Superior Labral Lesions in the Shoulder: Pathoanatomy and Surgical Management

Robert A. Mileski, MD, and Stephen J. Snyder, MD

Abstract

Progress in shoulder arthroscopy has led to the identification of previously undiagnosed lesions involving the superior labrum and the biceps tendon anchor. Additional research has substantiated the role of the long head of the biceps tendon in anterior and rotational glenohumeral stability. Careful attention to the history and physical examination and directed diagnostic imaging may arouse suspicion of injury to the biceps tendon and the superior labral complex. Identification of injuries to the superior labrum extending from anterior to posterior, or "SLAP" injuries, can be made with diagnostic glenohumeral arthroscopy. Appropriate treatment can then be based on the type of lesion encountered (generally, debridement of most type I and III lesions and repair of type II and many type IV lesions).

J Am Acad Orthop Surg 1998;6:121-131

The advent and increased use of shoulder arthroscopy has facilitated the diagnosis of intra-articular lesions previously unrecognized with standard open surgical procedures. One such entity involves tearing of the superior labrum near the insertion of the long head of the biceps tendon. Andrews et al[1] described tears of the glenoid labrum in 73 overhead-throwing athletes, with most tears located over the anterosuperior glenoid labrum. Later, Snyder et al[2] described a pattern of injury to the superior glenoid labrum beginning posteriorly and extending anteriorly and introduced the term "SLAP lesion." The resultant lesions, although uncommon, can often be a source of considerable disability and pain. In this review, we will describe the anatomy, functional importance, diagnosis, classification, and treatment of these shoulder lesions.

Anatomy

Histologically, the glenoid labrum is composed of fibrocartilaginous tissue distinct from the adjacent hyaline articular cartilage of the glenoid and the fibrous tissue of the joint capsule.[3] Frequently, there is a fibrocartilaginous transition zone from the hyaline glenoid articular cartilage to the fibrous labral tissue.[4] There may be short, delicate elastin fibers sparsely distributed in the fibrocartilaginous matrix.[3] With aging, there is loss of chondrocytes in the labrum.[3]

The inferior labrum is typically seen as a rounded fibrous structure that is continuous with the articular cartilage. The superior labrum may be more meniscal in nature and attach loosely to the underlying glenoid. The anterosuperior labrum frequently extends into the middle glenohumeral ligament or the inferior glenohumeral ligament rather than inserting into the glenoid margin.[4] This must be appreciated as a normal variant.

The vascular supply of the glenoid labrum arises from branches of the suprascapular, circumflex scapular, and posterior circumflex humeral arteries. The labrum receives its blood supply from capsular or periosteal vessels and not from the underlying bone.[4] Vessels are typically more numerous peripherally than centrally, although vessels do penetrate the labrum in a radial and circumferential fashion.[3,4] Vascularity is decreased in the anterior, anterosuperior, and superior parts of the labrum. Vascular penetration is only to the peripheral attachment of the labrum

Dr. Mileski is Attending Surgeon, Phoenix Orthopedic Group, Phoenix, Ariz. Dr. Snyder is Attending Surgeon, Southern California Orthopedic Institute, Van Nuys, Calif.

Reprint requests: Dr. Snyder, Southern California Orthopedic Institute, 6815 Noble Avenue, Van Nuys, CA 91405.

The authors or the departments with which they are affiliated have received something of value from a commercial or other party related directly or indirectly to the subject of this article.

in the anterosuperior region, as well as in other regions that have a meniscal configuration.[4] Vascularity decreases with increasing age.[3]

At the 12-o'clock position, the supraglenoid tubercle is approximately 5 mm medial to the superior rim of the glenoid, and there is a synovial reflection between the biceps tendon and the superior aspect of the glenoid labrum.[5] The long head of the biceps tendon arises from both the supraglenoid tubercle and the superior glenoid labrum. It is quite common for a portion of the biceps tendon to be attached to the glenoid labrum, with only a small part of the tendon attached to the supraglenoid tubercle.[6] Additionally, the biceps attachment usually extends the posterior glenoid labrum.[5]

Functional Importance

The long head of the biceps tendon is generally regarded as a humeral-head depressor. Recent studies also suggest its role in anterior stability of the glenohumeral joint. In one study,[7] the long head of the biceps and the short head of the biceps were replaced by spring devices, and translation tests in 90 degrees of abduction were performed by applying a 1.5-kg anterior force. Various loads from 0 to 3 kg were applied to the tendons with the shoulder rotated from 60 to 120 degrees externally. With the glenohumeral joint capsule intact and the shoulder externally rotated 60 or 90 degrees, application of a 3-kg load to the long head of the biceps tendon decreased the amount of humeral head translation recorded in response to a 1.5-kg anterior force as compared with when no load was applied to the long head of the biceps tendon. The effect of biceps-tendon loading on anterior humeral head displacement was even more dramatic after creation of a Bankart lesion.

The stabilizing function of the biceps is also supported by a study by Rodosky et al.[8] Utilizing a dynamic cadaveric shoulder model and simulated forces of the rotator cuff and the long head of the biceps muscles, the authors determined the effect a superior labral lesion had on stability of the glenohumeral joint in the abducted and externally rotated position. In the normal shoulder, the addition of a force equal to 100% of the force of the long head of the biceps muscle increased the ability of the shoulder to withstand excessive rotational forces by 32%. Torsional rigidity (the ability to withstand excessive rotational forces) in normal shoulders was 11% to 19% greater than in those with an experimentally created superior labral lesion involving subperiosteal stripping of the superior labrum and the long head of the biceps tendon from the 10-o'clock to the 2-o'clock position on the glenoid. In effect, in the abducted and externally rotated position, the long head of the biceps muscle has the ability to help limit external rotation at the glenohumeral joint. The presence of a SLAP lesion decreases this restraint. Additionally, the authors found that the creation of a SLAP lesion resulted in a 102% to 120% increase in the amount of strain recorded in the anterior superior band of the inferior glenohumeral ligament. Thus, in the presence of a superior labral lesion, similar to a type II SLAP lesion (as described in the "Classification" section), the glenohumeral joint is less able to withstand external rotation forces in the abducted and externally rotated position. Furthermore, the lack of an intact superior labrum results in greater stress demand on the inferior glenohumeral ligament, which could theoretically lead to damage to the inferior glenohumeral ligament and subsequent anterior instability.

