How Right To Left Side Imbalances Affect Pitching Performance Part II

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Part one of this series discussed the rotational influences of the pelvic girdle as it relates to the throwing athlete. Emphasis was placed on the arthrokinematics of the left and right acetabular femoral (AF) and femoral acetabular (FA) joints. Imbalances between the left and right sides of the pelvis predispose the upper extremities to various pathomechanics. It is important that hip rotation occurs prior to trunk rotation. Deviations or disturbances of the axial skeleton "i.e. trunk" may result in muscle imbalances. These habitual movement patterns have been defined as "malalignment."[7] Another author has indicated when biomechanics are altered due to shoulder injury or malalignment, undue stress may be placed on soft tissues; as a result, the individual may develop a posture that predisposes the individual to secondary pathologies such as impingements, instabilities, and rotator cuff injuries.[1] Unskilled throwers tend to rotate their hips and trunk simultaneously, placing undue rotational stress upon the throwing arm.

In order to understand the biomechanics of the scapular thoracic (ST) and humeral glenoid (HG) joint, which links the upper extremity to the thorax, these articulations must be identified in relationship to the bones and musculature contained within it and those affecting it.

Anatomy Shoulder

The shoulder is the anatomical structure that links the upper extremity to the thorax. The shoulder complex is made of two separate structures: the shoulder girdle, which is compromised of the acromioclavicular joint, sternoclavicular joint, the scapulothoracic joint; and the humeral glenoid (HG) "shoulder" joint. The acromioclavicular joint articulates with the lateral clavicle "collar bone" and the acromion of the scapula. The sternoclavicular joint articulates with the medial clavicle and the sternum.

The scapulothoracic (ST) joint is formed by the articulation of the scapula with the thorax beneath it via musculature. The muscles that connect the scapula to the thorax are the trapezius, rhomboids, levator scapulae and the serratus anterior. Although this joint is an atypical joint in that it lacks all of the traditional characteristics of a joint, its primary role is to amplify the motion of the humeral glenoid joint, thus increasing the range and diversity of movements between the arm and the thorax.

The shoulder joint (HG) consists of the articulation between the convex humeral head and the concave surface of the glenoid cavity of the scapula. A group of four muscles make up the rotator cuff: supraspinatus, infraspinatus, teres minor, and subscapularis. The rotator cuff has the important job of stabilizing the shoulder as well as elevating and rotating the arm. Each muscle originates on the shoulder blade or scapula and inserts on the arm bone or humerus.

In overhead open-chain activities such as baseball and tennis the humerus is moving within the glenoid of the scapula to perform the task at hand. With proper scapular position, efficient humeral-glenoid function can occur. Therefore, the motion of the shoulder girdle will be referred to as humeral glenoid (HG) movement rather than the misleading traditional glenoid humeral (GH) motion.

The scapula or shoulder blades are large triangular flat bones situated in the posterior part of the thorax. The scapula transfers energy and motion coming from the leg and trunk/thorax and moves it out through the arm. According to Culham and Peat, during erect standing, the scapula should be positioned over ribs two through seven and between T-2 and T-8 and the spine of the scapula should be level with the spinous process of T-3. The vertebral (medial) border should lie about two inches from midline in the standing position with the scapula orientated 30-45 degrees anterior to the coronal plane (i.e. with the scapular plane) and in a slight forward tilt in the sagittal plane.

Thorax

The term thorax refers to the entire chest. The skeletal portion of the thorax is a bony cage formed by the sternum, costal cartilages, ribs and the bodies of the thoracic vertebrae. The thoracic spine and the ribs house the lungs, heart and the internal organs as well as provide support for the bones of the shoulder girdle and upper extremities. There are 12 thoracic vertebrae and 12 ribs. Ribs 1-7 attach directly to the vertebral body and breastbone and are called "true ribs". Ribs 8-10 are attached to the rib above via cartilage and are called "false ribs". The 11th and 12th ribs are "floating" because they do not directly attach to another rib.

