Total Knee Replacement in Medial Arthritis: Surgical Technique

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Preoperative Planning

A detailed history and orthopedic physical and radiological evaluation are required for preoperative planning. The aim is to establish which surgical approach is most suitable, to choose the appropriate prosthetic implant, and importantly to anticipate any possible intraoperative technical difficulties that may be encountered.

For the radiological evaluation, cf. Chapter 13 "Surgical indications in osteoarthritis of the knee" (Figs. 24.1 and 24.2).

Valgus stress radiographs show whether the varus deformity is reducible (Fig. 24.3). Incomplete reduction is secondary to contracture of the capsular and ligamentous structures on the medial side of the knee. In this situation, a surgical release will be necessary. The need for soft tissue release is also dependent on the asymmetry of the bony cuts (Fig. 24.4). This can be anticipated and appreciated when drawing the resection lines perpendicular to the anatomical axis. Although we commonly perform varus stress radiographs as well, lateral ligamentous laxity is more difficult to interpret. A pseudo lateral thrust is often observed in these patients. This pseudo thrust is not due to true lateral ligamentous laxity, but rather due to the closing down of the worn medial compartment (Fig. 24.5).

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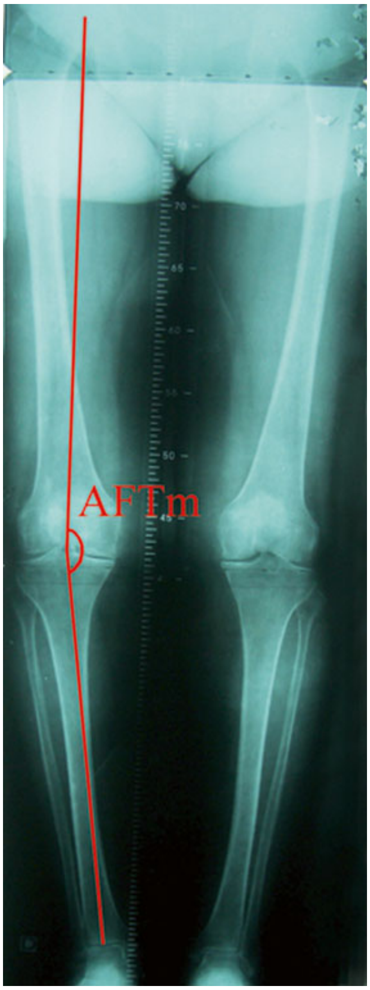


Fig. 24.1 Measurement of mechanical femorotibial angle

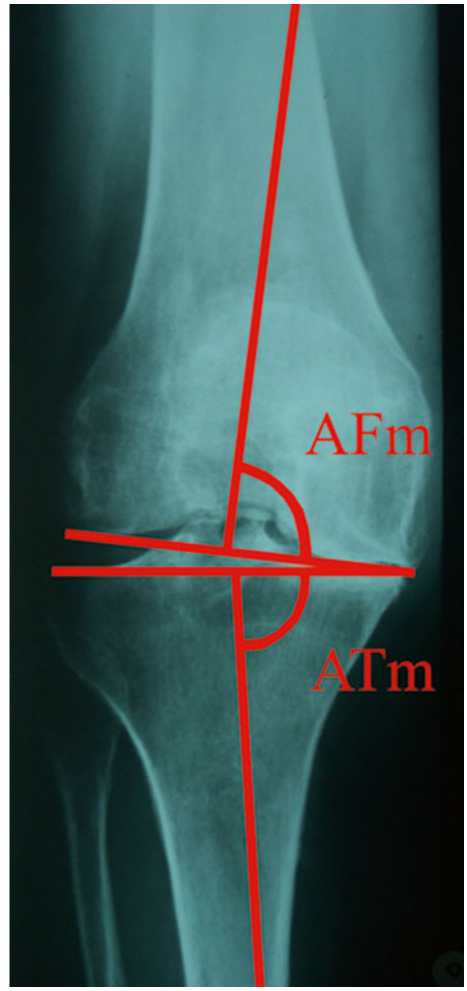


Fig. 24.2 Measurement of mechanical femoral and tibial angles

Fig. 24.3 Valgus stress x-ray (*arrow* designates direction of force)

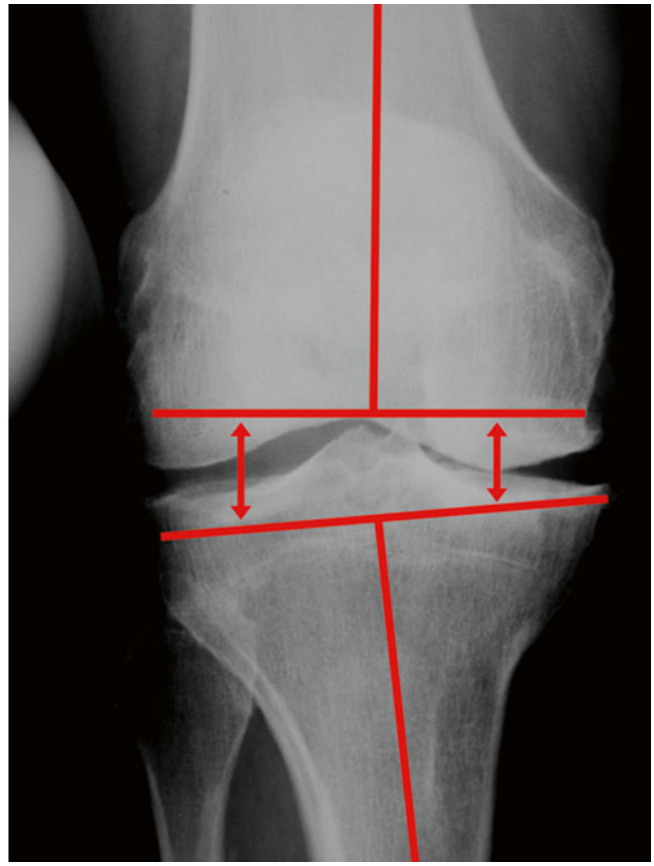


Fig. 24.4 Asymmetry of the bony cuts

Fig. 24.5 Varus stress x-ray (*arrow* designates direction of force)

Surgical Technique

Surgical Approach

A paramedian skin incision is made starting 5–6 cm proximal to the patella and ending on the medial border of the tibial tuberosity. After incising the skin and subcutaneous fat, it is important to dissect onto the superficial retinaculum. Undermining is performed between the superficial and deep retinacula. Laterally, the undermining should stop 5 mm past the patella. Proximally, the quadriceps tendon and distally the medial border of the patellar tendon are identified. At this stage we suture blue OR towels into the wound to isolate the skin edges from the rest of the operating field. Arthrotomy is performed with a 23 blade and starts on the medial side of the quadriceps tendon, leaving a small cuff of tendinous tissue attached to the muscle, to facilitate closure. The arthrotomy is continued distally on the medial side of the patellar tendon toward the medial side of the tibial tuberosity. The anterior part of the medial meniscus is incised while the scalpel blade stays in contact with the anterior border of the tibial plateau. Subsequently, the medial capsule is released from the anteromedial part of the tibial plateau. This release is triangular (Fig. 24.6). The deep fibers of the medial collateral ligament are released using a periosteal elevator on the proximal border of the tibial plateau at the joint line. Subsequently, a total medial meniscectomy is performed. The knee is now placed in full extension, and the extensor apparatus together with the patella are dislocated laterally and everted using a Volkmann retractor. The knee is then placed in flexion with the patella everted. Care must be taken not to rupture the patellar tendon or to avulse its insertion at the tibial tuberosity. Proximally, the synovium is removed to visualize the anterior cortex of the femur. We resect all of Hoffa fat pad and the anterior horn of the lateral meniscus, the intermeniscal ligament, and the footprint of the ACL. The femoral notch is debrided and all osteophytes are removed.

The tibia is now dislocated anteriorly using a Hohmann retractor in the condylar notch. The posterior border of the tibia should be exposed. A second Hohmann retractor is placed on the lateral side of the tibial plateau to complete the exposure.

Specific care should again be taken to prevent avulsion of the extensor mechanism during flexion of the knee between 30 and 100° with an everted patella and during the anterior dislocation of the tibia. Anterior dislocation of the tibia can be difficult in the presence of a patella infera or in arthritis secondary to chronic anterior cruciate ligament (ACL) instability. In this situation, the insertion of the patellar tendon, on the tibial tuberosity, can be secured using a pin. This pin is inserted and directed toward the lateral border of the tibia and should be placed so it does not hinder the next steps of the intervention (Fig. 24.7).

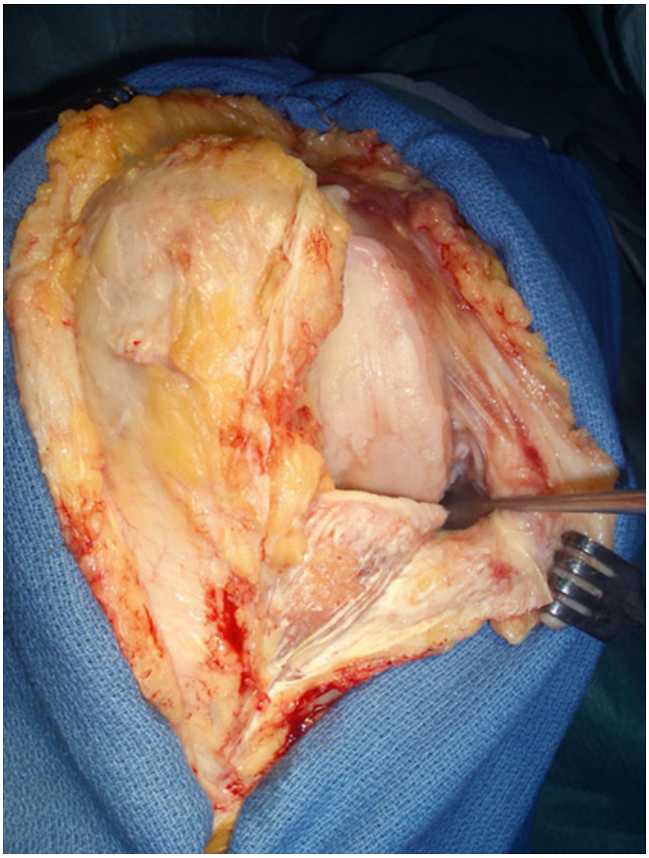


Fig. 24.6 The release of medial capsule is triangular

Fig. 24.7 In case of difficult exposure, the distal insertion of the patellar tendon can be easily secured using a pin

Tibial Cut

The tibial intramedullary (IM) aiming device is inserted at the footprint of the ACL. The entry point is opened up using a curved osteotome (Fig. 24.8). This ensures correct alignment in the sagittal plane; the tibial cut is best performed strictly perpendicular to the long axis of the tibia (we utilize a tibial implant with a 4° slope built into the polyethylene (PE)). However, as the intramedullary guide alone does not always ensure correct coronal alignment, an additional extramedullary (EM) aiming device is utilized to ensure appropriate varus-valgus alignment of the proximal tibial cut. This guide is aimed for the first intermetatarsal space. The thickness of the tibial cut is set to 9 mm referenced from the lateral tibial plateau. This is the nonaffected side in medial arthritic knees. The tibial cutting guide is subsequently fixed with four guide pins (Fig. 24.9). The IM aiming device is removed and the proximal tibial cut is performed using an oscillating saw. The tibial plateau is resected and, if necessary, a recut can be performed at the level of the pins. This maneuver is useful since the saw blade has the tendency to upslope on the more sclerotic parts of the tibial plateau. The saw blade should be controlled by both hands and should stay in contact with the guide pins at all times. After the tibial cut, the tibial plateau can be lifted off using a grabber that can be levered on the guide pins. These guide pins protect the remaining tibia from any damage (Fig. 24.10). A recut is sometimes necessary in the more inaccessible areas such as the edge and the posterior aspect of the lateral tibial plateau (Fig. 24.11). Care should be taken not to damage the popliteus tendon or the patellar tendon. An incomplete exposure of the lateral tibial border and the zone around Gerdy's tubercle can induce varus positioning of the tibial component or a medialization. After the tibial cut, the tibial plateau is sized using different trial sizers.

