Technical Note

Capsular Management with Traction-Assisted T-Capsulotomy Technique During Hip Arthroscopy

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Abstract: Capsular management, from the initial capsulotomy to capsule closure is essential to success in hip arthroscopy to achieve optimal outcomes. Although an interportal capsulotomy is typically sufficient for resection of proximal cam lesions and for performing central compartment procedures, T-capsulotomy is usually performed when large cam deformity needs to be addressed because it provides a broader field of view. The purpose of this Technical Note is to summarize each step of capsule management and to define a traction-assisted T-capsulotomy technique that allows for accurate placement of the T-capsulotomy while also avoiding damage to the articular cartilage.

The use of hip arthroscopy has exponentially increased in the past decade.[1-3] Because studies continue to report low complication rates, high return to activity,[4-6] and excellent outcomes and satisfaction ratings after surgery,[7-9] hip arthroscopy techniques continue to evolve. A capsulotomy is commonly performed by hip arthroscopists to provide necessary visualization of pathologies in the head-neck junction and to ensure adequate resection when treating femoroacetabular impingement.[10,11] The capsular ligaments of the hip, including the pubofemoral, ischiofemoral, and iliofemoral, contribute to the stability and mobility of the hip joint.[12] Among these, the iliofemoral ligament, which provides the greatest contribution for external rotation,[13] reveals its effect in preventing anterior hip instability.[14,15] As such, it is important to maintain the integrity of these structures and to perform the capsulotomy carefully because the transection of these ligaments may cause gross anterior translation of the hip.[16] On the other hand, previous studies have also shown that capsular closure after arthroscopy may prevent instability, yield lower revision rates, and improve postoperative outcomes.[16-18] Thus meticulous capsular management is a key to success in hip arthroscopy.

Various capsulotomy techniques have been identified for proper resection of a cam deformity. An interportal capsulotomy is typically sufficient for the resection of a proximal and relative mild cam deformity and for performing central compartment procedures,[19] whereas a T-capsulotomy may be used in the resection of a large cam deformity or when the deformity is more lateral because it provides a broader field of view.[10] The T-capsulotomy is usually performed with a radiofrequency probe or an arthroscopic blade while viewing the anteromedial aspect of the capsule. When a T-capsulotomy is performed, the lateral aspect of the femoral neck cannot be observed, and therefore an eccentric cut can jeopardize visualization during the case, as well as capsular closure at the conclusion of the procedure.

The purpose of this Technical Note is to summarize each step of capsule management, from the initial capsulotomy to capsule closure, and to define a traction-assisted T-capsulotomy technique (performing

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the cut in line with the midline of the femoral neck axis while viewing the bottom of the capsule after passing traction sutures), which may provide better control than other T-capsulotomy techniques while avoiding damage to hip cartilage.

Surgical Technique

The patient is placed supine on a traction table (Smith & Nephew, Andover, MD) after being prepared under general anesthesia for complete muscle relaxation. Traction is ensured with a pink pad positioning device (Xodus Medical Pink Hip Kit; Smith & Nephew) that eliminates the need for a perineal post. Following joint distraction of approximately 1 cm (confirmed with fluoroscopy), the anterolateral (AL) and modified midanterior (mMAP) portals are created. The hip arthroscopy technique of a right hip is shown in Video 1.

Periportal and Interportal Capsulotomy

Interportal capsulotomy is performed 1 cm distal to the labrum to achieve capsule closure after hip arthroscopy. The AL portal is established under fluoroscopic guidance, which is followed by creation of the mMAP 1 cm distal to the labrum while viewing with a 70° scope through the AL portal. The scope is then switched to the mMAP to first perform a periportal capsulotomy around the AL portal using an arthroscopic blade (CAP-FIX; Smith & Nephew). The scope is switched back to the AL portal, and the interportal capsulotomy is completed with an arthroscopic blade toward the AL periportal capsulotomy line through the mMAP (Fig 1). To avoid disruption of the iliofemoral ligament while allowing adequate room for instrumentation, the capsulotomy should be 2 cm or less in length.

