Concerns on Little League Elbow

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ABSTRACT: Little League elbow is a common overuse injury that will become more prevalent as more youths participate in baseball programs and other sports that involve overhead arm activities. The condition is highly treatable if diagnosed early in its development. Symptoms such as swelling and limited range of motion usually indicate an advanced overuse condition. Prevention and treatment should emphasize education of athletes, parents, and coaches about its etiology. Factors involved are proper pitching mechanics, stretching and strengthening programs, improving early recognition, and, most importantly, limiting the number of pitches thrown daily.

The rise of health awareness in the United States has brought with it an increased participation in sporting activities for all ages. Youngsters are commencing rigorous fitness training programs at an earlier age. Twenty million youths between the ages of 8 and 16 are in nonschool, community-sponsored athletic programs.[25] Of particular interest is participation in Little League baseball. Injuries occurring in this sport are unique in that the participants are still developing physically, and severe injury at this stage can have long-term consequences.

The elbow is the most frequently reported area of injury in child and adolescent baseball players.[11] Specifically, this paper will discuss the overuse injury known as "Little League elbow" (or pitcher's elbow in older individuals). This condition was defined by Brogden[4] in 1960 as "an avulsion of the ossification center of the medial epicondylar epiphysis in pubertal pitchers." Little League elbow results from repetitive valgus stress on the elbow during overhead throwing. As research into this problem evolved, the term came to encompass all of the stress responses observed in the symptomatic adolescent baseball pitcher. This condition can also result from weight lifting, gymnastics, wrestling, some field events, and other athletic activities.

If you were to take a moment to observe a beginning pitcher, it would not take long to ascertain that the pitching motion is not a natural act. Poor mechanics and a developing elbow complex leave the young, inexperienced pitcher susceptible to Little League elbow. These young individuals possess an elbow complex comprised of epiphyseal plates that continue to develop until the age of 17.[5] The problem of Little League elbow is centered around these growth plates in the pitching arm. The epiphyseal line has been identified as the weakest link in the musculotendinous unit in the adolescent (due to the rapid period of growth) which leaves the tendons and ligaments tight on lengthening bones.[25]

Literature on Little League elbow suggests that the occurrence of this injury is not significant relative to the large number of youth participants in organized baseball. If this is true, why should there be a reason for concern? We offer the following thoughts for consideration:

1. As the number of youths taking part in organized sporting activities grows, the number of sport-related injuries will follow.
2. Basically, baseball is a 3-month sport. There is too much stress placed on the arm in a short time without proper preseason strengthening/conditioning. This leads to overuse injuries.[8]
3. Little League has age-determined teams. Youths with the skeletal maturity of 12-year-olds can find themselves under the pitching restrictions intended for a 14- to 15-year-old.
4. The young athlete is continually growing and developing. Adolescent growth cartilage is less resistant to repetitive microtrauma than adult cartilage.[14] The rapid growth of the bones during this period creates a muscle-tendon imbalance that places additional tension on musculo-tendinous units, decreasing flexibility. These two factors create an enhanced environment for overuse on the still-developing epiphyseal plates at the elbow complex. Damage to the epiphyseal plates at this stage of development can result in permanent cessation or retardation of growth in any bone of the pitching arm.

MEDICAL HISTORY OF LITTLE LEAGUE ELBOW

Before 1972, prior to the major rule changes, accelerated growth and separation of the medial epicondyle was present in 90% of youths between the ages of 9 and 14 playing baseball in Southern California.[1] In 1968, Adams[1] looked at 162 individuals (aged 9 to 14 years) with varying baseball experience. He studied three groups: 80 pitchers, 47 nonpitchers, and 35 individuals with no previous baseball experience. The conclusion was that "there exist definite changes in direct proportion to the type and amount of throwing, with the pitchers showing the most striking changes."[1] The injury with the highest occurrence was accelerated growth and separation of the medial epicondyle.[1]

Since then, the literature has reflected attempts to erase or justify the continued fear of the threat of Little League elbow. Micheli and Fehlandt[15] looked at 724 cases of tendinitis and apophysitis in 445 patients (aged 8 to 19 years) and found that baseball had the highest occurrence of injury in the upper extremity for males. For females in this study, softball ranked

