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Original article

Ramp lesion repair via dual posteromedial arthroscopic portals: A cadaveric feasibility study

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ABSTRACT

Background: Ramp lesions are found in 16% to 40% of patients undergoing anterior cruciate ligament reconstruction. The repair technique traditionally involves using a suture hook through a posteromedial portal, with the arthroscope positioned in the intercondylar view via an antero-lateral portal. Ramp lesions may be difficult to visualize and repair, even with a 70° arthroscope. The objective of this study was to assess the feasibility of suturing ramp lesions via dual posteromedial portals for the arthroscope and instruments.

Hypothesis: Dual posteromedial arthroscopic portals allow good visualisation and high-quality suturing of ramp lesions, without inducing specific iatrogenic injuries.

Material and methods: We used 11 fresh cadaver knees. Two posteromedial portals were created under visualisation via an arthroscope introduced through an antero-lateral portal: one was the traditional instrumental portal and the other, located more proximally, was the optical portal. A 2-cm long ramp lesion was created. A suture hook was used to place one or two stitches of PDS n°0 suture. A probe was used to test the quality and stability of the suturing. The posteromedial plane was then dissected to evaluate the anatomical relationships of the portals.

Results: The dual posteromedial approach allowed the visualisation and hook suturing of the ramp lesions in all 11 cases. A single stitch was placed in 4 cases and two stitches in 7 cases. The suture was always of good quality and stable when tested with the probe. The dissection found no injuries to nerves, blood vessels, or tendons.

Conclusion: Ramp lesions can be repaired through a dual posteromedial arthroscopic approach. This surgical technique provides good visibility of these lesions and allows high-quality suturing, with no specific iatrogenic injuries. It is an alternative to ramp lesion repair via a single posteromedial portal, which can be challenging.

Level of evidence: IV, experimental study with no control group.

1. Introduction

Ramp lesions, which involve the posterior horn of the medial meniscus, are the meniscal lesions most often observed during reconstruction of the anterior cruciate ligament (ACL) [1]. Among these lesions, peripheral tears at the meniscocapsular or meniscosynovial junction have been found in 16.6% to 40% of cases [2–8]. Described in the 1980s as ramp lesions [9,10], they have attracted attention in recent years. Ramp lesions are difficult to diagnose by preoperative magnetic resonance imaging (MRI) [11] and are usually missed during arthroscopy when only anterior portals are used [12]. Routine exploration of the posterior compartment via the intercondylar view or even using a probe introduced through a posteromedial portal are needed to diagnose ramp lesions [3]. The meniscocapsular junction plays a major role in ensuring knee stability, as it limits anterior tibial translation and rotational laxity [13–16]. If ramp lesions are missed during ACL reconstruction, there is a risk of residual laxity and of excessive constraints on the ACL transplants, which may lead to functional failure and to deterioration of the menisci and cartilage. In Europe, ramp lesions are classically repaired using a suture hook introduced via a posteromedial portal [17], with the arthroscope introduced through an antero-lateral portal and positioned to provide an intercondylar view. Repairing ramp lesions is a reliable technique that allows meniscal healing in 89% to 93% of cases [6,18]. However, they are

