

## Biomechanical evaluation of metatarsal osteotomies for Hallux Rigidus. A cadaveric testing

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**Introduction/Purpose:** Metatarsal osteotomies for Hallux Rigidus (HR) is a treatment option when neither a cheilectomy nor an arthrodesis are indicated. Different osteotomies exist that elevate, shorten or depress the metatarsal head. No biomechanical information exists that evaluates the effect of osteotomies on hallux range of motion (ROM) and stiffness. Our objective was to evaluate, in a cadaveric model, the first metatarsophalangeal joint (MTPJ) stiffness and kinematics changes, after three different metatarsal osteotomies.

**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. Each specimen served as its own control, testing hallux dorsiflexion when pulling the extensor hallucis longus tendon. 10 cycles were performed for every condition: control (A), and three different metatarsal extraarticular neck osteotomies: vertical osteotomy with 5 mm of depression (B), 5 mm of shortening (C) and 5 mm of shortening and depression (D). All osteotomies were performed on a Hallux Rigidus cadaveric model. We registered the MTPJ stiffness and kinematic changes after each intervention using a tensile testing machine and high definition cameras.

**Results:** B and C were significantly stiffer than group A and D ( $p < 0.05$ ). D was the only condition with a similar stiffness to the control group (A) ( $p > 0.05$ ). Groups B, C and D achieved similar kinematics (range of motion) to group A ( $p > 0.05$ ).

**Conclusion:** Different metatarsal osteotomies exist for HR. The osteotomy of choice, should be one that recreates the healthy MTPJ motion and stiffness. According to our study, the osteotomy of choice should be one that results in metatarsal head depression and shortening. A possible explanation to our finding, is that a pure shortening or depression osteotomy is really elevating or depressing the head respectively, hence altering the tendon pull and relative head position. Only with metatarsal shortening and depression, the Hallux MTPJ biomechanics in a Hallux Rigidus cadaver model, returns to a healthy state.