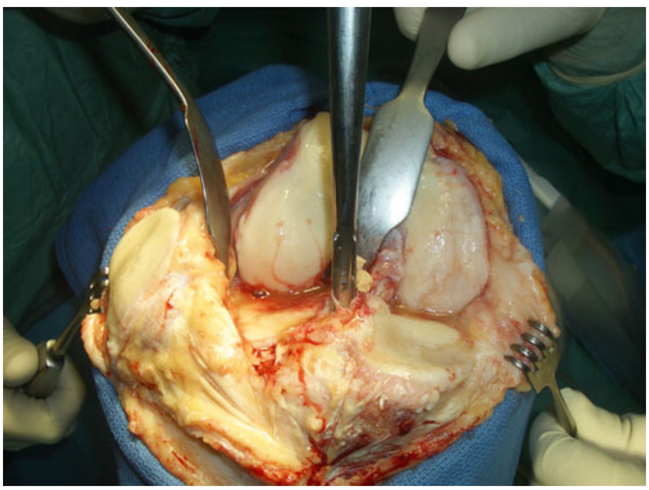


Fig. 24.8 The entry point is opened up using a curved osteotome

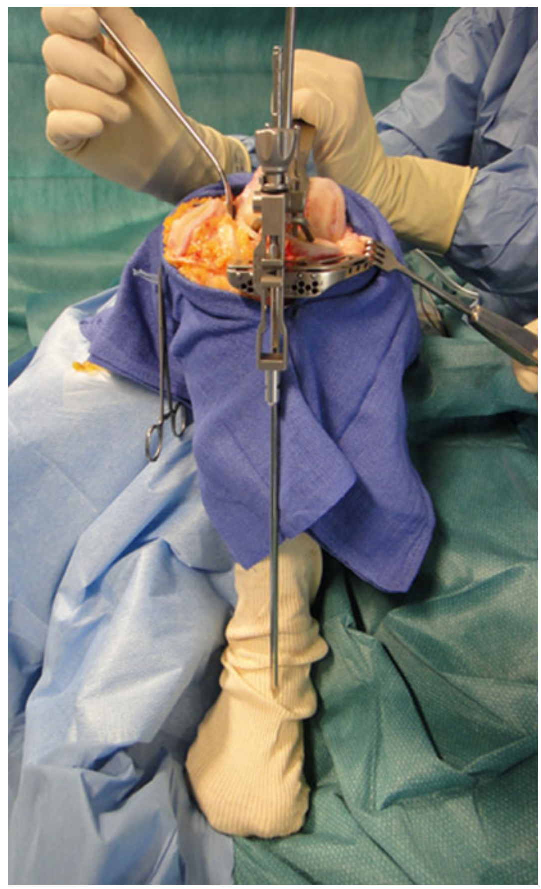


Fig. 24.9 Additional extramedullary aiming device

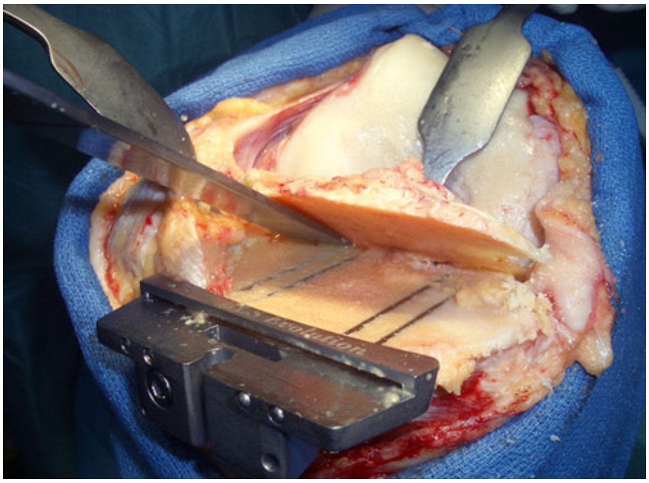


Fig. 24.10 The tibial plateau is lifted off

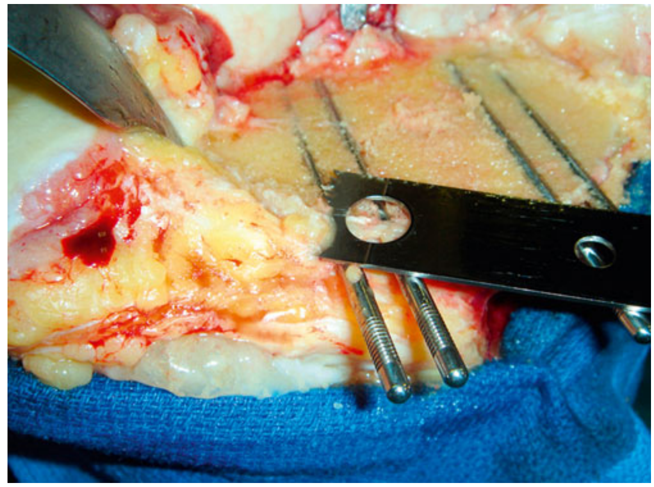


Fig. 24.11 Tibial recut on pins

Technical Points

All bone cuts are performed using an oscillating saw. The surgeon is protected from splatter of blood and bone fragments by covering the joint with a transparent plastic board (Fig. 24.12).

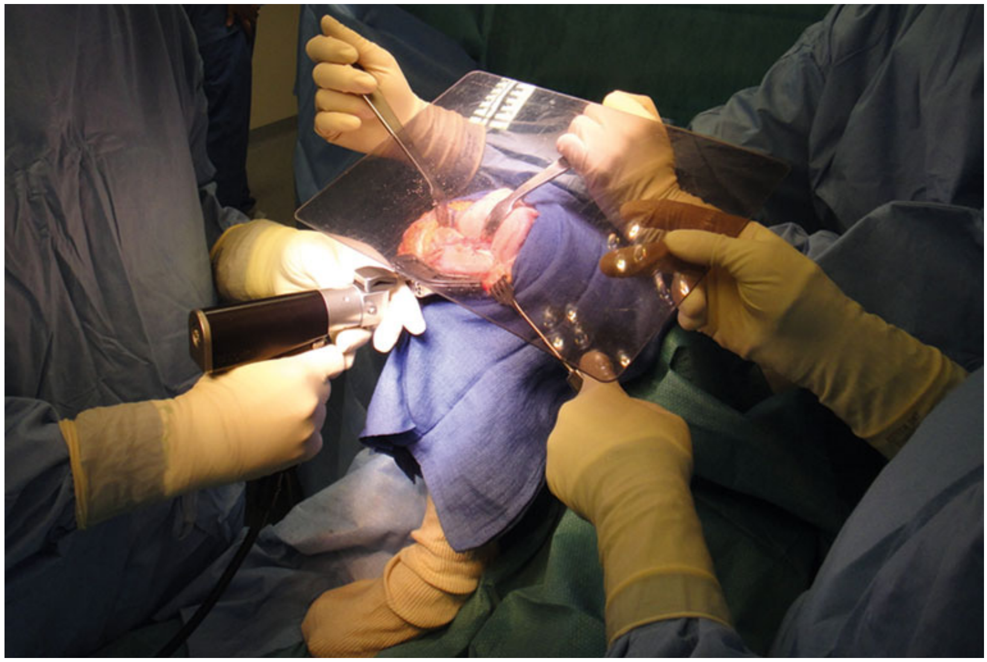


Fig. 24.12 Transparent plastic board

Particular Difficulties

The popliteus tendon is at risk on two occasions. The first is during the tibial cut and the second is during the posterior lateral femoral condyle cut (Fig. 24.13).

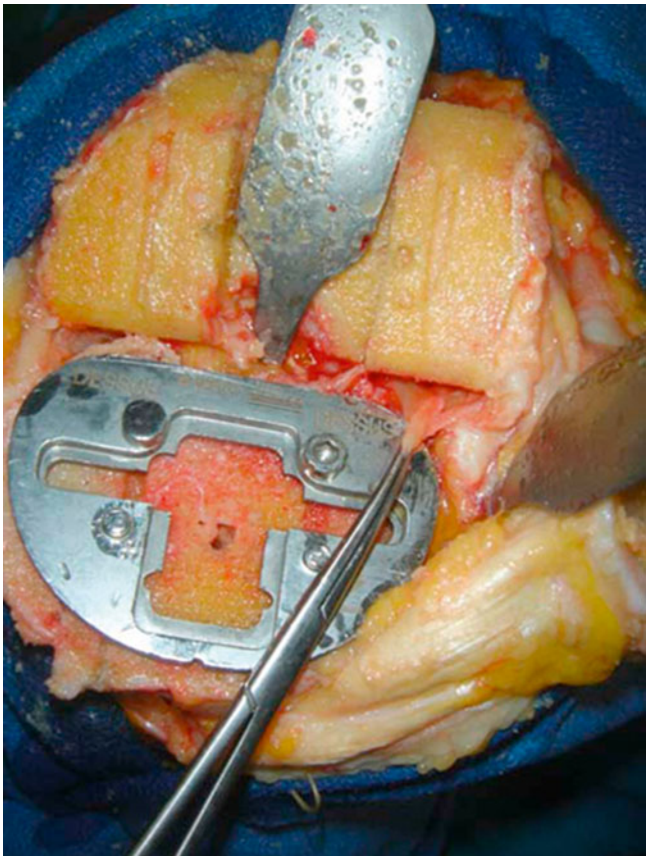


Fig. 24.13 Accidental popliteus tendon transection

Posterior Femoral Condyle cut

The knee is now flexed to 90°. The entry point for the IM aiming device is situated approximately 1 cm above the insertion of the posterior cruciate ligament (PCL) and somewhat to the medial side. This entry point is opened up using a curved osteotome. Special guides are available which enables us to optimize the position of this entry point taking into consideration the size of the femoral component (Fig. 24.14). An entry point which is too anterior on the femur results in malpositioning of the femoral component in flexion, while an entry point which is too posterior results in recurvatum of the component and anterior notching. It is of critical importance to achieve the correct sagittal alignment of the femoral cutting guide.

