Dynamic Chiropractic

ORTHOTICS & ORTHOPEADICS

The Gyroscopic Motion of the Sacrum during a Gait Cycle

Abstract: The gyroscopic movement of the sacrum is a primary function of sacroiliac motion during a normal gait cycle. The biomechanical relationship of the normal gait cycle with the gyroscopic motion of the sacrum is discussed. As the keystone, the sacrum plays a role influencing gyroscopic motion in both the upper and lower extremities. The relationship of this gyroscopic motion with kinematics and kinetics is discussed.

Key words: gyroscopic motion, geometric, kinetic, kinematic, human gait.

Human walking does not resemble the movement of a rotating wheel, where the centre of gravity is always directly above the point of contact and perpendicular to the line of progression. Instead, the normal gait cycle resembles the action of a rolling cubic box and has considerable impact loading when contact takes place with the ground.[1]

This essay examines the biomechanical relationship of the sacrum, the ilium, the entire lower extremity, and its gyroscopic relation with the upper extremities during the normal gait cycle. The gyroscopic motion in balance of the upper and lower extremities and its relation to the centre of gravity is discussed. The compensatory nature of human locomotion and the exerted weight bearing surfaces of the body attempt to defy the centre of gravity.

During a normal gait cycle, the kinetics of human locomotion demonstrate a "gyroscopic" motion of the lower extremity extending from heel strike to foot flat. At this time, the foot is being loaded down with the weight of the body (i.e., pronation of the foot). The pronation of the foot at the instance of foot strike appears to be a passive mechanism. This mechanism seems to depend on the configuration of the joints, ligaments and significant muscle groups playing a vital role in this motion. Weight bearing occurs at "foot flat" with the body passing over the foot. When the forefoot is fixed momentarily to the floor, an inversion of the heel is accompanied by external rotation of the leg. When extending from the moment of heel rise to toe-off, a plantar flexion of the foot occurs. Progressively, the foot supinates and the leg continues to rotate externally.[2]

By performing a simple test, allow me to demonstrate this lower extremity motion. Stand up! Put most of your weight on your right foot and collapse your right arch. Notice that your right leg, kneecap, thigh and hip rotate internally. What you have just done by internally rotating the leg and lowering the arch is to pronate your lower extremity. The gyroscopic motion of the lower extremity demonstrates and points to the foot as a universal joint focal point allowing the forces to be absorbed by the lower extremity.[2]

When walking, for example, the swing-leg motion is internal rotation. This means that the foot and patella rotate from a position where they are facing outward to facing inward. This gives a gyroscopic motion (i.e., like a spinning top) to the basic gait cycle. By the same token, the gyroscopic motion of the sacrum during the normal gait cycle is the initiator or keystone structure for this particular locomotion.

The sacrum, the keystone and the foundation of the spinal column, is a key wedge between two innominate bones, like a keystone in the arch between two pillars where this arch rests. An inverted triangle, the sacrum serves as the weight bearing foundation of the spinal column. For instance, when we draw a horizontal line through the base of this inverted triangle, we notice the "tilting" of the "laterality" of and the "inferiority" of the base as a whole structure or only on one side.[3]

Upon heel strike, for example, the right ilium rotates back in a posterior-inferior position, whereas the sacral base in turn tilts anterior-inferior and vice-versa. When a vertical line is drawn through the spinous processes of the sacrum and the spinal column is horizontal to the sacral base, it will provide a lateral tilt motion-type effect. At "toe-off" intervals, the ilium on that side is rotated forward in an anterior-superior position with a corresponding motion of the sacral base moving in a posterior-inferior motion and vice-versa.

The articulating surface of the sacrum with the innominate bone project lines of stress and are clearly seen through the centre of this articulation. This line projects anteriorly, posteriorly, and displays rotational twists of the sacrum between the innominate bones during a normal gait cycle.

With this picture of the gyroscopic motion of the sacrum, there appears a manifesting influence that the sacral gyroscopic motion not only appears in the lower extremities, but also appears noticeable in the upper extremities where the occiput becomes the upper or superior bipolar keystone. This superior-occipital and inferior-sacral bipolar relation demonstrates an overall gyroscopic action of the body. In other words, the sacrum is the opposite pole to the brain as an expression of coordination between these two synergistic poles. It is necessary for the trained chiropractor to see this gyroscopic relationship of the two poles manifesting throughout human locomotion.

The coordination of the sacrum and the occiput both attempting to maintain a gyroscopic relationship during the pull of gravity becomes a compensatory reaction motion. Because the human gait cycle resembles the action of a "rolling cubic box," it sustains considerable impact when contacting the ground. We as humans, like every particle in the universe, possess our own centers of gravity upon which this gravitational pull acts. This centre of gravity lies at our lumbosacral articulation.

Studies on the engineering and mechanical principles involved found that the sacrum's position changes from a point within the mass of the bone to a point as much as one-fourth of an inch anterior to its concave face. It lies midway between the anterior foramina nearest the base. When viewed from the posterior, it is opposite the middle of the first sacral spine.[4]

What now appears to be more of a significant fact provides circumstantial evidence for why the gyroscopic motions of the upper extremity and the lower extremity (with the sacrum as the foundation and keystone of the south pole) is merely a compensatory motion reaction of two opposite forces attempting to meet in common focus.

The centre of gravity of the body as a while is roughly an inch forward from the centre of gravity of the sacrum (see Figures 4 and 5). All the weight of the upper half of the body is pressing this last centre toward the earth. The feet and legs are resisting that push through the first-mentioned centre, with the two opposite forces not meeting in common focus. The fact that these two points, that is, the centre of gravity of the body and the centre of gravity of the sacrum, are removed from each other by approximately one inch and that any strain will produce distortion at this point. It is a fact, for example, that no structure is distorted until the centre of gravity is displaced. Any

distorted structure will lose its usefulness in direct proportion to the distortion present.

The law of gravity holds us in contact with the earth. The law of gravity then clearly becomes the most important of the laws of nature, which have from time to time been known as the laws of health. The bipolar gyroscopic motions attempt to coordinate to compensate for the natural imbalance of the centre of gravity of the sacrum with the centre of gravity of the body.[4]

The symbolic picture of a kite or a poor semblance of a gyroscope joins two triangles into a diamond-shaped figure. The upper, broader and shorter triangle represents the occiput or superior pole and the brain centres. The lower, longer triangle, with its base upward joining the upper triangle, represents the sacrum and the lower brain centres. The kite is symbolic of the important relationship of these two bony structures and their action and reaction. It is a clear geometric presentation of which much could be said: "As above, so below." For example, the two articulating surfaces of the sacrum and ilium have a direct bearing and relationship on the condyles of the occiput and atlas. The superior rests on the inferior by gravitational pull.[5]

References

1. Dirix A, Knuttgen G, Tittel K. The Olympic Book of Sports Medicine, 1988, p. 27.

2. Danbert R. Runners, sneakers and biomechanics. ACA Journal of Chiropractic March 1988.

3. Stone R. The mysterious sacrum. Polarity Principles and Practices November 1954, Orange County, USA.

4. Rosquist WL. Gravity's influence on the body. In: Spinal Touch Encyclopedia 1975;5:31-32.

5. Fogerty S. Spinal Biomechanics Master of Chiropractic Sport Science Study Guide. The Centre for Chiropractic -- Macquarie University, Sydney, Australia, 1995.

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