifier check must be carried out!

A final word on distal interlocking:

Distal interlocking can also be carried out using the traditional freehand technique under image intensifier control. With this technique, however, you expose yourself to intensive levels of radiation, which can have a serious negative impact on your health!

Removing the proximal targeting device:
First undo the adapter screw on the proximal targeting device with a universal socket wrench, and remove. Then remove the targeting device.

Screwing-in the end cap:
Lock the proximal ¼-turn at a fixed angle. If first proximal interlocking was left out, the end cap only serves as a proximal nail seal without angle stability to secure the thread for complication-free extraction.

Fully interlocked femoral nail with antegrade insertion:
Nail insertion for retrograde indication:
When using for retrograde nail insertion, see page 2 Fig. 1 left, page 3 Fig. 3 and page 5 Fig. 7.

**Note:**
Pay attention to positioning, reduction and the determination of the insertion point as described!

**All remaining steps are as for antegrade insertion.**

---

Fully interlocked femoral nail with retrograde insertion:
Nail extraction:

After approx. 12 to 15 months, the implants must be removed; the patient must be informed of this by the surgeon when he leaves the hospital!

When extracting, remove the distal interlocking screws first of all, followed by the fixed-angle end cap. Once the end cap is removed, screw the femoral extraction bolt into the proximal end of the nail. Then, remove the proximal interlocking screws and attach the sliding hammer to the screwed-in extraction bolt. You can now start extracting the nail by using a steady, reverse action of the attached sliding hammer. Unless complications arise, the patient is normally kept in hospital for 24 hours for the final check.

When implanting titanium implants the general operating instructions No. 6 OSTEOSYNTHESIS IMPLANTS MADE OF TITANIUM from Ortho-Medical GmbH must be consulted and followed!
Introduction: Why a new type of tibial nail?

The latest standard in treating tibial fractures as a result of evolution in the types of fracture (ever-increasing trend towards proximally and distally located tibial fractures, and also for conventional diaphyseal fractures).

Objective: Improved clinical outcome in the minimally invasive treatment of tibial fractures.

- More interlocking options, both proximal and distal
- Many options in the direction of interlocking
- More anatomically compatible design (new continuous nail curvature).
- Locking of an oblique (first proximal) interlocking screw at a fixed angle
- High central load-bearing stability
- Short learning curves and minimum investment, as 90% of the existing standard instruments for femoral and tibial nails from the basic standard instrument set are compatible. Only the proximal tibial targeting jig, which is also new, and the adapter for the distal targeting device are required (two new additional instruments)
INDICATIONS

- Open and closed conventional shaft fractures
- Proximal fractures
- Distal shaft fractures
- The titanium tibial nail with extended set of indications allows treatment of fractures within a range of 80% - 85% of the length of the tibia.

For the diameter and lengths of the nails and interlocking screws and associated instrument set, see the titanium nail brochure!

Advantages

- Open and closed shaft fractures
- Unreamed insertion
- Proximal fractures
- Distal shaft fractures
- Minimally invasive treatment
- Dynamisation
- Highly economical
Positioning the patient

Positioning on a standard operating table

Note:
Recommended especially for open fractures to guarantee the optimal treatment of soft tissue.

The operating table must be radiolucent; the injured leg is exposed. To facilitate insertion of the nail, flex the knee joint and raise the lower leg. Make sure that the table is low enough. For the purpose of reduction, a large distractor or a forceps-shaped fixator (pinless) may be used.

![Positioning on a standard operating table](image1.png)

Positioning on a traction table

Note:
The use of this positioning technique enables only limited treatment of soft tissue damage!

The patient is in the supine position; the injured leg, with the knee flexed at an angle of 90°, is stretched out obliquely. Ensure that the X-ray image intensifier can be freely manipulated, and especially that it can be swivelled from AP to lateral. Reduction (incl. rotation) must be done before covering with the sterile drape. It cannot easily be changed during the operation. It is also important to pad the hollow of the knee well (apply pressure more so against thigh). Position the healthy leg in abduction, flexion and external rotation to ensure that the image intensifier can be freely manipulated.

