The Use of 3D-Printed Custom Titanium Implants to Treat Traumatic Lower Extremity Critical-Sized Bone Defects

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Purpose: Despite advances in modern orthopaedic traumatology, bone loss following high-energy trauma remains a treatment challenge. Three-dimensional (3D) printing is the process of creating digitally designed objects by deposition of materials in sequential layers. This rapidly advancing field has created access to almost limitless sized and shaped 3D structures. This makes 3D printing a novel and attractive alternative to treat traumatic critical-sized bone defects of the lower extremity. The purpose of this abstract was to showcase the innovative use of 3D printing to treat traumatic critical-sized bone defects.

Methods: Three patients with open distal tibia epiphyseal-metaphyseal-diaphyseal fractures (AO/OTA 43C3.3) with bone loss resulting in critical-sized bone defects were treated with custom 3D-printed titanium cages. Because of the nature of the intra-articular damage, the cages were designed to span the bony defect and fuse to the talus. The custom implants were designed from the patients' anatomy and satisfied the U.S. Food and Drug Administration guidelines for custom devices.

Results: The mean age of the patients at the time of surgery was 31 years (range, 21-46). The mean length of follow-up was 30 months (range, 12-62). Standard radiographs and CT scans demonstrated bony incorporation of the implants at most recent follow-up. All patients returned to preinjury activity levels.

Conclusion: Critical-sized lower extremity bony defects can be difficult to treat. These injuries require structural support that may not be available with autograft or allograft bone. The use of patient-specific 3D-printed titanium implants offers a new technology that can address a variety of bone defects and deformities of the lower extremity. Furthermore, the flexibility and ease of customization of implants allows for patient-specific needs to be met and planned for preoperatively.