List of Objectives:

1. Participants will be able to list and describe two types of elbow injuries in youth baseball players.
2. Participants will be able to list three critical components of preventing elbow and shoulder injuries in youth baseball players.
3. Participants will be able to describe the phases of pitching and identify which phase is most closely related to elbow injuries in baseball.

Elbow And Shoulder Injuries In Youth Baseball Players

Introduction

Injuries come with the long hours of practice and competition in the sport of baseball. Research has indicated that injuries in professional and collegiate baseball players may result from years of overuse and repetition. For example, a recent study of collegiate males in the United States reported fifteen percent of the athletes who had pitched in youth baseball stated that pain, tenderness, or limited motion compromised their ability to throw. (5)

There are more than 19,000,000 amateur baseball players. (5) Approximately twenty five percent of these athletes participate in pitching. The repetitive nature of baseball pitching results in a high-risk for overuse injuries. (17) The majority of youth baseball injuries involve the upper extremity. (7) Due to the repetitive nature of pitching, pitchers are at the greatest risk for sustaining a throwing injury to the arm. (6) The purpose of this article is to discuss the epidemiology, biomechanics, and prevention of elbow and shoulder injuries in youth baseball players.

Epidemiology of Injuries

The following section will examine the basic anatomy of the elbow and shoulder and common types of elbow and shoulder injuries in baseball pitchers.

Basic Anatomy

The medial ligaments of the elbow are called the ulnar collateral-ligament (UCL) complex. This includes three parts: an anterior oblique bundle, a posterior bundle, and a transverse segment. It is only at less than 20 degrees and more than 120 degrees of flexion that the ulna and the radius in the elbow provide stability. Between these extremes, the UCL is the primary medial stabilizer of the elbow joint. It is the violent forces produced during the throwing motion that exceed the strength of the UCL and produce microscopic tears in the ligament. (10)

Secondary ossification centers are present in the elbows of younger athletes in the distal humerus, radial head, and the olecranon. Repetitive stress causes the growth plates of these centers to be more vulnerable than the surrounding muscles or tendons. (22) Ossification of these centers begins in the first year of life but does not completely unite with the body of the humerus until age 20. (8) The problem arises when athletes age 9-13 have the un-united epiphyses that are subjected to the pull of the attached muscles. (1)

Types of Injuries

There are several common types of shoulder and elbow injuries in youth pitchers. The primary injury in the arm of a youth baseball pitcher is Little League Elbow. Little League Elbow, identified in 1960 by Brogdon (2), is "the clinical diagnosis in the immature athlete that results from hard, repetitive sub-

threshold throwing." This condition is caused by repetitive valgus micro trauma. The cause is vague and usually is a result of overuse inflammation of the proximal humerus or an actual stress fracture. Little League elbow directly relates to the amount and intensity of throwing. (9) Other injuries to the elbow include flexor-pronator tendonitis and posterior impingement. (20)

Although injuries in youth baseball players occur to the elbow, some injuries occur to the shoulder. Commonly injured shoulder structures include the rotator cuff, glenoid labrum, glenohumeral ligaments, and biceps anchor. Rotator cuff injuries are the result of one of three mechanisms: primary impingement, secondary impingement due to underlying stability, and tensile overload. (20) Another injury to the shoulder is a lesion of the labrum. This is a result of extreme compressive, distraction, and translational forces during the cocking and deceleration phases of pitching. This repetitive micro-trauma to the area can cause fraying or tearing of the anterosuperior portion of the labrum. Most often these are referred to as a superior labral anterior-posterior lesion or a SLAP lesion. This is accompanied by disruption of the biceps anchor that can lead to increased anterior-inferior translation of the humeral head when the anchor is detached. (20)

Little Leaguer's Shoulder is also a medically recognized injury. This was described by Dotter in 1953 (18) and is best defined as "a stress fracture of the proximal humeral physis". This is caused because the weakest link in the kinetic chain of the throwing shoulder is the proximal humeral epiphysis in the adolescent population (18).

