In House Resident Led Virtual Surgical Planning Using Open-Source Software

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Introduction

Virtual surgical planning (VSP) has become an essential tool for mandibular and maxillary reconstruction. Recent advances in **open-source software** have made this technology increasingly accessible, especially in resource-limited settings.

At our regional medical center, we implemented **in-house VSP** for mandibular reconstruction using only free, open-source tools. CT scans were segmented to create virtual osteotomies and reconstructive plans, which were then converted into **3D-printed surgical guides** for intraoperative use.

This project demonstrates the **feasibility and practicality** of performing complex craniofacial reconstruction using open-source software, broadening access to VSP without reliance on commercial platforms.

Methods

A retrospective review of a cohort of five patients underwent in-house virtual surgical planning (VSP) for reconstruction of craniomaxillofacial defects.

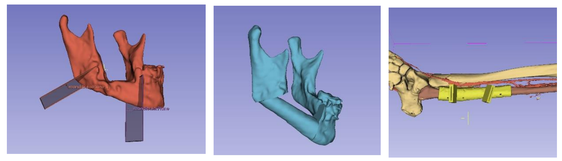
Virtual surgical plans were developed collaboratively by the ablative and reconstructive surgical teams to ensure oncologic safety and optimal reconstructive alignment using 3D Slicer.

Segmented models of the mandible, fibula, and surrounding structures were refined using Meshmixer (Autodesk, Inc.).

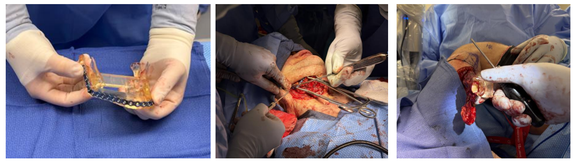
The finalized models were exported for 3D printing using Formlabs PreForm software and printed on a Form 4B 3D printer with biocompatible Surgical Guide Resin.

Case 1

45 y.o. male with history of osteonecrosis/osteomyelitis of the right mandible secondary to osteopetrosis. This had been present for 2.5 years during which time he has undergone multiple rounds of IV antibiotics, HBO therapy, surgical debridements, and PRF treatments without improvement.

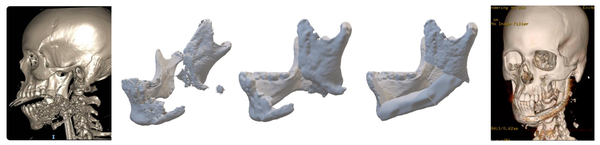


He underwent segmental mandibulectomy with single segment fibula free flap.

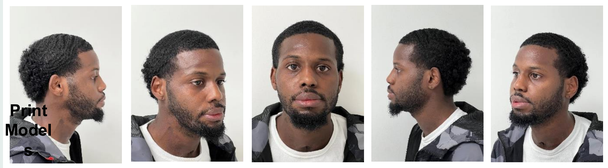


Case 2

29 year old male presenting with GSW to left face with exit wound to right shoulder. CT demonstrated a extensively comminuted left mandible. Patient was placed in MMF and underwent serial debridements and washouts over the following months.

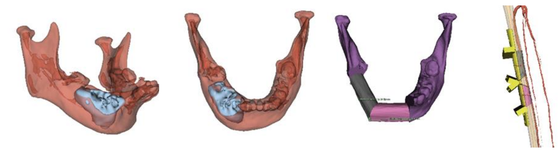


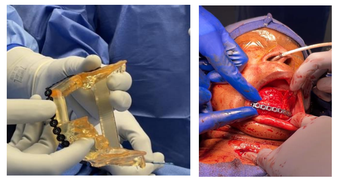
The ramus was virtually reduced, and reconstruction was planned with who fibula segments with coronoidotomy.



Case 3

79 year old female with ORN of the right mandible from dental extractions while on Boniva in 2017. Patient with exposed mandibular bone intraorally as well as submental fistula.

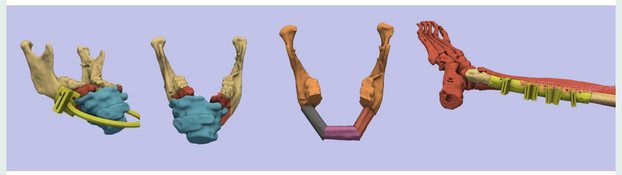




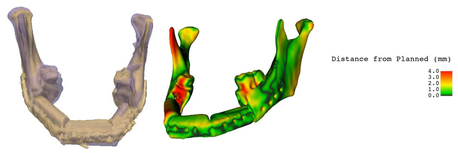
Preoperative Imaging showed a large area of sequestered necrotic bone. This was resected an reconstructed with a planned two segmented anterior reconstruction

Case 4

49 y.o. female T4aN0 oral cavity SCCa. She had avery large tumor extending through the mandible and involving chin skin and her lip.



Anterior mandibular resection was planned with 3 segment reconstruction.



Post operative overlay shows very close alignment of the actual fibula placement with the planned fibula placement.

Online Learning Materials

Conclusions

In-house virtual surgical planning using open-source and low-cost tools is feasible and effective for a variety of craniomaxillofacial pathologies. The workflow—leveraging open/free source software and in house printing—enabled rapid turnaround, surgeon-driven customization, and accurate guide fabrication. This approach reduced reliance on commercial planning services and fostered closer collaboration between ablative and reconstructive teams.

Early experience with this small cohort demonstrates that resident- and faculty-led in-house VSP can streamline preoperative planning, enhance surgical precision, and provide an accessible educational platform for trainees.

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