COMPARISON OF GLIDING RESISTANCE OF TENDONS ABOUT THE ANKLE

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INTRODUCTION: The etiology of posterior tibial tendon dysfunction (PTTD) is unclear although it has been suggested that it may be related to a preexisting flexible flatfoot. Obesity, diabetes, and hypertension may increase the risk of PTTD according to epidemiological studies. It is uncertain how tendonopathy can severely affect the PT tendon, while adjacent tendons, flexor digitorum longus (FDL) and flexor hallucis longus (FHL), are unaffected. We propose that mechanical resistance in the gliding portion of the PT tendon is significantly greater than FDL and FHL. The purpose of this study is to compare the gliding resistance of PT, FDL, and FHL in intact and flatfoot conditions, and in different ankle positions. We hypothesize that the PT gliding resistance is greater than FDL and FHL in all testing conditions.

MATERIALS AND METHODS: Gliding resistance of PT, FDL, and FHL were measured with the testing device (Fig. 1) that was reported previously (1, 2). Six fresh frozen cadaver feet (four males, two females; mean age 75 years old), with soft tissue envelope preserved. The tibia and fibula were amputated at the junction of middle and distal thirds of the leg, and proximal portions of tendons were exposed. Each tendon was attached distally to a cable, which was connected to a mechanical actuator via a load cell. The tendon was attached proximally to a cable, which was connected to a 500-gram weight via a load cell. Gliding resistance was determined by the difference between two load transducers. Testing was conducted with the foot positioned in maximum dorsiflexion which was shown to be the most sensitive position for gliding resistance. Testing was repeated after sectioning peritalar soft tissue constraints to create a flatfoot deformity. Tendon excursion was 10 mm at the rate of 1 mm/sec. Verification studies were performed for repeatability. Statistical analysis was performed with analysis of variance with repeated measures, with significance level p<0.05.

RESULTS: Gliding resistance measurements were highly repeatable. Intact: In intact foot, gliding resistance in PT was 1.38±0.36 N. Gliding resistance in FDL was 0.95±0.71 N. Gliding resistance in FHL was 0.79±0.26 N. Gliding resistance of PT was 75% higher than the resistance of FHL in intact condition and was 45% higher than the resistance of FDL.

Flatfoot: Flatfoot deformity increased gliding resistance compared to intact condition for PT, but not FDL or FHL. Gliding resistance in PT was 2.14±0.70 N. Gliding resistance in FHL was 1.31±0.26 N. Gliding resistance of PT was 75% higher than the resistance of FHL in intact condition and was 55% higher than the resistance of FDL.

DISCUSSION: The higher gliding resistance observed in PT tendon compared with FDL and FHL tendons is consistent with the observation that PT tendonitis, tendon dysfunction, and rupture are very common, while tendonopathy of FDL and FHL at the malleolar level is rare. The mechanical environment is different about the PT tendon as it is in direct apposition to the tibia. As flatfoot deformity develops, PT gliding resistance increases further, accentuating the abnormal tendon environment and accelerating tendon degeneration. These findings suggest that treatment designed to realign the flatfoot, such as orthoses or operative treatment should be considered.

Fig. 1: Measurement system with actuator, 2 load transducers measure tension of proximal [F₁] and distal [F₂] PT tendon. Gliding resistance: \( f = F₂ - F₁ \)

Fig. 2: Gliding resistance (N) of posterior tibial (PT), flexor digitorum longus (FDL), and flexor hallucis longus (FHL) tendons. Mean±standard deviation.

REFERENCES