Anterior Knee Endoscopy

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Tsz Lung Choi, Tun Hing Lui, Peter Wai Pan Yau, and Gabriel Ching Ngai Leung

Abstract

Anterior knee endoscopy can access the quadriceps tendon, patellar tendon, Hoffa fat pad, and various bursae. Prepatellar bursa, infrapatellar bursa, and Morel-Lavallée lesion are superficial lesions that are easily approached. However, open resection is associated with poor healing of the surgical wound, decreased sensation over scar area, contracted scar tissue, atrophic skin changes, subcutaneous collection, and scar hypersensitivity. Endoscopic resection is a minimally invasive surgical approach that may reduce the risk of complications associated with open surgery. Acute quadriceps tendon rupture typically occurred in the distal 2 cm of the tendon. While delay in diagnosis was common, it was associated with poor outcome even after open surgical repair. An endoscopic technique of acute quadriceps tendon rupture at the osteotendinous junction and the mid-substance is developed. There is no early post-operation complication and the short-term results are favorable. Patellar tendon pathology typically occurs at the enthesis site; in most cases it occurs at the inferior pole of the patella, but it can occur at the tibial tuberosity. Pathology of the Hoffa pad can be intrinsic, e.g. intracapsular chondroma, localized nodular synovitis, post-surgery or post-traumatic fibrosis, or extrinsic, e.g. pigmented villonodular synovitis, meniscal cyst. Patellar tendoscopy and endoscopy of the Hoffa fat pad are useful minimally invasive approaches to deal with these pathologies with the advantages of better cosmetic result, less post-operative pain, and less surgical trauma. In this chapter, the endoscopic techniques are outlined.

Keywords

Prepatellar bursa · Infrapatellar bursa · Morel-Lavallée lesion · Endoscopy · Resection · Acute · Quadriceps tendon rupture · Endoscopic repair · Tendoscopy Patellar tendon · Hoffa fat pad

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T. H. Lui (ed.), *Endoscopy of the Hip and Knee*, https://doi.org/10.1007/978-981-16-3488-8_9

9.1 Endoscopic Resection of Prepatellar Bursa, Infrapatellar Bursa, and Morel-Lavallée Lesion

Tsz Lung Choi and Tun Hing Lui

9.1.1 Introduction

9.1.1.1 Infrapatellar Bursa Anatomy

Infrapatellar bursa comprises superficial and deep ones. The superficial infrapatellar bursa lies between the subcutaneous tissues and the upper part of the patellar tendon. Superficial infrapatellar bursa may exist as a single bursal sac or, in some patients, as a multisegmented series of loculated sacs. The deep infrapatellar bursa (DIB) is located directly posterior to the distal one third of the patellar tendon, just proximal to its insertion on the tibial tuberosity. It has no communication to the knee joint. Its average width at the most proximal margin of the tibial tuberosity is slightly wider than the average distal width of the patellar tendon [1]. The ventral side of the DIB contains only patellar tendon tissue without synovial covering. The medial and lateral mini recess of DIB consists of a folded synovial membrane based on smooth subsynovial fat tissue, which is responsible for the gliding mechanism of the patellar tendon during knee flexion and extension [1, 2]. The dorsal side of the bursa contains a flat synovial membrane which is based on a loose interstitial connective tissue [2].

9.1.1.2 Disorder of Infrapatellar Bursa

Disorders of infrapatellar bursa can be a source of anterior knee pain. Superficial infrapatellar bursitis, also called clergyman's knee, is due to inflammation and fluid accumulation resulting from chronic stress. Clinically, there is a palpable swelling inferior to the patella [3]. On MRI, it appears as a loculated collection that projects exophytically, anterior to the patellar tendon, forming a swelling [4].

Deep infrapatellar bursa can be site of a number of pathologies, which includes calcification [5], inflammatory bursitis [6], gout, septic bursitis [5], and traumatic hemorrhage [7] and as a possible factor in the infrapatellar contracture syndrome [8]. Inflammatory bursitis of DIB can provoke symptoms like patellofemoral arthralgia [9]. Osgood-Schlatter disease can cause inflammation and pain associated with the DIB [10]. In one study, Rosenberg et al. [11] found distended deep infrapatellar bursa on magnetic resonance imaging in 71% (12 of 17) of cases of Osgood-Schlatter disease. Injection of DIB with lidocaine or a combination of lidocaine and corticosteroids has been reported to result in clinical relief of symptoms [10, 11].

9.1.1.3 Infrapatellar Bursa Endoscopy

Endoscopy is reserved for those who failed conservative treatment. William et al. [2] described a few indications for infrapatellar bursa endoscopy, which include Osgood-Schlatter's disease, infrapatellar bursitis, and patellar tendinopathy. In case of bursitis and soft tissue impingement, the bursa can be removed using a synovial resector. Intratendinous pathology and superficial fraying of the patellar tendon can be cleaned with a shaver [2]. Intratendinous ossicle which can occur in Osgood-Schlatter's disease can produce symptoms. William et al. described a technique by using finger control from outside as counter pressure on the bone piece in the tendon to assist removal [2]. Surgeon must pay special care to patellar tendon and its insertion during removal of the ossicle [2]. Symptomatic osteophytes on the ventral tibial side can be removed with cautions of the patellar tendon insertion in infrapatellar endoscopy as well [2].

9.1.1.4 Prepatellar Bursa Anatomy

A trilaminar arrangement of fibrous soft tissue structures is present anterior to the patella in most knees [12]. From superficial to deep, there are a transversely oriented fascia, an obliquely oriented aponeurosis, and the longitudinally oriented fibers of the rectus femoris tendon [12]. Prepatellar subcutaneous bursa, prepatellar subfascial bursa, and prepatellar subaponeurotic bursa are present between the soft tissue fibrous layers [12]. No potential bursal space exists between the rectus femoris tendon and the anterior patellar bone [12]. The prepatellar bursa usually does not communicate with the knee joint [13].

9.1.1.5 Prepatellar Bursitis and Its Treatment Options

Prepatellar bursitis can be septic or aseptic. Prepatellar aseptic bursitis can occur after repetitive minor trauma. "Housemaid's knee," in those whose occupations require a kneeling posture, such as house cleaners and carpet layers [14]. Acute trauma or low-grade inflammatory conditions, such as gout, syphilis, tuberculosis, rheumatoid arthritis, sarcoid, idiopathic calcification, and calcinosis, Raynaud phenomenon can be other causes of aseptic prepatellar bursitis [13, 15]. In prepatellar septic bursitis, the mechanism of infection is believed to be direct inoculation, not hematogenous seeding, likely because of the poor blood supply to the bursa [13, 14].

Nonoperative treatment is the mainstay of treatment for aseptic prepatellar bursitis. Aspiration, applying compressive dressings, prescribing nonsteroidal anti-inflammatory drugs, and treating underlying causes [13, 15] should be tried before operative treatment.

There are a number of operative treatments for aseptic prepatellar bursitis, which includes aspiration and intra-

bursal injection of an appropriate drug (corticosteroid, autologous blood, caustic chemical, such as sodium morrhuate) and placement of a short-term indwelling drainage catheter; incision and drainage in cases of acute suppurative bursitis; and excision of chronically inflamed and thickened bursa [13, 15]. Risk of open bursectomy includes poor healing of the surgical wound, decreased sensation over scar area, contracted scar tissue, atrophic skin changes, subcutaneous collection, and scar hypersensitivity [16]. This is related to the poor blood supply to the prepatellar skin and the dense anastomosing network of the vertically descending branches of the anterior divisions of the medial and lateral cutaneous nerves of the thigh, divisions of the intermediate cutaneous nerve, and the infrapatellar branch of the saphenous nerve [13, 15, 17]. Risk of wound complications can be reduced by excising only the posterior half of the prepatellar bursa and leaving the anterior wall intact [18]. Endoscopic bursectomy has been proposed because of the advantages of better cosmetic result and fewer wound complications [16, 19–21].

Septic prepatellar bursitis can usually be treated nonoperatively with resting, compression dressing, aspiration, and antibiotics [22]. Rarely, bursectomy may be required for cases not responding to conservative treatment [22]. Endoscopic bursectomy has the risk of inadequate debridement to prevent recurrence and risk of spreading of the bacteria to the nearby fascia leading to necrotizing fasciitis [23, 24].

9.1.1.6 Morel-Lavallée Lesion

Morel-Lavallée lesion (MLL) is first described by Maurice Morel-Lavallée in 1863. It is a post-traumatic close degloving of soft tissue [25], MLL is caused by shearing blunt trauma which disrupt the perforating blood vessels and separate subcutaneous tissue from underlying fascia. Blood, dead fatty tissue, and lymph fluid then fill the potential space left behind. Pain and persistent swelling can occur if no treatment is given [26]. MLL is usually described around the thigh region in association with pelvic and acetabular fractures. Vanhegan et al. reviewed 204 MLLs and the frequency of occurrence according to site is as follows: pelvis 69.1%, knee 15.7%, Gluteal 6.4%, lumbosacral spine 3.4%, abdominal wall 1.5%, lower leg 1.5%, head 0.5%, and 2% unspecified.

MLL itself is a rare cause of pain and swelling around the knee. It is typically presented as rapid onset, fluctuant collection in anterior knee extending into the suprapatellar area [27]. MRI is considered as the diagnostic imaging modality of choice for MLL. Ultrasonography is a useful adjunct and potential replacement for MRI in diagnosis and monitoring of MLL [27]. MLLs are hypoechoic or anechoic, compressible and located between fascia and underlying deep fat tissue [28, 29].

There is no universally accepted treatment protocol for MLLs [26]. There are studies reported that MLL which is less than 3 weeks old and not encapsulated could be treated conservatively [30]. Conservative treatment includes compression dressing, aspiration of fluid, and injection of sclerosing agent into the MLL [26]. Nickerson et al. showed that aspiration of more than 50 ml of fluid in a MLL is a sign which predicts failure of conservative treatment [31].

As for surgical management of MLL of knee, only a few cases have been reported [26, 32–36]. Mostly are open debridement. Only two cases were reported as endoscopic debridement of MLL [26, 36]. Open debridement can result in wound complication which endoscopic debridement has the advantage of decreasing the chance of wound complication [26, 36]. Baris et al. reported a case of a 33-year-old man with MLL of knee which was treated successfully with endoscopic debridement and fibrin glue injection [26]. While Kim et al. reported a case of successful treatment of a 14-year-old boy with MLL of knee with endoscopic debridement and doxycycline injection.

9.1.2 Indications

For these superficial lesions, endoscopic resection is indicated for symptomatic ones which are recalcitrant to conservative treatment.

9.1.3 Contra-indications

- Skin infection at the planned portal sites
- Recurred lesions after previous endoscopic surgery
- Infected bursitis

9.1.4 Author Preferred Technique

9.1.4.1 Pre-operative Planning

These superficial lesions are obvious clinically. The diagnosis is confirmed by magnetic resonance imaging (Fig. 9.1) or ultrasound study. Any sign of infection or underlying pathologies of the knee joint, quadriceps tendon, and patellar tendon should be examined.

9.1.4.2 Patient Positioning

The patient is in supine position with the legs spread. A thigh tourniquet is used to provide a bloodless operative field. Fluid inflow is driven by gravity and no arthro-pump is used. A 4.0-mm, 30° arthroscope is used for this procedure.

9.1.4.3 Portal Design

Portals can be made at any point of the periphery of the lesion. Usually, two portals, one medial and one lateral to the lesions are sufficient for this procedure. These medial and lateral portals are coaxial portals and interchangeable as the viewing and working portals. The medial and lateral placement of the portals can avoid hindrance of instrument motion. If the lesion has a long longitudinal dimension, one of the portals is placed at the proximal medial corner of the lesion and the other at the distal lateral corner of the lesion or vice versa (Fig. 9.2).

