

Dual Cannula Combined With Modified Shoelace Continuous Capsular Closure Technique in Hip Arthroscopic Surgery



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Abstract: The Technical Note aims to present an arthroscopic capsular closure technique at the end of the hip arthroscopy. The technology employs a dual-channel approach and modified shoelace suture technique to continuously suture the hip capsule. Recent studies have indicated that routine intraoperative repair of the articular capsule at the end of the hip arthroscopy is advocated. However, the majority of the hip capsular closure techniques are relatively complex, time-consuming, and bring many complications, which has hindered their widespread use in clinical practice. Herein, we provide an arthroscopic capsular closure technique using the modified shoelace continuous suture in combination with a dual cannula for correcting hip instability during hip arthroscopic surgery of femoroacetabular impingement.

One of the key factors contributing to adult hip joint pain is femoroacetabular impingement.¹ The effectiveness of hip arthroscopy in treating femoroacetabular impingement has been confirmed, with the features of minimum trauma and quick recovery.² This has been made possible by the advancement of arthroscopy technology and thorough research on hip pain. A smooth incision of the articular capsule into the hip joint is the key to full exposure. This is mostly due to the deep position of the hip joint, which is encompassed by thick muscles and articular capsule

ligaments.³ Most surgeons who perform hip arthroscopic surgery opt for interportal capsulotomy,⁴ a procedure that entails creating a transverse incision in the anterior articular capsule of the hip joint. The iliofemoral ligament (ILF) and the anterior articular capsule of the hip joint, which affect the stifle, could be harmed by certain surgeons who employ a “T”-incision technique to manipulate the joint capsule for better visibility or even excising a portion of the articular capsule for better vision.⁵ Discussions pertaining to the suturing of the incised hip articular capsule begin as a result. However, given the inherent complexity of this technique, there remains ongoing debates regarding whether the clinical effect would get improved after the repair.

Thus, Uchida et al.⁶ describe a surgical technique for capsular closure or plication using smooth suture tape (Ultratape; Smith & Nephew, Andover, MA) (the shoelace technique). In light of this, we modified the shoelace suture technique and integrated it with the dual cannula technique (Clear Cannula System, DePuy Mitek).

This method is a particular technique that we regularly use because it helps to quickly and securely close the hip articular capsule. It can minimize the emergence of mild hip joint instability after surgery and thus decrease the revision rate after hip arthroscopy.

There is currently an absence of information in the literature about shoelace suture technique outcomes and complication rates. It is currently unknown

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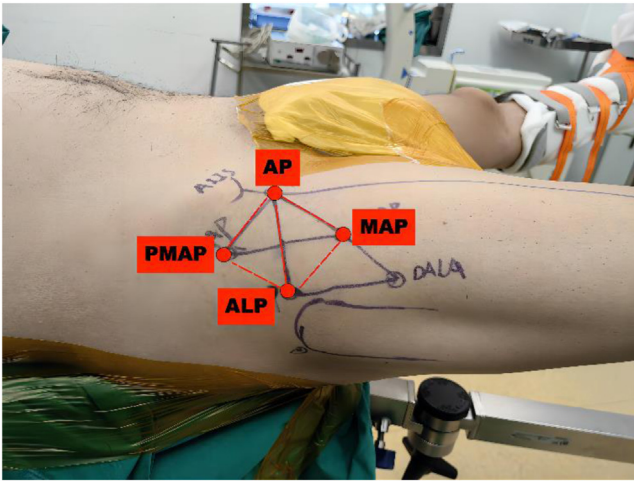


Fig 1. In a right hip arthroscopic examination and treatment, 4 portals are marked with the patient in the supine position: anterior portal (AP), 6 mm distal to the ASIS; anterolateral portal (ALP), established by outside-in technique, 1 cm anterior to the level of apex of greater trochanter; mid-anterior portal (MAP), distal vertex positions of equilateral triangles (AP, ALP, MAP jointly composed); proximal mid-anterior portal (PMAP), proximal vertex positions of equilateral triangles (AP, ALP, PMAP jointly composed). (ASIS, anterior superior iliac spine.)

whether capsular suturing should be done as a standard technique in hip arthroscopy or not, especially in cases when additional risk factors for instability, such as hypermobility or hip dysplasia, are absent.

