Technical Note

Anatomical Double-Row Lateral Meniscus Root Repair Using Suture Anchors

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Abstract: Posterior lateral meniscus root tear leads to extrusion of meniscus and increased instability of knee joint. This leads to loss of hoop stresses with increased and progressive wear of cartilage. Conservative management of root tear in the absence of osteoarthritis is ineffective, and meniscus root repair results in delayed progression of osteoarthritis and improved clinical outcomes. Lateral meniscus root, having a larger surface area, needs a stiffer and secure fixation. Our double-row meniscus root repair technique allows a larger contact area for healing, better biomechanics, low retear, and no tunnel interference with concomitant procedure.

Meniscus root tear comprises of 10% to 21% of all meniscal tear pathology. Lateral meniscus root tear has an incidence of approximately 12% in association with anterior cruciate ligament (ACL) injury. Untreated meniscus root tear leads to altered biomechanics, increased contact pressure, and rapid progression of articular cartilage damage, eventually leading to osteoarthritis. Posterior horn of the lateral meniscus has an additional role in stabilizing the knee joint, and its tear increases pivot shift, ultimately leading to graft failure.[1] Meniscus root tear is considered equivalent to total meniscectomy.[2] Even if root repair is done but is nonanatomical, it is equivalent to a total meniscectomy.[3,4] Good anatomical reduction and proper healing of the lateral meniscus root is essential to reduce the hoop stresses and increase stability of the knee joint. Various techniques described for meniscus root repair include the transtibial pull-out single-tunnel,[5] double-tunnel,[6] all-suture anchor,[7] triple-loaded suture anchor,[8] and knotless anchor technique.[9,10] We describe our technique for posterior horn lateral meniscus root tear repair using double-row lateral meniscus repair, medial row with all sutures, a 1.6-mm double-loaded FiberTak anchor, and lateral row with the Biocomposite Knotless PushLock 2.9-mm anchor (Arthrex, Naples, FL).

Surgical Technique (With Video Illustration)

Positioning

Under spinal anesthesia, the patient is positioned supine on the operating table with the knee in 90° of flexion at the edge of the table on the affected side in such a way as to have adequate space for the surgeon to create posterolateral and posteromedial portals (Fig 1). A thigh support is placed just proximal to the knee at mid-thigh level. The tourniquet is placed high on the thigh.

The operative site is prepared with an aseptic sterile technique. Draping is done in the standard way. The lower limb is exsanguinated, and the tourniquet is inflated.

Operative Steps

Arthroscopy and Portal Placement

A standard anterolateral portal is made 1 cm above the joint line and just next to the patellar tendon in a palpable soft spot. A second anteromedial portal is made 1 cm above the joint line and 1 cm medial to the patellar tendon in a palpable soft spot. Diagnostic

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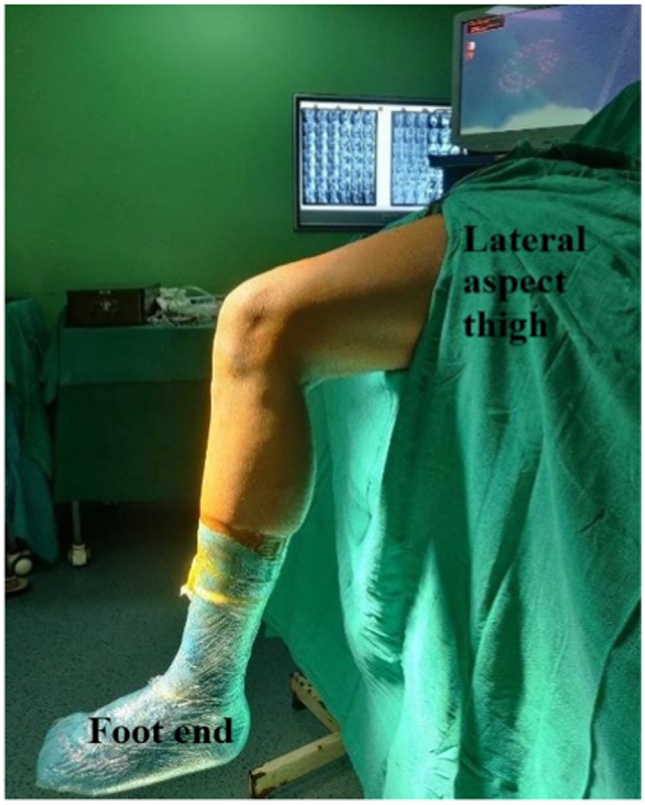

