

Arthroscopic Belt Capsulodesis Using a Knotless Soft Suture Anchor for Extruded Medial Meniscus



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Abstract: In recent years, degenerative meniscal lesions have received increasing attention as an etiologic factor of knee osteoarthritis. Among various relevant factors, medial meniscal extrusion has been shown to be an independent predictor of the onset and progression of knee osteoarthritis. Therefore, surgical reduction of the extruded medial meniscus to restore meniscal function is key to preventing osteoarthritis of the knee. The arthroscopic centralization technique using knotless anchors has been developed and refined to reduce meniscal extrusion in the posteromedial region of the knee. Although a short-term study has reported favorable outcomes, the technique presents some pitfalls and can be technically challenging. This article describes the rationale and procedure for arthroscopic belt capsulodesis using 2 knotless anchors for reduction of medial meniscal extrusion. The reported procedure is technically simple and efficiently reduces meniscal extrusion by repairing the meniscotibial capsule, and it may be useful in the prevention of osteoarthritic progression.

Several risk factors for knee osteoarthritis (KOA) have been reported, including age, sex, malalignment, obesity, genetic factors, and trauma.¹⁻³ Regarding the relation between meniscal extrusion and KOA, several longitudinal cohort studies have shown that the presence of baseline meniscal extrusion is closely associated with the subsequent development and progression of KOA.^{4,5} Because medial meniscal extrusion is often associated with degenerative meniscal tears, the surgical option for KOA prevention should combine surgical reduction of the meniscal extrusion with repair of the tear.^{1,6} The centralization technique was developed for the treatment of meniscal extrusion. Koga et al.⁷ originally reported arthroscopic centralization of an extruded lateral meniscus by suturing the capsule attached to the meniscus to the edge of the

tibial plateau using suture anchors. Centralization techniques using knotless soft anchors have also been applied as reinforcement during medial meniscal posterior root tear repair.^{8,9} Although centralization procedures have shown good clinical and radiologic results, these techniques are quite complex and technically challenging because they require specific devices and suture relays that penetrate the meniscus. Ozeki et al.¹⁰ reported a combination of discoid lateral meniscal repair and the capsulodesis technique as another surgical procedure to manage meniscal extrusion. This technical note describes our technique of arthroscopically assisted capsulodesis using a belt-like restraint for degenerative medial meniscal extrusion in KOA.

Surgical Technique

Indication

This procedure is indicated in patients with KOA of Kellgren-Lawrence osteoarthritis grade 3 or lower for medial meniscal extrusion associated with degenerative or medial meniscal posterior root tears.

Surgical Setting

The patient is placed in the supine position on the operating table under general anesthesia. A lateral thigh support is attached to the side rail of the table to assist in knee positioning during the procedure. The contralateral limb is positioned with the hip abducted to

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facilitate access to the medial aspect of the operative knee. A tourniquet is not used to monitor or manage intraoperative bleeding.

Arthroscopic Procedure

Our technique can be applied in combination with repair of associated meniscal tears and correction of lower-extremity alignment varus by high tibial osteotomy. First, standard arthroscopic examination of all compartments is performed to evaluate the condition of the intra-articular structures such as the articular cartilage, meniscus, and synovia. If meniscal repair is required, a 6-cm oblique skin incision is made at the anteromedial aspect of the proximal tibia; then, the periosteum at the osteotomy site is exposed (Fig 1). This skin incision is used for high tibial osteotomy. The superficial medial collateral ligament (sMCL) is distally inserted to facilitate opening of the medial-compartment joint space during subsequent meniscal repair surgery. After the sMCL is released, arthroscopic surgery is resumed. The location of the first low posteromedial portal is determined using a spinal needle (Video 1). This portal is placed just below the medial meniscus, 10 to 15 mm posterior to the posterior border of the sMCL. The second low posteromedial portal is placed just posterior to the sMCL. Osteophytes at the medial tibial plateau (if identified) are removed using an arthroscopic rasp—originally invented for Bankart shoulder repair—and a shaver, both of which are inserted through the first and second low posteromedial portals. The meniscotibial capsule under the medial meniscus is then released from the medial tibial plateau to mobilize the medial meniscus and reduce meniscal extrusion. This step of the procedure is important because it facilitates healing of the meniscotibial capsule by adhering to the edge of the medial tibial plateau after it has been affixed with suture anchors. A 1.8-mm Knotless FiberTak Soft Anchor (Arthrex, Naples, FL) is inserted as far posteriorly as possible from the first low posteromedial portal at the end of the medial tibial

