Chapter 1

Anterior Shoulder Instability

INTRODUCTION

Ellen Shanley, PhD, PT, OCS, Charles A. Thigpen, PhD, PT, ATC, and Richard J. Hawkins, MD

Epidemiology

Overall Incidence

- Estimates of the initial incidence of anterior glenohumeral instability in the general population range from 8.2 occurrences per 100,000 person years[1] in the rural United States to as high as 24 occurrences per 100,000 person years in Scandinavian countries.[2,3]
- In NCAA athletes the instability incidence at the glenohumeral joint was calculated as 0.12 injuries per 1000 athletic exposures (AE).[4]
- The frequency of instability episodes in a military population over 1 year was calculated as 2.8%.[5]
- The overall injury rate, including both initial and recurrent episodes of shoulder instability, has been documented to significantly increase the total number of episodes.[1,4]

Age

- Owens et al. reported that 80% of shoulder dislocations occur in younger patients.[5] Forty seven percent of patients presenting to U.S. emergency departments with traumatic dislocations were between the age of 15 and 29.[6] A Scandinavian population study reported that the overall peak incidence of shoulder dislocations in males occurred between the ages 21 and 30 and in females between the ages of 61 and 80.[2] Recurrent instability has been reported at highest frequencies in patients younger than 20 years old (66% to 94%).[7,8]

Gender

- Male collegiate athletes (0.15/1000 AE) were 2.7 times more likely to sustain a shoulder instability episode than female (0.06/ 1000 AE) collegiate athletes.[4] In the military, male cadets had a slightly higher frequency of shoulder instability than their female counterparts with 2.9% and 2.5% documented over a 1-year study period, respectively.[5]

Sport

- In collegiate athletes, the rate of shoulder instability was greatest in Spring football at 0.40/1000 AE followed by wrestling (0.21/1000 AE), women's ice hockey (0.18/1000 AE) and fall football (0.18/1000 AEs).[4]
- In high school athletes, dislocations were reported to be higher in male sports (38%) than female sports (29%).[9] However, female basketball players sustained more shoulder dislocations than male basketball players (proportion ratio = 2.7).[9,10]
- Injuries were sustained more in games (0.31/1000 AE) than practices (0.09/1000 AE) and NCAA athletes were 3.5 times more likely to sustain an injury in games than in practice.[4]

Position

- In football, linebackers, wide receivers, and running backs most frequently sustained dislocations.[9]
- Outside hitters reported the highest percentage of shoulder dislocation amongst volleyball players [9]

Pathophysiology

Intrinsic Factors

- Several anatomic factors have been theorized to increase the potential for anterior instability of the

glenohumeral joint. Capsular redundancy, patulousness of the inferior glenohumeral capsule, variations in the capsular and ligament insertion to the glenoid, and laxity of the rotator interval have been identified as risk factors for initial and recurrent instability.[11,12] The glenoid labrum is a static stabilizer of the joint and disruption of this structure yields a decrease in the stability of approximately 10% in all directions.[13] Generalized joint hypermobility (Figure 1-1), as measured by the Beighton scale, has been associated with a 2.5 times increased risk of having reported an episode of glenohumeral instability.[14]

- The loss of osseous integrity by altered inclination or version, as well as bone loss on the glenoid or humeral side of the joint, may affect anterior and inferior joint stability. There is the concept of bone loss inferiorly which may suggest, if significant, a bone block operation rather than an arthroscopic Bankart type of repair.
  - Following failure of an arthroscopic procedure, an open procedure going through the subscapularis might be considered.
  - There may be associated pathology that requires attention such as a superior labrum anterior to posterior (SLAP) lesion. Most surgeons in doing a Bankart repair in the presence of a SLAP, also repair the SLAP for added stability.[15]
  - There is a relationship of the presence of SLAP tears and increased strain on the anterior inferior glenoid humeral ligament. Thus it is related to instability.
- Dynamic stability of the shoulder is dependent on concavity-compression.[16] This phenomenon is related to the centering forces produced by coordinated contraction of the rotator cuff musculature combined with proper position and stabilization of the scapula. [17] A lack of neuromuscular control secondary to interruption of descending neural input,[18-21] rotator cuff inhibition or decreased integrity,[13,22-25] or scapular dyskinesis can lead to shoulder instability.[26,27]

Extrinsic Factors

- The initial incidence of shoulder dislocation was greater in those involved in sport and recreational activities as compared with sedentary individuals in the general population.[2,6] Also, the frequency of recurrent dislocation was greater in athletes (> 80%) than the general population (33%).[7,28]
- Contact has been documented as the most common mechanism of shoulder dislocation.[9,29] In full to partial contact sports, contact with another participant was the most frequent cause of dislocation.[9] Another common mechanism for injury was player contact with equipment and playing surfaces.[9,10]
- In the general population, especially older women, falls on the outstretched arm have been theorized as a frequent cause of dislocation.[2]

Traumatic Factors

- Bankart described the mechanism for shoulder dislocation as a fall on the extended arm causing a forceful extension of the humerus resulting in anterior-inferior dislocation.[30]
- More recently, contact or externally applied energy to the distal upper extremity while the arm is abducted and externally rotated, forcing the shoulder beyond the limits of normal range of motion, has been documented in weight lifters and rugby players sustaining anterior shoulder dislocations.[31-33]

Classic Pathological Findings

- Intraarticular pathology, including disruption of the anterior inferior capsule and labrum associated with anterior dislocation has been classically documented by Perthes (Figure 1-2).[34] Bankart has been credited with describing a shearing disruption of the glenoid labrum naming this the "essential lesion" of any anterior glenohumeral dislocation (Figure 1-3).[30] Previously, Flower in 1861 and Caird in 1887, described the relationship of a defect in the head of the humerus as an associated injury suffered with anterior dislocation.[35]
- Bony injury to the glenoid has been documented as a frequent concomitant injury suffered during a high energy dislocation.[36] The presence of a bony Bankart lesion in association with a Hill-Sachs lesion (often termed an engaging Hill-Sachs lesion) is a risk factor for recurrent dislocation.

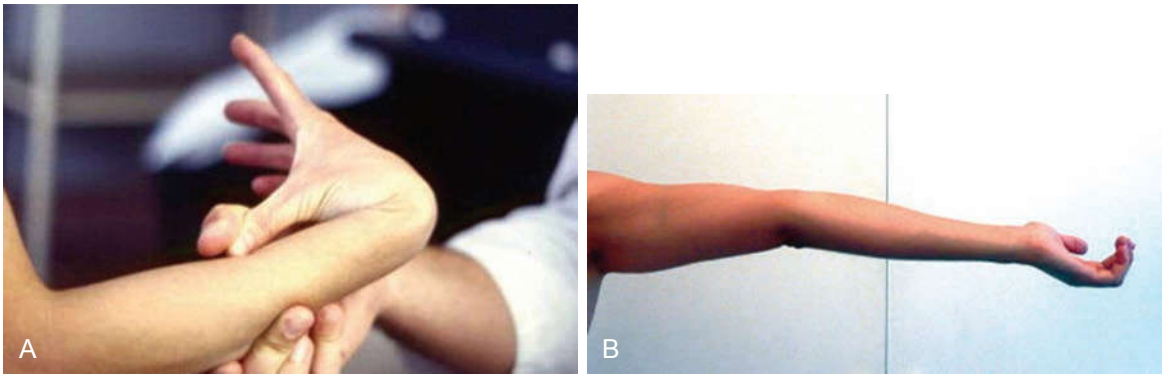

FIGURE 1-1. Hyperlaxity of the wrist (A) and elbow (B).*(Courtesy of Drs. Baujat and Finidori, Necker Hospital, Genetics Department and Pediatric Orthopaedic Surgery Department, Paris, France.) (From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 481) Fig 42-10 and 42-11.*

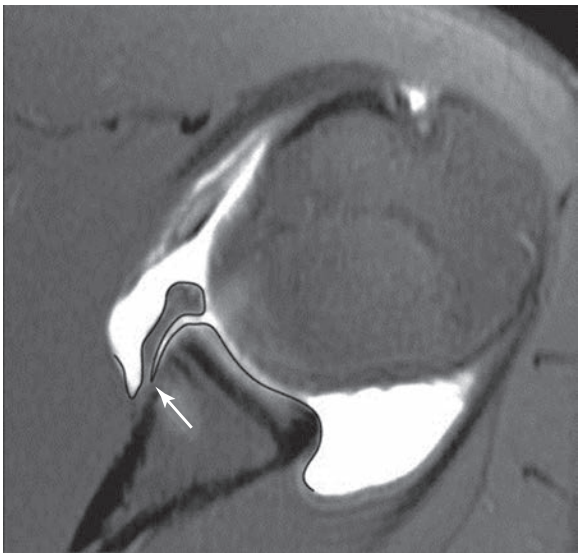

FIGURE 1-2. Axial MRI scan of a Perthes lesion: Incomplete tear of nondisplaced anteroinferior labrum that remains attached to the glenoid neck only through periosteal fibers *(arrow). (From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 98.) Fig 8-10.*

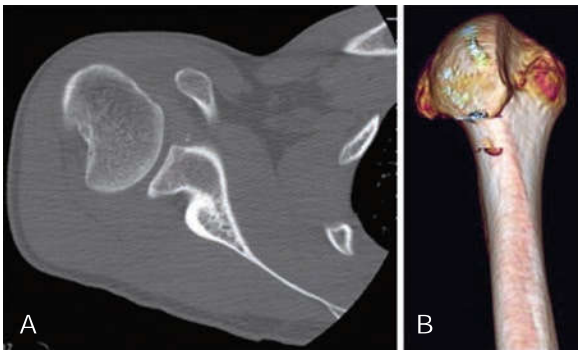

FIGURE 1-3. The axial CT image and associated 3-D reconstruction demonstrate a large Hill-Sachs lesion of the posterosuperolateral humeral head and evaluation of the anterior glenoid rim reveals loss of normal contour consistent with a compression type glenoid injury. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 251.) Fig 21-4.*

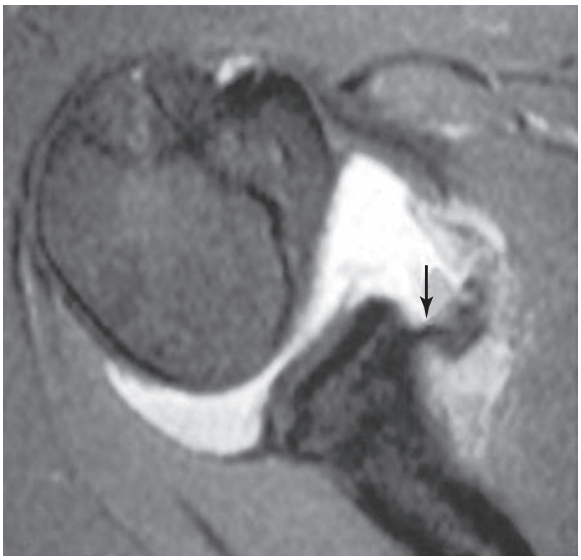

FIGURE 1-4. Axial MRA demonstrating an ALPSA lesion *(arrow). (From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 72.) Fig 6-5A.*

FIGURE 1-5. Performance of the anterior apprehension test. An examination is positive when the patient expresses "apprehension" or the feeling of their shoulder slipping out of socket when in this abducted externally rotated position. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 26.) Fig 2-8A.*

- Researchers documenting the prevalence of specific tissue injury after primary and recurrent anterior dislocations reported anterior labrum periosteal sleeve avulsion (ALPSA) (Figure 1-4) lesions (27%) occurred with greater frequency than Bankart lesions (24%) during primary dislocation.[36]

Clinical Presentation

History

- Depending on the timing of presentation, patients presenting for evaluation often complain of pain after an initial episode of traumatic anterior instability. The pain and muscle spasm may accompany prolonged dislocation with a delay in reduction.
- The individual may report impaired sensation, loss of motion, and impaired strength.[37]
- Commonly, patients report feelings of apprehension and instability.[33]

Physical Examination

Abnormal Findings

- Positive anterior apprehension test (+/– relocation test) (Figure 1-5) is suggestive of anterior instability.[37] The relocation test (Figure 1-6) must not be confused with a positive relocation for reduction of pain which would be suggestive of internal impingement.
- Positive results for the combination of all three provocative (apprehension, relocation, and surprise) tests,

FIGURE 1-6. Performance of the anterior relocation test. The addition of a posteriorly directed force to the anterior proximal arm results in relief of patient apprehension in the abducted, externally rotated position. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 26.) Fig 2-10.*

FIGURE 1-7. True anteroposterior (Grashey) radiographic view demonstrating intact glenoid rim. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 90.) Fig 8-2C.*

was highly specific for the presence of anterior instability.[33]

- The athlete may complain of popping or clicking in the shoulder on movement.[38]
- Neurologic assessment including sensory and motor exam might demonstrate impaired sensation over the deltoid [38] and decreased strength for abduction and external rotation[38]. These symptoms are usually found in an individual requiring eduction of the dislocation. Symptoms may be related to neuropraxia and are usually transient axillary nerve injury.[38] There is rarely decreased strength related to a true persistent neurological injury.

Pertinent Normal Findings

- The patient with anterior instability will demonstrate normal to near normal single plane range of motion after an initial recovery.
- Strength will return after a brief period of recovery barring neurological involvement.
- The patient will resume participation at a high level of play with the exception of overhead activities and activities requiring the arm to extend behind the body or adopt a position of abduction and external rotation.
- The provocative position for anterior instability is the maximal cocking position for a thrower.

Imaging

- Radiographic studies routinely consist of a true AP (right angle to the scapula) (Figure 1-7), a lateral scapula, and an axillary view. They often demonstrate the presence of a Hill-Sachs lesion of the humeral head and may demonstrate a loss of bone at the anterior surface of the glenoid. *There can be specialized X-rays such as a west point view (Figure 1-8) to determine anterior glenoid bone involvement and specialized views to identify a Hill-Sachs lesion.*

FIGURE 1-8. West Point view. Red dots outline glenoid bone loss (about 15%) *(white arrow). (From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 173.) Fig 14-2B.*

- Magnetic resonance imaging (Figure 1-9) may demonstrate tearing of the anterior inferior glenoid labrum and with less frequency the anterior capsule and anterior aspect of the inferior glenohumeral ligament. Increased signals denoting structural deficits and tissue inflammation are noted on the T2-weighted images. The concomitant rotator cuff tear, in an older patient, can be diagnosed with an MRI.
- Commuted tomography (CT) is utilized to identify bone defects in two dimensions.
- CT reconstructions are three-dimensional studies (Figure 1-10) and are used to quantify bone defects on both the humeral and glenoid surfaces when standard X-ray images fail to specifically define the

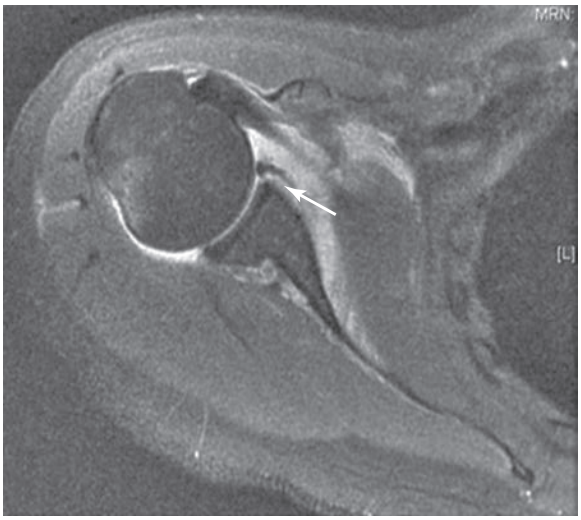

FIGURE 1-9. Axial MR arthrogram demonstrating an anterior labral tear. Note fluid interposed between anterior labrum and glenoid *(arrow). (From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 71.) Fig 6-4A.*

FIGURE 1-11. Commercially available external rotation sling that can be used for immediate postreduction immobilization. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 103.) Fig 9-3.*

FIGURE 1-10. Three-dimensional CT: Arrow indicates the bone fragment detached from the anterior glenoid rim. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach. Philadelphia, 2011, Elsevier (Saunders), p. 96.) Fig 8-7A.*

lesion. These images are used sparingly as they deliver a fair amount of radiation exposure to the patient.

Differential Diagnosis

- Multidirectional instability of the glenohumeral joint may be confused with anterior glenohumeral joint instability. The differential diagnosis is made by history (chronic episodes of subluxation/dislocations and often laxity in multiple joints), unwanted translation in two or more directions (always inferior and either anterior, or posterior), and positive sulcus sign. Additionally, the athlete may present with decreased dynamic stability and poor muscle control in multiple planes of motion.
- Posterior instability may be misdiagnosed as anterior instability. Patients with decreased force couple/concavity compression, and altered positioning of the humeral head in the glenoid fossa can be misdiagnosed with anterior instability. These patients will appear to have increased anterior translation on examination if the humeral head is not centered prior to conducting the load shift test. The differential diagnosis begins with recognizing the presenting symptoms. The patient will often complain of an inability to bring their arm across their body especially when weight is applied to the distal portion of the upper extremity.
- Superior labrum from anterior to posterior (SLAP) lesions have been documented in patients complaining of anterior instability. Patients with complaints of anterior instability have been documented to present with a variety of labral and bony lesion (ALPSA).[15]

Treatment

Nonoperative Management

- Bracing: Itoi et al. have shown that traumatic anterior instability can be placed in a **sling** (Figure 1-11) with pillow at 45° to 60° of external rotation (ER) and the injury heals. However, compliance and long-term success seem to be problematic, based on follow-up studies.
- A criterion-based, progressive exercise program is thought to be effective for short-term management of traumatic anterior shoulder instability coupled with bracing when the athlete returns to sport. This program focuses on rotator cuff and scapular stability as well as maximizing shoulder proprioception/kinetic awareness in higher ranges of elevation and ER.

Guidelines for Choosing Among Nonoperative Treatments

- Patients with initial, unidirectional, capsular injuries may be appropriate for immediate bracing in slight abduction and ER.
- A progressive rehabilitation program works well for many patients to ensure success.

Surgical Indications

- Disability related to recurrent dislocations.
- First-time dislocations with combinations of specific pathologies (e.g., an older patient with combined dislocation and rotator cuff tear).
- Selected patients presenting with acute dislocation and combined bone loss (humeral and glenoid).

Aspects of History, Demographics, or Exam Findings that Affect Choice of Treatment

- Number of dislocations[39]
- Severity of dislocation
  - Was anesthesia required?
  - Was it a "locked" dislocation?
- Labral involvement
- Bony avulsion
- Percentage glenoid bone loss[39]
- Residual neurological or vascular symptoms
- Rotator cuff involvement
- Concomitant SLAP repair[15]

Aspects of Clinical Decision-Making When Surgery is Indicated

- Number of dislocations and the resultant disability are considered when planning for surgery.
- Patient age and overall health.
- Patients presenting with apprehension concerns are examined carefully to define the size and location of the lesion.
- Patients with engaging lesions require consideration to determine if the engagement occurs prior to attainment of the 90-90 positions.
- Patients presenting to the orthopedic surgeon reporting recurrent dislocations with difficult reduction.
- Sport and occupational requirements (i.e., position played, contact, ROM requirements).
- Associated complications (i.e., axillary nerve or rotator cuff involvement).
- Previous failed reconstruction.

Evidence

Arciero RA, Wheeler JH, Ryan JB, et al: Arthroscopic Bankart repair versus nonoperative treatment for acute, initial anterior shoulder dislocations. *Am J Sports Med* 22:589–594, 1994.

This is a prospective study evaluating the effectiveness of two treatment pathways for anterior dislocation of the shoulder in young athletes. Non-operative treatments verses arthroscopic Bankart suture repair for the dislocation was compared. Thirty-six athletes met the inclusion criteria: first time with a traumatic anterior dislocation, no history of impingement or subluxation, dislocation required manual reduction, and no neurological injury present. Of the two patient groups, Group 1 was immobilized for 1 month followed by rehabilitation and return to full activity at 4 months. Group 2 received arthroscopic Bankart repair before receiving similar rehabilitation as those athletes in Group 1. Twelve of the 15 nonoperative patients developed instability following return to full activity. Seven of these patients required open Bankart repair to correct instability. Eighty-six percent of the patients (18/21) in the arthroscopic Bankart repair group were deemed stabile and only one patient returned for an open procedure. It was determined that Bankart repair significantly reduced recurrent instability in anterior shoulder dislocation sustained in young athletes. (Level I evidence).

Bigliani LU, Kelkar R, Flatow EL, et al: Glenohumeral stability. Biomechanical properties of passive and active stabilizers. *Clin Orthop Relat Res* 330:13–30, 1996.

The article focuses on the stability of the glenohumeral joint. The anatomy of the joint is evaluated to analyze how osseous stability is achieved and the mechanics of arthrokinematic motion within the joint. The function of the joint capsule and ligaments are detailed regarding static and dynamic stability. The author recommends conducting studies to elucidate motion and biomechanics under abnormal conditions, such as rotator cuff pathology, and shoulder degeneration. (Level V evidence).

Buss DD, Lynch GP, Meyer CP, et al: Nonoperative management for in-season athletes with anterior shoulder instability. *Am J Sports Med* 32:1430–1433, 2004.