Fig 1. Left knee, positioning of the limb—supine position with a tourniquet over the thigh. Left leg is hanging down at the edge of table in 90° flexion with lateral side support.

arthroscopy is performed. We look for ACL tear and any associated meniscal and chondral damage. For identification of the lateral meniscus root lesion, a figure-of-four position is made and probing is done from anteromedial portal. The lateral meniscus root tear can be seen (Fig 2) as lifted off from the bony

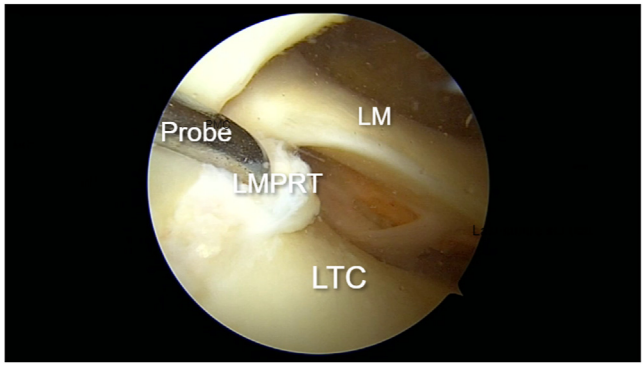

Fig 2. Left knee in 90° of flexion. Visualization is performed from the anterolateral portal, probe is from anteromedial portal, lateral meniscus is lifted with tear from posterior root of lateral meniscus (LM, lateral meniscus; LMPRT, lateral meniscus posterior root tear; LTC, lateral tibial condyle.)

attachment or oblique or radial tear within 10 mm from its attachment. An associated ACL tear usually presents with lateral meniscus root lesion; hamstring graft is harvested, and a 6-strand graft is prepared. An anatomical femoral tunnel is made using the transportal technique. Attention is focused now for anatomical lateral meniscus root repair. Root reducibility up to the anatomical footprint is checked, and underlying cartilage is denuded for better healing of meniscus. An additional central portal is made just below the lower pole of the patella for suture management.

Double-Row Anchor Repair

Looking from anterolateral portal with knee in 90° flexion, an ACL tibial guide is introduced from the anteromedial portal. The guide is placed with the aimer at the lateral extent of the anatomical footprint (Fig 3a) of lateral meniscus root, and the bullet of the guide is on the anteromedial aspect of tibia close to tibial tuberosity. A drill pin is placed on the bone and drilling is performed; the guide/drill pin emerges at anatomical point intra-articularly. The pin is removed from anterior cortex and spinal needle loaded with 1 ETHILON (Ethicon, a Johnson & Johnson Company, Somerville, NJ) is passed through this tunnel track; the looped suture will be intra-articular (Fig 3B). Then, an 8-mm PassPort canula (Arthrex, Naples FL) is placed in the anteromedial portal.

A 1.7-mm double-loaded all-suture FiberTak anchor (Arthrex) is unwound from its shaft so that the free anchor with 2 suture tails (blue and black) is ready. A no. 5 ETHIBOND suture (Ethicon, a Johnson & Johnson Company) suture is looped around the all-suture anchor, which acts as leading suture for anchor passage (Fig 4A). A suture retriever is used to retrieve the ETHILON loop from the anteromedial portal and on this loop a no. 5 ETHIBOND suture (Ethicon, a Johnson & Johnson Company) leading suture is passed for relaying (Fig 4B). ETHILON is pulled from the anteromedial cortex and the no. 5 ETHIBOND is ready at the anterior cortex. This suture is pulled and under vision, an anchor is passed intra-articular to be lodged in the predrill track for about 2 cm (Fig 5A). Once the suture is inside, it is pulled back, as to make it a flower shape for deployment of anchor at lateral footprint of meniscus root. Leaving one, the remaining 3 sutures are retrieved from the central portal (Fig 5B). This black-colored suture is mounted on a Scorpion (Arthrex) (Fig 5C), and a bite is taken 5 to 7 mm from the anterior margin of the meniscus (Fig 5D and Fig 6A). Now, this suture is retrieved and parked in the central portal. Then, another black-colored suture is retrieved from the anteromedial portal mounted on a Scorpion, and a bite is taken to have vertical mattress configuration (Fig 6B). Sequentially the other 2 sutures are taken and

