Technical Note

Proximal Capsular Augmentation With the Indirect Head of the Rectus Femoris for Longitudinal Capsulotomy in Primary Hip Arthroscopy

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Abstract: The positive effect of the capsular closure in maintaining the integrity of the joint capsule has been demonstrated, but most capsular closure techniques are primarily for interportal capsulotomy, with few techniques described for longitudinal capsulotomy. In our clinical practice, the incomplete closure of the proximal capsule in longitudinal capsulotomy may result in weakness or nonunion of the proximal capsule. Thus, we propose a technique of anatomic repair of the joint capsule with the indirect head of the rectus femoris as proximal augmentation in cases of longitudinal capsulotomy. This technique could provide a plausible and feasible solution for complete capsular closure of the longitudinal capsulotomy, which could decrease the risk of weakness or nonunion of the proximal capsule.

The biomechanical properties of the hip capsule and its role in maintaining hip joint stability are well known. Complete closure of the capsule after hip arthroscopy has been shown to improve patients' long-term outcomes.[1] Conversely, hip arthroscopy with capsular nonclosure may increase the risk of postoperative complications.[2] Therefore, surgeons increasingly perform complete closure of the capsule for better clinical outcomes.

The choices of the closure technique for hip capsule depend on the type of capsulotomy performed. Interportal and T-capsulotomies are commonly used approaches, both requiring the transection of the iliofemoral ligament, which can lead to a high rate of nonunion, even if it is completely repaired. Thaunat et al.[3] proposed a technique that splits the capsule in alignment with the iliofemoral ligament. We call this method longitudinal capsulotomy. This method offers significant advantages over traditional techniques because it maximizes the preservation of the iliofemoral ligament, facilitating closure of the capsule. Longitudinal capsulotomy has been routinely performed in hip arthroscopy, and we find that releasing the synovial layer of the capsule or partially detaching the anterior inferior iliac spine attachment area may be necessary for good visualization and maneuverability. However, this may impair the integrity of the proximal capsule, resulting in iatrogenic hip instability, especially in cases of borderline developmental hip dysplasia. In this report, we introduce a technique of proximal capsular closure in which overlap reinforcement of the indirect head in longitudinal capsulotomy is performed.

Preoperative Evaluation and Surgical Plan

Preoperative evaluation should include general health, current medical history, past history, and trauma history. Physical examination should assess hip mobility and include flexion adduction and abduction external rotation tests, anterior hip apprehension test, and Beighton Score. Comprehensive radiographic evaluation is crucial to determine the surgical protocol (Video 1). This includes anteroposterior view of the pelvis, Dunn's view, and the false profile view to assess acetabular coverage and femoral head deformity. A 3-dimensional computed tomography scan can provide better visualization of cam lesions and the morphology of the anterior inferior iliac spine. A magnetic

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resonance imaging scan provides information on labrum and ligamentum teres injuries and reveals the characteristics of the anterior joint capsule.

Surgical Technique

Anesthesia and Positioning

The surgery is performed under general anesthesia, with the patient lying supine on a traction table. The operative limb is placed in a neutral position of abduction-adduction with 5° to 10° of flexion, and the contralateral side is placed in 45° of abduction.

Establishment of Portals and Capsulotomy

The surgery is performed via standard anterolateral, mid-anterior, and distal anterolateral accessory portals. The longitudinal "outside-in" capsulotomy technique is used for the incision of the capsule with the indirect head of rectus femoris as the reference structure. The incision is made roughly perpendicular to the indirect head and extended to the anterior inferior iliac spine proximally below the indirect head. Subspinous attachments of the capsule are partially released to facilitate the acetabular trim and labrum repair. The distal end of the incision is stretched to the zona orbicularis for adequate management of the cam lesion (Fig 1).

Intra-articular Management

Traction is gently applied, and then the joint space reaching 8 to 10 mm after capsulotomy is completed. At this point, the arthroscope and instruments are introduced into the central compartment to identify and address the chondrolabral injury, ligamentum teres, and pathology on the acetabulum (Fig 2). With the traction released, the hip is flexed by 30° to 60°, further relaxing the anterior capsule and expanding the arthroscopic workspace to identify the cam lesion and perform cam-plasty.

