



3D Modelling of Zygomatic Implants: Approaches for the Rehabilitation of Atrophic Maxilla



Laura Alberto¹, Ravi Chandran², Yuefeng Lu³, Jason Griggs¹, Yuanyuan Duan¹

¹ Department of Biomedical Materials Science, University of Mississippi Medical Center, Jackson, MS 39216, USA.

²Department of Oral-Maxillofacial Surgery and Pathology, University of Mississippi Medical Center, Jackson, MS 39216, USA.

³ Department of Advanced Biomedical Education, University of Mississippi Medical Center, Jackson, MS 39216, USA

Introduction

Edentulism

- Mastication
 - Phonetic function
 - Social interactions
 - Psychological issues
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- Age
 - Social-economical conditions

60 years or over: 962 million
US prevalence: 19%

Zygomatic implants

- Brånemark, 1984
- Zygoma anatomic-guided approach (ZAGA), Aparicio, 2011
- Longer (30 to 62.5 mm)
- Tilted (17 to 60 degrees)
- **Zygomatic bone:** compact bone
- High elastic modulus: 18.7 GPa
- Not affected by bone remodeling process

Benefits:

- Less patient morbidity
- Graft-free procedure
- One-step surgery
- Immediate loading
- High level of primary stability
- High success rate

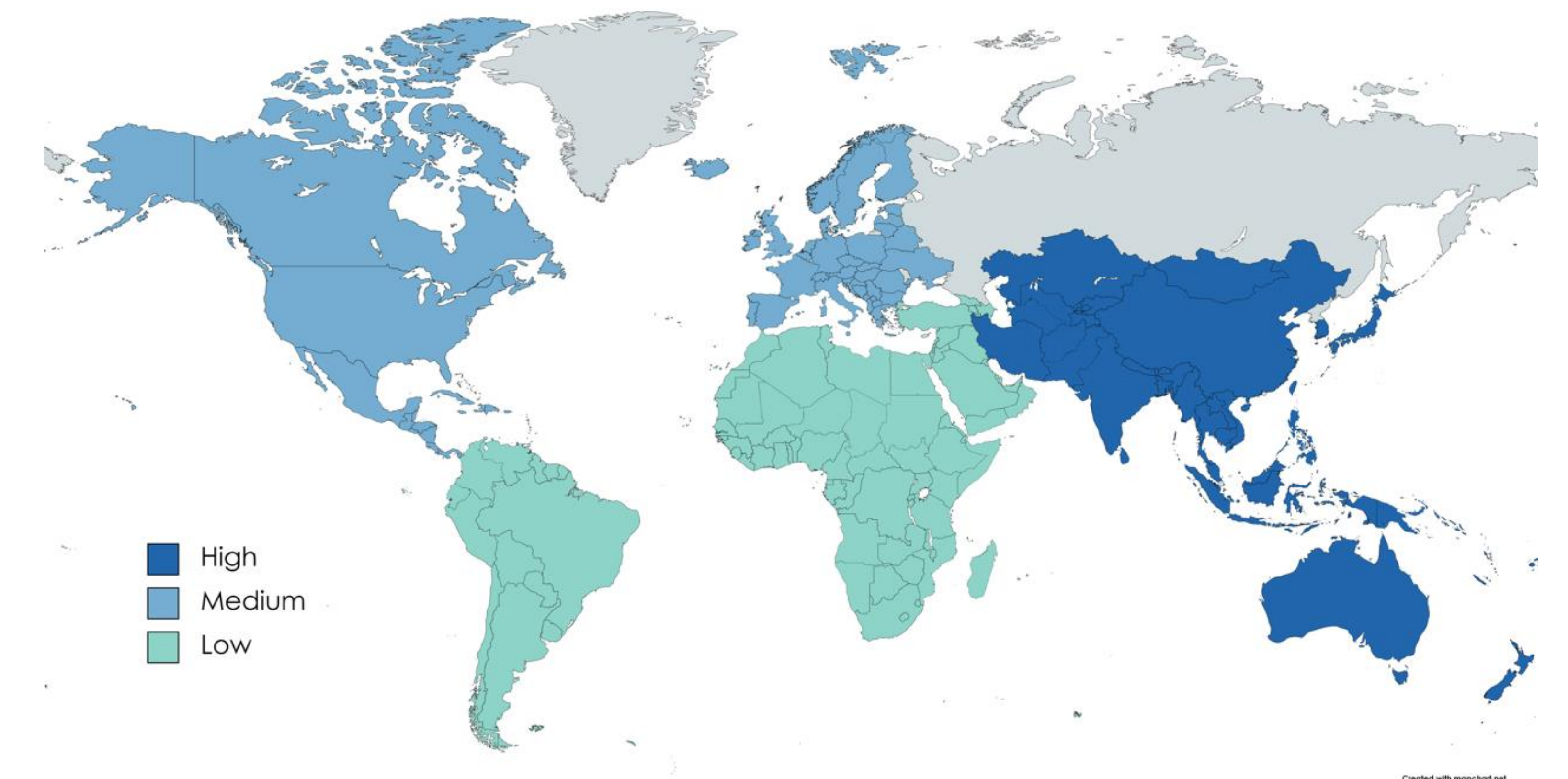


Figure 1: Zygomatic and pterygoid market-growth rate by region (created with mapchart.net; source: Mordor Intelligence)

Global zygomatic and pterygoid implants market:

- 2019: more than US\$ 270 million
- 2029: expected to reach over US\$ 484 million

Lack of studies on biomechanical behavior of the new implant designs and surrounding bones.

Materials and methods

Objective:

To establish a three-dimensional (3D) finite element modeling protocol to simulate different rehabilitation approaches of severe atrophic maxilla and maxillectomy using zygomatic implants based on computed tomography (CT) data.

Implants:

- NobelZygoma 45°
- 42.5 mm length
- 45 degrees head angulation
- 3 mm height abutment, 0°
- Micro-CT scanner
- Reconstruction software
- 3D models
- Components assembly
- Assembly in skull – clinical scenarios

