High Tibial Osteotomy

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R. Debarge, F. Trouillet, G. Demey,
and Robert A. Magnussen

Introduction

In patients who have osteoarthritis of the medial compartment of the knee in association with genu varum, a high tibial osteotomy remains an important surgical option. The clinical outcome at 10 years continues to be favorable in more than 70 % of the patients if the frontal angular malalignment has been corrected to 3–6° of valgus.

The main reasons for failure are:

1. Initial undercorrection with the presence of a residual varus deformity
2. Overcorrection with progressive lateral arthritis
3. Development of patellofemoral arthritis

Two surgical techniques are available:

The medial opening wedge high tibial osteotomy (HTO) requires the use of a tricortical bone graft from the iliac crest for large corrections, and the lateral closing wedge high tibial osteotomy requires an osteotomy of the fibula neck. The clinical outcome is more predictable in patients who are not obese. Therefore, we generally provide information on a weight-loss program preoperatively. In the young, sports-minded patient, the osteotomy still remains the option of choice above an arthroplasty. More recently, we have started to use the TomoFix plate in medial opening wedge osteotomies. This technique has the benefit of not requiring a bone graft.

Radiological evaluation: See the chapter on surgical indications and osteoarthritis. The amount of opening or closing of the osteotomy needed to obtain a valgus correction of 3–6° is calculated with respect to the width of the tibia at the level of the osteotomy and the angular correction needed (Fig. 16.1).

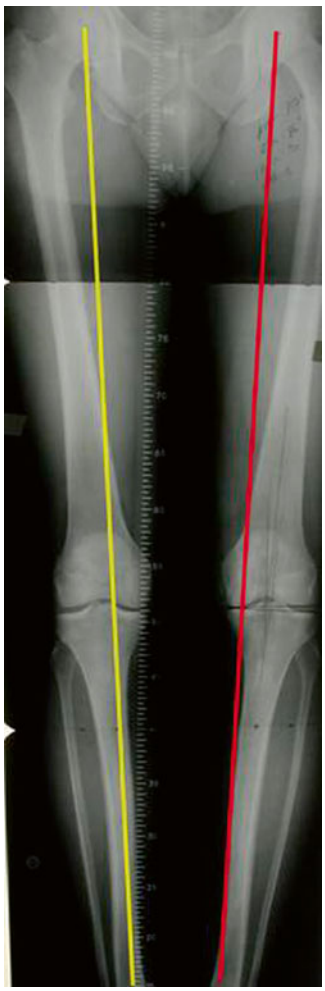

Fig. 16.1 Femorotibial mechanical angle of 174°: a correction of 9° (6+3) is planned for the osteotomy

R. Debarge, MD
Clinique Jean Causse,
Traverse de Béziers, 34440 Colombiers, France
e-mail: r_debarge@hotmail.com

F. Trouillet, MD
Renée Sabran Hospital,
550 Boulevard Edouard Herriot, 83400 Giens, France
e-mail: ftrouillet@hotmail.com

G. Demey, MD (✉)
Lyon Ortho Clinic, Clinique de la Sauvegarde,
29B avenue des Sources, 69009 Lyon, France
e-mail: demeyguillaume@gmail.com

R.A. Magnussen, MD, MPH
Department of Orthopaedic Surgery, Sports Health and
Performance Institute, The Ohio State University,
Suite 3100, 2050 Kenny Road, Columbus, OH 43221, USA
e-mail: robert.magnussen@gmail.com

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Lateral Closing Wedge HTO

Setup

The patient is placed in the supine position. A tourniquet is generally used. The patient is draped using an extremity sheet (Fig. 16.2) and the image intensifier is positioned. A slightly oblique, almost horizontal, anterolateral skin incision is used. It starts 1 cm above the anterior tibial tuberosity and proceeds laterally to 1 cm below the fibular head (Fig. 16.3). The fascia of the proximal portion of the origin of the tibialis anterior is released as a Z-plasty. Subsequently, the tibialis anterior muscle and the long toe extensor muscle are released from the tibial metaphysis using a large periosteal elevator (Figs. 16.4 and 16.5).

Fig. 16.2 Patient installation

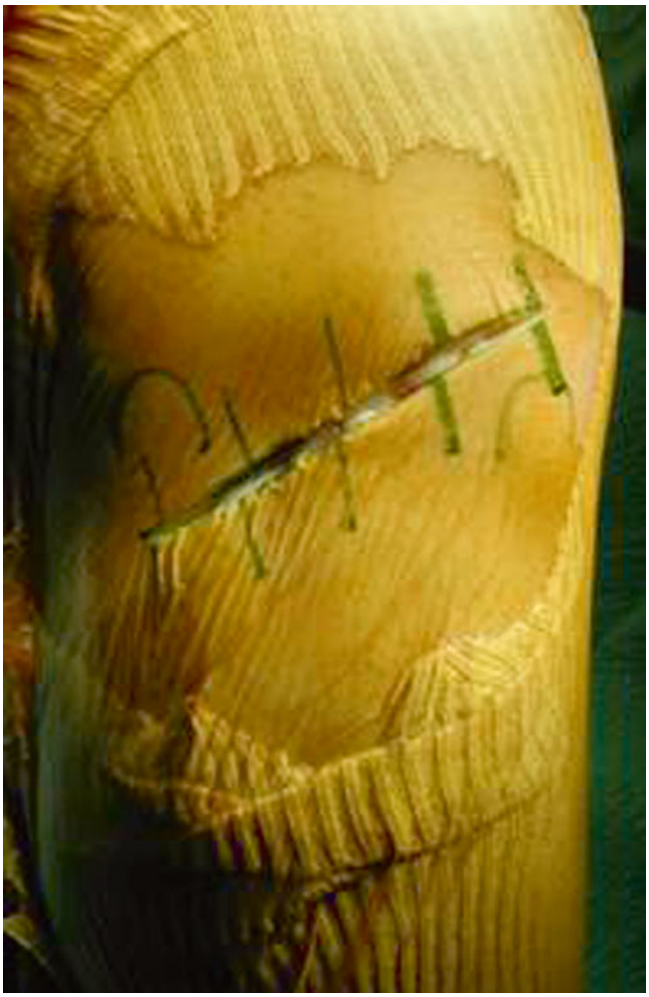
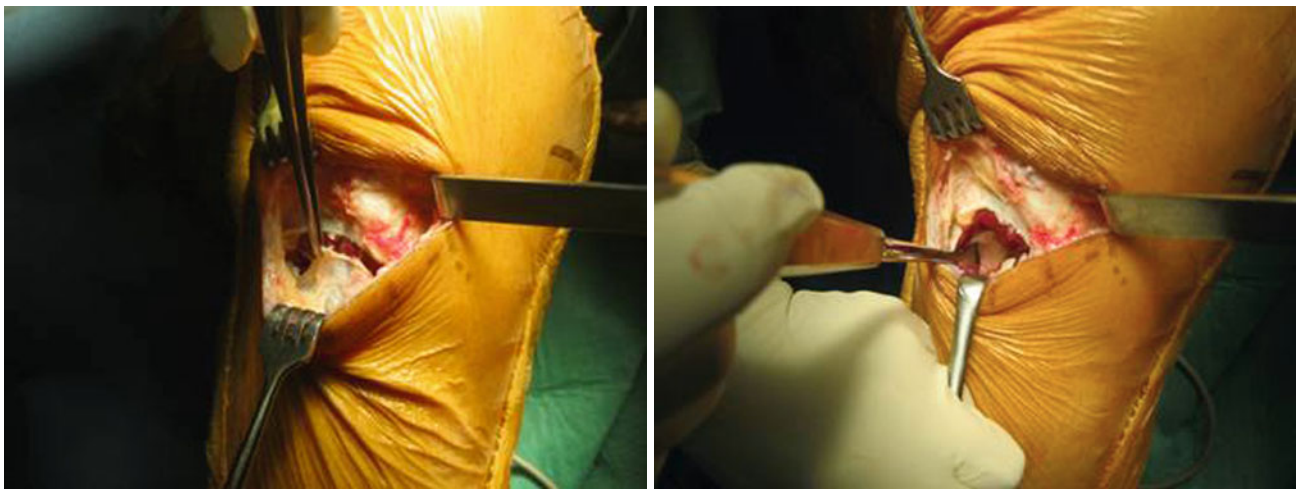