Biomechanics

The biomechanics of throwing and pitching are critical components when examining elbow and shoulder injuries in youth baseball players. Biomechanics are considered to be one of the most important factors that affect throwing performance and injury potential. (13) Due to unnatural movements, excessively high stresses are generated at the shoulder joint during throwing. The complex movement pattern of throwing requires flexibility, muscular strength, coordination, synchronicity of muscular firing, and neuromuscular efficiency. (23) This section will discuss the six phases of throwing, the kinematics of throwing, and the relationship of biomechanics and kinematics to injury.

Phases of Pitching

Pitching is one of the most dynamic motions in sport. This is demonstrated when the average time from initial foot contact of the stride leg to ball release is 0.145 seconds. The ball is accelerated from 4 to 85 miles per hour during this time. (11) The most dynamic movements of the human body are the external and internal rotation of the shoulder during throwing. (11) Thus, it is important to differentiate the six phases that comprise the motion of pitching. These phases include windup, stride, arm cocking, arm acceleration, arm deceleration, and follow-through.

During the windup phase, the pitcher must achieve a balanced position as the knee of the stride leg raises. The delivery of the ball to the pitcher is then initiated from this position. (11) During the windup phase, minimal elbow movements and kinematics are present. (21) The stride phase begins as the hands separate and ends as the front foot contacts the mound. The elbow reaches eighty-five degrees of flexion with foot contact. (21) The most important part of the stride phase is the location of the front foot. The stride foot should land directly in front of the back foot with toes slightly inverted. However, it is when the toes are turned too far in that the pitcher "throw's across his body" and reduces the energy contributed by the lower body. This predisposes a pitcher to upper extremity injury. (11) The third phase is arm cocking. This phase begins when the front foot contacts the pitching mound and ends when the arm is in maximum external rotation. (21) At the end of the phase, one of the pitcher's arms is cocked and the thrower's legs, hip, and trunk have been accelerated. (11)

Arm acceleration, the fourth phase of pitching, is short and dynamic. (21) The arm acceleration

phase starts when the humerus begins to internally rotate about the shoulder. The release of the ball signifies the end of this phase. (11) The next phase of pitching is arm deceleration. This phase starts with the ball release and ends when the arm reaches its maximum internal rotation. Follow-through, the final phase, is marked at the beginning by the arm reaching maximum internal rotation and at the end when the pitcher attains a balanced field position. Larger body parts, especially the trunk and legs, assist in dissipating energy in the throwing arm. (21) The follow-through is critical in minimizing the risk of injury in the baseball pitcher. Follow-through is complete with extension of the stride leg, continued hip flexion, shoulder adduction, horizontal adduction, elbow flexion, and forearm supination. (11)

Kinematics of Pitching

The kinematics of baseball throwing is also important in baseball biomechanics. Kinematics includes the kinetic chain that encompasses a coordinated human movement. It is within this human motion that both energy and momentum are transferred through body segments to achieve maximum magnitude in the final segment. (13) During pitching, the shoulder exceeds 7,000 degrees per second for adult pitchers. This has been referred to as the fastest human movement. (23) The concept of a kinetic chain is developed from the idea that this energy is being created with large segments and muscles, and is then transferred through the legs and trunk, out to the throwing arm, wrist, and then eventually the ball. (23) For example, the kinetic chain for throwing consists of the legs, hip, trunk, upper arm, forearm, hand, and the baseball. (13) This kinetic chain for throwing includes the mentioned sequence of motions: stride, pelvis rotation, upper torso rotation, elbow extension, shoulder internal rotation, and wrist flexion. (13)

The potential velocity at the distal end where the object is released is greater if more body segments contribute to the total overall force. Less energy is required if the kinetic chain is executed properly. Also, the performance of the throw, either the velocity or distance, should ultimately be increased. (23) Seven segments have been identified which incorporate movements during the overhand throwing motion. These segments include the lower extremity, pelvis, spine, shoulder girdle, upper arm, forearm, and the hand. (23)