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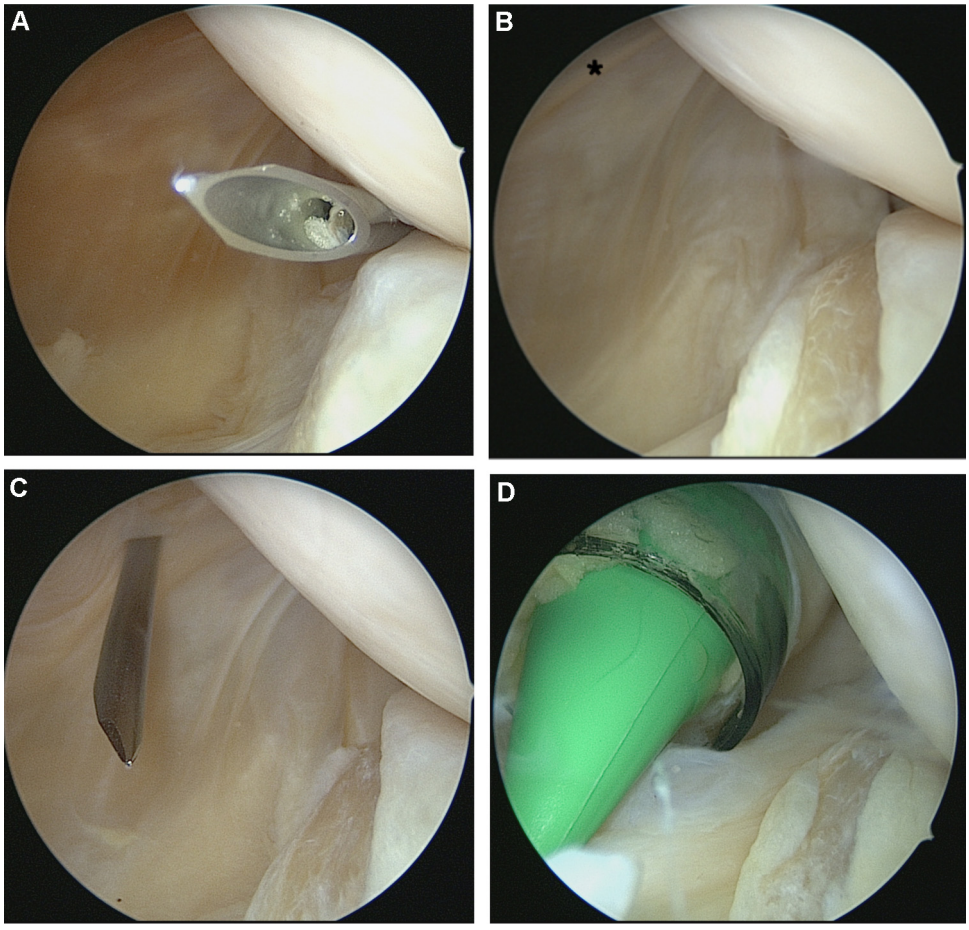

Fig. 1. Intercondylar view of the posteromedial compartment. A. Needle location of the main posteromedial portal (MPM). B. Creation of the ramp lesion. *Synovial fold in the supero-posterior quadrant. C. Needle location of the accessory posteromedial portal (APM). D. Positioning of the arthroscopic cannula through the APM portal.

difficult to repair when using the intercondylar view and a posteromedial instrument portal, even with a 70° arthroscope.

The objective of this study was to establish the feasibility of ramp lesion suturing via a new arthroscopic approach involving two posteromedial portals, one for the arthroscope and the other for the instruments. Our working hypothesis was that the dual posteromedial arthroscopic approach provided good visualisation and high-quality suturing of ramp lesions, without inducing any specific iatrogenic injuries, notably at the accessory posteromedial portal.

2. Material and methods

We conducted a cadaveric study at the school of surgery of the Paris University Hospital Network (Assistance Publique des Hôpitaux de Paris) using a research protocol that complied with the school's ethical requirements and after a test dissection on a cadaver knee.

The same operator (CT) dissected 11 fresh cadaver knees. The cadavers kept at −18 °C were brought to room temperature 24–36 hours before the dissection. Inclusion criteria were absence of a history of surgery or trauma to the knee and normal range of motion. Exclusion criteria were absence of the medial meniscus discovered during the dissection and the presence of osteophytes in the intercondylar notch, preventing passage of the arthroscope to the intercondylar view position.

The cadaver was placed supine, with the leg hanging over the edge of the table to allow mobilization of the knee between 0° and 90° of flexion.

The protocol was divided in to two parts:

- ramp lesion suturing via the dual posteromedial arthroscopic approach, then;
- open dissection of the posteromedial plane.

The arthroscopic procedure, performed with a 30° arthroscope, involved five steps (Video).