Fig. 16.3 Skin incision



Figs. 16.4 and 16.5 The tibialis anterior muscle and the long toe extensor muscle are released from the tibial metaphysis

Osteotomy of the Neck of the Fibula

The neck of the fibula is identified and exposed. A periosteal elevator is slid around the neck always staying in contact with the bone. This maneuver protects the peroneal nerve (Fig. 16.6).

Four holes are now drilled in the neck using 3.2 mm drill. With the use of the osteotome, the four holes are interconnected and the segment is removed using a large grasper. The fibular shaft should be freely mobile. Care is taken that the peroneal nerve is not in contact with the osteotomy site.

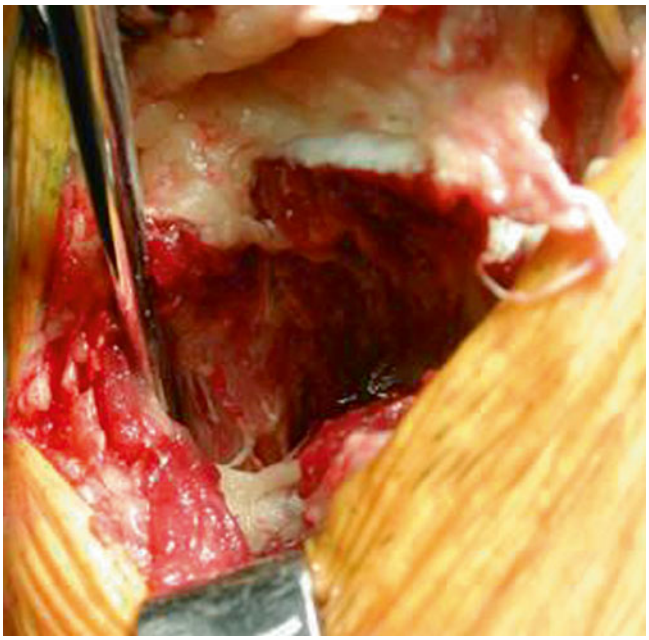


Fig. 16.6 Protection of the peroneal nerve

High Tibial Osteotomy (HTO)

Specific instruments are available to perform – in a reproducible way – the high tibial osteotomy (HTO) and achieve its fixation.

Closing Wedge High Tibial Osteotomy (HTO)

The osteotomy is performed proximal to the tibial tubercle in an oblique direction.

Identification of the osteotomy site with imaging is not necessary if the following rules are respected.

- Laterally, the osteotomy should start distally to the proximal tibiofibular joint and should cross the tibia proximal to the tibial tubercle. In this direction, there is no danger to the tibial plateau. The correct direction of the osteotomy is shown in Fig. 16.7
- The patellar tendon should be protected during the procedure.
- Always use imaging to control the amount of alignment correction that is to be obtained during the operation.

We currently use the high tibial osteotomy (HTO) Intrasoft instrument for the fixation (Fig. 16.8). This blade plate/screw system has been specifically designed to minimize subcutaneous irritation. Different lengths of the blade and the screws are available to fit different width of the tibia:

(a) *Introduction of the guide pin parallel to the joint line* (Fig. 16.9)
A small guide pin is introduced at the level of the joint line, and an alignment guide is subsequently introduced over this guide pin. This guide will position the second guide pin parallel to the joint line and 1 cm distal to it.

(b) *Blade reamer introduction over the second guide pin* (Figs. 16.10 and 16.11)
Length of the blade should be 1 cm shorter than the total width of the tibia.

(c) *Box preparation for the blade* (Fig. 16.12)
The box preparation guide is introduced over the guide pin and impacted. Four drill holes are made with 6 mm diameter.

(d) *Introduction of the HTO blade* (Figs. 16.13 and 16.14)
The blade is introduced and impacted into the box.

(e) *Distal cut of the closing wedge osteotomy* (Figs. 16.15 and 16.16)
Many surgeons use a guide pin for the distal cut of the osteotomy. We do not feel this is necessary. The posterior surface of the tibia is protected by a large periosteal elevator; anteriorly the patellar tendon is retracted. An oscillating saw is used to perform the distal cut.