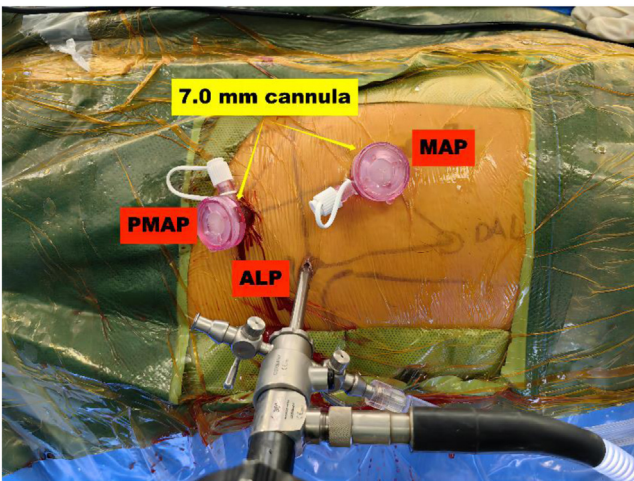


Fig 2. After completing arthroscopic examination and management of right hip, final joint capsule suturing is performed. Two 7.0-mm cannulas are separately inserted into PMAP and MAP, aiming to achieve safer and quicker suture operation. The scope is inserted into ALP with the objective of achieving better visibility and understanding of the surrounding structures. (ALP, anterolateral portal; MAP, mid-anterior portal; PMAP, proximal mid-anterior portal.)

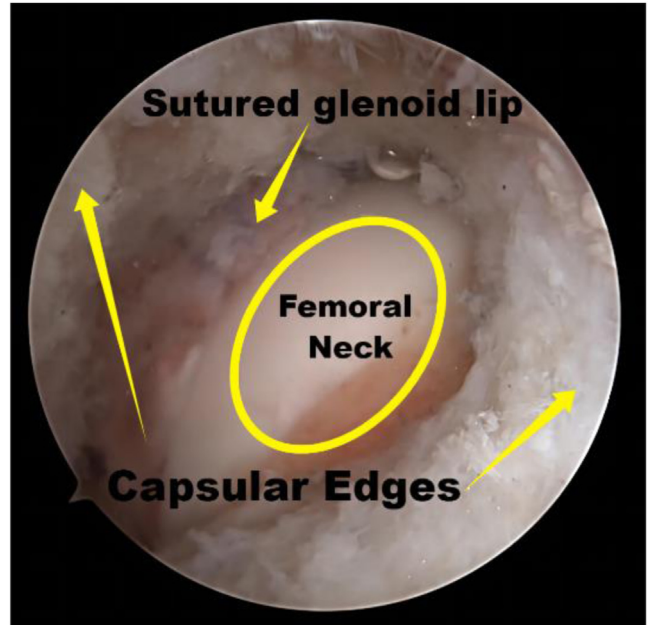


Fig 3. Arthroscopic images of right hip. The scope is inserted into ALP and is situated the outside of capsule, revealing the edge of the hip capsule. The femoral neck can be seen at the bottom of the image. (ALP, anterolateral portal).

A retrospective research study is conducted to assess the effects of the modified shoelace suture technique on the functional outcome. The capsular closure at the end of the procedure, as per our hypotheses, demonstrates a positive influence on the functional outcome and is a reliable and secure modification of the shoelace suture technique.

Surgical Technique (With Video Illustration)

Patient Preparation and Positioning

After general anesthesia with tracheal intubation, the patient is placed in the supine position on a traction bed with a soft padded wrapped perineal column placed on the inner thigh of the affected side for traction protection. Hip traction is conducted with the C-arm machine fluoroscopy.

Hip Traction With Fluoroscopy

The acquisition of an accurate anteroposterior pelvic radiograph involves tilting the c-arm. Under fluoroscopy, the traction force applied to the affected hip is incrementally raised to approximately 10 to 20 kg. Also, the hip gap needs to be altered by about 8 to 10 mm so that the femoral head is in a state of subluxation. This condition is usually accompanied by the air sign within the hip joint, which marks the sealing disruption of the hip joint and the successful distraction of the hip joint. At this point, the position of the greater trochanter, anterior superior iliac spine, and joint gap are marked on the body surface (Fig 1).

