How Right to Left Side Imbalances Affect Pitching Performance

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The majority of our daily activities, such as walking, running, and occupational activities require rotation throughout many joints. In a sport such as baseball, rotation is imperative. Rotation of the pelvis during pitching and/or swing is an essential part of the development of power and transfer of energy up the kinetic chain from the proximal to distal extremities. A common biomechanical model for striking and throwing is an open linked system of segments that work in a proximal-to-distal sequence.[10] Because baseball involves all body segments, these principles can be extended to the lower extremities, which can influence arm mechanics at a relatively early stage of the cycle. Pappas described baseball pitching as a sequential activation of body segments through a linked segmentation beginning with the contralateral foot and progressing through the trunk to the rapid accelerating upper extremity.[9]

Although anatomical differences between the two sides of the body exist, we are functionally asymmetrical to variable degrees. Thus the problem exists to understand and appreciate how movement patterns on one side of the body may directly influence movements on the opposite/contralateral side. Symmetry is established when there is a mechanism for specifying different movement patterns between the left and right side of the body. Patterns evolve and exist in all of us to a degree. Patterns usually develop as one trains or repeats the same movement pattern habitually which would contribute to an undesirable asymmetrical state. It is the sequential action of muscles, bones, and joints that leads to differences in the development of the asymmetrical human.

Hruska has described an opinion that there is an underlying postural pattern of asymmetry existing in all humans to some measure in spite of hand dominance, known as the left Anterior Interior Chain pattern (left AIC).[6] Interrelated body and soft tissue relationships are suggested in a left Anterior Interior Chain pattern. This pattern reflects an imbalance of muscular activity and a host of differences between the right and left sides of the body. For example, the left hemi-pelvis is anteriorly tilted and forwardly rotated comparatively to the right hemi-pelvis. This predominate position orientates the sacrum and lumbar spine to the right.[6]

This article is part one of a three part series that will provide the reader a better appreciation of how biomechanics of the lower extremities may directly influence the function and performance of the upper extremities. Body segment movements, (i.e. limbs), do not exist in isolation. By understanding their relationship to each other one can try to maximize the effectiveness of movement patterns in developing optimal performance. Furthermore, special consideration will be made to understand how movement patterns of the left lower extremity can influence right upper extremity function.

Asymmetry and/or pathomechanics of the pelvic structure can lead to a cascade of compensations throughout the axial spine predisposing individuals to dysfunction and potential injury. Human movement is a series of linked movements that can be dissected joint by joint. They typically follow a progression from proximal to distal movement in a successive order. This series of movements is carefully balanced along the entire kinetic chain and leaves little room for substitution. With the introduction of compensatory patterns, especially early in the task, the body must go through a series of adjustments to complete the task at hand. In baseball, maximum throwing velocity requires the proper chain of coordination from the leg drive to hip rotation to shoulder and trunk rotation to arm motion. If the hips rotate slightly late, for instance, the thrower cannot reach his maximum potential velocity.

In order to comprehend the biomechanics of the pelvis, which is the foundation of the spine, the pelvis must be defined in relationship to the bones contained within it and those affecting it. The pelvic girdle is formed by six joints (two femoral-acetabular joints "hip joints", two sacroiliac joints, the lumbosacral junction "L5-S1", and the symphysis pubis joint). The pelvis is formed with the sacrum wedged between the right and left innominate bones. The right and left innominate bones articulate anteriorly to form the symphysis pubis joint and posteriorly to form the sacroiliac joints. The femurs articulate with the acetabulum of the innominates to form the hip and/or femoral-acetabular (FA) joint.

Femoral-acetabular (FA) motion refers to the femur moving within the acetabulum. Acetabular-femoral (AF) refers to the acetabulum moving on the femur. Movement of the femur relative to the acetabulum does not produce pure arthokinematic motion, rather, combinations of movements.[11] The habitual pattern of motion for the non-weight bearing lower extremity is a combination of flexion, abduction, and external rotation (ER) and extension, adduction and internal rotation (IR).[7] Arthrokinematics of both motions are impure swings.[7] Therefore, acetabular-femoral internal

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rotation (AFIR)/femoral-acetabular internal rotation (FAIR) is a combination of extension, internal rotation and adduction.

