4 Labral Tears of the Shoulder

Elena Nehrbass

This chapter describes the normal anatomy and function of the labrum, pathologic conditions, clinical presentation, exam findings, diagnostic studies, treatment options, and return-to-activities protocols.

Normal Labral Anatomy and Function

The labrum is the fibrocartilaginous fold that lines the edge of the glenoid. The inner surface of the labrum is covered with synovium, and the outer surface attaches to the joint's capsule [1, 2].

The superior and anterosuperior portions of the labrum are loosely attached to the glenoid, and the macroanatomy of those portions is similar to that of the meniscus of the knee. The superior portion of the labrum inserts directly into the biceps tendon, while its inferior portion is firmly attached to the glenoid rim and appears as a fibrous, immobile extension of the articular cartilage.

The vascular supply of the periphery of the glenoid labrum comes from the suprascapular, circumflex scapular, and posterior circumflex humeral arteries. In general, the superior and anterosu-

E. Nehrbass (✉)
Mount Sinai Hospital, New York, NY, USA

J. Harounian et al. (eds.), *A Case-Based Approach to Shoulder Pain*,
https://doi.org/10.1007/978-3-031-17305-9_4

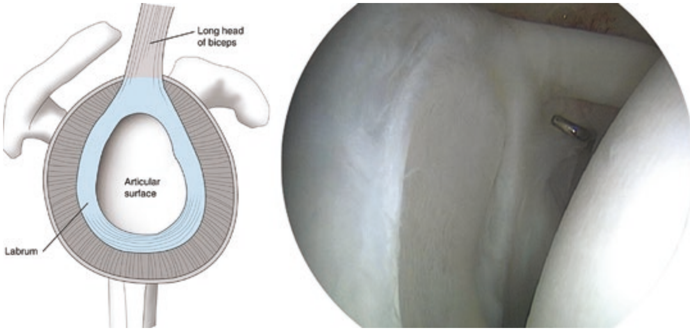

Fig. 4.1 Pictorial drawing (left) with face view of the glenoid, intact labrum, and long head of biceps insertion. Arthroscopic view (right) of the normal glenoid labrum [3]

perior parts of the labrum have less vascularity than the postero-superior and inferior parts, and the vascularity is limited to the periphery of the labrum (Fig. 4.1). Vessels supplying the labrum originate from either capsular or periosteal vessels and not from the underlying bone [4].

The labrum has several functions which include increasing the depth of the glenoid, increasing the articulating surface of the glenoid, and providing attachment for the glenohumeral ligaments as well as attachment to the long head of the biceps tendon [3].

Lesions of the glenoid labrum can cause symptoms of shoulder instability through both anatomical and functional means. Anatomic instability occurs by allowing the shoulder to dislocate or subluxate recurrently, while functional instability occurs by allowing the shoulder to click, catch, and lock secondary to partially attached fragments becoming interposed between the articular surfaces [5].

Etiologies of labral tears include trauma, such as fall on the outstretched arm that forces the humeral head upward against the superior labrum, arm traction injury, direct force on the abducted shoulder, and chronic degeneration as seen with repetitive loading, overhead work-related activities, and throwing sports.

Types of Labral Tears

Labral tears can typically be subcategorized into the predominant location of pathology as delineated below:

- Superior labrum:
  - SLAP lesion
- Anteroinferior labrum:
  - Bankart lesion
  - Perthes lesion
  - GLAD
  - ALPSA
- Posteroinferior labrum:
  - reverse Bankart lesion
  - posterior GLAD
  - POLPSA
  - Kim lesion
- Circumferential labral lesion

Superior Labral Tears

SLAP tears occur when the superior labrum and its associated long head of the biceps (LHB) tendon insertion detach from the glenoid. Such lesions of the superior part of the labrum may extend anterior and posterior to the biceps tendon insertion, hence their designation as SLAP (superior labrum anterior and posterior) tears. The symptoms of SLAP lesions can mimic those of impingement syndrome, pathologic conditions of the rotator cuff or the acromioclavicular joint, or other shoulder disorders [6].

