Technical Note

Arthroscopic Labral Repair of the Hip Using a Self-Grasping Suture-Passing Device: Maintaining the Chondrolabral Junction

Taylor J. Ridley, M.D., Joseph J. Ruzbarsky, M.D., Max Seiter, M.D., Liam A. Peebles, B.A., and Marc J. Philippon, M.D.

Abstract: In the setting of femoroacetabular impingement, the acetabular labrum may be torn or pathologic, and it must be surgically repaired to restore the native suction seal and hip function. However, the current methods of arthroscopic suture passage commonly result in some degree of disruption of the chondrolabral junction, with penetration and shuttling of the repair sutures. Novel instrumentation and surgical techniques have aimed to repair the acetabular labrum with decreased violation of the intrasubstance fibers to provide anatomic eversion/inversion of the labrum to restore the suction seal. In this Technical Note, we describe a method of suture passage through the use of a self-grasping suture-passing device that allows for anatomic labral repair while maintaining the chondrolabral junction as well as minimizing iatrogenic damage the labrum intrasubstance fibers.

The acetabular labrum has several important roles in maintaining hip joint function and preserving general hip homeostasis.[1,2] Structurally, it acts to increase the acetabular surface area and depth, allowing for both broader distribution of force and increased stability, respectively. In addition, the labrum creates a seal with the femoral head, which allows for a suction seal mechanism through a thin layer of synovial fluid, permitting a synergistic increase in stability.[1,2]

From the Steadman Philippon Research Institute (L.A.P., M.J.P.) and The Steadman Clinic (T.J.R., J.J.R., M.S., M.J.P.), Vail, Colorado, U.S.A.

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Address correspondence to Marc J. Philippon, M.D., The Steadman Clinic, Steadman Philippon Research Institute, 181 West Meadow Dr., Suite 400, Vail, CO 81657. E-mail: drphilippon@sprivail.org

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Restoration of labral function remains one of the primary goals of hip arthroscopic surgery in the setting of femoroacetabular impingement. In most circumstances this is accomplished by repair through the use of suture anchors placed along the acetabular rim, which act to refix the separated or torn labrum back down to its anatomic position. Regardless of the suture configuration pattern used, whether looped or pierced,[3] the current methods of suture passage result in some degree of disruption of the chondrolabral junction with penetration and shuttling of the repair sutures.

Preservation of the chondrolabral junction, is extremely important in preserving the suction-seal mechanism and reducing the incidence of adhesions.[2] This is particularly important anteriorly, where histologically the collagen fibers of the labrum run parallel to the chondrolabral junction and are thus more susceptible to damage.[1] The purpose of this Technical Note is to describe a method of suture passage through the use of a self-grasping suture-passing device which allows for anatomic labral repair while maintaining the chondrolabral junction as well as minimizing iatrogenic damage the labrum intrasubstance fibers.

Surgical Technique (With Video Illustration)

A video overview of this procedure with narration can be found in Video 1. The authors' preferred surgical technique uses an interportal capsulotomy between anterolateral and midanterior portals, as previously

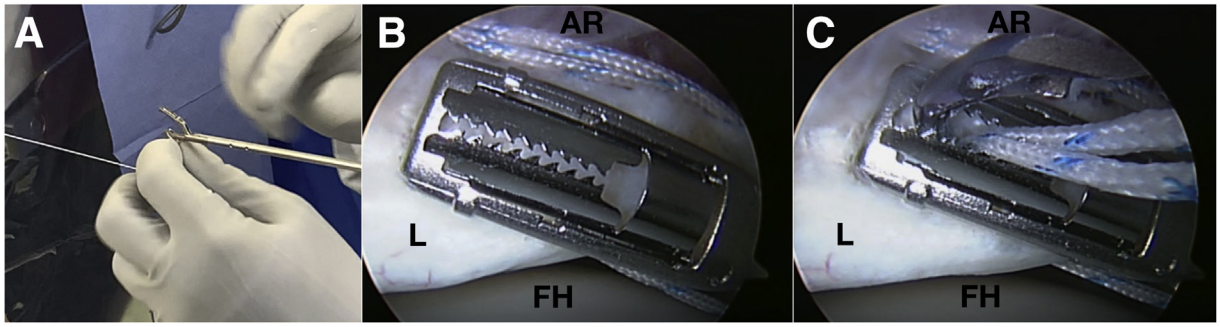

Fig 1. Mid-anterior viewing portal. (A) The suture-passing device is loaded outside of the left hip joint, ensuring the suture is fully seated within the groove of the inferior jaw. (B) The jaws of the device are clamped around the mid substance of the labrum, here, with the piercing needle aimed away from the articular surface. (C) The needle pierces the labrum while avoiding disruption of the chondrolabral junction. The suture is secured within the trap doors of the superior jaw of the device. The device along with the suture limb can then be pulled back out of the joint. (AR, acetabular rim; FH, femoral head; L, labrum.)