The aiming device references on the posterior condyles. The anterior cortex can be palpated using the stylus, and the approximate size of the femoral component can be determined (Fig. 24.15). This size can now be transferred to the entry point guide. A small drill now opens up the entry hole (Fig. 24.16), which is subsequently reamed (Fig. 24.17). In order to decrease the risk of fat embolus, the reaming is done in two steps, while the intramedullary bone marrow is aspirated in between these two steps.

Preoperative calculation of the HKS angle between the mechanical and anatomical femoral axis is not reproducible. Except in the case of specific anatomical variations, we always set the distal femoral cut to 7° of the valgus in the medial arthritic knee (see section "Rotation of the Femoral Component" for further information). The femoral cutting guide is applied to the distal femoral condyles and stays in contact with the posterior femoral condyles. This step is critical to the outcome of the procedure as it determines the size in the AP plane and the final rotation of the femoral component. The correct size of the femoral component is made using a stylus on the anterior cortex (Figs. 24.18 and 24.19). The posterior cut is performed and subsequently the posterior cutting guide is removed.

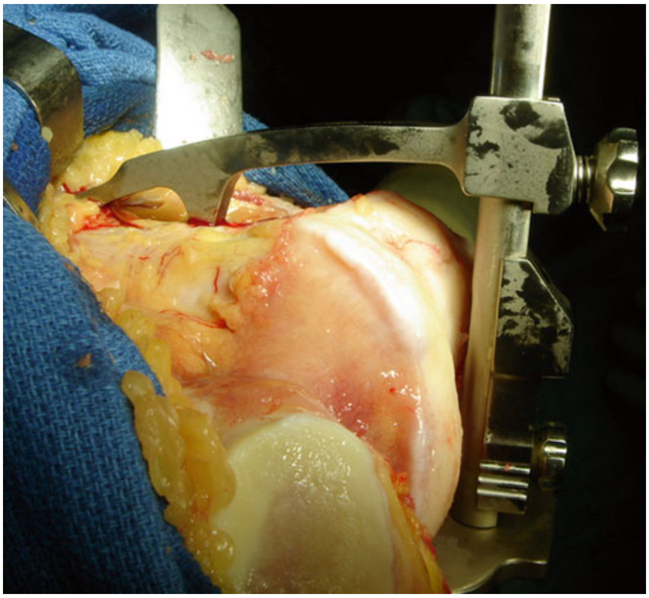


Fig. 24.14 Special guide to optimize the position of the entry point

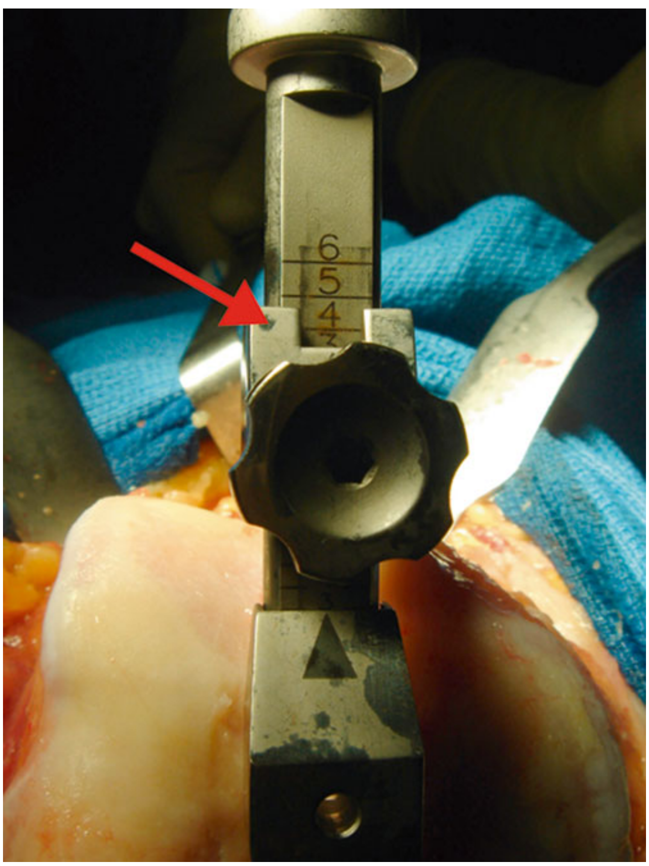


Fig. 24.15 Approximate size of the femoral component (here, size 3)

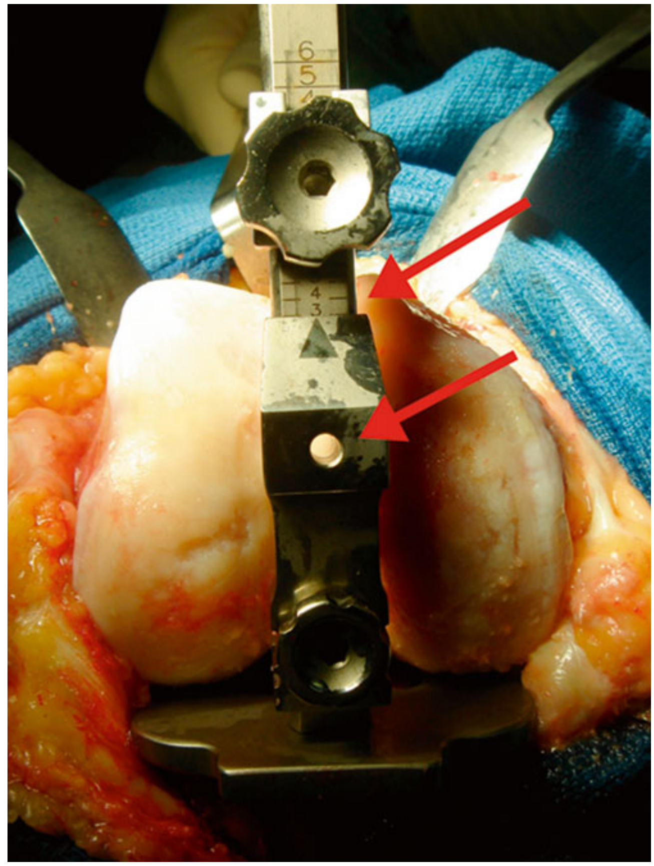


Fig. 24.16 Entry point (*lower arrow*) and size of the femoral component (*upper arrow*)

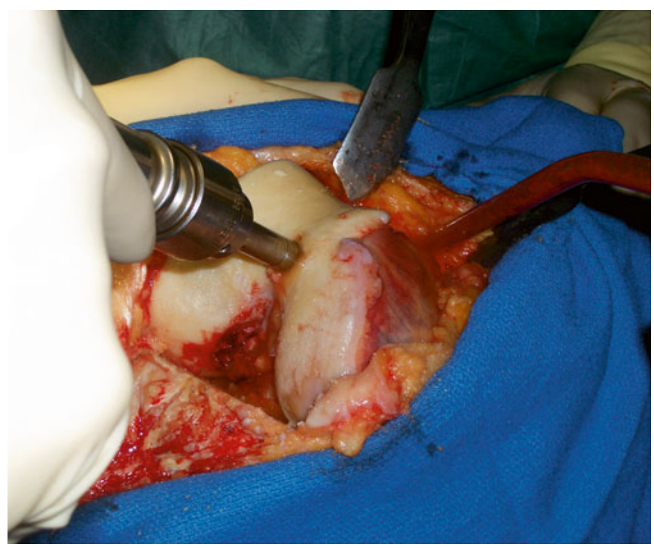


Fig. 24.17 Intramedullary reaming

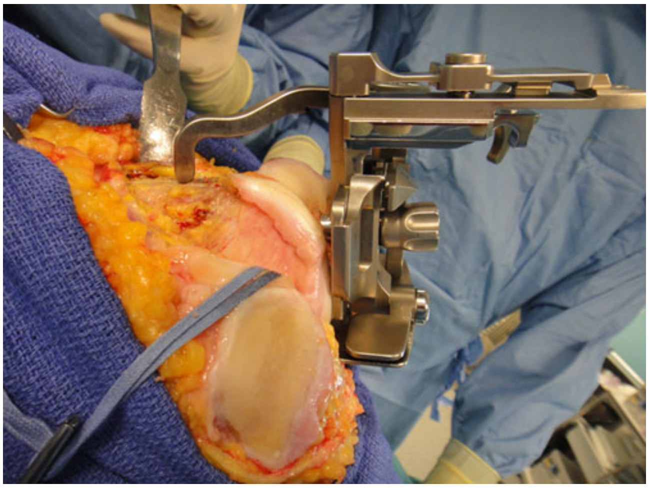


Fig. 24.18 Posterior cutting guide (lateral view)

Ligament Balancing in Flexion

The tibial cut and posterior femoral condyle cut create a flexion gap, which can be measured using a spacer. The thickness of the spacer represents the thickness of the femoral and tibial component as well as the PE. The PCL should now be completely resected using an 11 blade (Fig. 24.20). The femoral notch should be carefully debrided. In order to avoid the risk of neurovascular injury, the blade should stay in contact with the bone at all times. In case of contracture of the soft tissues on the concave side of the knee or in case of a malaligned tibial cut, the flexion space will be more trapezoidal. In these cases, a tibial recut or ligamentous release (depending on the etiology of the trapezoidal shape) is necessary in order to obtain a rectangular flexion space. A balanced flexion gap is necessary to achieve correct stability in the sagittal plane and allow an adequate range of motion without stiffness.

