Surgical Management of Episodic Patellar Dislocation

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Background

Episodic patellar dislocation is also termed objective patellar instability or occasional patellar dislocation.

This condition is defined by a history of one or more episodes of patellar dislocation confirmed by the patient or the physician and/or a radiographic abnormality due to a dislocation (e.g. fracture/bone bruise of the medial border of the patella or lateral condyle).

This terminology avoids the term of instability. H. Dejour highlighted the different meaning of instability and separated objective "laxity" from subjective "instability." Nevertheless, instability is a symptom and not a syndrome. Moreover, a misunderstanding still exists with the terminology of objective patellar instability in the English-speaking world. With Dan Fithian, after his visit to Lyon for 4 months, we came to this suggestion that clarifies the situation: Episodic Patellar Dislocation (EPD). Our global approach concerning the predisposing factors was modified during the 15th Journées Lyonnaises du Genou, coordinated by David Dejour in 2012.

Morphological Abnormalities

In the EPD group, we have identified several morphological anomalies that facilitate or allow patellar dislocation. In more than 96% of the cases of EPD, the radiographic examination will reveal at least one of the following anomalies:

- Medio Patellar Femoral Ligament (MPFL) insufficiency
- Trochlear dysplasia
- Patella alta
- Tibial Tubercle-Trochlea Groove (TT-TG) distance >20 mm
- Patellar tilt >20° (a consequence of the other morphological abnormalities)

Constant Factor

MPFL Insufficiency

This may be due to an acute rupture from a direct traumatic event, and/or chronic incompetence secondary to other morphological factors.

Fundamental Factor

Trochlear Dysplasia

Trochlear dysplasia, according to the literature and our experience, is present in more than 90% of patients in whom a patellar dislocation has occurred. It is the principal anatomical feature of EPD and consists in a flattening or convexity of the upper part of the trochlear groove.

Imaging features: crossing sign and a prominence ("bump," "boss," or "eminence") of the floor of the groove on the lateral radiograph.

Main Factors

These factors are called **main factors** for several reasons. They are very often present in the EPD group and absent in a

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control group (patient without any history of patellar dislocation). We were able to measure them radiographically and a threshold has been defined, so that they can be corrected.

Tibial Tubercle-Trochlea Groove (TT-TG) Distance

The TT-TG distance is used to assess rotational alignment of the extensor mechanism. It is obtained by superimposing CT images of the summit of the trochlear groove (coronal cut where the femoral notch resembles a roman arch) and the tibial tubercle in a fully extended knee. The deepest point of the trochlear groove and the highest point of the tibial tuberosity are projected perpendicularly on the line tangent to the posterior condyles. The distance between these points is defined as the TT-TG.

Abnormal when the TT-TG >20 mm in CT coronal images.

Patellar Height

The patella engages in the trochlea in the first degrees of flexion. If the patella is too high in relation to the trochlea, this engagement will occur too late, with an increased risk for dislocation.

Abnormal when the Caton-Deschamps index >1.2 on the lateral radiograph.

Patellar Tilt

The patellar tilt is the inclination of the patella in its transverse plane in relation to a line tangent to the posterior femoral condyles. Several factors may result in patellar tilt: dysplasia of the quadriceps muscle, dysplasia of the trochlear groove, and patella alta. It can be addressed by a soft tissue reconstruction, e.g., medial patellofemoral ligament reconstruction or vastus medialis obliquus plasty.

Abnormal when the patellar tilt >20° on CT images.

Secondary Factors

We call them **secondary factors** because they are present in the EPD group at a lower frequency and we were not able to establish a threshold. They are more common in females. We must consider them as potential factors and it is uncommon to propose a surgical act to correct them.

- Genu valgum
- Genu recurvatum
- Excessive femoral ante-torsion

Clinical Examination

The clinical findings are less reliable in the evaluation of EPD.

Smillie Test (The Apprehension Sign)

With the patient in the supine position and the knee extended, the patella is forced laterally by the examining physician. To be positive, the patient and the physician must have the impression of imminent dislocation. A negative Smillie is much more helpful than a positive sign; a negative Smillie sign rules out a dislocatable patella while a positive Smillie sign does not confirm a dislocatable patella.

"J" or "Comma" Sign

Lateral subluxation of the patella in terminal active knee extension due to the non-linear path of the patella during the first 30° of flexion.

Lateral "Squint" of the Patella

The so-called "grasshopper" sign, due to the appearance of the high-riding and laterally subluxated patella at the upper outer corner of the knee at 90° of flexion.

Increased Q-angle

It is also known as "bayonet sign." The distal insertion of the patellar tendon is too lateral with respect to the patella itself and the quadriceps muscle. It is a clinical finding that is difficult to quantify. It is an indication of a potential excessive TT-TG. To quantify the exact position of the tibial tubercle with respect to the trochlear groove, a TT-TG measurement should be performed.

Other aspects of the physical examination, such as effusion and tenderness, recurvatum and lower limb alignment, are secondary or indirect signs and do not contribute strongly to treatment decisions.

Imaging Studies

Trochlear Dysplasia

Crossing Sign

On the *strict lateral radiograph* (the posterior portions of the femoral condyles are aligned), the floor of the normal groove is visible in profile as a distinct sclerotic line curving distally and posteriorly, starting from the anterior cortex and ending at the anterior end of Blumensaat's line. In its entire course, this line should never pass anterior to a tangent line extending down the anterior femoral cortex.

Patients with trochlear dysplasia have an abnormally prominent groove which passes anteriorly to the anterior cortex and eventually crosses the medial and lateral trochlea walls (Fig. 33.1a, b). The more distal the crossing, the worse is the trochlea dysplasia.

Prominence

Also called the trochlea "boss," "bump," or "eminence" of the floor of the groove with respect to the distal 10 cm of the anterior femoral cortex. Values superior to 3 mm are considered pathological (Figs. 33.2 and 33.3).

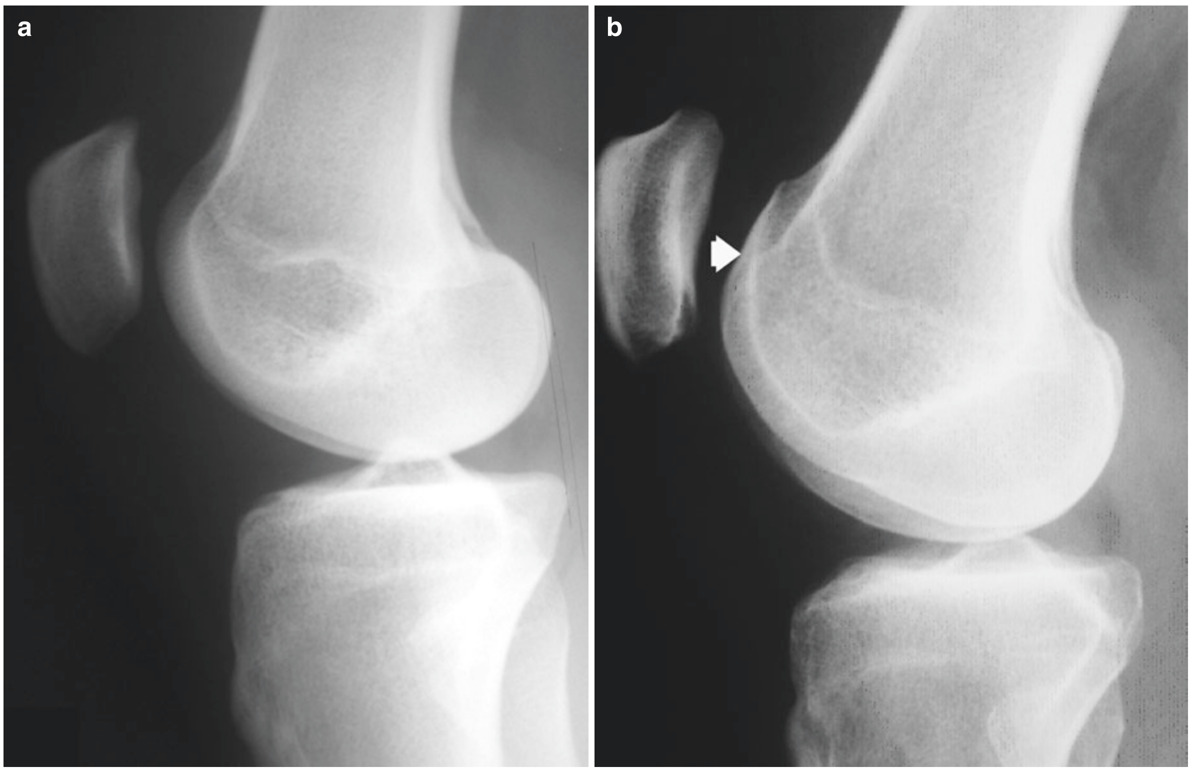


Fig. 33.1 Lateral view. (**a**) Normal knee. (**b**) Trochlea dysplasia with crossing sign (arrow)

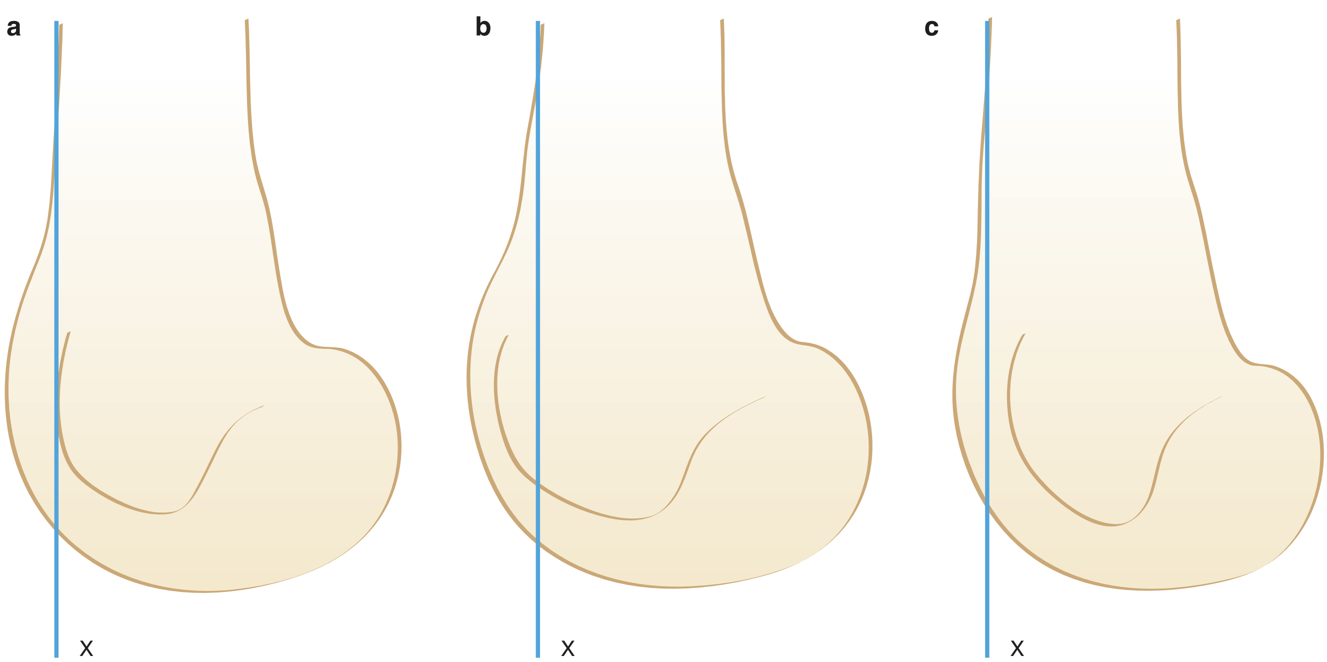


Fig. 33.2 Prominence. (**a**) No prominence. (**b**) Positive prominence. (**c**) Negative prominence