Anteroinferior Labral Tears

Bankart lesions occur at the anteroinferior aspect of the labrum, often as a result of an anterior shoulder dislocation. They are usually seen in association with a Hill-Sachs deformity of the glenoid.

Perthes lesions are a variant of Bankart lesions. They also present as an anterior shoulder injury where the anterior labrum is avulsed from the glenoid by remains partially attached to the scapula via the periosteum. It is best seen on MR arthrography.

Glenolabral articular disruption (GLAD) lesions are associated with injury to the anteroinferior articular cartilage and anteroinferior labrum.

Anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesions occur when the anteroinferior labrum remains attached to the scapular periosteum, but the periosteum is often widely lifted or stripped. It is often associated with inferomedial displacement of the inferior glenohumeral ligament complex on MRI.

Posteroinferior Labral Tears

A reverse Bankart lesion occurs when there is detachment of the posteroinferior labrum and avulsion of the posterior capsular periosteum. Similar to its anterior counterpart, such lesions can lead to laxity and subsequent posterior displacement of the humeral head.

Posterior glenolabral articular disruption (posterior GLAD) lesions are also similar to their anterior variant. It is associated with injury to the posteroinferior articular cartilage and posteroinferior labrum.

Posterior labrocapsular periosteal sleeve avulsion (POLPSA) lesions occur when the posterior periosteum and posterior labrum strip off the glenohumeral joint. This is usually in the setting of trauma.

Kim lesions are superficial labral tears that occur between the posterior labrum and the glenoid articular cartilage. There is no associated labral detachment, though failure to identify and treat this type of lesion may lead to posterior instability.

Circumferential Labral Tears

Pan-labral or circumferential tears of the glenoid labrum are an uncommon injury, comprising roughly 2.4% of all labral lesions [7]. These 360-degree lesions can cause significant and recurrent instability and pain.

Clinical Presentation

Labral tears often present as deep-seated pain within the glenohumeral joint or anterior shoulder pain radiation to the biceps muscle. The pain can either be constant or activity-related. It is often associated with glenohumeral instability, as well as mechanical symptoms such as clicking, catching, popping, or locking. Neurological symptoms including paresthesias, numbness, and tingling can be present in the setting of paralabral cysts causing nerve compression [8]. Patients may also endorse a “dead arm” sensation.

Physical Exam: *Labral Tear Pain-Provoking Tests*

O’Brien Test for Superior Labrum Anterior Posterior (SLAP) Tear

With the patient standing, the arm is elevated forward to 90° and placed at 10–15° of adduction and full internal rotation (thumb pointing down). The patient is asked to hold the arm in that position and resist a downward force applied by the examiner over the distal forearm. This is repeated with the arm in the same position but in full external rotation (palm facing upward). The test is positive if the first maneuver causes or aggravates pain which improves with the latter maneuver. Pain felt deeply in the glenohumeral joint is suggestive of labral tear, while pain felt over the AC Joint is suggestive of AC joint arthropathy.

Jerk Test for Posterior Labrum Tear

With the patient sitting, the examiner stabilizes the scapula with one hand. With the other hand, the examiner abducts the patient's arm to 90° and internally rotates it to 90°. A posterior-directed axial force is then applied while bringing the arm into adduction. This aims to displace the humeral head posteriorly. Sharp glenohumeral pain is suggestive of a posterior labrum lesion.

Kim's Test for Posterior-Inferior Labrum Tear

The patient is sitting against the back of a chair. The arm is placed in 90° of abduction and internal rotation with the elbow flexed to 90°. The examiner holds the patient's elbow and proximal arm and flexes the arm forward by 45° while applying an axial posterior and inferior force on the proximal arm. The arm is then taken into adduction. The test is positive if this causes posterior shoulder pain with or without a posterior clunk of the humeral head. Essentially, Kim's test is a variation of the Jerk test that assesses the posterior-inferior part of the labrum (rather than the posterior labrum) due to the application of an inferior force. During the test, the humeral head is also compressed onto the glenoid.