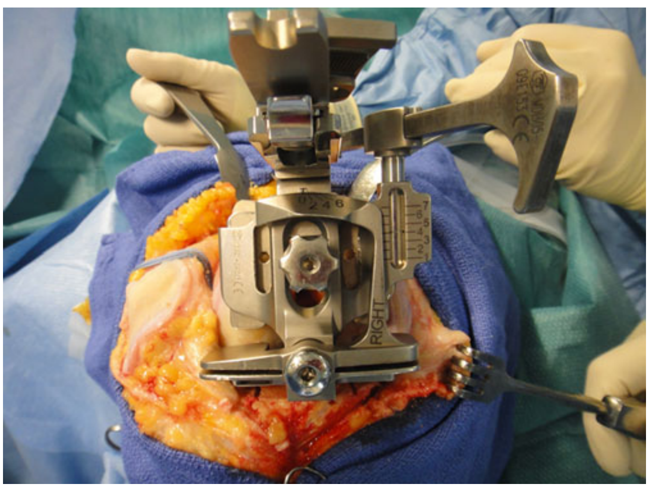


Fig. 24.19 Posterior cutting guide (front view)

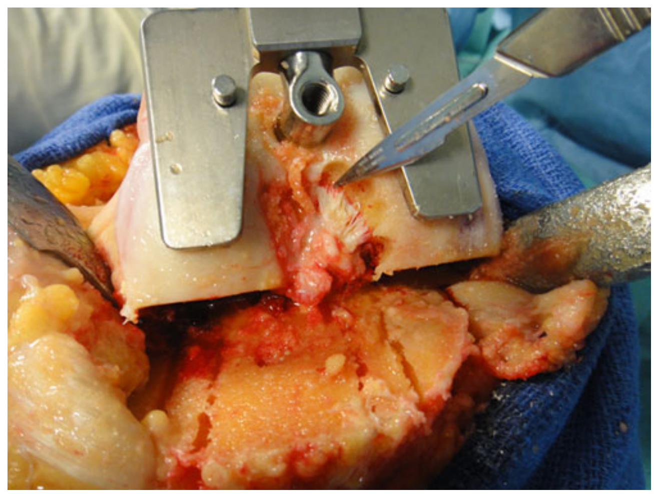


Fig. 24.20 PCL resection

Extension Gap Balancing and Distal Femoral Cut

Our aim is to reproduce this same rectangular flexion gap in extension. The original extension gap can be changed due to the previous flexion gap balancing, often resulting in a larger extension gap. At this stage, multiple options are available. We can fill up the extension gap by putting in a thicker PE, but this raises the joint line, inducing lowering of the patella. Another option—which we prefer—is to lower the distal femoral cut thereby reducing the extension gap. If the extension space is very large, one may have addressed both options.

If it is necessary to lower the distal femoral cut (usually 10–20 % of our cases), we use a femoral distractor. The purpose of this device is to obtain a satisfactory balanced extension gap. The distractor is mounted on the femoral IM cutting guide, which is in contact with the distal femoral condyles. The distractor itself is in contact with the tibial cut. The knee is now positioned in full extension and the extension space is evaluated. Ligamentous balancing in extension is performed. In case of balanced but extensive laxity, the ligaments are tensioned using the distractor device, and the distal femoral cut is lowered (Fig. 24.21). Overtightening of the extension gap results in a progressive flexion deformity, while undertensioning results in ligamentous laxity. Once an optimal extension gap is obtained, the distal femoral cutting guide is fixed to the femur using pin fixation (Fig. 24.22). The IM femoral device is removed. The distal femoral cut is now performed. The tibial plateau is protected by a large osteotome or using a posterior shield (Fig. 24.23).

A preoperative fixed flexion deformity is another common problem and is easily addressed by cutting an extra 2 mm from the distal femoral condyles. This can be achieved by using an 11 mm distal femoral cutting guide instead of the usual 9 mm guide.

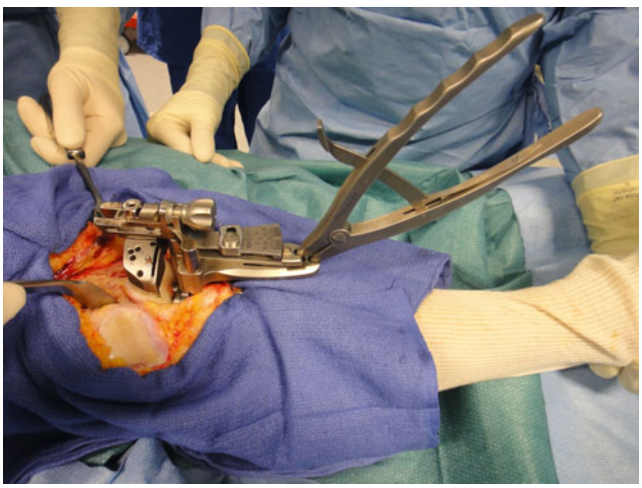


Fig. 24.21 Distractor device

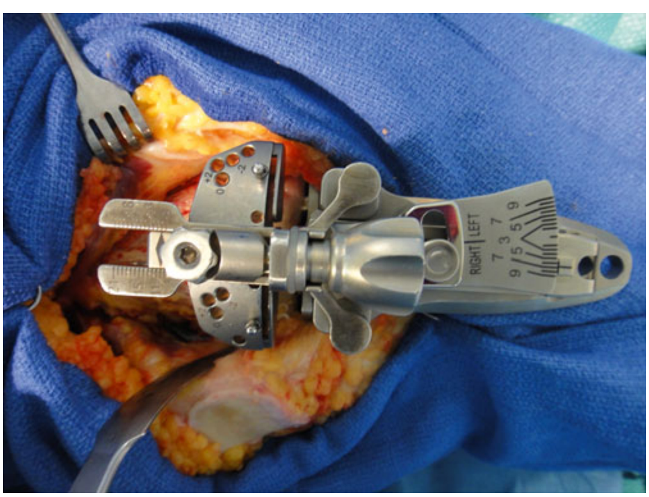


Fig. 24.22 Fixation of the distal femoral cutting guide

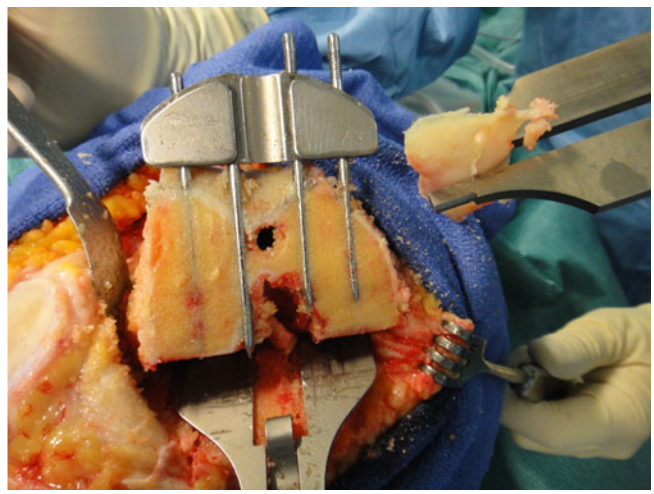


Fig. 24.23 Distal femoral cutting guide and protection of the tibial plateau

Anterior Femoral cut and Chamfer Cuts

The three-in-one cutting guide is positioned on the previously cut posterior and distal condyles. The size of the femoral component can be rechecked using a stylus on the anterior femoral cortex. Care is taken to avoid notching. If the femoral component is positioned in external rotation, the lateral anterior cortex should be checked since it is a high risk for femoral notching. We always do the anterior cut starting from the medial side and progressively move up to the lateral anterior cortex. Subsequently, the chamfer cuts are made.

Patellar Cut

The patella is the critical link to the extensor mechanism. One must substitute the articular surface without augmenting the total patellar thickness. Overcutting the patella can weaken it, increasing the risk of a fracture. The knee is placed in the extended position. The patella is everted to the lateral side. The proximal and distal soft tissues should be resected in order to expose the tendon structures. The thickness of the patella is measured. The patellar cutting clamp is designed using an anterior reference guide (Fig. 24.24). The aim is to obtain a symmetrical cut, parallel to the anterior cortex of the patella, with a residual thickness of approximately 15 mm. This should always be thicker than 12 mm to avoid fractures and sometimes goes up to 16 or 17 mm in larger patellae. The sum of the patellar component and the resected patella should never be thicker than the original patella.

After the patellar cut, symmetry should be checked manually. For sterility reasons, surgical gloves are changed and direct contact with the patella is avoided by using a compress while palpating the patella cut. The three patellar component fixation holes are reamed. These fixation holes should be positioned in order to avoid a horizontal alignment because of the risk of patellar fractures. Two fixation holes are reamed medially and one laterally (Fig. 24.25).

The patellar component is placed somewhat inferiorly and medially.

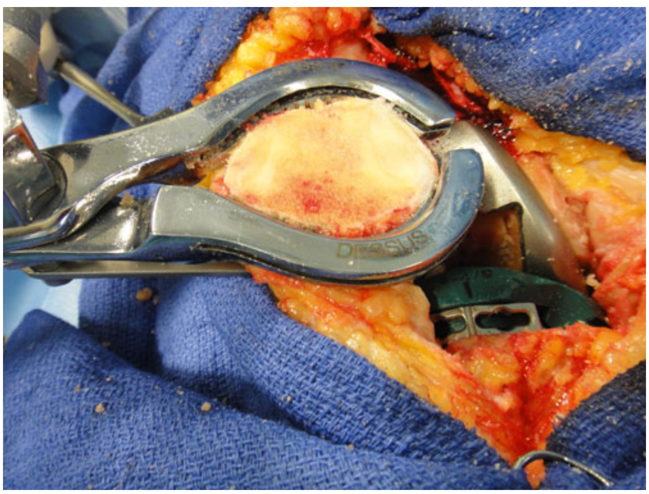


Fig. 24.24 Patellar cutting clamp

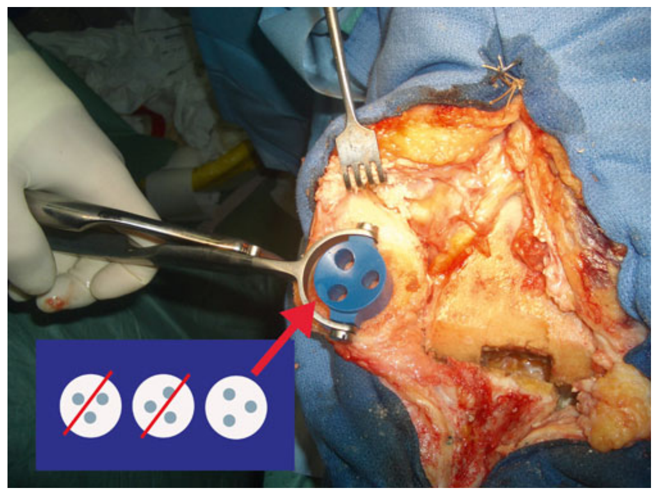


Fig. 24.25 Appropriate positioning of the patellar fixation holes (*arrow*)

Placement of the Trial Components

First, the tibial trial component is placed. The tibia is dislocated anteriorly, and specific attention should be paid to the lateral femoral condyle. Frequently impingement between the lateral condyle and the tibial component can result in the malpositioning of the tibial component in internal rotation.

Multiple references are taken into consideration (Fig. 24.26a):

- The posterior border of the tibial component should be parallel to the posterior border of the tibial plateau.
- The medial border of the tibial tuberosity should be aligned to the middle of the tibial base plate.
- The correct rotation of the tibial component is determined by the femoral tibial alignment.

