Christopher J. Wahl, M.D.

Assistant Professor
University of Washington Medical Center
Sports Medicine
www.orthop.washington.edu/faculty/wahl

Jason J. Wilcox, M.D., Michael Hwang, M.D.,
Patrick Cunningham, B.S.,
and Suzanne L. Slaney, P.A.-C, M.S., A.T.C.

Arthroscopic Reconstruction of Engaging Humeral Hill-Sachs Defects Using Cannulated Ostoeoconductive Grafts

- Shoulder instability and shoulder dislocations are among the most commonly occurring and disabling of sports injuries.
- In the majority of cases, traumatic dislocations result not only in a disruption of the stabilizing glenohumeral ligaments, but also an impression/compression defect on the humeral head (termed a *Hill-Sachs defect*).
- When large enough, these volumetric bony defects will cause re-dislocation of the shoulder even after anatomic repair of the ligaments; these are termed *engaging Hill-Sachs defects*.
- Because the region of the defect is hard to access with traditional surgical approaches, previous treatment strategies have centered on open non-anatomical surgical procedures (Latarjet, Eben-Hybinette, etc) that alter the normal shoulder anatomy to try and prevent re-dislocation - these non-anatomic procedures can be complicated by shoulder stiffness and pain.
- Working in the University of Washington Arthroscopy, Research and Training Laboratory (ART-lab), the authors were able to develop a minimally invasive, arthroscopic technique that restores the circumferential surface area of the humeral head by grafting the volumetric bone loss with synthetic bio-conductive plugs.
- We present the short-term clinical results of this novel technique, which appears to restore exceptional range of motion and a return to athletic participation with a minimally invasive, anatomic procedure.

It is generally accepted that most small Hill-Sachs defects and bony Bankart lesions will not significantly alter the results of Bankart reconstruction. However, it has been shown that larger bone defects may result in "engaging" Hill-Sachs defects, which have been associated with a poor result following arthroscopic reconstruction (Figure 1). Some surgeons will attempt to over tension the anterior glenohumeral ligaments to restrict motion to avoid engagement, bone loss can lead to significant motion deficits and such stiffness may predispose to degenerative arthropathy over the long term.

Numerous procedures have been designed to increase the surface area for bony constraint of the glenohumeral joint. These reconstructions are usually performed at the anterior glenoid and include the Eden-Hybinette, Bristow, and Latarjet procedures, among others. Miniaci, Gerber, Kropf and others have described open posterior and anterior approaches to reconstruct bony defects with allografts, and recently Chapovsky described the arthroscopic placement of osteochondral allograft plugs to reconstruct such a defect. Kazel described a percutaneous approach to perform retrograde disimpaction of these defects in a cadaveric model, while Re described a similar retrograde technique using a deltopectoral approach. A minimally invasive arthroscopic approach to repair large Hill-Sachs defects would be ideal, but the visualization and arthroscopic access to these defects can be difficult.

Biologic osteoconductive graft plugs (TruFit BGS Plug, Osteobiologics, Inc. Smith+Nephew, Andover, MA), have been approved and widely for the reconstruction of traumatic bone defects and to 'backfill' cartilage defects after osteoarticular transplant harvests in the knee.

We described a technique that allows excellent visualization and access to the large Hill-Sachs defect that allows placement of pre-cannulated biphasic

Patient	Age-Sex	Dominance /Inj Side	Revision?	Mechanism	Glenoid Loss	Humeral Arc Deficit (mm)	AP Glenoid Width (mm)	HAD/APGW
1	40-M	R/R	N	Diving	N	20.5	25.0	0.82
2	22-M	R/R	N	Football	Y	23.7	25.9	0.91
3	22-M	R/R	N	Wakeboard	N	19.3	27.1	0.71
4	21-M	L/L	N	Skateboard	N	15.0	21.8	0.69
5	17-F	R/R	Y	Basketball	Y	22.1	25.9	0.85
6	22-M	R/L	Y	Basketball	Y	18.1	20.0	0.91
7	38-M	R/R	Y	Waterskiing	Y	16.5	19.4	0.85
8	16-F	R/R	N	Motocross	N	15.6	21.3	0.73
9	25-M	R/R	N	Skydiving	N	14.7	23.2	0.63
10	39-M	R/R	N	MVC	N	18.3	24.1	0.76
Totals/Avg	**26.2**	**89%**	**33%**		**40%**	**18.4**	**23.8**	**0.79**

Table 1: Demographic and pre-operative imaging data on 10 patients who underwent arthroscopic placement of grafts. (HAD, Humeral Articular Arc Deficit-the largest arc of lost surface area ; APGW, Antero-Posterior Glenoid Width-the width of the glenoid socket; HAD/APGW, a circumference ratio-ratios higher than .85 are shoulders in which dislocation is extremely likely without repair of the bone defect).

bone graft substitute plugs into large defects via an all-arthroscopic technique (Figure 2A, 2B). We have performed this technique on ten patients thus far, three of whom presented with recurrent instability after previously failed open and arthroscopic Bankart repairs.