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fourth. Injury at the elbow ranked highest for both sexes. In 1980, Grana and Rashkin[9] evaluated 73 older pitchers with an average age of 17 years. At the time of evaluation, 58% of these individuals reported pain while throwing or developed pain during the season. Grana and Rashkin[9] concluded that "occurrence of pain about the elbow during pitching tends to increase with age,"[9] and stated further that these abnormalities did not occur in large numbers nor were they too severe. Other authors[11,12] concluded that preadolescents may successfully participate in organized baseball with no worry of developing permanent arm problems. It should be noted, however, that these studies involved younger subjects than those in Adams'[1] study and that these individuals possessed a greater potential for the remodeling of injured epiphyses due to their younger age. More longitudinal studies spanning the late teens are needed to establish or disprove any significant relationship between pitching and Little League elbow.

BONE DEVELOPMENT

Three main areas of concern for injury in the elbow complex are: the medial epicondyle, the olecranon epiphysis, and the articular surface at the capitellum-radial junction (Figs 1 & 2). The threat of epiphyseal injuries and Little League elbow begins with the appearance of the secondary growth plates and lasts until the final plate fuses with the long bone. In the elbow complex, the first epiphysis appears in the capitellum around age 2 and the last plate to fuse is the medial epicondyle, which fuses around 17 years for male and 14 years for female adolescents.[5] In the growing child, cartilage is articulated between tendon and bone at the medial epicondyle. Once this apophysis is separated, continued use and stressful activity (eg, the pitching delivery) will prevent normal closure of the damaged growth plate.[20] For this reason, it is pertinent to restrict the activities of a youngster with a sore/swollen elbow. The threat of Little League elbow does not pertain just to youngsters, however. It is a reality for individuals well into high school. High school baseball does not have consistent limitations on pitching appearances and places the individual in a situation that is conducive to overuse/degenerating injuries at the elbow complex. Moreover, the pitching arm of the high school athlete continues to remain at risk of injury beyond the spring baseball season as it extends into summer leagues and camps.

INJURY DESCRIPTION

Four of the most common injuries among children and adolescents are Little League elbow, Osgood-Schlatter disease, Sever's disease, and stress fracture.[22] Epiphyseal injuries constitute between 6% and 15% of all long bone fractures in individuals under the age of 16. Seventy-five percent of these injuries occur between the ages of 10 and 16.[21] The typical incident of Little League elbow occurs in youths aged 9 through 14 whose enthusiasm for sports and eagerness to participate outweigh their capabilities, which is particularly obvious in poor pitching/throwing mechanics.[21]