This is a prospective study of 30 athletes sustaining an episode of anterior shoulder instability. The athletes were treated conservatively without a sling and with physical therapy, if necessary, to restore range of motion and strength to symmetrical limits. The athletes were returned to full participation in their sport with a brace and were monitored for the number of recurrent instability episodes, additional injuries, and the ability to complete their season. (Level III evidence)

Cameron KL, Duffey ML, DeBerardino TM, et al: Association of generalized joint hypermobility with a history of glenohumeral joint instability. *J Athl Train* 45:253–258, 2010.

This study enrolled a cohort of 1050 incoming West Point freshman evaluated to identify risk factors for glenohumeral joint instability. The Beighton Scale was used to access generalized joint hypermobility. Those freshmen with a history of glenohumeral joint instability had higher total Beighton Scale scores than did those with no history of instability. Freshmen with a Beighton score greater than 2 were 2.5 times more likely to have an associated history of shoulder instability than those without a history of instability. (Level II evidence).

Griffith JF, Antonio GE, Yung PS, et al: Prevalence, pattern, and spectrum of glenoid bone loss in anterior shoulder dislocation: CT analysis of 218 patients. *AJR Am J Roentgenol* 190:1247–1254, 2008.

This cohort study quantified bone loss via CT scan in 218 patients to determine the prevalence and severity of glenoid bone loss in patients presenting after anterior dislocation. The CT scans were compared with 55 patients without a history of shoulder dislocation. The study determined that glenoid bone loss is common but generally mild. The severity of bone loss was maximally recorded at 33% of surface area. The

number of dislocations was only moderately correlated with the amount of glenoid bone loss. (Level II evidence).

Hantes ME, Venouziou AI, Liantsis AK, et al: Arthroscopic repair for chronic anterior shoulder instability: a comparative study between patients with Bankart lesions and patients with combined Bankart and superior labral anterior posterior lesions. *Am J Sports Med* 37:1093–1098, 2009.

Sixty-three patients with a diagnosis of chronic anterior shoulder instability were studied. Evaluation was performed to determine which of two groups each person should be assigned: Bankart/ALPSA lesion (n = 38), or a combined Bankart/ALPSA lesion and type II SLAP lesion (n = 25). Groups were matched for age, gender, activity level, apprehension and ROM. Arthroscopic examination, preparation, and repair of all injured tissues were performed for each patient. The patients received identical rehabilitation protocols. Patients in the second group displayed significantly more preoperative instability episodes and required on average an additional suture anchor for fixation. Similar results for postoperative success and function were documented between groups. (Level III evidence).

Kralinger FS, Golser K, Wischatta R, et al: Predicting recurrence after primary anterior shoulder dislocation. *Am J Sports Med* 30:116–120, 2002.

This study was a retrospective analysis of records and radiologic follow up of 241 patients treated after episodic anterior instability. Risk factors including: Rowe score, demographics, athletic activity, clinical (ROM, apprehension sign) and radiologic features (Hill-Sachs lesion, glenoid bone loss) were analyzed. The authors found that age (21 to 30) was the most accurate factor predicting recurrence of dislocation. The authors recommended that individuals in this age group participating in high levels of activity should undergo primary stabilization. (Level IV evidence).

Nelson BJ, Aciero RA: Arthroscopic management of glenohumeral Instability. *Am J Sports Med* 28:602–614, 2000.

Over the last 20 years there have been new developments in arthroscopic shoulder techniques, especially in the area of shoulder instability. The article discusses the various arthroscopic surgical techniques used to treat the unstable glenohumeral joint. The article looks at arthroscopic stabilization techniques for primary anterior glenohumeral instability, recurrent anterior instability, and multidirectional instability. The wide ranges of results are also discussed. (Level V evidence).

Owens BD, Duffey ML, Nelson BJ, et al: The incidence and characteristics of shoulder instability at the United States Military Academy. *Am J Sports Med* 35:1168–1173, 2007.

This is a prospective study, which looked at 4141 students at the United Military Academy to determine how many experienced a new traumatic shoulder instability event. Between September 1, 2004 and May 31, 2005; 117 students with a mean age of 20 experienced a traumatic shoulder instability event. Each instability event used the following methods to evaluate the injury: physical examination, plain radiographs, and magnetic resonance imaging. Subluxations where present in 85% of the instability events. Direction, chronicity, and whether it was a subluxation or dislocation were recorded. (Level II evidence).

Simonet WT, Melton LJ, 3rd, Cofield RH, et al: Incidence of anterior shoulder dislocation in Olmsted County, Minnesota. *Clin Orthop Relat Res* 186–191, 1984.

The study retrospectively analyzed the incidence of traumatic anterior shoulder dislocations among all Olmsted County, Minnesota residents during a 10 year period. The history of incidence was reviewed for the 124 patients who had been treated for an anterior dislocated shoulder. Of the 124, 116 had complete follow-up evaluation records. It was determined that the incidence rates were higher among men than women. According to the author, young males have the highest frequency of shoulder dislocations. No significant differences in incidence rates were found between urban and rural communities. (Level IV evidence).

REFERENCES

1. Simonet WT, Melton LJ, 3rd, Cofield RH, et al: Incidence of anterior shoulder dislocation in Olmsted County, Minnesota. *Clin Orthop Relat Res* 186–191, 1984.
2. Kroner K, Lind TJJ: The epidemiology of shoulder dislocations. *Arch Orthop Trauma Surg* 108:288–290, 1989.
3. Nordqvist A, Petersson CJ: Incidence and causes of shoulder girdle injuries in an urban population. *J Shoulder Elbow Surg* 4:107–112, 1995.
4. Owens BD, Agel J, Mountcastle SB, et al: Incidence of glenohumeral instability in collegiate athletics. *Am J Sports Med* 37:1750–1754, 2009.
5. Owens BD, Duffey ML, Nelson BJ, et al: The incidence and characteristics of shoulder instability at the United States Military Academy. *Am J Sports Med* 35:1168–1173, 2007.
6. Zacchilli MA, Owens BD: Epidemiology of shoulder dislocations presenting to emergency departments in the United States. *J Bone Joint Surg Am* 92:542–549, 2010.
7. Arciero RA, Wheeler JH, Ryan JB, et al: Arthroscopic Bankart repair versus nonoperative treatment for acute, initial anterior shoulder dislocations. *Am J Sports Med* 22:589–594, 1994.
8. Rowe MCR, Sakellarides HT: Factors related to recurrences of anterior dislocations of the shoulder. *Clin Orthop* 20:40–47, 1961.
9. Kerr ZY, Collins CL, Pommering TL, et al: Dislocation/separation injuries among US high school athletes in 9 selected sports: 2005–2009. *Clin J Sport Med* 21:101–108, 2011.
10. Bonza JE, Fields SK, Yard EE, et al: Shoulder injuries among United States high school athletes during the 2005–2006 and 2006–2007 school years. *J Athl Train* 44:76–83, 2009.
11. Levine WN, Arroyo JS, Pollock RG, et al: Open revision stabilization surgery for recurrent anterior glenohumeral instability. *Am J Sports Med* 28:156–160, 2000.
12. Rowe CR, Zarins B: Recurrent transient subluxation of the shoulder. *J Bone Joint Surg Am* 63:863–872, 1981.
13. Halder AM, Kuhl SG, Zobitz ME, et al: Effects of the glenoid labrum and glenohumeral abduction on stability of the shoulder joint through concavity–compression: an in vitro study. *J Bone Joint Surg Am* 83-A:1062–1069, 2001.
14. Cameron KL, Duffey ML, DeBerardino TM, et al: Association of generalized joint hypermobility with a history of glenohumeral joint instability. *J Athl Train* 45:253–258, 2010.
15. Hantes ME, Venouziou AI, Liantsis AK, et al: Arthroscopic repair for chronic anterior shoulder instability: a comparative study between patients with Bankart lesions and patients with combined Bankart and superior labral anterior posterior lesions. *Am J Sports Med* 37:1093–1098, 2009.
16. Matsen F, Harryman DT, Sidles JA: Mechanics of glenohumeral instability. *Clin Sports Med* 10:783–788, 1991.
17. Lippitt S, Matsen F: Mechanisms of glenohumeral joint stability. *Clin Orthop Relat Res* 20–28, 1993.
18. Price CIM, Franklin P, Rodgers H, et al: Active and passive scapulohumeral movement in healthy persons: a comparison. *Arch Phys Med Rehabil* 81:28–31, 2000.
19. Price CI, Rodgers H, Franklin P, et al: Glenohumeral subluxation, scpula resting position, and scapula rotation after stroke: a noninvasive evaluation. *Arch Phys Med Rehabil* 82:955–960, 2001.
20. Cofield R, Nessler JP, Weinstabl R: diagnosis of shoulder instability by examination under anesthesia. *Clin Orthop Relat Res* 291:45–53, 1993.

21. Cofield RH, Irving JF: Evaluation and classification of shoulder Instability with special references to examination under anesthesia. *Clin Orthop Relat Res* 223:32–43, 1987.
22. Bigliani LU, Kelkar R, Flatow EL, et al: Glenohumeral stability. Biomechanical properties of passive and active stabilizers. *Clin Orthop Relat Res* 13–30, 1996.
23. Halder AM, Halder CG, Zhao KD, et al: Dynamic inferior stabilizers of the shoulder joint. *Clin Biomech (Bristol, Avon)* 16:138–143, 2001.
24. Halder AM, Itoi E, An KN: Anatomy and biomechanics of the shoulder. *Orthop Clin North Am* 31:159–176, 2000.
25. Halder AM, Zhao KD, O'Driscoll SW, et al: Dynamic contributions to superior shoulder stability. *J Orthop Res* 19:206–212, 2001.
26. Ludewig PM, Reynolds JF: The association of scapular kinematics and glenohumeral joint pathologies. *J Orthop Sports Phys Ther* 39:90–104, 2009.
27. Warner JJ, Micheli LJ, Arslanian LE, et al: Scapulothoracic motion in normal shoulders and shoulders with glenohumeral instability and impingement syndrome. A study using Moire topographic analysis. *Clin Orthop Relat Res* 191–199, 1992.
28. Simonet WT, Cofield RH: Prognosis in anterior shoulder dislocation. *Am J Sports Med* 12:19–24, 1984.
29. Hurwitz S: Medical aspects of adolescents participating in sports. *West J Med* 121:443–447, 1974.
30. Bankart ASB: The pathology and treatment of recurrent shoulder dislocation of the shoulder. *Br J Surg* 26:23–29, 1939.
31. Longo UG, Huijsmans PE, Maffulli N, et al: Video analysis of the mechanisms of shoulder dislocation in four elite rugby players. *J Orthop Sci* 16(4):389–397, 2011.
32. Cresswell TR, Smith RB: Bilateral anterior shoulder dislocations in bench pressing: an unusual cause. *Br J Sports Med* 32:71–72, 1998.
33. Lo IK, Nonweiler B, Woolfrey M, et al: An evaluation of the apprehension, relocation, and surprise tests for anterior shoulder instability. *Am J Sports Med* 32:301–307, 2004.
34. Nelson BJ, Aciero RA: Arthroscopic management of glenohumeral instability. *Am J Sports Med* 28:602–614, 2000.
35. Jobe CM: Gross anatomy of the shoulder. In Rockwood CA, Matsen FA, editors: *The shoulder*, Philadelphia, PA, 1990, WB Saunders, pp 34–37.
36. Kim DS, Yoon YS, Yi CH: Prevalence comparison of accompanying lesions between primary and recurrent anterior dislocation in the shoulder. *Am J Sports Med* 38:2071–2076, 2010.
37. Abboud JA, Armstrong AD: Management of anterior shoulder instability: ask the experts. *J Shoulder Elbow Surg* 20:173–182, 2011.
38. Satterwhite YE: Evaluation and management of recurrent anterior shoulder instability. *J Athl Train* 35:273–277, 2000.
39. Griffith JF, Antonio GE, Yung PS, et al: Prevalence, pattern, and spectrum of glenoid bone loss in anterior shoulder dislocation: CT analysis of 218 patients. *AJR Am J Roentgenol* 190:1247–1254, 2008.

Multiple-Choice Questions

QUESTION 1. Overall in high school athletes, males are at a higher risk of sustaining at traumatic anterior shoulder dislocation when compared to females. However, when comparing which two sports females are at higher risk than males:

A. Boys' baseball to girls' softball
B. Boys' to girls' basketball
C. Boys' to girls' ice hockey
D. Boys' to girls' soccer

QUESTION 2. Generalized joint hypermobility, as measured by the Beighton scale, has been associated with a ____ times increased risk of having reported an episode of glenohumeral instability.

A. 1.5
B. 2.0
C. 2.5
D. 3.0

QUESTION 3. When documenting specific tissue injury after primary and recurrent anterior dislocations, researchers have reported:

A. ALPSA lesions occurred with greater frequency than Bankart lesions during primary dislocation
B. Concomitant intraarticular pathology occurs with increasing frequency with recurrent dislocations
C. Bony Bankart lesions occurred with greater frequency than Hill-Sachs lesions during recurrent dislocation
D. Glad lesions occurred with greater frequency than Bankart lesions during primary dislocation

QUESTION 4. Which of the following modalities is the best choice for an older patient presenting after initial dislocation episode presenting with complaints of weakness and inability to lift their arm overhead?

A. Computed tomography
B. Computed tomography with 3D reconstruction
C. Magnetic resonance imaging
D. Specialized radiographs (West Point view)

QUESTION 5. Neuropraxic symptoms in a patient presenting after anterior dislocation are most often related to:

A. Axillary nerve injury
B. Musculocutaneous nerve injury
C. Radial nerve injury
D. Suprascapular nerve injury

Answer Key

QUESTION 1. Correct answer: **B** (see Overall Incidence—Sport)

QUESTION 2. Correct answer: **C** (see Pathophysiology)

QUESTION 3. Correct answer: **A** (see Pathophysiology)

QUESTION 4. Correct answer: **C** (see Clinical Presentation)

QUESTION 5. Correct answer: **A** (see Clinical Presentation)

NONOPERATIVE REHABILITATION FOLLOWING ANTERIOR CAPSULOLABRAL INJURY

Charles A. Thigpen, PhD, PT, ATC, Ellen Shanley, PhD, PT, OCS, and Richard J. Hawkins, MD

Overview of Goals, Important Milestones, and Guidelines

- Conservative management of anterior shoulder instability is often considered for patients diagnosed with traumatic anterior shoulder instability.
- The rehabilitation process is not dependent on time as clearance for return to sport is not based on assumed tissue healing.
- The rate of recurrence following traumatic anterior shoulder instability is significant and should be considered during the counseling and rehabilitation process. In general, the younger the patient and the more tissues involved (capsule/ligament, labrum, glenoid), the greater the recurrence rate. Therefore, we recommend limiting the number of recurrent episodes as they may lead to increased incidence of intrarticular pathology and long-term complications.
- Rehabilitation following traumatic anterior instability is therefore based on criteria alone with a strong emphasis on maximizing dynamic stability about the shoulder girdle.
- The suggested treatment progressions should be constantly within the context of risk of reinjury based on age, sport, and involved pathology.

GUIDING PRINCIPLES OF NONOPERATIVE REHABILITATION

- Gradual, pain-free restoration of range of motion (ROM) avoiding the sensation of instability
- Muscle guarding/spasm must first be resolved before dynamic stability can be restored
- Correct application of manual techniques and therapeutic exercises to promote static balance in glenohumeral joint mobility and optimum dynamic stabilization from the rotator cuff and associated shoulder girdle muscles.
- Return to sport is not appropriate until the athlete demonstrates dynamic stability in the functional ROM in which they are expected to participate.

Phase I

Goals

- Educate the patient about restrictions, pain management, and activities of daily living (ADLs).
- Protect the anterior shoulder by avoiding positions/movements that are likely to increase stress on the anterior/inferior capsulolabral structures.
- Minimize shoulder pain to normalize muscle tone.
- Gradually restore frontal plane elevation, abduction, and external rotation (ER) above 45°, as suggested in Table 1-1.
- Restore scapular control.

Clinical Pearls

- Modalities and soft tissue mobilization are often helpful to decrease guarding and allow gradual increase in muscle function.
- Restore isometric, then positional, isometric muscle function before progressing to full ROM concentric activities

Protection

- We recommend initial sling use for dislocations with gradual progression to no sling based on pain, available ROM, muscle performance, and activity level.

Management of Pain and Swelling

- Oral pain medications as needed
- Electrical stimulation (Transcutaneous Electrical Neural Stimulation, TENS) is recommended to manage pain and muscle guarding.
- Intermittent cryotherapy for pain and inflammation reduction[1]

Table 1-1 Staged Range of Motion Goals Following Arthroscopic Anterior Capsulolabral Injury

	PFE	PER at 20° abd	PER at 90° abd	AFE
Phase I	90°	10°–30°	Contraindicated	NA
Phase II	155°	50°–65°	75°	145°
Phase III	WFL	WFL	WFL	WFL

AFE, Active forward elevation in the scapular plane; *NA*, not appropriate; *PER*, passive external rotation; *PFE*, passive forward elevation; *WFL*, within functional limits.

- Patient positioning: patients are encouraged to use pillows or bolsters to find a "position of comfort," usually slightly abducted (20° to 30°) in a neutral or slight internal rotation (IR), especially at night. This position is recommended to reduce stress on repaired structures as well as to "unload" the surrounding muscles.

Techniques for Progressive Increase in Range of Motion

- The initial phase is resolving pain, decreasing swelling, and allowing the acute, postinjury shoulder to recover.
- Supported Codman's pendulum exercises for gentle motion and joint distraction, supported forward elevation (FE) (<90°), and ER to 0° at the side (<20° abduction) can be performed immediately to maintain joint mobility but should not reproduce symptoms. We suggest all of these motions be performed with support to minimize rotator cuff activity due to incorrect technique.[2-4]

Manual Therapy Techniques

- Gentle joint distraction and grade I-II joint oscillations may be helpful before performing supervised passive/active assisted range of motion (P/AAROM) by the rehabilitation professional to decrease muscle guarding and prepare the joint for ROM exercise. We recommend these treatments to be performed in the scapular plane in approximately 30° of elevation, and neutral rotation to limit the stress on the capsulolabral injury.[5]

Soft Tissue Techniques

- Shortening, parallel techniques (such as positional release/strain-counterstrain) may be helpful to reduce protective guarding especially for the subscapularis, posterior rotator cuff, teres major, latissimus dorsi, and pectoralis major/minor.

Stretching/Flexibility Techniques for the Musculo-Tendinous Unit

- Stretching/flexibility exercises are not recommended at this time due the need to protect the repair. Cervicothoracic, elbow, hand, and wrist.

Other Therapeutic Exercises

- Lower extremity and cardiovascular exercises may begin immediately as long as there is no reproduction of instability symptoms. This is crucial especially for the in-season management with the goal to return to play in season.

Activation of Primary Muscles Involved

- Isometric exercises may begin day 1 as tolerated. We recommend performing these exercises in the "safe zone" of 20° to 30° abduction in the plane of the scapula in neutral rotation first with the elbow supported then gradually removing support.
- Gradual progression to positional isometrics can begin day 1.

Open and Closed Kinetic Chain Exercises

- Closed chain activities are often less painful and help to provide compression of the GH joint, thereby increasing the static stability of the joint (Figure 1-12).

Neuromuscular Dynamic Stability Exercises

- Exercises to emphasize rotator cuff balance and co-contraction should be emphasized during Phase I (Figure 1-13).

Milestones for Progression to the Next Phase

- Minimal to moderate pain (Numeric Pain Rating Scale [NPRS]: 2 to 4/10) with minimal pain at rest (2/10)

FIGURE 1-12. Closed kinetic chain perturbations in quadruped. Patient is positioned in quadruped loading affected arm as tolerated. Perturbations can then be applied manually or using an unstable surface.