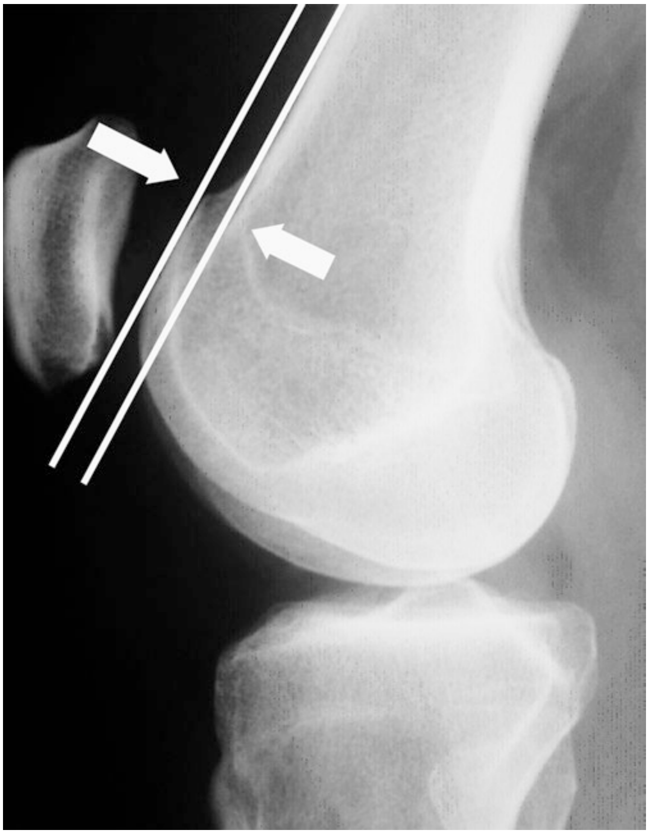


Fig. 33.3 Radiological measurement of the prominence on lateral view X-ray

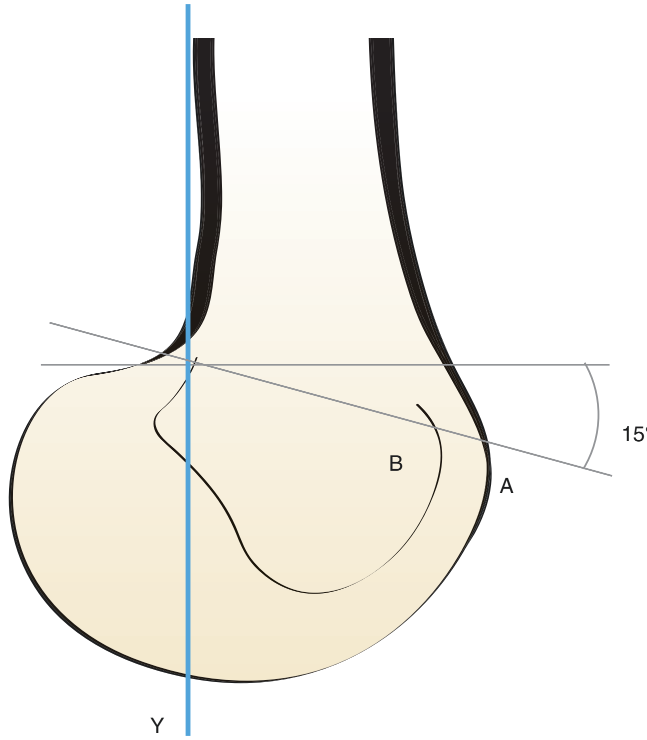


Fig. 33.4 Trochlear depth (=BA)

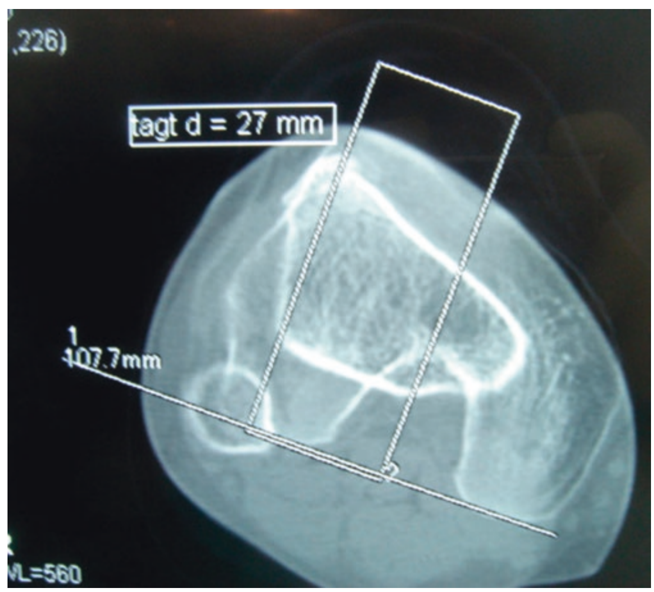


Fig. 33.5 TT-TG distance measurement on CT scan = 27 mm

Trochlear Depth

A tangent to the posterior cortex of the femur and its perpendicular passing through the posterior condyles are traced. The trochlea depth is measured in a line 15° from the perpendicular, crossing the trochlear groove line, where the trochlear depth is measured. Values below 4 mm are considered abnormal (Fig. 33.4).

Tibial Tubercle-Trochlea Groove (TT-TG) Distance

The TT-TG distance is used to assess rotational alignment of the extensor mechanism. It is obtained by superimposing CT images of the summit of the trochlear groove (coronal cut where the femoral notch resembles a roman arch) and the tibial tubercle in a fully extended knee. The deepest point of the trochlear groove and the highest point of the tibial tuberosity are projected perpendicularly on the line tangent to the posterior condyles. The distance between these points is defined as the TT-TG.

Measures greater than 20 mm are considered abnormal (Fig. 33.5). The TT-TG is the result of both the lateral position of tibial tubercle and the external torsion of the knee. In some situations, this measurement is therefore not accurate, for instance, in permanent dislocation of the patella where the external rotation of the knee is increased.

Patella Alta

There are several indices to measure patellar height. These indices can be categorized into those referencing the tibia (for example, Insall-Salvati, Caton-Deschamps, Blackburne-Peel) and those referencing the femur (for example, Blumensaat, Bernageau).

Theoretically, referencing the patellar height to the femur is more logical because what matters is how the patella engages in the femoral groove. But femoral referencing is

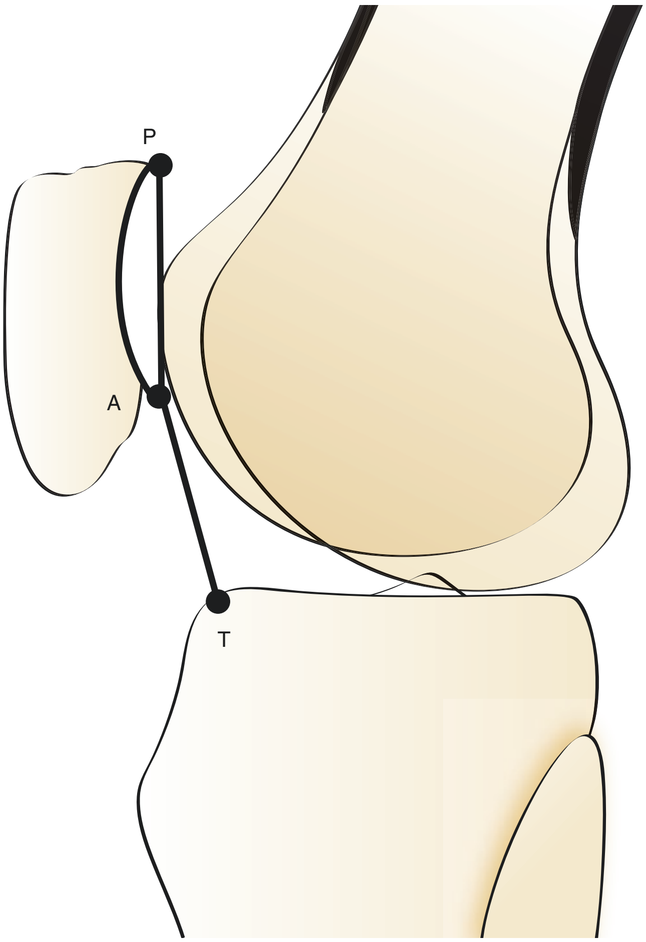


Fig. 33.6 Caton-Deschamps index measurement = AT/AP

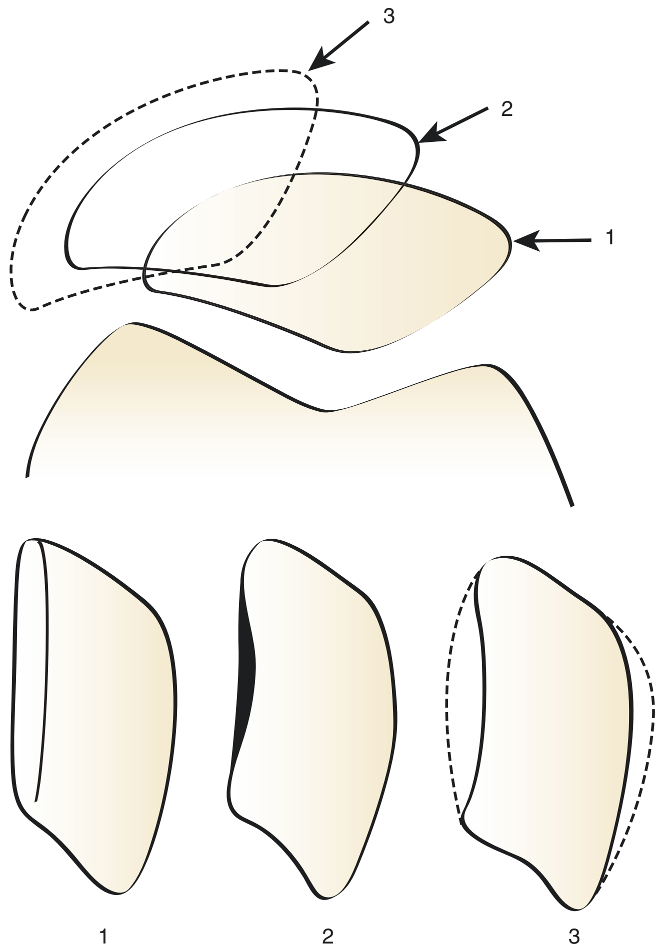


Fig. 33.7 Patellar tilt (Maldague and Malghem). (1) normal, (2) moderate tilt, (3) severe tilt

less reproducible. For this reason, tibial referencing is the standard method to measure patellar height.