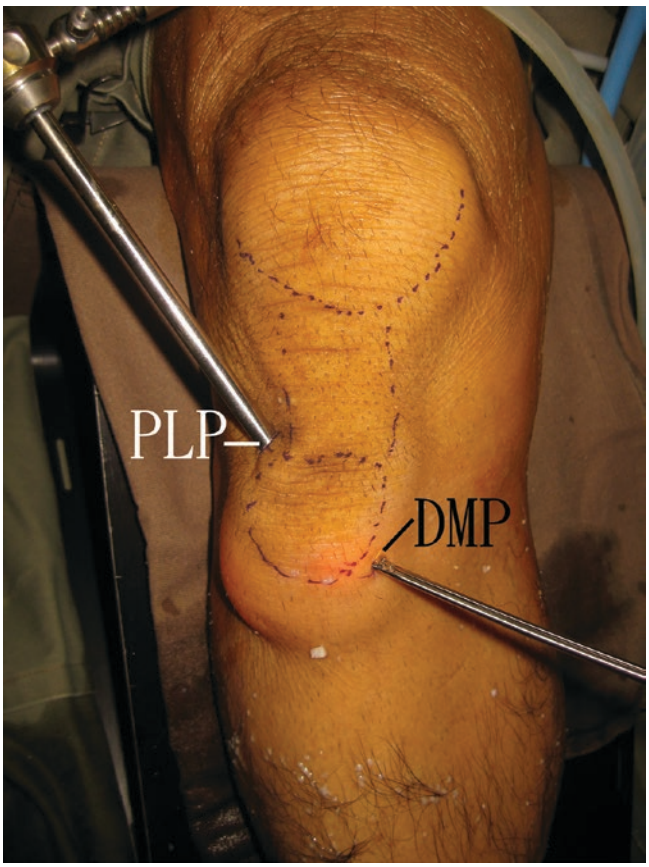

Fig. 9.2 Endoscopic resection is performed via the proximal lateral portal (PLP) and the distal medial portal (DMP)

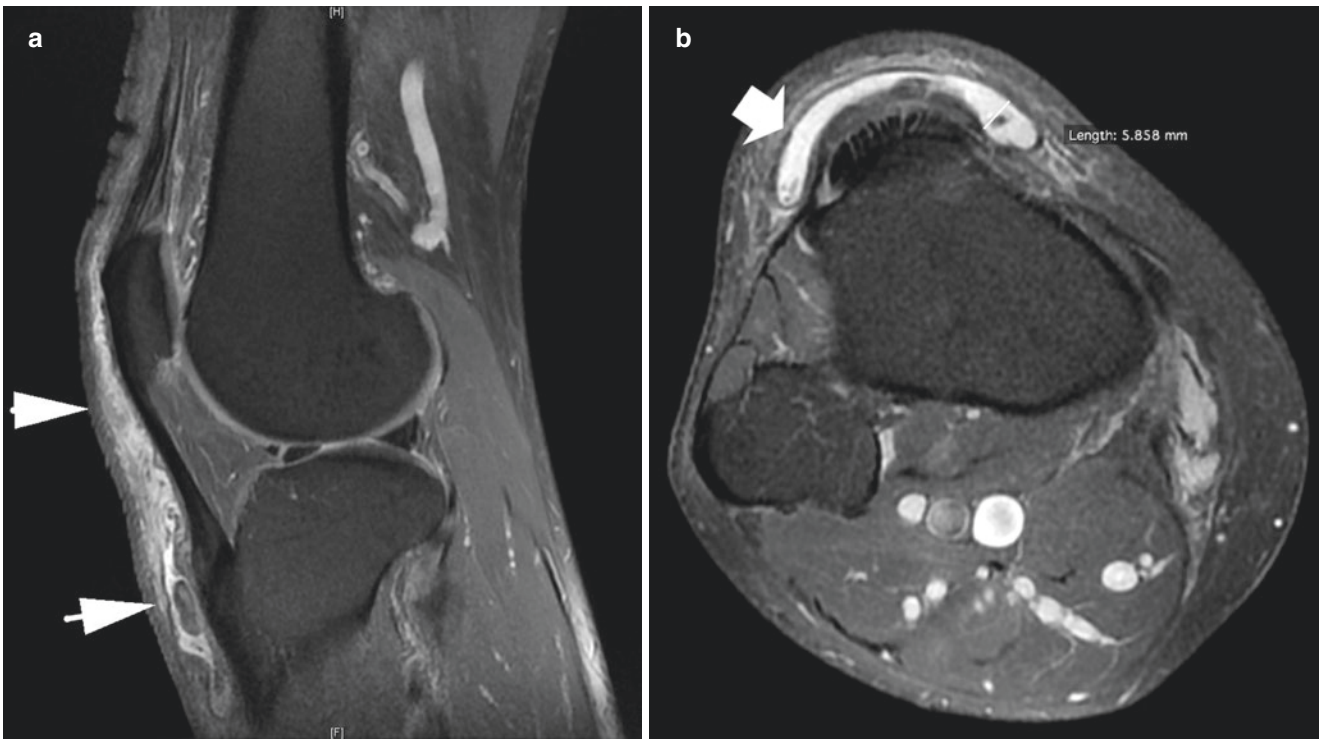

Fig. 9.1 Sagittal (**a**) and transverse (**b**) MRI views of the prepatellar bursa (arrows) of the illustrated case

9.1.4.4 Step-by-Step Description of the Technique

- 5 mm incisions are made at the portal sites.
- Intralesional approach is used for the endoscopic resection procedure. The arthroscope and arthroscopic shaver are inserted into the cavity of the lesion.
- The lesion is resected from inside out with the caution not to injure the underlying structure and the superficial nerve and vascular network (Fig. 9.3).
- The portals can be exchanged as the viewing and working portals by the switching rod technique in order to complete the resection.
- If the working space is collapsed after part of the lesion is resected and may not be distended well with gravity driven fluid inflow, an accessory portal can be used for insertion of small retractor to improve the endoscopic visualization.
- Complete resection of the lesion may not be necessary for subsequent seal off the cavity. The superficial part of the lesion may be preserved in order to avoid injury to the cutaneous nerve and dermal vascular network.
- A drain is inserted into the cavity via the distal medial portal.

9.1.4.5 Complications and Management

- Recurrence of the lesions,
- Cutaneous nerve injury,
- Injury to the cutaneous vascular network leading to patchy skin necrosis,
- Injury to the underlying structures, e.g. quadriceps tendon, patella tendon.

9.1.4.6 Post-operative Care

Compression dressing is applied for 2 weeks to facilitate seal off of the cavity. The patient can start free mobilization of the knee after the compression dressing is taken off.

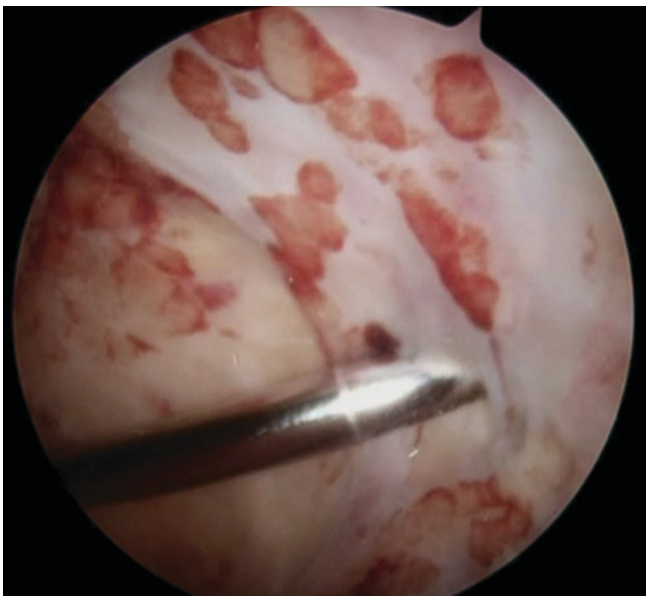

Fig. 9.3 Endoscopic view of the inflamed bursa

Full weight bearing is allowed immediately after the operation.

9.1.5 Summary

Prepatellar bursa, infrapatellar bursa, and Morel-Lavallée lesion are superficial lesions that are easily approached. However, open resection is associated with poor healing of the surgical wound, decreased sensation over scar area, contracted scar tissue, atrophic skin changes, subcutaneous collection, and scar hypersensitivity. Endoscopic resection is a minimally invasive surgical approach that may reduce the risk of complications associated with open surgery.

9.2 Endoscopic Repair of Acute Rupture of Quadriceps Tendon

Peter Wai Pan Yau and Gabriel Ching Ngai Leung

9.2.1 Introduction

- The prevalence of acute rupture of quadriceps tendon is ranged from 1.3 to 2.8 per 100,000 population [37, 38]. This condition is more commonly seen in patients older than 40 years of age [39], and with propensity for the male sex with a ratio of 9 to 1 [38].
- Histological analysis showed that degenerative changes were present in 64% of the ruptured tendons [40].
- Acute quadriceps tendon rupture typically occurred in the distal 2 cm of the tendon and in the osteotendinous junction of the superior pole of patella [41]. Avulsion fracture of superior pole of patella could be found in a small percentage of cases [39].
- Delay in diagnosis was common. The average time lapse between injury and diagnosis was 7 days (range: 1–40 days) [41]. Late surgical intervention of complete rupture of quadriceps tendon was associated with poor outcome [42]. Persistent extension lag of 5-degree and quadriceps weakness were found in 15–30% of the patients [39, 43, 44].
- Ciriello et al. (2012) published a review article on 319 open surgical repairs of quadriceps tendon rupture [41]. The most common early post-operation complications were infection (superficial wound infection: 1.2%; deep infection: 1.1%) and thromboembolic disease (2.5%). Mid-term complications included re-rupture of repair (average 2%, ranged from 0% to 8.3%) and heterotopic ossification (6.9%).

9.2.2 Indications of Endoscopic Repair of Acute Rupture of Quadriceps Tendon

- Acute or subacute complete rupture of quadriceps tendon, including:
  - Full-thickness, full-width rupture of quadriceps tendon
  - Full-thickness, partial-width rupture in athletes practicing contact sports or high demand individuals [45]

9.2.3 Contra-indications of Endoscopic Repair of Acute Rupture of Quadriceps Tendon

- Chronic full-thickness, full-width tear of more than 4 weeks
- Tear at musculotendinous junction
- Re-rupture of previous quadriceps tendon repair

9.2.4 Author Preferred Technique

9.2.4.1 Pre-operative Planning

- The diagnosis should be confirmed with pre-operative imaging (e.g., MRI or ultrasound). These provide information on the site of tear (at the osteotendinous junction or in the mid-substance) and the extent of retraction of the proximal stump.
- Use of pneumatic tourniquet and arthroscopic fluid management system is advised.
- Leg-holder system for placing the operated knee in full extension, 45-degree flexion, and 90-degree flexion will facilitate the operation.
- Arthroscopes: 30-degree 4-mm diameter arthroscope.
- Instruments: Arthroscopic manual instruments (including probes, basket forceps, graspers, and curettes) and arthroscopic knot-tying instruments (including knot pusher and knot cutter).
- Arthroscopic shaver system and arthroscopic radiofrequency system are required during the operation.
- Arthroscopic video system: the use of two video screens is advised.

9.2.4.2 Patient Positioning

- Surgery can be performed under either general or regional anesthesia with patient lying in supine position.
- Pneumatic tourniquet is inflated after the involved lower limb is exsanguinated.

9.2.4.3 Portal Design

- A total of seven portals are used in the endoscopic assisted acute quadriceps tendon repair described below. They are the anterior-lateral portal, anterior-medial portal, superior-lateral portals (high and low), superior-medial portals (high and low), and superior midline portal (Fig. 9.4).