Relationship of Biomechanics and Kinematics to Pitching

The information previously presented provides a background into why biomechanics and kinematics are important in examining youth pitching injuries in baseball players. A related biomechanical issue includes the relationship of biomechanics and kinematics to upper extremity injury. Based on the six phases of throwing, most overuse throwing injuries at the elbow and shoulders are believed to occur during the arm cocking and arm deceleration phase. It is during the arm deceleration phase that large loads are produced to decelerate the moving arm and prevent elbow and shoulder distraction. (13)

For elbow injuries, the shoulder is in extreme external rotation near the end of arm cocking and the elbow is in flexion. This produces a large amount of stress on the ulnar collateral ligament (UCL) of the medial elbow. (13) Valgus stress applied to the forearm can lead to medial elbow injury including muscle tears, avulsion fractures, medial collateral ligament spurs, and possibly ulnar nerve damage. (13) Also, the lateral elbow is susceptible to injury at the end of the arm-cocking phase. Compressive forces are created between the radial head and the humerus that contributes about one-third of the torque to the elbow (Fleisig, Dillman, and Escamilla's study (13). The compression that results may eventually lead to avascular necrosis, osteochondritis dissecans or osteochondral chip fractures. (13) A significant varus torque is placed on the posterior elbow during the arm acceleration phase that creates an increased chance of injury. In this case, impingement is combined with extreme elbow extension to produce an increased susceptibility to injuries. These possible injuries include osteophytes at the posteromedial olecranon tip, chondromalacia or the formation of loose bodies. (13)

Biomechanics also play a major role in shoulder injuries. Most throwing injuries to the shoulder include the rotator cuff. These injuries are the result of the rotator cuff muscles attempting to resist distraction, horizontal adduction, and internal rotation of the shoulder during arm deceleration. Humeral translation can cause entrapment of the labrum, which may result in labral tearing. Prevention of humeral

translation is difficult due to the large rotations, forces, and torques produced in the shoulder during throwing. Specifically, during the arm deceleration phase, an inferior force and adduction torque are produced. This may lead to superior translation of the humerus and eventually tendonitis of the supraspinatus, infraspinatus, and bicipital tendonitis. (13)

The kinematics of baseball pitching is important when examining the type of pitch utilized. Several studies conducted by Fleisig and Escamilla (23) were conducted to compare four commonly thrown pitches including the fastball, change-up, curveball, and the slider. Conclusions included that higher stress loads are produced in the fastball, curveball, and slider pitches than in the change-up. (23) However, the curveball was found to produce the greatest elbow medial force and elbow varus torque. (23)

Prevention

The prevention of elbow and shoulder injuries is important when examining youth baseball players. Approximately twenty-five percent of amateur baseball players participate in pitching. (17) In a recent study of collegiate males in the United States, fifteen percent of the players who had pitched in youth baseball reported pain, tenderness, or limited motion, which compromised their ability to throw. (6) This demonstrates the need for early prevention of elbow and shoulder injuries. This section will provide information pertaining to the trends and issues in the prevention of elbow and shoulder injuries in youth baseball players.

Trends in Prevention

Several landmark research studies help explain the beginning ideas behind preventing elbow and shoulder injuries in youth baseball players. The Houston Study in 1976 attempted to define the acute and chronic effects of Little League participants. (14)
Five hundred and ninety-five pitchers were questioned concerning age, number of years pitched, symptoms of elbow and shoulder injuries, and any known injuries. Also, each pitcher was x-rayed and examined by a physician. This particular study attempted to correlate the number of years pitched with injury. (14) The Eugene Study, also in 1976, used the same evaluation form and examined 120 pitchers. (15) Neither study found statistically significant correlations relating to pitching experiences, presence of symptoms, or x-ray findings and elbow and shoulder injuries. Thus, the conclusion from the beginning research studies was that the problem of abuse to the pitching arm remains on the practice field rather than during competition. (15)

The USA Baseball Medical and Safety Committee in collaboration with the American Sports Medicine Institute conducted the next group of significant studies concerning elbow and shoulder injuries. The purpose of these studies was to investigate the relationship between arm injuries and pain and factors believed to be related to injury. (12) These factors include types of pitches, number of pitches, and the quality of the mechanics. The 1996 study included surveying nationally recognized baseball coaches and physicians. The conclusions were that coaches at all levels of baseball should monitor the number of pitches thrown and not the number of innings pitched. A second recommendation was that pitchers should not use breaking pitches until their bones are completely finished growing. (3)

