Effects of Medial Displacement Calcaneal Osteotomy on Dynamic Ankle Joint Contact Characteristics

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Introduction: Posterior tibial tendon dysfunction (PTT) has been recognized as the most common cause of acquired flatfoot deformity in adults [1]. The medial calcaneal osteotomy (MDO) is used for treatment, but many questions about the mechanism by which MDO improves foot and ankle function still exist. To address this need this study aimed to improve our understanding of the contact characteristics of normal feet, simulated flatfeet, and in flatfeet following MDO in vitro.

Material and Methods: Eight fresh-frozen cadaver specimens without any visual or radiographic evidence of foot or ankle abnormality were utilized. The average age was 74.6 years old (range, 67-97 years); three donors were female and five were male. Skin and subcutaneous tissues were removed from the level of the proximal leg to the supramalleolar plantar surface of the hindfoot. No wedge was removed from the calcaneus, and no attempt was made to tilt the tuberosity into varus. Once the cadaver was secured, the posterior fragment is shifted 1 cm medially. The osteotomy was secured with two 1/8 inch threaded Steinmann pins, as can be seen below.

For each condition, the foot plate was passively moved for two cycles, in the sagittal plane (30° of plantarflexion- 20° of dorsiflexion), coronal plane (20° of inversion-20° of eversion), and transverse plane (20° of internal rotation- 20° of external rotation). It should be noted that foot plate motion in the coronal and transverse planes were slightly larger than the physiologic range of motion in order to ensure a full range of motion of the bones. Dynamic kinematic and contact data were collected during each trial.

Results: In the lateral joint (fibro-talar joint) during inversion/eversion the flatfoot increased average contact area (75.0 to 86.7mm²), pressure (0.3 to 0.39mm²), and peak pressure (0.56 to 0.74mm²) while the MDO reduced all values when compared to the flatfoot. Internal/external rotation in the flatfoot increased all contact characteristics (area 59.7mm² to 76.7mm², pressure 0.35KPa to 0.45KPa, and peak pressure 0.60KPa to 0.82KPa), however the MDO again reduced each. During plantar/dorsiflexion contact area decreased from 68.6mm² to 70.8mm² in the flatfoot, but decreased to 60.1mm² after MDO. Contact pressure increased from 0.30mm² to 0.31mm², but decreased to 0.29mm² after MDO. Peak contact pressure increased from 0.55mm² to 0.58mm², but decreased to 0.30mm² after MDO. During internal/external rotation, flatfoot decreased contact area, while contact pressure and peak pressure increased. In this same motion, the MDO slightly increased contact area, contact pressure decreased, while peak contact pressure decreased. During plantar/dorsiflexion, contact area decreased in flatfoot and further decreased after MDO. Contact pressure and peak contact pressure increased during flatfoot but decreased after MDO.

Discussion: Many methods exist to evaluate contact characteristics of the ankle joints like using powder carbon black. To the author’s knowledge this is the first study to evaluate MDO contact characteristics during dynamic conditions. In the lateral ankle joint, the contact area, pressure, and peak pressure increased after a flatfoot was created. MDO altered contact distribution, which more closely resembled the intact foot. In the central region, the MDO restored a similar contact area seen in the intact foot however average contact pressures and peak pressures were reduced. MDO treatment improves ankle contact characteristics during dynamic conditions.


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