Comparison of Arthroscopic Osteochondral Substitute Grafting and Remplissage for Engaging Hill-Sachs Lesions

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Abstract

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The optimum management for recurrent glenohumeral instability with significant humeral head defects remains controversial. The purpose of this study was to compare outcomes and recurrence rates between patients who underwent osteochondral substitute grafting and patients who underwent remplissage to treat recurrent shoulder instability from an engaging Hill-Sachs defect with a Bankart lesion.

Twenty consecutive patients who underwent remplissage and 19 consecutive patients who underwent osteochondral substitute grafting with Bankart repair were studied. Mean follow-up was 29.6 months for the remplissage group and 32.1 months for the osteochondral substitute grafting group. All patients had an engaging Hill-Sachs lesion, and indications for surgery were identical between groups. Three postoperative recurrences occurred in the remplissage group and 6 occurred in the osteochondral substitute grafting group (P = .18). Nineteen patients in the remplissage group and 7 patients in the osteochondral substitute grafting group had a large humeral head defect. Patients in the remplissage group had better Western Ontario Shoulder Instability Index [WOSI] scores than those in the osteochondral substitute grafting group for large lesions (74.7 vs 50.4, respectively), although they were not statistically significant (P = .077). After controlling for age, sex, lesion size, and follow-up differences, the remplissage group reported significantly better WOSI scores (P = .016).

This study demonstrated a potential advantage of remplissage compared with osteochondral synthetic grafting in patients who experienced recurrent anterior shoulder instability, particularly in shoulders with a large humeral head defect.

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In the absence of a significant glenoid or humeral head defect, arthroscopic Bankart repair alone is a good option for patients with anterior glenohumeral instability. When large bone defects are present, failure of capsular and labral surgery can be as high as 67% to 93%. As a result, many of these patients benefit from a procedure that directly addresses the osseous deficiency to restore the arc length and prevent early engagement of bone defects, which can contribute to recurrent instability and failure of a primary soft tissue repair. For anterior glenoid bone loss greater than 25%, one option is the Eden-Hybinette procedure using autograft to fill in the bone defect; in addition, other procedures, such as the Bristow-Latarjet, use local bone and soft tissue from the coracoid and conjoint tendon to restore glenoid bone stock, thereby eliminating the need for exogenous grafting. However, these procedures are associated with complications but offer good results for patients with significant glenoid bone loss.

On the humeral side, first-time shoulder dislocations are associated with Hill-Sachs lesions 40% to 71% of the time and with recurrent instability 50% to 100% of the time. In addition, the size of the defect has been correlated with recurrent instability, and in a subset of large, engaging lesions, it has been associated with failure after primary Bankart repair. As a result of this correlation, an increasing interest exists to address these large humeral head defects through grafting procedures to fill the lesion or bone through soft tissue procedures that prevent lesion engagement on the anterior glenoid rim. Currently available surgical options include humeral osteotomy, transmural bone tamp, iliac crest bone graft, osteochondral synthetic graft transplantation, and remplissage.

Despite the benefits of these surgical options, many of these open procedures can be technically challenging and cause significant morbidity. Much of this morbidity is due to extensive exposure, hardware failure, or a decrease in shoulder range of motion. Approximately 60% of patients undergoing humeral osteotomy eventually need a second surgery for hardware removal despite an initial satisfactory surgical outcome. As a result of this morbidity, arthroscopic repair or modulation of humeral head defects has recently garnered more attention. In addition to the less invasive nature of the arthroscopic technique, use of osteochondral synthetic grafting or remplissage has shown promising results in terms of preventing recurrent shoulder instability. By using less invasive humeral head techniques, patients with large defects can potentially benefit from reduced shoulder instability without the need for more invasive procedures.

To the authors’ knowledge, no published report compares arthroscopic remplissage (infraspinatus tenodesis to fill a Hill-Sachs defect) with synthetic osteochondral substitute grafting. The purpose of this study was to analyze the surgical outcomes of osteochondral substitute grafting and remplissage, as described in a prior report. Although the techniques have been reported to produce similar outcomes, the current authors hypothesized that remplissage may produce a better clinical outcome and reduce the risk of recurrence in patients with similar indications for surgery.

