Advantages and Disadvantages of Virtual Surgical Planning

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PGY-4, Class of 2020

Disclosure

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The following potential conflict of interest relationships are germane to my presentation.

Equipment: None
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Consultant: None

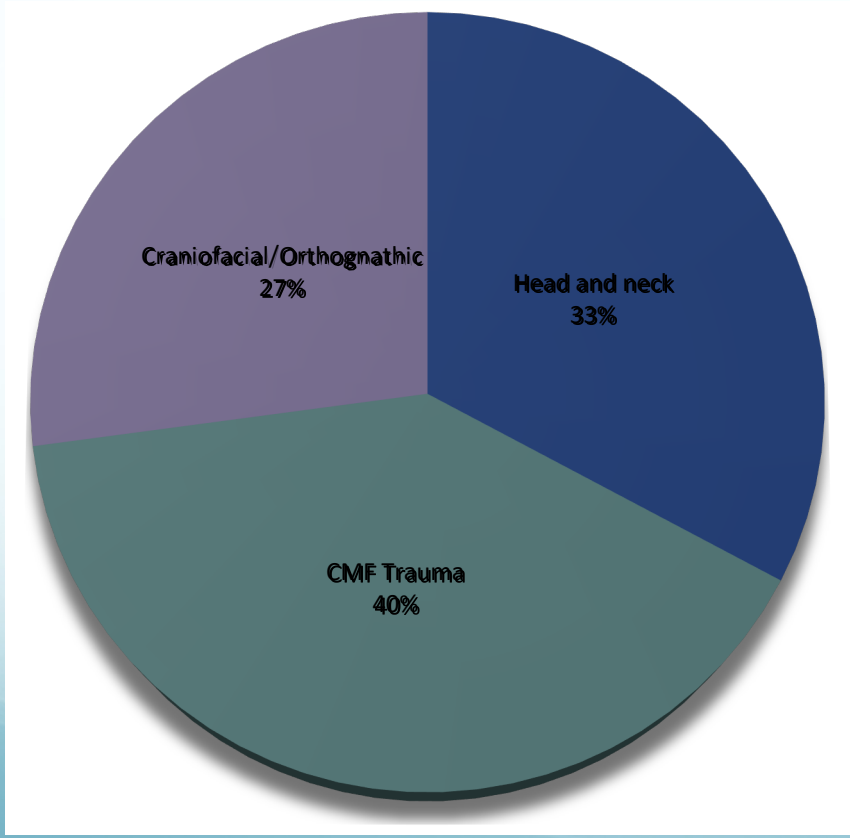
Status of FDA devices used for the material being presented
NA/Non-Clinical

Status of off-label use of devices, drugs or other materials that constitute the subject of this presentation
NA/Non-Clinical

Goals

- Advantages and Disadvantages
- Economics of Virtual Surgical Planning
- Treatment Applications
- JMH/UMH Experience

Computer aided Craniomaxillofacial Surgery (2006-2016)



- Head and neck
- CMF Trauma
- Craniofacial/Orthognathic

N=351 patients
Mean Age= 32
(range 8mo-78yrs)
M:F=1.8:1

VSP

2006 - Initial experience

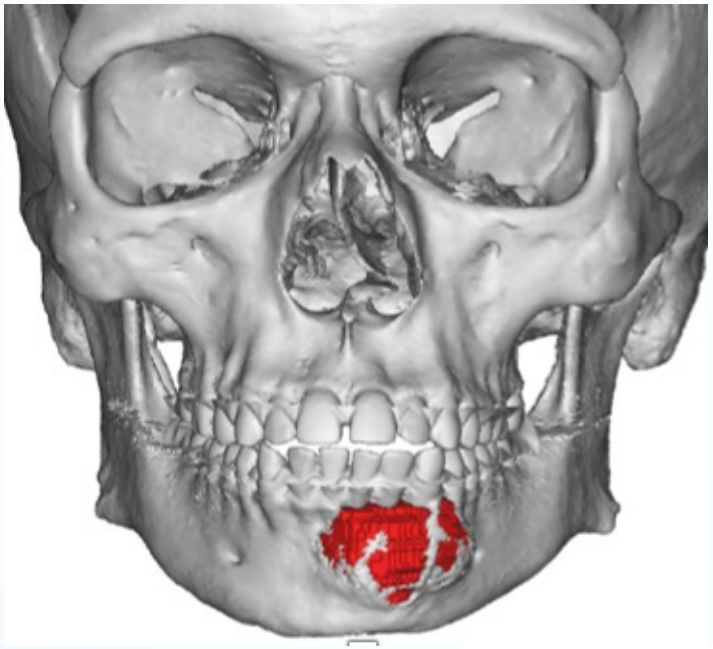
VSP

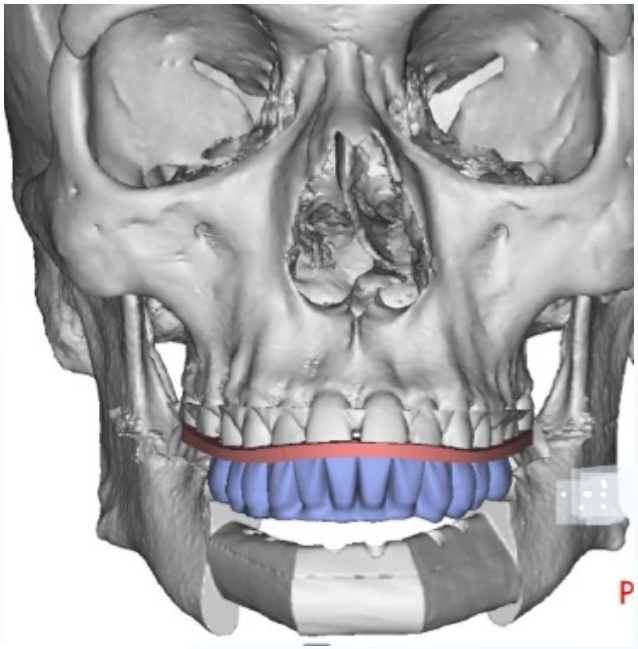
Use of Computer-Aided Design and Computer-Aided Manufacturing to Produce Orthognathically Ideal Surgical Outcomes: A Paradigm Shift in Head and Neck Reconstruction