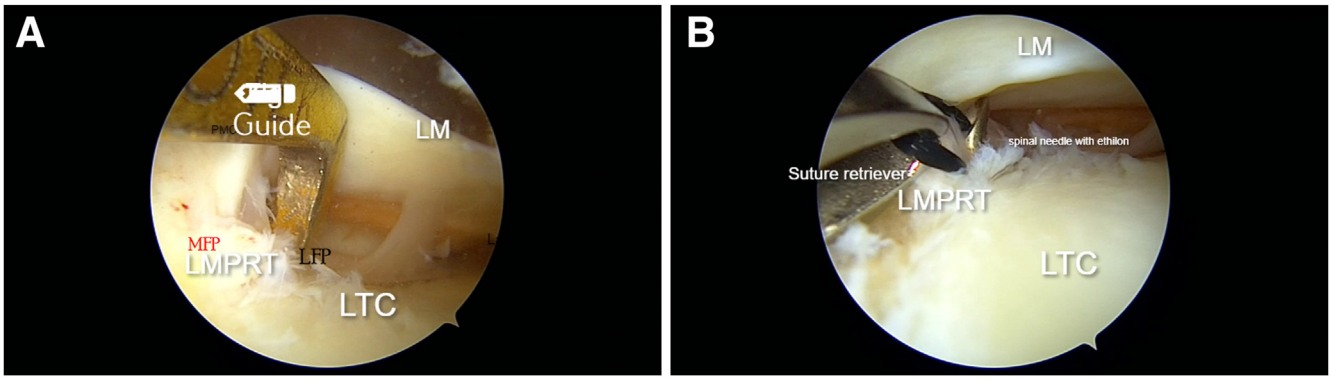

Fig 3. (A) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal, tibial guide is from the anteromedial portal, and the guide is placed at lateral meniscus root and guidewire passed at the LFP. (B) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and suture retriever is from the anteromedial portal. A spinal needle with looped ETHILON is passed after removing the guidewire in the same tract from the anteromedial cortex (LFP, lateral footprint; LM, lateral meniscus; LMPRT, lateral meniscus posterior root tear; LTC, lateral tibial condyle; MFP, medial footprint.)

passed through the meniscus one medial and one lateral to previously passed sutures to have a rip-stop effect with first blue and lasso effect from second blue (Fig 6 C and D). Then, 2 black sutures are taken again from the PassPort for knot tying, and alternate half hitches are taken (Fig 7). Then, the scope is shifted in the anteromedial portal and all sutures (2 black knotted and the other 2 untied blue sutures) are taken out from the anterolateral portal (Fig 8). Looking from the anteromedial portal using a spinal needle, a posterolateral portal is made via an outside-in method in such a way so that the trajectory of the needle is in the direction of medial margin of footprint of the lateral meniscus. A portal is made, and a 5.5-mm canula (Arthrex) passed (Fig 9 A and B). The spear of the knotless anchor is placed on the anatomical medial footprint of the lateral meniscus (Fig 9C). Drilling is done up to the marked depth of the anchor, and all 4 sutures are retrieved through posterolateral canula. All 4 sutures are mounted on a Biocomposite Knotless