Diagnosis

Owing to the overlap of symptoms among patients with SLAP lesions of the shoulder and patients with glenohumeral instability and rotator cuff disorders, the diagnosis of a SLAP lesion is quite difficult. Although the quality of imaging studies is improving, the technology is not yet far enough advanced to make a confirmatory diagnosis in many cases. Currently, the definitive diagnosis can be made only with diagnostic arthroscopy. Nonetheless, important information can be gleaned from a careful history and physical examination and appropriate imaging studies.

History

The two most common mechanisms of injury in patients who ultimately prove to have SLAP lesions are traction and compression. Traction injuries can occur in several ways[9] (e.g., a sudden pull in an inferior direction when one loses hold of a heavy object; in an anterior direction, as can occur when waterskiing; or in an upward direction, as when an individual attempts to grab an overhead object in an attempt to save himself from a fall from a height). Traction injuries can also occur after throwing or in other sports involving overhead motion or in the form of an overt glenohumeral dislocation. Compression injuries are also common and are frequently the result of a fall onto an outstretched arm positioned in slight forward flexion and abduction.[2] A direct blow to the shoulder was found to be the cause of injury in up to 17% of patients with isolated SLAP lesions and no other associated pathologic condition in our recent series.[10] It is important to note, however, that many patients will not have a history of trauma; an insidious onset of shoulder pain has been seen in as many as 33% of patients who ultimately prove to have SLAP lesions of the shoulder.[11]

The two most common complaints of individuals presenting with SLAP lesions are pain, typically with overhead activities, and mechanical symptoms of catching, locking, popping, or grinding.[2,9-14] Often, the pain is indistinguishable from impingement-type pain. Other complaints include pain while lying on the shoulder,[11] decreased range of motion,[14] pain with activities of daily living,[14] loss of strength,[9] and symptoms compatible with a "dead arm" syndrome.[11]

Physical Examination

There is no physical finding specific for SLAP lesions of the shoulder. The compression-rotation test (pain with internal or external rotation of the humerus with the patient in the lateral position and the arm in 90 degrees of abduction) may be positive.[13] The biceps tension test (pain with resisted shoulder flexion with the elbow extended and the forearm supinated) may also be positive.[10-13] Patients frequently have a positive Neer sign (pain with passive forward elevation of the arm) and a positive Hawkins sign (pain with passive internal rotation of the arm, forward-flexed to 90 degrees), which may lead the examiner to erroneously ascribe the patient's symptoms to rotator cuff pathology.

Further complicating diagnosis is the fact that partial and complete rotator cuff tears are frequently associated lesions in patients with SLAP injuries.[2,9,11-14] Crepitation on physical examination occurred in as many as 43% of patients with isolated SLAP lesions in our series.[10] Patients may also have a positive apprehension test. Pain in abduction and external rotation may arise from traction on the torn labrum, rather than being due to "true" instability; in our study,[10] 39% of patients had a positive apprehension test, yet only 4% had a positive apprehension suppression test (posteriorly directed force on the humeral head in the abducted and externally rotated shoulder with subsequent relief of pain). Other physical findings that are occasionally positive in patients with SLAP lesions include pain with resisted supraspinatus strength testing,[10,11] pain with resisted external rotation,[10] pain with cross-body adduction,[11] local tenderness,[9] a positive Yergeson sign,[11] and anterior, posterior, and inferior shoulder instability.[9] Because of these associations, the interpretation of these physical signs is frequently challenging. In our study of 23 patients who proved to have isolated SLAP lesions, the most common physical findings were pain with the Neer maneuver (52%), audible popping or snapping on shoulder motion (43%), and pain with the anterior apprehension provocative position (39%).[10] Pain was also encountered with the Hawkins test, with resisted supraspinatus strength testing, and with the biceps tension test in 35% of patients.[10]

Diagnostic Imaging

Conventional radiographs (anteroposterior, supraspinatus outlet, and axillary views) of the shoulder are recommended for the initial evaluation of patients with shoulder complaints, but they will not help disclose any possible intra-articular labral disorders. Additional studies to consider include computed tomographic (CT) arthrography, magnetic resonance (MR) imaging, and MR arthrography.

While CT arthrography is better for detecting bone abnormalities than soft-tissue abnormalities, MR imaging is superior for diagnosing labral lesions.[15] In addition to its superior soft-tissue imaging capabilities, MR imaging offers better resolution with the use of surface coils, as well as multiplanar imaging capability, which makes it ideal for evaluating not only the labrum but also the rotator cuff in patients with shoulder pain of uncertain origin.[16]

In an effort to improve the accuracy of MR imaging of partial rotator cuff tears and labral injuries, MR arthrography has gained more widespread use. The introduction of fluid into the glenohumeral joint increases contrast differences between the soft-tissue structures of the glenohumeral joint. Saline or iodinated contrast agents brighten only on T2-weighted images, which have longer imaging times, resulting in a less ideal signal-to-noise ratio and less clear images.[17] Gadopentetate dimeglumine (Magnevist; Berlex Laboratories, Wayne, NJ) is a highly magnetic contrast agent. This particular agent allows the use of a short T1 imaging time, which gives an excellent signal-to-noise ratio and ultimately excellent spatial resolution.[17] Although approved by the Food and Drug Administration for intravenous injection, it is not currently approved for intra-articular injection. The doses used are typically quite small compared with doses used in conventional intravenous techniques; to date, there has been no evidence of accumulation in the cartilage and synovium of rabbit knees, and there have been no ill effects reported with its intra-articular use in humans. When used in diluted form, the cost approaches that of sterile saline.[16] It is most useful when the results of standard MR imaging are unclear.[16]

Our current protocol involves the use of proton-density and T2-weighted images obtained in an oblique coronal plane along the long axis of the supraspinatus tendon, oblique sagittal images obtained perpendicular to the long axis of the supraspinatus, and axial images obtained perpendicular to the long axis of the humerus, with the palm and hand rotated and placed under the patient's thigh. If a labral lesion is suspected but not detected with this sequence, MR arthrography is recommended, and informed consent is requested. This is done at our institution under institutional review board approval. Under fluoroscopic control, 12 to 20 mL of diluted gadopentetate meglumine (1 mL per 200 mL of sterile saline) is injected into the glenohumeral joint, and additional images in coronal oblique planes are then obtained the same day.

