6.8.2 Tibia, shaft

1 Assessment 835
1.1 Soft-tissue assessment 835
1.2 Fracture classification 835

2 Treatment 836
2.1 Nonoperative treatment 836
2.2 Operative treatment 836
   2.2.1 Intramedullary nailing
   2.2.2 Plate fixation
   2.2.3 External fixation

3 Intramedullary nailing 837
3.1 Preoperative planning 837
3.2 Choice of nail 838
3.3 Surgical anatomy and approach 840
3.4 Reduction techniques 841
3.5 Postoperative management 841
3.6 Pitfalls and complications 843
3.7 Exchange nailing 843

4 Plate fixation 843
4.1 Preoperative planning 843
4.2 Choice of plate 844
4.3 Surgical anatomy and approach 844
4.4 Reduction techniques 846
4.5 Tricks and hints 846
4.6 Postoperative management 847
4.7 Pitfalls and complications 848

5 External fixation 848
5.1 Preoperative planning 848
5.2 Choice of external fixator 848
5.3 Surgical anatomy and approach 848
5.4 Reduction techniques 849
5.5 Tricks and hints 849
5.6 Postoperative management 850
5.7 Pitfalls and complications 850

6 Conclusions 850

7 Bibliography 852
6.8.2 Tibia, shaft

1 Assessment

1.1 Soft-tissue assessment

- The soft-tissue envelope is the most important component in the evaluation and subsequent care of tibial fractures.

One third of the tibia has no muscle cover and lies directly beneath the skin. Therefore, most tibial fractures—open as well as closed—are associated with an injury to the skin and subcutaneous tissues.

The extent and location of swelling and bruising are assessed first. Fracture blisters are a sign of massive soft-tissue swelling and should be a warning to delay any intervention. Next the skin must be assessed for intradermal swelling. When this occurs, the normal skin lines are lost and the skin appears shiny. Routine surgery is not safe in this situation and must be delayed until the skin starts to wrinkle again. While waiting for the condition of the soft tissues to improve, the limb should be stabilized by splinting, traction, or temporary external fixation.

Compartment syndrome occurs more often with tibial fractures than with other long-bone fractures. Causes can be swelling, bleeding, ischemia, or rebound edema following restoration of vascularity (reperfusion injury). The anterior compartment is most commonly involved.

- Any of the signs of compartment syndrome, including severe pain, pain with passive stretch, and localized loss of sensation requires immediate action, either measurement of compartment pressure or operative release of fascia.

This release must be combined with appropriate fracture fixation (chapter 1.6). The pulses are assessed. A missing pulse in an otherwise healthy leg must raise suspicion of vascular damage, especially in a displaced fracture of the proximal tibia. The Doppler signal may be helpful but is not always reliable. If in doubt, an arteriography should be performed. This is also advisable in the elderly patient with established or potential vascular disease. In tibial fractures, nerve injuries are less common than arterial injuries, but the limb must still be accurately assessed.

X-ray imaging of the tibia is usually confined to standard AP and lateral x-rays, which should include the knee and ankle joints. Additional imaging is rarely required in fresh fractures.

1.2 Fracture classification

In the diaphyseal segment, the AO Müller Classification distinguishes between simple (A), wedge (B), and complex (C) fractures (Fig 6.8.2-1). For further details see chapter 1.5; 2.2.

Fig 6.8.2-1 Müller AO Classification.
2 Treatment

2.1 Nonoperative treatment

Fractures of the tibial shaft that are stable and only minimally displaced can be treated, with good functional results, by initial immobilization in a cast followed by early weight bearing in a patellar tendon bearing cast. This is worn until union occurs. If nonoperative treatment is chosen for displaced fractures of the tibia, one must expect poorer outcomes in terms of the quality of reduction and range of motion [1, 2]. Prospective trials have shown fewer cases of good functional outcomes and slower return to work with cast care [1, 2].

- In most cases, unstable and displaced fractures of the tibial shaft benefit from operative fracture fixation.

2.2 Operative treatment

2.2.1 Intramedullary nailing

- Intramedullary nailing is indicated for the majority of closed midshaft fractures of the tibia as well as for open fractures with adequate soft-tissue cover [3–8].