Caton-Deschamps Index: It is measured in a strict lateral view. It is the ratio between the distance of the inferior border of the patellar articular surface to the anterior border of the tibial plateau and the patellar articular surface length (Fig. 33.6). It is simple to trace and it is not altered by knee flexion on the radiograph. Values greater than 1.2 characterize patella alta.

Patellar Tilt (Maldague and Malghem)

It cannot be well studied from strict lateral radiographies with the knee flexed to 30° (Fig. 33.7). It is measured on CT in extension, with the quadriceps contracted and relaxed. It is defined by the angle between the tangent of the posterior condyles at the level of the roman arch, and the long transverse axis of the patella. Sometimes it is necessary to superimpose two slices in order to measure this angle, particularly in case of patella alta.

Merchant angle: It is calculated on axial radiographic views of the knee at 45° of flexion. The bisecting line of the angle between the lateral and medial trochlea facets is traced. A second line is then traced between the deepest portion of trochlea groove and the most posterior (inferior) portion of the patellar ridge. The angle of Merchant is the angle between both lines. If the angle is medial to the bisecting line, it has a negative value; if it is lateral, its value is positive. Normally the angle is −6°. Merchant considered an angle superior than +16° abnormal (Fig. 33.8). The Merchant angle is not significantly altered, however, when the dysplasia of the trochlea is limited to its proximal part.

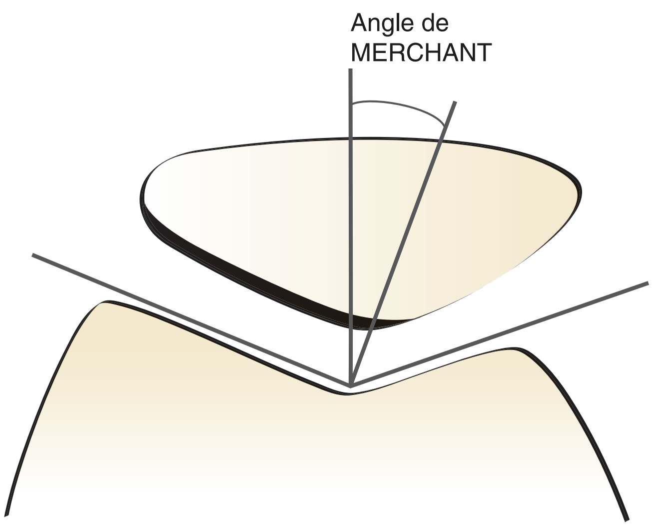


Fig. 33.8 Merchant angle

Patellar Tendon Length

Measured on MRI, it is more specific and sensitive for the study of patellar instability than the patellar height index measured on profile X-rays (Fig. 33.9). The patellar tendon is excessively long (generally greater than 52 mm) in patients with patellar instability.

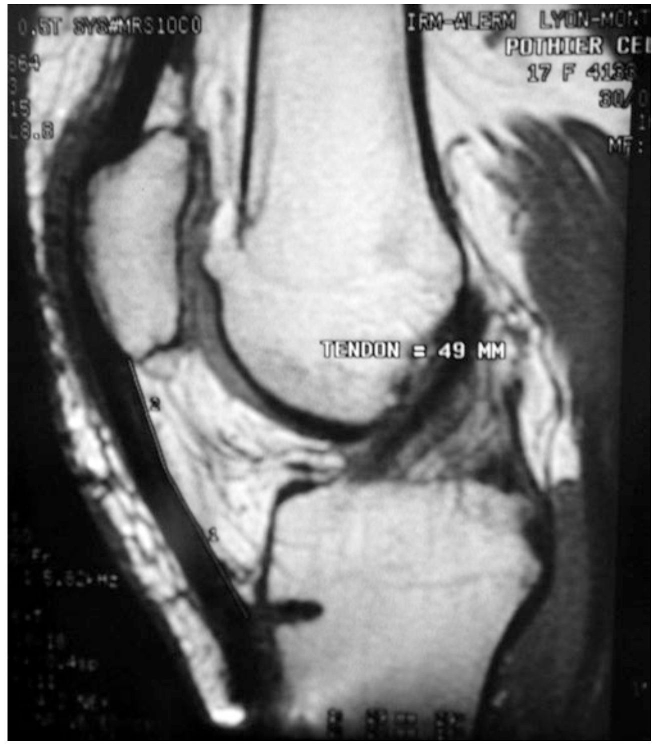
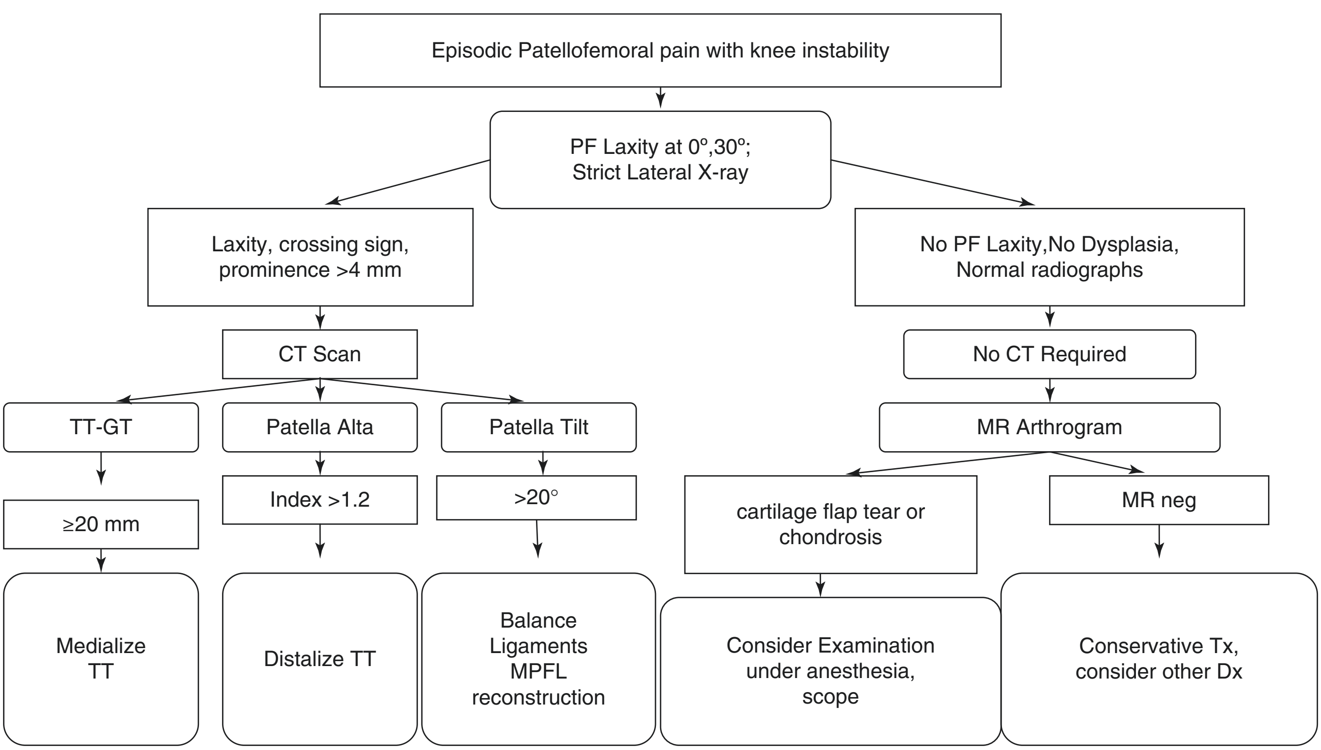


Fig. 33.9 Patellar tendon length after tenodesis measuring 49 mm on MRI

Treatment

An algorithm helps to plan treatment in a logical way:



D. Fithian, Ph Neyret:Patellar Instability: The Lyon Experience

Conservative Treatment

Non-surgical treatment is not the objective of this chapter and will not be developed here.

Unlike in painful patella syndrome, where conservative treatment is the rule and surgical treatment usually worsens symptoms, conservative treatment has a less important role in EPD management. This is particularly true when a threshold can be established due to a factor such as patella alta, augmented TT-TG or patellar tilt and the patient presents with repetitive episodes of patellar dislocation.

In cases of infrequent instability in which no threshold abnormality has been identified and pain is the most prominent symptom, a course of physiotherapy can be prescribed. These exercises consist of quadriceps and hamstrings muscle stretching and quadriceps reinforcement (especially VMO muscle).

Surgical Treatment

Surgical treatment is indicated in the presence of morphological anomalies. These patients should have had at least one or more episodes of patellar dislocation AND one or more main factors (patella alta, excessive TT-TG or patellar tilt).

In this chapter, we do not describe the trochleoplasty as proposed by H. Dejour and G. Walch in 1987. We do not treat the trochlear dysplasia in a primary setting, the fundamental factor responsible for EPD, for several reasons. Most frequently, the trochlear dysplasia is mild and well tolerated by the patient. Deepening of the trochlea groove is in our hands is only effective in severe cases with abnormal patellar tracking. It remains a very technical and demanding procedure with a variable outcome. Therefore, in our department a deepening trochleoplasty is only indicated for severe trochlear dysplasia (with a bump of >6 mm, abnormal patellar tracking or failure of previous surgery).

Techniques

The following procedures are generally easy, but can lead to significant complications if not carried out with prudence and for the correct indications. These techniques are not indicated for painful patella syndrome, which can be worsened by these procedures.

