

## Muscles help give you a spring in your step

**New evidence about the active role muscles play in the foot could have implications for the design of running shoes and the debate on barefoot running, say researchers.**

It could also provide insights into rehabilitation, prosthetics, robotics and our understanding of the evolution of bipedalism in humans, says Dr Glen Lichtwark, an exercise scientist at the University of Queensland. He and colleagues publish their findings today in the *Journal of the Royal Society Interface*.

Everyone knows that muscles are very important in moving our legs, says Lichtwark, but muscles in the foot have been relegated to a less important role. "Traditionally in text books you might see these muscles described as toe flexors or toe adductors," he says.

Ligaments in the foot, called the plantar fascia, have generally been regarded as the main support for the foot arch which helps us walk and run by acting as a spring. "As you compress the arch it stretches the bottom of the arch and that causes some tension in the ligaments that stores elastic energy, which can be released when you push off," says Lichtwark. But he says anatomical research has suggested muscles in the feet may also be important in supporting the arch of the foot as well. "We were really interested in whether or not these muscles had any capacity to assist this function of the foot."

### **Muscle activation**

To investigate the role of muscles in the foot, Lichtwark and colleagues carried out two experiments. In the first experiment, seated participants had a weight applied to their knee while the researchers studied activation of foot muscles, using needle electrodes. "After a certain amount of force is applied, these muscles started to activate and the more weight we applied, the more these muscles turned on," says Lichtwark. In a second experiment the researchers found this activation was actively supporting the arch. They electrically stimulated the foot muscles under different loads and found that as the muscles were stimulated, they caused the arch of the foot to rise. The muscles were basically acting as a parallel support to the ligaments, almost like a truss, says Lichtwark. "They're effectively stiffening the foot," he says.

### **Shoe design**

Lichtwark says the findings have implications for shoe design. "Footwear design should consider the role of these muscles and be working with the muscles rather than be working against them," he says. "Because we think these muscles respond to how much load you put them, if you put in some kind of cushioning effect on one side of the foot for instance, then that might slow the response of these muscles in being able to adjust to small perturbations in the substrate that we're walking on." The findings may also help us understand the pros and cons of barefoot running. "One of the proposed benefits of barefoot running is apparently you can build up these intrinsic foot muscles," says Lichtwark. He and colleagues have just completed a study looking at muscle activity during walking and running. "As people run faster these muscles definitely turn on more," says Lichtwark. "But whether that activity changes in barefoot

running is something we're not sure about yet. We haven't tested people wearing shoes versus not wearing shoes."

### **Rehabilitation**

The findings also have implications for rehabilitation of muscular skeletal injuries and may lead to exercise programs to strengthen foot muscles where there are problems with the arch, says Lichtwark. And, he says, the findings may also help in the design of efficient prosthetic and robot limbs. Last but not least, says Lichtwark, the findings have implications for understanding the evolution of bipedalism in humans, and how humans came to run efficiently on two flexed feet. "We believe these muscles help aid in the versatility of the foot and its ability to act like a spring and cope with large forces." The research was carried out as part of PhD research by Lichtwark's student Luke Kelly, who is a podiatrist.



**This is the first study to show that muscles in the feet help support the arch of the foot.**