As stated earlier, the pelvic girdle is comprised of six joints. The pelvic girdle is a ring and any change in its anatomy or applied forces to one of the six joints that comprise it will most likely result in compensation throughout one or more of the six joints. Therefore, a dysfunction on one side of the pelvis is likely to affect the contralateral side. To assess the functional pelvic girdle from a biomechanical standpoint, it is necessary to consider how a structure on one side of the pelvic girdle interacts and/or affects the contralateral extremity and/or structure. Very little literature tends to differentiate the right from the left and thus most orthopedic texts assume the body is symmetrical and describe normal mechanics paying very little attention to pathomechanics.

The major function of the pelvic girdle is to transmit forces and weight of the trunk and upper extremities to the lower extremities and to distribute ground reaction forces. The pelvic girdle forms the base of the trunk, supporting the superincumbent body structures and linking the vertebral column to the lower extremities.[2] In bilateral stance, if not symmetrical, muscle activity will be required to either control the motion or to return the FA joint (hip) to a symmetrical state. Shifting ones weight over the right hip results in relative adduction and internal rotation of the right hip (right acetabular-femoral internal rotation "AFIR") and abduction and external rotation of the left hip (left acetabular-femoral external rotation "AFER"). To return the pelvic girdle to a neutral state, an active contraction of the right hip abductors and/or left hip adductors is required.[8]

The inability to rotate an acetabulum on a non-moving femur and/or the inability to rotate a femur on a non-moving acetabulum results in compensatory shearing forces throughout the pubis symphysis, sacroiliac joints, and the lumbosacral junction. It is imperative to establish stability throughout these aforementioned structures. When these structures are relied upon for compensatory rotational control throughout the transverse plane secondary to decreased rotational control throughout the AF/FA joints, compression and shearing like forces are generated throughout.

Biomechanical considerations of the left hip and right upper extremity in the throwing athlete (Part I)

Rotary movements of the femur depend largely on the acetabular position, compression of the femur in the acetabulum from muscle activity during open kinetic chain activities, and from weight bearing during closed chain kinetic activities.[5] Anterior rotation of the two hemi-pelvis' on the femur places the femurs in a passively internally rotated position in relationship to the pelvis with accompanying internal rotation weakness. Anterior rotation of one hemi-pelvis places ones center of gravity on the contralateral lower extremity. On the side that the hemi-pelvis is rotated, there is accompanying internal rotation weakness exists. This occurs as a result of the passive internal orientation of the femur or as a result of compensatory activity of the external rotators to orientate the femur towards midline. The lower extremity on the contralateral side of the rotated pelvis would most likely demonstrate external rotation weakness secondary to the orientation of the pelvis on the femur.

The six phases of throwing as described by Fleisig,[3,4] are as follows: wind-up, stride, arm cocking, arm acceleration, arm deceleration and follow-through. During the throwing motion, three phases of rotation occur about the pelvic girdle: wind-up, release, and follow-through. Limitations in motion at the FA joints (hips) will affect the overall availability of rotational range of motion in completing the throw, while also placing increased stress on the spine and shoulders.

During the wind-up of a right-handed thrower, the motion occurring in relation to the right lower extremity is in a state of right acetabular-femoral internal rotation. The left lower extremity, is in a state of flexion, abduction, and internal rotation. During follow-through and release, the left lower extremity is in a state of left acetabular femoral internal rotation (left AF/IR) where the right lower extremity is in a state of right acetabular-femoral external rotation (right AF/ER). These motions can be affected by tightness in the right FA internal rotators (i.e. adductors and anterior gluteus medius) and left FA external rotators (i.e. psoas). If the thrower lacks left AF/ IR, the ensuing right rotation of the axial spine may lead to right upper extremity pathomechanics. It is in the author's point of view that when there is an inability to establish left acetabular femoral internal rotation exists (left AF IR) secondary to weakness of the thrower's left FA/AF internal rotators and/or hypertonicity of right FA/AF external rotators, the body must go through a series of adjustments and the thrower cannot reach his maximum potential velocity.

