

Shoulder and Elbow Pitching Injuries in Baseball

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Overview

Most of the injuries that occur in overhead throwing athletes involve the shoulder and elbow. Compared to female pitchers who throw underhanded, the overhead throwing mechanism generates higher forces at the elbow and shoulder which leads to higher injury rates among male pitchers. Considering the increase in popularity of youth athletics in the United States, these injuries are likely to increase. There are nearly 200,000 Little League teams alone that compete yearly, with countless more high school and collegiate leagues as well. Understanding the proper throwing mechanics, recognizing common throwing errors, and incorporating proper pre-season and intra-season strengthening and resting programs to help avoid these injuries is crucial to managing these athletes successfully.

Pitching Biomechanics

The pitching motion that propels a thrown ball up to speeds of 100 miles per hour is derived from energy that starts in the lower extremity. This energy is transferred from the legs, through the trunk and ultimately to the arm in what is known as a kinetic chain. This transfer of energy through the kinetic chain (legs to trunk to shoulder to elbow to hand) has been divided into specific phases, which are consistent across the throwing motion of any thrower. These phases include: 1) Windup, 2) Early Cocking, 3) Late Cocking, 4) Acceleration, 5) Deceleration, and 6) Follow-Through (see figure 1).

As this energy is funneled through the trunk to the arm, it is concentrated into sequentially smaller segments (i.e. the legs and trunk are bigger than the shoulder and elbow). This concentration of energy in the arm leads to tremendous biomechanical stresses at the shoulder and elbow. It is this concentration of stress at the shoulder and elbow that places a premium on proper throwing mechanics and muscle strength in order to avoid injury.

Common Injuries and their Mechanisms

Shoulder

Injury to the shoulder commonly occurs during the late cocking phase of throwing, when the arm is maximally above shoulder level and behind the head. Successful throwers are often those athletes who can achieve maximal motion above and behind their head (called abduction and external rotation of the shoulder), because in this position they are able to generate the largest amount of acceleration which increases the velocity of the thrown pitch. It is the achievement of this maximal motion, however, that can also place these throwers at increased risk of injury.

As the shoulder reaches this maximal point of abduction and external rotation during the late cocking phase, there is tremendous stress placed on the ligaments in the front of the shoulder (place your shoulder in this motion and feel the stretch in the front

of your own shoulder). This recurrent stretching can cause subtle instability of the shoulder over time, eventually leading to altered motion of the shoulder ball and socket joint and cause loss of velocity and control as well as pain. Additionally, as throwers repetitively place their arm in maximal external rotation, they may develop over time increased external rotation and decreased internal rotation (see figure 2). This alteration in the range of motion of the shoulder can increase the strain on the shoulder joint, the rotator cuff, and the elbow.

Additionally, the rotator cuff muscles are also maximally stressed during this motion. The rotator cuff is composed of four separate muscles which surround the joint. Their main responsibility is to keep the humeral head (the ball) perfectly centered in the glenoid (the socket). As throwers progress through the throwing motion, particularly late cocking and early acceleration, the stress across the rotator cuff muscles reaches its peak as the rotator cuff attempts to stabilize the ball in the socket. With repetitive maximal exertion of these muscles, throwers can develop tendonitis (inflammation in the tendon) and partial tearing.

Elbow

As throwers progress through the throwing motion, large stresses are placed across the inside (medial) aspect of the elbow. The ligament that stabilizes the inside of the elbow (medial collateral ligament, MCL) can become stretched over time or can experience an acute failure resulting in elbow instability and pain.

As the medial aspect of the elbow is stretched, the outside (lateral) aspect of the elbow joint is compressed. This repetitive compression over time can lead to injuries of the bones and their protective covering (cartilage) on the lateral elbow joint. This too can lead to pain.

Leg and Trunk

As throwers progress through their throwing motion, they are often placing weight only through one leg (ex. right handed throwers on their right leg). Proper strength and conditioning of the leg and trunk muscles is critical for the proper transfer of energy from the leg and trunk to the arm during the throwing motion. Often, young throwers lack sufficient core strength (trunk, low back, upper legs) to stabilize their trunk over their leg. This can lead to abnormal throwing mechanics which ultimately places more strain on the shoulder and elbow.

Common Throwing Errors

I look at five specific aspects of the throwing motion when evaluating a young thrower's pitching mechanics. Improper mechanics in each of these areas has been linked to an increased injury risk.

- 1) During the early cocking phase, does the pitcher remain erect or does he lead with his pelvis?
- 2) During the cocking phase, is the hand on top of the ball or off to the side/underneath the ball?
- 3) At the point of their stride foot contact with the ground, is the elbow above or below the level of the shoulder.

- 4) At stride foot contact, does the lead shoulder (left shoulder in a right-handed thrower) remain “closed”, or does it “open up”?
- 5) Does the stride foot point towards home plate?

Proper pitching mechanics involves a pitcher remaining upright with his hand on top of the ball, and at stride foot contact the elbow should be above the level of the shoulder with the shoulder closed and the foot pointed towards home plate. Improper mechanics in any of these areas causes the transfer of energy from the legs/trunk to the arm to be concentrated on the front part of the shoulder and the inside aspect of the elbow. This places the thrower at risk for the aforementioned shoulder and elbow injuries.

