Softball Throwing Fundamentals

Marion Alexander, Caroline Taylor
University of Manitoba

Throwing is one of the most important defensive skills in softball. The overhand throwing skill is dependent on the flexibility and mobility of the shoulder joint, which is a multiaxial joint with three degrees of freedom. This range of motion allows the projectile to be released well above the shoulder, increasing the length of the moment arm for shoulder and spinal rotation. However, this increased length of the effective levers may increase the forces on the shoulder and elbow joint during the deceleration phase, following release or impact. *The thrower must also have strong trunk muscles, including both the anterior and posterior muscle groups. Core strength training is important in training skilled softball players.* Knowledge of the key body movements producing these high speed sport skills, and the knowledge of basic biomechanics, will give an indication of the phases of the throwing motion. “Acute shoulder pain is the first sign of improper technique, which lead to most chronic shoulder injuries common in baseball (softball)” (Klatt 1992)

**Preparation phase**

“The preparation phase initiates body motion, individual timing, and rhythm, and places the thrower into the most efficient and effective position for maximum force and control” (Klatt 1992). Preparatory movements will usually begin with fielding or catching a ball and then include a shuffle step, a crow hop or a crossover step before the back foot gets firmly planted into the ground for the backswing and force producing movements. Which preparatory movement is used depends on the position of the athlete and the game situation (Figure 1).

![Figure 1: Preliminary movements of a throw](image)

**Backswing**

The backswing phase begins with the lifting of the front foot and the elevation of the front leg in a stepping motion. This motion consists of hip flexion, knee flexion and is accompanied by rotation of the hips and trunk away from the intended direction of the throw. As the player picks up the front foot, the player’s body is balanced over the back leg. This position of balance over the back leg will help to load up the back leg, producing larger ground reaction forces during push off. The greater the weight over the back leg, the larger the ground reaction forces which act to drive the athlete up and forward. The further and
faster the throw needs to be, the greater the step the athlete will take as the length of the step has been directly related to the velocity of the throw. As the front foot strides forward the hands separate as the throwing arm is extended behind the body, and the non-pitching arm is abducted to ninety degrees in front of the left shoulder. Figure 2 shows the sequence of movements that make up the backswing of a throw.

**Figure 2:** Backswing movements of a throw

**Force Producing Movements**

The force producing movements, as shown in Figure 3, consist of all the movements of the player which will increase ball velocity at release. The player will drive the weight forcefully forward from the back leg, thrusting the body upward and forward. This drive is produced by the forceful contraction of the muscles of the back leg, especially the hip extensors, knee extensors, and ankle plantarflexors. The stride foot should land almost directly in front of the back foot, with the toes pointing slightly in (hip medial rotation) which will allow for enough hip rotation but will also act as an effective block. If the foot is placed too far inside the back leg, the pitcher may end up "throwing across his body" that means that the hips will not be able to rotate and the contribution from the lower body will be limited.

**Figure 3:** Force producing movements of a throw.

As the foot contacts the ground, the throwing arm is abducted and extended as far as possible behind the player. This position places the trunk muscles on a maximum stretch,
allowing them to produce higher forces during trunk rotation. The key element in this phase of the skill is to keep the trunk back as much as possible to retain its potential for contributing to the velocity of the pitch.

An important aspect of the throwing motion is the synchrony between the throwing arm and the striding leg, as they both move away from the midline with the same angular velocity. The ball is removed from the glove when the stride is initiated, and the ball moves up as the leg moves down. The striding leg moves forward toward the target and the throwing arm moves backward at close to the same rate. If the throwing arm and striding leg are coordinated properly, the arm will be up in a semi-cocked position when the stride foot contacts the ground- this coordination is one of the most important aspects of throwing.