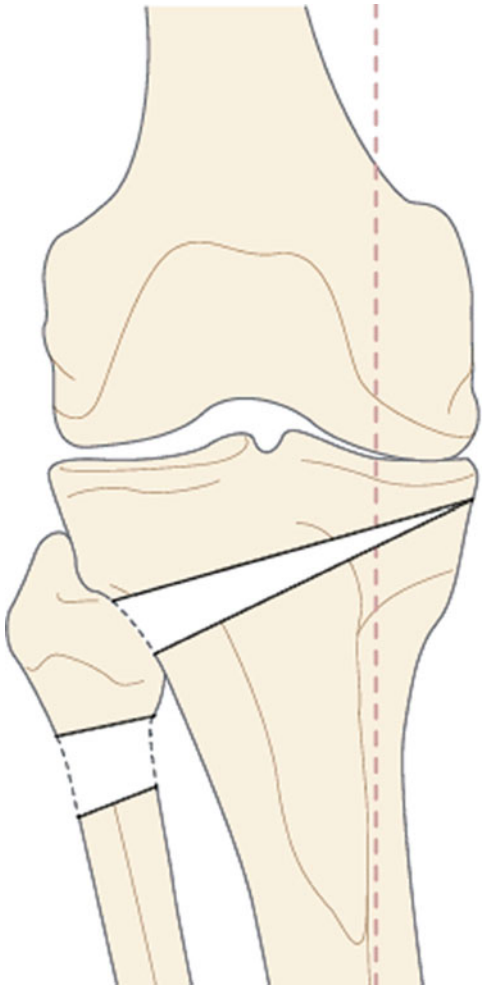


Fig. 16.7 Closing wedge high tibial osteotomy

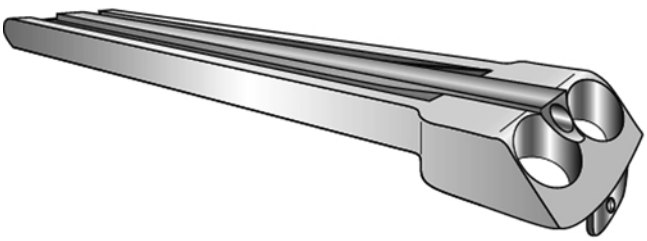


Fig. 16.8 HTO blade (Intrasoft, Tornier®)

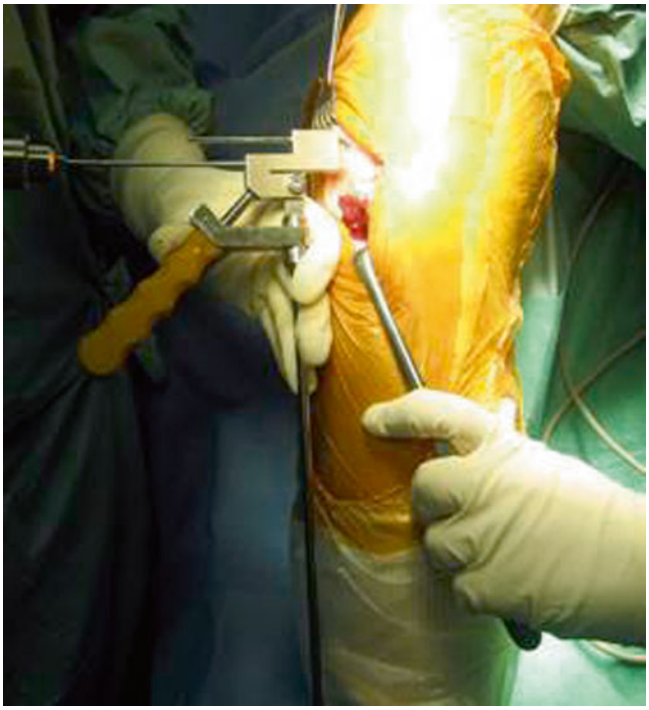
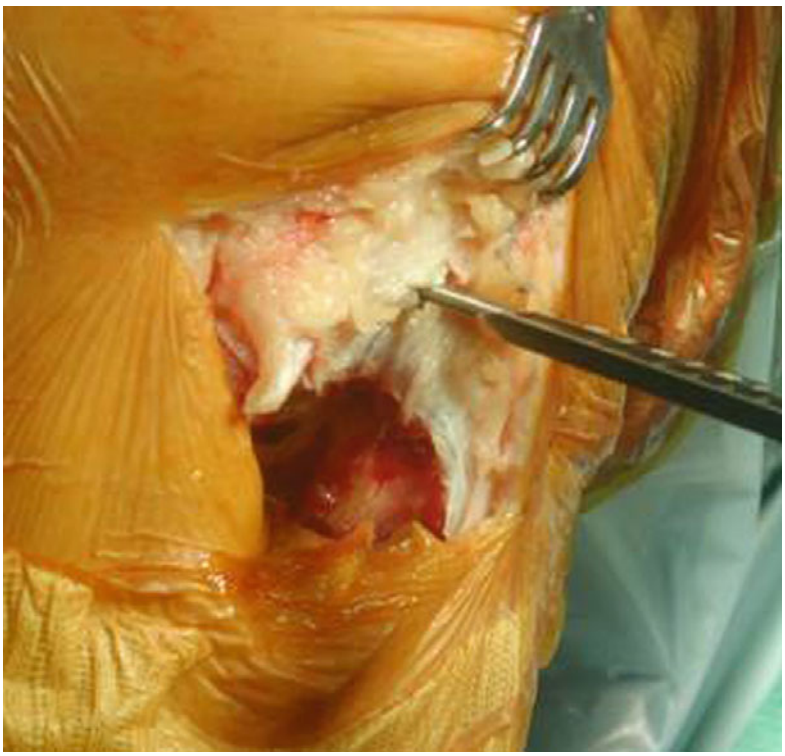


Fig. 16.9 Introduction of the guide pin parallel to the joint line

(f) *Proximal cut*
An angled cutting guide (6-8-10°) is introduced in the distal cut of the osteotomy; the proximal cut is now performed using this angle. The cutting guide should be introduced and impacted on the medial cortex. An oscillating saw is used (Fig. 16.17). The bone wedge is removed (Fig. 16.18).

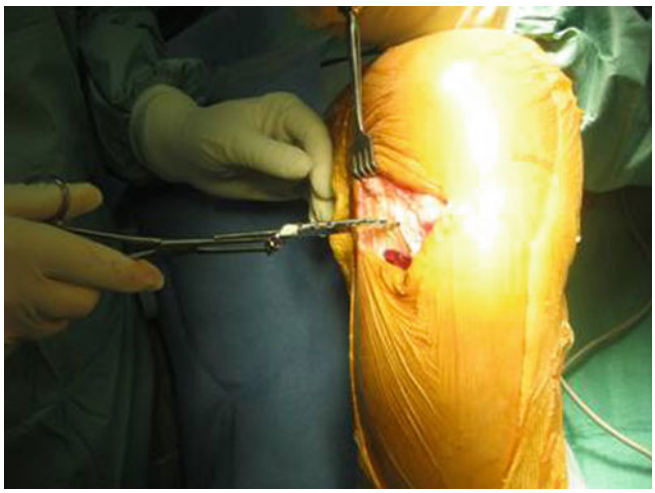
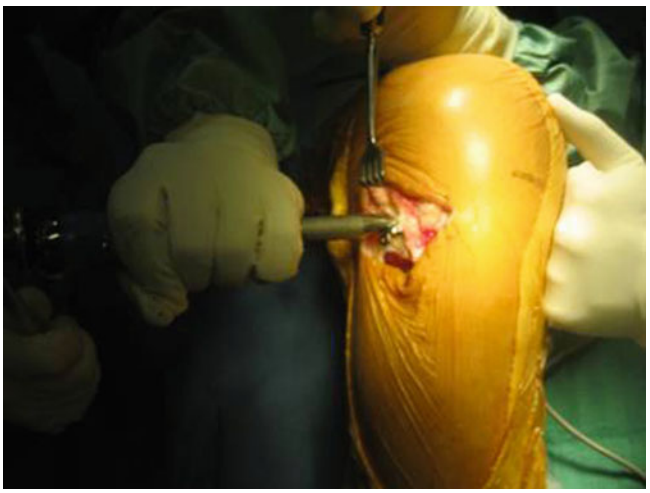
(g) *Closing the wedge and image intensifier control of the obtained mechanical axis*
The medial cortex is breached with a 3.2 mm drill. Distal from the osteotomy a temporary unicortical screw is positioned. This screw will be used as support for the reduction clamp. The wedge is closed with the reduction clamp (Figs. 16.19 and 16.20). Using a long metal rod positioned on the center of the femoral head and in a middle of the ankle joint, the mechanical axis of the limb is evaluated. The axis should pass just lateral to the lateral tibial spine (Figs. 16.21 and 16.22).