Augmentation Suturing Technique

Proximal Joint Capsule Augmentation and Repair

A drill guide (DePuy Mitek, Raynham, MA) is placed through distal anterolateral accessory portal, and 1 absorbable Gryphon anchor with a 1-strand No. 2 Orthocord suture (DePuy Mitek) is placed in the decompressed area under the anterior inferior iliac spine, 5 to 8 mm from the cartilage edge. A suture hook with PDS-II (Ethicon, Somerville, NJ) is the method we use for subsequent capsular closure. First, each flap of the joint capsule is penetrated with the hook, and the ends of the suture are retrieved to the outer surface of the capsule. Second, the suture hook is used to pass the suture from bottom to top through the indirect head. Finally, the suture is tightened and knotted on the surface of the indirect head (Figs 3 and 4). This achieves the anatomic repair of the joint capsule at the attachment of anterior inferior iliac spine. Meanwhile, using the indirect head to augment the weak areas of the capsule achieves the anatomic mechanical and histological repair.

Anatomic Repair of the Zona Orbicularis

The zona orbicularis is easily recognized on the inner surface of the capsule by its distinct elevated structure. The PDS-II is first passed through the lateral side of the capsule with the suture hook and then through the medial side. Next, the ends of the PDS-II are grasped and introduced into the ends of the high-strength suture, which are held with a grasper through the same portal. A knot is tied to complete the anatomic in situ restoration of the zona orbicularis.

Postoperative Rehabilitation

Medication for analgesia and prophylaxis of heterotopic ossification is prescribed for 4 weeks postoperatively. Hip flexion is limited to 0° to 90°, and extreme abduction and

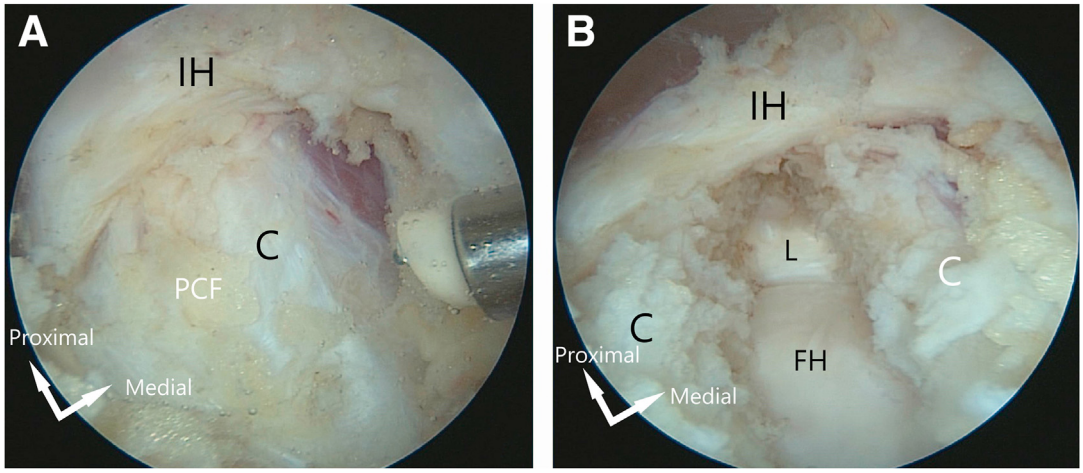

Fig 1. Arthroscopic views of the right hip show the longitudinal outside-in capsulotomy from the anterolateral portal. (A) Clean the precapsular fatty tissue (PCF) and identify the indirect head. (B) The capsular incision is extended to the labrum proximally and the zona orbicularis distally. C, capsule; FH, femoral head; IH, indirect head; L, labrum.

