Technical Note

All-Inside Arthroscopic Tie-Grip Suture Repair for Radial Tear in the Midbody of Lateral Meniscus Using an All-Inside Device and Slotted Cannula

Masaki Iguchi, M.D., Tsuneari Takahashi, M.D., Ph.D., Mikiko Handa, M.D., and Katsushi Takeshita, M.D., Ph.D.

Abstract: Inside-out repair of meniscal tears is the gold standard surgical approach; however, its use is limited by the need for a posterior incision and neurovascular risk. In this Technical Report, we present details of the all-inside arthroscopic tie-grip approach for repairing a radial tear of the midbody of the lateral meniscus using an all-inside device (TRUESPAN) and a slotted cannula. In contrast to the inside-out approach, this technique helps reduce surgical invasiveness and provides stable fixation as the vertical mattress sutures bundle the circumferential fibers and act as rip stops for the horizontal sutures. However, the operating surgeon must understand proper insertion techniques to successfully use the devices required for this procedure.

Radial tear in the midbody of the lateral meniscus (RT-LM) is a frequent cause of knee pain in young athletes with stable knees presenting as a locking sensation and pain during knee flexion.[1] A radial tear is induced by disruption of the circumferential fibers of the lateral meniscus (LM), the major meniscal collagen fibers responsible for creating resistance to hoop stresses.[2,3] Typically, RT-LM is repaired with arthroscopic inside-out tie-grip suturing,[4] in which a skin incision is made behind the lateral collateral ligament (LCL) with the knee in a flexed position; the lateral head of the gastrocnemius muscle is then separated from the posterolateral capsule using a retractor to protect neurovascular bundles.[5]

In contrast, the all-inside technique can reduce surgical invasiveness by eliminating the need for a posterior incision and the added requirement of an experienced assistant to catch the needle. In the past, there were concerns regarding the procedure due to the biomechanical fixation strength of previous-generation all-inside devices; today, the current devices have improved fixation strength and clinical results, and the procedure is now comparable to inside-out repair.[6-8] However, all-inside devices are associated with significant neurovascular risk, increased incidence of technical error and device problems, greater cost, and, theoretically, iatrogenic meniscus damage as a result of the insertion of larger diameter needles.[9] Therefore, we describe an all-inside arthroscopic tie-grip repair for RT-LM to minimize surgical invasiveness. This Technical Note aims to guide surgeons through the appropriate use of this technique using TRUESPAN (Mitek Sports Medicine, Raynham, MA).

From the Department of Orthopedic Surgery, Miyazaki Prefectural Nobeoka Hospital, Nobeoka, Japan (M.I.) and Department of Orthopaedics, School of Medicine, Jichi Medical University, Shimotsuke, Japan (T.T., M.H., K.T.).

Received April 2, 2024; accepted May 24, 2024.

Address correspondence to Tsuneari Takahashi, M.D., Ph.D., Department of Orthopaedics, School of Medicine, Jichi Medical University, 3311-1 Yakushiji, Shimotsuke 329-0498, Japan. E-mail: tsuneari9@jichi.ac.jp

2212-6287/24546
https://doi.org/10.1016/j.eats.2024.103139

Indications

A history of repeated knee pain and locking symptoms is an important indicator of possible RT-LM. The diagnosis is based on physical examination[10] and magnetic resonance imaging (MRI), which shows disrupted circumferential fibers in the midbody of LM. Surgery is indicated when patients with RT-LM complain of frequent pain and locking sensation.

