Technical Note

Arthroscopic Knotless Modified McLaughlin Procedure for Reverse Hill–Sachs Lesions

David L. Bernholt, M.D., Lucca Lacheta, M.D., Brandon T. Goldenberg, B.A., and Peter J. Millett, M.D., M.Sc.

Abstract: Posterior shoulder dislocations often are associated with an impression fracture involving the anterior humeral head known as a reverse Hill–Sachs lesion. These injuries can result in significant bone defects that require surgical management to prevent them from engaging the posterior glenoid. We present a modified arthroscopic, knotless McLaughlin procedure (tenodesis of the subscapularis tendon into the bone defect) for the treatment of small-to medium-sized, engaging Hill–Sachs lesions. The knotless fashion aims to eliminate potential problems associated with knot tying, such as knot migration, knot impingement, and chondral abrasion.

Posterior shoulder dislocations often are associated with an impression fracture involving the anterior humeral head known as a reverse Hill–Sachs lesion.1 Reverse Hill–Sachs lesions may cause significant clinical symptoms and may increase the risk for re-dislocation, progressive joint destruction, and early osteoarthritis.2 Similar to anterior shoulder instability, depending on size and location, reverse Hill–Sachs lesions can present risk for persistent posterior glenohumeral instability if untreated. For small-to medium-sized reverse Hill–Sachs lesions, several surgical open and arthroscopic techniques have been described with filling the bone defect by transferring the subscapularis tendon with or without the lesser tuberosity, resulting in reliable clinical outcome and low re-dislocation rate.3–6 The arthroscopic approach with “tenodesis” of the subscapularis tendon into the bone defect—the so-called McLaughlin procedure—has shown to be advantageous by maintaining the integrity of the subscapularis tendon, a dynamic stabilizer that resists posterior translation.7

This Technical Note describes a modified arthroscopic, knotless McLaughlin procedure for the treatment of small-to medium-sized, engaging Hill–Sachs lesions. The knotless fashion aims to eliminate potential problems associated with knot tying, such as knot migration, knot impingement, and chondral abrasion.8

Surgical Technique (With Video Illustration)

A detailed video of our knotless arthroscopic modified McLaughlin procedure is shown in Video 1. Pearls and pitfalls of this technique and advantages and disadvantages of this technique are described in Tables 1 and 2, respectively.

Patient Positioning and Anesthesia

Beach chair positioning is used for this technique. It is also possible to use the lateral decubitus position, but beach chair positioning is preferred when performing this surgery, as it allows the surgeon to forward flex the patient’s shoulder to relax the anterior deltoid and...
Table 1. Pearls and Pitfalls

| Pearls                                                                 | Pitfalls                                                                 |
|------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Preoperative evaluation should involve a thorough assessment of the    | Arthroscopic portals not in the plane of the glenohumeral joint will      |
| anterior humeral head on 3-dimensional imaging to assess for reverse    | make it difficult to work at the posterior and anterior-most extents      |
| Hill–Sachs lesions in patients presenting with posterior instability,   | of the glenohumeral joint, both of which are necessary in a case of      |
| as this is a common lesion in these patients.                           | posterior instability requiring reverse Bankart repair and reverse        |
|                                                                        | Hill–Sachs remplissage.                                                   |
|                                                                        | Caution must be taken when debriding anterior to the subscapularis       |
|                                                                        | tendon to avoid the axillary nerve at the inferior border of the tendon.  |
| Use of a 70° arthroscope can aid in visualization of the reverse        |                                                                          |
| Hill–Sachs lesion with the camera in the anterior portal.               |                                                                          |
| Diagnostic scope should be comprehensive and all associated posterior  |                                                                          |
| instability lesions should be recognized and treated (e.g. reverse      |                                                                          |
| Bankart, posterior capsular laxity, reverse HAGL, reverse Hill–Sachs). |                                                                          |
| A meticulous debridement of the subcoracoid recess, particularly      |                                                                          |
| anterior to the subscapularis tendon, helps to make suture retrieval    |                                                                          |
| easier.                                                                |                                                                          |
| The number of sutures and suture anchors used for subscapularis        |                                                                          |
| remplissage should be based on size of the lesion.                     |                                                                          |

HAGL, humeral avulsion of the glenohumeral ligament.

provide more working space anteriorly to perform a subscapularis remplissage. Once the patient is upright in the beach chair position, it is important to perform an examination under anesthesia of the affected shoulder as well as the contralateral shoulder for comparison. Anterior and posterior translation should be carefully assessed. The operative extremity, shoulder, and axilla are then prepped and draped using standard sterile technique and the extremity is placed in a mechanical arm holder (e.g. TRIMANO; Arthrex, Naples, FL).

