ELSEVIER

Operative Techniques in

Sports Medicine

Remplissage: Expand the Arthroscopic Repair Spectrum

Brian Cable, MD, Ann Marie Kelly, MSc, Elizabeth Mintz, BS, and John D. Kelly IV, MD

Humeral head defects (Hill-Sachs lesions) are common sequelae of glenohumeral instability and potentiate recurrence. Engaging Hill-Sachs lesions clearly increase risk of recurrent instability when not addressed surgically. Arthroscopic remplissage, in conjunction with Bankart repair, has proven to be a safe and effective means to treat anterior gelnohumeral instability. Remplissage, when executed properly, favorably alters the "glenoid track" and thus lessens the risk of glenohumeral engagement in abduction external rotation. Remplissage is a biologic tissue transfer that confers much less morbidity than glenoid bone grafting procedures (Latarjet), while demonstrating comparable efficacy.
Oper Tech Sports Med 27:35-41

KEYWORDS Remplissage, safe zone, anterior shoulder instability, Hill-Sachs, humeral head defect

Introduction

The association of humeral head defects with anterior glenohumeral instability has been described for many years. In 1940, Drs Hill and Sachs described the infamous Hill-Sachs lesion—a "line of condensation" in the posterolateral aspect of the humeral head frequently recognized in patients who had sustained a previous anterior dislocation event.[1] This lesion was posited to be essentially a compression fracture resulting from impaction of the largely cancellous bony humeral head against the more cortically dense anterior glenoid during an anterior dislocation event.

Much has been elucidated regarding the association of glenoid bone loss as both a sequela and predictor of anterior glenohumeral instability.[2] However, the contributing role of humeral head defects is equally important.[3] The notion of an "engaging" Hill-Sachs was first popularized by Palmer and Widen in 1948, where the authors detailed the inherent failure of isolated capsulolabral repair to sufficiently stabilize shoulders presenting with sizable humeral head defects.[4] Burkhart and De Beer in 2000 further defined an engaging Hill-Sachs lesion as a "defect parallel to the anterior glenoid with the shoulder in a functional position of abduction and external rotation" and emphasized the appreciably increased recurrence risk this lesion posed.[2] More contemporary studies have revealed that Hill-Sachs defects are found in 65%-71% of first-time dislocators, and up to 100% of recurrent anterior glenohumeral instability patients.[5]

Tissue Filling and Remplissage

Surgical management of glenohumeral instability uniformly addresses gleno-labral pathology, specifically both capsulolabral repair and repair or augmentation of deficient glenoid bone.[6] However, in the setting of engaging humeral head defects (Fig. 1), other options must be considered. The glenoid track concept, introduced by Yamamoto,[7] delineates the critical and synergistic interplay between glenoid and humeral bone loss. "Engaging" Hill-Sachs lesions will articulate with the anterior glenoid rim in a position of 90° humeral abduction and 90° external rotation—the position in which most anterior instability events occur. "Engaging" Hill-Sachs lesions will fall medial to the glenoid track, the area on the humeral head where the glenoid consistently remains in contact (Fig. 2). To prevent engagement, one may restrict external rotation so that the 90-90 position of engagement is not reached. However, profound external rotation restriction may potentiate the early onset of osteoarthritis by

University of Penn, Perelman School of Medicine, Philadelphia, PA.
Address reprint requests to John D. Kelly IV, MD, 235 S 33rd St., University of Penn, Perelman School of Medicine, Philadelphia, PA 19104. E-mail: John.kelly@uphs.upenn.edu

https://doi.org/10.1053/j.otsm.2019.01.006

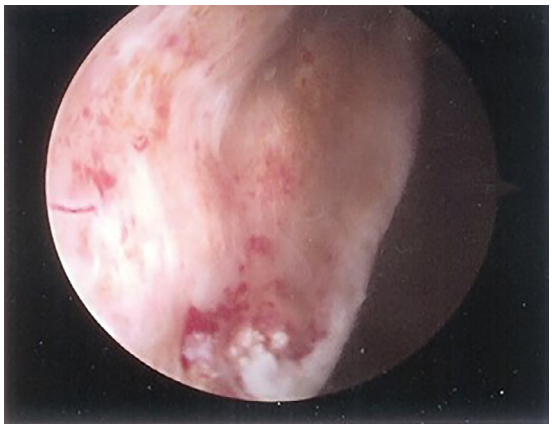

Figure 1 Large engaging Hill-Sachs lesion.

increasing glenohumeral joint reactive forces, promoting posterior subluxation, and depriving appreciable areas of the humeral articular surface contact with the glenoid.[8,9]

Other means of addressing anterior instability include glenoid bone augmentation, humeral head dis-impaction, humeral head resurfacing, synthetic bone plug[10] (Fig. 3), humeral allograft, and tissue filling.[6] The effectiveness of each of these options has been well described in the literature but deserve some mention.

