A Pilot Study Replicating Foot and Ankle Kinematics and Kinetics Using a Custom Robotic Simulator

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Conventional *in vivo* foot and ankle models with skin-mounted retroreflective markers are encumbered by inaccuracies related to skin-motion artifact and poor rigid body assumptions, where kinematic contributions of individual bones are lost [1, 2]. These assumptions lead to inaccurate descriptions of specific joint motions observable in lower extremity prosthetic designs and foot and ankle surgery. Although, *in vivo* biplane fluoroscopy studies have demonstrated more accurate individual bone motion tracking, these studies are limited by small sample sizes, the heterogeneity of the typical human population, and expensive equipment. Robotic simulators allow for direct kinetic and kinematic measurements *in vitro* while eliminating the heterogeneity of *in vivo* studies, where physiology and morphology vary [1]. The purpose of this pilot study is to develop a simulator for collecting *in vitro* kinetic and kinematic data during plantar-/dorsiflexion, inversion/eversion, and internal/external rotation. Three cadaveric male right tibial plateau-to-toe tip specimens will be procured. Infrared motion tracking markers will be mounted directly to the tibia, fibula, talus, calcaneus, cuboid, and navicular bones. A six-axis robotic manipulator will position the specimen over three load cells to measure forces and moments under the first and fifth rays and heel while manipulating the foot and ankle through the prescribed motions. Kinetic and kinematic data will be collected in sync using a custom LabVIEW program. Findings from this study will provide a better understanding of the tibiotalar, subtalar, calcaneocuboid, talocrural, and talonavicular joint motions; thus, informing future implant development and surgical treatment for the foot and ankle.
References