(h) *Fixation of the osteotomy* (Figs. 16.23 and 16.24)
Two bicortical screws are then introduced through the blade into the distal tibia. The muscle insertions are closed over a drain. The skin is closed with interrupted sutures.

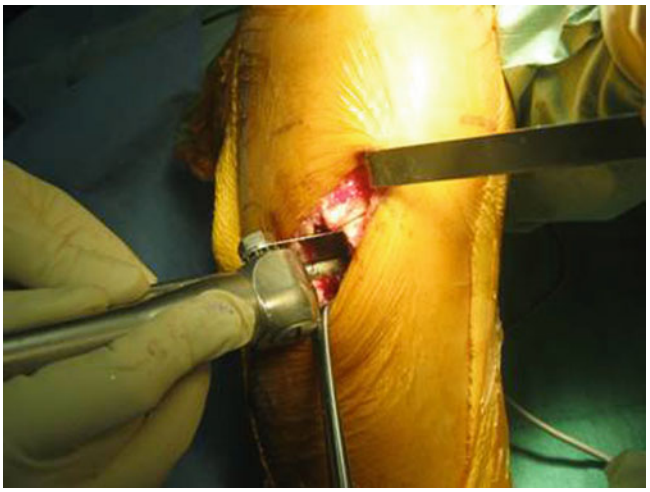


Figs. 16.10 and 16.11 Blade reamer introduction

Fig. 16.12 Box preparation for the blade

Figs. 16.13 and 16.14 Introduction of the HTO blade

Figs. 16.15 and 16.16 Distal cut of the closing wedge osteotomy

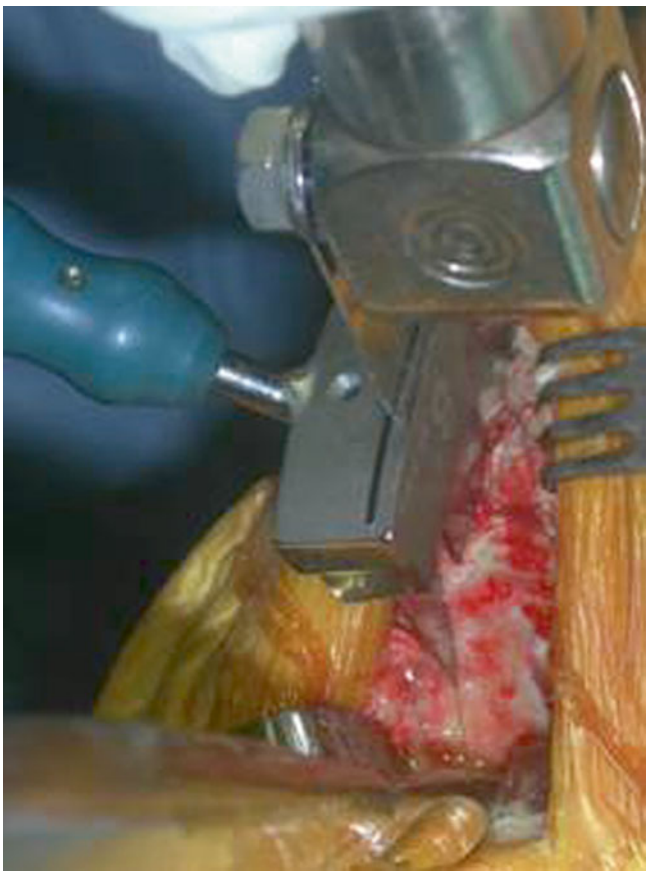
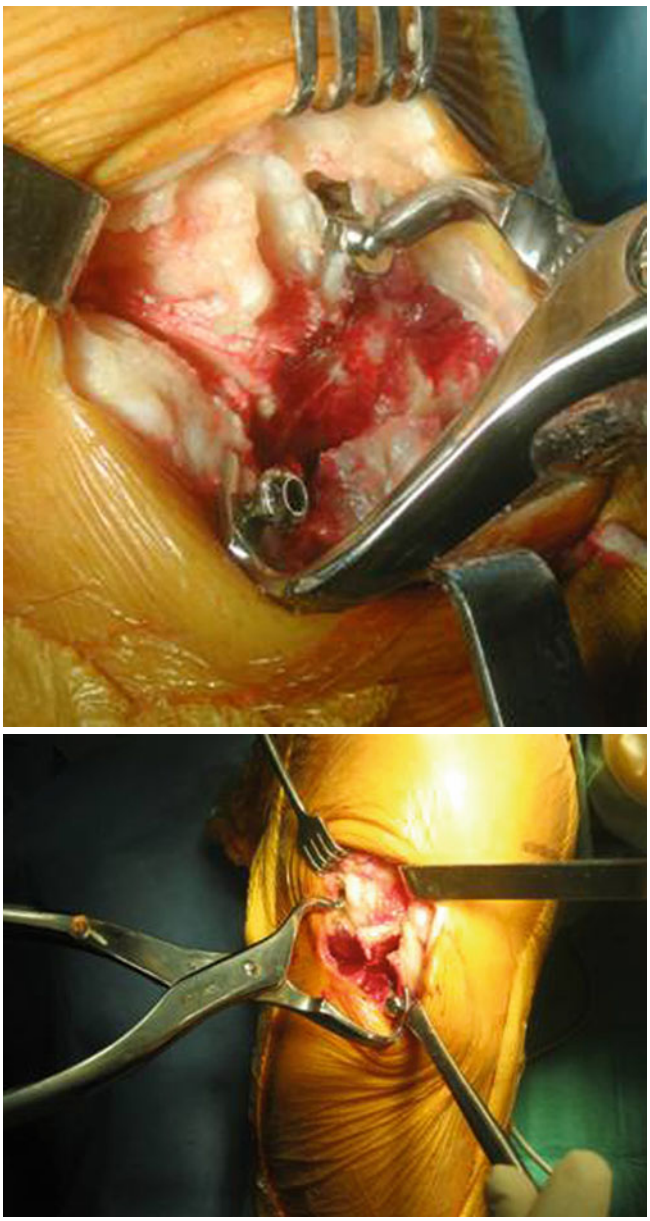
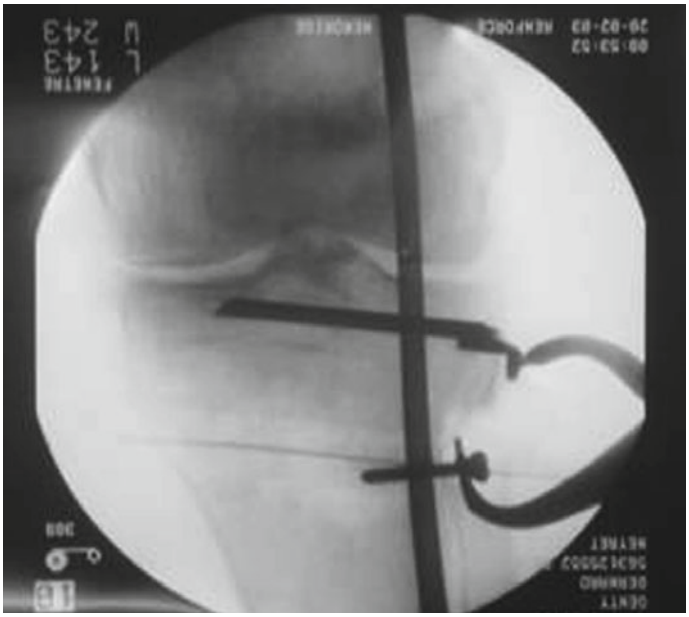


