The Thrower's Shoulder

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KEYWORDS

• Labrum • Rotator cuff • Humeral retroversion • GIRD

KEY POINTS

- Injuries specific to throwers most commonly involve the labrum and the undersurface of the rotator cuff.
- The act of throwing has been described as occurring in several distinct phases. Of particular importance are the late-cocking, ball release and follow-through phases. These portions of the throwing motion produce the largest forces about the glenohumeral joint, and therefore, the highest injury risk.
- In late-cocking, the anterior capsule is under significant strain in an effort to prevent anterior translation of the humerus. Tensile failure and attenuation of the anterior capsule is thought to occur from repetitive 'hard throwing'.
- During the follow through phase, the posterior capsule and posterior cuff undergo tremendous eccentric loads - up to 108% of body weight - in order to decelerate the rapidly internally rotating arm and to restrain the significant distractive forces seen at the posterior shoulder joint.
- The thrower's shoulder is prone to injury secondary to the convergence of the following factors: attenuation of the anterior capsular constraints, acquisition of a posterior capsular contracture, development of scapula dyskinesis, breakdown of the kinetic chain and repetitive contact of the posterior superior labrum and greater tuberosity.

INTRODUCTION

Throwers, or athletes who engage in repetitive overhead motions, are a unique subset of athletes who experience distinct shoulder injuries. For purposes of clarity, this article focuses on athletes engaged in baseball, because this patient population comprises most patients seeking orthopedic care for throwing-related injuries. Baseball remains one of America's favorite pastimes, and children often participate in the sport by the age of 5 or 6 years. The common participation in overhead throwing by today's youth increases the likelihood of orthopedic surgeons encountering patients with throwing-related shoulder pathology.

Injuries peculiar to throwers most commonly involve the labrum and the undersurface of the rotator cuff. In addition, tissue changes in both the anterior and posterior glenohumeral capsule are common with repetitive overhead motions. These capsular changes alter shoulder kinematics and subsequently contribute to both labral and cuff injury. Furthermore, the glenohumeral joint and the scapula are inextricably linked. In fact, scapular issues may herald the development of tissue breakdown in the shoulder. This article examines the pathomechanics of injuries to throwers, elaborates means of diagnoses of cuff and labral injury, and discusses recent advances in both nonoperative and operative interventions, including preventative principles.

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THE ACT OF THROWING

Throwing a baseball more than 90 mph generates great demands on the shoulder girdle. Humeral angular velocities have been estimated to exceed 7000° per second,[1] with estimated external rotation (ER) torques as high as 67 Nm.[2] The act of throwing has been elegantly described as occurring in several distinct phases. Of particular importance are the late-cocking, ball release, and follow-through phases. These portions of the throwing motion produce the largest forces about the glenohumeral joint and, therefore, the highest injury risk.

In late cocking, the anterior capsule is under significant strain in an effort to prevent anterior translation of the humerus. Tensile failure and attenuation of the anterior capsule is thought to occur from repetitive hard throwing. Throwers demonstrate increased passive ER in the abducted and externally rotated (ABER) position compared with controls.[3] Furthermore, stretching of the coracohumeral ligament (CHL) may also occur during forced ER and explain the rotator interval laxity commonly seen in overhead athletes.[4]

During the follow-through phase, the posterior capsule and posterior cuff undergo tremendous eccentric loads, up to 108% of body weight,[5] to decelerate the rapidly internally rotating arm and to restrain the significant distractive forces seen at the posterior shoulder joint. In time, the continual strains across the posterior cuff may lead to muscular fatigue and thereby a much larger transfer of stress to the posterior capsule.[6,7] Chronic attritional tearing of the posterior capsule may result in a fibroblastic healing response, increased collagen deposition, and loss of tissue compliance. All these elements converge and are thought to give the overhead thrower a stiff posterior cuff and capsule.[7]

To obtain the great arm velocity required to pitch effectively, throwers must attain increased degrees of ER.[8] The greater the arm can externally rotate, the more time the arm has to accelerate before ball release. Pitchers who are able to pitch at great velocities possess not only great muscle strength and fast twitch muscle capability but also inordinate degrees of ER ability.[9]

HUMERAL RETROVERSION

Fetal humeri demonstrate significantly greater degrees of retroversion compared with adult humeri, along the order of 78°.[10] During development and growth, retroversion slowly decreases until the adult average of roughly 30° is attained (**Fig. 1**).[10] Immature throwers, on the other hand, by virtue of Wolf's law, impose stresses across the proximal humeral physis, which impedes the loss of retroversion.[11] It is not unusual for a thrower, who began pitching in Little League, to present with more than 45° of retroversion in adulthood. There is also a particular asymmetry of the throwing and nonthrowing shoulders. A study in pitchers demonstrated that a the dominant shoulder exhibited increased humeral retroversion (HRT), glenoid retroversion (GRV), ER at 90°, ER in the scapular plane, and decreased internal rotation (IR) relative to their nondominant shoulder. In another study of professional baseball pitchers, the HRT to GRV ratio was found to be 2.3:1 for throwing shoulders and 7:1 for nonthrowing shoulders. The adaptive morphologic changes of increased proximal HRT and GRV in throwing shoulders are thought to be at least initially adaptive.[12] On the contrary, nonthrowing individuals do not display this discrepancy between their dominant and nondominant shoulders.[13]

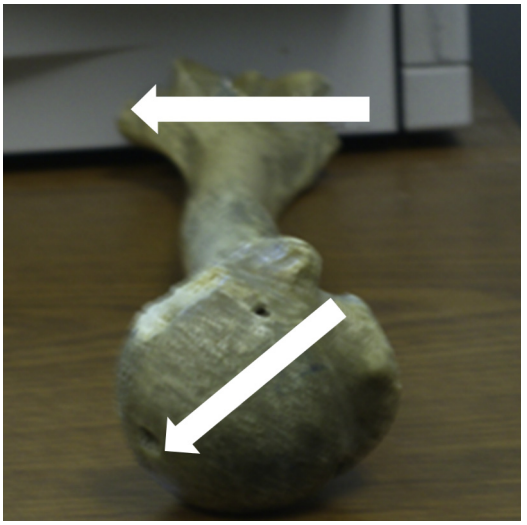

Fig. 1. Humeral retroversion (HRT). HRT is measured as the angle formed by an arrow drawn through the center of the longitudinal axis of the humeral head and neck meeting an arrow drawn along the transverse axis of the condyles, when looking proximal to distal along the humerus.

Increased retroversion resets the clock in terms of the arc of motion for the thrower, in which ER is gained with a symmetric loss of IR. This increased retroversion allows a greater amount of ER to occur before the greater tuberosity abuts the posterior superior labrum in the ABER position. This contact between the greater tuberosity and posterior superior labrum, sustained repetitively, can lead to posterior cuff and labral injury in many throwers. Although this contact, known as internal