Glenoid bone augmentation (Bristow, Latarjet) will widen the glenoid track and thus lessen engagement.[11] These procedures have gained much favor and clearly have merit in the presence of appreciable glenoid bone loss and will be covered in detail in other chapters. However, when used in the absence of substantial glenoid bone loss (less than 15%), bone resorption may manifest in the coracoid graft.[12] This is a consequence of Wolf's law, which states that bone subjected to minimal mechanical stress would be expected to atrophy.[13]

Disimpaction of a humeral head defect will clearly lessen "engagement" but usually requires an open delto-pectoral approach and is most effective in the acute setting.[14]

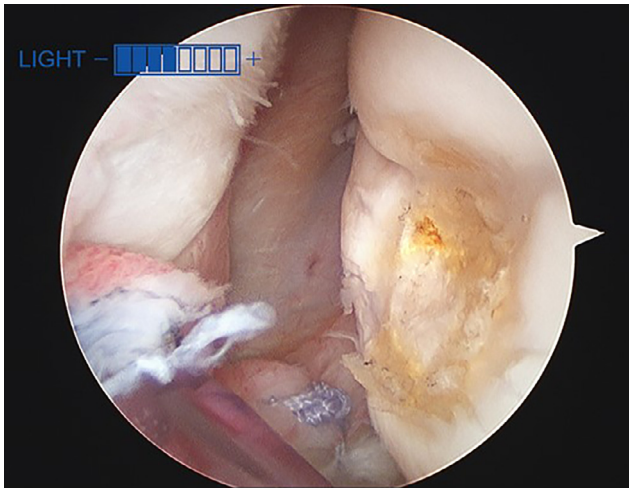

Figure 2 Smaller but more medial Hill-Sachs lesion will have high risk of engagement.

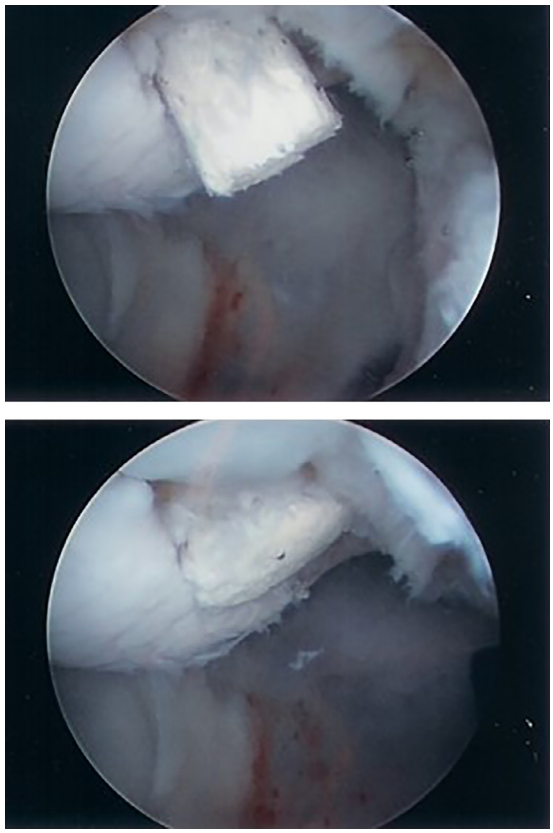

Figure 3 Synthetic bone grafting for small Hill-Sachs lesion.

Humeral resurfacing in the form of metallic implants, while a reasonable option for elderly patients, lacks long-term follow-up, is not physiologic, and is unsuitable for larger lesions. In addition, the presence of a metallic surface (humerus) articulating on hyaline cartilage (glenoid) may potentiate early joint wear.[15]

Humeral allograft, while a reasonable alternative, is expensive, invasive, creates an opportunity for disease transmission, and has also been associated with long-term resorption.[16]

The concept of soft tissue filling of humeral head defects was first popularized in 1972 by Connolly who described an open transfer of the infraspinatus as well as part of the greater tuberosity into the posterior humeral head defect.[17] By tenodesing the infraspinatus into the Hill-Sachs void, once *engaging* intra-articular lesions become extra-articular, obviating any possible articulation of the humeral head defect with the glenoid.[17] A modification of this index procedure evolved with the advent of arthroscopy. The remplissage procedure (derived from the French word *remplir* to *fill)* was first described by Wolf et al in 2007[18] and further modified by Koo et al in 2009[19] as a method of arthroscopically securing the infraspinatus tendon into humeral head defects. This de facto arthroscopic infraspinatus tenodesis of the humeral head defect provided both a biologic fill of the lesion as well as a static restraint to anterior translation of the humeral head. Consequently, remplissage has shown to be an effective method to treat glenohumeral instability, even in the presence of rather significantly sized Hill-Sachs lesions.[20]