Patients and Methods

From April 2007 to January 2009 ten patients presented to our institution with primary or recurrent instability in the setting of large or massive volumetric bone loss of the postero-superior humeral head (Hill-Sachs lesion). Date on the initial traumatic dislocation, previous surgical procedures and recurrences, and demographic and injury data were available for all patients (Table 1).

Digital MR arthrograms were available for every patient. CT scans were performed in patients who presented to our institution without MRI in whom plain shoulder radiographs demonstrated Hill-Sachs

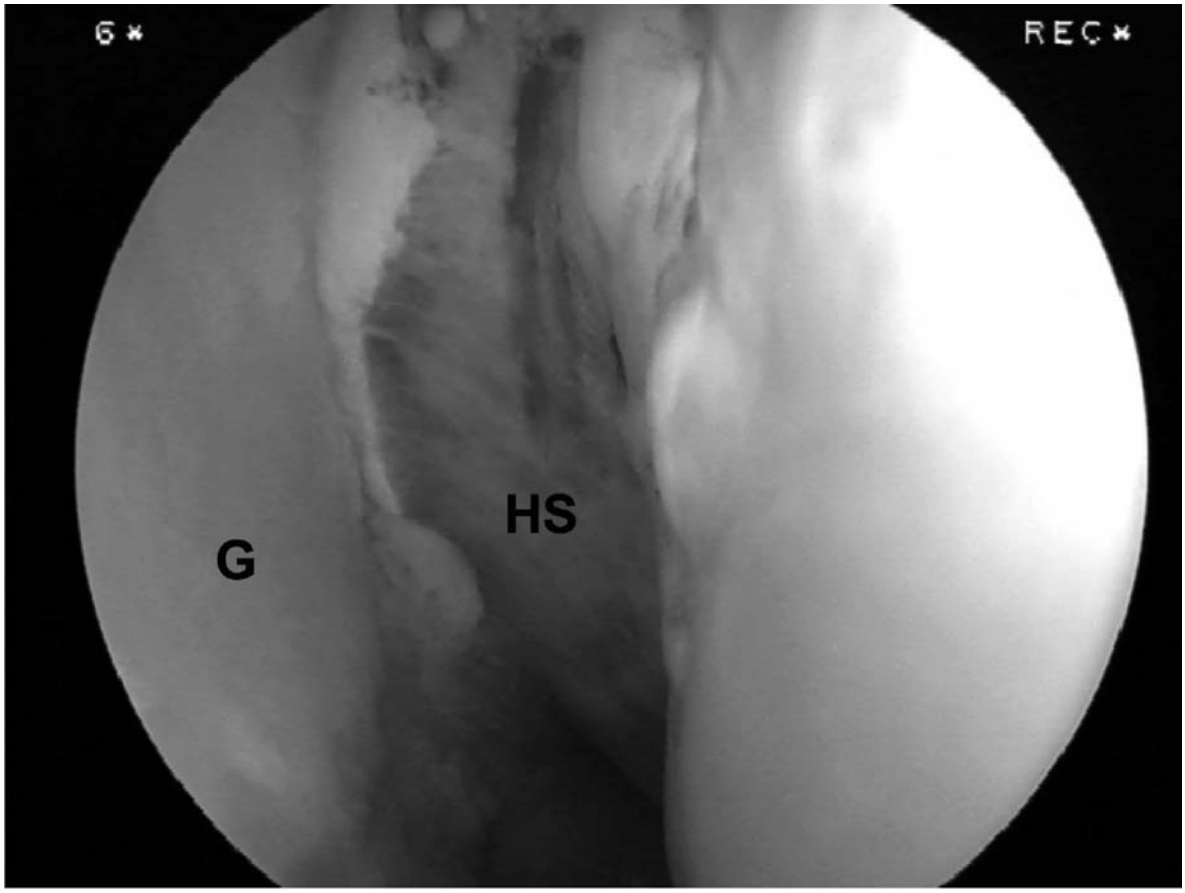

Figure 1: Arthroscopic view of an engaging Hill-Sachs defect from the posterior viewing portal. With external rotation, the Hill-Sachs defect is observed to engage the antero-inferior glenoid rim. (G) Glenoid. (HS) Hill-Sachs defect.

