Pediatric Shoulder Instability: Current Trends in Management

Christian A. Refakis, BA
Eileen P. Storey, BA
Christopher M. Brusalis, BA
Theodore J. Ganley, MD

Department of Orthopaedic Surgery
School of Medicine
University of Pennsylvania
Philadelphia, Pennsylvania, USA

Introduction

Pediatric shoulder instability commonly results from traumatic anterior dislocation of the humeral head.[1,2] Male adolescents aged 15-17 years participating in contact or collision sports have the highest risk of primary and recurrent dislocation.[3] In contrast to adolescents, children younger than 10 years seldom develop shoulder instability.[4] Adolescents are generally at a higher risk than their younger counterparts due to the dramatic increase in collision sports participation that occurs when children begin middle school at the onset of adolescence. Depending on the severity of instability and the patient's activity level, patients can range from being relatively asymptomatic to being unable to participate in sports or even engage in regular activities of daily living. Children and adolescents are at increased risk of developing recurrent shoulder instability as they are typically eager to return to sport and less likely to adhere to an appropriate course of physical therapy.[5,6] Limiting recurrences decreases the risk of future negative sequelae such as traumatic labral and cartilage injury.[7] Since non-operative treatments often fail in this highly active population, a number of surgical techniques are used to address specific defects of soft and bony tissue. In this article, we discuss our approach to shoulder instability in the high-risk pediatric patient.

Operative vs. Non-Operative Management

For the orthopaedic surgeon, the decision to surgically address shoulder instability in the child or adolescent ultimately depends on the rate of recurrence and the extent to which shoulder instability sufficiently impairs quality of life. Non-operative strategies generally rely on avoidance of strenuous shoulder activity, bracing and physical therapy to increase stability of the glenohumeral joint. These strategies have a particularly high failure rate in young athletes who often remain highly engaged in sports in spite of shoulder injury.[5] The reported rate of recurrence after primary dislocation in patients younger than 25 years of age is 40-95%; the greatest risk factor being age of primary dislocation under 20 years of age.[8,9,10,11] The risk of recurrent instability correlates inversely with the age at first dislocation, however, preadolescent children have been found to have good or excellent results with low recurrence rates after conservative treatment.[12,13]

Although some of the most competitive adolescent athletes will undergo surgical repair after primary dislocation, pressure to finish a season, as well as peer and scholarship pressures can influence the decision to continue participating in sports despite recurrences of shoulder instability. The clinician should bear these influences in mind when recommending a particular treatment, as the risk of recurrent instability when returning to play untreated is significant.

Several studies highlight the inefficacy of the non-operative approach in the adolescent population. In a retrospective cohort study of 65 pediatric patients aged 15-18 years, 19/27 (70%) of patients managed non-operatively developed recurrent instability, while only 5/38 (13%) of those treated arthroscopically developed recurrent instability.[14] A previously published review by the senior author of 32 patients with Bankart lesions aged 11-18 years followed over an average of 25.2 months sought to determine the potential benefit of arthroscopic repair following primary dislocation. The study compared 16 patients with Bankart lesions undergoing arthroscopic repair after primary dislocation to 16 patients undergoing arthroscopic repair after an average of 10.5 months of non-operative management. The authors concluded immediate Bankart repair limits multiple recurring shoulder dislocations that hinder quality of life and potentially lead to future negative sequelae.[15] Similar conclusions have been drawn when comparing the efficacy of non-operative treatment to the Latarjet procedure among skeletally immature patients. Khan et al retrospectively compared 23 non-operative patients with 26 patients undergoing the Latarjet procedure and found no significant differences between groups regarding functional scores and pain levels yet 92% of the post-surgical group returned to the same level of pre-injury activity compared to only 52% of the non-operative group.[16]

Non-operative management (physical therapy or activity modification) is most appropriate for a younger child with low activity demands and a single dislocation of the non-dominant shoulder with no symptoms. Operative intervention

is most appropriate for a high activity demand adolescent collision sport athlete with recurrent instability and evidence of damage to soft tissues, bony structures or both on MRI.

