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Changes in humeral retrotorsion and the development of little league shoulder: A case study

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ABSTRACT

Objective: To present the case of a 15 year-old baseball player with Little League Shoulder (LLS) and describe how developmental changes in the angle of humeral retrotorsion (HRT) may contribute to the underlying pathology of this condition.
Design: Case report.
Setting: Two years earlier, the patient had participated in a healthy player screening program at which time measurements of height, weight, shoulder motion, and HRT were obtained. These same measures were obtained during the initial evaluation after injury. Between measurements, the patient grew more than 12 cm in height and demonstrated a large shift in proximal humeral torsional alignment with a change of 13° and 19° of HRT in the dominant and non-dominant sides respectively.
Participant: 15 year-old male (1.88 m, 79.8 kg), right hand dominant baseball pitcher and 3rd baseman diagnosed with right LLS.
Conclusion: The pathoanatomical factors contributing to LLS are not well understood. The degree of HRT is a developmental characteristic that changes over the course of physiological maturation. The large changes in HRT seen in this case, may implicate rapid changes in HRT angle create a window of increased susceptibility to physeal damage, and contribute to the development of LLS.

1. Introduction

Shoulder pain is a common complaint among youth baseball players with a seasonal incidence of 32–35% (Popchak, Burnett, Weber, & Boninger, 2015). Proximal humeral epiphysiolysis, commonly referred to as Little League Shoulder (LLS), is one of the most common shoulder injuries within this group of athletes (Osbahr, Kim, & Dugas, 2010). Although the overall incidence is unknown, recent trends indicate the frequency of this pathology is increasing (Heyworth et al., 2016).

Unfortunately, the pathoanatomical factors contributing to LLS are not well understood. Jaramillo et al. (Jaramillo, Laor, & Zaleske, 1993) have suggested that epiphysiolysis is caused by repetitive stress about the physis that leads to decreased blood supply to the metaphysis. The relative decrease in blood supply leads to decreased calcification in the hypertrophic zone of the physis and this is manifested as a widened physis on radiographs or MRI. In the shoulder, this disorder is thought to result from the repeated transmission of traction and rotational stresses through the proximal humeral physis with repetitive throwing, which creates microfractures within the hypertrophic zone of the physis (Osbahr et al., 2010). Environmental and athlete specific risk factors for LLS have been identified and include frequent pitching without adequate rest, year-round baseball participation, more competitive play at younger ages, poor pitching mechanics, increased pitching velocity, strength imbalances, and a loss of shoulder range of motion (Chalmers et al., 2015; Heyworth et al., 2016; Osbahr et al., 2010; Popchak et al., 2015; Trakis et al., 2008).

More recently, there has been an increased focus on the assessment of humeral retrotorsion (HRT) among throwing athletes

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and the effect this may have on the development of shoulder or elbow injuries (Greenberg, Fernandez-Fernandez, Lawrence, & McClure, 2015). HRT refers to a twisting about the long axis of the humerus in which the humeral head is oriented in a more posterior medial direction (Krahl, 1947; Roach, Lieberman, Gill, Palmer, & Gill, 2012). As children grow from childhood through adolescence, the proximal humerus undergoes a remodeling process, moving from a position of greater to lesser degrees of HRT, occurring during the pediatric and adolescent years (Edelson, 2000; Krahl, 1947). While a small number of studies have implicated HRT as a risk factor leading to injury or pain within youth baseball players (Greenberg et al., 2017b; Whiteley, Adams, Nicholson, & Ginn, 2010), this relationship remains unclear and no studies have specifically evaluated the relationship of HRT to LLS.

The purpose of this manuscript is to present the case of a patient with LLS and describe how HRT may contribute to the development of LLS. We hypothesize that developmental changes in the angle of HRT that occur during physiological maturation are in opposition to those encountered during throwing activity, creating a “battle” of sorts within the proximal humeral physis. When the resultant stress within the physis exceeds the body's capacity for remodeling, this contributes to the window of opportunity, in which there is an increased susceptibility for developing LLS.