Surgical Technique

The technique is carried out under regional or general anesthesia without a pneumatic tourniquet. The patient is placed in a supine position with the operative knee

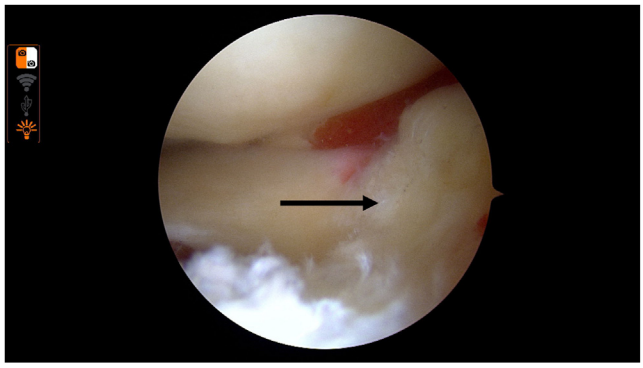

Fig 1. Arthroscopic image of radial tear in the midbody of the lateral meniscus (RT-LM) of the left knee from the anterolateral portal. The knee is flexed to 90° on the operating table with varus and internal rotation of the tibia, resulting in the figure-four position; additionally, adduction stress is applied to the medial femoral condyle. The black arrow indicates the RT-LM.

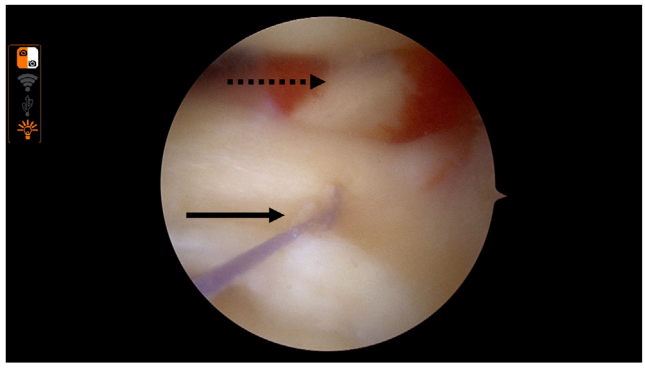

Fig 3. Arthroscopic image of the left lateral meniscus taken from the anterolateral portal in the figure-four position. The first vertical suture is placed through the far-anteromedial portal in the figure-four position (black arrow). The black dotted arrow indicates the popliteus tendon.

held in the leg drop position in 90° flexion. Standard anterolateral, anteromedial, and far-anteromedial portals are made, and a routine arthroscopic evaluation is performed; RT-LM is observed in the figure-four position (Fig 1). Then, the torn edge of the meniscus and adjacent synovium are refreshed with a rasp to promote healing with an adequate vascular supply. We used the all-inside tie-grip suture technique with TRUESPAN to restore the hoop structure of the LM without incising the lateral knee. The technique uses at least 4 suture anchors and fibrin clots when necessary: 3 stay sutures are placed vertically and 2 suture loops are placed horizontally.[4,11] Vertical sutures are placed as grips to prevent cutting and slipping of the subsequent horizontal sutures.

First, 2 vertical sutures are placed. A slotted cannula is inserted through the anteromedial and far-anteromedial portals when needed so that TRUESPAN can be easily inserted (Fig 2). The built-in adjustable depth penetration limiter is set at 14 to 16 mm. The deployment handle is pulled to deploy the first implant on the proximal side of LM (Fig 3). The delivery needle is then pulled slightly and rotated so that its tip aims slightly at the capsular side where the second implant is placed (Fig 4). If a defect persists between the RT-LM's torn edges after placement of 2 vertical sutures, a fibrin clot is introduced into the defect, and the horizontal sutures are performed to pull the torn edges closer (Figs 5 and 6). The clinician must be cautious not to damage the meniscus or cartilage during these procedures, and ensure that the sutures do not interfere with the LCL. The location of the LCL could be examined by palpating it from the outside of the knee joint. Subsequently, diagnostic probing is performed to evaluate the stability of tie-grip sutures (Fig 7 and Video 1). Tables 1 and 2 summarize the advantages and disadvantages of the technique.