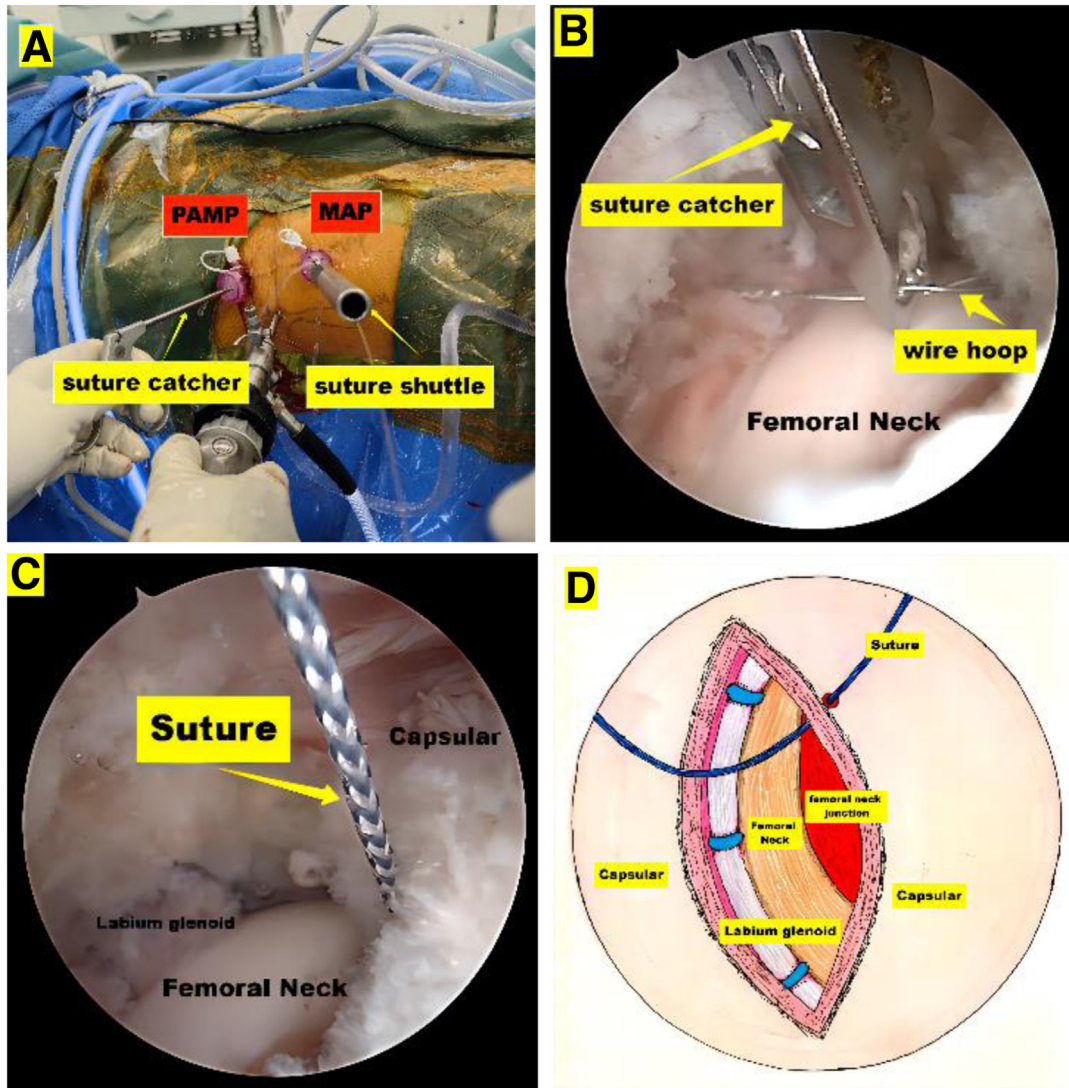


Fig 4. The first step of joint capsule suture. (A) A suture shuttle and a suture catcher are put into two 7.0 mm cannulas, which are separately inserted into PMAP and MAP. (B) A suture shuttle is used to pass a wire loop through the capsule at the distal side of the capsulotomy superficially to deep into the capsule, and a suture catcher is seen retrieving the wire loop through the capsule on the proximal side of the capsulotomy. (C) A suture is successfully inserted into the capsule. (D) Artistic rendering of arthroscopic and surgical images of right hip, in that a suture is successfully inserted into the capsule. (MAP, mid-anterior portal; PMAP, proximal mid-anterior portal.)

