# Reconstruction of the Posterior Cruciate Ligament

8

E Servien, G Demey, R Magnussen, P Neyret, and C Butcher

## Introduction

This chapter describes our technique for arthroscopic single-bundle reconstruction of the posterior cruciate ligament (PCL) with quadriceps tendon autograft. This technique can be adjusted to achieve a double-bundle reconstruction.

## Indications

In our practice, the majority of isolated PCL ruptures are treated conservatively. Our indications for surgical treatment are:

- Acute PCL ruptures associated with significant associated peripheral laxity (posterior drawer differential >10 mm): multi-ligament knee injuries (Fig. 8.1a, b)
- Persistent functional instability in chronic ruptures

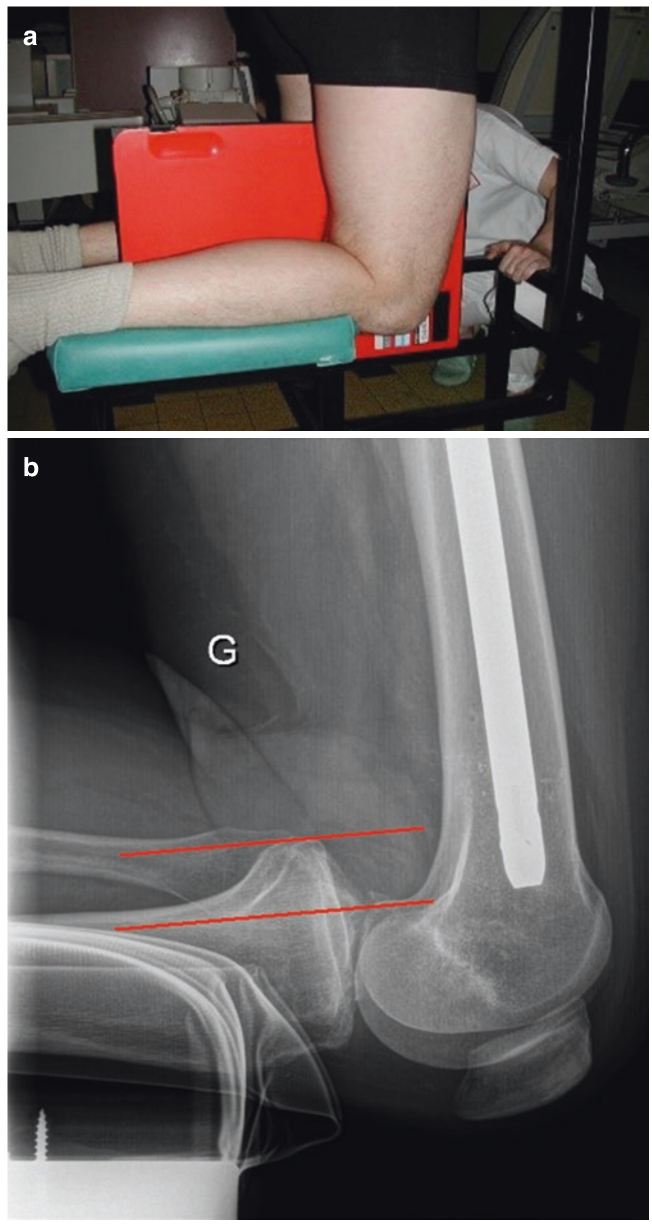


**Fig. 8.1** (**a**, **b**) Bartlett posterior stress view. (**a**) Setup. (**b**) X-ray showing posterior drawer of 22 mm

E Servien
Service d orthopedie de l Hopital de la Croix Rousse, Lyon 69004, France

G Demey
Clinique de la Sauvegarde, Lyon Ortho Clinic, Lyon, France

R Magnussen
Centre Albert Trillat, Lyon, France

P Neyret (✉)
Infirmerie Protestante, Lyon, Caluire, France
e-mail: Philippe.neyret01@gmail.com

C Butcher
Healthpoint, Abu Dhabi, UAE


P Neyret et al. (eds.), *Surgery of the Knee*, https://doi.org/10.1007/978-3-030-19073-6_8

## Surgical Technique

### Patient Positioning and Initial 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 90° flexed position. A lateral support holds the knee in this position, the thigh resting on the support with slight external rotation of the hip. Fluoroscopy is used routinely to control the correct positioning of the tibial tunnel. The image intensifier is positioned prior to the establishment of the sterile field, and the arch is positioned over the table to allow lateral images to be obtained when the knee is placed in 90° of flexion (Fig. 8.2). The image intensifier is moved in this position on its base up to the level of the patient's head, so that it does not interfere during the rest of the procedure.

Prior to prepping the surgical limb, the grade of the posterior drawer test is performed (Figs. 8.3a, b and 8.4a, b).