Passing Traction Sutures

With traction sutures, a working space is created between the labrum and the capsule to improve visualization during acetabuloplasty and any indicated labral procedures during central compartment arthroscopy. Traction sutures are placed at the proximal end of the capsule through the interportal capsulotomy. While the anterior acetabulum is prepared, traction sutures are first placed through the mMAP while viewing through the AL portal. Another traction suture is placed in the superolateral region of the capsule through the AL

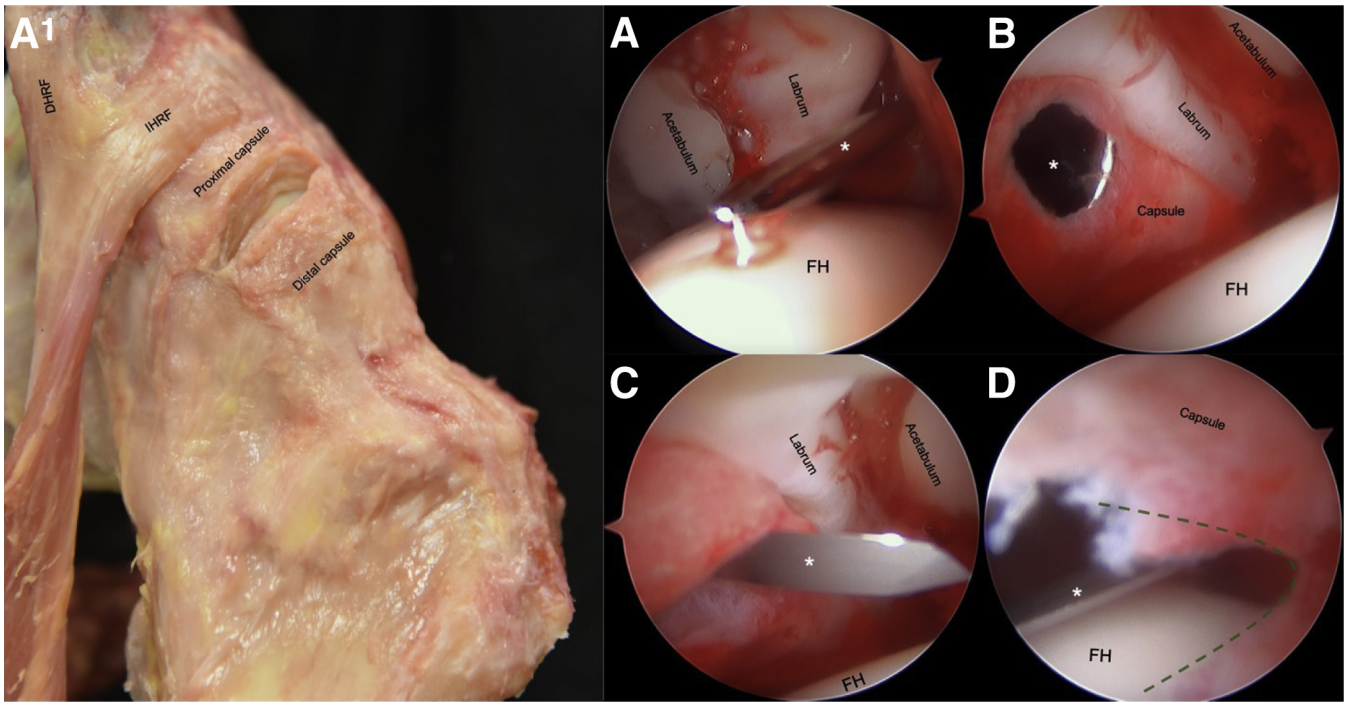

Fig 1. Interportal Capsulotomy. In right-sided hip arthroscopy, the anterolateral (AL) portal is created under fluoroscopic guidance, followed by (A) creation of the modified mid-anterior portal (mMAP) 1 cm distal to the labrum after determining its location with an 18-gauge spinal needle (*). (B) The scope is then switched to the mMAP, and the location of the AL portal (*) is confirmed. (C) Periportal capsulotomy is then performed around the AL portal, parallel to the labrum using an arthroscopic blade (*). (D) The scope is switched back to the AL portal, and the interportal capsulotomy is completed with an arthroscopic blade (*) toward the periportal capsulotomy direction through the mMAP. (A^1) Interportal capsulotomy is demonstrated in left-sided cadaveric dissection. (FH, femoral head; IHRF, indirect head of the rectus femoris; DHRF, direct head of the rectus femoris)