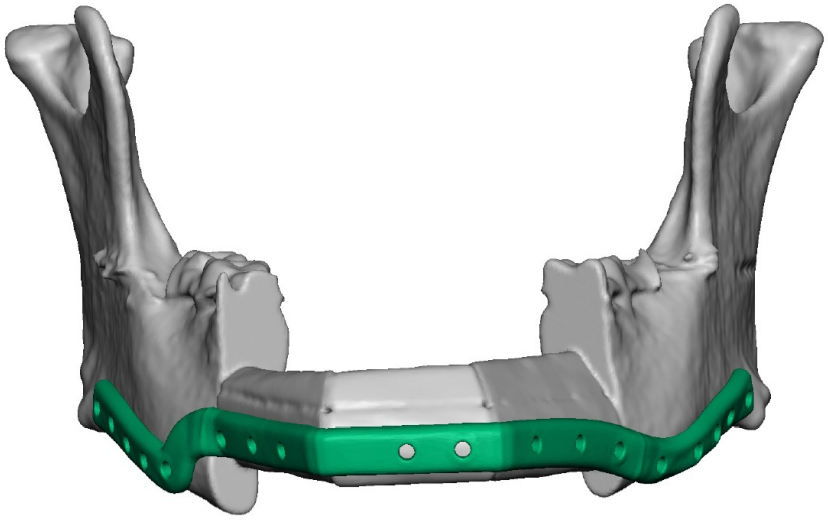
David L. Hirsch, DDS, MD, Evan S. Garfein, MD,†*
Andrew M. Christensen, BS,‡ Katherine A. Weimer, MS,§
Pierre B. Saddeh, MD,‖ and Jamie P. Levine, MD¶

J Oral Maxillofac Surg
67:2115-2122, 2009

Evolution







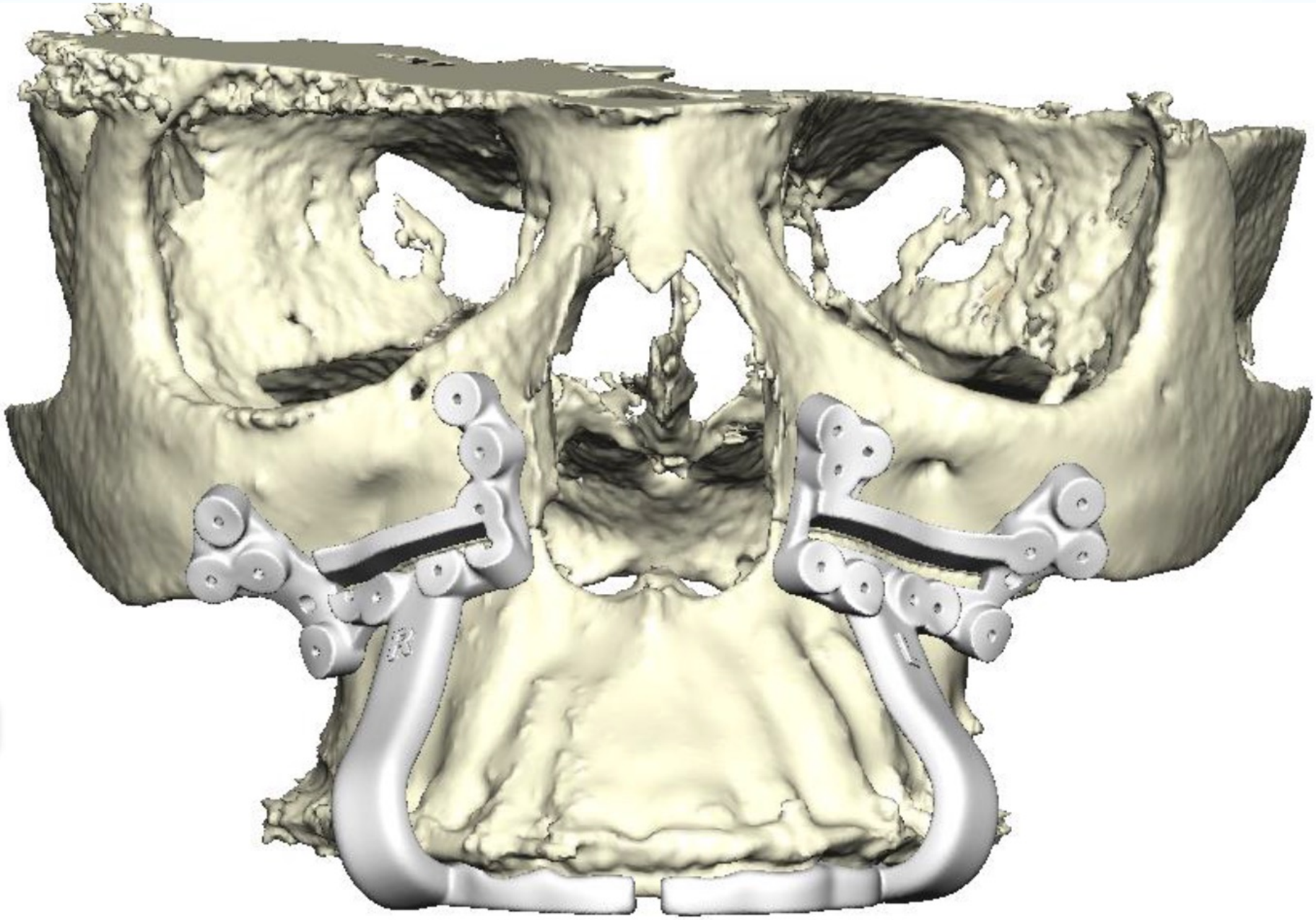
What can VSP Provide

- Knowledge
- Decreased planning costs for orthognathic surgery
- Anatomical models
- Occlusal splints
- Surgical guides
- Patient-specific implants (titanium and alloplastic)
- Potential for decreased operating time
  - Decreased general anesthesia time in patients with cardiopulmonary disease