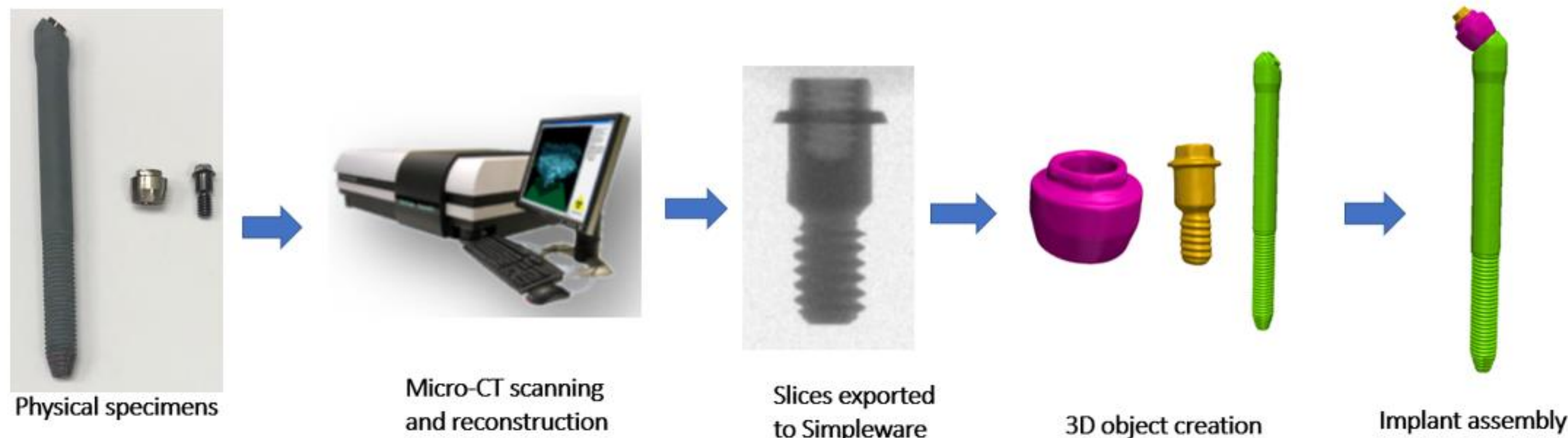


Figure 2: Workflow to produce 3D zygomatic implant models

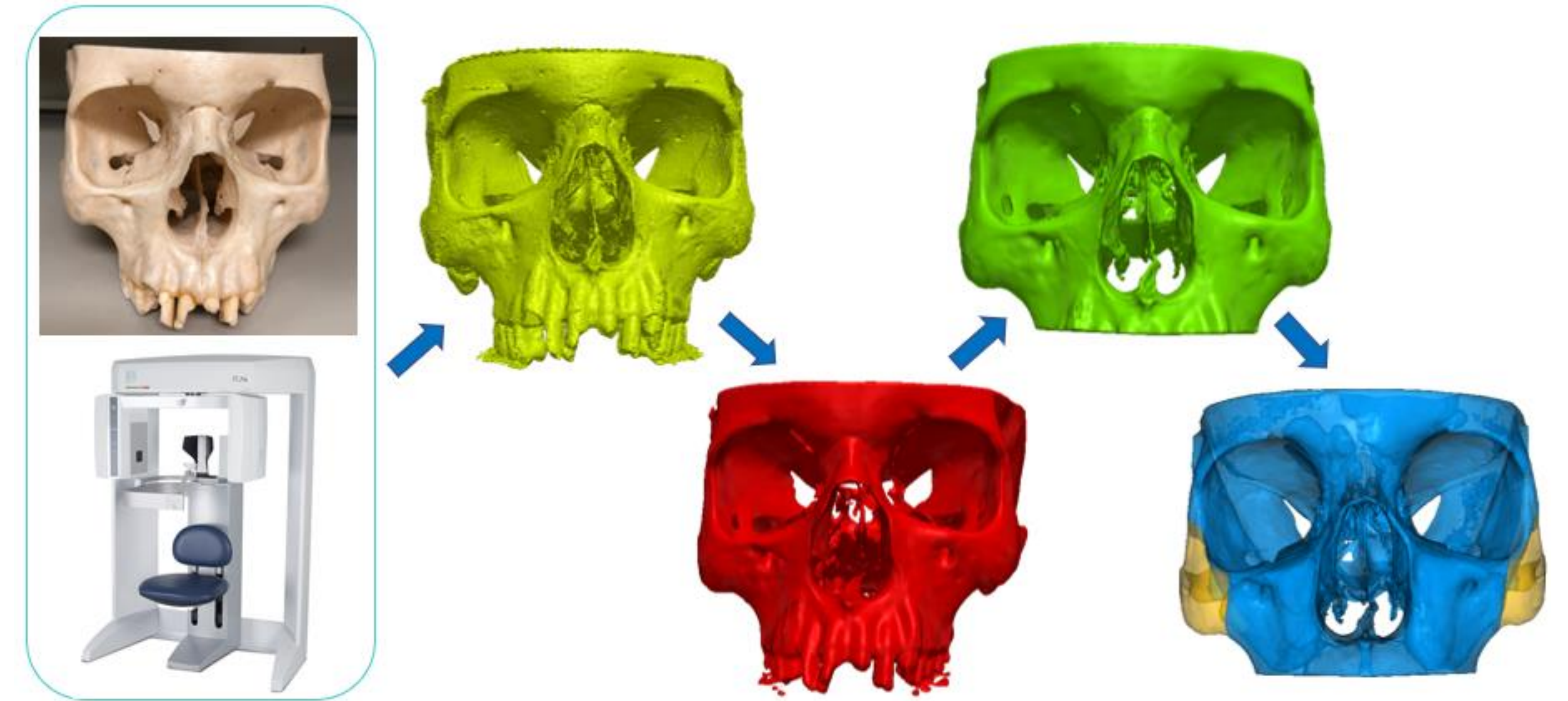


Figure 3: Workflow to produce 3D skull models simulating maxillary reabsorption

Skull:

- Ex-vivo skull
- i-CAT FLX v17 cone beam CT
- Reconstruction
- 3D models - Simpleware software
- Zygomatic bones
- Vertical and horizontal severe resorption
- Maxillectomy
- Simulated prostheses and superstructures