Findings that may indicate a labral or superior labral lesion include high signal intensity in the labrum-biceps anchor, high signal intensity between the superior glenoid labrum and the superior portion of the glenoid fossa, deformity, either inferior or anterior and medial displacement of the labrum, or the presence of a glenoid labral cyst.[18] In a study of 20 patients with cystic-appearing masses adjacent to the labrum on MR examination, all nine cysts in superior locations were found to be associated with a superior labral tear or SLAP lesion at the time of diagnostic arthroscopy. All cysts that extended into both the suprascapular and the spinoglenoid notch were associated with SLAP lesions as well. Many patients with cysts who were ultimately found to have an associated labral tear also had concomitant shoulder instability.[18] Therefore, if a glenohumeral cyst is noted on an MR examination, there should be a high index of suspicion for an underlying labral lesion and potential shoulder instability.

In the study by Chandnani et al,[15] the sensitivity of MR arthrography for detecting a labral tear was 96% and that for labral detachment was also 96%, compared with 93% and 46%, respectively, for standard MR imaging. Unfortunately, specificities were not reported in that study, and the problem of false-positive results still exists. Because of this, diagnostic glenohumeral arthroscopy remains the only definitive way to diagnose SLAP lesions of the shoulder.

Diagnostic Arthroscopy

In a patient with mechanical symptoms of catching or locking, particularly if there is a history of a traction or compression injury or a direct blow to the shoulder, the clinician should have a high index of suspicion for an underlying SLAP lesion. The surgeon should recognize that patients with SLAP lesions may present with signs and symptoms that are suggestive of rotator cuff lesions or shoulder instability. One must also recognize that the superior labrum–biceps tendon complex does indeed play a role in shoulder stability. Although MR arthrography may provide useful information in evaluating the glenohumeral joint as well as the superior labrum–biceps tendon complex, the diagnosis must ultimately be made with diagnostic arthroscopy.

Because of the difficulty in diagnosing SLAP lesions, patients often wait a considerable time before coming to diagnostic arthroscopy. This has ranged from 10 months to 29 months in numerous studies reported to date.[1,2,9-14] While there is no "ideal" time for arthroscopy, it may be offered when there is a high clinical suspicion of a biceps or labral lesion. It is essential that the patient understand the nature, benefits, and risks of the surgical procedure.

In a review of 2,375 shoulder arthroscopies performed between 1985 and 1993 at our institution, 140 injuries to the superior glenoid labrum were identified (incidence of 5.9%).[12] Of these 140 injuries, 28% were isolated SLAP lesions, and 72% were associated with other pathologic conditions in the shoulder (29% of the patients had partial rotator cuff tears, 11% had complete rotator cuff tears, 22% had associated Bankart lesions, 10% had evidence of humeral head injury, and 16% had acromioclavicular degenerative changes). The approximately 40% incidence of associated rotator cuff disorders has been seen in other studies as well,[2,9,13,14] although most commonly only partial tearing of the rotator cuff is involved. Other pathologic changes that have been reported include partial tearing of the biceps tendon,[1] evidence of subacromial bursitis,[14] and additional tears in the anterior, inferior, and posterior labrum.[9]

It is important to recognize variations in normal glenohumeral anatomy to appropriately diagnose SLAP lesions of the shoulder (Fig. 1). This includes appreciation of the frequently normal sublabral hole at the approximately 2-o'clock position, as well as the commonly seen meniscoid appearance of the superior labrum. Another normal variant seen in approximately 1.5% of shoulders is termed the "Buford complex." This includes a cordlike middle glenohumeral ligament that attaches to the base of the biceps anchor and the absence of labral tissue on the anterior superior glenoid.[19] Reattachment of this middle glenohumeral ligament as if it were a SLAP lesion can result in marked restriction of rotation.