Selection of Hip Approach

The anterolateral portal (ALP) and the mid-anterior portal (MAP) are first established. The guide needle is reinserted in the MAP to ensure that the approach successfully avoids the glenoid labrum and femoral head into the hip joint space, and the hip arthroscope is successfully placed into the intracapsular space using the over-the-wire technique, and then slowly withdrawn outside the capsule. In this case, a low-temperature plasma knife (Johnson & Johnson) is used in the anterolateral portal (ALP) to perform an inter-articular hip. The incision is approximately 0.5 cm from the acetabular rim, and the capsule incision is 2-3 cm in length. Furthermore, the proximal

mid-anterior portal (PMAP) is established in advance for capsule suturing (Video 1).

Diagnostic Arthroscopy

Arthroscopic examination and management of the affected hip are completed, including assessing the glenoid labral tear, the extent and degree of the tear, and identifying any cartilage damage and round ligament tears. Arthroscopic management, which involves decompression of the anterior inferior iliac spine, trimming of the rim, and refixation of the labrum, is performed based on preoperative imaging, a thorough physical examination, and the arthroscopic situation. The traction bed is then loosened, followed by an

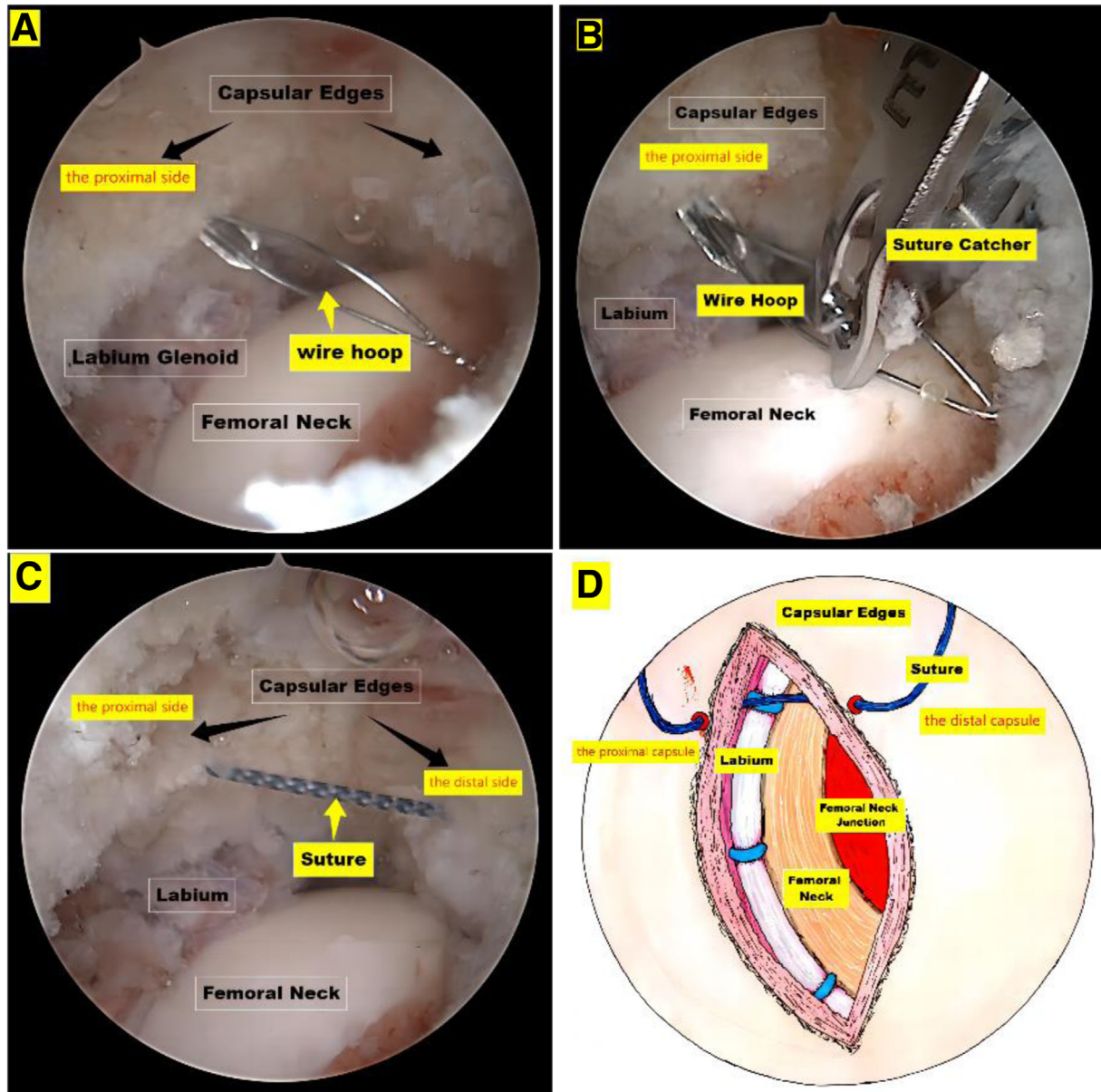


