



Revision Hip Capsular Repair and Augmentation With a Bioinductive Implant After a Post-arthroscopy Hip Subluxation Event

Christopher M. Larson, M.D., Brady T. Williams, M.D., Felipe Bessa, M.D.,
Rebecca Stone McGaver, M.S., A.T.C., Sunikom Suppauksorn, M.D.,
Scott Faucett, M.D., M.S., and Jorge Chahla, M.D., Ph.D.

Abstract: In the past decade, the number of hip arthroscopy procedures has exponentially increased, primarily for the treatment of femoroacetabular impingement syndrome and labral lesions. As the techniques have evolved, so has the acknowledgment of the potential complications, including iatrogenic instability that may result from soft-tissue laxity, subtle dysplastic morphologies, or residual defects from capsulotomies in which the capsular closure is insufficient. In most cases, direct capsular repair or plication can be performed at the conclusion of the procedure; however, larger defects, poor-quality tissue, or cases of gross ligamentous laxity may require reconstruction or augmentation. In such instances, several options exist. The purpose of this technical note is to describe a capsular repair augmentation with a bioinductive implant during revision hip arthroscopy.

The use of hip arthroscopy and hip joint preservation procedures has increased dramatically in the past decade to treat a wide range of intra-articular pathologies, primarily femoroacetabular impingement syndrome and labral lesions.¹⁻³ An important procedural step in hip arthroscopy is the

capsulotomy, which allows for necessary instrument access and appropriate visualization. Adequate visualization is essential for complete treatment of large cam and more extreme acetabular-sided deformities because insufficient resection and deformity correction remain primary reasons for revision arthroscopy.⁴

Historically, capsule repair at the end of the procedure was not routinely performed. However, this has evolved with increasing evidence of the micro-instability and macroinstability that can occur post-operatively and, in some cases, may exist preoperatively.^{3,5} Capsular closure and plication have also been shown to improve outcomes and accelerate the return to sports after treatment of intra-articular lesions.^{2,4-6} However, in patients with generalized ligamentous laxity, as in cases of Ehlers-Danlos syndrome (EDS), or those with poor tissue quality, which is not uncommonly seen in revision hip arthroscopy, repair alone may not be sufficient to restore adequate stability. In these cases, a capsular reconstruction or, in some cases, an augmentation technique with a bovine bioinductive implant may be used, as described in this article and summarized in Table 1. Similarly, both the advantages and disadvantages of this technique and the clinical indications are described in Tables 2 and 3, respectively.

From Twin Cities Orthopedics (C.M.L., R.S.M.), Edina, Minnesota; Rush University Medical Center (B.T.W., F.B., S.S., J.C.), Chicago, Illinois; and Centers for Advanced Orthopaedics (S.F.), Washington, DC, U.S.A.

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Address correspondence to Christopher M. Larson, M.D., Twin Cities Orthopedics, 4010 W 65th St, Edina, MN 55435, U.S.A. E-mail: chrislarson@tconn.com

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Table 1. Key Points to Capsule Closure and Augmentation With Bioinductive Device

Use of the posterolateral portal can improve the delivery angle of the bioinductive device; however, the distal anterolateral accessory portal can also be used.
The midanterior portal should be used as a viewing portal.
More extensive soft-tissue debridement should be performed to improve visualization in the extracapsular space when augmentation is performed.
Soft-tissue staples can be inserted through the anterolateral portal.
After the implant is provisionally secured, the delivery system can be retrieved.
The implant is not meant to be structural at time zero, and adequate capsular approximation should be achieved in this setting.

Surgical Technique

Patient Positioning and Portal Placement

The patient is positioned in the modified supine position with the hip positioned such that the pelvis is in a neutral position (10° of flexion, 15° of internal rotation, neutral adduction-abduction, 10° of lateral tilt, and variable degrees of Trendelenburg) on an operative traction table, with or without a well-padded perineal post. General anesthesia is used for muscular relaxation without paralysis. The operative hip is prepared, and traction is applied until 1 cm of joint space is achieved. Alternatively, a spinal needle may be used to release the seal if distraction is not easily obtained. Access to the hip joint is accomplished through 2 standard arthroscopic portals: anterolateral and midanterior portals. In revision cases and in patients with poor tissue quality, the resistance encountered with cannula penetration through the capsule is typically reduced. Intra-articular visualization is achieved with a 70° arthroscope (Smith & Nephew, Andover, MA) (Video 1).