Intramedullary nails inserted after reaming are preferred for closed fractures, allowing the use of large-diameter implants (up to 11 mm) [9, 10] with a higher chance of healing. The management of open tibial fractures is more controversial. Many advocate the use of solid nails without reaming [8] and small-diameter nails (8–10 mm). Nailing of fractures that are closer to the metaphysis at either end of the tibia is technically difficult. Freedmann and Johnson reported an incidence of 12% of malalignment in 133 tibial shaft fractures treated with intramedullary nailing, but the incidence increases to 58% when considering only the proximal third of the tibial shaft [11]. Theoretically, it is possible to nail all fractures below the level of the tibial tuberosity and 4 cm above the ankle joint [12, 13] using a standard locking nail. The expert tibial nail system (ETNS) (Fig 6.8.2-4; 6.8.2-5) has recently been introduced with a more anatomical design and increased options for proximal and distal locking. This should decrease the incidence of malalignment in fractures close to the metaphysis. However, these fractures require expert surgeons who are experienced in intramedullary nailing.

2.2.2 Plate fixation

- Displaced, unstable fractures of the proximal and distal thirds of the tibial shaft—with or without articular involvement—are best fixed with plates (Fig 6.8.2-2) because, in these areas, the intramedullary nail does not reduce the fracture anatomically nor maintain the reduction adequately.

Plate fixation is also indicated in cases that require anatomically accurate reduction (ie, more accurate than normal nailing will allow), for example, in high-performance athletes.

Plating is contraindicated in unreliable patients or when the soft tissues are damaged or deficient. If early weight bearing is more important than perfect alignment, intramedullary nailing is preferred [12]. The following principles, as described by Tcherne, are important:

- Place the plate under a viable soft-tissue coverage.
- Create a stable bone-plate construct.
- Apply the plate without periosteal stripping.
- Take great care of the already compromised soft tissues.

The MIPO technique takes these points into account (chapter 3.1.3).
6.8.2 Tibia, shaft

2.2.3 External fixation

External fixation is advocated in the most severe open fractures (Gustilo type IIIB and IIIC) involving bone loss, and fractures where other implants, such as plates and nails, would initially remain exposed.

External fixation is also indicated in life-threatening polytrauma situations where the fractures must be stabilized rapidly with no additional insult to the patient (damage-control surgery) [14]. External fixation can be applied as an adjunct to internal fixation (lateral bridging plate: medial external fixator) or as a joint-bridging device. In all these situations external fixation is intended to provide temporary fixation, to be followed by some means of internal fixation. External fixation can be used for definitive management of simple, closed, tibial shaft fractures, but malunion rates are usually higher than with internal fixation. The use of circular frame external fixation in these fractures is currently being evaluated.

3 Intramedullary nailing

3.1 Preoperative planning

Based on the surgeon’s preference and experience, the patient is placed on a traction table or on a radiolucent table, with the leg draped to be accessible from the ankle to above the knee. A support can be placed under the thigh proximal to the knee, so there is no pressure in the popliteal fossa (Fig 6.8.2-3). For intramedullary nailing without reaming, the width of the medullary canal must be carefully measured in order to choose the correct nail diameter. Careful measurement of nail length is also needed. This is more difficult with solid nails as it is not possible to use a guide wire for direct measurement; a ruler is used instead.
3.2 Choice of nail

Intramedullary nails are tubular, solid, or cannulated. Reamed and unreamed nails are, in essence, similar implants which splint the bone from within; the difference lies in the technique of insertion. Intramedullary nails inserted with reaming are tubular and tend to be used with a large diameter. They have a long, proven record of success and are to be favored for closed fractures and nonunions. Intramedullary nails inserted without reaming are solid or cannulated and smaller in diameter (8–10 mm). They were originally introduced as a temporary and minimally invasive splint for open fractures, but proved to be useful for definitive fixation and became popular even for the treatment of closed fractures (Fig. 6.8.2-4).

Locking with bolts or interlocking screws is mandatory for small-diameter nails in order to improve stability in a wide medullary canal. Locking is also recommended in all other situations unless the nail has achieved excellent endosteal contact above and below a stable type A midshaft fracture.

