

Shoulder Injuries in Pediatric Athletes



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KEYWORDS

- Pediatric shoulder injury • Shoulder overuse injuries • Adolescent shoulder instability
- Shoulder fractures

KEY POINTS

- Shoulder injuries in pediatric athletes may be acute injuries or caused by repetitive overuse.
- Acute injuries in skeletally immature shoulders tend to be fractures or sprains, as opposed to tendon or muscle injuries.
- Chronic overuse injuries tend to occur in overhead athletes. Baseball pitchers who have high pitch counts are at highest risk.

INTRODUCTION

As the number of children and adolescents participating in competitive sports has increased, especially in overhead activities, there has been a corresponding increase in the number of injuries to the shoulder.¹ Skeletally immature athletes present with many of the same complaints as more mature athletes, but differences in anatomy and technique often lead to age-specific injuries. Although traumatic injuries, such as sprains or fractures, are common across the spectrum of competitive activities, overuse injuries predominate.

Overuse injuries in young athletes are typically caused by repeated stress and cumulative trauma to the developing physis of the proximal humerus as well as adaptive changes in the soft tissue stabilizers of the glenohumeral joint. Physical injuries are usually diagnosed by history and physical examination and may be confirmed on radiographs. Soft tissue injuries such as SLAP (superior labrum anterior and posterior) lesions, glenohumeral instability, and rotator cuff disorders may be more difficult to diagnose definitively.

Traumatic injuries to the skeletally immature shoulder may occur with any activity, but are more common with high-energy collision sports such as football.¹ Traumatic injuries include ligament sprains, muscle strains, fractures of the humerus, and fractures of the clavicle. Knowing the anatomic differences of the developing osseous structures of the shoulder girdle is key in diagnosis and management.

Anatomy

During growth, the anatomy of the proximal humerus osseous and ligamentous structures undergoes multiple changes. The proximal humeral physis typically closes at between 14 and 17 years in girls and 16 to 18 years in boys. This physis also contributes about 80% of the overall humeral length, making an injury to this area at a young age possibly more consequential but also allowing extensive remodeling of acute fractures.²

Any activity that involves stress of the physis, such as overhead throwing or repetitive upper extremity activities, puts the physis at risk of injury. Injuries vary from chronic stress reaction caused by overuse to acute fracture of the physis. The

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physis is thought to be a weak point of the upper arm compared with the ligamentous structures. The ligaments of the glenohumeral joint provide static stability depending on the position of the arm.³ The rotator cuff muscles, scapular stabilizers, and long head of the biceps also contribute to dynamic stability of the shoulder.

The clavicle is the first bone in the body to start the ossification process via intramembranous ossification.⁴ It shows both intramembranous and endochondral types of ossification. The lateral clavicular epiphysis typically does not ossify until 18 years of age. The medial clavicular epiphysis is the last to appear, at approximately 18 to 20 years of age, and does not fuse until 23 to 25 years of age, making the clavicle the last bone in the body to completely fuse.⁵ Strong ligaments provide significant stability at the medial and lateral ends of the clavicle, thereby making fractures in the middle of the clavicle more likely.⁵

OVERUSE INJURIES

Introduction

Pediatric or adolescent athletes involved in repetitive overhead activities, such as baseball, swimming, or volleyball, are at risk for overuse injuries to the shoulder. Overuse injuries are very common, comprising approximately 60% of all sports injuries in children and adolescents. Female athletes typically present more often with overuse injuries, but male athletes participating in certain demanding team sports, such as baseball, are at highest risk.⁶ It is estimated that 50% of overuse injuries in physically active children and adolescents may be preventable.⁷ Volume of activity, whether measured in number of repetitions or quantity of time, may be the greatest predictor of overuse injury.⁸ Shoulder pain, fatigue, and/or decreased velocity should be an indication to coaches and parents that an overuse injury may exist. Educating players, coaches, and trainers about these symptoms may help identify overuse injuries early.^{9,10}

Baseball in particular has been the focus of extensive research with regard to pediatric shoulder injuries. Seasonal incidence of shoulder pain ranges from 32% to 35%, with nearly 9% of all pitching performances resulting in shoulder symptoms.^{9,11} The incidence of injury for pitchers was found to be 37.4%, whereas it was only 15.3% for position players. Overall, pitchers experienced 47.1% of all shoulder injuries in baseball.¹² In a study of youth baseball players by Olsen and colleagues,¹⁰ athletes who underwent surgery for shoulder or elbow injuries caused by pitching were more likely to

have increased number of pitches thrown per inning and per game, more likely to pitch with pain, and pitched with higher velocity. There was no significant difference between injured and uninjured athletes with regard to injury prevention programs, types of pitches thrown, or private pitching instruction.

The role of specific types of pitches on shoulder pain incidence is inconclusive. Although some data exist that show higher levels of injury in curveball throwing, other studies have found higher mechanical demands with fastball throwing.¹³ In general, many of the issues of the throwing shoulder are rooted in poor biomechanics, scapular dyskinesis, muscular imbalance, glenohumeral internal rotation deficit, and excessive throwing or overhead activity.¹⁴

Biomechanics of Throwing

The mechanism of baseball throwing is a complicated process involving the coordination of the upper and lower extremities as well as core musculature. Throwing is typically divided into 6 phases: wind-up, early cocking, late cocking, acceleration, deceleration, and follow-through (Fig. 1).^{13,14}

During the late cocking phase, the arm is in an abducted and externally rotated position, creating an anteriorly directed force of the humeral head. This force is then counterbalanced by the static and dynamic stabilizers of the glenohumeral joint. During the acceleration portion of throwing, the arm moves at speeds of several thousand degrees per second, creating a large rotational force at the proximal humerus, often several times greater than the rotational strength of the proximal humeral physis.

Youth pitchers show several changes compared with mature pitchers. Younger pitchers tend to begin trunk rotation earlier in the throwing process. There is also a trend toward more open pelvic position during throwing. Both of these mechanisms have been proposed to increase the likelihood of injury to the developing physis because of higher rotational stress at the proximal humerus.¹⁴

LITTLE LEAGUE SHOULDER AND OVERUSE SYNDROMES

Shoulder overuse injuries are most common in boys aged 11 to 16 years. The most common age of presentation is 14 years in boys.¹⁵ In adolescents, the most common causes of shoulder pain from overhead activities are Little Leaguer's shoulder, glenohumeral instability, and rotator cuff disorders.

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