Biomechanical Testing of Chevron Osteotomy Fixation in First Metatarsal: Bioabsorbable Compression Screw vs. OsteoMed Metal Screw

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Objective

The objective of this study was to compare the strength of fixation of two different distal chevron osteotomy fixation methods in the first metatarsal. Group 1 consisted of fixation using a 2.7-3.7 mm Bio-Compression Screw (AR-5025B). Group 2 consisted of fixation using a 2.4 mm OsteoMed metal screw.

Methods and Materials

The test methods were based on methods described by Vienne et al (2007 Foot and Ankle International).

Nine matched pairs of first metatarsal were used for this study. All soft tissue was dissected from the first metatarsal. The proximal portion of the first metatarsal was potted in a cylindrical fixture using PMMA.

A chevron osteotomy was made in each first metatarsal so that the apex of the chevron was approximately at the midline of the first metatarsal and 5 mm proximal to the MP-1 joint line. The distal portion of the first metatarsal was medialized by 5 mm without any angulation.

A specimen from each matched pair was randomly selected to be fixated using a 2.7-3.7 mm Bio-Compression Screw. Figure 1 depicts the Bio-Compression repair. The contralateral specimen received fixation using a 2.4 mm cannulated OsteoMed Screw. In both groups, the screw length was sized to match the particular specimen, and the screw was inserted from the distal dorsal to proximal plantar direction.

Figure 1: Bio-Compression repair

A circular marker was placed on each side of the osteotomy for optical tracking of the displacement during loading.

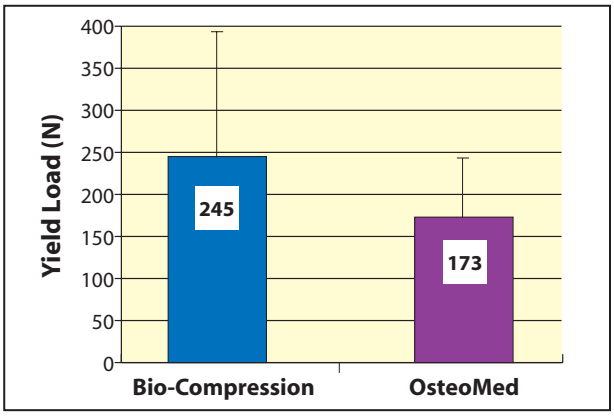
The potted construct was fixated to the base of the material testing machine using a v-block and an adjustable angle fixture. The potted specimen was oriented so that the plantar side of the first metatarsal faced upwards and fixated at a 15º angle (oriented upwards) to simulate anatomical loading.

A plunger was positioned in-line with the sesamoids on the bottom of the metatarsal, and the distal portion of the repair was loaded at a displacement rate of 10 mm/min. The load-displacement curve was used to record failure loads. Mode of failure was recorded for each specimen.

Results

All specimens failed at the repair sites as the distal metatarsal displaced from the proximal portion. A paired/ t-test ($\alpha = 0.05$) was used to compare the two different chevron repairs. The yield load for the Bio-Compression repair was on average greater than the OsteoMed; however, the difference was not significant ($p>0.05$). The data can be seen graphically in Figure 2.

Figure 2: BCS and OsteoMed Yield Loads



Conclusion

The biomechanical data suggest that the Bio-Compression Screw has, on average, stronger fixation of a distal chevron osteotomy than that of the OsteoMed. In addition, the Bio-Compression Screw is headless, bioabsorbable, and radiolucent during x-rays.