Medial Patellofemoral Ligament Reconstruction (D. Fithian's Technique)

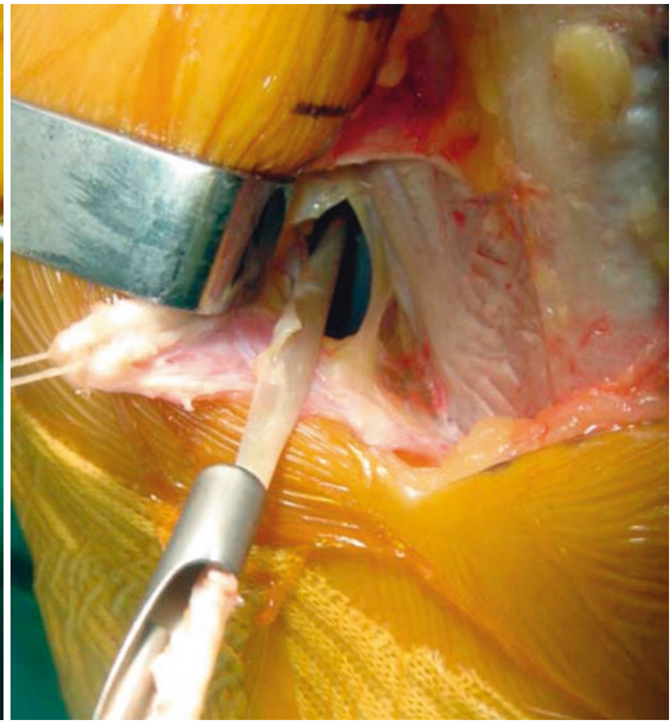
This technique is indicated when there is excessive laxity of medial retinacular patellar stabilizers, specifically the MPFL. A laterally applied force to the patella will result in lateral displacement of more than 9 mm with the knee at 30° of flexion. After the procedure, the patella must be in a horizontal position and no longer dislocatable. An arthroscopy is done first to evaluate associated lesions and patellar tracking, which can be performed using an accessory superolateral portal. Three small incisions are needed, one for graft harvesting and two for graft fixation, on the patella and on medial femoral epicondyle (Fig. 33.10).

Harvest of the Semitendinosus Tendon

The next step is to obtain the graft for the MPFL reconstruction. A small (5 cm) longitudinal or oblique incision over the pes anserinus is made. The conjoint tendon of the hamstrings is incised in "L" shape, with its angle positioned superiorly and medially. The semitendinosus tendon is identified and its insertions to the crural fascia and posteromedial corner are cut. Absorbable sutures are placed at its free end, and the tendon is released from the tibial insertion (Figs. 33.11 and 33.12). The graft is subsequently stripped using a closed stripper.

The graft is prepared on the back table. For an MPFL reconstruction, the length of the graft should be between 16 and 20 cm. Whipstitches are placed in the other free end, and the tendon is looped in two. The folded end is sutured together over a distance of 2–3 (Fig. 33.13).

Fig. 33.10 Three small incisions are needed for MPFL reconstruction



Figs. 33.11 and 33.12 Harvest of the semitendinosus tendon

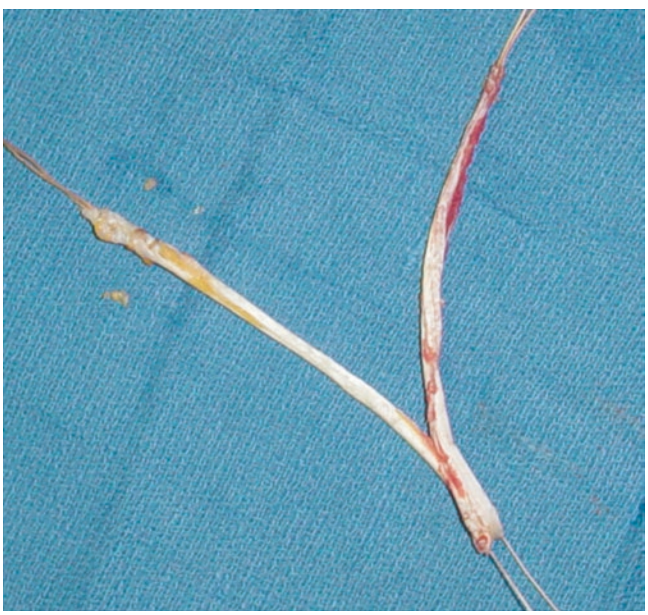


Fig. 33.13 Graft preparation

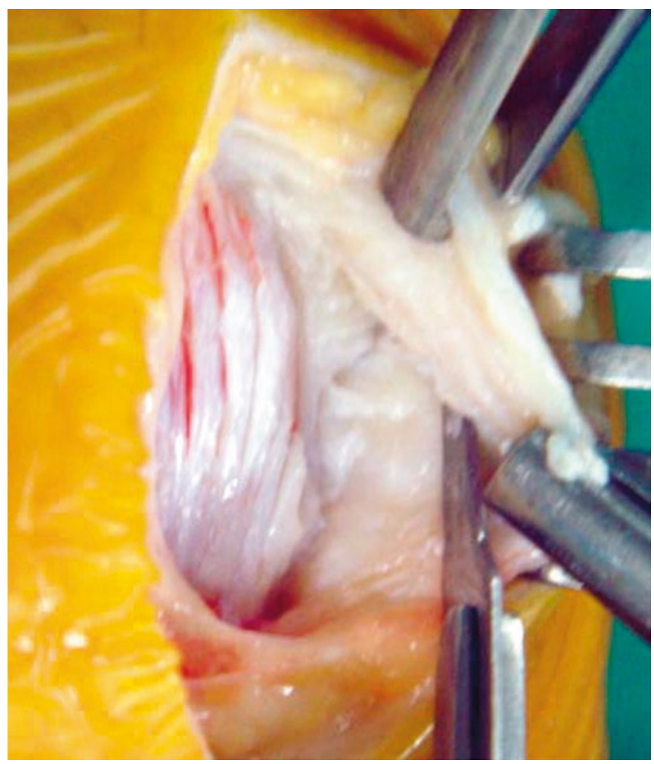


Fig. 33.14 Exposure of the medial third of patella

Patellar Tunnels

A longitudinal incision of about 4–5 cm is made over the patella, in between its medial border and the midline. The medial third of patella is exposed by subperiosteal dissection (Fig. 33.14). The dissection extends medially between the original MPFL and the capsular layer.

A 3.2 and subsequently a 4.5 mm drill are used to drill two tunnels in the proximal 1/3 of the patella. These tunnels start on the medial border of the patella, horizontally, and the exit holes are made on the anterior surface of the patella, 8–10 mm lateral to medial border (Fig. 33.15).

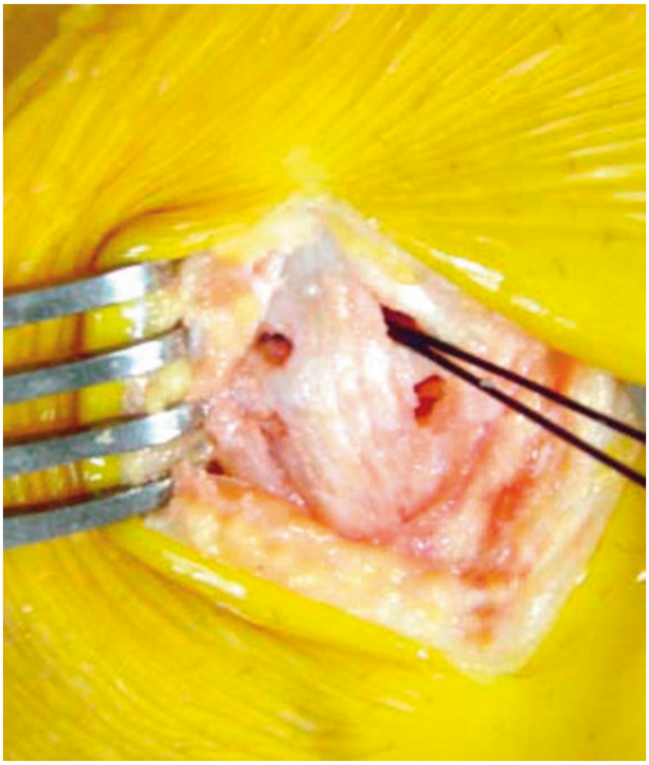


Fig. 33.15 Patellar tunnels

The Medial Epicondylar Tunnel and Its Dissection

A 5 cm longitudinal incision is made over the ridge connecting the medial epicondyle to the adductor tubercle (AT). Dissection is carried to the bone surface. From the patellar incision, in between the original MPFL and capsular layer, dissection scissors are driven toward the medial epicondyle, uniting both epicondylar and patellar incisions. A guide pin is passed just proximally to the medial epicondyle, distal to the AT toward the lateral epicondyle, under fluoroscopic guidance (Figs. 33.16 and 33.17). MPFL ligament isometry can be tested now, passing a #5 braided polyethylene suture around the guide pin through the patellar tunnels. If lengthening occurs in extension, the pin is placed more proximally, closer to the AT. If lengthening occurs in flexion, the pin is placed more distally, closer to the medial epicondyle. A blind bone tunnel is created on the medial epicondyle, 7 mm in diameter and 25–30 mm in length (enough to receive the folded end of the graft). The graft is pulled into the tunnel by a perforated pin, and then fixed with an interference screw (Habilis 7 mm, Phusis) (Figs. 33.18 and 33.19). The two free extremities of the graft are passed under the original MPFL between the two incisions, to enter the patellar tunnels medially and exit through the anterior drill holes. Each free extremity is sutured side-to-side onto itself with non-absorbable sutures (Figs. 33.20 and 33.21). The patella must be centered at the time of tying the sutures, so an adequate ligament tension is obtained. It remains very difficult to define "adequate" tension. Generally, tensioning is performed at 70° of flexion.

