Why humans choose running over walking

January 5 2012

Other than Olympic race walkers, people generally find it more comfortable to run than walk when they start moving at around 2 meters per second – about 4.5 miles per hour.

North Carolina State University biomedical engineers Dr. Gregory Sawicki and Dr. Dominic Farris have discovered why: At 2 meters per second, running makes better use of an important calf muscle than walking, and therefore is a much more efficient use of the muscle's – and the body's – energy.

Published online this week in *Proceedings of the National Academy of Sciences*, the results stem from a first-of-its-kind study combining ultrasound imaging, high-speed motion-capture techniques and a force-measuring treadmill to examine a key calf muscle and how it behaves when people walk and run.

The study used ultrasound imaging in a unique way: A small ultrasound probe fastened to the back of the leg showed in real time the adjustments made by the muscle as study subjects walked and ran at various speeds.

The high-speed images revealed that the medial gastrocnemius muscle, a major calf muscle that attaches to the Achilles tendon, can be likened to a "clutch" that engages early in the stride, holding one end of the tendon while the body's energy is transferred to stretch it. Later, the Achilles – the long, elastic tendon that runs down the back of the lower leg – springs into action by releasing the stored energy in a rapid recoil to help move you.

The study showed that the muscle "speeds up," or changes its length more and more rapidly as people walk faster and faster, but in doing so provides less and less power. Working harder and providing less power means less overall muscle efficiency.

When people break into a run at about 2 meters per second, however, the study showed that the muscle "slows down," or changes its length more slowly, providing more power while working less rigorously, thereby increasing its efficiency.

"The ultrasound imaging technique allows you to separate out the movement of the muscles in the lower leg and has not been used before in this context," Farris says.

The finding sheds light on why speed walking is generally confined to the Olympics: muscles must work too inefficiently to speed walk, so the body turns to running in order to increase efficiency and comfort, and to conserve energy.

"The muscle can't catch up to the speed of the gait as you walk faster and faster," Sawicki says. "But when you shift the gait and transition from a walk to a run, that same muscle becomes almost static and doesn't seem to change its behavior very much as you run faster and faster, although we didn't test the muscle at sprinting rates."

The research could help inform the best ways of building assistive or prosthetic devices for humans, or help strength and conditioning professionals assist people who have had spinal-cord injury or a stroke, Sawicki and Farris say.

More information: "Human medial gastrocnemius force-velocity behaviour shifts with locomotion speed and gait" Dominic James Farris and Gregory S. Sawicki, Online Jan. 4, 2012, in *Proceedings of the*

National Academy of Sciences.

Abstract
Humans walk and run over a wide range of speeds with remarkable efficiency. For steady locomotion, moving at different speeds requires the muscle-tendon units of the leg to modulate the amount of mechanical power the limb absorbs and outputs in each step. How individual muscles adapt their behaviour to modulate limb power output has been examined using computer simulation and animal models but has not been studied in vivo in humans. In this study we utilised a novel combination of ultrasound imaging and motion analysis to examine how medial gastrocnemius (MG) muscle-tendon unit behaviour is adjusted to meet the varying mechanical demands of different locomotor speeds during walking and running in humans. The results highlighted key differences in MG fascicle shortening velocity with both locomotor speed and gait. Fascicle shortening velocity at the time of peak muscle force production increased with walking speed, impairing the ability of the muscle to produce high peak forces. Switching to a running gait at 2.0 m·s-1caused fascicle shortening at the time of peak force production to shift to much slower velocities. This velocity shift facilitated a large increase in peak muscle force and an increase in MG power output. MG fascicle velocity may be a key factor that limits the speeds humans choose to walk at and may explain the transition from walking to running. This finding is consistent with previous modeling studies.

Provided by North Carolina State University