

Fully Digital Workflow for Fabrication of a Radiation Shield

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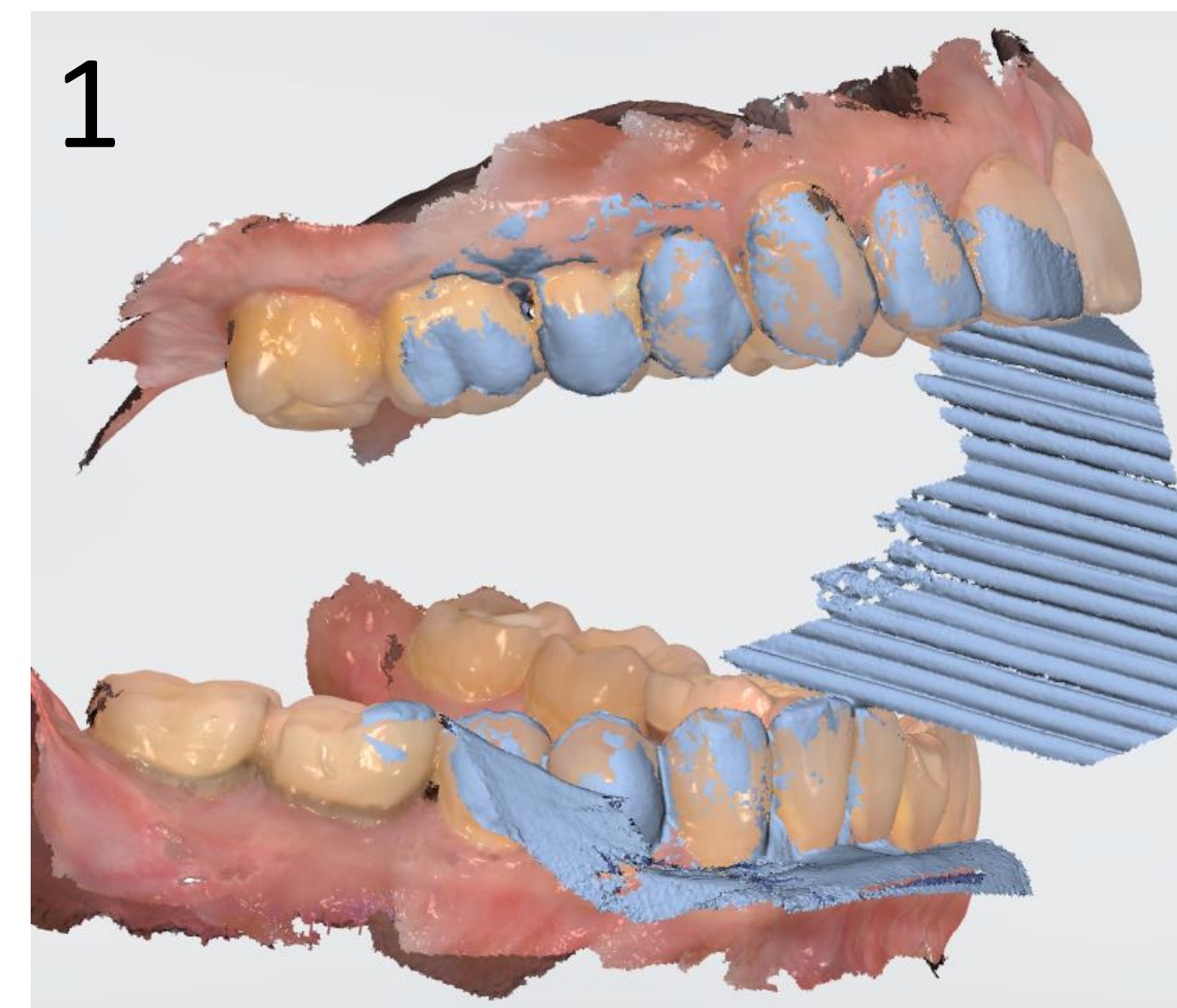