![Positioning on a traction table](image2.png)
Selecting the right implant

Determining nail length

Hold the radiolucent ruler (from the basic instrument set) against the tibia, parallel to the shaft, with the proximal end level with the point of entry. Mark the skin at the relevant point.

Position the image intensifier above the distal tibia. Align the gauge to the mark on the skin. You can now read the required nail length straight off the intensifier image – given correct reduction – at the level of the former epiphyseal cartilage using the markings on the side of the ruler.

Determining nail diameter

The diameter of the medullary cavity can be determined from the central markings (notches) on the ruler. Position the square mark (notch) above the isthmus. When the transition to the cortical bone is just visible to the left and right of the mark, the corresponding nail can be used.
Determining the insertion point

Crucial to the success of implantation is the correct choice of insertion point. It must be determined taking the individual anatomical situation into consideration. In general, it must be defined as follows: just distal of the tibial plateau, slightly medial, exactly in the extension of the medullary cavity. If an entry point too far towards distal is selected, there is a risk – particularly in the case of fractures located at the proximal extremity – of the nail penetrating the dorsal cortical bone of the proximal main fragment. On the other hand, care must be taken not to enter too much towards proximal, so as to avoid opening the knee joint.
Opening the medullary cavity

Make a 2-3 cm long stab incision above the patellar ligament in an extension of the medullary cavity; for this, the knee is flexed at an angle greater than 90°. The proximal patellar ligament is split.

It is important to maintain as flat as possible. The trocar with a diameter of 4.0 mm from the basic instrument set serves as an orientation guide, see Fig. 9.

Then open using the curved awl from the basic instrument set, see Fig. 9.
Inserting the nail guide wire

Insert the nail guide wire, 2.4 mm in diameter, in conjunction with the T-handle, and advance steadily towards distal (fragments are threaded on in the process).

Note:

The nail guide wire must always be inserted first, even with the non-cannulated solid tibial nails with diameters of 9 mm and 10 mm. When placing a solid nail, remove the guide wire after threading on the fragments. For the cannulated tibial nails with diameters of 10 mm and 11 mm, the guide wire is left in the medullary cavity; the cannulated nails are inserted over the guide wire. Not until after insertion is the wire removed for the remaining steps to be carried out!
Presetting for distal interlocking with distal targeting device:

Setup 1.

Tibial nail / proximal targeting device and adapter block for titanium tibial nails

Setup 1 (fully assembled)
Presetting for distal interlocking with distal targeting device:

Setup 2.

Preset to distal screw holes using accessories - green drill sleeve, gold drill sleeve and 4 mm drill for nail diameters 10 and 11 mm. For nail diameters 8 and 9 mm, the black drill sleeve and the 3.5 mm drill are used for presetting! The horizontal / vertical axis of the targeting device must be aligned in such a way that the drill goes through both distal screw holes!

Setup 3.

Insert hook arm into the distal targeting device, insert silver 8 mm drill sleeve / blue drill sleeve and 4.8 mm drill into the anterior opening on the hook arm (presetting for fixing hook insertion). The 4.8 mm drill must be between the two distal screw holes and touch the nail shaft laterally!
Presetting for distal interlocking with distal targeting device:

Setup 4.

Insert fixation hook into the anterior opening on the hook arm and adjust it so that it touches the back of the nail but does not apply pressure (presetting for nail fixation hook). For tibial nails the 15 mm fixation hook is used!

