

Arthroscopic Repair of Type II SLAP Lesions in Overhead Athletes



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Abstract: For overhead athletes and, in particular, baseball pitchers, the rates of success and return to play for those who have undergone arthroscopic repair of type II SLAP lesions are poor, ranging from 7% to 62%. The reasons for the poor results and high failure rates in overhead athletes with type II SLAP repairs are multifactorial and are a combination of many factors. These factors include the failure to establish the diagnosis and treat these athletes preoperatively; the inability of the operating surgeon to differentiate normal anatomic variants from pathologic SLAP lesions at the time of surgery; the surgical technique, which may violate the rotator cuff; or the placement of suture anchors, which restricts external rotation and alters overhead throwing mechanics. The proper diagnosis of SLAP lesions can be difficult because SLAP tears rarely occur in isolation and are often associated with other shoulder pathology. A proper history detailing the onset of symptoms and whether there was an acute episode of trauma or a history of repetitive use is critical. It is important to remember that no single physical examination finding is pathognomonic for SLAP tears. When seen in isolation, SLAP tears may mimic impingement syndrome (52%) or even anterior instability (39%). Surgical treatment of type II SLAP lesions should not be undertaken lightly in overhead athletes. If a 3-month rehabilitation period followed by a return to sports over the following 3 months does not allow the athlete to return to his or her preinjury level, diagnostic arthroscopy with SLAP repair is a reasonable option and can yield excellent results using the proper techniques. The technique described in detail in this article and our video can be technically demanding, but with the key points outlined, it can be reproduced and provide excellent results for overhead athletes undergoing SLAP repair. By not violating the rotator cuff, using a mattress configuration and keeping the suture knot away from the articular surface, and by not going anterior to the biceps tendon for repair, external rotation and strength can be preserved, leading to an excellent result with a predictable return to play for overhead athletes.

Superior labral tears anterior to posterior, the so-called SLAP lesions coined by Snyder et al.,¹ are common injuries in overhead athletes. The ability to return to play at an athlete's previous level of competition is a measure of the success of the operation. In

overhead athletes and, in particular, baseball pitchers, the success rates for those who have undergone arthroscopic repair of type II SLAP lesions are poor, ranging from 7% to 62%.²⁻⁹ In a recent systematic review of the literature, only 63% of overhead athletes who underwent type II SLAP repairs were able to return to sports at their previous level of competition.¹⁰ Biceps tenodesis has been proposed as an alternative procedure to SLAP repair for overhead athletes, but the results are even more disappointing, with an overall return-to-play rate of 35% in professional baseball players and only 17% in professional baseball pitchers.¹¹

Why the poor results and high failure rates in overhead athletes with type II SLAP repairs? Is it the failure to establish the diagnosis and treat these athletes preoperatively? Is it the inability of the operating surgeon to differentiate normal anatomic variants from pathologic SLAP lesions? Or is it the surgical technique, which violates the rotator cuff and places simple sutures on the articular surface, or the placement of suture

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received February 6, 2019; accepted March 13, 2019.

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2212-6287/19150

<https://doi.org/10.1016/j.eats.2019.03.013>

Table 1. Proper Indications

Detailed history and physical examination
Proper imaging studies including MRA
No single physical examination finding is pathognomonic for SLAP tears
Adequate course of nonoperative management including rest for 6 wk
Structured physical therapy program for minimum of 6-8 wk
Monitored and structured return to overhead sporting activities after 3 mo overseen by surgeon in conjunction with physical therapist and athletic trainer
MRA, magnetic resonance arthrogram.

anchors, which restricts external rotation and alters overhead throwing mechanics?

Many surgeons including the senior author (W.B.S.) believe that too many overhead athletes are undergoing arthroscopic SLAP repairs. Many athletes can be managed nonoperatively. A magnetic resonance imaging (MRI) scan or magnetic resonance arthrogram (MRA) that shows a SLAP lesion is not an automatic indication for surgery. In our MRI review of U.S. Olympic volleyball athletes, 46% of asymptomatic elite volleyball players had MRI evidence of SLAP tears or fraying but no history or complaints of shoulder problems.¹²

Nonoperative treatment is the mainstay of treatment for overhead athletes with SLAP lesions. In a study by Edwards et al.,¹³ 67% of overhead athletes with MRI diagnoses of SLAP tears were able to return to the same level or a higher level of competition without surgery.

For overhead athletes with SLAP lesions in whom conservative management fails, arthroscopic repair can yield excellent results if certain surgical techniques are used. This article describes—and shows in [Video 1](#)—an arthroscopic technique for a type II SLAP lesion that we believe gives overhead athletes the best chance to return to their previous level of competition.

History and Physical Examination

The proper diagnosis of SLAP lesions can be difficult because SLAP tears rarely occur in isolation and are often associated with other shoulder pathology.^{14,15} A proper history detailing the onset of symptoms and whether there was an acute episode of trauma or a history of repetitive use is critical. It is important to remember that no single physical examination finding is pathognomonic for SLAP tears.¹⁶ Even when seen in isolation, SLAP tears may mimic impingement syndrome (52%) or even anterior instability (39%).¹⁷

Diagnostic Imaging

After routine shoulder radiographs are obtained, including an anteroposterior view of the glenohumeral joint, an axillary view, and a supraspinatus outlet view to rule out any significant bony abnormalities including glenohumeral osteoarthritis, obtaining an MRI scan or MRA is the next step in evaluating the overhead athlete

with shoulder complaints. An MRA is recommended because it increases the sensitivity for detecting superior labral pathology and partial articular-sided rotator cuff tears, which can also be a source of shoulder pain in overhead athletes.¹⁸ However, even if the MRA does show a SLAP lesion, it is not an automatic indication for surgery. MRI or MRA evidence of SLAP tears in competitive volleyball players and baseball pitchers who were asymptomatic proves the point that many of these athletes can be treated nonoperatively.^{12,19}

Nonsurgical Options

Nonsurgical management should be attempted in the vast majority of overhead athletes with diagnoses of SLAP lesions. A period of rest (6 weeks) with a course of nonsteroidal anti-inflammatories followed by a structured physical therapy program emphasizing scapulothoracic mechanics, rotator cuff strengthening, and posterior capsular stretching should be tried in almost all athletes before surgical intervention. At approximately 3 months, a monitored and structured return to overhead sporting activities should be overseen by the surgeon in conjunction with the physical therapist and athletic trainer. If the overhead athlete is unable to return to his or her preinjury level, then surgical intervention is a reasonable option and can yield excellent results using the proper techniques ([Table 1](#)).