plateau. A second anchor is identically inserted at the end of the tibial plateau just posterior to the sMCL (Fig 1); a straight drill guide is used for anchor insertion (Fig 2). This knotless anchor has 3 sutures: a repair suture, a shuttling suture loop, and a shuttling suture. At this point, all sutures from the first anchor are retrieved from the second portal on the meniscotibial capsule. The first anchor repair suture is inserted into the second shuttle suture loop, and the shuttling suture of the second anchor is gently pulled through the first anchor repair suture without applying tension. Similarly, the second anchor repair suture is inserted into the first shuttle suture loop, and the shuttling suture of the first anchor is gently threaded through the second anchor repair suture without applying tension. The repair suture of the first anchor is then manually pulled and tightened. The repair suture of the second anchor is also tightened to complete the belt capsulodesis (Figs 3 and 4). In cases of medial meniscal posterior root tear, reduction of the torn posterior root to the anatomic insertion site is also possible after final fixation of the capsulodesis. Moreover, the extruded medial meniscus is reduced with this belt capsulodesis procedure by refixing the meniscotibial capsule. The advantages and disadvantages of this technique are described in Table 1, and pearls and pitfalls are described in Table 2. High tibial osteotomy is performed after all repair procedures have been completed.

Postoperative Rehabilitation

After surgery, the patient undergoes a routine postoperative protocol constructed for combined meniscal repair and high tibial osteotomy. Limited flexion range-of-motion exercises are started immediately after surgery. As for postoperative mobility, the operated knee is immobilized with a brace and the patient is instructed to use crutches and prohibited from weight bearing on the affected knee for 3 weeks. Knee flexion over 90° is permitted after 3 weeks. Partial weight bearing without knee immobilization is permitted at 3 weeks, with

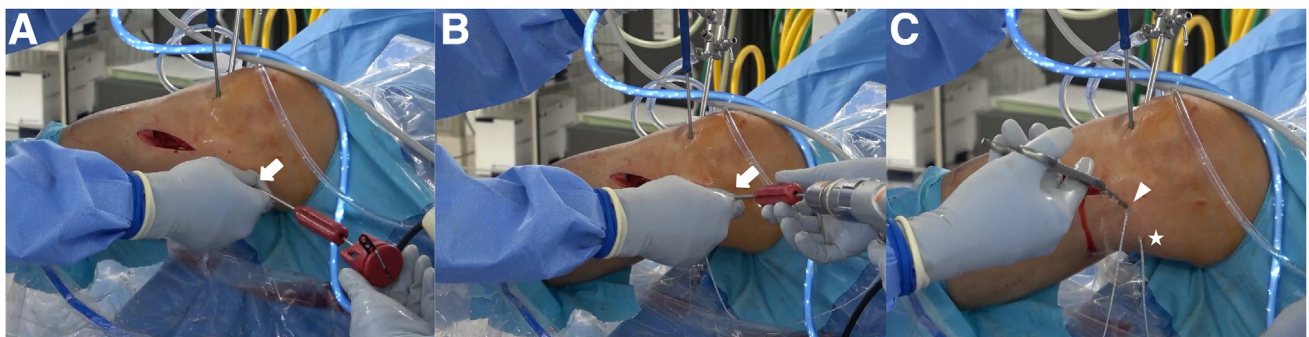


Fig 1. Overview of surgical procedure in right knee. A 6-cm oblique skin incision is made at the anteromedial aspect of the proximal tibia, and the periosteum of the osteotomy site is exposed. This skin incision is used for high tibial osteotomy. (A) The first low posteromedial portal (arrow) is created. (B) The second low posteromedial portal (arrow) is created. (C) All sutures of the first anchor (star) are retrieved using a small retriever from the second portal (arrowhead) on the meniscotibial capsule.