Note:

- For distal interlocking using the distal targeting device, only the two holes in the tibial nail running from the medial to lateral plane can be interlocked.
- The third distal hole from the ventral to dorsal plane must, when making use of this additional interlocking option, be done in the traditional freehand technique under image intensifier control. This third interlocking option is recommended mainly for fractures located at the distal extreme by way of additional securing. In such cases, during preoperative planning, we recommend performing distal interlocking entirely using the traditional freehand technique under image intensifier control.
- In treatment using tibial interlocking nails, distal interlocking is principally undertaken from medial to lateral!
Nail insertion:

Connect up targeting attachment for 135° and 90° interlocking

Insertion:

Feed in nail over the guide wire and insert by hand into the medullary cavity as far as it will go (remove guide wire beforehand for non-cannulated nails of 8 and 9 mm, see Fig. 17, illustration of the insertion of a non-cannulated nail). For inserting the tibial nails, also in the unreamed technique, we recommend proximal medullary cavity enlargement using flexible medullary reamers. The proximal access is enlarged to approx. 12 mm to 13 mm in diameter, and drilled to a depth of approx. 120 mm. This drilling corresponds to the proximal tibial nail shaft and eases insertion.

Please note: Follow procedure - use of flexible medullary reamers!
Insertion:

After insertion into the medullary cavity, attach sliding hammer, and hammer in the nail to the distal end of the medullary cavity (hold the targeting jig parallel while hammering in the nail to prevent rotation).

Remove sliding hammer and guide wire (guide wire does not have to be removed when inserting non-cannulated nails of 8 and 9 mm). Once the hammer components have been removed the connection between the nail and proximal targeting device is retightened with a universal socket wrench (the hammering action can loosen the connection, making it necessary to check the connection after insertion).
Insertion of the proximal interlocking screws:

There is an option of fivefold interlocking using two different targeting attachments on the proximal targeting device!
Insert green and gold drill sleeve; drill with non-cannulated 4 mm drill.

Measuring the length of the proximal interlocking screw:

After drilling, remove drill and gold drill sleeve, and insert length gauge with hook into the green drill sleeve via the opposing cortical bone, and hook in place. At the collar of the green drill sleeve read off the actual measured screw length from the large calibration.
Insertion of the proximal interlocking screws:

Remove gold drill sleeve and screw in the 5 mm interlocking screw using a 3.5 mm hexagonal screwdriver until it is flush with the mark on the collar of the green drill sleeve. **Proximal interlocking is achieved with 5 mm interlocking screws!**
Insertion of the proximal interlocking screws:

Steps for all proximal screw insertions as in Fig. 20 to Fig. 23.

Insertion of the proximal interlocking screws:

Steps for all proximal screw insertions as in Fig. 20 to Fig. 23.
Insertion of the proximal interlocking screws:

Note:
For twofold medial / lateral union, change the targeting attachment on the proximal targeting device. Undo connection screw on the targeting device and remove it, change targeting attachment and connect up using the connection screw. For undoing and connecting, use the wrench from the basic instrument set.

Steps for all proximal screw insertions as in Fig. 20 to Fig. 23.

Drilling

Measuring screw length
Insertion of the proximal interlocking screws:

Insertion of interlocking screw

Note:

How many or which options for proximal interlocking are implemented with the interlocking screws depends on the indications, see page 2 (however, at least two interlocking screws should be inserted proximally to give optimal rotational stability!).
On completion of proximal interlocking, remove the upper part of the proximal targeting device by undoing the adapter screw with a wrench from the basic instrument set.

**Distal interlocking with distal targeting device:**

Setup as for presetting in Fig. 13 / 14. *(When using drill sleeves and drills, follow procedure for presetting as in Fig. 13 / 14!)* All steps involved in distal interlocking for tibial nailing are identical to those for the femoral nail; the only difference is connection of the distal targeting device to the proximal targeting device. Insertion of the two distal interlocking screws running parallel is done from medial to lateral, as for the two proximal standard interlocking options which run parallel.

**Completion of distal interlocking:**

On completion of distal interlocking and insertion of the two interlocking screws lying parallel *(always two of them)* the hook arm is removed first of all, followed by the fixation hook and the distal targeting device with tibial adapter block.

**Note:**
The function of distal interlocking with the distal targeting device is only guaranteed when all steps are followed exactly. The components must always be fixed firmly as a unit with the right locking screws (this must be observed closely, including for presetting)!