Surgical Approach

A standard posterior portal made approximately 2 cm inferior and 2 cm medial to the posterolateral corner of the acromion, with a spinal needle used to ensure that the trajectory of portal is in the plane of the gleno-humeral joint before incising the skin. Under direct visualization, an anterosuperior portal is first established, just anterior and inferior to the clavicle, entering the joint high in the rotator interval. An anteroinferior portal is then established under direct visualization. Typically, the skin incision for the anteroinferior portal is near the level of the coracoid and the spinal needle should enter just superior to the subscapularis tendon. A 5.0-mm cannula is placed in the anterosuperior portal. A 6.0-mm cannula is placed in the anteroinferior portal, as this size of portal is required to allow for insertion of 4.75-mm SwiveLock suture anchor (Arthrex).

Diagnostic arthroscopy is then be performed, with thorough assessment of the posterior capsulolabral complex as well as the anterior humeral head (Fig 1). To better evaluate these areas, it is important to switch the camera to the anterosuperior portal. This allows examination of the size, depth, and location of the bony injury of the anterior humeral head (Fig 2). With the arthroscope in the anterosuperior portal, a posterior drawer examination should be performed to assess posterior translation of the humeral head relative to the glenoid, and the arm should be internally rotated to allow assessment of whether the reverse Hill–Sachs lesion engages the glenoid rim posteriorly.

Although the focus of this manuscript is on the modified McLaughlin procedure, it is crucial to address all concomitant pathology present, including reverse Bankart lesions, humeral avulsion of the gleno-humeral ligament lesions, or posterior capsular laxity. To facilitate work on the posterior glenoid, we recommend placement of the arthroscope into the anterosuperior portal and creation of an accessory posterolateral portal.

Table 2. Advantages and Disadvantages

| Advantages                                                                 | Disadvantages                                                                 |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Arthroscopic approach limits incision size                                 | Potential to overconstrain humeral head rotation, although this has not been  |
| Not detaching subscapularis tendon or performing lesser tuberosity        | demonstrated clinically                                                       |
| osteotomy can allow for less postoperative restrictions                  | Limited to reverse Hill–Sachs lesions smaller than 33% of humeral head volume |
| Technique removes biomechanically weaker tied knots and increases          |                                                                                |
| surgical efficiency by use of knotless fixation                           |                                                                                |
| Technique uses instrumentation and implants commonly used in shoulder    |                                                                                |
| arthroscopy                                                               |                                                                                |
For this reason, it is important that the anterosuperior portal is made in the plane of the glenohumeral joint. While the accessory posterolateral portal is used for concomitant procedures to address posterior instability, it is not used for the subscapularis remplissage itself.

**Subscapularis Remplissage**

To perform the subscapularis remplissage, the arthroscope is returned to the standard posterior viewing portal. In preparation for subscapularis remplissage, debridement of the rotator interval and subacoracoid space is performed, with particular attention to clearing the space anterior to the subscapularis tendon to facilitate future suture retrieval (Fig 3). Caution must be taken to protect the axillary nerve while creating this space anterior to the subscapularis tendon. After a working space is created, the reverse Hill–Sachs lesion is prepared with a shaver followed by a rasp (Fig 4). These tools are used to create a bleeding bony surface at the base of the anterior bony defect to facilitate healing of the subscapularis tendon to the bone.

To achieve a knotless construct, we first pass our suture through the desired location in the subscapularis tendon. A spinal needle is inserted percutaneously, passing through the space created anterior to the subscapularis and then into the subscapularis tendon medial to its attachment point on the lesser tuberosity, subscapularis tendon to facilitate future suture retrieval (Fig 3). Caution must be taken to protect the axillary nerve while creating this space anterior to the subscapularis tendon. After a working space is created, the reverse Hill–Sachs lesion is prepared with a shaver followed by a rasp (Fig 4). These tools are used to create a bleeding bony surface at the base of the anterior bony defect to facilitate healing of the subscapularis tendon to the bone.