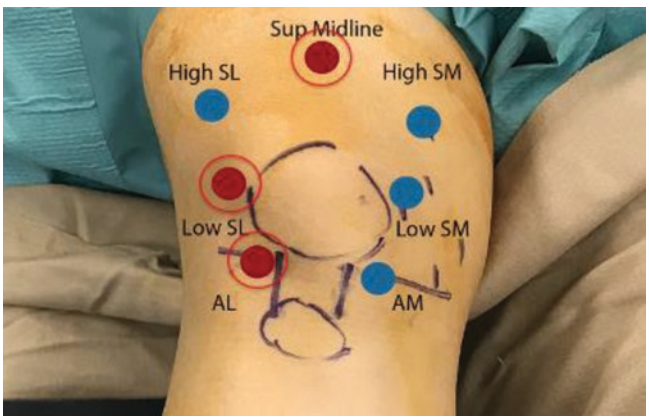

Fig. 9.4 Anterior view of knee, showing the seven portals used in endoscopic assisted quadriceps tendon repair

- The anterior-medial and anterior-lateral portals are the standard portals in conventional knee arthroscopy. They are used for diagnostic arthroscopy of the knee joint.
- The low superior-medial portal and low superior-lateral portal are established at the level of proximal patella, around 1 cm medial and 1 cm lateral to the medial and lateral border of the patella, respectively. They serve as the viewing and working portal within the suprapatellar pouch for surgery on the articular surface of quadriceps tendon.
- The high superior-medial portal and high superior-lateral portal are established at a level 2 cm proximal to the superior pole of patella, around 1 cm medial and 1 cm lateral to the medial and lateral border of the patella. They serve as the viewing and working portal within the prepatellar subfascial bursa [12] for surgery on the bursal surface of quadriceps tendon, repair of the ruptured para-patellar retinaculum, insertion of suture anchors on proximal pole of patella, and preparation of transosseous tunnel for fixation using pulled-out suture technique.
- The superior midline portal is located along the midline, at around 3–4 cm above the superior pole of patella. It is the main viewing portal during preparation of the footprint of quadriceps tendon at the superior pole of patella.

9.2.4.4 Step-by-Step Description of the Techniques

- Anterior-lateral and anterior-medial portals are established using standard arthroscopic technique. Diagnostic knee arthroscopy is performed. Concomitant intra-articular pathology (e.g., meniscus tear, cartilage lesion, etc.) is tackled.
- Knee is then put in full extension. Using the anterior-lateral portal as viewing portal and anterior-medial portal as working portal, the diagnosis of full-thickness quadriceps tendon rupture is confirmed. Debridement of the proximal stump of quadriceps tendon rupture till healthy tendon tissue is carried out (Fig. 9.5).
- Arthroscope was then introduced into the prepatellar subfascial bursa, which is a potential space between the superficial and intermediate layer of prepatellar fibrous tissue in the anterior knee region [12]. This space is easily accessible in full-thickness rupture of quadriceps tendon because the prepatellar subfascial bursa is distended and dissected by the bleeding at the time of injury. The bursal surface of the ruptured quadriceps tendon is dissected up to a level 3–4 cm proximal to the superior pole of patella. The exact level of dissection depends on the site of rupture (Fig. 9.6). The target is to view the whole width of the rectus femoris component of quadriceps tendon up to a level 2–3 cm proximal to the rupture site. After the dissection, the extent of quadriceps tendon tear (full-width versus partial-width) and the involvement of the medial and

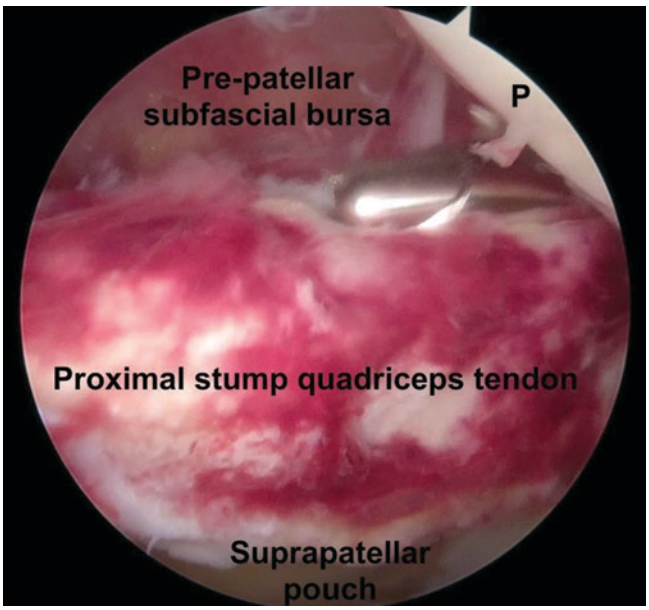

Fig. 9.5 Arthroscopic view of the rupture site of quadriceps tendon (P: Patella)

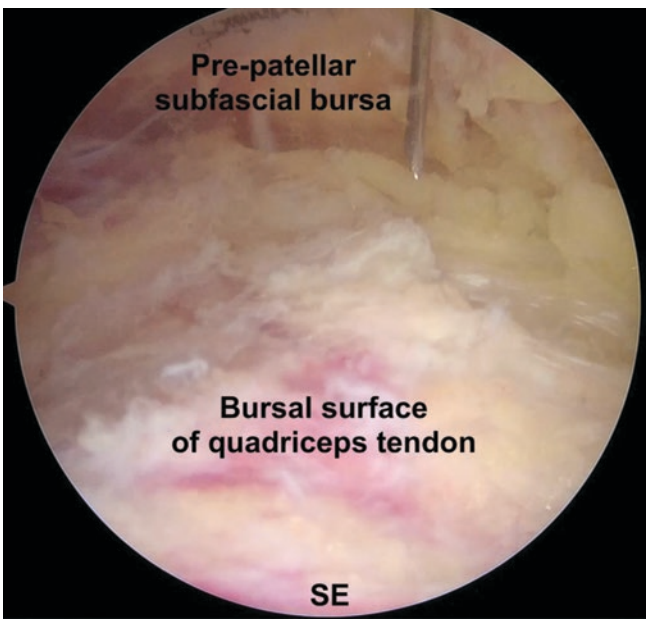

Fig. 9.6 Endoscopic view of bursal surface of quadriceps tendon within the prepatellar subfascial bursa (SE: ruptured end of proximal stump of quadriceps tendon)

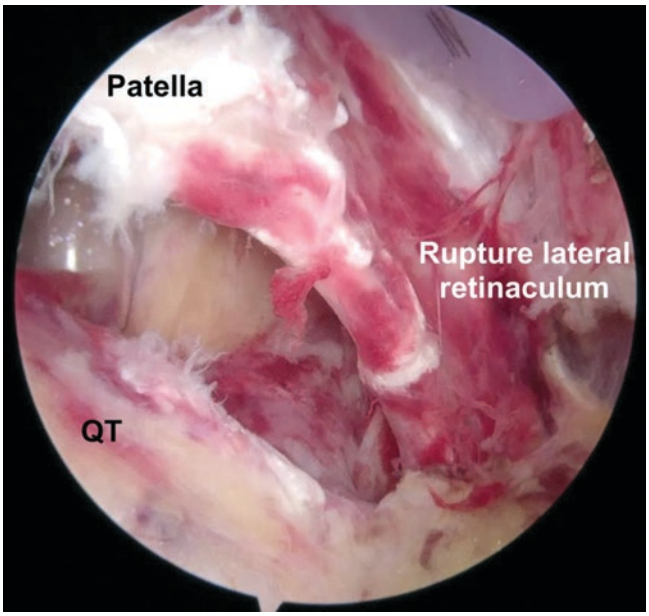

Fig. 9.7 Full-thickness, full-width tear of quadriceps tendon with concomitant full-thickness tear of lateral para-patellar retinaculum (QT: proximal stump of ruptured quadriceps tendon)

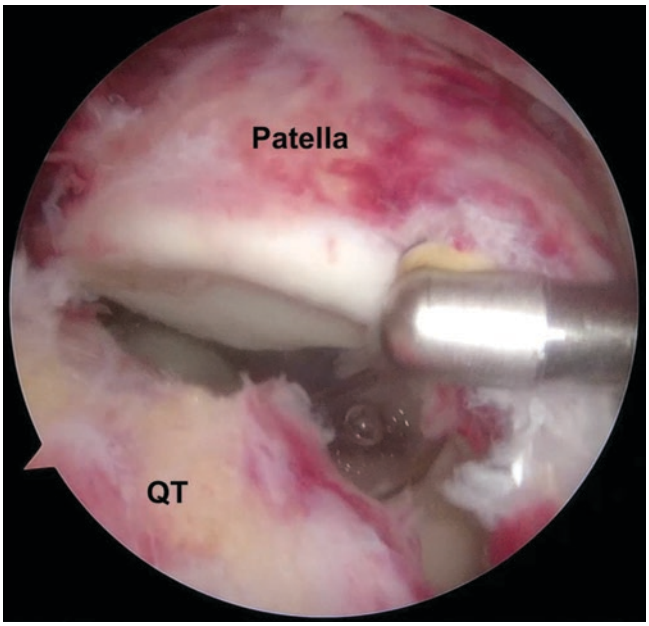

Fig. 9.8 Endoscopic view through the superior midline portal. The quadriceps tendon was found ruptured at the osteotendinous junction of the upper pole of patella (QT: proximal stump of ruptured quadriceps tendon)

lateral para-patellar retinaculum can be assessed accurately (Fig. 9.7).

- The remaining portals (low superior-medial, low superior-lateral, high superior-medial, high superior-lateral, and superior midline portals) are established.
- For majority of acute quadriceps tendon rupture (which occurs within 2 cm from its insertion in superior patella), all the above steps are performed via the anterior-lateral portal and anterior-medial portal.
- But for full-thickness mid-substance quadriceps tendon tear more than 2 cm above the insertion into superior pole of patella; and difficult cases (e.g., subacute tear with significant scarring), early establishment of the low superior-lateral and low superior-medial portals will facilitate the dissection of prepatellar subfascial bursa.
- In case of operating high grade acute partial thickness bursal side tear, one will need to establish an additional low-superior midline portal (which is located along the midline, immediately proximal to the superior pole of patella). This allows direct access into the pre-patella subfascial bursa. The two high superior portals (high superior-medial and high superior-lateral portal) and superior midline portals need to be established at this stage to allow proper dissection of the prepatellar subfascial bursa.
- Arthroscope is then introduced through the superior midline portal and the rupture of the quadriceps tendon at the patellar side is assessed (Fig. 9.8).
- During preparation of the footprint of quadriceps tendon at the superior pole of patella, it will be more convenient for the surgeon to stand in the cranial side of the operated knee. The second video screen should be placed at the end of the operation table to facilitate viewing by the surgeon.

Rupture at the Osteotendinous Junction

- For rupture at the osteotendinous junction or those within 1 cm from the insertion of quadriceps tendon, surgery is best performed by debriding the remaining distal stump and then repairing the proximal stump back to the footprint at the superior pole of patella.
- The footprint of quadriceps tendon insertion is prepared. The superior pole of the patella should be lightly decorticated to expose healthy cancellous bone. However, complete removal of the cortex should be avoided because this will compromise the pull-out strength of suture anchor. The aim is to remove all fibrous tissue on the superior pole of patella and allow the repaired tendon to heal to the bone directly.
- The repair of the tendon can be performed by two methods: (1) suture anchor technique; (2) pulled-out-suture technique.

Repair using suture anchor as distal fixation

- For repair using suture anchor as distal fixation, two to three double-loaded suture anchors should be used. The diameter of the anchors should be around 2–3 mm. Metal anchor is easy to be applied. But anchors made from other materials (e.g., all-suture anchor, bioabsorbable anchor, PEEK anchor) can be used. The author prefers to use 2.8-mm diameter all-suture double-loaded suture anchors.
- The viewing portal is the superior midline portal. The working portal is either the high superior-medial or high superior-lateral portal. The anchors should be inserted at the 11 o'clock and 1 o'clock position of the patella (Figs. 9.9 and 9.10). An optional third suture anchor can be inserted at the 12 o'clock position. During insertion of the suture anchor, the knee should be flexed to around 45-degree flexion. This allows the patella to be engaged in the trochlea and facilitate the drilling of pilot hole and the insertion of the anchors.
- After insertion of suture anchors, the viewing portal is changed to anterior-lateral portal and the knee is put in slight flexion (10–20 degree) for passing of sutures into the proximal stump.