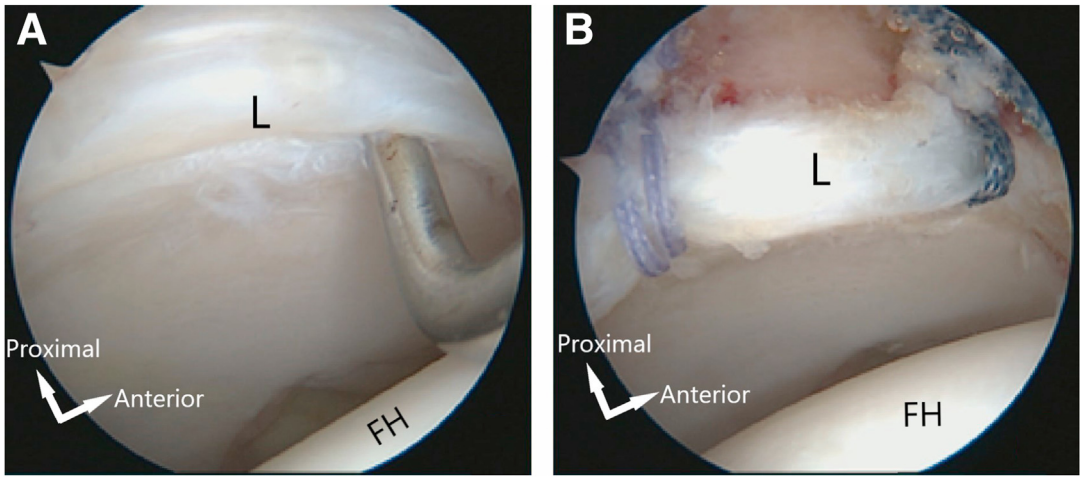

Fig 2. Arthroscopic views of the right hip show the intraoperative findings and main procedures from the mid-anterior portal. (A) Arthroscopic view shows the torn labrum. (B) Reattachment of the torn labrum with suture anchors. FH, femoral head; L, labrum.

external rotation is avoided for 2 weeks. Weightbearing is restricted to crutches for 3 to 4 weeks.

Discussion

Comprehensive capsular management is crucial for restoring biomechanical properties and maintaining the hip stability. Therefore, complete capsular closure can improve the functional outcomes of patients.[4] The selection of capsular closure techniques requires consideration of the incision methods, joint stability, and other factors. The main closure techniques include simple suture, multiple intermittent sutures, continuous suture, and special suture. Simple suture is suitable for cases in which the capsule is transected