Surgical Treatment

Preoperative Planning and Equipment

Preoperative planning is critical to the success of any surgical procedure. Up to date imaging studies including radiographs and MRI or MRA scans should be reviewed before the procedure. The proper equipment ([Table 2](#)) and a skilled assistant are critical to the success of the operation. The surgeon must also be prepared to

Table 2. Proper Equipment

Lateral decubitus positioning device (hip-grip system or beanbag device)
Shoulder suspension device with STARR Sleeve (Arthrex)
4.5-mm 30° arthroscope
5.5-mm × 8.5-cm metal J-lock arthroscopic cannula system (Smith & Nephew/Dyonics)
Two 5.75-mm × 7.0-cm arthroscopic disposable cannulas (Arthrex)
Clear Crystal Cannula
Clear Crystal Cannula with ring at end
2.8-mm nonabsorbable suture anchor (Twin-Fix, Mini-Revo, or Fast-Fix) with single-loaded high-strength suture
Crescent-shaped suture device (ConMed Linvatec)
No. 1 PDS suture—shuttle relay (Ethicon)
4.0-mm full-radius shaver (Smith & Nephew/Dyonics)
4.5-mm round burr (Smith & Nephew/Dyonics)
Shaver system (Smith & Nephew/Dyonics)
Arthroscopic pump (Smith & Nephew/Dyonics) with lactated Ringer solution with no epinephrine

address other pathology in the shoulder joint, including partial or complete rotator cuff tears, other labral tears requiring debridement or repair, and subacromial impingement requiring subacromial decompression. All of these can coexist with superior labral tears, and the surgeon must be ready to address all pathology.¹

Surgical Procedure

Positioning

We prefer the lateral decubitus position for shoulder arthroscopy for many reasons including ease of positioning and the lack of a need for an expensive hydraulic shoulder holder device. Lateral decubitus positioning also allows easier access to the anterior and anterior-inferior aspects of the glenohumeral joint. Finally, it is important to have a trained surgical assistant who is able to assist the primary surgeon in the handling of the arthroscope and surgical instruments.

Operating Room Setup and Anesthesia Considerations

It is up to the operating surgeon to make sure that all equipment needed for the procedure is available including such basic items as a 30° arthroscope, arthroscopic pump (set at 40 mm Hg), shaver, functioning arthroscopic tower, and proper hand instruments. A checklist is essential, and surgeons who may not be familiar with this are encouraged to read *The Checklist Manifesto: How to Get Things Right* by Gawande.²⁰ The entire arthroscopic tower as well as all equipment should be in front of the surgeon, similarly to an airline pilot and his or her control panel, so that it can be easily seen and checked at a moment's notice if anything is not working properly.

General endotracheal anesthesia is preferred to maintain an airway versus a laryngeal mask airway. We also do not recommend an interscalene block because the risks far outweigh the benefits in a procedure such as this; rather, we recommend a suprascapular nerve block, which is safer and administered by the surgeon at the beginning of the procedure. Hypotensive anesthesia (systolic blood pressure $\leq$ 90 mm Hg) is also recommended; this is essential for a clear arthroscopic view and can be used without the risk of cerebral hypoperfusion, which is possible with the patient in the beach-chair position.

Portal Placement

A standard posterior portal is created in the interval between the infraspinatus and teres minor, and the 30° arthroscope is inserted using a 5.5-mm $\times$ 8.5-cm "J-lock" metal cannula system (Smith & Nephew/Dyonics). We prefer this shorter type of cannula over the longer cannula used for knee arthroscopy because we believe it is easier to maneuver within the shoulder joint and gives the surgeon a better feel for the delicate movements needed to maneuver the arthroscope

within the glenohumeral joint. The 5.5-mm cannula also provides adequate inflow through the arthroscope for adequate joint distension, whereas a smaller-diameter cannula (3.5-4.5 mm) may not.

Once the posterior portal has been established and the glenohumeral joint has been entered, the glenoid should be oriented flat and parallel to the floor and the biceps tendon identified. Once the biceps tendon has been identified, an anterior-superior portal is created in the rotator interval between the subscapularis and supraspinatus tendons. The position of this portal is critical to the success of the operation.

The anterior-superior portal can be created in 2 ways, using either an inside-out technique or an outside-in technique. Whichever technique is used, it is critical that the portal be made high in the rotator interval at the anterior leading edge of the supraspinatus tendon. The supraspinatus tendon itself should not be violated because this can damage the rotator cuff and cause postoperative pain and weakness leading to a substandard result. The portal must be created high enough in the rotator interval to allow a proper angle for anchor placement in the superior aspect of the glenoid. If the portal is created too low in the interval, this will not allow the proper angle for anchor placement.

We prefer an inside-out technique in which the arthroscope is driven into the rotator interval, the scope is removed but the cannula remains, a smooth switching stick is inserted from the posterior cannula and tents the skin anteriorly, the skin is incised, a 5.5-mm $\times$ 8.5-cm arthroscopic J cannula (Smith & Nephew/Dyonics) is inserted over the switching stick, the assistant stabilizes the shoulder, the cannula is inserted over the rod, and a pop is felt as the anterior cannula enters the glenohumeral joint. As an alternative method, a spinal needle is placed anteriorly in the rotator interval, ensuring the proper angle at approximately 45° to the superior tubercle under the labrum, and this portal is created using an outside-in technique.

Once the anterior-superior portal has been established, a complete 15-point glenohumeral examination is performed.²¹ The superior labrum is examined as part of the diagnostic arthroscopy with careful attention to differentiate a meniscoid-type superior labrum from a type II SLAP tear (Fig 1). SLAP tears are rarely seen in isolation. All pathology needs to be addressed, and failure to do so may be one of the reasons that good results are not achieved in all patients undergoing SLAP repairs. In particular, partial articular-sided rotator cuff tears present a challenge to the surgeon (Fig 2). These need to be addressed with either debridement (<50% of the tendon involved) or repair (>50% of the tendon involved) either using a PASTA (partial articular supraspinatus tendon avulsion) repair technique,

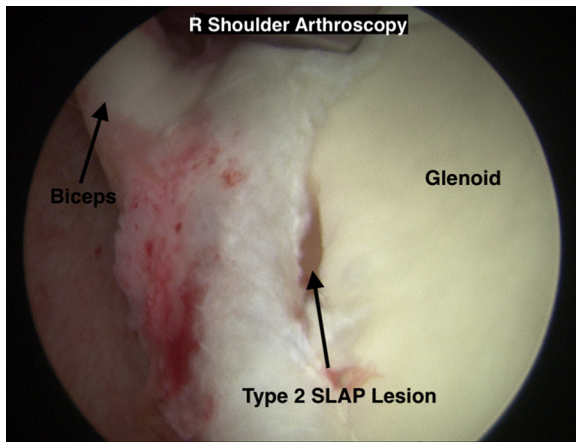


Fig 1. In a right (R) shoulder viewing from the posterior portal and looking anteriorly in the lateral decubitus position, a type II SLAP lesion is shown with detachment of the superior labrum from the superior glenoid.

which is preferred in younger overhead athletes, or completing the tear and repairing it in older athletes.