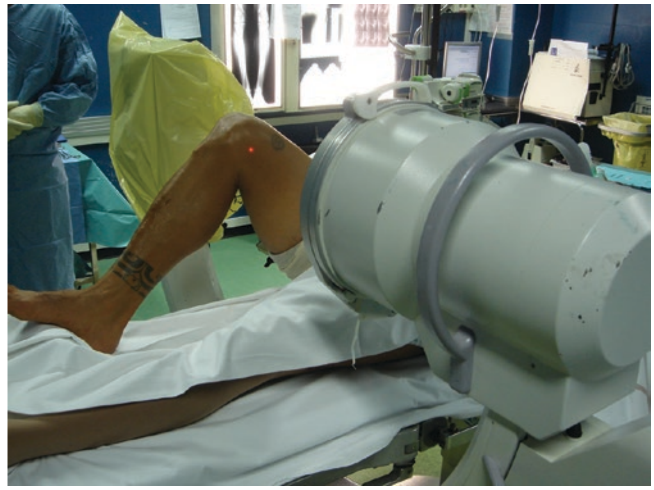

**Fig. 8.2** Preoperative positioning of the image intensifier

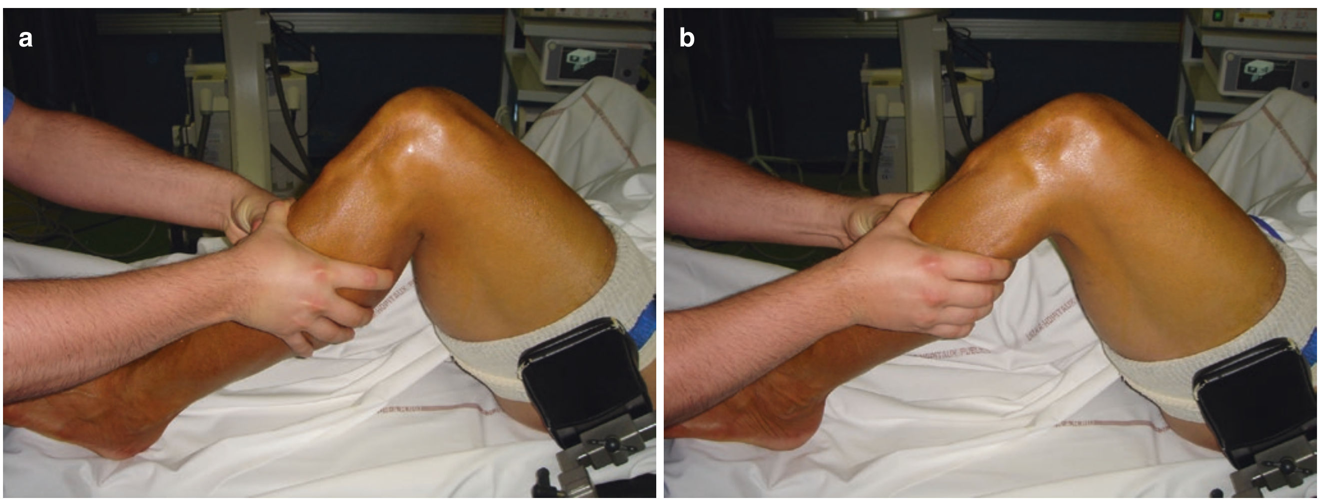

**Fig. 8.3** (**a**, **b**) Examination under anesthesia

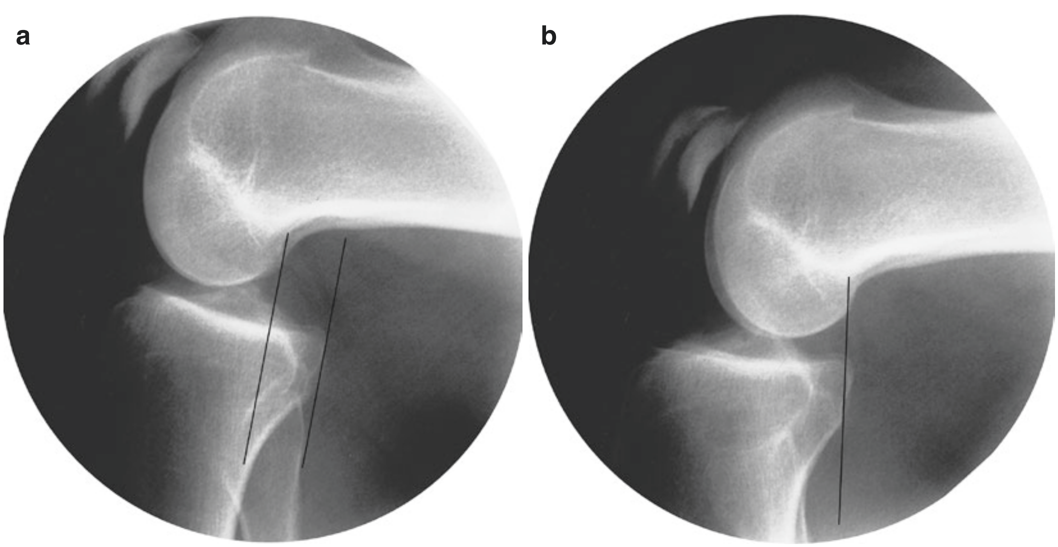

**Fig. 8.4** (**a**, **b**) Posterior tibial translation under fluoroscopy

## Harvesting of the Quadriceps Tendon

The quadriceps tendon graft is harvested through an anteromedial skin incision beginning at the superior pole of the patella and extending 6–8 cm proximally. Following exposure of the tendon, it is sometimes necessary to elevate some of the distal fibers of the rectus femoris muscle to achieve a sufficient graft length. The incision of the tendon is in line with its fibers. The width of the graft must be 10 mm for a length of 8 cm. In order not to breach the capsule, which causes leakage of arthroscopy fluid during the procedure, we try to only take the two most superficial layers of the quadriceps tendon, leaving vastus intermedius. The dimensions of the patellar bone block are 10 mm wide by 20 mm long. This is outlined in the periosteum using a 23 scalpel blade. Two holes are then drilled into the bone block using a 2.7 mm drill. These holes are used to pass the metal wire that is used for traction when positioning the graft.