Patient-Specific Titanium Implants

- Decrease operating time
- No need to adapt stock titanium plates
- Customized to patient's bony anatomy
- Milled vs 3D printed
- Optimize strength and thin plate profile
- No tensile or compressive strain

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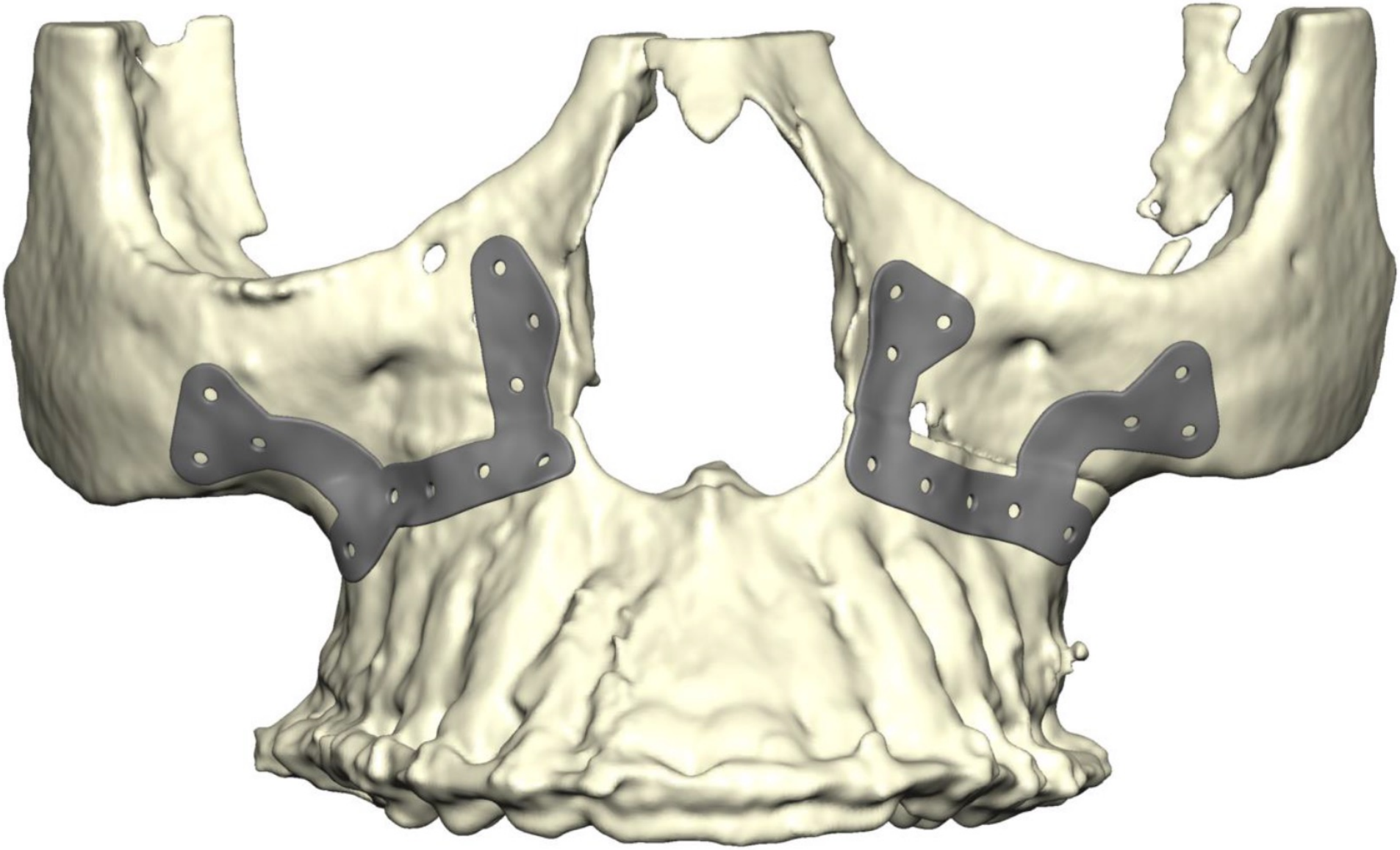


Patient Name: Ashley Garfield
Age: 32.10 years
Birthdate: 7/13/1987
Records Date: 2/13/2020
Timepoint: Final