Intra-articular Assessment

Both the central and peripheral compartments should be inspected for possible labral tears, acetabular and femoral head chondral lesions (Fig 1), loose bodies, adhesions, and residual cam and/or pincer deformities. After intra-articular inspection is performed and all injuries and pathologies are assessed and managed, attention is turned to the capsule.

Table 2. Advantages and Disadvantages of Augmenting Capsule Repair With Bioinductive Device

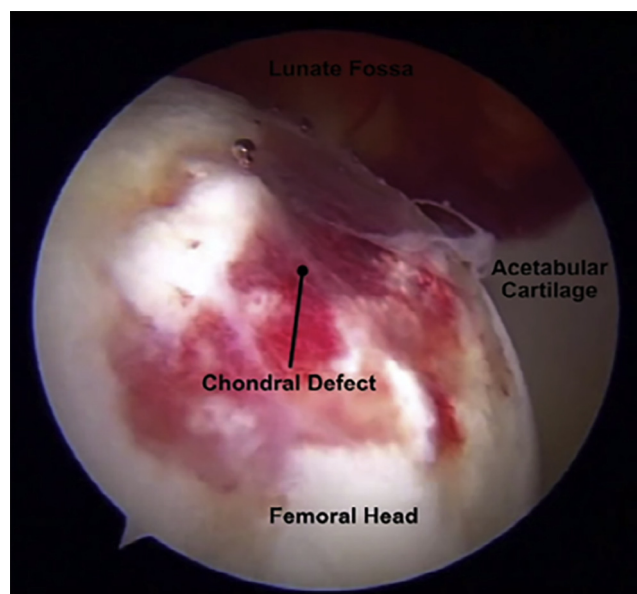
Advantages
Native capsular augmentation can improve thickness and strength of repair
Can strengthen and thicken lax capsular tissue in carefully selected patients
Disadvantages
More time-consuming
Posterolateral portal may be required to insert bioinductive implant
Increases procedural costs
Technically demanding

Table 3. Indications for Capsule Repair Followed by Augmentation With Bioinductive Device

Generalized ligamentous laxity
Revision hip arthroscopy with capsular disruption and/or poor capsular tissue quality but able to approximate majority of capsule
Augmentation of capsular tissue in hip arthroscopic revision for microinstability or macroinstability after hip arthroscopy

Capsular Repair and Augmentation

The capsular repair is performed using a suture passer device and a tissue penetrator to restore the watertight capsule with a combination of multiple ultrahigh-molecular-weight-polyethylene sutures (No. 2 Ultra-braid [Smith & Nephew] and No. 2 Vicryl [Ethicon, Cincinnati, OH]). By use of a midanterior viewing portal and anterolateral working portal, a monofilament suture passer is inserted through a partially threaded, 8.5 × 11-cm cannula (Smith & Nephew), passed through the distal leaflet of the capsule with the Accupass Suture Shuttle (Smith & Nephew), and then deployed and captured with a suture retriever (Smith & Nephew), as shown in Figures 2 and 3. The braided suture is passed through the loop of the monofilament suture, which is retrieved, carrying the braided suture through the capsule, and a standard extracapsular knot is tied (Fig 4). This process is repeated as the stitches are sequentially passed and tied from posterolateral to anteromedial (Fig 5). To place the more anterior sutures, the anterolateral portal is repositioned more anteriorly to have a better angle for suture passing and tying. In cases with large capsular deficiency or laxity and revision cases, more sutures are typically required

**Fig 1.** A large femoral head chondral lesion related to instability after hip arthroscopy viewed through an anterolateral viewing portal in the left hip.