**Materials and Methods**

Institutional review board approval was obtained prior to data collection. Data were collected by retrospective review of clinic charts for patients who underwent osteochondral substitute grafting or remplissage by the senior author (J.D.K.) between January 2005 and January 2008. Indications for surgery were identical between groups, including patients with previous recurrent anterior shoulder instability (more than 2 dislocations within 1 year), significant humeral head defects (as defined by Rowe et al) with glenoid bone defects less than 20% as detected by magnetic resonance imaging (MRI), and a corresponding Bankart lesion. The technique as described by Sugaya et al using the circle method to evaluate for a glenoid defect of less than 20% was used in all patients, and the bare spot method was used to confirm that all patients had glenoid deficits of less than 20%. All patients had failed an initial trial of conservative treatment, which included a comprehensive physical therapy program.

Operative and clinical records for 20 consecutive patients who underwent remplissage and 19 consecutive patients who underwent osteochondral synthetic graft implantation were studied. Patients were contacted at final follow-up to obtain their final shoulder outcome score. Five patients in the remplissage group had bony glenoid defects, none of which were directly addressed, but all patients underwent arthroscopic Bankart repair. The type of procedure performed was secondary to a shift toward remplissage during the latter part of the study period. This represented an evolution of the surgeon’s technique and was not secondary to any identifiable factor that may have negatively influenced data interpretation.

The size of the humeral head defect was indirectly measured by records of the size of the synthetic graft bone plug in the osteochondral synthetic graft group and the depth of probe measurement in the remplissage group, correlated with MRI findings. Demographic data (ie, age and sex), type of surgery, and operative time were extracted from the operative records of all patients in the series. All patients were assessed with the Western Ontario Shoulder Instability Index (WOSI) score, which was previously validated for shoulder instability, as well as determination of recurrence at final follow-up.

Independent-samples t test with equal variances not assumed was used to analyze differences between groups where the parameters were continuous. Chi-square test and Fisher’s exact test were used to determine differences between binary and categorical variables. Linear
regression analysis was used to determine outcome differences between patients in the remplissage and osteochondral substitute grafting groups after controlling for potential confounders. Binary logistic regression analysis was performed to determine whether any factor was predictive of future dislocation. Statistical analyses was performed using SPSS version 16.0 software (SPSS, Inc, Chicago, Illinois).

**SURGICAL TECHNIQUE**

**Remplissage**

The patient is positioned in the lateral decubitus position and leaned back slightly with the shoulder in 30° of abduction and 15° of forward flexion. The arm is then suspended with appropriate weight to give adequate traction. The posterior portal is established slightly lateral to the convexity of the humeral head to visualize the Hill-Sachs lesion. The anteroinferior portal is established in the rotator interval, and the anterosuperior portal is established at the anterior margin of the acromion, behind the biceps tendon. The anterosuperior portal is used for visualization of the humeral defect and to assess the placement of the posterior portal. The posterior portal should be directly over the humeral head defect for the purpose of anchor placement.

When appropriate posterior portal placement is confirmed, the Hill-Sachs lesion is gently debrided with a shaver. For the Bankart repair, the anterior labrum and glenoid need to be prepared at this time, prior to remplissage because remplissage may affect tension in capsular sutures. After adequate preparation for Bankart repair, the posterior portal is used to place an anchor in the humeral head defect. One anchor per approximately 1 cm of defect is used, with the first anchor placed distally. A tap is used for younger, denser bone. After the anchor is placed, the cannula is withdrawn superficial to the infraspinatus, and a penetrating grasper is passed through the tendon and posterior capsule to retrieve 1 suture limb proximal and 1 distal, surrounding the anchor insertion site. A second anchor may be placed in the superior aspect of the humeral head defect, and a grasper or penetrator is used in the same fashion to shuttle the suture limbs in a mattress configuration. The inferior suture is tied first, with the knots remaining extra-articular in the subdeltoid space, taking care to push the humeral head anteriorly while tying to reduce tension in the sutures. The superior suture is tied to complete remplissage. These mattress sutures draw the infraspinatus and posterior capsule to the abraded bony surfaces, thus filling the Hill-Sachs lesion. The Bankart repair can then be completed.

Postoperatively, patients are completely immobilized in a sling for 6 weeks, with gentle activities of daily living allowed out of the sling. Gentle active and active-assistive range of motion is allowed 6 weeks postoperatively. Patients are instructed not to abduct or externally rotate the arm beyond neutral until 6 weeks. Patients are advised to avoid hard labor or contact sports for 6 months.