Fig 6.8.2-3a–c Positioning for intramedullary nailing of the tibia.

a On a traction table.
b On a radiolucent table, the knee fully flexed.
c On a padded knee support, the knee flexed as far as possible.
The extent of reaming should be adjusted to ensure that the intramedullary nail will pass the isthmus easily and permit the insertion of a large enough nail to provide stability.

In most cases, this means a nail with a diameter of 11–12 mm in acute fractures. In delayed unions or nonunions, even larger nails may be required for better stability.

Most intramedullary nails, including the expert tibial nail, have the option of either static or dynamic locking. Both provide rotational stability, but dynamic locking allows impaction of the fracture while controlling axial alignment and rotation (controlled dynamization). Dynamization is achieved by using a single proximal screw, placed in the proximal part of the oval locking hole in the nail (Fig. 6.8.2-5). Unstable fracture patterns, such as long oblique fractures (42-A2) or multifragmentary fractures (B and C types) should have static locking with two proximal screws. If one of the screws is placed in the dynamic slot, this leaves the option of secondary dynamization by removal of the static interlocking screw. However, in statically locked nails, dynamization is rarely required unless there is a gap wider than 2 mm that will

Fig 6.8.2-4a–b Segmental 42-C1 fracture stabilized with a 9 mm unreamed expert tibial nail.

Fig 6.8.2-5a–b The expert tibial nail system (ETNS) provides many proximal locking options. The oval hole allows dynamization. The proximal static screw can be blocked in position using the end cap to increase stability.
probably delay fracture healing [15, 16]. The expert tibial nail allows the surgeon to compress the fracture by up to a maximum of 7 mm, and so it should be possible to prevent fracture gaps using this nail. In an atrophic or poorly vascularized healing response, other methods of stimulating fracture union are necessary, such as the exchange to a reamed, large-diameter nail.

In distal fractures with associated fibula fracture, it may be useful [12] to fix the fibula to aid reduction and increase stability (Fig 6.8.2-6).

### 3.3 Surgical anatomy and approach

The proximal nail entry point is not in line with the medullary canal in the sagittal plane, and so its exact position varies depending on the design and stiffness of the nail. The recommendations for different types of nails must be considered carefully. In the coronal plane, the entry point must remain extraarticular and be centered over the medullary canal, especially if there is a short proximal fragment. Eccentric nail insertion will result in a valgus or varus tilt of the proximal fragment. The correct entry point is usually situated at the medial edge of the patellar tendon. The entry point can be reached by retracting the patella tendon (Fig 6.8.2-7a) or splitting it (Fig 6.8.2-7b). The approach used depends on the surgeon’s experience and preference. In some oblique fractures, a lateral parapatellar incision helps ensure a proper entry point and prevents fracture displacement during nail insertion (Video 6.8.2-1).

The entry point should be monitored by image intensifier in both planes before commencing the procedure. The interlocking screws are usually inserted from the medial or anterior aspect. During distal locking, the saphenous vein and/or nerve can be injured if care is not taken to identify and protect them during drilling and screw insertion.
6.8.2 Tibia, shaft

3.4 Reduction techniques

The key to the initial reduction of tibial shaft fractures is the restoration of length. If the correct length is not obtained, an accurate reduction is almost impossible. Length can be obtained in a variety of ways, including:

- via a traction table;
- manually by an assistant pulling on the lower segment;
- with a distractor.

In fresh fractures, manual traction usually restores length. In delayed cases, the traction table or a distractor may be helpful. Once length has been obtained, axial and rotational reduction is achieved with percutaneously placed pointed reduction forceps, or with a wide, temporary tourniquet at the fracture site, or indirectly using the nail as a joystick. In these cases, a nail that fills the medullary canal will align the bone fragments when it passes the fracture site. Reaming while the tourniquet is inflated should be avoided as it theoretically increases the risk of thermal necrosis of the cortex and overlying soft tissues.