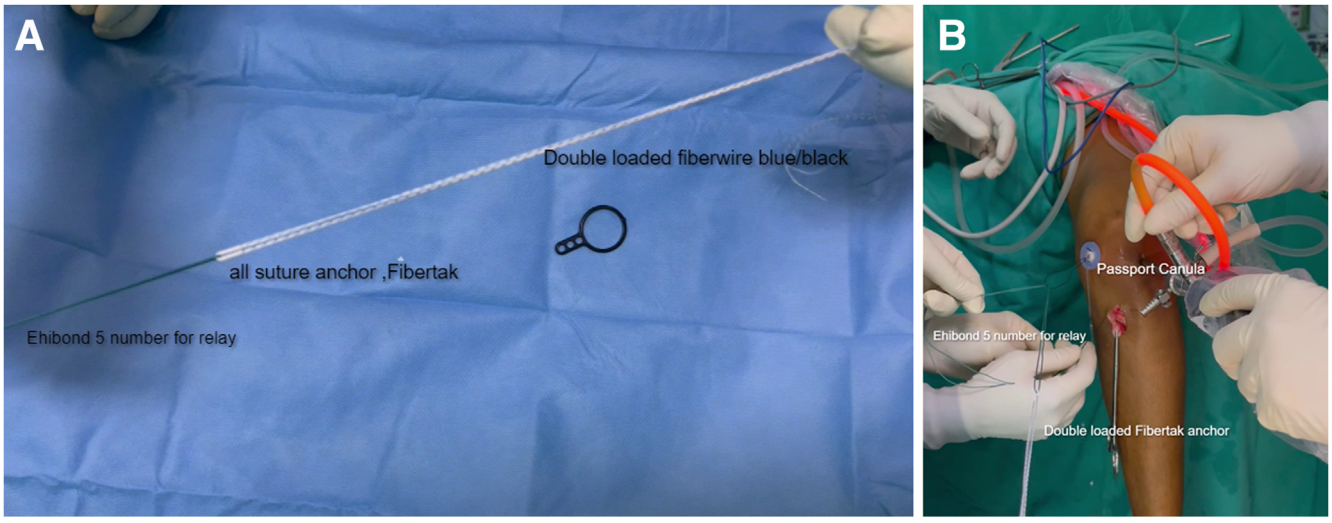

Fig 4. (A) A 1.7-mm double-loaded all-suture FiberTak anchor (Arthrex) is unwound from its shaft so that free anchor with 2 suture tails (blue and black) is ready. A no. 5 ETHIBOND suture (Ethicon, a Johnson & Johnson Company) is looped around all suture anchor, which acts as the leading suture for anchor passage. (B) Left knee in 90° of flexion. The arthroscope is in the anterolateral portal and the PassPort canula is in the anteromedial portal. An ETHILON loop is retrieved from this port and on this loop, a no. 5 ETHIBOND (Ethicon, a Johnson & Johnson Company) leading suture is passed for relaying 1.7-mm double-loaded all-suture FiberTak anchor (Arthrex). Another end of ETHILON is pulled from the anteromedial cortex for relaying the suture anchor.

