34 Chronic Rupture of the Extensor Apparatus

G. Demey and Robert A. Magnussen

Chronic Rupture of the Quadriceps Tendon

Often, the clinical picture is very suggestive of a chronic deficiency of the extensor mechanism. Typical symptoms relate to the extensor lag, episodes of giving way, and disability with stairs and rising from a seated position. Clinical examination should focus on the degree of extensor lag, the restriction to passive extension (flexion contracture), and patellar height. In particular, patellar mobility should be assessed. If the patella cannot be mobilized proximally, it indicates that the patellar tendon is retracted.

MRI confirms the diagnosis. It also assesses the feasibility of surgery by measuring the size of the gap and by showing the degenerative change in the quadriceps muscle (Fig. 34.1). Due to fibrosis and retraction, it is a more complex surgery than that for acute repairs and requires reinforcement. If patella infera is present on comparative weight-bearing lateral radiographs at 30° of flexion, the patellar tendon is retracted. This finding indicates that it will be necessary to reinforce the repair. This technique was proposed by Pierre Chambat.

This chapter also describes the use of an extensor mechanism allograft, although this technique is more suitable for chronic ruptures of the patellar tendon.

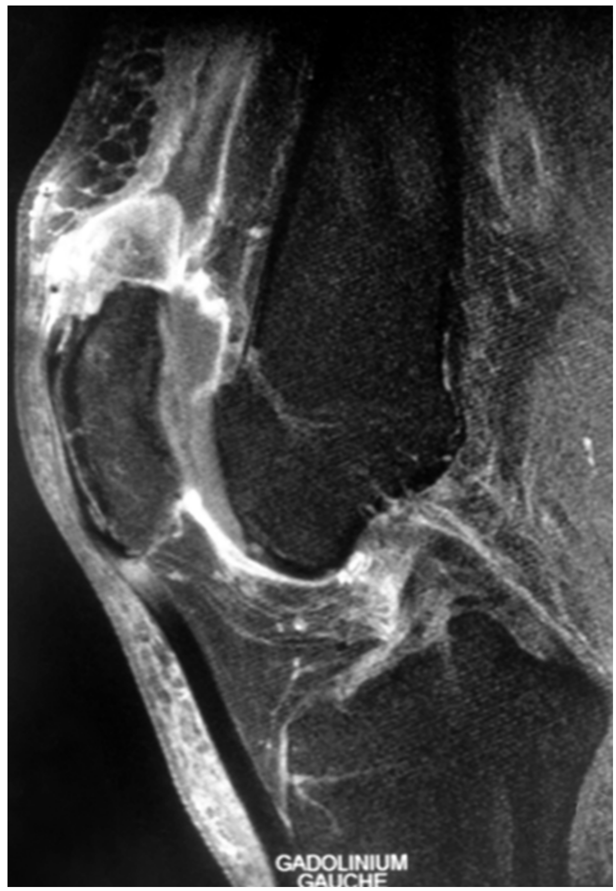

Fig. 34.1 MRI findings in a chronic tear of the quadriceps tendon

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P. Neyret, G. Demey (eds.), *Surgery of the Knee*,
DOI 10.1007/978-1-4471-5631-4_34,

Suture Technique Protected by Metal Framing

Chronic quadriceps tendon ruptures occur through the tendon or secondary to an avulsion of the tendon from its patellar insertion.

Patient Positioning and Setup

The patient is positioned on the operating table in the supine position. A horizontal post is positioned distally on the table to hold the knee in a 60° flexed position. A lateral support holds the knee in this position. A tourniquet is placed at the base of the thigh but not inflated, as it can hamper the repair by preventing full mobilization of the quadriceps. In a chronic rupture with tendon retraction, it is sometimes unrealistic to seek to achieve 90° of flexion during the procedure.

Incision

A midline longitudinal incision is made beginning at the lower pole of the patella and extending 10 cm above the superior pole (Fig. 34.2).

The dissection is carried down in the midline elevating subcutaneous flaps. The upper pole of the patella and ends of the tear are exposed. The ends of the tear are carefully identified and mobilized by excising scar tissue and dissecting medially and/or laterally as required (Fig. 34.3). It is critically important to preserve as much healthy tissue as possible. It is usually not necessary to perform arthroscopic arthrolysis or to incise the retinaculum.

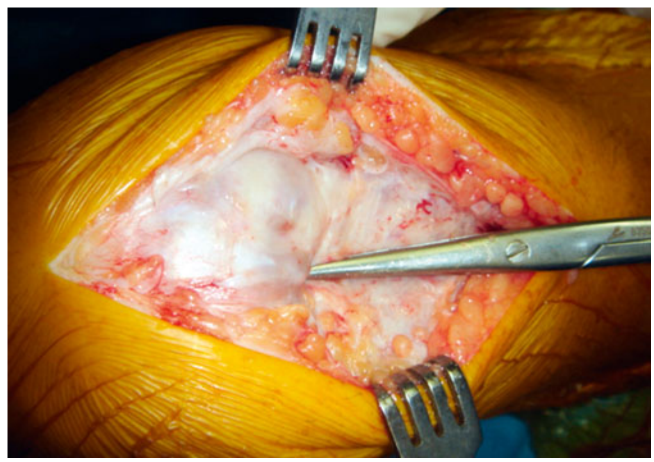

Fig. 34.2 Surgical exposure of the chronic tear

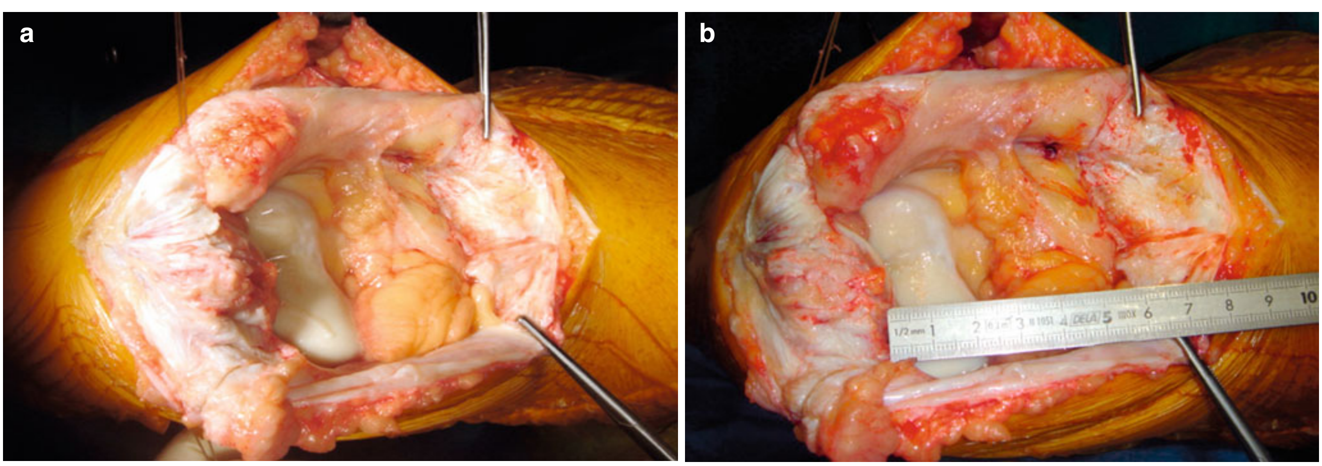

Fig. 34.3 Mobilization and debridement of the ends of the tear (**a**) and measurement of the gap (**b**)

Mobilizing the Proximal Quadriceps Stump

A 2 mm K-wire is inserted transversely into the stump of the quadriceps tendon. Contrary to popular belief, there is no "cheese-slicing effect," and the K-wire will not pull out of the tendon distally. A second trans-patellar 2 mm K-wire is placed transversally 1 cm below the proximal pole of the patella. A loop of metal wire is then placed on either side of the K-wires (this arrangement is preferred to a mounting frame or a figure of 8 with a single wire) (Fig. 34.4). By progressively tightening the wires with the knee in extension, the proximal quadriceps tendon stump is pulled to the stump at the proximal pole of the patella (Fig. 34.5).

To complete the repair, a whipstitch is placed in the two tendon stumps with FiberWire suture and the ends are tied over the tear. The repair is then reinforced with 0 Vicryl suture around the repair site as described in the previous chapter.

The strength of the repair is tested at 60° and 90° of knee flexion. Closure is achieved in layers, and a suction drain is placed subcutaneously. The skin is closed with staples (Fig. 34.6).

In cases of osteotendinous avulsion, a similar technique to that used in acute ruptures of the quadriceps tendon is used to complete the repair after placement of the wire augment as described above. The sutures are passed through the quadriceps tendon stump proximally and then through longitudinally bone tunnels in the patella and tied (see chapter 33).