Differentiating a type II SLAP tear from a meniscoid type of labrum or from a normal sublabral foramen or variant is also critical to the success of the operation. Gobeze et al.²² showed that even among expert shoulder surgeons, interobserver and intraobserver reliability is poor (48%) in differentiating type II SLAP tears from normal variants or degenerative type I SLAP lesions. Arthroscopic repair of a normal variant can lead to loss of external rotation and alter normal throwing mechanics.

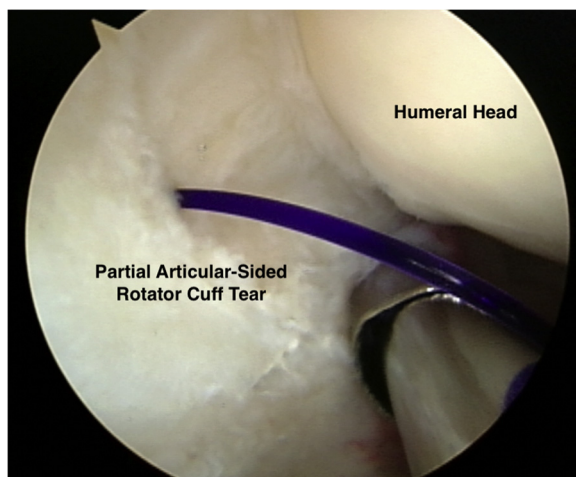


Fig 2. In a right shoulder viewing from the posterior portal and looking anteriorly in the lateral decubitus position, a partial articular-sided tear of the supraspinatus tendon is shown with a blue marker suture placed. This helps identify the area of the tear in the subacromial space. Overhead athletes with partial rotator cuff tears at the time of SLAP repair have a lower rate of return to sports.

Surgical Technique

Once the type II SLAP tear has been identified, surgical repair can be performed using the basic steps described in the following sections.

Step 1: Debridement of Superior Labrum and Glenoid. A clear, smooth 5.75-mm × 7-cm cannula (Smooth Crystal Cannula; Arthrex) is inserted into the anterior-superior portal using a switching-stick technique to maintain portal placement, and the metal arthroscopic J cannula is removed. If no cannula is used, multiple attempts at inserting surgical instruments such as shavers and burrs into the glenohumeral joint can damage the surrounding soft tissues unnecessarily. An arthroscopic 4.0-mm full-radius shaver (Smith & Nephew/Dyonics) is inserted through the anterior-superior portal, and debridement of the superior labrum is delicately performed to a stable rim. The shaver is then used to debride the superior glenoid rim of all soft tissues extending from the biceps anchor posteriorly to the extent of the tear anteriorly.

Step 2: Decortication of Superior Glenoid. A 4.5-mm round burr (Smith & Nephew/Dyonics) is inserted carefully through the anterior-superior portal, with care taken not to damage the articular surfaces of the glenoid or humeral head. The burr is carefully placed between the labrum and the superior glenoid, and decortication of the superior glenoid is performed (Fig 3). Decortication must be carried out to the subchondral bone to generate a bleeding surface, which will enhance healing. Punctate bleeding bone should be seen once the fluid is turned off (Fig 4). This is a critical step because it creates a bleeding surface and access to all the growth factors present

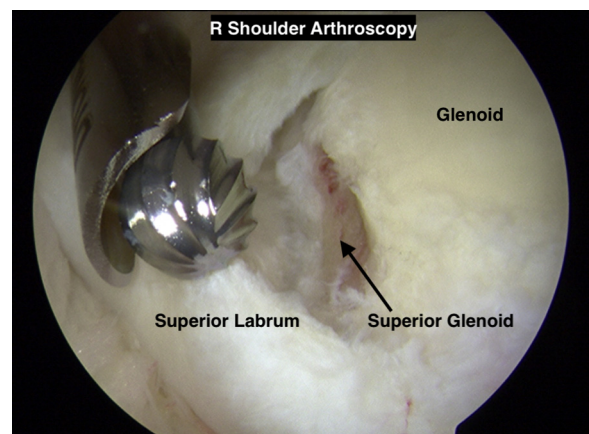


Fig 3. In a right (R) shoulder viewing from the posterior portal and looking anteriorly in the lateral decubitus position, a 4.5-mm round burr is placed through the anterior-superior portal through the rotator interval. Arthroscopic debridement and decortication of the superior glenoid are performed in the area of the type II SLAP lesion.

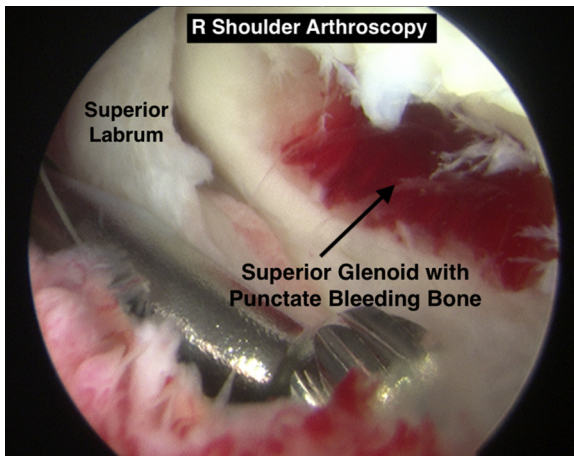


Fig 4. In a right (R) shoulder viewing from the posterior portal and looking anteriorly in the lateral decubitus position, a 4.5-mm round burr is placed through the anterior-superior portal through the rotator interval and decortication of the superior glenoid is performed until punctate bleeding bone is seen at the bone surface.

within the bone marrow, which allows healing. Again, there is no need to go anteriorly beyond the biceps anchor. It is also advised not to debride the articular surface above the superior glenoid to maintain as much of the articular surface as possible.

