

displacement was minimal and he was successfully treated nonoperatively.

Surgical fixation of painful os acromiale has not been evaluated in the specific population of adolescent throwers, although ORIF has been described in adult populations.⁶⁰ Similarly, treatment of superior glenoid rim lesions has not been evaluated in the specific population of adolescent throwers, but in a report of 5 athletes with superior Bennett lesions—3 of them adult male baseball players—with a mean age of 30 years, arthroscopic resection of an unstable mobile bony fragment at the posterosuperior medial glenoid rim resulted in return to play by 2 years postoperative in all athletes.³⁷

Comparison of Adult and Adolescent Throwers

A few other studies on adult or professional baseball pitchers have concluded that significant associations exist between maximum pitch velocity and elbow injury,⁶¹ and that the late cocking phase has a critical point of high torque levels at the shoulder and elbow, and can result in increased risk of injury.¹³ Authors have also found that valgus torque at the elbow during pitching is closely related to late trunk rotation, reduced shoulder external rotation, and increased elbow flexion.¹⁶ These concepts are not unlike what has been described above in the adolescent pitcher. Ramappa et al⁶² studied 39 professional and 13 young pitchers with high-speed videography and determined that young pitchers experience significant anterior shoulder forces and internal rotation torques, although at much lower magnitudes than those seen in their professional adult counterparts. Although young pitching mechanics differ from adult mechanics, these studies highlight that an early focus on good technique is necessary to provide young pitchers with injury-free play into adulthood.

Prevention Strategies

These clinical and biomechanical studies on shoulder and elbow pathology in adolescent pitchers provide clinicians with a potential roadmap to injury prevention. A common theme from these reports is the importance of promoting proper pitching mechanics along the entirety of the body

Table 4. Suggested Limitations by Pitch Count, Inning Count, and Batters Faced for Young Overhead Throwers³⁹⁻⁴¹

Timing Designation	Suggested Limitation
Pitches per game	75
Pitches per season	600
Innings per year	100
Batters faced per game	15
Batters faced per season	120

Table 5. USA Baseball Medical and Safety Advisory Committee Pitch Count Limits⁶⁵

9-10 Years Old	11-12 Years Old	13-14 Years Old
50 pitches/game	75 pitches/game	75 pitches/game
75 pitches/week	100 pitches/week	125 pitches/week
1000 pitches/season	1000 pitches/season	1000 pitches/season
2000 pitches/year	3000 pitches/year	3000 pitches/year

(arms, torso, and legs).^{10,12,63} Pitch count, inning count, and the number of batters faced are important approaches to injury prevention (Table 4). A young pitcher should be taken out of a game if he develops arm fatigue or pain, decreased accuracy or ball speed, or increased time between pitches.^{39,40} Pitchers should avoid playing in games outside of their primary competitive league, and they should take several months off from overhead throwing each year to avoid overuse and difficulty in maintaining pitch counts.⁴⁰ It may be prudent to include clinical shoulder and elbow range of motion and strength examination in preathletic participation screening, given that there is a relationship between shoulder strength and motion and pitching biomechanics.⁶⁴ Physicians should be included early on in the Little Leaguer's career to recognize signs and symptoms of impending injury prior to significant damage occurring.

Table 5 depicts the most current recommendations on daily, weekly, per season, and per year pitch count limit recommendations from the USA Baseball Medical and Safety Advisory Committee.⁶⁵ In their epidemiologic study of 476 young (ages 9-14 years) baseball pitchers over the course of a single season, Lyman et al⁴¹ found a significant association between the number of pitches thrown in a game and during a season and the rate of elbow pain and shoulder pain, which helps provide evidence for these recommendations.

Conclusion

Because of anatomic and biomechanical differences, the injuries produced in skeletally immature pitchers are analogous to, but very different from, those seen in skeletally mature pitchers. Although young pitchers generate lower shoulder and elbow torques than do adults,^{10,62} medial elbow pain and radiographic changes at the medial epicondylar physis and proximal humeral physis are common in this patient population. Fortunately, the majority of these injuries respond to nonoperative treatment and a throwing holiday of several months, followed by a gradual return to throwing when the affected joint is asymptomatic; this is the first-line treatment.²⁰ Stretching (ie, sleeper stretch, side-lying cross-body stretch) as well as strengthening exercises (rotator cuff,

periscapular musculature, and flexor-pronator mass) are also worthwhile for rehabilitation and prevention of reinjury.¹⁹ In acute displaced fractures of the medial epicondyle, ORIF can be considered.^{4,54,66} Athletes, parents, and coaches should be informed about the risk factors for injury, particularly fatigue. Pitch counts must be recorded and limits enforced to prevent injury, especially for players playing on multiple teams who may not have a single coach who is aware of all of their play.

Conflict of Interest Statement

Bryan M. Saltzman, MD, Peter N. Chalmers, MD, and Randy Mascarenhas, MD, FRCSC, have no conflicts of interest to declare. Brian J. Cole, MD, MBA, is a consultant to Arthrex, Inc., DJ Orthopaedics, Johnson & Johnson, Regentis, and Zimmer; a member of the advisory board of Elsevier, AAOS, the *American Journal of Orthopedics, Cartilage*, the Arthroscopy Association of North America, the *Journal of Bone and Joint Surgery-American*, and the *Journal of Shoulder and Elbow Surgery*; a stockholder in Carticept and Regentis; and has received research funding from Johnson & Johnson, Medicpost, and Zimmer. Anthony A. Romeo, MD, is a consultant and speaker for Arthrex, Inc.; a member of the speaker's bureau of Arthrex, Inc., a member of the advisory board of the *Journal of Shoulder and Elbow Surgery*, SLACK Incorporated, *Orthopedics Today*, *Sports Health*, *Techniques in Shoulder and Elbow Surgery*, *Operative Techniques in Sports Medicine*, the *Orthopaedic Journal of Sports Medicine*, the American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, and the Arthroscopy Association of North America; and has received research funding from Arthrex, Inc., DJO Surgical, Smith and Nephew, and Ossur.

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