The Effect of Orthotics on Ankle and Subtalar Joint Orientation and Load Distribution Utilizing a Novel System to Simulate Weight Bearing in a Cadaveric Model

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Introduction/Purpose: Orthotics are commonly prescribed by orthopaedic surgeons to address the hindfoot and midfoot deformity resulting from posterior tibial tendon dysfunction. The public however will often purchase over the counter orthotics for generalized complaints of foot pain that is not associated with any significant deformity or foot pathology. The mechanical axis of the lower limb may be altered in patients who use orthotics despite a normal foot alignment. We hypothesize that patients with normal alignment who use orthotics may adversely change ankle and subtalar joint orientation and load distribution.

Methods: Five fresh frozen lower limb cadaveric specimens without known skeletal condition were used. The femoral head was potted with PMMA and TekScan pressure sensors were inserted into the ankle and subtalar joint. The specimens were placed on a custom jig, which allowed for load cell modulated loading of the leg; 75lb load (half body weight) was applied at the femoral head while the foot was supported against a fixed plate keeping the ankle in neutral position. Testing was achieved by placing an orthotic under the medial half of the plantar talonavicular joint level. Mean pressure (MP), peak pressure (PP), contact area (CA), and center of force (COF) were measured in both the ankle and subtalar joints under three conditions; barefoot (BASE), with a 1.5cm (ORT1) and 3cm (ORT2) height orthotic. Each condition was tested three times per specimen. Displacement of COF was calculated relative to its location at baseline.

Results: The MP, PP and CA showed a constant decrease from BASE to ORT1 and ORT2. Despite this relation, the only comparison that was significantly different was that between peak pressure values of the baseline and ORT2 conditions of the subtalar joint. The average displacement of COF from BASE was 0.14mm and 0.42mm medially, and 0.26mm and 0.46mm posteriorly at the ankle joint with ORT1 and ORT2 respectively. The average displacement of COF from BASE was 0.03mm laterally and 0.08mm posteriorly with ORT1, and 0.2mm medially and 0.46mm posteriorly with ORT2 at the subtalar joint.

Conclusion: Foot deformities have an impact on the articular forces in the lower limb. Our results agree with previous studies about the role of foot deformity on the distribution of body weight forces and its consequences across the ankle and subtalar joint. Our novel study also demonstrates that orthotics and orthotics of varying sizes can change the mean pressure, peak pressure, contact area center of force in the ankle and subtalar joint. This study proves the feasibility of its design for studying intra-articular pressure changes in a lower limb cadaveric model with simulated weight bearing.

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