The correct size of the tibial component is that size that maximally covers the tibial plateau without overhang. The femoral trial component is positioned in hyperflexion but is impacted in the 90° position. Care is taken such that the femoral trial component is in contact with the medial and lateral condyles. One must pay attention not to impact the femoral trial component in a flexed position. The trial patellar component is also positioned. If the patella is larger than the patellar trial component, the lateral bony overhang is resected freehand using the oscillating saw (Fig. 24.26b). Care is taken not to perform a lateral release since this can influence the blood supply to the patella. The ligamentous balance is assessed in the flexed and extended positions.

Multiple ROM cycles are done to assess the patellofemoral tracking. PF tracking is considered to be the thermometer of the TKR procedure (Bousquet). If every step of the surgical procedure has been performed correctly, the patellofemoral (PF) tracking should be perfect. Lateral retinacular release is seldom necessary; however, if needed it should be done at the end of the procedure with the tourniquet deflated.

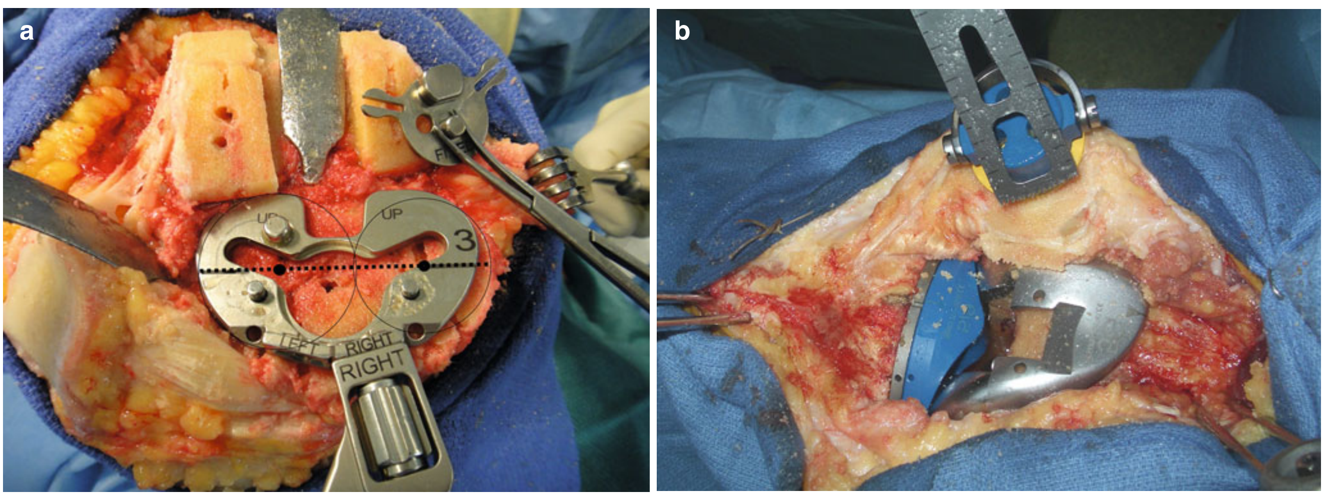


Fig. 24.26 (**a**) Current method for placement of the tibial trial component: it is aligned with the two centers of the medial and lateral plateau. (**b**) Lateral patella facetectomy

Final Tibial Keel Preparation and Cementation of the Final Components

Keel preparation is done while the cement mix is started (Fig. 24.27). The tibial component is cemented first. Impaction is done with a specific plastic impactor to avoid scratches on the tibial surface. Excessive cement is removed. Subsequently, the polyethylene is positioned, and the knee is then moved to a hyperflexed position to seat the femoral component. Again this component is impacted in the 90° position. The knee is subsequently positioned in the fully extended position to compress the cement. Subsequently the patellar component is cemented in compression using a specific clamp. The lower limb is held in this extended position by elevating the heel in neutral rotation until the cement has completely hardened.

Wound Closure

The tourniquet is released after the cement hardens and hemostasis is achieved. The knee is closed at 90° of flexion with multiple interrupted resorbable stitches. One intra-articular drain is left in situ.

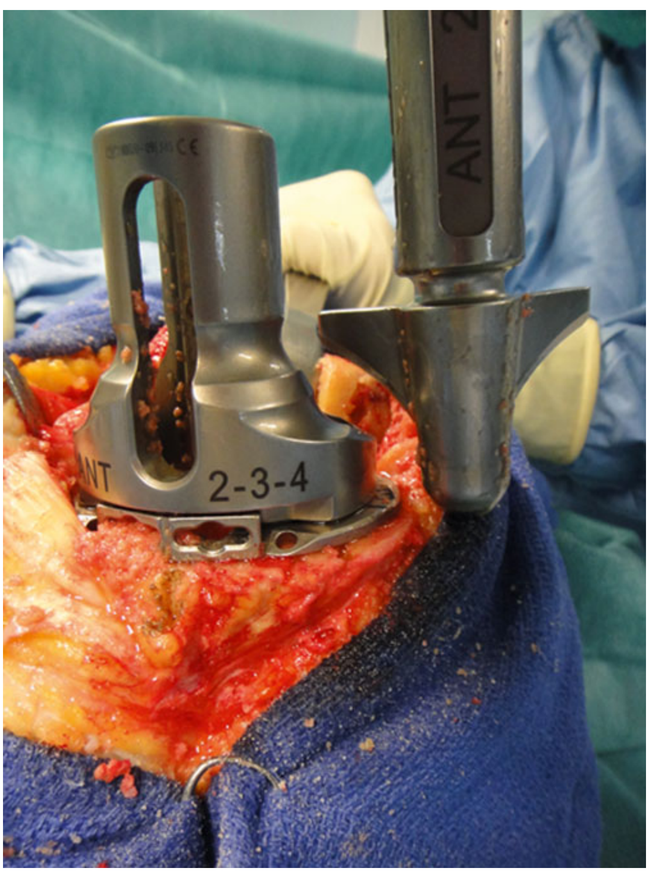


Fig. 24.27 Keel preparation

Specific Technical Points

Rotation of the Femoral Component

A posterior femoral cut parallel to the posterior condyles does not induce any rotation of the femoral component. For us, rotation of the femoral component is only necessary if the distal femoral cut is asymmetrical. When the femoral cutting guide is only in contact with the distal medial condyle, the distal cut will result in cutting less from the lateral condyle. This asymmetrical cut should be transferred to the flexion gap by externally rotating the femoral cutting guide so that less of the lateral posterior condyle is cut (Fig. 24.28). The exact rotation needed is calculated by measuring the distance between the lateral distal femoral condyle and the femoral guide (Fig. 24.29). This measurement is done using the thickness of multiple osteotome blades (thickness 2 mm). Subsequently, the exact same number of osteotome blades is applied to the lateral posterior condyle, and thus, the femoral cutting guide is rotated externally (Figs. 24.30 and 24.31a). The center of rotation in this case is the medial condyle.

A more recent device (Kneetec®) allows us to rotate the cutting guide by placing the center of rotation into the intramedullary axis (Fig. 24.31b).

Of course, in a varus-aligned knee (mFA <90°), an asymmetrical distal femoral cut is not translated into internal rotation.

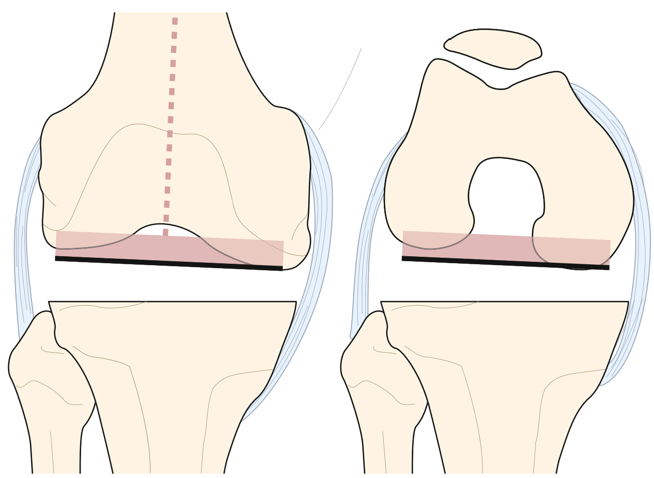


Fig. 24.28 Rotation of the femoral component

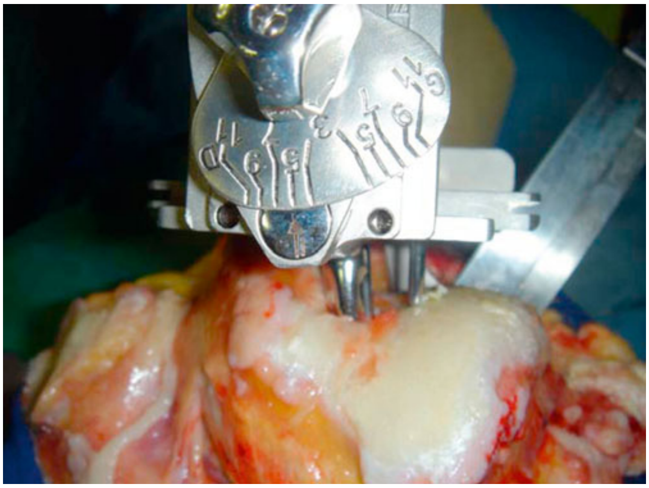


Fig. 24.29 Distance between the lateral distal femoral condyle and the femoral guide

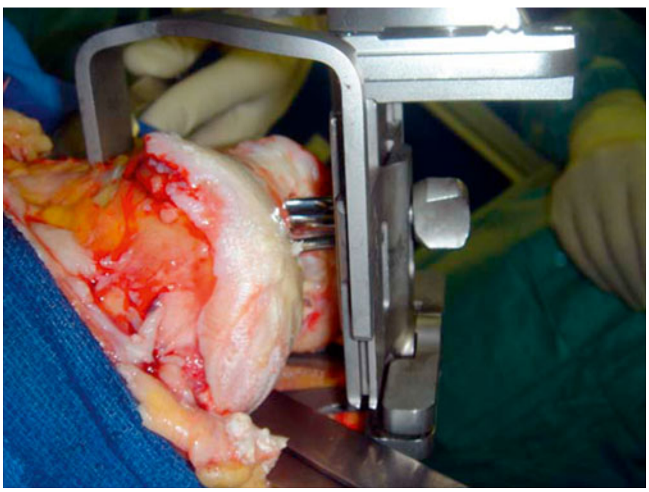


Fig. 24.30 The asymmetrical cut is transferred to the flexion gap using osteotome blades applied under the lateral posterior condyle