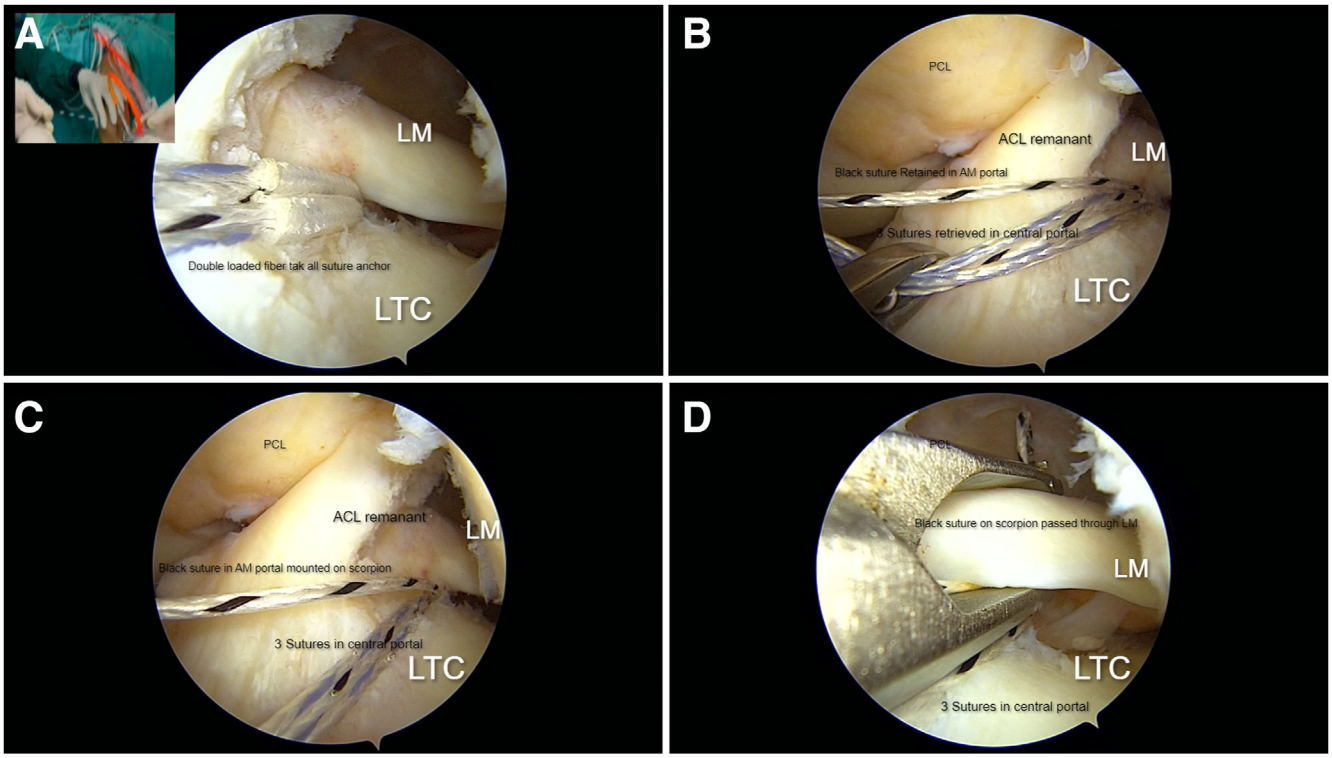

Fig 5. (A) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and a 1.7-mm double-loaded all-suture FiberTak anchor is from anteromedial portal and ready for deployment in the tibia at the lateral footprint. Inset picture showing relaying of anchor. (B) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal, and a 1.7-mm double-loaded all-suture FiberTak anchor with 2 black- and blue-colored sutures is from the anteromedial portal. One tiger black suture is retained in the anteromedial portal and the remaining 3 sutures are retrieved in the central portal. (C) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and black-colored FiberWire from the anteromedial portal is mounted on a Scorpion. The remaining 3 sutures are seen parked in the central portal. (D) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and black-colored FiberWire mounted on a Scorpion is passed 6 mm from the anterior margin of the lateral meniscus. The remaining 3 sutures are still parked in in the central portal. (LM, lateral meniscus; LTC, lateral tibial condyle; PCL, posterior cruciate ligament.)

PushLock 2.9-mm anchor (Arthrex) (Fig 9D). An anchor is placed on the mouth of drilled area and all sutures are tensioned appropriately; the PushLock is hammered in. Sutures are cut. The meniscus is palpated for checking stability from the posterolateral portal, anteromedial, and anterolateral portal (Fig 10 A and B). The ACL graft is passed and fixed with a TightRope (Arthrex) and bioscrew.

Postoperative Rehabilitation

The next day, quadriceps tightening, ankle pumping, and hip rotation exercises are advised. Toe-touch weight-bearing and passive range of motion up to 45° are permitted in the first 2 weeks. From the second to fourth week, 0 to 90° of motion with partial weight-bearing is allowed. After 4 weeks, full weight-bearing is allowed. At 8 weeks, motion beyond 90° is started. Squatting is allowed after 6 months. Return to sports activities are permitted after 9 months.

Discussion

The transtibial pull-out technique for meniscus root repair is most the popular and gold standard method.[11,12] This technique involves placement of a tunnel beneath the root, passing sutures through the root, and fixation on the anterior tibia. Although technically simpler, this technique leads to a bungee effect,[13] micromotion of the meniscus root, and tunnel interference with concomitant ligament reconstruction and osteotomy. Another method of fixation for lateral meniscus root repair described by several authors is the suture anchor technique.[14,15] This technique involves less elongation, greater load to failure strength, and better healing rates.[16] Among the suture anchor technique variations described are double-loaded, triple-loaded, and knotless anchor. Our technique involves the use of 2 rows of anchor medial and lateral row using FiberTak anchor and push lock anchor, respectively.