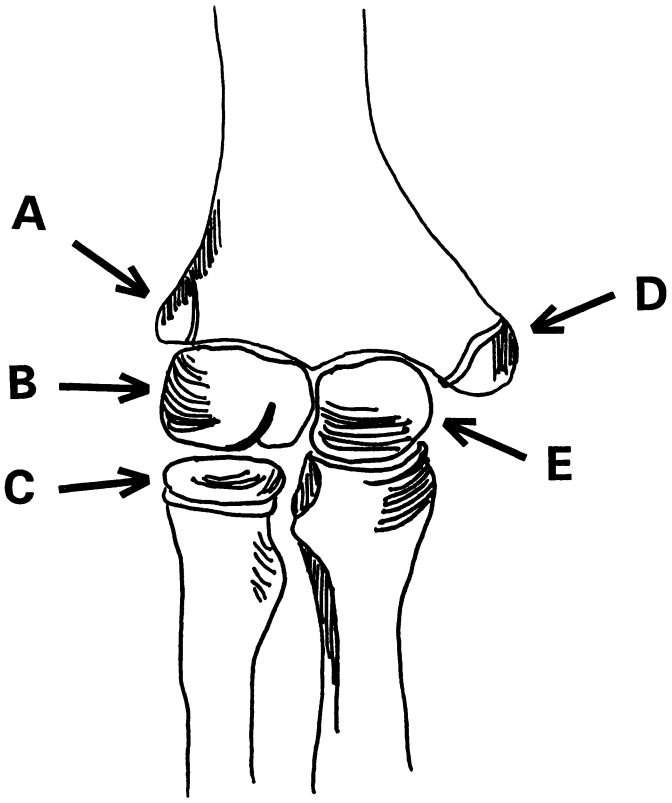

Fig 1. Anterior aspect. A) Lateral epicondyle: usually not involved in Little League elbow. B) Capitellum: appears at 2 years; closes in female at 13 years; closes in male at 14.5 years. Repetitive compression/shearing against radial head can lead to osteochondritis dissecans. C) Radial head: Repetitive compression/shearing against capitellum can lead to osteochondritis dissecans. D) Medial epicondyle: appears in male at 7 years, closes at 17 years; appears in female at 5 years, closes at 14 years; stretching from valgus stress may cause partial or complete avulsion during the acceleration phase of pitching. E) Trochlea: appears in male at 9 years, closes at 13 years; appears in female at 8 years, closes at 11 years; rarely develops osteochondritis dissecans. (Figure by Laura Kiser)

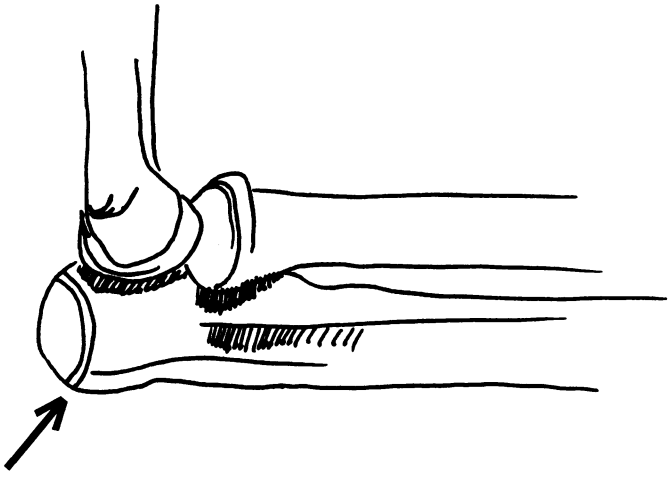

Fig 2. Proximal olecranon epiphysis (see arrow). Appears in male at 10 years, closes at 16 years; appears in female at 8 years, closes at 14 years. Triceps traction may cause partial or complete separation. Trauma during follow-through can prevent epiphyseal closure or cause stress fracture. (Figure by Laura Kiser)

The mechanism of injury is the valgus stress placed on the arm during the acceleration phase of the pitching delivery. During this phase at the elbow complex, there are stretching forces medially and compression forces laterally. Injury to the epiphyseal plates occurs either as an acute incident (fracture) or from repetitive stress placed on the area. Many of the injuries incurred during sporting activities in the young athlete refer to the Salter-Harris categorization of fractures (Fig 3), but equal attention should also be placed on microtrauma injuries caused by repetitive motion.

When the vascular supply crosses the physis, a fracture at the physeal-metaphyseal junction may disrupt the blood supply and result in osteonecrosis.[3] Most injuries to adolescents fall under the lower classifications and usually at the onset of a growth spurt.[16,20] Due to the remarkable remodeling capabilities of developing bone, many injuries incurred at an early age heal with no long-term consequences if recognized early and if activity is restricted. During a growth spurt, however, there is an increase in muscle-tendon tightness about the joint and a decrease in flexibility, which makes the elbow complex susceptible to acute and overuse injury. Even with proper strengthening and stretching, the repetitive motion of pitching can induce debilitating microtrauma in elbow tissues.

PATHOLOGY

As mentioned before, the delivery of a pitch causes traction forces medially and compressive forces laterally. As would be expected, the signs and symptoms of Little League elbow reach their peak during the adolescent growth spurt, in the 13- to 14-year-old age range.[2] The most common injury is an avulsion fracture of the medial epicondyle.[11] Before epiphyseal closure, strong contraction of the forearm flexors during a pitch is capable of avulsing a medial epicondyle weakened by repetitive microtrauma.[18] Complications that can develop laterally from the compressive and shearing forces involve the radial head and capitellum.