This same study in 1997-1998 study included monitoring 300 youth baseball pitchers in the Birmingham, Alabama area. (16) Almost half of these youth baseball pitchers, ages 8-12, reported elbow or shoulder pain at least once during the study. The increase in the number of pitches thrown per game and the number of pitches thrown per season resulted in an increase in the risk of elbow and shoulder pain. Thus, the recommendations based on this study included limiting a youth baseball pitcher to 75 pitches per game for this age group. (16) The 1999 study again monitored 500 youth baseball pitchers throughout the state of Alabama. (16) This study again showed that half of all youth pitchers have shoulder or elbow pain during the season and the risk of pain increases with the number of pitches thrown. Recommendations included limiting the number of pitches to 75 per game and 600 pitches per season. The study also demonstrated that youth pitchers who use curveballs and sliders increase their risk of pain. (16) The 2000 and 2001 studies consisted of conducting end of the year interviews of the

1999 subjects. These data will be used in the future to identify trends and to relate career cumulative pitching characteristics with serious elbow and shoulder injuries.

Issues in Prevention

Several guiding principles are related to preventing elbow and shoulder injuries in youth baseball pitchers. These include the idea that prevention is participatory, dependent upon rules and regulations, and multi-dimensional. First, prevention is participatory. This includes the idea that preventing injuries needs to include the league personnel, parents, coaches, and any other pertinent members. For example, the parents can identify early recognition of injuries. Simultaneously, coaches are responsible for knowing the fundamentals of baseball and teaching the proper mechanics of throwing and pitching. Secondly, prevention is dependent upon the Little League rules and regulations. For example, Little League rules state that 9-12 year olds can pitch up to six innings per week and 13-14 year olds are allowed to pitch up to 9 innings per week. (5) Also of interest, is the age cut off for teams. If a child's skeletal maturation is delayed and participation is based upon an age-determined team, then the child may pitch beyond their physical tolerance and develop secondary problems. (19)

Finally, prevention is multi-dimensional. The term "overuse" is often used and is an oversimplification. It implies that the solution to youth pitching injuries is for players to pitch and throw less. However, prevention must also include several other dimensions. These prevention strategies include monitoring the number of pitches or throws, the frequency of play, the velocity or speed, throwing mechanics, the player's age, and the implementation of an interval throwing program. (22)

The interval-throwing program is a recently developed distance-based throwing program based on distance and speed. The program is progressive as it loads the upper extremity either by increasing the intensity (speed or distance), duration (sets or repetitions), or both. Two components make up the program. The short component simulates the physical demands of the player that occur in a game situation. The long component is designed to provide low-intensity, long duration stimulation to throwers to increase arm strength. Criteria necessary to implement the interval-throwing program include the program being functional, personal, safe, and practical. (5)

Summary

Overall, several important areas need to be examined to understand elbow and shoulder injuries in youth baseball players. These areas include but are not limited to epidemiology, biomechanics, and prevention of elbow and shoulder injuries in youth baseball pitchers. First, most injuries occur to the elbow, with Little League Elbow being the most common injury. The anatomy of the elbow allows for instability that is a predisposing factor to injury, however the shoulder can also be injured with pitching and throwing in youth baseball players. Secondly, the ability to pitch correctly requires proper biomechanics. Improper mechanics may lead to a decrease in performance or an increase in the risk of injury. (21) Information concerning throwing injuries and the six phases of throwing can help teach techniques to improve treatment and prevention of throwing injuries. (13)

Finally, prevention is another aspect of elbow and shoulder injuries. Prevention is multi-dimensional and includes all personnel involved. Additionally, the major concern is the number of pitches not the number of innings pitched per youth baseball player.

The information above indicates that researching elbow and shoulder injuries in youth baseball players requires a comprehensive approach. Many components, including epidemiology, biomechanics and prevention must be examined to completely understand the significance and severity of injuries to a youth baseball pitcher's arm.