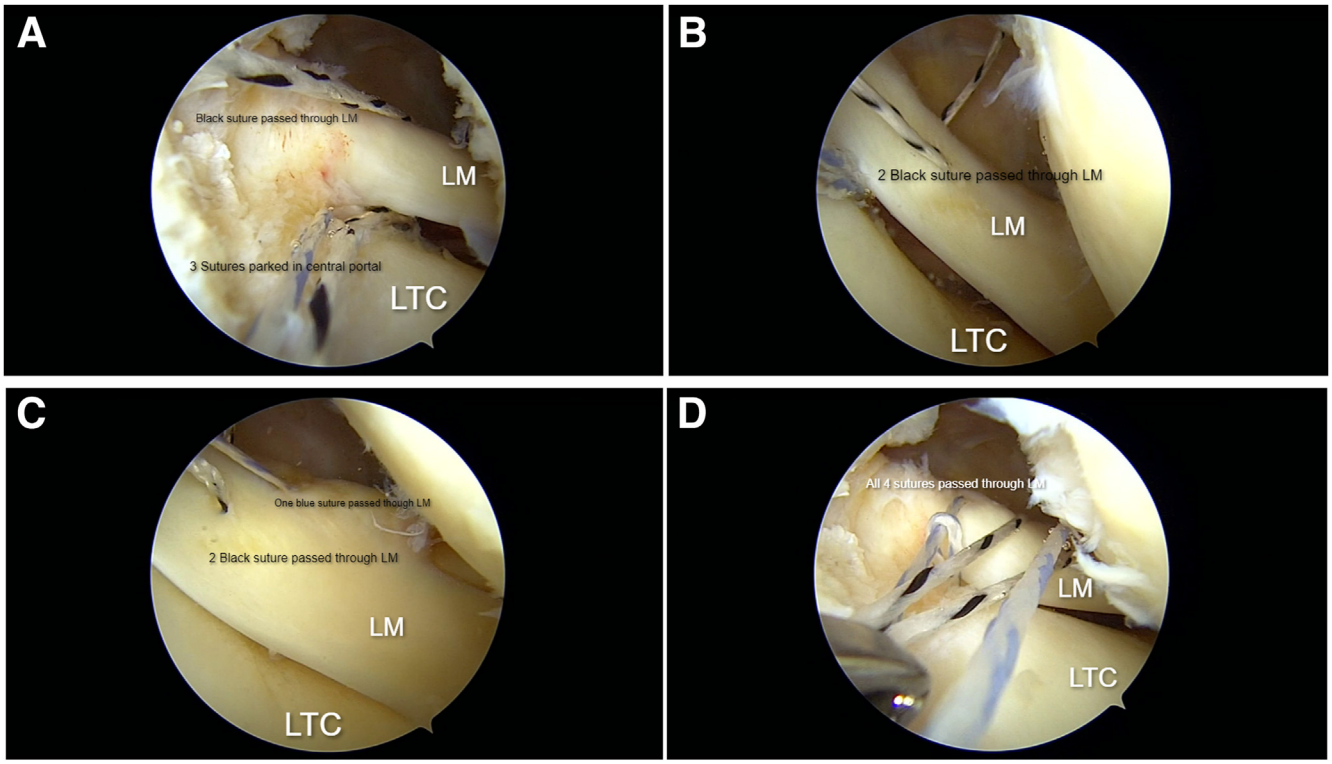

Fig 6. (A) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal, and black suture is seen passed through the meniscus. The remaining sutures are parked in the central portal. (B) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and first suture, which is already passed is parked in central portal, another tiger black-colored FiberWire is now retrieved from anteromedial portal, mounted on the Scorpion, and is passed from the anterior margin of the lateral meniscus in mattress configuration. (C) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and blue-colored FiberWire mounted on the Scorpion is passed in the lateral meniscus; the remaining 3 sutures are parked in in central portal. (D) Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and the last blue-colored FiberWire mounted on the Scorpion is passed through the lateral meniscus as to form a lasso. The remaining 3 sutures are parked in the central portal. (LM, lateral meniscus; LTC, lateral tibial condyle.)

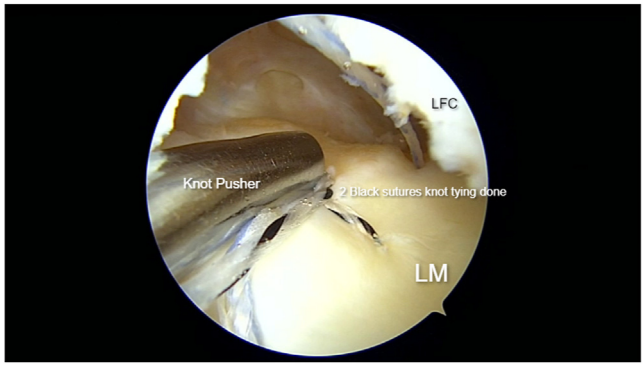

Fig 7. Left knee in 90° of flexion. Visualization is performed from the anterolateral portal and 2 black-colored FiberWire are retrieved from anteromedial portal and knot-tying is performed to secure a lateral footprint using a knot pusher from the anteromedial portal. (LFC, lateral femoral condyle; LM, lateral meniscus; LTC, lateral tibial condyle.)

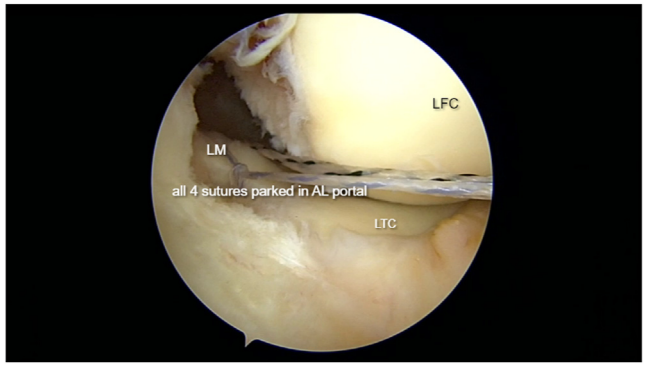

Fig 8. Left knee in 90° of flexion. Visualization is done by shifting the scope to the anteromedial portal and all 4 sutures (of which 2 black are knotted and 2 blue are not knotted) are taken out from the anterolateral portal. (LFC, lateral femoral condyle; LM, lateral meniscus; LTC, lateral tibial condyle.)