Biomechanics of the Scapula

Scapular-Thoracic (ST) Motion

Scapular-thoracic (ST) motion refers to the scapula moving on the thorax. This activity occurs in open-chain activities. The motions of the scapula from its resting position are given as elevation-depression, abduction-adduction (also known as protractionretraction), and upward and downward rotation.[10] These motions are described as if they could occur independently of each other, however, the linkage of the scapula to the AC and SC joints prevents such pure motions from occurring. For example, elevation may be associated with concomitant abduction and upward rotation and depression may be associated with concomitant adduction and downward rotation. Elevation and depression of the scapula are translatory motions in which the scapula moves upward or downward along the rib cage from its resting position. Abduction and adduction are also translatory motions, occurring as the scapula slides along the rib cage away from or toward the vertebral column. Upward and downward rotations are rotary motions that tilt the glenoid fossa upward or downward. The same motions can be described by movement of the inferior angle of the scapula away from the vertebral column (upward rotation) or movement of the inferior angle toward the vertebral column (downward rotation).[10]

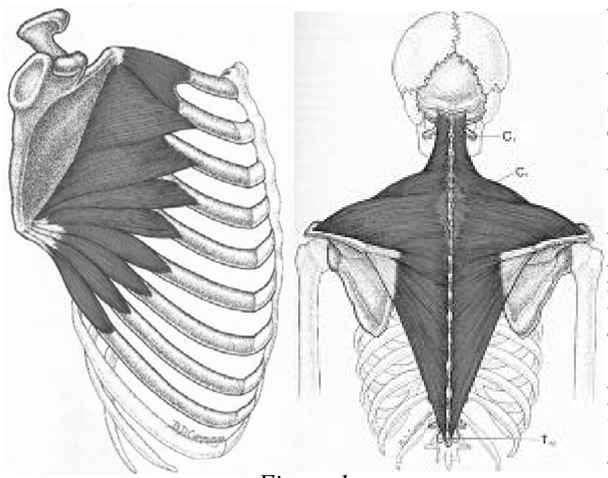

Figure 1

The scapula has another motion that is is less commonly described but still critical to its movement along the curved rib cage, scapular winging. The "winging" scapula is generally used to describe a posterior displacement of the vertebral border of the scapula. This motion can be described in an exaggerated state "pathological" or in a "nonpathological" state as it relates to the normal motion that occurs across the ribcage. Therefore, winging can be described as the normal posterior movement of the vertebral border of the scapula (or anterior movement of the glenoid fossa) that must occur to maintain contact of the scapula to the thorax during abduction and adduction. If abduction of the scapular thoracic joint occurred as a pure translatory movement, the scapula would move directly away from the vertebral column and the glenoid fossa would face laterally leaving only the vertebral border of the scapula in contact with the thorax. The scapula has to follow the contour of the rib cage by rotating around a vertical axis at the AC joint, with the vertebral border of the scapula moving posteriorly and the glenoid fossa moving anteriorly.[10]

Thoracic Scapular Motion (TS)

Scapular positioning on the rib cage is essential to allow an optimal axis of rotation to occur at the humeral glenoid joint. Traditional scapular thoracic (ST) stabilization programs place a great deal of attention to retracting and depressing the scapula on the thorax. However, very little attention is given to how the underlying thorax position may affect the scapula's role in upper extremity function. Thoracic scapular (TS) motion refers to the thorax moving on the scapula, occurring in closed-chain activities. [5, 6]

Based on the proximal-to-distal premise, the scapula depends on the segments proximal to it for movement. The large muscles of the hips and trunk thereby help position the thorax to accommodate appropriate scapular motion.[9] Just as the femur requires proximal stability from the pelvis, in a very similar fashion the scapula also requires proximal stability from the thorax for optimal upper extremity function. Therefore, thoracic scapular (TS) movement must not be ignored. Thoracic scapular (TS) motion refers to the thorax moving towards or away from the scapula. Thorax position is directly related to the orientation of the spine as thus the position of the pelvis.