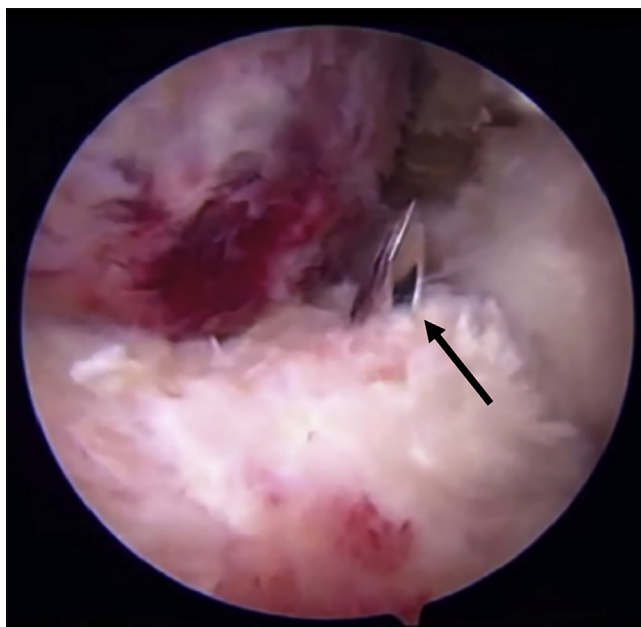


Fig 2. By use of a midanterior viewing portal and anterolateral working portal in the left hip, the Accupass Suture Shuttle (arrow) is inserted through the distal leaflet of the capsule to allow for suture passage and closure of the interportal capsulotomy.

beyond the usual 3 to 4 used to close the interportal capsulotomy.

After complete capsule repair is performed, if the capsule is approximated but somewhat tenuous, a 25 × 31-mm bovine bioinductive implant (Regeneten; Smith & Nephew) is introduced through a new posterolateral portal with a delivering device and is placed over the site of repair and tenuous capsule (Fig 6). A tendon stapler is inserted through the anterolateral portal, and the implant is provisionally secured to the capsule with absorbable polylactic acid copolymer staples (Smith & Nephew). It is important to note that these staples should be placed within the footprint of the bioinductive implant indicated by the blue border. After the implant is provisionally secured to the capsule, the delivering device is removed and additional staples are placed to achieve adequate stability of the implant, with 7 to 9 staples typically being sufficient to secure the implant to the capsule (Fig 7).

Discussion

In this technical note, we have presented a safe and reproducible technique for capsule repair and augmentation with a bioinductive implant to stimulate adequate capsule healing after hip arthroscopy and a postoperative subluxation event. Recent data have shown that residual microinstability due to an inadequately repaired iliofemoral ligament defect or capsulotomy can negatively impact outcomes, despite

adequate treatment of intra-articular pathology.^{2,5} Patients typically reported vague and persistent pain in the hip, as well as a sensation of laxity or uncontrolled translation in the joint, resulting in inferior patient-reported outcome measures (PROMs).² In contrast, complete capsule closure resulted in improved athletic performance and reduced rates of revision surgery compared with patients treated with partial capsular closure. In more rare but more severe cases, patients can present with frank dislocation of the hip.³ In a systematic review, Yeung et al.³ reported 10 cases of hip dislocation after hip arthroscopy, which correlated with capsular deficiency and laxity including unrepaired capsulotomy (77.8%), female sex (77.8%), iliopsoas release (33.3%), acetabular dysplasia (22.2%), and ligamentous laxity (11.1%). In patients with borderline dysplasia undergoing hip arthroscopy, Larson et al.⁷ reported a higher percentage of good or excellent outcomes (73% vs 53%) and lower failure rates (18% vs 40%) for patients who underwent capsular plication versus patients who did not. Regarding EDS, Larson et al.⁸ reported on a series of 16 hips, showing increased instability evidenced by an ability to distract the hip with manual traction under fluoroscopy. In these patients, PROM assessment showed significant improvements in modified Harris Hip Scores, 12-Item Short Form Health Surveys, and Visual Analog Scales in EDS patients undergoing arthroscopy with capsular plication.⁸