The anterior cortex is then cut with an oscillating saw along the periosteal incision. A 10 mm Lambotte osteotome is used to elevate the bone plug to a thickness of 8 mm. Once the graft has been harvested, it is taken to a side table to be prepared for implantation by the assistant surgeon. The edges of the quadriceps tendon are closed with a No. 2 braided absorbable suture. Some more recent instrumentation has been developed by C. Fink (Karl Storz Minimally Invasive Quadriceps Tendon Harvesting System, see Chap. 33, Fig. 33.22a). This allows the graft to be harvested through a smaller transverse incision just proximal to the patella, but it needs some experience.

## Graft Preparation

After stripping any remaining muscle from the tendon graft, the end of the graft is tubularized with a whipstitch for a length of 5 cm with nonabsorbable suture, typically FiberWire®. These will facilitate passage of the graft. The bone plug and graft are then trimmed with a rongeur, so that it can pass easily through a 10 mm sizing tube (Fig. 8.5). Through the two drill holes in the patellar bone block, a 0.5 mm diameter metal wire is introduced in a figure of "8," which will allow distal control of the graft and double-distal tibial fixation. The free wire ends should be sufficiently long (20 cm) for this fixation. Allograft can also be used if necessary. Its preparation is identical (Fig. 8.6).

**Fig. 8.5** Prepared quadriceps tendon autograft

## Arthroscopy

An anterolateral portal is used for the arthroscope and an anteromedial portal for the instruments. We now routinely used in our practice an accessory posteromedial portal that is useful to fully visualize and clean the tissue off the posterior aspect of the tibia at the outlet of the tibial tunnel (Fig. 8.7). Coblation is particularly helpful for the preparation of the posterior aperture of the tibial tunnel. We believe that notch clearance and debridement of the PCL, however, should be minimized in order to enhance the biological integration of the graft. We also try to preserve the meniscofemoral ligaments (Fig. 8.8a, b). A thorough diagnostic arthroscopy is performed to assess the anterior cruciate ligament and look for chondral and meniscal pathology.

**Fig. 8.6** Prepared quadriceps tendon allograft

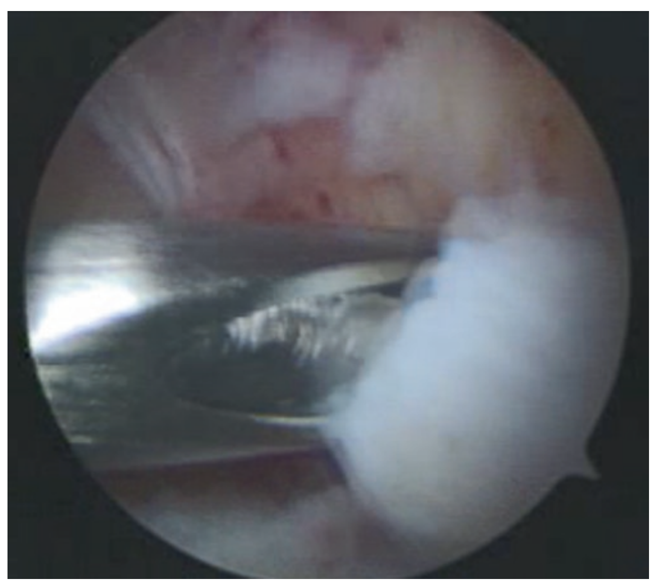

**Fig. 8.7** Debridement of the tibial footprint via the posterior medial portal

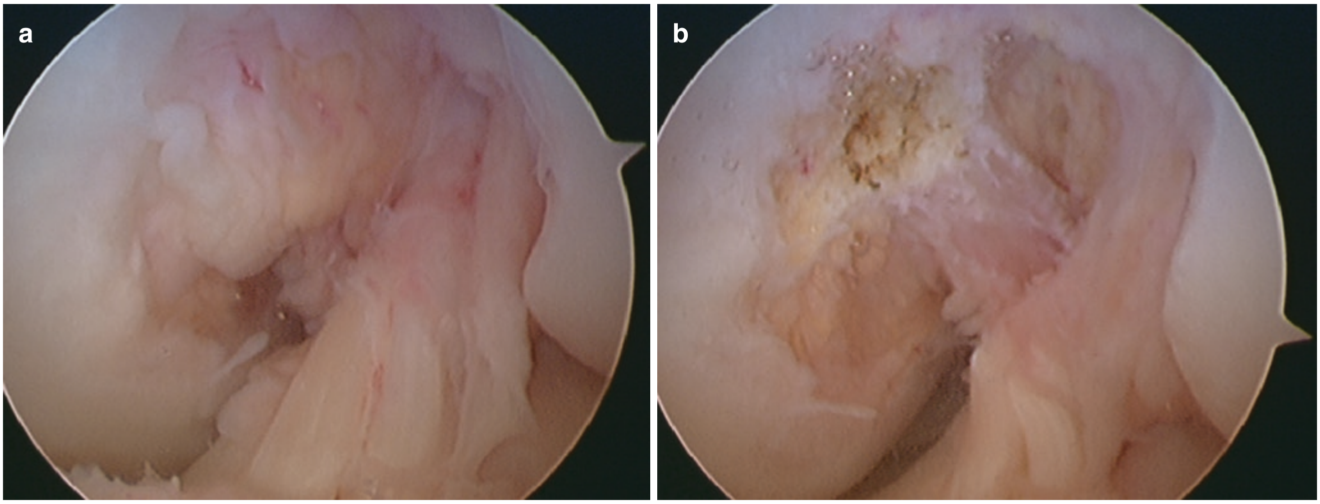

**Fig. 8.8** (**a**, **b**) Arthroscopic view of the notch following shaving of the synovium. This highlights the residual fibers of the PCL that are preserved in order to optimize biological integration of the graft