Fig. 9.9 Anterior-posterior view of X-ray of right knee, showing the position of suture anchor at 11 and 1 o'clock position at superior pole of patella

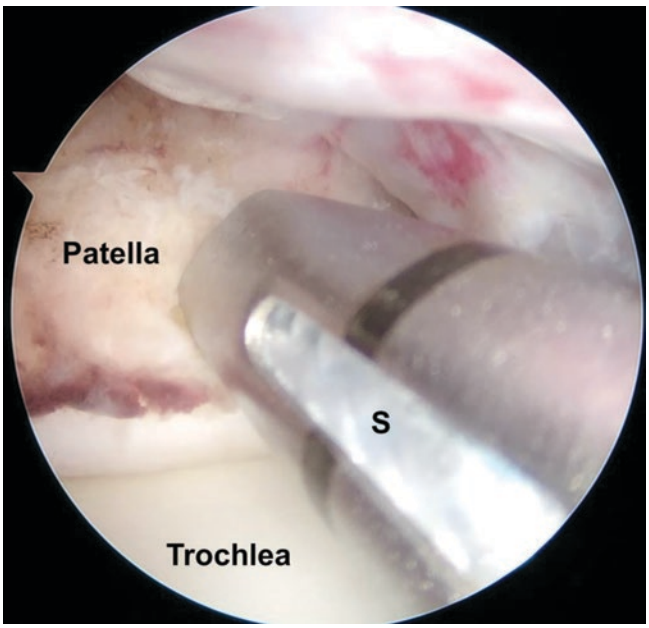

Fig. 9.10 Suture anchor insertion at the superior pole of patella (S: Suture anchor)

- If the quality of the tendon tissue in the proximal stump is satisfactory, the proximal stump can be secured with four horizontal mattress knots with sutures from the two suture anchors (Figs. 9.11 and 9.12). The four mattress knots should be placed at a distance at least 1 cm from the rupture site.
- If the quality of the tendon in the proximal stump is suboptimal, instead of mattress knots, two grasping stitches (e.g., modified Mason Allen stitch, Bunnell stitch, etc.) should be used. One should be put on the medial side and the other one on the lateral side of the tendon. Use of high-tensile strength tape is recommended to further increase the grasping power of the sutures in the proximal stump.
- During fixation of the repair, the knee should be put in full extension to reduce tension at the repair site. The viewing portal is changed to the superior-lateral portal and the arthroscope is put in the prepatellar subfascial bursa to monitor the approximation of the repair site endoscopically. The target is to ensure good approximation of tissue at the tendon–bone junction (Fig. 9.13).
- After confirming good approximation of the tendon–bone junction on the bursal side, the arthroscope is then introduced into the knee joint through the anterior-lateral portal. The quality of the repair in the articular side is assessed (Fig. 9.14).
- After confirming good approximation of tendon–bone junction in both the bursal and the articular side, the fixation is secured by tying of the knots using standard arthroscopic knot-tying technique.

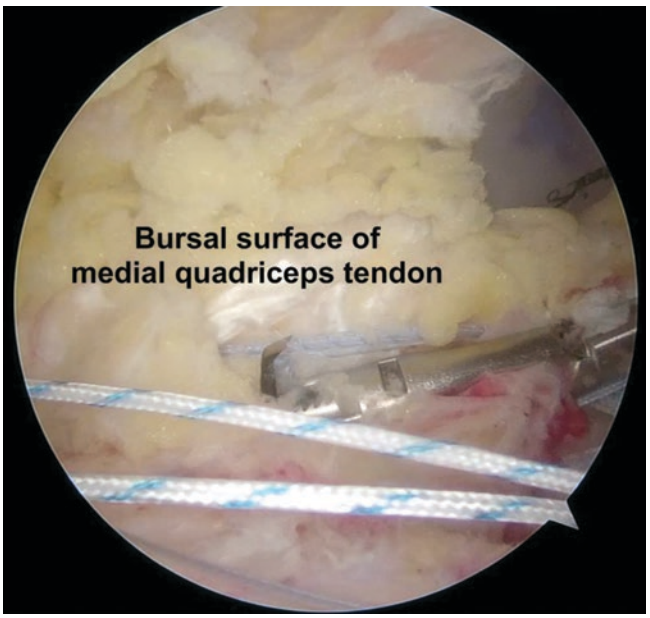

Fig. 9.11 Passing mattress stitches on the medial side of the proximal stump of quadriceps tendon rupture

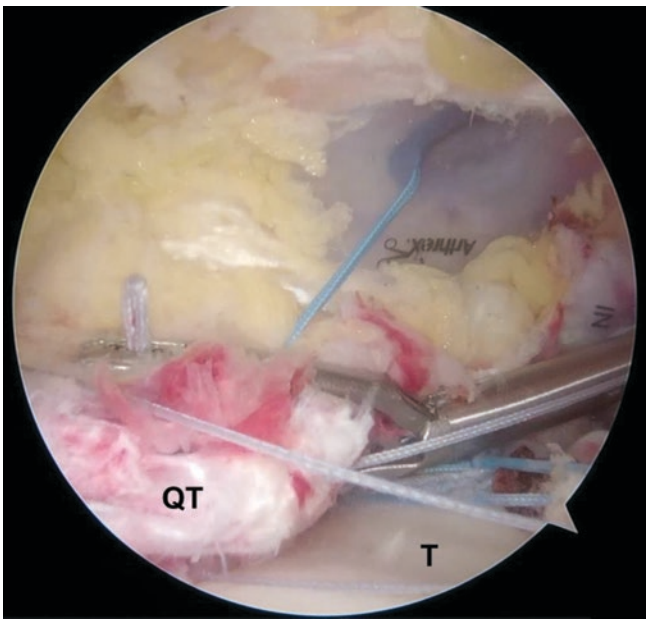

Fig. 9.12 Passing mattress stitches on the lateral side of the proximal stump of quadriceps tendon rupture (QT: Quadriceps tendon; T: Trochlea)

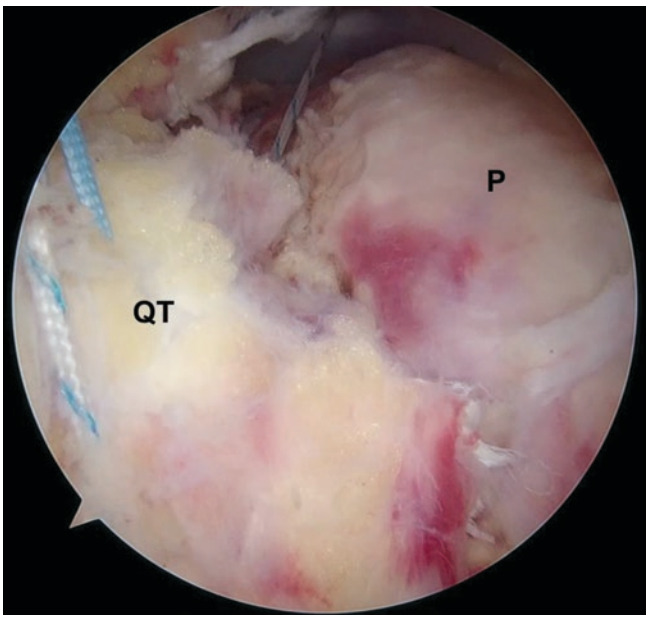

Fig. 9.13 Monitoring of the approximation of tissue at the repair site from the bursal side (QT: Quadriceps tendon; P: Patella)

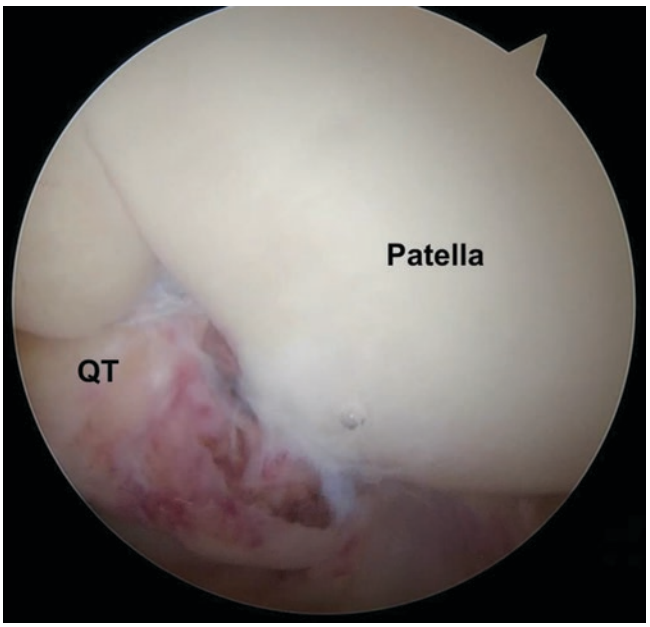

Fig. 9.14 Viewing of the approximation of tissue at the repair site from the articular side (QT: Quadriceps tendon)

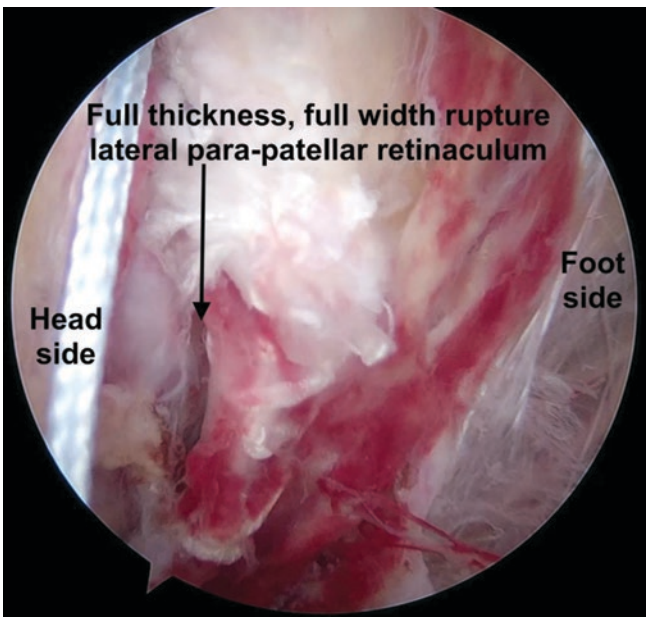

Fig. 9.15 Full-thickness tear of lateral para-patellar retinaculum (view from bursal surface within the prepatellar subfascial bursa)

- If there is concomitant full-thickness para-patellar retinaculum tear (Fig. 9.15), repair of the torn para-patellar retinaculum is done at this stage.
- Over 70% of full-thickness, full-width tear of quadriceps tendon within 2 cm from its insertion in superior pole of patella is associated with full-thickness tear of para-patellar retinaculum.
- Knee is kept in full extension. The arthroscope is put into the prepatellar subfascial bursa again through one of the superior portals. Repair of the para-patellar retinaculum is done using standard side-to-side arthroscopic repair technique with No. 2 high-tensile strength non-absorbable multi-filament suture (Fig. 9.16). If the tissue of para-patellar retinaculum is suboptimal, horizontal mattress stitch should be used (Fig. 9.17).