described.[4] The labrum is assessed and areas of pathology are identified. Labral inversion and eversion are noted, as is the quality of labral tissue. Subspinal decompression is performed to the depth indicated by preoperative imaging, and to the level of the acetabular rim to allow for a bleeding bony bed appropriate for healing of labral tissue. Following appropriate identification and preparation of the repair site, the initial anchor is placed at the most anterior aspect of the tear, through a curved guide via the anterolateral portal.

After placement of the suture anchor, a cannula is placed in the anterolateral portal, and sutures are passed through the cannula to prevent entanglement or soft-tissue bridging. Before loading the suture-passing device, free sliding of sutures within the anchor must be verified; this prevents poor loop security and ensures a tight repair. A single limb of suture is then loaded and fully seated into the groove of the lower jaw of the self-grasping suture device (FIRSTPASS MINI, Smith & Nephew, Andover, MA) (Fig 1A). The device is inserted through the cannula and labrum is grasped at its mid-substance, adjacent to previously placed anchor (Fig 1B). Importantly, this avoids violation of the chondrolabral junction. The jaws of the suture passer grasp the labrum at the desired position and orientation, and the device is deployed so that the needle pierces the labrum and is captured by the trap doors of the device's upper jaw (Fig 1C). This results in inverted pierced configuration of suture, similar to what has been described by Espinosa et al.[5] when performing open repair. The self-capturing device is removed from the joint, and a knot pusher is used for the placement of arthroscopic knots on the capsular side of the labrum (Fig 2). When the labrum is pierced in this fashion, the suture topography places the tension of the knot onto the post limb, rather than the labrum. This pattern of tensioning may be desirable if a degenerative or atrophic labrum is encountered. After the placement of 2 half hitches in the same direction, 5 alternating half hitches are thrown and the suture is cut with a closed knot cutter.

Following stabilization of the anterior edge of the tear, the chondrolabral junction is assessed and debrided where necessary; gentle cautery is performed with a flexible radiofrequency probe (DYONICS EFLEX TAC-S; Smith & Nephew) and can be further debrided with a motorized shaver. A second anchor is placed, typically at the 12:00 position as shown in the video. The degree of inversion and eversion of the labrum is assessed, as is the ability of the suture passer to pierce

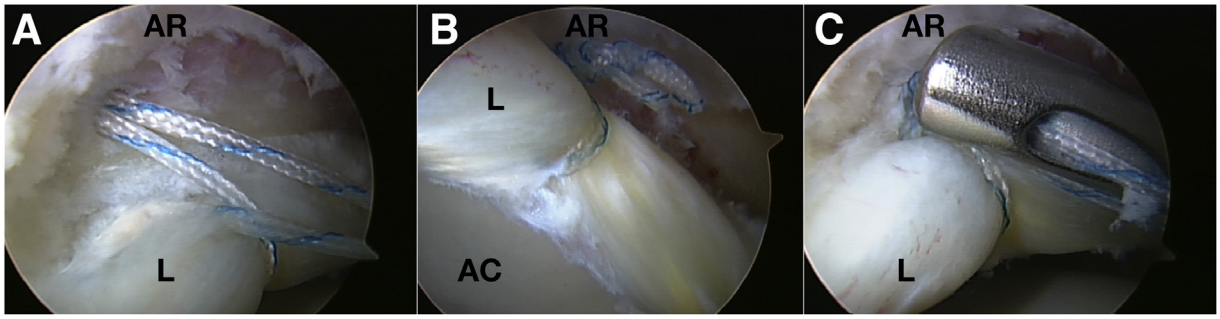

Fig 2. Mid-anterior viewing portal. (A) The suture configuration allows for tension to be placed on the sutures, rather than the labrum. (B) Arthroscopic knots are tied to allow for fine adjustment of the suture tension around the larum. (C) The suture limbs are cut and the repair is visualized. (AC, acetabular cartilage; AR, acetabular rim; L, labrum.)