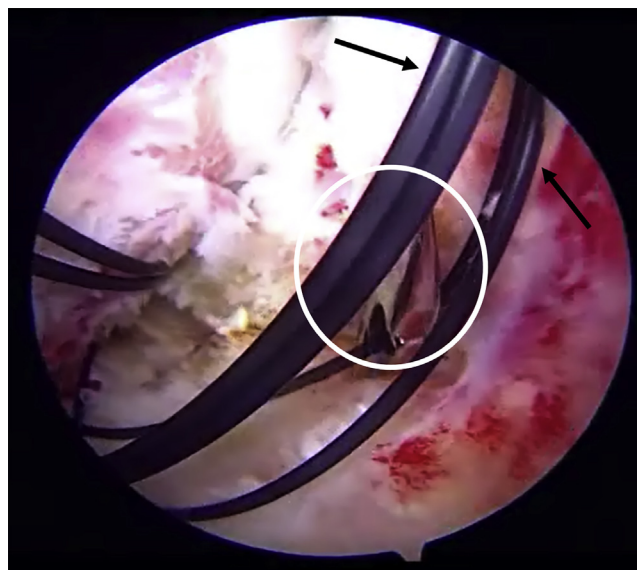
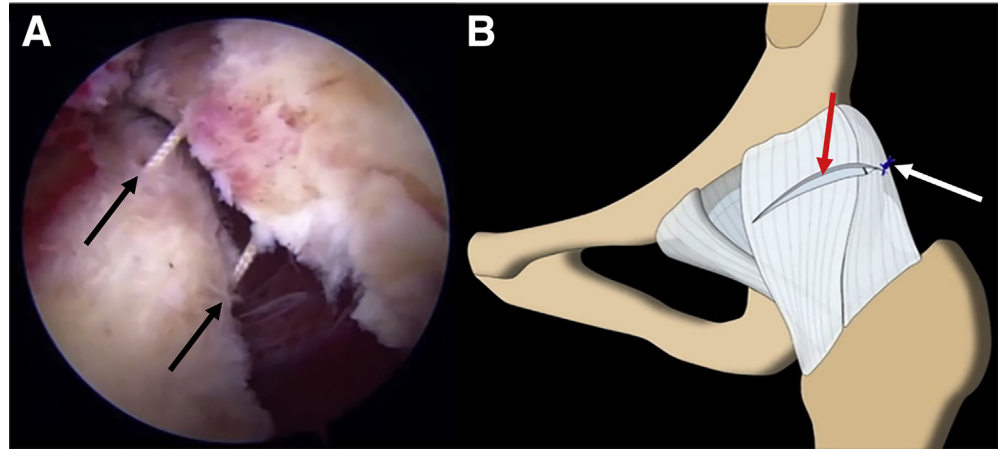


Fig 3. Through the anterolateral working portal, the suture retriever (circle) is used to pass the monofilament suture (arrows) through the proximal leaflet of the capsule while viewing from the midanterior portal in the left hip. The monofilament suture is subsequently used to pass nonabsorbable No. 2 braided and No. 2 Vicryl sutures for closure of the interportal capsulotomy.

Fig 4. (A) Capsular repair (arrows) in a left hip is accomplished through a mid-anterior viewing portal and anterolateral working portal. (B) A combination of nonabsorbable No. 2 braided and No. 2 Vicryl sutures is used to repair the interportal capsulotomy (red arrow) with a series of simple sutures (blue thread), beginning posterolaterally (white arrow).



These clinical findings are supported by prior anatomic investigations. During hip arthroscopy, the interportal capsulotomy is usually performed between the 10- and 2-o'clock positions, 1 cm distal to the labrum, followed by the longitudinal limb of the T-capsulotomy starting at the 2-o'clock position when a T-capsulotomy is performed.^{5,6} Philippon et al.⁶ showed, in an anatomic study, that the thickest portion of the capsule is at the 2-o'clock position, between 0 and 15 mm from the labrum, consistent with the origin of the iliofemoral ligament, which has a primary function in the restriction of extension and external rotation, preventing anterior instability of the hip. Given that this is potentially the thickest portion of the iliofemoral ligament, it is essential that this be adequately repaired to restore stability.

