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Functional Anatomy: Rehabilitation Implications

By Craig Liebenson, DC

Most of us learned anatomy under fire. It was the first term we learned in chiropractic college, before we had any understanding of the function of the locomotor system. What we learned was origins, insertions, and actions ... or did we? When does the piriformis externally rotate the leg? Is this an important function of the piriformis in daily life? To understand rehabilitation it is important not just to know anatomy, but to know functional anatomy.

A new videotape series by Robert Acland of the University of Louisville beautifully shows layered dissections of muscle anatomy and demonstrates open (distal joint segment free) and closed chain function.[1] In the discussion that follows, I give video clock references for each functional observation.

The piriformis in the open chain is a lateral hip rotator. In the closed chain, such as during gait, it rotates the trunk to the opposite side (14:40 into the videotape).

The gluteus medius in the open chain is a hip abductor, but during gait, it raises the opposite pelvis, thus enabling the foot to clear the ground during the swing phase (21:05).

The iliopsoas in the open chain is a hip flexor, such as during the swing phase of gait. In a closed kinetic chain, like laying supine, the iliopsoas can lift the trunk, e.g., abdominal paralysis in polio (28:40).

The hamstrings in the open chain are both hip extensors and knee flexors. However, during the stance phase of gait in the closed chain, the hamstrings extend the hip without knee flexion. Why? Simultaneous quadricep co-contraction maintains a "neutral" knee position throughout the mid to late stance phases (22:50). See some of my previous articles in DC for further elaboration about the importance of co-contractions for injury prevention and motor control.

The gluteus maximus is a hip extensor in the open chain. In the closed chain, it is primarily active when the trunk is flexed such as occurs when climbing stairs, transitioning from sit to stand, and rising up from a squat (28:57). It is also active during forward bending of the trunk as well as rising back up (29:47).

The gluteus maximus has a number of key anti-gravity functions. For instance, along with the quadriceps, they work to lift the body upwards during walking uphill, rising from a chair, and jumping (1:02:32). With gravity, they decelerate sitting down, squatting down, and walking downhill.

The quadriceps in the open chain is a knee extensor. This occurs during the swing phase of gait (1:01:47). In a closed chain, these muscles straighten the leg as the foot hits the ground during the early stance phase of gait. They then keep the leg straight while co-activation of the hamstrings extends the hip during mid and late stance.

The gastrosoleus and plantaris muscles plantarflex the foot in the open chain. In the closed chain, they lift the body (1:07:08). They also lift us up on our tiptoes (1:13:19). Like the gluteus maximus and quadriceps, they have a significant anti-gravity function. They control our rate of descent and propel us forward during gait, going uphill, running or jumping.

The tibialis anterior and posterior and peronei are ankle invertors and evertors in the open chain. In a closed chain they help us to balance on an unstable or tilted surface in the frontal plane (1:41:20).

The quadratus plantae (flexor accessories) and other small plantar muscles of the foot insert into the flexor digitorum muscle and aid in toe flexion (2:10:09). Gripping with the toes or making a "small" foot helps to increase the arch of the foot and prevent hyperpronation during gait.[2,3]

In upcoming columns I will discuss functional anatomy of the upper quarter and trunk regions.

References

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2. Janda V. Propriosensory Training. OPTP.
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