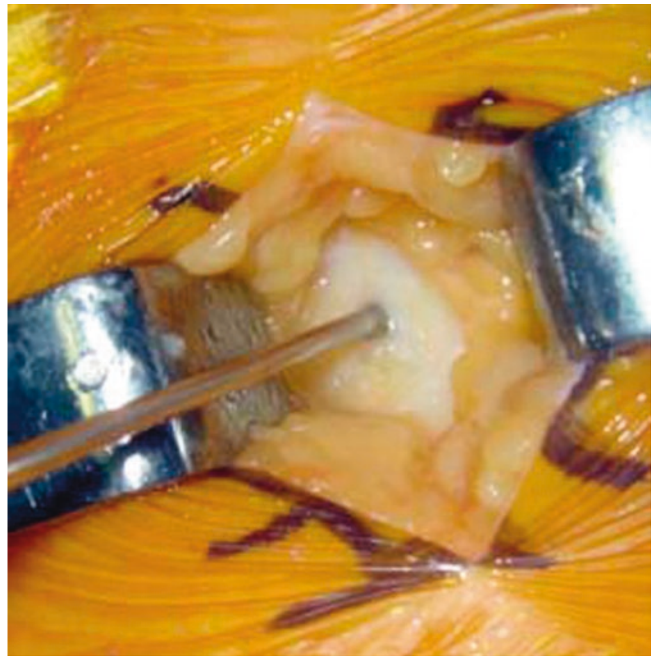


Fig. 33.16 Guide pin passed proximally to the medial epicondyle

Fig. 33.17 The tunnel is too proximal and anterior, and the pin will be repositioned. We recommend a fluoroscopic control to optimise femoral tunnel positioning

Patellar mobility is checked. A good endpoint must be achieved, with patella lateral mobility of 7–9 mm, the patella must be in a horizontal position and it should be impossible to dislocate it laterally. A 3.2 mm drain is placed subcutaneously, and the incision is closed.

Fig. 33.18 Femoral fixation using absorbable screw

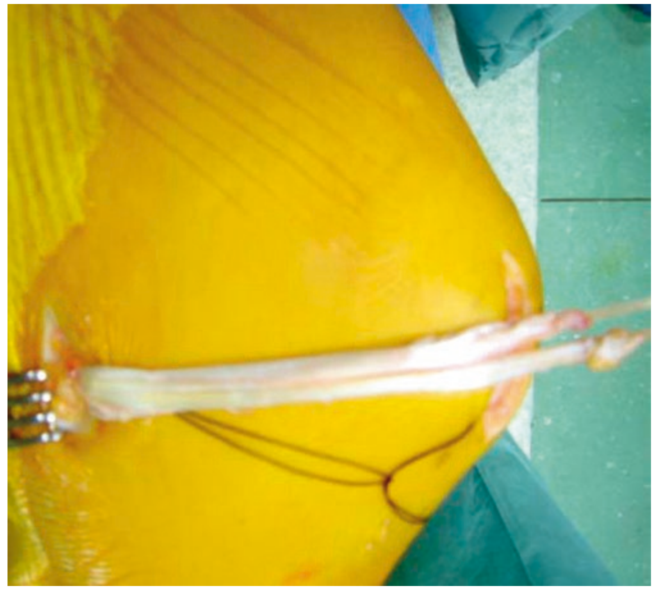


Fig. 33.19 The two bundles are long enough

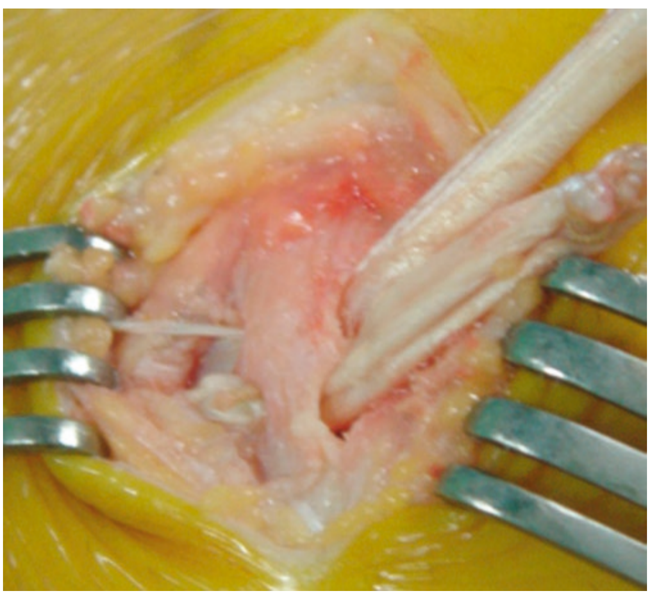


Fig. 33.20 The two free extremities of the graft are passed into the patellar tunnels

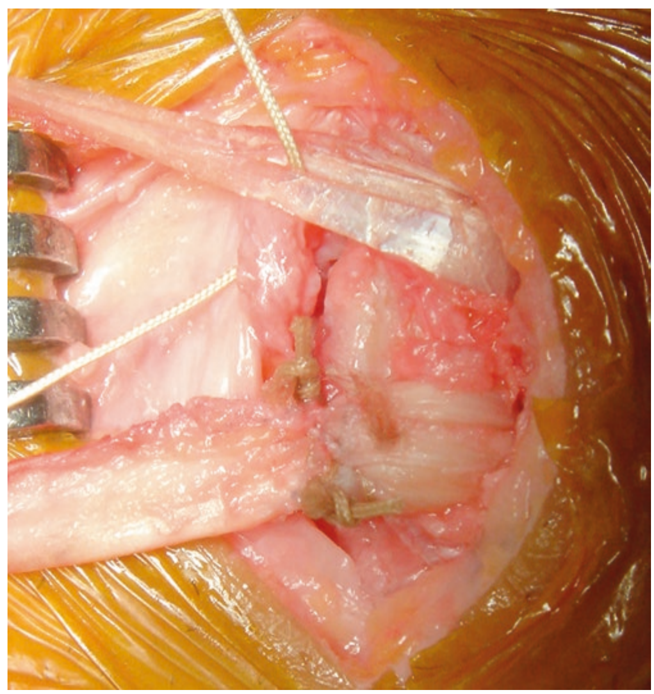


Fig. 33.21 Suture side to side

Medial Patellofemoral Ligament Reconstruction Using Quadriceps Tendon Autograft

This has become our preferred technique since 2013. The main advantage is the absence of risk of patellar fracture. The femoral tunnel, tensioning, and femoral fixation are the same as the previous technique.

The quadriceps tendon graft is taken through an open incision, or in a minimally invasive manner using a proprietary harvester (Karl Storz Minimally Invasive Quadriceps Tendon Harvesting System) (Fig. 33.22a, b). The quadriceps graft is 9 cm long, 6 mm wide, and partial thickness of the tendon (around 3–4 mm thick). The free proximal end is tubularized with No. 2 Ethibond for 3 cm. The distal end is dissected no more than 5 mm subperiosteally onto the patella, to preserve the strong quadriceps insertion. The periosteal sleeve of the medial 1/3 of the proximal patella is raised (Fig. 33.23). The graft is folded 90° on itself to point medially, and passed deep to the periosteum and the native MPFL toward the femoral tunnel site, where it will be tensioned and fixed as per the previous technique (Fig. 33.24). At the

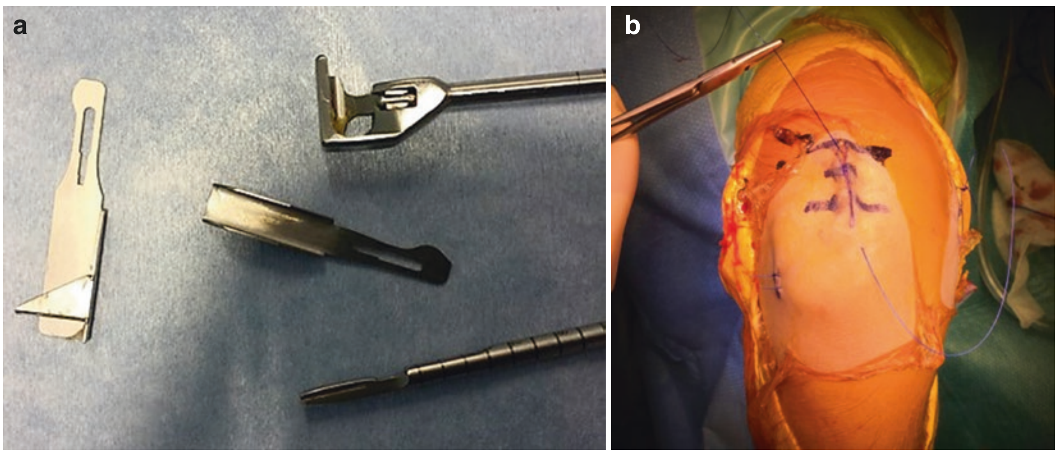


Fig. 33.22 (**a**) Quadriceps tendon harvester (Karl Storz Minimally Invasive Quadriceps Tendon Harvesting System). (1) Double blade to define width. (2) Transverse blade to define thickness. (3) Handle. (4) Cutter. (**b**) Vertical incision for quadriceps harvest

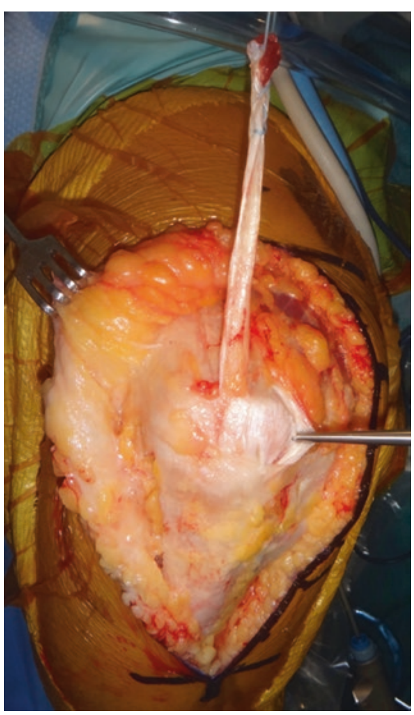


Fig. 33.23 Tubularized quadriceps tendon graft. The periosteal sleeve of the medial 1/3 of the proximal patella has been raised to allow passage of the graft

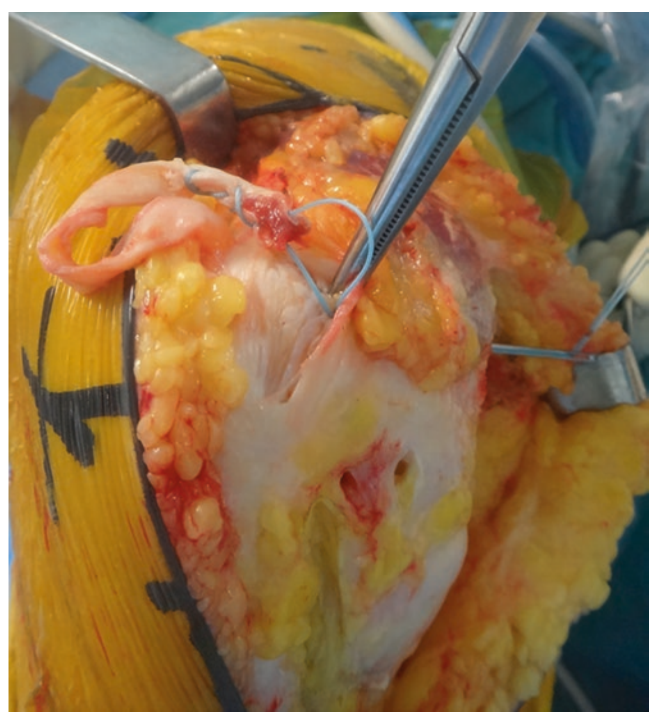


Fig. 33.24 The graft is routed deep to the periosteum and native MPFL to reach the femoral tunnel site