TIMELINE 1-1: Nonoperative Rehabilitation Following Anterior Capsulolabral Injury

PHASE I	PHASE II	PHASE III
• Sling • PT modalities • ROM wk 3—forward elevation to 90° • ROM wk 3—external rotation to 10°–30° • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises • AAROM exercises within functional range • Wk 4—submaximal isometrics for GH joint muscles	• Sling • PT Modalities • ROM wk 3—forward elevation to 90° • ROM wk 3—external rotation to 10°–30° • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises • AAROM exercises within functional range • Wk 4—submaximal isometrics for GH joint muscles	• Sling • PT Modalities • ROM wk 3—forward elevation to 90° • ROM wk 3—external rotation to 10°–30° • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises • AAROM exercises within functional range • Wk 4—submaximal isometrics for GH joint muscles

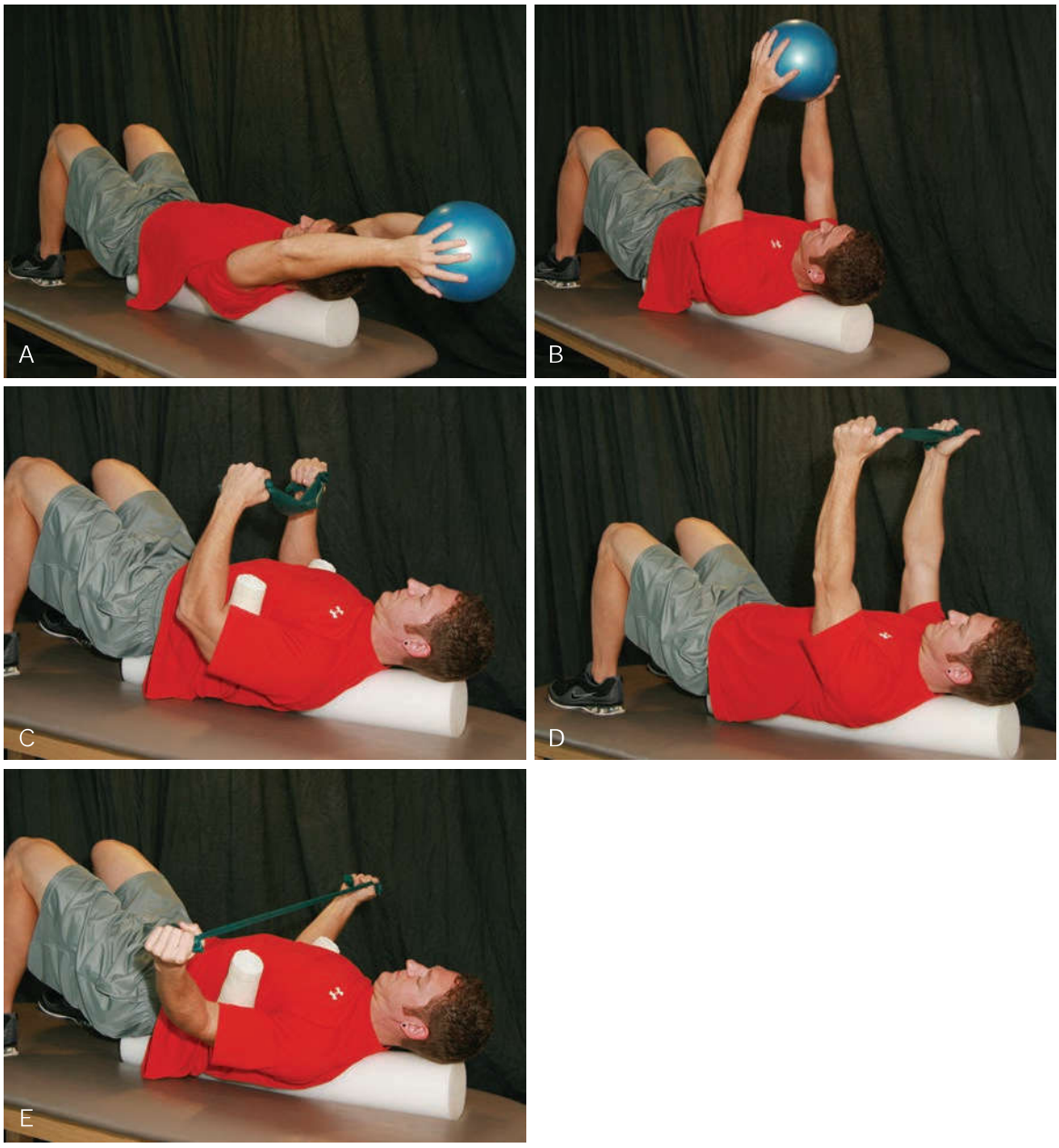

FIGURE 1-13. Cuff co-contraction during elevation: **A, B,** Patient squeezes ball into internal rotation/adduction while elevating arm as tolerated. **C-E,** Patient maintains ER while elevating arm as tolerated.

- Stage I ROM goals achieved but not significantly exceeded

Phase II

Goals

- Minimize shoulder pain (<2/10)
- Achieve staged ROM goals to normalize passive ROM and active ROM.
- Normalize rotator cuff guarding and neuromuscular control
- Normalize scapular position and control

Clinical Pearls

- Normalize subscapularis muscle function to provide dynamic stability for the anterior shoulder.
- Avoid scapular protraction with coronal plane shoulder motion to limit stress on the anterior capsulolabral structures.[6,7]
- Follow up soft tissue work with proprioceptive neuromuscular facilitation (PNF), positional isometrics, and proprioceptive activities to maximize neuromuscular facilitation during early phases after injury.

Patient-Oriented Outcomes

- Best clinical practice uses patient-rated measures of function and disability to comprehensively assess patient response to treatment.
- There are many available scales for measuring functional loss and disability in patients with instability and one measure is likely not superior to another.[8,9]
- We recommend two measures, a general measure of shoulder function that includes pain, function, and patient satisfaction similar to the American Shoulder and Elbow Surgeons' (ASES), the Pennsylvania Shoulder Score (PSS) and a measure specifically for instability, such as the Western Ontario Instability Index (WOSI).[10-14]

Protection

- Treatment for pain/analgesia oral pain medications
- Electrical stimulation (TENS) is recommended to manage pain and muscle guarding. TENS units at home are often helpful to control pain, especially shortly after surgery.
- Intermittent cryotherapy for pain and inflammation reduction.[1] We recommend 20 minutes per hour for the first week following surgery.

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- Gentle joint distraction and grade I-III joint oscillations may be helpful before performing supervised PROM by the rehabilitation professional to decrease muscle guarding, restore capsular balance, and prepare the joint for ROM exercise. Anterior-inferior or inferior glides should not be performed. We recommend these positions to be performed in the scapular plane in approximately 30° of elevation, and neutral rotation to limit the stress on the capsulolabral repair.[5]

Soft Tissue Techniques

- Shortening, parallel techniques such as (Positional Release/Strain-Counterstrain) may be helpful to reduce protective guarding especially for the subscapularis, posterior rotator cuff, teres major, latissimus dorsi, and pectoralis major/minor.
- Passive ROM and active assist ROM exercises may be initiated after POW 2 for ER and FE (see Table 1-1).

Stretching/Flexibility Techniques for the Musculo-Tendinous Unit

- Should not be performed as these are end ROM exercises.

Other Therapeutic Exercises

- Gradual introduction of total body strengthening (TBS), total leg strength (TLS), core stability, uninvolved total arm strength (TAS), and cardiovascular conditioning can be initiated with attention to the safety of the activity. All exercises should be performed so that the patient does not have symptoms of instability during activity.

Activation of Primary Muscles Involved

- Scapular retraction and proprioceptive neuromuscular facilitation (PNF) patterns should be emphasized and positions based on patient tolerance. We recommend first achieving stability in a retracted position then progressing to scapular protraction to minimize increased stress on the anterior capsulolabral structures.[6,7] Although scapular elevation and retraction are safe we suggested limited resistance because of the load placed through the glenohumeral joint for most exercises.
- Active ROM and rotator cuff strengthening within the staged ROM goals in Table 1-1. The recommended procedure is to begin with submaximal isometric strengthening of the shoulder and elbow with the arm adducted to the side in neutral rotation first, then to progressively increase the angle of arm elevation and ER. As the patient demonstrates improved rotator cuff endurance and absence of pain or other symptoms it is recommended to progress to dynamic isometrics, then concentric/eccentric exercises, then AROM exercises within the ROM restrictions.

Sensorimotor Exercises

- Angular reposition, rhythmic stabilization, and repeated contractions within staged ROM limits may be implemented during Phase II.

Open and Closed Kinetic Chain Exercises

- Closed kinetic chain (CKC) exercises may be implemented below 90° of elevation during Phase II. These exercises should begin in a modified weight-bearing position and progressed to full weight-bearing as tolerated.[15]

Techniques to Increase Muscle Strength, Power, and Endurance

- See above w/AROM

Milestones for Progression to the Next Phase

- Appropriate healing of the surgical repair by adhering to the precautions and immobilization guidelines.
- Staged ROM goals achieved but not significantly exceeded
- Minimal to no pain (NPRS: 0—2/10) with ROM
- PSS greater than 60% and WOSI less than 50%. These are estimates based on reported normative data and our experience. This combined with other objective criteria provides clear communication between the patient and medical professionals on how the patient perceives their shoulder function, and gives potential insight as to how care can be improved upon.

Phase III

Goals

- Achieve staged ROM goals to normalize passive ROM and active ROM. DO NOT significantly exceed especially for ER at 90° of abduction

- Minimize shoulder pain (0/10 at rest and <2/10 following exercises or activity)
- Begin to increase strength and endurance
- Increase functional activities as evidenced by PSS > 80% and WOSI < 30%.

Clinical Pearls

- Nearly full active elevation in the plane of the scapula should be achieved before progressing to elevation in other planes or initiating resistive elevation exercises.
- Ensuring posterior rotator cuff performance and scapular stability below 90° of abduction before progressing to higher elevation and difficulty of exercises.
- Posterior-inferior glides are often helpful to gain full ER and FE. Addition of posterior shoulder flexibility exercises in conjunction with these mobs before and after exercise is helpful in the stiff shoulder.
- In our opinion, rapid gain of ER towards 90° of abduction should be avoided (before 8 weeks). If the athlete must return to overhead, throwing sports and the involved shoulder is their throwing arm, then more aggressive stretching of ER towards 90° of abduction may begin at 8 weeks.
- Functional exercises may begin toward the end of this phase. Simple patient instruction to *"keep their hands where they can see them"* will allow the patient to resume desired activities without risking reinjury.

Protection

- No sling use
- Avoid positions of max ER towards 90° of abduction, especially with a posteriorly directed load. (e.g., NO push-ups, bench press, pectoral flys)

Management of Pain and Swelling

- Pain should not be a limiting factor at this point. If pain is limiting progression of activities rest and reevaluation of all aspects of the shoulder should be performed in consultation with the referring surgeon
- Cryotherapy as needed.
- NSAIDS as needed.

Patient Education

- Counsel about using the upper extremity for appropriate ADLs in the pain-free ROM (starting with waist level activities and progressing to shoulder level and finally to overhead activities over time)
- Continue education regarding avoidance of heavy lifting or quick sudden motions
- Education to avoid positions which place stress on the anterior inferior capsule during ADLs

Techniques for Progressive Increase in Range of Motion

- FE should be progressed from active-assistive exercises (e.g., rope and pulley, wall walks), to active, to resistive upright exercises, then finally to prone exercises as per reported electomyography (EMG) activity of the shoulder.[3,4] Although protection of the rotator cuff is not needed, the EMG activity reflects overall stress to the shoulder and is a good guide to exercise progression.

Manual Therapy Techniques

- Grade I-III joint mobilizations (up to tissue resistance) are most often all that is required especially for anterior/inferior directions. If ROM is greater than 50% less than staged ROM goals as compared with the uninvolved extremity then gentle joint mobilizations may be performed. However they should be done only into the limited directions and only until staged ROM goals are achieved. It is crucial in the patients that appear "tight" to discern if there is capsuloligamentous tightness/stiffness, musculotendinous, pain limitation, or some combination.

Soft Tissue Techniques

- Deeper soft tissue techniques may be initiated during this phase. More aggressive techniques such as Active Release® or other instrumented soft tissue mobilizations to normalize muscle tone and extensibility. Particular attention should be paid to the subscapularis, latissimus, pectorals, teres major, and posterior rotator cuff. In our experience these techniques often allow for gradual return consistent with the staged goals without aggressive joint mobilizations or excessive end range stretching.

Stretching/Flexibility Techniques for the Musculo-Tendinous Unit

- Total upper quarter mobility should be evaluated with restoration of cervical, thoracic, and scapulothoracic mobility to facilitate optimal return upper extremity ROM.
- End range flexibility exercises may begin in particular for posterior shoulder (horizontal adduction and sleeper stretch beginning at 60° to 70° of elevation on side.[16,17] Pectoralis minor flexibility can begin with attention not to increase stress on anterior shoulder as these have been shown to be effective at increasing pectoralis minor length (Figure 1-14).[18,19] Gradual introduction of latissimus, posterior shoulder, and FE stretches as needed (Figure 1-15).

Other Therapeutic Exercises

- Address core stability deficits as needed beginning in the sagittal plane and progressing to frontal and transverse plane exercises.
- Total leg strengthening exercises may be progressed as tolerated but high loads should be avoided on the shoulder in activities such as power clean, dead lifts, and back squats should be avoided. Front squats during this phase are recommended to allow for safe positioning of the shoulder with large loads.

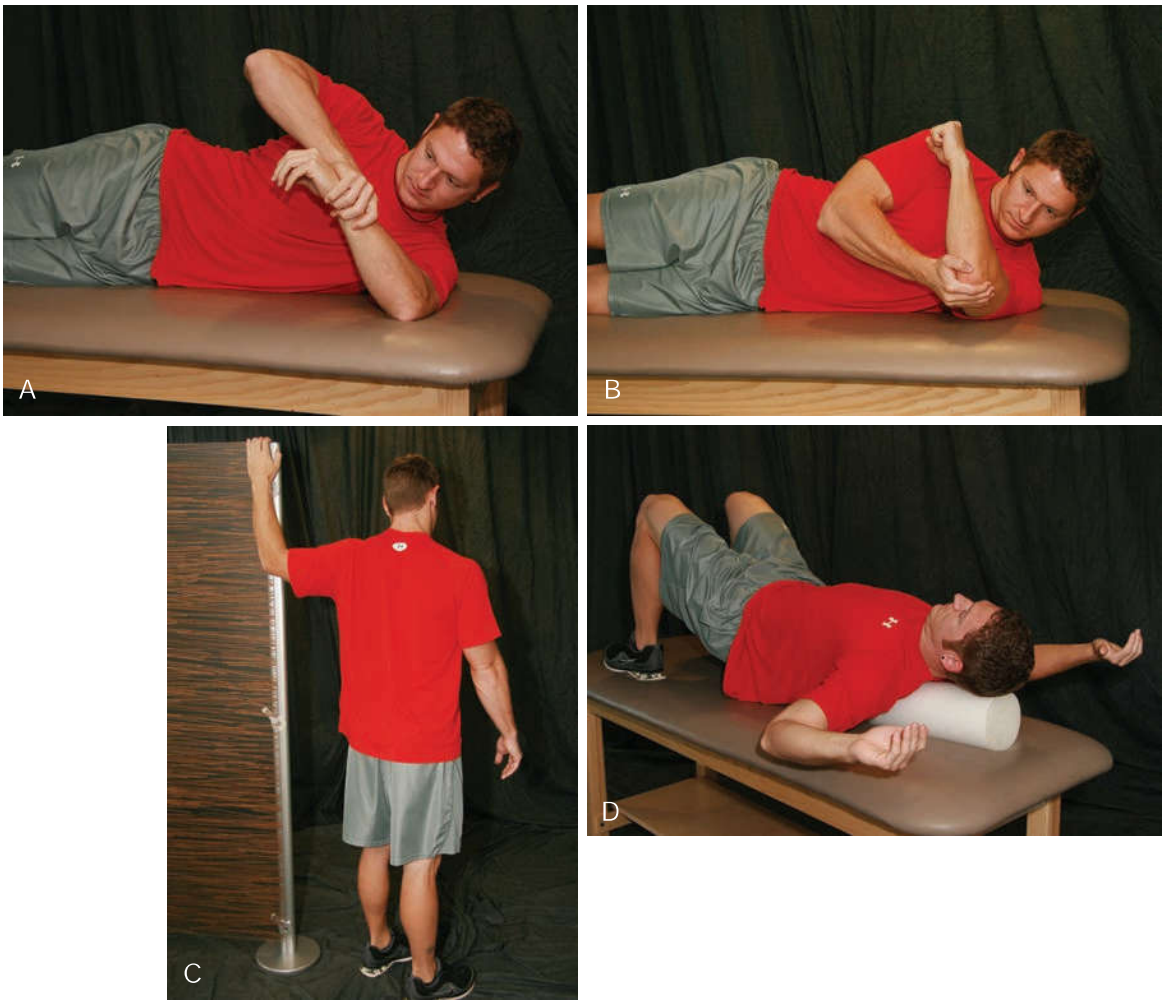

FIGURE 1-14. A, The pectoralis major and minor are stretched by placing the arm at 90° of abduction then leaning forward and rotating away from affected arm while keeping the elbow in line with the scapula and thorax. The patient should report feeling a "stretch" along the anterior shoulder and pectorals, not glenohumeral joint discomfort. **B,** The pectoralis major and minor are stretched by placing the arm at 120° of abduction then leaning forward and rotating away from affected arm the while keeping the elbow in line with the scapula and thorax. The patient should report feeling a "stretch" along the anterior shoulder and pectorals, not glenohumeral joint discomfort. **C, D,** Pectoralis minor flexibility can begin with attention not to increase stress on anterior shoulder as these have been shown to be effective at increasing pectoralis minor length.

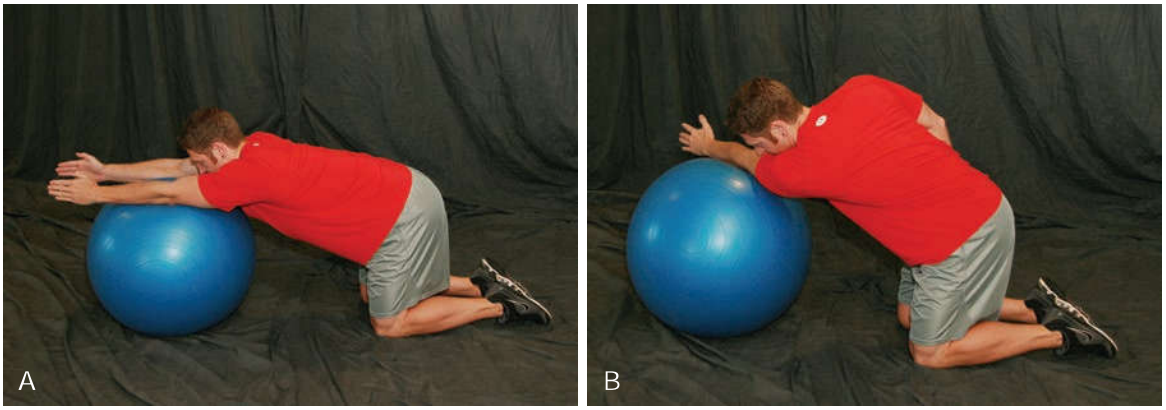

FIGURE 1-15. Latissimus and posterior shoulder flexibility on ball: (A) Patient actively rolls ball away from body and sits back on buttocks maintaining neutral spine then (B) adding trunk rotation away from affected side to change angle of stretch from distal latissimus to posterior cuff and teres major.

- It is also recommended to use this phase of rehabilitation to address kinetic chain deficits using basic functional screens such as the overhead squat, single leg squat, or more in-depth approaches such as the Functional Movement Screen. These approaches will provide areas for improvement for the athlete allowing for total body and lower extremity kinematic chain assessment.

Activation of Primary Muscles Involved

- Elbow flexion/extension strengthening with elbow by the side can begin in this phase
- Exercises and functional activities should be pain free and performed without substitutions or aberrant movement patterns (shrugging, thoracic extension)
- Balanced rotator cuff strengthening to maintain the humeral head centered within the glenoid fossa during progressively more challenging activities
- Should be initially performed in a position of comfort with low stress to the glenohumeral joint such as less than 45° elevation in the plane of the scapula (e.g., elastic band or dumbbell ER, IR, FE)
- Exercises should be progressive in terms of shoulder elevation (e.g., start with exercises performed at waist level progressing to shoulder level and finally overhead activities)
- Depending upon the goals of the exercise (control versus strengthening), rehabilitation activities may also be progressive in terms of speed once the patient demonstrates proficiency at slower speeds

Sensorimotor Exercises

- Activities to improve neuromuscular control of the rotator cuff and shoulder girdle such as use of unstable surfaces, body blade, and manual resistance exercises in conjunction with auditory, visual, or tactile cues or biofeedback.
- PNF patterns are particularly effective for restoring muscle balance and proper coordination patterns. This manual feedback is preferable, especially early during this phase because the clinician controls the load to the extremity and is able to best match the patient's level of performance.

Open and Closed Kinetic Chain Exercises

- Strengthen scapular retractors and upward rotators
- Weight-bearing exercises with a fixed distal segment. Examples: quadruped position while working to maintain proper position of the scapula, quadruped with scapula protraction, progressing from quadruped to tripod position, *no push-ups*[20]

Techniques to Increase Muscle Strength, Power, and Endurance

- Exercises should be progressive in terms of muscle demand. It is suggested to use activities that have muscle activity levels documented with EMG.[2,20-36] In general, increasing elevation increases deltoid and supraspinatus activity, whereas increasing ER at lower levels of elevation increases posterior rotator cuff EMG.[2,20-36] The subscapularis is most active during forward punches (combined scapular protraction and glenohumeral IR) and should be performed at lower and higher levels of elevation.[32]
- Exercises should be progressive in terms of adding stress to the anterior capsule, gradually working towards a position of 90° of ER and 90° of abduction by 12 weeks.
- Rehabilitation should include isolated and complex movement patterns progressing from isolated to complex movement patterns.
- The rotator cuff and scapula stabilizer strengthening program should emphasize high repetitions (typically 30 to 50 reps) and relatively low resistance (typically 1 to 2 kg) during this phase.
- General shoulder strengthening exercises (front/side raises, shoulder presses) may be initiated as full AROM is achieved and rotator cuff and scapular stabilizer strength is adequate for normal movement patterns. This is usually a late Phase III exercise and should begin with 3 to 5 kg and similar reps (15 to 20 for 3 to 4 sets).

Neuromuscular Dynamic Stability Exercises

- Development of dynamic stability is crucial during this phase of rehabilitation following stabilization procedure. Rhythmic stabilization starting at 45° of abduction in the scapular plane in neutral rotation and gradually increasing in elevation and ER as performance increases. Four to five bouts for 30 seconds are recommended before progressing the difficulty of exercises.
- CKC push up plus progression are important exercises as it promotes rotator cuff and scapular stabilizer co-contraction needed for dynamic stability.[30,37]

Plyometrics

- No heavy lifting or plyometrics should be performed during this stage.

