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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed Patient Consent

The author(s) should confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

Abstract

Lacrosse has become an increasingly popular sport in recent decades with more players competing at the high school and collegiate levels. Along with the rise in popularity, lacrosse has also seen an increase in and evolution of common injuries experienced by players. Specifically, the incidence of shoulder
instability episodes in lacrosse players has continued to increase over the years leading to a progressive focus in further understanding shoulder injuries in lacrosse.

Lacrosse players are at risk for shoulder instability due to the nature of the game. The biomechanics and contact aspect of the sport place a unique stress on the shoulder. Thus, there is an appropriate emphasis on how clinicians understand, diagnose, and treat shoulder instability in lacrosse players. This rise in popularity means every clinician involved in the treatment of athletes should be proficient in performing physical exam components specific to shoulder instability, develop their own treatment approach, and understand commonly used test batteries for determining an athlete’s return to sport.

Despite this recent focus, there remains a lack of substantial data regarding shoulder instability as it relates to lacrosse. Therefore, we have conducted an extensive literature review and provided an overview of many of the most recent concepts discussed surrounding shoulder instability in lacrosse players.

Introduction

Lacrosse has become an increasingly popular sport in the past few decades with more and more players at the high school and collegiate levels. In 2020, it was estimated that 113,703 men and 99,750 women played high school lacrosse.[1] In the same year, 14,603 men and 12,452 women played National Collegiate Athletic Association (NCAA) collegiate lacrosse.[1] These numbers have been steadily increasing since the early 2000s.[2, 3] As the number of players continues to rise, so do injuries and injury trends.[2-8]

Lacrosse is a unique sport that combines elements of collision sports such as football and throwing plays as seen in baseball.[9, 10] This puts players at risk for a variety of injuries. Some of the highest reported injuries in lacrosse include concussions, shoulder injuries, hand injuries, and ankle injuries.[2-8, 11, 12]

Epidemiology

As a collision sport, lacrosse players are at particularly high risk of injury. Among collegiate sports, men’s lacrosse has had the 6th highest injury rate, just below football, wrestling, and ice hockey.[13]

The rate of injuries in high school lacrosse has been reported between 2.5-3 per 1,000 athletic exposures (AE), with approximately 6-9% of injuries being shoulder injuries.[6, 8] Recent data in NCAA lacrosse reports 4.9 injuries per 1,000 AEs, while data obtained during the 2018 World Championship play reports injury rates as high as 19.6 per 1,000 AEs.[3, 4] Shoulder injuries are reported between 7-9% of all injuries in these populations.[3, 4] Epidemiological data from the 2010 Lacrosse World Championship reports that 23% of lacrosse injuries affect the upper extremity, and the shoulder is the second most commonly injured joint in lacrosse players, second to the ankle.[10, 12] Anterior glenohumeral subluxation and AC joint separation are reported to be the most common shoulder instability injuries among collision athletes.[9, 11] Incidence of shoulder injuries among lacrosse players has been reported to be 0.35 per 1,000 AEs during practice, and 1.89 per 1,000 AEs during competition.[9]

The majority of shoulder injuries occur during competition rather than practice.[3, 11] Contact with another player was the most common mechanism of shoulder injury, responsible for nearly 57% of all shoulder injuries.[9, 11] For all contact injuries, the shoulder has been reported as the most frequently injured body part.[4] Overuse injury was less common, accounting for approximately 5% of injuries.[9] It
has also been demonstrated that men participating in collision sports are more likely to sustain shoulder instability injuries than women in comparable sports. [11]

**Biomechanics**

Lacrosse players are at risk of sustaining a wide array of shoulder injuries due to the unique nature of the game. Like baseball and tennis players, lacrosse athletes engage in repetitive overhead throwing movements that primarily apply rotational and anterior directed forces on the glenohumeral joint. Similar to football and ice hockey, lacrosse is a contact sport where players are consistently making contact with other players. This results in direct blows that place force of varying directions on the shoulder. Additionally, much of defensive play involves pushing off of and checking other players in lacrosse. The anteriorly directed force generated by players during contact often results in a posterior force being driven across the glenohumeral joint. This repetitive motion can result in shoulder instability often seen in linemen, hockey players, and lacrosse players.