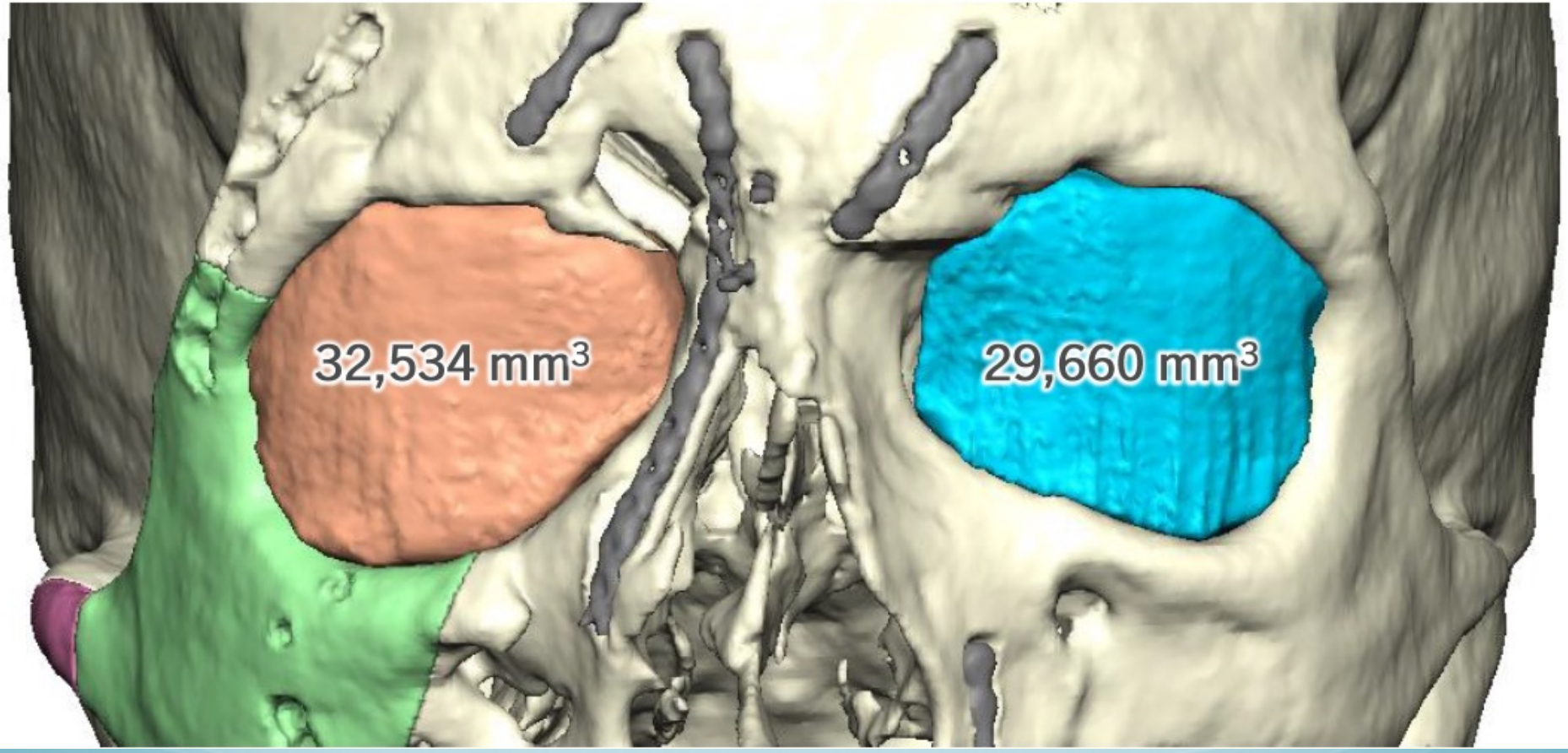
orthodonticsonly

Derek A Sanders DMD MDS
Diplomate, American Board of Orthodontics

Orbit Reconstruction

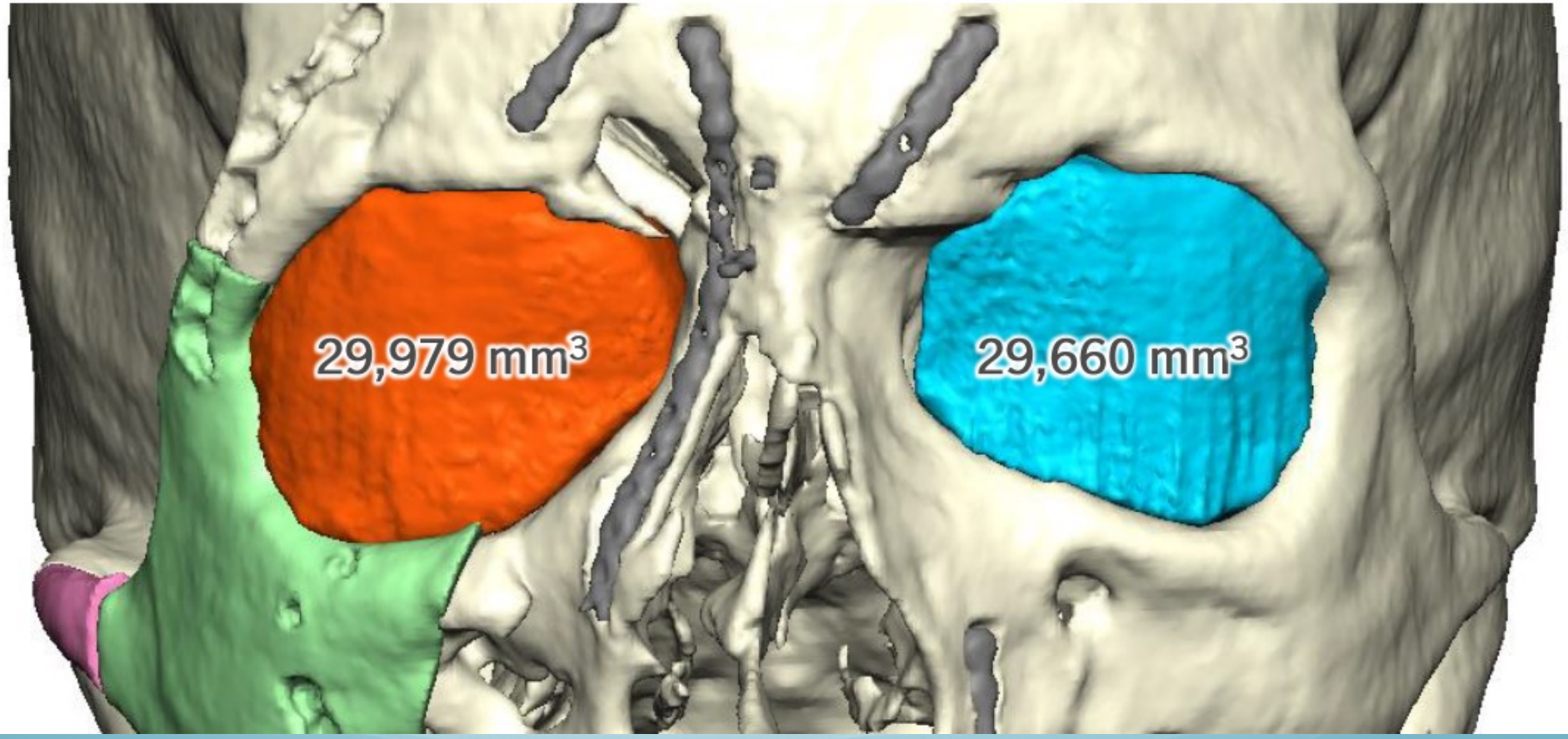
- Fewer repeated insertions of the implant for plate adjustments
- Pre-bent plate on stereolithic model vs expensive 3D-printed plate
- Can take account pitch, yaw, roll of the implant, which is difficult to do intraoperatively with a stock implant