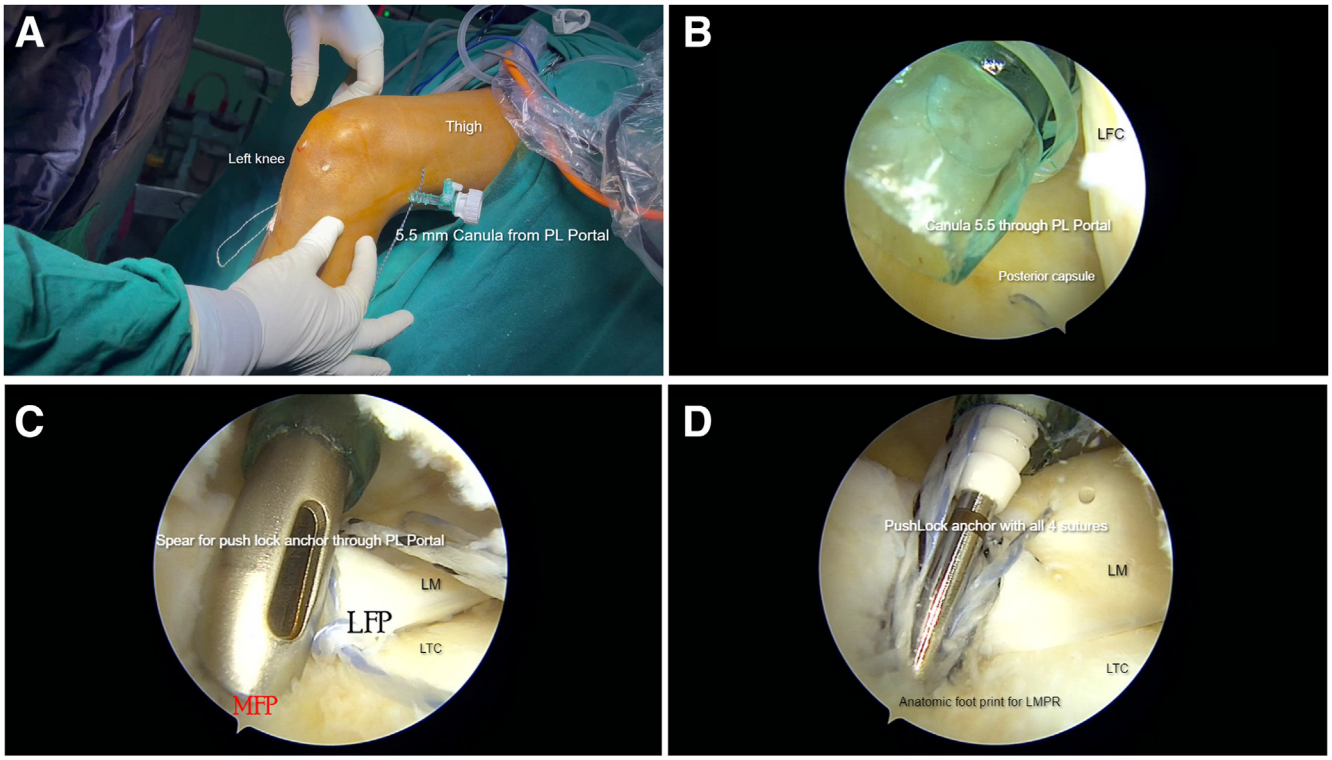

Fig 9. (A) Left knee in 90° of flexion, with knee in 90° of flexion, a 5.5-mm canula is passed after creating a posterolateral portal using the outside-in method. (B) Left knee in 90° of flexion. Visualization is done from anteromedial portal and a 5.5-mm canula is coming from posterolateral portal in such way to direct it toward the medial footprint of lateral meniscus root. (C) Left knee in 90° of flexion. Visualization is performed from the anteromedial portal and the PushLock sleeve for drilling track for anchor is directed toward the medial footprint of lateral meniscus root. (D) Left knee in 90° of flexion. Visualization is performed from anteromedial portal and the PushLock anchor with all 4 sutures from lateral row is advanced toward the predrilled hole located at medial footprint of the lateral meniscus root. (LFC, lateral femoral condyle; LFP, lateral footprint of lateral meniscus root; LM, lateral meniscus; LTC, lateral tibial condyle; MFP, medial footprint of lateral meniscus root.)