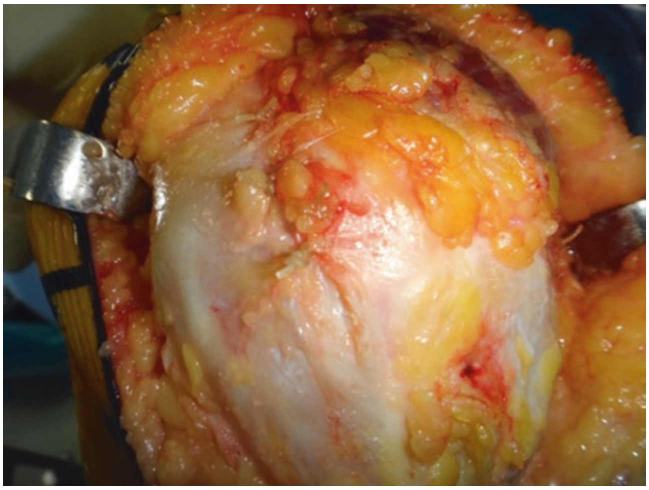


Fig. 33.25 At the patella, the graft is secured to itself and to the patella periosteum with absorbable suture

patella, it is secured to itself and to the patella periosteum with absorbable suture (Fig. 33.25).

Distal Tibial Tubercle Transfer (TTT)

This technique is indicated to correct patella alta. The patient is prepared and a tourniquet is applied high on the proximal thigh. An arthroscopy can be performed in combination in order to verify patellar tracking and look for possible chondral lesions.

The objective of the procedure is to bring the tibial tubercle (TT) to a more distal position in order to obtain a Caton-Deschamps index of 1. For example, in a patient with a Caton-Deschamps index of 1.3, with AT distance of 39 mm and an AP distance of 30 mm, the distalization necessary is 9 mm to reach an index of 1. Two extra millimeters should be added due to possible proximal movement of TT during screw fixation, resulting in a total of 11 mm of distalization.

An 8 cm medial parapatellar skin incision is made, centered on the TT. The subcutaneous tissues are dissected (Fig. 33.26). The TT osteotomy has a length of 6 cm and is marked using the electrocautery. The patellar tendon and the inferior pole of the patella are identified.

Two 4.5 mm holes are drilled in the midline of the TT. A countersink is then used in each hole in order to avoid prominence of the screw heads underneath the skin (Fig. 33.27).

The osteotomy is done with an oscillating saw and completed with an osteotome. The lateral cut is done first, in a horizontal direction, followed by the medial cut, in an almost vertical direction, and finally the transverse distal cut. Distal to this transverse cut, an additional bone block is

Fig. 33.26 Skin incision

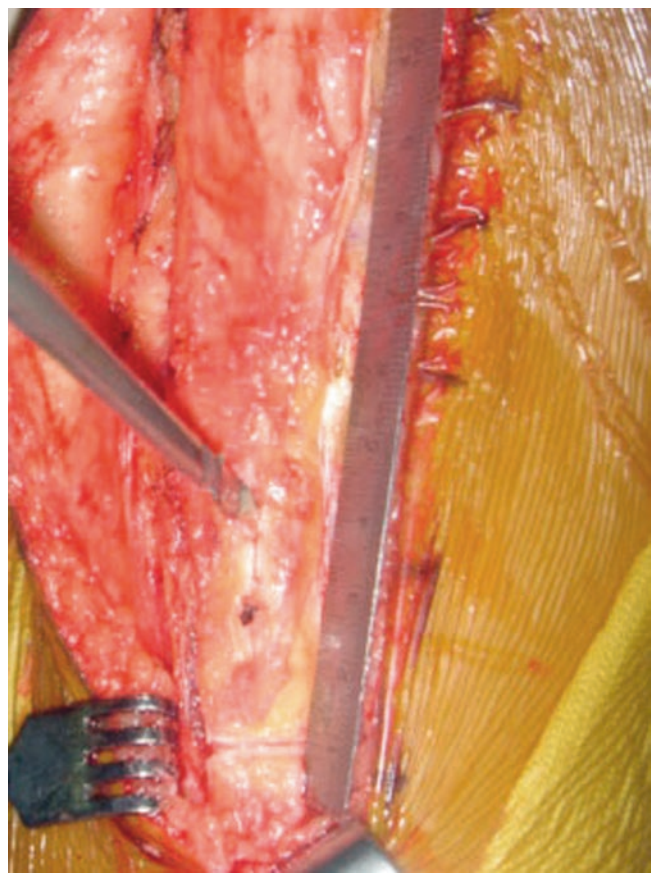


Fig. 33.27 Tibial tubercle osteotomy: 6 cm length. Two 4.5 mm holes are drilled

removed of which the length corresponds to the amount of distalization. This allows the TT to be positioned distally (Figs. 33.28 and 33.29). The free TT is now transferred to its more distal position as planned and kept in position with a Farabeuf retractor. With the knee in 90° of flexion and the calf of the lower limb free, two 3.2 mm holes are made in the posterior tibial cortex through the TT 4.5 mm drill holes, perpendicular to the tibial shaft. The osteotomy is then fixed with two 4.5 mm cortical screws. It's imperative that the screws are fixed in a strict perpendicular position in relation to the tibial shaft. The screw length should be 2 mm longer than the measured length of the drill trajectory to ensure adequate fixation and to avoid postoperative detachment of the TT (Fig. 33.30). The screws should not be tightened excessively, otherwise the TT might be positioned too posteriorly. Care must be taken to keep the TT parallel to its original bed, otherwise a lateral patellar tilt might occur (Fig. 33.31).

The incision is closed over a drain.

Fig. 33.28 Lateral cut in a horizontal direction

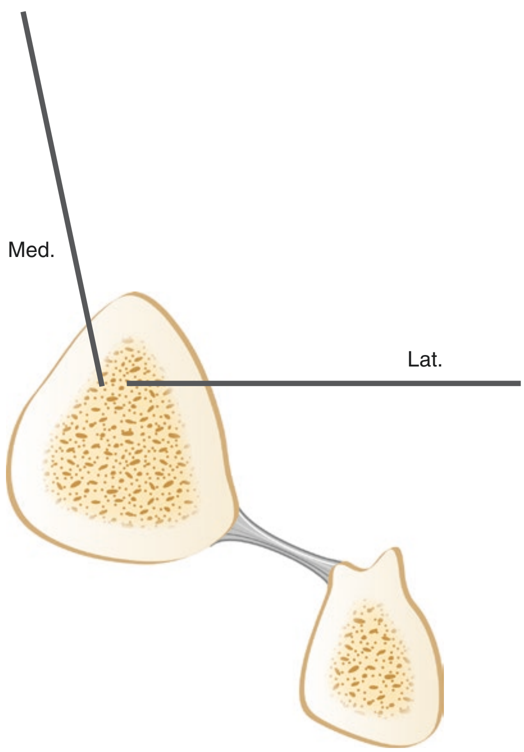


Fig. 33.29 Lateral cut in a horizontal direction and medial cut in a vertical direction

Fig. 33.30 Postoperative X-ray

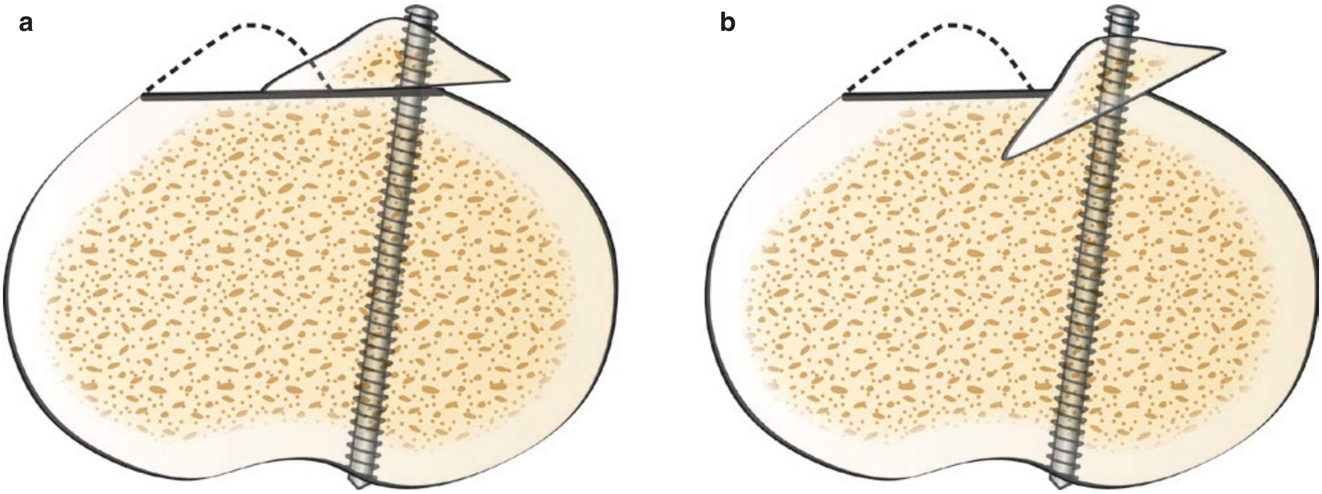


Fig. 33.31 Example of medial and distal tibial tubercle transfer with correct fixation (**a**) and incorrect fixation (**b**) with a lateral patellar tilt

Patellar Tendon Tenodesis

This is an adjuvant procedure to a distal TTT procedure. It is indicated in cases where the patellar tendon length is greater than 52 mm (Fig. 33.32).

After the TT osteotomy but prior to its fixation, two anchors with sutures are fixed on both sides of the patellar tendon, about 3 cm distal to tibial plateau level (the normal insertion level of the tendon) (Fig. 33.33). The TT is subsequently fixed at the desired position with two 4.5 mm cortical screws (Fig. 33.34).

After fixation of the osteotomy, the tendon is vertically incised at 1/3 and 2/3 of its width with a 23 scalpel blade. The sutures are tied across the lateral and medial 1/3 (Fig. 33.35). Thus the length of the patellar tendon is reduced. This can be assessed postoperatively with MRI (Fig. 33.36).

The remaining steps of the surgery are the same as for a distal TTT.

