Development of a cadaveric Hallux Rigidus model. Biomechanical testing.

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Introduction/Purpose: Hallux Rigidus (HR) is characterized initially by a decrease in Hallux metatarsophalangeal joint (MTPJ) dorsiflexion, decreasing the total range of motion. To be able to study different surgical treatment options, a cadaveric model has to be developed that recreates the limited range of motion. Our objective was to develop an Hallux Rigidus cadaveric model by shortening the plantar fascia (PF). Hallux MTPJ range of motion and joint stiffness were evaluated.

Methods: 8 cadaveric foot- ankle – distal tibia specimens were prepared, identifying all extensor and flexor tendons proximally. The skin and subcutaneous tissue was kept intact. Each specimen was mounted on a special frame and luminous markers were attached to the skin (Oxford Foot Model). A dead weight equal to 50% of the stance phase force was applied to each tendon, except for the Achilles tendon and the posterior tibialis. 10 Hallux MTPJ dorsiflexion-plantarflexion cycles were performed by pulling the Extensor Hallucis longus tendon using an tensile testing machine (Kinetecnics). A Hallux Rigidus model was then developed by shortening the PF by 6 mm using a triple fiberwire suture technique. The same 10 cycles were repeated with a shortened PF. Each specimen served as its own control. Hallux metatarsophalangeal stiffness and kinematics were tested using a tensile testing machine and high definition cameras.

Results: The group with a shortened PF significantly reduced the hallux dorsiflexion (18.6 degrees) compared to the native foot (23.7 degrees) (p<0.05). No significant difference in joint stiffness was seen between groups: 3.3 N per degree for the native foot and 4.3 N per degree for the Hallux Rigidus model (P>0.05).

Conclusion: To create a HR model is vital to allow further understanding of the pathology. The cadaveric model should not alter the joint stability (intact periarticular soft tissues) but has to limit Hallux range of motion. The model we present successfully recreates HR by limiting MTPJ dorsiflexion. The absence of stiffness change shows that joint congruity and isometry were not modified.

There are a few reports that state a PF shortening as the first stage in HR. This would lead to a hinge-like MTPJ dorsiflexion, creating a dorsal metatarsal head impingement that could evolve to a dorsal exostosis.

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