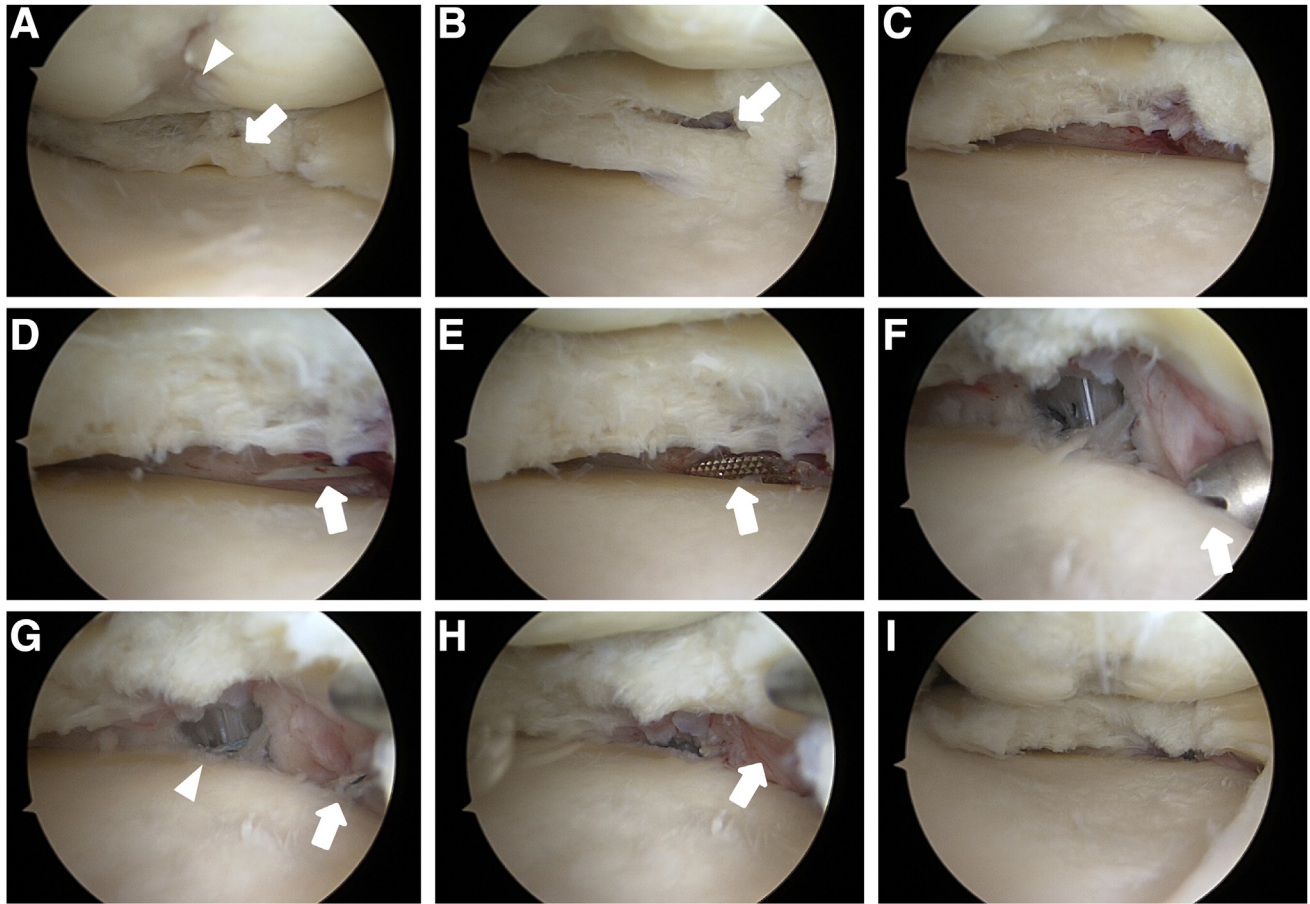


Fig 2. Arthroscopic view of right knee from anterolateral portal in 52-year-old male tennis player. (A) Degenerative tear of medial meniscus (star) and full-thickness chondral defect of medial femoral condyle (arrowhead). (B) Complex degenerative tear of medial meniscus (arrow). (C) Appearance after partial resection of severely damaged portion for medial meniscal degenerative tear. (D) The first low posteromedial portal is created with a scalpel (arrow). (E) A rasp (arrow) is inserted from the first low posteromedial portal to remove osteophytes and release the meniscotibial capsule. (F) The second anchor is inserted from the second low posteromedial portal (arrow) just posterior to the superficial medial collateral ligament. (G) Appearance before suture relay. Sutures are inserted from the first portal (arrowhead) and second portal (arrow). (H) Appearance after suture relay between first and second knotless anchors. The meniscotibial capsule (arrow) is reattached to the tibia. (I) The medial meniscus is centralized once the procedure is complete.

progression to full weight bearing at 6 weeks. Squatting with knee flexion greater than 90° is prohibited until 3 months postoperatively. Running is allowed at 3 months, and progression to full-scale athletic activities is permitted at 6 months after surgery.