Due to the lack of left acetabular-femoral internal rotation (left AF/IR) secondary to inadequate activation of the left ischio-condylar adductor, left gluteus medius and/or right gluteus medius in the frontal plane compensation will develop throughout the lumbar spine and ensuing right upper extremity. Aguinaldo and colleagues studied the biomechanical sequence of the pelvis, trunk, and shoulder joint torques during baseball pitching. He found professional pitchers, on average, were 34% of the way through their pitching motion before initiating trunk rotation. Premature rotation of the trunk causes the thrower to compensate for lost rotational energy by generating more internal rotation torque to the upper extremity.[1] As a result of decreased left acetabular internal rotation there is a propensity for the lower lumbar spine to remain oriented to the right and thus triggers a multitude of compensations throughout the thoracic spine. These compensations will directly affect the position of the scapula on the rib cage of the thoracic spine and thus impinge upon proper scapular-thoracic/thoracic-scapular (ST/TS) mechanics. The subsequent article will describe proper scapular-thoracic/thoracic-scapular (ST/TS) mechanics and how it influences proper humeral glenoid (HG) mechanics.

Practical and Clinical Considerations

The following 'Postural Restoration' tests will assist in determining if an asymmetrical pelvis and resulting pattern of muscle compensation exists in an athlete. Identifying this common pattern as an underlying cause of dysfunction will then direct further intervention to correct the asymmetry of the left FA joint (hip) and the right humeral glenoid (HG) joint (shoulder). For example, an athlete's inability to adduct their hip will likely result in the athlete's inability to also extend their hip.

Adduction Drop Test (Ober Test) Figure 1

Athlete lies on his or her side with the lower leg and hip flexed (90 degrees). Clinician stands behind them and passively

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flexes, abducts and extends the hip to neutral while maintaining 90 degrees of knee flexion. Passively stabilize the pelvis from falling backward and allowing femoral internal rotation to occur.

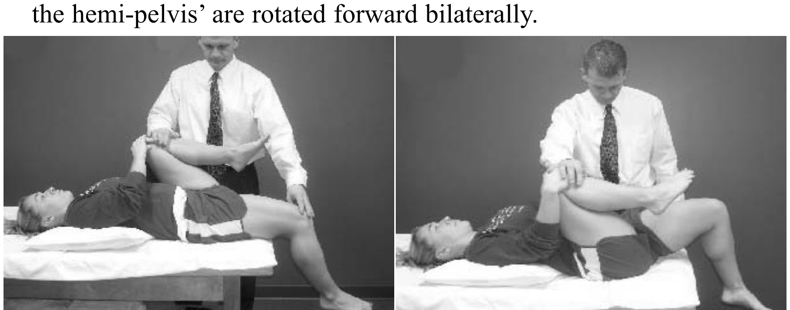
A positive test is indicated by the inability to extend and adduct the tested hip. This test measure soft tissue and/or bony restriction in both the sagittal and frontal planes. This restriction does not allow the femur to adduct secondary to an anteriorly tilted forwardly rotated hemipelvis. Usually seen on the left especially if the Extension Drop Test (Modified Thomas Test) is positive in a Left AIC orientated athlete.

Negative Result *Positive Result*

Extension Drop Test (Modified Thomas Test) Figure 2

The athlete is positioned in supine with both thighs on the table. Both hips and knees are flexed to the chest. Passively lower one leg over the edge of the table while helping the athlete hold the untested knee close enough to the chest to maintain the low back against the table. Do not allow hip abduction to occur past zero degrees on the tested extremity while passively dropping the FA joint into extension.

A positive test is indicated when the tested lower extremity (usually the left) is restricted in hip extension because of the forward orientation of the tested side compared to the other. If both femurs do not approach the edge of the mat or table the patient is tested on, the hemi-pelvis' are rotated forward bilaterally.



Negative Result *Positive Result*

Trunk Rotation Figure 3

The athlete is positioned supine with knees maximally flexed and together, and feet flat on the table. Passively rotate the legs to the trunk's resting state with one hand, while stabilizing the trunk with the other hand (placing it on the lower ribs). A yardstick may be used to measure the distance from the mat to the upper-most point of the superior knee, while maintaining the opposite posterior thorax contact with the mat. Repeat the test in the other direction.

A positive test is indicated when the legs do not rotate in one direction as compared to the other. For example, the legs are restricted in rotation to the left (ie. the legs do not rotate to the left as they do to the right as measured through the use of an upright ruler). This means that trunk rotation is limited more to the right secondary to probable left hip anterior rotation and sacral-lumbar orientation of the spine to the right. Therefore, postural restoration should be initiated at the left lower extremity to address left mechanical instability and maintain proper restored pelvi-femoral neuromechanics. R

Negative Result *Positive Result*

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

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