Orbital Volumes – PreOp



Orbital Volumes – Planned

Mirror used to reconstruct orbital floor



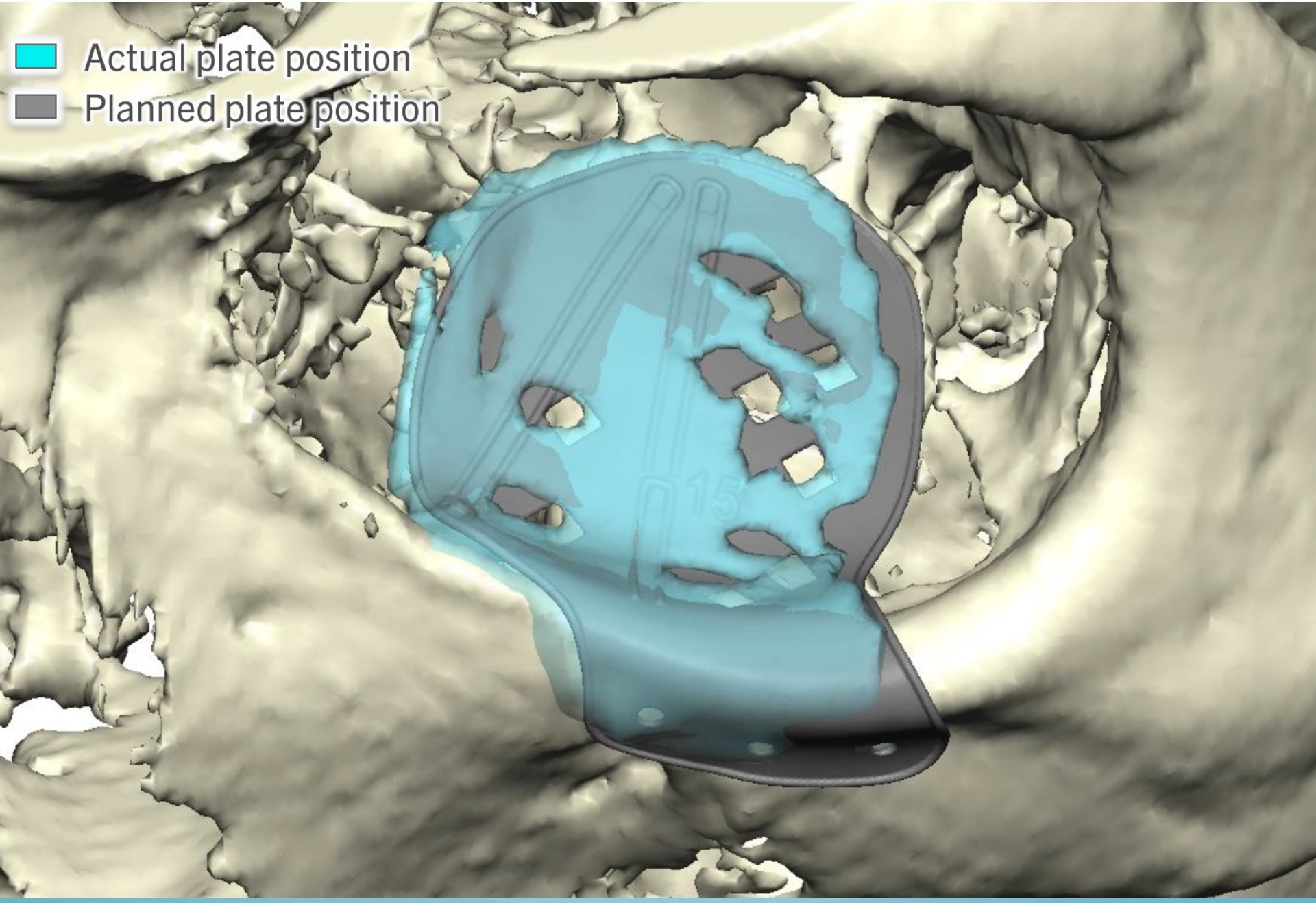
Segmentation and Mirroring of the Orbit

Table 2. MEAN, SD, MINIMUM, AND MAXIMUM OF LEFT AND RIGHT ORBITAL CAVITY TOTAL VOLUMES AND VOLUME DIFFERENCES BY GENDER

	Men		Women	
	Mean	SD	Mean	SD
Right orbital volume (mL)	28.82	3.12	26.29	2.56
Left orbital volume (mL)	28.74	3.22	26.27	2.52
Absolute volume difference (mL)	0.45	0.36	0.42	0.25
Volume difference (%)	1.58	1.25	1.61	0.94

Abbreviation: SD, standard deviation.