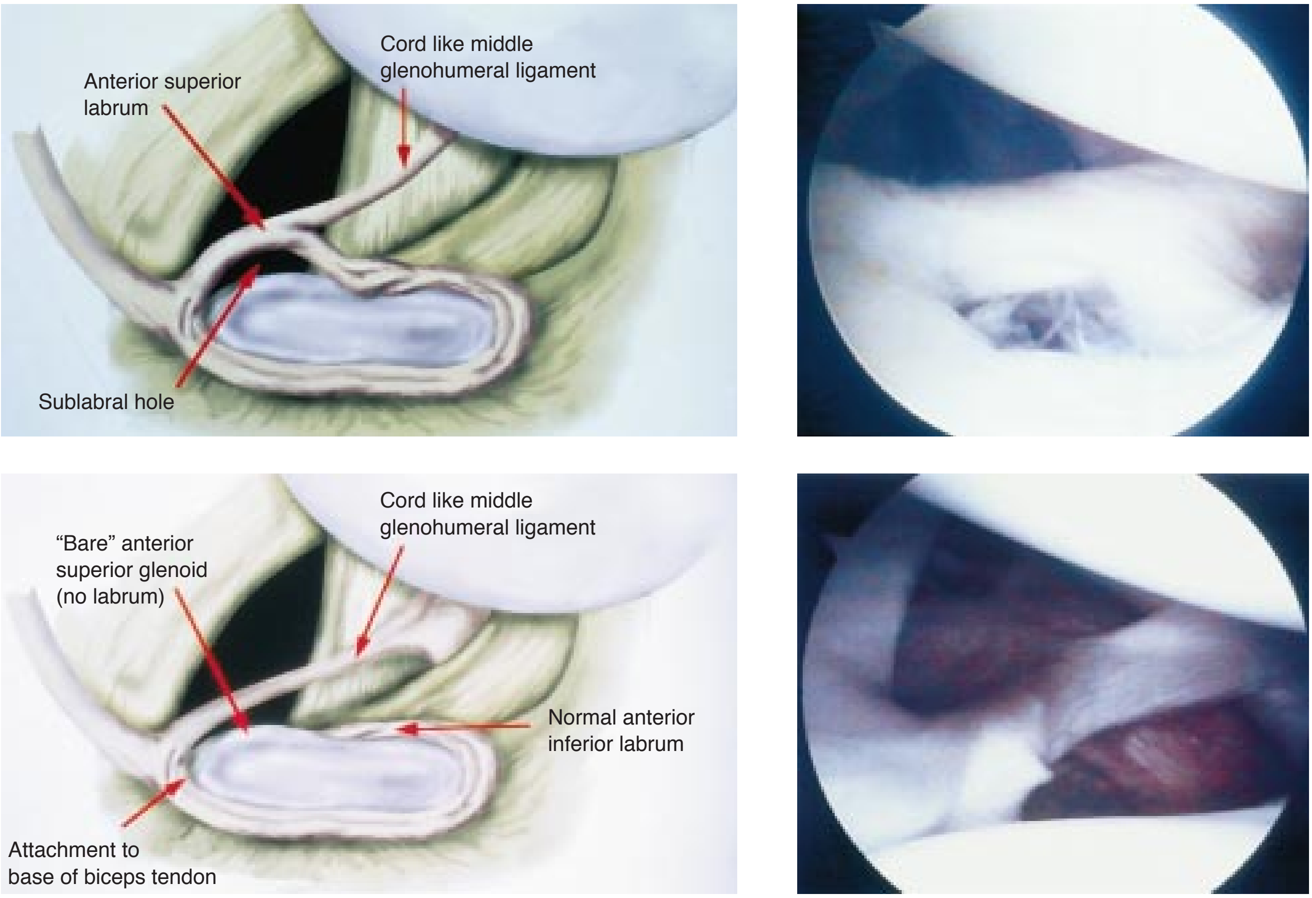

Fig. 1 Diagrams and representative arthroscopic images of variations in normal glenohumeral anatomy. **Top,** A sublabral hole is a normal finding at the 2-o'clock position. **Bottom,** The Buford complex consists of a cordlike middle glenohumeral ligament attaching to the base of the biceps anchor and no labral tissue on the anterior superior glenoid. (Diagrams copyright Stephen J. Snyder, MD.)

Findings consistent with SLAP lesions of the shoulder include signs of hemorrhage or granulation tissue beneath the biceps tendon and superior labrum, presence of a space between the articular cartilage margin of the glenoid and the attachment of the labrum and biceps anchor, and arching of the superior labrum mechanism more than 3 to 4 mm away from the glenoid when traction is applied to the biceps tendon.[19]

Classification

There are four basic types of SLAP lesions[2] (Fig. 2). In type I, there is fraying and degeneration of the edge of the superior labrum but with a firmly attached labrum and biceps anchor. In type II, the labrum and the biceps anchor are detached from the insertion on the superior glenoid, and the complex arches away from the glenoid neck. In type III, there is a bucket-handle tear of the superior labrum, although the remaining portions of the labrum and biceps anchor are still well attached to their insertion. In type IV, there is a bucket-handle-type tear of the superior labrum with extension of the tear into the biceps tendon. Portions of the labral flap and biceps tendon are displaceable into the glenohumeral joint. The remaining labrum and biceps anchor are still attached to the glenoid. Complex lesions involve a combination of two types of SLAP lesions, typically type II and type IV.

Other investigators have described three variations on these four basic types of SLAP lesions. These are (1) an anterior-inferior Bankart-type labral lesion in continuity with the SLAP lesion, (2) biceps tendon separation with an unstable flap tear of the labrum, and (3) extension of the superior labrum–biceps tendon separation to beneath the middle glenohumeral ligament.[9]