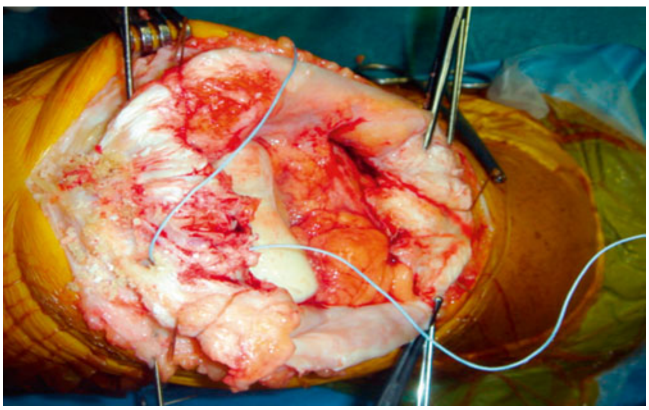

Fig. 34.4 Placement of the 2 mm K-wires and wire loops

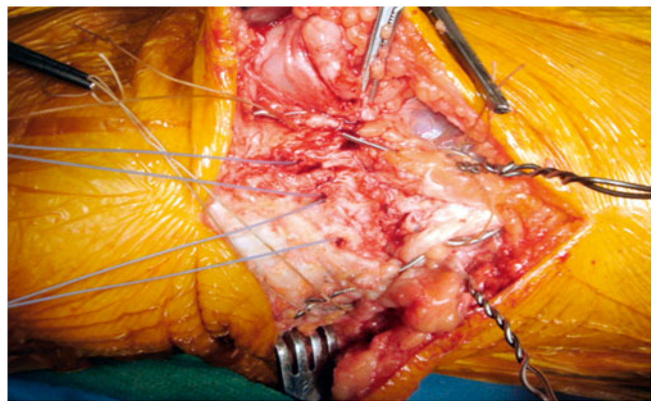

Fig. 34.5 Tightening of the wires and closure of the tear

Fig. 34.6 Postoperative x-ray

Reinforcement of the Tear Using a Patellar Tendon and Semitendinosus Graft

Reinforcement of a chronic quadriceps tendon rupture is indicated when the direct repair is at high risk of failure due to poor tissue quality. The reinforcement may be achieved with both a patellar tendon and semitendinosus graft. Dependent on the quality of the repair, a single or double reinforcement can be done.

Incision

A longitudinal paramedian incision is made extending from 10 cms above the superior pole of the patella ending on the medial side of the tibial tuberosity.

Full-thickness flaps are elevated to expose the chronic rupture. Scar tissue is excised in an economical manner to expose the upper pole of the patella and the ends of the tear (Fig. 34.7).

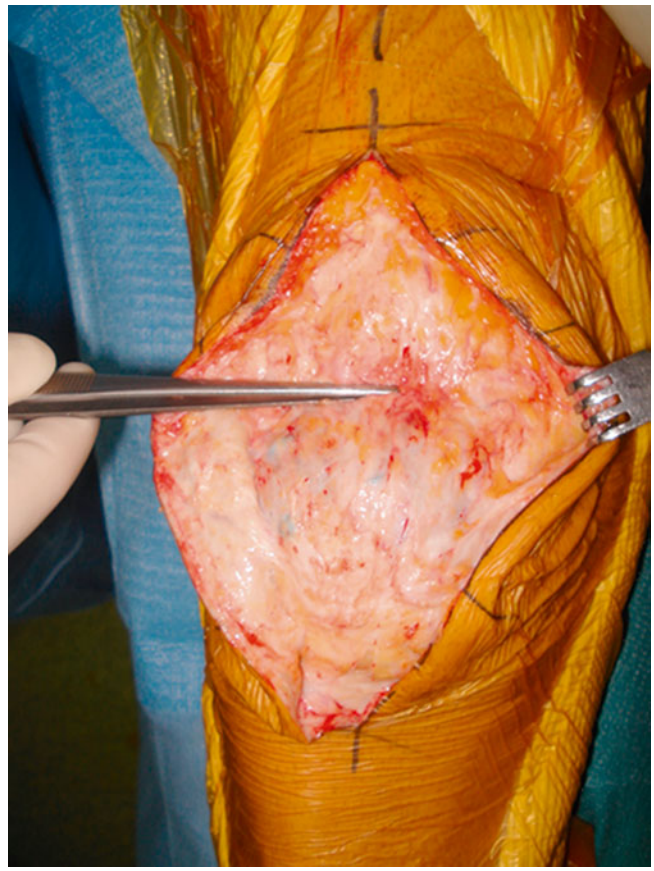

Fig. 34.7 Surgical exposure of the chronic tear

Harvesting the Semitendinosus Graft

The tendon is harvested by extending the incision 2 cm distally. The pes anserinus is exposed and the tendon is stripped and prepared (Figs. 34.8, 34.9, and 34.10). This produces a graft about 25–30 cm long (Fig. 34.11).

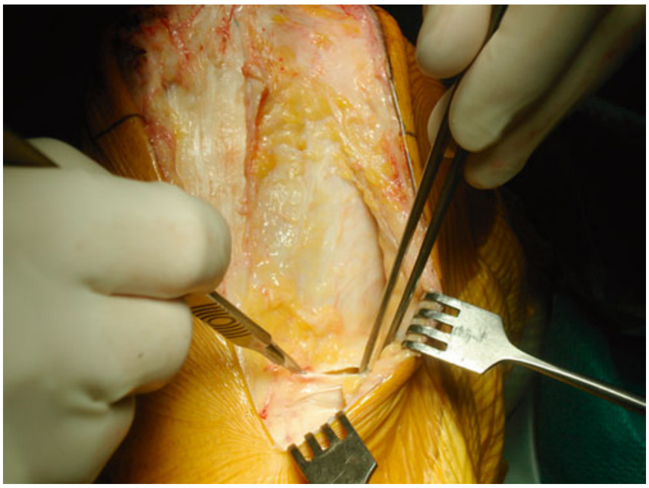

Fig. 34.8 Harvesting of the semitendinosus graft (1)

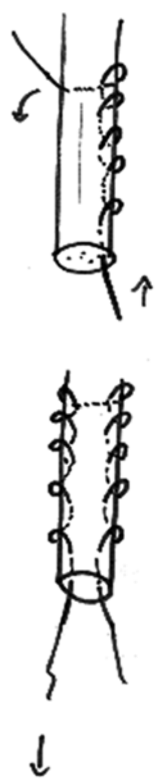

Fig. 34.9 Preparation of the tendon extremity

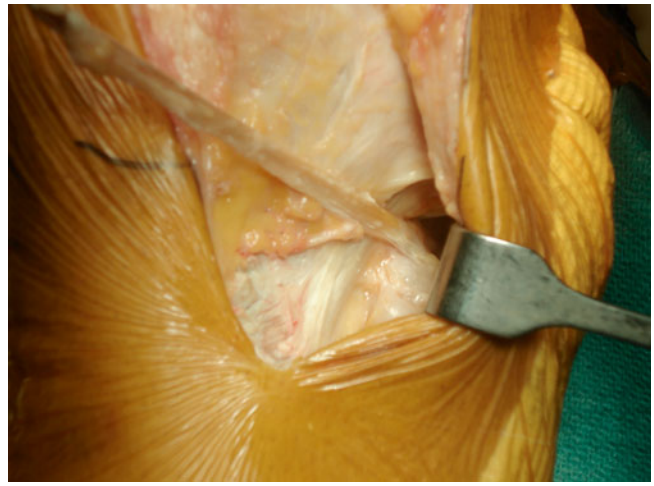

Fig. 34.10 Harvesting of the semitendinosus graft (2)

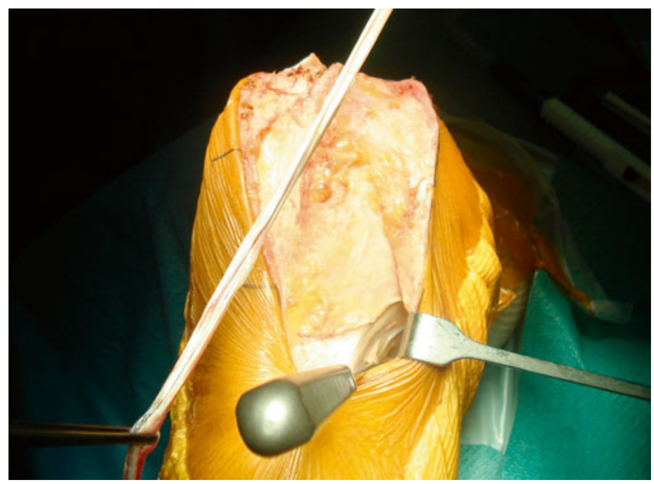

Fig. 34.11 Harvesting of the semitendinosus graft (3)

Harvesting the Patellar Tendon Graft

A 1 cm strip in the middle third of the patellar tendon is incised. Its distal insertion is mobilized with a strip of periosteum from the TT using a scalpel. This strip of tendon is then peeled from the front of the patella being careful to leave it attached to at least half the height of the patella. A compromise between getting sufficient graft length and keeping enough of its attachment to the patella must be made (Fig. 34.12a–c).