Indications

The evaluation of patients with glenohumeral instability must always commence with a thorough history and thorough physical examination. Of note, a positive apprehension test in lesser degrees of abduction (45°) suggests appreciable glenohumeral bone loss which cannot be ignored surgically.[21] Supplemental imaging should include radiographs as well as magnetic resonance imaging, so that both osseous and soft-tissue pathology are optimally visualized. In the setting of recurrent instability with large glenoid defects (>25% of the glenoid surface), studies have consistently proven that glenoid augmentation options, such as a Latarjet reconstruction with coracoid autograft, are likely most suitable.[22] However, in the setting of recurrent instability with glenoid bone loss less than 25% of the glenoid width and concomitant large (>20% humeral head) Hill-Sachs defects, addressing the humeral head lesions in conjunction with a standard anterior capsulolabral repair (Bankart) may prove sufficient in preventing recurrence.[20] In addition, Sugaya et al have shown that repair of even small bony Bankart lesions may result in glenoid bone hypertrophy and reattainment of native (preinstability) bone dimensions.[23] The fact that many bony Bankart lesions are unrecognized is another reason to consider arthroscopic treatment before resorting to more invasive options. It is in the situation of large Hill-Sachs lesion with uncertain glenoid bone loss that arthroscopic remplissage may prove most useful. Since Sekiya[24] has shown that humeral head lesions as small as 12.5% have potential implications in affecting stability, it is the senior author's routine practice (JDK) to treat all humeral head lesions greater than 1 cm in width with remplissage.

Technique

After the patient is placed on the surgical table and anesthesia is administered, a thorough shoulder examination is performed. The patient's shoulder is taken through full range of motion supine and passive range of motion is compared to the contralateral shoulder. Increased external rotation in adduction suggests anterior interval laxity, while excessive external rotation in mid abduction denotes laxity of the middle glenohumeral ligament.[25] Next, a modified "load shift" exam is performed in the lateral position in order to discern which portions of the anterior glenohumeral ligament complex are incompetent. The patient is then carefully positioned in the lateral decubitus position on a beanbag with a slight posterior tilt so that the glenoid of the operated shoulder is positioned close to parallel to the floor. The affected extremity is held in 30°-45° of abduction, and approximately 15° of forward flexion. Initially, 5 pounds of traction are applied, though this can be safely adjusted upward of 15 pounds if required.[26]

Three arthroscopic portals are typically required to complete this procedure (Fig. 4). The posterior portal is made approximately 2 cm inferior and 2 cm medial to the posterolateral edge of the acromion in the glenohumeral "soft spot" and is used as the primary viewing portal as well as the working portal during anchor passage. The anterosuperolateral portal is localized just off the lateral edge of the anterolateral acromion, and it utilized chiefly as a viewing portal during the remplissage procedure. The anterior portal is made approximately 1 cm lateral to the coracoid and is utilized as a working portal during the initial diagnostic arthroscopy as well as during the capsulolabral repair.

After the initial posterior viewing portal is established, a diagnostic glenohumeral arthroscopy is performed. From this portal, the labrum is examined circumferentially to look for the expected Bankart lesion but also for the presence of associated posterior inferior labral separation (Kim lesion) or occult superior labral tears requiring repair. The Hill-Sachs lesion is noted from the standard posterior portal and is characterized as engaging (large and medial) or nonengaging (small and lateral). At this point, it may be helpful to remove the arm from traction and place the humerus in the 90-90 position of abduction and external rotation to confirm engagement.

Upon completion of the initial diagnostic arthroscopy and confirmation of the Hill-Sachs lesion, the anterosuperolateral portal, located just lateral to the anterior lateral corner of the acromion, is created. The arthroscope in this portal affords a "room with a view" of both the humeral head as well as the labrum. It also provides an excellent viewing site for dynamic visualization of Hill-Sachs engagement with the anteroinferior glenoid if the arm is to be taken into abduction and external rotation. This portal is also used to evaluate the adequacy of the posterior portal for anchor insertion into the humeral head defect. A more superior or rarely more inferior portal may be necessary for proper anchor insertion. If remplissage is undertaken, the senior author feels strongly that the Bankart lesion should be prepared *initially*, then repaired *after* completion of remplissage. Since the posterior infraspinatus tenodesis reduces the humeral head posteriorly, it is easier to tension the anterior capsule *after* the remplissage. In addition, since the remplissage reliably effects a posterior translational shift of the humerus, access to the anterior capsulolabral region is facilitated subsequent to the humeral head

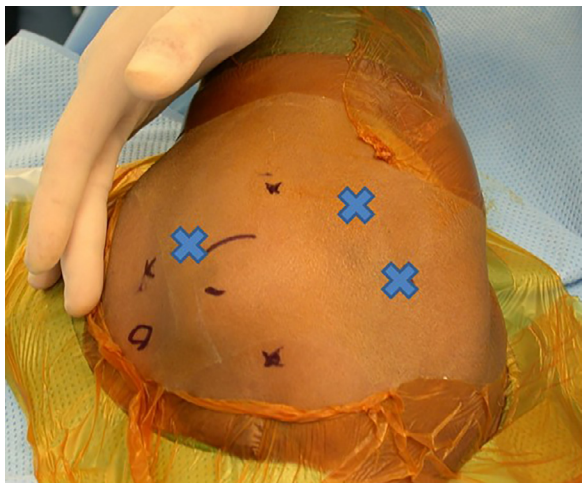

Figure 4 Portals for remplissage.