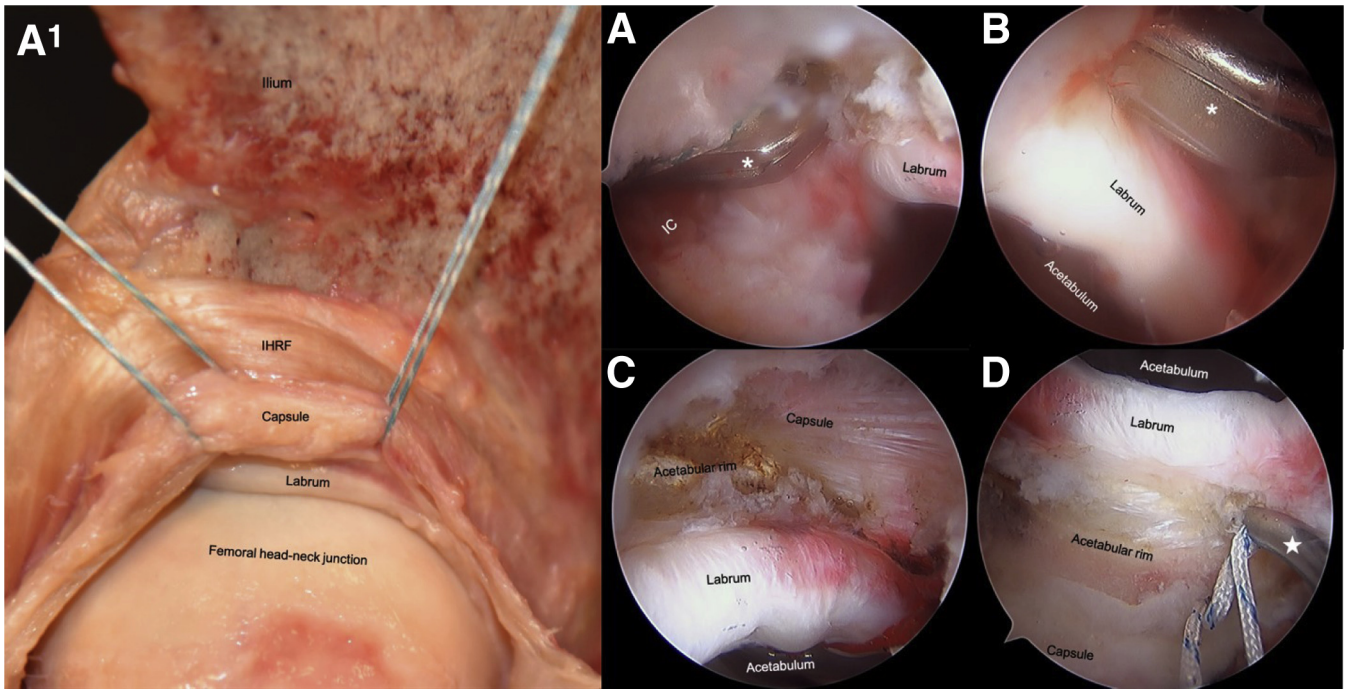

Fig 2. Passing traction sutures. (A^1) The view of interportal capsulotomy after the placement of traction sutures through the proximal capsule is demonstrated in left-sided cadaveric dissection. In right-sided hip arthroscopy, sutures are passed with a suture passer (*) through the (A) anterior and (B) superolateral aspects of the capsule at the proximal side of interportal capsulotomy, and traction is applied on the skin by placing a hemostat to ensure better visualization during arthroscopy of the central compartment. As such, a working space is created for procedures such as labral repair to be performed with instruments including suture passers (star) at the (C) anterior and (D) lateral aspects of the acetabulum. (IHRF, indirect head of the rectus femoris; IC, interportal capsulotomy)

portal while viewing through the mMAP (Fig 2). A distal anterolateral accessory (DALA) portal is created within the interportal capsulotomy for anchor placement that may be required for the anterior acetabulum. After the capsule has been protected and retracted, an acetabuloplasty and a labral repair can be performed if indicated (Fig 3).

Traction-Assisted T-Capsulotomy Technique

Following traction release after completion of central compartment arthroscopy, arthroscopy of the peripheral compartment is initiated. During viewing through the AL portal, a radiofrequency probe (Dyonics RF System; Smith & Nephew Endoscopy, Andover, MA) is used to perform fat pad debridement. The iliofemoral