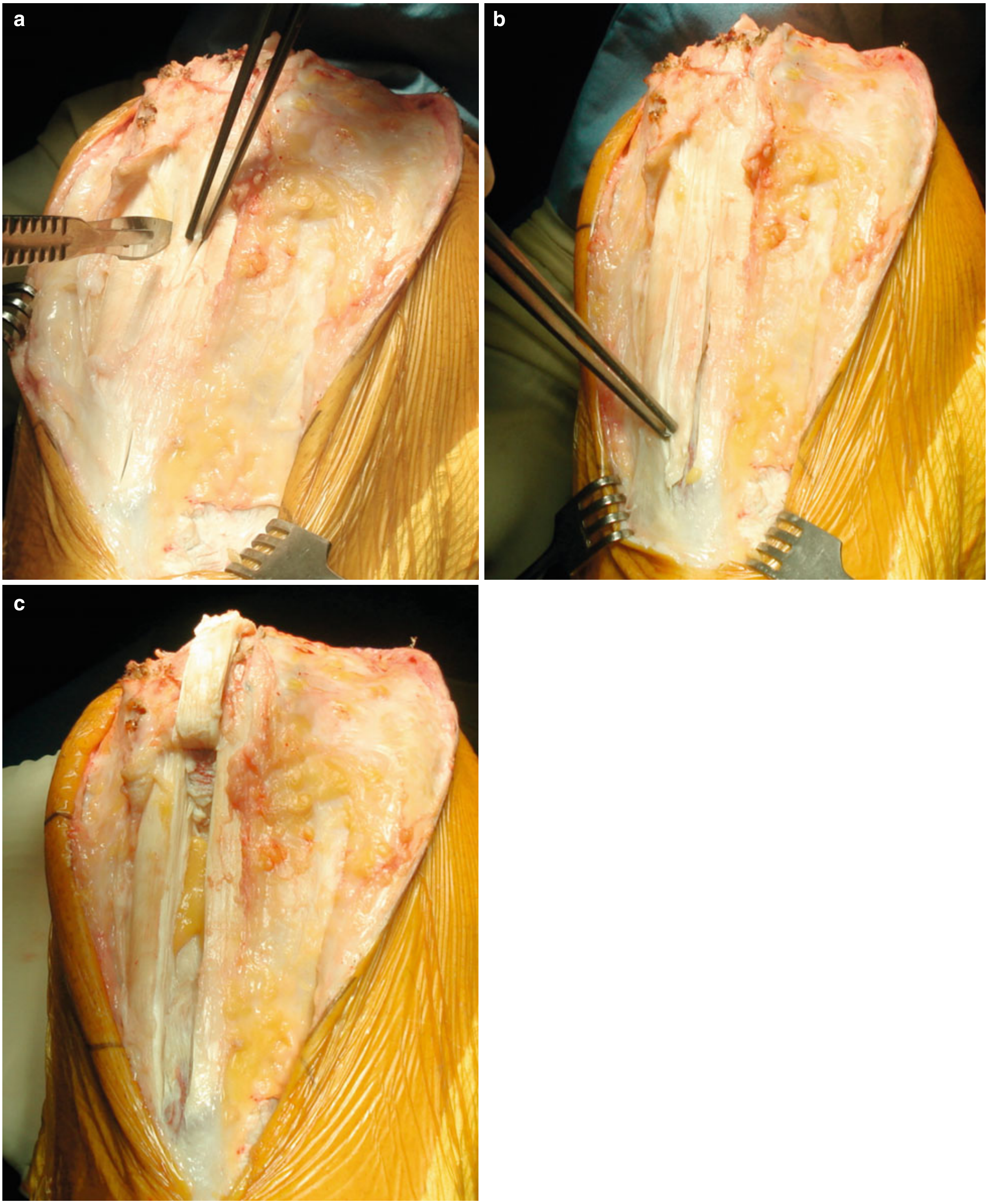

Fig. 34.12 Harvest of the patellar tendon begins by isolating the central third (**a**), detaching the tibia insertion of the central third of the tendon (**b**), and finally flipping the tendon proximally and performing subperiosteal elecation off the the pattla (**c**), while making sure that sufficient patellar attachment is maintained

Three 2.7 mm transosseous tunnels are drilled in the proximal pole of the patella. These are started on the upper surface of the patella 1 cm from its proximal edge and exit through the midpoint of the proximal pole, taking care not to damage the articular surface (Fig. 34.13).

A 4.5 mm horizontal tunnel is made through the upper one-third of the patella. Care must be taken to do this in the right direction to prevent any weakening of the patella and a possible fracture (Fig. 34.14). FiberWire® sutures are then placed through the tendon and then through the transosseous tunnels back into the tendon. These sutures are tied in extension.

The semitendinosus tendon graft is then passed through the patella using a guide pin.

Dissection is then carried out to create a tunnel in the quadriceps tendon in order to create a tunnel for the semitendinosus graft (Fig. 34.15). The graft is then pulled tight at 60° of flexion and sutured to itself with absorbable Vicryl at multiple points. The sutures are tied in extension (Fig. 34.16a, b).

Finally, the strip of patellar tendon is turned over and sutured over the front of the repair using number 2 Vicryl. The strength of the repair is tested by placing the knee in 60° of flexion. Closure is achieved in layers and a suction drain is placed subcutaneously. The skin is closed with staples. The postoperative instructions are identical to those described in acute ruptures of the quadriceps tendon.

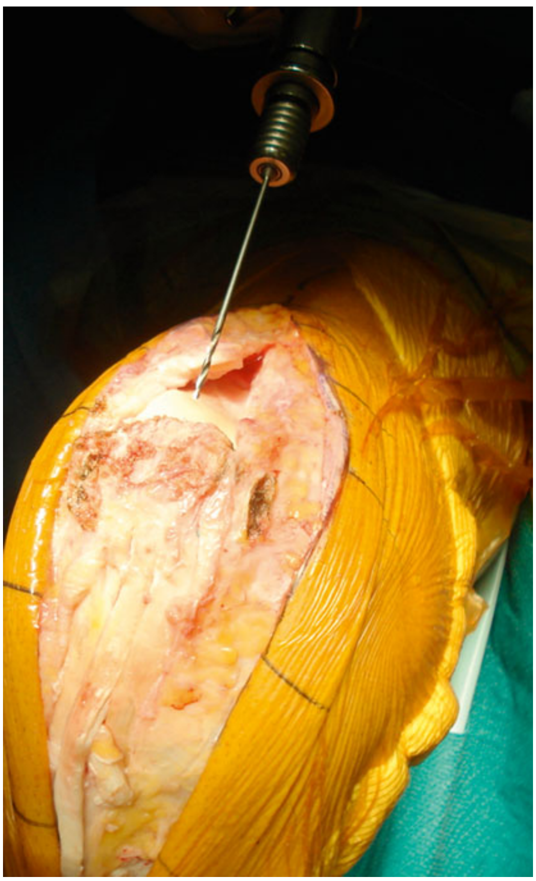

Fig. 34.13 Transosseous tunnels in the proximal pole of the patella

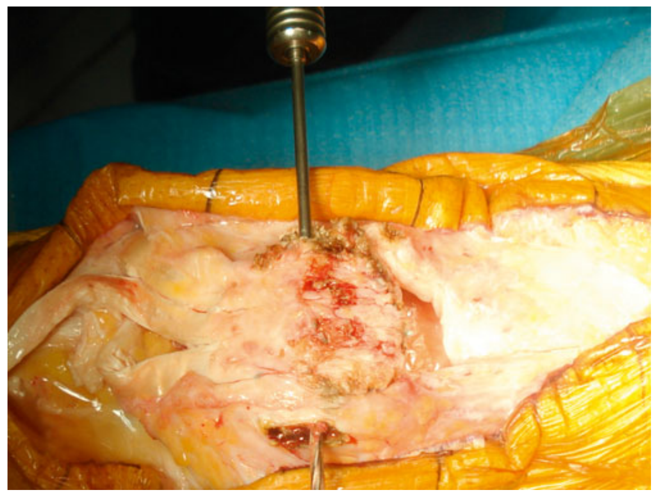

Fig. 34.14 Horizontal transosseous patellar tunnel

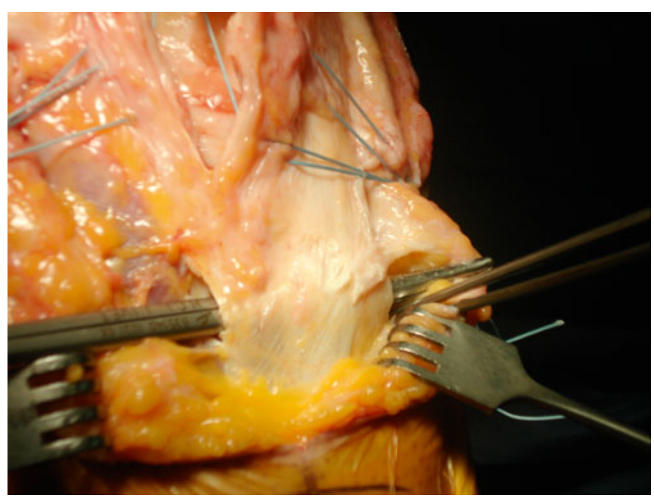

Fig. 34.15 Creating a tunnel for the semitendinosus graft within the quadriceps tendon

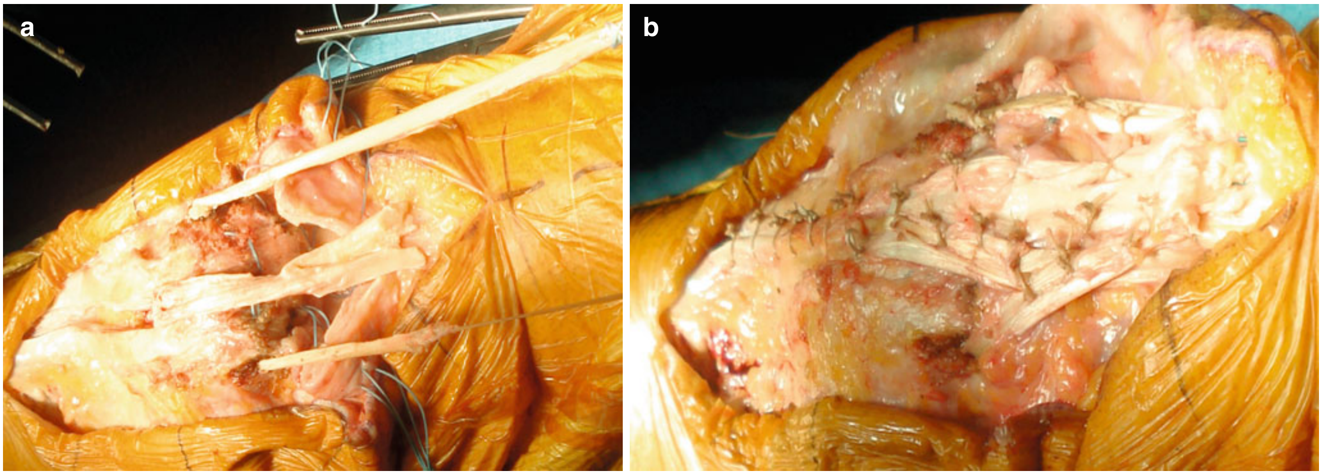

Fig. 34.16 Patellar tendon and semitendinosus grafts are placed (**a**) and tied in position (**b**)

Reconstruction of a Chronic Rupture of the Patellar Tendon

Reconstruction of chronic ruptures of the patellar tendon is difficult due to contraction of the quadriceps and hence the difficulty of restoring the correct height of the patella.

