3D Digital Image Correlation Evaluation of First Tarsometatarsal Joint Arthrodesis in a Cadaveric Model

ABSTRACT

Background: Hallux valgus deformity is often addressed through realignment and arthrodesis of the first tarsometatarsal (TMT) joint. The purpose of this study is to characterize biomechanical performance of two implant constructs in a matched pair cadaveric model.

Methods: Simulated first TMT arthrodesis was performed using two orthopedic implant constructs; a locking screw plus lag screw versus two nitinol compression staples placed in 90 degree configuration. Six matched pair cadavers were randomly selected to receive either locking plate implants or nitinol compression staples. *In-situ* digital image correlation (DIC) was then performed on twelve fresh-frozen adult cadaveric specimens to characterize gapping at the first TMT articulation during cyclic mechanical loading.

Results: Bone-implant interface characterization was enabled by DIC, identifying maximum strain concentrations of 59% along the implants. Interfacial characteristics were analyzed in context with gap displacement allowed by the implant over cyclical loading. Under 50 N of load, the locking plate/lag screw construct and nitinol compression staples gapped an average of 1.367 mm and 2.116 mm, respectively. Removing all load, the locking plate implant and nitinol staples averaged ~0.335 mm and ~1.045 mm of residual gapping respectively.

Conclusion: In cadaveric bone, lag screw combined with a locking plate fixation exhibited greater initial stability and resistance against gapping under load. Nitinol staples were more susceptible to plastic deformation. Under simulated weight bearing, the lag screw/locking plate group performed better in our cadaveric model, especially in more osteoporotic samples.

Keywords: Lapidus, Hallux Valgus, Arthrodesis, Biomechanics

Levels of Evidence: Level V - Biomechanical Study