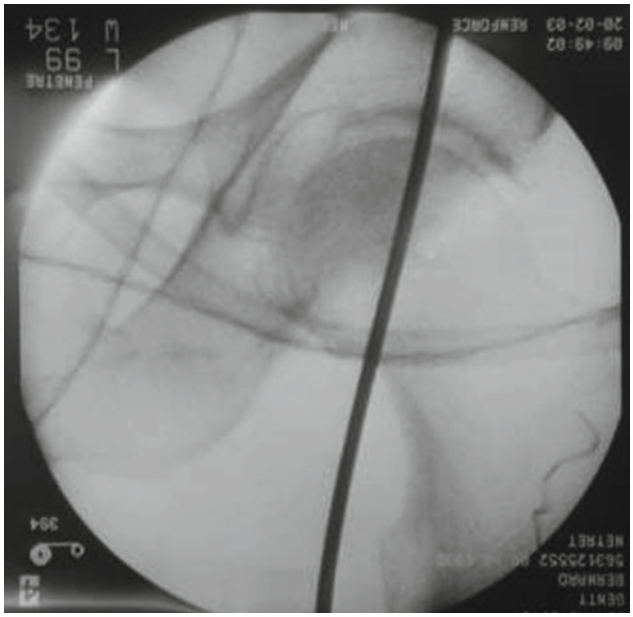
Fig. 16.17 Proximal cut of the closing wedge osteotomy using a cutting guide (6-8-10°)

Fig. 16.18 Bone wedge removal



Figs. 16.19 and 16.20 Wedge closing using the reduction clamp





Figs. 16.21 and 16.22 Preoperative fluoroscopic control using a long metal rod

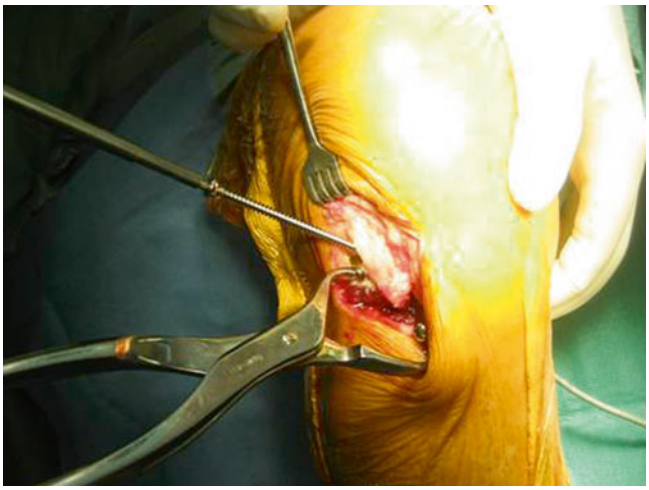


Fig. 16.23 Fixation of the osteotomy

Fig. 16.24 Postoperative X-ray

Medial Opening Wedge High Tibial Osteotomy (HTO)

Setup

The patient is placed in the supine position. A tourniquet is applied. An extremity sheet is used for the knee and a small square field is applied over the ipsilateral iliac crest. A small bump is positioned underneath the ipsilateral buttocks to obtain a better exposure of the iliac crest.

Skin Incision

The joint line and tibial tuberosity are marked with a pen and a 10 cm anteromedial vertical skin incision is used for exposure of the proximal tibia (Fig. 16.25). The pes anserinus tendons are retracted. The superficial medial collateral ligament is incised at the level of the osteotomy (Fig. 16.26). The posterior surface of the tibia is exposed using a large periosteal elevator. During the osteotomy, this periosteal elevator is left in place. Anteriorly, the patellar tendon is retracted using a Farabeuf retractor.

