3D-Printed Surgical Guides for Endoscopic Repair of Subcondylar Mandible Fractures

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Introduction

Endoscopic repair of subcondylar mandible fractures is a technically difficult procedure and can be time-consuming[1-3]. Unlike other open mandible repair techniques, the endoscopic approach requires adapting fixation implants to patient-specific anatomy with only 2-dimensional screen displays to guide the surgeon. We initiated a pilot program using 3D-printed surgical guides (3DSG) to aid implant adaption during these challenging cases. We hypothesized that utilizing a 3D-printed surgical guide would decrease operative times and save costs with each procedure.

Methods and Materials

A pilot program was conducted with the craniofacial reconstruction team at a single level-one trauma center. Patient CT scans were used to create patient-specific anatomic models for subcondylar fracture repairs. To create each patient-specific model, the bones were segmented out in 3D Slicer, a computer-aided design program, by highlighting Hounsfield units correlating to bone density from the patients' CT scan (Figure 1). The mandible was then isolated (Figure 2). The non-fractured mandibular ramus was then mirrored to create a symmetrical segment (Figure 3). This symmetrical segment was then 3D-printed to allow for a guide for plate-bending in the operating room (Figure 4).

A retrospective review was performed examining all cases of patients who had undergone endoscopic repair of subcondylar mandible fractures from January 2019 to January 2024. Operative times were compared between cases utilizing a 3D-printed surgical guide (3DSG group) and those done without (non-3DSG group). Total operative times as well as operative times per fracture were analyzed. A subgroup analysis of the patients with single subcondylar mandible fractures was also performed.

