The Effect of Medializing Calcaneal Osteotomy with and without Inferior Translation on Foot Pressures and Joint Angles Indicative of Acquired Adult Flatfoot Deformity

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INTRODUCTION:
Acquired adult flatfoot deformity (AFFD) is a debilitating condition characterized by a flattened medial longitudinal arch, posterior tibial tendon deficiency, forefoot abduction at the talonavicular joint, and hindfoot valgus. Several radiographic parameters have been used to assess the degree of severity of AFFD and to aid in planning corrective procedures. The medial calcaneal osteotomy (MCO) is a commonly used corrective procedure to successfully treat AFFD; however, lateral foot pain is a common postoperative complaint [1]. Recent studies have shown that MCO causes an increase in plantar pressures over the lateral forefoot and heel, which may contribute to postoperative lateral foot pain [2,3]. The purpose of this study is to determine the effects of adding an inferior translation (MCO+INF) to a standard MCO on plantar pressures and radiographic measurements of AFFD in cadaver feet.

METHODS:
Sixteen fresh frozen cadaver legs, 8 matched pair, were disarticulated at the knee. Specimens were thawed for twenty four hours at room temperature. Specimens were subjected to a simulated stance phase of gait with axial and plantar loading using a Contact Gait Simulation System (CGSS) as previously described [4] and summarized here, briefly. An Achilles tendon clamp facilitated plantarflexion loading. Specimens were mounted under a body weight simulating actuator in the CGSS. A TekScan HR mat (South Boston MA) was employed to measure foot pressures (4 sensel per cm² resolution) during simulation and was calibrated for each specimen before simulation. An outline of the foot position was recorded along with anatomical indicators for the locations of metatarsal heads. Furthermore, a portable x-ray unit (General Electric KX5-225 Model 11CK13) was used to capture joint angles in both the anteroposterior (AP) and lateral views. During gait simulation, axial compressive load ramped up to 100lbs and held for 60s; the plantar load ramped to 100lbs, initiated after half axial load is reached. Ten seconds of pressure data, collected at 10 frames per second were taken from 25s to 35s of full axial load; x-rays taken at 30s. Specimens underwent three consecutive simulations for each state tested (the intact, standard MCO, and MCO with 5mm inferior translation).

Following the intact simulations, each specimen in a pair was randomly selected to undergo either a standard MCO or MCO with a 5mm inferior translation. The standard MCO was performed using the classic exposure and technique [5]. Two ACE-Depuy 6.5mm canulated screws (DePuy Corp., Warsaw IN) were used to fix the osteotomy in place after translating the posterior aspect of the calcaneus 10mm medially for the standard MCO, and an additional 5mm inferiorly for the MCO with inferior translation. To evaluate plantar pressures, the foot was loaded into the regions (Figure 1) [2,3]. Statistical analysis was performed with an incomplete block design ANOVA. If significance was detected a Tukey-Kramer post-hoc pairwise comparison was used to detect difference between states (Intact, MCO, MCO+INF). Joint angles measured included talonavicular coverage and talar-first metatarsal angles in the AP view, and calcaneal pitch, talocalcaneal, and talar-first metatarsal angles in the lateral view [7].

RESULTS:
For measured joint angles, significant difference was detected only between the Intact and MCO+INF at the talocalcaneal joint (p<0.005). (Figure 2). No significant change in average pressure was detected in the medial and mid forefoot (regions 1 and 2, respectively); however the lateral forefoot (region 3) had a significant difference in average pressure between Intact and MCO (p<0.031) (Figure 3). No difference was seen in the medial midfoot (region 4); the lateral midfoot (region 5) had a significant difference in average pressure between Intact and MCO (p<0.27). The ANOVA detected a change in peak pressure for region 5, but pair wise comparison did not yield difference. The medial and hindfoot (regions 6 and 7 respectively) had no significant change in either average or peak pressures.

DISCUSSION:
Our results were consistent with recently published findings that a standard MCO significantly increases plantar pressures in the lateral aspect of the forefoot, which may contribute to postoperative lateral foot pain. In contrast, MCO with an inferior translation did not significantly increase average pressures in these areas. In addition, average pressures in the hindfoot and medial forefoot were not significantly changed with either standard MCO or that with inferior translation in this cadaver model. This suggests that inferiorly translating the MCO may lessen the frequently seen lateral foot pain associated with this procedure.

Interestingly, inferiorly translating the MCO showed the lateral talocalcaneal angle as the only radiographic parameter to be significantly different when compared to the intact specimen. The effect of this finding is unclear as previous studies have concluded that the talonavicular coverage angle and lateral talar-first metatarsal angles were the most significant radiographic parameters in assessing AFTD. This may indicate that these parameters are not improved by MCO alone, but may be more affected by soft tissue transfers or other bony procedures not tested in this study.

REFERENCES:

ACKNOWLEDGEMENTS:
The donation of hardware by DePuy Inc. is greatly appreciated.