3D-Printed Fracture Models: A Low-Cost Tool for Improved Preoperative Planning

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Purpose: Our objective is to demonstrate the process of creating full-scale 3-dimensional (3D)-printed models for preoperative planning.

Methods: The primary author acquired a home 3D printer for less than $500. Three patients presenting with periarticular fractures were chosen for demonstration. Standard CT of the fractures were obtained and imported into OsirixMD Lite, a free image viewing program. The data were then exported in DICOM (digital imaging in communications and medicine) format and imported into 3DSlicer, a free modeling program. Within 3DSlicer, the following was performed: a “segment” was created in the Segment Editor; threshold density was set for inclusion in the model; a 3D model was created; the Scissors function was used to trim the model to the anatomy to be printed; and in the Segmentation tab, the model was exported to a “.stl” file. That file was opened in the 3D printer software to create final instructions for the printer. Each model took less than 30 minutes to digitally create, less than 12 hours to print, and cost less than 1 dollar. The models were made available to the primary surgeon prior to the operation and were present in the operating room during surgery.

Results: The first case was a 6-week old malreduced OTA/AO 43C1 pilon fracture. The model allowed for planning the approach, location, and volume of callus, and size and location of implants. The second case was an acute OTA/AO 82C calcaneus fracture. Based on the location of comminution and fracture fragments, the decision was made to use a sinus tarsi approach for reduction and fixation. In the third case, an OTA/AO 41B3 tibial plateau fracture, the model helped the surgeon decide on a location for a medial cortical window and trajectory for elevating the depression as well as estimate bone graft volume by measuring the depression. In each case, the operation was carried out successfully according to plan.

Conclusion: 3D-printed fracture models for preoperative planning are inexpensive and easy to create. Compared to 3D imaging, tactile feel of the fracture prior to operating provides planning advantages such as approach, adjuvant usage, and implant choice.