In cases of generalized ligamentous laxity, insufficient capsular tissue, or postoperative capsular disruption, primary repair with the addition of a bovine bio-inductive graft can be used to augment the repair when the tissue can be approximated but is somewhat tenuous. The graft does not mechanically strengthen the repair but instead improves the biological environment surrounding the capsule by enhancing local vascularity. Cases that require mechanical support or those with large irreparable defects require capsular reconstruction when significant osseous dysplastic features are not present. This patch has been used previously for other indications such as in the technique described by Gullledge and Makhni,⁹ who successfully used the patch to augment open gluteus medius repair, with good outcomes, suggesting that the patch may be useful in the repair of other soft tissues. Similarly,

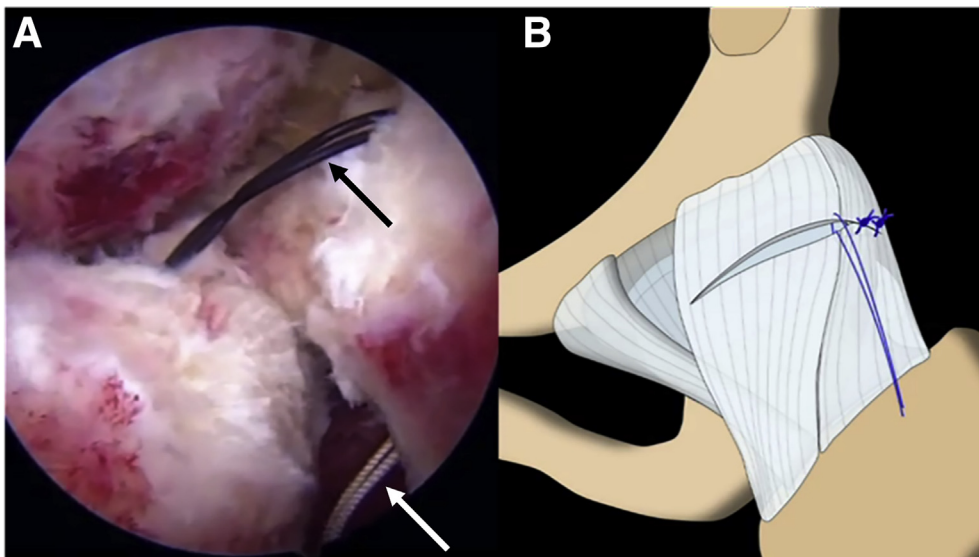
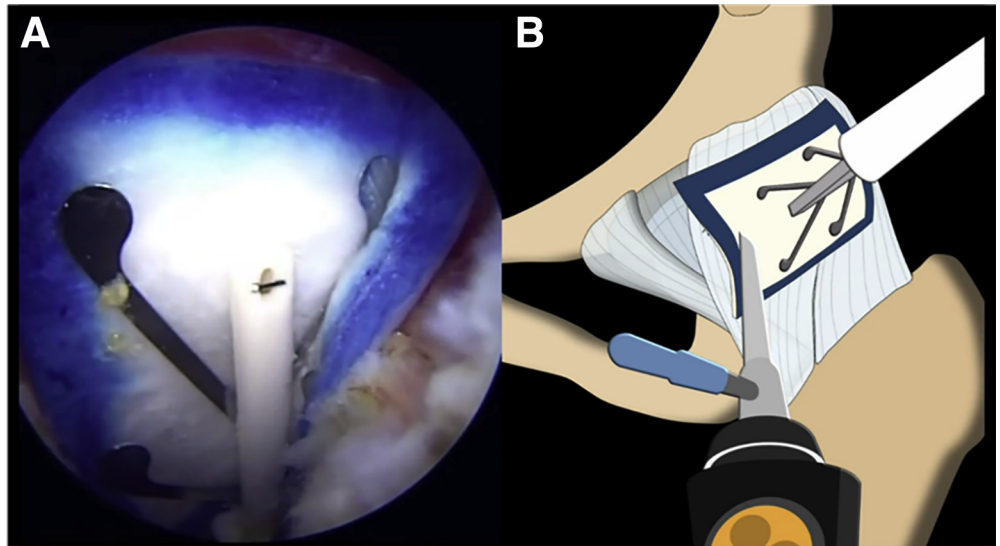


Fig 5. (A) Arthroscopic view of the monofilament suture (black arrow) being pulled back and passing a No. 2 Vicryl suture or No. 2 nonabsorbable braided suture (white arrow) through the capsule leaflets in the left hip. (B) Continuation of the capsular repair and closure of the interportal capsulotomy using the same mid-anterior viewing portal and anterolateral working portal.