## Tibial Tunnel Preparation

The preparation of the tibial tunnel is performed with the knee flexed to 90°. This helps to protect the popliteal neurovascular structures. We use a specific tibial drill guide, Phusis® (Fig. 8.9a, b). If this is not available, an alternative is the Smith & Nephew (ACUFEX) instrumentation. The latter guide is not fully stabilized to the tibia however, and visualization of the back of the knee through a posteriomedial portal as well as flouroscopy becomes more important (Fig. 8.9c). The arm of either guide is inserted into the knee via the anteromedial portal and through the notch and positioned in the PCL fossa on the posterior tibia (Fig. 8.10). The tip of the guide is positioned under arthroscopy, and a double check is made with fluoroscopy to control the ideal location for the tibial tunnel: The recommended landmark for placement of this guide is approximately 1.5 cm distal to the articular edge of the posterior plateau, which corresponds to the junction of the middle and distal 1/3 of the posterior tibial facet (Fig. 8.11). The bullet portion of the Phusis drill guide is placed on the anterior medial aspect of the proximal tibia. A vertical incision is made approximately 3 cm medial to the tibial tuberosity, and the guide is applied to the bone. The guide is then secured to the tibia with two short pins (Fig. 8.12). The guidewire is drilled under fluoroscopic control to prevent injury to the popliteal vessels (Fig. 8.13). In the sagittal plane, the guidewire forms an angle of 55° (first setting of the guide) with the tibial diaphysis. The bullet is then removed, keeping the guide on the posterior aspect of the tibia in place to protect the vessels. The tibial tunnel is made using cannulated reamers over the guidewire, under fluoroscopic control. The tunnel diameter is gradually increased from 6 to 9 mm and then to the definitive 11 mm (Fig. 8.14a–c). The guidewire is then removed. The arthroscope is introduced into the tibial tunnel, and the shaver is used to debride the remnants of the ligament (Fig. 8.15a, b). This stage is critical in order to allow easy passage of the graft. In this case, the arthroscope is placed via the anterolateral portal, and the shaver can be used via the posteromedial portal.

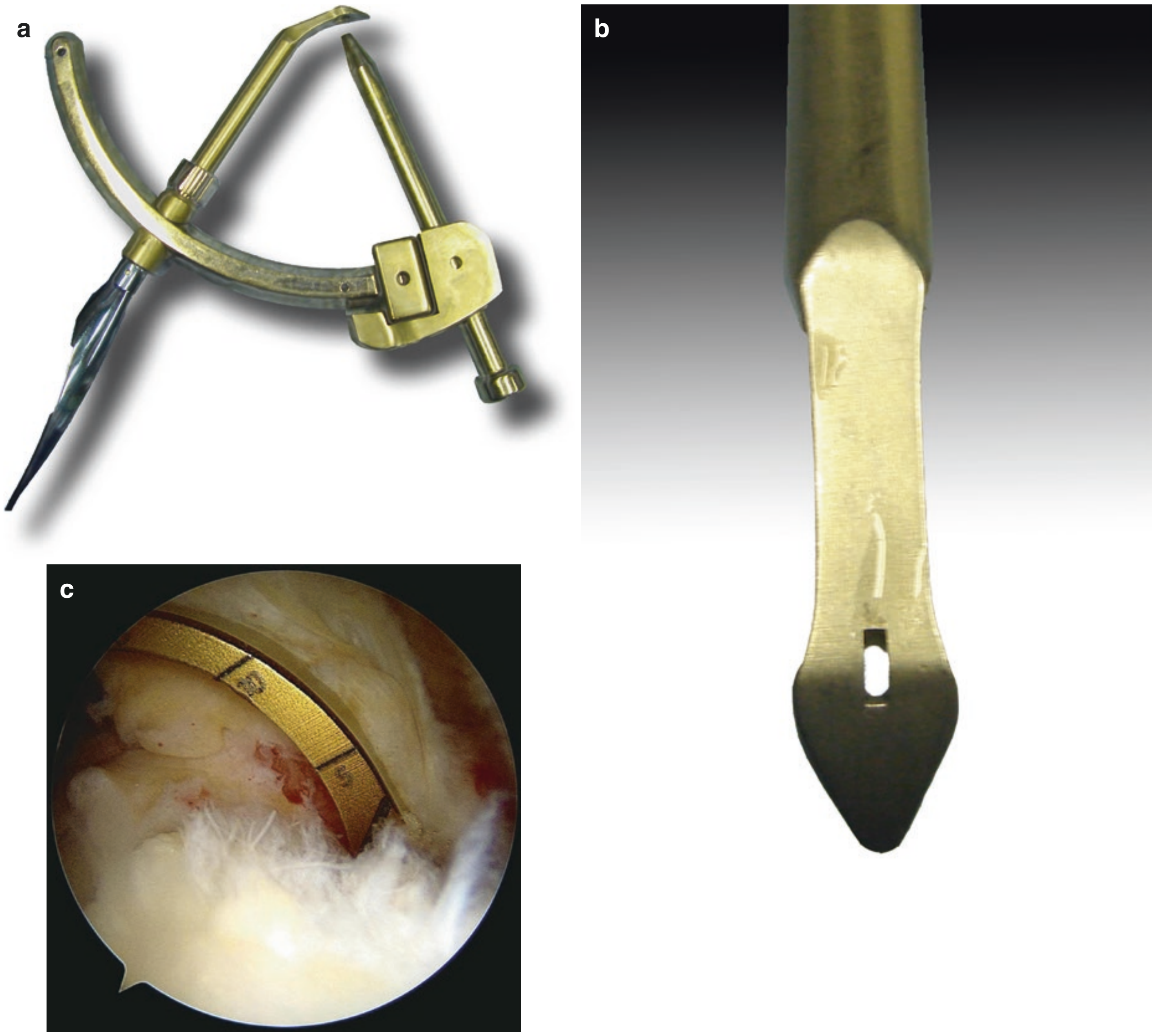


**Fig. 8.9** (**a**, **b**) Specific PCL tibial drill guide, set at an angle of 55°. (**c**) Positioning of Acufex tibial PCL guide (posteromedial portal view). The gradations will help position the wire 15 mm distal to the articular surface