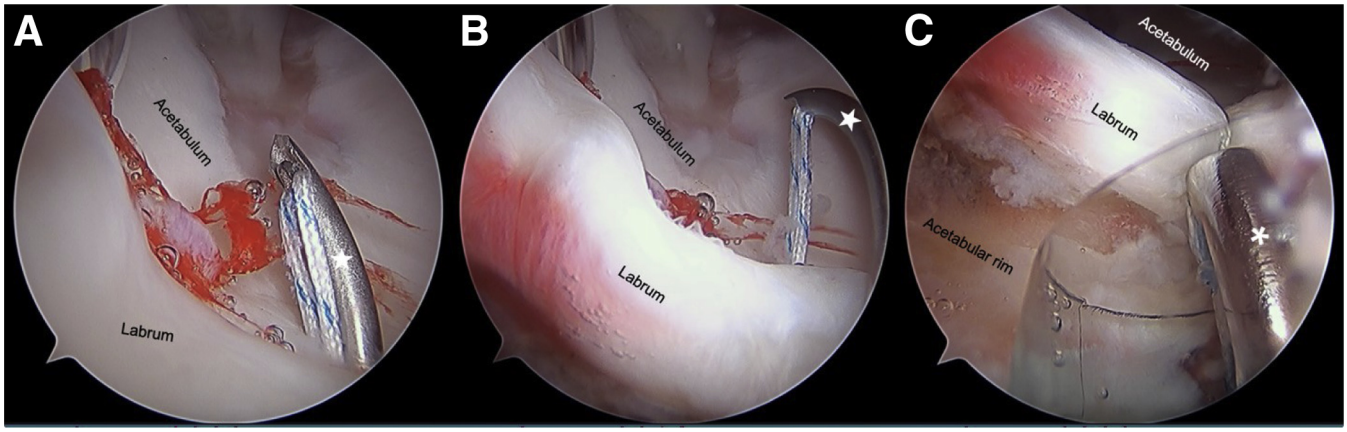

Fig 3. Labral repair. In a right-sided hip arthroscopy, the anchor sutures placed at the 12-o'clock position (A) are passed through the AL portal into the labrum with a suture passer (star) during viewing through the modified mid-anterior portal (B) retrieved and pulled at the joint side and (C) tied with a knot-pusher (*) through a cannula placed in the AL portal.

ligament, which the T-capsulotomy will be performed parallel to, is dissected and identified. The scope is switched to the mMAP. Traction sutures, 1 medially and 1 laterally, are then passed into the distal limb of the capsule from the interportal capsulotomy, through the DALA and AL portals, respectively, with a suture passer (Pivot Injector II; Stryker, Kalamazoo, MI), and suspension is applied on the skin with a hemostat (Fig 4). Then, the scope is moved toward the interportal capsulotomy line, as shown in Fig 5, allowing for achievement of a proximal-to-distal view. The T-capsulotomy is performed in the proximal-to-distal direction in a controlled manner centered on the interportal capsulotomy, parallel to the femoral neck using an arthroscopic blade (CAP-FIX; Smith & Nephew). In a right hip arthroscopy, a capsulotomy is performed with 30° to 40° of hip abduction through the DALA portal, whereas the AL portal is used in left-sided hip arthroscopies. The femoral head-neck appearance obtained by half T-capsulotomy is assessed for adequate visualization to perform the desired cam resection (Fig 6). If inadequate, the T-capsulotomy can be extended distally, depending on the size of cam deformity (Fig 7). The view is improved by suspension sutures passed through the medial and lateral ends of the capsulotomy using a suture passer (Pivot Injector II; Stryker). In a right-sided hip arthroscopy, a 5.5-mm arthroscopic burr (Arthrex, Naples, FL) is placed through the DALA portal to perform the cam resection, while the cam deformity is viewed at the femoral head-neck junction through the mMAP.

Capsule Closure

After confirmation of an adequate cam resection, primary closure of the T-capsulotomy is performed. T-capsulotomy closure is initiated from the area that is parallel to the femoral neck. Closure of the said area is achieved by tying No. 2 Ultrabraid sutures (Smith & Nephew) passed through the medial and lateral ends of the capsule with a suture passer (Pivot SlingShot; Stryker). This is followed by closure of the horizontal component of capsulotomy, which may be performed with a different suture passer (Pivot Injector II; Stryker) depending on the surgeon's choice. The sutures that are passed during closure of the horizontal capsule component are tied at 0° of hip flexion (Fig 8). During the capsule closure procedure, all sutures are passed through the AL and DALA portals while viewing from the mMAP.