Repetitive compression and shearing forces between the radial head and capitellum can lead to the most serious form of Little League elbow (or pitcher's elbow), osteochondritis dissecans. Development of osteochondritis dissecans in either of these structure is difficult to treat.[13] Osteochondritis dissecans is a localized area of necrosis that is classified as a Salter-Harris type V fracture and results in fragmentation of bone tissue.[19] Repetitive trauma appears to be responsible for many cases of osteochondritis in the elbow of the child pitcher.[12,13] An injury of this type might not be realized for months or even years after the injury occurs. Osteochondritis dissecans should not be confused with Panner's disease. Panner's disease occurs in much younger individuals (average age, about 8 years) and is a condition brought about by changes in circulation, resulting in avascular necrosis of the capitella. It is characterized by fragmentation of the entire ossific center and no loose bodies are present.[22] Osteochondritis dissecans occurs in individuals from 13 to 17 years and is a localized area of necrosis.[18,22]

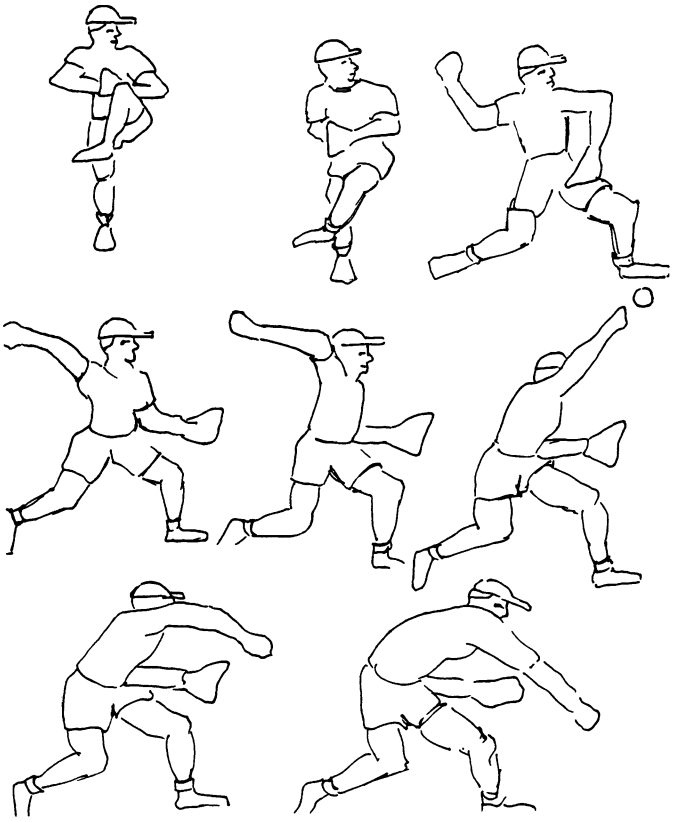

Fig 4. Stages of pitching motion. Stage 1—windup (upper left); stage 2—cocking (upper right); stage 3—acceleration (middle); stage 4—follow-through (lower). (Figures by Laura Kiser)

Other complications that can occur are general inflammation, apophysitis, fragmentation, loose bodies, stretching of the ulnar nerve (medially), and degeneration of the elbow joint.[8] Later in life, these conditions can develop into osteoarthritis of the affected elbow. In considering the posterior aspect of the elbow complex, the olecranon slams into its fossa during follow-through. Repetitive action of this nature can prevent closure of the olecranon epiphysis and cause a stress fracture through the growth plate.[23,24]

Fig 3. Salter-Harris categorization of epiphyseal fractures. (Figure by Laura Kiser)

PITCHING MECHANICS

Pitching is a complex activity that requires the coordination and interaction of numerous muscles, joints, and body segments to perform in a specific sequence of motions. Any abnormality or inefficiency in this motion will place additional stress on the elbow complex.