Fig 5. The second step of joint capsule suture: (A) A suture shuttle is used to pass a wire loop through the capsule at the proximal side of the capsulotomy superficially to deep into the capsule. (B) A suture catcher is seen retrieving the wire loop through the capsule on the distal side of the capsulotomy. (C) A suture was successfully inserted into the capsule. (D) Artistic rendering of arthroscopic and surgical images of right hip.

assessment of the peripheral interval, and the decompression and shaping of the cam-shaped deformity at the femoral neck junction. After addressing these, the final joint capsule suturing is performed.

Dual Cannula Combined With Modified Shoelace Continuous Capsular Closure

First, the limb is kept in a 20° to 30° hip flexion posture with the traction being fully released. Next, a 7.0-mm cannula (7.0 mm × 75 mm, Clear Cannula

System; DePuy Mitek, Warsaw, IN) is successfully inserted into the PMAP using the over-guided wire approach, and a second 7.0-mm cannula (7.0 mm × 75 mm, smooth, Clear Cannula System; DePuy Mitek) is inserted into the MAP using the same technique (Fig 2). A planer and a low-temperature plasma knife are subsequently used to completely expose the joint capsule's margins (Fig 3) (Video 1).

After passing the cannula through the MAP with a suture shuttle, suture from the proximal surface of the