For the purpose of this article, three muscles (middle trapezius, lower trapezius, and serratus anterior Figure 1) will illustrate how they have an effect on thoracic scapular (TS) motion. The proximal attachment of the middle trapezius comes from the first five thoracic vertebrae. The distal attachment comes from the superior lip of the scapular spine. The proximal attachment of the lower trapezius comes from the spinous processes of thoracic vertebrae 6-12, whereas, its distal attachment is at the apex of the scapular spine. The serratus anterior has a proximal attachment to the first eight or nine ribs and a distal attachment to the underlying scapula along its medial border.

The serratus anterior is commonly understood to pull the scapula forward on the thorax during right reaching/punching activities. What is often misinterpreted is the effect the serratus anterior has on the thorax. With the shoulder girdle in a fixed position, the serratus anterior acts to displace the thorax posteriorly very similar to the action taking place during a push-up.

The middle trapezius retracts the scapula whereas the lower trapezius is commonly understood to depress the scapula. With their distal attachments fixed, the middle and lower trapezius have the ability to rotate the spine and thorax in the opposite/contralateral direction. For example, the right middle and lower trapezius will rotate the spine and thorax to the left, whereas the left middle and lower trapezius can rotate the spine and thorax to the right.[5,6]

<u>Pathomechanics</u>

The presence of asymmetry throughout the pelvic girdle, as described by Hruska, is known as the Left Anterior Interior Chain (Left AIC) pattern. [4, 5, 6] This pattern calls attention to the tendency for the anterior tilt and forward rotation of the left hemi-pelvis. The position of the pelvic girdle orients the pelvic girdle to the right causing a shift in one's center of gravity to the right. The pelvic girdle is directed into a stance-like AF IR position on the right and AF ER position on the left. This predominate position orients the sacrum and spine to the right. Due to the lack of left AF IR, secondary to the inadequate activation of the left acetabular-femoral/femoral-acetabular (AF/FA) rotators, this will result in compensatory activity throughout the frontal and transverse planes of the thorax and consequently the right upper extremity. The typical Left AIC pattern involves a pattern of pelvic, spinal, and diaphragmatic orientation towards the right with compensation usually occurring above the diaphragm (usually T-8/ T-9) rotating the spine back to the left (Figure 2).[4,5,6]

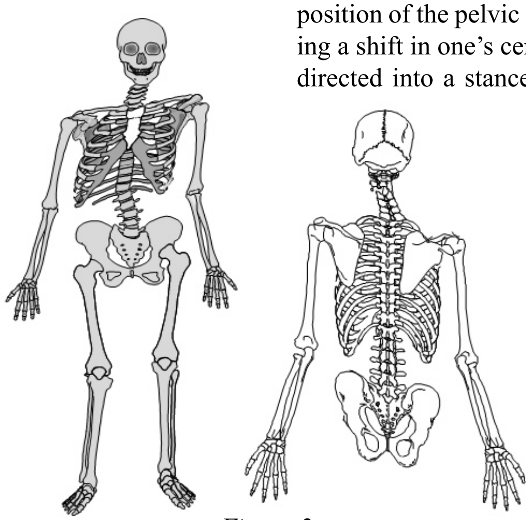

Figure 2

See IMBALANCES, page 10

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Upon observation of the thorax and lumbar spine, there will be a convexity to the left (sidebent right) with the right shoulder appearing to be lower than the left. The scapular resting position will assume an adducted or depressed orientation on the thorax (translatory motion). Furthermore, the scapula will appear to be upwardly rotated around the sagittal axis and internally rotated "winging" around the vertical axis.[5,6] Burkart et al has found very similar findings in that there will be an apparent "dropped" scapula in the dominant shoulder compared to the opposite shoulder. The scapula protracts with the upper scapula rotating anteroinferiorly. With the arms relaxed, the involved scapula will appear lower than the uninvolved side. The inferior medial scapular border appears more prominent, with the superior medial border of the acromion appearing less prominent.[2]