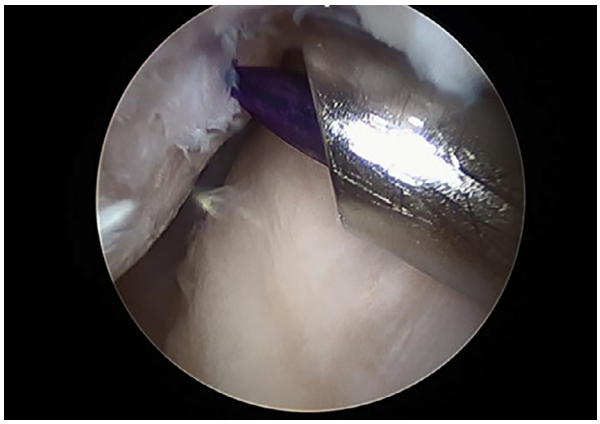

Figure 5 Marking entry site with ink-coated awl tip.

tenodesis. Thus, the labrum is liberated and the glenoid is rasped before the humeral head lesion is addressed and repaired subsequent to remplissage completion.

To begin remplissage, while viewing from the anterosuperior lateral portal, the shaver is inserted posteriorly. In preparation for the remplissage, the Hill-Sachs defect is gently debrided down to its bleeding base. A microfracture awl may be introduced at this time to effect a more robust bleeding bony bed.

After preparation of the Hill-Sachs lesion, a decision is made as to how many anchors are necessary. If 2 anchors are required, the distal most one is inserted first. A small metallic cannula is placed through the posterior portal (Fig. 5). Using this cannula, a single loaded anchor is inserted into the Hill-Sachs defect, making sure that the trajectory remains perpendicular to the bone. If the initial portal is deemed too medial, an additional, more distal and lateral portal is created. After initial anchor placement, a switching stick is placed through the metallic cannula and the sheath withdrawn and replaced over the switching stick only rendering the first 2 sutures outside the sheath (Fig. 6). The second anchor is then placed

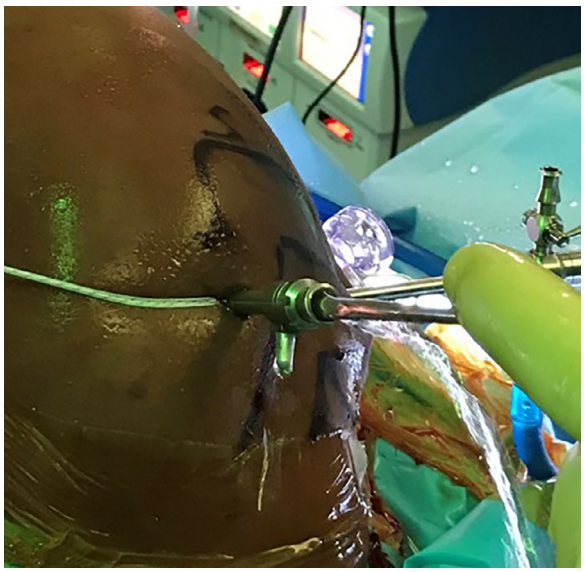

Figure 6 Sutures of first anchor outside of cannula in preparation for second anchor insertion.

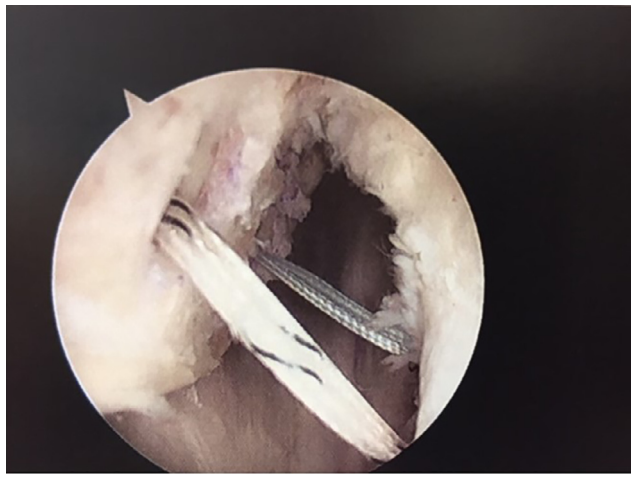

Figure 7 Proximal and distal anchors inserted via posterior portal.

more proximally as close to the proximal articular margin of the lesion as possible (Fig. 7). Rarely a more proximal portal is required to ensure adequate perpendicular access to the bony bed. Once the second anchor is placed, the sheath is withdrawn, and each pair of suture limbs is clamped with a hemostat.