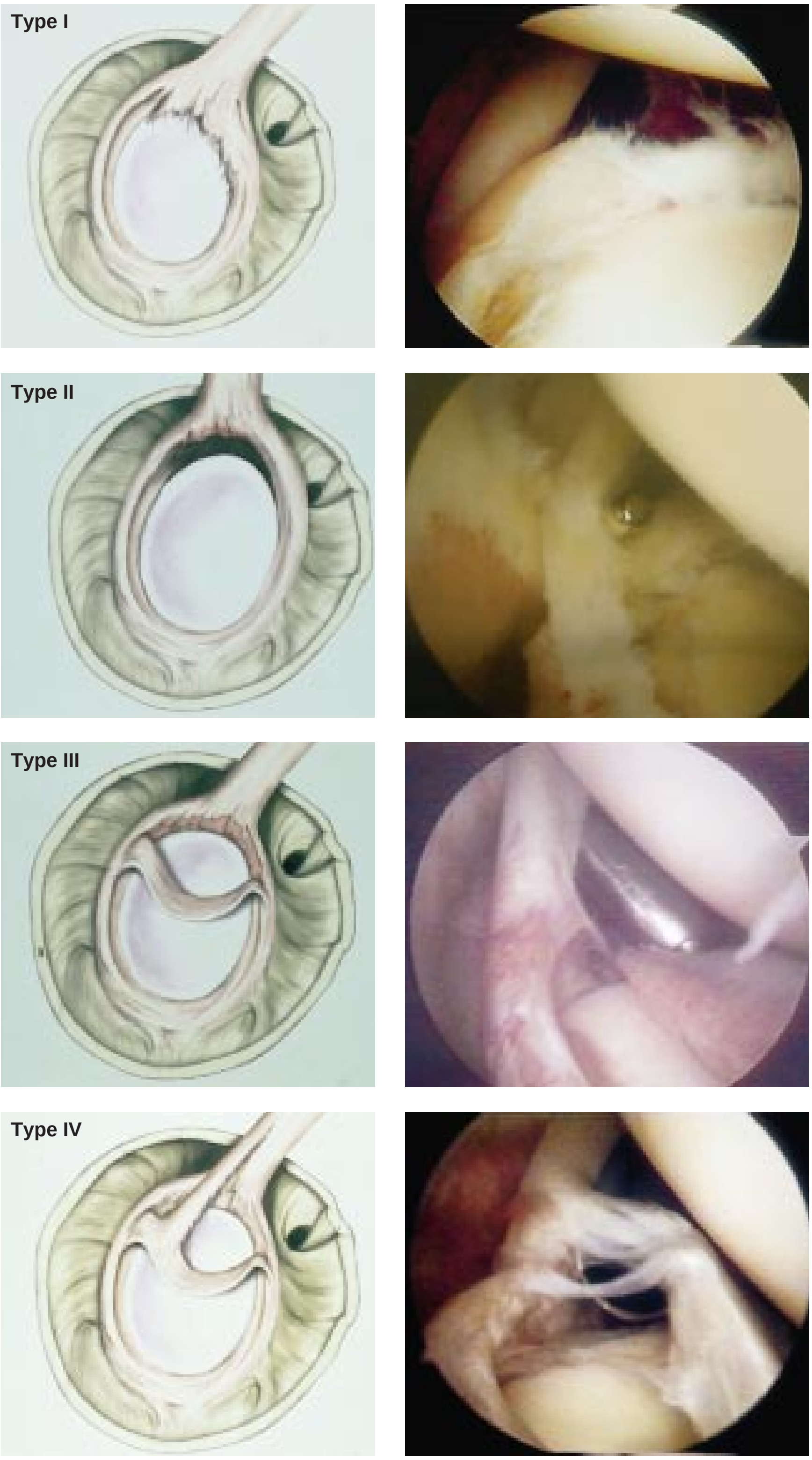

Fig. 2 Diagrams and representative arthroscopic images of the four types of SLAP lesions. (Diagrams copyright Stephen J. Snyder, MD.)

Treatment

Previous Experience

Appropriate treatment of patients with SLAP lesions depends on accurate arthroscopic classification. Conservative therapy is generally a failure, as is manifested by the fact that most patients do not come to diagnostic arthroscopy for a minimum of 10 months from symptom onset.[14] Simple debridement alone is often ineffective in achieving long-term satisfactory results in patients with unstable SLAP lesions. In one study of 27 patients with SLAP lesions treated with debridement alone,[20] 78% had excellent pain relief at the 1-year follow-up. This decreased to 63% at the 2-year follow-up. Similarly, at 2 years, only 45% of patients were able to return to their previous level of athletic performance. These relatively poor and diminishing results were attributed to the occult instability that is frequently present in patients with glenoid labral tears. Although none of the patients had a history of dislocation or clinically evident instability, 70% of the patients had instability on examination under anesthesia. Therefore, the treatment of SLAP lesions must involve a careful assessment of glenohumeral stability. Our own experience with simple debridement of type II SLAP lesions in five patients yielded similarly poor results; at the time of second-look arthroscopy, three were healed, and two had loose biceps-anchor attachments.

Because of the uncertain healing with simple debridement, and the association of labral injury and instability, the treatment of SLAP lesions continues to evolve. If instability is mild and no other capsular or labral lesion is identified, secure reattachment of the biceps anchor should restore stability.

However, if stability on examination under anesthesia is substantial and another capsular or labral lesion is found, that lesion should be treated at the same time. Devices to securely reattach the superior labrum–biceps tendon anchor include staples, absorbable implants, metal screws, metal anchors, and transosseous sutures.

Utilizing a high-profile staple with a 5.5-mm head, Yoneda et al[14] repaired 10 superior labral lesions similar to type II SLAP lesions. They reported 80% good or excellent results at a minimum follow-up interval of 24 months using a scoring system based on the degree of restoration of sporting activity. At repeat arthroscopy performed for staple removal 3 to 6 months postoperatively, there was evidence of complete healing in 4 cases and superficial healing but good stability in the other 6 cases. A fair result was seen in a patient with preoperative symptoms of subacromial impingement, and a poor result was seen in a patient considered to have multidirectional instability preoperatively. There were no problems with the staple. However, the need for staple removal led the authors to recommend the use of absorbable staples in the future.

Using a transosseous suture technique, Field and Savoie[13] fixed 15 type II and 5 type IV SLAP lesions. With their technique, numerous 2-0 PDS sutures are placed in the unstable labrum–biceps tendon complex with a suture punch. Anchor stitches (PDS 0 or 2-0) are placed in the biceps tendon itself. With use of a Beath pin, a hole starting at the one-o'clock position of a right shoulder is drilled through the glenoid neck via the anterior portal, exiting in the infraspinatus fossa. The sutures are retrieved and then tied over the infraspinatus fascia. On follow-up ranging from 12 to 42 months, considerable improvements in pain and function scores were achieved (utilizing the American Shoulder and Elbow Surgeons rating scale). All 20 patients received an excellent or good score on the Rowe scoring system, whereas only 5 patients had such a score preoperatively. There was also substantial improvement in pain and in preoperative popping. All 10 patients who sustained work-related injuries were able to return to work. Six patients involved in throwing sports were able to return to their sport without limitations or loss of velocity. Four recreational athletes were also able to resume their activities. Adhesive capsulitis that developed in one patient was successfully managed by manipulation under anesthesia with good long-term follow-up results. There were no reported complications from the subcutaneous sutures.

In 1993, Resch et al[11] reported on the stabilization of 14 of 18 SLAP lesions. Six were stabilized with a cannulated titanium screw 2.7 mm in diameter with a 5-mm washer. Five of these screws were placed under arthroscopic control; the other was placed in an open surgical procedure. Eight lesions were stabilized with absorbable tacks with a 6.5-mm head diameter. The screw was subsequently removed, typically 3 to 5 months postoperatively. The implants were inserted just posterior to the long head of the biceps tendon. Six implants were positioned from a portal anterior and medial to the tip of the acromion; five were inserted through a superomedial portal behind the acromioclavicular joint; and three were inserted via a transacromial approach (one screw, two absorbable tacks). In five cases, additional fixation was performed just anterior to the long head of the biceps tendon. In one of two patients with a "bucket-handle" component, the loose segment of labrum was removed. At follow-up 6 to 30 months after stabilization, eight patients were completely rehabilitated and were back to sports at the previous level of performance. Four were improved, with two returning to sports but not at the same level. Two patients had no improvement. Notably, only one of four patients who were treated with debridement without secure anchor fixation showed improvement. Complications included two instances of intraoperative repositioning of the metal screw because of inadvertent articular penetration and one instance of screw loosening necessitating early screw removal at 11 weeks.