Good axial alignment prior to nail insertion is important when using a solid, unreamed nail. This relatively thin implant will not accomplish fracture reduction automatically, as can be the case with a large-diameter implant (Fig 6.8.2-8). Poller screws may help to correct axial malalignment (chapter 3.3.1). In delayed cases with some shortening, the distractor is most useful to gain length. It is also useful in fresh fractures when a surgical assistant is not available. The application of the distractor is shown in Fig 6.8.2-9. The distractor is placed medially because this is safer, and the proximal pin is posterior to avoid the entry point of the nail. Since the distractor tends to cause a valgus position, the pins should be inserted in a slightly converging direction (ie, place the fracture into varus), so that the axis is corrected when distraction occurs. The most difficult part is determining the correct rotation. Keys to this are:

- matching of cortical thickness on x-rays;
- placement of pointed fragments in correct position;
- ensuring that the tension lines of the skin are not twisted;
- preparing the opposite leg to allow intraoperative comparison of length and rotation in severely comminuted fractures.

3.5 Postoperative management

The leg is splinted with the ankle in a neutral position for a day or two. This improves patient comfort and helps prevent equinus deformity. The leg is elevated for the first few days and the patient observed for signs of compartment syndrome. Active ankle and knee movements are started early. The timing of weight bearing depends on the fracture pattern and patient compliance. In axially stable fractures fixed with a large nail, immediate weight bearing as tolerated is allowed. In axially unstable fracture patterns, partial weight bearing with 20–25 kg is begun immediately, while full weight bearing should be reached within 8–12 weeks, according to the evolution of callus formation.
Specific fractures

6.8 Tibia

Fig 6.8.2-8a–c Reduction can be difficult in very unstable fractures and is aided by percutaneous reduction forceps. Static locking is necessary. An expert tibial nail (ETN) is shown.
6.8.2 Tibia, shaft

Fig 6.8.2-9 Reduction by the large distractor with correction of length and axial and rotational alignment prior to intramedullary nailing.

3.6 Pitfalls and complications

About 30% of patients will have some knee pain regardless of the nail entry point. Irritation of the patellar ligament can occur if the nail is protruding. Any incision on the anterior aspect of the knee can lead to pain and discomfort, especially when kneeling [17].

Bending and breakage of interlocking screws is not uncommon, especially with the use of small intramedullary nails (8 mm diameter), and when time to union is delayed, i.e., in open fractures [9]. Though some series report a rate of broken screws of more than 12% [18], only a small number of patients report a clinical problem related to this complication. In many cases the bending or the breakage of the screw represents a sort of autodynamization [10]. In fact, one of the features of closed intramedullary nailing is the high rate of union (98.5%) [9]. The use of unreamed nails did not improve these results. The average time to healing of closed fractures treated with an unreamed nail is longer than those treated by reamed nails [6].

3.7 Exchange nailing

In nonunion following tibial nailing, the technique of exchange nailing has become a standard procedure. Implant removal, reaming of the medullary cavity through the same approach, and insertion of a larger nail are the main steps of exchange nailing. This technique offers both a biological and a mechanical advantage: The reaming is an effective stimulus for osteogenesis and the use of a larger nail enhances the stability of the nonunion site. Most series report that exchange nailing, by itself or with additional bone graft or fibular osteotomy, normally leads to bone healing in almost 100% of cases.

4 Plate fixation

4.1 Preoperative planning

Tibial plating requires the basic instrument set, a range of narrow LC-DCP 4.5 and LCP 4.5, and reduction instruments. The patient is positioned supine on a regular, and preferably radiolucent, operating table. The use of a tourniquet is rarely necessary but it may be an advisable precaution to have a uninflated cuff on the thigh. It is always helpful to draw a formal preoperative plan using the templates (chapter 2.4).
4.2 Choice of plate

In diaphyseal tibial fractures, the narrow LC-DCP 4.5 or LCP 4.5 is most commonly used. Conventional plating requires screw fixation in at least six cortices on either side of the fracture. Broad plates should not be used in the tibia; they are too stiff and bulky. Smaller plates (LC-DCP 3.5 or LCP 3.5) are occasionally indicated in the distal tibia in very small patients. In the family of locking compression plates there are metaphyseal plates with one end slightly precontoured and tapered as well as anatomically preshaped plates for both the proximal and the distal end of the tibia. For the proximal, lateral tibia, a low-profile, L-shaped plate as well as the somewhat heavier LISS PLT with combination holes are available and suited to complex plateau fractures extending into the diaphysis. For the distal end of the bone there is the distal tibia LCP.