1.1. Case description

The patient was a 15 year-old male, right hand dominant baseball pitcher and 3rd baseman, with complaints of an insidious onset of throwing related right shoulder pain over the past 4 weeks. The patient was evaluated by an orthopaedic physician and diagnosed with proximal humeral epiphysiolysis (i.e. Little League Shoulder) and subsequently referred to physical therapy for management. Plain films obtained at the time orthopaedic evaluation demonstrated proximal humeral physis widening, which is considered a classic radiographic hallmark of LLS (Osbahr et al., 2010) (Fig. 1). The patient played baseball approximately 8 months per year and participated in basketball and individual weight training when not playing baseball.

Fig. 1. A-P radiograph of the patients right shoulder demonstrating irregular lateral widening of the proximal humeral physis (white arrow), consistent with the diagnosis of Little League Shoulder.

The patient was previously known to the physical therapist (E.G.) from participation in a screening program for healthy throwers 2 years earlier. At that time, measurements of height, weight, shoulder external rotation (ER) and internal rotation (IR) range of motion (ROM), and HRT were obtained. These same measurements were obtained as part of the initial physical therapy examination after LLS diagnosis. Tanner staging was assessed using a patient self-report measure developed by Kriz et al. (Kriz et al., 2016) From the time of his initial screening to when he was diagnosed with LLS, the patient matured from an approximated Tanner stage 2 to Tanner 4. In addition, there were significant changes in body characteristics as the patient grew nearly 5 inches (12.7 cm) in height and gained 36lbs (16.3 kg), between assessments (Table 1).

All data was collected by the same physical therapist (E.G.) with 15 years of clinical experience, who is skilled in all examination techniques. Assessment of glenohumeral ER and IR ROM at 90° of abduction was performed utilizing previously described and validated methods (Hibberd, Oyama, & Myers, 2014; Myers et al., 2009; Wilk et al., 2009), which have been shown to have excellent intra and interrater reliability with ICC values > 0.90 and an SEM of 1.5°–2.6° (Hibberd et al., 2014; Mullaney, McHugh, Johnson, & Tyler, 2010; Myers, Oyama, Rucinski, & Creighton, 2011). Humeral retrotorsion (HRT) refers to a longitudinal twist about the long axis of the humerus, with higher degrees of retrotorsion indicating a more posteriorly oriented humeral head. HRT was assessed utilizing indirect ultrasonographic techniques described and validated by Myers et al. (Myers, Oyama, & Clarke, 2012) in which the bicipital groove is visualized in order to standardize the position of the proximal humerus. A digital inclinometer placed along the ulnar aspect of the forearm is utilized in order to obtain the relative angular difference between the proximal and distal humerus. The examiner underwent specific training for this measurement and an independent reliability study was conducted as part of this training. Intraclass correlation statistics demonstrated excellent reliability with ICC coefficients of 0.91–0.98 and a SEM of 1.8°. Patient assent and parental consent was received in order to utilize previously collected data and current measurements for the purposes of comparison and presentation.

Comparison of current measures to previously collected data demonstrated significant changes in all measurements in both dominant and non-dominant arms. Overall, there was a shift in the arc of shoulder motion towards internal rotation, with the patient losing ER and gaining IR motion bilaterally (Table 2). Despite this bilateral shift in arc of motion, the changes between the dominant and non-dominant side were not symmetric. Within the dominant arm, the patient *lost* 12° of ER and *gained* 7° of IR, with a net *loss* of 5° in total range of motion (TROM defined as ER + IR). Within the non-dominant shoulder the patient *lost* 16° of ER, and *gained* 28° of IR, with a net *gain* of 12° in TROM (Table 2). In terms of HRT angle, there was a decrease bilaterally, with the non-dominant side showing a greater degree of change (19°) than the dominant side (13°) (Table 2). Finally, with respect to side-to-side differences, ER was greater on the dominant side when compared to the non-dominant side, and IR was greater on the non-dominant side.

Table 1
Subject physical growth characteristics.

Time	Age (years)	Height (cm)	Weight (kg)	BMI
Time 1	13.2	175.3	63.5	20.7
Time 2	15.0	188.0	79.8	22.6
Difference	1.8	+12.7	+16.3	+1.9