Posterior shoulder instability is a relatively rare injury, but can present more commonly in athletes that receive repeated blows or blunt trauma to the shoulder as seen in football or lacrosse. [14] Checking is allowed in lacrosse if it is above the waist and below the shoulder and performed in a certain manner. Specifically, players who contact their opponents with their arms in front of their body are at particularly high risk. [15] Additionally, as players anticipate contact, they tighten their shoulder muscles leading to increased compressive forces across the glenohumeral joint. [15] Interestingly, lacrosse shoulder pads tend to be thinner than those used other contact sports such as hockey and football, while also having a non-cantilever design to improve shoulder range of motion. [9] Together, these aspects of the sport may put lacrosse players at higher risk for experiencing shoulder injuries and instability.

**Examination**

A thorough and complete history and physical examination is the crucial first step in managing suspected shoulder instability injuries in any patient. In athletes who have experienced shoulder dislocation, they may recall one specific instance of traumatic dislocation or multiple events of instability. Meanwhile, athletes with shoulder instability who have experienced subluxation may not recall a specific event or injury. [16-18] Rather, these patients may describe a history of generalized laxity in their shoulder as well. [16-18] It is also important for the clinician to understand the mechanism of injury when applicable. For instance, episodes of anterior shoulder instability often involve shoulder abduction and external rotation. [16-18] Proper questioning while taking a history may elude to the sustained injury pattern.

In patients who present acutely with dislocation, exam is typically notable for a prominence of the humeral head both anterior and inferior to the shoulder with loss of palpable deltoid contour. [16] Patients will often present holding their arm in an adducted and internally rotated position and experience decreased ability to abduct beyond 90 degrees. [16]

Prior to and immediately following reduction of any dislocation, the shoulder should be assessed for passive and active range of motion as well as a complete neurovascular exam. Close attention should be paid to ensuring the axillary and radial nerves are uninjured as they are particularly susceptible during dislocation. It is also important to perform provocative testing to fully assess shoulder stability.

**Anterior Apprehension Test**
The anterior apprehension test involves placing the patient in a supine or seated position, abducting the shoulder to 90 degrees and passively externally rotating it (Figure 1). [16, 19] The test is considered positive if guarding and apprehension is observed by the examiner. [16, 19]

*Figure 1: Demonstration of the anterior apprehension test as the patient is placed in a supine position stabilizing the scapula and the arm is abducted and externally rotated.*

Relocation

Anterior shoulder dislocations can be reduced using the apprehension positioning as described by Jobe et al (ie Jobe test).[19] The shoulder is abducted to 90 degrees and externally rotated (Figure 2). A posterior force is then applied and relocation is confirmed by resolution of apprehension or symptomatic improvement (Figure 2).[16, 19]

*Figure 2: Demonstration of the anterior dislocation reduction maneuver in which the arm is abducted and externally rotated while a posterior force is applied across the glenohumeral joint.*

Surprise Test

The surprise test is performed by applying posterior force across the glenohumeral joint and suddenly releasing it.[16] A positive test is considered an immediate sense of instability or apprehension following release of force.[16]

Load-and-Shift Test

The load-and-shift test involves applying an axial load to center the humeral head on the glenoid followed by an anterior and posterior directed force at 0, 45, and 90 degrees of shoulder abduction to evaluate the degree of translation at each position (Figure 3).[16]

*Figure 3: Demonstration of the load-and-shift test as a posterior force is directed while the arm is abducted to 90 degrees.*

Sulcus Sign

The sulcus test involves applying longitudinal inferior traction to the humerus to objectively evaluate inferior glenohumeral laxity (Figure 4). The degree of laxity is determined by measuring displacement of the humerus with regard to the acromion.[18] A sulcus sign represents 1 cm of translation.[16, 18] Beyond 1 cm, 2+ and 3+ represents 2 cm and 3 cm displacement, respectively.[16, 18] The same test is then performed at 30 degrees of external rotation and persistence of the sulcus sign indicates incompetence of the superior glenohumeral ligament and rotator interval.[16, 18] Disappearance of the sulcus sign with external rotation indicates a sufficient rotator interval.[16, 18]