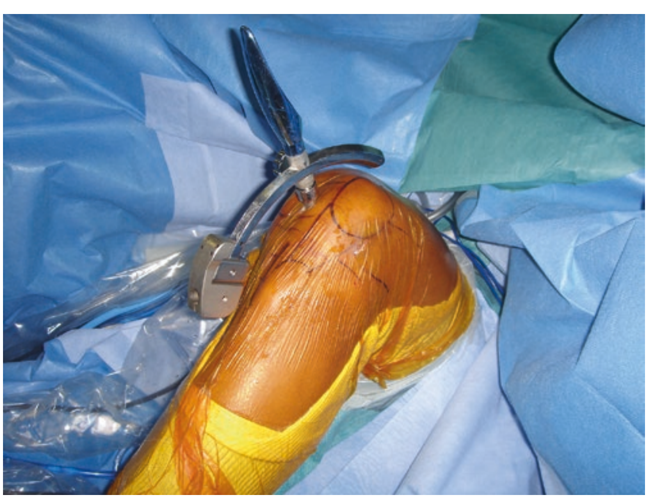

**Fig. 8.10** The tibial guide is inserted through the anterior medial portal

**Fig. 8.11** Fluoroscopic control of the position of the tibial guide

**Fig. 8.12** Arthroscopic control and pinning of the guide to the tibia

**Fig. 8.13** Placement of the guidewire under fluoroscopic control

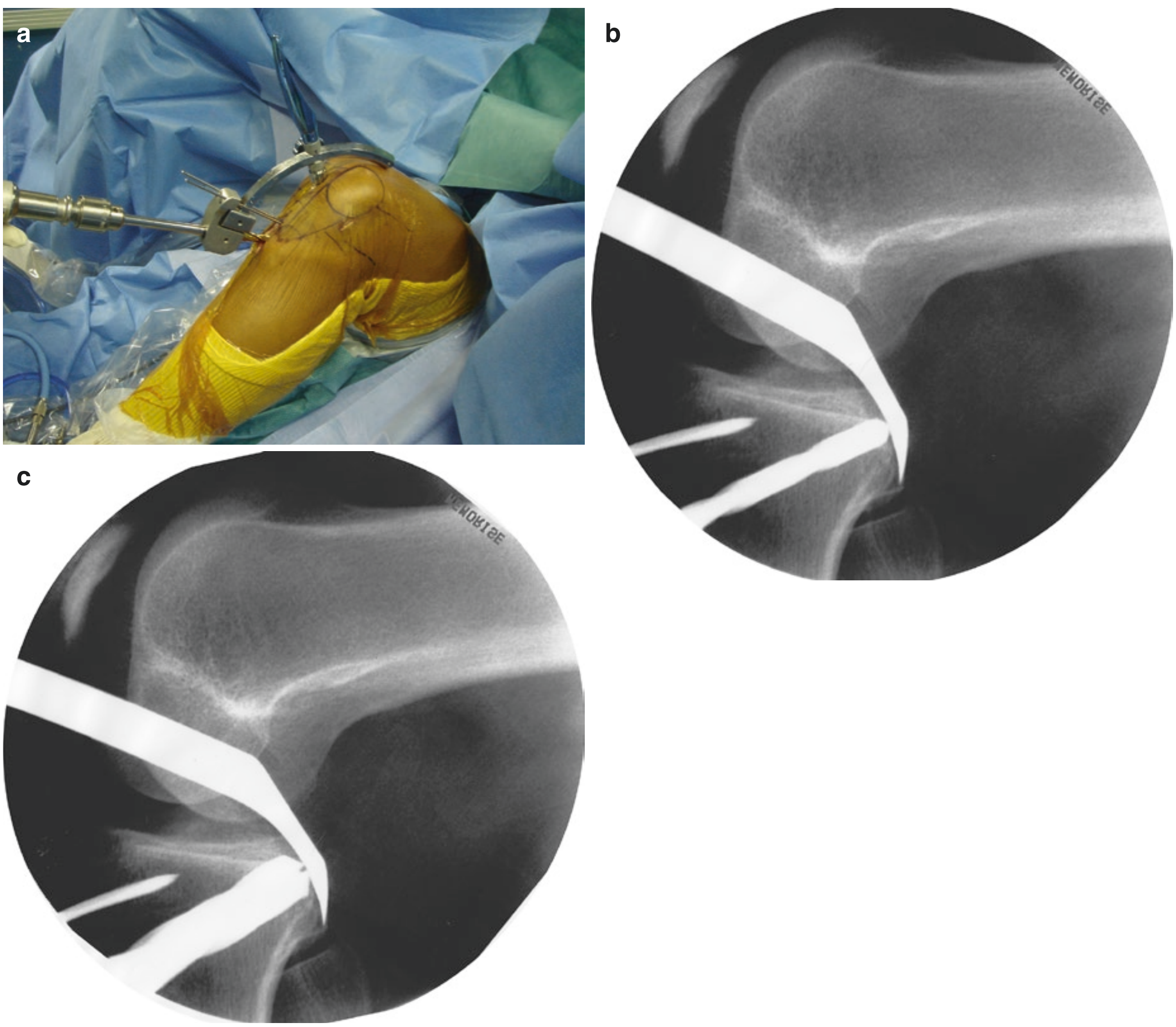

**Fig. 8.14** (**a**–**c**) Progressive reaming of the tibial tunnel (6 mm diameter drill bit, then 9 mm and 11 mm)

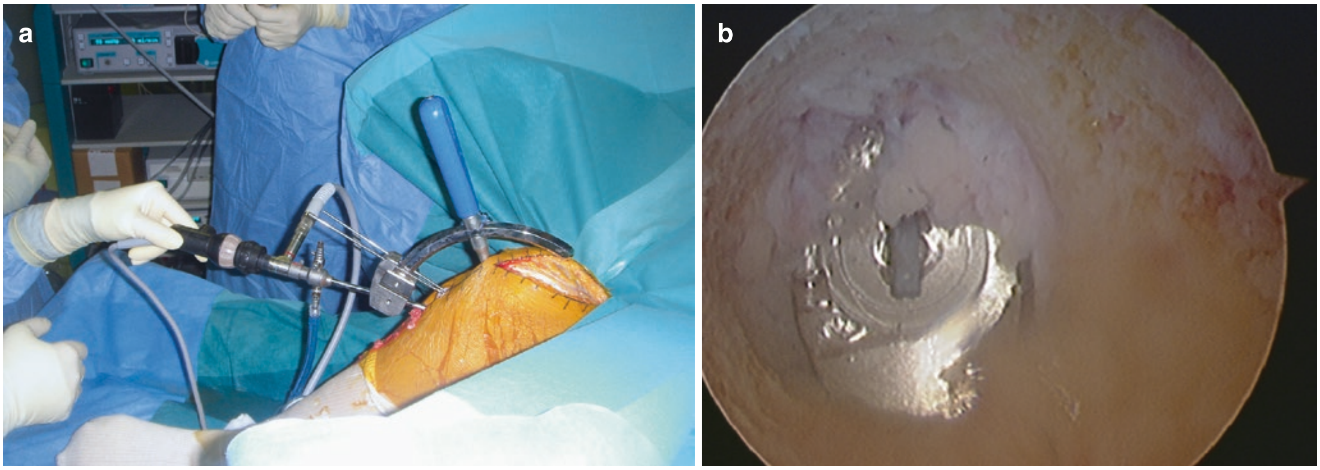

**Fig. 8.15** (**a**, **b**) The arthroscope is inserted into the tibial tunnel to visualize debris and remnants of the PCL at the posterior exit of the tibial tunnel

## Drilling the Femoral Tunnel

The single-bundle technique that we describe aims to reconstruct the anterolateral bundle of the PCL. We use an outside-in femoral tunnel guide. The arm of the guide is introduced through the anteromedial portal. The tip of the guide is placed such that the guidewire will exit through the center of the femoral insertion of the anterolateral bundle of the PCL. This goal is achieved with the knee at 90° of flexion. In this position, the intra-articular