Bryan[5] separates the pitching motion into four stages: windup, cocking, acceleration, and follow-through (Fig 4). In the windup phase, the pitcher balances on his/her back foot and

reaches a "gathering point." Bryan states that young pitchers often rush this stage to start ball release and lose all benefit from their lower extremity. In the cocking phase, the ball is brought behind the head with at least 90° of external shoulder rotation. The front foot contacts the ground midway through this phase and the abdominal muscles prepare to initiate trunk rotation toward home plate.

It is during the third phase, acceleration, that a majority of Little League elbow symptoms develop, caused by the extreme valgus forces produced in the pitching delivery.[2,13] Also, if the body moves ahead of the arm in this phase, it is known as "opening up too soon" and this places stress on the anterior shoulder.[7] Bryan suggests that the young pitcher should concentrate on keeping the opposite shoulder tucked under the chin to allow arm motion to accelerate before trunk rotation.

The last phase is follow-through. In this phase, there is rapid pronation of the forearm which produces a shearing and compressive force between the radial head and the capitellum. Also, at the end of follow-through, the olecranon process slams into its fossa, and this can have consequences over time. If the stride foot is placed short of the midline in this phase, the pelvis will not rotate properly and the body will lose its momentum. The pitcher will "open up" too late and throw mainly with the arm.[5] Things to look for in a young pitcher's delivery include: balance, body rotation, shoulder rotation, proper stride, and sufficient follow-through.[6]

Effects of Delivery

The type of pitching delivery can also affect the forces at the elbow during the throwing motion. Albright et al[2] discuss three types of delivery: vertical, three-quarter, and sidearm. They found that individuals who incorporated a sidearm delivery had a definite susceptibility to elbow injury. This method involves using the arm in a whipping type motion. The result is increased valgus forces about the elbow and increased incidence of elbow discomfort and pain.[2] Albright et al[2] state that some of their subjects switched from sidearm to the three-quarter or vertical delivery. After the change, the subjects displayed a drastic decrease in elbow difficulty. It was concluded that an efficient, overhead delivery is not only more effective, but it also causes fewer injuries since there is less abnormal stress placed on the extremity.[2]

Type of Pitch

The type of pitch thrown can also affect the forces at the elbow during the throwing motion. In the normal pitch, the arm has a natural inclination to pronate during the throwing motion.[17] The immature pitcher believes that there is a need to forcefully supinate the forearm/wrist to elicit sufficient spin on the ball to make it curve.[10] Repetitive attempts to go forcefully against the natural motion of the arm during a throw may cause irritation of the tendons and flexor muscles. Long-term exposure to this type of trauma may cause widening or separation of the medial epicondyle. Even with a three-quarter or vertical delivery, the repetitive shearing forces of the radial head on the capitellum and the jamming of the olecranon into its fossa may have long-term significance.[17] An experienced coach will alter the young pitcher's style away from the sidearm throwing delivery and prohibit the curve ball; both have been shown to cause symptoms of Little League elbow.[5,10]

PREVENTION

Prevention of Little League elbow involves preseason stretching and strengthening programs, evaluating and correcting pitching techniques, limiting the number of pitches thrown, and, most importantly, educating coaches, parents, and athletes on the condition.

It has been said numerous times before, "Warm up to throw; do not throw to warm up." Stretching and general calisthenics allow sufficient warm-up before throwing activity begins. Preseason training should gradually increase the number, distance, and intensity of throws.[8] There should be no pitches thrown by a player from the mound until well into the second week of practice.

Although the Little League has restrictions on the number of innings pitched, tallying the number of pitches thrown is more important to avoid the condition of Little League elbow.[8] This point should be stressed when educating coaches, pitchers, and parents, because more pitches are thrown during the week in practice than in a single game. Congeni[8] sets reasonable limits in the range of 90 to 100 pitches per game or practice, barring elbow or shoulder pain. If discomfort arises, activity should stop and throws should decrease for the following few days. If pain persists, total rest and radiographic studies are recommended.[8] Before returning to competition, the player should display a full recovery of strength, range of motion, and pain-free throwing.

