Arthroscopic versus Open MTP Arthrodesis: A Biomechanical Comparison
Kenneth Hunt, MD, Alastair Younger, MB ChB, ChM, FRCSC, Richard Fuld III, BA, Judas Kelley, BA, Nicholas Anderson, BS, Todd Baldini, MS

Category: Midfoot/Forefoot

Keywords: MTP fusion, compression screws, MTP arthroscopy, locked plate

Introduction/Purpose: Hallux metatarsophalangeal (MTP) arthrodesis is a common procedure for painful conditions of the great toe. Dorsal plate fixation for MTP arthrodesis using locked plates produces good clinical outcomes and superior biomechanical strength to other techniques. However, arthroscopic fusion with new generation full thread compression screws is emerging as an alternative to open fusion. This method has been utilized clinically with good outcomes, but the biomechanical strength of arthroscopic MTP fusion fixation techniques is unknown. The purpose of this study was to compare low profile contoured locked plates to new generation full thread compression screws for first MTP fusion, in a biomechanical cadaver model. We hypothesize that there will be no significant difference in plantar gapping during cyclic loading, stiffness, or load-to-failure between the two groups.

Methods: The first rays of eight matched pairs of fresh frozen cadaveric feet underwent dissection and DEXA scanning to measure bone mineral density (BMD). The “plate” group was prepared with cup-and-cone reamers, and fixation of the MTP joint with one compression screw and low profile dorsal locked plate. The matched pair “screws” group was prepared through a simulated arthroscopic technique, achieving fixation with two new generation full-thread compression screws, while preserving capsular attachments. Each specimen was loaded on the proximal phalanx in a cantilever fashion to 90 N at 3 Hz for a total of 250,000 cycles. Plantar MTP gap was recorded using a calibrated extensometer; Load-to-failure testing was performed for all specimens that endured cyclic loading; and stiffness was calculated from the final load-to-failure. Data was analyzed with a Student’s T-Test, with significance set at p<.05. Pearson Correlation coefficient (r) was calculated for stiffness and load-to-failure vs. BMD.

Results: The plate group demonstrated significantly more plantar gapping during cyclic loading. There was no significant difference in stiffness, 31.6 N/mm (plates) and 51.7 N/mm (screws) (p=0.24) or load-to-failure, 198.6 N (plates) and 290.1 N (screws) (p = .07). Two of 8 screws-only specimens, and 3 of 8 locked plate specimens failed during cyclic loading. These early failures, and stiffness and load-to-failure were highly correlated to BMD for plates (r=0.85 and r=0.62, respectively) and screws only (r=0.82 and r=0.94, respectively). Maximum metatarsal head width measured on lateral view was strongly correlated with load-to-failure and stiffness for both groups (r > 0.7).

Conclusion: Arthroscopic hallux MTP arthrodesis utilizing full thread compression screws has similar mean stiffness and load-to-failure compared to a low-profile locking plate, with significantly less plantar gapping. These data, combined with advantages of the arthroscopic preparation technique, support an increased role of arthroscopic fusion in lieu of more invasive open plating techniques. The two preload failures of the screws-only cohort occurred in specimens with the lowest BMD, potentially indicating a clinical contraindication with this technique. BMD and metatarsal width may aid in predicting early failure such that appropriate fixation construct and more conservative post-operative protocols might improve results for these patients.