- The current trend for bridge plating and conventional plating is to use longer plates (8-hole to 10-hole) and not to fill every hole.

Two or three bicortical screws above and two or three below the fracture focus are considered sufficient, provided they are spaced apart and anchored in bone of good quality. More screws are probably unnecessary (chapter 3.3.2). In complex type C fractures a bridging plate should be about three times the length of the fracture zone (Fig 6.8.2-10).

4.3 Surgical anatomy and approach

The tibia is well suited to plate fixation, especially along its medial subcutaneous border, where a plate does not interfere with the critical blood supply to the bone. Moreover, the flat medial surface makes contouring of the plate easy.

The lateral surface is also accessible, but the exposure requires opening of the lateral compartment, dissection of the muscles, and protection of the nerves and vessels. Plate contouring is more demanding distally on this side.

The standard approach to the tibia is 1 cm lateral to the tibial crest (Fig 6.8.2-11). An incision placed directly over the crest will end up over the medial aspect of the tibia when the swelling has subsided.
6.8.2 Tibia, shaft

In the proximal and midshaft area the incision is straight; distally it is curved gently in the direction of the medial malleolus. The incision is carried down straight to the fascia without undermining the subcutaneous tissues. The fascia of the anterior compartment is left intact. The skin and subcutaneous tissues are elevated sharply from the periosteum. At the level of the fracture gap, the periosteum may be very gently pushed aside to judge the exact reduction, while the plate will be placed on top of the intact periosteum.

The narrow LC-DCP 4.5 and the locking plate, ie, the LCP 4.5 or Tibia-LISS, lend themselves to minimally invasive insertion and extraperiosteal positioning; especially in complex type C fractures. These implants which—thanks to the locking head screws—have only limited or no contact to the bone are meant to preserve the periosteum and its blood supply.

---

**Fig 6.8.2-11a–b** Standard approach to the tibia, 1 cm lateral to the crest.

a  At the distal end, the incision crosses the crest in a gentle curve in the direction of the medial malleolus.

b  The cross section of the lower leg shows the best ways to approach the medial as well as lateral side of the tibia. The four compartments of the lower leg are demonstrated.

Yellow = Anterior compartment.
Red  = Lateral compartment.
Blue = Deep posterior compartment.
Green = Superficial posterior compartment.
The skin incision for the lateral approach to the tibia is similar to the medial side. The fascia overlying the muscle is incised a few millimeters away from the tibial crest to leave a fringe of tissue for later reattachment. In order to position the plate on the lateral side, the muscles are gently elevated from the periosteum. Minimally invasive techniques are discussed in chapter 3.3.1; 3.3.4; 6.8.2-4.5.

4.4 Reduction techniques

Selection of the correct reduction technique is probably one of the most important parts of internal fixation. The goal is to restore correct length, axial alignment, and rotation, and this can be achieved using direct or indirect methods.

Length is the key to correct reduction and should be restored as the first step in most reductions. Manipulations to obtain reduction must be gentle to avoid further compromise to the essential blood supply to the fracture fragments.

With a simple type A fracture, or type B bending and spiral wedges with a single fragment, direct anatomical reduction should be maintained by interfragmentary lag screw fixation and a protection or compression plate to provide absolute stability—a classical AO principle. Bridge plating, even with locking plates, should not be used for these fracture patterns. The strain in the fracture gap will be high, and nonunion is likely to develop (see Perren’s strain theory, chapter 1.2).

In complex type C fractures, exact reduction is not required and the plate should only have a bridging function. Minimally invasive techniques with indirect reduction and extra long implants (preferably with locking head screws) provide relative stability (biological or bridge plating, chapter 3.3.2) and a low-strain environment that allows healing by callus formation.