If the correct patellar height is achieved relatively easily, reinforcement of the repair can be achieved by using a strip of PDS tape or a quadriceps tendon graft (see section "Acute Ruptures of the Patellar Tendon"). In contrast, if it is difficult to lower the patella (Fig. 34.17), it is necessary to use an autologous extensor mechanism graft.

Fig. 34.17 MRI showing a chronic tear of the patellar tendon

Autologous Transplantation of the Extensor Mechanism

This technique was presented with Henri Dejour in Toronto in 1991. In revision surgery or when the quality of the patellar tendon is insufficient to achieve a satisfactory repair, we use an autograft taken at the expense of the middle third of the contralateral extensor mechanism. This is a composite graft: quadriceps tendon, patellar bone block, patellar tendon, and tibial bone block. The contralateral patellar tendon must be healthy and had no previous surgery (tibial nailing, TT transfer, harvest for ACL reconstruction, etc.). If necessary, an extensor mechanism allograft can be used, using the same surgical technique.

Harvesting the Autograft (Contralateral Knee)

Both lower limbs are placed in the operative field. A tourniquet is placed at the base of each thigh (Fig. 34.18).

Fig. 34.18 Patient setup

Incision

The incision begins 3 cm below the tibial insertion of the patellar tendon and extends 5–7 cm above the proximal pole of the patella. The paratenon is incised vertically (Fig. 34.19).

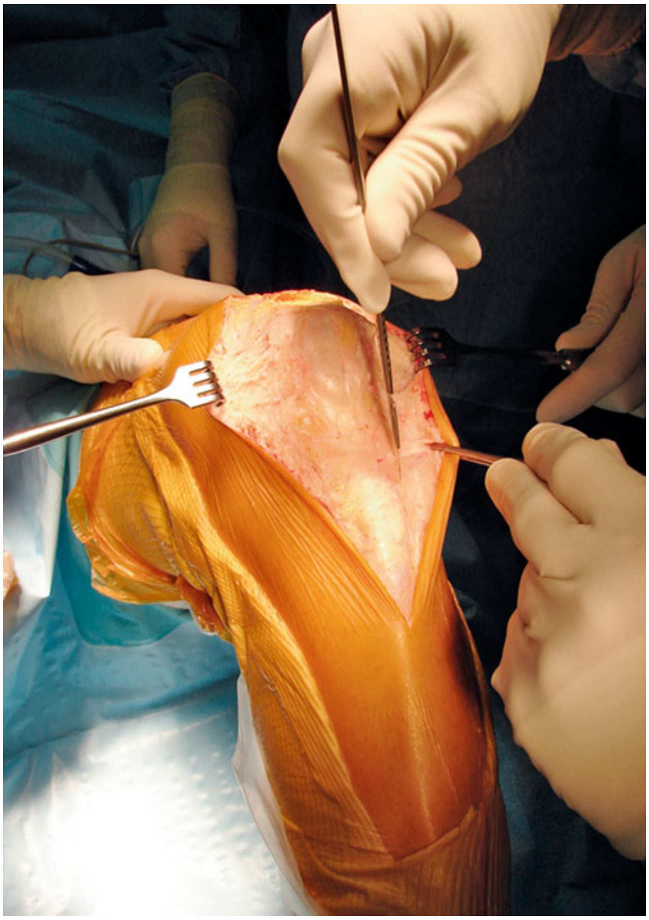

Fig. 34.19 Exposure of the extensor mechanism autograft

Delineation of the Transplant

The quadriceps tendon is exposed along its entire length, extending the exposure to reveal the most distal muscle fibers of the rectus femoris. The tendon is then incised for 5–6 cm in the line with its fibers. Only the two most superficial layers are incised to avoid entering the knee joint. The width of the graft should be 12–14 mm (Fig. 34.20a, b).

The incision extends onto the periosteum of the patella as a "dovetail," that is to say, a trapezoidal base of 14 mm proximally with a width of 10 mm distally. The harvest then continues on to the patellar tendon. The middle third is harvested at a width of 10 mm (Fig. 34.21). The tibial periosteum is then incised to mark out a 35 mm-long bone block that is 10 mm wide at its proximal portion and 12 mm at its base (Fig. 34.22). It should be noted that the bone blocks must have trapezoidal shapes in order to prevent migration of the graft.

A variant of these bone blocks can be harvested, i.e., a bone block with a narrower waist that is wider proximally and distally. This method allows the harvest of a wider patellar tendon graft while still avoiding migration of the graft and is especially useful if allograft is used.

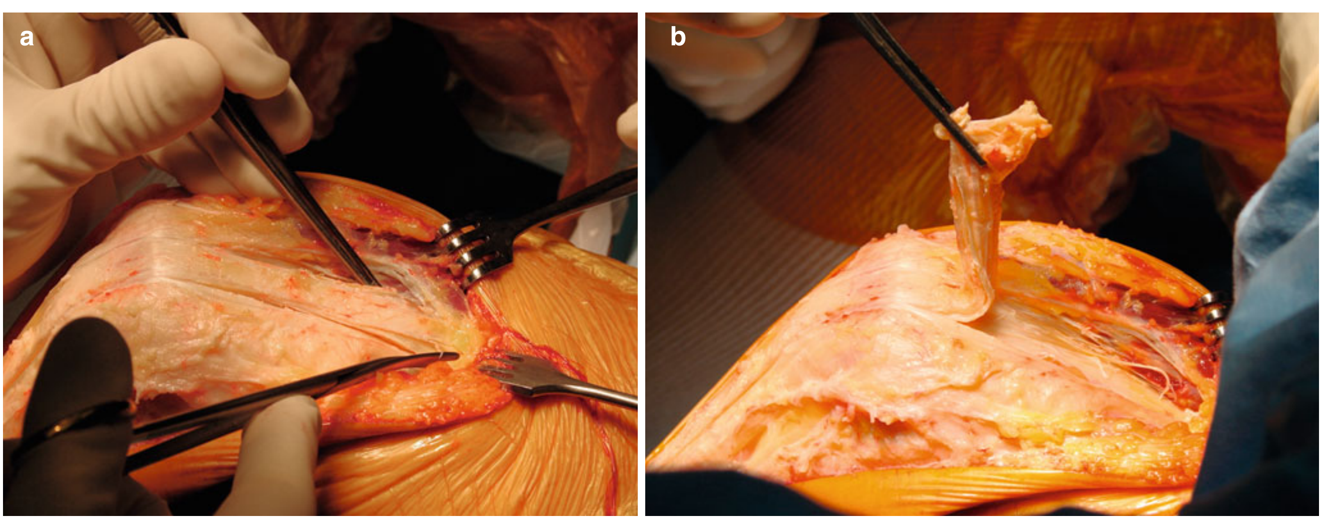

Fig. 34.20 The central third of the quadriceps tendon is identified (**a**) and detached proximally (**b**)

Fig. 34.21 Harvest of the patellar tendon

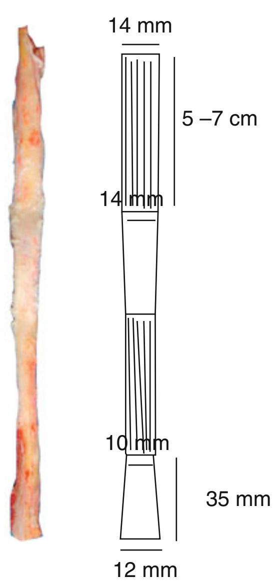

Fig. 34.22 Dimensions of the extensor mechanism autograft

Harvesting the Bone Blocks

The tibial and patellar bone blocks are harvested with an oscillating saw (Fig. 34.23a, b). At the distal end of the tibial block, the saw has to be tilted to avoid any risk of fracture. The bone block is then separated using an open gouge. The patellar tendon is then retracted upward, and it is released from the fat on its posterior surface. It must be elevated off the tip of the patella in order to assess the thickness of the bone block. A 10 mm Lambotte osteotome is then introduced parallel to the anterior cortex. This helps remove the entire bone block (Fig. 34.24). The osteotome should not be used as a lever due to risk of breaking the bone block or fracturing the patella (Figs. 34.25 and 34.26).

