Little League Elbow Syndrome

**Background**

The number of organized sports for children has grown significantly over the past several decades, and each year millions of children are participating in organized athletics. The resulting increase in participation has been paralleled by an increase in sports-related injuries in the pediatric population.Participating in sports has numerous health benefits; however, increased single-sport participation with year-round training, at higher intensities and with longer competitive seasons can be contributing factors to the increased injury rates seen in pediatric athletes. In addition, conditioning and training errors also contribute significantly to the risk and frequency of injury.1, 2

Little League elbow (LLE) syndrome is a valgus overload or overstress injury to the medial elbow resulting in pain that occurs from repetitive throwing motions. Classic Little League elbow refers specifically to an apophysitis of the medial epicondylar growth plate found in skeletally immature athletes.3 Pitchers are most likely to be affected by this condition, but it can occur in other positions associated with frequent and forceful throwing in which motion creates traction forces on the medial portion of the elbow and compression forces on the lateral portion of the elbow.4

When the young athlete performs the throwing motion, valgus stress is placed on the elbow resulting in tension on the medial structures (ie, medial epicondyle, medial epicondylar apophysis, medial collateral ligament complex) and compression of the lateral structures (ie, radial head, capitellum) and shear stress posteriorly. Repeated high valgus stress and extension loads to the athlete’s elbow, results in overuse injury as tissue breakdown exceeds tissue repair, often leading to either acute or chronic injury or progressive structural changes. If not accurately diagnosed and appropriately treated then recurrent microtrauma of the elbow joint can lead to little league elbow, a syndrome that encompasses, delayed or accelerated growth of the medial epicondyle (medial epicondylar apophysitis), traction apophysitis (medial epicondylar fragmentation), and [medial epicondylitis](http://emedicine.medscape.com/article/97217-overview). Furthermore, common injuries encountered in the throwing elbow include ulnar collateral ligament tears, ulnar neuritis, flexor-pronator muscle strain or tendinitis, medial epicondyle apophysitis or avulsion, valgus extension overload syndrome with olecranon osteophytes, olecranon stress fractures, osteochondritis dissecans of the capitellum, and loose bodies.5, 6, 7

**Epidemiology**

An estimated 27 million US youth 6-18 years of age participate in team sports. The National Council of Youth Sports survey found that 60 million children aged 6-18 years participate in some form of organized athletics, with 44 million participating in more than 1 sport. However, very little research is available specifically on the incidence and prevalence of overuse injuries in children and adolescents. Overall estimates of overuse injuries versus acute injuries range from 45.9% to 54%. Overuse injuries are underestimated in the literature because most epidemiologic studies define injury as requiring time loss from participation. In the United States, an estimated 4.8 million children 5-14 years of age participate annually in organized and recreational baseball and softball. The overall incidence of injury in baseball ranges between 2% and 8% of participants per year.4, 8 However, the true prevalence of any sports-related injury goes unknown as a result of many athletes never reporting or seeking proper care. Therefore, early recognition of youth athletic injuries such as little league elbow syndrome is important for better outcomes and decreasing the risk of persistent functional disabilities.

 **Functional Anatomy**

The young adolescents’ elbow consists of numerous ossification centers and cartilaginous physes. To help with remembering the chronologic order of appearance and ossification of the growth centers the clinician can use the mnemonic CRITOE (ie, capitellum, radius, internal epicondyle, trochlea, olecranon, external epicondyle). Starting around age 1-2 years the ossification centers will begin to appear at relatively predictable times. Then from age 14-16 years each apophyses closes, with the medial epicondyle closing at the approximate age of 15 years. By the athlete’s late teen years the elbow is likely skeletally matured and as a result injuries to the (ulnar) collateral ligament (UCL) are more common. Therefore, until the athlete reaches mature growth development the young thrower is at risk for little league elbow syndrome.5, 6

The static stabilizers around the elbow (ie, bony articulations, joint capsule, and various ligament bundles) and the medial UCL complex consisting of the anterior oblique bundle, posterior oblique bundle, and transverse ligament are the primary medial supports of the elbow during valgus stress. During varus stress, structures that provide support include the lateral (radial) ligamentous complex, composed of the lateral collateral, lateral ulnar collateral, and accessory lateral collateral ligaments. In addition the triceps, biceps, and brachioradialis muscles cross the elbow joint and provide dynamic support. The flexor-pronator group stabilizes against valgus stress, and the extensor-supinator group stabilizes against varus stress.9, 10