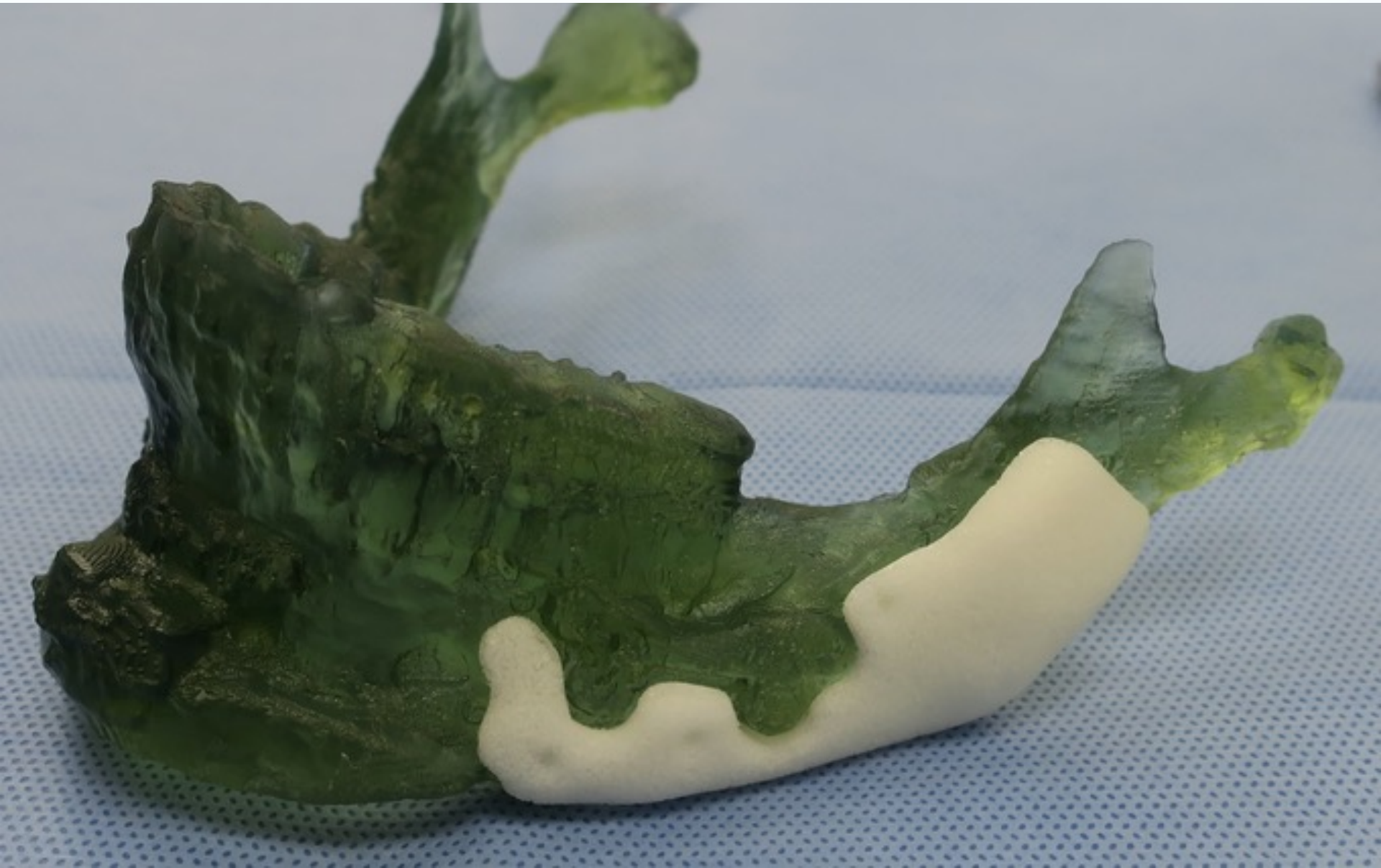
Jansen et al. Virtual Mirroring for Orbital Reconstruction. J Oral Maxillofac Surg 2018.


