6.8.3 Tibia, distal intraarticular (pilon)

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6.8.3 Tibia, distal intraarticular (pilon)

1 Surgical anatomy

1.1 Bone structures and ligaments

The ankle joint is formed by the articulation of the distal ends of the tibia and the fibula with the talus, and is supported by the joint capsule and ligaments. Any incongruity of the components of the ankle joint (deviation in length, axis or rotation) or widening of the distal tibiofibular joint frequently results in cartilage degeneration and posttraumatic osteoarthritis [1–5].

The distal fibula is held in the notch of the tibia by the interosseous membrane and the anterior and posterior tibiofibular ligaments. In pilon fractures involving both bones, the syndesmotic ligaments usually remain intact but may be avulsed from the tibia [6–8] with minor or major fragments (Tilleaux-Chaput tubercle and Volkmann’s triangle). The talofibular ligaments may be torn, especially in case of a valgus injury where the fibula remains intact, while the deltoid ligaments are nearly always intact, permitting indirect reduction by ligamentotaxis in selected cases. In contrast to malleolar fractures where rotational forces are the main mechanism of injury, pilon fractures are characterized by impaction of the articular components of the distal tibia.

Depending on the position of the foot the pattern of the injury will vary considerably (Fig 6.8.3-1).

1.2 Blood supply

The distal fibula is supplied by branches of the fibular artery, the distal tibia by branches of the anterior and posterior tibial artery. Extensive surgical exposure may endanger the anteromedial portion of the tibia. In elderly patients with more vulnerable blood vessels, the injury itself may already have compromised local vascularity.

Fig 6.8.3-1a–c Influence of the position of the foot upon the pattern of the fracture: plantar flexion results in posterior injury (a), dorsal flexion results in anterior injury (b), neutral position results in anterior and posterior impaction (c).
2  Assessment

2.1  History

Knowledge of the mechanism of injury is most important. Low-energy trauma (e.g., skiing) usually leads to less complicated fracture patterns with little soft-tissue injury, while high-energy trauma with axial compression (fall from great height, road traffic accident) produces complex articular fractures with metaphyseal impaction and bone loss [9] with contused or crushed soft tissues or an open injury.

2.2  Clinical examination and soft-tissue evaluation

Clinical assessment must include the condition of the soft parts as well as the sensory and motor function of the foot structures. Special attention is given to any signs of a compartment syndrome. Grossly displaced or dislocated fractures must be reduced immediately and temporarily stabilized, preferably by a joint-bridging external fixator.

2.3  Imaging and fracture classification

Standard AP and lateral x-rays are taken, but in most pilon fractures more information is needed from CT scans with 2-D and 3-D reconstructions. All fractures are classified according to the Müller AO Classification (Fig 6.8.3-2).

3  Preoperative planning

3.1  Indications for surgery

As in most displaced articular fractures, exact reconstruction of the articular components of the distal tibia is best achieved by open reduction and internal fixation (ORIF). Simple fracture patterns might be managed nonoperatively or by minimally invasive procedures, but complex fractures almost always require a direct inspection of the articular surface. Ideally, this is achieved through a limited surgical exposure that preserves vascularity. From a technical point of view, the majority of displaced pilon fractures can be reconstructed by ORIF [9]. Exceptions are severely shattered fractures, where the only solution may be external fixation with a circular or hybrid frame [5, 10]. Very important factors for success appear to be the surgeon’s experience and skill [2, 11].

3.2  Timing of surgery

Timing of surgery is determined by the condition of the soft tissues. Staged procedures are recommended.

Only simple fractures with minimal soft-tissue injury may be definitively stabilized within the first 6–8 hours [8].
For the great majority of pilon fractures, we prefer to delay surgery for 7–14 days. A joint-bridging external fixator (or alternatively calcaneal traction) should be used with limb elevation until the soft-tissue edema has subsided and the skin begins to wrinkle. This also allows detailed radiological assessment (CT scan) and careful preoperative planning.

### 3.3 Choice of procedure

The soft-tissue conditions usually dictate the choice of procedure: early single-stage or multiple-stage surgery. The decision is based on the individual situation and not necessarily on general principles.