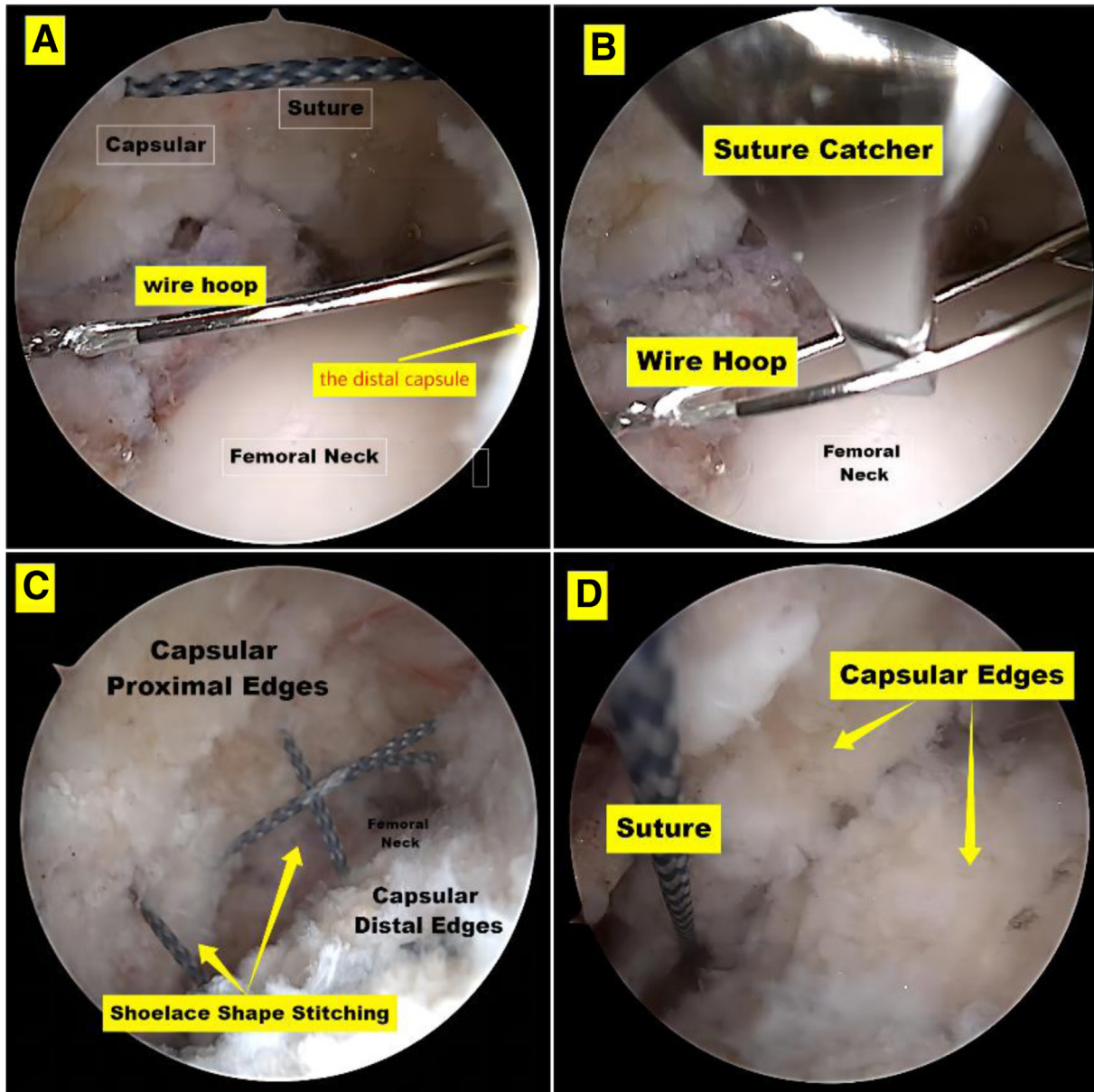


Fig 6. Arthroscopic images of continuous capsular closure of right hip. (A) A suture shuttle is used to pass again a wire loop through the distal capsule at the side of the capsulotomy superficially to deep into the capsule. (B) A suture catcher is seen retrieving again the wire loop through the capsule on the proximal side of the capsulotomy. (C) The suture is repeated back and forth over the line, typically three times, with a distance of 6-7 mm between each stitch, and eventually forming shoelace suture. (D) The ends of the high-strength sutures are gradually stretched tightly in the cannula.

joint capsule into the deeper layers of the joint capsule, and grasp it out through the PMAP cannula using a suture catcher (Fig 4).

To establish a unilateral suture, a No. 2 Arthrex high-strength thread is successfully inserted into the joint cavity through the suture hook lead. Then, use a suture hook to pass through the sleeve of the PMAP, suture from the proximal surface of the joint capsule into the deeper layer of the joint capsule. Following this, use a wire grasper to grasp it out through the MAP sleeve and bring out the original strong suture from the PMAP. A

similar procedure is carried out to achieve a contralateral suture of the joint capsule (Fig 5).

To achieve the shoelace suture technique, successfully pass the proximal end of the strong suture through the joint capsule at the MAP end by the suture hook lead, and sew it once at the PMAP end in the same way. This is done after using the suture hook to sew the joint capsule at the MAP end by going in through the MAP sleeve. The suture is repeated back and forth over the line, typically three times, with a distance of 6 to 7 mm between each stitch (Fig 6).