position of the tunnel opening in the axial plane is at 1 o'clock in the right knee and 11 o'clock in the left knee. The anterior border of the tunnel lies between the condylar wall and roof of the notch.

A 2 cm incision is made over the anteromedial aspect of the medial femoral condyle. The distal edge of the vastus medialis is identified and retracted upward to avoid injury to the muscle belly (Fig. 8.16). The bullet of the outside-in femoral guide is advanced to bone. A guidewire is then passed through the condyle under arthroscopic control. The bullet and guide are removed, and the end of the guidewire is held in a curette (Fig. 8.17a, b). The femoral tunnel is drilled using a cannulated reamer. Like the tibial tunnel, an initial tunnel of 6 mm in diameter is drilled and then enlarged using a reamer of 10 mm in diameter (Fig. 8.18). The intra-articular opening of the tunnel is then debrided by successively introducing the arthroscopic shaver through the anteromedial portal and the femoral tunnel.

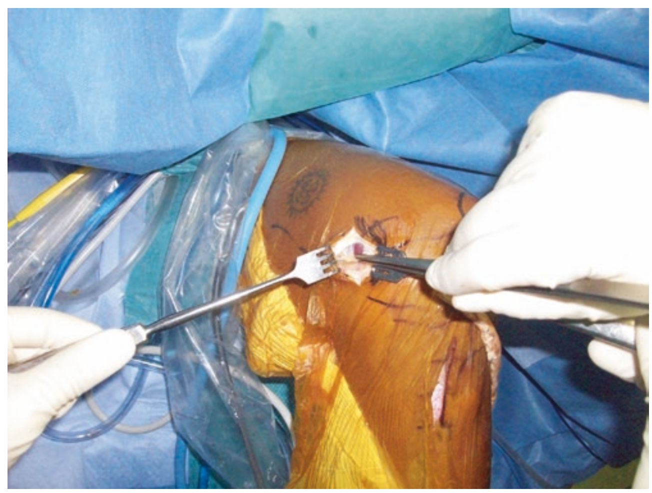

**Fig. 8.16** Incision for the femoral tunnel. The vastus medialis is elevated to allow placement of tunnel without injury to the muscle