Introduction

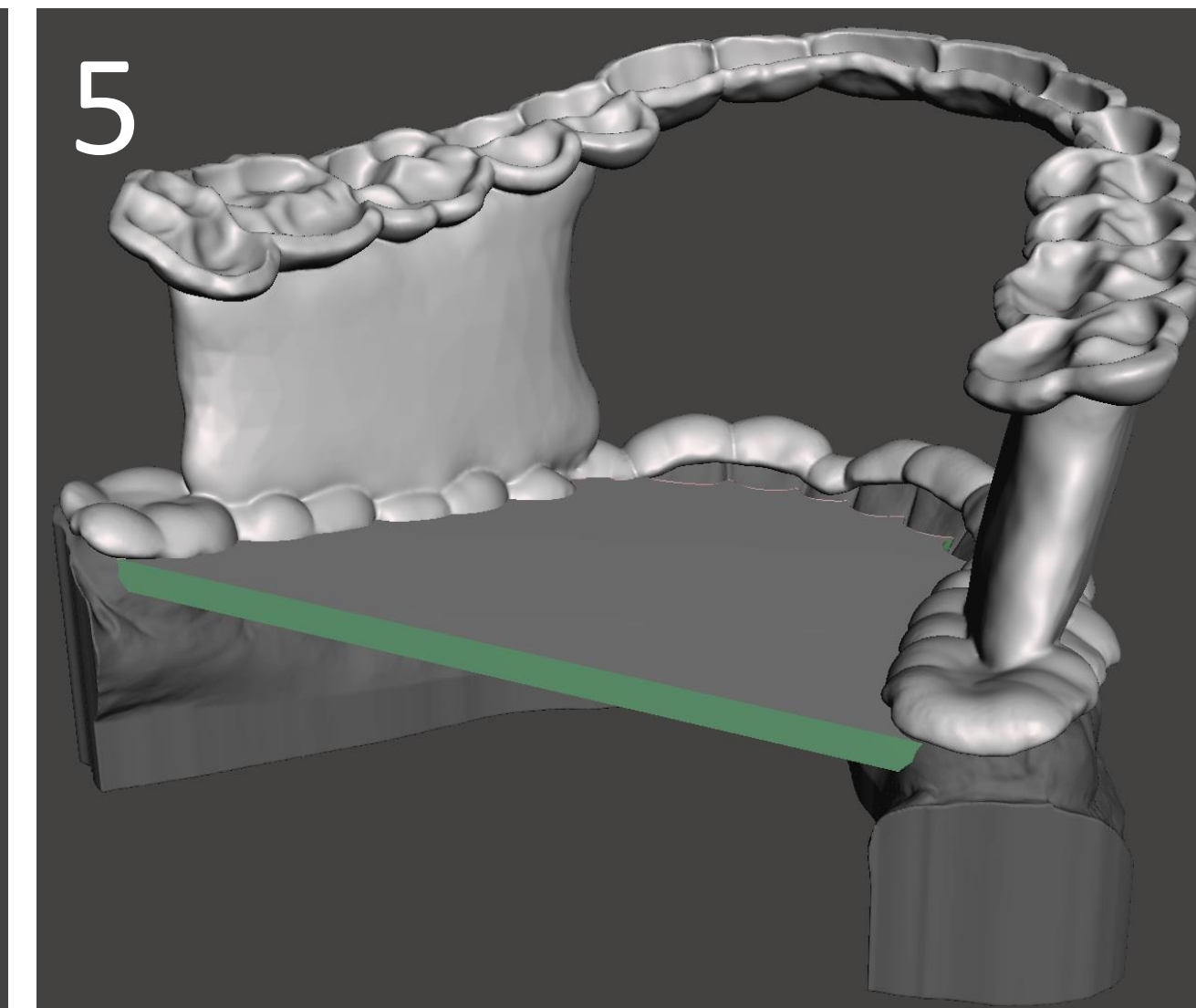
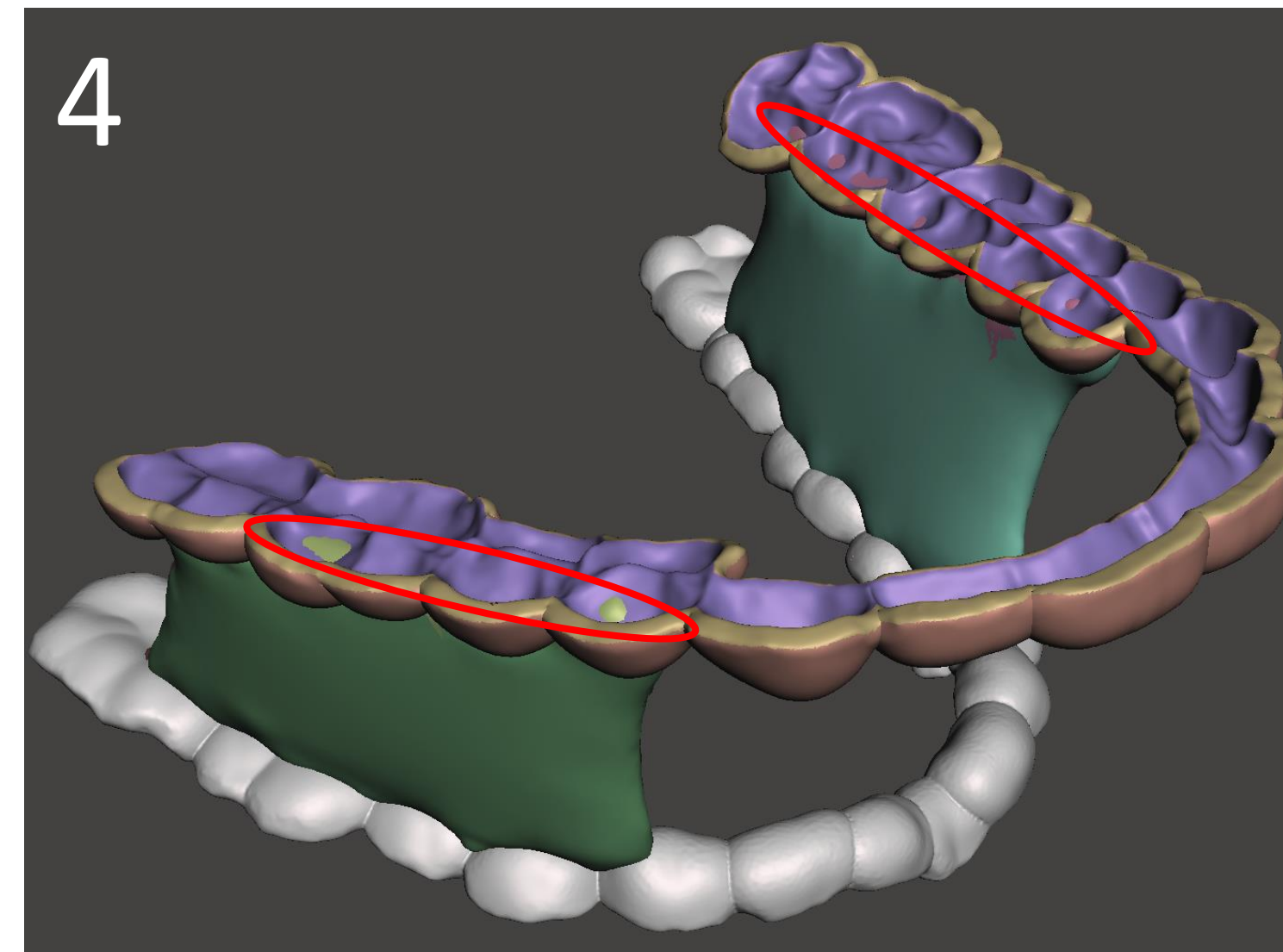
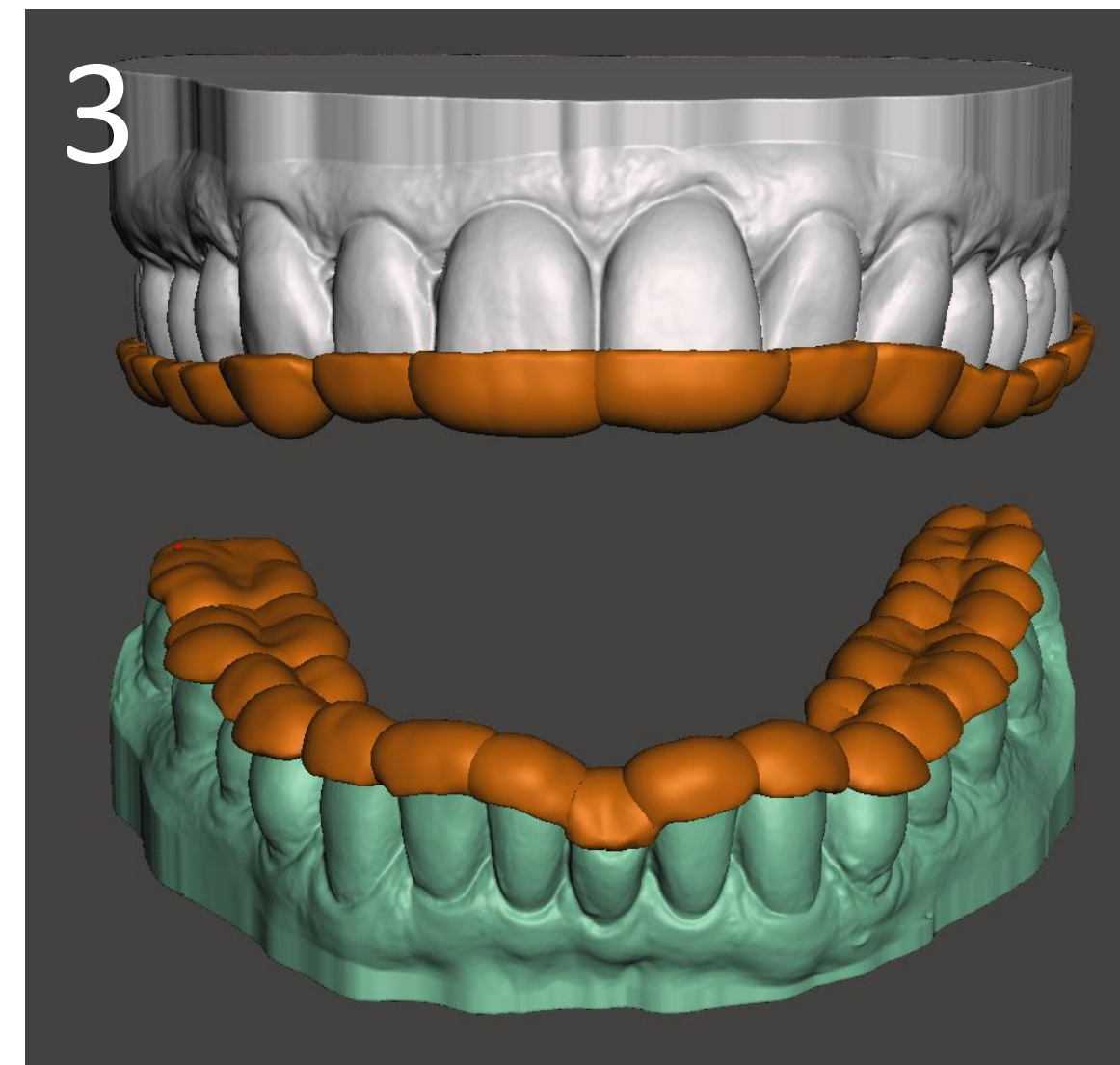
For patients diagnosed with head and neck cancer, external beam radiotherapy is a common mode of treatment either alone or in combination with chemotherapy, or after tumor resection surgery. During treatment, reproducible patient positioning and limitation of movement of intraoral structures is crucial to minimize toxicity and exposure dose of healthy structures.