Rehabilitation

The described traction-assisted T-capsulotomy technique does not require a modification in the standard rehabilitation regimen. The patient is initially restricted to 20-pound flatfoot weightbearing with the use of crutches and uses a de-rotational boot for the first 3

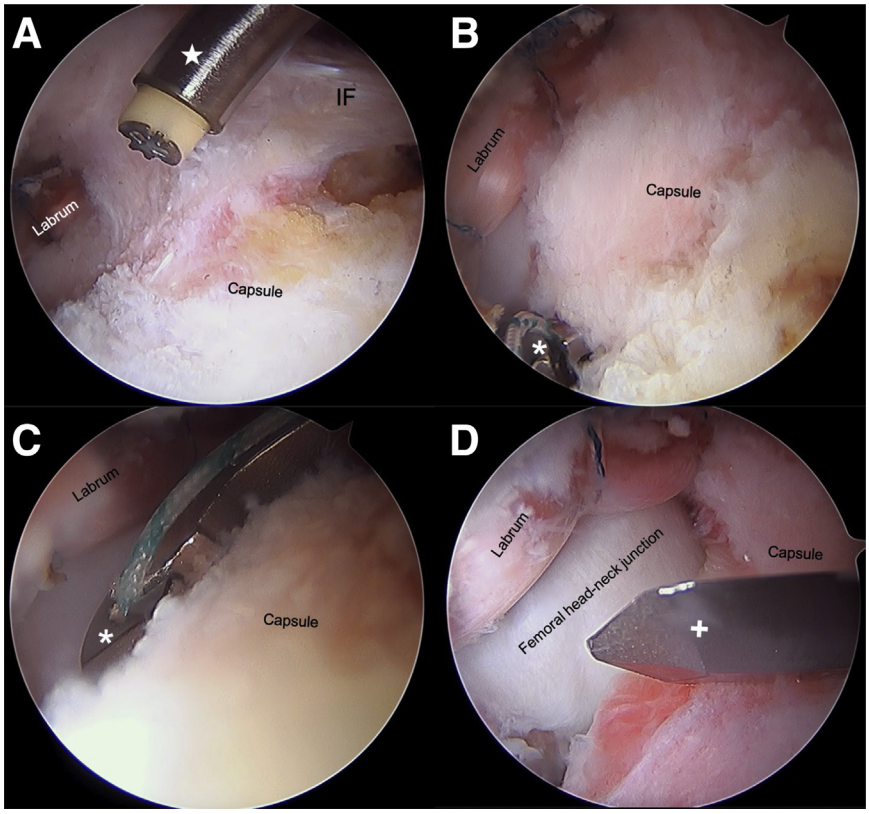

Fig 4. Steps of the traction-assisted t-capsulotomy technique in a right-sided hip. (A) Fat pad debridement is performed with a radiofrequency probe (star) and the iliofemoral ligament (IF), which T-capsulotomy will be performed parallel to, is identified. This is followed by passing traction sutures with a suture passer (*) into the (B) lateral and (C) medial aspects of the distal limb of the capsule in interportal capsulotomy. (D) T-capsulotomy is performed parallel to the femoral neck with an arthroscopic blade (+). (IF, iliofemoral ligament)

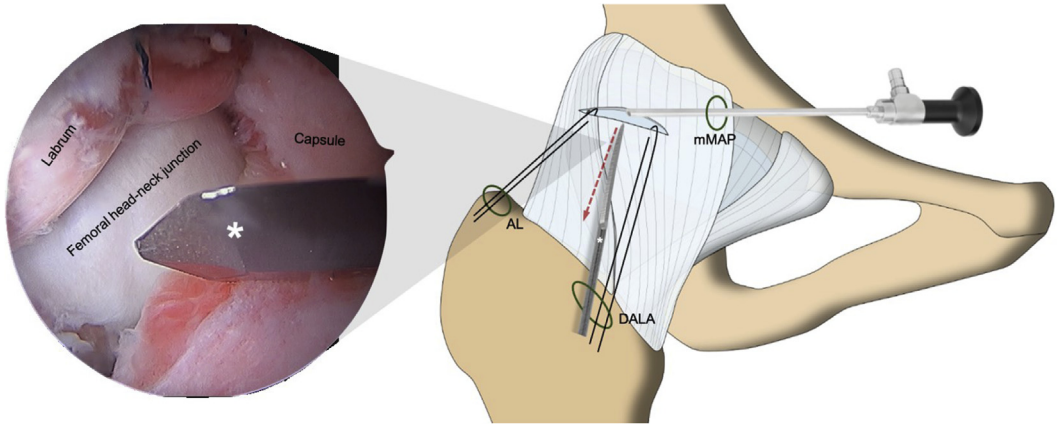

Fig 5. Illustration of the traction-assisted T-capsulotomy technique in a right-sided hip. Traction sutures are passed into the medial and lateral aspects of the distal limb of the capsule through the anterolateral (AL) and distal anterolateral accessory (DALA) portals, respectively, in interportal capsulotomy during viewing through modified mid-anterior portal (mMAP). Then, the scope is moved toward the interportal capsulotomy line and a proximal-to-distal view is achieved by moving the scope towards the interportal capsulotomy line. The obtained arthroscopic view is demonstrated on the left side of the figure. T-capsulotomy is then performed in line with the femoral neck, in the direction indicated (red arrow) using an arthroscopic blade (*).