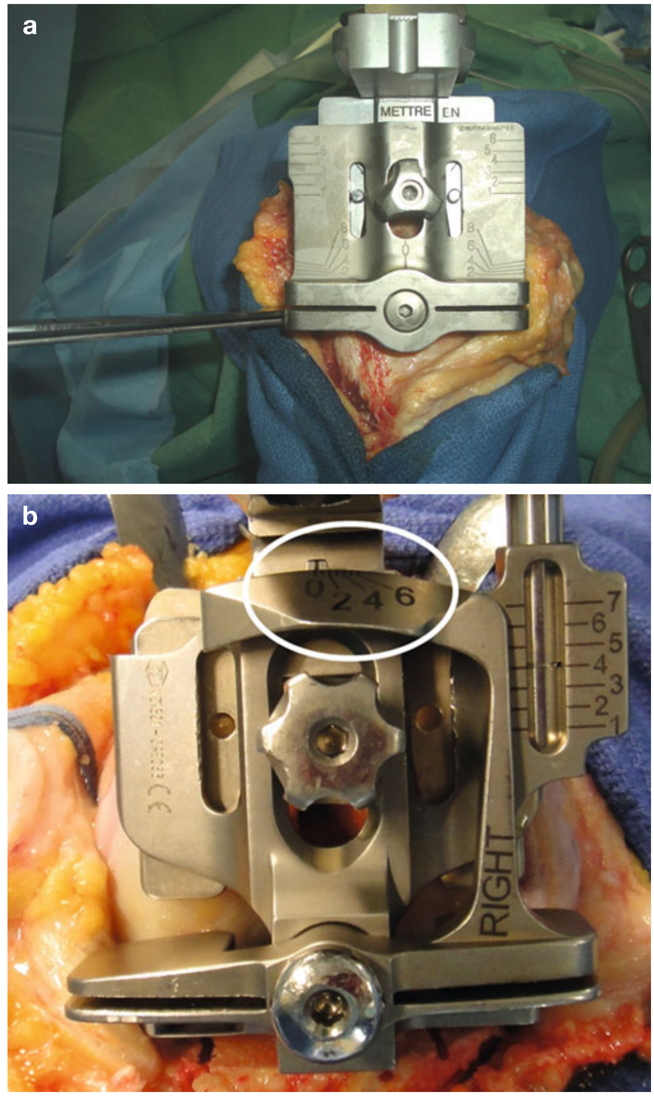


Fig. 24.31 (**a**) Osteotome blades applied under the lateral posterior condyle (*front view*). (**b**) A more recent device allows us to rotate the cutting guide by placing the center of rotation into the intramedullary axis

Release of the MCL

According to the initial recommendations of Insall in the 1980s, soft tissue releases should precede the bony cuts. At present, however, we feel it is more logical to perform any releases after the bony cuts. In the case of a constitutional tibial varus with a proximal metaphyseal varus deformity, a tibial cut perpendicular to the longitudinal axis will result in laxity on the lateral side (Fig. 24.32). This lateral laxity can increase when the anterolateral soft tissues are severed with a thick bony cut on the lateral tibial plateau (see section "Anterolateral Capsular Structures" below). In these cases, a medial release of the soft tissue structures is required. Usually, the medial approach releases the capsule and the deep MCL sufficiently for adequate balancing. However, if this is not sufficient, as with a significant constitutional varus deformity, several surgical techniques can be used to achieve an adequate medial soft tissue release:

Pie Crust of the MCL

Insall proposed to release the superficial MCL on the distal tibial side. This is to be considered an extensive release frequently ending up in an "all or nothing" situation: an excessive release of the MCL with excessive laxity on the medial side. We use the pie crust technique to release the MCL. To achieve this we use an 11 blade to make multiple perforations in the superficial MCL inside out. Subsequent testing in flexion allows us to progressively test and release the MCL and thus to obtain ligamentous balance in flexion and extension (Figs. 24.33 and 24.34). It is our experience that this procedure can be performed in cases with up to 6° of constitutional (extra-articular) deformity. The pie crust technique can lengthen the MCL by 6–8 mm in both flexion and extension. We do not agree with Whiteside that a selective release of the posterior and anterior fibers of the MCL to increase the extension and flexion gap, respectively, is routinely possible. In cases of more extensive deformities, the pie crust procedure can result in complete sectioning of the MCL.

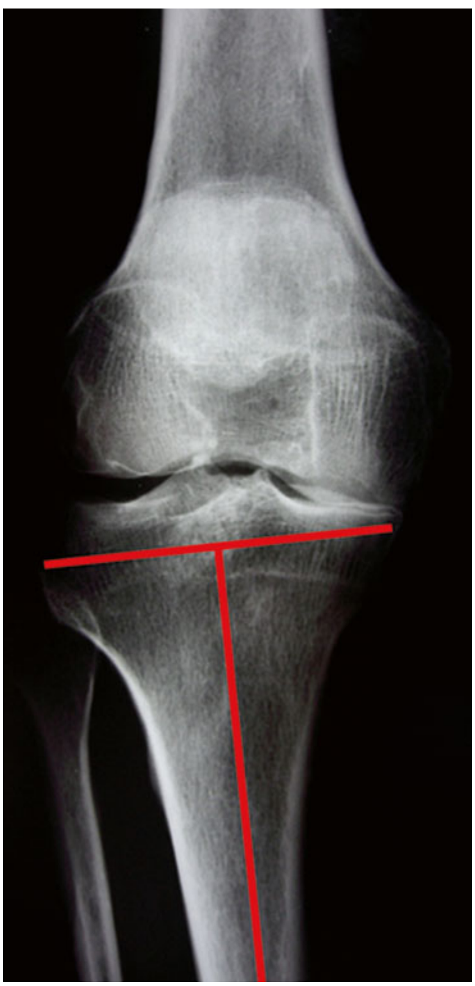


Fig. 24.32 An asymmetrical cut will result in laxity on the lateral side

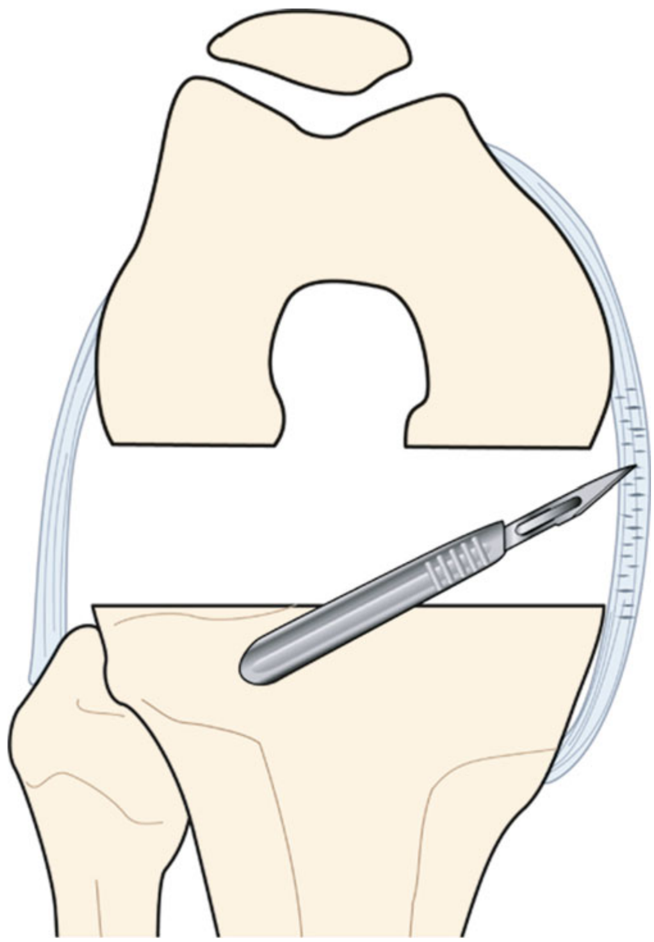


Fig. 24.33 Pie crust of the medial collateral ligament

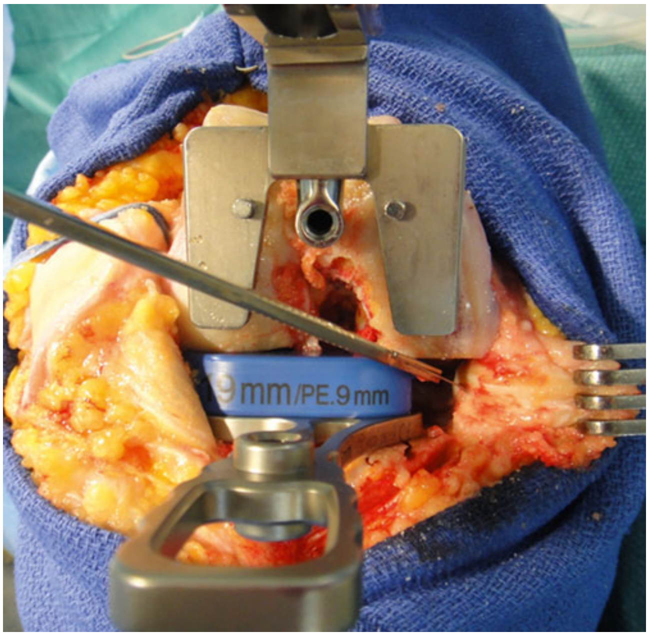


Fig. 24.34 Pie crust of the medial collateral ligament (perioperative view)

Distal Release of the MCL

In case of a varus deformity between 6 and 8°, a distal MCL release is performed on the tibial side. The release is performed close to the bone using a periosteal elevator, leaving the pes anserinus tendons in continuity (Figs. 24.35 and 24.36).