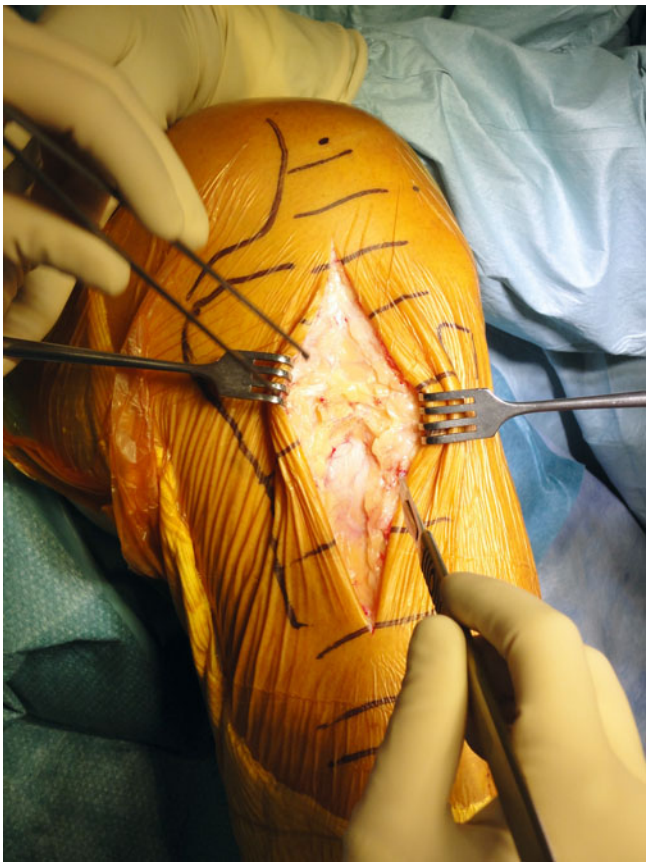


Fig. 16.25 Skin incision

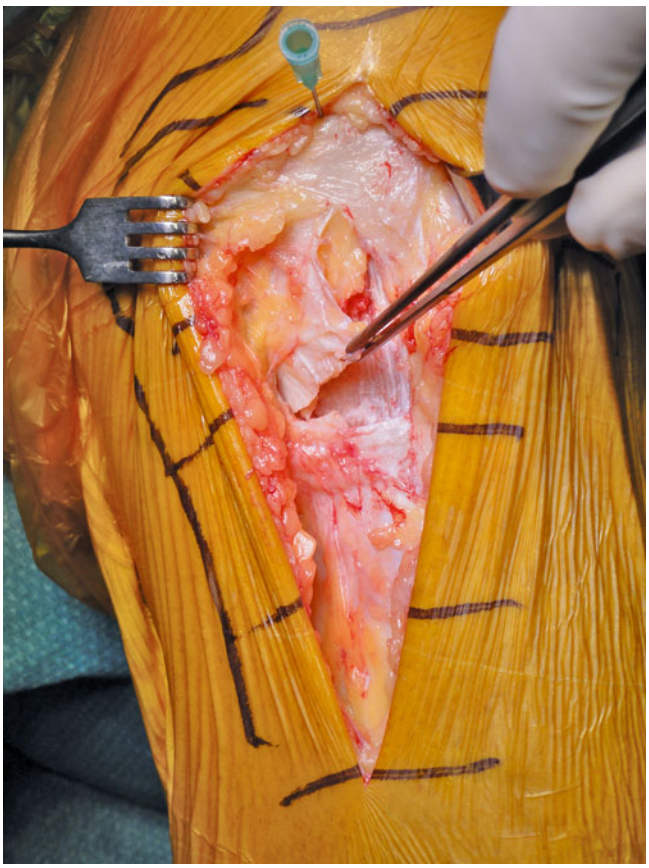


Fig. 16.26 Incision of the superficial medial collateral ligament

High Tibial Osteotomy (HTO)

The osteotomy is performed proximal to the tibial tubercle and through the superficial medial collateral ligament, which has previously been incised. The plane of the osteotomy is horizontal (slightly different from the closing wedge medial high tibial osteotomy which is more oblique). First, 2 Kirschner 20/10 guide pins are introduced medially. Laterally, these guide pins should be just superior to the head of the fibula. An image intensifier is used to correctly position the guide pins. The direction can be adjusted, if necessary (Fig. 16.27). Using an oscillating saw, the tibial cut is now performed underneath these guide pins, but always staying in contact with them. The center of the tibia is cut first followed by the anterior and posterior cortices. The cuts are completed using an osteotome (Fig. 16.28), especially on the anterior cortex where the patellar tendon can be damaged. It is necessary to have an intact lateral hinge for this type of osteotomy. We preserve this hinge by first weakening it with a number of 3.2 mm drill holes (Fig. 16.29).

Subsequently, a Lambotte osteotome (thickness 2 mm, corresponding with approximately 2° of angular correction) is introduced into the osteotomy. A second osteotome is then introduced below the first. To gently open up the osteotomy, several more osteotomes are introduced between the first two (Fig. 16.30):

The first osteotome should be impacted against the lateral cortex and the second nearly as far. The third osteotome is then introduced in between the previous 2. If necessary a fourth and fifth osteotome are introduced between the first two. These osteotomes should not be impacted too deep, since they could break the lateral hinge.

If an insufficient opening of the osteotomy is obtained, the bony corticals anteriorly and posteriorly should be carefully broken using an additional osteotome.

Two primary complications can be encountered during this type of osteotomy:

- Fracture of the lateral hinge – frequently observed in significant corrections. This results in a surgical undercorrection of the deformity.
- Fracture of the lateral tibial plateau – this complication can occur if the lateral hinge has been insufficiently weakened or if one forcefully tries to open the osteotomy with a valgus maneuver or if the osteotomes are not placed deep enough. Usually, plate and screw fixation would suffice to overcome this complication.

The obtained angle of correction is systematically evaluated using a long metal rod centered on the hip and ankle (Figs. 16.31 and 16.32). The angular correction is evaluated at the level of the joint line (Fig. 16.33). If necessary, an additional osteotome is introduced or removed.

