Ankle and Hindfoot Kinematics After Total Ankle Arthroplasty in Cadaveric Gait Simulation

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Introduction/Purpose: Total ankle arthroplasty (TAA) is an effective treatment option for end-stage ankle arthritis. However, with reports on long-term survivorship of current implant designs still anticipated in the literature, current research has focused on assessing prosthetic function and predicting potential failure mechanisms. Cadaveric gait simulation is a valuable tool for investigating the effects of surgical techniques on foot and ankle biomechanics. The objective of this study was to assess the effect of TAA on ankle and hindfoot kinematics using cadaveric gait simulation. We hypothesized that joint motion would be altered by the change in the articular constraint associated with joint replacement.

Methods: Three mid-tibia cadaveric specimens were secured to a static mounting fixture about a six-degree of freedom robotic platform. A force plate was moved relative to the stationary specimen through an inverse tibial kinematic path calculated from in vivo data. Target tendon force profiles were applied to the nine extrinsic ankle tendons by linear actuators instrumented with load cells. Ankle and hindfoot kinematics were measured from reflective markers attached to bones via surgical pins. TAA was performed using the Salto Talaris prosthesis (Bloomington, MN). After replacing the ankle joint, foot and ankle kinematics were directly measured using the same kinematic inputs and muscle force as the intact condition. To assess the effect of TAA on joint kinematics, pre- and post-TAA motions were directly compared throughout the stance phase, and differences were assessed using two-tailed, paired Student’s t-tests with an alpha value set at p = 0.05.

Results: Analyses revealed that ankle joint transverse plane motion was affected by TAA, with significantly greater talar internal rotation during the middle portion of stance after joint replacement (Figure 1B). In contrast, no differences were present in ankle joint sagittal and coronal
plane motion between the intact and TAA condition. Dorsiflexion was greater in the subtalar joint after TAA during early stance. Similarly, there was greater dorsiflexion in the talonavicular joint during mid-stance in the TAA condition compared to the intact condition. There were no differences observed in the coronal or axial plane in either the subtalar or talonavicular joint after TAA.

**Conclusion:** This study revealed that the talus underwent greater internal rotation during the weight acceptance portion of gait after TAA. The ankle joint however behaved similarly with respect to sagittal and coronal plane motion throughout stance after TAA. Compensatory motion however was noted in the subtalar and talonavicular joints, with greater dorsiflexion present in both joints during stance after TAA. This abstract represents an early subset of an ongoing study; smaller yet clinically important differences may still be present, and may be detected as more specimens are completed.