As the foot is planted in front of the player, the weight starts to shift onto this foot, as it is being driven from the rear foot to the front foot. “When a player throws, his back leg produces forces of 1-1/2 times his body weight. The front leg stride produces forces 2-1/2 times body weight” (Klatt 1992). As the weight is taken onto the front foot, hip rotation occurs, followed by the trunk rotation and shoulder rotation. The hip rotation precedes the shoulder rotation, so that the rotational momentum of the hips can be transferred to the trunk and shoulders. Trunk rotation follows the hip, but in highly skilled players hyperextension of the upper trunk occurs as it is rotated around to face the target. The rapid and forceful trunk and shoulder rotation is accompanied by relaxation of the throwing arm and shoulder, producing "inertial lag" of the throwing shoulder. This inertial lag causes the throwing arm to assume a position of maximal lateral rotation at the end of the trunk rotation phase, so that the trunk and hips are facing forward before the pitching arm has begun the forward movement. “Each body segment must come forward as the preceding movement or proximal segment reaches its greatest speed (angular velocity), to develop maximum force in throwing or batting (e.g., hips-trunk-shoulder-elbow-wrist)(Klatt 1992). The upper arm undergoes extreme lateral rotation while the elbow is in a flexed position. The throwing arm is in a position of maximal lateral rotation up to 30 ms prior to release, with the forearm and hand pointing away from the intended direction of the pitch.

This inertial lag produces a position of stress in the shoulder and elbow of the throwing arm. The anterior shoulder is placed under extreme tension, stretching the anterior capsule and the anterior shoulder muscles (anterior deltoid, pectoralis major); while the medial rotators are also placed under maximal stretch in this position. These muscles are therefore extrinsically loaded, in preparation for the subsequent throwing motion. This position places the throwing shoulder in a position of optimal loading, so the subsequent motions are performed through the optimal range of motion. The humerus is in a position of optimal lateral rotation of 160 degrees prior to the beginning of internal rotation. Injury to the medial rotators, especially subscapularis can occur due to the high tensile forces in this position. The subscapularis has its peak activity in late cocking when eccentrically contracting to protect the anterior shoulder joint. It then continues to function as an internal rotator to help carry the arm across the chest during acceleration and follow through. Figure 4 demonstrates the position of extreme lateral rotation at the shoulder joint. Professional throwing athletes demonstrated selective use of the individual rotator cuff muscles, as the professional pitchers were able to use the subscapularis muscle exclusively among the rotator cuff muscles during the acceleration phase of throwing. This was in contrast to amateurs who tended to use all the rotator cuff and biceps muscles.
This position of maximal lateral rotation of the shoulder joint is accompanied by elbow flexion and valgus, placing the medial elbow structures under extreme tension and the lateral structures under compression. The greater the inertial lag produced by the trunk rotation, the greater the valgus position of the elbow and the higher the stresses on the medial elbow. During this position of maximal lateral rotation, the pectoralis major and latissimus dorsi function together to act as internal rotators and eccentrically contract to protect the joint along with subscapularis during late cocking. As the upper arm reaches the position of maximal lateral rotation, the trunk rotation is completed, and then decelerates and the rotation stops. This deceleration is closely followed by the movements of the joints of the right upper extremity. Although the trunk rotation has now been decelerated to zero, the trunk will continue to laterally flex toward the left side, away from the pitching arm.

Dillman has suggested that there are two phases in the acceleration phase of pitching. The first phase occurs when the shoulders have reached a position facing forward. At this point, the shoulder is moved linearly forward, which increases the position of maximal lateral rotation to an even greater extent. The second phase occurs when the linear acceleration of the shoulder joint has ended, and the shoulder joint begins to medially rotate.

Following the position of maximal lateral rotation of the shoulder joint, the arm acceleration phase begins when the humerus begins to internally rotate about the shoulder. To pitch effectively, a short delay between the onset of elbow extension and shoulder internal rotation is crucial. Rapid elbow extension begins, and this elbow extension is later joined by internal rotation of the upper arm through release of the ball. The initial arm movement is elbow extension, closely followed by medial shoulder rotation. The extension of the arm at the elbow will reduce the moment of inertia of the lower arm about the longitudinal axis. With less inertia, the internal rotation torque generated at the shoulder can accelerate the arm to a greater angular velocity. Shoulder rotation is accomplished by the medial rotators, including the subscapularis, pectoralis major, and latissimus dorsi. The shoulder rotation is accompanied by pronation and wrist flexion and adduction.

The rate of elbow extension is very high at this phase, and is controlled by the elbow flexors which are undergoing eccentric contraction. The acceleration torque on the elbow joint, when coupled with a high rate of extension of this joint, can cause relatively high shear forces to be imposed on the articular cartilage. The greater the extension velocity, the greater the shear stress on the articular cartilage.