Step 3: Mid-glenoid Portal Placement. Once adequate decortication of the superior glenoid has been performed, a mid-glenoid portal is established at the leading edge of the subscapularis tendon. This is achieved by an outside-in technique using a spinal needle for localization, followed by cannula placement using a 5.75-mm $\times$ 7.0-mm clear cannula (Clear Crystal Cannula; Arthrex) with a ring at the end. The ring prevents the cannula from “squirting” out

inadvertently during the procedure. This creates “twin” anterior cannulas for anchor placement and suture management (Fig 5).

Step 4: Anchor Placement. Attention is turned to the superior glenoid for anchor placement. To ensure accurate anchor placement in the superior glenoid at approximately the 12-o’clock position, we use a 3-step process. We do not use a drill system or sleeve system because we have found that the drill can “skip” and be less accurate than the 3-step process described by Snyder.²¹ With the cannula in the anterior-superior portal just inferior to the biceps tendon, we first insert a 2.0-mm Mini-Revo punch (ConMed Linvatec) through the anterior-superior portal angled obliquely into the area of decortication of the superior glenoid at approximately the 12-o’clock position. The punch is used to create a pilot hole with gentle tapping with a mallet. To adequately visualize this, the 30° arthroscope, viewing from the posterior portal, is rotated downward to about the 5-o’clock position (right shoulder) to make sure there is bone surrounding the pilot hole (Fig 6). This should not be performed blindly or without adequate visualization of the pilot hole to ensure it does not skive off the bone. This is followed by placement of a 2.5-mm Mini-Revo tap (ConMed Linvatec) into the pilot hole (Fig 7). We use this punch and tap technique because in hard bone seen in younger patients and athletes, the “self-tapping” screws may become too tight in the pilot hole, in which case the driver will strip and the screw will not be fully seated in the superior glenoid, leaving it proud. This can be a very difficult problem to rectify because a proud anchor may cause significant damage to the articular surface of the humeral head. We have encountered this problem on

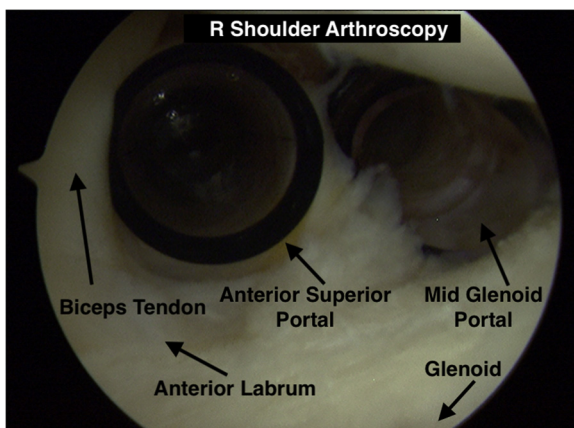


Fig 5. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, twin anterior cannulas are shown, with one superiorly through the rotator interval and the second just superior to the leading edge of the subscapularis tendon.

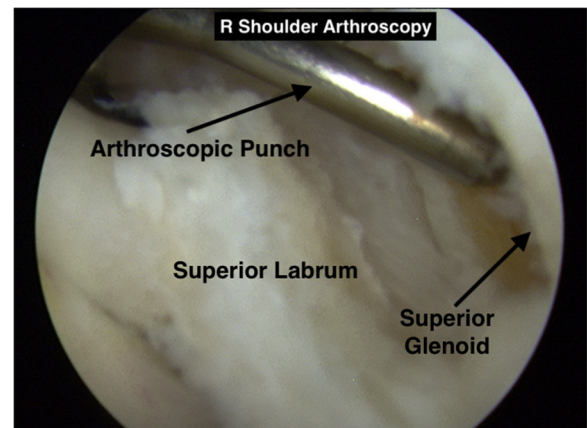


Fig 6. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, an arthroscopic punch (ConMed Linvatec) is placed via the anterior-superior portal to create a pilot hole in the superior glenoid.

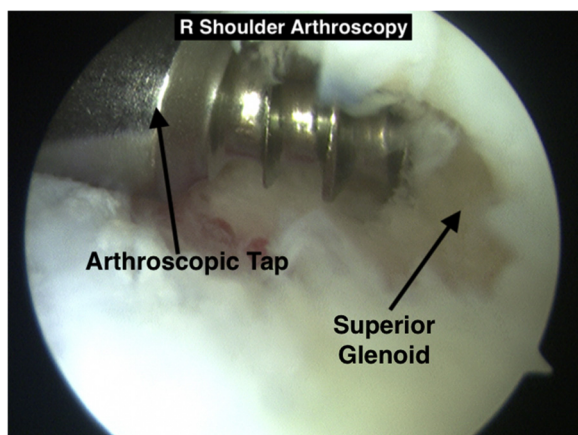


Fig 7. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, an arthroscopic tap (ConMed Linvatec) is placed via the anterior-superior portal into the pilot hole in the superior glenoid.

more than 1 occasion, especially in young patients, and that is why we recommend using the punch and tap technique. Once the tap has been used to create thread holes in the pilot hole, a 2.8-mm metal anchor single loaded with a high-strength suture (Twin Fix, 2.8 mm [Smith & Nephew]; Fast-Fix, 2.8 mm [Arthrex]; or Mini-Revo, 2.8 mm) is inserted via the anterior-superior portal into the superior glenoid. We have abandoned using absorbable types of similar anchors because too many problems associated with them have been reported, including fragmentation, synovitis, and chondrolysis.

It is paramount that the anchor be placed under direct visualization and not blindly, again using the 30° arthroscope rotated to approximately the 3:30–clock face to 5-o’clock position in a right shoulder to see the anchor go into the pilot hole created (Fig 8). Once the anchor is firmly seated into the superior glenoid, the

sutures are loosened from the driver and the driver is gently tapped out to disengage it from the anchor. After this is achieved and the sutures are visible, the driver stays in position and the sutures are then tugged to ensure “anchor security” and to make sure the anchor does not come loose or become proud. If the anchor is not secure and pulls out even a few millimeters, this can damage the articular surface of the humeral head. If the anchor does come somewhat loose, the driver is easily slid back down into the anchor, the anchor is re-engaged, and the driver is used to seat the anchor deeper until it is firmly engaged in the bone and will not come loose.

Step 5: Suture Management. Once the anchor is well seated into the bone, the arthroscope is rotated up to approximately the 1-o’clock position. A crochet hook is placed through the mid-glenoid portal, and 1 limb of the suture is grasped and pulled out through the mid-glenoid portal. We now have 1 suture limb through the mid-glenoid portal and the second limb through the anterior-superior portal (Fig 9).