To achieve a knotless construct, we first pass our suture through the desired location in the subscapularis tendon. A spinal needle is inserted percutaneously, passing through the space created anterior to the subscapularis and then into the subscapularis tendon medial to its attachment point on the lesser tuberosity.
and in-line with the area of the reverse Hill–Sachs lesion (Fig 5). A polydioxanone suture is then passed through the spinal needle and retrieved through the anteroinferior portal where the 6-mm cannula had been placed (Fig 6). This polydioxanone suture is then used to shuttle a FiberTape (Arthrex) suture through the subscapularis tendon. The limb of the FiberTape that is exiting the subscapularis tendon anteriorly is then retrieved through the anteroinferior portal using a FiberTape retriever (Arthrex) (Fig 7). This results in both limbs of the FiberTape exiting the anteroinferior portal through the 6-mm cannula to ensure no tissue bridge. The 2 FiberTape limbs are then loaded into a 4.75-mm SwiveLock anchor (Arthrex) in standard fashion, and a clamp is placed on the free ends of the FiberTape sutures to hold the SwiveLock anchor at the ready for insertion. A punch is used to create a hole to receive the SwiveLock anchor, centered in the reverse Hill–Sachs bony lesion (Fig 8). The SwiveLock is then placed into the hole, sutures tensioned to pull the subscapularis tendon into the prepared bony defect, and then the suture anchor is impacted into place.

Fig 5. Left shoulder: Arthroscopic visualization through the posterior portal showing the spinal needle inserted percutaneously, passing through the space created anterior to the subscapularis, and then into the subscapularis tendon medial to its attachment point on the lesser tuberosity and in-line with the area of the reverse Hill–Sachs lesion (yellow arrow). (HH, humeral head; SSC, subscapularis tendon.)

Fig 6. Left shoulder: Arthroscopic visualization through the posterior portal showing the polydioxanone suture passed through the spinal needle and retrieved through the anteroinferior portal, where the 6-mm cannula had been placed. (SSC, subscapularis tendon.)

Fig 7. Left shoulder: Arthroscopic visualization through the posterior portal showing the 2 suture limbs retrieved through the anteroinferior portal (yellow arrow) using a FiberTape retriever through the 6-mm cannula to ensure no tissue bridge. (SSC, subscapularis tendon.)

Fig 8. Left shoulder: Arthroscopic visualization through the posterior portal showing the punch used to create a hole to receive the SwiveLock anchor, centered in the reverse Hill–Sachs bony lesion. (rHS, reverse Hill–Sachs lesion; SSC, subscapularis tendon.)
(Fig 9). Of note, for larger lesions, additional FiberTape sutures can be passed through the subscapularis tendon or a double-row construct can be created with FiberTape inserted into a SwiveLock anchor into the reverse Hill–Sachs lesion and passed transtendinously before being fixed through additional SwiveLock anchor(s) within the defect. After fixation is complete, the sutures are cut flush (Fig 10), and a dynamic arthroscopic examination can be performed to confirm that the reverse Hill–Sachs lesion no longer engages the posterior glenoid rim.

Discussion

In this manuscript, we present a detailed description of a technique for performing an arthroscopic knotless modified McLaughlin procedure that is easily reproducible and can be modified for applicability to reverse Hill–Sachs lesions of a variety of sizes based on the number of FiberTape sutures or anchors used in the construct. The modified McLaughlin procedure can be used as an adjunct procedure in the setting of posterior shoulder instability, that when paired with posterior Bankart repair or posterior capsulorrhaphy, can provide more comprehensive treatment of posterior shoulder instability.

Although posterior shoulder instability is rare in comparison with anterior shoulder instability, reverse Hill–Sachs lesions are quite common in the setting of posterior shoulder dislocation, with a reported incidence of 30% in one systematic review and as high as 86% in one case series. A recent biomechanical study identified size and location risk factors for engagement of these lesions on the posterior glenoid rim with internal rotation and posterior translation forces and suggested the use of the gamma angle, which measures the degree arc from the medial aspect of the reverse Hill–Sachs lesion to the anterior aspect of the bicipital groove, to predict which lesions would engage. Engaging reverse Hill–Sachs lesions are problematic and if unaddressed can result in recurrent shoulder instability.

Reverse Hill–Sachs lesions can be addressed by either anatomic or nonanatomic surgical procedures. Anatomic procedures are those which attempt to restore the anatomic shape of the humeral head and include bone grafting and disimpaction procedures, whereas nonanatomic procedures include rotational osteotomies and the more commonly used transfer/transposition procedures that use transfer of the subscapularis tendon or lesser tuberosity to fill the bony defect. Nonanatomic procedures remain the gold standard for reverse Hill–Sachs lesions smaller than 33% of the humeral head. The first described nonanatomic procedure to address a reverse Hill–Sachs lesion was the McLaughlin procedure, which involved detachment of the subscapularis insertion from the humeral head and suture fixation of the tendon into the reverse Hill–Sachs defect. This procedure was later modified by Hawkins et al., who performed a lesser tuberosity osteotomy, Charalambous et al., who used the subscapularis tendon to fill the void without tendon detachment, and Krackhardt et al., who first introduced an arthroscopic technique. We have previously described an arthroscopic technique for subscapularis remplissage using a 2-suture anchor construct requiring tying of arthroscopic knots, but with the advancement...
of arthroscopic techniques and implants, it is now possible to perform a modified McLaughlin procedure using a knotless technique. Knotless anchors afford the ability of a more efficient surgery and may offer a biomechanically sounder construct, as it eliminates tied knots as a weak point in the construct.