4.5 Tricks and hints

Minimally invasive percutaneous plate application is a technique which can be used as an alternative to classical ORIF [19]. It requires experience in indirect reduction techniques (with either a large distractor or external fixator), as correct length and axial alignment are mandatory before the plate is applied. In distal tibial fractures, indirect partial reduction and further stability may be achieved by plating the fibula. The length and rotation of the fibula must be exact, or the tibia will be malaligned. Once the fracture has been reduced and the plate contoured, the skin incision to introduce the plate is placed either proximally or distally to the fracture (Fig | Animation 6.8.2-12). With an elevator, an extraperiosteal tunnel is prepared to insert the plate. Some plates, such as the LCP, have a tapered end to facilitate the subcutaneous passage. The correct position is checked by image intensifier, and subsequently the screws are inserted through stab incisions (Video 6.8.2-2). As percutaneous plate application does not allow precise contouring of the implant, the LCP—used as an internal fixator—is the ideal implant for this technique. Thanks to the locking head screws the plate is not pressed against the bone, thereby preventing secondary malalignment.

Video 6.8.2-2 Percutaneous plate fixation (MIPO technique) of a complex tibial and fibular fracture with bridging LCPs.
4.6  Postoperative management

The leg is elevated and splinted with the ankle at 90° for about 4–5 days or until swelling has subsided and active dorsiflexion is regained. Immediate active ankle and knee movement with the help of a physiotherapist is encouraged. If compliant, the patient is allowed to get up with immediate toe-touch weight bearing (10–15 kg). Exceptionally, the limb is protected by a short leg splint or cast. At 4–6 weeks, weight bearing is increased. Depending on the original fracture pattern and on x-ray and clinical follow-up, full weight bearing should be reached by 8–12 weeks postoperatively. X-rays are obtained after 6 and 12 weeks. After a simple fracture treated by open reduction and absolute stable fixation, uneventful fracture healing is identified by a gradual disappearance of the fracture lines, while any appearance of external callus is a sign of some motion at the fracture site. After bridge plating (relative stability) and in contrast to direct or primary healing, the appearance of visible external callus is a positive sign of progressing bony union.

---

Fig | Animation 6.8.2-12a–c  Percutaneous plate insertion—bridging technique.

| a | Alignment of the fracture with a temporary large distractor—indirect reduction.

| b | Proximal incision on the medial tibia. The saphenous vein and nerve must be protected.

| c | The plate is introduced and pushed distally between fascia and periosteum. A short distal incision is made. The position is checked by image intensifier.

The bridging plate is fixed proximally and distally by a few (2–3) screws only.
Besides x-ray evidence, the clinical condition of the leg (absence of swelling, tenderness, pain) is the best indicator for the progress of fracture healing.

4.7 Pitfalls and complications

The greatest concern after plating of tibial fractures is to obtain uneventful soft-tissue healing, particularly of the skin, which is very sensitive to poor handling. To avoid skin problems, correct timing of surgery, gentle soft-tissue technique, wound closure without tension, and meticulous suture technique are essential. This is also true for percutaneous plating in which the plate is situated directly beneath the skin incisions.

The temptation to use excessive retraction of the skin in order to avoid a slightly larger incision must be resisted.

5 External fixation

In most situations, the unilateral half-pin frame will be the best choice for diaphyseal fractures. Circular frames with tensioned, thin wires, including the hybrid frame, are useful in fractures that involve the proximal and distal tibia, as they allow stable fixation close to a joint without impairing joint movement. Circular frames may also be useful for acute shortening of open fractures with bone and soft-tissue loss, allowing distraction osteogenesis at a later stage. If the use of an intramedullary nail is planned, the change should occur within 2 weeks of the injury (chapter 3.3.3).

5.1 Preoperative planning

The main purpose of external fixation is to provide stable conditions for safe soft-tissue healing and wound control. The construction of the frame should be as simple as possible, allowing full access to the wound. Secondary soft-tissue procedures such as skin grafts, muscle flaps, and free tissue transfers are possible, as well as definitive internal fixation, if desired. To save time it is advisable to preassemble the different components of the frame before application.

5.2 Choice of external fixator

With external fixation, the surgeon can build a custom-made device almost without limits. To increase stability there are several options, such as

- placing the pins as far apart as possible, ie, one pin close to the fracture and another spaced far away from it;
- increasing the number of pins;
- decreasing the distance between bar and bone;
- adding a second bar;
- adding a second frame to build a V-construction.

