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Kinesiology of the Throwing Motion of a Quarterback

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Introduction

An overhead throw is a common movement within athletics. This analysis reviews the kinesiology of a quarterback's throwing motion specifically. An overhead throwing motion is broken down into four phases: loading, arm-cocking, acceleration, and follow-through. These phases were labeled and identified in scholarly literature, identifying the starting and stopping points. According to Escamilla and Andrews (2009), the maximum shoulder external rotation begins the arm acceleration phase and the release of the ball ends this phase. Specific movements have been identified and labeled within each phase and are discussed as individual contributors to the overall goal of each phase. The throwing motion of the quarterback is a very complex motion and involves all three movement planes.

Loading Phase

Primary Plane Involved: Sagittal, Frontal
Primary Muscle Contributors: Quadriceps, glutes
Sequence of Phase: The loading phase is the initial movement when the quarterback receives the ball. After receiving the ball, they will take two to three steps backward and begin to turn sideways to their target. The rear knee and hip will begin to flex and the trunk will experience separation from the lower and upper half. This is crucial for the athlete because this allows the thrower to build up torque and power in order for them to release the ball.
Video analysis: The quarterback shows rear hip and knee flexion as they begin to move backwards from their target. Subject shows 108.2 degrees of flexion in the rear knee which allows them to build up power from their back leg so that they can translate it to their front side as they begin their throw. Most of their weight is on the rear leg as they search for their target. Once they pick a target, they begin to externally rotate their front hip and point their front leg to their target. This creates a should and hip separation which results in creating torque and power.
Improvements: More hip and knee flexion will result in more torque and power output due to the ground-up force output. This would allow the quarterback to activate more of the quadriceps muscles which allow force output. This is key in a quarterback because without a good amount of hip and knee flexion, they can put a lot of stress and pressure by trying to overcompensate with their shoulder. This stress can then lead to injuries which could result in surgery.

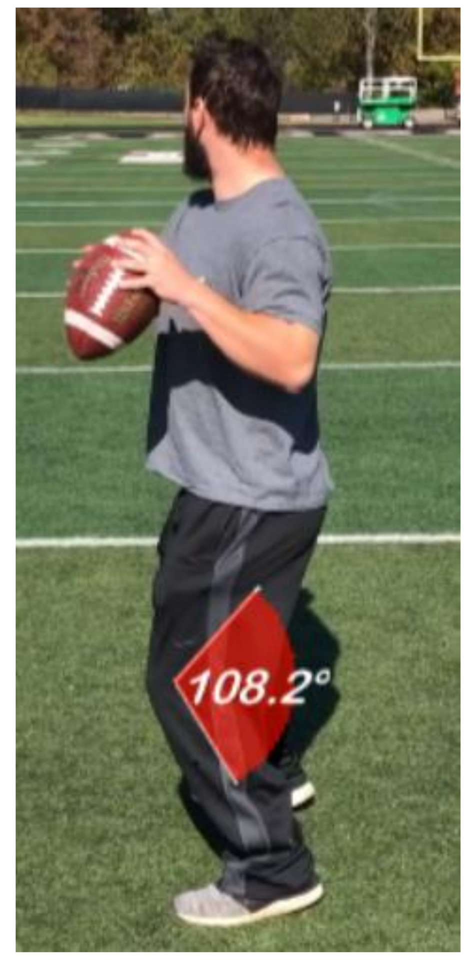

Figure 1. The Loading phase shows flexion in the rear knee and hip allowing the body to prepare for power and torque.