Next, a retrieving portal is established lateral to the acromion so that tendon, not muscle, is secured to the anchors. The "safe zone" as described by Garcia[27] is the region whereby a penetrating instrument will pierce the infraspinatus tendon reliably rather than muscle (Fig. 8). A lateral tendinous suture purchase is important for 2 reasons: first a more lateral-based tenodesis will be far more secure and resistant to pull out than muscular purchase. Secondly, the more laterally the tendon is secured to the humeral head defect, the less likely motion restriction will ensue.[28]

A spinal needle located in the safe zone is first placed to ensure adequate portal placement, which usually falls approximately 1 cm lateral to the posterolateral corner of the

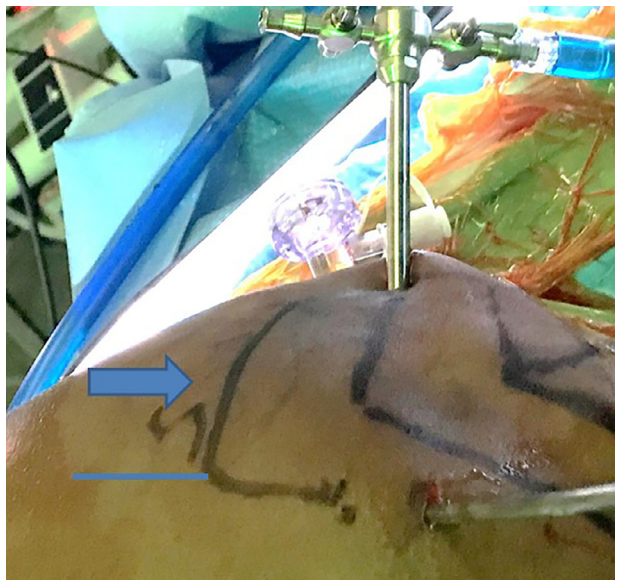

Figure 8 "Safe zone" region outlined lateral to acromion.

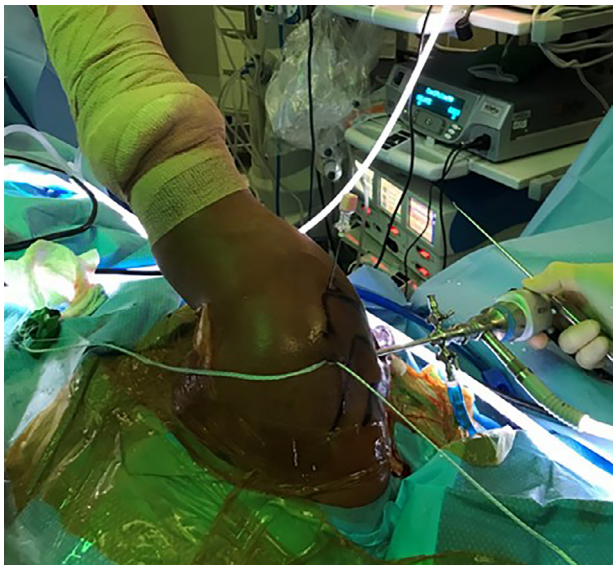

Figure 9 Spinal needle in "safe zone" to determine retrieving cannula placement.

acromion, or in reasonable proximity to this area (Fig. 9). Once location is confirmed, a stab incision is made and a 6 mm cannula is inserted in this plane with a blunt obturator into the subacromial space. The obturator should be swept freely in the subacromial space, preventing bursal tissue from being interposed between knots and the infraspinatus tendon.

Once this retrieving portal is established, the first (distal) set of sutures is retrieved approximately 1 cm medial to the tendinous insertion. Careful bites are taken to ensure an adequate tissue bridge results for each knot (Fig. 10). After the distal suture limbs are retrieved, the sutures from the distal anchor are tensioned and placed on the distal edge of the cannula (Fig. 11). The cannula is then positioned to retrieve the proximal sutures, again medial to the tendinous insertion, and with adequate tissue purchase. Rarely, a second more superior portal is necessary to effectively complete this step. Once all 4 suture limbs are passed through tendinous tissue, tying should commence with the sutures of the distal anchor first. Suture limbs are tied with a gentle posterior force applied to the humeral head during knot throw progression. Once distal sutures are secured, the proximal most sutures are tied to complete the remplissage (Fig. 12).

Figure 11 Sutures separated in cannula after retrieval.

The capsulolabral repair can then be performed and a switching stick is used to re-establish the original posterior portal which will be used for suture shuttling during the Bankart repair.

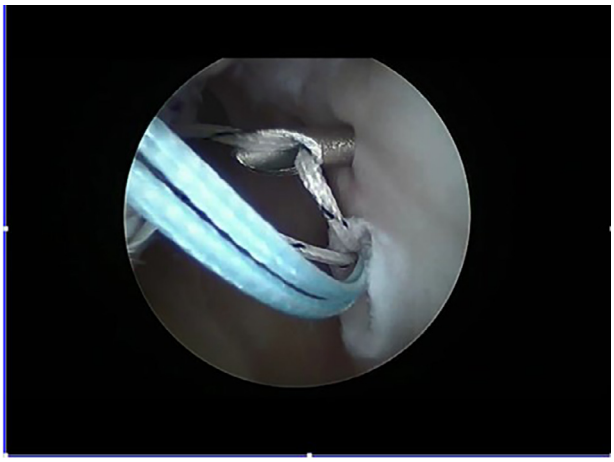

Figure 10 Retrieving sutures from "safe zone."