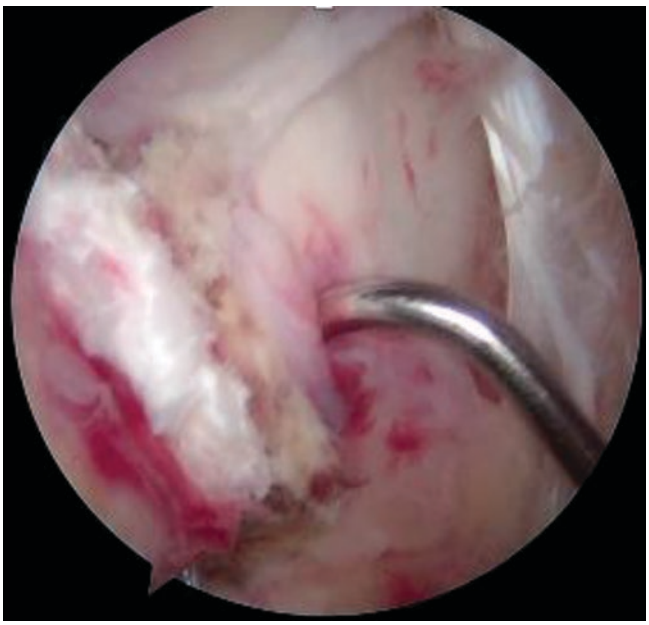

Fig. 9.16 Side-to-side repair of full-thickness tear of lateral para-patellar retinaculum using suture hook

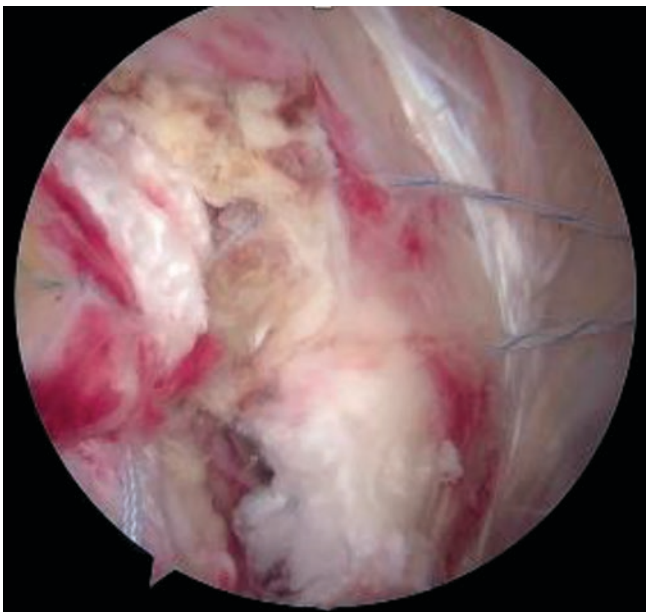

Fig. 9.17 Tying of horizontal mattress stitch for repair of lateral para-patellar retinaculum tear

- After the repair is complete, the integrity of the repair is checked (Figs. 9.18, 9.19, and 9.20).
- Portal wounds are closed in standard manner. Drain is not required as post-operation bleeding is typically minimal.
- The knee is then immobilized in full extension with a long leg back-slab.

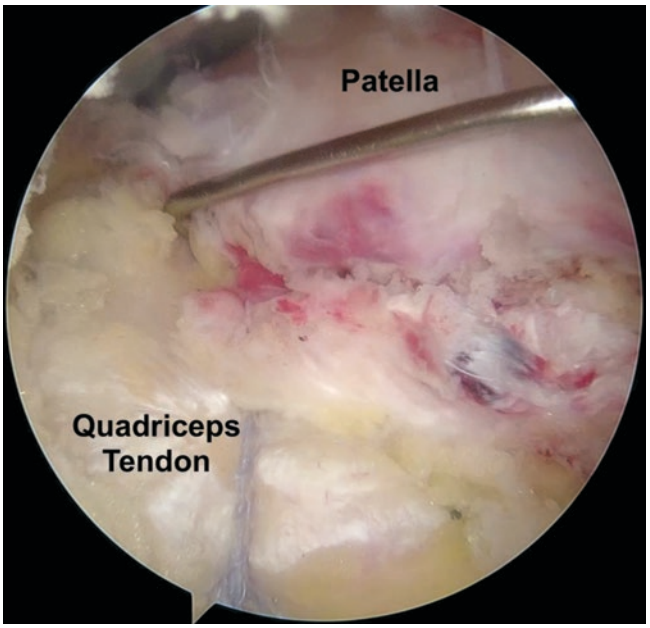

Fig. 9.18 Checking of medial part of repair of quadriceps tendon rupture (view of bursal surface within prepatellar subfascial bursa)

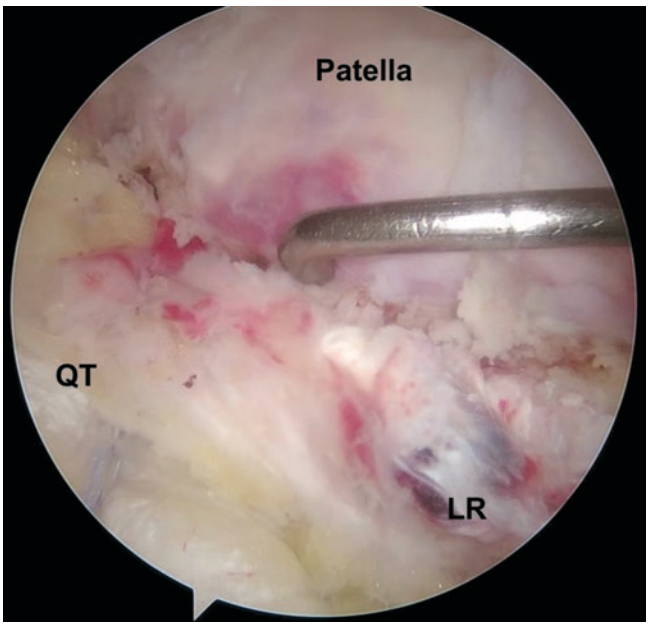

Fig. 9.19 Checking of lateral part of repair of quadriceps tendon rupture (view of bursal surface within prepatellar subfascial bursa) (QT: Quadriceps tendon; LR: Lateral para-patellar retinaculum)

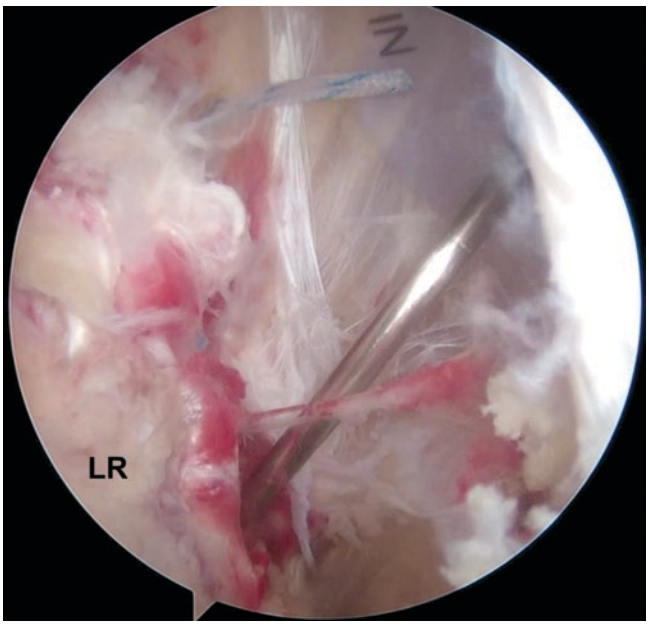

Fig. 9.20 Checking of lateral para-patellar retinaculum repair (view of bursal surface within prepatellar subfascial bursa) (LR: Lateral para-patellar retinaculum)

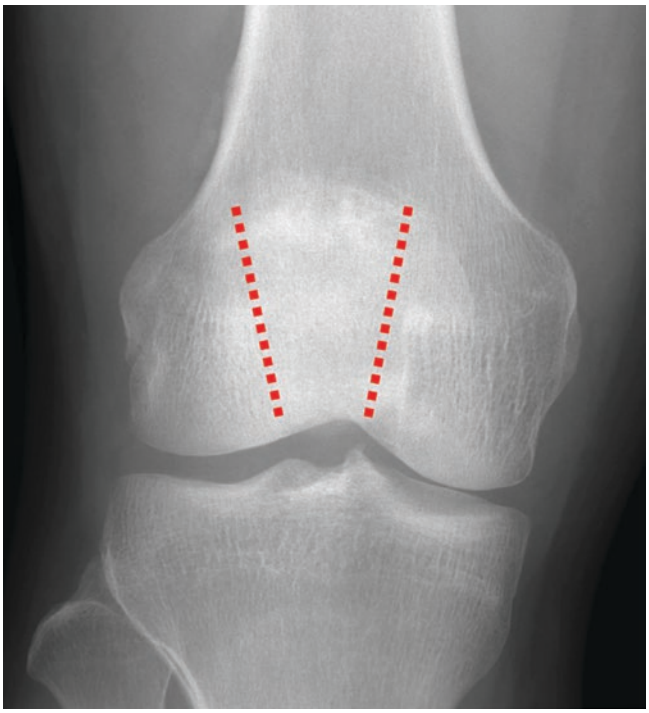

Fig. 9.21 Position of transosseous tunnels for pulled-out-suture

Repair using pulled-out-suture technique as distal fixation

- For repair using pulled-out-suture technique as distal fixation, two longitudinal transosseous tunnels are drilled in the patella with a 2.3-mm diameter guide pin. The entry sites of the guide pin are 11 o'clock and 1 o'clock position of the footprint at superior patella (Figs. 9.21 and 9.22).

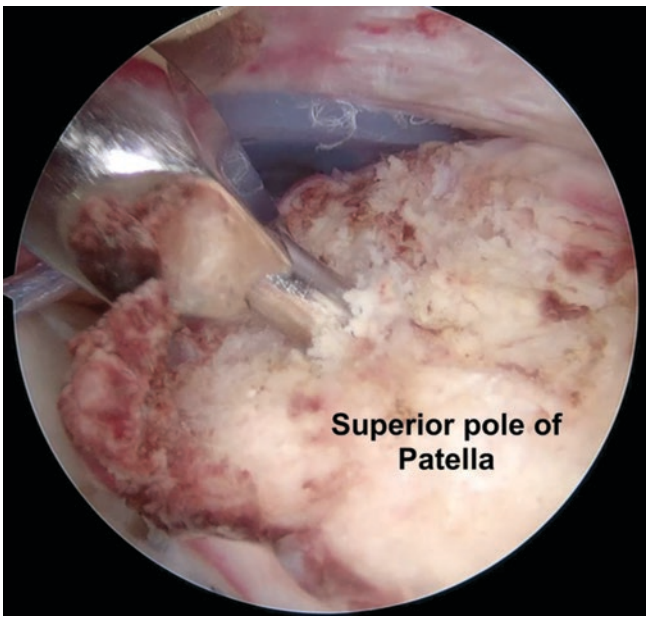

Fig. 9.22 Drilling of transosseous tunnel using 2.3-mm diameter guide pin

Fig. 9.23 A longitudinal stab wound is made in the skin at the region of patella tendon to facilitate retrieval of the transosseous suture

The exit site is the extra-articular surface at the lower pole of patella. The viewing portal is the superior midline portal. The working portal is either the high superior-medial or high superior-lateral portal. The knee should be flexed to around 45-degree flexion before preparation of the transosseous tunnels. A longitudinal stab wound is made in the skin at the region of patella tendon to facilitate retrieval of the transosseous suture (Fig. 9.23).

- The passage of the transosseous suture can be facilitated using long cannulated arthroscopic needle.
- The guide pin used in preparing the transosseous tunnel is first removed. The cannulated needle is passed into the drill hole in the proximal patella (Fig. 9.24) and the distal end is retrieved from the distal longitudinal wound through a split in the patella tendon (Fig. 9.23).
- A PDS 0 suture is first passed into the cannulated needle and is retrieved from the distal stab wound in the region of patellar tendon.
- After passing the PDS suture, the arthroscopic needle is removed (Fig. 9.25).