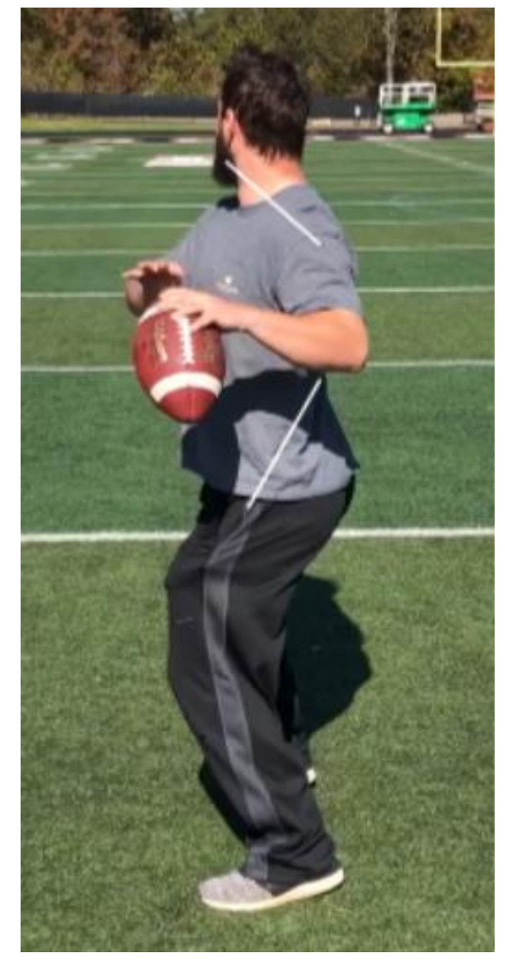

Figure 2. The end of the loading phase shows front foot contact with the ground and shoulder and hip separation.

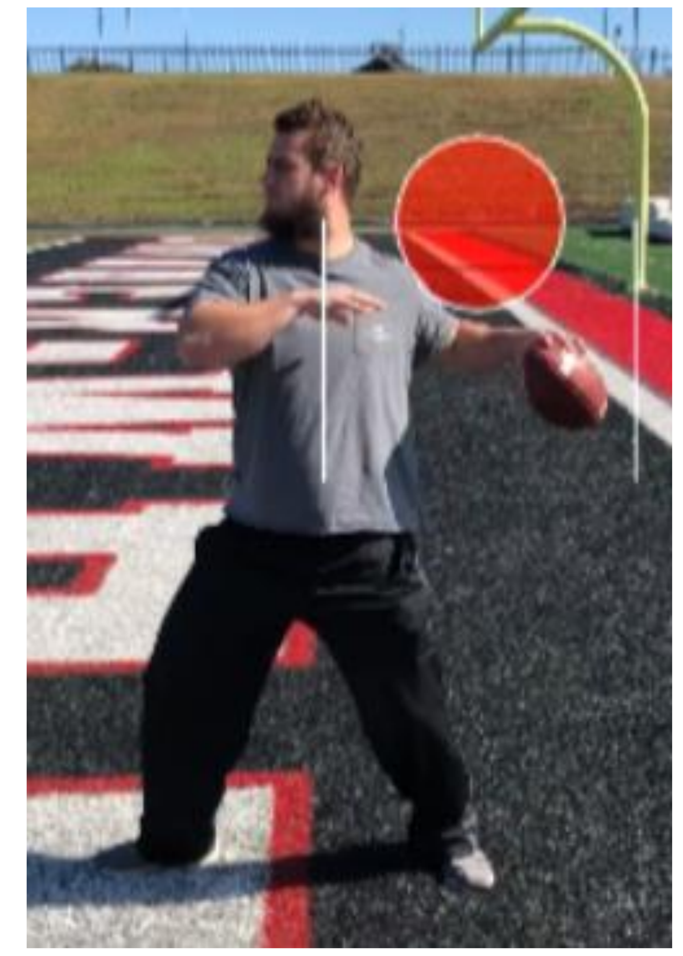

Figure 3. The arm cocking phase shows the shoulder beginning to abduct and externally rotate. The circle is inserted to show where the arm should be in order to be efficient.

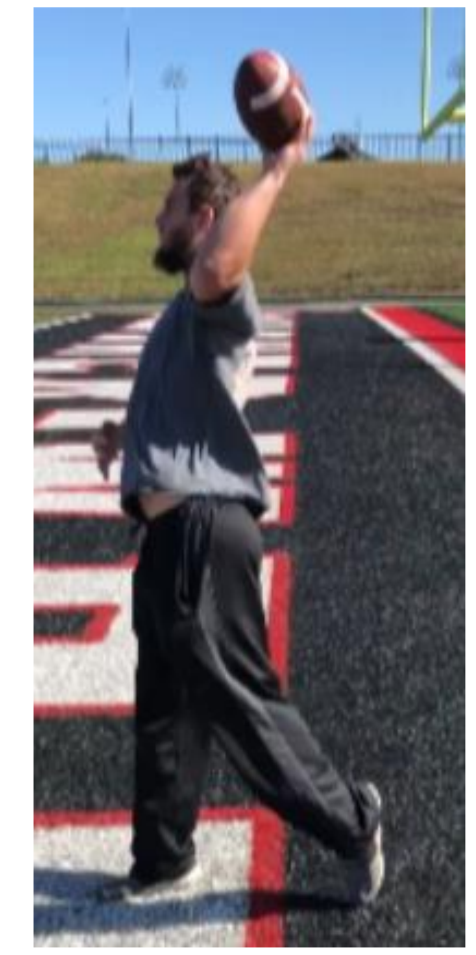

Figure 4. The acceleration phase propels the ball forward toward the target while still in the hand.