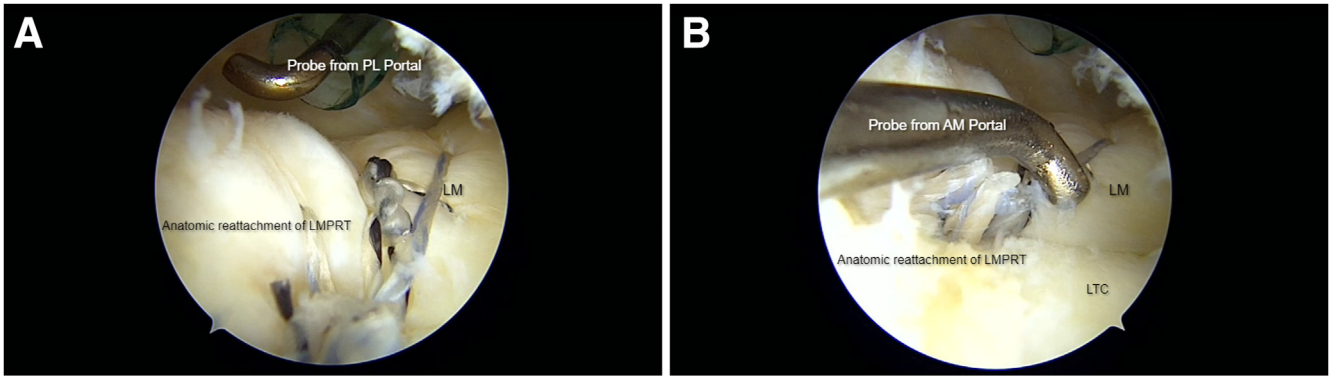

Fig 10. (A) Left knee in 90° of flexion. Visualization is performed from the anteromedial portal and the probe is from posterolateral portal with stable and secure double-row root repair. (B) Visualization is performed from the anterolateral portal, and the probe is from the anteromedial portal with stable and secure double-row root repair. (LM, lateral meniscus; LTC, lateral tibial condyle)

Table 1. Advantages and Disadvantages of Anatomical Double-Row Lateral Meniscus Root Repair Using Suture Anchors

Advantages	Disadvantages
• Wider footprint coverage of lateral meniscus root by double row • Fixation is remarkably close to meniscus • Avoidance of tunnel in tibia so avoid bungee effect and loss of fixation • Early and aggressive rehabilitation can be started • Better healing of meniscus and more stable and secure construct	• Technically challenging • Poor bone quality may not hold anchor properly • Knotless second row can be difficult if trajectory is not proper • Poor meniscal quality may lead to cut-through of sutures

Table 2. Pitfalls and Tips of Anatomical Double-Row Lateral Meniscus Root Repair Using Suture Anchors

Pitfall	Tips
Suture anchor placement at lateral footprint may be difficult	Use of relay technique and passage from anteromedial portal leads to smooth passage
Suturing while passing individually through the lateral meniscus may lead to entanglement	Use central portal as parking portal, use the PassPort cannula in anteromedial portal, and take one suture at a time in the anteromedial portal once it is passed through meniscus park it in central portal
Suture may cut through the lateral meniscus	Use mattress configuration and rip-stop stich; also, take bite 6 to 7 mm from the anterior margin of meniscus
Knotless anchor trajectory for medial footprint may change	Use of a spinal needle followed by canula from posterolateral portal directed toward footprint will lead to correct placement of the medial-row knotless anchor

Lateral meniscus root has wide area of attachment on tibia, which is reported to be up to 115 mm squared,[17] and increased contact area is needed for better healing without increasing the size or number of tunnels. The double-row technique achieve this by covering the entire footprint and load distribution at the same time. Also, it has been shown load to failure of suture anchor is more than transtibial technique (120 N vs 50 N) but less than native root[18] (120 vs 360 N). With the use of 2 anchors, load to failure is increased significantly. Low displacement and greater stiffness are also needed for preventing retear, increasing contact compression, and early mobilization. With the use of 2 anchor row and rip stop suture configuration, we achieved a stable, secure, wider footprint and greater load to failure, making it equivalent to double-row in rotator cuff repair.

Lateral meniscus root repair to native footprint is necessary for ensuring proper knee kinematics and contact pressure. Wide varieties of techniques for root repair have been described with different limitation and pitfalls, as reported various biomechanical studies.[19,20] Our technique is developed with aims of strong construct, larger contact area, avoidance of micromotion, reduction of extrusion, prevention of retear, and accelerated rehabilitation. Advantages and disadvantages of our technique are summarized in Table 1, and technical challenges can be overcome by pitfalls and tips of this technique (Table 2).

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