Step 6: Suture Passage. For suture passage and stitching, we prefer the Spectrum Soft Tissue device (ConMed Linvatec) with the medium-sized crescent attachment. This is a low-profile device with a small handle that is easy to maneuver within the glenohumeral joint and easily fits through a 5.75-mm-diameter cannula. We use a “poor man’s” shuttle relay, a No. 1 PDS suture (Ethicon) loaded into the back of the device, not the front. The anterior-superior portal is maneuvered from inferior to now superior or above the biceps tendon. The Spectrum device is placed through the anterior-superior portal just behind the biceps tendon and just above the superior labrum. With the arthroscope again viewing from the posterior portal, it is rotated approximately

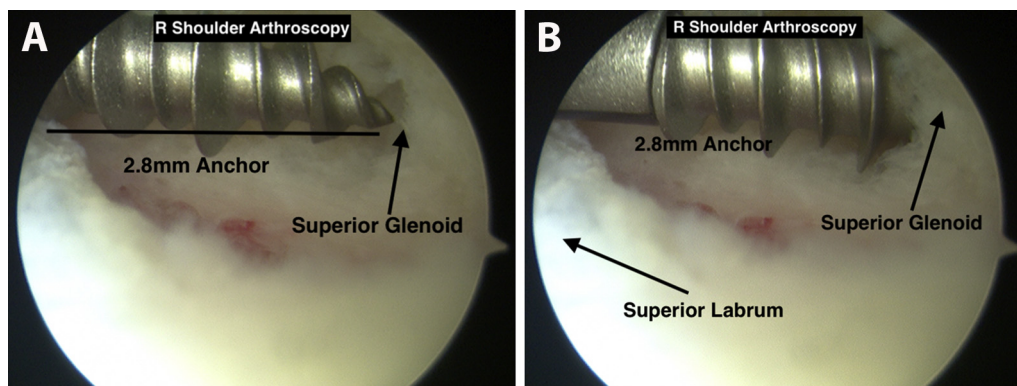


Fig 8. (A) Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a 2.8-mm metal anchor is placed into the superior glenoid pilot hole under direction visualization by rotating the arthroscope to approximately the 3:30–clock face or 4-o’clock position. (B) Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a 2.8-mm metal anchor is placed into the superior glenoid under direction visualization.

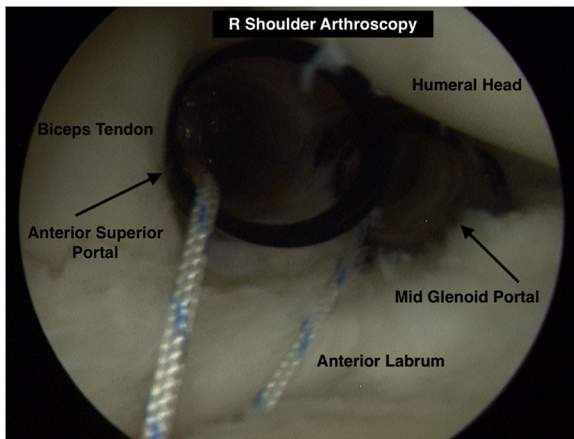


Fig 9. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, 1 suture limb is positioned through the anterior-superior portal cannula and the second limb is positioned through the mid-glenoid portal cannula.

to the 4- or 5-o'clock position for visualization of the superior portion of the superior labrum (Fig 10). The tip of the Spectrum device pierces the superior labrum just posterior to the biceps tendon. It is gently maneuvered through the labrum with careful attention not to scrape the articular surface of the glenoid as the device pierces the labrum (Fig 11).

Once the tip pierces the labrum, the shuttle is deployed and a suture grasper is placed through the mid-glenoid portal; the shuttle is then grasped and pulled out the mid-glenoid portal (Fig 12). Once it is pulled out, a Kelly clamp or snap is used to snap its end to make sure it is not inadvertently pulled out as the Spectrum device is removed carefully from the labrum and pulled out via the anterior-superior portal. All

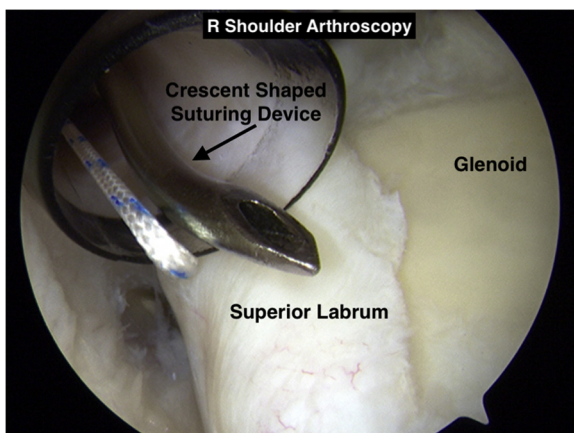


Fig 10. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a crescent-shaped suturing device (Spectrum) is placed through the anterior-superior portal cannula. The cannula is placed superior or behind the biceps tendon and above the superior labrum.

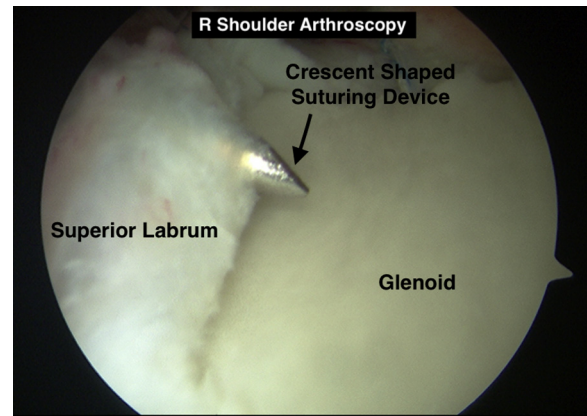


Fig 11. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a crescent-shaped suturing device (Spectrum) is placed via the anterior-superior portal cannula through the superior labrum.

sutures and shuttles should always be snapped once outside the cannulas. The limb of the suture that is in the mid-glenoid portal will then be passed or shuttled through the labrum using the PDS suture as a shuttle relay. Outside the mid-glenoid portal, a "dilator knot" is created near the end of the shuttle relay, which allows smoother passage of the shuttle through the tissue. Just proximal to the dilator knot, another knot is created, the end of the suture is passed through the knot, and the knot is tightened, securing the suture into the shuttle relay. The shuttle relay is then pulled from the anterior-superior portal (with the assistant holding the cannula so that it is not pulled out), and this shuttle will pass the first limb of the suture from the mid-glenoid portal through the superior labrum and out the anterior-superior portal (Fig 13). The crochet hook is placed into the shoulder joint via the mid-glenoid portal, and the other limb of the suture is brought from the anterior-superior portal out the mid-glenoid