2.1. Arthroscopic exploration

An antero-lateral portal for the arthroscope, and an anteromedial portal for the instruments, were used.

2.2. Creation of the main posteromedial (MPM) portal

The 30° arthroscope introduced through the antero-lateral portal was slipped into the intercondylar notch under the posterior cruciate ligament (PCL) then positioned for the intercondylar view to visualise the posteromedial compartment. The MPM portal was created under arthroscopic visualisation after needle localisation. The entry site of the needle was at the junction of the posterior femoral condyle with the tibial plateau (Fig. 1A). The MPM portal was located 1 cm anterior to the site of the traditional posteromedial portal.

2.3. Creation of the ramp lesion

A scalpel with a #11 blade introduced through the MPM, was used to create a 2-cm long vertical tear at the meniscocapsular

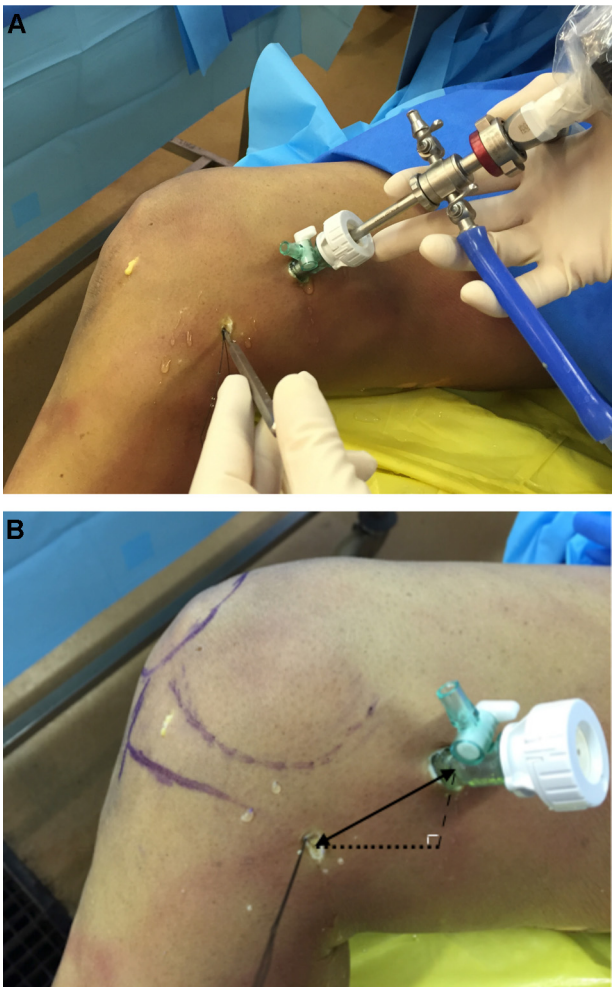

Fig. 2. Main posteromedial portal (MPM) and accessory posteromedial portal (APM) portals: external view. A. MPM instrumental portal, APM optical portal. B. Distances between the MPM and APM portals with the knee in 90° of flexion. ↔ Distance over the skin (mean, 3.8 ± 0.2 cm). ····· Distal to proximal orthogonal distance (mean 2.9 ± 0.3 cm). — Antero-posterior orthogonal distance (mean, 1.9 ± 0.2 cm).

junction of the medial meniscus (Fig. 1B). A probe was then introduced to confirm that the lesion was a full-thickness tear.

2.4. Creation of the accessory posteromedial (APM) portal

The accessory posteromedial portal was created under arthroscopic visualisation with the arthroscope in the intercondylar view position, after needle localisation. The APM portal was posterior and superior relative to the MPM portal. The needle entry site was in the supero-posterior quadrant of the intercondylar view, at the level of the superior synovial fold (Fig. 1B). This synovial fold was consistently present. The needle was directed obliquely downwards and medially (Fig. 1C). A rigid transparent arthroscopy cannula 7 mm in diameter (CLEAR-TRAC®, 7 mm–90 mm, Smith&Nephew, London, UK) was introduced through the APM portal (Fig. 1D).