Functional Exercises

- Functional exercises may be initiated toward the end of Phase III (weeks 9 to 12); however, we strongly recommend avoiding undue stress on the anterior shoulder.
- Multi-planar exercises should be progressed in a similar fashion as previously described, emphasizing rotational control across each plane of elevation.

Milestones for Progression to the Next Phase

- Staged active ROM goals achieved with minimal to no pain (NPRS 0 to 2/10) and without substitution patterns
- Appropriate scapular posture at rest and dynamic scapular control during ROM and strengthening exercises
- Strengthening activities completed with minimal to no pain (NPRS 0 to 2/10)
- <20% deficit using isokinetic or hand held dynamometer for ER, IR, abduction, and elevation.
- Able to complete 20 hand-taps during modified Davies CKC upper extremity (UE) test.[38] We recommend modifying the Davies test by using biacromial width as in our experience a standard 36″ is too wide for many patients.

- Able to complete 30 reps of ER at <20° of abduction in 30 seconds (1 rep/sec).

Phase IV

- The length of Phase IV will vary dependent upon sport participation. For noncontact sports it may be as simple as a gradual return to sport. For contact athletes it may require a more gradual return to activity in a braced condition.

Goals

- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities
- No or minimal sensation of instability with activities
- Normalize strength, endurance, neuromuscular control, and power as evidenced by:
  - <10% deficit using isokinetic or hand held dynameter for ER, IR, abduction, and elevation.
  - 30 reps in 30 seconds with blue Thera-Band at 0° and 90° abduction
  - Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[38]
  - Gradual demonstration of confidence and performance in sports specific positions.
  - Functional improvement in ADLs and sport as evidenced by PSS > 90% and WOSI < 20%.

Clinical Pearls

- A balance of posterior and anterior rotator cuff strength (ER:IR ratio) of 66% before beginning return to sport training is recommended.[39,40]
- Progression of presport training activities should be monitored, re-evaluating the athlete's pain and strength (no >10% advancement as compared to presport).
- We recommend soreness rules avoiding activity postsoreness for 24 to 48 hours.[41]

Management of Pain and Swelling

- Pain should not be a limiting factor at this point. If pain is limiting progression of activities rest and reevaluation of all aspects of the shoulder should be performed in consultation with the referring surgeon
- Cryotherapy as needed
- NSAIDS as needed

Patient Education

- Counsel about using the upper extremity for appropriate ADLs in the pain-free ROM (starting with waist level activities and progressing to shoulder level and finally to overhead activities over time)
- Continue education regarding avoidance of heavy lifting or quick sudden motions
- Education to avoid positions which place stress on the anterior inferior capsule during ADLs

Other Therapeutic Exercises

- Progressing from Phase III there are no limitations to TBS/TLS or TAS. However, unless end range of motion is required for the athlete's sport then we strongly recommend avoiding training that stresses the shoulder in the ABER position as the risk of developing recurrent instability outweighs the benefits of training.

Open and Closed Kinetic Chain Exercises

- Progression of OKC and CKC consistent with principles previously outlined.

Techniques to Increase Muscle Strength, Power, and Endurance

- During this phase the focus of exercises should progress from endurance to strength and power. This will require increasing loads, speed of movements, and type of contraction.
- *Loads*—loads now may be increased appropriate to sport and body weight beginning with 3 to 5 sets of 10 and progressing to 3 to 5 sets of 4 to 6 reps over the next 8 to 10 weeks consistent with a traditional strength training program.
- *Speed of movement*—concentric movements are challenged first beginning with IR, then ER, then punches and complex movements. Punches are last as this as scapular protraction places increased stress on the capsulolabral complex and is a common mode of dislocation.
- *Type of contraction*—eccentric loads can now be initiated beginning with ER (towards IR) and abduction (towards adduction) first then progressing to IR and abduction in preparation for plyometric exercises.
- It is recommended to gradually progress to positions of high stress during this phase as needed. For example, to progress back to bench press begin with the athlete performing a dumbbell bench press on the floor, then barbell on the floor, then dumbbell (Figure 1-16).

Neuromuscular Dynamic Stability Exercises

- Integration of higher loads and greater perturbations are important in particular for athletes returning to sport.

Examples include:

- For football players clap pushups on foam or Dynadisc
- For throwers repeated ER yo-yos (with 1-kg weight on band)

Plyometrics

- Because of the explosive nature of this type of exercise, emphasis of plyometric exercises should be on quality not quantity. Additionally, 2 to 3 weeks of tolerance to high speed multi-planar activities is recommended, which progressively mimics functional demands before initiating plyometric exercises.
- Perform two to three times/week and utilize moderate reps (e.g., 3 to 5 sets of 15 to 20 reps).

FIGURE 1-16. A, B, The bench press progression begins with dumbbells and the athlete on the floor. The arms are shoulder level then the weight is pushed up finishing with scapular protraction. When the athlete can complete 3 sets of 15 without pain or soreness the barbell bench on the floor can be considered. **C,** The barbell progression is performed in the same manner as dumbbell bench press on the floor completing the exercise with full scapular protraction. **D,** Traditional bench press should begin after completing the floor progression. Hands should be shoulder width apart and the elbows should not go behind the body when the bar is to the chest to protect the anterior repair. A towel roll or other que can be used on the chest to help the athlete modify the exercise.

- Begin with unweighted balls and progress to lightly weighted balls (Plyoballs).

Functional Exercises

- Continue as per Phase III.

Sport-Specific Exercises

- Med ball throws against a wall, for distance for OKC sports.
- UE fitter/stepper in prone position for CKC sports (Figure 1-17).
- Dribbling on wall or rebounding with one hand.

Milestones for Progression to Advanced Sport-Specific Training and Conditioning

- Clearance from physician.
- PSS > 90% and WOSI < 10%.
- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Restoration of sufficient ROM to perform desired activities.
- Maintenance of strength and endurance as evidence by the following:
  - <10% deficit using isokinetic or hand held dynamometer for ER, IR, abduction, and elevation.
  - 30 repetitions in 30 seconds with blue Thera-Band at 0° and 90° abduction
  - Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[38]

Phase V: Return to Sport Progression

- Similar to Phase IV, the length will vary dependent upon sport participation.
- The timing of this phase will be greatly impacted by risk of reinjury and timing relative to competition requirements.
- As risk of reinjury increases, a more conservative approach in return to competition is recommended.

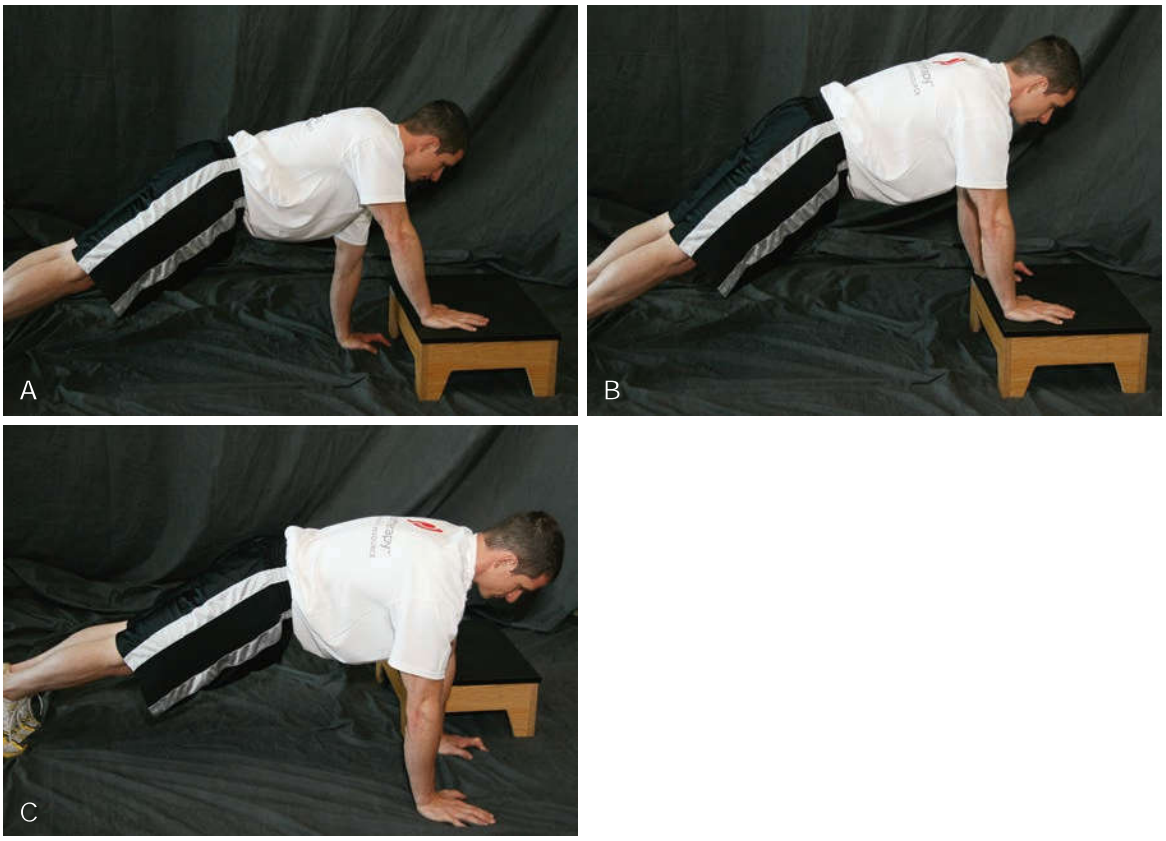

FIGURE 1-17. Hand Walks on Box: Patient "walks" one hand at a time up on box and back down maintaining scapular stability without shrugging and remaining symptom free for 1 rep/sec (both hands up and down) for 30 to 60 seconds.

- As maturity of the athlete and level of competition increase athlete education becomes imperative allowing the sports medicine team (athlete, PT, ATC, and MD) to reach the best decision for that athlete.

Goals

- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities
- No or minimal sensation of instability with activities
- Maintenance of sufficient ROM to perform desired activities
- Maintenance of shoulder strength and endurance as previously described with minimal to no pain (NPRS 0 to 2/10) or difficulty

Clinical Pearls

- Soft tissue and joint mobilizations (once or twice per week) will prevent loss in ROM during the return to sport progression. Careful attention to maintenance of ROM and flexibility will allow for long-term successful return to sport.
- Begin sessions with a complete dynamic warm-up including rotator cuff before complex, functional, and plyometric exercises.
- Continued strengthening of the rotator cuff and scapular stabilization exercises to fatigue should be performed once or twice per week.

Protection

- Use of either a Sully or Donjoy (formerly SaWa) brace is recommended during initial return to sport, in particular for contact athletes. We prefer the SaWa brace-9 (lace up/strap brace) for contact athletes as it is the only brace demonstrated to limit ER and abd ROM.[42] The Sully (neoprene) is recommended for all others as it has been shown to increase proprioception and kinesthetic awareness which are altered in shoulders with anterior instability.[43,44]

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- As previously described PRN.

Soft Tissue Techniques

- As previously described PRN.

Stretching/Flexibility Techniques for the Musculo-Tendinous Unit

- Regular assessment of ROM/flexibility during the return to sport progression and after return to sport is important for long-term shoulder function.

Other Therapeutic Exercises

- As previously described.

Open and Closed Kinetic Chain Exercises

- As previously described.

Techniques to Increase Muscle Strength, Power, and Endurance

- Care should be taken to ensure that the athlete maintains shoulder-strengthening and dynamic strengthening exercises. We recommend 3 days for 20 to 30 minutes of focused rotator cuff and scapular stabilizing exercises in addition to TBS and TAS that may be apart from normal athletic activities.

Plyometrics

- PRN as previously described.

Sport-Specific Exercises

- PRN as previously described.

Criteria for Return to Sport

- PSS > 95% and WOSI < 10%.
- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Maintenance of sufficient ROM to perform desired activities.
- Maintenance of strength and endurance as evidenced by the following:
  - <10% side-to-side deficit using isokinetic or hand held dynameter for ER, IR, abduction, and elevation.
  - <33% unilateral ER:IR ratio[39,40]
  - 30 repetitions in 30 seconds with blue Thera-Band at 0° and 90° abduction
  - Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[38]

Evidence

Arciero RA, Wheeler JH, Ryan JB, et al: Arthroscopic Bankart repair versus nonoperative treatment for acute, initial anterior shoulder dislocations. *Am J Sports Med* 22:589–594, 1994.

We will include all varsity, junior varsity, and freshmen baseball and softball players in our study. Players will be excluded from the study if they are being treated for a shoulder or elbow injury at the beginning of the preseason training. Players will be excluded if they are following a physician, therapist or trainer prescribed arm care program. Athletes complaining of pain during flexibility or strength testing will be excluded from the study. (Level IV evidence)

Bankart ASB: The pathology and treatment of recurrent shoulder dislocation of the shoulder. *Br J Surg* 26:23–29, 1939.

The article looks at the condition of recurrent shoulder dislocation and the operation techniques used to repair the disability, causes of the recurrent dislocation, and the recommended operation for most effective repair. Abnormal laxity in the capsule of the joint and weakness of the surrounding muscles have been associated with the condition. Stretching and imperfect healing from too much use early after reduction has said to cause the recurrent dislocation. Two types of operations to fix the problem are described; one which decreases the size of the capsule, and the other which is supposed to give support to the capsule. The problem with the two techniques is that they can limit normal movement and range of motion. The articles suggest an operation that exposes the anterior margin of the glenoid cavity, and repair the defect with sutures that pass through the free edge of the capsule and glenoid ligament. The goal of the technique is to correct the condition and still maintain normal motion. (Level IV evidence).

Buss DD, Lynch GP, Meyer CP, et al: Nonoperative management for in-season athletes with anterior shoulder instability. *Am J Sports Med* 32:1430–1433, 2004.

This is a prospective study of 30 athletes sustaining an episode of anterior shoulder instability. The athletes were treated conservatively without a sling and with physical therapy, if necessary, to restore range of motion and strength to symmetrical limits. The athletes were returned to full participation in their sport with a brace and were monitored for the number of recurrent instability episodes, additional injuries, and the ability to complete their season. (Level III evidence)

Edouard P, Degache F, Beguin L, et al: Rotator cuff strength in recurrent anterior shoulder instability. *J Bone Joint Surg Am* 93:759–765, 2011.

The study analyzes the relationship between internal/external rotator muscle strength and recurrent anterior shoulder instability. The study included 37 patients with recurrent unilateral shoulder dislocation and 11 healthy nonathletic subjects. A Con-Trex dynamometer was used to test internal and external rotator strength with side-to-side comparisons of the effected group as well as comparisons of the control group. Angles of measure were 180°, 120°, and 60° in concentric mode. Findings showed that patients with recurrent anterior shoulder instability also had weakness in the rotator cuff. Side-to-side differences in strength were present and increased depending on which arm was dominant or non-dominant. The strength difference increases when the nondominant arm was involved, and decreased when the dominant arm was involved. The control group was representative of other studies with healthy subjects who had more strength in the dominant arm. It is suggested that further studies be conducted to determine whether weakness contributes to or is a consequence of recurrent instability. (Level III evidence).

Ellenbecker TS, Mattalino AJ: Glenohumeral joint range of motion and rotator cuff strength following arthroscopic anterior stabilization with thermal capsulorraphy. *J Orthop Sports Phys Ther* 29:160–167, 1999.

This descriptive study of 20 patients diagnosed with anterior shoulder instability described their postoperative rehabilitation program following arthroscopic shoulder stabilization. The involved patients experienced return of ROM and scapular/rotator cuff strength at 12 weeks when compared with the uninjured extremity. (Level IV evidence).

Matias R, Pascoal AG: The unstable shoulder in arm elevation: a three-dimensional and electromyographic study in subjects with glenohumeral instability. *Clin Biomech (Bristol, Avon)* 21(Suppl 1):S52–S58, 2006. [Epub 2005 Nov 9];

An altered scapulohumeral rhythm is said to be related to some shoulder dysfunction, but little is known about the shoulder muscle activation patterns in patients with

glenohumeral instability. The study included six subjects with glenohumeral instability who all performed arm elevations in eight positions. A 6 DOF electromagnetic device was used to record the kinematics. The scapulohumeral rhythms were compared among subjects. The most significant differences were seen in the scapular protraction and spinal tilt and no differences were seen in the scapular lateral rotation. The kinematic changes during certain angles of arm elevation may be due to changes in alignment of the humeral head and glenoid and as a result contribute to shoulder instability. The study emphasizes the importance of assessing scapulohumeral rhythms in the rehabilitation process of individuals with shoulder instability. (Level IV evidence).

Myers JB, Ju YY, Hwang JH, et al: Reflexive muscle activation alterations in shoulders with anterior glenohumeral instability. *Am J Sports Med* 32:1013–1021, 2004.

The study looks at the relationship between anterior shoulder instability and muscle activation alterations. Eleven patients with anterior shoulder instability where matched with 11 control subjects. Each subject underwent external humeral rotation apprehension perturbation while muscle activation characteristics were recorded using electromyographic analysis. Patients with instability showed decreased pectoralis major and biceps brachii mean activation along with increased peak activation in the subscapularis, supraspinatus, and infraspinatus when compared with the control subjects. A much slower bicep brachii mean reflex latency as well as suppressed supraspinatus-subscapularis coactivation was seen in the patients with instability. These results may explain recurring episodes of instability in patients with glenohumeral instability. (Level IV evidence).

Paletta GA, Jr, Warner JJ, Warren RF, et al: Shoulder kinematics with two-plane x-ray evaluation in patients with anterior instability or rotator cuff tearing. *J Shoulder Elbow Surg* 6:516–527, 1997.

The study analyzes the relationship of biplanar glenohumeral kinematics and glenohumeral-scapulothoracic motion in normal patients using a two-plane radiograph series and then in patients with either shoulder instability or rotator cuff tear. The measurements were taken before and after surgery and after postoperative rehabilitation. X-rays of normal adults were obtained to have control values. Patients who had anterior instability showed abnormal motion anterior humeral translation in the anterior posterior plane and in the scapular plane. Following open stabilization the results were normal. The abnormal glenohumeral-scapulothoracic motion relationships persisted after open stabilization. Patients with rotator cuff tears also experienced abnormal glenohumeral kinematics, but after repair the problem become normal. It is suggested that further studies be conducted to understand the significance of the results. (Level IV evidence).

Rodosky MW, Harner CD, et al: The role of the long head of the biceps muscle and superior glenoid labrum in anterior stability of the shoulder. *Am J Sports Med* 22:121–130, 1994.

The study analyzes the role of the long head of the biceps muscle and superior glenoid labrum in anterior stability of the shoulder in overhead positions. Seven nonembalmed cadaver shoulders without history of articular disease where dissected for use in the study. The shoulders simulated the forces of the rotator cuff and long head biceps muscle as the glenohumeral joint was abducted and externally rotated by an Intron testing device. The device applied external rotator torque to the humerus. The testing was first completed on a normal shoulder, then the superior glenoid labrum was detached and the testing was repeated. Results showed that the long head of the biceps muscle contributes to the anterior stability of the shoulder through increasing torsional rigidity. This allows for resistance of external rotatory forces which occurs during abducted and externally rotated positions of the shoulder. In addition, the protective role of the biceps muscles helps to lessen the stress of the inferior glenohumeral ligament. Lesions to the superior glenoid labrum decrease the shoulder's torsional rigidity and put added strain on the inferior glenohumeral ligament and therefore lessen anterior shoulder stability. (Level IV evidence).

Rowe CR, Zarins B: Recurrent transient subluxation of the shoulder. *J Bone Joint Surg Am* 63:863–872, 1981.

Transient subluxation of the shoulder may be the causation of the "dead arm syndrome" characterized by sharp paralyzing pain occurring during extreme external rotation. Activities such as throwing and strained positions with the arm above the shoulder can cause the syndrome. The study includes 58 patients (60 shoulders) all with dead arm syndrome caused by transient dislocation. The treated patients were followed up at 2 to 16 years. Group 1 had the sensation of subluxation and group 2 did not have the sensation. Patients without the sensation are difficult to diagnose correctly. To obtain the most accurate physical finding for patients, an apprehension test was performed. Of the 50 shoulders that underwent a Bankart repair, the following grading system results were obtained: 70% excellent, 24% good, and 6% fair. Deficiencies in the shoulder capsule are said to be a factor of anterior subluxation of the shoulder. (Level III evidence).