Between 20-120 degrees of elbow flexion the UCL complex is the primary medial stabilizer of the elbow joint and violent forces produced during the throwing motion that exceed the strength of the UCL produce microscopic tears in the ligament. Repetitive stress causes the growth plates of secondary ossification centers in the elbows of young athletes to be more vulnerable than the surrounding muscles or tendons. Ossification does not completely unite until age 20 and problems often arise in athletes’ age 9-13 years because the un-united epiphyses is subjected to the pull of the attached muscles.9, 10, 11

**Sport Specific Biomechanics**

Appreciating the stages of throwing helps in understanding the complexities of the biomechanical forces that contribute to the young thrower's risk of little league elbow syndrome and related injuries. Medial elbow injuries are the most common type seen in throwers and occur most commonly in the cocking and acceleration phases of throwing, owing to the presence of maximum valgus extension or distraction forces. The pitching or throwing motion can be divided into 6 phases (Fig. 1): 1) **Windup** The objective of the wind-up is to put the athlete in a good starting position as they balance their weight over the rea leg, with the elbow flexed and the forward leg flexed at least 90°. The time from when the stance foot pivots to when the knee has achieved maximum height and the pitcher is in a balanced position is typically 0.5 to 1.0 second. The elbow is flexed throughout this phase, and elbow flexion is maintained by isometric contractions of the elbow flexors. In addition, minimal elbow kinetics and muscle activity are present during the windup (Table 1). 2) **Stride** starts with the lead leg beginning to descend toward the plate, and the 2 arms separate. A typical stride lasts 0.50 to 0.75 seconds and moderate activity from the elbow flexors are needed to control elbow flexion and extension. As the hands separate the elbow flexors first contract eccentrically as the elbow extends, and then concentrically as the elbow flexes near the completion of the stride. The elbow is flexed 80 ° to 100 ° at lead foot contact. Minimal elbow kinetics and muscle activity are present during the stride phase (Table 1). 3) **Arm Cocking** lasts around 0.10 to 0.15 seconds andoccurs when the humerus is in extreme abduction and external rotation and the elbow is flexed. The lead foots contacts the ground, the pelvis and trunk rotate, and elbow torque transfers valgus force across the elbow joint. During this phase, medial tension and lateral compression forces are applied to the elbow. The flexor and pronator muscle mass of the forearm displays moderate to high activity, which helps contribute to varus torque (Table 1). **Acceleration** is the shortest pitching phase, lasting only a few hundredths of a second from maximal external shoulder rotation to ball release. In this phase, the trunk rotates as the elbow extends. Maximum elbow angular velocity is comparable during fastballs, sliders, and curveballs, but it less during the change-up pitch. Velocity comes from rotation of the trunk, shoulder, and hips. Varus torque forces during this phase act to resist the valgus extension “overload” phenomenon and can contribute to posterior elbow (olecranon) impingement. 5) **Deceleration** is initiated at ball release and ends when the shoulder has reached full internal rotation lasting only a few hundredths of a second. The body must decelerate the arm and dissipate forces in the elbow and shoulder. 6) **Follow-through** is the final phase of the baseball pitch and ends with the pitcher reaching a balanced fielding position with full-trunk rotation and the body weight fully transferred from the rear leg to the forward leg. During follow-through, the elbow flexes into a relaxed position and crosses the body.10, 11, 13

**History**

There are a number of important variables the healthcare provider should identify during history taking. First, identifying the injured player’s field position makes determining the magnitude of the stress placed on the elbow and the subsequent risk of injury clearer. Second, identifying skeletal age can help indicate the stage of skeletal maturity and potential types of injuries for the athlete’s age group. Third, identify the athletes throwing history including: types of pitches, pitch count of approximate numbers of competitive pitches per game per week and/or season, level of play and time of season, changes in pitch types, counts, or other alterations in training. Fourth, identify the location, timing, characteristics, and duration of symptoms is vital for determining and treating the injury. Fifth, identifying the athlete’s preferred throwing arm is important because symptoms usually manifest in the dominant extremity. Lastly, identifying the athletes past history of injuries is vital because altered biomechanics of throwing may place the elbow at increased risk for overuse injuries.3, 6, 12, 13, 14