This manuscript is a Technical Note and as such, has a limited scope without comment on clinical results of the described technique. Unfortunately, there is a paucity of reported outcomes on any arthroscopic modified McLaughlin techniques, and further study is needed to better evaluate the clinical efficacy of these procedures.

References

1. Martetschlager F, Padalecki JR, Millett PJ. Modified arthroscopic McLaughlin procedure for treatment of posterior instability of the shoulder with an associated reverse Hill–Sachs lesion. Knee Surg Sports Traumatol Arthrosc 2013;21:1642-1646.

2. Bock P, Kluger R, Hinttermann B. Anatomical reconstruction for reverse Hill–Sachs lesions after posterior locked shoulder dislocation fracture: A case series of six patients. Arch Orthop Trauma Surg 2007;127:543-548.

3. Hawkins RJ, Neer CS 2nd, Pianta RM, Mendoza FX. Locked posterior dislocation of the shoulder. J Bone Joint Surg Am 1987;69:9-18.

4. Demirel M, Erden A, Karademir G, Atalar AC, Demirhan M. Transfer of the lesser tuberosity for reverse Hill–Sachs lesions after neglected posterior dislocations of the shoulder: A retrospective clinical study of 13 cases. Acta Orthop Traumatol Turc 2017;51:362-366.

5. Banerjee M, Balke M, Bouillon B, et al. Excellent results of lesser tuberosity transfer in acute locked posterior shoulder dislocation. Knee Surg Sports Traumatol Arthrosc 2013;21:2884-2888.

6. Kokkalis ZT, Mavrogenis AF, Ballas EG, Papanastasiou J, Papagelopoulos PJ. Modified McLaughlin technique for neglected locked posterior dislocation of the shoulder. Orthopedics 2013;36:e912-e916.

7. Kelly BJ, Field LD. Arthroscopic transfer of the subscapularis tendon for treatment of a reverse Hill–Sachs lesion. Arthrosc Tech 2017;6:e2061-e2064.

8. Leedle BP, Miller MD. Pullout strength of knotless suture anchors. Arthroscopy 2005;21:81-85.

9. Kowalsky MS, Levine WN. Traumatic posterior glenohumeral dislocation: Classification, pathoanatomy, diagnosis, and treatment. Orthop Clin North Am 2008;39:519-533. viii.

10. Rouleau DM, Hebert-Davies J. Incidence of associated injury in posterior shoulder dislocation: Systematic review of the literature. J Orthop Trauma 2012;26:246-251.

11. Sauer N, White LM, Bleakney R, et al. Acute traumatic posterior shoulder dislocation: MR findings. Radiology 2008;248:185-193.

12. Moroder P, Runer A, Kraemer M. Influence of defect size and localization on the engagement of reverse Hill-Sachs lesions. Am J Sports Med 2015;43:542-548.

13. Moroder P, Tauber M, Scheibel M, et al. Defect characteristics of reverse Hill–Sachs lesions. Am J Sports Med 2016;44:708-714.

14. Paul J, Buchmann S, Beitzel K, Solovyova O, Imhoff AB. Posterior shoulder dislocation: Systematic review and treatment algorithm. Arthroscopy 2011;27:1562-1572.

15. Robinson CM, Aderinto J. Posterior shoulder dislocations and fracture-dislocations. J Bone Joint Surg Am 2005;87:639-650.

16. McLaughlin LH. Posterior dislocation of the shoulder. J Bone Joint Surg Am 1952;24:584-590. A.

17. Charalambous CP, Gullet TK, Ravenscroft MJ. A modification of the McLaughlin procedure for persistent posterior shoulder instability: Technical note. Arch Orthop Trauma Surg 2009;129:753-755.

18. Krackhardt T, Schewe B, Albrecht D, Weise K. Arthroscopic fixation of the subscapularis tendon in the reverse Hill–Sachs lesion for traumatic unidirectional posterior dislocation of the shoulder. Arthroscopy 2006;22:e221-e227.