Crank Test Vs O'Brien Test

According to Stetson et al. in a study of 65 patients with initial symptoms of shoulder pain, the Crank test was positive in 45% of patients, and the O'Brien test was positive in 63%. The Crank test had a positive predictive value of 41%, was 56% specific, was 46% sensitive, and had a negative predictive value of 61%. The O'Brien test had a positive predictive value of 34%, was 31% specific, was 54% sensitive, and had a negative predictive value of 50%. Shoulder MRI had a positive predictive value of 63%, was 92% specific, was 42% sensitive, and had a negative predictive value of 83% [9].

Diagnostic Studies [10, 13–15]

MRI and MR Arthrography

On conventional MRI, labral tears are best seen on fat-saturated (FS) fluid-sensitive sequences. However, in MR arthrography (MRA), the T1, T1 FS, and T2 FS sequences are typically combined for further assessment. Imaging in three orthogonal planes is recommended, and additional planes may be included for a more detailed assessment. There are differing viewpoints as to whether MRA is superior to conventional MRI in detecting labral tears. A 2012 meta-analysis demonstrated that the accuracy of MRA was slightly superior, with a sensitivity of 88% and a specificity of 93%, compared to a sensitivity of 76% and a specificity of 87% for conventional MRI [10].

The biggest advantage of MR arthrography comes from the joint distension, which can help spot otherwise occult tears. However, patients with acute lesions often have a joint effusion which also distends the joint space, making the contrast administration unnecessary. MR arthrography has excellent accuracy in differentiating between SLAP lesions and its anatomic variants [11, 12].

CT Arthrography

CT arthrography (CTA) has been reported to have 97.3% accuracy for detecting Bankart lesions and 86.3% for SLAP lesions. This makes CTA comparable to MRA and provides an alternative for patients with MRI contraindications [10]. CT is also superior to MR in assessing bony structures, so this modality is helpful in detecting coexisting small glenoid rim fractures.

Management

Treatments for pain and instability include analgesia, activity modification, corticosteroid injections into glenohumeral joint, as well as physical therapy guided toward posterior capsular stretching to address contractures and regain motion loss, improve scapular muscle strength and neuromuscular control, and increase extremity and core strengthening. Platelet-rich plasma, in conjunction with appropriate rehabilitation, can also assist in the clinical recovery of glenoid labral tears [16]. Nonsurgical treatment of SLAP tears can be quite successful, as some studies report up to 70% of patients with nonsurgical SLAP tears returning to sports with improvement in pain and function [17]. As such, a trial of nonsurgical treatment may be appropriate for some patients.

Surgical options can include *arthroscopic debridement* of the degenerate labrum tear if biceps anchor is stable, *resection of an unstable bucket handle fragment*, partial removal of a damaged LHB tendon segment/flap, and *arthroscopic labrum reattachment*. Alternatively, open or arthroscopic *LHB tendon tenotomy or tenodesis* is another option that is preferable in patients over 35–40 years old, as the outcomes of arthroscopic labrum repair in this population are inferior to those seen in younger patients [18, 19].

Outcomes of arthroscopic resection of glenoid labral tears in athletes vary depending on whether or not there is shoulder instability. In a 29 patient case study with greater than 2 year follow-up, there was a statistically significant difference in the functional outcome between patients with stable versus unstable glenohumeral joints. In those with stable joints, there was a 91% good or excellent functional outcome. In those with unstable joints, there was a 25% good functional outcome and a 75% fair or poor functional outcome. Arthroscopic resection of a longitudinal labral tear in a stable shoulder can relieve the patient's discomfort and allow him or her to return to athletic competition. In patients with anterior instability and labral tears, labral debridement was not a successful alternative to formal stabilization [20].

Outcomes of SLAP repair can also vary significantly. Roughly 88% of professional athletes return to pre-injury levels within a year [21], whereas 26% experience resolution of pain and only 13% have complete restoration of normal function [22].