**Physical Examination**

During inspection the healthcare provider should note the athlete’s carrying angle and possible flexion contractures that occur relative to the uninvolved side. Furthermore, the clinician should evaluate for muscle atrophy or hypertrophy, bony deformities, or the presence of swelling and ecchymosis. The clinician should continue with palpation of bony structures including both involved and un-involved epicondyles, olecranon process, capitellum, and radial head. In addition, the clinician should palpate the soft-tissue structure of the UCL (felt best with the patient’s elbow in 50-70° of flexion), biceps tendon, triceps tendon, and flexor-pronator and extensor-supinator muscle complexes. Follow with strength testing of bilateral upper extremity muscles and a complete examination of the athlete’s neck, shoulders, wrist, and hand including a general inspection of height and weight. Follow with neurologic and vascular testing of the neck and upper extremity and the ulnar nerve in addition to palpation tenderness, stability testing, and a Tinel test via percussion over the ulnar groove for paresthesias. Furthermore, the valgus stress test can be used to evaluate the athlete’s UCL. The clinician can position the elbow in 20-30° of flexion and exert a valgus force. A resulting opening up on the involved side, compared with the un-involved side, is most reflective of a UCL injury; however, pain without instability during valgus testing is more commonly seen with little league elbow syndrome.12, 13, 14

**Causes**

There are many potential factors that can cause injury to occur in young overhead athletes’ as they age. Possible causes for Little League Elbow syndrome to occur include: Poor preseason conditioning and entering the season with a lack luster coach. Improper pitching program made up of random abrupt changes in intensity, duration, or frequency of throwing activity. Poor training errors that result in strength and flexibility imbalances and anatomic malalignment can cause injury to occur. In addition, improper footwear, playing surface, preexisting injury, and growth patterns are all possible causes of injury.8, 15, 16, 17

**Differential Diagnosis**

The differential diagnosis of ‘little league elbow’ encompasses a group of related injury patterns, which are the result of repetitive and recurrent microtrauma to specific and vulnerable areas of the immature elbow (Table 2).6 The most common injuries occur on the medial side as valgus overload creates chronic tension forces primarily at the medial epicondyle. The majority of early pathology is apophysitis and fragmentation as the medial epicondyle apophysis is the weakest structure on the medial side of the elbow. As the athlete ages secondary centers begin to fuse and muscular strength increases, as a result avulsion fractures of the medial epicondyle and medial collateral ligament become more common. In addition isolated ulnar collateral ligament injuries occur in mid-to-late adolescence.6

If the athlete continues throwing, lateral side injuries become more apparent. These injuries relate to the repetitive valgus overload and compressive forces placed on the lateral elbow joint during the late cocking and early acceleration phases of throwing. In addition, shear forces can occur during follow-through; however, the most common occurrences are pathologic changes in the capitellum and radius. Injuries to the extensor origin and lateral extension overload are less frequently seen in the young athlete.6

In young throwers posterior injuries are less common, however, the prevalence increases with age. Posterior injuries are brought on as the olecranon apophysis is acted upon by pathologic forces in the form of shear. Therefore, during the acceleration phase of throwing the olecranon gets impinged into the olecranon fossa and can lead to the formation of posteromedial osteophytes, loose bodies, or chondromalacia. Finally, anterior pathology can result in flexion contracture of the elbow.6

**Treatment**

First step of successful treatment of Little League elbow is limiting immobilizations as much as possible and complete rest from pitching for a minimum of 4 to 6 weeks. At the discretion of the overseeing primary care provider the athlete can initiate range-of-motion exercises and joint mobilizations as necessary to prevent joint contractures, in addition to general conditioning endurance activities and core strengthening programs in the throwing athlete including exercises for the trunk, abdomen, lumbar paraspinus muscles, gluteal muscles, hip flexors, quadriceps, and hamstring muscles.3 The clinician can treat hypermobility with joint stabilization exercises and pain and inflammation with cryotherapy and anti-inflammatory medications.

