

Effect of Achilles tendon loading on plantar fascia tension in the standing foot.

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Abstract

BACKGROUND: The plantar fascia, which is one of the major arch-supporting structures of the human foot, sustains high tensions during weight-bearing. A positive correlation between Achilles tendon loading and plantar fascia tension has been reported. Excessive stretching and tightness of the Achilles tendon are thought to be the risk factors of plantar fasciitis but their biomechanical effects on the plantar fascia have not been fully addressed. **METHODS:** A three-dimensional finite element model of the human foot and ankle, incorporating geometrical and material nonlinearity, was employed to investigate the loading response of the plantar fascia in the standing foot with different magnitudes of Achilles tendon loading. **FINDINGS:** With the total ground reaction forces of one foot maintained at 350 N to represent half body weight, an increase in Achilles tendon load from (0-700 N) resulted in a general increase in total force and peak plantar pressure at the forefoot of up to about 250%. There was a lateral and anterior shift of the centre of pressure and a reduction in the arch height with an increasing Achilles tendon load as a result of the plantar flexion moment on the calcaneus. From the finite element predictions of simulated balanced standing, Achilles tendon forces of 75% of the total weight on the foot (350 N) were found to provide the closest match of the measured centre of pressure of the subject during balanced standing. Both the weight on the foot and Achilles tendon loading resulted in an increase in tension of the plantar fascia with the latter showing a two-times larger straining effect. **INTERPRETATION:** Increasing tension on the Achilles tendon is coupled with an increasing strain on the plantar fascia. Overstretching of the Achilles tendon resulting from intense muscle contraction and passive stretching of tight Achilles tendon are plausible mechanical factors for overstraining of the plantar fascia.

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