#### 3.3.1 Single-stage procedure

In displaced fractures with minimal, closed soft-tissue injury, reconstruction may be achieved by a single-stage open procedure, embracing the classical four principles of Rüedi and Allgöwer [6]:

1. reconstruction of the fibula (if fractured);
2. reconstruction of the tibial joint surface;
3. autogenous cancellous or corticocancellous bone graft (if necessary);
4. support by a buttress plate.

#### 3.3.2 Multiple-stage procedure

**Closed fracture**

In grossly displaced fractures and/or fractures with severe, closed soft-tissue injury [5, 12, 13], it is generally advisable to proceed in two or more stages:

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Emergency management</th>
<th>Wound debridement and lavage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Closed reduction and joint-bridging</td>
<td>Joint-bridging external fixator</td>
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<td></td>
<td>external fixator</td>
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<td></td>
<td>Stabilization of the fibula</td>
<td>(if needed and soft tissues allow)</td>
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<td></td>
<td>Stabilization of the tibial</td>
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<td></td>
<td>joint surface</td>
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<tr>
<td></td>
<td>Autogenous cancellous or</td>
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<td></td>
<td>corticocancellous bone graft (if</td>
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<tr>
<td></td>
<td>necessary)</td>
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<tr>
<td></td>
<td>Support by a buttress plate</td>
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</table>

**Open fracture**

Open pilon fractures are very severe injuries often requiring plastic surgery for soft-tissue reconstruction. The management includes several stages:

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Emergency management</th>
<th>Wound debridement and lavage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Closed reduction and joint-bridging</td>
<td>Joint-bridging external fixator</td>
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<td></td>
<td>external fixator</td>
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<tr>
<td></td>
<td>Stabilization of the fibula</td>
<td>(if needed and soft tissues allow)</td>
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<td></td>
<td>(if necessary)</td>
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<tr>
<td></td>
<td>Stabilization of the tibial</td>
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<td></td>
<td>joint surface</td>
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<td></td>
<td>Autogenous cancellous or</td>
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<td></td>
<td>corticocancellous bone graft (if</td>
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<tr>
<td></td>
<td>necessary)</td>
<td></td>
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<tr>
<td></td>
<td>Support by a buttress plate</td>
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</tbody>
</table>

**Stage 2**

Second look operation

<table>
<thead>
<tr>
<th>At 48 hours</th>
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</thead>
<tbody>
<tr>
<td>Debridement as necessary</td>
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<tr>
<td>Reconstruction of the tibial articular block</td>
</tr>
<tr>
<td>Soft-tissue coverage (local or free flap)</td>
</tr>
</tbody>
</table>

**Stage 3**

Definitive stabilization

| “Limited” ORIF of the articular block |
| Bridging of the metaphyseal comminution, +/- bone graft |
Definitive stabilization between joint block and tibial shaft by an internal or external fixator may be performed at 48 hours or preferably later, depending on the individual situation.

Exceptionally, a single-stage procedure with radical debridement, immediate definitive skeletal stabilization, and soft-tissue cover with a vascularized muscle flap may be performed with favorable results, provided the multidisciplinary reconstructive team is available around the clock [14].

In any case of a large soft-tissue defect the plastic surgeons must be involved as early as possible. In very complex fractures with extensive damage to the metaphysis or in case of a bone defect combined with poor soft-tissue condition, primary shortening may be an alternative to salvage. Secondary lengthening, using a circular frame system at the metaphyseal fracture site or more proximally will be required later [11].

### Planning of reduction techniques

Preoperative planning is an essential part of treatment of pilon fractures. It consists of careful study of the x-rays and CT scan, drawing of both the fracture fragments and the desired end result, consideration of intraoperative reduction techniques as well as the choice of implants (Tab 6.8.3-1). Once we have drawn and outlined all the fragments of the fibula and tibia in two planes, the following questions have to be answered:

1. Can we follow the classical principles or not?
2. Do we need a bone graft or bone substitute?
3. Is there a lateral key fragment in conjunction with the anterior syndesmosis that should be reduced and fixed?
4. Are screws alone sufficient or do we need a medial buttress plate? If so, which size and type of plate—with or without locking head screws—and in which position?
5. Do we need an open approach (limited ORIF) or can the planned stabilization be performed by a minimally invasive approach?
Finally the reconstructed distal tibia and fibula are drawn with the implants and the sequence of individual steps of the operation is defined.