The senior author (S.J.S.) reported the results of treatment of 140 patients with injuries to the superior labrum in the period from 1985 to 1993.[12] During that time, SLAP lesions were encountered in 6% of patients who underwent diagnostic glenohumeral shoulder arthroscopy. Twenty-one percent were type I SLAP lesions, 55% type II, 9% type III, 10% type IV, and 5% complex injuries. Partial rotator cuff tearing was seen in 29% of the patients, full rotator cuff tearing was found in 11%, and a Bankart lesion was present in 22%; these additional pathologic changes were treated with conventional open or arthroscopic techniques. In 28% of the patients, the SLAP lesions represented an isolated entity. The labral lesion was treated in a variety of ways. Second-look arthroscopy performed on 18 shoulders revealed healing in 3 of 5 type II lesions treated with debridement and glenoid abrasion. Of 5 type II lesions treated with an absorbable anchor, 4 were healed. On reexamination of 3 type III lesions and 1 type IV lesion treated with debridement, the superior labrum was normal. Two type IV injuries treated with suture repair had completely healed, and 2 complex type II-III injuries treated with debridement and anchor fixation were also healed. Five reoperations were necessary because of loose bioabsorbable tack fragments.

Because interpretation of the results of treatment of SLAP lesions may be obscured by the concomitant associated pathologic changes, Stetson et al[10] evaluated a subset of 23 patients with isolated SLAP lesions. All patients with glenohumeral instability, partial or complete rotator cuff tears, acromioclavicular joint arthritis, Bankart lesions, advanced glenohumeral arthritis, or impingement were excluded. Follow-up averaged 3.8 years (range, 14 months to 8 years). Of the 23 SLAP lesions, 1 type I lesion was treated with debridement, 6 type II lesions were treated with debridement and abrasion, 12 type II lesions were treated with suture anchors, 1 type III lesion was treated with debridement, 2 type IV lesions were treated with debridement, and 1 complex type II-III lesion was treated with a combination of debridement and anchor fixation. Three different types of anchors were used: an absorbable tack, a nonabsorbable suture tack, and a 4-mm removable screw-in suture anchor. Overall, on the Rowe scoring system, 82% of patients had good or excellent results, 9% had fair results, and 9% had poor results. Of the 2 patients with poor results, 1 had a type II SLAP lesion that was treated initially with debridement alone; this patient ultimately required open anterior shoulder stabilization. The other patient had a type IV SLAP lesion that was considered to be unstable on further follow-up. Of the 2 patients with fair results, 1 with a complex type II-III lesion had cracking in the joint and ultimately needed removal of the absorbable tack fragments. The second patient had a type III SLAP lesion that was treated with debridement. Notably, all 3 patients whose type II SLAP lesion was treated with a screw-type suture anchor were able to return to their previous level of sports competition.

Current Recommendations

Because of concerns about (1) the need for implant removal; (2) the technical difficulties of transosseous approaches; (3) the potential for fracture with transacromial approaches; (4) breakage of absorbable implants; and (5) failure of simple debridement with type II SLAP lesions, we favor stabilization of type II SLAP lesions with the screw-type suture anchor. The eyelet of the anchor is threaded with a No. 2 nonabsorbable suture, which is passed through the base of the biceps in a mattress-stitch fashion. Early in our experience, we used a nonabsorbable suture anchor, but although pleased with the quality of the fixation, we were unhappy with the inability to remove the anchor intraoperatively if problems arose. In addition, we had two cases in which the barbed anchor caught on the deltoid muscle on insertion, requiring surgical dissection for removal. We have also used an absorbable polylactide tack anchor on an experimental basis, but have had problems with fragmentation of the anchor, necessitating repeat arthroscopy in five patients.[12]

Type I and type III SLAP lesions are currently treated with debridement and careful assessment for glenohumeral stability. In a type III lesion, the bucket-handle portion of the labral tear is excised. Type II lesions are now treated with arthroscopic fixation of the biceps anchor to the glenoid rim, typically with a screw-in suture anchor. Treatment of type IV lesions depends on the extent of tearing of the biceps tendon. If the segment of biceps tendon involvement is less than approximately 30% of the substance of the tendon, the detached fragment of labrum and biceps tendon can simply be resected. If the tear encompasses 30% or more of the substance of the tendon, the decision becomes more complex. In older patients with symptoms of biceps tendon irritation, labral debridement and biceps tenodesis is performed. In younger patients with extensive tears, we recommend arthroscopic suture repair of the biceps tendon and torn labrum and secure anchor fixation, if necessary. Of course, associated lesions, such as partial and complete rotator cuff tears, Bankart lesions, additional labral tearing, glenohumeral instability, and acromioclavicular degenerative changes, should be appropriately addressed.

Arthroscopic repair of type II SLAP lesions requires the use of three portals (Fig. 3). A standard posterior portal is made first, and then, with the use of a transarticular rod, an anterosuperior portal is created from the inside out just anterior to the biceps tendon. Through this portal, suture anchors and suture needles are placed. A third anterior midglenoid portal is established by using an outside-in technique approximately 2 cm inferior to the anterosuperior portal. The portal is created with the assistance of a spinal needle placed just at the superior border of the subscapularis tendon.

With visualization from the posterior superior portal, the fibrous material covering the glenoid neck is debrided from the anterosuperior portal with a shaver. A 4-mm ball-tipped burr is used to lightly decorticate the bone beneath the superior labrum and biceps