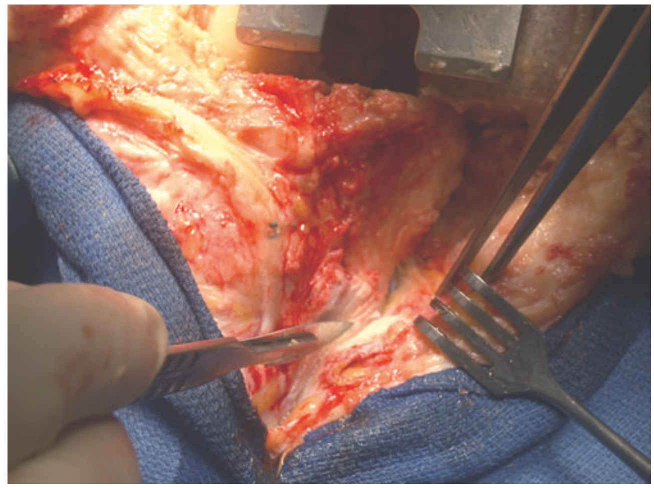


Fig. 24.35 Distal release of the MCL

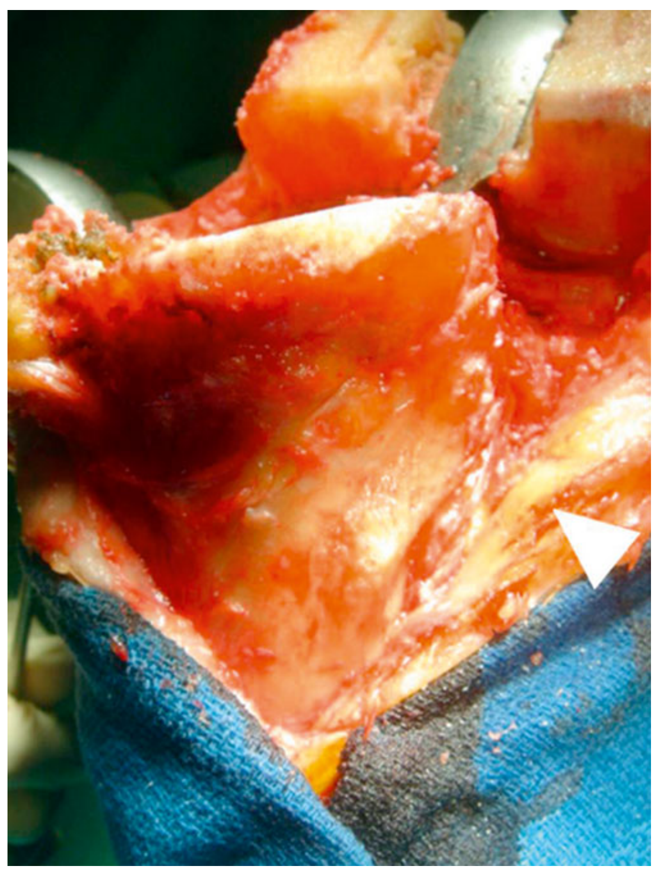


Fig. 24.36 The distal release is performed posteriorly until the posteromedial part of the capsule

Fixed Flexion Deformity (FFD) Correction

When large posterior osteophytes are present, one should remove them. These osteophytes are best observed on the lateral plain radiographs. These osteophytes tent the posterior capsule and result in a FFD. Frequently, contracture of the semimembranosus muscle and tendon is responsible for the FFD (Fig. 24.37). This tendon can be released on the posterior side of the proximal tibia (Fig. 24.38). In our hands, a preoperative FFD is better addressed with a thicker distal femoral cut of 11 mm instead of the normal 9 mm thus enlarging the extension gap. The final implantation of a 9 mm polyethylene spacer resolves the FFD. A posterior capsular release on the other hand is of little value to resolve FFD.

Lateral Patellar Release

Instability of the patella is very rarely observed in varus TKA. If detected during trialing, the surgeon should look for femoral component malrotation. Most commonly, the femoral component has been positioned in excessive internal rotation. If necessary, a lateral patellar release should be performed at the end of the intervention when the definitive components are in place and the tourniquet is deflated. A lateral release is performed from within the joint using a 23 blade and the knee in full extension. Sectioning of the lateral structures starts at the superior border of the patella and is extended distally. Care is taken to achieve hemostasis (Fig. 24.39).

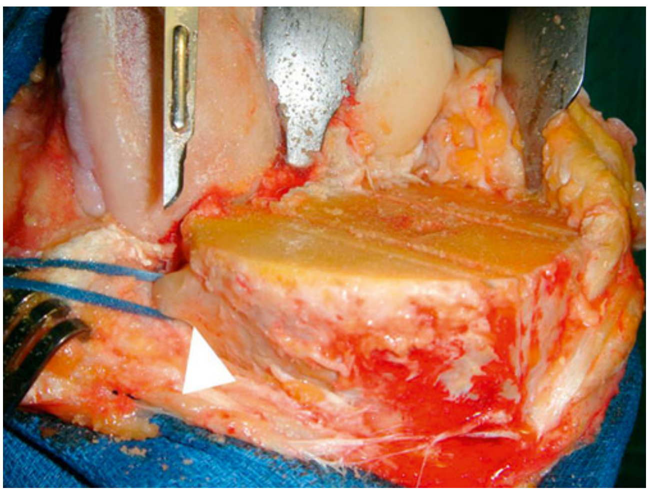


Fig. 24.37 Insertion of the semimembranosus tendon (*arrow*)

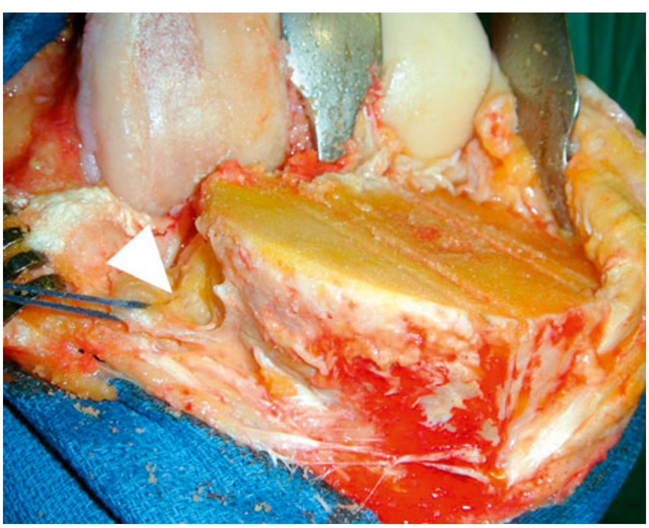


Fig. 24.38 Section of the semimembranosus tendon (*arrow*)

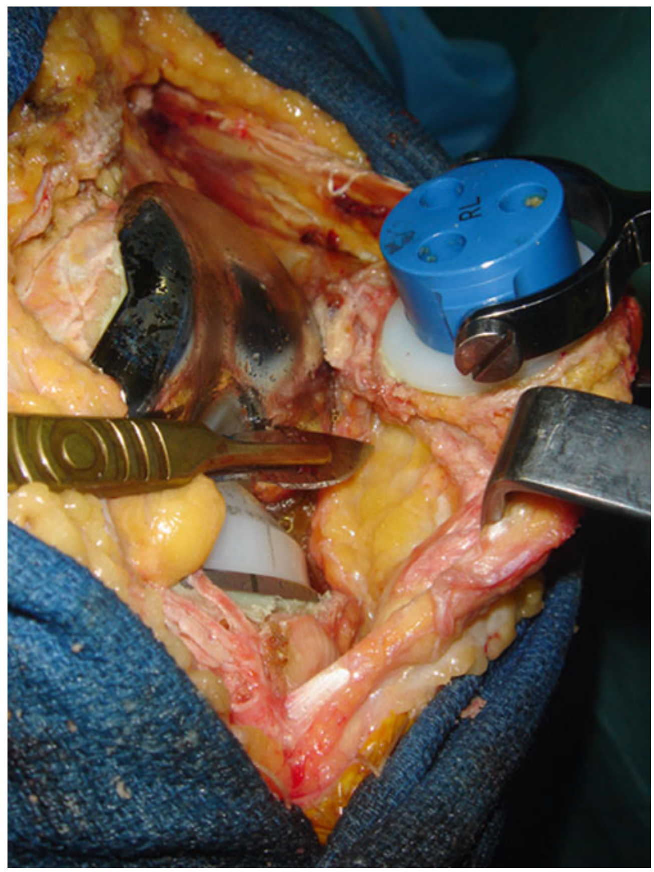


Fig. 24.39 Lateral patellar release performed from within the joint

Anterolateral Capsular Structures

The anteromedial approach in a varus knee preserves the lateral capsular structures. However, in case of a thick tibial cut, the anterolateral structures can be severed. Thus, the resection laxity is further increased laterally. To better understand this phenomenon, we use the example of an ACL tear complicated with a Segond fracture (Fig. 24.40). This type of fracture results from the avulsion during the torsion trauma of the anterolateral capsular structures from the tibial plateau (Fig. 24.41). A thick bony cut on the lateral tibial plateau can have the same effect, as can the anterior dislocation of the tibia during surgical exposure. These structures are readily identifiable during surgery (Fig. 24.42a, b). If the tibial cut is higher than its insertion, the structures remain intact and functional. They can be identified as a ropelike structure tensioned between the anteriorly dislocated tibial plateau and the femoral capsule. In a thick or asymmetrical tibial cut, its insertion is resected (Fig. 24.43).

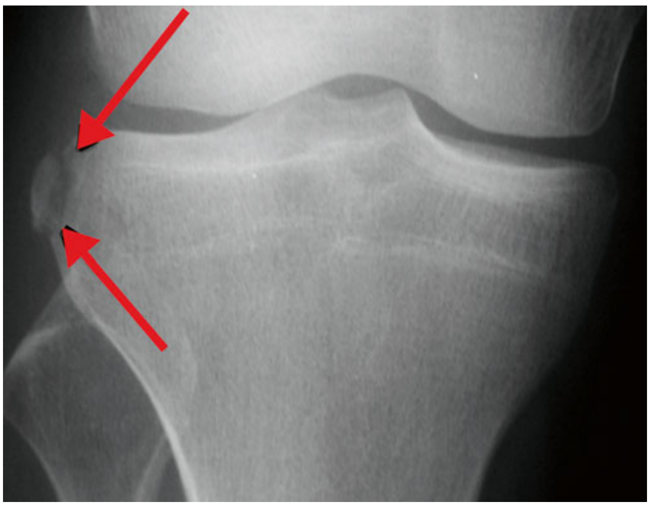


Fig. 24.40 Segond fracture (*arrows*)

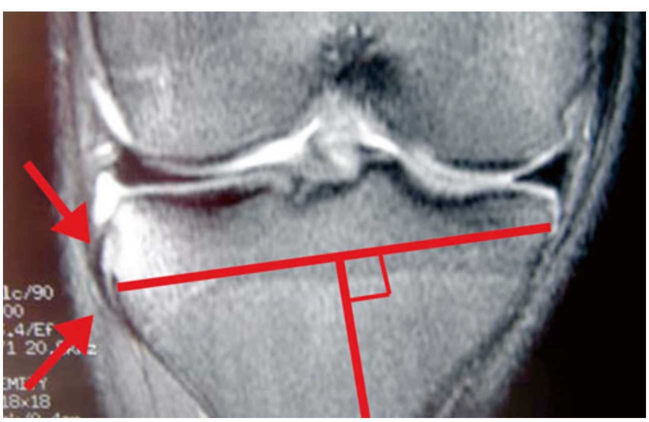


Fig. 24.41 MRI showing anterolateral capsular structures (*arrows*)