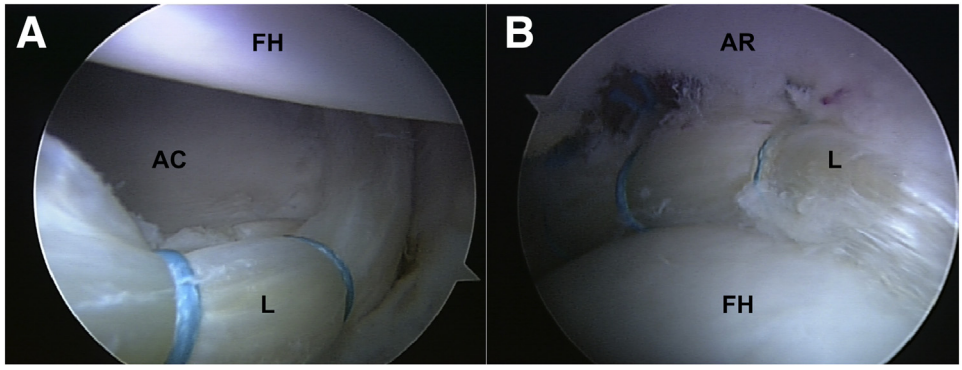

Fig 3. Mid-anterior viewing portal. (A) Final repair of the labrum before (B) and after traction is released. This technique allows for anatomic repair of the labrum with restoration of the suction seal and avoidance of labral abrasion of the femoral head. (AC, acetabular cartilage; AR, acetabular rim; FH, femoral head; L, labrum.)

through the desired mid-substance area of the labrum. Our experience has demonstrated that given the overhang of the superior jaw, the most optimal bite of labrum may be obtained by flipping the device with the inferior jaw located on the capsular side. Grasping the labrum in this fashion prevents hinderance of the device on the acetabular rim, allowing the surgeon to pass the needle of the device deeper within the circumference of the labrum. When passing in this orientation, care must be taken to position the device such that the piercing needle does not damage the cartilage of the femoral head. Partial deployment of the needle in these situations will allow the suture to be passed without risking penetration of the femoral head cartilage; however, enough suture must be passed through for the self-grasping mechanism to work properly. Again, this configuration results in an inverted pierced repair stitch. The arthroscopic knot is then delivered into the countersunk drill hole of the anchor and is secured in the same fashion as before.

Additional anchors are placed at appropriate spacing, according to the morphology of the tear. When a labral tear extending posteriorly is discovered, this same technique may be used. For a 9:00 anchor, as depicted in the included video, a curved guide placed through the anterolateral portal allows for optimal anchor placement. Again, the same sequence is performed: the device is loaded with a limb of suture, the device is positioned for optimal capture of labral tissue, and arthroscopic knots are tied on the capsular side of labrum. By closing the jaws of the device, suture placement may be evaluated prior to deployment of the needle. The surgeon should ensure that adequate labral tissue is incorporated with the repair; if this is not the case, a 17° angled device is available and may facilitate optimal placement.

We have found that improper seating of the suture in the device or loading too small of a tail limb in the device, may result in a single tail of suture being passed through the labrum. In these instances, the self-capturing device may not capture the penetrating suture. If this occurs, a grasping device may be used to receive the suture end, and knots may be tied for a repair without violation of the chondrolabral junction.

If eversion of the labrum is desired, the device may be positioned to pass closer to the chondrolabral junction, resulting in a looped configuration equivalent. Small adjustments of the piercing needle allow for ideal suture positioning as dictated by the surgeon's preference for labral inversion or eversion.

After completion of the labral repair and evaluation of the suction seal, the surgeon may appreciate the fact that this suture configuration preserves the integrity of the chondrolabral junction and minimizes potential suture abrasion of the femoral head (Fig 3). A femoral osteoplasty is performed, and again the suction seal and quality of labral repair is evaluated. When satisfactory lack of impingement has been identified on dynamic testing, we conclude the procedure with an approximated closure of the interportal capsulotomy.

