

A review by Clifton Bradeley, 6th July 2015.

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Variation in Pelvic Morphology May Prevent the Identification of Anterior Pelvic Tilt.

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I read this paper some time ago, and came back to it again recently to write this simple review, as I felt so strongly about how potentially misleading it could be to the unwary. The pelvis and lumbosacral biomechanics is so incredible when it works well, and so devastating when it works badly, that scholars learning this vastly important segment of the kinetic chain need to be correctly informed for this area not to remain the mystical region of the body that so many practitioners avoid. When like so many segments of the body, once a thorough understanding prevails treatment becomes logical and easy to manage.

I've not been able to cover every aspect of the paper, but for what it is worth here are my opinions. In the order that they appear (extracts from the paper in bold):

Abstract

'Pelvic tilt is often quantified using the angle between the horizontal and a line connecting the anterior superior iliac spine (ASIS) and the posterior superior iliac spine (PSIS). Although this angle is determined by the balance of muscular and ligamentous forces acting between the pelvis and adjacent segments, it could also be influenced by variations in pelvic morphology'.

Sagittal innominate angle is influenced by either forces acting on the acetabulae axes from ground reaction forces (GRF), and/or forces acting on the sacral base from the body centre of mass (CoM) above it via the sacral 3 axis. Either one can be the dominant factor and influence the other depending on which is the greater force i.e. GRF or CoM. A naturally flexed/nutated sacrum is more likely to be influenced by weight on the sacrum, where as an extended/counter-nutated sacrum is more likely to be influenced by GRF in the acetabulum. Therefore, if one side has greater force it also has the greater

posterior rotation (because of the posterior rotational lever arm i.e. the distance between the two forces in a posterior direction). The ligaments move with the joint complex and provide either approximation to the joint or restriction to the range about the axes e.g. the long dorsal sacroiliac ligament (Vleeming A et al, 1996) restrict the degree of counter-nutation, but cannot influence innominate orientation directly. Yes, musculature can have limited influence on innominate angle, however, the vector forces being applied on the axes from ascending, and descending forces are far greater than that being applied by muscle. GRF and CoM will always win over muscle contraction. Our global relationship with gravity is greater than any internal force being applied by muscle(s).

‘The primary objective of this anatomical study was to establish how such variation may affect the ASIS-PSIS measure of pelvic tilt. In addition, we also investigated how variability in pelvic landmarks may influence measures of innominate rotational asymmetry and measures of pelvic height.’

Morphology does not affect innominate (PSIS to ASIS) angle (tilt), because you are measuring the angle of the innominate relative to sacrum. The innominate could be any shape; you are still measuring a relative angle. If you were comparing the morphology of two innominates with no influence from third party structures, then you could make a true comparison. However, there are too many other factors, which have to be taken into account before the conclusion is drawn.

‘Thirty cadaver pelves were used for the study. Each specimen was positioned in a fixed anatomical reference position and the angle between the ASIS and PSIS measured bilaterally. In addition, side-to-side differences in the height of the innominate bone were recorded’.

What surprises me most is the fact that thirty cadaver pelves were prepared and ethics granted/licensed, to measure:

- Innominate angle
- Innominate height

Surely these same angles could have been obtained in vivo using standing X-ray or ultrasound scan. This would have allowed said forces, axes, soft tissue,

neuromotor, physiological and emotional parameters that influences innominate orientation, to have been taken into consideration. Amazing what a collective of PhD's can get through licencing!

When you compare this in vitro study against that of a cohort of 100 healthy young adult volunteers, also measuring pelvic morphology (Vaz G et al, 2002) it highlights the limited usefulness of the Preece SJ et al study above, which was a study on inanimate pieces of bone. How does this help practitioners?

'In addition, anterior pelvic tilt has been associated with a loss of core stability, and therefore the degree of pelvic tilt has been used to assess core strength (Willson JD, 2005).'

This statement with a single reference from a lower limb – not pelvis based paper, is contrary to my belief and that of many very well respected researchers on pelvic mechanics (Vleeming A et al 1995). In fact, anecdotally, most of the athletes, footballers and stronger individuals I have assessed over many years have a naturally flexed/nutated sacrum with high innominate angles. It is somewhat strange that these researches are shy of this fact, but not surprising if they are lacking volume of patients in a clinical setting.

