

Homemade 3D Mirror Imaging Models' (HM3DMIM) Utility for Surgical Treatment of Complex Fractures of Scapula

José María Martínez Gómiz, MD; Francisco Chana Rodríguez, PhD;
Manuel Perez-España, MD; Jose Manuel Abril Larrainzar; Ricardo Larrainzar
1 General University Hospital Infanta Leonor, Madrid, Spain

Purpose: Preoperative planning using HM3DMIM of the scapula allows more effective diagnosis, reduced improvisation, and simulates the surgical procedure. We describe a new methodology, through a Do It Yourself (DIY) process, from the initial diagnosis until the final plates premodeling, analyzing advantages and potential drawbacks.

Methods: We report the case of a 54-year-old male suffering from a floating shoulder. The CT study showed a double disruption of the shoulder's suspensory complex, sustaining a clavicle fracture (15.2C) associated with a complex fracture of the scapula (F1 B [Im]). Segmentation of the healthy scapula was performed and its mirror image was obtained, by inverting the x-axis, using image processing software (Osirix). The study was exported in STL format obtaining a 3-dimensional (3D) mesh that was repaired by software (MeshLab). HM3DMIM was printed with the Ultimaker 2+ Extended printer using polylactic acid (PLA) for fused deposition modeling, obtaining a tangible model that accurately reproduced the anatomy of the patient's scapula before suffering the fracture. We use the biomodel to select and premold the osteosynthesis implants. Model and plates were sterilized using ethylene oxide. After restoring the clavicular length by osteosynthesis with 1 plate, an extended Judet approach was performed exposing the scapula fracture. Once reducing and fixing the articular surface with 2 cannulated 4-mm screws through the glenoid neck was completed, an indirect reduction of the scapular body fracture was performed using the previously premolded osteosynthesis plates.

Results: The printing time was 8 hours and 22 minutes, and the plastic consumption was 230 g of PLA, so we printed our model for less than \$7 USD. The final plates, with the aid of standard plate-benders, were contoured over the plastic model during 25 minutes. No intraoperative modifications were required. The postoperative CT scan obtained 4 months after the surgery showed complete consolidation, good alignment of the scapula in all the planes, restoration of the native glenopolar angle, adequate joint congruence, and no gaps between plates and cortical bone. After 6 months of monitoring, the patient presented complete glenohumeral mobility, and has reincorporated his work and sports activity without restrictions, which gives him a score of 89 points on the Constant scale.

Conclusion: The use of preoperative planning, by HM3DMIM of the opposite scapula and precontouring plates over them leads to effective achievement of a predefined surgical objective and reduces the inherent risks. Its main advantages include indirect reduction and anatomical adaptation.