postoperative weeks. At postoperative week 3, the patient should be weaned from crutches and advance weightbearing. The goal is symmetric range of motion by 6 to 8 weeks. Return to sport may occur 4 to 6 months after surgery beginning with activities such as golf and swimming and then transitioning to impact-loading activities and exercises.

Discussion

An accurate and complete management of the capsule is essential for successful hip arthroscopy. Capsulotomies that are performed during hip arthroscopy enhance visibility, thereby providing the opportunity to complete the procedure thoroughly and efficiently. Moreover, capsule closure is necessary in preventing instability and in achieving the desired clinical outcomes.[16,17] This technical note underlined the pearls of interportal and T-capsulotomies, traction sutures use, and capsule closure methods while defining a traction-assisted T-capsulotomy technique.

The method defined in this technical note allows for a reliable and efficient T-capsulotomy to be performed parallel to the femoral neck at the midline. Before the capsulotomy, traction sutures are placed at the distal end of interportal capsulotomy to aide in evaluation of the extent of cam deformity and the femoral head-neck junction. With this view, the T-capsulotomy can be performed without causing damage to the cartilage at the femoral head. As such, this field of view enables the visual analysis and resection of large cam deformities.

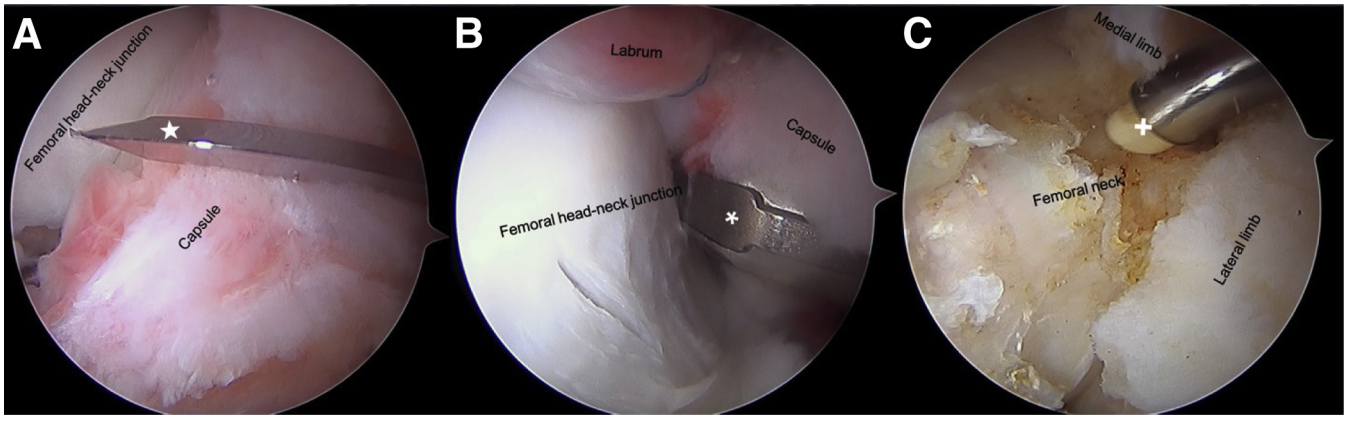

Fig 6. Further steps of the T-capsulotomy in a right-sided patient. (A) T-capsulotomy is performed in the proximal-to-distal direction with an arthroscopic blade (star). (B) The view is improved by passing traction sutures with a suture passer (*) into the medial and lateral limbs of T-capsulotomy. (C) Half T-capsulotomy can be extended distally with a radiofrequency probe (+), depending on the size of the cam deformity.