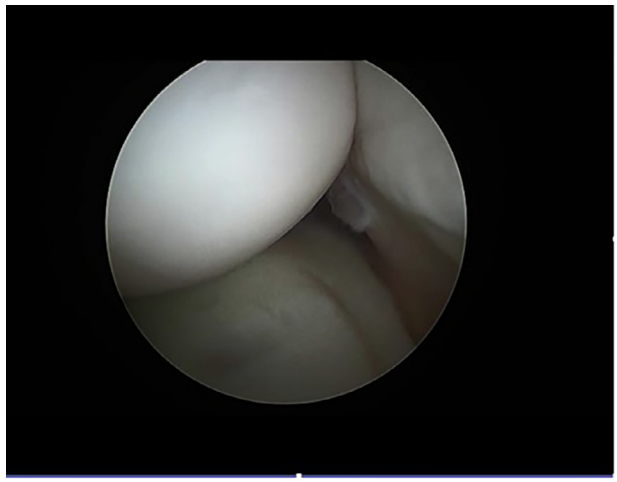

Figure 12 Completed remplissage.

Results

Overall, arthroscopic remplissage has proven to be a safe in the treatment of recurrent anterior glenohumeral instability. Compared to other methods of addressing humeral head defects, remplissage provides several distinct advantages. The procedure can be performed entirely arthroscopically, thus avoiding the morbidity and the prolonged recovery often encountered with open procedures. Likewise, it is a procedure that can be performed in conjunction with other arthroscopic procedures, such as Bankart repair, without adding substantial operative time. The infraspinatus does appear to integrate well into the defect as Park[29] has shown at least 75% fill of the lesion on post-op magnetic resonance imaging. The presence of fibrous-like signal on post-op magnetic resonance imaging scans in this study suggests the possibility that the tenodesed infraspinatus tissue may transform into fibrocartilaginous tissue in time.[29]

Several biomechanical studies have been performed to evaluate the effectiveness of remplissage. In 2012, Giles et al evaluated cadaveric specimens with Hill-Sachs lesions on a shoulder simulator and found that remplissage was effective in preventing engagement and dislocation of humeral heads with Hill-Sachs defect sizes of both 30% and 45%.[30] A separate cadaveric analysis by Elkinson et al in 2012 helped further developed this protective effect of remplissage against engagement.[31] In their investigations, the authors evaluated Hill-Sachs lesions sized at 15% and 30% and treated with a combination of Bankart repair with remplissage. They found that when treated with Bankart alone, none of the 15% Hill-Sachs lesions engaged and dislocated, whereas all of the 30% lesions did. However, the dislocation rate of the 30% Hill-Sachs lesions was significantly reduced if remplissage was added in conjunction to Bankart repair—thus helping to corroborate the notion that remplissage is most effective in the setting on minimal glenoid bone loss and sizable engaging Hill-Sachs defects.[31]

Clinically, several studies have been performed highlighting the effectiveness of remplissage with both good clinical and functional outcome scores.[32,33] In 2001, Park et al examined a series of 20 patients who underwent the procedure and concluded that remplissage was an effective procedure for restoring function, alleviating pain, and improving patient satisfaction.[33] Complications, such as posterosuperior shoulder pain as well as loss of shoulder motion, particularly external rotation, have been described.[34,35] Despite this, several investigations have revealed that arthroscopic remplissage is well tolerated without postoperative shoulder pain or loss of motion.[5,32,33,36] Garcia[37] reported a 95% return to sport following remplissage, while Buza,[20] in a systematic review, concluded that the results of remplissage compared favorably to those of Bankart repair performed in the absence of appreciable bone loss.

Most impressively, Cho[38] recently compared remplissage to Latarjet and found similar recurrence rates but an appreciably higher complication rate with coracoid transfer.

Conclusion

Several treatment options exist for the management of recurrent anterior shoulder instability. Defining the pathogenesis of this instability is an important first step in helping to guide these options. It is generally accepted that management of large glenoid defects (greater than 25% width) generally demand bony augmentation techniques, such as coracoid transfer. However, management of engaging Hill-Sachs lesion is likely best served with a biologic and focal solution. The premise of "tissue filling" was initially described in the 1970s. Since that time, the field of orthopaedic surgery has witnessed the maturation of this method into today's arthroscopic remplissage procedure. The indications for remplissage have become better defined, but as the pathogenesis