### 3.5 Approaches

We approach the fibula by a straight or slightly curved incision posterior to the fibular crest (Fig 6.8.3-5b). Care must be taken not to damage the superficial fibular nerve. For multifragmentary fibular fractures a bridging plate maintaining correct length, axial alignment, and rotation is preferred instead of attempting an anatomical reduction of all fragments (Fig 6.8.3-6).

For the reduction of all type B and type C pilon fractures with displaced central fragments and/or impaction the exact approach is planned from the CT scan. In general, a limited open anteromedial approach (seldom anterolateral) is required to achieve anatomical reduction of the tibial articular surface (Fig 6.8.3-5a). These fractures cannot be reduced by ligamentonotaxis alone and always need some direct manipulation and inspection of the joint.

The incision for the anteromedial approach starts about 5–8 cm proximal to the ankle joint, lateral to the tibial crest, and runs in a straight line over the ankle joint towards the base of the navicular, following the medial border of the anterolateral fibular tendon (Fig 6.8.3-5a). It provides a better approach to the anterior part of the tibia than a curved incision [11]. Lateral undermining of the skin flaps must be avoided; minimal exposure and careful handling of the periosteum are essential to prevent any further vascular damage of the fracture fragments (Fig 6.8.3-7). The tibiotalar joint is opened in the same vertical (sagittal) direction. Any transverse incision of the anterior capsule to further expose the joint should be kept short as this risks devascularization of the anterior fragments (supplied by branches of the anterior tibial artery). Separating the anteromedial and anterolateral articular fragments with a

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<table>
<thead>
<tr>
<th>Fracture</th>
<th>Approach</th>
<th>Reduction</th>
<th>Fixation</th>
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<tr>
<td></td>
<td>Zone</td>
<td>Pattern</td>
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<td>Articular</td>
<td>Simple</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>+++</td>
<td>-</td>
</tr>
<tr>
<td>Meta-/diaphyseal</td>
<td>Simple</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>–</td>
<td>+++</td>
</tr>
<tr>
<td>Fibular</td>
<td>Simple</td>
<td>+++</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>+</td>
<td>++</td>
</tr>
</tbody>
</table>

**Tab 6.8.3-1** Advised techniques (approach, reduction, and fixation) for the definitive reconstruction of pilon fractures in relation to the zone and pattern of the fracture.
Specific fractures
6.8 Tibia

Fig 6.8.3-5a–b

a Posterolateral approach to the fibula, which is mainly used for simple fibular fractures. The CT scan may be helpful in placing the incision precisely, which reduces the need of raising flaps. Between the two incisions, a broad bridge of healthy tissue must be preserved (> 6–7 cm).

b Surgical anatomy and anteromedial approach for “limited” open reduction and internal fixation of the distal tibia.

1 Great saphenous vein and nerve.
2 Dorsalis pedis artery.
3 Superficial fibular nerve.
4 Sural nerve.
6.8.3 Tibia, distal intraarticular (pilon)

Instead of two separate incisions, the anterolateral approach to the tibia may allow fixation of the fibula in selected cases. This skin incision is placed between the anterior border of the fibula and the tibia at the position of the anterolateral tibial corner (Tilleaux-Chaput tubercle). The retinaculum of the extensor tendons is opened and the anterior tibial neurovascular bundle is retracted to the medial side. The joint capsule is incised in a vertical direction between the anterolateral and anterior articular fragment.

Formal exposure is limited to the articular region (“limited ORIF”) with the incision long enough for adequate joint reduction and fixation but not extending to the full length of the planned plate. The multifragmentary meta-/diaphyseal fracture zone should not be pieced together anatomically: indirect reduction is used to restore length, rotation, and alignment. Therefore, this biologically compromised region is not directly exposed; the plate is inserted subcutaneously in a retrograde fashion and the proximal screws are placed through small stab incisions.

Fig 6.8.3-6a–b Percutaneous bridge plating of a complex fibular fracture using a LCP 3.5.
   a Clinical aspect.
   b Postoperative x-ray.

