Deep Transverse Metatarsal Ligament Transection in Morton’s Neurona Excision: A Cadaveric Study Examining Effects of Metatarsal Alignment

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Introduction

In the dorsal incisional approach for Morton’s neuroma, it is required to transect the Deep Transverse Metatarsal Ligament (DTML) that lies in the interspace between the 1st and 2nd metatarsal heads. The DTML is an important structure in the stability of the metatarsophalangeal joint (MPJ) as it acts as a tether to bind the metatarsal heads together. Each MPJ has a plantar thickening of the capsule or volar plate to which the DTML can adhere and maintain a transverse arch at the level of the metatarsal heads. Weakening of the DTML can result in various pathologies including: hallux abducto valgus, tailor’s bunions, metatarsus primus varus, and flat foot.

The purpose of this study is to evaluate the relationship between the transection of the DTML in the 3rd intermetatarsal space as seen with the dorsal incisional approach for Morton’s neuroma excision and the overall effects on the metatarsal alignment.

Methods

Ten human cadaveric lower extremity limbs were utilized for this study. Exclusion criteria included: rigid arthritic ankle deformity, history of foot/forefoot/midfoot/ rearfoot arthritis, severe pes cavus deformity, severe pes planus deformity, pedal amputations, and knee arthropathy. Inclusion criteria included ankle joint range of motion >90°, intact plantar fascia, and 2D foot positioning. Each limb was mounted to the MT5 85B Mini Bionix biomechanical test system and loaded to 120% of the donor's documented body weight at a rate of 15 lb/sec in order to simulate peak weight-bearing ground reactive forces on the forefoot. (Figure 1) The limb was held at 120% of body weight for 1 minute and then an anterior-posterior (AP) radiograph was taken using the X-Cel x-ray machine. (Figure 1) The x-ray tube head was angled at 15 degrees cephalic and the central ray was directed at the height of the 1st metatarsal heads. The AP radiograph was taken after the MT5 85B Mini Bionix system was unloaded and the 3rd intermetatarsal space was performed with a #15 blade until adequate visualization of the DTML was obtained. The AP was then completely transected using a #15 blade. (Figure 2) [9, 17, 18]

The purpose of this study was to evaluate the effect of the transection of the DTML at the 3rd interspace, as seen with a dorsal incisional approach for Morton’s neuroma, would have on metatarsal alignment. When the DTML was transected in the 3rd interspace, it was anticipated that the greatest change in IMA would be between metatarsals 3 and 4, with minimal effect on the adjacent intermetatarsal angles. Perhaps the most interesting and unexpected data showed that there was a statistical significant difference in the IMA 1-2, which also extended to the IMA 1-4. The 1st ray range of motion is greater than rays 2-5 and is restricted to motion in the frontal and sagittal planes. The 2nd ray has the least amount of foot movement found due to the medial and lateral column curves and the base of the 2nd metatarsals. Rays 3, 4, and 5 have increasing amounts of motion respectively in the frontal and sagittal planes but still less than the 1st ray.

Results

Nine out of the ten legs prepared were used for data collection. The limb excluded from the study was secondary to a rigid plantarflexion deformity of the ankle joint. Of the nine limbs used, one had an inadvertent lateral disarticulation at the ankle joint during the month cycling period of simulated weight bearing. As a result, the data were not able to be collected for this limb after one week of simulated weight bearing.

A statistical significant difference was noted with IMA 1-2 and IMA 1-4. IMA 1-2 at 1 week and also at 1 month cycling times showed statistical significant difference from pre-operative IMA 1-2 (p<0.05). Also, IMA 1-2 after 1 month cycling time showed statistical significant difference from post-operative IMA 1-2 to pre-operative IMA 1-2 time was 2.18 degrees. The power of the analyses for IMA 1-2 was 0.992.

Regarding the IMA 1-4, data recorded at 1 week and also at 1 month cycling times showed statistical significance from pre-operative IMA 1-4 (p<0.05). The average increase in IMA 1-4 from pre-operative to 1 month cycling time was 1.79 degrees. The power of the analyses for IMA 1-4 angles was 0.953.

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Discussion

The purpose of this study was to evaluate the effect on the IMA with 3rd interspace DTML transection and IMA with 1st interspace DTML transection. The IMA was measured pre-operatively, immediately post-operative, 1 week post-op, and 1 month post-op.

The results for this study are summarized in the clustered column graph. (Figure 4)

References