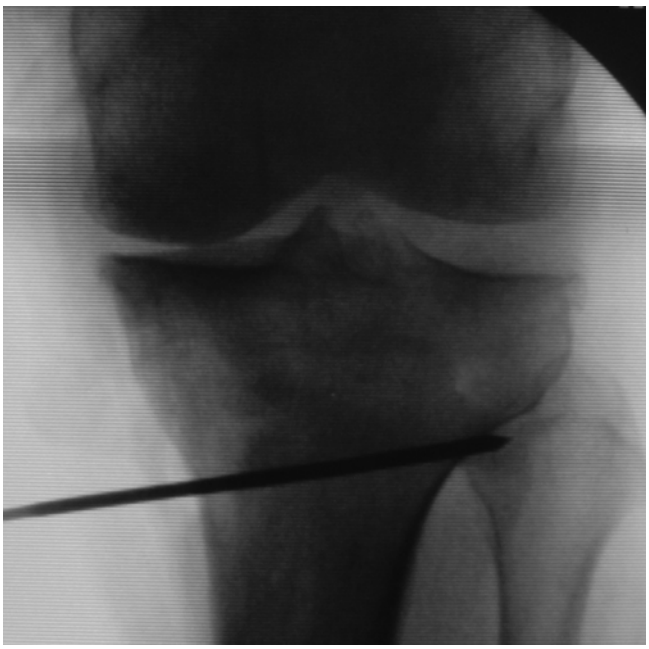


Fig. 16.27 Preoperative fluoroscopic control

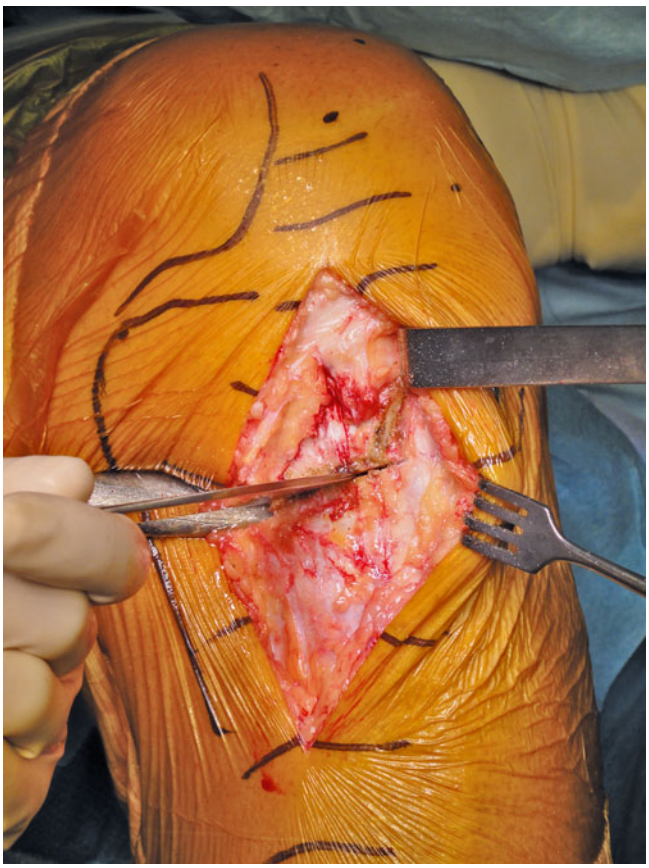


Fig. 16.28 The tibial cut is completed using an osteotome

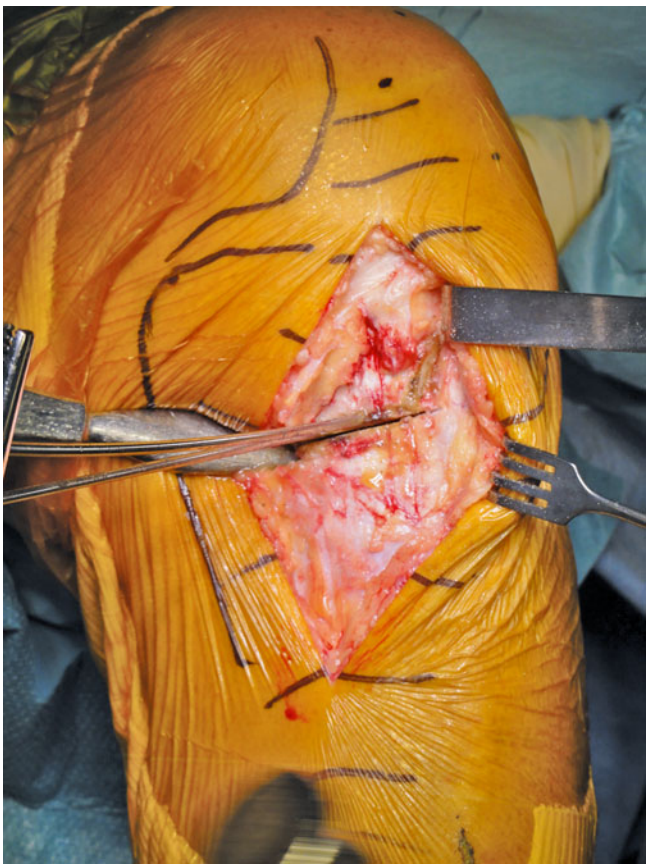


Fig. 16.29 The hinge is weakened using a 3.2 mm drill holes

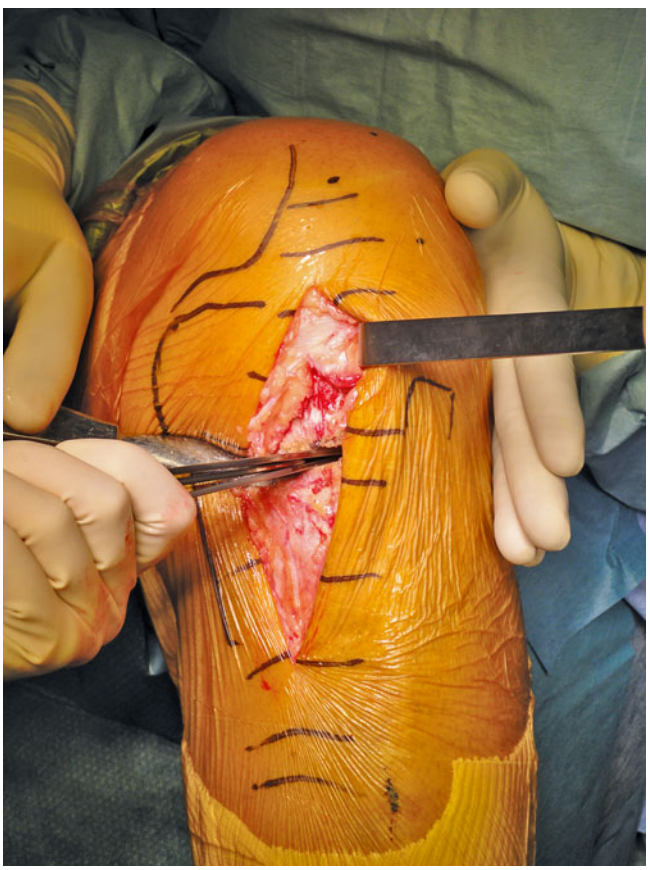
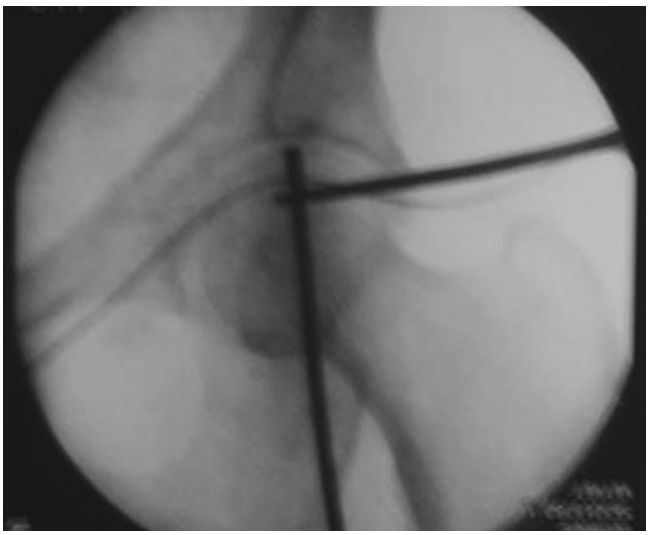


Fig. 16.30 To gently open up the osteotomy several more osteotomes are introduced between the first two



Figs. 16.31 and 16.32 Preoperative evaluation of correction using a long metal rod

Fig. 16.33 The femorotibial mechanical axis is lateral to the lateral tibial spine

Osteosynthesis

In order to avoid loss of correction in the postoperative period, the fixation should be strong and stable. We currently use a locking plate (TomoFix, Synthes®) (Fig. 16.34). Other types of fixation are also possible (Staples, Surfix Plate, Chambat Plate, etc.). The anatomically pre-shaped TomoFix plate is inserted into the subcutaneous plane and centered on the anteromedial tibia. Proximal fixation is achieved first with three locking screws, which provide wide support for the subcortical tibial plateau. At this stage a lag screw can be placed in the screw hole just distal to the osteotomy site; this approximates the plate to the tibia and induces compression at the lateral hinge. For definitive fixation of the plate, the distal locking screws can now be placed. Finally, the lag screw can be replaced with a locking screw, and an X-ray is taken to check screw lengths and plate position.