Actual plate position
Planned plate position

Mandibular Trauma

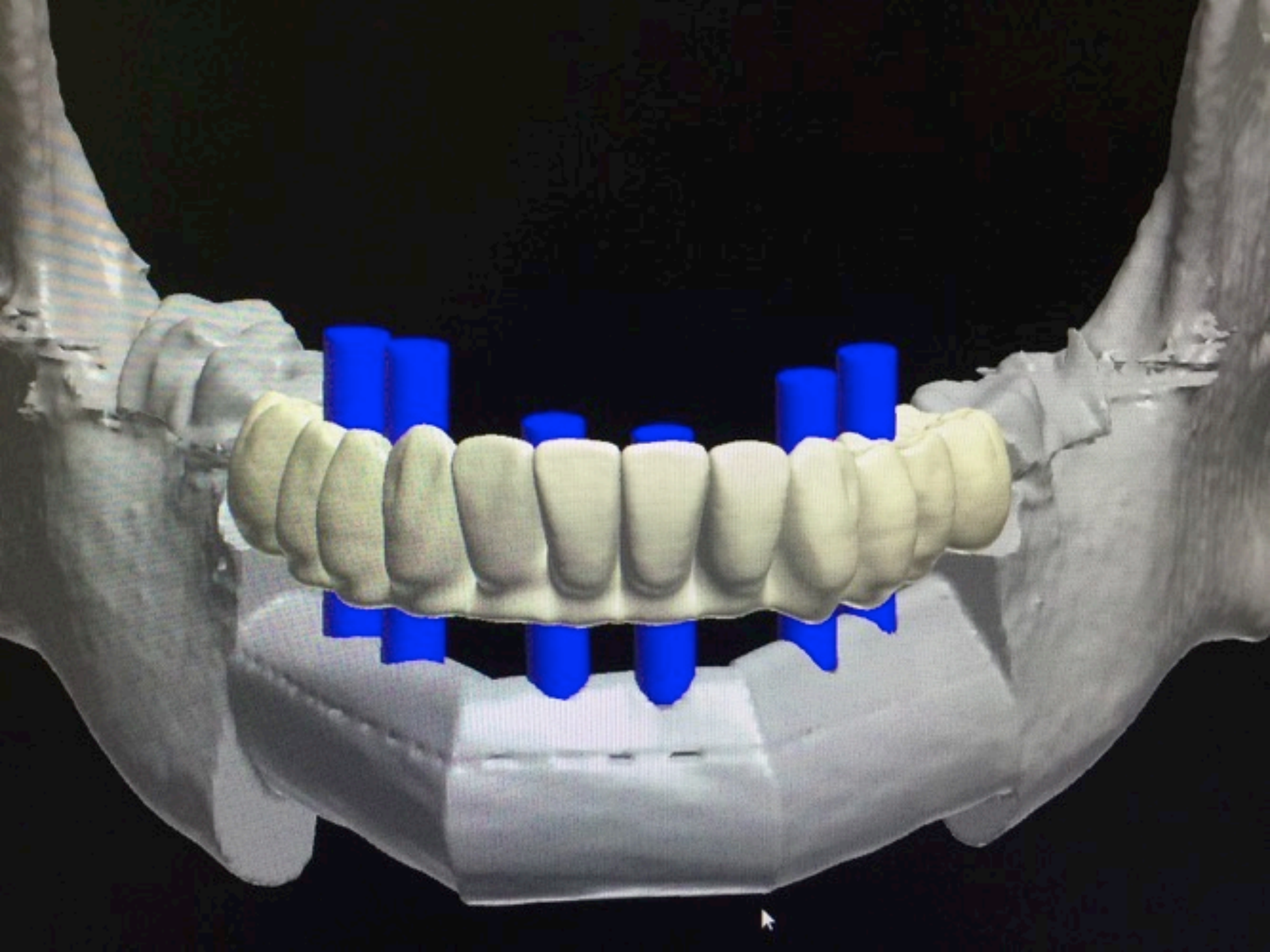
- CAD/CAM splints vs manually fabricated acrylic splints
- Allows for more accurate splints
  - Restoration of ideal pre-trauma dental occlusion
  - Arch micromovement in sagittal and horizontal planes
  - Lingual splay
  - Cross-arch stability during fixation

Patient-Specific Alloplastic Implants



Reconstruction Plate Turnover

- Pre-bent and milled fixation hardware
  - 7-14 days
- 3D printed plates
  - 14-17 days



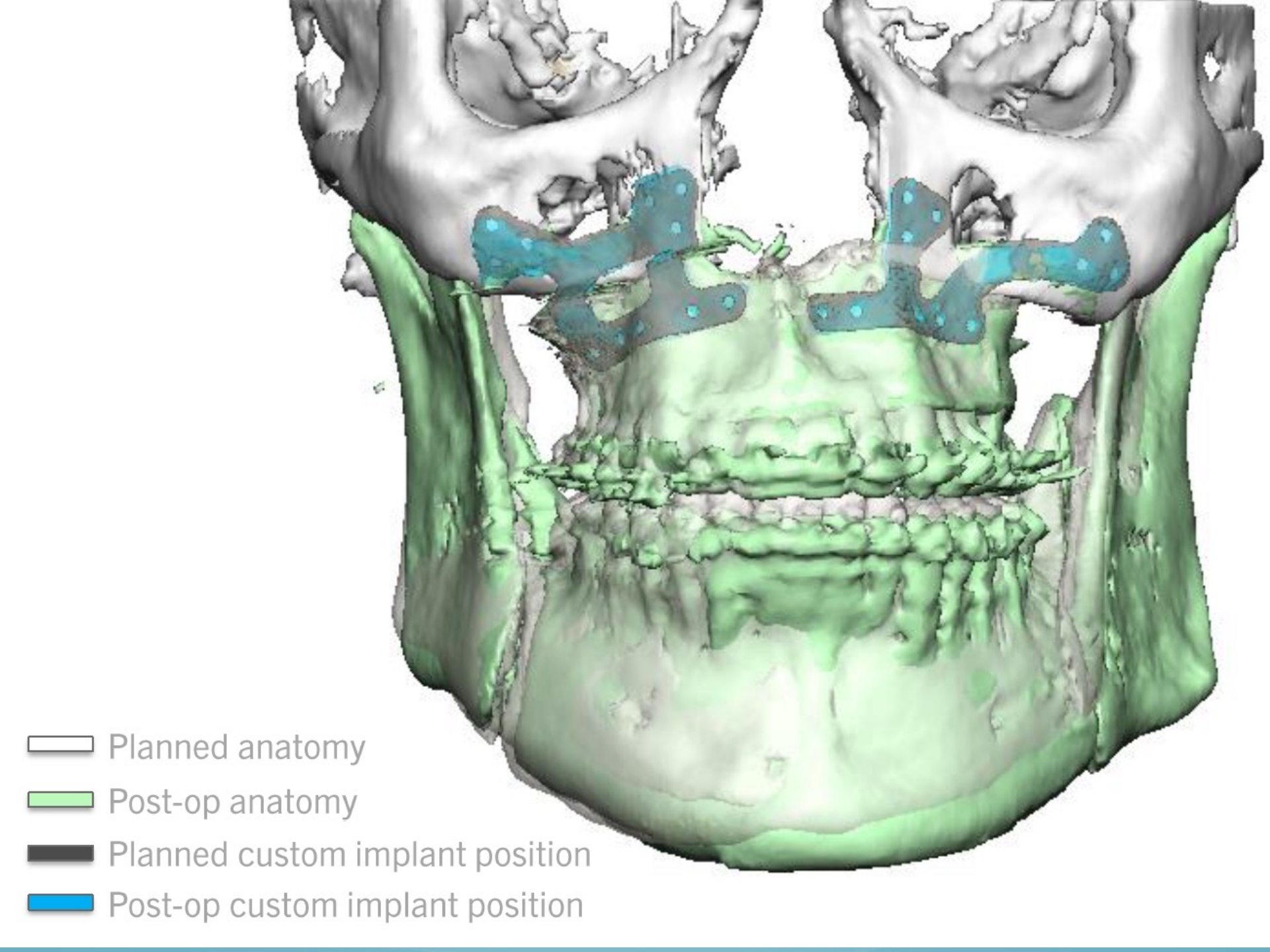
Mandibular Reconstruction Improved outcomes?