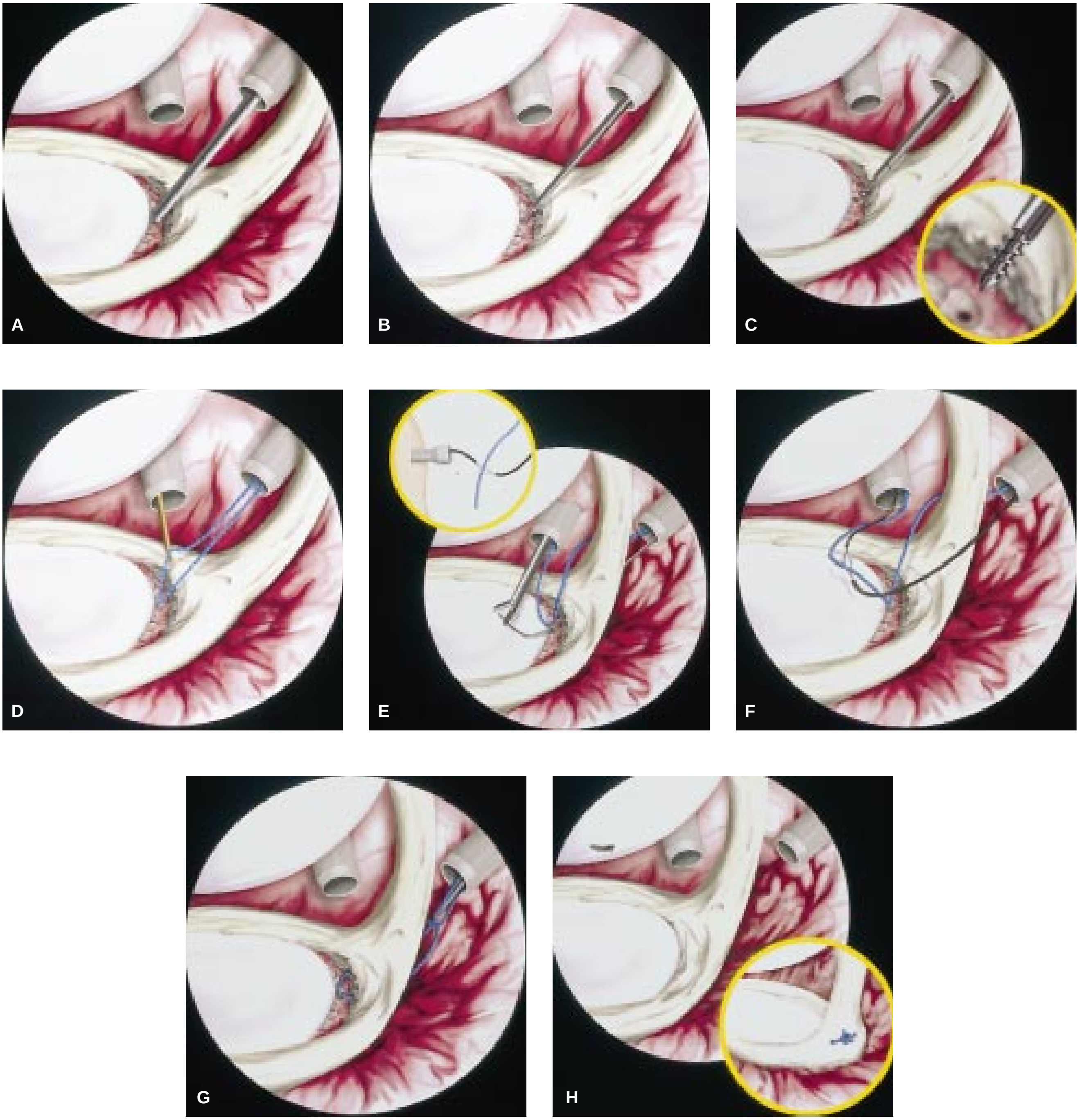

Fig. 3 Arthroscopic repair of type II SLAP lesions. **A,** The bone beneath the superior labrum and biceps anchor is decorticated with a 4-mm ball-tipped burr inserted through the anterosuperior portal. **B,** A 2-mm drill bit angled 45 degrees posteriorly and 45 degrees medially is used to create a hole for suture anchor placement from the anterosuperior portal. **C,** A suture anchor is placed from the anterosuperior portal. **D,** A crochet hook retrieves one limb of the suture through the anterior midglenoid portal. **E,** A 6-inch 17-gauge spinal needle or crescent suture hook is passed through the anterosuperior labrum, just at the anterior edge of the biceps tendon. A suture passer is inserted through this needle and is then retrieved out the anterior midglenoid portal. **F,** The eyelet of the suture passer is threaded with the suture outside the anterior midglenoid portal. The suture passer is pulled out the anterosuperior portal, delivering the suture from the glenoid side of the labrum to the peripheral side. **G,** The two limbs of the suture are tied with an arthroscopic knot pusher, and a mattress stitch is completed. **H,** The biceps anchor and superior labrum are reattached to the osseous glenoid. (Copyright Stephen J. Snyder, MD.)

anchor (Fig. 3, A). An arthroscopic drill bit or punch is used to create an anchor pilot hole through the anterosuperior portal and is directed at an angle 45 degrees away from the articular surface and 45 degrees posteriorly (Fig. 3, B).

A 4-mm threaded suture anchor, loaded with No. 2 braided suture, is inserted via the anterosuperior portal into the predrilled hole (Fig. 3, C). After the anchor is seated, its stability is tested by pulling on the free ends of the suture. A crochet hook is then used to retrieve one limb of the suture through the anterior midglenoid portal (Fig. 3, D).

A 6-inch 17-gauge spinal needle or crescent-shaped suture hook is inserted through the anterosuperior portal, through the labrum and the biceps anchor, near the posterior edge of the long head of the biceps tendon. A suture passer is placed through the tissue and is retrieved out the anterior midglenoid portal (Fig. 3, E). The suture passer is 30 inches long and has a central eyelet. The passer is advanced out the anterior midglenoid portal until the eyelet exits the anterior midglenoid portal. The end of the suture that is outside the anterior midglenoid portal is then inserted through the eyelet, which is pulled back through the tissues and out the anterosuperior portal (Fig. 3, F). The second free end of the suture is retrieved out the anterior midglenoid portal with a crochet hook. The mattress stitch is completed by passing the spinal needle and suture passer through the anterosuperior portal and placing it 8 mm anterior to the first stitch. The passer is again retrieved out the anterior midglenoid portal, the eyelet is loaded with the suture, and the passer is withdrawn back out the anterosuperior portal so that both limbs of the suture exit on the peripheral side of the superior labrum and out the anterosuperior portal. The two limbs of the suture are tied together using an arthroscopic knot pusher through the anterosuperior portal (Fig. 3, G). A minimum of five half-hitch knots are used for security, alternating the post suture after the third and fourth throws. An arthroscopic probe is used to palpate the repair and ensure stability (Fig. 3, H). Additional suture anchors are placed if the superior labral detachment is quite large.