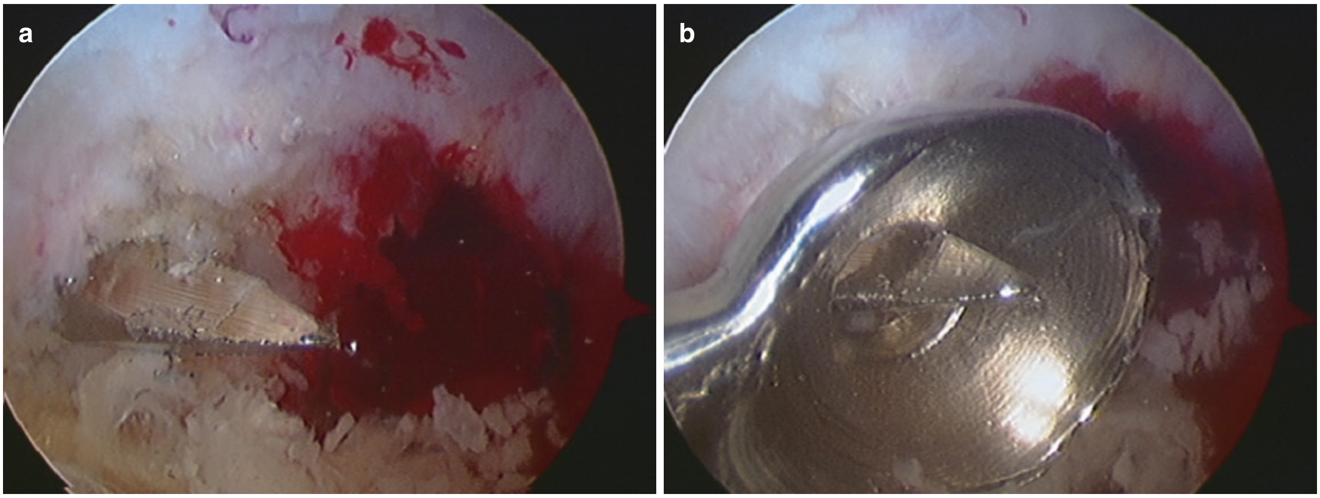


**Fig. 8.17** (**a**, **b**) Insertion of the guidewire. Drilling the femoral tunnel is facilitated by placement of the special curette to maintain the guidewire in an optimum position

**Fig. 8.18** Femoral tunnel

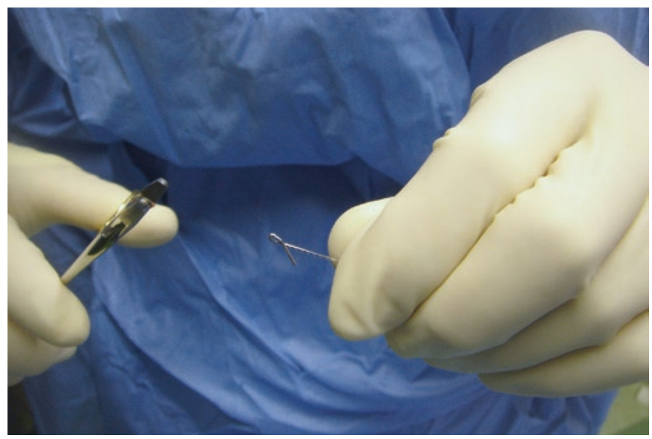

**Fig. 8.19** Preparation of metal traction wire

## Graft Passage

The graft can be inserted with traction using a 0.5 mm metal wire or FiberWire. In the case of the metal wire, it is bent at its end to form a loop (Fig. 8.19). This is then passed up through the tibial tunnel inside a 6 mm cannulated reamer. Under fluoroscopy, the tip of the metal wire is then passed through a slot at the end of the tibial guide. The wire locks into the slot due to the loop at its end (Fig. 8.20). The tibial guide and the wire are then removed through the anteromedial portal (Fig. 8.21). The wire should be secured at both ends with a Kocher. If a FiberWire is used, a doubled suture loop is passed up the tibial tunnel, retrieved with a curved grasper, and pulled out of the anteromedial portal. This is then used to pass another doubled suture in a retrograde fashion, passing the loop out of the tibial tunnel distally.

The graft is now passed from distal to proximal, through the tibial tunnel using the wire, or FiberWire suture loop (Fig. 8.22). It is inserted so that the bone remains in the tibial tunnel, using counter tension on the distal wires. The progression of the graft through the tibial tunnel is monitored using the image intensifier. A probe inserted through the posterior medial portal acts like a pulley to modify the orientation of the traction. It is considered sufficiently advanced when the end of the bone block is flush with the intra-articular end of the tibial tunnel (Fig. 8.23). The other end of the graft is delivered into the notch, and the passing sutures (FiberWire) are easily retrieved using a Kelly clamp through the femoral tunnel (Fig. 8.24).

**Fig. 8.20** The wire is aimed at the hole in the tibial guide using a drill bit

**Fig. 8.21** The guide is withdrawn bringing the wire out of the anterior medial portal

Next the bone block of the graft is fixed in the tibia. A guidewire is inserted into the tibial tunnel and positioned in front of the bone block. A 9 × 25 mm absorbable or metallic interference screw is inserted over the guidewire and screwed into position. When the screw is flush with the joint line, the tightening is stopped. The advancement is easily assessed with the image intensifier by knowing that the screw protrudes 5 mm beyond the tip of the screwdriver (Fig. 8.25). The arthroscope can be inserted into the tibial tunnel to

