Jason Bottoms

**Synthesis of Evidence**

While this review encompasses overhead athletes in general, much of the literature focuses on overhead throwers. The phases of overhead throwing include: wind-up, stride, cocking, acceleration, deceleration and follow through in that order. The phases most associated with shoulder injury are late cocking phase (when the arm is maximally externally rotated and abducted; both stress on anterior capsule and rotator cuff activation peak; bicep contraction begins) and deceleration (high velocity internal rotation and abduction must be accommodating by posterior shoulder musculature; eccentric bicep contraction must slow elbow extension; inferior shear forces and medial compressive forces peak).

Common shoulder injuries in overhead athletes cited in the literature include rotator cuff tears, labral injuries, gelnohumeral instability, and biceps tendon injuries. Rotator cuff tears and labral injuries are cited most frequently. Other less common injuries include capsular injuries, lesser tuberosity avulsion fractures, latissimus dorsi and teres minor injuries, as well as glenoid osteochondral injuries. Many different mechanisms are provided for these injuries including the inherent demands of high velocity overhead striking and throwing, potential osseous and soft tissue adaptations to these demands, poor scapular control/coordination, and fatigue affecting the coordination and contraction strength of muscles required for overhead sports. Specific to rotator cuff injuries, the supraspinatus tendon is most frequently involved. Tears can be full thickness or partial thickness and are thought to occur due to three primary mechanisms: eccentric tensile overload during the deceleration phase of throwing; internal impingement due to abnormal contact of the rotator cuff and the superior glenoid and labrum during late cocking phase; and external or subacromial impingement of the supraspinatus tendon. Labral tears vary in location and severity but superior labrum anterior posterior (SLAP) lesions are by far the most common in this patient population. Two primary mechanisms for SLAP lesions are suggested in the literature: eccentric tensile forces on the biceps long head during deceleration; and internal impingement (as discussed above however contact is with the biceps anchor where it attaches to glenoid) plus the “peel-back mechanism” (late cocking phase creates a posteriorly directed, twisting strain that can result in the biceps anchor and posterosuperior glenoid labrum “peeling back” from the glenoid). It is unlikely that any one of the above mechanisms entirely explains an injury but rather a combination of these contributes to eventual injury over time.

Overall, there is a paucity of high-level evidence regarding prevalence of various shoulder injuries along with rehabilitation guidelines and protocols as well as outcomes for shoulder injuries in overhead athletes. Most articles located were narrative reviews or expert opinion indicating the need to integrate suggestions/recommendations into practice with an appropriate amount of clinical judgment. There was strong agreement in the literature regarding shoulder complex anatomy and overhead throwing biomechanics discussed in the second paragraph. Narrative reviews by Cools et al (2015), Stone et al (2018) and Wilk et al (2011) present useful information regarding risk factors for developing shoulder pathology in this patient population. While most of the evidence was in the form of narrative reviews, it does appear that underlying risk factors for shoulder injury in the overhead athlete are understood and generally agreed upon in the literature. These articles agree that scapular dyskinesia, glenohumeral internal rotation deficit (GIRD) and weak rotator cuff musculature represent the primary risk factors for shoulder injury in these athletes. A cohort-study by Clarsen et al (2014) mirrored this opinion and offered odds ratios for each of these risk factors: scapular dyskinesia (OR: 8.41), GIRD (OR: 0.77 per 5 degree change), external rotators strength (OR: 0.71 per 10 Nm change). Cools et al (2015) suggest the following interventions to reduce the potential for shoulder injuries based on the risk factors: stretching of the posterior shoulder capsule, strengthening of the posterior cuff, and restoration of flexibility and muscle balance of the scapular muscles.

A narrative review by Economopoulos et al (2012) does an exceptional job examining the anatomy, pathoanatomy and mechanisms resulting in rotator cuff injuries in baseball pitchers. The authors agree with the mechanism of injury for rotator cuff tears discussed above and suggest conservative management for minor to moderate tears results in higher rates of return to sport than surgical approaches. However they also comment on the lack of evidence for outcomes in this population. Liu et al (2018) and Stone et al (2018) conducted narrative reviews regarding diagnosis and treatment of rotator cuff injuries. Stone et al (2018) recommended specific guidelines and cutoff scores that put an athlete at increased risk for rotator cuff injury. They also present a multi-phased rehabilitation program with a gradual, sequential introduction of sport-specific demands as tissues heal, range of motion is restored and muscles are strengthened. The authors also emphasize the importance of training the entire kinetic chain to reduce stress on the shoulder during throwing. Liu et al (2018) was one of the few reviews to comment on return to function rather than simple return to sport – indicating that many athletes return to playing but at a lower level of function than before their rotator cuff injury. The authors suggest less 50% of high-level overhead athletes return to prior level of function following a rotator cuff tear.