Table 1. Advantages and Disadvantages of Using the Self-Grasping Suture-passing Device

Advantages	Disadvantages
Preserved chondrolabral junction	Risk of cartilage injury by penetrating needle
Pierced suture pattern limits abrasion of suture on femoral head	Cost of device
Instrument ease of use with both straight and 17° curved options	Difficult trajectory at the 9-o'clock position
Small needle diameter (0.9 mm)	
Versatility of device to accommodate various suture sizes	

Discussion

Damage to the acetabular labrum has been shown to disrupt the suction seal, which leads to decreased intra-articular fluid pressurization and stability of the hip.[6,7] This has been shown to increase the risk for cartilage damage of the hip, potentially predisposing the hip to osteoarthritis. Successful labral repair has been shown to restore this suction seal, returning the hip to normal function and kinematics.[4] Labral repair has resulted in

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
The direction of the device can be oriented to allow for passing of the suture in either direction.	The surgeon should pay attention to and visualize the piercing needle so as not to violate the articular cartilage.
A slotted or plastic cannula can be used to avoid tissue bridging and guide the passing device into the joint.	The surgeon must ensure the needle has pierced the labral tissue far enough that the suture is self-captured adequately.
Instrument ease of use with both straight and 17° curved options.	Difficult trajectory at the 9-o'clock position.
In case the labrum is excessively everted or inverted, standard looped or pierced suture techniques may be used in combination.	
The surgeon should always perform a thorough examination of the labrum and suction seal as traction is released.	

significant improvement in patient outcome scores in comparison with labral debridement.[8,9]

The hip fluid seal, in addition to allowing for intra-articular fluid pressurization, also appears to have a role in hip stability. Negative intra-articular pressure is generated with distractive forces on the hip and results in a stabilizing force within the joint.[6,7] The labrum has a primary role in the suction effect and small displacements (1-2 mm). The labrum resists distraction until a 6-mm threshold, after which the capsule becomes the primary stabilizer. Both labral repair and labral reconstruction have been shown to improve the distracted stability of the hip with restoration of the suction seal.[8,10]

Debate is ongoing over the optimal method for maintenance and restoration of the labral anatomy when repairing it with suture anchors. Both looped and pierced suture techniques have been described. A looped suture configuration passes the limbs in a circumferential manner around the labral tissue to secure it to the acetabular rim. This technique may cause eversion of the labrum; however, it provides a strong fixation around the labrum.[3] Alternatively, a pierced technique involves passing one or both of the suture limbs through the labral tissue in a mattress fashion. This technique tends to invert the labral tissue on the acetabular rim.[3] Biomechanical analysis has demonstrated significant increases in fluid pressurization following labral repair with the pierced technique.[6,7] However, the pierced, or intrasubstance, repair technique is technically demanding and poses a theoretical risk of failure because of its reliance on intrasubstance suture passage through damaged tissue. With a goal of re-establishing the suction seal of the hip joint to anatomic levels, biomechanical evidence has demonstrated that likely a combination of pierced and looped sutures best restores the suction seal.[6,7] Regardless, patient outcomes have been similar between looped, pierced, and combined labral repairs.[11]

Our technique not only provides anatomic restoration of the labrum without excessive eversion or inversion, it has the unique advantage of maintaining the chondrolabral junction. In addition, the instrumentation allows for ease of use. Nevertheless, the operator still needs to keep in mind the trajectory of the piercing needle so as not to violate the articular cartilage. Furthermore, the diameter of the piercing needle is significantly smaller at 0.9 mm compared with other commonly used devices. This allows for significantly decreased violation of the intrasubstance fibers of the labrum when passing the suture, potentially decreasing the incidence of labral retear or suture cutout which may lead to failure of fixation of the labral repair. This has implications in the ultimate success of primary labral repair; a recent systematic review investigating indications for revision hip arthroscopy demonstrated that labral retear was the most common reason for revision hip arthroscopy, present in approximately 75% of patients undergoing revision.[12]

This labral repair method differs from those of previous authors because it allows for preservation of the chondrolabral junction with decreased violation of the intrasubstance fibers to provide anatomic eversion/inversion of the labrum to restore the suction seal. This restores the normal anatomic function of the hip joint while preserving the articular cartilage. Our repair technique can be performed with various anchors and sutures, including knotted and knotless devices. Our preferred technique is to use arthroscopic knot tying as this allows for subtle adjustments of the suture tension to anatomically reduce the labrum. These knots are placed on the capsular side so as not to abrade the articular cartilage. We acknowledge that some believe the knots may increase the risk for adhesions, however, this has not been demonstrated in the literature.

This technique is safe and reproducible overall but requires attention to not damage the articular cartilage with the piercing needle. The technique described in the article allows for preservation of the chondrolabral junction using standard approaches and operative techniques, restoring the physiological suction seal, and maintaining the native labrum. A list of the advantages and disadvantages as well as pearls and pitfalls for the proposed technique can be found in Tables 1 and 2, respectively. This technique for labral repair using a self-grasping suture-passing device allows for preservation of the chondrolabral junction to anatomically restore the suction seal of the hip joint while allowing the surgeon ease of use and versatility of the device.

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