REFERENCES

1. Osbahr DC, Cawley PW, Speer KP: The effect of continuous cryotherapy on glenohumeral joint and subacromial space temperatures in the postoperative shoulder. *Arthroscopy* 18:748–754, 2002.
2. Dockery ML, Wright TW, LaStayo PC: Electromyography of the shoulder: an analysis of passive modes of exercise. *Orthopedics* 21:1181–1184, 1998.
3. Uhl TL, Muir TA, Lawson L: Electromyographical assessment of passive, active assistive, and active shoulder rehabilitation exercises. *PM R* 2:132–141, 2010.
4. Gaunt BW, McCluskey GM, Uhl TL: An electromyographic evaluation of subdividing active-assistive shoulder elevation exercises. *Sports Health* 2:424–432, 2010.
5. Blasier RB, Goldberg RE, Rothman ED: Anterior shoulder instability: contribution of rotator cuff forces and capsular ligaments in a cadaver model. *J Shoulder Elbow Surg* 1:140–150, 1992.
6. Weiser WM, Lee TQ, McMaster WC, et al: Effects of a simulated scapular protraction on anterior glenohumeral stability. *Am J Sports Med* 27:801–805, 1999.
7. Smith J, Dahm DL, Kotajarvi BR, et al: Electromyographic activity in the immobilized shoulder girdle musculature during ipsilateral kinetic chain exercises. *Arch Phys Med Rehabil* 88:1377–1383, 2007.
8. Oh JH, Jo KH, Kim WS, et al: Comparative evaluation of the measurement properties of various shoulder outcome instruments. *Am J Sports Med* 37:1161–1168, 2009.
9. Plancher KD, Lipnick SL: Analysis of evidence-based medicine for shoulder instability. *Arthroscopy* 25:897–908, 2009.
10. Kirkley A, Griffin S, McLintock H, et al: The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. The Western Ontario Shoulder Instability Index (WOSI). *Am J Sports Med* 26:764–772, 1998.
11. Kocher MS, Horan MP, Briggs KK, et al: Reliability, validity, and responsiveness of the American Shoulder and Elbow Surgeons subjective shoulder scale in patients with shoulder instability, rotator cuff disease, and glenohumeral arthritis. *J Bone Joint Surg Am* 87:2006–2011, 2005.
12. Michener LA, McClure PW, Sennett BJ: American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, Patient

Self-Report Section: Reliability, Validity, and Responsiveness. *J Shoulder Elbow Surg* 11:587–594, 2002.
13. Leggin BG, Michener LA, Shaffer MA, et al: The Penn Shoulder Score: Reliability and Validity. *J Orthop Sports Phys Ther* 36:138–151, 2006.
14. Michener LA, Snyder AR, Leggin BG: Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status. *J Sport Rehabil* 20:115–128, 2011.
15. Wise MB, Uhl TL, Mattacola CG, et al: The effect of limb support on muscle activation during shoulder exercises. *J Shoulder Elbow Surg* 13:614–620, 2004.
16. Borstad JD, Mathiowetz KM, Minday LE, et al: Clinical measurement of posterior shoulder flexibility. *Man Ther* 12:386–389, 2007.
17. McClure P, Balaicuis J, Heiland D, et al: A randomized controlled comparison of stretching procedures for posterior shoulder tightness. *J Orthop Sports Phys Ther* 37:108–114, 2007.
18. Borstad JD, Ludewig PM: Comparison of three stretches for the pectoralis minor muscle. *J Shoulder Elbow Surg* 15:324–330, 2006.
19. Wang CH, McClure P, Pratt NE, et al: Stretching and strengthening exercises: their effect on three-dimensional scapular kinematics. *Arch Phys Med Rehabil* 80:923–929, 1999.
20. Uhl TL, Carver TJ, Mattacola CG, et al: Shoulder musculature activation during upper extremity weight-bearing exercise. *J Orthop Sports Phys Ther* 33:109–117, 2003.
21. Blackburn TA, McLeod WD, White B, et al: EMG analysis of posterior rotator cuff exercises. *Athl Train* 25:40–47, 1990.
22. Moseley JB Jr., Jobe FW, Pink M, et al: EMG analysis of the scapular muscles during a shoulder rehabilitation program. *Am J Sports Med* 20:128–134, 1992.
23. Ballantyne BT, O'Hare SJ, Paschall JL, et al: Electromyographic activity of selected shoulder muscles in commonly used therapeutic exercises. *Phys Ther* 73:668–677, discussion 77–82, 1993.
24. Reinold MM, Wilk KE, Fleisig GS, et al: Electromyographic analysis of the rotator cuff and deltoid musculature during common shoulder external rotation exercises. *J Orthop Sports Phys Ther* 34:385–394, 2004.
25. Illyes A, Kiss RM: Electromyographic analysis in patients with multidirectional shoulder instability during pull, forward punch, elevation and overhead throw. *Knee Surg Sports Traumatol Arthrosc* 15:624–631, 2007.
26. Kibler WB, Chandler TJ, Shapiro R, et al: Muscle activation in coupled scapulohumeral motions in the high performance tennis serve. *Br J Sports Med* 41:745–749, 2007.
27. Lister JL, Del Rossi G, Ma F, et al: Scapular stabilizer activity during Bodyblade, cuff weights, and Thera-Band use. *J Sport Rehabil* 16:50–67, 2007.
28. Reinold MM, Macrina LC, Wilk KE, et al: Electromyographic analysis of the supraspinatus and deltoid muscles during 3 common rehabilitation exercises. *J Athl Train* 42:464–469, 2007.
29. Jaggi A, Malone AA, Cowan J, et al: Prospective blinded comparison of surface versus wire electromyographic analysis of muscle recruitment in shoulder instability. *Physiother Res Int* 14:17–29, 2009.
30. Maenhout A, Van Praet K, Pizzi L, et al: Electromyographic analysis of knee push up plus variations: what's the influence of the kinetic chain on scapular muscle activity? *Br J Sports Med* 44:1010–1015, 2010.
31. Decker MJ, Hintermeister RA, Faber KJ, et al: Serratus anterior muscle activity during selected rehabilitation exercises. *Am J Sports Med* 27:784–791, 1999.
32. Decker MJ, Tokish JM, Ellis HB, et al: Subscapularis muscle activity during selected rehabilitation exercises. *Am J Sports Med* 31:126–134, 2003.
33. Ekstrom RA, Donatelli RA, Soderberg GL: Surface electromyographic analysis of exercises for the trapezius and serratus anterior muscles. *J Orthop Sports Phys Ther* 33:247–258, 2003.
34. Hintermeister RA, Lange GW, Schultheis JM, et al: Electromyographic activity and applied load during shoulder rehabilitation exercises using elastic resistance. *Am J Sports Med* 26:210–220, 1998.
35. Ludewig PM, Hoff MS, Osowski EE, et al: Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. *Am J Sports Med* 32:484–493, 2004.
36. Townsend H, Jobe FW, Pink M, et al: Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program. *Am J Sports Med* 19:264–272, 1991.
37. Malliou PC, Giannakopoulos K, Beneka AG, et al: Effective ways of restoring muscular imbalances of the rotator cuff muscle group: a comparative study of various training methods. *Br J Sports Med* 38:766–772, 2004.
38. Goldbeck T, Davies G: Test-retest reliability of the closed kinetic chain upper extremity stability test: a clinical field test. *J Sport Rehabil* 9:35–45, 2000.
39. Ellenbecker TS: Rehabilitation of shoulder and elbow injuries in tennis players. *Clin Sports Med* 14:87–109, 1995.
40. Ellenbecker TS, Mattalino AJ: Glenohumeral joint range of motion and rotator cuff strength following arthroscopic anterior stabilization with thermal capsulorraphy. *J Orthop Sports Phys Ther* 29:160–167, 1999.
41. Axe MJ, Snyder-Mackler L, Konin JG, et al: Development of a distance-based interval throwing program for Little League-aged athletes. *Am J Sports Med* 24:594–602, 1996.
42. Weise K, Sitler MR, Tierney R, et al: Effectiveness of glenohumeral-joint stability braces in limiting active and passive shoulder range of motion in collegiate football players. *J Athl Train* 39:151–155, 2004.
43. Chu JC, Kane EJ, Arnold BL, et al: The effect of a neoprene shoulder stabilizer on active joint-reposition sense in subjects with stable and unstable shoulders. *J Athl Train* 37:141–145, 2002.
44. Ulkar B, Kunduracioglu B, Cetin C, et al: Effect of positioning and bracing on passive position sense of shoulder joint. *Br J Sports Med* 38:549–552, 2004.

Multiple-Choice Questions

QUESTION 1. Recurrent episodes following traumatic anterior shoulder instability generally increase

A. The older a patient and less tissues involved.
B. The younger a patient and more tissues involved.
C. The older a patient and more tissues involved.
D. The younger a patient and less tissues involved.

QUESTION 2. Rotator cuff exercises in Phase I are best tolerated

A. In the "safe zone" of 20° to 30° abduction in the plane of the scapula.
B. In neutral abduction and rotation.
C. In supported elevation at 90° of abduction.
D. In 45° of abduction and 20° of IR.

QUESTION 3. Which statement best describes the rationale of why recurrent instability is worrisome?

A. Clearance for return to sport isn't based on number of recurrent episodes.
B. Contact athletes are at risk for rotator cuff tears with recurrent instability.
C. There is no evidence that recurrent instability increases injury risk or long-term disability.
D. Recurrent instability episodes may lead to increased incidence of intraarticular pathology and early onset osteoarthritis.

QUESTION 4. Criteria for initiating resistance exercises above shoulder height include

A. Pain free at rest, full AROM in abduction and ER.
B. Pain free at rest, PROM within functional limits, and negative apprehension test.
C. Pain free after exercise, AROM within functional limits, and tolerance of Phase 2 exercises.
D. Pain free at rest, AROM within functional limits, and tolerance of Phase 2 exercises.

QUESTION 5. A 16-year-old linebacker is 4 weeks s/p a right shoulder dislocation without labral or bony injuries confirmed by MRI. What criteria should they meet to return to play?

A. No sense of instability at end ROM, < 50% ER:IR strength ratio, and 60 hand-taps during CKC UE test.
B. No sense of instability at end ROM, < 50% ER:IR strength ratio, and 90 hand-taps during CKC UE test.
C. Minimal sense of instability at end ROM, < 33% ER:IR strength ratio, and 60 hand-taps during CKC UE test.
D. Minimal sense of instability at end ROM, < 33% ER:IR strength ratio, and 90 hand-taps during CKC UE test.

Answer Key

QUESTION 1. Correct answer: **B**. (see Overview)

QUESTION 2. Correct answer: **A**. (see ROM Guidelines Phase I)

QUESTION 3. Correct answer: **D**. (see Overview/Return to Sport-Phase IV)

QUESTION 4. Correct answer: **C**. (see Phases II and III)

QUESTION 5. Correct answer: **D**. (see Phase IV-Return to Sport)

POSTOPERATIVE REHABILITATION AFTER ARTHROSCOPIC ANTERIOR SHOULDER STABILIZATION

Charles A. Thigpen, PhD, PT, ATC, Ellen Shanley, PhD, PT, OCS, and Richard J. Hawkins, MD

Indications for Surgical Treatment

- Disability related to recurrent shoulder instability.
- Following first time dislocation selected patients combined with certain pathologies (e.g., full thickness rotator cuff tear following dislocation in older patient, large glenoid or humeral defect).

Brief Summary of Surgical Technique

Major Surgical Steps

- Examination under anesthesia for translation in all directions and range of motion.
- Positioning in lateral decubitus or sitting (beach chair) position (Figures 1-18 and 1-19). Either requires some lateral distraction.
- Prepping and draping protecting vulnerable areas and insuring sterility and accessibility.
- Insertion of scope for visualization (establish outflow when necessary) (Figures 1-20 and 1-21).
- Identify pathology and determine approach.
- Prepare anterior glenoid surface.
- Mobilize labrum and capsule (Figures 1-22 and 1-23).
- Secure capsule and labrum to anterior glenoid usually with bone anchors (Figure 1-24).
- Usually three anchors securing capsule and labrum.
- Amount of capsule incorporated varies based on the amount of laxity under exam under anesthesia (EUA), labral/capsular damage, and functional range of motion (ROM) requirements (thrower vs. linebacker)
- Usually three anchors. Anchors at apex or slightly upon the face of glenoid to recreate bumper.
- Remove traction and close portal sites in usual fashion.

Factors That May Affect Rehabilitation

Surgical

- In this section we discuss arthroscopic plication and the Bankart repair. The principles of open surgical reconstruction for anterior instability would be similar if soft tissue in nature (i.e., modified Bankart procedure). Bony procedures if secured by screws may allow earlier mobilization.
- Amount of capsular plication and integrity of the capsule.[2] ROM progression and goals may be delayed for excessive plication to correct excessive capsular redundancy or for patients with a long-standing instability history as their anterior-inferior capsule is often not robust.[2,3]
- Degree of labral repair/reconstruction repairs.[4] Typically, the labrum is detached from the 3 to 6 o'clock position off the glenoid. Tears that extend beyond these borders would require close consultation with the surgeon to modify ROM limits and precautions.
- Amount of glenoid bone loss.[5-7] The degree of glenoid bone loss will influence ROM expectations as well as amount of protection needed postoperatively. Emerging evidence suggests glenoid bone loss as a likely factor in recurrent dislocations. Significant bone loss anteriorly may suggest soft tissue arthroscopic reconstruction inadequate and may require a bony reconstruction (i.e., Latarjet).
- Associated injuries such as a Hill-Sachs lesion, SLAP (superior labral tear from anterior to posterior) tears,

FIGURE 1-18. The lateral decubitus position. (A) Operative setup. The arm is usually abducted between 45 and 60 degrees. (B) Final balanced suspension setup with the arm abducted about 50 degrees and a lateral strap is used to facilitate the visualization of the glenohumeral joint. Care must be taken to ensure the lateral suspension strap is around a padded arm sleeve. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), p. 37.) Fig. 3-10B and 3-12.*

FIGURE 1-19. Beach chair position. Final positioning with the arm reduced to a pneumatic arm positioner. It is easier to reduce the arm to the arm holder that has been previously placed on the pneumatic arm positioner. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), p. 41.) Fig. 3-20C.*

rotator cuff tears, or other osteochondral injuries may also be present.[4] The impact of these concomitant injuries and potential procedures should be accounted for in the rehabilitation plan.

Anesthetic

- Anesthesia interscalene blocks are commonly used postoperatively for short-term pain control.
- Usually, one interscalene injection is appropriate for anterior instability procedures.
- Patients may perform ROM exercises carefully as directed by the surgeon.
- An interscalene block may require careful early mobilization under the direction of a Physical Therapist or Certified Athletic Trainer as directed by the surgeon.

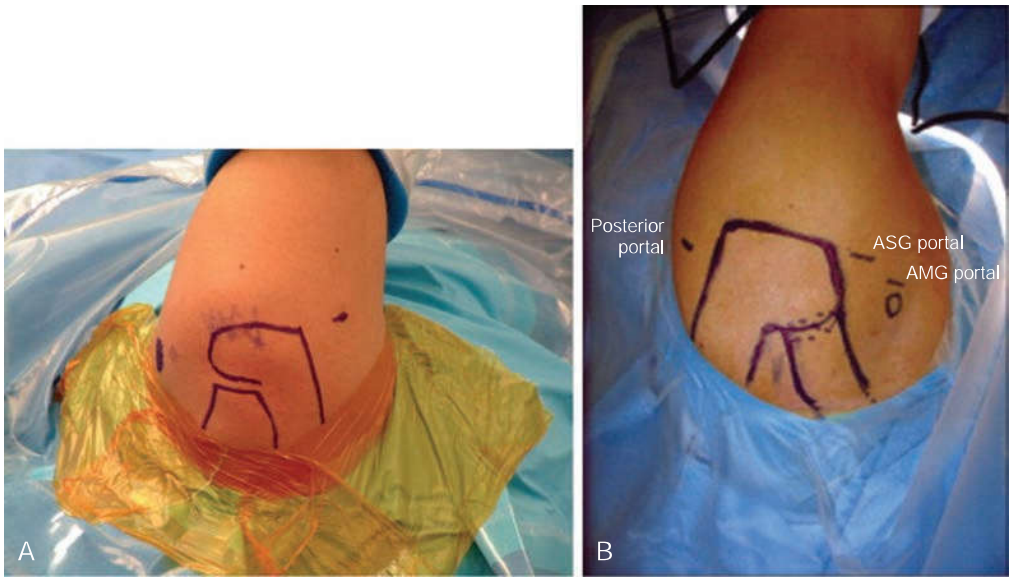

FIGURE 1-20. Surgical skin landmarks. **A,** Initial skin markings showing landmarks. Note lateral position of anticipated portal posteriorly. **B,** Shows portals. *(From Reider B, et al: Operative techniques: sports medicine surgery, Philadelphia, 2010, Elsevier (Saunders)) Fig. 11-14A and B.*

FIGURE 1-21. Outside picture demonstrating arthroscope posterior and 18-gauge needles placed in outside-in fashion. Note anterosuperior portal is adjacent to anterior acromion and anterior mid-glenoid portal is adjacent to coracoid. *From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), p. 135.) Fig. 11-15.*

Other Surgical Techniques and Options

- Major differences in other surgical techniques
  - Open Bankart repair is the same as the arthroscopic Bankart repair with the exception that the subscapularis is either detached or split for accessibility to the anterior labrum, capsule, and glenoid (see Figure 1-29).
  - Open procedures for bone loss or bony defects require secure fixation or a bone block such as a Latarjet (see Figure 1-33) with an associated soft tissue reconstruction. Rehab is much the same but may allow early mobilization. Other grafts may be used such as iliac crest graft or allograft. These are securely fixed to anterior glenoid. These also require subscapularis violation.
- This chapter is dedicated primarily to arthroscopic plication with or without a Bankart repair. The primary difference between the following guidelines and these surgical modifications is rate of ROM return. For the open surgical reconstruction significant attention should be given to external rotation (ER). ER should be limited to 30° with the arm at the side and a measured rate of ROM. We recommend ER to 0 for 3 weeks then gradual stretching with a goal of attaining 30° of ER by 6 weeks. In contrast, bony procedures if secured by screws may allow earlier mobilization with gradual return of ER and ABD ROM.

GUIDING PRINCIPLES OF POSTOPERATIVE REHABILITATION

- Understanding of the surgical procedure and anatomic structures, which require protection.
- Consideration of healing rates of the involved tissues while balancing the stresses needed for tissue proliferation/remodeling and protecting the repaired/reconstructed tissues.[1]
- Gradual restoration of PROM while protecting the anterior-inferior aspect of the glenohumeral joint through initial immobilization and the rate of ROM gain. Emphasizing PROM then AROM then resisted activities.
- Correct application of manual techniques and therapeutic exercises to promote static balance in glenohumeral joint mobility and optimum dynamic stabilization from the rotator cuff and associated shoulder girdle muscles.

Phase I (0 to 14 days): Immediate Postoperative Period

Goals

- Protect the surgical repair (capsule, ligaments, labrum, sutures)

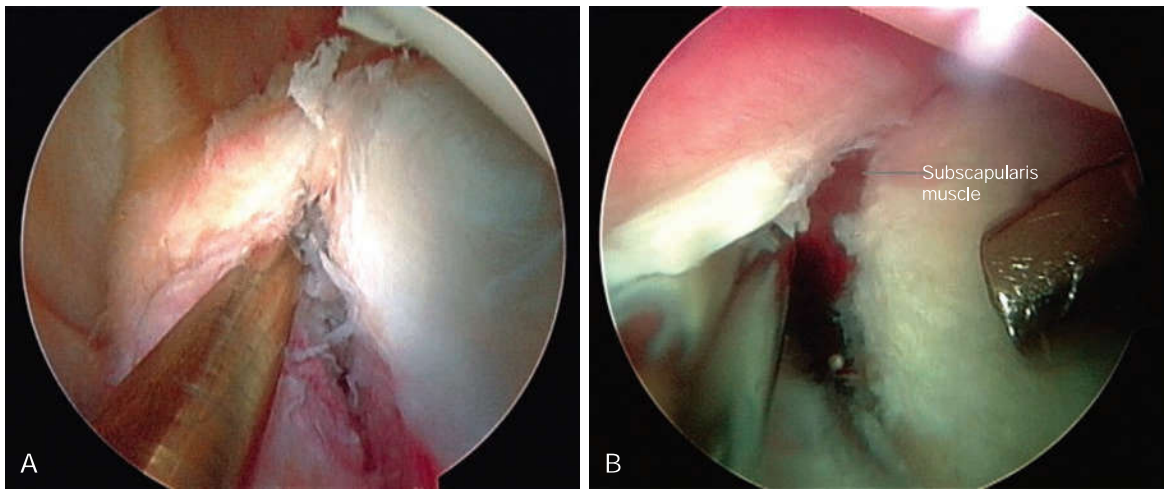

FIGURE 1-22. Preparation of anterior labrum. **A,** Arthroscopic view from anterosuperior portal in a right shoulder showing anterior-inferior capsulolabral avulsion. **B,** Right shoulder showing mobilization of anterior capsulolabral avulsion with subscapularis muscle visible deep to labrum. *From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), pp.136 and 137.) Fig. 11-20 and 11-22.*