Fig. 34.23 Bone blocks cut with the saw from the patella (**a**) and tibia (**b**)

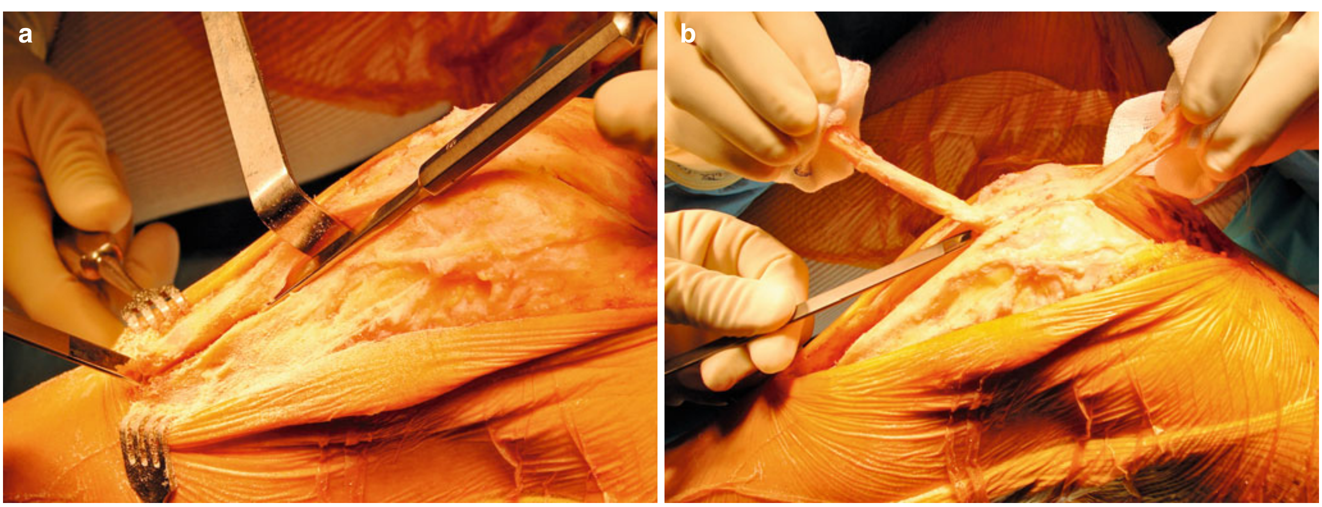

Fig. 34.24 The tibial (**a**) and patellar (**b**) bone blocks are then carefully elevated form the bony beds

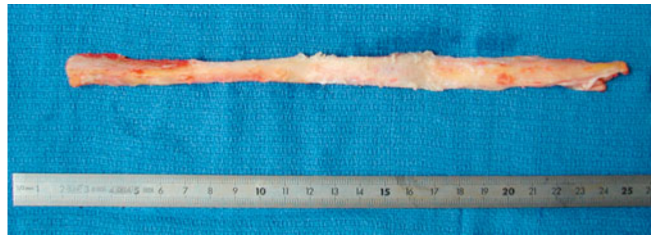

Fig. 34.25 The extensor mechanism autograft

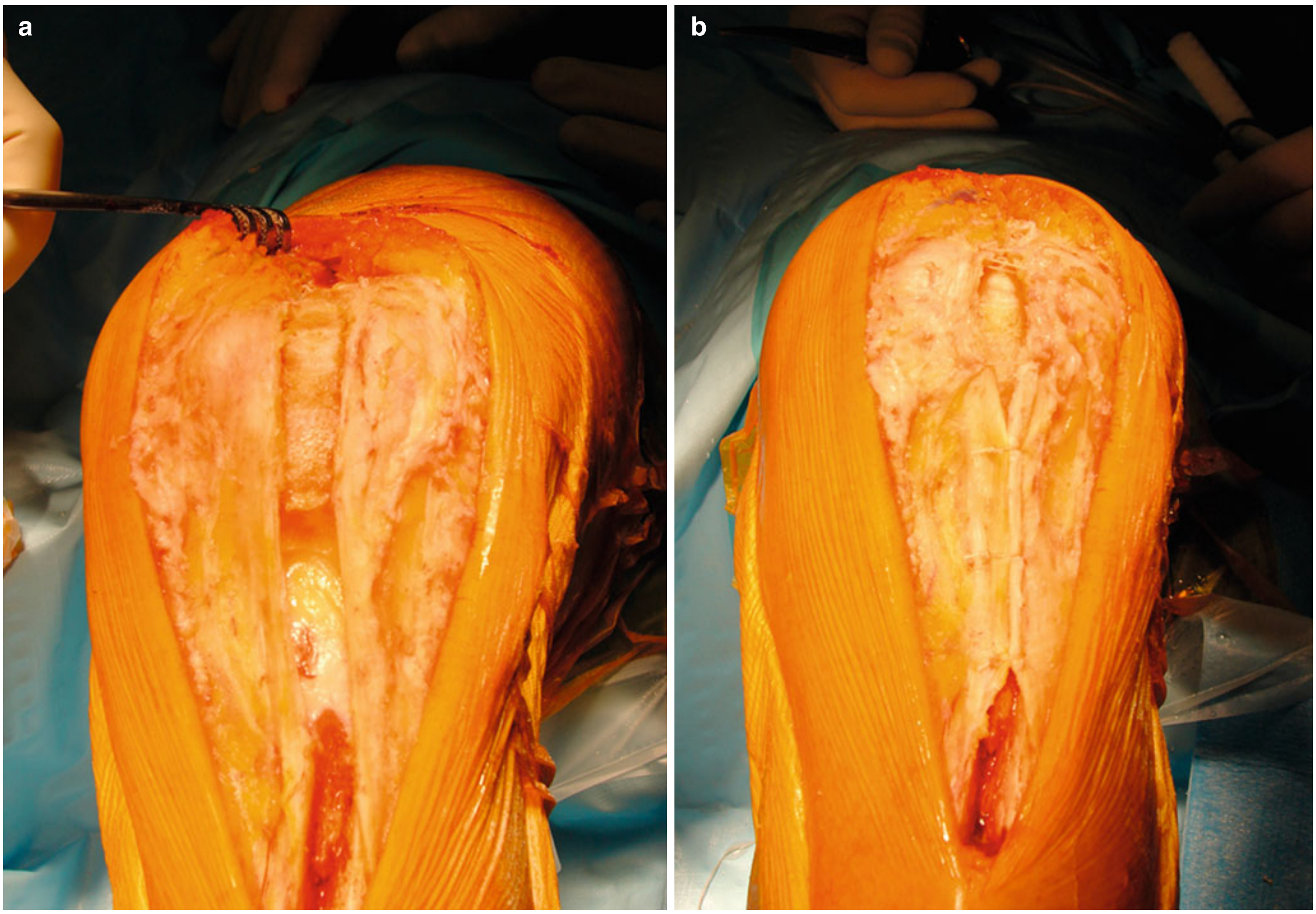

Fig. 34.26 Following autograft harvest (**a**), the quadriceps and patellar tendon and closed side to side (**b**)

Preparation of Recipient Site

Incision

A paramedian skin incision is made beginning 10 cm above the proximal pole of the patella and ending 3 cm below the distal insertion of the patellar tendon. In revision surgery, previous incisions must be taken into consideration.

Exposure

The medial and lateral edges of the patellar tendon are identified, and the scar tissue is excised to expose the two tendon stumps. The quadriceps tendon is exposed using the technique described above. The next part of the procedure involves creating a tibial and patellar bone trench to accommodate the harvested bone blocks (Fig. 34.27a, b).