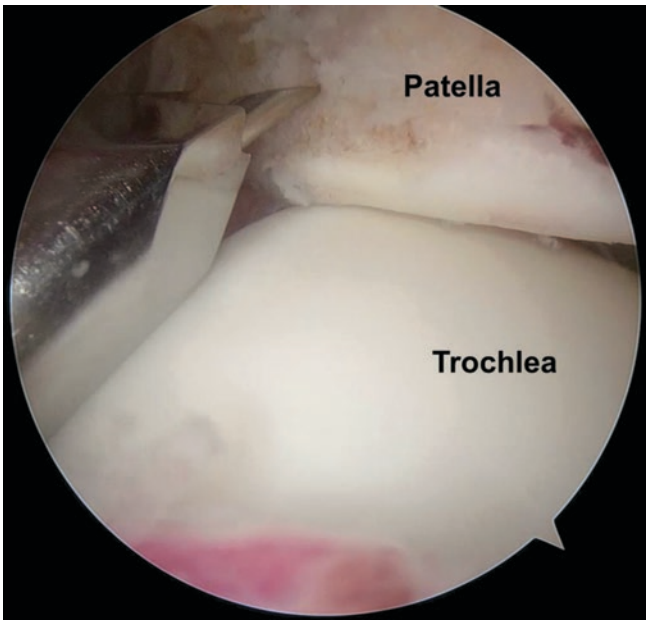

Fig. 9.24 The 2.3-mm diameter guide pin was removed and replaced by a long cannulated arthroscopic needle

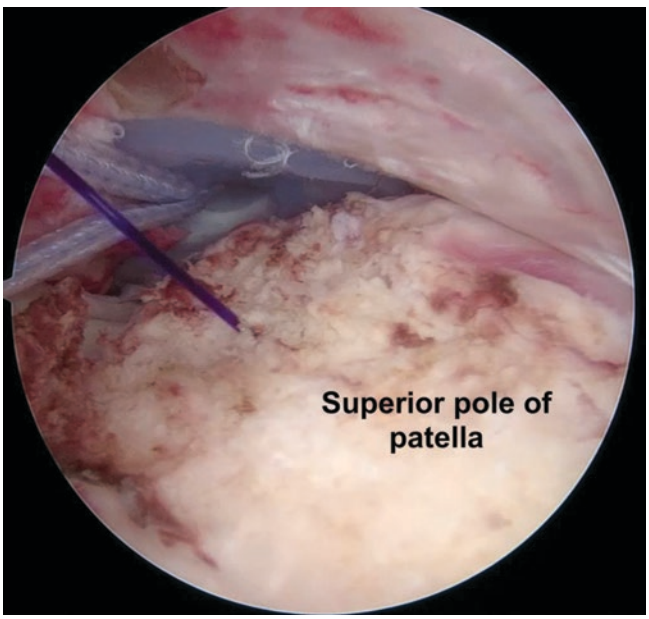

Fig. 9.25 One PDS 0 suture was passed into the cannulated needle and was retrieved from the distal wound. The arthroscopic needle was then removed, leaving the PDS 0 suture passing through the transosseous tunnel

- The PDS suture is used to relay the passage of two No. 2 high-tensile strength non-absorbable multi-filament suture (Fig. 9.26) through the transosseous tunnel. The distal stumps of the transosseous suture are retrieved from the distal wound.
- Afterwards, the surgeon should start to prepare the proximal stump for insertion of two grasping stitches. The knee is put in 10–20-degree of knee flexion. The anterior-lateral portal is used as the viewing portal. The superior-medial and superior-lateral portals are used as the working portals.
- Two grasping stitches are placed in the medial and lateral aspect of the proximal stump of quadriceps tendon using either modified Mason Allen stitch or Bunnell stitch.
- It is important that to ensure good endoscopic view of the bursal surface of the proximal stump of quadriceps tendon within the prepatellar subfascial bursa (Fig. 9.27) and good arthroscopic view of the articular surface of quadriceps tendon within the suprapatellar pouch (Fig. 9.28) during insertion of stitches in the proximal tendon stump.

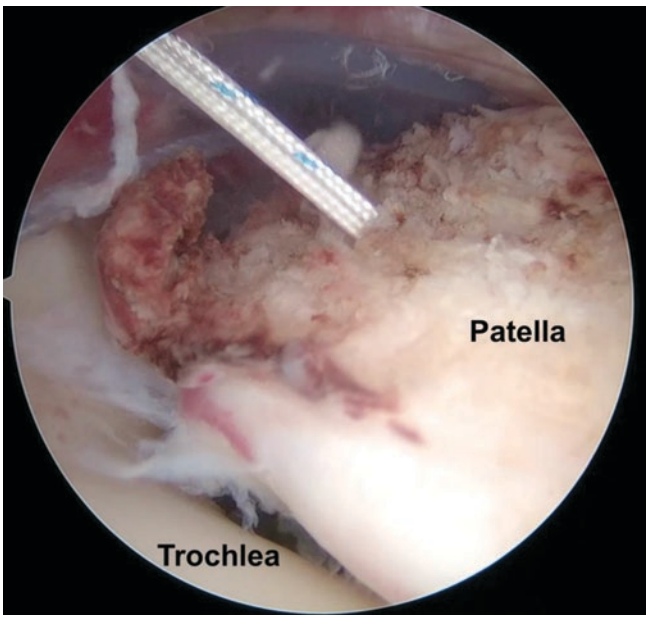

Fig. 9.26 The PDS suture is used to shuttle two high-tensile strength multi-filament non-absorbable sutures through the transosseous tunnel

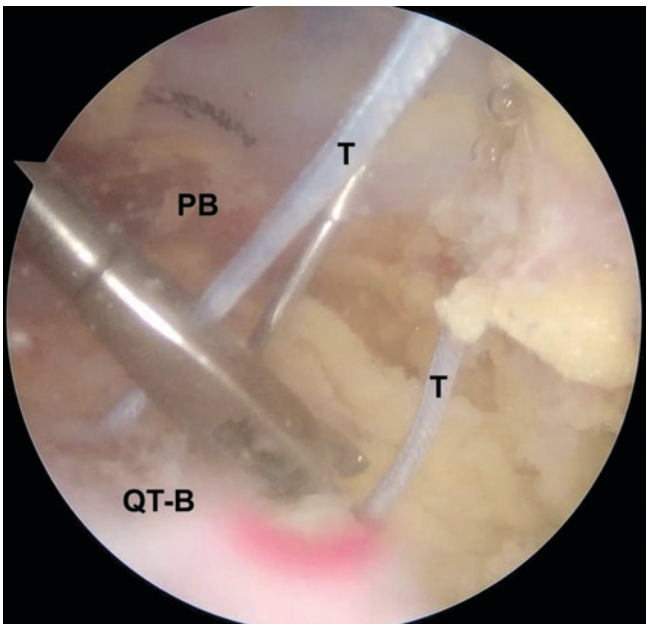

Fig. 9.27 Endoscopic view of bursal surface of proximal stump of quadriceps tendon rupture (QT-B: Bursal surface of quadriceps tendon; T: High-tensile strength multi-filament tape; PB: Prepatellar subfascial bursa)

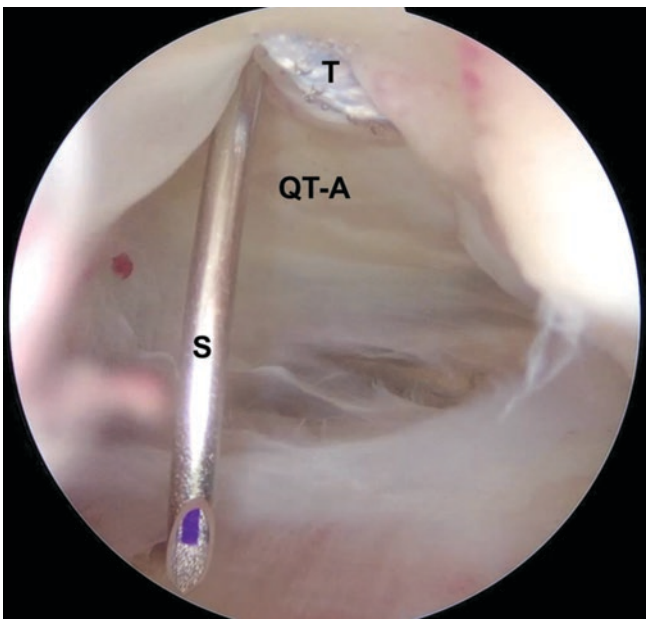

Fig. 9.28 Arthroscopic view of articular surface of proximal stump of quadriceps tendon rupture (QT-A: Articular surface of quadriceps tendon; T: High-tensile strength multi-filament tape as horizontal limb of modified Mason Allen stitch; S: Relay suture for passing vertical limb of modified Mason Allen stitch)

- Two grasping stitches are placed in the medial and lateral aspect of proximal stump of quadriceps tendon rupture (Figs. 9.29 and 9.30). The use of high-tensile strength multi-filament non-absorbable tape increases the mechanical strength of these grasping stitches and reduces the chance of failure of the repair.
- The free ends of the two grasping stitches are then shuttled through the two transosseous tunnel in the patella (Fig. 9.31) and retrieved from the distal stab wound in front of the patella tendon.
- During fixation of the repair, the knee is kept in full extension (Fig. 9.32). The transosseous pulled-out suture is tied at the distal end of patella, anterior to the patellar tendon.

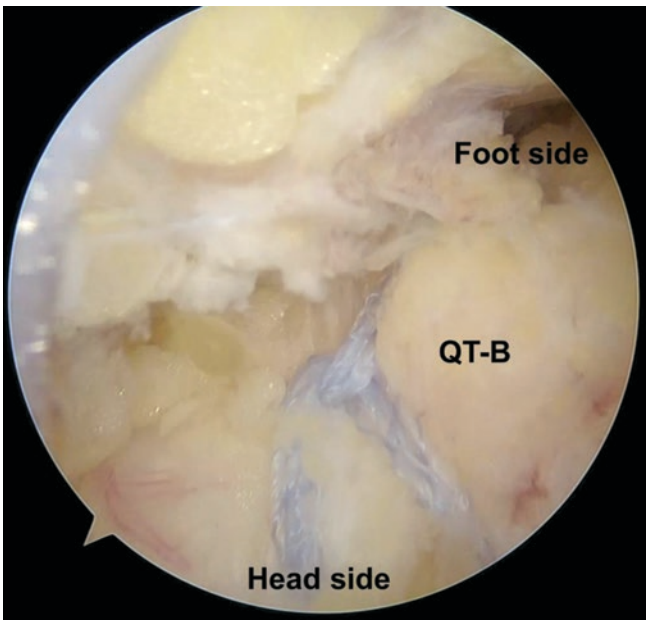

Fig. 9.29 Bursal view of a modified Mason Allen stitch put in the medial side proximal stump of quadriceps tendon with tape (QT-B: Bursal side of quadriceps tendon)

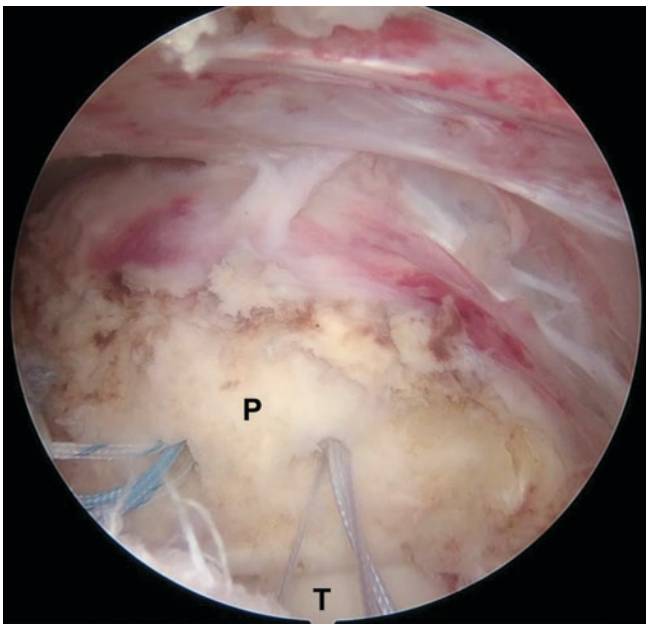

Fig. 9.31 No. 2 high-tensile strength multi-filament non-absorbable suture helps to shuttle the free end of the grasping stitches through the transosseous tunnel (P: Patella; T: Trochlea)