Fig 6.8.3-7 Small periosteal window (marked blue) showing minimal detachment of the periosteum to visualize the articular fractures lines. The plate(s) are placed onto the periosteum (epiperiosteally), which is not further detached.
Specific fractures
6.8  Tibia

3.6  Choice of implants

The standard implant for the fibula is the one-third tubular plate, which can be applied either on the lateral aspect or on the posterior crest of the fibula as a buttress or antiglide plate. A complex fracture may require the stronger LC-DCP 3.5 or LCP 3.5. In the rare case of severe lateral soft-tissue damage, an intramedullary pin or elastic nail, inserted from the tip of the lateral malleolus, may be a useful option, but this does not control rotation [8].

For the tibia a number of implants are available. The clover leaf plate is bulky and should not be used anymore as it causes soft-tissue problems. Instead, one or two one-third tubular plates or LC-DCP 3.5 placed anteriorly and medially may be used. These allow a more individual, indirect reduction (eg, push-pull technique in different planes). Additional 3.5 mm lag screws, regular or cannulated, are often required for fixation of the tibial joint block (Fig 6.8.3-6; 6.8.3-7).

Anatomically preshaped LCPs are now available for the distal tibia. Although most fractures can be stabilized adequately by conventional (nonlocking) plates, the new generation of plates based on the internal fixator principle with locking head screws providing angular stability offers several advantages in complex fractures and osteoporotic bone [15]. These special pilon plates facilitate gentle insertion and the percutaneous placement of screws [16]. According to the fracture pattern, the LCP pilon plate (eg, 43-B3, 43-C3), the LCP distal tibia plate (eg, 43-A3, 43-C2) or the LCP metaphyseal plate 3.5/4.5/5.0 (fracture with diaphyseal extension) can be applied (Fig 6.8.3-9).

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Fig 6.8.3-8  Separating the anteromedial and anterolateral fragments, without soft-tissue detachment, “opens the book” and allows the surgeon access to the center of the fracture (same case as Fig 6.8.3-12).

Fig 6.8.3-9a–b  Preshaped locking plate for less complex pilon fractures—LCP distal tibia plate 3.5 (a), LCP metaphyseal plate (b).
3.7 Wound closure

Before wound closure, radiographic confirmation of joint congruity, length, and axial alignment is mandatory. The skin is sutured paying great attention to a less traumatic suture technique. Should a tension-free skin closure not be possible, the lateral incision may be left open and covered after some days by a split skin graft or the vacuum sealing technique [9]. Skin and soft-tissue defects usually require a free flap procedure.

4 Surgical treatment—tricks and hints

- The outcome of pilon fractures depends on the quality of reconstruction of the joint [1, 2, 6] and on the recovery of the soft tissues.

4.1 The four classical principles

4.1.1 Fibula

A simple fracture of the fibula is reduced anatomically, fixed with a lag screw, and protected by a lateral 5- or 6-hole one-third tubular plate. If appropriate, a posterior buttress (anti-glide) plate may be used. This first step usually reduces the lateral “key fragment” of the tibia to its correct position (Fig 6.8.3-10).

A complex fibular fracture is preferably addressed after the reconstruction of the tibia. The anterior syndesmotic ligaments are usually intact, so gross realignment of the fibula occurs with reduction and fixation of the tibia (especially of the anterolateral and posterolateral fragments). The final reduction can be perfected indirectly with the push-pull-technique or the small distractor. It is essential to achieve the correct length, rotation, and axial alignment. For stabilization, we advocate long bridging plates. This procedure can also be performed in a minimally invasive manner using a short incision over the distal end of the fibula with percutaneous, retrograde insertion of the slightly contoured long LCP 3.5 (Video 6.8.31).

Fig 6.8.3-10a–b  Step one: reconstruction of the fibula.

a  On the unreduced x-ray you can recognize (dotted line) the lateral key fragment of the distal tibia, which is attached to the fibula by the anterior syndesmotic ligament.
b  Reduction and fixation of the fibula as first step reduces the key fragment of the distal tibia to its correct position.
Specific fractures
6.8 Tibia