Results

Intra Sinus Model

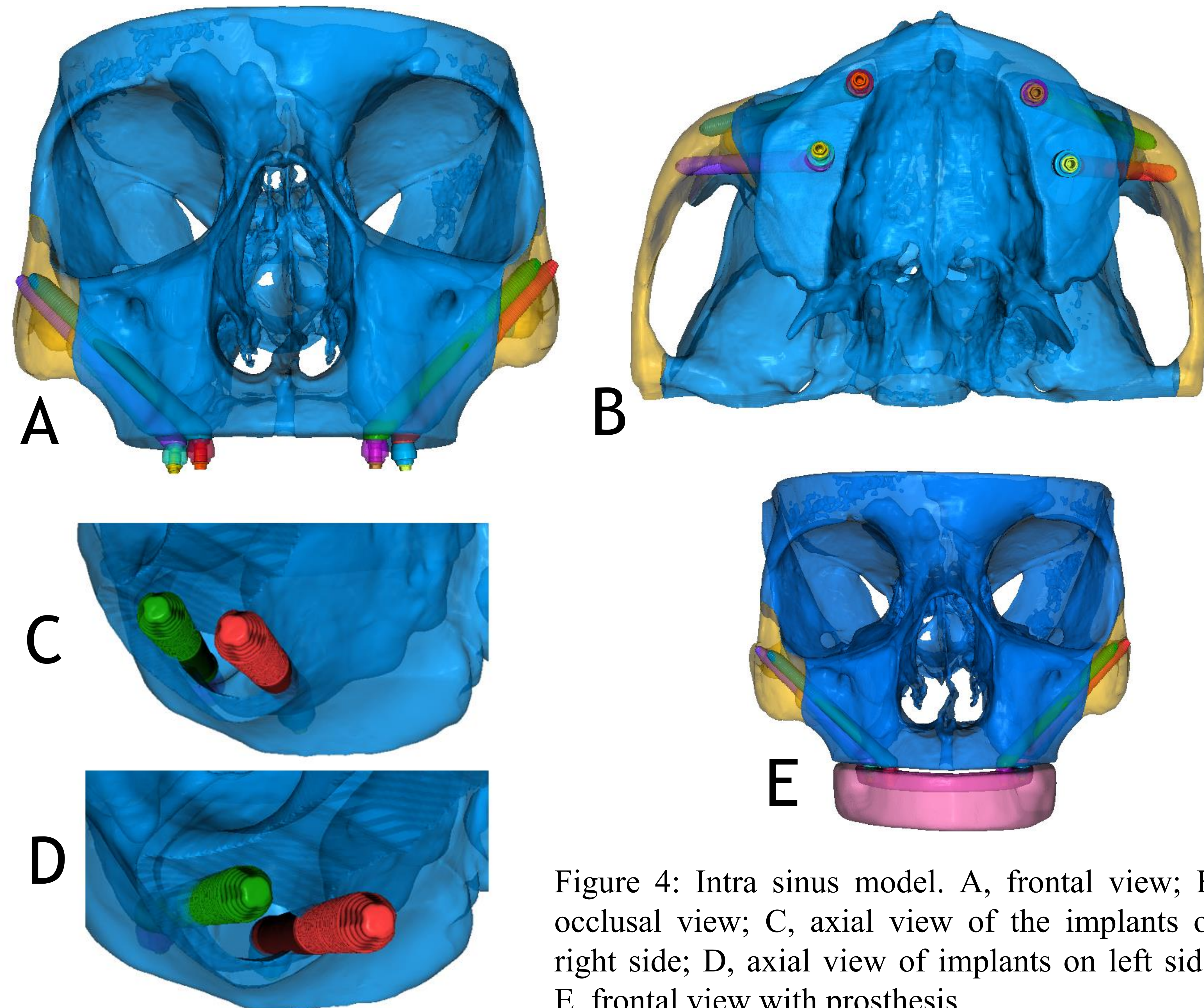


Figure 4: Intra sinus model. A, frontal view; B, occlusal view; C, axial view of the implants on right side; D, axial view of implants on left side; E, frontal view with prosthesis.