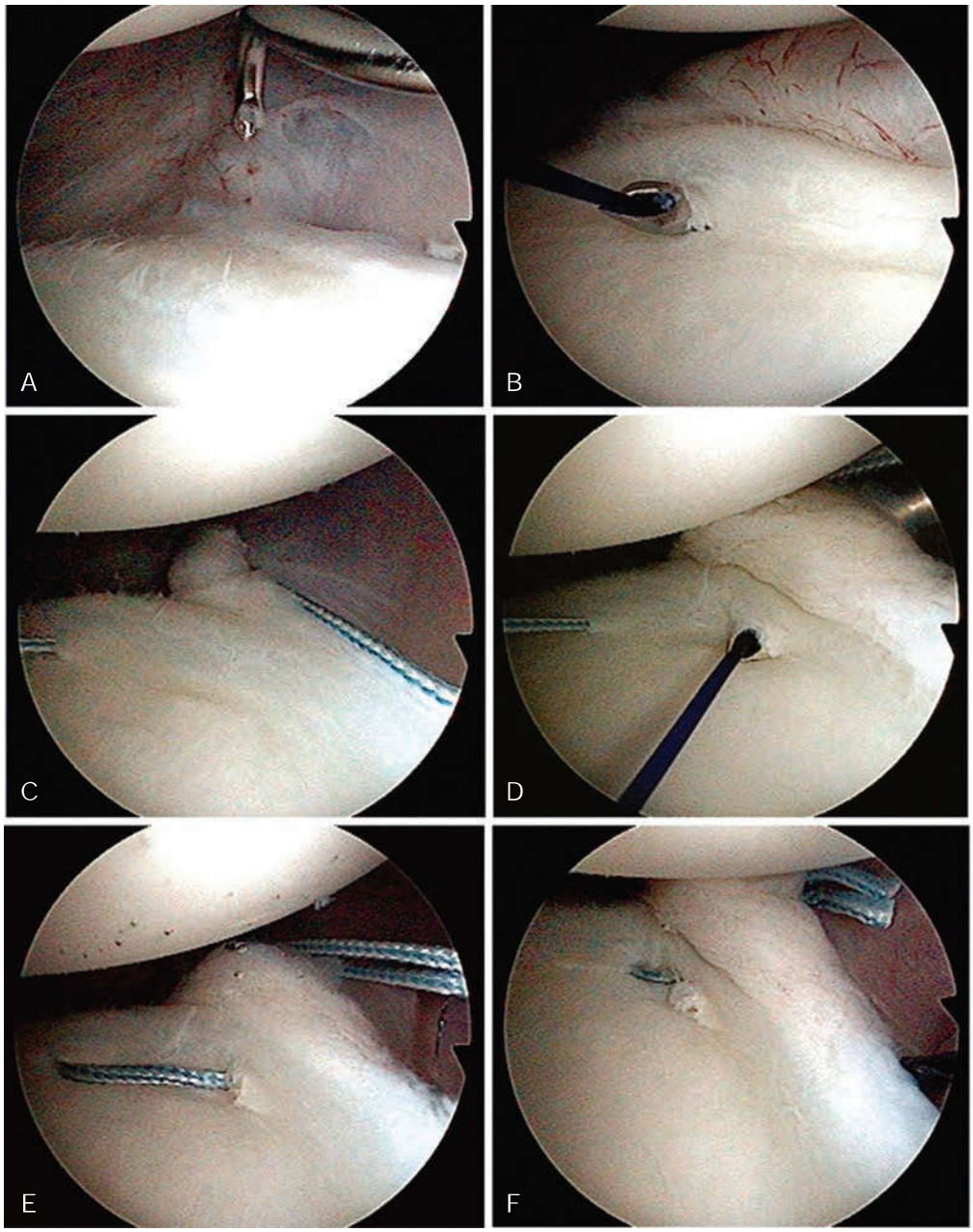

FIGURE 1-23. Mobilization of labrum and capsule. Sequence of performing plication posteroinferiorly as part of the initial phase of the repair in a right shoulder; viewing portal is anterosuperior. **A,** A suture shuttling device pierced capsule about 10 mm lateral to labrum at 6 o'clock position. **B,** The needle is then brought through the labrum and a monofilament suture (0 or No. 1) is passed and retrieved out of the anterior mid-glenoid portal. **C,** A nonabsorbable suture (No. 2) is tied to the monofilament suture outside the anterior mid-glenoid portal, and the monofilament suture acts to shuttle the nonabsorbable suture. **D,** Steps are repeated to shuttle the other limb of the nonabsorbable suture through labrum and capsule. **E,** Mattress plication suture in place posteroinferiorly. **F,** Mattress plication suture tied; note reduction of posteroinferior redundancy. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), p. 138.) Fig. 11-24A-F.*

- Educate the patient in terms of restrictions, pain management, and ADLs
- Minimize shoulder pain
- Achieve staged ROM goals, DO NOT significantly exceed them
- Restore scapular control

Clinical Pearls

- When patients are very painful and guarded reviewing sleeping habits, sling use, and HEP are often helpful in managing pain allowing for gentle restoration of ROM.
- Gradual "weaning" of the sling in 4-hour increments/day provides for gradual introduction of stress to shoulder decreasing likelihood of development of pain and loss of ROM.

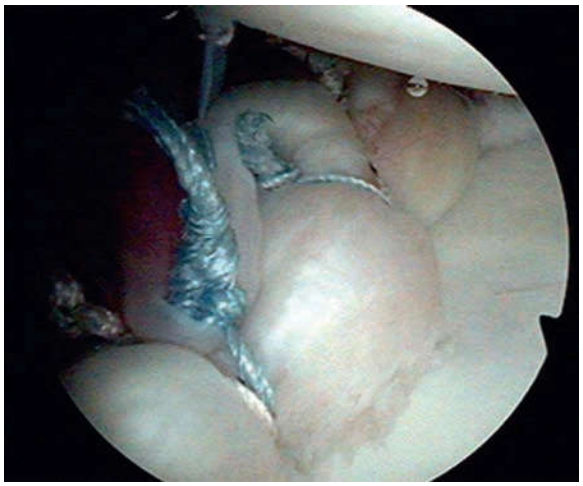

FIGURE 1-24. Securing labrum and capsule. Finished repair with combined plication and labral repair performed anteriorly with each anchor. In this case double-loaded anchors were used. *(From Provencher MT, Romeo AA, editors: Shoulder instability: a comprehensive approach, Philadelphia, 2011, Elsevier (Saunders), p. 142.) Fig. 11-31.*

Protection

- Postoperative immobilization using a sling (with or without a pillow) is recommended for patient comfort and limits stress on the anterior/inferior structures for the first 2 weeks.
  - The sling is to be used at all times, including during sleep
- We recommend gradual progression to no sling from weeks 4 to 6 based on pain, available ROM, muscle performance, and activity level.

Management of Pain and Swelling

- Interscalene pain pumps are often used during postoperative days 1 to 3 to control early postoperative pain.
- Oral pain medications.
- Electrical stimulation (Transcutaneous Electrical Neural Stimulation [TENS]) is recommended to manage pain and muscle guarding.
- Intermittent cryotherapy for pain and inflammation reduction.[8]
- Patient positioning: patients are encouraged to use pillows or bolsters to find a "position of comfort" which is usually slightly abducted (20° to 30°) in a neutral or slight internal rotation. This position is recommended to reduce stress on repaired structures as well as "unload" the surrounding muscles.

Techniques for Progressive Increase in Range of Motion (Table 1-2)

- The initial 2 weeks are essentially quiet with little or no ROM exercises required. The focus of this phase is resolving pain, decreasing swelling, and allowing the postsurgical shoulder to recover.
- Codman's pendulum exercises for gentle motion and joint distraction, supported FE (<90°), and ER to 0° at the side (<20° abd) can be performed 1 to 3 times/day to maintain joint mobility. We suggest all of these motions be performed with support to minimize rotator cuff activity due to incorrect technique.[9-11]
- Manual therapy techniques—gentle joint distraction and grade I-II joint oscillations may be helpful before performing supervised PROM by the rehabilitation professional to decrease muscle guarding and prepare the joint for ROM exercise. We recommend these treatments to be performed in the scapular plane in approximately 30° of elevation, and neutral rotation to limit the stress on the capsulolabral repair.[12]
- Soft tissue techniques—shortening, parallel techniques such as (Positional Release/Strain-Counter-strain) may be helpful to reduce protective guarding especially for the subscapularis, posterior rotator cuff, teres major, latissimus dorsi, and pectoralis major/minor.
- Stretching/flexibility techniques for the musculotendinous unit are not recommended at this time

TIMELINE 1-2: Postoperative Rehabilitation After Arthroscopic Anterior Shoulder Stabilization[1]

PHASE I (weeks 1 to 2)	PHASE II (weeks 3 to 6)	PHASE III (weeks 6 to 10)
• Sling • PT modalities • ROM-passive forward elevation to 90° • Active assistive Codman's exercises • TBS/TAS/TLS activities as recommended & tolerated	• Sling • PT Modalities • ROM wk 3—forward elevation to 90° • ROM wk 3—external rotation to 10–30° • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises • Wk 4—AAROM exercises • Wk 4—submaximal isometrics for GH joint muscles	• DC sling • PT Modalities as needed • ROM wk 6—forward elevation to 135° • ROM wk 6—external rotation to 35°–50° • ROM wk 9—forward elevation to 155° • ROM wk 9—external rotation to 35°–50° • Mobilizations as needed • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises—PREs • TAS—Biceps/Triceps PREs • Glenohumeral exercises—PREs • Rotator cuff exercises—PREs • PNF exercises • OKC Rhythmic stabilization exercises • CKC Exercises • CKC manual perturbation exercises

Table 1-2 Staged Range of Motion Goals for Arthroscopic Anterior Capsulolabral Repair

	PFE	PER at 20° abd	PER at 90° abd	AFE
POW 3	90°	10°–30°	Contraindicated	NA
POW 6	135°	35°–50°	45°	115°
POW 9	155°	50°–65°	75°	145°
POW 12	WNL	WNL	WNL	WNL
POW 12	WNL	WNL	WNL	WNL

AFE, Active forward elevation in the scapular plane; *NA*, not appropriate; *PER*, passive external rotation; *PFE*, passive forward elevation; *POW*, postoperative week; *WNL*, within normal limits.

because of the need to protect the repair. Cervicothoracic, elbow, hand, and wrist.

Other Therapeutic Exercises

- Although lower extremity and cardiovascular exercises may begin during the first 2 weeks while in the sling, in our experience patients do not tolerate these activities until after 14 days.

Activation of Primary Muscles Involved in Injury Area or Surgical Structures

- Submaximal isometric exercises may begin POW 1 as tolerated. We recommend performing these exercises in the "safe zone" of 20° to 30° abduction in the plane of the scapula in neutral rotation first with the elbow supported then gradually removing support.

Milestones for Progression to the Next Phase

Minimal to moderate pain (NPRS: 2 to 4/10) with minimal pain at rest (2/10)

- Staged ROM goals achieved but not significantly exceeded

Phase II: Weeks 2 to 6 Postoperatively

Goals

- Minimize shoulder pain (<2/10)
- Achieve staged ROM goals to normalize passive ROM and active ROM. **DO NOT** significantly exceed
- Normalize rotator cuff guarding and neuromuscular control
- Normalize scapular position and control

Clinical Pearls

- Avoid scapular protraction during the first 6 weeks as this position has been shown to have high levels of subscapularis activity and increases stress on the anterior capsulolabral structures.[13,14]
- Restoration of ER first then FE will allow for optimal ROM recovery.

TIMELINE 1-2: **Postoperative Rehabilitation after Arthroscopic Anterior Shoulder Stabilization** (Continued)

PHASE IV (weeks 10 to 14)	PHASE V (weeks 14 to 24)	PHASE V (weeks 24 to 52)
• PT Modalities as needed • PROM-full • Mobilizations as needed • ROM wk 12—forward elevation progress to full ROM • ROM wk 12—external rotation progress to full ROM at 90°/90° • Wk 12- begin terminal shoulder girdle stretches as needed • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises—PREs • Glenohumeral exercises—PREs • Rotator cuff exercises—PREs • PNF exercises • OKC Rhythmic stabilization exercises • CKC Exercises • CKC manual perturbation exercises	• PROM-maintain full motion • Mobilizations as needed • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises—PREs • TAS—Biceps/Triceps PREs • Glenohumeral exercises—PREs • Rotator cuff exercises—PREs • PNF exercises • OKC Rhythmic stabilization exercises • CKC Exercises • CKC manual perturbation exercises • Plyometrics—2 arm progressing to 1 arm • Overhead strengthening exercises • Sport specific exercises begin • Overhead throwing athletes can begin tossing at 30ft per the • interval throwing program	• PROM-maintain full motion • Mobilizations as needed • TBS/TAS/TLS activities as recommended & tolerated • Scapular exercises—PREs • Biceps/Triceps PREs • Glenohumeral exercises—PREs • Rotator cuff exercises—PREs • IR/ER exercises at 90° • Thrower's 10 progress intensity • PNF exercises • OKC Rhythmic stabilization exercises • Exercises • CKC manual perturbation exercises • Plyometrics—2 arm chest passes progressing to 90°/90° • Single arm plyometrics • Overhead strengthening exercises • Sport-specific exercises progressed • Overhead throwing athletes progress through an interval throwing program

Patient-Oriented Outcomes

- Best clinical practice uses patient-rated measures of function and disability to comprehensively assess patient response to treatment.
- There are many available scales for measuring functional loss and disability in patients with instability and one measure is likely not superior to another.[15,16]
- We recommend two measures, a general measure of shoulder function that includes pain, function, and patient satisfaction similar to the ASES, the Pennsylvania Shoulder Score (PSS) and a measure specifically for instability, such as the Western Ontario Instability Index (WOSI).[17-21]

Protection

- Treatment for pain/analgesia oral pain medications
- Electrical stimulation (TENS) is recommended to manage pain and muscle guarding. TENS units at home are often helpful to control pain especially early following surgery.
- Intermittent cryotherapy for pain and inflammation reduction.[8] We recommend 20 minutes on/hour for the first week following surgery.

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- Gentle joint distraction and grade I-III joint oscillations may be helpful before performing supervised PROM by the rehabilitation professional to decrease muscle guarding, restore capsular balance, and prepare the joint for ROM exercise. Anterior-inferior or inferior glides should not be performed. We recommend these positions to be performed in the scapular plane in approximately 30° of elevation, and neutral rotation to limit the stress on the capsulolabral repair.[12]

Soft Tissue Techniques

- Shortening, parallel techniques such as (positional release/strain-counterstrain) may be helpful to reduce protective guarding especially for the subscapularis, posterior rotator cuff, teres major, latissimus dorsi, and pectoralis major/minor.
- Passive ROM and active assist ROM exercises may be initiated after POW 2 for ER and FE (see Table 1-2)
- Stretching/flexibility techniques for the musculotendinous unit should not be performed as these are end ROM exercises.

Other Therapeutic Exercises

- Gradual introduction of TBS, TLS, core stability, and uninvolved TAS beginning POW 2.
- Additionally, cardiovascular conditioning can be initiated with attention to the safety of the activity.
- All exercises should be performed with the patient in the sling until POW 5 to 6 to decrease the use of index shoulder during these exercises.

Activation of Primary Muscles Involved in Injury Area or Surgical Structures

- Scapular retraction and PNF patterns may begin POW 3 based on patient tolerance (Figure 1-25). We recommend avoiding scapular protraction as this position has been shown to have high levels of subscapularis activity and increase stress on the anterior capsulolabral structures.[13,14] Although scapular elevation and retraction are safe we suggested limited resistance due to the load placed through the glenohumeral joint for most exercises.
- Active ROM and rotator cuff strengthening are purposefully de-emphasized until POW 6 because of the potentially detrimental effect to the healing tissues.[22,23] Although these exercises within the staged ROM goals would not likely result in excessive loading, in our opinion aggressive strengthening is not consistent with the achieving optimal healing of the repaired tissues. Therefore, we recommend beginning with sub-maximal isometric strengthening of the shoulder and elbow with the arm adducted to the side in neutral rotation. As the patient demonstrates improved rotator cuff endurance and absence of pain or other symptoms we recommend progressing to dynamic isometrics then AROM exercises within the ROM restrictions.

Sensorimotor Exercises

- Angular reposition, rhythmic stabilization, and repeated contractions within staged ROM limits may be implemented beginning POW 2.

Open and Closed Kinetic Chain Exercises

- CKC exercises may be implemented below 90° of elevation beginning POW 2. These exercises should begin in a modified weight-bearing position and progressed to full weight-bearing by POW 6.

Techniques to Increase Muscle Strength, Power, and Endurance

- See above w/AROM

Milestones for Progression to the Next Phase

- Appropriate healing of the surgical repair by adhering to the precautions and immobilization guidelines.
- Staged ROM goals achieved but not significantly exceeded
- Minimal to no pain (NPRS: 0 to 2/10) with ROM
- PSS greater than 60% and WOSI less than 50%. These are estimates based on reported normative data and our experience. This combined with other objective criteria provides clear communication between the patient and medical professionals on how the patient perceives their shoulder function and potential insight as to how care can be improved upon.

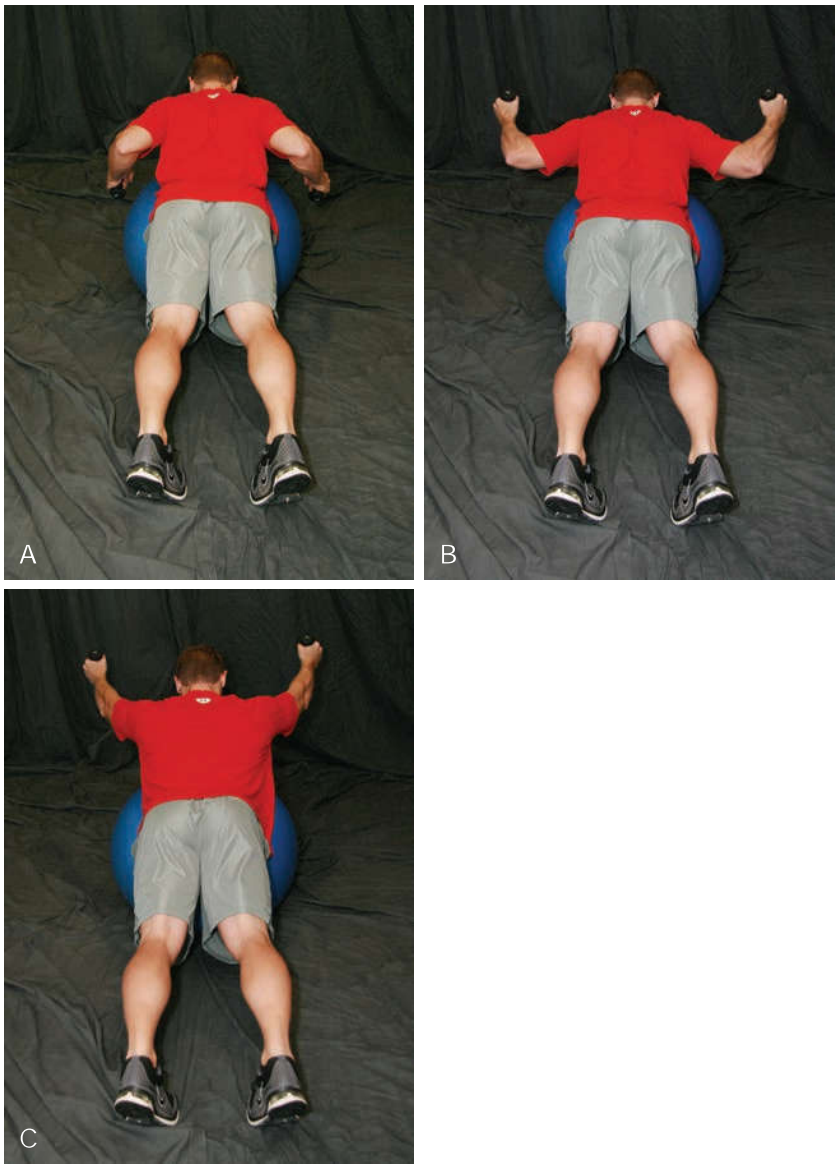

FIGURE 1-25. A–C, Ws to Ys: Patient performs scapular retraction, then glenohumeral external rotation, then elevates to the "Y" position while maintaining scapular stability.

Phase III: Weeks 7 to 12 Postoperatively

Goals

- Achieve staged ROM goals to normalize passive ROM and active ROM. DO NOT significantly exceed especially for ER at 90° of abduction.
- Minimize shoulder pain (0/10 at rest and <2/10 following exercises or activity).
- Begin to increase strength and endurance.
- Increase functional activities as evidenced by PSS > 80% and WOSI < 30%.

Clinical Pearls

- Nearly full active forward elevation should be achieved before progressing to elevation in other planes or initiating resistive elevation exercises.
- Ensuring posterior rotator cuff performance and scapular stability below 90° of abduction before progressing to higher elevation and difficulty of exercises.
- Anterior-inferior glides are often helpful to gain full ER and FE. Addition of posterior shoulder flexibility exercises in conjunction with these mobs before and after exercise is helpful in the stiff shoulder.
- In our opinion, rapid gain of ER towards 90° of abduction should be avoided (before 8 weeks). If the athlete must return to overhead, throwing sports and the involved shoulder is their throwing arm, then more aggressive stretching of ER towards 90° of abduction may begin at 8 weeks.
- Functional exercises may begin toward the end of this phase. Simple patient instruction of *"keeping their hands where they can see them"* will allow the patient to resume desired activities without risking reinjury.

Protection

- No sling use.
- Avoid positions of max ER towards 90° of abduction, especially with a posteriorly directed load. (e.g., NO push-ups, bench press, pectoral flys).

Management of Pain and Swelling

- Pain should not be a limiting factor at this point. If pain is limiting progression of activities rest and reevaluation of all aspects of the shoulder should be performed in consultation with the referring surgeon.
- Cryotherapy as needed.
- NSAIDS as needed.

Patient Education

- Counsel about using the upper extremity for appropriate ADLs in the pain-free and nonprovocative ROM (starting with waist level activities and progressing to shoulder level and finally to overhead activities over time).
- Continue education regarding avoidance of heavy lifting or quick sudden motions.
- Education to avoid positions which place stress on the anterior inferior capsule during ADLs.

Techniques for Progressive Increase in Range of Motion

- Forward elevation should be progressed from active-assistive exercises (e.g., rope and pulley, wall walks), to active, to resistive upright exercises, then finally to prone exercises as per reported EMG activity of the shoulder.[10,11] Although protection of the rotator cuff is not needed we feel the EMG activity reflects overall stress to the shoulder and good guide to exercise progression.