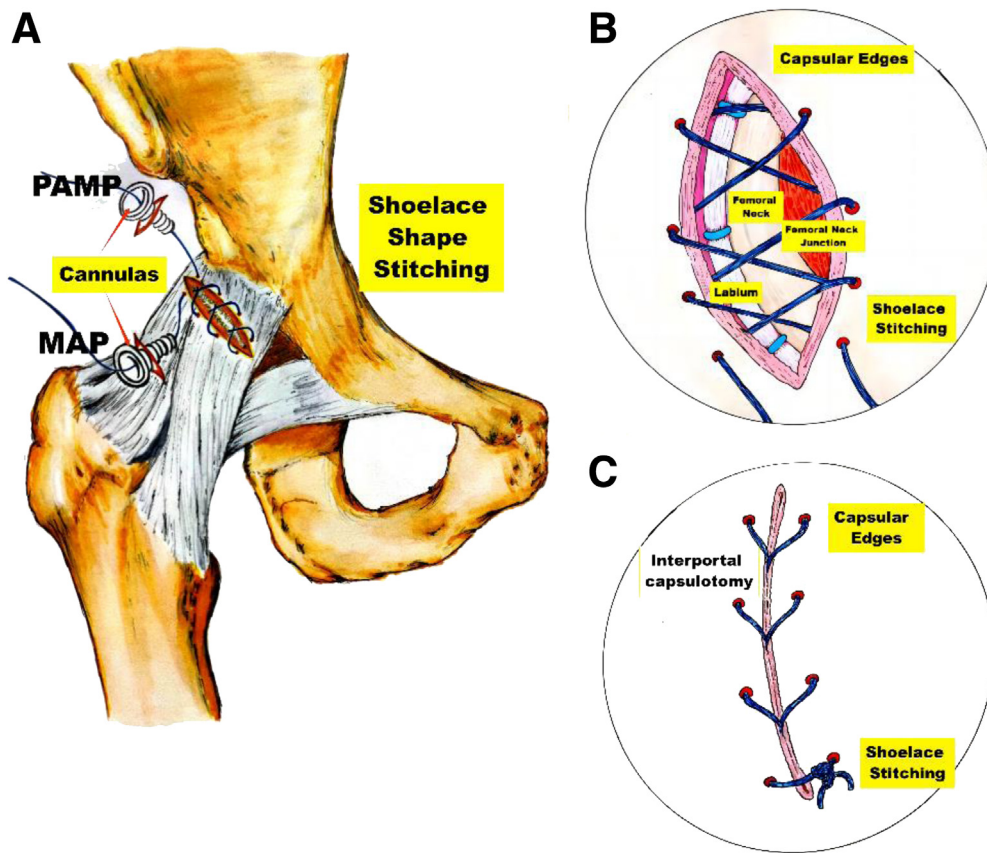


Fig 7. Artistic rendering of arthroscopic and surgical images of right hip. (A) Anterior view of a right hip after modified shoelace continuous capsular closure in 2 cannula portals. (B) Arthroscopic and surgical views of right hip capsular suture management. The suture strand utilized for capsular repair is colored dark for easy identification. Before being tightened, the stitch shuttle moves back and forth in a manner like tightening shoelaces. (C) Arthroscopic and surgical views of right hip capsular suture management. After tightening the stitch, complete capsular closure can be finished, and 4-5 knots are tied to avoid slipping.

The high-strength suture's two ends are then retracted through a cannula. To create enough tension in the capsule, the ends of the high-strength sutures are gradually stretched tightly in the cannula. In order to secure them, 4 to 5 knots are tied (Fig 7 and Video 1).

Postoperative Rehabilitation

Close the wound after taking stock of the tools. Following surgery, anti-inflammatory and analgesic drugs are routinely given. On the day of surgery, patients can start hip flexion and extension exercises and utilize double crutches to move around on the ground. Two follow-up visits are conducted within 6 months following the treatment, during which a magnetic resonance imaging scan of the hip joint is performed to examine the recovery of the joint capsule.

Discussion

The article outlines a surgical strategy for addressing hip instability in hip arthroscopic surgery of femoroacetabular impingement. The arthroscopic capsular closure technique involves the use of a modified shoelace continuous suture in combination with a dual cannula. Reports indicate that routine intraoperative

repair of the articular capsule at the end of the hip arthroscopy is advocated, especially in capsular laxity and borderline hip dysplasia. In recent studies, the prevailing approach for Joint capsular closure in most cases is choosing standard capsular closure, that is interrupted suture, sewing 2 to 4 needles intermittently on the left and right sides of the Joint capsule incision.⁷ However, the risk of injuring blood vessels and nerves during operation also increases due to repeated suture operations in the portals. On the basis of this, we modified the shoelace suture technique and combined it with the dual cannula technique (Clear Cannula System; DePuy Mitek).

Traditionally, the articular capsule is typically sliced transversely during hip arthroscopic surgery between 12 o'clock and 3 o'clock in front of the hip joint, which is the running location of the ILF.⁸ Some surgeons will additionally use "T"-shaped incisions to open and close the joint capsule, or even excise the articular capsule at the location, in order to gain better visibility.⁹ The femoral head will move excessively inside the acetabulum when the ILF is torn or relaxed, leading to joint instability and clinical symptoms. The instability of the hip joint will therefore unavoidably be affected by any

Table 1. Comparison of Advantages and Disadvantages of Dual Cannula Combined With Modified Shoelace Suture Technique and Standard Capsular Closure Technique