Discussion

Koga et al.⁹ reported a modified centralization technique using 3 knotless anchors for reduction of medial meniscal extrusion. Although its clinical efficacy has been shown, this technique presents some pitfalls. First, there is an additional cost for the surgical equipment needed for this procedure. Second, during arthroscopic surgery, instruments such as the Micro SutureLasso (Arthrex) and Scorpion (Arthrex) must be carefully manipulated to avoid chondral damage. Therefore, this technique may prove difficult for beginners. Third, the

procedure involves surgical invasion of the capsule at the peripheral meniscal margin and meniscal body. Fourth, fixation of the meniscus to the tibial plateau edge with the centralization technique may over-constrain the meniscus and risk limiting physiological movement during knee motion. Furthermore, when 3 anchors are used, the surgical time is prolonged.

In recent years, the meniscotibial ligament (MTL) has been the focus of much attention when considering the cause of medial meniscal exclusion.¹¹ There have been some studies investigating the functional anatomy of the MTL.¹²⁻¹⁴ In 2023, Tsutsumi et al.¹⁵ reported on the layered structure of the joint capsule and semi-membranosus muscle. They showed that the medial meniscus was attached to the tibia through the joint capsule and was continuous with the joint capsule over the entire circumference. Their study also revealed that

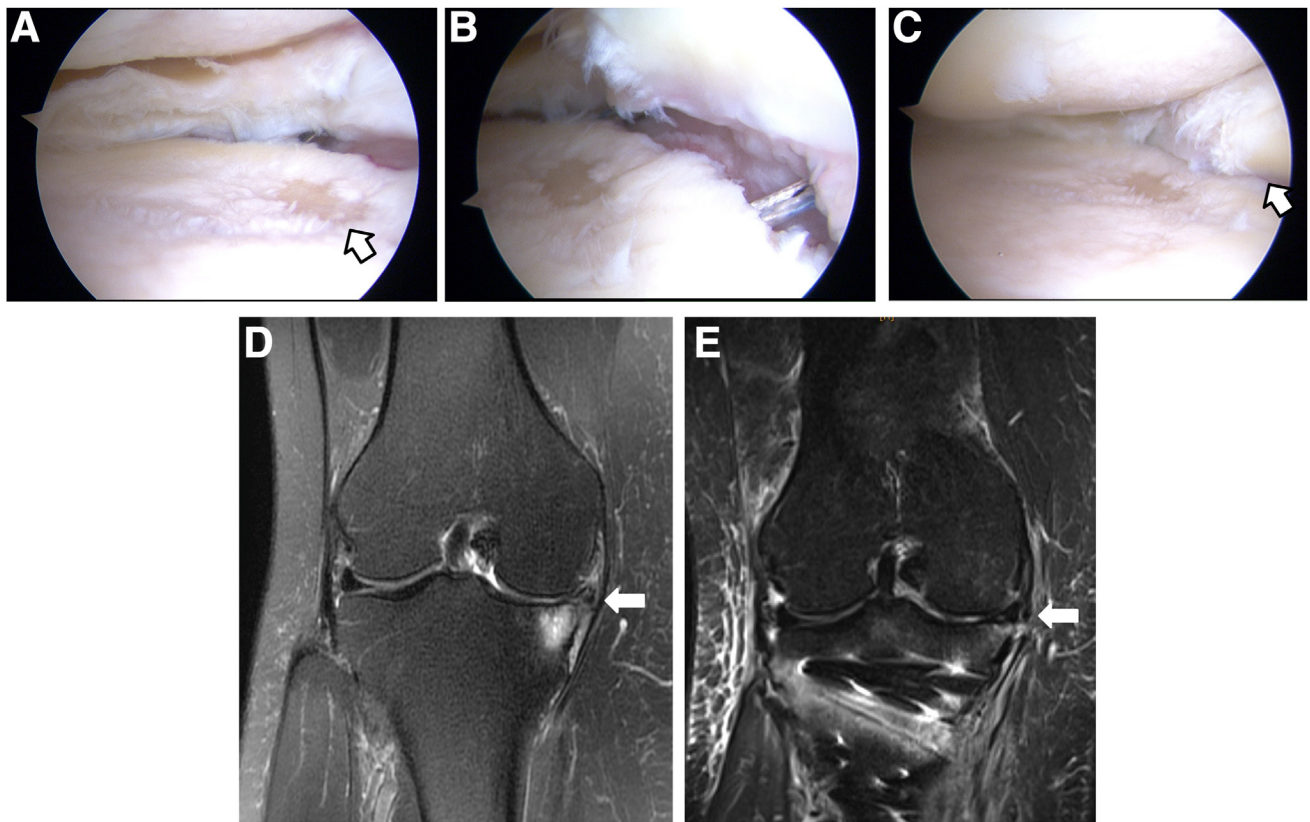


Fig 3. Arthroscopic view of right knee from anterolateral portal and magnetic resonance images in 58-year-old female taekwondo player. (A) Degenerative tear of medial meniscus and full-thickness chondral defect of medial tibial condyle (arrow). (B) Appearance before suture relay. (C) After suture relay, the meniscotibial capsule is reattached to the tibia (arrow). The medial meniscus is centralized once the procedure is complete. (D) Coronal T2-weighted fat-suppressed (FS) magnetic resonance image at initial presentation showing findings indicative of extruded degenerative tear of medial meniscus (arrow). (E) Coronal short inversion time inversion recovery (STIR) magnetic resonance image at 2 weeks after surgery. The medial meniscus is centralized (arrow) once the procedure is complete.

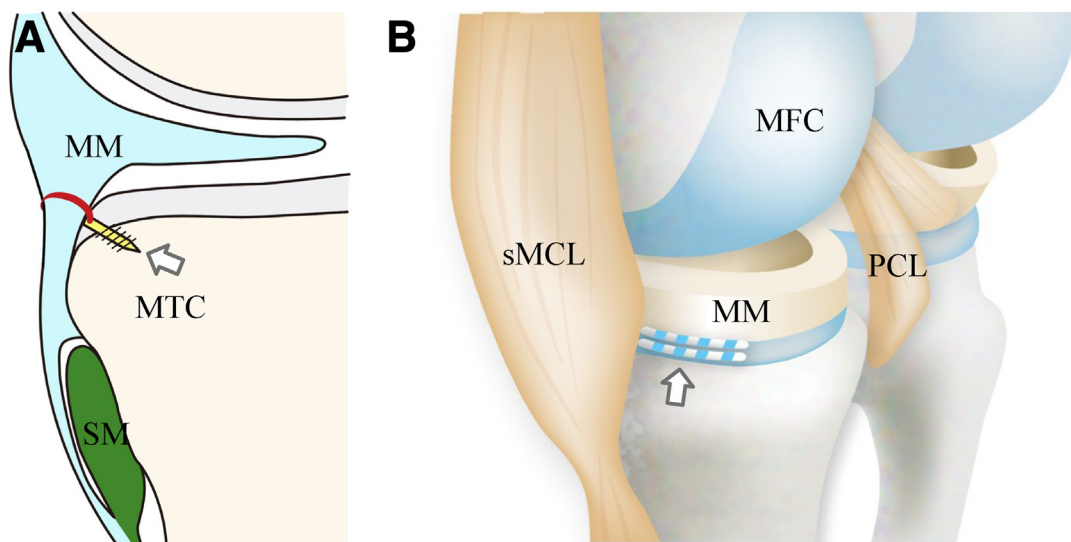


Fig 4. Illustration of arthroscopic belt capsulodesis anchor positions. (A) Anchoring capsule to edge of tibia (arrow). (B) Postero-medial view of right knee. Belt capsulodesis sutures are placed just posterior to the superficial medial collateral ligament (sMCL) (arrow). (MFC, medial femoral condyle; MM, medial meniscus; MTC, medial tibial condyle; PCL, posterior cruciate ligament; SM, semimembranosus.)