Type IV SLAP lesions are repaired with multiple sutures through the labrum and biceps, with knots tied in a mattress fashion away from the articular surface. This can typically be accomplished with a posterior portal and an anterosuperior portal. An 18-gauge spinal needle is placed percutaneously below the anterolateral border of the acromion, through the biceps tendon, and across the split portion. A suture passer is inserted and then retrieved out the anterosuperior portal. The spinal needle is withdrawn. The eyelet of the suture passer is loaded with a suture, which is delivered across the torn biceps tendon, leaving one end outside the anterosuperior portal and the other end in a percutaneous location. The epidural needle is reinserted 3 to 4 mm away from the first passage site, and the suture passer is again inserted and retrieved through the anterosuperior portal. The limb of suture exiting the anterosuperior portal is inserted into the eyelet of the suture passer, which is withdrawn through the biceps tendon, thereby leaving both ends of the suture in a percutaneous location. A crochet hook is used to retrieve both ends of the suture through the anterosuperior portal, and a mattress stitch is completed by tying the two limbs with an arthroscopic knot pusher. This process is repeated through the labrum, both posterior and anterior to the biceps tendon, until the entire labrum and biceps tendon have been repaired.

Complex type II-III or complex type II-IV SLAP lesions occasionally occur, and the previously described principles can dictate appropriate treatment—namely, torn segments of labrum and biceps tendon may be debrided, and if the remaining portion of the biceps anchor is detached and substantial, it should be repaired to the glenoid with suture anchors as described for the repair of type II SLAP lesions.

Postoperatively, a sling is used, and gentle elbow, wrist, hand, and pendulum exercises are prescribed. Active biceps strengthening with only 3 to 5 lb of weight is begun slowly at 4 to 5 weeks and no stressful biceps activity is allowed for 3 months.

Summary

Patients with SLAP lesions of the shoulder typically present with complaints of pain and mechanical symptoms. The most common mechanisms of injury are traction and compression, although the injury may be insidious. Careful patient examination must include an assessment of glenohumeral stability. Magnetic resonance arthrography has improved our ability to document these lesions; however, the definitive diagnosis must be made with diagnostic arthroscopy. Associated findings frequently include tearing of the rotator cuff and additional labral lesions. Treatment depends on the type of SLAP lesion. Long-term results with simple debridement have been poor. Type I and III lesions can frequently be treated with simple debridement while addressing any potential instability. The management of type II lesions should include stabilization of the detached biceps tendon–superior labrum complex. Suture repair of many type IV lesions is also appropriate if there is extensive involvement of the superior labrum and biceps tendon. Attention to these evolving concepts may enable us to provide better care to patients presenting with injuries to the superior labrum and biceps tendon complex.

References

1. Andrews JR, Carson WG Jr, McLeod WD: Glenoid labrum tears related to the long head of the biceps. *Am J Sports Med* 1985;13:337-341.
2. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ: SLAP lesions of the shoulder. *Arthroscopy* 1990;6:274-279.
3. Prodromos CC, Ferry JA, Schiller AL, Zarins B: Histological studies of the glenoid labrum from fetal life to old age. *J Bone Joint Surg Am* 1990;72: 1344-1348.
4. Cooper DE, Arnoczky SP, O'Brien SJ, Warren RF, DiCarlo E, Allen AA: Anatomy, histology, and vascularity of the glenoid labrum: An anatomical study. *J Bone Joint Surg Am* 1992; 74:46-52.
5. Vangsness CT Jr, Jorgenson SS, Watson T, Johnson DL: The origin of the long head of the biceps from the scapula and glenoid labrum: An anatomical study of 100 shoulders. *J Bone Joint Surg Br* 1994;76:951-954.
6. Pal GP, Bhatt RH, Patel VS: Relationship between the tendon of the long head of biceps brachii and the glenoidal labrum in humans. *Anat Rec* 1991;229:278-280.
7. Itoi E, Kuechle DK, Newman SR, Morrey BF, An KN: Stabilising function of the biceps in stable and unstable shoulders. *J Bone Joint Surg Br* 1993;75: 546-550.
8. Rodosky MW, Harner CD, Fu FH: The role of the long head of the biceps muscle and superior glenoid labrum in anterior stability of the shoulder. *Am J Sports Med* 1994;22:121-130.
9. Maffet MW, Gartsman GM, Moseley B: Superior labrum-biceps tendon complex lesions of the shoulder. *Am J Sports Med* 1995:23:93-98.
10. Stetson WB, Snyder SJ, Karzel RP, Banas MP, Rahhal SE: Long term clinical follow-up of isolated SLAP lesions of the shoulder. Presented at the 65th Annual Meeting of the American Academy of Orthopaedic Surgeons, New Orleans, March 23, 1998.
11. Resch H, Golser K, Thoeni H, Sperner G: Arthroscopic repair of superior glenoid labral detachment (the SLAP lesion). *J Shoulder Elbow Surg* 1993;2: 147-155.
12. Snyder SJ, Banas MP, Karzel RP: An analysis of 140 injuries to the superior glenoid labrum. *J Shoulder Elbow Surg* 1995;4:243-248.
13. Field LD, Savoie FH III: Arthroscopic suture repair of superior labral detachment lesions of the shoulder. *Am J Sports Med* 1993;21:783-790.
14. Yoneda M, Hirooka A, Saito S, Yamamoto T, Ochi T, Shino K: Arthroscopic stapling for detached superior glenoid labrum. *J Bone Joint Surg Br* 1991;73: 746-750.
15. Chandnani VP, Yeager TD, DeBerardino T, et al: Glenoid labral tears: Prospective evaluation with MR imaging, MR arthrography, and CT arthrography. *AJR Am J Roentgenol* 1993;161:1229-1235.
16. Tirman PFJ, Applegate GR, Flannigan BD, Stauffer AE, Crues JV III: Magnetic resonance arthrography of the shoulder. *Magn Reson Imaging Clin North Am* 1993;1:125-142.
17. Karzel RP, Snyder SJ: Magnetic resonance arthrography of the shoulder: A new technique of shoulder imaging. *Clin Sports Med* 1993;12:123-136.
18. Tirman PFJ, Feller JF, Janzen DL, Peterfy CG, Bergman AG: Association of glenoid labral cysts with labral tears and glenohumeral instability: Radiologic findings and clinical significance. *Radiology* 1994;190:653-658.
19. Snyder SJ: *Shoulder Arthroscopy*. New York: McGraw-Hill, 1994, pp 31-33, 122.
20. Cordasco FA, Steinmann S, Flatow EL, Bigliani LU: Arthroscopic treatment of glenoid labral tears. *Am J Sports Med* 1993;21:425-431.