The key in treatment is prevention a responsibility that is widespread to many components including the evaluating or team physician, coach and team trainer, parents, and officials. Parents, players, and coaches should be educated about the symptoms and sequence of recovery from little league elbow syndrome. Furthermore, all throwing athletes should emphasize preseason conditioning, proper throwing mechanics, and proper ‘warm-up’ exercises. The Klingele article highlights three main contributors to a young pitcher’s ability to stay healthy including: pitching mechanics, pitch type and pitch volume. As the amount of force placed upon the player‘s elbow increases with the level of play in which he or she is involved, the risk of injury increases as well; therefore, emphasis should be placed on proper throwing and pitching techniques during practices and games at an early age to help reduce this risk.6 In addition, the number of competitive pitches thrown in practice and the number of innings per week, per season, and per year should be monitored. Fleisig et al reported on a 10-year cohort study that found young baseball pitchers who pitch more than 100 innings a year are at significantly increased risk of elbow or shoulder injury.19 A prescreening examination by a trained healthcare professional such as a physical therapist is advantageous for uncovering potential injury risks for athletes’ and affords excellent opportunity for the clinician to provide information to the child and their parents.

**Follow-up**

Athletes’ with little league elbow syndrome returning to play should be carefully monitored cumulatively by the athlete, family, an educated trainer, the coach, and a pediatric sports medicine or orthopedic specialist. The athlete should only return to competitive pitching when they fully complete and are discharged from a rehabilitation program. Furthermore, as the athlete returns to competitive throwing, attention should focus on pitch types, pitch counts, proper rotation scheduling, and maintenance of core strength and flexibility. There are existing controversies regarding the frequency of pitching and number of pitches thrown. In a prospective study of 298 youth baseball players, arm fatigue and >600 pitches thrown per season were found to be risk factors for elbow pain.6 Older players who pitched in non-league, recreational baseball were at higher risk, thought to be due to higher pitch counts. 6 Overall, every ten pitches thrown per ball game equated to a 6% increased risk of elbow pain.6 Little League, Inc. guidelines relate to the number of innings pitched per week: <6 innings/week for the 9–12 year age group and <9 per week for those between 13–15 years of age.6 Some authors have emphasized the number of actual pitches thrown both in practice and in games: <75 pitches/game, <600 pitches/season.6

**Conclusion**

During the throwing motion, the elbow is stressed to its biomechanical limits as the muscles around the joint generate rapid extension, flexion, pronation, and supination needed for spots performance. Hard and soft joint tissues are loaded to capacity to generate and control the rapid motions that occur during throwing. The resulting loads may include large tensile forces on medial soft tissue (eg, UCL), large compressive forces on lateral hard tissue (eg, radiocapitellar articulation), soft tissue tensile loads to prevent joint distraction, and hard tissue loads to withstand compression. The key to treating those injuries entailed in so-called ‘little league elbow’ is through early recognition and prevention.

 Little League elbow is a potentially preventable injury and when it does occur, early intervention and proper treatment can minimize the risks of permanent injury. Therefore, whenever the throwing athlete complains of mild or intermittent medial elbow pain a resulting high index of suspicion should arise, followed by appropriate counseling and intervention. The reality is young athletes are too often treated like high-level, adult athletes and told to ‘play through the pain’ or ‘throw the pain out’ and resulting injury ensues. Therefore, it is essential to educate coaches, parents, officials, and athletes so they can recognize these injuries thereby initiating early and appropriate intervention/treatment. In addition the evaluating clinician must keep in mind the anatomic-based differential diagnosis, and have a working understanding of normal elbow development and the throwing mechanism to accurately diagnose and treat such injuries.

Pitching recommendations for young athletes have become quite sophisticated with regard to the development of guidelines for pitch types, quantities, and mechanics. The young athlete should master pitching skills in the order of control and command of the ball in the strike zone followed by velocity (speed) and ball movement during pitch (eg curveball, breaking pitches, etc). Furthermore, young athletes should be exposed to proper warm-ups, interval rest between outings, and year-round conditioning programs to help decrease the frequency of occurrence of injury. In addition, professionals such as physical therapists, strength and conditioning coaches, etc. can provide these athletes with additional treatment, prevention strategies, and interventions including core-strengthening exercises to improve soft tissue flexibility, endurance, and neuromuscular control. Benjamin & Briner recommend that competitive pitching should be limited to a maximum of 9 months per year and throwing at high velocities (over 80 MPH) should be discouraged in skeletally immature young pitchers.3 The USA Baseball Medical and Safety Advisory Committee have made the following recommendations addressing youth baseball pitching injuries. The average age in years to learn types of pitches is as follows: fastball, 8; change-up, 10; curveball, 14; knuckleball, 15; slider, 16; forkball, 16; splitter, 16; screwball, 17. Breaking pitches should not be thrown until skeletal maturity is reached. The recommended pitch counts per game by age are as follows: 8 to 10 years, 50; 11 to 12 years, 75; 13 to 14 years, 75; 15 to 16 years, 90; 17 to 18 years, 105 (Table 3). Pitchers should not compete more than 9 months per year and should avoid all overhead activities during those 3 months of rest. In addition, pitchers should be discouraged from after-game pitching practice and from participating in more than 1 league during overlapping seasons. Once removed, the pitcher should never return in the same game.3, 18 Once the throwing athlete is injured, relative rest from pitching followed by a slow progressive symptom-free return to competition is essential for a complete recovery.