Manual Therapy Techniques

- Grade I-III joint mobilizations (up to tissue resistance) are most often all that is required especially for anterior/inferior directions. If ROM is greater than 50% less than staged ROM goals as compared with the uninvolved extremity then gentle joint mobilizations may be performed. However, they should be done only into the limited directions and only until staged ROM goals are achieved. It is crucial in the patients that appear "tight" to discern if there is capsuloligamentous tightness/stiffness, musculotendinous, pain limited or some combination.

Soft Tissue Techniques

- Deeper soft tissue techniques may be initiated during this phase. More aggressive techniques such as Active Release® or other instrumented soft tissue mobilizations to normalize muscle tone and extensibility. Particular attention should be paid to the subscapularis, latissimus, pectorals, teres major, and posterior rotator cuff. In our experience these techniques often allow for gradual return consistent with the staged goals without aggressive joint mobilizations or excessive end range stretching.
- Stretching/flexibility techniques for the musculotendinous unit.
- Total upper quarter mobility should be evaluated with restoration of cervical, thoracic, and scapulothoracic mobility to facilitate optimal return upper extremity ROM.
- End range flexibility exercises may begin in particular for posterior shoulder (horizontal adduction and sleeper stretch beginning at 60° to 70° of elevation on side (Figure 1-14*A*,*B*).[24,25] Pectoralis minor flexibility can begin with attention not to increase stress on anterior shoulder as these have been shown to be effective at increasing pectoralis minor length.[26,27] Gradual introduction of latissimus, posterior shoulder, and FE stretches as needed.

Other Therapeutic Exercises

- Address core stability deficits PRN beginning in the sagittal plane and progressing to frontal and transverse plane exercises.
- Total leg strengthening exercises may be progressed as tolerated but high loads should be avoided on the shoulder in activities such as power clean, dead lifts, and back squats should be avoided. We recommend front squats during this phase to allow for safe positioning of the shoulder with large loads.
- We also recommend using this phase of rehabilitation to address kinetic chain deficits using basic functional screens such as the overhead squat, single leg squat, or more in-depth approaches such as the Functional Movement Screen. These approaches will provide areas for improvement for the athlete allowing for total body movement evaluation of the entire kinematic chain.

Activation of Primary Muscles Involved in Injury Area or Surgical Structures

- Elbow flexion/extension strengthening with elbow by the side can begin in this phase
- Exercises and functional activities should be pain free and performed without substitutions or aberrant movement patterns (shrugging, thoracic extension)
- Balanced rotator cuff strengthening to maintain the humeral head centered within the glenoid fossa during progressively more challenging activities
- Should be initially performed in a position of comfort with low stress to the glenohumeral joint such as less than 45° elevation in the plane of the scapula (e.g., elastic band or dumbbell external rotation, internal rotation, forward elevation).
- Exercises should be progressive in terms of shoulder elevation (e.g., start w/exercises performed at waist level progressing to shoulder level and finally overhead activities).
- Depending upon the goals of the exercise (control vs. strengthening), rehabilitation activities may also be progressive in terms of speed once the patient demonstrates proficiency at slower speeds.

Sensorimotor Exercises

- Activities to improve neuromuscular control of the rotator cuff and shoulder girdle such as use of unstable surfaces, body blade, and manual resistance exercises in conjunction with auditory, visual, or tactile cues or biofeedback.
- Proprioceptive Neuromuscular Facilitation (PNF) patterns are particularly effective for restoring muscle balance and proper coordination patterns. We prefer this manual feedback especially early during this phase as the clinician controls the load to the extremity and is able to best match the patient's level of performance.

Open and Closed Kinetic Chain Exercises

- Strengthen scapular retractors and upward rotators
- Weight-bearing exercises with a fixed distal segment. Examples: quadruped position while working to maintain proper position of the scapula, quadruped with scapula protraction, progressing from quadruped to tripod position, *no push-ups*.[28]

Techniques to Increase Muscle Strength, Power, and Endurance

- Exercises should be progressive in terms of muscle demand. It is suggested to use activities that have muscle activity levels documented with EMG.[9,28-44] In general, increasing elevation increases deltoid and supraspinatus activity while increasing ER at lower levels of elevation increases posterior rotator cuff EMG.[9,28-44] The subscapularis is most active during forward punches (combined scapular protraction and glenohumeral IR) and should be performed at lower and higher levels of elevation (Figure 1-26).[40]
- Exercises should be progressive in terms of adding stress to the anterior capsule, gradually working towards a position of 90° of ER and 90° of abduction by 12 weeks.
- Rehabilitation should include isolated and complex movement patterns progressing form isolated to complex movement patterns.
- The rotator cuff and scapula stabilizer strengthening program should emphasize high repetitions (typically 30 to 50 reps) and relatively low resistance (typically 1 to 2 kg) during this phase.
- General shoulder strengthening exercises (front/side raises, shoulder presses) may be initiated as full AROM is achieved and rotator cuff and scapular stabilizer strength is adequate for normal movement patterns. This is usually a late Phase III exercise and should begin with 3 to 5 kg and similar repetitions (15 to 20 for 3 to 4 sets).

Neuromuscular Dynamic Stability Exercises

- Development of dynamic stability is crucial during this phase of rehabilitation following stabilization

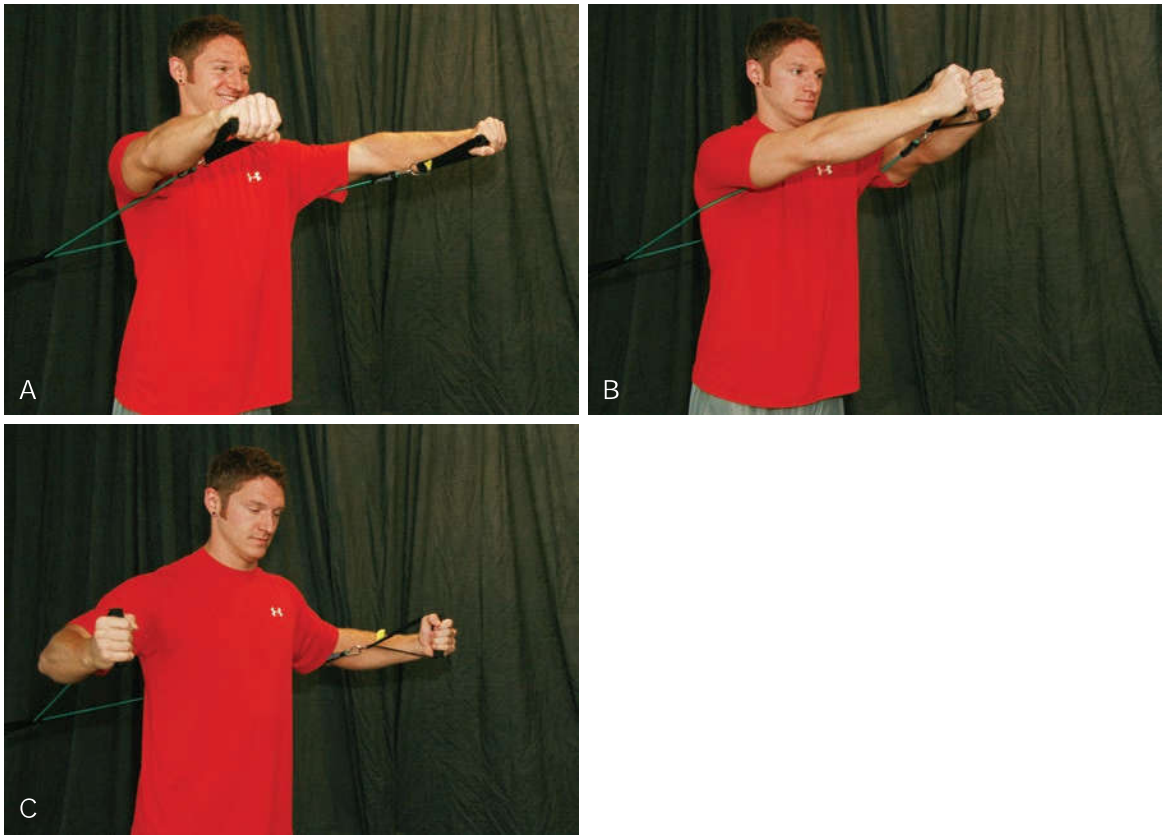

FIGURE 1-26. A–C, Forward punches with internal rotation: The patient steps and punches forward emphasizing scapular protraction without scapular elevation at varying levels of forward elevation then internally rotating the humerus at the end of the motion.

procedure. Rhythmic stabilization starting at 45° of abduction in the scapular pane in neutral rotation and gradually increasing in elevation and ER as performance increases. Four to five bouts for 30 seconds is recommended before progressing difficulty of exercises.
- CKC pushup plus progression are important exercises as it promotes rotator cuff and scapular stabilizer co-contraction needed for dynamic stability.[38,45]

Plyometrics

- No heavy lifting or plyometrics should be performed during this stage.

Functional Exercises

- Functional exercises may be initiated toward the end of Phase III (weeks 9 to 12) however we strongly recommend avoiding undue stress on the anterior shoulder.
- Multiplanar exercises should be progressed in a similar fashion as previously described emphasizing rotational control across each plane of elevation.

Milestones for Progression to the Next Phase

- Staged active ROM goals achieved with minimal to no pain (NPRS 0 to 2/10) and without substitution patterns
- Appropriate scapular posture at rest and dynamic scapular control during ROM and strengthening exercises
- Strengthening activities completed with minimal to no pain (NPRS 0 to 2/10).
- <20% deficit using isokinetic or hand held dynamometer for ER, IR, abduction, and elevation.
- Able to complete 20 hand-taps during modified Davies CKC UE test.[46] We recommend modifying the Davies test by using biacromial width as in our experience a standard 36″ is too wide for many patients.
- Able to complete 30 reps of ER at <20° of abduction in 30 seconds (1 rep/sec).

Phase IV: Weeks 13 to 24 Postoperatively

The length of Phase IV will vary dependent upon sport participation. For noncontact sports with less stress on the anterior shoulder and therefore reinjury risk return to sport progression may begin at 16 weeks. For contact sports with high dislocation rates (football, wrestling) or high stress on the anterior shoulder (throwing sports) return to sport progression will begin between POW 20 to 24. Phase IV will overlap with Phase V return to sport progression depending on injury, sport, and timing of season and return to play goals.

Goals

- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Normalize strength, endurance, neuromuscular control, and power as evidenced by:
  - <10% deficit using isokinetic or hand held dynameter for ER, IR, abduction, and elevation.
  - 30 repetitions in 30 seconds with blue Thera-Band at 0° and 90° abduction.
  - Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[46]
  - Gradual demonstration of confidence and performance in sports specific positions.
  - Functional improvement in ADLs and sport as evidenced by PSS > 90% and WOSI < 20%.

Clinical Pearls

- Athletes should perform a structured, reproducible dynamic warm up including rotator cuff exercises before pre sport and sport activities.
- Progression of presport training activities should be monitored reevaluating the athlete's pain & strength (no >10% advancement as compared to presport).
- We recommend a balance of posterior and anterior rotator cuff strength (ER:IR ratio) of 66% before beginning return to sport training.[47,48]

Management of Pain and Swelling

- Pain should not be a limiting factor at this point. If pain is limiting progression of activities rest and reevaluation of all aspects of the shoulder should be performed in consultation with the referring surgeon.
- Cryotherapy as needed.
- NSAIDS as needed.

Patient Education

- Counsel about using the upper extremity for appropriate ADLs in the pain-free ROM (starting with waist level activities and progressing to shoulder level and finally to overhead activities over time).
- Continue education regarding avoidance of heavy lifting or quick sudden motions.
- Education to avoid positions which place stress on the anterior inferior capsule during ADLs.

Other Therapeutic Exercises

- Progressing from Phase III there are no limitations to TBS/TLS or TAS. However, unless end range of motion is required for the athlete's sport then we strongly recommend avoiding training that stresses the shoulder the ABER position as the risk of developing recurrent instability outweighs the benefits of training.

Open and Closed Kinetic Chain Exercises

- Progression of OKC and CKC consistent with principles previously outlined.

Techniques to Increase Muscle Strength, Power, and Endurance

- During this phase the focus of exercises should progress from endurance to strength and power. This will require increasing loads, speed of movements, and type of contraction.
- Loads—loads now may be increased appropriate to sport and body weight beginning with 3 to 5 sets of 10 and progressing to 3 to 5 sets of 4 to 6 reps over the next 8 to 10 weeks consistent with a traditional strength training program.
- Speed of movement—concentric movements are challenged first beginning with IR, then ER, then punches and complex movements. Punches are last as this as scapular protraction places increased stress on the capsulolabral complex and is a common mode of dislocation.
- Type of contraction—eccentric loads can now be initiated beginning with ER (towards IR) and abduction (towards adduction) first then progressing to IR and abduction in preparation for plyometric exercises.
- We recommend gradually progressing to positions of high stress during this phase as needed. For example, in order to progress back to bench press begin with the athlete performing dumbbell bench press on the floor, then barbell on the floor, then dumbbell.

Neuromuscular Dynamic Stability Exercises

Integration of higher loads and greater perturbations are important in particular for athletes returning to sport.

Examples include:

- For football players clap pushups on foam or DynaDisc.
- For throwers repeated ER yo-yos (with 1-kg weight on band) (Figure 1-27).

Plyometrics

- Because of the explosive nature of this type of exercise, emphasis of plyometric exercises should be on quality not quantity. Additionally, we recommend 2 to 3 weeks of tolerance to high speed multiplanar activities which progressively mimic functional demands before initiating plyometric exercises.
- Perform two to three times/week and utilize moderate repetitions (e.g., 3 to 5 sets of 15 to 20 repetitions)
- Begin with unweighted balls and progress to lightly weighted balls (Plyoballs)

Functional Exercises

- Continue per Phase III.

Sport-Specific Exercises

- Med ball throws against a wall, for distance for OKC sports.
- UE fitter/stepper in prone position for CKC sports.
- Dribbling on wall or rebounding with one hand.

Milestones for Progression to the Next Phase

- Clearance from physician.
- PSS > 90% and WOSI < 10%.
- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Restoration of sufficient ROM to perform desired activities.
- Maintenance of strength and endurance as evidence by:
  - < 10% deficit using isokinetic or hand held dynameter for ER, IR, abduction, and elevation.
  - 30 repetitions in 30 seconds with blue Thera-Band at 0° and 90° abduction.
  - Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[46]

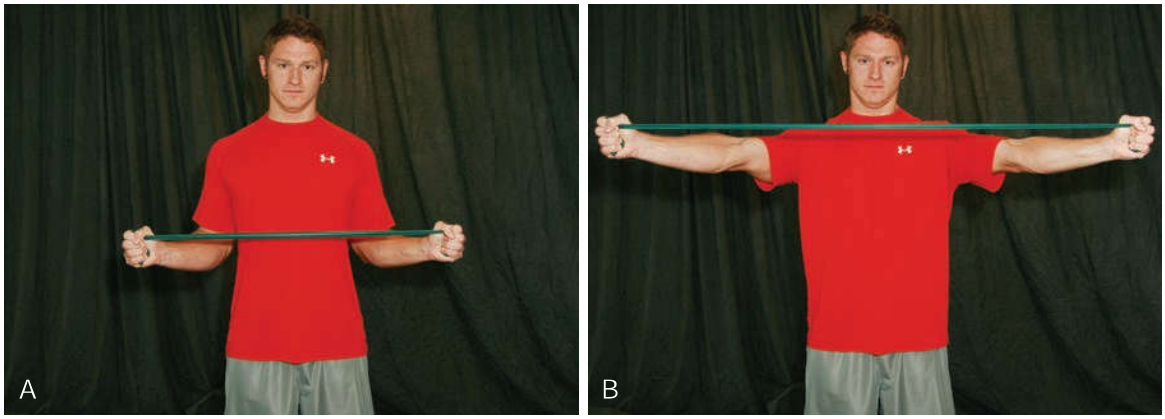

FIGURE 1-27. A,B, External rotation to scaption. Patient holds a 1-kg weight tied into a Thera-Band at 0° of ER, then externally rotates and elevates to 90°.

Phase V: >Weeks 16 to 24 Postoperatively—Return to Sport Progression

Similar to Phase IV the length will vary dependent upon sport participation. The timing of this phase will be greatly impacted by risk of reinjury and timing relative to competition requirements. As risk of reinjury increases we recommend more conservative approach in return to competition. As maturity of the athlete and level of competition increase athlete education becomes imperative allowing the sports medicine team (athlete, PT, ATC, and MD) to reach the best decision for that athlete.

Goals

- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Maintenance of sufficient ROM to perform desired activities.
- Maintenance of shoulder strength and endurance as previously described with minimal to no pain (NPRS 0 to 2/10) or difficulty.

Clinical Pearls

- 1 to 2 times/week of soft tissue and joint mobilizations will prevent loss in ROM during the return to sport progression. Careful attention to maintenance of ROM and flexibility will allow for long-term successful return to sport.
- Begin sessions with a complete dynamic warm-up including rotator cuff before complex, functional, and plyometric exercises.
- Continued strengthening of the rotator cuff and scapular stabilization exercises to fatigue should be performed 1 to 2 times/week.
- Instruct patients to: *"Perform all exercises so that you can see the backs of your hands"* to protect their surgical repair.

Protection

- Use of either a Sully or Donjoy (formerly SaWa) brace is recommended during initial return to sport, in particular for contact athletes. We prefer the SaWa brace (lace up/strap brace) for contact athletes as it is the only brace demonstrated to limit ER and abduction ROM.[49] We recommend the Sully (neoprene) for all others as it has been shown to increase proprioception and kinesthetic awareness which are altered in shoulders with anterior instability.[50,51]

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- As previously described PRN.

Soft Tissue Techniques

- As previously described PRN.

Stretching/Flexibility Techniques for the Musculo-Tendinous Unit

- Regular assessment of ROM/flexibility during the return to sport progression and after return to sport is important for long term shoulder function.

Other Therapeutic Exercises

- As previously described.

Open and Closed Kinetic Chain Exercises

- As previously described.

Techniques to Increase Muscle Strength, Power, and Endurance

- Care should be taken to ensure that the athlete maintains shoulder-strengthening and dynamic strengthening exercises. We recommend 3 days for 20 to 30 minutes of focused rotator cuff and scapular stabilizing exercises in addition to TBS and TAS that may be apart from normal athletic activities.

Plyometrics

- PRN as previously described.

Sport-Specific Exercises

- PRN as previously described.

Criteria for Return to Sport

General

- PSS > 95% and WOSI < 10%.
- No complaints of pain at rest and minimal to no pain (NPRS 0 to 2/10) following activities.
- No or minimal sensation of instability with activities.
- Maintenance of sufficient ROM to perform desired activities.
- A balance of posterior and anterior rotator cuff strength (ER:IR ratio) of 66% before beginning return to sport training.[47,48]
- Maintenance of strength and endurance as evidence by <10% change in strength measures post activity using isokinetic or hand held dynameter for ER, IR, abduction, and elevation.
- 30 repetitions in 30 seconds with blue Thera-Band at 0° and 90° abduction.
- Able to complete 90 hand-taps during modified Davies CKC UE test in 60 seconds.[46]

Sport-Specific

Overhead athlete—The return to sport of an overhead athlete requires consideration for all position specific

factors before return to full participation. Before and during of progression of throwing, batting, and hitting activities the following criteria should be obtained and maintained throughout the interval throwing program:

- PSS > 95% and WOSI < 10%.
- No sensation of instability with activities.
- No complaints of pain at rest or during activity. Minimal discomfort postactivity with minimal discomfort (NPRS 0 to 2/10) following activities.
- Before throwing/hitting, the throwing arm rotational ROM must measure within 15° of the non-throwing arm. Total rotation must be >150°. External rotation must measure ≥100°. Additionally, horizontal adduction (HA) ROM must be within 15° of the non-throwing arm.
- Postthrowing/hitting the rotational and HA ROM should be within 10% of the prethrowing/hitting ROM within 24 to 48 hours and return to preactivity baseline ROM before subsequent participation.
- The athlete should recover from soreness for 24 to 48 hours before returning to full participation.
- Before competition or practice, throwing arm ER strength should be similar to the nonthrowing arm ER strength[52] and the athlete should demonstrate a balance of posterior and anterior throwing arm rotator cuff strength (ER:IR ratio) of 66%.[47,48]
- The athlete must demonstrate sufficient core and scapula control for participation. This is measured by completion 90 hand taps during the modified Davies CKC UE test in 60 seconds before throwing/hitting.[46]
- Post throwing/hitting the rotational strength and stability (hand taps during modified Davies CKC UE test in 60 seconds) should be within 10% of the prethrowing/hitting levels within 24 to 48 hours and return to preactivity baseline before subsequent participation.
- Athletes should be monitored for performance and fatigue levels during their progression to full competition as athletes pitching while fatigued have 36 times greater risk of injury.[53]

After Return to Sport

Continuing Fitness or Rehabilitation Exercises

- Maintain ROM with regular flexibility routine in particular for latissimus, pectoralis and posterior shoulder flexibility.
- Maintain rotator cuff and scapular stabilization force couples with 2 to 3 times/week of core exercises integrated into regular fitness/training routine.