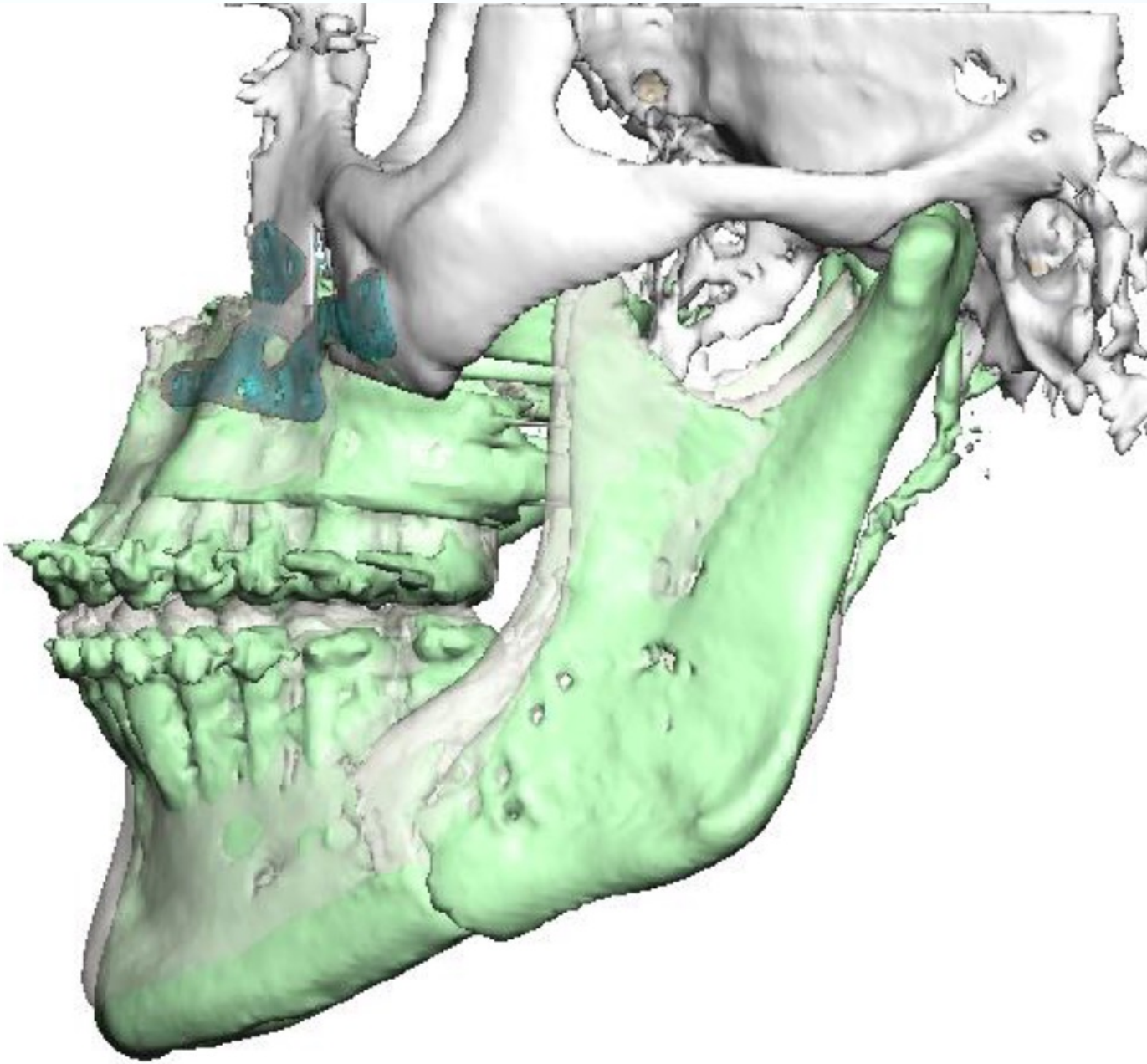
- Surgeon
  - Shorter operative time
  - Shorter ischemia time
  - More accurate osteotomies
  - Improved symmetry and angulation

- Patient
  - No statistically significant data on improvement in patient outcomes
  - Potentially quicker advancement to functional occlusion and mastication
  - Overall functional benefit may be minimal overall

Disadvantages

- #1 failure is poor planning
- Surgical access
- Bony interferences may be overlooked
- Stability of cutting guides
- No soft tissue evaluation
- Extended planning period
- Surgery delay (risk of rapid tumor growth, trauma)
- Inaccurate surgical margins in cancer surgery
- Cannot extend margins
- Patient specific plates are expensive


Planned anatomy
Post-op anatomy
Planned custom implant position
Post-op custom implant position


Planned anatomy
Post-op anatomy
Planned custom implant position
Post-op custom implant position

Where Errors Can Occur

- Technical errors while obtaining CT
  - Motion artifacts
  - Inadequate data acquisition
- Technical errors in computer processing compatibility of the DICOM files
- CT cuts too large
- Errors in segmentation calculations
- CAD/CAM errors
- Miscommunication between surgeon, and technicians

Take Home Points

- VSP should be used as an adjunct to and not substitute the need for surgical experience in reconstruction
- Intraoperative changes to the surgical plan can be costly in terms of operative time, adequate operative results, and complications
- VSP accuracy is not questionable, but it may not be statistically significant
- Over-reliance on VSP can lead to diminished skills in problem-solving and implant manipulation.