The end of acceleration occurs before ball release, as the external rotators such as the posterior deltid and the teres minor are starting to contract to stop the arm.
**Critical Instant**

The critical instant during the baseball throw is the moment of release of the ball, which will determine the pathway of the ball to the target. It is shown in Figure 5. The ball is released over an 8-10 ms period, in a position anterior to the front foot. When the ball is released, the trunk is flexed, the arm is almost in a fully extended position at the elbow, and the shoulder is undergoing shoulder internal rotation. At release, the elbow is fully extended, the shoulder is in mid medial rotation and the lower arm is in mid pronation. The wrist is in a position of 0 degrees of extension, and continuing toward flexion. The thrower's trunk should be tilted forward at release and the lead knee should be extending. The player should have lateral trunk lean away from the throwing arm, allowing the arm to extend more directly upward from the shoulder and prevent shoulder impingement.

**Follow Through**

The follow through, as shown in Figure 6, is also known as the deceleration phase, from ball release to the point of maximal pronation of the forearm. This may be the most violent phase of the pitching motion, as the angular velocities of the active joints must decelerate from very high angular velocities to zero in a very short period of time. After ball release, the arm continues to extend at the elbow and internally rotate at the shoulder. The forearm pronation that is observed may actually be the combined effect of elbow...
extension and internal rotation at the shoulder. Follow through is completed with extension of the stride leg, continued hip flexion, shoulder adduction, shoulder horizontal adduction, elbow flexion and forearm supination.

All of the shoulder lateral rotator muscles are strongly contracted at this phase of the throw, to maintain the apposition of the glenohumeral joint. This is a very stressful position on the shoulder joint musculature due to the eccentric nature of the contractions. Since eccentric contractions produce larger forces than concentric contractions, this action produces rotator cuff tears and biceps and labral tears. The deceleration torques are much higher but of shorter duration than the acceleration torques. Following release of the ball, the throwing arm continues to move across the body toward the left leg. Mechanical impingement may also occur as the arm is rapidly brought across the body in an internally rotated position. The trunk continues to flex forward and to the left, and the right leg is brought through to a position alongside the left foot. The body moves forward with the arm to reduce shoulder distraction force and to allow the pitcher to regain his balance. “A complete follow-through includes a balanced stride-leg position, trunk flexion, and the throwing arm positioned across the body and angled downward toward the stride foot. The weight shifts slightly forward, with the pivot leg and foot coming into a ready position” (Klatt 1992).

“Efficient and proper mechanics will prevent from 80% to 90% of your baseball injuries…” (Klatt 1992).

Long-term athlete development
Active start stage (0-6):
Ball selection

When teaching children to throw for the first time, there are a few things to consider, first and foremost – the size of the ball. As ball size increases, there is a point where performers resort to a less mature throwing pattern (Payne 2002). Therefore it is important that the ball not be too large for the size of the child’s hand. Softballs tend to come in two sizes 11” and 12”, both of which are too large for the hands of children in this age group to throw properly, thus, attention must be made to use an adequate ball size. Another important research finding when teaching children to throw a ball is that, “…less than maximal effort [results] in patterns characterized as “less advanced”. Subjects evaluated as using advanced patterns to throw a ball for greatest distance, for example, would most likely use a less advanced pattern to “toss” a ball to a partner standing 10 feet away (Roberton, 1987) (Strohmeyer 1991). Young softball players within the active start stage will display more advanced throwing mechanics if instructed to throw as hard as they can or to throw far. This is another reason why ball selection is important as the weight of the ball is another factor to take into consideration. If a child is to throw the ball with maximal effort and the weight of the ball is too heavy, then the ball will not go very far which will discourage the child and also the greater the weight, the greater the forces within each muscle and the greater the chance of muscle soreness afterwards. One other factor to consider when choosing the correct ball is the texture of the ball. Ideally the ball should have a covering that will allow for a good grip with
either laces like a real softball or a material that has a high coefficient of friction so the ball will not slip out of the child’s hand when trying to throw the ball.