Operative Techniques for Restoring Shoulder Stability in the Pediatric Patient

The goals of operative treatment are to restore shoulder stability in an attempt to decrease the rate of dislocation and the risk of future sequelae such as axillary nerve damage, post-traumatic arthritis and glenoid bone loss. For an athlete with functional impairment of the unstable shoulder, the potential to restore quality of life is immense. Multiple techniques for operative management of shoulder instability have been reported by various authors.[24,25] In addition to patient lifestyle and wishes, the specific type of technique used is a multifactorial consideration of the severity of recurrent instability, the extent of glenoid labrum avulsion, the extent of capsular stretch as well as pre-existing laxity, the presence and severity of a Hill-Sachs deformity, and the extent of glenoid bone loss.

Open vs. Arthroscopic Repair Of Glenoid Labrum Tears

Arthroscopic repair of soft-tissue damage (glenoid labrum avulsion, SLAP tears, capsular laxity, rotator cuff tendinopathy, etc.) has been the mainstay of shoulder instability treatment for over two decades. While open techniques have traditionally been considered the gold standard repair, recent studies have found they result in similar rates of recurrent instability to arthroscopic techniques but have significantly longer recovery time.[17,18] A retrospective review of 99 children with Bankart lesions compared 28 children undergoing open repair with 71 children undergoing arthroscopic repair found no significant difference in redislocation rates (21%) or functional outcomes.[18] Open procedures remain a viable alternative in cases of severe glenoid fracture or subscapularis tendon avulsion fracture.[19]

It is crucial to address any and all bony defects contributing to instability. Studies suggest both open and arthroscopic repairs of isolated soft tissue defects are likely to result in recurrent shoulder instability if bony defects, such as glenoid bone loss or engaging Hill-Sachs lesions, are not addressed. A study found that for both open and arthroscopic techniques, the adolescent shoulder undergoing Bankart repair had a two-year survival rate of 86% and a five-year survival rate of 49%.[6] A prospective study found 15% of 131 children and adults followed a minimum of two years after arthroscopic Bankart repair developed recurrent anterior shoulder instability. This relatively high failure rate was mostly attributed to several risk factors: age of primary dislocation less than 20 years, involvement in competitive/contact sports or those with overhead activity, shoulder hyperlaxity, a Hill-Sachs lesion (HSL) present on AP radiograph of the shoulder in external rotation, and loss of sclerotic inferior glenoid contour.[20] While this study only addressed the arthroscopic failure rate, it highlights the importance of addressing bony defects. HSLs and glenoid bone loss in particular are common causes of instability that are typically repaired arthroscopically and open, respectively. While arthroscopic soft-tissue repair is acceptable for the vast majority of children and adolescents with soft-tissue lesions, those with significant bony defects likely require additional procedures best performed either open or arthroscopically. The severity of both soft-tissue and bony defects must be considered together before the decision to proceed with open or arthroscopic repair is made.

Addressing Hill-Sachs Lesions: The Remplissage Technique

HSLs are posterolateral humeral head compression fractures that typically result secondary to anterior dislocations of the shoulder, whereby the posterolateral aspect of the soft, cancellous humeral head is compressed against the anteroinferior aspect of the dense, cortical glenoid. The resulting impression left in the humeral head can then engage on the anterior glenoid rim during abduction and external rotation, causing shoulder dislocation. The presence of HSLs is critical to determine as they can be key causes of recurrent instability and can worsen in severity (depth and width) with each dislocation.

The location, diameter and depth of HSLs vary depending on the type and number of traumas sustained. The most clinically relevant consideration is simply whether HSLs engage on the anterior glenoid rim. In this consideration, the concept of the glenoid track has become an important new paradigm.[22] To engage on the anterior glenoid rim and cause shoulder dislocation, an HSL must be "off track," i.e. it extends over the anterior margin of the glenoid and engages the glenoid rim. Conversely, a lesion is "on-track" and non-engaging if it lies completely within the glenoid track (Figure 1). This concept of glenoid track was developed as a means to quantitatively