*Figure 4: Demonstration of the sulcus test as axial traction is applied to the humerus.*

**Treatment**

In-season injuries and decisions surrounding treatment can be stressful for players, as they are usually trying to minimize time off the field. For many, conservative treatment may be a reasonable first step.
Conservative treatment includes immobilization, bracing and physical therapy. Data regarding immobilization is controversial, with some studies indicating immobilization in external rotation in optimal for healing, while other studies report no significant difference.[20-22] One such study examined a group of collegiate lacrosse players and saw minimal improvement with bracing.[23] Physical therapy may vary depending on injury and provider, but in general there is a focus on early range of motion with progression toward strengthening exercises. [24] When athletes return to sport, they may continue to wear a brace. This could be either a motion limiting brace or a shoulder stabilization brace.[16] These braces primarily limit overhead motion, which makes their practical use in the lacrosse player limited.

There are a variety of factors to consider when indicating a player with shoulder instability for surgery including clinical findings as well as season timing and future career goals. Clinical indications to pursue surgical intervention would include significant glenoid bone loss, humeral head bone loss, associated fracture and recurrent instability or dislocations.[21, 25, 26] Greater than 15-25% glenoid or humeral head bone loss has been associated with increased risk of instability, and is a strong indication for surgery.[25, 26] Surgery would depend on the amount of bone loss. In patients without significant glenoid bone loss, they may undergo direct bankart repair, but those with >15-25% glenoid bone loss, bony reconstruction, such as a latarjet procedure, may be indicated. ([Fig 5]) For patients with relative indications for surgery, such as first time dislocators, or labral injuries without significant bony defects, their decisions may be based more on situational factors, such as what part of the season they are in, or if they plan on pursuing a future career in the sport.[16]

Surgical treatment for first time dislocators remains controversial.[21, 27] Studies have shown that after a first time traumatic shoulder dislocation, 53% of patients sustain an second dislocation event when treated conservatively.[21] Patients that do undergo surgical treatment after a first time dislocation are less likely to have significant glenoid bone loss or biceps pathology compared to recurrent dislocators.[27] They are more likely to undergo arthroscopic treatment, for example with bankart repair or capsular plication.[27] Surgical labral repair after a first time dislocation is associated with a decreased risk of recurrent dislocation compared to those who are treated conservatively (Figure 6). Additionally, patients who have multiple dislocations, or are treated surgically greater than 6 months after their first time dislocation event have poorer functional outcome scores.[28]

**Figure 5:** Postoperative radiograph of a patient with a latarjet procedure.

**Figure 6:** (a) Anterior labral tear (b) Labral tear status post suture repair.

**Time Lost**

Shoulder injuries among lacrosse players often lead to a significant amount of time lost from their season and a lengthy recovery. One study in men’s collegiate lacrosse reported the average time lost due to shoulder injuries to be 11 days.[9] Anterior dislocation events generally led to an even higher time lost with an average of 16.8 days lost.[9] Additionally, anterior dislocation events frequently contributed to season ending injuries.[9] Meanwhile, posterior dislocation events led to less time lost, at only 7.2 days.[9] Approximately 41% of shoulder injuries led to greater than 10 days of lost time. [9] Among collision athletes, there appears to be significant differences between time lost due to shoulder injuries
depending on NCAA division. One study showed that division I athletes averaged only 4.77 days of time lost compared to 20.52 days for division II. [11]

Return to Sport

Discrepancies in overall time lost underscores a lack of understanding surrounding factors contributing to athlete recovery and rehabilitation. Return to sport (RTS) or return to play (RTP) has traditionally been defined by an athlete’s ability to return to make a full return to their level of sport or activity prior to injury. However, this definition allows for ambiguity in certain scenarios without the consideration of specific criteria. A systematic review was performed in 2018 evaluating surgical stabilization in patients who experienced primary traumatic anterior shoulder instability by reviewing 5,100 articles published between 1994 and 2017.[29] Of the 5,100 articles reviewed, 58 specifically addressed return to play utilizing seven different criteria used to determine return to play.[29] The most common criteria were the following: (1) time from surgery, (2) range of motion, (3) strength, (4) stability, (5) pain, (6) proprioception, and (7) postoperative plain radiographic assessment of union involving bony procedures.[29] Thirteen combinations of the criteria were utilized to determine RTS in these studies placing emphasis on the complexity of evaluating RTS.[29] These combinations were used to determine a rate of RTS over 80% in two-thirds of the included studies.[29]