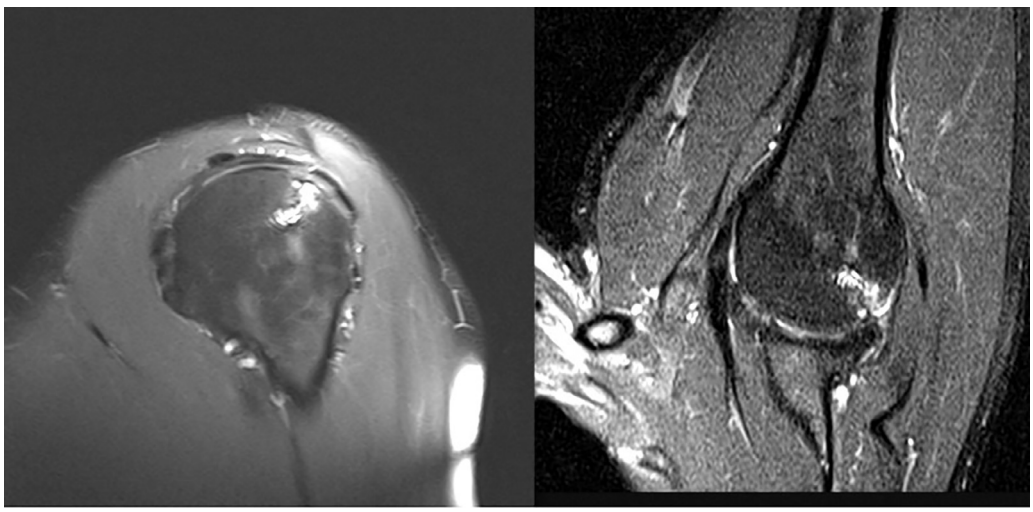

Figure 13 5.5 months status post remplissage demonstrating integration into bone of infraspinatus arthroscopic sequence of remplissage.

and the pathomechanics of shoulder instability continue to become more elucidated, they will surely continue to evolve. Both safe and effective, arthroscopic remplissage continues to gain widespread acceptance as a treatment option for shoulder instability with a concurrent humeral head defect. It has proven effective in minimizing recurrence, has been shown to incorporate, and has not been shown to appreciably affect motion. Remplissage will undoubtedly continue to remain an important part of a surgeon's armamentarium in the treatment of shoulder instability (Fig. 13).