2.5. Ramp lesion repair using a suture hook

The 30° arthroscope was removed from the antero-lateral portal and introduced into the APM portal through the arthroscopy cannula. Thus, the APM portal was the optical portal (Fig. 2A). A 45° suture hook (ACU-PASS®, 45°, Smith&Nephew, London, UK) with PDS n°0 suture introduced through the MPM portal was used to repair the ramp lesion. A suture hook curved to the left was used for the right knee and vice versa. The suture hook was passed from superior to inferior in the posterior capsule, then from inferior to superior in the posterior segment of the medial meniscus. The two ends of the thread were then recovered through the MPM portal and the suture hook was removed. A slipknot was created. As many stitches as needed to stabilize the lesion were performed. The quality of the suture was tested using a probe introduced through the MPM. Suture quality was classified as tight, loose, or failed:

- tight: the probe could not be introduced into the lesion;
- loose: the probe could be introduced into the lesion due to the persistence of a gap between its two edges;
- failed: the ramp lesion was not repaired due to insufficient tightening of the knot or to failure to pass the suture.

The posteromedial plane was then dissected to evaluate the anatomical relationships of the two posteromedial portals with the saphenous nerve, great saphenous vein, and tendons of the hamstring and adductor muscles. A ruler with millimetre graduations was used to measure the distances separating these structures from the APM and MPM portals.

3. Results

We studied 11 cadaver knees (6 right knees and 5 left knees from 6 males and 5 females). Mean age at death was 74 ± 5.2 years. In all 11 knees the medial meniscal ramp was intact.

The mean distance on the skin between the MPM and APM portals was 3.8 ± 0.2 cm with the knee at 90°. In the orthogonal system, the APM portal was 2.9 ± 0.3 cm proximal and 1.9 ± 0.2 cm anterior to the MPM (Fig. 2B).

Triangulation via the two posteromedial portals was always easy. Visualisation of the ramp lesion through the optical posteromedial arthroscopic portal was easy and more complete than that obtained through the intercondylar view (Fig. 3A and B).

Repair of the ramp lesion using a suture hook was consistently possible through the dual posteromedial portals. In 4 (36%) knees, a single stitch was sufficient (Fig. 4A), whereas in the 7 (64%) remaining knees two stitches were placed (Fig. 4B). All sutures were considered tight.

The subsequent dissection found no injuries to nerves, blood vessels, or tendons. All these structures were located more than 15 mm away from the two portals. In 2 cases, a cutaneous branch of the saphenous nerve ran between the two posteromedial portals but was not injured.

4. Discussion

This study demonstrates the feasibility of ramp lesion repair through dual posteromedial arthroscopic portals. To our knowledge, this is the first study to use this dual posterior arthroscopic approach. This technique is easier to perform compared to hook suturing via a single posteromedial portal with the arthroscope in the intercondylar view position. The direct visualisation of the posteromedial compartment and easy triangulation related to the distance between the APM and MPM portals facilitate the manipulation of the suture hook and the positioning and distribution of the stitches. In addition, this study proves that the APM portal is safe, since the dissections found no injuries to nerves, vessels, or tendons. Our hypothesis is thus confirmed.

Ramp lesions cannot be properly identified using only anterior portals. Sonnery-Cottet [3] and Peltier [19] have demonstrated the importance of conducting the arthroscopic exploration in three steps:

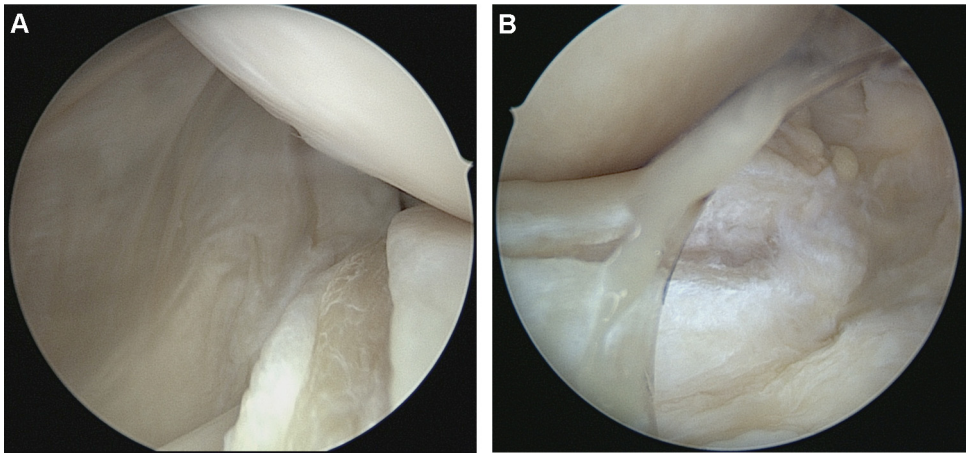

Fig. 3. Visualisation of the ramp lesion. A. Intercondylar view. B. View through the accessory posteromedial (APM) portal.

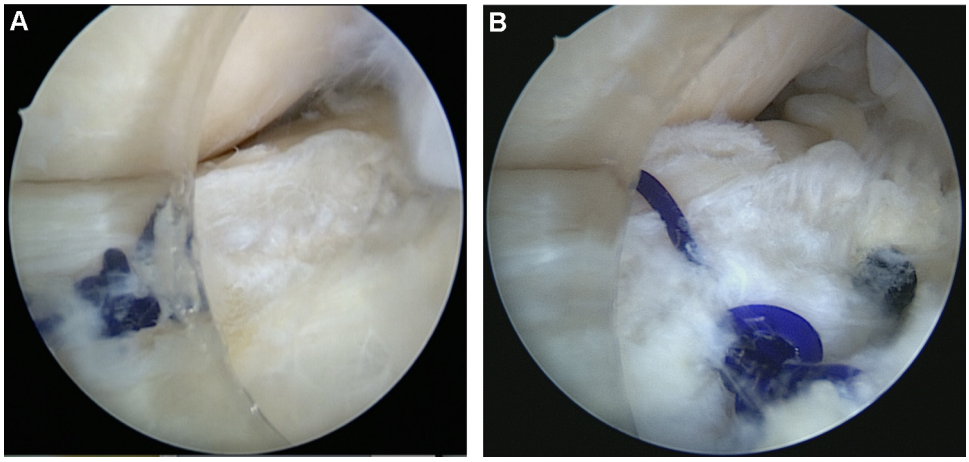

Fig. 4. Hook suturing of the ramp lesion. A. With a single stitch. B. With two stitches.

- exploration via the anterior portals;
- exploration of the posteromedial compartment through the intercondylar view;
- creation of a posteromedial instrument portal to allow needle probing and superficial debridement.

This systematic exploration method with a 30° arthroscope identifies ramp lesions missed by the anterior portals in 15% to 40% of cases [3,19]. Nonetheless, the 30° arthroscope does not provide visualisation of the entire posteromedial compartment because it leaves a blind spot on the meniscus. A 70° arthroscope provides better visualisation [7]. The blind spot with the intercondylar view has been estimated at 31% to 47% with a 30° arthroscope and 21% to 32% with a 70° arthroscope [20,21]. Mariani [22] has pointed out the usefulness of the 45° arthroscope, which increases the field of view of the posteromedial compartment in the intercondylar view compared to the 30° arthroscope, while providing a more familiar appearance than does the 70° arthroscope, which is rarely used for the knee. Finally, the introduction of a 30° arthroscope through a posteromedial portal provides a greater increase in the field of view of the posteromedial compartment [2,4]. Direct visualisation via a posteromedial portal diminishes the blind spot to 8.4% [21].