Table 1. Advantages and Disadvantages of Arthroscopic Belt Capsulodesis**Advantages**

- The surgical procedure is less technically demanding than the conventional centralization technique.
- The surgical time is shorter than that of the conventional centralization technique.
- The technique uses a smaller number of anchors than the conventional centralization technique (2 anchors vs 3 anchors), thereby reducing the cost.
- Because the sutures do not need to be threaded through the tough peripheral meniscal tissue, they can easily pass through the capsule and prevent anchor breakage.
- Refixation of the meniscotibial capsule, as in a Bankart shoulder repair, effectively reduces meniscal extrusion.
- Preservation of the meniscus is achieved even in the presence of severe degeneration.
- Only 2 additional portals are needed.
- The technique allows for a direct approach from the low posteromedial portal for osteophyte removal and meniscotibial capsular release.
- There is a potential application for lateral meniscal extrusion.

Disadvantages

- Posterior anchor placement in the popliteal region is difficult.
- Capsular refixation may not be applied to the middle portion of the meniscus attached to the MCL.
- Damage and degeneration of meniscal substance may not be fundamentally curable.

MCL, medial collateral ligament.

Table 2. Pearls and Pitfalls of Arthroscopic Belt Capsulodesis**Pearls**

- HTO is concomitantly performed with alignment correction.
- During arthroscopic surgery, the sMCL is released to facilitate the opening of the medial joint space.
- A spinal needle is used to determine the direction and level of the incision for portal creation.
- The first low posteromedial portal is placed 10-15 mm posterior to the posterior edge of the sMCL.
- The second low posteromedial portal is placed at the posterior edge of the sMCL.
- The osteophytes are removed, and the capsule is released from the portals using a rasp and shaver.
- Knotless anchors are inserted using a straight drill guide.
- Sliding of sutures along the anchors should be confirmed.
- All sutures from the first anchor are retrieved from the second portal on the meniscotibial capsule.
- The first anchor repair suture is inserted into the second shuttle suture loop, and the shuttling suture of the second anchor is gently pulled to pass through the first anchor repair suture without applying tension. The second anchor repair suture is inserted into the first shuttle suture loop and handled in the same fashion as the first anchor repair suture.
- The first and second anchor repair sutures are pulled tight to complete the belt capsulodesis.

Pitfalls

- The first low posteromedial portal should be placed as far posteriorly as possible, with care taken to note the depth and direction of the surgical instrument to avoid injuring the posterior neurovascular bundle.
- The second low posteromedial portal should not be created on the MCL. Incorrect placement of the sMCL to the edge of the tibial plateau can cause ROM restriction and medial knee pain.
- If osteophyte removal is incomplete, meniscal extrusion may not be efficiently reduced.
- The drill guide for anchor insertion should always be directed at the tibial plateau.
- If all sutures from the first anchor are not retrieved from the second portal on the meniscotibial capsule, the saphenous nerve may become entrapped.

HTO, high tibial osteotomy; MCL, medial collateral ligament; ROM, range of motion; sMCL, superficial medial collateral ligament.

the joint capsule attaches close to the articular cartilage where osteophytes form. They consider that structural abnormalities in the joint capsule precede posterior root tears and osteophyte formation, both of which are closely related to meniscal extrusion.¹⁵ On the basis of the findings of their report, a combination of meniscotibial capsule repair and meniscal repair can be considered a reasonable surgical option for medial meniscal extrusion with degenerative tears. The current procedure for meniscotibial capsule repair is less technically demanding than the centralization technique and can be performed by surgeons who are not fully experienced in meniscal preservation surgery. An

additional application of this technique is capsular repair for lateral meniscal extrusion.

There are also some risks and pitfalls associated with our technique. First, the first low posteromedial portal is placed as posteriorly as possible, which may bear the risk of posterior neurovascular bundle injury. Therefore, attention should be paid to the direction of instrument insertion. Second, the second low posteromedial portal should not be created on the sMCL. In the case of incorrect placement, penetration and fixation of the sMCL to the edge of the tibial plateau may cause range-of-motion restriction and medial knee pain. Third, although this procedure may

restore the capsular restraint function by securing the slack portion like a belt, it may not fundamentally cure the meniscal damage or degeneration of the meniscal substance.

The arthroscopic belt capsulodesis technique for medial meniscal extrusion described in this article can restore the restraining function of the meniscotibial capsule using knotless anchors. This surgical option can reasonably manage medial meniscal extrusion while avoiding the technical complexities and difficulties involved in conventional centralization techniques.

Disclosures

All authors (H.N., R.K., S.O., T.T., S.Y., T.I.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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