	Advantages	Disadvantages
Dual cannula combined with modified shoelace suture technique	<ol style="list-style-type: none"> 1. The scope is situated both inside and outside the capsule for better visualization and understanding of the surrounding structures. 2. Insert two 5.0mm cannulas into PMAP and MAP to achieve safer and quicker suture operation. 3. Only 1 suture tape is used. 4. Completely close the hip joint capsule and the biomechanical strength may be stronger. 	<ol style="list-style-type: none"> 1. The operation is fairly complicated, technically challenging, and has a high learning curve. 2. There is a risk of complete failure of the suture due to suture breakage.
Standard capsular closure technique	<ol style="list-style-type: none"> 1. It is easier and has a shorter surgical duration. 2. There is no risk of complete failure of the suture due to one of the suture breakage. 	<ol style="list-style-type: none"> 1. Lack of visibility: the scope is placed only inside the capsule, which thus has a potentially higher risk of soft tissue bridging within the suture's capsule and can cause persistent pain or discomfort after hip arthroscopy. 2. Two or more suture tapes are utilized. Risk of suture strand entanglement, air knot, and/ or breakage. 3. Potential for incomplete closure and plication.

partial damage to the hip articular capsule, particularly when the capsule is moderately loosened when flexing forward.¹⁰

At present, for the suture of the hip capsule, the main suturing techniques include simple suture, multiple intermittent suture, continuous suture and special suture. If the scope of the incision of the hip capsule is of limited extent, the capsule can be closed by choosing the simple suture.¹¹ Recent studies usually choose standard capsular closure, that is interrupted suture, sewing 2 to 4 needles intermittently on the left and

right sides of the joint capsule incision to close the joint capsule.⁷ However, the article also points out that the risk of standard capsular closure lies in the following; (1) There exists a risk of suture strand entanglement, incomplete knotting, air knot, and even breakage. (2) An excessively wide needle pitch can easily prevent the capsule from closing completely. (3) Being too close to the incision edge increases the risk of tearing off and subsequent failure of suturing. So we coupled the dual cannula technique (Clear Cannula System; DePuy Mite) with the modified shoelace suture technique. This approach is one that we routinely use because it can quickly and securely close the hip articular capsule, minimizing the emergence of mild hip joint instability after surgery and reducing the revision rate after hip arthroscopy. The advantages and disadvantages of this technique are shown in Table 1.

The acetabular glenoid lip, the ligament system around the hip joint, and the hip articular capsule are all essential elements in preserving the stability of the hip joint. The main components to ensuring the post-operative effectiveness of hip arthroscopy include cutting the articular capsule in the right way and repairing it at the right time. Hip arthroscopy doctors must be skilled in articular capsule suture technology in order to ensure the suture effect, shorten the procedural time, and minimize complications. When accomplish using the correct technique, as discussed in this article with a step-by-step approach, including the pearls and pitfalls of this procedure (Table 2), we believe this is a safe and readily reproducible process.

Additionally, this method has the following limitations. First, this is merely a Technical Note that outlines

Table 2. Pearls and Pitfalls

Pearls
Interportal capsulotomy or repair to interportal capsulotomy with the aim of making the cuts at both ends parallel.
The capsule suturing is performed while the limb is kept in a 20°-30° hip flexion posture and the traction is completely released.
The scope is placed both outside the capsule for better visualization and understanding of the surrounding structures.
Two 7.0 mm cannulas are separately inserted into PMAP and MAP, using the over-guided wire approach, aiming to safely and quickly pass the suture hook and wire grasper.
The suture sequence is from the inside to the lateral side.
The suture is repeated back and forth over the line, typically three times, with a distance of 6-7 mm between each stitch.
Sutures must be tied visibly, with the feel of the knot pusher against the capsular tissue.
Pitfalls
Unnecessary expansion of capsulotomy could aggravate damage and difficulty.
Failure to pre-identify left and right suture ends in PAMP and MAP.
Unable to smoothly tighten the SMC knot, or unable to gradually tighten.
Suture breakage during knot tying.

a surgical technique. The efficacy of the technique can be substantiated by further biomechanical research and clinical outcomes, which can be compared to alternative fixation or reconstruction techniques.

In conclusion, we demonstrate dual cannula combined with a modified shoelace suture technique for correcting hip instability in hip arthroscopic surgery of femoroacetabular impingement. This technique may be efficient in treating hip instability after hip arthroscopy is advocated, especially in cases with capsular laxity and borderline hip dysplasia.

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