Materials and Methods

1. Obtain intraoral digital scans (Trios 4 - 3Shape)
2. Determine patient's maximal comfortable opening and reduce by ~2-4 mm
3. Use tongue depressors in anterior as reference to connect posterior scans on both sides for bite scan (digital jaw relation record) ¹
4. Import scans into Meshmixer (Autodesk) with grid parallel to occlusal surfaces
 - Create models by smoothing borders, extruding, and "Make Solid" ("Accurate" solid type/"Solid Accuracy" 512/"Mesh Density" 512) ²

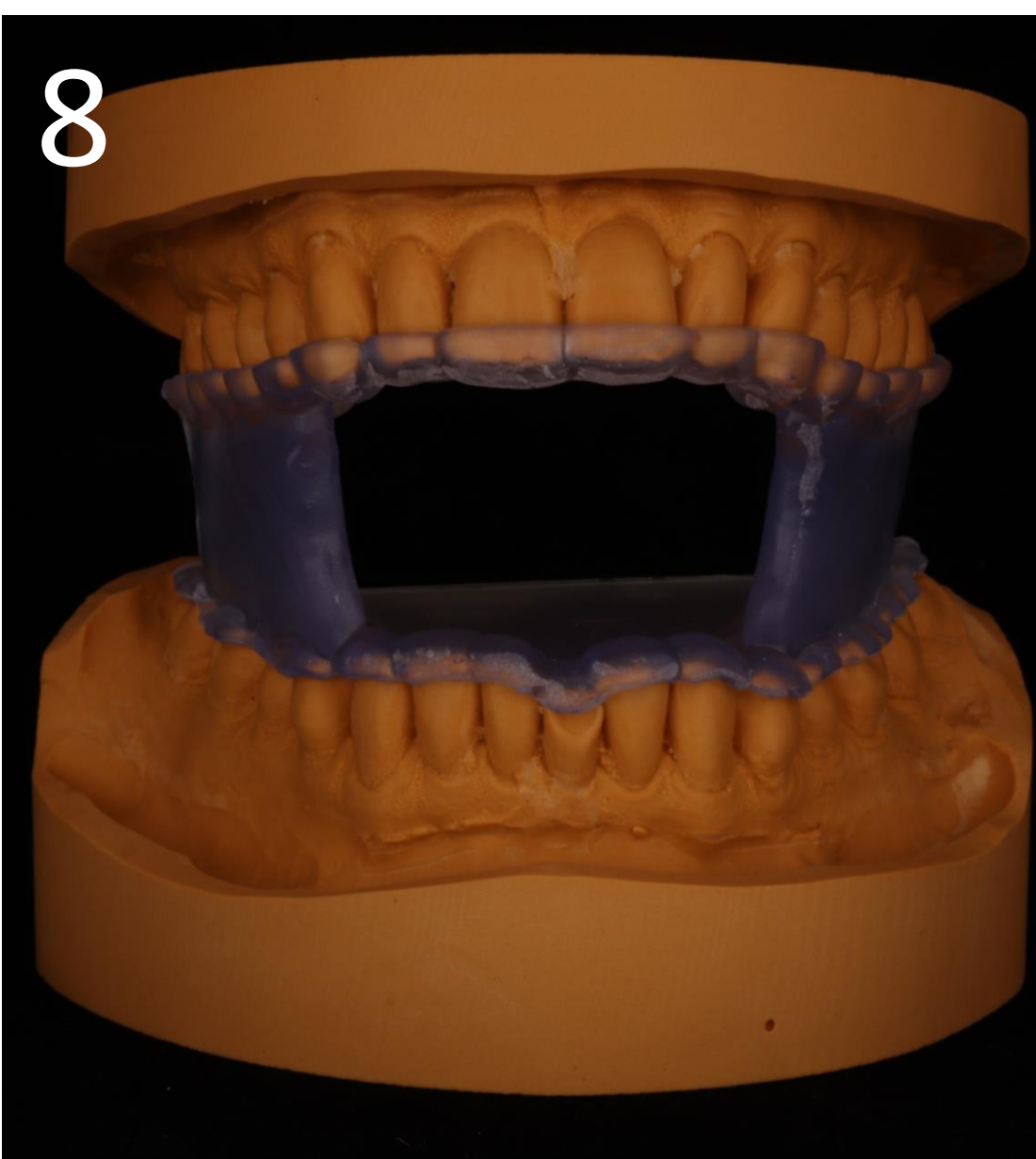
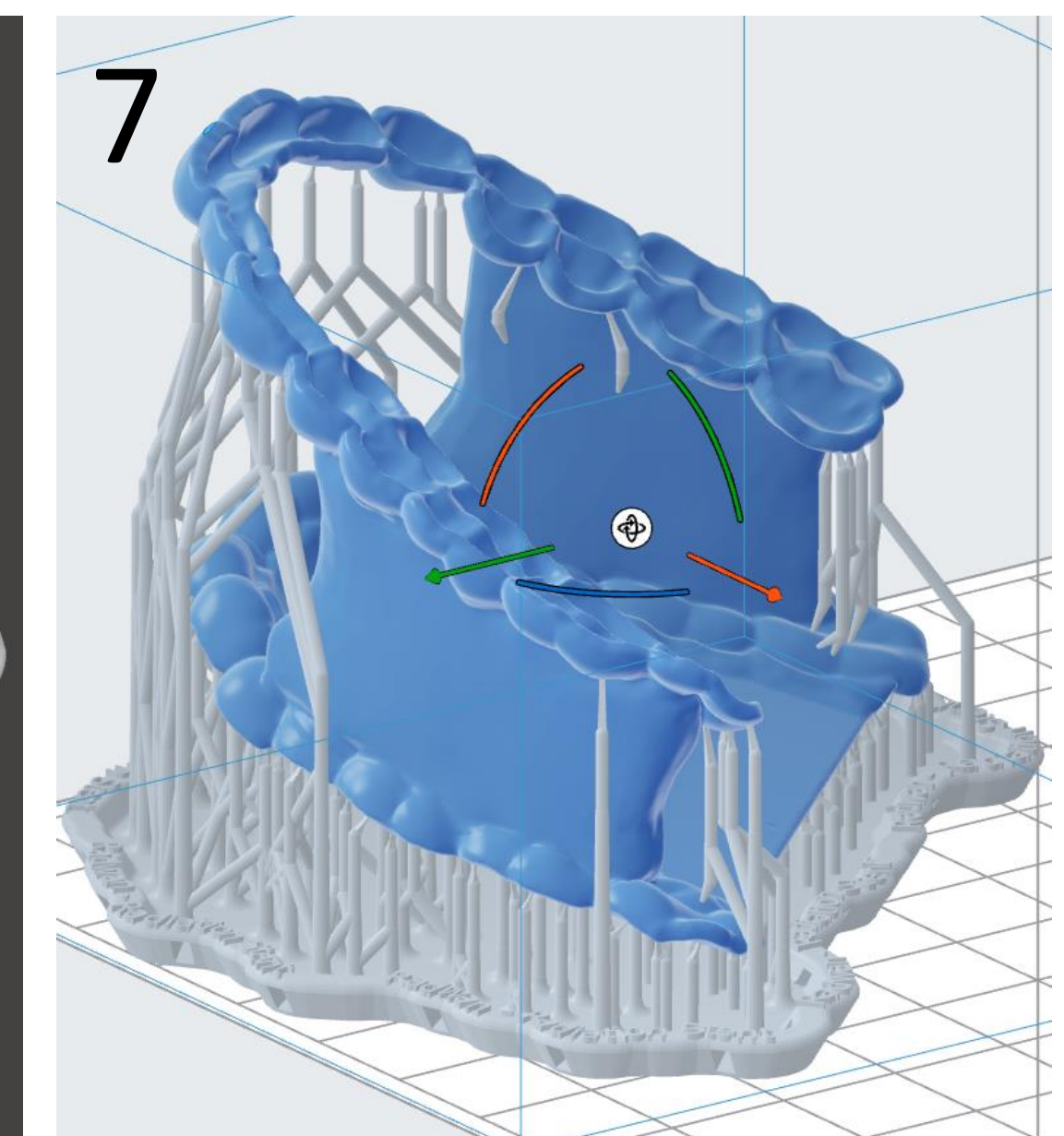
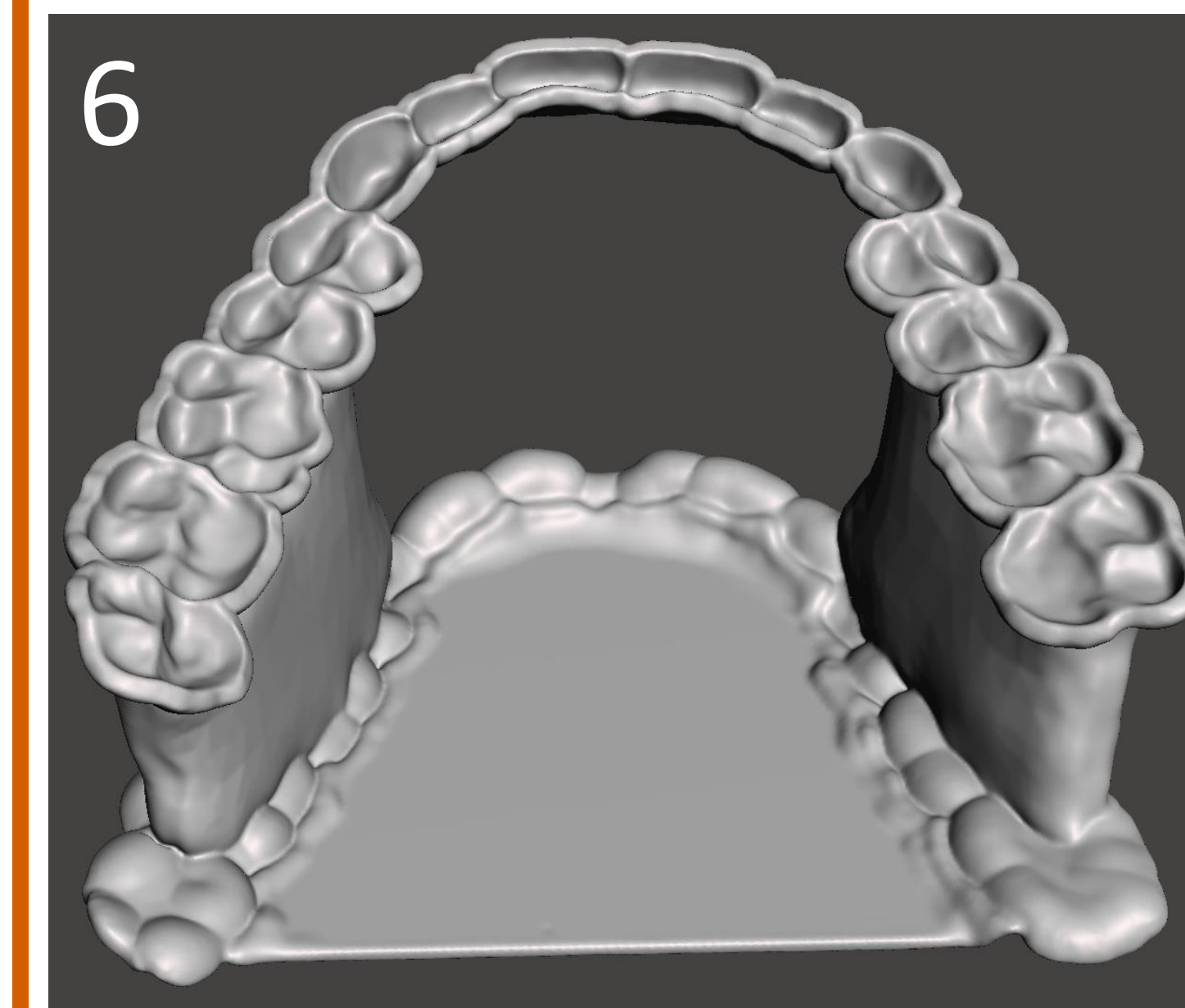