**Osteochondral Substitute Grafting**

The patient’s position and portal placement are similar to those in remplissage. The posterior portal should be directly over the humeral head defect for the purpose of introduction of the synthetic graft material. When appropriate posterior portal placement is confirmed, the Hill-Sachs lesion is gently debrided with a burr in reverse mode, followed by debridement of the posterior and inferior capsule using a whisker blade. For the Bankart repair, the anterior labrum and glenoid need to be prepared at this time, prior to the grafting procedure. After adequate preparation for Bankart repair, the size of the humeral head defect is assessed, and the appropriate size of synthetic graft is prepared. The synthetic graft plugs (TruFit BGS plugs; Smith & Nephew, Andover, Massachusetts) is then introduced through the posterior portal using Osteochondral Autograft Implantation System instrumentation (Arthrex, Inc, Naples, Florida). The synthetic graft plugs are press-fit into the defect. Care is taken to fill in the presumed glenoid track of the humeral head. Enough graft is placed to prevent critical engagement of the lesion during abduction and external rotation. The Bankart repair can then be completed.

Patients receive the same activity restrictions and physical therapy regimen as patients undergoing remplissage.

**RESULTS**

Age, sex, and handedness were similar between the 2 groups (Table 1). Mean operative time was considerably longer for the osteochondral substitute grafting group than for the remplissage group (3.3 vs 2.01 hours, respectively; $P<.001$). Mean follow-up was 24.6 months (range, 24.3-37.7 months) for the remplissage group and 32.1 months (range, 24.1-45.0 months) for the osteochondral substitute grafting group. Overall, 3 (15%) postoperative recurrences of shoulder instability occurred in the remplissage group and 6 (32%) occurred in the osteochondral substitute grafting group ($P = .18$) (Table 1). No patient underwent further operative treatment, and no patient had a glenoid defect of more than 20%. All patients who had documented recurrence reported that their shoulder was stable enough for activities of daily living and declined further surgery. No other significant postoperative complications occurred.

Nineteen patients in the remplissage group and 7 in the osteochondral substitute grafting group had a moderate to severe humeral head defect (larger than 2 cm long/0.3 cm deep) as defined by Rowe et al.17 When comparing only patients who had large humeral head defects, 3 (100% of the failures in this group) in the remplissage group and 3 (50% of the failures in this group) in the osteochondral substitute grafting group had postoperative recurrent shoulder instability ($P = .293$) (Table 2). Mean WOSI score was 74.7 for the remplissage group and 50.4 for the osteochondral substitute grafting group ($P = .77$). After controlling for age, sex, le-
sion size, and follow-up differences using linear regression analysis, the remplissage group reported significantly better WOSI scores ($P = .009$). Humeral lesion size was a significant negative confounder, and female sex was a significant positive confounder ($P = .042$ and .007, respectively). No variable was predictive of recurrent instability on logistic regression analysis. The number of previous dislocations trended toward predicting increased risk of future dislocation ($P = .065$).

**DISCUSSION**

In general, Hill-Sachs lesions are present in patients with anterior shoulder instability between 38% to 93% of time.$^2,12,13$ Small humeral head defects are not thought to contribute to shoulder instability. However, large defects can alter the biomechanics of shoulder range of motion and have been found to contribute to anterior shoulder instability.$^{19}$ Perhaps more importantly, an unrecognized and untreated humeral head defect can result in failure of primary stabilizing procedures, such as Bankart repair.$^8,20-24$ Filling the humeral head defect in turn lengthens the glenoid track surface. This occurs by preventing any incongruity throughout the glenohumeral joint space during active range of motion.

As arthroscopic techniques have evolved, surgeons have tried to expand the indications of these techniques to areas where open surgery has previously been the gold standard. In shoulder instability with bone defects, the Bristow-Latarjet procedure, humeral head osteotomy, and open osteoarticular allograft have been reported in the literature as providing good and durable outcomes and are the current gold standard for addressing these lesions in an open fashion.$^5,6,13,25$ Preliminary study results on arthroscopic bone grafting (eg, Latarjet and iliac crest) seem encouraging.$^{26}$ Remplissage can be performed arthroscopically and effectively converts an intra-articular lesion into an extra-articular lesion. Implantation of osteoarticular synthetic graft to a humeral head defect can also be performed arthroscopically and has shown promising results with the potential advantage of restoring a full glenohumeral range of motion relative to other techniques that use soft tissue transfers.$^{12,13}$ However, it is incumbent upon arthroscopists to ensure that these techniques provide outcomes as durable and successful as those of more traditional methods, in addition to providing adequate filling of the humeral defect, which in turn lengthens the glenoid track for the humeral head.