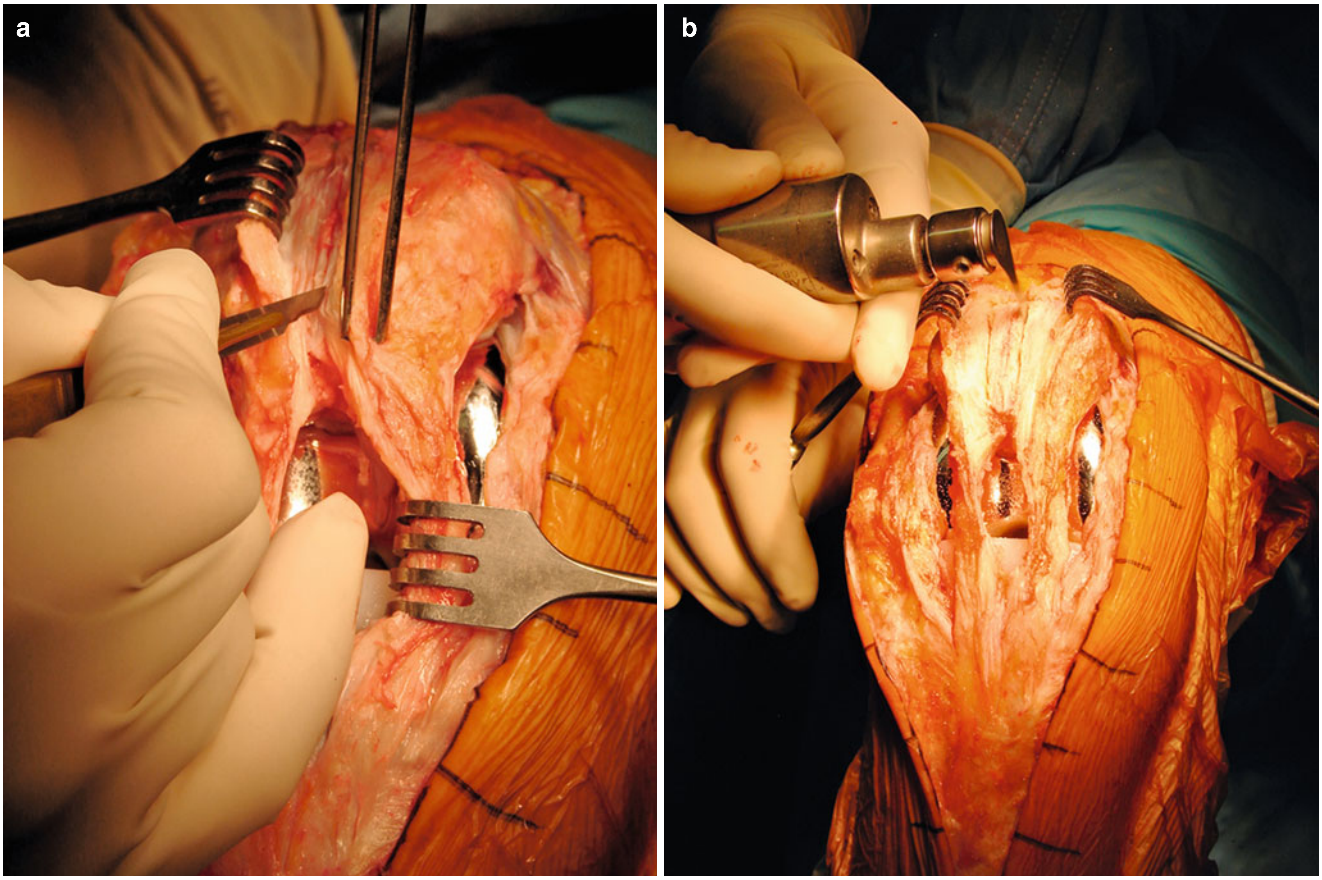

Fig. 34.27 Preparation of the recipient knee – the patellar bone trench is marked (**a**) and creasted with a saw (**b**)

Preparation of Bone Trenches

The recipient sites are marked out on the periosteum using a scalpel. The bone trenches are then cut with an oscillating saw. On the TT, the trench is 10 mm wide proximally, 12 mm distally, and 35 mm long. In order to elevate the block of bone and make the trench, a gouge is inserted vertically just above the reflected patellar tendon (Fig. 34.28a, b). On the patella, the trench is trapezoidal measuring 14 mm wide proximally and 10 mm wide at its distal end. In order to elevate the bone block and from the trench, a Lambotte osteotome is inserted parallel to the anterior cortex at the tip and at the proximal pole of the patella. The match between the transplant and recipient site is then evaluated. It is often necessary to adjust the graft using a rongeur.

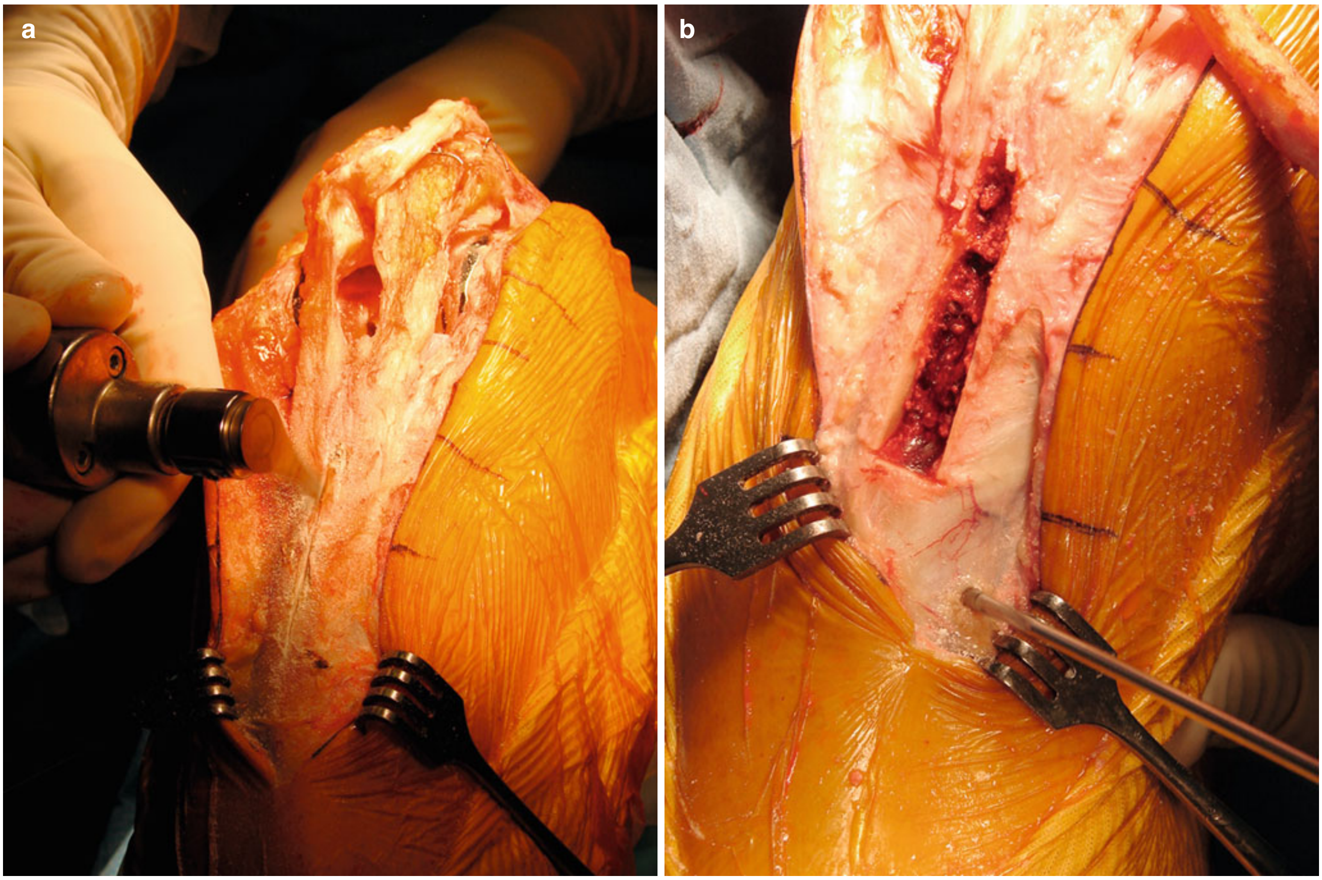

Fig. 34.28 Preparation of the recipient knee – the tibial bone trench is cut (**a**) and the bone block removed (**b**) to allow placemnt of the corresponding graft bone block

Fixation of the Graft

Patellar Fixation (Fig. 34.29a, b)

The extensor mechanism graft is initially fixed proximally. The patellar bone block is positioned in the recipient patellar trench. This should be achieved without impact in order to prevent a fracture or injury to the patellar cartilage. The dovetail of the bone block is placed proximally in the trench. The bone block is fixed with two separate metal wires, which pass transversely through the patella and bone block. The wires are tightened on one side by twisting and then cut short and buried. Proximally, an opening is made in the midline of the quadriceps tendon, and the quadriceps tendon graft is sutured into this site using a No. 2 absorbable suture.

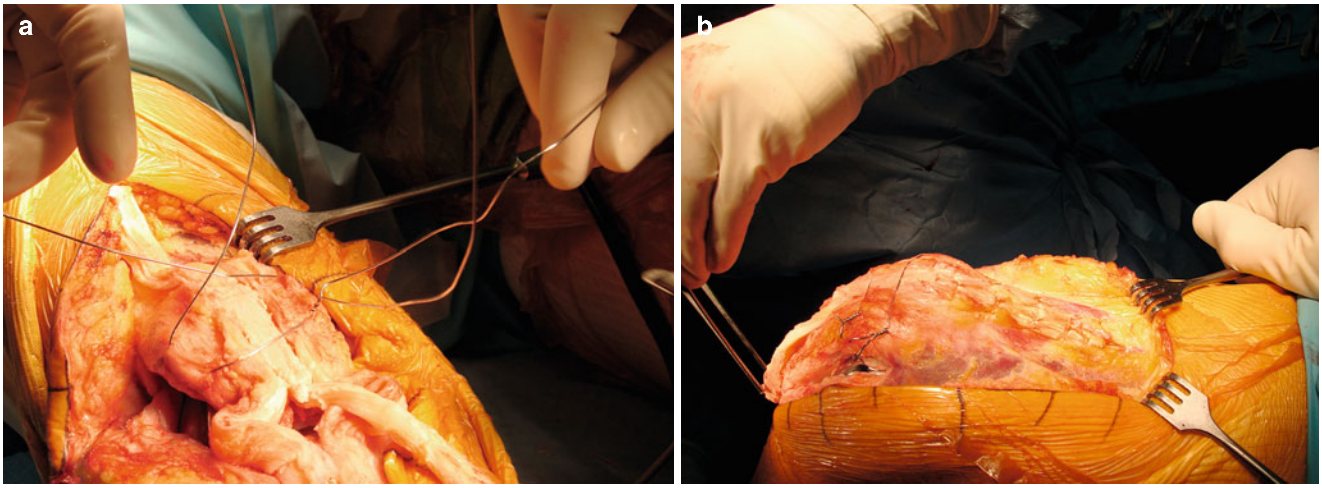

Fig. 34.29 Patellar fixation is achieved by passingtrans-osseous wires (**a**) and ties them over the graft anteriorly (**b**)

TT Fixation

A wire is passed through the tibial bone block. The tibial bone block is then positioned in the trench and impacted into the recipient site on the tibia. This restores the correct patellar height. Fixation is achieved with the wire and a screw (Hooper, Lepine®). The screw, which is placed distally, prevents proximal migration of the bone block (Fig. 34.30a, b). This fixation is supplemented by two Orthomed® staples, which can also be used to fix a strip of PDS prepared by the same technique described in the chapter "Acute ruptures of the extensor mechanism."