Extra Sinus Model

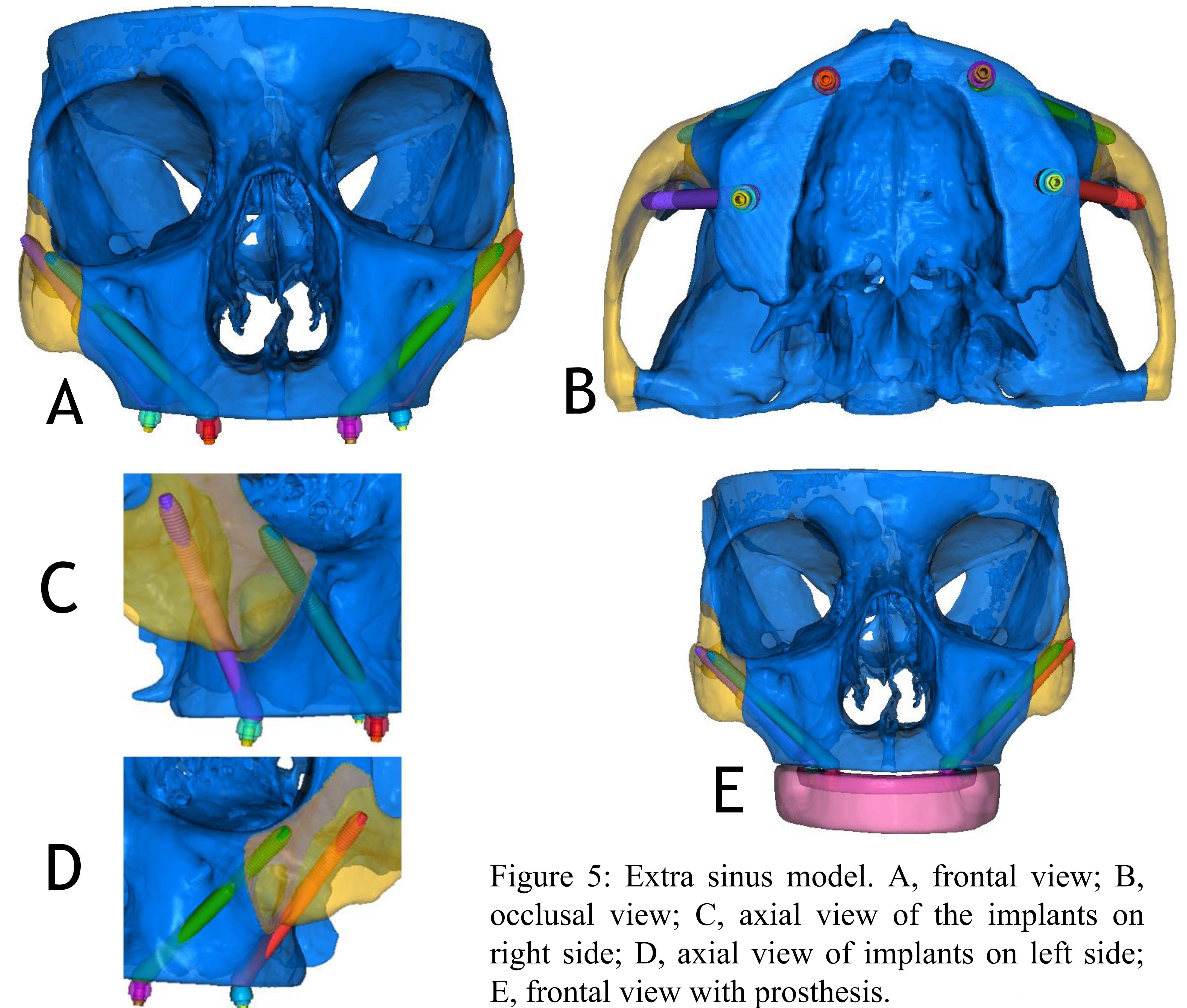


Figure 5: Extra sinus model. A, frontal view; B, occlusal view; C, axial view of the implants on right side; D, axial view of implants on left side; E, frontal view with prosthesis.