4.1.2 Tibial articular surface
In complex cases with articular impaction and several fragments, it may be helpful to apply an external joint-bridging distraction device (small or large distractor, or an external fixator) medially to obtain a preliminary indirect reduction of length and axial alignment. Alternatively, a transverse Schanz screw through the talus or calcaneus can assist the reduction maneuver. Using a standard anteromedial approach, the tibial articular block is reduced by a combination of direct and indirect techniques. Anterior and medial fragments may be retracted by a pointed hook or a small bone spreader exposing the tibiotalar joint. This brings the central and posterior fragments clearly into view (Fig 6.8.3-8). It is essential to remove all blood clots and small osteochondral debris from the joint and fracture before the reduction process starts. Impacted central fragments are cleaned and occasionally temporarily removed. The posterior fragment is often the key to the articular reduction and may need to be derotated. This is best done by a K-wire used as a joystick. An impactor or elevator reduces partially impacted fragments. Finally, all articular fragments are lined up one after the other, starting at the back and finishing in front, using the talus as a mold to restore anatomical congruity. Once aligned, the fragments are held in position by preliminary K-wires or a pointed reduction forceps (Video 6.8.3-1). The K-wires—preferably those compatible with cannulated screws—must be inserted parallel to the joint surface to allow subsequent interfragmentary compression without creating articular steps. Another key fragment, the anterolateral edge of the tibia, which is usually joined by the intact anterior syndesmotic ligament, must also be perfectly aligned (Fig 6.8.3-11). Ideally, this is done through a separate stab incision avoiding the anterior tibial artery. The preliminary reduction must be checked by x-ray or image intensifier before definitive stabilization is started. Wherever possible, anatomical reconstruction and stable fixation by interfragmentary lag screws should be achieved, thus permitting early active motion of the ankle joint.
4.1.3 Bone grafting
Thanks to less invasive techniques, gentle reduction, and the primary stability of fixation with locking-plates (LCP), bone grafting to stimulate fracture healing is less often necessary. However, in cases with a large metaphyseal bone defect (B2, B3, C2, C3 fractures), especially if close to the joint, mechanical support is necessary. Autogenous bone graft or a bone substitute is used. The graft is often applied prior to the plate, which is then placed over this zone. Alternatively, it may be easier to fix the plate first (keeping the main fragments reduced) and then fill the bone defect. In cases with marked bone loss, a bicortical cancellous bone block can be used as a strut.

4.1.4 Tibial buttressing
The precisely contoured plate(s) should be placed on the medial and/or anterior aspect of the tibia in buttress function, depending on the site of the main zone of impaction as well as on soft-tissue conditions. The preshaped LCP distal tibia plate is usually placed medially, where it should be covered by healthy soft tissues. Using the LCP pilon plate, its three distal branches have to be cut precisely according to the preferred position of the plate and the fracture pattern (Fig 6.8.3-12).

Fig 6.8.3-12a–h
a–b Typical skiing injury with central and anterior impaction of the distal tibia, intact fibula.
c–d The CT scans show the extent of the fracture and articular comminution more clearly (43-B3).
e–f Preliminary fixation of the nicely reduced articular surface.
g–h The LCP pilon plate has been contoured to buttress the anterior tibia.
4.2 Alternative procedures

In cases with severe bone and soft-tissue injuries, it may not be advisable or possible to achieve an anatomical and safe reconstruction by the standard procedure described. Alternative methods must therefore be employed. Selection of the preferred procedure is multifactorial, and should be individualized [12]. Joint-bridging unilateral frames as well as ring and hybrid fixators are options [17–20]. These alternative procedures are often applied acutely and in a single step (Fig 6.8.3-13).

A below-knee removable plaster splint is applied with the ankle in a neutral position to counteract an equinus position. The leg is elevated with physiotherapy starting on day 1. After 5–7 days ambulation is started on two crutches, allowing partial weight bearing (10–15 kg) flat foot position, depending on the quality of fixation and reconstruction as well as patient compliance. A removable splint maintains the neutral position of the foot. Full weight bearing may be started after

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**Fig 6.8.3-13a–f**

- **a** 29-year-old male. Fall from a roof. Closed injury 43-C3.
- **b** Emergency spanning external fixation. Alignment with ligamentotaxis. Lateral fragments were not anatomically reduced.
- **c–d** Percutaneous reduction and lag screw fixation of the articular fragments. Soft tissues did not permit open reduction, the central fragments therefore remained unreduced.
- **e–f** The 2-year follow-up shows moderate arthritis. The patient is working in construction with satisfactory function.
8–10 weeks depending on the fracture consolidation seen on x-rays as well as on the clinical follow-up. In cases with extensive articular comminution or needing large bone grafts, definitive consolidation may take up to 4–6 months (or even longer).