The inner and outer edges of the graft are sutured to the patellar tendon with a No. 2 absorbable suture (Fig. 34.31a, b). Imaging is not necessary prior to closure, as the corrected patellar height is only dependent on the length of the contralateral patellar tendon (Fig. 34.32a, b).

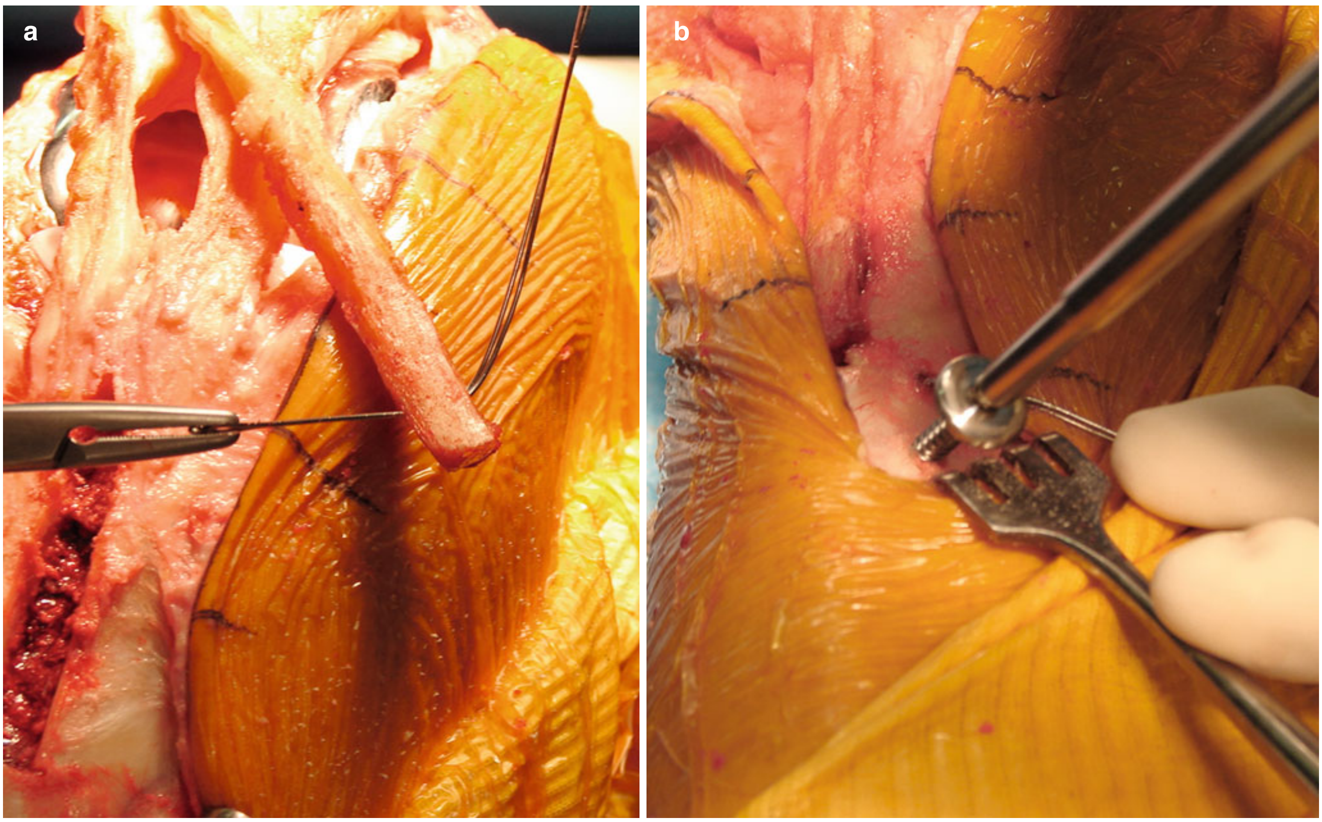

Fig. 34.30 Tibial fixation includes a trans-osseous wire (**a**) that is scured around a distal screw (**b**)

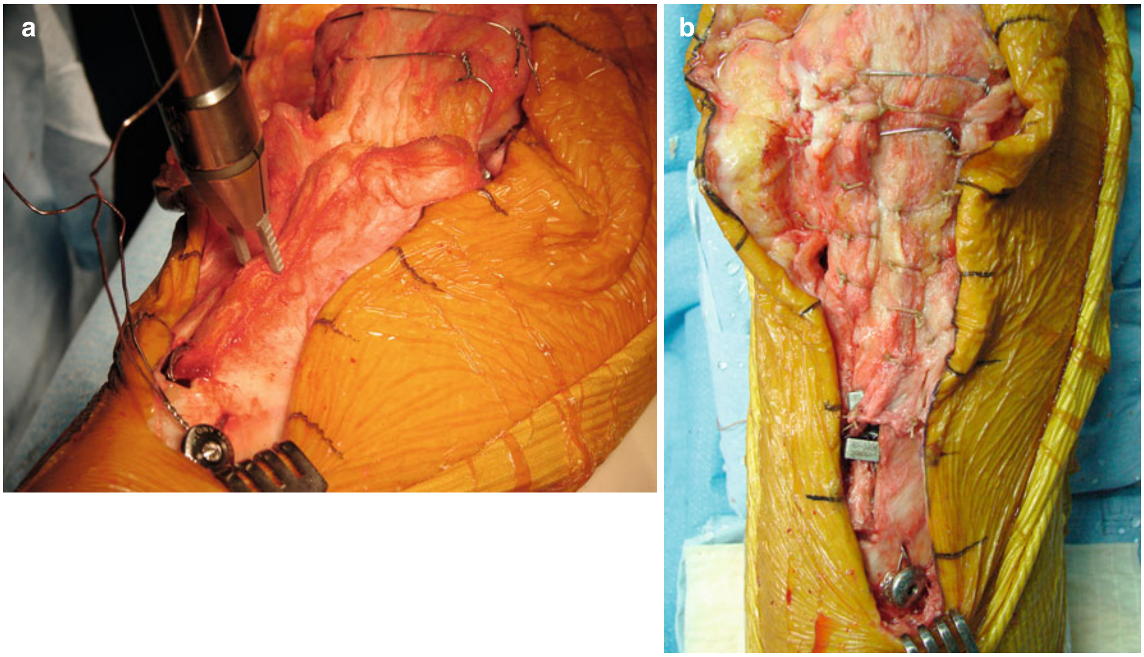

Fig. 34.31 Tibial fixation is augmented with two staples (**a**), yielding the final construct (**b**)

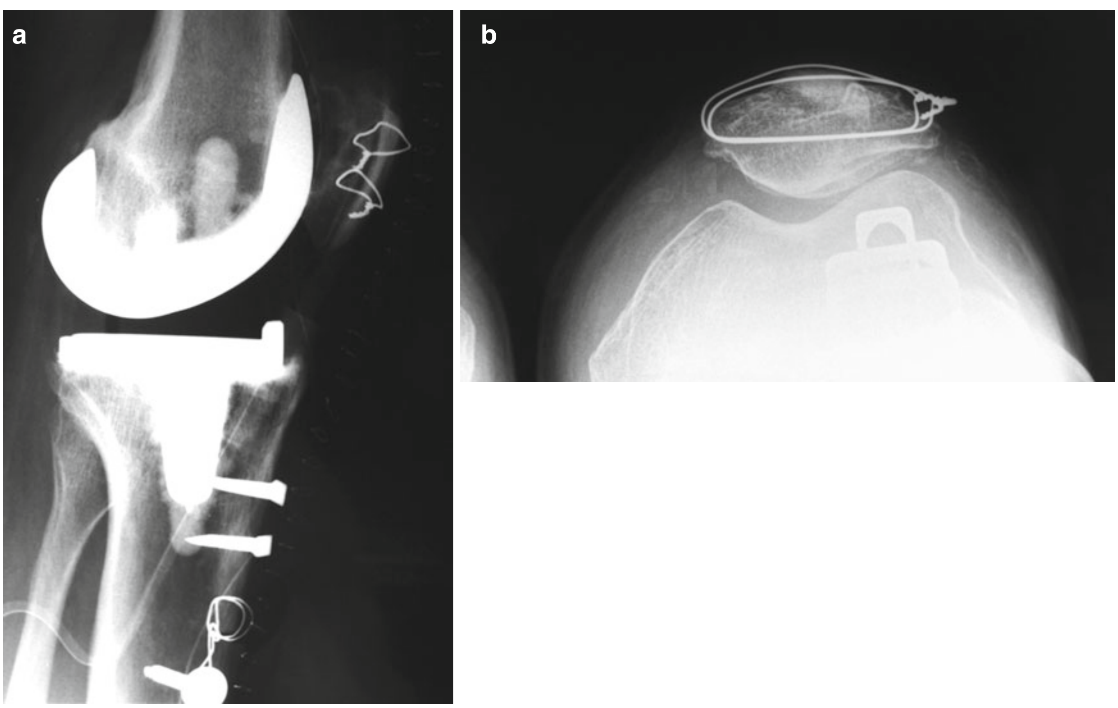

Fig. 34.32 Postoperative lateral (**a**) and axial (**b**) x-rays

Closure

Recipient Site (Fig. 34.33)

A suction drain is placed in contact with the graft. Hemostasis is achieved and closure is achieved in layers. Staples are used in the skin.