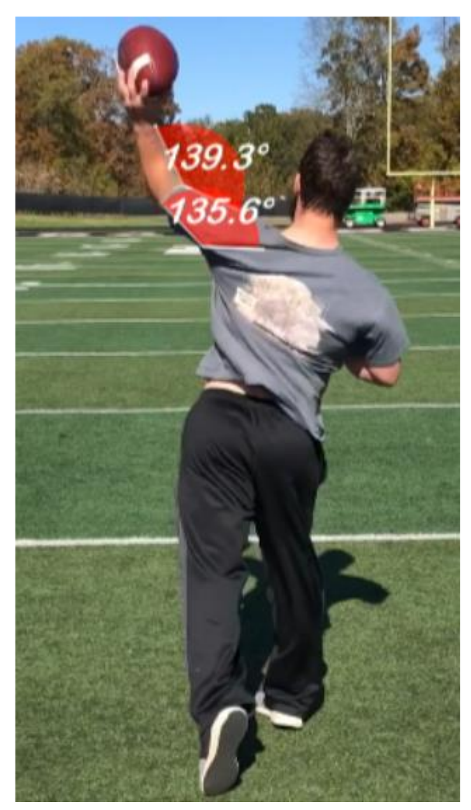

Figure 5. The follow-through phase allows the shoulder to decelerate after the ball is released.

Table 1. Significant temporal events of pitching.

Key Events in the Throwing Motion	Percentage of Time From Stride Foot Contact (0%) to Ball Release (100%)
Maximum pelvis rotational angular velocity[21,29]	25-39
Max upper torso rotation angular velocity during cocking phase[21,29]	51-52
Elbow begins extending just prior to max external rotation[21]	81
Transition from late cocking to acceleration[29]	81
Maximum shoulder external rotation[21,29]	81
Shoulder begins internal rotation at beginning of acceleration[21]	81
Max elbow extension velocity, during acceleration[21,29]	90-95
Maximum forward trunk tilt angular velocity[21,29]	93-96
Maximum shoulder internal rotation angular velocity, 3 to 4 milliseconds after ball release[7,21,29]	102-104

Table 1. These percentages at these movements allow for the greatest efficiency and power output.