In France, surgical procedures on the menisci account for 30.3% of all primary knee surgeries [23]. Over the last decade, the number of meniscal repair procedures increased by 320% [24]. Ramp lesions can impair knee stability [13–16] and must therefore be repaired [25]. However, whether ramp lesions that are stable and less than 1.5 cm in length should be repaired is controversial [26–28]. Several repair techniques have been described: inside-out suturing through a posteromedial approach, all-inside suturing with a hybrid system such as FAST-FIX® (Smith&Nephew, London, UK), and hook suturing through a posteromedial portal. Inside-out suturing [29], which is chiefly performed in the US [30], requires an open posteromedial approach. The all-inside technique via anterior arthroscopic portals [31–33] is popular because it is fast and easy to perform. However, it has a number of disadvantages for repairing ramp lesions: difficulties may arise in approximating the edges of the tear [34] and avoiding that the anchors penetrate the intra-articular cavity [34], and the suturing is not circumferential [35]. Hook suturing through a single posteromedial portal with the arthroscope in the intercondylar view is the technique usually performed in Europe. It was first described by Morgan [17], who used a 70° arthroscope, but is now usually performed with a 30° arthroscope [3,6,8,18]. Some surgeons are reluctant to perform this procedure because it is technically challenging and increases the operative time. To make the technique easier, Ahn et al. [36] suggested using a second posteromedial portal created 1 cm above the classical posteromedial portal. This second portal allows the introduction of a hook to pull on the capsule. We believe that the technical difficulty of hook suturing is related to the poor visualisation of the posteromedial compartment by the arthroscopic intercondylar view. Hook suturing via a dual posteromedial approach, as described here, has several advantages compared to hook suturing through a single posteromedial portal

with the intercondylar arthroscopic view. The direct visualisation of the posteromedial compartment through the APM portal provides a panoramic downwards view of the posterior part of the medial meniscus. This direct visualisation of the entirety of the posterior segment of the medial meniscus facilitates the handling of the suture hook, as well as the placement and distribution of the stitches. Furthermore, the distance between the two posteromedial portals, which is 3.8 ± 0.2 cm on average, facilitates triangulation and allows easy handling of the instruments.

The rate of complications related to the posteromedial portal is low. Injury to branches of the saphenous nerve have been reported in 1.3% to 1.8% of cases [37–39] and injury to the great saphenous vein in 1.1% to 1.5% of cases [38,39]. These injuries are more common with inside-out suturing, as an open posteromedial approach is required. The saphenous nerve and great saphenous vein are located 1.5 cm [40] and 2.26 cm [41], respectively, from the postero-inferior portal, in the posteromedial direction, when the knee is in 90° of flexion. In our study, the creation of a second posteromedial portal, the APM portal, was not responsible for any injuries to nerves or vessels. The APM portal is in a postero-superior location relative to the MPM portal when the knee is flexed to 90°.

Our study has several limitations. The feasibility and risk of iatrogenic injuries associated with the repair of ramp lesions via the dual posteromedial arthroscopic approach must be confirmed by in vivo studies. We did not directly compare the arthroscopic field of view or the quality of the meniscal sutures to those obtained with the conventional suture hook technique. Neither did we perform biomechanical studies after the ramp repair to assess resistance of the meniscal sutures to stress, as well as residual laxity. Finally, the potential benefits of this technique on meniscal healing and knee kinematics require investigation.

5. Conclusion

Ramp lesions can be repaired using a dual posteromedial arthroscopic approach. This surgical technique provides a direct panoramic view of meniscocapsular lesions and allows high-quality suturing, without inducing specific iatrogenic injuries. These findings need to be confirmed by in vivo investigations.

Disclosure of interest

CT and MS declare that they have no competing interest.

PB occasionally serves as an educational consultant for Smith&Nephew and is a consensus advisor for the European Society of Sports Traumatology, Knee Surgery & Arthroscopy.

NP occasionally serves as an educational consultant for Zimmer-Biomet, Smith&Nephew, and Lima.

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None.

Contributions of each author

CT performed the procedures at the school of surgery and drafted the manuscript.

MS supervised the procedures and contributed to write the manuscript.

PB revised the manuscript for important intellectual content.

NP conceived the study and revised the manuscript for important intellectual content.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.otsr.2021.103175.

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