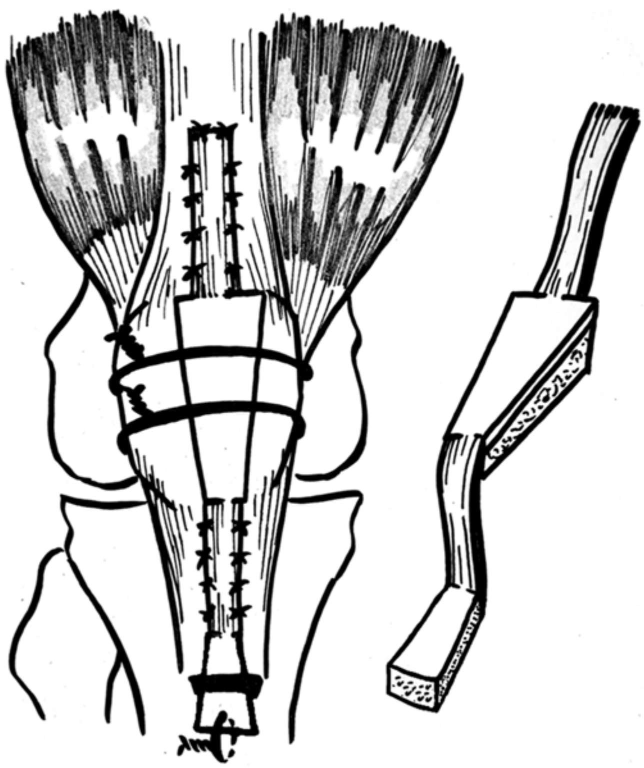

Fig. 34.33 Diagram showing the graft in situ

Donor Site

The edges of the tendons are approximated with a No. 2 absorbable suture. A suction drain is placed in the subcutaneous space, and closure is achieved in layers. We do not fill the bone defects on the patella or TT with the bone fragments taken from the recipient knee.

Postoperative

The postoperative regime is identical to the protocol described above. Prophylactic anticoagulation should be avoided unless absolutely necessary. The skin should be monitored closely due to the risk of infection or necrosis. The grafted side should be protected in complete extension for 2 months.

Allograft Transplantation of the Extensor Mechanism

There are some advantages to the use of allograft tissue for extensor mechanism reconstruction. There is no harvest site morbidity on the other extremity such as fracture, extensor mechanism rupture, or pain after harvesting. Allograft tissue is particularly useful in patients with a collagen disease or a history of injury or surgery involving the contralateral knee (contralateral TKA, fracture, or more generally osteoporosis) (Fig. 34.34). Further, the allograft can be thicker and longer than autograft and results in shorter surgical times.

On the other hand, there are a few disadvantages. Allograft is not available in every country and can be costly. While the risk of viral contamination is low (estimated to be 1/200,000), the patient must be informed of the risk of this devastating complication. Finally, poor tissue quality is sometimes seen with allografts relative to autografts.

The length of the patellar tendon and patella should be matched to the patient when allograft is used. Specific measures of these structures must be made during the preoperative radiological assessment.

The surgical technique for reconstruction with allograft is very similar to the autograft technique described above. The surgical assistant can prepare the graft while the senior surgeon prepares the surgical site.

There are a few key differences between the techniques. The allograft typically can be made larger because of the absence of morbidity at the donor site. The allograft arrives as a complete extensor mechanism with tibial tuberosity, patellar tendon, patella, and quadriceps tendon (Fig. 34.35). The patellar bone block is prepared to be wider proximally and distally with concave edges medially and laterally. This method allows for the use of wider patellar and quadriceps tendon grafts (Fig. 34.36).

The fixation technique is similar. We use a wire wrapped around a low profile screw distally with the addition of staples for tibial bone block fixation (Fig. 34.37). Metal wires are used to fix the patella (Fig. 34.38). The tendon is secured with absorbable suture and sometimes FiberWire® depending on tissue quality. One PDS tape is distally fixed by the staple and sutured throughout extensor mechanism with the knee flexed to 90°. This tape protects allograft stress during bending (Fig. 34.39). Rehabilitation is very careful (see protocol cited above). The range of motion is particularly cautious and progressive to allow time for consolidation of the bone blocks. Successive radiographs are done every 45 days to check bone block consolidation before advancing range of motion (Fig. 34.40).

Fig. 34.34 Chronic patellar tendon rupture on TKA with failure of conventional technique. An allograft is required. Another option would be a technique utilizing synthetic mesh (recently described by Hanssen and Browne)

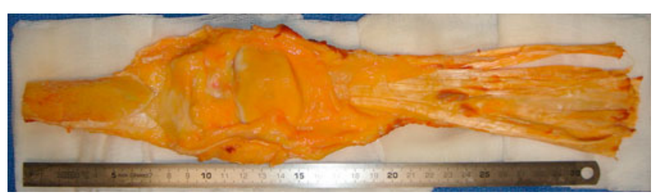

Fig. 34.35 Complete extensor mechanism

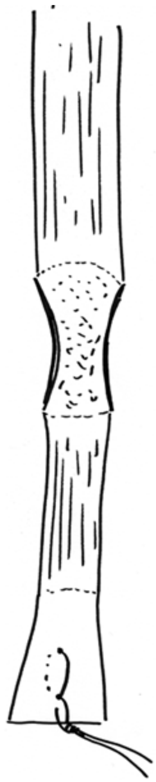

Fig. 34.36 Shape of the graft

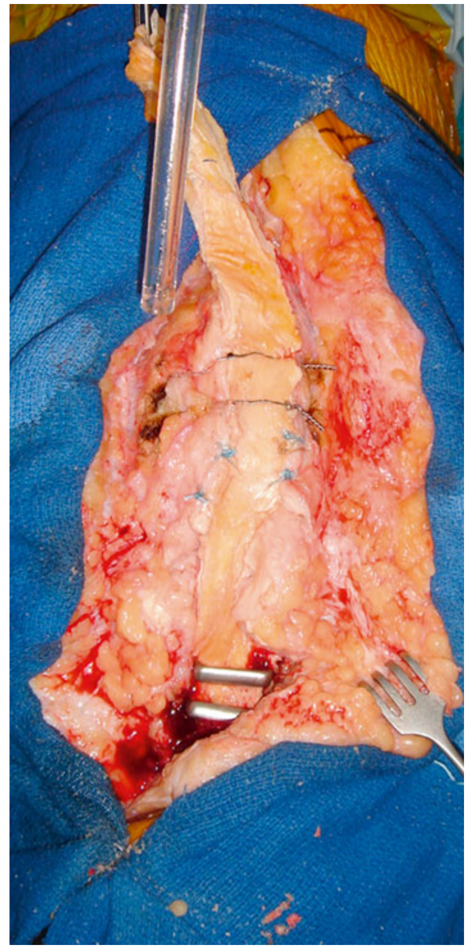

Fig. 34.38 Tibial fixation (2) using Blount staples

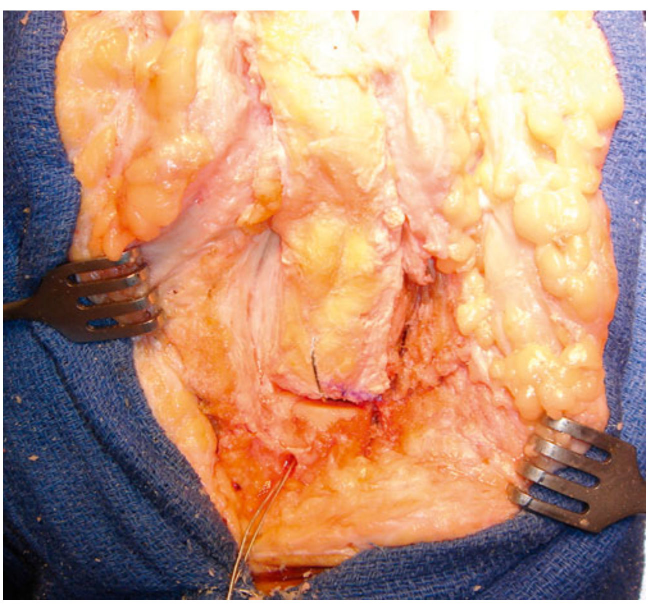

Fig. 34.37 Tibial fixation (1) using metal wire passed through the bone block and fixed using a cortical screw

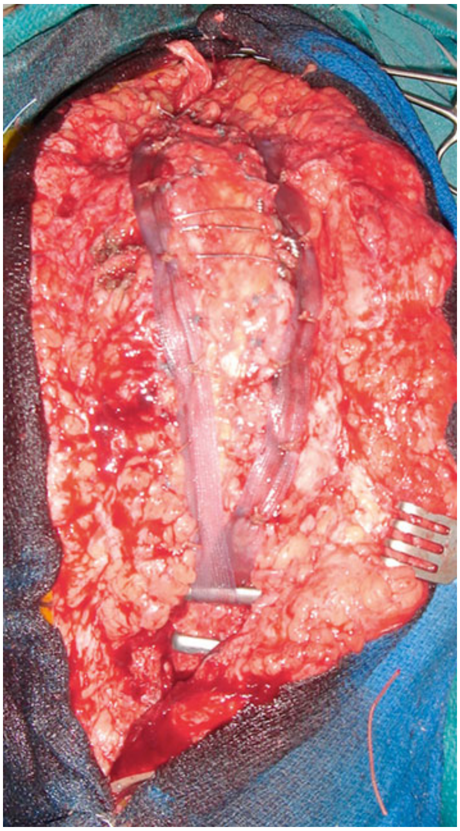

Fig. 34.39 Final aspect after fixation, suture, and reinforcement using PDS tape

Fig. 34.40 Case of chronic rupture with previous failure of suture plus augmentation. Excellent result at 6-month follow-up