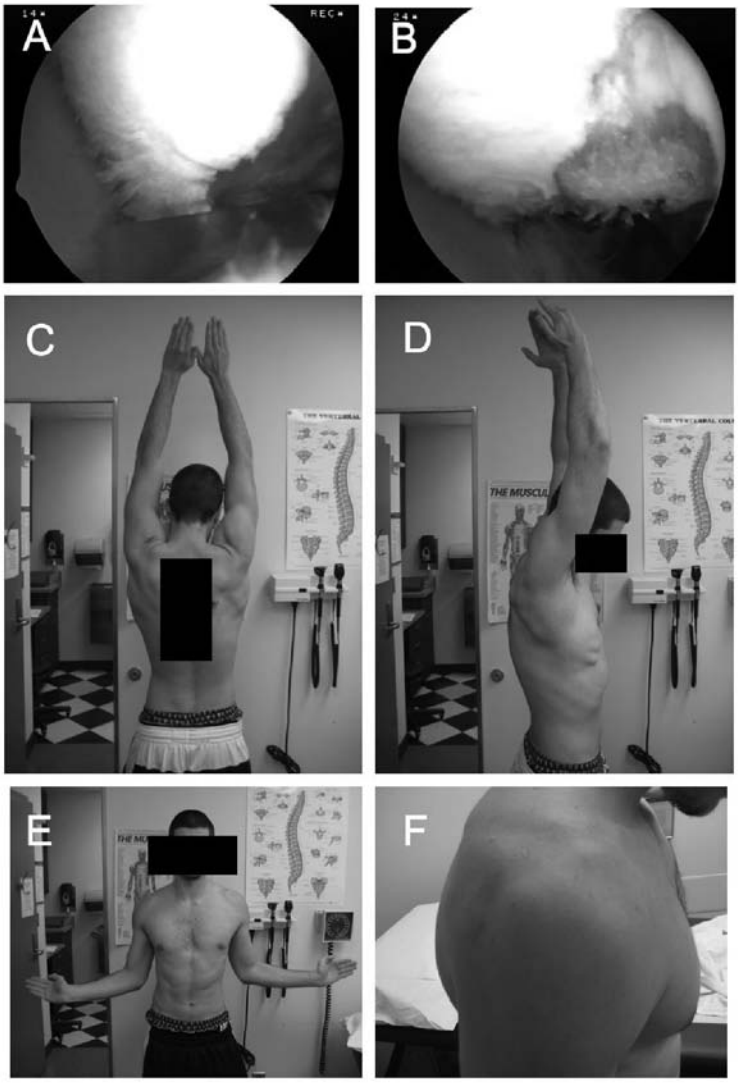

Figure 2: 17-year old male with recurrent right shoulder instability after a failed arthroscopic Bankart repair. A. View of the posterior humeral head from the Neviaser portal. A volumetric Hill-Sachs defect is apparent. B. View of the posterior humeral head after grafting with two cannulated synthetic grafts. C-E. Abduction, forward elevation, and external rotation evaluated 6-months following revision Bankart with arthroscopic placement of grafts. F. Shoulder incisions used for revision reconstruction.

or bony Bankart lesions. Using the electronic media, the size of the defects was measured. Previous cadaveric studies have defined criteria in which a defect is likely to lead to recurrent instability.

All patients underwent a diagnostic arthroscopy, arthroscopic grafting of the Hill-Sachs defect and arthroscopic ligament repair. Clinical results were graded based on range of motion, return to work, and return to athletics as 'excellent', 'good', 'fair', or 'poor'.

Results

The average age at the time of surgery was 26.2 years. The injury involved the dominant hand in 9 of 10 patients. Three of 10 patients (33%) presented after having failed one or more previous stabilization procedures.

On physical examination, clinical signs of instability were uniformly present with positive findings on apprehension, relocation, and surprise tests (all tests positive in all patients). Two patients had clinical evidence ligamentous laxity without multidirectional instability.

Deficits of the anterior glenoid rim were apparent on 4 of 10 patients (40%), three of whom were revision cases. All patients with anterior glenoid bone deficits had significantly reduced contact between the glenoid and humeral surfaces.

The average length of follow-up after surgery in this group is 12.3 months (range, 4-24 mo.) All patients have regained a functional range of motion and 9 of 10 returned to their pre-operative sporting activities. Based on our clinical grading criteria, 8 patients have excellent results, 1 patient has a good result, and one patient re-dislocated while skydiving 6-months after the surgical procedure.

Discussion

Numerous clinical studies of failures after arthroscopic Bankart repair have implicated the presence of engaging bone defects as a potential contributing factor.

Many approaches to addressing engaging bony deficits have been described. The most commonly performed procedures include open, non-anatomic coracoid transfers (Bristow, Latarjet), glenoid autologous or allograft bone grafting procedures (Eden-Hybinette). These non-anatomic approaches do not directly address the Hill-Sachs defect, but rather increase the glenoid articulating surface area and/or potentially alter the normal mechanics of the subscapularis muscle to stabilize the shoulder. Although an arthroscopic Latarjet has been described, most surgeons perform an open approach, which is more invasive and has been associated with permanent weakness of the subscapularis, stiffness, or premature arthrosis.

In our initial treatment of 10 patients, 100% of persons who have been followed more than 6 months were able to return to athletic participation, including contact sports. Thus far, 90% of these patients have stable shoulders and a normal range of motion. It should be noted that the failure rates associated with arthroscopic ligament repair of shoulders without defects is approximately 85-92%.

Conclusion

We believe that an anatomic solution to the anatomic problem of shoulder instability may be the best alternative in terms of preserving a functional range of motion, preserving shoulder joint stability, and avoiding morbidity and the risks of shoulder arthritis. Further follow-up on this patient group will indicate whether

this minimally invasive procedure is superior to current open non-anatomic techniques. In the UW ART-lab, we continue to challenge the status quo in care of athletic injuries in an effort to find less-invasive techniques that will restore normal function with rapid rehabilitation.

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Recommended Reading

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