Postoperative Rehabilitation and Return to Activities after SLAP Debridement or Repair

For the first 6 weeks after surgery, any position which may create tension on the biceps should be avoided and approached with caution thereafter. These positions include shoulder extension, internal rotation behind the back, and using the arm to carry or lift objects with the elbow extended. External rotation with the arm at 90° of abduction should also be approached with caution. When a biceps tenodesis is performed, any resistive active motion of the elbow, either in flexion or supination, is avoided [23, 24].

0–6 Weeks Postop: Protective and Restrictive Phase

A sling is used for comfort during the first 7 to 10 days after surgery. Phase I ROM exercises are then initiated and performed as tolerated. External rotation ROM may need to be limited to 45° in patients who have evidence of a peel-back tear. Patients are expected to achieve full passive forward elevation 6 weeks after surgery. Goals and treatments examples are listed below:

Pain and swelling control: Cryotherapy, electrical stimulation, grade I/II mobilizations.

***Mobilization* (safe ROM, 10 to 25 repetitions, 2 to 3 times per day):**

- Sling for comfort for up to 3 weeks.
- Passive forward elevation in plane of the scapula by 2 days with physician-set limitations.
- Passive external rotation (ER) in plane of the scapula (POS) and abduction/external rotation with physician-set limitations.
- Pendulum.
- Progress to active ROM in all motions.

***Strength* (safe ROM, 3 to 5 x 10 repetitions, 2 times per day, 0 to 5 lbs):**

- Begin with isometrics for flexion, adduction, abduction, extension, internal/external rotation, and grip strengthening.
- Wrist curls and extensions.
- Elbow curls and extensions.
- Shoulder shrugs with scapular adduction (retraction).
- Bent row.
- Scaption.
- Non-weight-bearing push-up.
- Seated press-up.
- Modified prone horizontal abduction.
- Side-lying external rotation.
- Modified prone 90–90° external rotation.
- Arm at side in internal rotation.

***Proprioception* (safe ROM, 10 to 25 repetitions, once per day):**

- Rhythmic stabilization.
- Weight shifts (progress wall to table).
- Oscillations (Boing [Boing Ltd., Bristol, UK], Bodyblade [Fitter International Inc., Calgary, Alberta, Canada] or tubing.

***Cardiovascular fitness* (30–60 min, 3–5 times per week):**

- Bicycle.
- Stairmaster/elliptical.
- Walking.

***Mobilization* (active ROM against suture line in all directions):**

- Passive ROM and active ROM
- 60°–90° external rotation
- 45°–60° internal rotation
- 135°–155° abduction
- 135°–165° scaption

***Strength*:**

- 3+ to 4/5 on manual muscle testing
- Progress exercises through available ROM.
- Add weight as tolerated.

6–12 Weeks Postop

At 6 weeks postop, active ROM, passive ROM, and rotator cuff and deltoid strength are assessed. Patients are instructed to begin phase II ROM exercises, which include extension, internal rotation, cross-body adduction, and phase I strengthening exercises, which include external rotation, internal rotation, and extension. Scapular retraction exercises with elastic resistance can also be performed at this time. Goals and treatments examples are listed below:

***Mobilization*:**
- Passive ROM and active ROM
- 90° external rotation
- Full internal rotation
- 160°–180° abduction
- Gradually increase passive ROM stretching
- Grades III–IV mobilization techniques
- Wand
- Overhead pulley

Strength
- 4 to 4+/5 on manual muscle testing
- Progress above exercise weights to 5 lbs. Progress to weight machines.
- 15% or less differences isokinetically:
  - Bench press
  - Military press
  - Seated row
  - Latissimus dorsi pull-down
  - Biceps
  - Triceps

***Proprioception*:**
- Progress to full weight-bearing on closed chain proprioceptive activities.
- Progress open and closed chain proprioceptive exercises closer to end range.

***Function*:**
- Light, nonrepetitive overhead activity, light lifting.
- Activities of daily living as tolerated.
- No sports activities.

12–24 Weeks Postop

Patients who are able to perform the phase I strengthening exercises with the green band are instructed in phase II strengthening (abduction, forward elevation, external rotation supported at 45°). Advanced scapular strengthening exercises may be used at this time. In addition, biceps strengthening with light weights may begin.