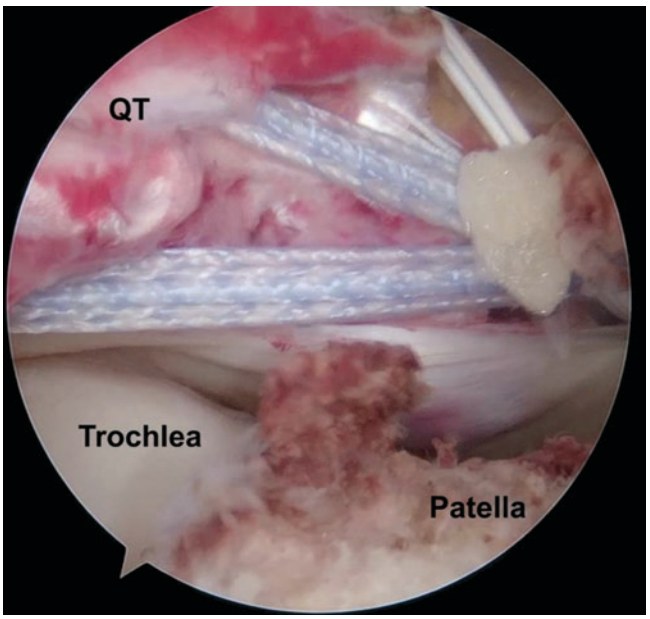

Fig. 9.30 Arthroscopic view of modified Mason Allen stitch with tape at the osteotendinous junction (QT: Rupture end of proximal stump of quadriceps tendon)

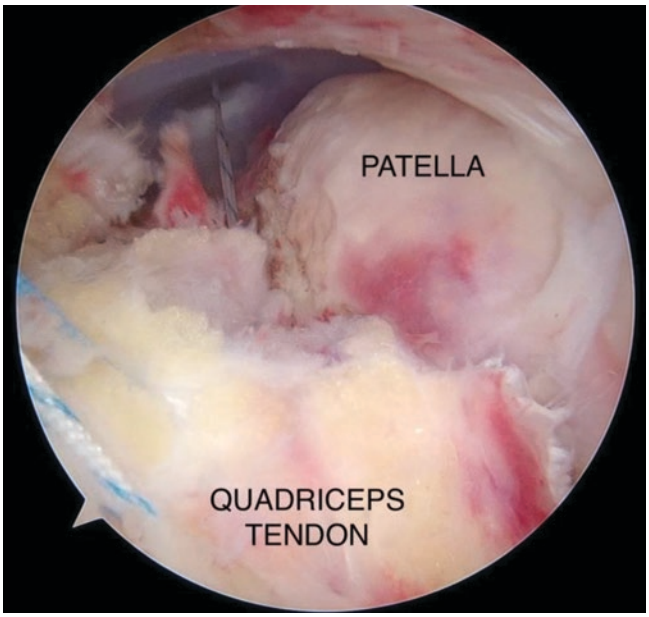

Fig. 9.32 Just before tying of transosseous pulled-out-suture

- The repair of the para-patellar retinaculum is then carried out and the quality of the repair is then checked as described above.

Rupture at the mid-substance

- For rupture at the mid-substance of quadriceps tendon with a distal stump of adequate length, the repair can be done as an end-to-end repair between the two stumps of the quadriceps tendon. The pre-requisite is that the remaining stumps should be healthy enough to allow insertion of grasping stitch to facilitate a strong repair.
- The steps in the placement of the two grasping stitches in the proximal stump are the same as the one described in the section of the pulled-out-suture technique.
- During placement of the grasping stitches in the distal stump, the viewing portal is switched to the superior midline portal. Two grasping stitches are placed in the distal stump of rupture quadriceps tendon.
- The repair is secured by tying the grasping stitches on the proximal stump and that of the distal stump together with knee in full extension. Any full-thickness tear of para-patellar retinaculum is then repaired.

9.2.4.5 Complications and Management

- The author performed a total of seven endoscopic assisted repair of acute quadriceps tendon rupture. There was no early complication (including infection, wound problem, hematoma, neurovascular complication, deep vein thrombosis, and fracture).
- There was one case of re-rupture of quadriceps tendon repair at 3 months after the index operation. The case belonged to a 55-year-old gentleman suffering from simultaneous bilateral quadriceps tendon rupture at the osteotendinous junction. The time lag between injury and surgery was 16-days. One-stage bilateral endoscopic assisted quadriceps tendon repair was performed. The right side healed uneventfully, but the left side re-ruptured at 3-month after the index operation. Revision open repair without augmentation was performed. The proximal stump was repaired to the superior pole of patella using combination of pulled-out suture technique and suture anchor as distal fixation. The revised repair healed uneventfully.

9.2.4.6 Post-operative Care

- Patient's knee is immobilized in long leg cast kept in full extension for 6 weeks. Full weight bearing walking is practiced.
- The cast is taken off from post-operation 7 weeks onwards. This is followed by active and passive mobilization of the operated knee and quadriceps muscle strengthening exercise.
- Squatting is not allowed within the first 3 months.
- Return to pre-injury sport is not advised within the first 6 months.

9.2.5 Summary

- Endoscopic assisted repair of acute quadriceps tendon is a simple operation with good clinical outcomes. Early post-operation complications are rare. Range of motion is usually well preserved.
- A small percentage of patients still suffer from subjective quadriceps weakness and re-rupture of the repair site.
- This operation is indicated in closed, full-thickness rupture of quadriceps tendon at the osteotendinous junction or mid-substance level.

9.3 Tendoscopy of Patellar Tendon and Endoscopy of the Hoffa Fat Pad

Tsz Lung Choi and Tun Hing Lui

9.3.1 Introduction

There are three fat pads found in anterior knee joint compartment, the infrapatellar (Hoffa), quadriceps, and pre-femoral fat pads. The Hoffa fat pad is an intracapsular but extra synovial structure, covered by synovial membrane posteriorly [46]. Gallagher et al. revealed that Hoffa fat pad comprised a central body with medial and lateral extension [46]. Hoffa fat pad is inferior to the inferior pole of patella, posterior to patellar retinacula and patellar tendon (from which the deep infrapatellar bursa separated Hoffa fat pad). The posteroinferior part of the Hoffa fat pad is related to the anterior tibia and anterior horns of the menisci, while the posterior part of the Hoffa fat pad is related to the femoral condyles and intercondylar notch. The Hoffa fat pad is attached to the intercondylar notch by the ligamentum mucosum. The nerve supply of the Hoffa fat pad is mainly from the posterior tibial nerve [47]. The infrapatellar fat pad would be metabolized only in severe malnutrition, implying that it has an essential role in joint function [46, 48].

The Hoffa fad pad acts as a space filler. It may enhance the gliding between the joint capsules and femoral condyles [49]. Inflammation of the Hoffa fat pad can cause bulging on either side of the patella tendon with the synovial membrane compressed against the femoral condyles. It may give rise to pain and effusion [50]. For example, reduced joint space in osteoarthritis may also compress on Hoffa fat pad and result in similar symptoms [51]. Another example is Hoffa's disease, with inflammation and subsequent hypertrophy, compression and trapping of the fat pad. It is characterized by anterior knee pain, functional impairment, and often a bulky effusion. Magnetic resonance imaging would show fibrotic trabeculae and liquid infiltration of fat pads and synovial recesses [52], with an ossifying chondroma being implicated as end-stage Hoffa's disease [53]. Ganglion or meniscal cysts may also increase pressure over Hoffa fat pad and cause symptoms like pain and effusion [46]. Other causes of abnormalities with the Hoffa fat pad include trauma (e.g., post-traumatic or post-surgery fibrosis), synovial diseases (e.g., pigmented villonodular synovitis) and rarely, neoplasm [54].

Injection of hydrocortisone and local anesthetic to the Hoffa fat pad can reduce pain and improve range of motion for the duration of the action of the local anesthetic. Complete or partial resection of Hoffa fat pad can improve symptoms and knee function [55, 56]. It can be done in open surgery or in endoscopy approach. However, Resection of the Hoffa fat pad has been associated with a decrease in patellar blood supply [57].

The patellar tendon extends distally from the infrapatellar pole to the tibial tuberosity. Embryologically there is a single tendon attaching the quadriceps to the tibia in which a mesenchymal condensation develops and becomes the patella, a sesamoid bone. The formation of the patella separates the tendon into two regions, the quadriceps and patellar tendons [58]. The patellar tendon is 25–40 mm wide, 4–6 cm long, and 5–7 mm thick [59, 60]. At the site of bone–tendon junctions of patellar tendons, there is a fibrocartilaginous enthesis with four tissue zones—dense fibrous connective tissue, uncalcified fibrocartilage, calcified cartilage, and bone [61]. The posterior aspect of the patella consisted of an articular zone and a non-articular zone, devoid of patellar tendon attachment and covered by a fold of synovial tissue. The patellar tendon is thin and broad proximally, becoming thick and narrow distally, since the fiber bundles converge as they run towards the tibial tuberosity. In the frontal plane the angle that the bundles formed with the midline axis of patellar tendon is estimated to be 2 degrees in the anterior layers and about 4 degrees in the posterior layers. The patellar tendon becomes narrow toward its tibial attachment. This reflects the shape of the bony attachments of patellar tendon. There is a transition from the flat frontal plane characteristic of the patellar attachment to a medio-laterally convex attachment on the tibial tuberosity [59].

Patellar tendon pathology typically occurs at the enthesis site; in most cases it occurs at the inferior pole of the patella, but it can occur at the tibial tuberosity [62, 63]. Patellar tendinopathy is an overuse injury with the onset typically characterized by no single specific traumatic injury event but gradually increasing tendon pain [58]. There are intrinsic factors and extrinsic risk factors for patella tendinopathy. Intrinsic factors include sex, race, bone structure, bone density, muscle length, muscle strength, joint range of motion, and body composition [58]. Extrinsic factors include training volume, types of conditioning activities, types of sports, surface of training, and environmental conditions [58].

The mainstay of treatment for patella tendinopathy is reduced level of activity or training volume for tendon healing while maintain basic level of exercise to maintain tendon length and strength [58]. Eccentric quadriceps exercise had been discussed in literatures [64–67]. Oral nonsteroidal anti-inflammatory drugs (NSAIDs) and injections of corticosteroids can also reduce inflammation and pain in patellar tendinopathy. Almekinders et al. reported oral NSAIDs may result in some pain relief but the effect on patellar tendon is not known [68]. Fredberg et al. reported injection of corticosteroid in patellar tendon can result in significant reduction in pain and tendon thickness [69].

Operative treatments only reserved for those who do not response to maximal conservative treatments. Principle of operative treatment is excision of diseased tendon tissue, stimulation of active healing response by scarification or drilling on the non-articulating part of distal patellar, and reattachment of tendon to maintain tendon integrity when necessary [70]. It can be achieved by open method or minimal invasive approach such as tendoscopy.

9.3.2 Indications

1. Intrinsic pathology of the Hoffa pad, e.g. intracapsular chondroma, localized nodular synovitis, post-surgery or post-traumatic fibrosis, that is not responsive to conservative treatment [54].
2. Extrinsic pathology of the Hoffa pad, e.g. pigmented villonodular synovitis (PVNS), meniscal cyst [54].
3. Painful bony fragment at the tibial tuberosity as a result of Osgood-Schlatter disease or tophaceous tuberosity [71].
4. Gouty tophus around the patellar tendon [72].
5. Chronic patellar tendinitis and tendinosis [73].
6. Resistant bursitis around the patellar tendon [73].
7. Jumper's knee [73].
8. Synovial lipoma of the patellar tendon [73].