**Note:**
After distal interlocking an AP and LM image intensifier check must be carried out!

**Note:**
When inserting the third interlocking screw running from ventral to dorsal, it must be placed using the traditional freehand technique under image intensifier control! In such cases, we recommend performing distal interlocking as described on page 8 entirely using the traditional freehand technique without using the distal targeting device!

**Completion of distal interlocking:**
Remove nail fixation hook, hook arm and then the distal targeting device and tibial adapter block.

Remove the nail adapter screw on the proximal targeting device. Remove the targeting device and adapter screw.
Note:
After distal interlocking an AP and LM image intensifier check must be carried out!

A final word on distal interlocking:

Distal interlocking can also be carried out using the traditional freehand technique using image intensifier control. With this technique, however, you expose yourself to intensive levels of radiation, which can have a serious negative impact on your health!

Screwing-in the nail end cap:

Screw-in the proximal end cap 5/16" for tibial nails with a 5 mm hexagonal screwdriver and once it makes contact, lock it at a fixed angle with a ¼ turn.
If oblique proximal interlocking was left out, the end cap only serves as a proximal nail seal without angle stability to secure the thread for complication-free extraction.
Fully interlocked tibial nail:

Nail extraction:

After approx. 12 to 15 months, the implants must be removed; the patient must be informed of this by the surgeon when he leaves the hospital!

When extracting, remove the distal interlocking screws first of all, followed by the fixed-angle end cap. Once the end cap is removed, screw the tibial extraction bolt into the proximal end of the nail. Then, remove the proximal interlocking screws and attach the sliding hammer to the screwed-in extraction bolt. You can now start extracting the nail by using a steady reverse action of the attached sliding hammer. Unless complications arise, the patient is normally kept in hospital for 24 hours for the final check.

When implanting titanium implants the general operating instructions No. 6 OSTEOSYNTHESIS IMPLANTS MADE OF TITANIUM from Ortho-Medical GmbH must be consulted and followed!
Reamed technique using flexible medullary reamers for inserting interlocking nails
Using flexible medullary reamers

When using flexible medullary reamers to insert interlocking nails, the following must be observed:

1. Insert guide wire with olive tip (2 mm wire for 6 mm-7 mm drills / 3 mm wire for 8 mm-18 mm drills)
2. Drill over guide wire (clockwise only)
3. Begin drilling at 6 mm to 7 mm max.
4. Ream in 0.5 mm increments, 1.0 mm to 1.5 mm more than the measured distal shaft diameter of the chosen interlocking nail.
5. Once drilling is complete, insert the guide wire exchange tube over the guide wire with olive tip to the end of the drilled canal.
6. Now remove the guide wire with olive tip (when doing so, exchange tube is left in the medullary cavity).
7. Next, insert the nail guide wire into the exchange tube right to the end of the canal and then remove the exchange tube.

Note:
When inserting non-cannulated nails (solid nails) take steps 5 to 7; the nail is inserted as soon as drilling is finished!

Contraindication for unreamed insertion of an interlocking nail:

Warning:
When inserting interlocking nails in an unreamed medullary cavity (for the unreamed interlocking technique), a set of flexible medullary reamers must be available at all times during the operation in case of insertion complications. Why?
In patients who have a medullary cavity with a narrow shaft, the latter must be reamed for insertion, even when using an interlocking nail for the unreamed technique. Reaming the constriction in the medullary cavity is a precautionary measure to prevent the nail from sticking or the shaft from fracturing during insertion. Only the narrow part is drilled, not right to the end of the medullary cavity. The narrow part is overreamed a full 1.0 to 1.5 mm more than the distal, measured nail diameter.

General contraindication (fault detection with medullary drilling):

- Pressure too high
- Cutting edge blunt
- Guide wire or medullary reamer deformed
- Connection to drive unit faulty
- Soiling
- Excessive build-up of heat
- Operating instructions for medullary reamers not followed
- Fat embolism as a result of drilling the medullary cavity

Warning!
Follow Operating Instructions from Ortho-Medical GmbH for Flexible Medullary Reamers!