For the overhead athlete, sport-specific training can begin using the Bodyblade and plyometrics to enhance neuromuscular control, strength, and proprioception. Recommendations and instruction for proper use of gym equipment should also be done at this time. Patients should be encouraged to avoid exercises with the arm behind the plane of the body. Latissimus pull-downs should be performed to the chest, not behind the head. Caution should be used when performing any type of "pushing" exercise, such as chest press or shoulder press. It is safer to perform these exercises with a machine to allow for greater safety.

***Mobilization*:**
- Progressive passive and active ROM exercises
- Full or sufficient ROM to perform sport

***Strength* (continue weight machines):**
- 5/5 manual muscle testing: Progress to free weights
- <10% isokinetic strength difference:
  - Military press
  - Bench press
  - Incline press
  - Rows
  - Flies

Proprioception **(weight-bearing on unstable surfaces):**

- <10% proprioception difference: Bodyblade, Plyoback.

Function **(gradually progress to functional activities):**

- Begin return to football, wrestling, overhead activities.

4 Months Postop

The player or athlete must be ready to begin throwing. The role of the pitcher, number of throws, distance, intensity, and frequency of the program need to be considered. It is recommended to allow at least 6 weeks of strengthening before considering a throwing program. Scapular positioning, shoulder ROM, spinal mobility, and lower extremity ROM should also be evaluated at this time. When considering a return to throwing, it is important to evaluate the entire body mechanics in the process of throwing. Asymmetries are bound to exist, and it is the goal and the art of rehabilitation to conclude what is an acceptable difference. Leggin et al. recommend performing the following tests and measures prior to initiating a throwing program:

- Shoulder ROM (internal rotation at 90°, external rotation at 90°, total ROM in comparison with uninvolved side, flexion, abduction).
- Scapular evaluation—static and dynamic evaluation and any concerns for scapular dyskinesis (digital photo or video).
- Spinal ROM—lumbar flexion, sidebending, rotation (digital photos).
- Lower extremity ROM (hip internal rotation and external rotation in prone and seated positions, hip flexion, Thomas test, knee flexion).
- Functional movement screen performed (looking for asymmetry to be addressed with appropriate corrective exercises) [25, 26].

References

1. Culham E, Peat M. Functional anatomy of the shoulder complex. J Orthop Sports Phys Ther. 1993;18(1):342–50.
2. Terry GC, Chopp TM. Functional anatomy of the shoulder. J Athl Train. 2000;35(3):248–55.
3. The Shoulder Made Easy. Panayiotou Charalambous, Charalambos. Author. 2019; https://link-springer-com.eresources.mssm.edu/chapter/10.1007/978-3-319-98908-2_2
4. Cooper DE, Arnoczky SP, O'Brien SJ, et al. Anatomy, histology, and vascularity of the glenoid labrum. An anatomical study. The journal of bone and joint surgery. American Volume. 1992;74(1):46–52.
5. Pappas AM, Goss TP, Kleinman PK. Symptomatic shoulder instability due to lesions of the glenoid labrum First Published September 1, 1983 https://doi.org/10.1177/036354658301100501
6. Stetson WB, Snyder SJ, Karzel RP. Long term clinical follow-up of isolated SLAP lesions of the shoulder. Arch Am Acad Orthop Surg. 1997;1:161–4.
7. Lo IK, Burkhart SS. Triple labral lesions: pathology and surgical repair technique—report of seven cases. Arthroscopy. 2005;21(2):186–93.
8. Tirman PF, Feller JF, Janzen DL, Peterfy CG, Bergman AG. Association of glenoid labral cysts with labral tears and glenohumeral instability: radiologic findings and clinical significance. Published Online: Mar 1 1994 https://doi.org/10.1148/radiology.190.3.8115605.
9. Stetson WB, Templin K. The crank test, the O'Brien test, and routine magnetic resonance imaging scans in the diagnosis of labral tears. Am J Sports Med. 2002;30(6):806–9. https://doi.org/10.1177/03635465020300060901.
10. Smith T, Drew B, Toms A. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of Glenoid Labral Injury. Arch Orthop Trauma Surg. 2012;132(7):905–19. https://doi.org/10.1007/s00402-012-1493-8.
11. Liu SH, Henry MH, Nuccio S. Diagnosis of glenoid labral tears: a comparison between magnetic resonance imaging and clinical examinations. First Published March 1, 1996. https://doi.org/10.1177/036354659602400205.
12. Symanski JS, Subhas N, Babb J, Nicholson J, Gyftopoulos S. Diagnosis of superior labrum anterior-to-posterior tears by using MR imaging and MR arthrography: a systematic review and meta-analysis. Radiology. 2017;285(1):101–13.
13. De Coninck T, Ngai S, Tafur M, Chung C. Imaging the Glenoid Labrum and labral tears. Radiographics. 2016;36(6):1628–47. https://doi.org/10.1148/rg.2016160020.

