

Biomechanics of the pelvis

The phrase “biomechanics of the pelvis” sounds somewhat antiquated as we are much more used to talking about the biomechanics of the sacroiliac joint. Although this is fine as a starting point the pelvis is a closed mechanical system and its movement as a whole is far greater than the sum of its parts.

I believe it is essential to talk about the pelvis as a whole not just from a biomechanical point of view but also as the basis of assessment, diagnosis and treatment.

The movement of the sacrum is described as nutation and counternutation. The sacrum can nod forward which is known as nutation and tilt backward which is known as counternutation.

Pure nutation occurs while standing where the weight of the torso falls in front of the sacroiliac joints and induces rotation of the sacrum where the sacral base moves anteriorly. Pure counternutation only really occurs when both hips are fully flexed e.g. when bending down with straight legs or in the foetal position.

However these pure movements do not occur on both sides during ambulant movement. In fact one side nutates as the other counternutates.

From the perspective of the innominate the equivalent of nutation is posterior rotation and the equivalent of counternutation is anterior rotation.

During ambulation one side posteriorly rotates as the other anteriorly rotates.

Studies of the centre of rotation show numerous possible axes. These axes can appear to be posterior as well as anterior to the joint as well as within the joint itself. The reality in ambulation is likely to be a shifting axis during different gait stances coupled with significant variation between individuals.

In this model, CR represents the centre of rotation of the sacroiliac joint and the black stars represent where there is joint surface

proximation and locking. If you just look at the top 3 illustrations you can see the centre of rotation varies from anterior to the joint to the centre of the joint to posterior to the joint. At the same time the joint surface proximation/locking of the joint shifts from the lower pole to the whole joint to the upper pole. At the same time the reverse is happening on the other side.

When we couple the two sacroiliac joints with the pubic symphysis at the front, posterior rotation on one side is accompanied by anterior rotation on the other side. In other words the ambulatory mechanics of the pelvis involves 2 opposing movements creating a cyclical movement of torsion.

I want to present the following as a simple model for visualisation:

I think the ambulatory movement of the pelvis is best visualised using your hands. Imagine you are holding a large bowl in your hands. Join your little fingers at the front to represent the pubic symphysis. Leave a gap of 10cm between your wrists.

Now imagine your first metacarpals are the sacroiliac joints and the sacrum is sitting in the gap between your hands. Now start to walk your pelvis! Posteriorise the left hand while anteriorising the right and then do the reverse and repeat in a rhythmic fashion. When this feels comfortable imagine the movement of the sacrum between your first metacarpals rather like a spinning top gently de-rotating as it slows down.

If you think of your first metacarpal as the iliac portion of the sacroiliac joint you may also begin to get a sense of the opposing poles of joint surface proximation/locking at the extremes of torsion.

Now focus on the sacral base. Although in reality the base is tilted anteriorly we can visualise the sacral base as the upper part of the spinning top as it de-rotates.

This movement of the sacral base would be directly transferred to the body of L5 and hence the ambulatory movement of the base of the lumbar spine. The handle of the spinning top can be visualised as the axis of the movement of the body of L5. Each intervertebral disc would dampen the movement as it travels upwards.

We can now imagine how the pelvis might move when there is an inherent torsion. By far the most common torsion is where the left innominate is posteriorised and the right innominate is anteriorised. Hold your hands in this position and then start to walk your pelvis.

Now focus on the sacral base and its influence as the foundations of the lumbar spine. Observe the spindle of a spinning top as the axis of the centre of the lumbar spine.

The primary movement of the ilium on the sacrum is described as posterior and anterior rotation. This is usually ascribed a value of 2-4 degrees. However, when combined with the movement of the pubic symphysis the amount of torsion in the pelvis is much greater and from observation the sacrum can deviate from the vertical by at least 20 degrees.