

3D-Printed Palatal Obturators for Pediatric, Bilateral Cleft Patients

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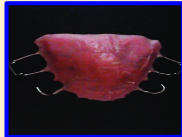
Advisor: Adrian Shieh, PhD (Drexel University); **External Advisor:** Quinn McCarthy (Depuy Synthes)

Medical Need

- **Cleft Palate:** Most common congenital craniofacial abnormality that occurs in 1 in every 700 live births
- Alveolar arch collapse can occur due to inadequate intraoral support
- Without treatment, midface deficiency, collapsed dental arches, and the malformation of teeth can occur
- 44% of patients turned away from treatment in developing countries
- Existing solutions include a lengthy fabrication process involving impression/casting/molding, which is expensive and time consuming



Bilateral cleft palate



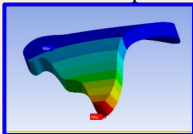
Palatal obturator

Project Goal

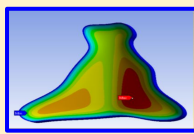
Create a palatal obturator design with a 3D-printable material that will prevent alveolar arch collapse for preoperative bilateral cleft patients in ages ranging from 7-11

Finite Element Analysis

- 3D prototype imported into ANSYS software to analyze stress and deformation heatmaps

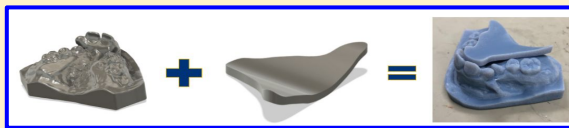


Cheek force deformation heatmap



Tongue force deformation heatmap

Solution

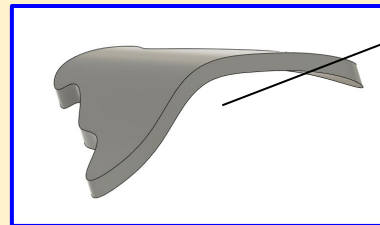


3D Oral Model from Medical Scan

3D Personalized Obturator Prototype

3D Prototype on Patient Palate

| Requirement | Orientation | Acceptance Criteria |
|------------------------------------|--|---|
| Withstand 1.2 N load cheek force | Side to side (medial to lateral forces) | $< 8 * 10^{-3}$ mm displacement bottom face |
| Withstand 0.68 N load tongue force | Dynamic vertical loading during chewing and swallowing | $< 6.5 * 10^{-3}$ mm displacement sides |

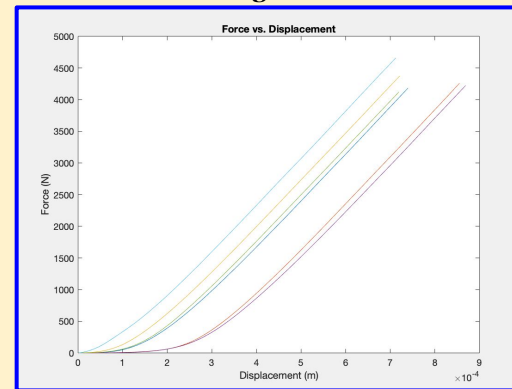


Single component

Uniform 4.0 mm thickness

Obturator Material - Stratasys Verobluue RGD840

Testing Results



- Tongue force verification testing negligible - simple compression test
- 6-run cheek force verification testing - **PASS**

Impact & Future Plans

- This non-invasive solution utilizes 3D-printing and engineering simulation software to fabricate palatal obturator designs leading to more efficient processes
 - Fast turnaround to treat patients in developing countries
- Automation of prototype production for future innovations

Special Acknowledgments

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