To the authors’ knowledge, no published study has compared postoperative outcome scores for remplissage and osteochondral substitute grafting. The current study compared 2 arthroscopic pro-

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*Abbreviation: WOSI, Western Ontario Shoulder Instability Index.*

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*Abbreviation: WOSI, Western Ontario Shoulder Instability Index.*
cures that address significant humeral head defects that cause symptomatic anterior shoulder instability. Overall, remplissage took significantly less operative time compared with osteochondral substitute grafting. In terms of patient satisfaction, the 2 procedures had no significant differences, and the rate of recurrent instability was also comparable. However, in subgroup analysis of patients with moderate to severe humeral head defects, the WOSI score increased significantly in favor of the remplissage group, although it was not statistically significant.

The rates of recurrent instability were significantly different in the moderate to large humeral head defect subgroups. This difference in recurrence rates between the groups can be accounted for by 2 distinct mechanisms that are specific to remplissage. With remplissage, the Hill-Sachs lesion is filled with biologic tissue, which may be more likely to incorporate and provide biologic fixation. Also, shoulder capsular volume is reduced and the tenodesis of the infraspinatus causes limited excursion, providing more soft tissue tension around the shoulder, which may create both a static and dynamic stabilizing force. Furthermore, synthetic graft may resorb over time, contributing to increased recurrent dislocations of the exposed Hill-Sachs lesion.

Differences in WOSI scores and rates of recurrent instability were more pronounced after controlling for age, sex, and lesion size. The data suggest that remplissage may be superior for patients with moderate to severe humeral head defects. This is particularly true in light of the fact that the scores in the remplissage group were higher despite more patients in this subgroup having large humeral head lesions ($P<.001$). Furthermore, no motion deficits were observed in either group, which is reassuring to surgeons who treat high-level athletic patients.

This study had several limitations. No preoperative data were available for patients in this series, so making firm conclusions about improvement during the study period for each procedure was challenging. The goal of the study was to provide a comparison between 2 current techniques, and the study design and method of data collection were adequate to achieve this goal with a retrospective analysis. Another limitation was the lack of postoperative graft analysis by MRI. This would be useful for academic purposes, but in general, most recent studies place the highest significance on the failure rate and clinical outcome scores rather than postoperative advanced imaging.

In another study, the authors analyzed the degree of incorporation of remplissage by high-resolution MRI and the results were favorable; however, they were unable to image all patients in the current study. Although no true control group existed, the recurrent instability rate of 15% with remplissage compared favorably with that of 31% with osteochondral substitute grafting. In addition, historic results of dislocation rates of isolated Bankart repair with “significant bone defects” range between 20% and 75% in some series.

Providing patients with a safe arthroscopic alternative with a lower failure rate than that seen with isolated Bankart repair is important for surgeons who are counseling patients on treatment options.

Another limitation of this study was that with 19 patients in one group and 20 in the other, the study was only powered to detect large differences on 1-sided tests. However, linear regression showed superiority of remplissage compared with synthetic osteochondral graft transplantation when controlling for confounding factors. This suggests that remplissage in properly selected patients should be considered as a suitable option for large Hill-Sachs lesions in the setting of anterior instability. In addition, the size of the glenoid defects, when present, was not specifically quantified; however, the authors ensured that all patients had glenoid defects less than 20% (evaluated by MRI and confirmed during arthroscopy). To what degree these lesions contributed to the failure rate could not be adequately determined from this study. Finally, the sizes of the Hill-Sachs lesions in this series were indirectly measured in the osteochondral substitute grafting group. Determining the size of the lesion from the amount of surface area that the plugs cover is inaccurate because only enough plugs were used to prevent engagement, which may have underrepresented the true size and nature of the lesion. This may have negatively biased the results in the osteochondral substitute grafting group.

This study also had significant strengths. A single, fellowship-trained orthopedic surgeon with more than 20 years of experience performed all procedures according to the same protocol for the synthetic osteochondral graft transplantation procedure and the remplissage procedure. Patients had a standardized rehabilitation protocol with standardized follow-up. The series comprised consecutive patients who underwent the procedures, thereby minimizing the effects of selection bias on the results.

**Conclusion**

This study demonstrated that recurrent shoulder instability caused by large Hill-Sachs lesions can be successfully treated using relatively less invasive techniques that address humeral defects along with soft tissue repair of the glenoid labrum, potentially avoiding significant morbidity with open surgery. Relative to osteochondral synthetic grafting, remplissage demonstrated a clear advantage in operative time and a trend toward superiority with regard to recurrence rate and functional outcome score at a minimum 2-year follow-up.

**References**


