Building a Workflow for Cooperatively Controlled Robotic Mandibular Surgery

Computer Integrated Surgery II - Spring, 2022
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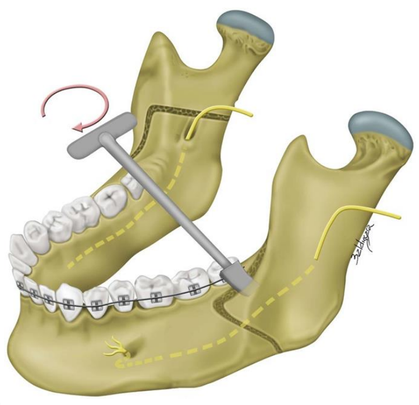
Introduction

- This project aims to improve the safety and accuracy of the Bilateral Sagittal Split Osteotomy (BSSO) procedure using a cooperative robotic system and virtual fixtures.
- Such a workflow will be the first of its kind for the BSSO and will help pave the way for future cooperative robotic procedures.

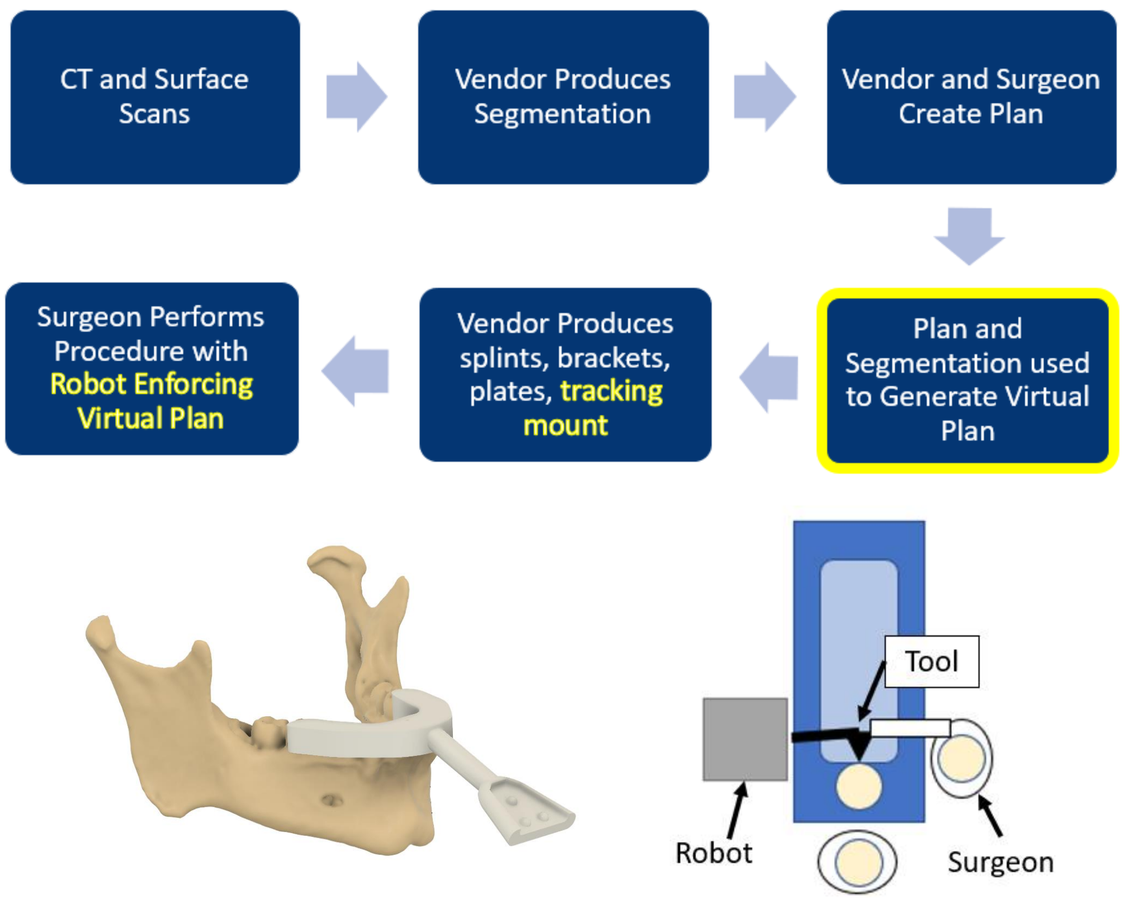
The Problem

- BSSO is used to correct an overextended jaw or receded chin.
- The mandible is cut on both sides and fixed in place in the desired position.
- Alveolar nerve that runs through the jaw can be damaged during the procedure.
- Temporary nerve damage occurs in 100% of patients with 10% of cases being permanent.