If pins are placed close to fracture lines, care must be taken to avoid insertion into the fracture hematoma as this carries the risk of causing deep infection.

Too much stability may delay fracture healing due to a lack of load at the fracture site. It is always possible to dynamize the external fixation frame, taking into account the different options of stability listed above.

5.3 Surgical anatomy and approach

The surgeon must be aware of the safe zones for external fixation through which half pins, transfixing pins, or Schanz screws can be placed without involving muscles, tendons, nerves, or vessels [20]. The safe zones for half pins comprise an arc of about 220° proximally, 140° in the diaphysis, and 120° distally (Fig. 3.3.3-2b).
The safe zones for transfixing pins are narrower, and good knowledge of the anatomy is essential. It is safer to use tensioned, thin wires (1.8–2.0 mm) for transfixation.

5.4 Reduction techniques

The external fixator can be applied after reduction of a fracture, as described for plating or nailing. The external fixator can also be used as a reduction tool, especially if the modular tube-to-tube principle is applied, which is of great advantage if no intraoperative image intensifier is available (Fig 6.8.2-13) (chapter 3.3.3).

5.5 Tricks and hints

For detailed instructions on application of the external fixator see chapter 3.3.3.

In case of severe soft-tissue compromise it is helpful to extend the fixator by placing a pin in the first metatarsal and fixing the ankle at 90°. This will help prevent a plantar flexion contracture (Fig 6.8.2-14). Occasionally, a second pin is needed in the fifth metatarsal to prevent a supination deformity. As an alternative, a footplate can be attached to the frame to hold the foot in a neutral position.

---

Fig 6.8.2-13 A 42-C1.1 fracture stabilized by external fixator with tube-to-tube clamps.

Fig 6.8.2-14 To prevent plantar flexion contracture of the foot, a pin may be placed in the first metatarsal and connected to the main frame by a single bar.
5.6 Postoperative management

This will vary considerably depending on the treatment plan and the soft-tissue condition. If external fixation is used as the definitive device, weight bearing starting at 10–15 kg should be encouraged early, as in plate fixation. As soon as callus formation is visible and once there are no clinical signs of instability, the patient can start to bear full weight. After removal of the external fixator, it may be prudent to protect the leg temporarily in a splint or brace. One more option is to remove the external fixator in several steps.

When the plan is to replace external with internal fixation, the timing of the second surgery is very important, especially if intramedullary nailing is being considered. The interval between initial application of the fixator and the nailing should not be longer than 10–14 days because the danger of pin-track infection appears to increase considerably after that time. Any signs of pin-track irritation should preclude replacement of the fixator by a nail or a plate.

5.7 Pitfalls and complications

Pin site infection and pin loosening are the problems most frequently encountered with external fixation. The two are usually related and either can give rise to the other. They almost always indicate instability of the entire construction. Loose or infected pins must therefore be repositioned and oral antibiotics may sometimes be required.

External fixation constructs that provide too much stability can lead to delayed union, as the necessary application of load to the fracture is missing. Therefore, sequential reduction of the rigidity of a frame, which is the equivalent of dynamization of an intramedullary nail, may be advisable.

6 Conclusions

In diaphyseal tibial fractures there are different, well established treatment modalities. Each one has its special indications, advantages, and disadvantages, and each technique must be correctly applied to obtain success (Fig 6.8.2-15). Although the intramedullary nail has gained much popularity thanks to the smaller solid nails, the pendulum presently seems to be swinging back in favor of the plate, especially for the proximal and distal third of the bone, where anatomical reduction is easier to obtain with plates than with nails and where less damaging methods (MIPO) are applied. The state of the soft-tissue cover remains the most important factor in the treatment and outcome of tibial fractures.
6.8.2 Tibia, shaft

Fig 6.8.2-15a–c
a Complex fracture of the tibial diaphysis (42-C1.1) with distal fibular fracture.
b Postoperative view after fixing the fibula with a one-third tubular plate and the tibia with a statically locked 8 mm solid tibial nail.
c 1-year follow-up.
6 Specific fractures
6.8 Tibia

7 Bibliography