References

1. Hill HA, Sachs MD: The grooved defect of the humeral head: A frequently unrecognized complication of dislocations of the shoulder joint. Radiology 35:690-700, 1940
2. Burkhart SS, De Beer JF: Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. Arthroscopy 16:677-694, 2000
3. Cho SH, Cho NS, Rhee YG: Preoperative analysis of the Hill-Sachs lesion in anterior shoulder instability: how to predict engagement of the lesion. Am J Sports Med 39:2389-2395, 2011
4. Palmer I, Widen A: The bone block method for recurrent dislocation of the shoulder joint. J Bone Joint Surg Br 30:53-58, 1948
5. Longo UG, Loppini M, Rizzello G, et al: Remplissage, humeral osteochondral grafts, weber osteotomy, and shoulder arthroplasty for the management of humeral bone defects in shoulder instability: systematic review and quantitative synthesis of the literature. Arthroscopy 30:1650-1666, 2014
6. Provencher MT, Frank RM, Leclere LE, et al: The Hill-Sachs lesion: diagnosis, classification, and management. J Am Acad Orthop Surg 20:242-252, 2012
7. Yamamoto N, Itoi E, Abe H, et al: Contact between the glenoid and the humeral head in abduction, external rotation, and horizontal extension: a new concept of glenoid track. J Shoulder Elbow Surg 16:649-656, 2007
8. Hawkins RJ, Angelo RL: Glenohumeral osteoarthrosis. A late complication of the Putti-Platt repair. J Bone Joint Surg Am 72:1193-1197, 1990
9. Schmidt TA, Gastelum NS, Nguyen Q, et al: Boundary lubrication of articular cartilage: role of synovial fluid constituents. Arthritis & Rheumatism 56:882-891, 2007
10. Kelly JD IV, Ogunro S: Arthroscopic Filling of Hill- Sachs Lesions. Arthroscopy 23(supplement):e2, 2007
11. Mook WR, Petri M, Greenspoon JA, et al: Clinical and anatomic predictors of outcomes after the Latarjet procedure for the treatment of anterior glenohumeral instability with combined glenoid and humeral bone defects. Am J Sports Med 44:1407-1416, 2016
12. Di Giacomo G, de Gasperis N, Costantini A, et al: Does the presence of glenoid bone loss influence coracoid bone graft osteolysis after the Latarjet procedure? A computed tomography scan study in 2 groups of patients with and without glenoid bone loss. J Shoulder Elbow Surg 23:514-518, 2014
13. Woo SL, Kuei SC, Amiel D, et al: The effect of prolonged physical training on the properties of long bone: a study of Wolff's Law. J Bone Joint Surg Am 63:780-787, 1981
14. Re P, Gallo RA, Richmond JC: Transhumeral head plasty for large Hill-Sachs lesions. Arthroscopy 798:e1-798, 2006
15. Dawson CK, Rolf RH, Holovacs TF: The management of localized articular cartilage lesions of the humeral head in the athlete. Oper Tech Sports Med 16:14-20, 2008
16. Miniaci A, Gish MW: Management of anterior glenohumeral instability associated with large Hill-Sachs defects. Tech Shoulder Elbow Surg 5:170-175, 2004
17. Connolly JF: Humeral head defects associated with shoulder dislocation: Their diagnostic and surgical significance. Instr Course Lect 21:42-54, 1972
18. Purchase RJ, Wolf EM, Hobgood ER, et al: Hill-Sachs "remplissage": an arthroscopic solution for the engaging Hill-Sachs lesion. Arthroscopy 24:723-726, 2008
19. Koo SS, Burkhart SS, Ochoa E: Arthroscopic double-pulley remplissage technique for engaging Hill-Sachs lesions in anterior shoulder instability repairs. Arthroscopy 25:1343-1348, 2009
20. Buza JA 3rd, Iyengar JJ, Anakwenze OA, et al: Arthroscopic Hill-Sachs remplissage: a systematic review. J Bone Joint Surg Am 96:549-555, 2014
21. Bushnell BD, Creighton RA, Herring MM: The bony apprehension test for instability of the shoulder: a prospective pilot analysis. Arthroscopy 24:974-982, 2008
22. Burkhart SS, De Beer JF, Barth JR, et al: Results of modified Latarjet reconstruction in patients with anteroinferior instability and significant bone loss. Arthroscopy 23:1033-1041, 2007
23. Kitayama S, Sugaya H, Takahashi N, et al: Clinical outcome and glenoid morphology after arthroscopic repair of chronic osseous Bankart lesions: a five to eight-year follow-up study. J Bone Joint Surg 97:1833-1843, 2015
24. Sekiya JK, Jolly J, Debski RE: The effect of a Hill-Sachs defect on glenohumeral translations, in situ capsular forces, and bony contact forces. Am J Sports Med 40:388-394, 2012
25. Gerber C, Werner CM, Macy JC, et al: Effect of selective capsulorrhaphy on the passive range of motion of the glenohumeral joint. J Bone Joint Surg Am 85:48-55, 2003
26. McHale KJ, Park MJ, Kelly JD IV: Arthroscopic Remplissage for Humeral Head Defects. Techniques in Orthopedics 30:39-41, 2015
27. Garcia GH, Degen RM, Liu JN, et al: Accuracy of Suture Passage During Arthroscopic Remplissage—What Anatomic Landmarks Can Improve It? A Cadaveric Study. Orthop J Sports Med 4, 2016. 2325967116663497 (online)
28. Elkinson I, Giles JW, Boons HW: The shoulder remplissage procedure for Hill-Sachs defects: does technique matter? J Shoulder Elbow Surg 22:835-841, 2013
29. Park MJ, Garcia G, Malhotra A, Major N, Tjoumakaris FP, Kelly JD IV: The evaluation of arthroscopic remplissage by high-resolution magnetic resonance imaging. Am J Sports Med 40:2331-2336, 2012
30. Giles JW, Elkinson I, Ferreira LM, et al: Moderate to large engaging Hill-Sachs defects: an in vitro biomechanical comparison of the remplissage procedure, allograft humeral head reconstruction, and partial resurfacing arthroplasty. J Shoulder Elbow Surg 21:1142-1151, 2012
31. Elkinson I, Giles JW, Faber KJ, et al: The effect of the remplissage procedure on shoulder stability and range of motion: an in vitro biomechanical assessment. J Bone Joint Surg Am 94:1003-1012, 2012
32. Zhu YM, Lu Y, Zhang J, et al: Arthroscopic Bankart repair combined with remplissage technique for the treatment of anterior shoulder instability with engaging Hill-Sachs lesion: a report of 49 cases with a minimum 2-year follow-up. Am J Sports Med 39:1640-1647, 2011
33. Park MJ, Tjoumakaris FP, Garcia G, et al: Arthroscopic remplissage with Bankart repair for the treatment of glenohumeral instability with Hill-Sachs defects. Arthroscopy 27:1187-1194, 2011
34. Nourissat G, Kilinc AS, Werther JR, et al: A prospective, comparative, radiological, and clinical study of the influence of the "remplissage" procedure on shoulder range of motion after stabilization by arthroscopic Bankart repair. Am J Sports Med 39:2147-2152, 2011
35. Deutsch AA, Kroll DG: Decreased range of motion following arthroscopic remplissage. Orthopedics 31:492, 2008
36. Haviv B, Mayo L, Biggs D: Outcomes of arthroscopic "remplissage": capsulotenodesis of the engaging large Hill-Sachs lesion. J Orthop Surg Res 6:29, 2011
37. Garcia GH, Wu HH, Liu JN, Huffman GR, Kelly JD IV: Outcomes of the remplissage procedure and its effects on return to sports: average 5-year follow-up. Am J Sports Med 44:1124-1130, 2016
38. Cho NS, Yoo JH, Rhee YG: Management of an engaging Hill–Sachs lesion: arthroscopic remplissage with Bankart repair versus Latarjet procedure. Arthroscopy 24:3793-3800, 2016