The osteotomy site is filled with tricortical bone graft harvested from the ipsilateral anterior iliac crest (Fig. 16.35) in cases of large correction (over 10°). These grafts are impacted, taking care not to overcorrect. Bone substitutes are also available and can be used instead of the bone graft. The superficial medial collateral ligament is now approximated over the staples.

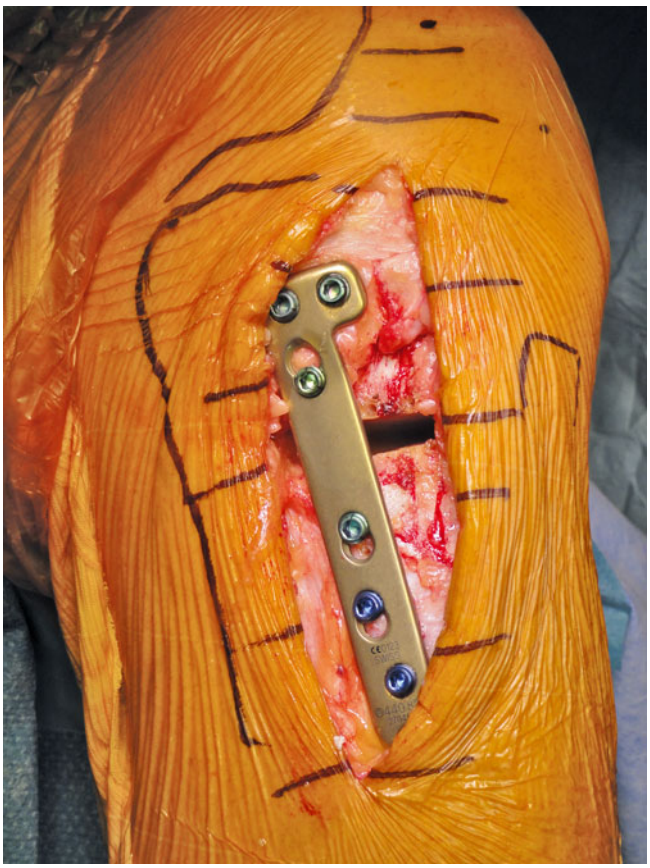


Fig. 16.34 Fixation of the osteotomy with a locking plate

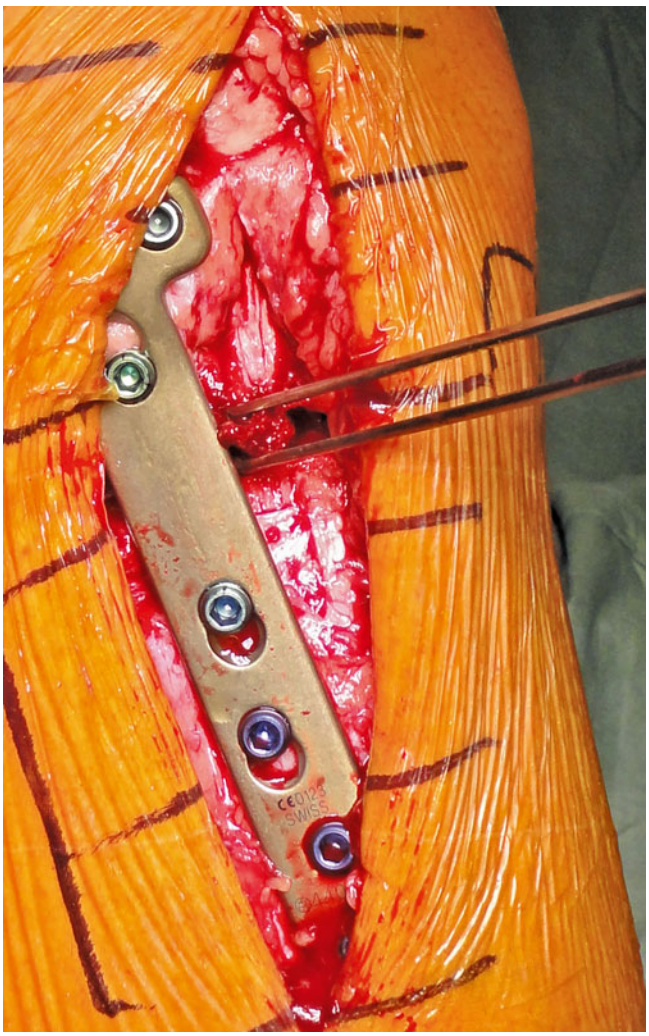


Fig. 16.35 Osteotomy site filled with bone graft in case of correction over 10°

Postoperative Guidelines

The postoperative guidelines are identical for the closing wedge as well as the opening wedge high tibial osteotomy (HTO).

- With the TomoFix plate patients can be mobilized with partial weight bearing 15–20 kg on the operated leg the day following the operation. The knee is mobilized with active and passive range of movement exercises, and the patient is discharged home when ambulating safely on crutches. Progressive weight bearing is allowed from 6 weeks depending on evidence of radiological union.
  - Walking protected by two crutches.
  - Thromboprophylaxis for 1 month.
  - Bracing in extension for 2 months.
  - Flexion is limited to 120° the first 15 days. After that date flexion can be progressively augmented.
  - Skin sutures are removed around day 12.
  - Driving a car is not allowed for 10 weeks.
  - Physical work is not allowed for 3–4 months.
  - Sports are allowed after 6 months after bony union has been achieved.

  Note:

  Two specific complications can be observed after a closing wedge high tibial osteotomy (HTO):
- Peroneal nerve lesion
- Compartment syndrome

  Radiographs should be taken 2 months after the intervention. If bony healing is observed, weight bearing can begin. If delayed union is suspected, weight bearing is delayed and the patient is invited to come back in 1 month.

Future Improvements

Future work may include inclusion of the degree of femoral rotation in the preoperative plan postoperative evaluation. Computer assisted surgery which can be used to obtain and evaluate the post-osteotomy mechanical axis is currently under investigation.