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Descending Pronation Patterns

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Abstract
This practical paper is a continuation of previous papers presented in this section discussing over-pronation. The focus of this article is the way that the body has evolved to handle pronation forces in a descending manner from trunk to foot. It was written to accompany the "Toe-tal Function" editorial in the 20:2 edition of JBMT, but didn't make it in for publication.

The bipedal design of the human body means that, in standing, humans spend most of their time on two feet, in walking they spend most of their time on one foot, and in running they spend 100% of the load-bearing time on one foot.

Essentially, bipedal gait requires is some rather high-level neural control and, in addition, it requires high-level efficiency, high-level strength and significant coordination; which is why it takes an infant about 7-8 years to get good at it; and may explain why humans have the highest density of spindle cells (in certain of their tissues) of any creature on the planet. Because hominids put themselves upright, the human biomechanical frame must be able to effectively manage loads akin to a nail being hammered into the ground when running and jumping, in contrast to the greater spread of load that a quadruped utilizes across two or more limbs per step. Indeed, a Boeing engineer once received a call from a cargo company enquiring about transporting an elephant. "Will we need to reinforce the floor?" the cargo executive asked. The engineer laughed and replied, "Don't worry. We design our floors for a woman in a stiletto heel." He went on to explain that a 100-pound (50kg) woman standing on a heel that tapers down to a quarter-inch (5mm) diameter exerts a force of 1600lb/square inch, far more than the amount an elephant exerts on its broad foot pads (Yancey & Brand 1997). Humans, as bipeds, are more like stilettos than elephant pads when it comes to gait.

The upshot is that in order to be an effective bipedal creature humans have developed various mechanisms to stabilize the body, to resist, overcome and harness gravity. In the ancestral environment the consistent requirement to perform significant levels of walking and running, plus the inevitable lifting and carrying of objects would have resulted in what, in this day and age, would be termed "functional exercise". Back then, of course, it would have been termed "life". Either way it is and was a key ingredient to provide sufficient conditioning of the anti-gravity musculature. For example, picking up something heavy from the ground, whether that be a child and walking with it (rather than putting it in a push-chair) or carrying home a log or a downed animal or building with heavy stones; these activities would all condition the lifting muscles. These lifting muscles are the same muscles to both lift these extrinsic loads, and also to lift the body from the ground. As such, the lifting muscles are our anti-gravity muscles. Our pro-gravity muscles are those used for generating downward forces towards the ground, such as when hurling a stone or punch downward, serving a tennis ball, striking a hammer, and even in throwing in general. For most sports, however, the body needs to generate upward power, which is why it's so common to see athletes of many disciplines practicing lifting-based techniques.

In terms of foot mechanics, what is rarely discussed in any detail is that the musculature in the human leg is focused towards the proximal end, so there is very little muscle mass in the foot and ankle; although there are lots of tendons and connective tissues; tissues capable of transferring significant load and providing significant information. The question then becomes what is the function of these tiny, insignificant muscles of the foot? And the probable answer is that they serve a fine control function as opposed to a gross movement function, because the kinds of loads that are passed through the foot are extreme – multiples of bodyweight as discussed in previous papers.

In terms of the larger muscles - those that are used to counteract gravity and to move the body through space, which of these are key in controlling the loading through the foot? It depends to some degree on what motion is being conducted. Running down a hill for example, the quadriceps are being heavily recruited as anti-gravity muscles, but, at the same time, the rectus femoris as part of the quadriceps group will be pulling on the pelvis tilting it