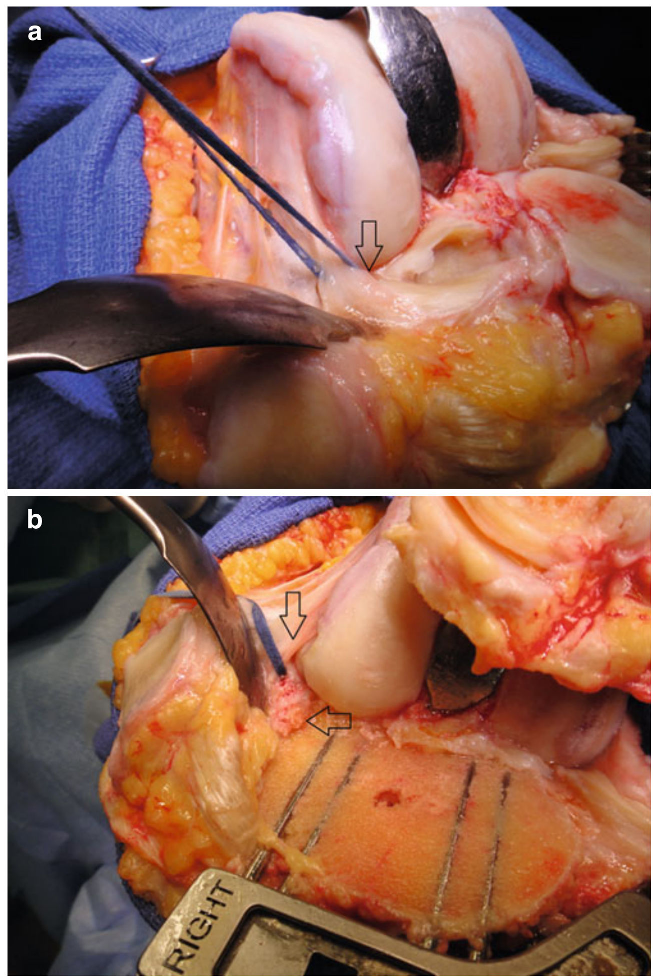


Fig. 24.42 (**a–b**) Anterolateral capsular structures (perioperative view)

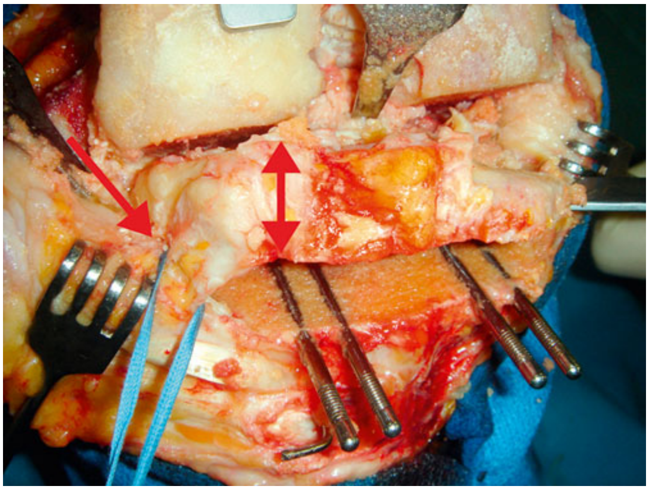


Fig. 24.43 Asymmetrical and thick tibial cut. The anterolateral capsular structures are resected (*arrow*)

Difficulties During the Patellar Preparation

The patella is infrequently significantly worn in medial OA. However, if this is the case, the patellar cut can be very difficult. In case of chondrocalcinosis, the wear of the patella can be extreme with a sawlike pattern on the Merchant view (Fig. 24.44). In this situation, we propose to preserve the lateral osteophyte during the positioning of the cutting guide. This will help to stabilize the guide and to obtain a flat and symmetrical cut of the patella (Figs. 24.45 and 24.46). In cases of severe patellar wear, one can consider avoiding patellar resurfacing altogether.

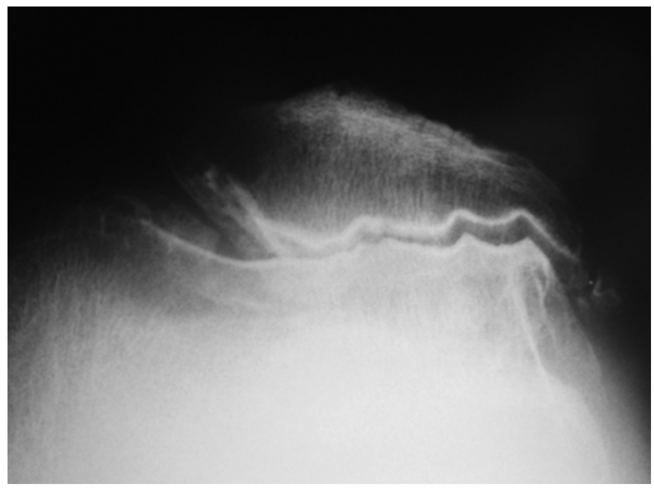
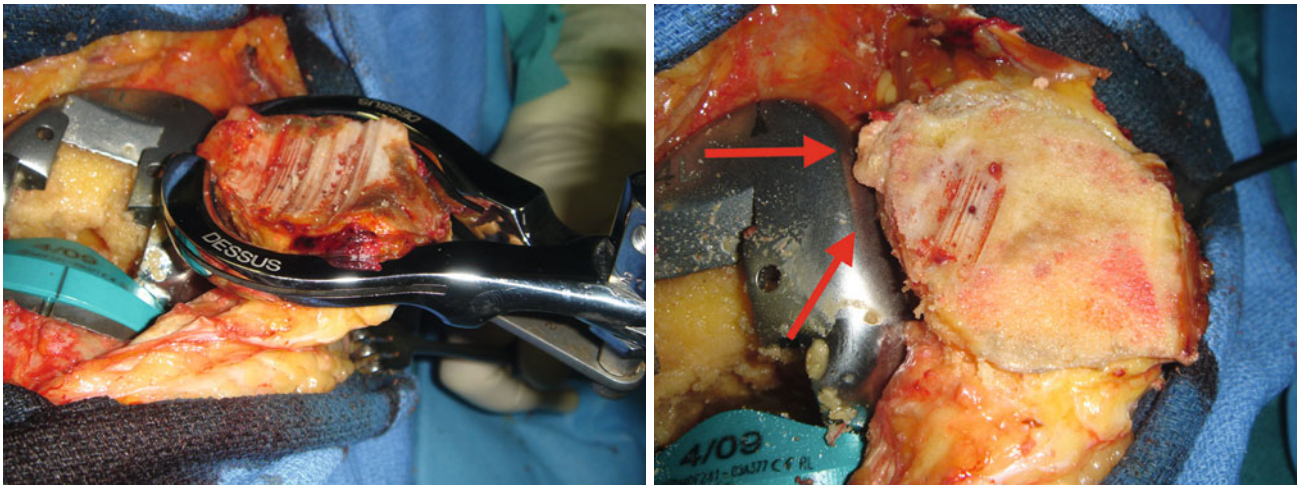


Fig. 24.44 Typical appearance of chondrocalcinosis



Figs. 24.45 and 24.46 Extreme wear of the patella. We propose to preserve the lateral osteophytes (*arrows*) during the positioning of the cutting guide

Postoperative Care

Compressive bandages are applied immediately after the intervention. A highly compressive Velpeau bandage is additionally applied to the knee, but is removed in recovery, 1 h after the intervention. The lower limb is immobilized with a brace in extension. Low molecular weight heparin is used as thromboprophylaxis and is started on the evening of surgery.

The foot is regularly checked for adequate perfusion. Both calves are frequently palpated to check for DVT. In doubt a duplex ultrasound is performed.

Close attention is paid to the respiratory function of the patient. Sudden desaturation may be a sign of pulmonary embolism. A spiral CT scan or VQ scan can rule out this pathology.

Rehabilitation

Rehab is started 1 day after surgery. A CPM is applied as well as progressive active training. The aim is to regain passive and active flexion and extension. Flexion is limited to 95° for the first 6 weeks. This protects the sutures, limits pain, and avoids hematoma formation. Generally, patients leave the hospital on day 7 and are transferred to a rehab center. A patient visit is scheduled 2 months after surgery.

Future Perspectives in TKA Surgery

Recently, computer-assisted surgery (CAS) and navigation system have been developed to assist the surgeon during TKA.

The sequence of priorities for TKA surgery are:

1. Mechanical tibial angle (mTA) at 90° in the frontal and sagittal plane
2. Ligamentous balance in extension
3. Ligamentous balance in flexion
4. Reproduction of the joint line height
5. Mechanical femoral angle (mFA) close to 180° (some variation is accepted in the mDFA according to the initial deformity)

However, the *sequence of priorities* is not the sequence of the different steps during the surgical procedure. This discrepancy is largely due to the currently used surgical instrumentation. Therefore, the surgeon has to think one or two steps ahead during the procedure and foresee the influence of the current step on the next steps:

- Tibial cut first at 90°
- Posterior femoral condyle cut
- Flexion gap balancing
- Extension gap balancing
- Matching extension gap to flexion gap (distraction possible)
- Distal femoral cut

CAS enables the surgeon to anticipate the effect of one step on the following step(s) and to perform this virtually. However, in current TKA surgery, the main problem remains the so-called resection laxity. It is currently impossible to anticipate or precisely predict this type of laxity by virtual surgery using any current CAS or navigation system available on the market due to:

1. The amount of resection laxity is highly correlated to the size of the knee.
2. During the tibial cut, ligaments and capsular structures could be partially or completely released. Thus, a bony cut could result in a larger flexion or extension gap than originally planned using CAS or navigation.

In our experience, the "tibial space" can and should only be evaluated and quantified once the tibial cut is made and the ligament balancing in flexion and extension is performed. However, ligament balancing in flexion and extension is classically performed after the femoral cuts. By means of CAS or navigation, one is able to perform this balancing prior to the femoral cuts, which is in accordance with the *sequence of priorities* stated earlier:

1. Tibial cut.
2. Virtual positioning of the distal femoral cut.
3. Ligamentous balancing in extension creating the virtual rectangle in extension.
4. Virtual positioning of the posterior femoral condyle cut. The rotation of the femoral component can be determined using several systems:
   - Equally tensioning the collateral ligaments in flexion (CORES system) and then performing a posterior condyle cut parallel to the tibial cut.
   - The asymmetry of the distal femoral cut in extension is reproduced in flexion (this implies an anatomical correlation between the distal femur and the posterior condyle): our choice.
   - The Whiteside line.
   - The epicondylar axis.
5. The height of the joint line is obtained automatically.
6. The femoral cuts are now made according to the virtual planning.

Nevertheless, some considerations can be made on:

1. An anterior or posterior referencing system for the femoral component. Anterior referencing will affect the size of the flexion gap, while posterior referencing could result in either overstuffing of the anterior compartment or notching.
2. The center of femoral external rotation. An intercondylar center will result generally in a decreased posterior offset with more bone resection from the medial posterior condyle and less from the lateral. If centered on the medial condyle, the anatomical offset is maintained, but even less bone is resected from the lateral condyle.

In conclusion, CAS and navigation systems offer us the possibility to achieve the proposed "sequence of priorities." These new evaluation tools will affect the way we perform a TKA and will give rise to novel arthroplasty concepts.