It is in the author's point of view that this scapular position is the consequence of compensatory thoracic scapular (TS) movement. The right scapula appears to be adducted and depressed secondary to the passive upper thoracic orientation to the left to provide the needed resting congruence of the scapula on the thorax. The upward rotation of the scapula is a result of compensatory activity of the upper trapezius and levator scapulae to restore frontal plane motion of the head and neck secondary to the depressed right shoulder. "Winging" of the scapula brings the glenoid fossa anteriorly in an attempt to correct the axis of rotation of the scapula so that humeral glenoid motion can occur.

An individual with a Left AIC pattern must compensate by abducting and elevating the scapula more to allow an axis of rotation to occur at the humeral glenoid joint. These individual's compensate secondary to the lack of left AF IR to promote lower trunk rotation to the left. Furthermore, the individual must abduct and elevate the scapula secondary to the upper thorax orientation to the left. This anterior orientation of the scapula provides the humeral glenoid joint greater inclination of external rotation throughout the cocking phase of throwing and thus increased tightness of the posterior shoulder capsule and external rotators of the rotator cuff. Without a strong base of support to work from, the rotator cuff will not be able to perform efficiently. The external rotators (infraspinatus and the teres minor) act as shoulder girdle retractors rather than humeral-glenoid external rotators. The external rotators are given a dual role; one to retract the scapula secondary to weak scapular stabilizers (rhomboids, middle trapezius, and lower trapezius) as well as to decelerate the upper extremity during forward propulsion.

Loss of humeral glenoid internal rotation (HG IR) motion is common with the various shoulder pathologies among overhead athletes. Most often, athletes show signs of excessive external rotation and a loss of internal rotation as compared to the non-throwing shoulder. Burkhart et al found that the loss of internal rotation was due to the tightening of the posterior shoulder secondary to the repetitive eccentric forces on the posterior shoulder musculature during arm deceleration.[2]

The tightening of the posterior shoulder changes the axis of rotation of the shoulder, allowing for the increase in external rotation and decrease in internal rotation. It is in the author's point of view that this tightness in the posterior shoulder is a result of compensatory activity within the arthrokinematics and myokinematics of the scapular thoracic and thoracic scapular position. Furthermore, the rotational demands placed upon the lumbo-pelvic-femoral complex and spine has to be slower than the rapid accelerating upper extremity in order to decelerate the upper extremity.

In summary, many overhead athletes suffer from shoulder discomfort as a result of poor scapular position on the rib cage and from altered muscle firing patterns due to scapular position. Due to this unstable attachment of the scapula on the thorax, any deviations about the pelvis, spine, and thorax can affect the shoulder girdle. Often times even the slightest deviations result in poor distribution of forces to the trunk, which in turn leads to strain patterns as the shoulder girdle compensates for these forces in the least favorable way. These adaptive firing patterns may occur as a result of proper lower extremity pathomechanics, which influence further compensation up the kinetic chain. Assessment of the entire shoulder complex and the lumbo-pelvic-femoral complex are crucial in treating upper quadrant dysfunction. Part three of this series will illustrate integrative exercises that promote left acetabular internal rotation (Left AF IR) scapular thoracic (ST) and thoracic scapular (TS) motion as well as humeral glenoid internal rotation to restore proper positioning of a Left AIC patterned individual. R

More Information Please! To contact Jason go to the Postural Restoration Institute™ web sit at www.posturalrestoration.com

Acknowledgement: *Figure 1-Simons D, Travell J, Simons L. (Illustrations by Cummings B.) Myofascial pain and dysfunction: the trigger point manual, upper half of body. Volume 1, Second Edition. 1999 Lippincott Williams & Wilkins.*

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