'Anterior pelvic tilt and increased lumbar lordosis have been suggested to increase loading on the lumbar spine (Jull GA, 1987). As such, exercise programs are often prescribed to reduce anterior pelvic tilt (Levine D, 1997).'

Again, this statement has a single citation from old paper. It is my understanding that pathomechanical loading can occur on facet joints and lumbar structures if the excessive anterior innominate angle is couple with a flexed/nutated sacrum, and this an **abnormal** orientation for that individual. The pathomechanical loading would reduce once the innominate and sacrum is returned to normative values for that individual, and this may well be obtained through specific exercises.

However, this is not the case for many individuals who have a naturally flexed/nutated sacrum, excessive anterior innominate angle, and hyperlordosis that **is normal for them**. In these individuals the facet joints are orientated to suit. Exercises to counter act the anterior pelvis would potentially create abnormal stresses, and create issues i.e. it can be perfectly **normal** to have an anterior pelvis.

Incidentally the Levine D, 1997 paper discussed the effects of abdominal strength training on pelvic angle, and the lumbar lordosis, and not exercise programs to reduce anterior pelvic tilt.

‘Conclusion

This study found significant variation in the ASIS-PSIS angle across 30 cadaver pelves all positioned in a fixed anatomical reference position. This variation may significantly influence clinical measures of pelvic tilt and has the potential to weaken any true correlations between tilt and other clinical measurements. The study also showed that significant side-to-side variability in the relative position of the ASIS and PSIS landmarks. Again, this variability has the potential to significantly influence clinical measures of innominate rotational asymmetry.’

There is agreement that there is variation in the PSIS – ASIS angle between individuals. However, many including myself would disagree that this variation may significantly influence clinical measures of pelvic tilt, and has the potential to weaken any true correlations between tilt, and other clinical measurements. In fact, knowing that there exists a variation amongst individuals helps to explain why other clinical measures may differ, and also help to explain injury patterns and especially lower back pain (LBP). In fact the variation offers an explanation for LBP not a hindrance.

My Conclusion

What on the surface was a well-intended paper, which many would be impressed with, even if simply by the fact that six academics managed to be licensed for thirty pelves to measure. Actually, for me was a disappointing read. In short, even though this is not a new paper, it is still recommended reading for pelvic scholars, and I feel that there are a few misleading points in this paper that could potentially have a negative effect on patient care. The main point that I wish to make is that anterior pelvic tilt especially if bilateral is a healthy, stable position, contrary to this paper. These authors seem to suggest that a posteriorly rotated pelvis, and counter-nutated sacrum may be a better position. This fundamentally is not the case, and is the polar opposite to my own beliefs, and that of many other experts and researchers in this field. Form closure (Vleeming A, 1990a) and approximation of the SIJ occurs

with nutation of the sacrum and elicits a more stable pelvis. The iliac bones are pulled to each other due to ligament tension in an anterior position creating a 'self-bracing' position (Vleeming A, 1995a).

Moreover, Sacral nutation/flexion serves to increase the tension of certain important ligaments of the SIJ (sacrospinous, sacrotuberous and interosseous ligaments), which enhances SIJ stability via the pull of the erector spinae group of muscle (O'Sullivan et al 2002, Porterfield & DeRosa 1998, p74).

Other researchers suggest that internal abdominal oblique muscles and its role in the anterior oblique sling can exert a powerful forward and elevation movement of the pelvis – a motion that is essential in sprinting (Hungerford et al, 2003). There are many more papers I could quote to suggest that anterior pelvic tilt is a more stable functioning position.

If this review does nothing else other than make you question these statements, and that an anterior pelvic orientation may not be a pathological position, but might even be the most stable orientation, then I am glad I took the time to write this simple review.

And finally, during one discussion I was having with a podiatrist on MSK: UK, they suggested that moving away from kinematics to kinetics was an advancement in biomechanical analysis. Likewise, in the past decade, research on LBP has focused on the pain generators of the condition at the expense of understanding the abnormal motion patterns that occur. It is time that we move to an approach that investigates functional kinematic relations between the lower limb and lumbopelvic function to understand the potential causes behind the injuries that we all see.

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(This review has been based on my interests and anecdotes of pelvic function based on my experience over the last twenty-five years and over fifteen thousand biomechanical assessment, with the odd reference thrown in).