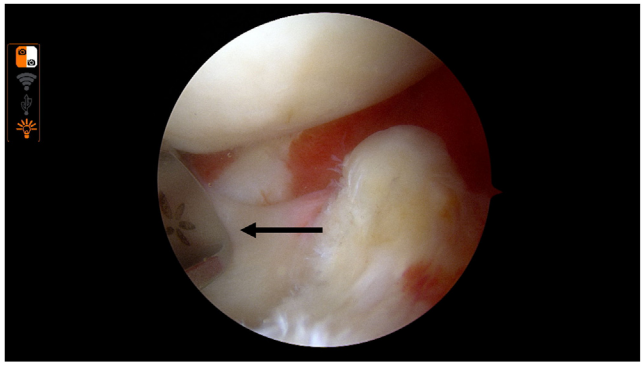

Fig 2. Arthroscopic image of the left lateral meniscus taken from the anterolateral portal. A slotted cannula is inserted through the far-anteromedial portal in the figure-four position and is placed on the superior peripheral rim of the lateral meniscus (black arrow) to place vertical sutures as grips to prevent cutting and slipping of the subsequent horizontal sutures using TRUESPAN.

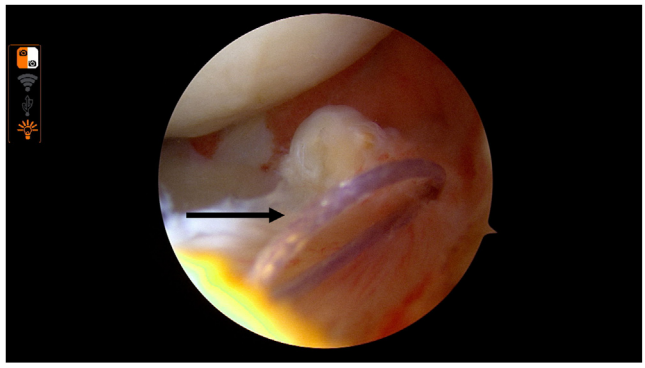

Fig 4. Arthroscopic image of the left lateral meniscus taken from the anterolateral portal in the figure-four position. A second vertical suture is placed through the far-anteromedial portal (black arrow).

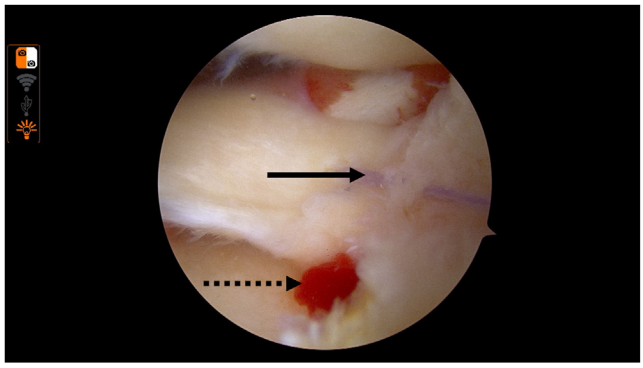

Fig 5. Arthroscopic image of the left lateral meniscus taken from the anterolateral portal. A slotted cannula is inserted through the far-anteromedial portal in the figure-four position and placed on the superior peripheral rim of the lateral meniscus to place the first horizontal suture after placing the 2 vertical sutures (black arrow). The black dotted arrow indicates a fibrin clot introduced into the defect.

Postoperative Rehabilitation

A brace is applied for 4 weeks to immobilize the affected limb. Range of motion exercises and open kinetic chain muscle training are permitted after immobilization and the patients are permitted full weight bearing.[12] High-impact activities, including jogging, are not allowed until 6 months after surgery.[4]

Discussion

Inside-out repair is still the gold standard for meniscal tears in terms of biomechanical strength.[13] However, the need for a posterior incision is a considerable disadvantage with this technique, and special attention must be given to ensure no damage to the LCL, popliteus tendon, neurovascular bundles, or peroneal nerve when treating RT-LM. In contrast, the all-inside arthroscopic tie-grip repair technique described here allows for treating RT-LM safely and less invasively