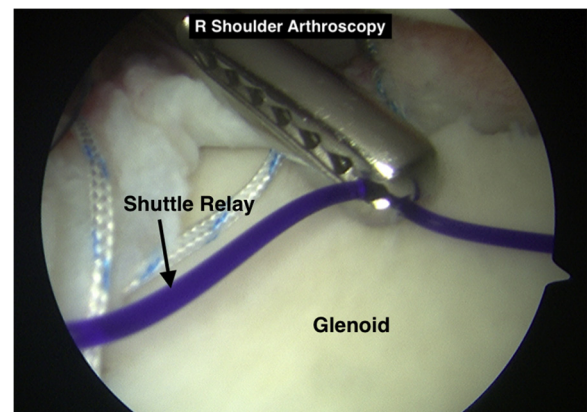


Fig 12. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a grasper via the mid-glenoid portal grasps the shuttle relay and will pull it out the mid-glenoid portal.

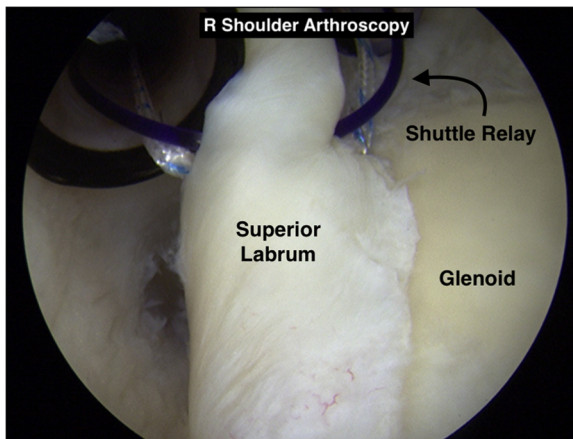


Fig 13. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a PDS suture (Ethibond; Ethicon) (poor man's shuttle relay) is used to pass the first limb of suture loaded from the mid-glenoid portal and is shuttled through the superior labrum from right to left and out the anterior-superior portal cannula.

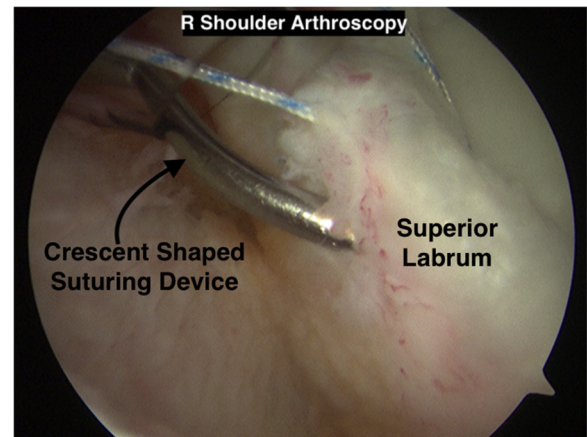


Fig 15. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, 1 limb of the suture has been placed through the superior labrum, exiting superiorly. The suturing device is placed through the anterior-superior portal, and the labrum is pierced approximately 1 cm posterior to the first suture limb.

portal (Fig 14). The process is then repeated with the Spectrum suturing device (ConMed Linvatec) placed through the anterior-superior portal, and the labrum is pierced approximately 1 cm posterior to the first suture limb (Fig 15). The shuttle is deployed, grasped from the mid-glenoid portal, and brought out of the shoulder joint via this portal. The suture is loaded on the shuttle relay and again pulled out via the anterior-superior portal through the labrum (Fig 16), creating a mattress configuration. We prefer a mattress configuration because it does not strangle the labrum, as does a simple knot configuration, and it has been shown to be biomechanically stronger than a simple stitch

configuration (Fig 17).^{23,24} This also places the arthroscopic knot superior to the labrum and away from the articular surface, which avoids postoperative clicking and pain.²⁵

Step 7: Knot Tying. Viewing from the posterior portal, the surgeon ties the sutures using a series of alternating half-hitches or a so-called Revo knot.²¹ We do not use a sliding knot because the sutures can damage the labrum as they slide through the tissue. Moreover, sliding the suture through an anchor can damage the suture. With a mattress configuration, the final knot also lies superior to the labrum off the articular surface, where it will not contact the humeral head or impinge

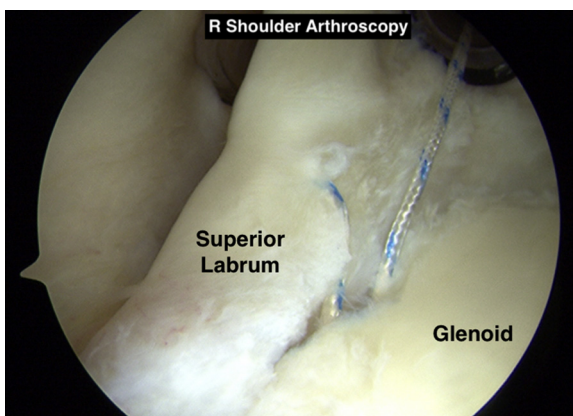


Fig 14. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, 1 limb of the suture has been placed through the superior labrum, exiting superiorly. The second limb of the suture is then grasped from the anterior-superior portal and placed into the mid-glenoid portal cannula before it is sutured through the superior labrum to complete the mattress configuration.

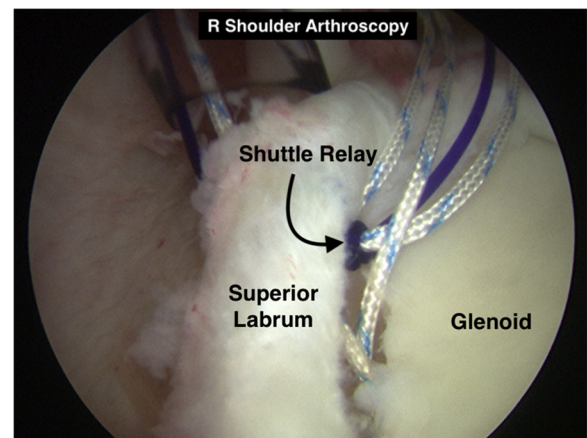


Fig 16. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, the second limb of the suture is shuttled through the superior labrum, exiting superiorly approximately 1 cm posterior to the first suture, and is pulled out through the anterior-superior portal.