Exercises and Other Techniques for Prevention of Recurrent Injury

- We recommend postoperative bracing for at least the first season returning to competition.
- Unless the sport requires motion in extremes of abduction and ER limit training in these ranges.
  - For all training patients are instructed to: "*Perform all exercises so that you can see the backs of your hands*"

Evidence

Boileau P, Villalba M: Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. *J Bone Joint Surg* 88A(8):1755–1763, 2006.

This is a retrospective study conducted to look at outcomes and determine risk factors related to the recurrence of shoulder instability following arthroscopic Bankart repair. Ninety-one patients who underwent arthroscopic stabilization were included in the study and followed up at a mean of 36 weeks. Absorbable suture anchors were used for capsulolabral reattaching and capsule retensioning. Fourteen patients experienced recurrent instability, six experienced dislocation, and eight had an episode of subluxation. The study results suggest that bone loss or defect on the glenoid or humeral side along with anterior or inferior hyperlaxity was significantly related to postoperative recurrent instability. The presence of either condition led to a 75% recurrence rate in the study. In addition, less than three sutures used during surgery led to an increased risk of recurrence. The study suggests that arthroscopic treatment for shoulder instability should be used only after patient selection and rigorous technique.

Ellenbecker TS, Mattalino AJ: Glenohumeral joint range of motion and rotator cuff strength following arthroscopic anterior stabilization with thermal capsulorraphy. *J Orthop Sports Phys Ther* 29:160–167, 1999.

This descriptive study of 20 patients diagnosed with anterior shoulder instability described their postoperative rehabilitation program following arthroscopic shoulder stabilization. The involved patients experienced return of ROM and scapular/ rotator cuff strength at 12 weeks when compared with the uninjured extremity.

Hiemstra LA, Sasyniuk TM, Mohtadi NG, et al: Shoulder strength after open versus arthroscopic stabilization. *Am J Sports Med* 36:861–867, 2008.

Arthroscopic or open shoulder stabilization surgeries are currently the standard of treatment for recurrent anterior shoulder dislocations. The difference between the surgical techniques is the violation of the subscapularis tendon during the open stabilization. This study looks at the strength differences in internal and external rotation of the two surgical groups. The study included 48 patients with an average age of 30.6 who were randomized into either the open or arthroscopic group. Each group underwent standardized rehabilitation and was followed up with isokinetic strength testing (concentric and eccentric peaks at 60 and 180 degrees) between 12 and 36 weeks postop. The results showed no significant difference between groups in the area of age, gender, and operative limb. When comparing the arthroscopic versus open surgical shoulder stabilization, no significant isokinetic strength deficits were observed. Both groups showed strength deficits when compared to the non-involved limb.

Kim SH, Ha KI, Kim HS, et al: Electromyographic activity of the biceps brachii muscle in shoulders with anterior instability. *Arthroscopy* 17:864–868, 2001.

The study evaluated the activity of the biceps muscle in 38 patients with traumatic anterior shoulder instability. The abduction and external rotation positions were evaluated. Electromyographic (EMG) data was used to determine activity levels of the biceps muscles. The unstable side was compared with the opposite non-involved shoulder of each patient. EMG data was obtained for the following positions:

0°, 45°, 90°, and 120°. The root mean squared voltage of the bicep muscle was significantly greater in the unstable shoulder in all positions. The maximum voltage was greatest in the unstable arm at 90° and 120° of external rotation. No difference was seen in the RMS voltage of the supraspinatus muscle. In conclusion, the results show that in an unstable shoulder, in the abducted and externally rotated positions, the bicep muscles play a compensatory role.

Matias R, Pascoal AG: The unstable shoulder in arm elevation: a three-dimensional and electromyographic study in subjects with glenohumeral instability. *Clin Biomech (Bristol, Avon)* 21(Suppl 1):S52–S58, 2006.

An altered scapula-humeral rhythm is said to be related to some shoulder dysfunction, but little is known about the shoulder muscle activation patterns in patients with glenohumeral instability. The study included 6 subjects with glenohumeral instability who were all performed arm elevations in 8 positions. A 6 DOF electromagnetic device was used to record the kinematics. The scapulohumeral rhythms were compared among subjects. The most significant differences were seen in the scapular protraction and spinal tilt and no differences were seen in the scapular lateral rotation. The kinematic changes during certain angles of arm elevation may be due to changes in alignment of the humeral head and glenoid and as results contributing to shoulder instability. The study emphasizes the importance of assessing scapulohumeral rhythms in the rehabilitations process of individuals with shoulder instability.

Myers JB, Ju YY, Hwang JH, et al: Reflexive muscle activation alterations in shoulders with anterior glenohumeral instability. *Am J Sports Med* 32:1013–1021, 2004.

The study looks at the relationship between anterior shoulder instability and muscle activation alterations. Eleven patients with anterior shoulder instability where matched with 11 control subjects. Each subjected underwent external humeral rotation apprehension perturbation while muscle activation characteristics were recorded using electromyographic analysis. Patients with instability showed decreased pectoralis major and biceps brachii mean activation along with increases peak activation in the subscapularis, supraspinatus, and infraspinatus when compared with the control subjects. A much slower bicep brachii mean reflex latency as well as suppressed supraspinatus-subscapularis coactivation was seen in the patients with instability. These results may explain recurring episodes of instability in patients with glenohumeral instability.

McMahon PJ, Jobe FW, Pink MM, et al: Comparative electromyographic analysis of shoulder muscles during planar motions: anterior glenohumeral instability versus normal. *J Shoulder Elbow Surg* 5:118–123, 1996.

The electromyographic activity of the rotator cuff and scapular muscles were compared between normal subjects and those with anterior instability. 23 subjects had instability, 15 were normal. Fine wire electrodes were placed in the scapular muscles. Abduction, scaption, and forward flexion were performed over the range of motion. In patients with instability, the supraspinatus showed significantly less electromyographic activity from 30° to 60° during abduction and scaption compared with normal shoulders. During all three motions, shoulder with instability showed significantly less activity in the serratus muscle compared with the normal shoulders at 30° to 120° of abduction and 0° to 120° of scaption and forward flexion. These results show that the supraspinatus and serratus muscles may be under challenged in daily activities and add to the complexity of shoulder instability.

Nelson BJ, Aciero RA: Arthroscopic management of glenohumeral instability. *Am J Sports Med* 28:602–614, 2000.

Over the last 20 years there have been new developments in arthroscopic shoulder techniques, especially in the area of shoulder instability. The article discusses the various arthroscopic surgical techniques used to treat the unstable glenohumeral joint. The article looks at arthroscopic stabilization techniques for primary anterior glenohumeral instability, recurrent anterior instability, and multidirectional instability. The wide ranges of results are also discussed.

Uhorchak JM, Arciero RA, Huggard D, et al: Recurrent shoulder instability after open reconstruction in collision and contact sports. *Am J Sports Med* 28:794–799, 2000.

This study evaluated the recurrence of instability in a group of 66 young athletes who had previously undergone open shoulder stabilization using a modified Bankart repair and anterior capsulorrhaphy. In order for the incidence to be considered a recurrent dislocation, it had to be a complete dislocation with manual reduction. "Slipping or popping" was considered a recurrent subluxation. The results showed that two patients experienced recurrent shoulder instability, eight patients had fewer than three episodes of subluxation, and five patients had multiple episodes of recurrent subluxation. The studied concluded that a 3% to 5% recurrent dislocation rate is reasonable to expect after undergoing open Bankart repair/capsulorrhaphy for young athletes involved in collision sports. This same patient group experiences a 20% frequency in recurrent postsurgical subluxations. This incidence is higher than most literature and is attributed the athletes being involved in collision sports. Factors such as age, activity level and type of instability may influence postoperative recurrence rates.

Warner JJ, Micheli LJ, Arslanian LE, et al: Patterns of flexibility, laxity, and strength in normal shoulders and shoulders with instability and impingement. *Am J Sports Med* 18:366–375, 1990.

This is a prospective study looking at factors of flexibility, laxity, strength and their causality to the conditions of shoulder impingement and instability. Fifty-three subjects were included in the study: 15 asymptomatic volunteers, 28 patients with glenohumeral instability, and 10 patients with impingement. Range of motion was performed using a goniometer and Biodex testing was used to measure strength. Normal subjects showed significant differences in IR/ER ratios for peak torque between the dominant and nondominant shoulder and greater IR strength in the dominant side. Impingement was linked to posterior capsular tightness and weakness of the external rotators. Anterior instability was associated with excessive external rotation and weakness of the internal rotators. Rehabilitation should include an emphasis on shoulder strengthening and capsular stretching for treatment of impingement. Performing isokinetic strength testing in the modified abducted position can help determine if either impingement or instability is the problem.

REFERENCES

1. Gaunt BW, Shaffer MA, Sauers EL, et al: The American Society of Shoulder and Elbow Therapists' consensus rehabilitation guideline for arthroscopic anterior capsulolabral repair of the shoulder. *J Orthop Sports Phys Ther* 40:155–168, 2010.
2. Ticker JB, Warner JJ: Selective capsular shift technique for anterior and anterior-inferior glenohumeral instability. *Clin Sports Med* 19:1–17, 2000.

3. Higgins LD, Warner JJ: Arthroscopic Bankart repair. Operative technique and surgical pitfalls. *Clin Sports Med* 19:49–62, 2000.
4. Warner JP, Boardman ND: Anatomy, biomechanics, and pathophysiology of glenohumeral instability. In Warren RF, Craig EV, Altchek DW, editors: *The unstable shoulder*, Philadelphia, 1999, Lippincott-Raven.
5. Greis PE, Scuderi MG, Mohr A, et al: Glenohumeral articular contact areas and pressures following labral and osseous injury to the anteroinferior quadrant of the glenoid. *J Shoulder Elbow Surg* 11:442–451, 2002.
6. Itoi E, Lee SB, Berglund LJ, et al: The effect of a glenoid defect on anteroinferior stability of the shoulder after Bankart repair: a cadaveric study. *J Bone Joint Surg Am* 82:35–46, 2000.
7. Burkhart SS, Debeer JF, Tehrany AM, et al: Quantifying glenoid bone loss arthroscopically in shoulder instability. *Arthroscopy* 18:488–491, 2002.
8. Osbahr DC, Cawley PW, Speer KP: The effect of continuous cryotherapy on glenohumeral joint and subacromial space temperatures in the postoperative shoulder. *Arthroscopy* 18:748–754, 2002.
9. Dockery ML, Wright TW, LaStayo PC: Electromyography of the shoulder: an analysis of passive modes of exercise. *Orthopedics* 21:1181–1184, 1998.
10. Uhl TL, Muir TA, Lawson L: Electromyographical assessment of passive, active assistive, and active shoulder rehabilitation exercises. *Pm R* 2:132–141, 2010.
11. Gaunt BW, McCluskey GM, Uhl TL: An electromyographic evaluation of subdividing active-assistive shoulder elevation exercises. *Sports Health* 2:424–432, 2010.
12. Blasier RB, Goldberg RE, Rothman ED: Anterior shoulder instability: contribution of rotator cuff forces and capsular ligaments in a cadaver model. *J Shoulder Elbow Surg* 1:140–150, 1992.
13. Weiser WM, Lee TQ, McMaster WC, et al: Effects of a simulated scapular protraction on anterior glenohumeral stability. *Am J Sports Med* 27:801–805, 1999.
14. Smith J, Dahm DL, Kotajarvi BR, et al: Electromyographic activity in the immobilized shoulder girdle musculature during ipsilateral kinetic chain exercises. *Arch Phys Med Rehabil* 88:1377–1383, 2007.
15. Oh JH, Jo KH, Kim WS, et al: Comparative evaluation of the measurement properties of various shoulder outcome instruments. *Am J Sports Med* 37:1161–1168, 2009.
16. Plancher KD, Lipnick SL: Analysis of evidence-based medicine for shoulder instability. *Arthroscopy* 25:897–908, 2009.
17. Kirkley A, Griffin S, McLintock H, et al: The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. The Western Ontario Shoulder Instability Index (WOSI). *Am J Sports Med* 26:764–772, 1998.
18. Kocher MS, Horan MP, Briggs KK, et al: Reliability, validity, and responsiveness of the American Shoulder and Elbow Surgeons subjective shoulder scale in patients with shoulder instability, rotator cuff disease, and glenohumeral arthritis. *J Bone Joint Surg Am* 87:2006–2011, 2005.
19. Michener LA, McClure PW, Sennett BJ: American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, Patient Self-Report Section: Reliability, Validity, and Responsiveness. *J Shoulder Elbow Surg* 11:587–594, 2002.
20. Leggin BG, Michener LA, Shaffer MA, et al: The Penn Shoulder Score: reliability and validity. *J Orthop Sports Phys Ther* 36:138–151, 2006.
21. Michener LA, Snyder AR, Leggin BG: Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status. *J Sport Rehabil* 20:115–128, 2011.
22. Hill AM, Jones IT, Hansen U, et al: Treatment of ligament laxity by electrothermal shrinkage or surgical plication: A morphologic and mechanical comparison. *J Shoulder Elbow Surg* 16:95–100, 2007.
23. Wetzler MJ, Bartolozzi AR, Gillespie MJ, et al: Fatigue properties of suture anchors in anterior shoulder reconstructions: Mitek GII. *Arthroscopy* 12:687–693, 1996.
24. Borstad JD, Mathiowetz KM, Minday LE, et al: Clinical measurement of posterior shoulder flexibility. *Man Ther* 12:386–389, 2007.
25. McClure P, Balaicuis J, Heiland D, et al: A randomized controlled comparison of stretching procedures for posterior shoulder tightness. *J Orthop Sports Phys Ther* 37:108–114, 2007.
26. Borstad JD, Ludewig PM: Comparison of three stretches for the pectoralis minor muscle. *J Shoulder Elbow Surg* 15:324–330, 2006.
27. Wang CH, McClure P, Pratt NE, et al: Stretching and strengthening exercises: their effect on three-dimensional scapular kinematics. *Arch Phys Med Rehabil* 80:923–929, 1999.
28. Uhl TL, Carver TJ, Mattacola CG, et al: Shoulder musculature activation during upper extremity weight-bearing exercise. *J Orthop Sports Phys Ther* 33:109–117, 2003.
29. Blackburn TA, McLeod WD, White B, et al: EMG Analysis of posterior rotator cuff exercises. *Athl Train* 25:40–47, 1990.
30. Moseley JB, Jr, Jobe FW, Pink M, et al: EMG analysis of the scapular muscles during a shoulder rehabilitation program. *Am J Sports Med* 20:128–134, 1992.
31. Ballantyne BT, O'Hare SJ, Paschall JL, et al: Electromyographic activity of selected shoulder muscles in commonly used therapeutic exercises. *Phys Ther* 73:668–677, discussion 677–682, 1993.
32. Reinold MM, Wilk KE, Fleisig GS, et al: Electromyographic analysis of the rotator cuff and deltoid musculature during common shoulder external rotation exercises. *J Orthop Sports Phys Ther* 34:385–394, 2004.
33. Illyes A, Kiss RM: Electromyographic analysis in patients with multidirectional shoulder instability during pull, forward punch, elevation and overhead throw. *Knee Surg Sports Traumatol Arthrosc* 15:624–631, 2007.
34. Kibler WB, Chandler TJ, Shapiro R, et al: Muscle activation in coupled scapulohumeral motions in the high performance tennis serve. *Br J Sports Med* 41:745–749, 2007.
35. Lister JL, Del Rossi G, Ma F, et al: Scapular stabilizer activity during Bodyblade, cuff weights, and Thera-Band use. *J Sport Rehabil* 16:50–67, 2007.
36. Reinold MM, Macrina LC, Wilk KE, et al: Electromyographic analysis of the supraspinatus and deltoid muscles during 3 common rehabilitation exercises. *J Athl Train* 42:464–469, 2007.
37. Jaggi A, Malone AA, Cowan J, et al: Prospective blinded comparison of surface versus wire electromyographic analysis of muscle recruitment in shoulder instability. *Physiother Res Int* 14:17–29, 2009.
38. Maenhout A, Van Praet K, Pizzi L, et al: Electromyographic analysis of knee push up plus variations: what's the influence of the kinetic chain on scapular muscle activity? *Br J Sports Med* 44:1010–1015, 2009.
39. Decker MJ, Hintermeister RA, Faber KJ, et al: Serratus anterior muscle activity during selected rehabilitation exercises. *Am J Sports Med* 27:784–791, 1999.
40. Decker MJ, Tokish JM, Ellis HB, et al: Subscapularis muscle activity during selected rehabilitation exercises. *Am J Sports Med* 31:126–134, 2003.
41. Ekstrom RA, Donatelli RA, Soderberg GL: Surface Electromyographic analysis of exercises for the trapezius and serratus anterior muscles. *J Orthop Sports Phys Ther* 33:247–258, 2003.
42. Hintermeister RA, Lange GW, Schultheis JM, et al: Electromyographic activity and applied load during shoulder rehabilitation exercises using elastic resistance. *Am J Sports Med* 26:210–220, 1998.
43. Ludewig PM, Hoff MS, Osowski EE, et al: Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. *Am J Sports Med* 32:484–493, 2004.
44. Townsend H, Jobe FW, Pink M, et al: Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program. *Am J Sports Med* 19:264–272, 1991.
45. Malliou PC, Giannakopoulos K, Beneka AG, et al: Effective ways of restoring muscular imbalances of the rotator cuff muscle group: a comparative study of various training methods. *Br J Sports Med* 38:766–772, 2004.
46. Goldbeck T, Davies G: Test-Retest reliability of the closed kinetic chain upper extremity stability test: a clinical field test. *J Sport Rehabil* 9:35–45, 2000.
47. Ellenbecker TS: Rehabilitation of shoulder and elbow injuries in tennis players. *Clin Sports Med* 14:87–109, 1995.
48. Ellenbecker TS, Mattalino AJ: Glenohumeral joint range of motion and rotator cuff strength following arthroscopic anterior stabilization with thermal capsulorraphy. *J Orthop Sports Phys Ther* 29:160–167, 1999.
49. Weise K, Sitler MR, Tierney R, et al: Effectiveness of glenohumeral-joint stability braces in limiting active and passive shoulder range

of motion in collegiate football players. *J Athl Train* 39:151–155, 2004.
50. Chu JC, Kane EJ, Arnold BL, et al: The effect of a neoprene shoulder stabilizer on active joint-reposition sense in subjects with stable and unstable shoulders. *J Athl Train* 37:141–145, 2002.
51. Ulkar B, Kunduracioglu B, Cetin C, et al: Effect of positioning and bracing on passive position sense of shoulder joint. *Br J Sports Med* 38:549–552, 2004.
52. Hurd WJ, Kaplan KM, ElAttrache NS, et al: A profile of glenohumeral internal and external rotation motion in the uninjured high school baseball pitcher, part II: strength. *J Athl Train* 46:289–295, 2011.
53. Olsen SJ, II, Fleisig GS, Dun S, et al: Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med* 34:905–912, 2006.

Multiple-Choice Questions

QUESTION 1. Clear communication from the surgeon to the rehabilitation team concerning tissues to be considered following anterior instability surgery includes:

A. Capsule, labrum, biceps, humerus, and subscapularis.
B. Capsule, labrum, glenoid, humerus and subscapularis.
C. Labrum, biceps, glenoid, humerus, and subscapularis.
D. Capsule, labrum, biceps, glenoid, and subscapularis.

QUESTION 2. Which of the following is not included in the guiding principles of postoperative rehabilitation?

A. Understanding of the surgical procedure and anatomic structures, which require protection.
B. When patients are very painful and guarded reviewing sleeping habits, sling use, and HEP are often helpful in managing pain allowing for gentle restoration of ROM.
C. Correct application of manual techniques and therapeutic exercises to promote static balance in glenohumeral joint mobility and optimum dynamic stabilization from the rotator cuff and associated shoulder girdle muscles.
D. Gradual restoration of PROM while protecting the anterior-inferior aspect of the glenohumeral joint through initial immobilization and the rate of ROM gain.

QUESTION 3. The following goals: minimize shoulder pain, achieve staged ROM goals to normalize passive ROM and active ROM, normalize rotator cuff guarding and neuromuscular control, normalize scapular position and control, are expected by:

A. First 14 days postoperatively.
B. 2 to 6 weeks postoperatively.
C. 7 to 12 weeks postoperatively.
D. 13 to 24 weeks postoperatively.

QUESTION 4. The primary rationale for limiting ROM during Phase I is:

A. Glenoid bone loss occurs in all instability and requires protection.
B. Labral repairs require significant protection.
C. Loading from resistance exercises may "stretch out" the capsulolabral repair.
D. Cyclical loading may "stretch out" the capsulolabral repair.

QUESTION 5. A 23-year-old wrestler presents 3 months status after R anterior arthroscopic Bankart repair and capsular plication. His ROM is as follows: 145 degrees of FE, 20 degrees of IR at 90, and 75 degrees of ER at 90. Based on this you recommend:

A. Anterior stretching of the shoulder including pectorals.
B. Posterior stretching of the shoulder including sleeper stretch.
C. Anterior stretching of the shoulder for ER with hands behind the head.
D. No stretching needed his ROM is within the guidelines.

Answer Key

QUESTION 1. Correct answer: **C** (see Surgical Summary)

QUESTION 2. Correct answer: **B** (see After Surgery PostOp Rehab)

QUESTION 3. Correct answer: **B** (see Phase I)

QUESTION 4. Correct answer: **D** (see Phase I)

QUESTION 5. Correct answer: **C** (see Phase II-III criteria)