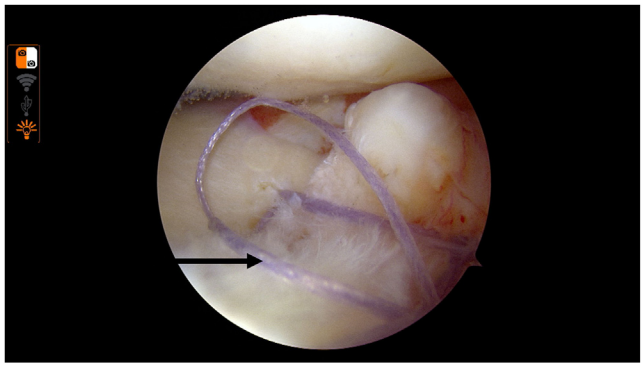

Fig 6. Arthroscopic image of the left lateral meniscus from the anterolateral portal in the figure-four position. The second horizontal suture is placed through the far-anteromedial portal in the figure-four position after the 2 vertical sutures and the first horizontal suture have been placed (black arrow).

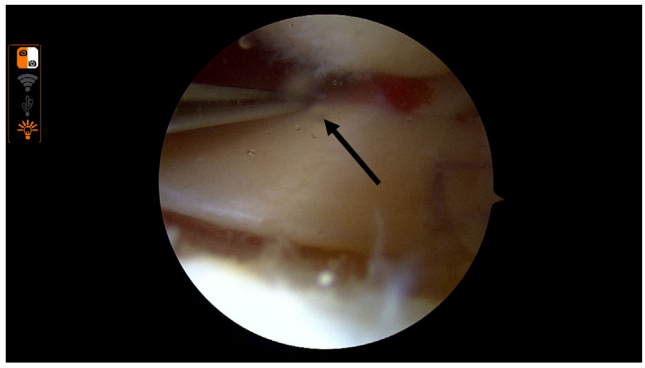

Fig 7. Arthroscopic image of the left lateral meniscus taken from the anterolateral portal in the figure-four position. Diagnostic probing is performed after all-inside arthroscopic tie-grip repair (black arrow).

without posterior incision or the need for an experienced assistant to hold the needle. Previous generations of all-inside devices often resulted in chondral damage because the suture was too rigidly prominent on the meniscal surface[14] and caused pain due to penetration of the posterior capsule.[15] We modified the technique to address these disadvantages using the all-inside arthroscopic tie-grip repair performed using TRUESPAN. This implant contains 2-0 partially-absorbable ORTHOCORD suture; in addition, repairs with TRUESPAN do not leave a knot or hard body on articular surfaces. We set the depth penetration limiter at 14 to16 mm to curb postoperative pain, which can occur if the capsule penetrates too deeply. There is also a potential risk of interfering with the LCL, popliteus tendon, neurovascular bundles, and peroneal nerve in this technique; hence, an accurate understanding of the anatomy of the posterolateral knee is a prerequisite for performing this procedure safely. Furthermore, a biomechanically modified cross tie-grip suture showed less displacement and equivalent load-to-failure values

Table 1. Pearls and Pitfalls of the All-Inside Arthroscopic Tie-Grip Repair Using TRUESPAN

Pearls
Holds the figure-four position
Adduction stress for better visualization
Appropriate portals
Appropriate placement of the slotted cannula
Avoid too deep penetration of the delivery needle
Tighten the knot appropriately for both vertical and horizontal sutures
Pitfalls
Inappropriate portals
Handling error due to insufficient synovectomy
Poor visualization due to intraarticular bleeding
Chondral damage when inserting the slotted cannula and TRUESPAN
Neurovascular injury
Penetration of the lateral collateral ligament and popliteus tendon

Table 2. Advantages and Disadvantages of the All-Inside Arthroscopic Tie-Grip Repair Using TRUESPAN

Advantages
No need for a skin incision behind the lateral collateral ligament
Reduced surgical invasiveness
No need for an experienced assistant
Disadvantages
Neurovascular risk
Technical error and device problems
Implant cost

compared with that of the tie-grip sutures.[16] It is uncertain whether this applies to this technique; therefore, further research is warranted to clarify the appropriate candidates for this procedure when treating RT-LM.