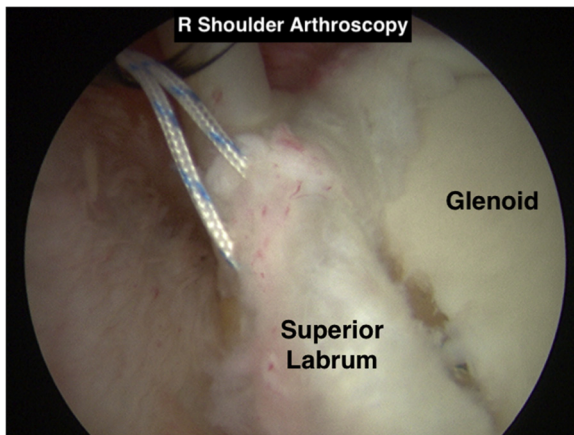


Fig 17. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder, a mattress configuration is created. We prefer a mattress configuration because it does not strangle the labrum, as does a simple knot configuration, and has been shown to be biomechanically stronger than a simple stitch configuration.

between the glenoid and humeral head as it can with a simple suture configuration. The sutures are then cut with an arthroscopic knot cutter leaving a small tail at the end, and the repair is inspected. The arthroscopic knot is posterior to the biceps and not anterior (Fig 18). Placing a knot anterior to the biceps may limit external rotation by capturing the superior glenohumeral ligament (Fig 19).

Discussion

SLAP tears in overhead athletes can be a challenging problem. With a rate of return to the preinjury level of competition of only 63% postsurgically in overhead

athletes, many overhead athletes are reluctant to undergo surgery and for good reason.^{10,26} The return-to-play results in baseball pitchers after surgery are even worse, with reported rates of 7%, 22%, 32%, 38%, 57%, 60%, and 62%.²⁻⁹ The reasons for the high failure rates are most likely multifactorial, including lack of adequate preoperative or conservative management, surgical technique, concomitant pathology, or postoperative rehabilitation.

The delicate balance of the thrower's shoulder—the so-called thrower's paradox described by Wilk et al.,²⁷ with sufficient laxity to allow excessive external rotation and stability provided by the glenohumeral articulation and scapula—can be easily disrupted. An MRI or MRA finding of a SLAP lesion is not uncommon in overhead athletes. We found a 46% rate of superior labral pathology in asymptomatic elite Olympic volleyball players.¹² Nonoperative treatment is the mainstay in overhead athletes, and surgery should be performed only after a long course of conservative management ranging from 3 to 6 months.

At the time of diagnostic arthroscopy, even “expert shoulder surgeons” have poor interobserver and intra-observer reliability, with 48% making the incorrect diagnosis of type II SLAP tears.²² The poor results of arthroscopic SLAP repair may be a failure of not only diagnosis but also repair of normal variants or SLAP tears that are misdiagnosed as normal at the time of surgery.

The arthroscopic technique used may also be able to explain why some authors report such poor results. Using the trans-rotator cuff portal with cannula placement—the so-called port of Wilmington—can damage the musculotendinous portion of the supraspinatus tendon and may explain the poor results. Using the

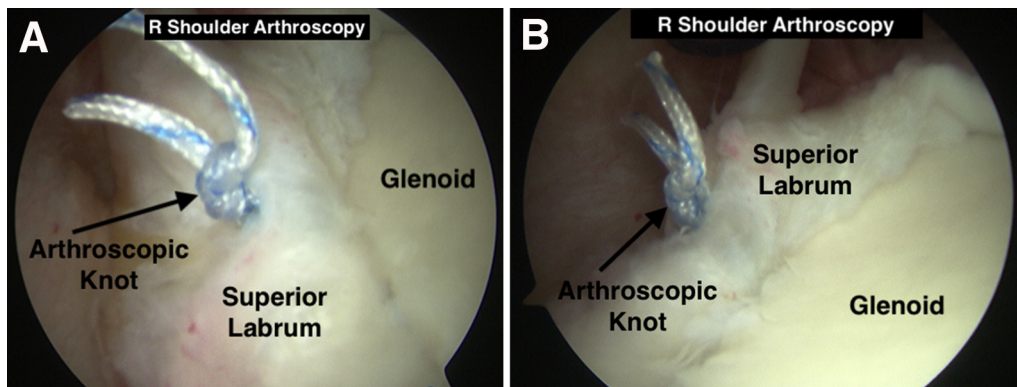


Fig 18. (A) Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder with the arthroscope at approximately the 5-o'clock position, the final mattress configuration repair is inspected. This places the arthroscopic knot superior to the labrum and away from the articular surface, which avoids postoperative clicking and pain. (B) Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right (R) shoulder with the arthroscope at approximately the 8-o'clock position, the final mattress configuration repair is again inspected. The arthroscopic knot is posterior to the biceps and not anterior. Placing a knot anterior to the biceps may limit external rotation by capturing the superior glenohumeral ligament.

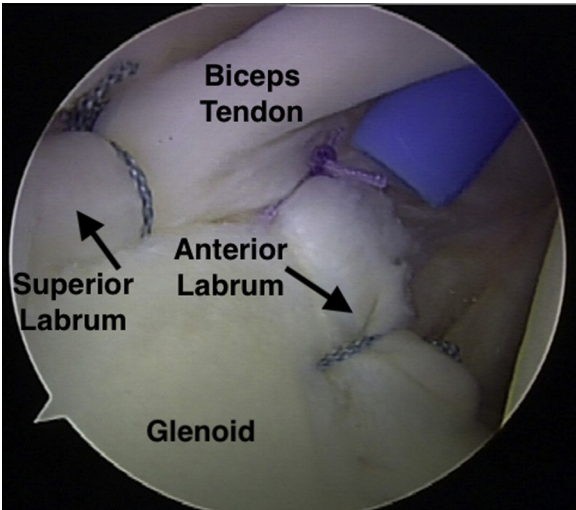


Fig 19. Intraoperative image from a patient who underwent repair with a simple knot configuration. Viewing from the posterior portal and looking anteriorly in the lateral decubitus position in a right shoulder with the arthroscope at approximately the 8-o’clock position, the simple knot configuration repair is shown. We do not recommend this configuration because the suture can catch on the humeral head and cause mechanical symptoms. Two more anchors and sutures have been placed anterior to the biceps tendon. Placement of these knots anterior to the biceps may limit external rotation by capturing the superior glenohumeral ligament and is not recommended, especially in overhead athletes because it can limit external rotation.

trans-rotator cuff portal, O’Brien et al.²⁸ reported a 44% return-to-sport rate and Cohen et al.⁸ reported a 38% rate whereas Neri et al.⁶ reported a 13% rate. We do not recommend this technique but rather prefer our technique using a single anchor placed via a cannula through the rotator interval.