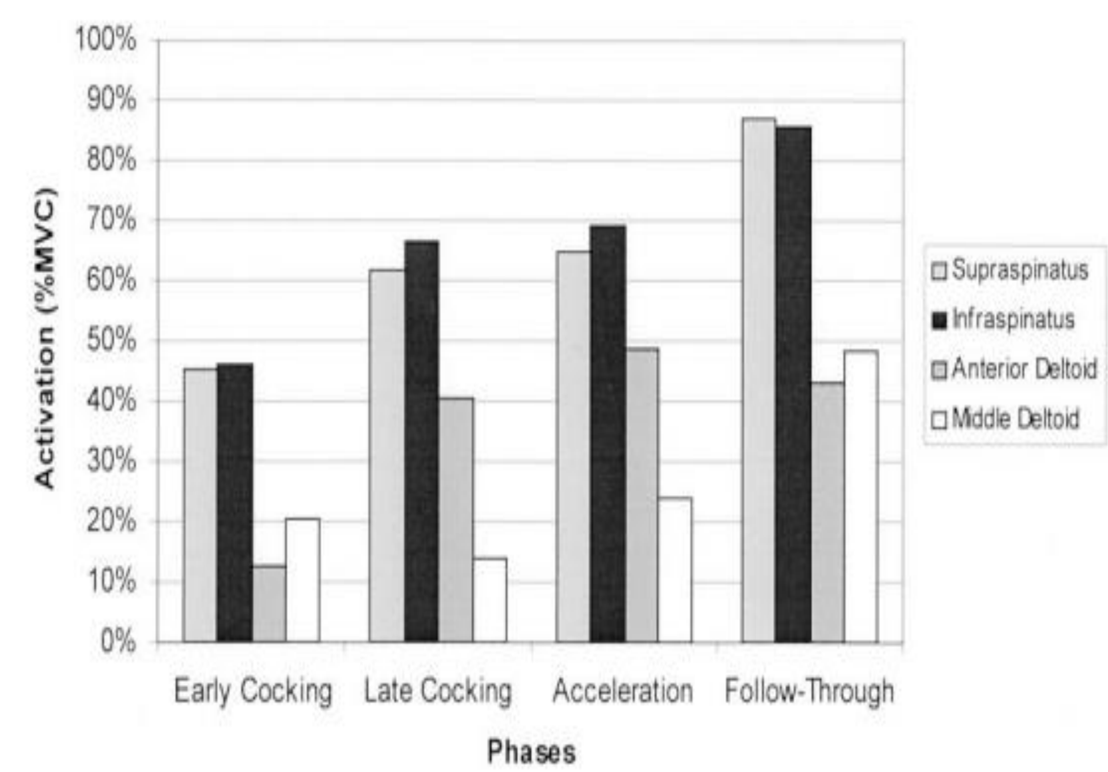

Table 2. This table shows the amount of activation in the key muscles of a thrower such as the supraspinatus, infraspinatus, anterior, and middle deltoid during each phase. Anything less than tis can result in injury or may be caused from poor mechanics.

Cocking Phase

Primary Plane Involved: Transverse
Primary Muscle Contributors: Supraspinatus, infraspinatus, and teres minor
Sequence of Phase: According to Escamilla and Andrews (2009), the lead foot contact begins the arm cocking phase and maximum shoulder external rotation ends this phase. According to Escamilla and Andrews (2009), maximum shoulder external rotation ends this phase.
Video analysis: The elbow begins to drop as the elbow and shoulder begin to abduct. As the shoulder and elbow are at an elevated position away from the body, the shoulder will begin to externally rotate. The external rotation allows for the ball to be propelled forward while still in contact and control of the quarterback's hand. This is a key position to be in for the quarterback because this allows for more accuracy, power, and also less chance of injury.
Improvements: Begin arm cocking phase with the shoulder in a more abducted position for increased movement efficiency. Also, keep the ball elevated near shoulder height so that a smaller arm circle is created. The smaller the arm circle, the less room for error there is which creates less chance of incorrect mechanics which can save the quarterback from potential injury.

Acceleration Phase

Primary Plane Involved: Transverse, Sagittal
Primary Muscle Contributors: Teres major, latissimus dorsi, pectoralis major, subscapularis
Sequence of Phase: According to Escamilla and Andrews (2009), the maximum shoulder external rotation begins the arm acceleration phase. According to Kelly, Backus, Warren, & Williams (2002), the pectoralis major reaches maximum activation during the acceleration phase.
Video analysis: The ball is beginning to move towards its target while still in contact of the quarterback. The shoulder is going from external to internal rotation. The hips are also internally rotating bringing the body to a position in which it is facing square to their target.
Improvements: Increase difference between hip and shoulder rotation angles to create more torque. Increase shoulder external rotation so that more torque is built up in the shoulder in order to throw further.

Follow-Through Phase

Primary Plane Involved: Sagittal
Primary Muscle Contributors: teres minor, infraspinatus, posterior deltoid, serratus anterior
Sequence of Phase: According to Calabrese (2013), "The deceleration phase begins at ball release and culminates with maximal dominant shoulder internal rotation and 35° of horizontal adduction."
Video analysis: The ball has been released, the body begins to decelerate as the muscle contributors slow down the shoulder and the hips stop rotating.
Improvements: Decreasing the shoulder-angle to around 120 degrees allows the muscle contributors to have less stress and work at an optimal rate.

Conclusion

The throwing motion of a quarterback is a complex motion that involves all three planes of movement. The body has to be in multiple key positions such as rear knee and hip flexion in the loading phase, shoulder and hip separation, and 120 degrees of shoulder flexion in the follow-through phase so that the body can work at an optimal rate. Not only does this result in optimum performance but also results in decrease risk of injury.

References

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