The only systematic review examined was by Michner et al (2018). This review was of exceptional quality, detailing diagnosis and management concepts related to labral injuries. Suggestions include: a three-test diagnostic cluster for labral injuries (compression rotation, apprehension and Yergason’s test); a conservative treatment period of 3-6 months with goals of decreasing pain, improving shoulder function, and returning to previous activity levels; a cutoff of 70% overall shoulder strength compared to other side before return to sport-specific program. Michner et al (2018) also reported a portion of the few statistics regarding outcomes for labral injuries citing a 40-95% return to sport rate range with non-operative management. The authors however, also comment on the lack of evidence for outcomes, noting these statistics were based on only two studies. A narrative review by Burkhart et al (2001) suggests the Jobe relocation test as a method for diagnosing a labral injury and emphasizes the importance of focusing on the kinetic chain during rehabilitation.

This review found very little high-level evidence regarding prevalence, prevention, treatment and outcomes for shoulder injuries in overhead athletes. Despite this, the literature does seem to agree on risk factors for shoulder injuries in this patient population. General rehabilitation concepts also seem to be shared amongst several studies. Higher-level evidence on effectiveness of certain interventions for specific injuries may be useful for clinicians when developing a plan of care. Additionally, statistics on outcomes would be especially useful for patients, clinicians and physicians when discussing conservative versus surgical management. These outcome statistics should be focused on return to previous or higher level of function rather than simply return to sport.

**References**

1. Lin D, Wong T, Kazam J. Shoulder injuries in the overhead-throwing athlete: epidemiology, mechanisms of injury and imaging findings. *Radiology*. 2018. Vol. 286, No. 2. https://doi.org/10.1148/radiol.2017170481
2. Liu JN, Garcia GH, Anirudh GK et al. Treatment of Partial Thickness Rotator Cuff Tears in Overhead Athletes. Curr Rev Musculoskelet Med. 2018 Mar; 11(1): 55–62.
3. Michener LA, Abrams JS, Bliven KC. National Athletic Trainers’ Association Position Statement: Evaluation, Management, and Outcomes of and Return-toPlay Criteria for Overhead Athletes With Superior Labral Anterior-Posterior Injuries. Journal of Athletic Training 2018;53(3):209–229. doi: 10.4085/1062-6050-59-16.
4. Stone MA, Jalali O, Alluir RK, et al. Nonoperative treatment for injuries to the in-season throwing shoulder: a current concepts review with clinical commentary. *Int J Sports Phys Ther*. 2018 Apr; 13(2): 306–320.
5. Cools A.M., Johansson F.R., Borms D., Maenhout A. Prevention of shoulder injuries in overhead athletes: A science-based approach. Braz. J. Phys. Ther. 2015;19:331–339. doi: 10.1590/bjpt-rbf.2014.0109.
6. Clarsen B, Bahr R, Andersson SH, Munk R, Myklebust G. Reduced glenohumeral rotation, external rotation weakness and scapular dyskinesis are risk factors for shoulder injuries among elite male handball players: a prospective cohort study. Br J Sports Med. 2014;48(17):1327–1333. doi: 10.1136/bjsports-2014-093702.
7. Edmonds E W, Dengerink D D. Common conditions in the overhead athlete. Am Fam Physician. 2014;89:537–541.
8. Economopoulos KJ, Brockmeier SF. Rotator cuff tears in overhead athletes. Clin Sports Med. 2012;31:675–692.
9. Wilk KE Macrina LC Fleisig GS, et al. Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball pitchers. Am J Sports Med. 2011;39(2):329-335.
10. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, part 1: reliability. J Athl Train. 2009;44(2):160–164. doi: 10.4085/1062-6050-44.2.160.
11. Burkhart SS, Morgan C. SLAP lesions in the overhead athlete. Orthop Clin North Am. 2001;32(3):431–441.