**Fig. 8.22** Passage of the graft from distal to proximal

**Fig. 8.23** Positioning the graft bone block near the posterior aperture of the tunnel, confirmed by fluoroscopy

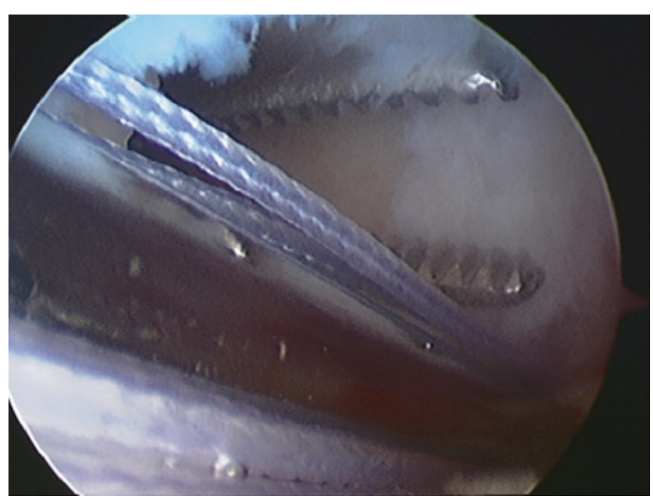

**Fig. 8.24** The FiberWire is retrieved through the femoral tunnel

**Fig. 8.25** Correct position of the interference screw is inferred by the position of the screwdriver

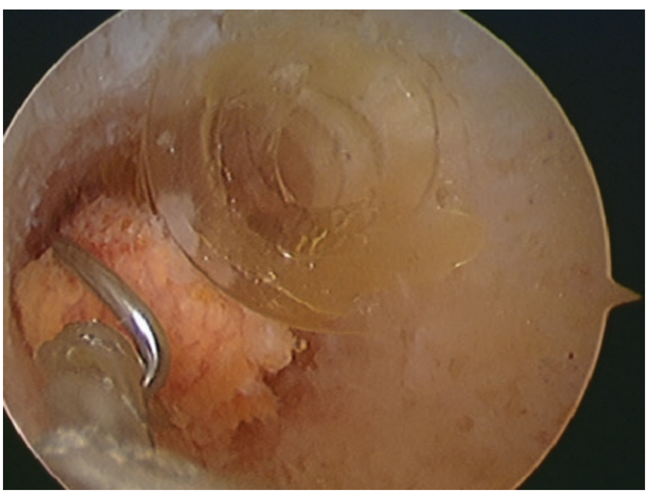

**Fig. 8.26** Appearance of the screw and bone block in the tibial tunnel using the arthroscope

check the position of the screw in relation to the bone block (Fig. 8.26).

The tibial fixation is supplemented with a 4.5 mm cortical screw on the anterior cortex of the tibia. The two strands of wire are wound around the screw, and the screw is tightened (Fig. 8.27). The tibia is correctly reduced in 90° of flexion, and the graft is tensioned (Fig. 8.28). The femoral fixation is with a 9 × 25 mm absorbable interference screw in an outside-in manner. The tension of the graft and the absence of residual posterior tibial translation are evaluated clinically and arthroscopically (Fig. 8.29).

**Fig. 8.27** The wires are wound around a cortical tibial screw, providing double fixation

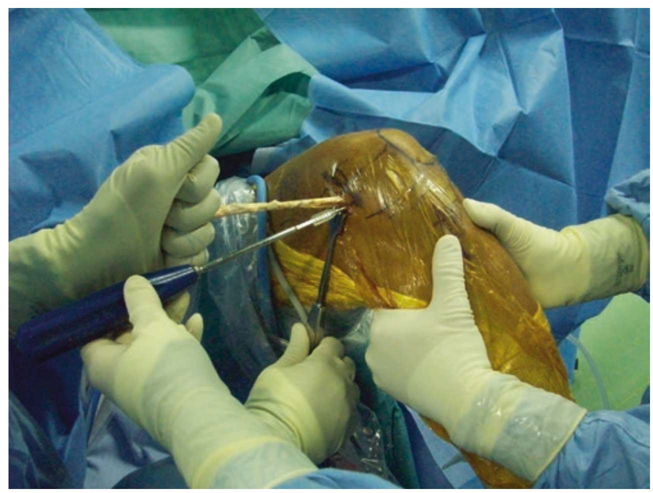

**Fig. 8.28** Manual reduction of the posterior drawer, and placement of the femoral interference screw

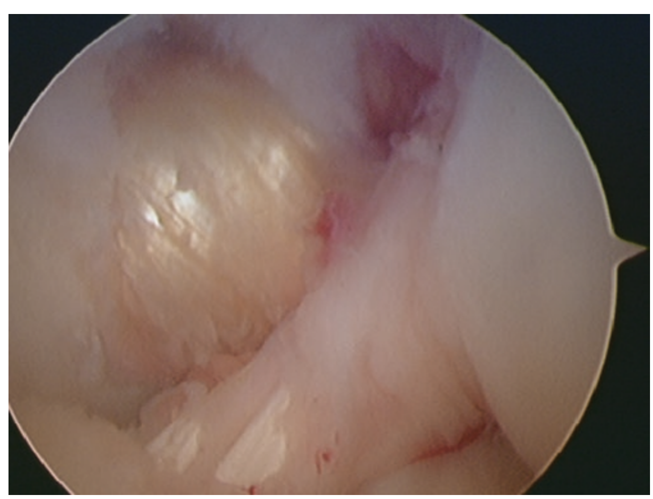

**Fig. 8.29** Arthroscopic control

## Postoperative Care

Following deflation of the tourniquet, hemostasis is achieved. A suction drain is placed intra-articularly, and the wounds are closed. The knee is locked in extension using an extension splint. This should include a wedge or a pillow under the calf to prevent posterior tibial translation due to gravity. The surgeon verifies the presence of distal pulses and normal capillary refill of the limb prior to awakening the patient. An AP and true lateral radiograph of the knee is taken. DVT thomboprophylaxis is continued for a period of 15 days, and antibiotics are given for 24 h. Staples are removed from the wounds on the 15th postoperative day. Postoperative follow-up is scheduled 45, 90, and 180 days and 1 year postoperatively. Rehabilitation is designed to prevent posterior tibial translation and can be done in the prone position.