Lapidus I-Beam Plate

Arthrex Research

BACKGROUND

Lapidus fusion is a widely accepted procedure for the treatment of arthritis, instability, and deformity of the forefoot and midfoot. Numerous rigid fixation constructs have been developed to support successful arthrodesis, yet union-related failure rates remain as high as 10%-20%,[1-3] despite ongoing advances in fixation strategies. The purpose of this study was to evaluate whether the Lapidus I-Beam plate provides rigid fixation of the 1st tarsometatarsal (TMT) joint during a simulated fusion in cadaveric specimens.[4]

METHODS

Twenty-one fresh-frozen lower limb cadavers (12 M/12 F; mean age 60.0 ± 10 years; range 42-87 years) were incised medially to expose the TMT joint of the 1st ray, and arranged into three groups (n = 7 per group) such that the mean bone scores (OsteoProbe) at the fusion site did not differ statistically among groups (medial plate, I-Beam, and dual plate groups: 35.6 ± 6.3, 38.9 ± 7.1, and 36.3 ± 10.1, respectively; one-way ANOVA on ranks, *P* = .601). Repairs, conducted by one board-certified orthopedic surgeon, included a standard 3.0 mm medial plate, a 2.7 mm dorsal and medial plate configuration (dual plate), and the new 3.0 mm I-Beam plate. All locking screws were torqued, without overtightening, to a predetermined value deemed appropriate for each plate size (22.5 Nm for 3.0 mm plates, and 17.2 Nm for 2.7 mm plates). The joint was disarticulated and embedded in potting material proximal to the repair site.

Specimens were mounted rigidly on a mechanical testing system (Instron 8871) so that the medial aspect of the specimen faced forward and the plantar aspect was upwards (Figure 1). The custom fixture held the specimen at 15°, and a cantilever load was applied in 4 loading blocks (loading block 1: 5-50 N for 100 cycles; loading block 2: 5-100 N for 100 cycles; loading block 3: 5-150 N for 100 cycles; loading block 4: 5-200 N for 100 cycles) at the sesamoid location. Optical tracking and load cell data were analyzed. A gap measurement of 2 mm between articulating surfaces at the plantar aspect of the joint site was considered nonunion, as previous authors have described.[5,6] Mean cyclic failure load was defined based on the maximum load within the cycle block that failure occurred. Stability outcomes were derived from optical tracking, which measured metatarsal rotation (internal/external, varus/valgus) at failure.

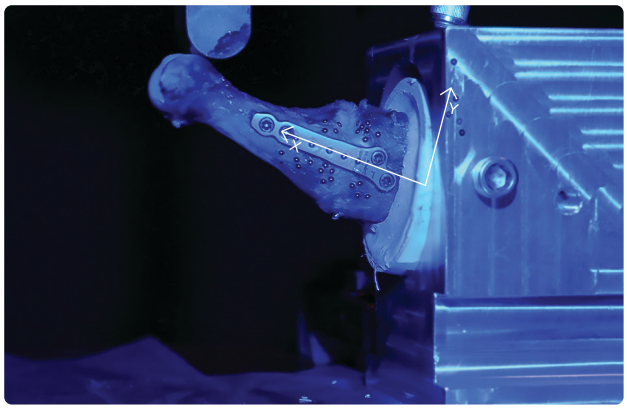

Figure 1. Plantar cantilever bending test setup. Motion about the x-axis indicates internal/external rotation. Motion about the y-axis indicated varus/valgus motion.

RESULTS

When considering plantar gap of 2 mm or higher as failure, the dual-plate and I-Beam plate groups both had 6/7 samples survive loading block 1, 3/7 samples survive loading block 2, and 1/7 samples survive loading block 3. The medial-plate group had 4/7 samples survive loading block 1 and 2/7 survive loading block 2 (Figure 2).

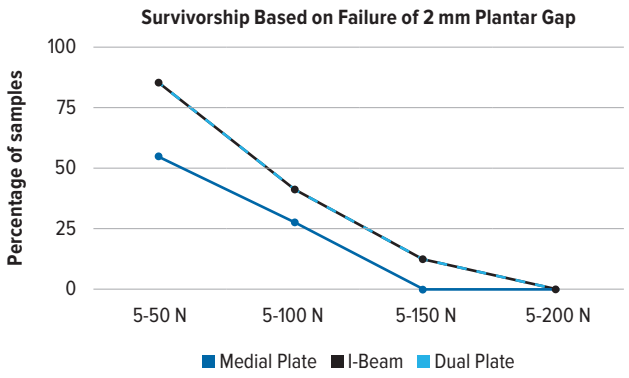

Figure 2. An equal number of samples in the I-Beam and dual-plate groups survived each loading block.

One-way ANOVAs were performed in SigmaPlot 14.0, comparing all three groups based on the means and standard deviations of each outcome measure presented in Table 1. All analyses showed insignificant findings ($P > .05$ for all tests).

CONCLUSION

The I-Beam plate group demonstrated biomechanical strength and reproducible directional failure behavior comparable to the dual-plate group, with no specimens exhibiting external rotation at failure (0/7), identical numbers of failures by cycle block, and no significant differences in cyclic ultimate load or rotational behavior under load.

Table 1. Optical Tracking Outcomes. N/A indicates no motion in that anatomic direction was captured at failure for all tested samples.

	Mean Cyclic Ultimate Failure Load (N)	Mean Internal Rotation (degrees)	Mean External Rotation (degrees)	Mean Valgus (degrees)	Mean Varus (degrees)
Medial Plate	92.9 ± 45.0	2.2 ± 1.3, N = 5	0.29 ± 0.3, N = 2	3.8 ± 2.6, N = 4	1.3 ± 1.6, N = 3
I-Beam	121.4 ± 48.8	2.5 ± 1.4, N = 7	N/A	1.3 ± 0.9, N = 5	1.0 ± 0.8, N = 2
Dual Plate	121.4 ± 48.8	2.2 ± 1.4, N = 7	N/A	1.6 ± 1.5, N = 4	2.2 ± 1.4, N = 3

References

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