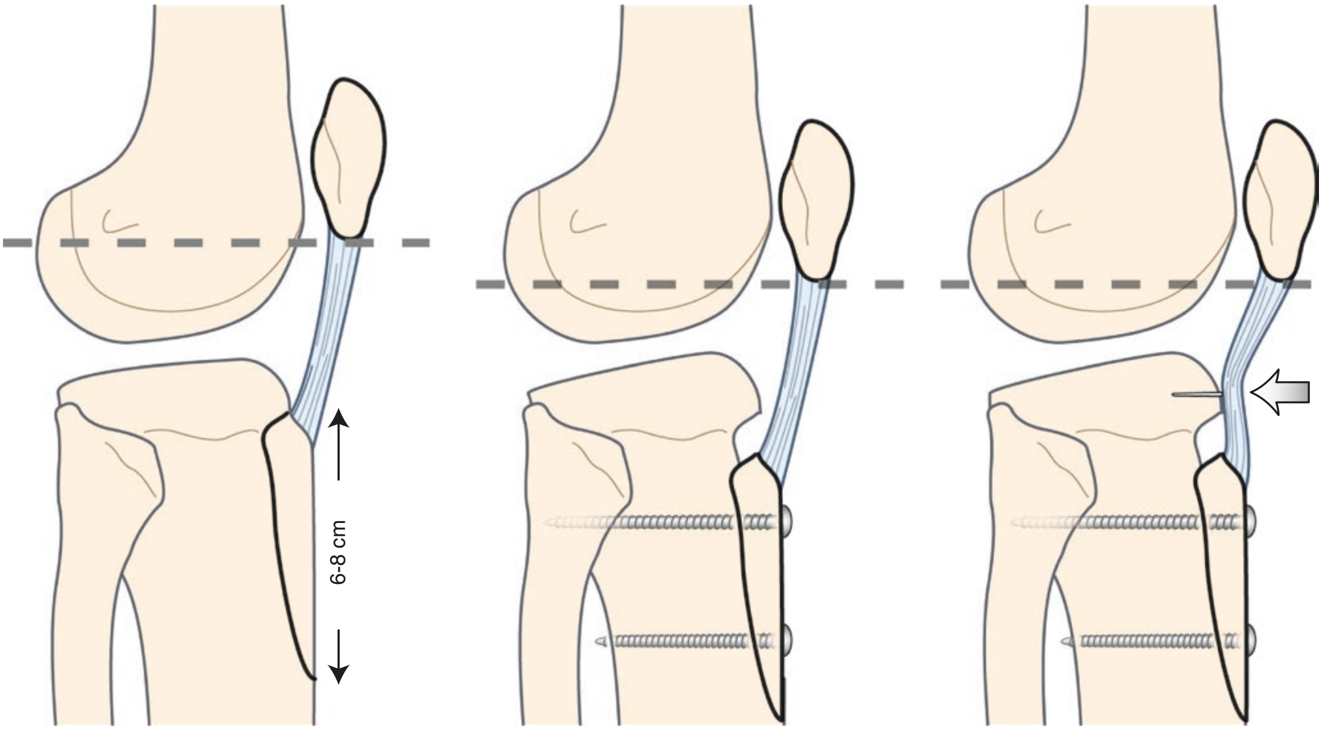


Fig. 33.32 Principles of patellar tendon tenodesis associated with distal tibial tubercle transfer

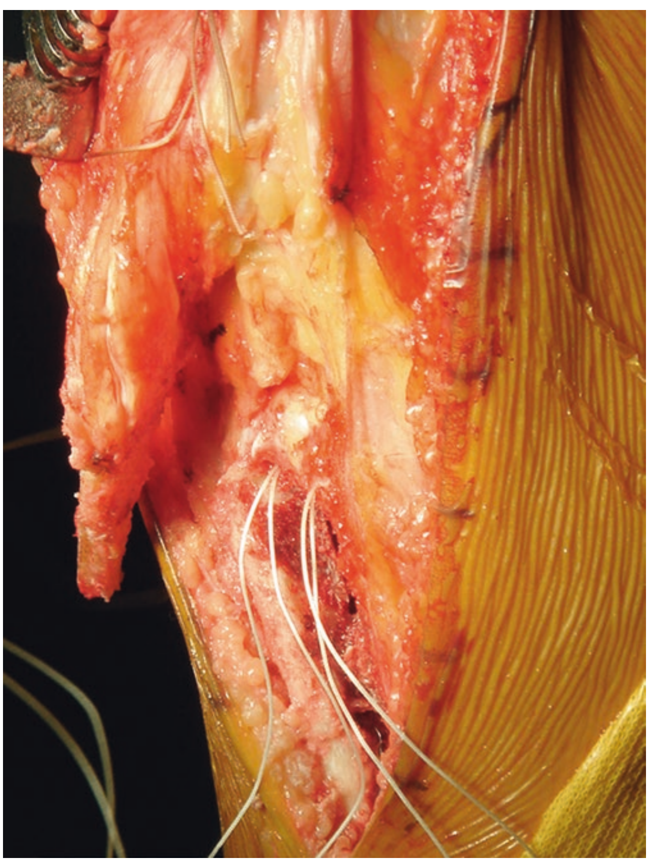


Fig. 33.33 Anchors fixation on the normal insertion level of the tendon

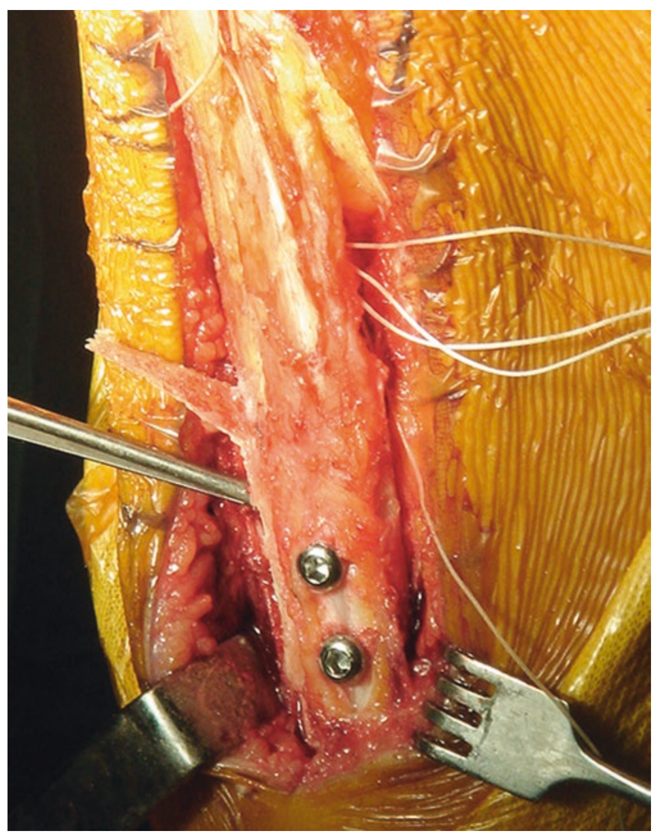


Fig. 33.34 Tibial tubercle fixation

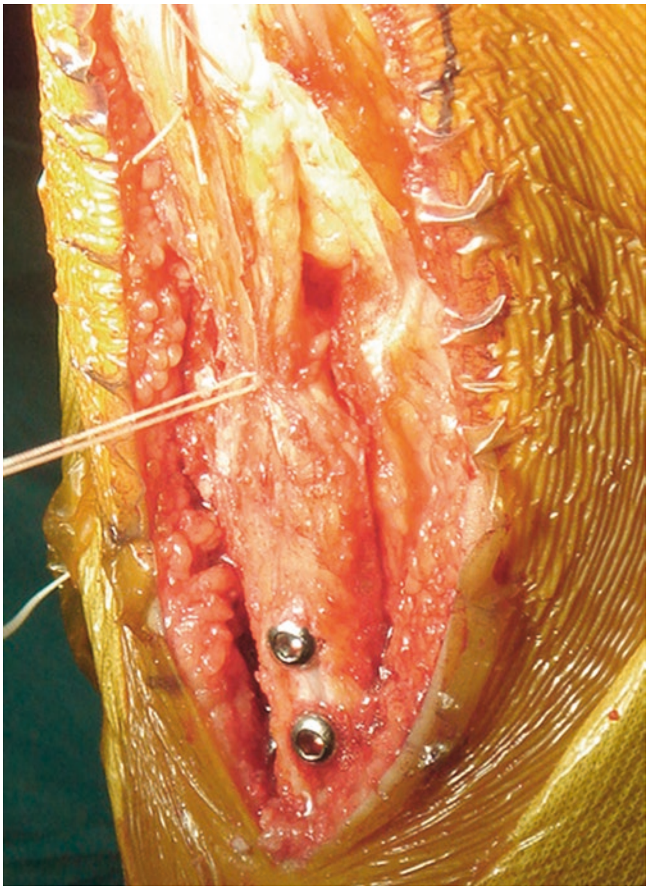


Fig. 33.35 Final aspect after suture

Medial Tibial Tubercle Transfer

This technique is indicated in the correction of an increased TT-TG. A 6 cm medial parapatellar skin incision is made, centered on the TT (Fig. 33.37). The subcutaneous tissues are dissected. Comparable to a distal TTT, the TT bone block has a length of 6 cm. The patellar tendon, the lateral and medial attachments, the inferior pole of the patella, and the TT are identified. The objective is to bring the TT to a more medial position in order to obtain a TT-TG value of 12 mm. For example, in a patient with a TT-TG value of 20 mm, it is necessary to medialize the TT by 8 mm. One 4.5 mm hole is drilled in the center of the TT. The osteotomy is made with an oscillating saw. The cut begins laterally and exits out of the cortex medially. Leaving an intact portion of inferior TT attached to the anterior tibial cortex. Subsequently, the TT is brought to a more medial position as planned preoperatively (Fig. 33.38). Different to the distal TTT, only one screw is necessary for the TT fixation (Fig. 33.39). A 3.2 mm drill hole is made in the posterior cortex through the TT 4.5 mm hole, in a slightly more proximal position. The osteotomy is then fixed with a 4.5 mm cortical screw, 2 mm longer than the measured drill trajectory. The incision is closed over a drain.