5. Working one arch at a time, select occlusal surfaces of all teeth above heights of contour and "offset" by 0.2 mm (provides relief for undercuts), smooth borders
6. Next "offset" that selection again by 1.5 mm and smooth borders
 - May need to use -1.5 mm for maxilla and 1.5 mm for mandible
 - This extrusion is the material thickness of the occlusal coverage of the stent and can be adjusted accordingly if thicker material is desired
7. Select borders of each offset, "Join" to create a continuous object, then "Make Solid" ³
8. Add preformed cylinders from the "Meshmix" tab, "transform" them (resize/rotate) to roughly span the occlusal surfaces of all posterior teeth, and "Plane cut" roughly along occlusal surfaces (will act as vertical support for shield)
 - Sculpt ("draw"/"flatten"/etc.) any areas that would interfere with occlusal surfaces of teeth – indicated in red circles ⁴
 - Finalize sculpting by adapting shape to the occlusal coverage portions



9. Select area around lingual height of contour along all mandibular teeth and offset and extrude as described above (this time in the "Normal" direction)
10. Add a cube from the "Meshmix" tab, "transform" into a flat plane (~1.5-2 mm thick), position at lingual offset, and perform "Boolean Difference" to adapt to linguals
11. "Sculpt" preformed shape until the contours approximate lingual offset, "Make Solid"
 - This plate will depress tongue during radiation treatment and limit mobility ⁵
12. "Combine" the occlusal stents with the preformed shapes and "make solid" (same settings as before)
13. Export STL file for 3D printing ⁶

14. Nest in PreForm (Formlabs) at ~10-30°, 0.100 mm layer thickness, "Full Raft" supports with minimum acceptable touchpoint size and default settings ⁷
15. Print on Form 3B 3D-printer (Formlabs) with "LT Clear V2" resin, post-process, and remove supports (smooth rough areas) – casts used for patient anonymity
16. Try-in intraorally, adjust any undercuts to allow full seating, confirm stability and repeatability of jaw positioning, and verify patient comfort ⁸



Discussion

Conventionally, tongue depressing devices and radiation stents are fabricated on mounted articulated models using resin bases with occlusal indices. The digital workflow allows printing of the device multiple times, if necessary, eliminates the need for stone models, and minimizes laboratory steps in which errors could occur. Minimal clinical adjustment was required with this workflow.

Conclusion

The fully digital workflow for fabrication of a radiation shield is a predictable method for the dentate patient. It allows for reproducibility in printing, can speed up fabrication time, and minimizes the potential for processing errors.

References

1. Bruno JS, Miranda-Silva W, Guedes VDS, Parahyba CJ, Moraes FY, Fregnani ER. Digital Workflow for Producing Oral Positioning Radiotherapy Stents for Head and Neck Cancer. J Prosthodont. 2020 Jun;29(5):448-452. doi: 10.1111/jopr.13155. Epub 2020 Apr 20. PMID: 32128953.

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