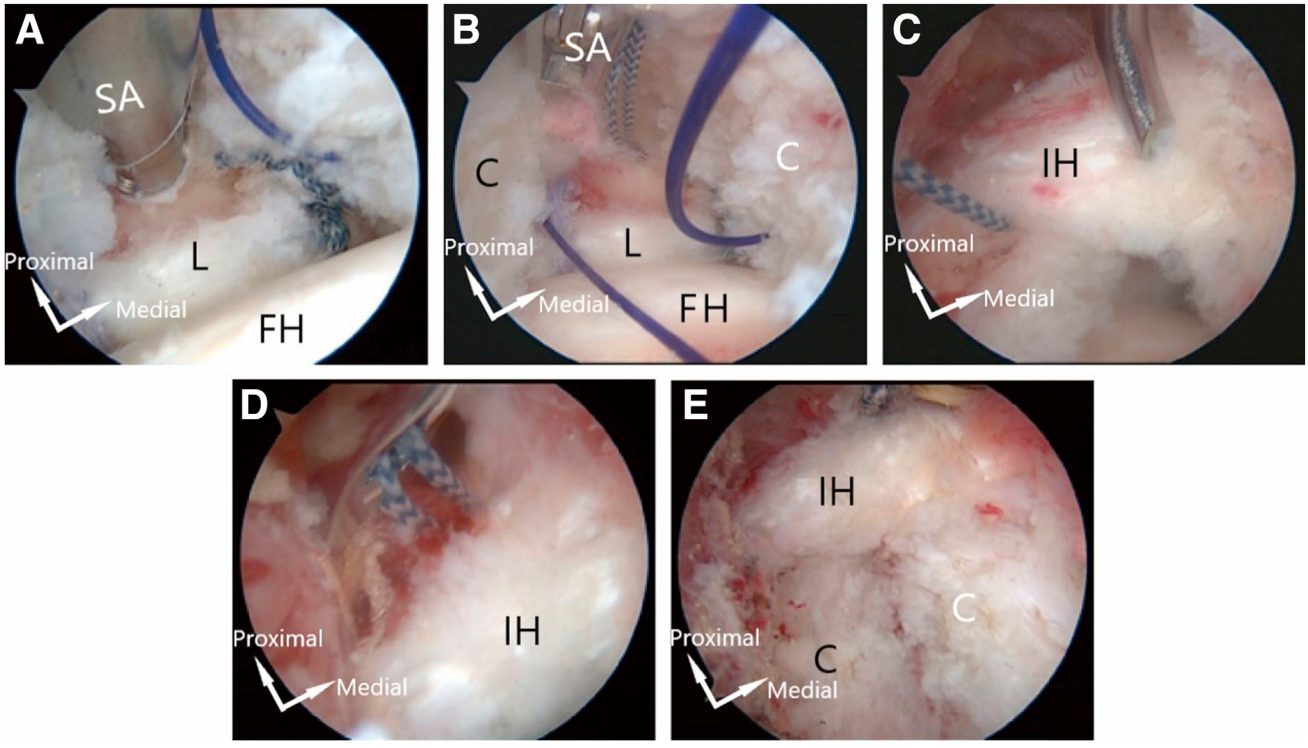

Fig 3. Arthroscopic views of the right hip show proximal capsular augmentation in longitudinal capsulotomy from the mid-anterior portal. (A) The absorbable suture anchor is placed proximal to the cartilage edge. (B) The suture is passed through each side of the vertical capsulotomy. (C) The suture is passed through the indirect head from bottom to top. (D) The suture is knotted on the surface of the indirect head. (E) Arthroscopic view shows capsular closure. C, capsule; FH, femoral head; IH, indirect head; L, labrum; SA, suture anchor.