Table 3. Risks and/or Limitations of Procedure

Without a well-trained surgical assistant to hold the arthroscope in the correct position and to assist the surgeon, the described technique is technically challenging to reproduce.
The surgeon should always be prepared to address other shoulder pathology including significant partial articular-sided rotator cuff tears, which may need to be surgically prepared by completing the tear vs performed a transtendinous repair.
The technique uses a punch followed by a tap before anchor placement. This requires 2 extra steps but allows proper anchor placement, especially in younger patients with hard bone stock. If these steps are skipped, one runs the risk of the anchor driver stripping and the anchor becoming not fully seated in the superior glenoid.
If the anterior-superior or rotator interval portal is too low, anchor placement is difficult, if not impossible, so the portal should be placed high in the rotator interval.
A meniscoid superior labrum is a normal variant and should not be repaired. The ability to differentiate normal anatomy from pathology is key when addressing superior labral pathology.

Correct anchor placement for SLAP repairs is critical. Anchor placement anterior to the biceps tendon (Fig 19) can entrap the superior glenohumeral ligament and middle glenohumeral ligament causing an inadvertent small but statistically significant loss of external rotation.^{29,30} A biomechanical study of the peel-back mechanism of failure has shown no advantage to the placement of an anterior anchor.³¹

Kartus et al.³² reported that an anterior suture anchor led to a loss of external rotation in the patients they reviewed. Indeed, most patients with failed SLAP repairs complain of not only pain but loss of motion.³³ Chalmers et al.¹¹ detected a trend toward a decrease in maximal external rotation in pitchers after SLAP repair compared with normal controls.

Another small but important detail of the arthroscopic technique for type II SLAP repairs is a mattress configuration versus a simple stitch. It has been shown that a horizontal mattress suture configuration, which we recommend, better re-creates the normal superior labral anatomy.^{23,24} In addition, the use of a mattress suture with a single anchor has been shown to be biomechanically superior to the use of simple sutures with either 1 or 2 anchors.³⁴

Moreover, the mattress configuration, which places the knot superior to the glenoid and away from the articular surface, can prevent postoperative pain and mechanical-like symptoms in the thrower’s shoulder. Arthroscopically tied knots can be bulky and cause irritation, even in procedures performed by experienced surgeons.³⁵⁻³⁷ Park et al.²⁵ retrospectively studied 11 patients with failed type II SLAP repairs, all of

Table 4. Key Points for Arthroscopic Repair

The anterior-superior portal should be placed high enough in the rotator interval to allow placement of an anchor in the superior glenoid.
The second anterior portal at the leading edge of the subscapularis tendon should be created using an outside-in technique.
Decortication of the superior glenoid surface should be performed with a 4.0-mm burr to create a bleeding surface with punctate bleeding bone.
The supraspinatus tendon should never be violated with a cannula because this can lead to residual pain and weakness in the postoperative period.
An anchor should never be placed anterior to the biceps tendon because this can capture the superior glenohumeral ligament and middle glenohumeral ligament, leading to loss of external rotation as well as tethering of the biceps tendon.
A single anchor centered at approximately the 12-o’clock position of the glenoid with a single high-strength suture is almost always adequate for repair.
Use of the port of Wilmington is rarely necessary for anchor placement. If this portal is used, a cannula should not be used because this can substantially damage the rotator cuff tendon.
A mattress stitch with the knot tied behind the labrum should always be used.
A half-hitch knot, not a sliding knot, should always be used because a sliding knot can damage the labrum.

whom complained of pain and 64% of whom complained of clicking. The knot was positioned on the glenoid side in 5 patients, and all had associated humeral head cartilage damage. After arthroscopic knot removal, all patients had significant and dramatic pain relief and improved clinical outcomes.

Electromyography and motion analysis of baseball pitchers who underwent SLAP repairs showed significantly altered patterns of mechanics, including altered thoracic rotation, a decrease in maximal external rotation, and less horizontal abduction, which led to a decrease in pitching velocity.^{11,38} SLAP repair may alter pitching biomechanics, resulting in permanent alterations in the thrower's mechanics, preventing pitchers from regaining command and velocity.¹¹

Associated shoulder pathology may be another reason SLAP repairs fare so poorly. Baseball pitchers with partial rotator cuff tears at the time of SLAP repair have shown a lower rate of return to baseball. Neri et al.⁶ reported that only 13% were able to return to baseball, whereas Brockmeier et al.³⁰ reported that 64% were able to return.

Arthroscopic biceps tenodesis has been proposed as an alternative to SLAP repair by many authors, with variable results.³⁹⁻⁴² Chalmers et al.¹¹ recently reported their results using biceps tenodesis as an alternative to SLAP repair in baseball players; the overall rate of players able to return to their prior level of play was only 35%, with only 17% of pitchers able to return to their prior level of play.

The risks and/or limitations of the described technique are outlined in Table 3. First and foremost, without a well-trained surgical assistant to hold the arthroscope in the correct position and to assist the surgeon, this technique is technically challenging to reproduce. In addition, one must be prepared to address other shoulder pathology including significant partial articular-sided rotator cuff tears, which may need to be surgically prepared by completing the tear versus performing a transtendinous repair. The described technique uses a punch followed by a tap before anchor placement. This requires 2 extra steps but allows proper anchor placement, especially in younger patients with hard bone stock. If these steps are skipped, one runs the risk of the anchor driver "stripping" and the anchor becoming not fully seated in the superior glenoid. Attention to proper portal placement is key: If the anterior-superior or rotator interval portal is too low, anchor placement is difficult, if not impossible, so the portal should be placed high in the rotator interval. Finally, a "meniscoid" superior labrum is a normal variant and should not be repaired. The ability to differentiate normal anatomy from pathology is critical when addressing superior labral pathology.

The technique described in detail in this article and in Video 1 can be technically demanding, but with the key

points outlined in Table 4, it can be reproduced and provide excellent results for overhead athletes undergoing SLAP repair. By not violating the rotator cuff, using a mattress type of stitch configuration, and by not going anterior to the biceps tendon for repair, external rotation and strength can be preserved, leading to an excellent result with a predictable return to play for overhead athletes.

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