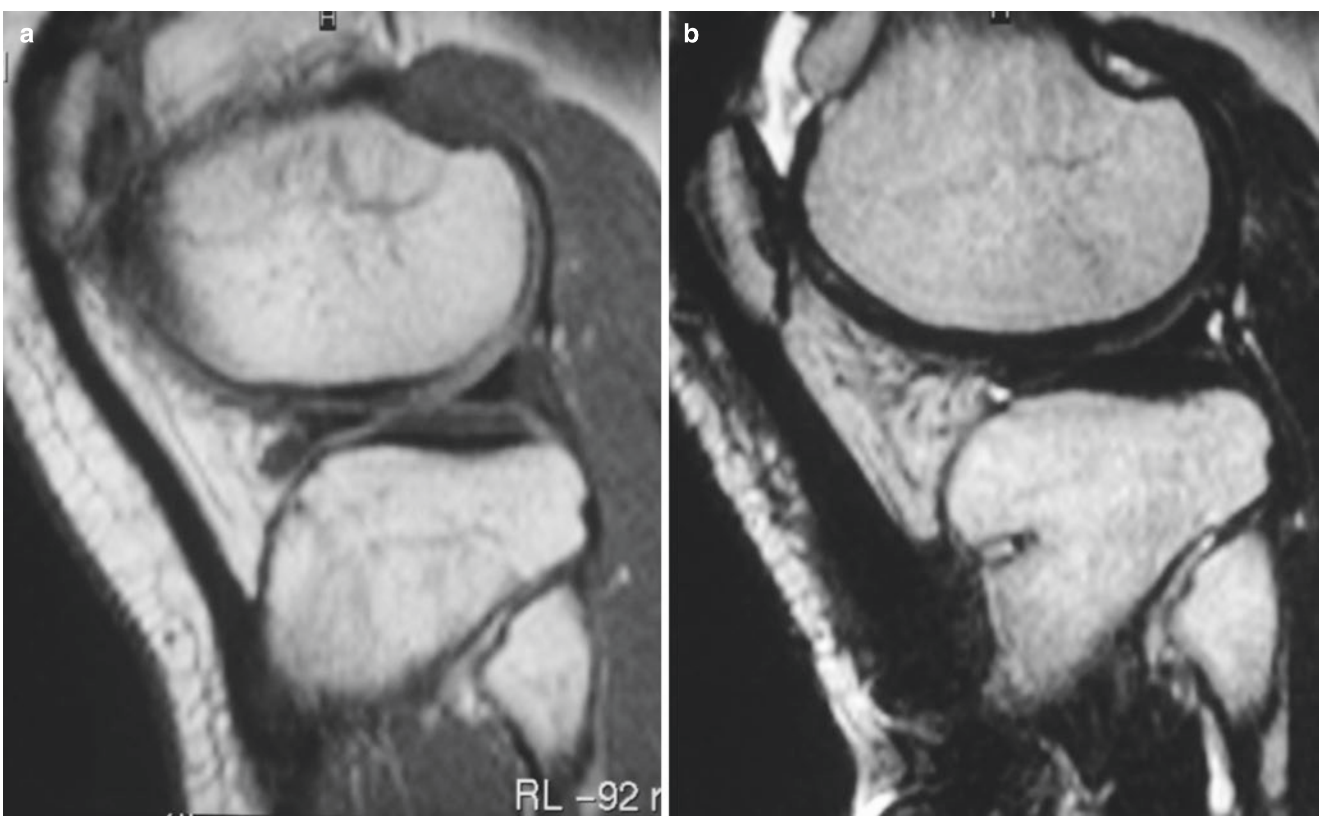


Fig. 33.36 (**a**, **b**) Pre- and postoperative MRI showing length modification of the patellar tendon

Fig. 33.37 Skin incision

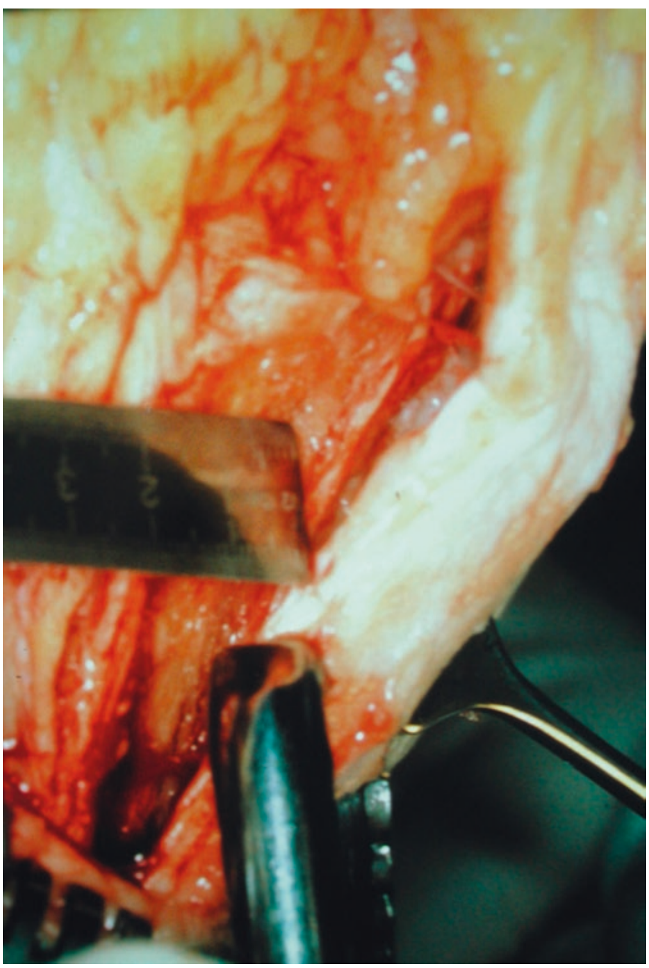


Fig. 33.38 Medial transfer, distance measured using a ruler

Fig. 33.39 Postoperative X-ray

Postoperative Care

Prophylactic antibiotics are administered for 24 hours. LMWH thromboprophylaxis is continued for 10 days. Ice is generally applied for 5 days. A 30° splint is used at night and between periods of walking and physiotherapy. Protected full weight bearing is allowed immediately using crutches.

In the case of a TTT osteotomy, a locked splint in extension must be used for walking until radiographic evidence of consolidation is found. Daily physiotherapy consists of active isometric quadriceps contractions with good patellar ascension and medial-lateral patella mobilization. Passive flexion is initiated early, but must be limited at 95°.

In case of MPFL reconstruction, protected (crutches) full weight bearing is allowed on the first post-surgical day. Knee flexion is unlimited.
After 45 days or when bone consolidation is obtained, the patient returns to normal walking, avoiding stairs. Full flexion must be recovered. After 60 days, normal activities of daily life and driving are started. Open kinetic chain exercises are initiated. Patient can commence sports activities after 4 months. Forced kneeling and jumping are not allowed for 6 months. In the case of a combination of procedures, rehabilitation is limited by the most demanding procedure.

Complications

The most frequent complication, inherent to all kinds of EPD surgery, is hematoma. It can cause intense pain and can lead to wound dehiscence and infection. This problem can be avoided with careful coagulation and the use of a vacuum drain. As in any surgical procedure, infections can occur in EPD procedures. Complex regional pain syndromes may arise after surgery and may result in a patella infera (Fig. 33.40). A prominent screw head usually causes discomfort or pain. Countersinking of the screw head is sufficient to prevent this problem.

Failure to obtain sufficient TT osteotomy fixation can result in migration, delayed union, or non-union. If this is the case, a revision operation must be performed. It is of major importance to always use a screw 2 mm longer than the measured drill trajectory in order to provide adequate fixation (Fig. 33.41). Fractures of the tibial shaft can occur when the ATT osteotomy cuts are too aggressive, especially the distal cut, even several weeks after surgery (Fig. 33.42).

Undercorrection can result in persistent instability and dislocation. Insufficient distalization or medialization, and suboptimal tensioning of the MPFL reconstruction or of the VMO plasty can result in this situation.

Overcorrection can be even worse. Patients usually present with pain and with signs of medial patellar impingement. Patella baja is further complication of overcorrection, leading to increased patellar pressures and pain. These complications frequently cause more disability than the instability itself (Fig. 33.43a, b). Procedures that include an ATT osteotomy can lead to non-union. This risk can be minimized with a TT fragment of at least 6 cm.

The MPFL reconstruction can cause an avulsion fracture of the medial border of the patella.

Fig. 33.40 Patella infera

Fig. 33.41 Tibial tubercle non-union

Fig. 33.42 Tibial shaft fracture

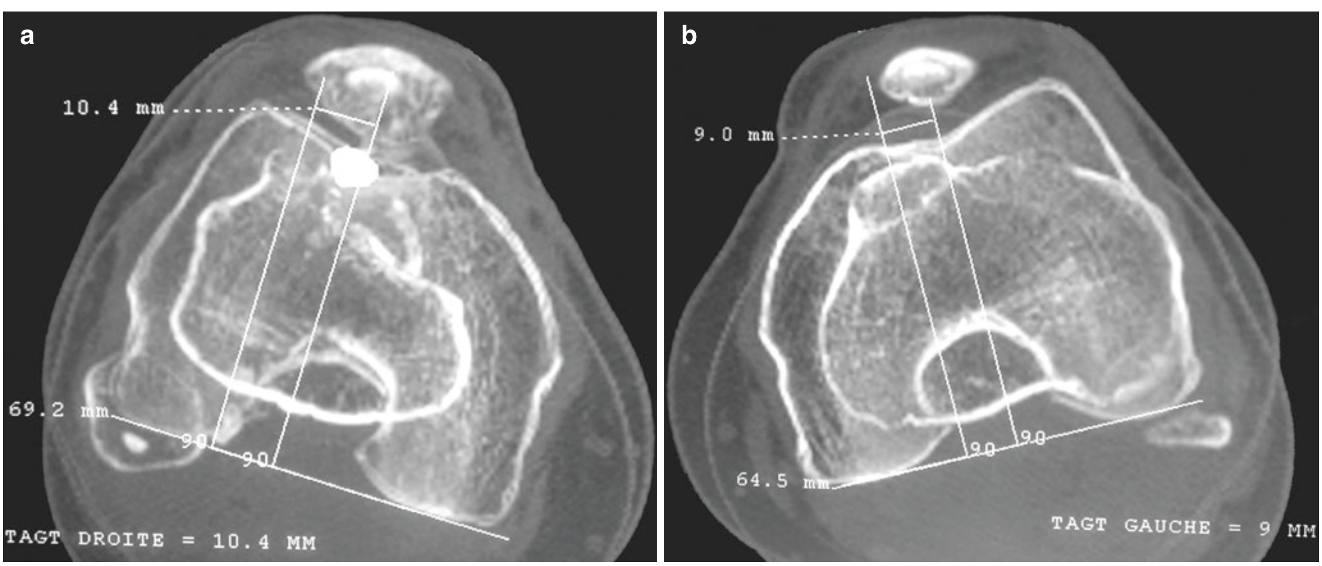


Fig. 33.43 (**a**) Postoperative TT-TG distance = 10.4 mm; (**b**) on contralateral side, overcorrection with a TT-TG distance = −9 mm