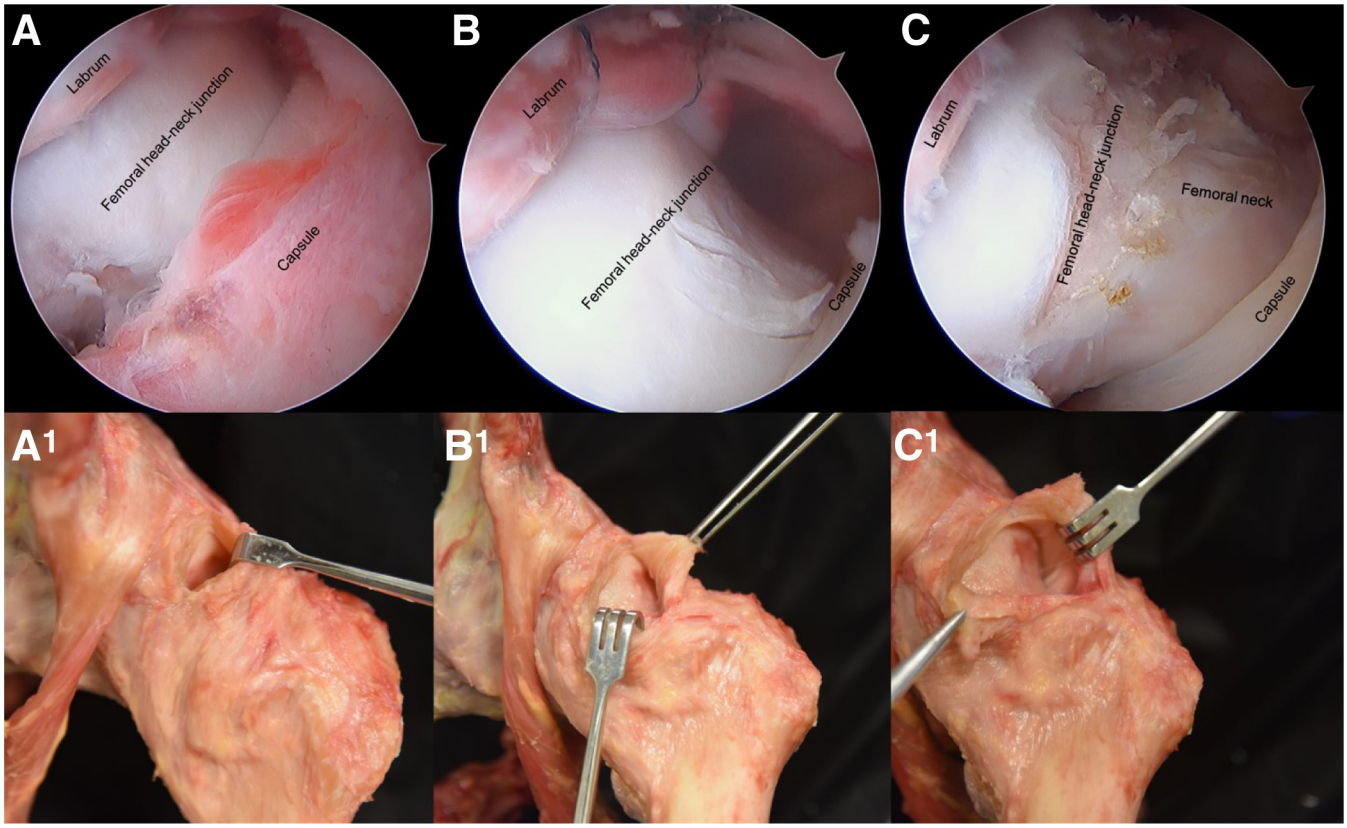

Fig 7. Side-to-side comparisons of capsulotomy types. (A, B, C) Arthroscopic views after interportal, half T- and full T-capsulotomies, respectively. The bottom row provides the corresponding demonstration of (A^1) interportal, (B^1) half T- and (C^1) full-T capsulotomies, respectively in cadaveric dissection.

Although this method improves visualization, passing traction sutures may prolong the operative time compared to directly cutting the capsule from above. In addition, the proximal-inferior visualization of the capsule requires additional orientation as compared to using the top view of the capsule.

