Clinical Application of 3D Printing Technology in Orthopaedic Trauma Surgery
Rahat Jarayabhand, MD*; Chittawee Jiamton, MD*
Bhumibol Adulyadej Hospital, Bangkok, Thailand

Purpose: Our objective was to evaluate and summarize the uses and clinical applications of 3-dimensional (3D) printing technology in orthopaedic trauma surgery.

Methods: Data from all consecutive trauma cases operated with the use of 3D printing technology were collected and evaluated. The workflow starts from obtaining CT data from the patient and sending them to the team of engineers. The surgeon discusses the plan of treatment with the team and after discussion 3D images are created according to the specific needs of each case, such as 3D model of fracture, mirror image from the nonfractured side, simulation of fracture reduction, osteotomy and drilling guides, and patient-specific implants. After the planning is approved from the team, all the necessary models, guides or implants are printed. Surgery is done according to plan and the clinical applications of 3D printing and results of treatment are recorded. Postoperative anatomic parameters in each particular case were compared to the uninjured side.

Results: A total of 19 cases were treated with use of 3D printing technology. Six acetabulum fractures (5 both- column and 1 transverse with posterior wall) models were printed and used for preoperative contouring of plate and planning of screws. One model of pelvis malunion was printed for preoperative planning. Four cases of malunion distal end radius fracture were treated with cutting and drilling guides and fixation with commercially available locking plates. Two malunions of forearm (1 Monteggia fracture and 1 radial shaft) were treated with cutting and drilling guides and patient-specific plates. Four cases of clavicle fractures were treated with patient- specific plates with drilling guides for plate placement and 2 of the cases were malunions corrected with cutting guides. One case of nonunion proximal tibia was treated with customized cutting guide for allograft. One case of malreduction of pronation external rotation ankle fracture was corrected with drilling guide for plate placement and syndesmotic screw insertion, and fixation with a patient-specific plate. In total, fracture models were printed for all cases, 12 cases used cutting and drilling guides, and 7 cases were fixed with patient-specific implants. Comparable anatomic parameters to the uninjured side were achieved in all cases.

Conclusion: From our study the clinical application of 3D printing technology in orthopaedic trauma surgery can be summarized as follows: (1) preoperative planning, using models and simulation of fracture reduction; (2) malunion correction, with cutting and drilling guides; (3) intraoperative navigation for implant positioning and fracture reduction, using cutting and drilling guides; and (4) patient-specific 3D-printed implant. This innovative technology is very promising and can be applied for orthopaedic trauma surgery especially in areas with complex anatomy, nonunions, and malunions for the achievement of anatomical reduction in these difficult cases.