Fig 6. (A) Arthroscopic view of the Regeneten bioinductive implant placed over the capsular repair and site of the interportal capsulotomy closure in the left hip. (B) The scope is placed in the mid-anterior viewing portal, while the implant is introduced through a new posterolateral working portal, leaving the anterolateral working portal open for subsequent staple fixation of the implant.



Bokor et al.¹⁰ and Schlegel et al.¹¹ have shown promising results with this type of implant in partial rotator cuff tears, after arthroscopic subacromial decompression without repair of the tears, with magnetic resonance imaging showing new tissue formation, no tear progression, and improvements in PROM scores. More recently, Thon et al.¹² reported a 96% healing rate, confirmed by ultrasound and magnetic resonance imaging, with no reported complications in patients undergoing large or massive rotator cuff tear repair augmented with this bioinductive implant.

There are some limitations and inherent risks to the described technique. The risks of surgery are similar to those of other hip arthroscopy procedures, including infection, persistent pain and instability, and the potential need for subsequent revision surgery. The bioinductive implant does not have any inherent strength, so in some cases, when a gap in the capsular repair is

present, a capsular reconstruction may be more biomechanically appropriate than this bioinductive patch. In addition, this technique does require a third portal such as a posterolateral portal or distal anterolateral portal, requiring greater operative time and technical demand. Finally, the polylactic acid staples can sometimes become dislodged, requiring retrieval, which can also lengthen the operative time.

We have described the successful use of this bioinductive patch to repair and augment the closure of the interportal capsulotomy in the context of poor tissue quality and a postoperative hip subluxation event. However, more extensive research and long-term outcomes are required to further characterize the preoperative and intraoperative indications for the use of this bioinductive implant to enhance the healing capacity of the capsule in revision cases and a subset of primary cases.

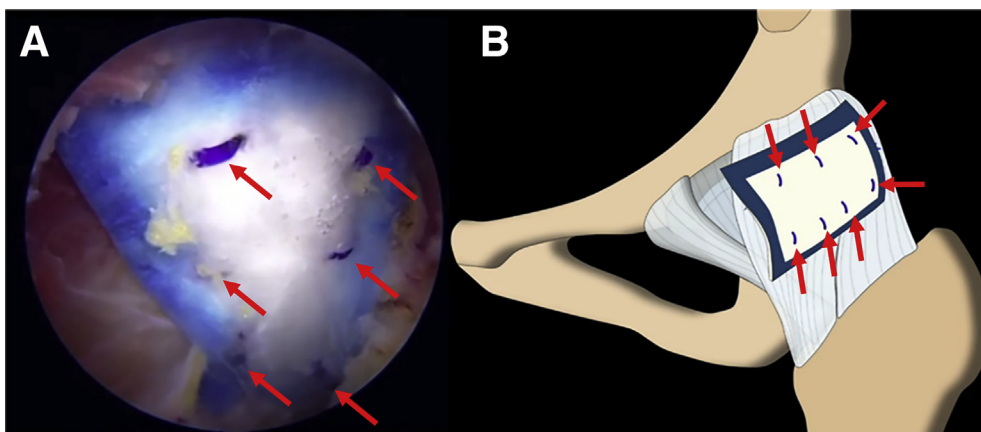


Fig 7. (A) Arthroscopic view through the midanterior portal in the left hip showing the final construct after staple fixation (arrows) of the Regeneten bioinductive implant. (B) All fixation staples (arrows) are within the footprint of the implant as outlined by the blue border.

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