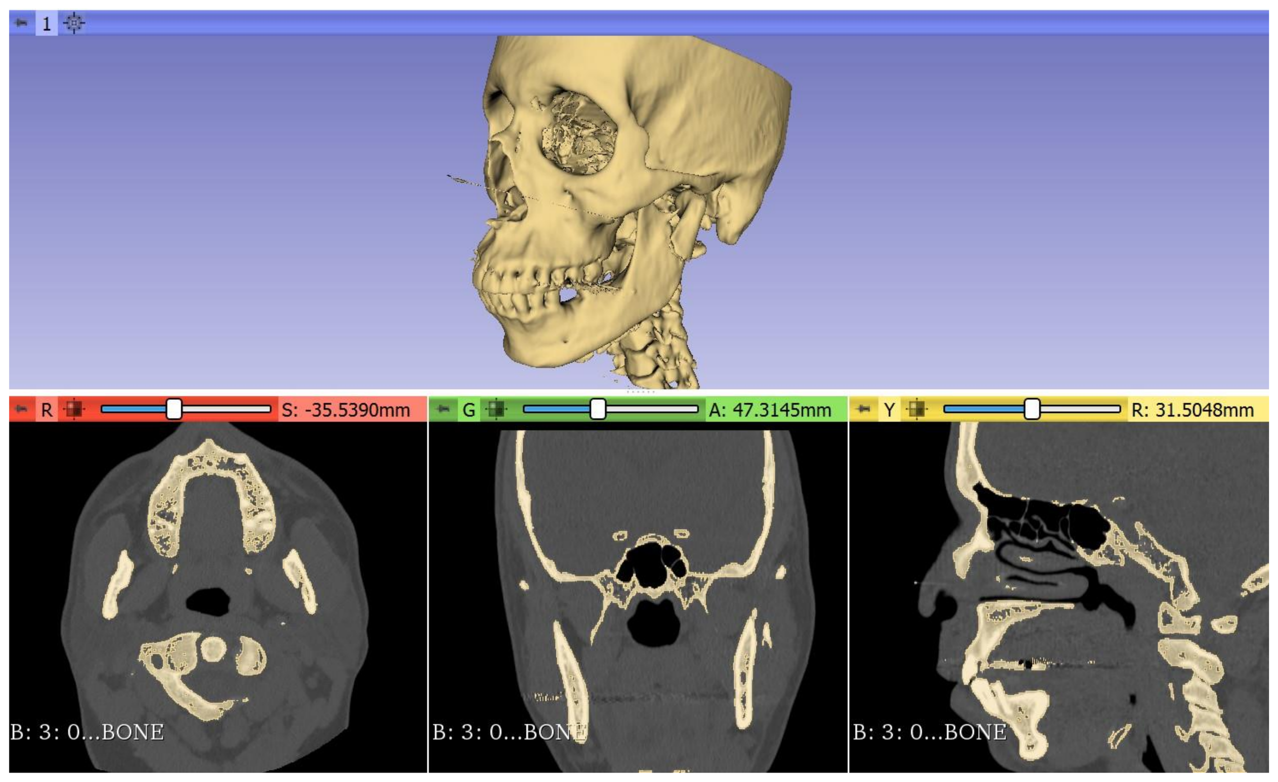
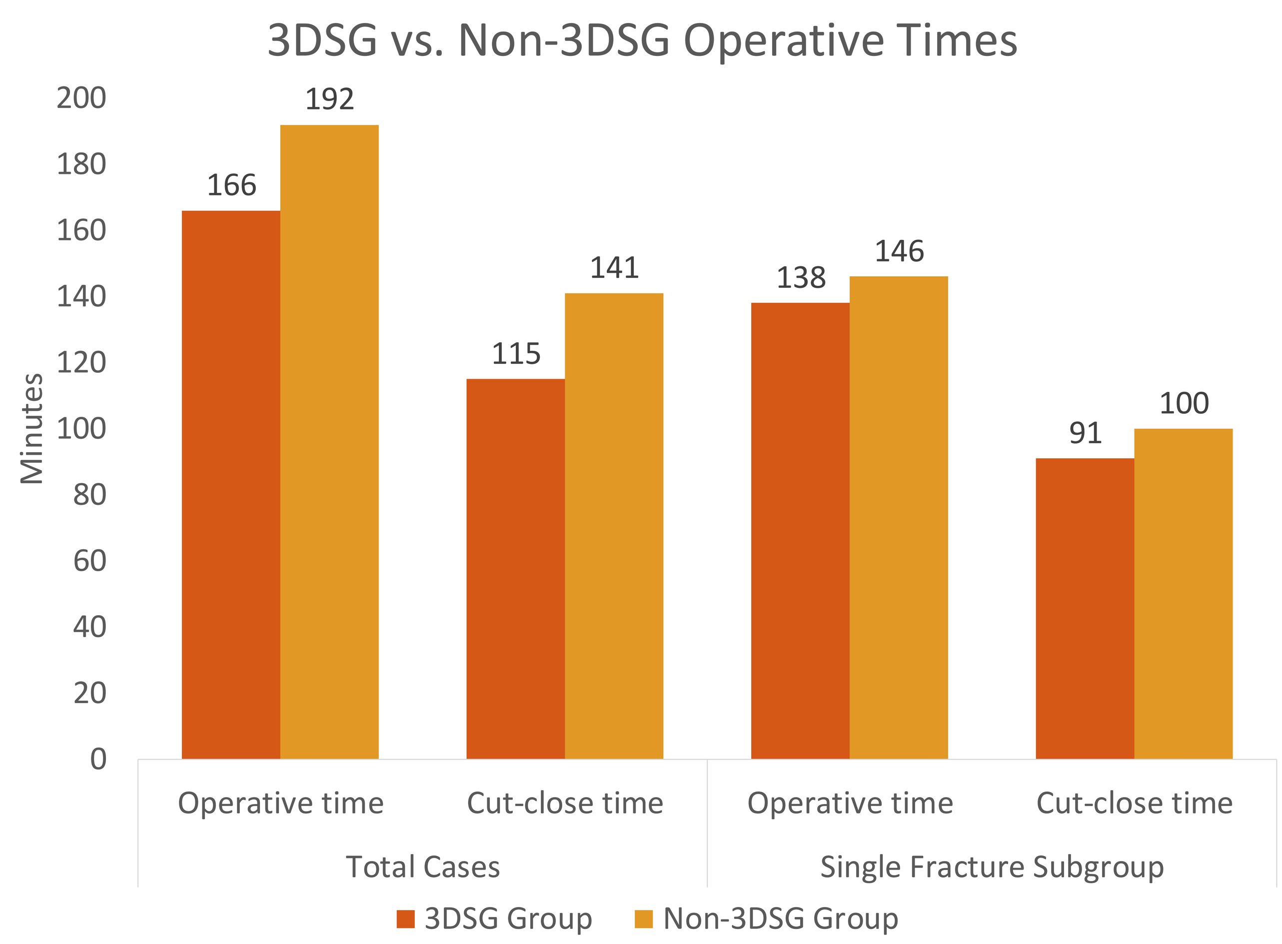


Figure 1. Bone segmentation. 3D Slicer is used to segment the patient's bony structures from their CT scan .

Results

Forty cases were examined, of which 13 repairs (33%) were performed with the aid of a 3D-printed surgical guide. Anecdotally, the team reported the use of 3DSG improved their technique and simplified the implant adaptation. Mean total operative times appeared to be less in the 3DSG group when compared to the non-3DSG group (166 min vs 192 min, p=0.16) as were the incision to close times (115 min vs. 141 min, p=0.19), though neither reached statistical significance. Twenty-six cases (65%) involved repair of additional fractures so operative times per fracture were also examined. The 3DSG group appeared to have shorter operative times per fracture than the non-3DSG group (138 min vs. 146 min, p=0.45) as well as shorter cut-close times (91 min vs. 100 min, p=0.48).