14. De Maeseneer M, Van Roy F, Lenchik L, et al. CT and MR arthrography of the normal and pathologic anterosuperior labrum and labral-bicipital complex. Radiographics. 2000;20(suppl_1):S67–81. https://doi.org/10.1148/radiographics.20.suppl_1.g00oc03s67.
15. Glenoid CP, Pathology L. Orthop Traumatol Surg Res. 2015;101(1 Suppl):S19–24. https://doi.org/10.1016/j.otsr.2014.06.028.
16. Vander Kraats R, Doss A. Glenoid Labral Tear: follow up case series on ultrasound guided autologous platelet rich plasma in conjunction with a progressive rehabilitation program; First published:19 December 2012, 1:68 https://doi.org/10.3410/f1000research.1-68.v1.
17. Jang SH, Seo JG, Jang HS, Jung JE, Kim JG. Predictive factors associated with failure of nonoperative treatment of superior labrum anterior-posterior tears. J Shoulder Elb Surg. 2016;25(3):428–34.
18. Denard PJ, Lädermann A, Parsley BK, Burkhart SS. Arthroscopic biceps tenodesis compared with repair of isolated type II SLAP lesions in patients older than 35 years. Orthopedics. 2014;37(3):e292–7.
19. Erickson J, Lavery K, Monica J, Gatt C, Dhawan A. Surgical treatment of symptomatic superior labrum anterior-posterior tears in patients older than 40 years: a systematic review. Am J Sports Med. 2015;43(5):1274–82.
20. Glasgow SG, Bruce RA, Yacobucci GN, Torg JS. Arthroscopic resection of glenoid labral tears in the athlete: a report of 29 cases. Arthroscopy. 1992;8(1):48–54.
21. Beyzadeoglu T, Circi E. Superior labrum anterior posterior lesions and associated injuries: return to play in elite athletes. Orthop. J Sports Med. 2015;3(4):2325967115577359. https://doi.org/10.1177/2325967115577359.
22. Weber SC, Martin DF, Seiler JG 3rd, Harrast JJ. Superior labrum anterior and posterior lesions of the shoulder: incidence rates, complications, and outcomes as reported by American Board of Orthopedic Surgery. Part II candidates. Am J Sports Med. 2012;40(7):1538–43.
23. Leggin BG, Scott S, Eckenrode BJ. Rehabilitation after surgical Management of the Thrower's shoulder. Sports Med Arthrosc Rev. 2012;20(1):49–55. https://doi.org/10.1097/JSA.0b013e3182471f31.
24. Yamaguchi K, Bindra RIannotti JP, Williams GR. Disorders of the biceps tendon. Disorders of the shoulder: diagnosis and management. Philadelphia: Lippincott, Williams & Wilkins; 1999. p. 159–90.
25. Leggin BG, Sheridan S, Eckenrode BJ. Rehabilitation after surgical management of the thrower's shoulder. Sports Med Arthrosc Rev. 2012;20(1):49–55. https://doi.org/10.1097/JSA.0b013e3182471f31.
26. Blackburn TA, Guido JA. Rehabilitation after ligamentous and labral surgery of the shoulder: guiding concepts. J Athl Train. 2000;35(3):373–81.