9.3.3 Contra-indications

1. Extensive involvement of the patellar tendon by paratendinous pathology
2. Active infection at the planned portal sites
3. Malignant lesions
4. Vascular lesions

9.3.4 Author Preferred Technique

9.3.4.1 Pre-operative Planning

Magnetic resonance impinging is important to determine location of the pathology and its extent especially the degree of involvement of the patellar tendon.

9.3.4.2 Patient Positioning

The patient is in supine position with a thigh tourniquet to provide a bloodless operative field. The knee can be supported with a triangular frame to keep the knee and hip flexed. The knee can be extended to facilitate approach to the tibial and patellar insertion of the patellar tendon.

9.3.4.3 Portal Design

Portals can be made at any point along the medial and lateral edges of the patellar tendon. The exact locations of the portals depend on the location of pathology. During tendoscopy, different working zones related to the patellar tendon can be accessed:

- Anterior surface of patellar tendon
- Medial and lateral edge of the patellar tendon
- Posterior surface of the patellar tendon
- Hoffa fat pad
- Knee joint

In general, the classic anteromedial and anterolateral portals of knee arthroscopy can be used to approach all working zones related to the patellar tendon. Placement of portals not at the level of the knee joint will affect access to the knee joint proper.

In case of gouty tophus around the patellar tendon, the portals should be placed away from the skin invaded by the tophus in order to prevent unhealed surgical wound with persistent tophaceous discharge.

If the pathology is located at the tibial insertion of the tendon, portal just proximal to the insertion is useful as working portal.

9.3.4.4 Step-by-Step Description of the Technique

- The patella, patellar tendon, and the lesion are outlined with skin marker. Five millimeters incisions are made at the portal site.
- The subcutaneous tissue is bluntly dissected down to the lesion or the respective working zone locating the lesion.
- Whenever possible, extralesional approach is preferred rather than intralesional approach when starting the

endoscopy. A plane superficial to the lesion and the tendon and deep the superficial fascia is developed by a hemostat. This serves as the initial endoscopic working space and allows identification of the lesion and its relationship with the surrounding structure before starting the resection (Fig. 9.33).

- The patellar tendon is the important and consistent endoscopic landmark during patellar tendoscopy.
- The portals are interchangeable as the viewing and working portals.
- The synovial membrane between the Hoffa fat pad and the knee joint proper should be preserved if the knee joint is not involved by the lesion.
- Intra-operative fluoroscopy can be used to identify the osseous lesion, e.g. bony fragment at the tibial tuberosity.
- For lesions surrounding the patellar tendon, circumferential debridement can be performed via the portals (Fig. 9.34).

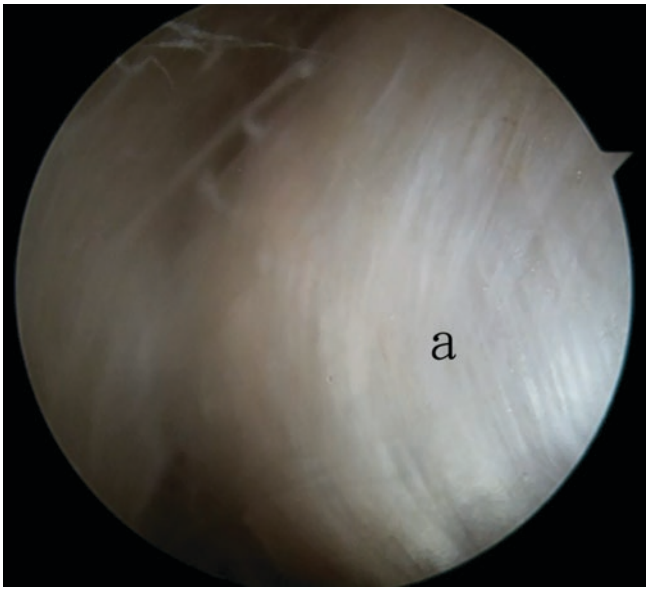

Fig. 9.33 Patellar tendoscopy is performed with the initial working plane superficial to the patellar tendon and its lesion (a)

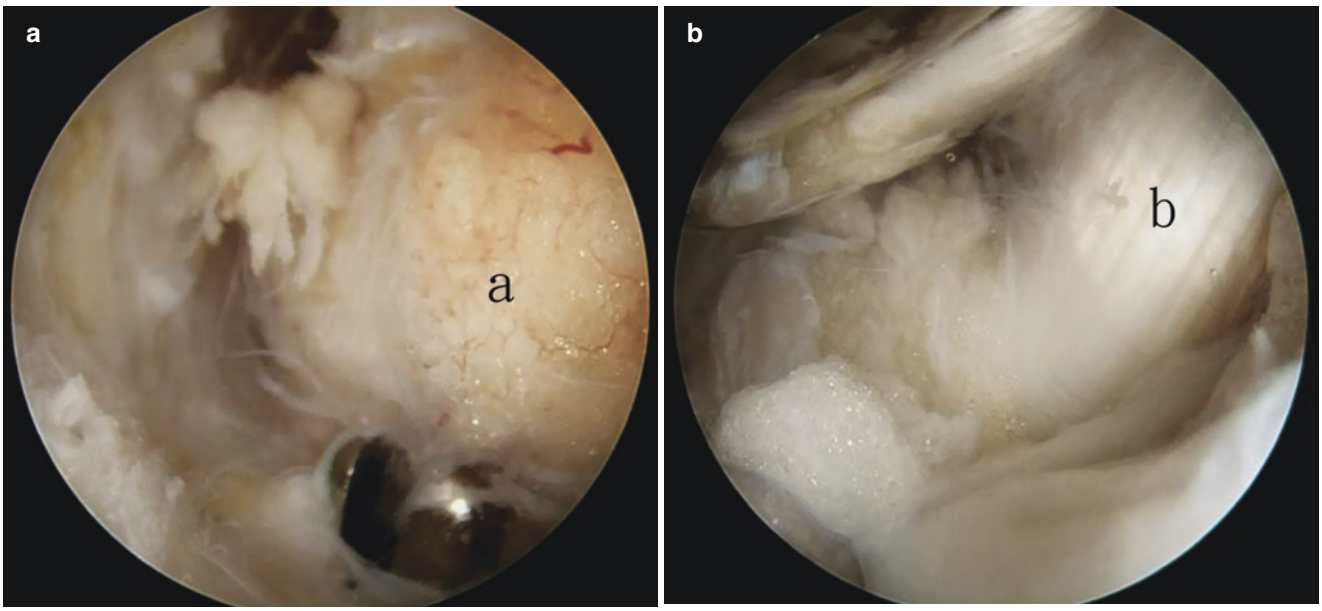

Fig. 9.34 (**a**,**b**) The synovial lipoma (a) surrounding the patellar tendon (b) is resected endoscopically

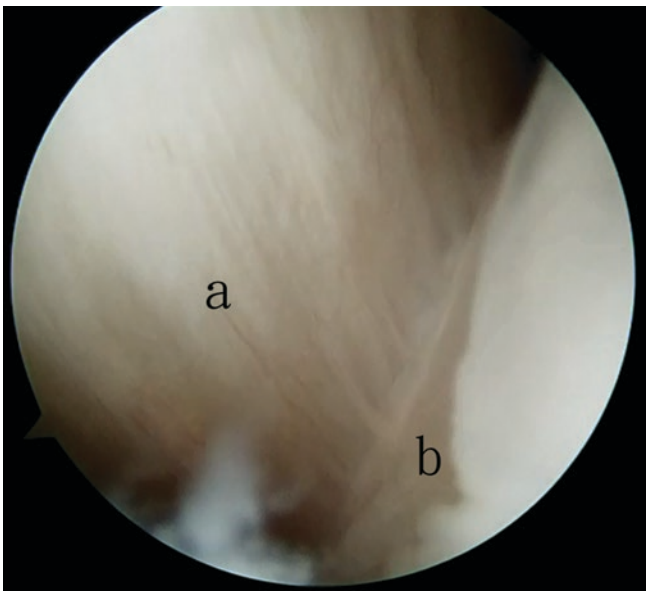

Fig. 9.35 Knee extension can facilitate approach to the tibial insertion of the patellar tendon. a: Patellar tendon; b: tibial tuberosity

- For lesions deep to the patellar tendon and close to its tibial insertion, access can be facilitated by knee extension relaxing the patellar tendon (Fig. 9.35). Access to the tibial insertion of the tendon via proximal portals may be limited as the freedom of motion of the arthroscopic instruments can be hindered by the patella. A distal portal close to the tendon's tibial insertion will be a useful working portal.
- The Hoffa fat pad is pyramidal in shape with the anterior synovial membrane of the knee joint very close to the patellar insertion of the patellar tendon. Caution should be paid not to breach the thin anterior synovial membrane of the knee joint during endoscopic resection of lesion at this area, in order to avoid spreading of the lesion (e.g., PVNS) into the knee joint.
- For lesion at the Hoffa fat pad, the space is obscured by fatty tissue and identification of lesion in this zone can be difficult. The appropriate endoscopic approach can be determined by careful study of the MRI about the location of the lesion related to the patellar tendon and the anterior synovial membrane of the knee joint. If the lesion is close to the deep surface of the patellar tendon, the initial endoscopic working space is developed at the deep surface of the tendon by hemostat via the portals and the fatty tissue is resected from anterior to posterior till the lesion is seen (Fig. 9.36). If the lesion is abutting to the anterior synovial membrane of the knee joint, knee arthroscopy can be performed and the anterior synovial membrane is resected to expose the lesion. However, this is chance of spreading of the disease into the knee joint. This approach is more appropriate if the knee joint is already involved by the disease.

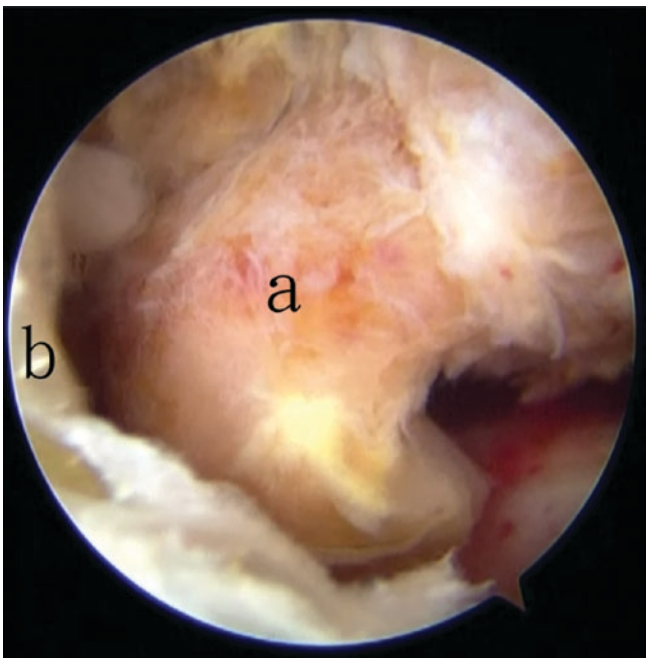

Fig. 9.36 Endoscopy of the Hoffa fat pad. a: Nodular PVNS of the Hoffa fat pad; b: patellar tendon

9.3.4.5 Complications

- Injury to the infrapatellar branch of saphenous nerve
- Spreading of pathology, e.g. PVNS
- Injury to the patellar tendon and its patellar or tibial insertion

9.3.4.6 Post-operative Care

Free mobilization of the knee is allowed immediately after the procedure. Physiotherapy can be offered to control local soft tissue edema and strengthening exercise.

9.3.5 Summary

Patellar tendoscopy and endoscopy of the Hoffa fat pad are useful minimally invasive approaches to deal with different pathologies of the patellar tendon and the Hoffa fat pad with the advantages of better cosmetic result, less post-operative pain, and less surgical trauma.

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