In conclusion, beyond the risks and limitations, this technique allows reduced surgical invasiveness and more stable fixation for treating RT-LMs because the vertical mattress sutures bundle the circumferential fibers and act as rip stops for the horizontal sutures.

Disclosures

The authors (M.I., T.T., M.H., K.T.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Terzidis IP, Christodoulou A, Ploumis A, Givissis P, Natsis K, Koimtzis M. Meniscal tear characteristics in young athletes with a stable knee: Arthroscopic evaluation. *Am J Sports Med* 2006;34:1170-1175.
2. Ghosh P, Ingman AM, Taylor TK. Variations in collagen, non-collagenous proteins, and hexosamine in menisci derived from osteoarthritic and rheumatoid arthritic knee joints. *J Rheumatol* 1975;2:100-107.
3. Voloshin AS, Wosk J. Shock absorption of meniscectomized and painful knees: A comparative in vivo study. *J Biomed Eng* 1983;5:157-161.
4. Tsujii A, Amano H, Tanaka Y, et al. Second look arthroscopic evaluation of repaired radial/oblique tears of the midbody of the lateral meniscus in stable knees. *J Orthop Sci* 2018;23:122-126.
5. Kamiya T, Suzuki T, Otsubo H, et al. Midterm outcomes after arthroscopic surgery for hypermobile lateral meniscus in adults: Restriction of paradoxical motion. *J Orthop Sci* 2018;23:1000-1004.
6. Rosso C, Muller S, Buckland DM, et al. All-inside meniscal repair devices compared with their matched inside-out vertical mattress suture repair: Introducing 10,000 and 100,000 loading cycles. *Am J Sports Med* 2014;42:2226-2233.
7. Fillingham YA, Riboh JC, Erickson BJ, Bach BR Jr, Yanke AB. Inside-out versus all-inside repair of isolated meniscal tears: An updated systematic review. *Am J Sports Med* 2017;45:234-242.
8. Jemes O, Robert Y, Alex D, et al. Several techniques exist with favorable biomechanical outcomes in radial meniscus tear repair—a systematic review. *Arthroscopy* 2022;38:2557-2578.
9. Miller MD, Kline AJ, Gonzales J, Beach WR. Pitfalls associated with FasT-Fix meniscal repair. *Arthroscopy* 2002;18:939-943.
10. LaPrade RF, Konowalchuk BK. Popliteomeniscal fascicle tears causing symptomatic lateral compartment knee pain: Diagnosis by the figure-4 test and treatment by open repair. *Am J Sports Med* 2005;33:1231-1236.
11. Kamimura T, Kimura M. Meniscal repair of degenerative horizontal cleavage tears using fibrin clots: Clinical and arthroscopic outcomes in 10 cases. *Orthop J Sports Med* 2014;2:2325967114555678.
12. Takahashi T, Kimura M, Takeshita K. All-inside arthroscopic meniscal stacked suture repair for hypermobile lateral meniscus with FASTFIX 360. *Arthrosc Tech* 2021;10:e1757-e1761.
13. Passaro E Jr, Howard T, Sawicki M. Gastrinomas in MEN-I. *N Engl J Med* 1990;323:349-350.
14. Ross G, Grabill J, McDevitt E. Chondral injury after meniscal repair with bioabsorbable arrows. *Arthroscopy* 2000;16:754-756.
15. Goradia VK. All-inside arthroscopic meniscal repair with meniscal cinch. *Arthrosc Tech* 2013;2:e171-e174.
16. Nakanishi Y, Hoshino Y, Nagamune K, et al. Radial meniscal tears are best repaired by a modified "cross" tie-grip suture based on a biomechanical comparison of 4 repair techniques in a porcine model. *Orthop J Sports Med* 2020;8:2325967120935810.