Common characteristics

Taken from Payne (2002) are Monica Wild’s Four Developmental Stages of Throwing that break down the common characteristics of throwing by age. Two to three years old children tend to have arm dominated throws and they bring their throwing arm sideways-upward or forward and upward instead. Children this age will throw the ball facing the direction of the throw as their feet remain stationary throughout the throw and there is no hip or trunk rotation. When children become 3.5 years of age, children begin to move in a horizontal plane and not an anterior-posterior direction as before. The throwing arm move in a high oblique plane or horizontal plane above the shoulder and the throw is initiated by arm and elbow extension. The feet continue to remain stationary and trunk rotation appears. These characteristics are common until around the age of five where the children move into another developmental stage. Between the ages of five and six, children begin to take a unilateral step towards the direction of the throw and the backswing is obliquely upward over the shoulder with lots of elbow flexion. The arm usually will follow through forward and downward and is accompanied by forward trunk flexion. According to the developmental model developed by Haubenstricker, Branta and Seefeldt (1983) 60% of boys around 5.5 years of age are capable of a mature throwing pattern using the proper timing of movements and segmental rotation) (Payne 2002). Girls displayed stage 5 of the developmental model around the age of 8.5 years (Payne 2002) (see figure 7 below). It is important to remember that these developmental stages are merely guidelines. “Development within component parts may proceed at different rates in the same individual or at different rates in different individuals (Robertson 1977)” (Payne 2002).
Stage 1  The throwing motion is essentially posterior-anterior in direction. The feet usually remain stationary during the throw. Infrequently, the performer may step or walk just prior to moving the ball into position for throwing. There is little or no trunk rotation in the most rudimentary pattern at this stage, but children at the point of transition between stages 1 and 2 may evoke slight trunk rotation in preparation for the throw and extensive hip and trunk rotation in the follow-through phase. In the typical stage 1, the force for projecting the ball comes from hip flexion, shoulder protraction, and elbow extension.

Stage 2  The distinctive feature of this stage is the rotation of the body about an imaginary vertical axis, with the hips, spine, and shoulders rotating as one unit. The performer may step forward with either an ipsilateral or contralateral pattern, but the arm is brought forward in a transverse plane. The motion may resemble a "sling" rather than a throw due to the extended arm position during the course of the throw.

Stage 3  The distinctive pattern in stage 3 is the ipsilateral arm-leg action. The ball is placed into a throwing position above the shoulder by a vertical and posterior motion of the arm at the time that the ipsilateral leg is moving forward. This stage involves little or no rotation of the spine and hips in preparation for the throw. The follow-through phase includes flexion at the hip joint and some trunk rotation toward the side opposite the throwing arm.
Stage 4: The movement is contralateral, with the leg opposite the throwing arm striding forward as the throwing arm is moved in a vertical and posterior direction during the wind-up phase. There is little or no rotation of the hips and spine during the wind-up phase; thus, the motion of the trunk and arm closely resembles the motions of stages 1 and 3. The stride forward with the contralateral leg provides for a wide base of support and greater stability during the force production phase of the throw.

Stage 5: The wind-up phase begins with the throwing hand moving in a downward arc and then backward as the opposite leg moves forward. The concurrent action rotates the hip and spine into position for forceful derotation. As the contralateral foot strikes the surface, the hips, spine, and shoulder begin derotation in sequence. The contralateral leg begins to extend at the knee, providing an equal and opposite reaction to the throwing arm. The arm opposite the throwing limb also moves forcefully toward the body to assist in the equal and opposite reaction.

Figure 7: Haubenstricker, Branta and Seefeldt (1983) Developmental stages of throwing using the total body approach.

FUNdamental stage (6-8) (6-9):

Continuing on with Wild’s developmental stages, children in stage four take a forward step with the contralateral leg (the correct leg) (similar to Haubenstricker et al. developmental stage 5) with obvious trunk rotation being used to help generate force and the arm is horizontally adducted in the forward swing. Wild has observed that children around the age of six and one-half fall into this stage four. Research by Ulrich supports Wild’s findings as he found that 60% of children aged six took the proper step forward and goes on to add that by the age of 10, 80% of the children take the correct step.
According to research done by Ulrich (2000), 60% of all six year olds and 80% of all seven year olds initiate the backswing with a downward arc of the throwing arm and rotation of hip and shoulder to a point where the non-dominant side faces an imaginary target occurs in 60% of children 7 years of age and 80% of children 8 years of age. As far as the follow through is concerned with children in this age group, the follow-through beyond ball release diagonally across body toward side opposite throwing arm is observed in 60% of children by age 8 and 80% by age 10) (Ulrich 2000).

Learning to Train (9-12) (8-11)
Coaches input and video observation
Training to train (12-16) (11-15)

Training to Compete (16-23 +/-) (15-21 +/-)

Training to Win (19 +/-) (18 +/-)

Active for Life (any age)
Bibliography