In addition to utilizing specified criteria to evaluate an athlete’s ability to RTS, many clinicians use a battery of tests. The goal of a test battery is to minimize the risk of injury recurrence and the likelihood of an athlete developing secondary sequelae. [37] Test batteries set benchmarks to inform clinicians, athletes, and their stakeholders on an athlete’s progress towards meeting the demands of their respective sport. [37] A test battery proposed by Otley et al. that assesses psychological readiness and absence of kinesiophobia, adequate range of motion specific to their sport, ability to develop and resist force, and scapulohumeral stability and endurance (Figure 7). [37] Test batteries, such as the one proposed in Figure 7, offer invaluable guidance in evaluating many different types of athletes for a safe RTS. Although, it is important to select individual tests based on the type of athlete being evaluated. For instance, lacrosse players may require both open and closed chain tests and require further customization depending on their position due to the unique demands of their sport. Meanwhile, athletes of another sport with differing biomechanics and demands may require different tests.

Figure 7. Framework for testing athletes recovering from shoulder stabilizing procedures. This criteria is to be used as the athlete progresses through phased rehabilitation and graduated exposure towards return to sport. Tests most beneficial to lacrosse players are those bolded. Abbreviations: CKC, closed kinetic chain; ER, external rotation; HHD, handheld dynamometry; IR, internal rotation; KJOC, Kerlan-Job Orthopaedic Clinic Shoulder and Elbow Score; MMT, manual muscle testing; OKC, open kinetic chain; PSET, Posterior Shoulder Endurance Test; ROM, range of motion; SIRSI, Shoulder Instability Readiness to Return to Sport Index; UQ, Upper Quarter; WOSI, Western Ontario Shoulder Instability Index.

Return to sport following successful shoulder stabilization is determined by several factors including the number of instability incidents experienced, direction of instability, amount of bone lost, and degree of risk associated with the patient’s sport or activity.[30] Additionally, one study demonstrated that a patient’s expectation greatly influenced their prognosis and ability to return to their previous level of activity.[31] In athletes undergoing primary and recurrent interventions, 92% of athletes anticipated a
return to their previous level of play while 79% anticipated complete resolution of their instability. [31] Together, proper consideration of these variables while managing player expectation may help to shorten an athlete’s RTS time. The complexity of determining an athlete’s return to sport warrants involvement of and a thorough, team-based discussion with the athlete, team physician, athletic trainer, physical therapist, and coach. In many instances, it may be beneficial to include a sports psychologist or mental skills coach when available to assist with athlete coping, decision making, and setting of expectations.

Conclusion

While there is a large amount of data on shoulder injuries in sports like baseball and football, there remains very few that specifically focus on shoulder instability in the lacrosse player. The shoulder joint during lacrosse play is subjected to both repetitive overhead and sidearm throwing motions, while also being subject to repeated collisions and blunt trauma. Lacrosse continues to grow in popularity each year, with more and more players at every level, and we can expect to see more injuries as a result. More research on the types of shoulder instability that lacrosse players typically present with, as well as recovery and return to sport would help to shape preventative training as well as post-injury rehabilitation for these athletes.

References


*Figure 1*: Demonstration of the anterior apprehension test as the patient is placed in a supine position stabilizing the scapula and the arm is abducted and externally rotated.
Figure 2: Demonstration of the anterior dislocation reduction maneuver in which the arm is abducted and externally rotated while a posterior force is applied across the glenohumeral joint.

Figure 3: Demonstration of the load-and-shift test as a posterior force is directed while the arm is abducted to 90 degrees.
Figure 4: Demonstration of the sulcus test as axial traction is applied to the humerus.

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