Results

Extra Maxillary Model

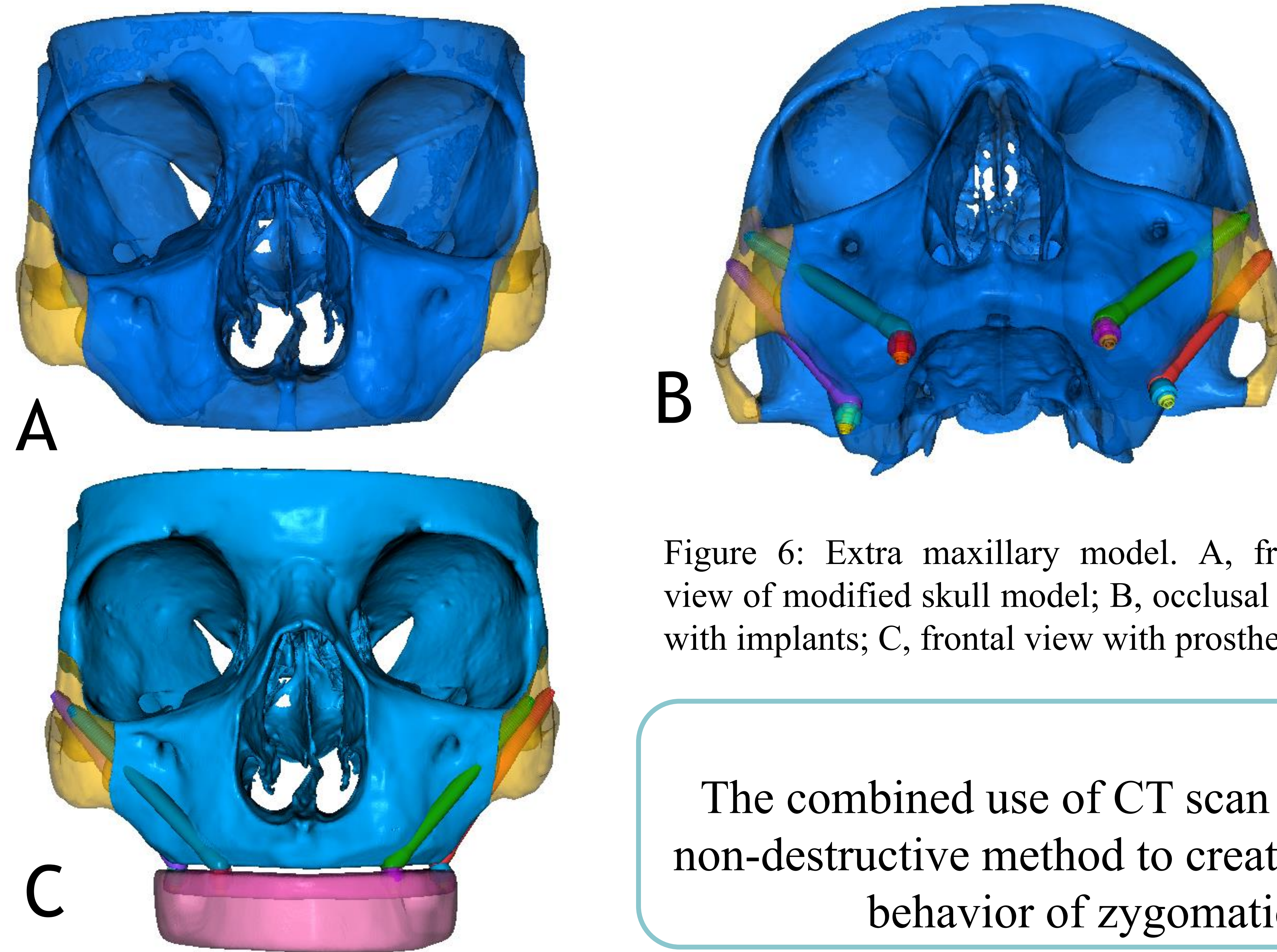


Figure 6: Extra maxillary model. A, frontal view of modified skull model; B, occlusal view with implants; C, frontal view with prosthesis.