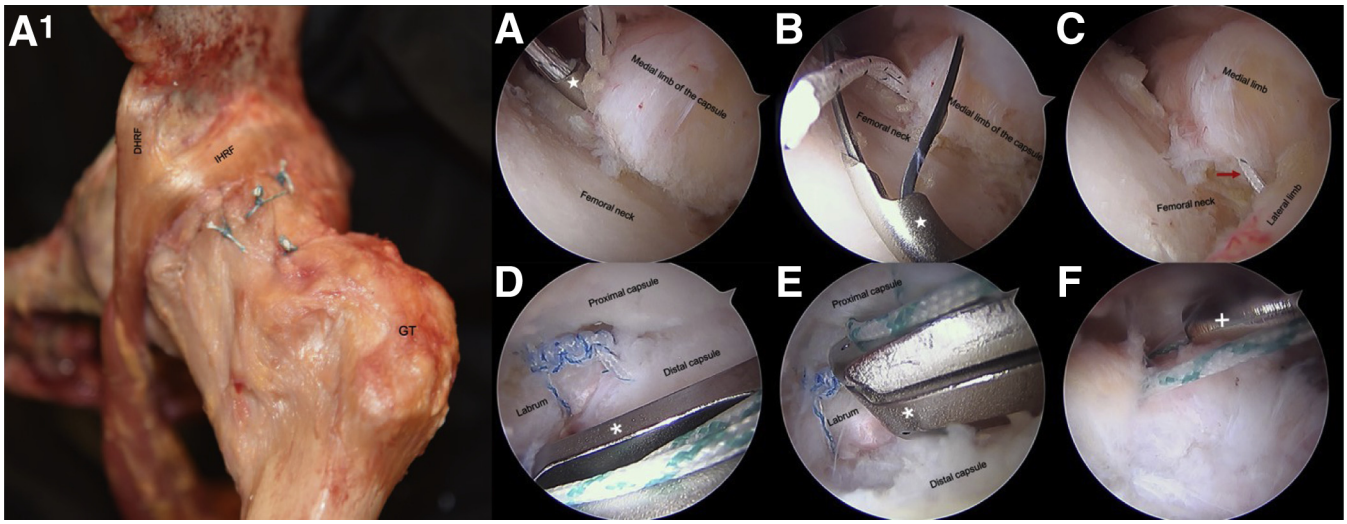

Fig 8. Capsule Closure. (A^1) The view after capsule closure is demonstrated in the left-sided cadaveric dissection. T-capsulotomy closure is initiated from the area parallel to the femoral neck. (A) The suture passed through the medial limb with a suture passer (star) (B) is retrieved with a suture passer (star) through the lateral limb, (C) allowing the suture (red arrow) to pass through both limbs of the capsule. In the closure of the horizontal capsulotomy component, sutures that are passed through the (D) distal and (E) proximal ends of the capsulotomy using a different suture passer (*) (F) are tied using a suture passer (+). (IHRF, indirect head of the rectus femoris; DHRF, direct head of the rectus femoris)

Table 1. Pearls and Pitfalls

Pearls
Before T-capsulotomy, placement of the traction sutures separately at the medial and lateral aspects through the AL and DALA portals, respectively, provides balanced capsule traction and better visualization.
Performing T-capsulotomy at 30° to 40° of hip abduction brings the portal used and femoral neck closer, allowing for better control of the arthroscopic blade.
During T-capsulotomy, distal traction of the capsule with an arthroscopic blade, followed by anterior-posterior movement of the blade for cutting enables a full-layer cut of the capsule in one movement.
Pitfalls
The remaining capsule may not be suitable for closure if an interportal capsulotomy is performed too close to the labrum and or if the capsule is excessively debrided.
Knotting the sutures that are used for closure of the interportal capsulotomy in flexion may lead to an increased risk of postoperative flexion contracture.

Capsulotomies that are performed to enhance surgical visualization should allow for easy reclosure of the capsule. However, when the interportal capsulotomy is performed too close to the labrum or when the capsule is excessively debrided, the remaining capsular tissue may not be suitable for closure. Moreover, knotting the sutures, which are used for closure of interportal capsulotomy, in flexion may lead to an increased risk of postoperative flexion contracture. The pearls and pitfalls, as well as the advantages and limitations, are described in Tables 1 and 2.

Table 2. Advantages and Limitations

Advantages
Placement of traction sutures at the distal aspect of interportal capsulotomy provides better visualization for performing T-capsulotomy parallel to the femoral neck at the midline.
The use of additional traction sutures provides better visualization of the femoral head-neck junction during capsulotomy, thereby preventing damage to articular cartilage.
Performing T-capsulotomy precisely at the midline using the defined traction-assisted technique enables complete visualization of the anterior and superolateral extensions of a cam deformity.
Limitations
Passing traction sutures before T-capsulotomy may lead to a prolonged operative time.
The proximal-inferior visualization of the capsule requires additional orientation in T-capsulotomy.
The use of an arthroscopic blade with the defined technique requires surgical experience compared to a capsulotomy performed with Radiofrequency probe by using a top view of the capsule.
Passing suspension sutures into the distal limb of the capsule from the interportal capsulotomy without damaging the femoral head cartilage may require specially developed suture passer surgical devices for the capsular management in hip arthroscopy.

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