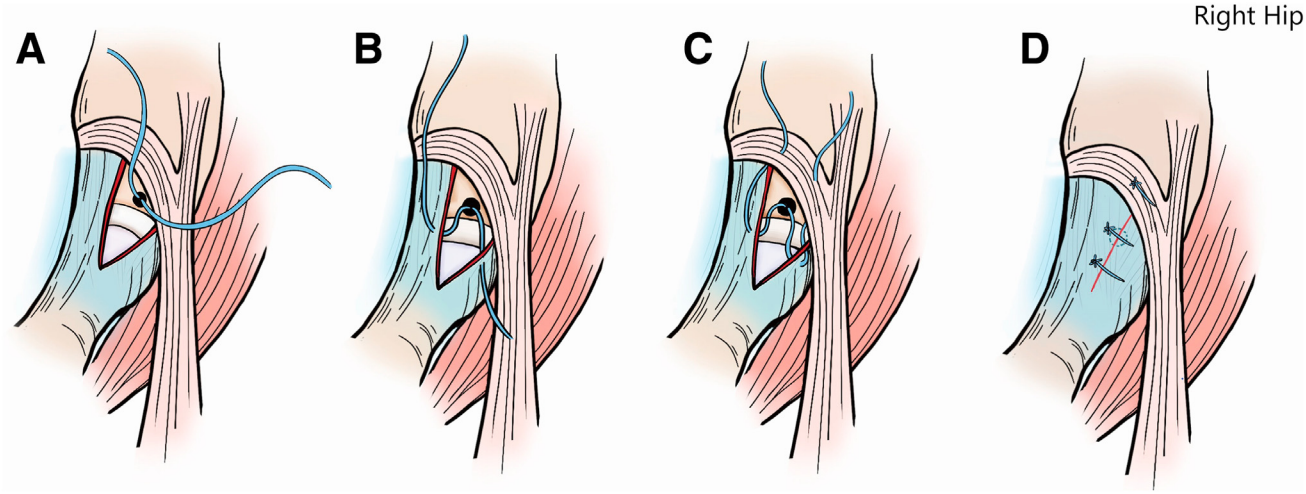

Fig 4. Schematic diagram of the right hip shows the main procedures in the anatomic repair of the proximal capsule in longitudinal capsulotomy from the mid-anterior portal. (A) Place an absorbable suture anchor proximal to the cartilage edge. (B) Pass the suture through each side of the vertical capsulotomy. (C) Pass the suture through indirect head from bottom to top. (D) Tighten and knot on the surface of the indirect head, and 2 additional side-to-side sutures are made in the distal capsule.

and the incision is of limited extent. Use of multiple intermittent sutures is the most popular capsular closure method for interportal and T-capsulotomies.[5] For borderline developmental hip dysplasia with capsular laxity, Uchida et al.[6] used the "shoelace" technique to suture the capsule and achieve complete capsular closure. Fenn et al.[7] proposed a special suture technique for T-capsulotomy cases, in which the vertical portion is closed with numerous high-strength sutures, and the transverse portion is closed with a double-loaded suture anchor. However, most of these techniques are directed at interportal and T-capsulotomies, whereas few methods are suitable for longitudinal capsulotomy. The technique of closing the longitudinal capsulotomy with separate suture anchors permits an anatomic reconstruction of the capsule and the iliofemoral ligament. However, proximal weakness persists because this procedure does not strengthen the proximal capsule.

Longitudinal capsulotomy is an important advance in hip capsulotomy, and its surgical security, feasibility, and clinical efficacy in hip arthroscopic treatment for cam-type femoracetabular impingement has been confirmed by clinical studies.[8] Nevertheless, compared with traditional capsulotomies, the release of the anterior inferior iliac spine attachment area of the proximal capsule may result in weakness of the proximal capsule, although longitudinal capsulotomy maximizes preservation of the iliofemoral ligament. The side-to-side suturing routinely used in longitudinal capsulotomy makes it difficult to perform a complete closure and may lead to a nonhealing capsule. Therefore, a technique using reinforcement sutures on the proximal capsule in longitudinal capsulotomy is desirable. The indirect head is adjacent to and spans the proximal part of the anterolateral joint capsule. Given its anatomic proximity, using the indirect head for proximal reinforcement of the capsule does not significantly change the capsule's position. Table 1 details the advantages and disadvantages of our technique; pearls and pitfalls are detailed in Table 2.

Table 1. Advantages and Disadvantages of Proximal Capsular Augmentation

Advantages	Disadvantages
• Achieves tissue preservation and maximal capsule repair	• Requires identification of the structures outside the capsule, especially the indirect head
• The repaired capsule structure is of high strength, allowing early functional exercise and reducing tissue tension and contracture	• Difficult arthroscopic technique
• Simple to perform	• Additional anchors and sutures may be required

Table 2. Pearls and Pitfalls of Proximal Capsular Augmentation

Pearls
- Expose the articular capsule externally to identify and protect the indirect head; operate below the indirect head to avoid injuring it
- Limit stripping of the proximal articular capsule to avoid extensive tissue defects
- The suture should be passed through the capsule and indirect head as vertically as possible to maintain tissue in situ and avoid misaligned tissue traction
- Perform additional side-to-side sutures if there are still openings after completing the suturing of the key points of the capsule

Pitfalls
- Avoid incising the indirect head during longitudinal capsulotomy
- Avoid extensive capsular tissue defects during joint capsule release
- The distance between each stitch should not be too large, and the tissue should not be excessively or too tightly sutured

The zona orbicularis can keep the femoral head from protruding outward and provide protection for hip joint stability. During longitudinal capsulotomy, anatomic restoration of the zona orbicularis is crucial for maintaining hip stability; therefore, we recommend the use of high-strength sutures to assess in situ anatomic restoration of the zona orbicularis.

In conclusion, using the indirect head to reinforce the proximal capsule provides a feasible and effective capsular closure approach for longitudinal capsulotomy.

Disclosures

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