I will also evaluate the thrower’s core strength by asking them to perform a single leg squat to 90 degrees of knee flexion. An inability to keep their balance with their knee centered over their foot is an indication of core weakness which can further exacerbate the aforementioned stress at the shoulder and elbow.

Proper Conditioning and Rest

While outside the scope of this article, I counsel each of my throwing patients on ten specific exercises to perform to optimally strength their arm musculature to meet the demands of pitching. These are referred to as the “Thrower’s Ten.” Additionally, specific core strengthening exercises are also incorporated to ensure proper low back, hip, and upper leg strength.

Proper rest between throwing sessions and during the entire year is also crucial to avoiding injury. Guidelines from USA Baseball dictate that athletes ten years of age and under throw no more than 50 pitches per game. The following maximum pitches per game are also recommended for older athletes: age 11-12, 65 pitches; age 13-14, 75 pitches; age 15-16, 90 pitches, and ages 17 and up, 105 pitches. The maximum number of games or throwing sessions per week is two for all age groups.

Finally, as competition among athletes of all ages continues to increase, there are more young throwers who participate year round in baseball. I recommend taking at least 3 months off per year from baseball, but encourage young athletes to play other sports such as soccer, football, or basketball that involve less throwing.

Summary

Understanding the proper throwing mechanics, recognizing common throwing errors, and incorporating proper pre-season and intra-season strengthening and resting programs to help avoid these injuries is crucial in keeping overhead throwers injury-free. Incorporating specific modifications into an individual athletes’ throwing motion has been shown to help avoid injuries. Proper core strengthening and appropriate rest are also important areas in helping to manage the health of these athletes.

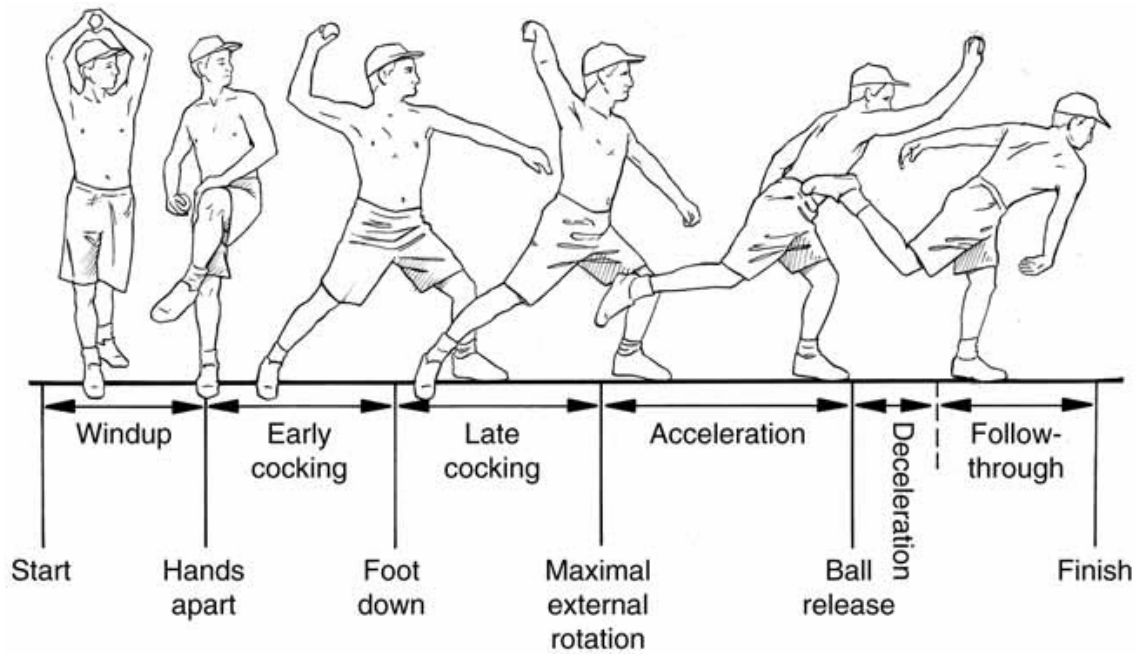


Figure 1- The Phases of the Throwing Motion

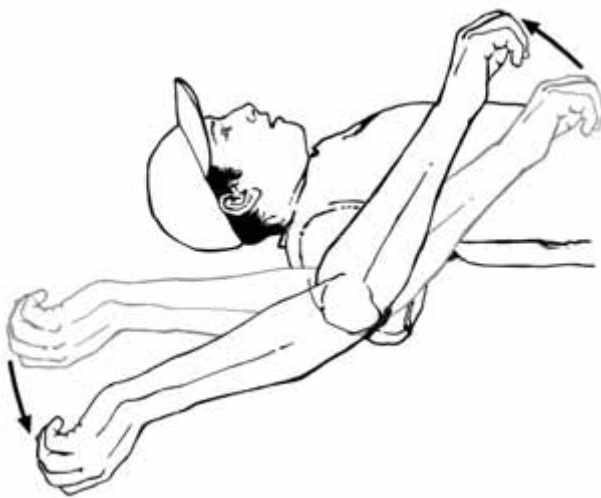


Figure 2- The Arc of Rotation in a Thrower's Shoulder. Over time, there is increased external rotation and decreased internal rotation. Light lines indicate initial shoulder range of motion. Dark lines indicate range of motion after prolonged throwing. Figure courtesy of Journal of American Academy of Orthopaedic Surgeons, March 2007, pg. 140.