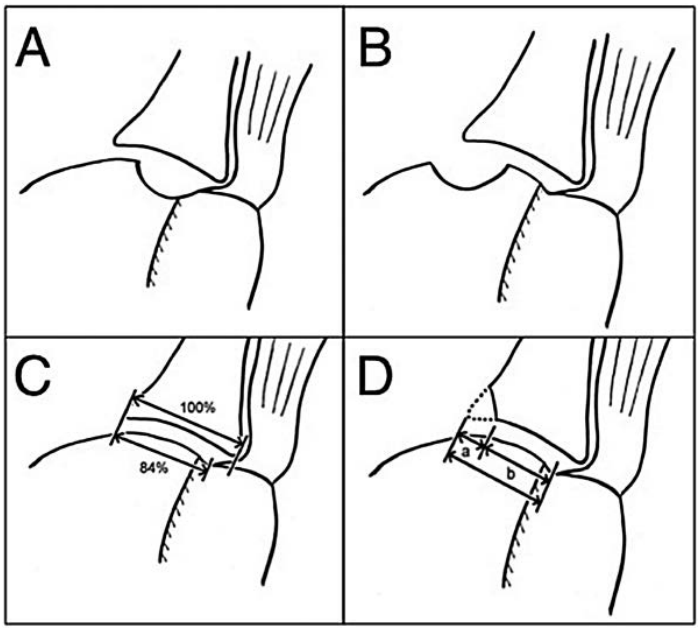

Figure 1. A: On-track, non-engaging Hill-Sachs lesion. B: Off-track, engaging Hill-Sachs Lesion. C: Full glenoid width maximizes chance of Hill-Sachs lesion being on-track. D: Glenoid bone loss increases the likelihood of engagement as Hill-Sachs lesions more likely to be off-track.[22]

assess the Hill-Sachs lesion in relation to the size of anterior bone loss, then integrate that quantification into a treatment algorithm.[21,22] Standard stabilization techniques such as Bankart repair are unlikely to restore shoulder stability when large, engaging, "on-track" HSLs are present.[21,22] A study found 21/194 (10.8%) of children who underwent Bankart repair developed recurrent instability. Of those 21 failures, 67% were found to have engaging HSLs, while children with no bony defects of the shoulder developed recurrent instability only 4% of the time. Inverted pear configuration of the glenoid, as well as engaging HSLs were deemed contraindications to arthroscopic Bankart repair.[23]

From a management standpoint, shoulder arthrograms can help assess the size and depth of HSLs as well as their relationship to the glenoid track.[24] By measuring the widths of the glenoid track and the Hill-Sachs lesion, one can then compare these to classify the lesion as "on-track" or "off-track." For the difficult subgroup of instability patients with high potential for failure after a standard arthroscopic Bankart repair, HSLs are surgically addressed via the remplissage technique, an arthroscopic capsulotenodesis of the posterior capsule and infraspinatus tendon to fill the HSL. Remplissage, which in French means "fill in," effectively makes the Hill-Sachs defect extra-articular, preventing it from engaging the glenoid, and ultimately improving stability. Although this technique has only recently become popular, research has shown that it is effective for addressing HSLs. In a study evaluating the efficacy of the technique, only 2/24 patients treated with the Remplissage technique had recurrent instability, both of which occurred after significant trauma. The procedure produced no significant loss of external rotation.[25] A systematic literature review by Buza et al to evaluate the outcomes of arthroscopic Hill-Sachs Remplissage showed similar results, as only 9/167 shoulders (5%) experienced episodes of recurrent glenohumeral instability. These rates of instability were comparable to patients without HSLs.[26]

For the vast majority of children and adolescents with engaging HSLs sustained from recurrent anterior dislocations and no significant other bone defects, the arthroscopic remplissage technique achieves excellent results. However, in the rare event that an HSL reaches a critical size, the Remplissage technique is unlikely to be effective and other humeral head resurfacing approaches must be considered.

Addressing Glenoid Bone Loss: The Bristow-Latarjet Procedure

The significance of glenoid bone loss must be considered since the combined surgical approach of arthroscopic Bankart repair and Hill-Sachs Remplissage are successful when there is an intact glenoid or minimum bone loss. In those rare cases where glenoid bone loss is significant, a more robust approach is required. Given the long-term instability associated with failure to address bony deficits of the glenoid, there has been renewed interest in the Bristow-Latarjet procedure. First described in 1954, the Bristow-Latarjet procedure restores congruity of the shoulder joint using the coracoid process as an augmentation of the anteroinferior glenoid rim (Figure 2).[27] The procedure is recommended in cases where glenoid bony defect is >25% of glenoid width of if risk of instability is higher, as it is with collision-sport athletes.[28] An instability severity index score has been developed to guide surgical decision making for patients with recurrent instability.[29]

