Hindfoot Motion Following Reconstruction for Posterior Tibial Tendon Dysfunction

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Summary / Objectives

Standard gait analysis treats the foot as a rigid unit, and the most distal motion analyzed is the tibio-talar joint. However, the deformities caused by Posterior Tibial Tendon Dysfunction (PTTD), which can be severe, occur distal to the ankle joint. Segmental gait analysis of the foot can elucidate hindfoot deformity, but only pre-op studies exist for this condition. There are few studies which quantify mechanical abnormalities in PTTD, and no studies which evaluate the mechanical effect of its surgical reconstruction, specifically, on hindfoot motion and function. This study evaluated segmental foot and ankle function using high-resolution gait analysis to quantify the motion and power of the hindfoot following surgical reconstruction for PTTD.

Methods

This is a laboratory study of twenty patients who underwent posterior tibial tendon reconstruction for Stage II PTTD, using transfer of the flexor digitorum longus tendon to the navicular tuberosity, reconstruction of the calcaneo-navicular ligament complex, and a medial displacement calcaneal osteotomy. Minimum follow-up was one-year. Two types of controls were used in this study. The first was the comparison to the patients’ unaffected lower extremity; the second, a set of age-matched control patients without foot and ankle pathology. Three-dimensional gait analysis was performed using a 12 camera Vicon® motion capture system, and dual AMTI force plates. A 4 segment foot model, as first reported by Kidder et al. in 1996 was utilized, which consisted of the tibia/fibula, hindfoot, midfoot/forefoot and hallux. Temporal-spatial parameters including walking velocity, cadence, step length, and single support time were recorded. Kinematic parameters calculated included range of hindfoot motion with respect to the tibia/fibula in plantarflexion-dorsiflexion, varus-valgus and internal-external rotation, throughout the gait cycle. The kinetic parameter measured was ankle power. Analytic software utilized ANOVA with Tukey’s Post-Hoc to determine statistical differences of these variables between the affected side, and the unaffected side and the normal controls. Statistical significance was set at p < 0.05.

Results

Walking velocity was not different (p = 0.409) between the study subjects and the controls (1.06 +/- 0.18 m/sec and 1.02 +/- 0.21 m/sec respectively). There was also no significant difference in cadence and step length between the groups. Study patients did show a significantly smaller single support time on both the affected and unaffected limbs compared to controls. Throughout the gait cycle there was no statistical difference in motion in the planes of plantarflexion-dorsiflexion or varus-valgus, or in ankle push-off power between the affected and unaffected sides of the subjects, or between the affected side and the normal controls. There were small differences in internal-external rotation which were interpreted to have low clinically importance.

Clinical Significance

Earlier studies have shown that hindfoot motion is significantly changed in PTTD compared to normal controls. This study used high resolution gait analysis based on a segmental model of foot motion to evaluate and quantify the walking velocity as well as hindfoot and ankle range of motion and power following PTTD reconstruction. The study demonstrated post-operative range of motion and power to be within the normal range compared to the contralateral unaffected side and to the control group. In this preliminary post-operative laboratory study, surgical
reconstruction for PTTD effects quantifiable objective improvement in walking velocity, hindfoot motion and hindfoot power.