Maxillectomy Model

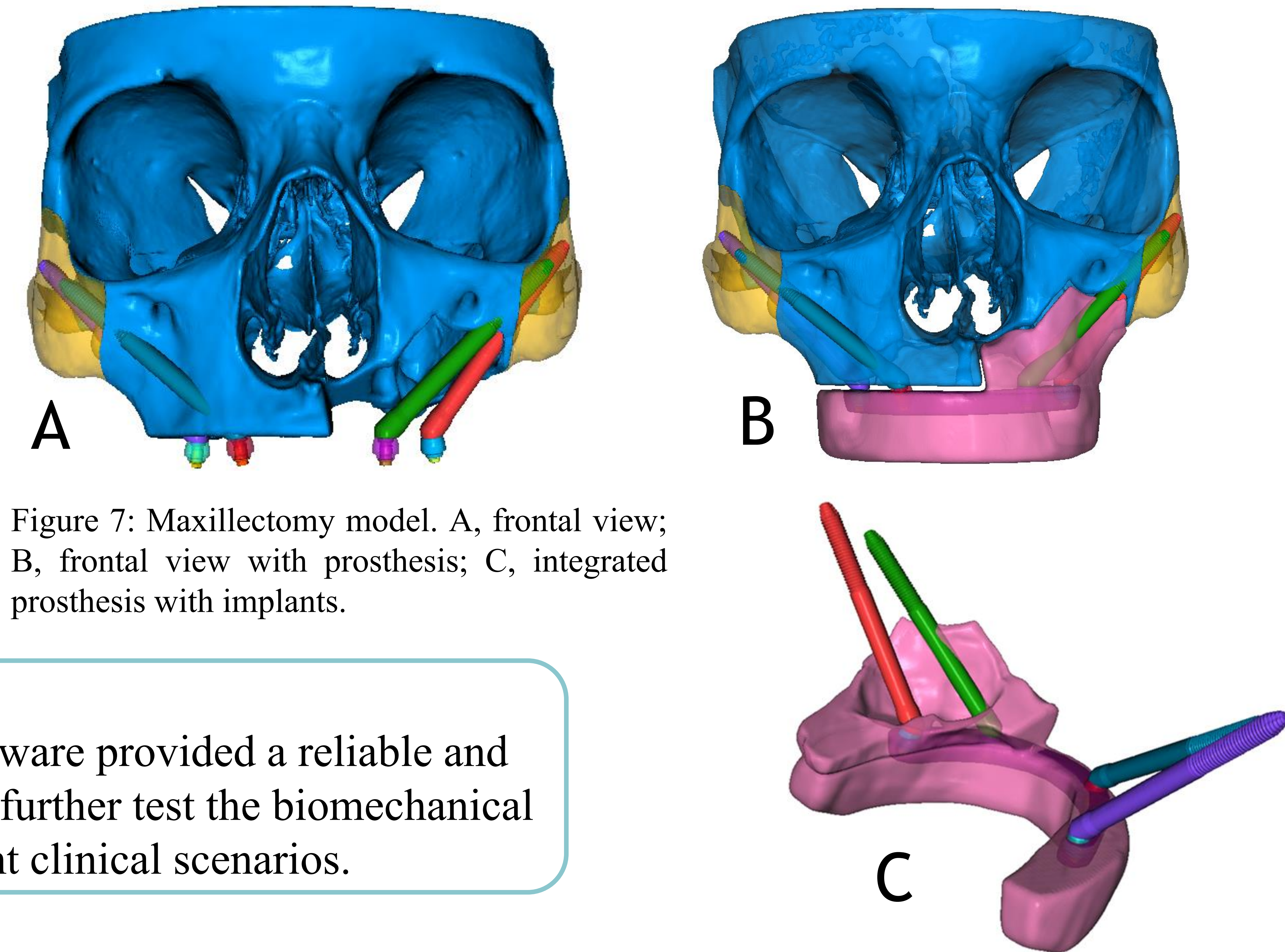


Figure 7: Maxillectomy model. A, frontal view; B, frontal view with prosthesis; C, integrated prosthesis with implants.

Conclusion:

The combined use of CT scan and Simpleware software provided a reliable and non-destructive method to create digital models and further test the biomechanical behavior of zygomatic implants in different clinical scenarios.

References:

- 1- <https://www.mordorintelligence.com/industry-reports/zygomatic-and-pterygoid-implants-market>
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- 3- Brånemark, P.I., et al., *An experimental and clinical study of osseointegrated implants penetrating the nasal cavity and maxillary sinus*. Journal of Oral and Maxillofacial Surgery, 1984. 42(8): p. 497-505.
- 3- Aparicio, C., et al., The zygoma anatomy-guided approach (ZAGA) for rehabilitation of the atrophic maxilla. Clinical Dentistry Reviewed, 2022. 6(1).