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Number of contact hours: 1 hour

Description: Injuries come with the long hours of practice and competition in the sport of baseball. This article examines the epidemiology, biomechanics, and prevention of elbow and shoulder injuries in youth baseball pitchers.

List of Objectives:

1. Participants will be able to list and describe two types of elbow injuries in youth baseball players.
2. Participants will be able to list three critical components of preventing elbow and shoulder injuries in youth baseball players.
3. Participants will be able to describe the phases of pitching and identify which phase is most closely related to elbow injuries in baseball.

1. The term for the "clinical diagnosis in the immature athlete that results from hard, repetitive sub-threshold throwing."
    a. Little League Shoulder
    b. Rotator cuff tendonitis
    c. Little League Elbow
    d. SLAP lesion

2. During which of the following phases of pitching ends when the pitching arm reaches its maximum internal rotation?
    a. Arm acceleration
    b. Wind up
    c. Arm cocking
    d. Arm deceleration

3. All of the following are identified segments that incorporate movements during the overhand throwing motion, except:
    a. Upper arm
    b. Spine
    c. Pelvis
    d. Abdomen

4. Most overuse injuries at the elbow and shoulder occur during the:
    a. Stride and arm cocking phase
    b. Arm cocking and arm deceleration phase
    c. Arm acceleration and arm deceleration phase
    d. Arm deceleration and follow through phase

5. The interval-throwing program is based on what two components:
    a. Distance and speed
    b. Time and speed
    c. Distance and time
    d. None of the above

6. Several studies conducted by Fleisig and Escamilla identified four commonly thrown pitches. Which of the following was found to produce the greatest elbow medial force and elbow varus torque.
    a. Fastball
    b. Curveball
    c. Change-up
    d. Slider

7. It is only at less than 120 degrees of flexion that the ulna and the radius in the elbow provide stability.
    a. True
    b. False

8. All of the following are mechanisms of rotator cuff injuries except:
    a. Distraction
    b. Primary impingement
    c. Tensile overload
    d. Secondary impingement

9. The injury defined as "a stress fracture of the proximal humerus physis" is termed:
    a. Little League Shoulder
    b. Lesion of the labrum
    c. Rotator cuff tendonitis
    d. Little League Elbow

10. In a recent study of United States collegiate males, 25% of the players who had pitched in youth baseball reported pain, tenderness, or limited motion, which compromised their ability to throw.
    a. True
    b. False

11. Which of the following principles are critical when preventing elbow and shoulder injuries in youth baseball players:
    a. Prevention is participatory
    b. Prevention is dependent upon rules and regulations
    c. Prevention is multi-dimensional
    d. All of the above

12. Which of the following injuries is a result of extreme compressive, distraction, and translational forces during the cocking and deceleration phases of pitching:
    a. Lesion of the labrum
    b. Rotator cuff tendonitis
    c. Little League Elbow
    d. None of the above

13. What are the most dynamic movements of the human body:
    a. External rotation and horizontal flexion of the shoulder
    b. Internal rotation and external rotation of the shoulder
    c. Horizontal abduction and horizontal adduction of the shoulder
    d. None of the above

14. All of the following are critical to implement in an interval-throwing program except:
    a. Program is functional
    b. Program is personal
    c. Program is safe
    d. Program is inexpensive

15. What is the average time from initial foot contact of the stride leg to ball release in the pitching motion:
    a. 0.145 seconds
    b. 0.768 seconds
    c. 0.415 seconds
    d. None of the above

Record answers below. (Or you can click here for the answer sheet on separate page)

CEU Quiz IX Elbow and Shoulder Injuries In Youth Baseball Players

The National Athletic Trainer's Association Board of Certification accepts this continuing education for 1.0 hours from MEDCO SUPPLY COMPANY (Provider # P2504) provided this quiz is completed as designed. A passing score is 70% for CEU credit. A certificate of completion will be forwarded for all completed quizzes with a passing grade. It is the individual's responsibility to properly report this and all CEU information to the NATABOC at the end of each CEU cycle. Participation is confidential.

Clearly circle ONE answer:

1. a b c d
2. a b c d
3. a b c d
4. a b c d
5. a b c d
6. a b c d
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