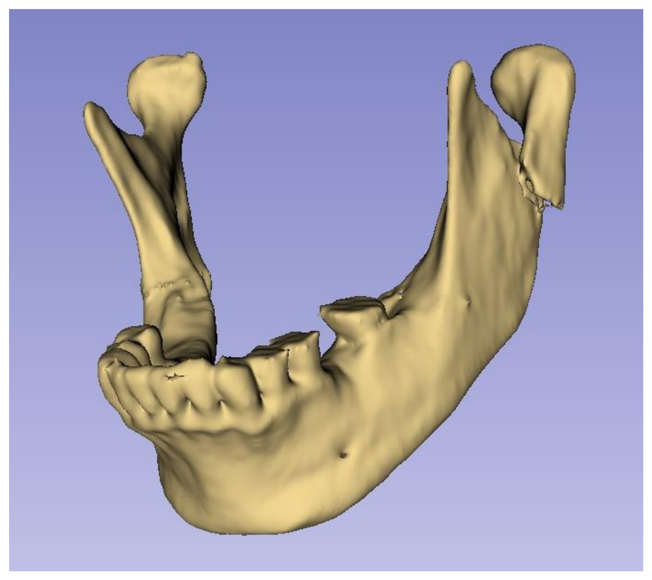


Figure 2. Segmented mandible. The mandible is isolated by removing the unnecessary bony structures from the segmentation.

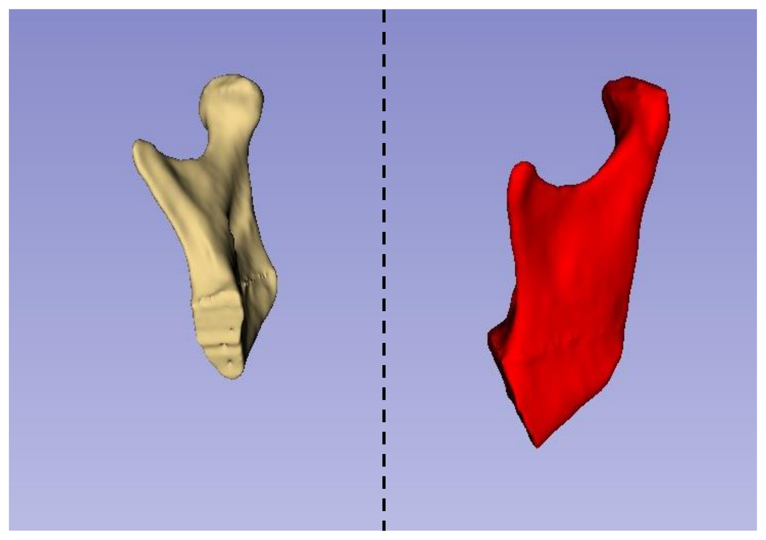


Figure 3. Mirrored mandibular ramus. The unfractured mandibular ramus is isolated and then mirrored along the Y-axis to create a symmetrical ramus to serve as the plate guide.

Discussion and Conclusions

The results of this pilot program highlight the potential benefits of using 3D-printed surgical guides for endoscopic repair of subcondylar mandible fractures. Although the differences in mean operative times between the 3DSG and non-3DSG groups did not reach statistical significance, there is a trend toward shorter operative times in cases where the guides were used, indicating that the 3DSG may streamline the surgical workflow and improve the efficiency of the procedure.

While the reduction in operative time is important from a technical standpoint, it also has significant financial implications. Operative time is a key driver of surgical costs, with one estimate placing the cost at approximately $46 per minute[1]. Based on this estimate, the use of a 3DSG could potentially save $1,196 per case (26 minutes of reduced time), making these guides not only a valuable tool for improving surgical precision but also a cost-saving measure for hospitals and healthcare systems.

The anecdotal feedback from the surgical team further supports the practical utility of 3DSGs. Surgeons reported that the guides improved their ability to adapt implants to patient-specific anatomy, reducing the inherent difficulty of working with 2-dimensional screen displays in an endoscopic setting.

Despite the promising trends observed in this pilot study, the lack of statistical significance highlights the need for additional studies to validate these findings. Future studies should aim to control for variables such as complexity of fractures and resident participation, while also assessing the long-term benefits, including patient outcomes and complication rates.

Figure 4. 3D-printed surgical guide. The mirrored mandibular ramus is printed to serve as a guide to bend the plates to in the operating room.

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References

1. Jacobovicz J, Lee C, Trabulsy PP. Endoscopic repair of mandibular subcondylar fractures. Plast Reconstr Surg. 1998;101(2):437-41.
2. Loukota RA. Endoscopically assisted reduction and fixation of condylar neck/base fractures--The learning curve. Br J Oral Maxillofac Surg. 2006;44(6):480-1.
3. Khiabani KS, Raisian S, Khanian Mehmandoost M. Comparison between two techniques for the treatment of mandibular subcondylar fractures: closed treatment technique and transoral endoscopic-assisted open reduction. J Maxillofac Oral Surg. 2015;14(2):363-9.
4. Smith, T. S., Evans, J., Moriel, K., Tihista, M., Bacak, C., Dunn, J., Rajani, R., & Childs, B. (2022). Cost of Operating Room Time is $46.04 Dollars per Minute. Journal of Orthopeadic Business, 2(4), 10–13. https://doi.org/http://dx.doi.org/10.55576/job.v2i4.23