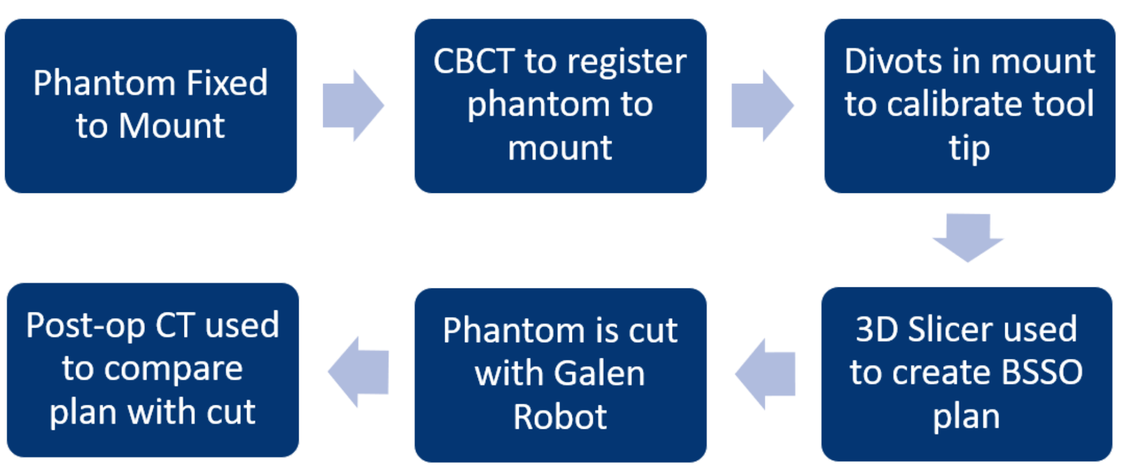


The Solution

- The solution utilizes a “hand over hand” style robot to enforce virtual guidance.
- Physician will use segmented patient CT data to plan an ideal mandibular cut.
- Robot will enforce the defined plan, ensuring the accuracy and safety of the procedure.
- Proposed Clinical Workflow (changes from current clinical workflow are highlighted):

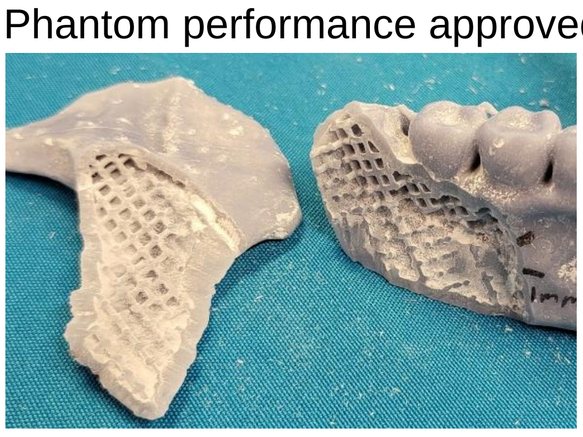


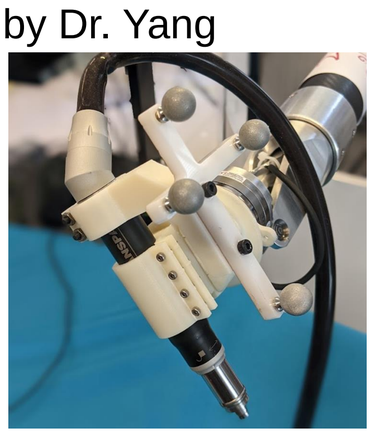
- Bench Testing Workflow:



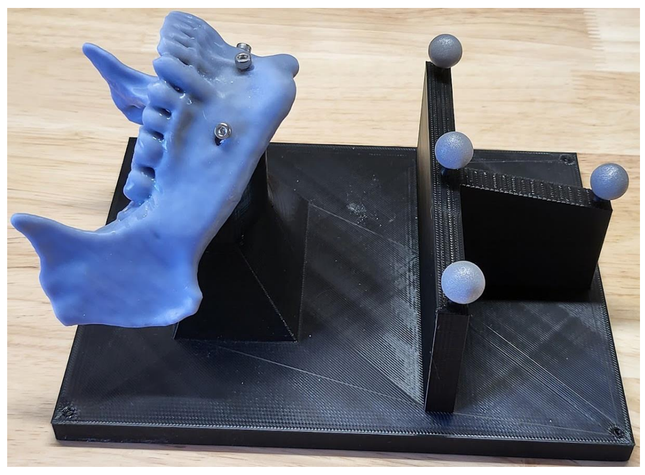
Outcomes and Results

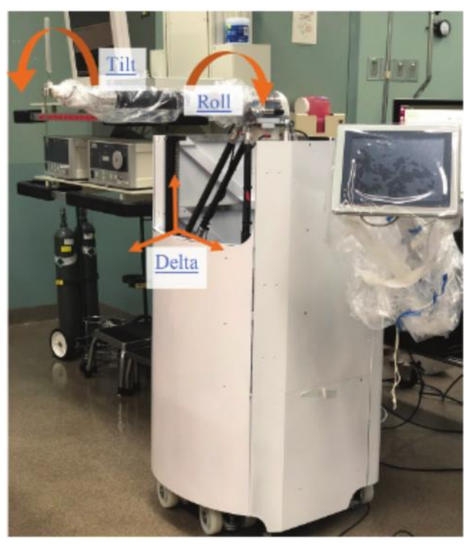
- Designed a clinically relevant bone phantom from patient CT data that is representative of bone.
  - Used SLA printing and photopolymer resin
  - Shell used to represent cortical bone
  - Lattice used to represent cancellous bone
  - Phantom performance approved by Dr. Yang





- Created an adaptor for the Anspach EG1 drill to be used with the Galen robot.
  - Optical markers will be used to track the tool position
- Mount created to track the position of the mandible using optical markers.
- Workflow setup with the Galen robot approved by physician Dr. Yang.





Future Work

- Setting up optical tracking for bench testing
- Using CT to register the mandible to the markers and pivot calibration to register the tool tip to markers
- Implementing a system for enforcing virtual fixtures during the procedure
- Designing bone registration for the clinical setting

Lessons Learned

- The many components involved in a comprehensive robotic workflow for surgery: Patient data, surgical plan, registration, tracking, surgical tools, etc.
- Characteristic important to surgeons in surgical phantoms

Credits

- Jesse Haworth was responsible for all project work.
- Sahana Kumar & Niranjan Behera segmented the CT data.

Support by and Acknowledgements

- Johns Hopkins CiiS Lab
- Thank you to Dr. Yang, Dr. Taylor, and Dr. Creighton for your mentorship.