**Appendix:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **N** | **Windup** | **Stride** | **Arm Cocking** | **Arm Acceleration** | **Arm Deceleration** | **Follow-Through** |
| **Elbow and Forearm Muscles** |  |
| **Triceps** | 13 | 4±6 | 17±17 | 37±32 | 89±40 | 54±23 | 22±18 |
| **Biceps** | 18 | 8±9 | 22±14 | 26±20 | 20±16 | 44±32 | 16±14 |
| **Brachialis** | 13 | 8±5 | 17±13 | 18±26 | 20±22 | 49±29 | 13±17 |
| **Brachioradialis** | 13 | 5±5 | 35±20 | 31±24 | 16±12 | 46±24 | 22±29 |
| **Pronator teres** | 14 | 14±16 | 18±15 | 39±28 | 85±39 | 51±21 | 21±21 |
| **Supinator** | 13 | 9±7 | 38±30 | 54±38 | 55±31 | 59±31 | 22±19 |
| **Wrist and Finger Muscles** |  |
| **Extensor carpi radialis longus** | 13 | 11±8 | 53±24 | 72±37 | 30±20 | 43±24 | 22±14 |
| **Extensor carpi radialis brevis** | 15 | 17±17 | 47±26 | 75±41 | 55±35 | 43±28 | 24±19 |
| **Extensor digitorum communis** | 14 | 21±17 | 37±25 | 59±27 | 35±35 | 47±25 | 24±18 |
| **Flexor carpi radialis** | 12 | 13±9 | 24±35 | 47±33 | 120±66 | 79±36 | 35±16 |
| **Flexor digitorum superficialis** | 11 | 16±6 | 20±23 | 47±52 | 80±66 | 71±32 | 21±11 |
| **Flexor carpi ulnaris** | 10 | 8±5 | 27±18 | 41±25 | 112±60 | 77±42 | 24±18 |

**Table 1: (provided by Fleisig & Escamilla11):** Muscle Activity During Pitching

|  |
| --- |
| **Differential diagnosis of ‘little league elbow’**  |
| **Medial**  | **Lateral**  | **Posterior**  | **Anterior** |
| **Medial Epicondyle** | **Capitellum** | **Olecranon** |  |
| apophysitis | Osteochondrosis (Panner’s disease) | Apophysitis/osteochondrosis | Flexion contracture/capsular contracture  |
| Avulsion fracture | Osteochondritis dissecans (OCD) | Avulsion fracture/lack of apophyseal fusion  |  |
| Fragmentation | Traumatic osteochondral fracture  | Posteromedial impingement/osteophyte |  |
| Growth disturbance | **Radial Head** |  |  |
| Delayed ossification | Osteochondritis dissecans (OCD) |  |  |
| Accelerated growth | Deformation  |  |  |
| Ulnar collateral ligament | Lateral extension overload  |  |  |
| Common flexor origin | Extension origin |  |  |
| Ulnar nerve neuritis |  |  |  |

**Table 2 (provided by Klingele & Kocher6):** Differential diagnosis of ‘little league elbow’

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age in years** | **OK To Start Throwing** | **Pitches per Game** | **Pitches per Week** | **Pitches per Season** | **Pitches per Year** |
| 8-10 | Fastball | 50 | 75 | 1000 | 2000 |
| 11-12 | Change-up | 75 | 100 | 1000 | 3000 |
| 13-14 | Curve | 75 | 125 | 1000 | 3000 |
| 15-16 | Slider, forkball, splitter, knuckleball | 90 |  |  | 3000 |
| 17-18 | Screwball | 105 |  |  |  |

\*Applies to pitches in game competition. Adapted from USA Baseball recommendations.

**Table 3 (provided by Benjamin HJ, Briner3) Maximum Pitch Count**

**Figure 1 (provided by HOUSE DPT.20):** The six phases of pitching

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