### 6 Pitfalls and complications

- The most important measures to prevent complications are careful preoperative planning, correct timing of the operation, and gentle handling of the soft tissue and bone during surgery.

Many of these points are difficult to teach and are learned through experience.

Complex pilon fractures should therefore be treated by the most experienced and skilled surgeons and are not the domain of junior surgeons (Tab 6.8.3-2).

Many complications can occur after operative treatment of pilon injuries [16, 21]. Most of them stem from soft-tissue problems such as wound dehiscence and skin necrosis with superficial infection. The range of such complications is reported in older literature to be between 10–35% of cases. This is strongly correlated to the mechanism and energy of the injury (and thus extent of soft-tissue damage) as well as the surgeon’s experience. If management of complications is not timely and adequate (early wound revision, antibiotics, free tissue transfer), the sequelae can become disastrous with deep infection (osteomyelitis, septic arthritis), resulting in arthrodesis or even amputation. Using a staged procedure and smaller incisions in cases with critical soft-tissue injury, the incidence of wound healing problems and deep infection has been markedly reduced [5, 11, 13].

<table>
<thead>
<tr>
<th>Pitfalls</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct preoperative planning, but not strictly adhered to during surgery</td>
<td>Incorrect reconstruction with deformity, nonunion, osteoarthritis</td>
</tr>
<tr>
<td>Wrong timing: operation too soon after trauma</td>
<td>Wound healing problems (skin necrosis and/or infection)</td>
</tr>
<tr>
<td>Incorrect reconstruction of the fibula (too short, malrotation, axial deviation)</td>
<td>Deformity (valgus, varus), prevention of correct tibial reduction</td>
</tr>
<tr>
<td>Persistant intraarticular dislocations (gaps &gt; 2 mm, steps &gt; 1 mm)</td>
<td>Articular incongruity with posttraumatic osteoarthritis</td>
</tr>
<tr>
<td>Anterolateral tibial key fragment not anatomically reduced and fixed</td>
<td>Ankle mortise too wide with posttraumatic osteoarthritis</td>
</tr>
<tr>
<td>Insufficient bone graft in the metaphyseal defect</td>
<td>Secondary collapse of the articular surface, delayed union</td>
</tr>
<tr>
<td>Too early partial or full weight bearing, poor patient compliance</td>
<td>Implant loosening and/or failure with deformity and/or nonunion</td>
</tr>
</tbody>
</table>

Tab 6.8.3-2 Main pitfalls and the resulting complications in operated pilon fractures.
Delayed unions and/or nonunions are reported to occur in 0–22% and are strongly dependent on the fracture pattern and the stability achieved: the greater the comminution and impaction, the higher the risk of nonunion [8].

Adequate primary bone grafting of the metaphyseal defect and appropriate stability of fixation can prevent delayed unions, while a nonunion of borderline articular fragments may be due to vascular deficiency resulting from the trauma itself or the surgical exposure (Tab 6.8.3-2).

### 7 Results

Three main factors influence the outcome after pilon fractures:
1. the impact (energy) of injury as reflected in the fracture pattern and soft-tissue injury (classification) [18, 22];
2. the surgeon’s planning, manual skills, and experience;
3. the patient’s compliance, general condition, vascular status, etc.

It is very difficult to compare the results reported in different publications. The patient groups vary greatly (rate and grade of soft-tissue injury, percentage of complex fractures) as do the operative procedures (traditional ORIF, purely percutaneous techniques, combinations of both). As in articular fractures in general, good functional results can be observed in 60–85% of patients [1, 2, 5, 19, 21, 23, 24]. Furthermore, there seems to be a direct correlation between an anatomical reconstruction of the ankle joint and a good long-term functional outcome [1, 2, 4]. On the other hand x-ray appearance does not necessarily reflect the clinical and functional results. Ankle fusions (3–27%) are mostly related to cases with septic arthritis. The best functional results can be achieved in patients with high compliance (frequently self-employed, sport-active, socially integrated people). Low annual personal income respectively lower educational achievement seems to correlate with poorer outcome [25]. In a consecutive series of 77 patients, the functional results after 1 year were good in 75% and improved after an average of 10 years to 81%, although the degree of radiographic osteoarthritis increased [2].
6.8.3 Tibia, distal intraarticular (pilon)

8 Bibliography