TREATMENT

Developing bone is highly tenacious and displays remarkable healing capabilities. If symptoms of Little League elbow are recognized early and activity is restricted, injury can be kept to a minimum. However, enthusiastic children and adolescents have a tendency to postpone seeking medical attention until they are unable to throw because of pain.[8] Unfortunately, swelling and limited elbow motion usually characterize more advanced overuse conditions. Prevention is the best way to "treat" Little League elbow. Radiographs are of little advantage in detecting early changes, but are needed to locate loose bodies, joint abnormalities, avulsions, and osteochondritis dissecans.[8] These findings indicate the need to refer the patient to an orthopedist for evaluation.

Initial treatment involves resting the elbow joint and applying ice to alleviate pain, swelling, and inflammation. Athletic activities should be ceased until elbow tenderness has disappeared and the individual can complete a throwing motion with no pain or discomfort.[8] Treatment should also include stretching and strengthening exercises of the flexor and extensor muscles of the forearm. An isotonic program of light weights and high repetitions decreases stress about the elbow, yet allows an endurance factor.[24] It is important to provide support for the affected elbow at the beginning of rehabilitation. Wrist curls, a baseball curl-up weight, and/or therapeutic putty can also be used for both flexor and extensor muscles.[24] Throwing activities should be commenced gradually and an elbow sleeve can be worn for support.

SUGGESTIONS AND CONCLUSION

We recommend the following for preventing Little League elbow:

1. Increase awareness among coaches, parents, and athletes.
2. Use proper warm-up, stretching, and strengthening.
3. Use proper pitching technique/mechanics.
4. Limit pitches thrown during games and practice (and home).
5. Prohibit breaking balls until the mid- to late-teenage years.
6. Rehabilitate previous injuries.
7. Improve early recognition of signs and symptoms.

Although the pitching rules established by the Little League have definitely decreased the incidence of Little League elbow, concerns on this injury extend well beyond restricting the number of innings pitched. All too often, a team is dependent on a single pitcher, and that individual is used in every possible situation as governed by the rules. Throwing during practice is also a major concern. As Gugenheim et al[11] stated, the problem of abuse of the pitching arm lies not on the baseball diamond, but on the practice field. In warmer climates, baseball is virtually a year-round sport, leaving the individual no recovery time or time for unstressed skeletal growth.

The youngsters involved in sports such as Little League, Junior Tackle Football, etc, are the athletes that athletic trainers will be treating in the future. Establishing lines of communication and relationships with coaches, parents, and athletes when the athletes are young is advantageous to the trainer. It simplifies initiation of future education/prevention programs as the athletes mature. Also, establishing a familiar history with the athletes makes future treatment that much easier. In addition, prevention of Little League elbow should include stretching and strengthening programs and limiting the number of pitches thrown daily. Both of these factors involve community education of the condition.

The type of delivery and pitch thrown is also important in avoiding Little League elbow. A sidearm delivery has been shown to increase the incidence of elbow discomfort or pain.[2] A change to a vertical or three-quarter delivery proved to dramatically reduce elbow problems caused by a sidearm delivery.[2] Video evaluation of the biomechanical aspects of the delivery and correcting problems will also decrease unnecessary stress on the elbow or shoulder. Throwing curve balls is another stress that can cause Little League elbow. Youngsters should not throw curve balls until the mid- to late-teenage years, giving the epiphyseal plates a chance to fuse.

In treating the condition, coaches need to be aware of early warning signs. These include noticeable discomfort while throwing, or swelling and tenderness over the affected area. A gradual return to throwing activities should occur only when there is a full recovery of strength, range of motion, and painless throwing motion.[8] Radiographic evidence of loose bodies, joint abnormality, avulsions, or osteochondritis dissecans indicate the need for referral to an orthopedist.[8]

Little League elbow is an avoidable overuse injury. Community education is an important key in decreasing its occurrence. Permanent injuries that do occur are often a result of late recognition or simply a lack of knowledge on the part of coaches, parents, and athletes. Future studies need to evaluate the effects of rigorous activity at an early age and examine just how tenacious the epiphyseal plates and elbow are in response to these stresses over time. As mentioned previously, longitudinal studies need to assess athletes who begin pitching at an early age and continue into their late-teenage years.

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