Primary Stability and Stiffness of Ankle Arthrodesis Techniques – Crossed Screws vs. Anterior Plating

Foot & Ankle Category: Hindfoot

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Introduction
Despite recent advances with total ankle replacement designs, ankle arthrodesis still remains the gold standard in treating symptomatic end-stage osteoarthritis. Among all techniques, screw fixation has shown to be one of the most applied techniques to perform ankle fusions. Due to a considerable rate of failures of conventional cross-screw techniques, more recently, a more anatomically shaped anterior double plate system has been introduced with a union rate of 100%. The purpose of the present biomechanical study was to compare the primary stability and stiffness of two groups of ankle fusion constructs - crossed screw fixation and the anterior double plate system.

Methods
Twelve cadaver specimens of lower legs were used for this study. Three pairs of human cadaveric lower legs were usable for direct matching. The pair matching for the other six legs was performed according to the projectional BMD from previous DEXA scans. One specimen from each pair was randomly assigned to be stabilized by means of an anterior double plating system while the other has been fixed using the three-screw technique. The different methods of fusion were tested flexing the foot until failure of the system, defined as rotation of the talus relative to the tibia. All experiments were performed on a universal materials testing machine (model 1456; Zwick, Ulm, Germany). The force required to make arthrodesis fail was documented. For calculation of the stiffness, a linear regression was fitted to the force–displacement curve in the linear portion of the curve (R2 average value was 0.984, with a range from 0.948 to 0.996) and its slope taken as the stiffness.

Results
The anatomically shaped double-plating system revealed a mean load to failure averaging 967N (range from 570N to 1400N) compared with 190 N (range from 100N to 280N) (p=0.005) for the three-screw fixation method. Regarding stiffness a mean of 56N/mm (range from 35 to 79 N/mm) was achieved for the anterior double-plating system whereas a mean of 10 N/mm (range from 6 to 18 N/mm) was achieved for the three-screw fixation method (p=0.004).

Conclusion
The current biomechanical study demonstrates an improved performance of the anterior double-plating system if compared with the cross-screw fixation technique when considering primary stability and stiffness of the constructs. This data can be used to adjust postoperative rehabilitation protocols regarding ambulation and weight bearing.