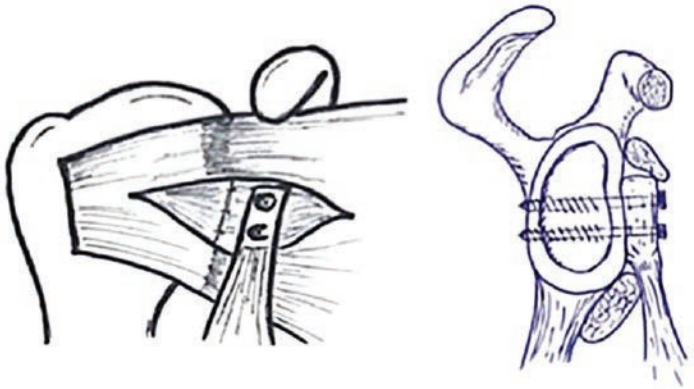

Figure 2. Transfer of the coracoid process to the anterior glenoid with two-screw fixation restores the congruity of the glenoid, stabilizing the glenohumeral joint. The downward displacement of the inferior belly of the transected subscapularis muscle is also thought to provide a stabilizing "sling effect" to the humeral head.[32]

Several studies have demonstrated that the Bristow-Latarjet procedure is highly effective for recurrent stability secondary to significant glenoid bone loss. In a prospective study of 79 patients with recurrent anterior instability and bone loss of more than 20% of the glenoid, 98% of patients had stable shoulders and 83% returned to sports at preinjury level.[27] A retrospective study of 63 shoulders undergoing the Bristow-Latarjet procedure found only 1/63 (1.6%) developed recurrent instability at 5-year follow-up.[30] Another study found a 5% dislocation rate at 20-year follow-up.[31] While the dislocation rate is lower (0-8% rate), the procedure is associated with a higher incidence of complications, such as screw breakage, nonunion, and stiffness.[32] The Bristow-Latarjet procedure remains one of the best surgical techniques to address significant glenoid bone loss.

Treatment Algorithm

Determinants of treatment options include symptoms of recurrent instability and laxity, associated pathology such as soft-tissue and bony defects, and adherence by the patient and family. The case vignettes shown in Figure 3 highlight key management strategies. Primary dislocators with low activity demands who lack symptoms of recurrent instability may be managed conservatively. For athletes with high activity demands and recurrent instability, operative intervention is recommended. Arthroscopic soft-tissue repairs suffice in cases where bony defects are minimal to non-existent, but large, engaging Hill-Sachs lesions or significant glenoid bone loss (> 25% of glenoid width) require alternate approaches.

Conclusion

Shoulder instability is an increasingly common problem in the pediatric population as participation in youth sports continues to rise. Since a relatively high activity level predisposes one to recurrent instability, non-operative

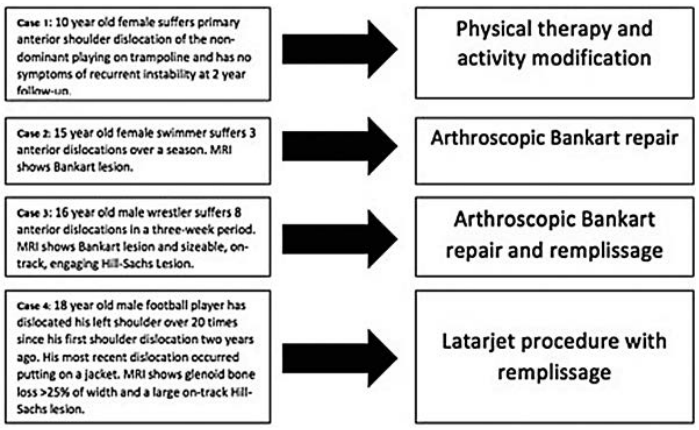

Figure 3. Case vignettes highlighting key scenarios in the management of shoulder stability in children and adolescents.

treatment has a higher risk of failure among pediatric patients. In addition to patient activity level and potential collegiate athletic aspirations, the management approach requires a multifactorial consideration of the severity of recurrent instability, patient-specific pathoanatomy, and recovery time. While several surgical techniques exist to restore shoulder stability, pediatric patients' pathological and functional risk factors can help guide a surgeon's decision.

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