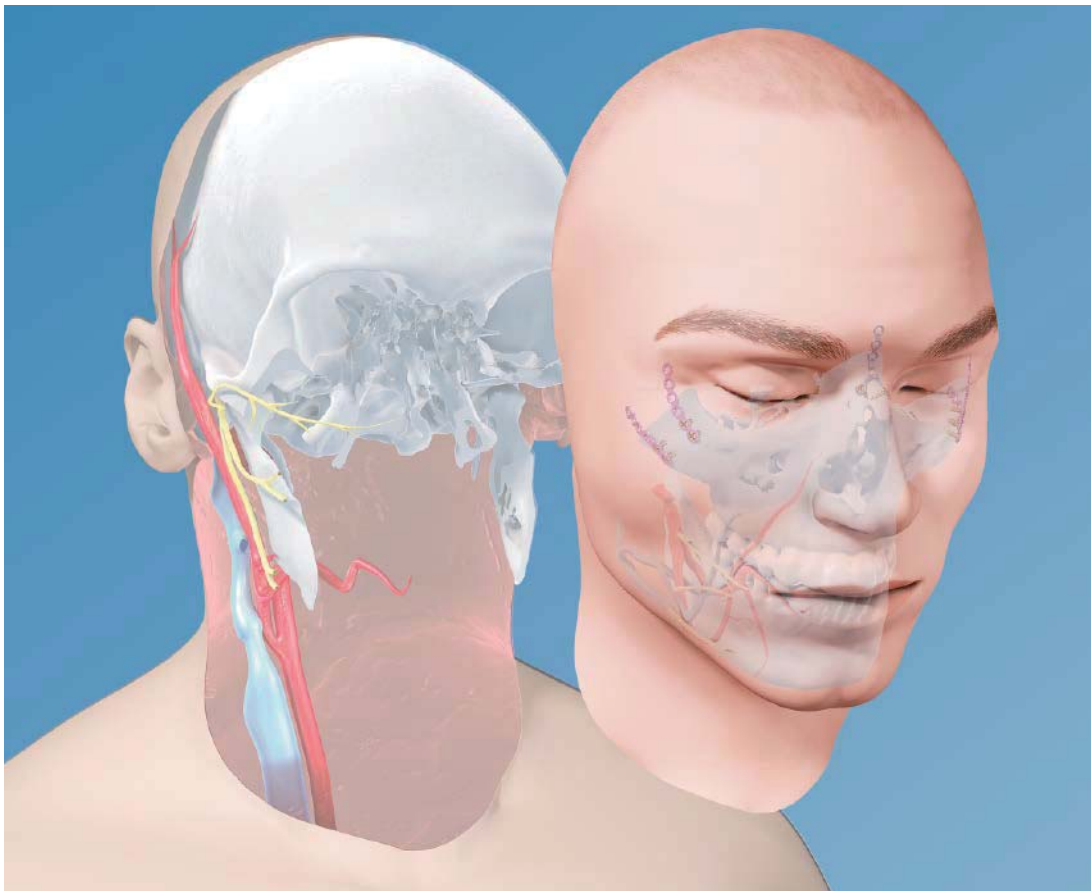
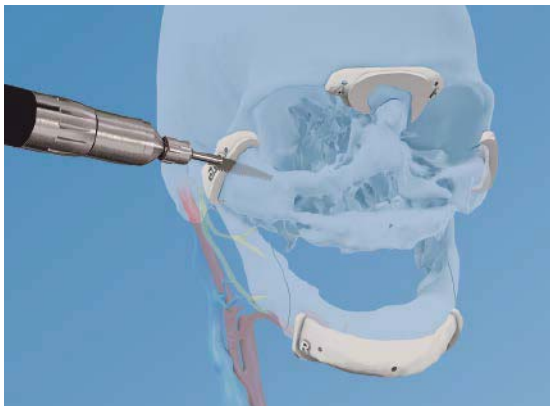
Comprehensive Facial Transplant.

Using Synthes ProPlan CMF, MatrixMIDFACE and MatrixMANDIBLE Plating Systems

Case Report





SYNTHES® CMF

Comprehensive Facial Transplant

Using Synthes ProPlan CMF, MatrixMIDFACE and MatrixMANDIBLE Plating Systems

Patient Profile

A 37 year old male sustained a significant deformity of his central and lower face as a result of a gun accident fifteen years prior to the transplant. His maxilla, mandible, teeth, lips and part of his nose and tongue were lost, leaving him with limited movement of his mouth.

While his vision was largely unaffected, numerous life-saving and reconstructive surgeries left his forehead and neck with considerable scar tissue. His nose was reconstructed using a skin flap from the forehead, and he received bone grafts for his mandible and midface. As the soft tissue healed, he was left with a sunken mouth and flattened nose. He could not taste and had lost his sense of smell. This young man endured a very limited life. He wore a baseball cap and mask to his hospital appointments and otherwise couldn't integrate into society.

The patient first came to the University of Maryland Medical Center in 2005 to discuss reconstructive options with Dr. Rodriguez. The University of Maryland's basic and clinical research program had been investigating the immune system's response to vascular composite allograft (VCA) transplants for over ten years. Their work focused on the anatomic and immunologic challenges to craniofacial transplantation and set the groundwork for this surgical achievement.

The goal for this patient was to restore function and attain aesthetically pleasing results. Cutting edge surgical practices and computer-aided planning would be employed to precisely transplant a matched donor maxilla and mandible including teeth, a portion of the tongue, facial muscles and related soft tissue. Facial tissue, nerves and underlying muscle from the scalp to the base of the neck of the donor would be used to restore sensory and motor function.

Figures 1 and 2 show the patient prior to the accident and after numerous reconstructive procedures.

Patient in high school
Figure 1

Patient presurgical
Figure 2

Results from case reports are not necessarily predictive of results in other cases. Results in other cases may vary.

Preoperative Planning

Recipient

CT scans of the recipient patient were uploaded to Synthes ProPlan CMF to create virtual images of the patient's facial anatomy. The challenges to reconstruction can be observed in Figure 3. There is a significant loss of volume of the midface and previous grafting is evident in both the mandible and midface.

Through a web-based meeting with a Synthes ProPlan CMF engineer, the location for osteotomies was determined based on the bony defects. A Le Fort III osteotomy and a BSSO were virtually planned (Figures 4–5). Synthes ProPlan CMF surgical guides for the osteotomies were then designed and manufactured. Planned placement of the surgical guides for the nasion, left and right zygomas and mandible are shown in Figure 6.

Figure 3

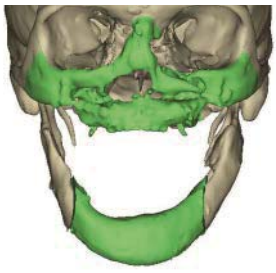


Figure 4

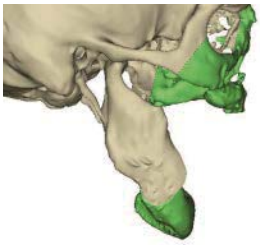


Figure 5

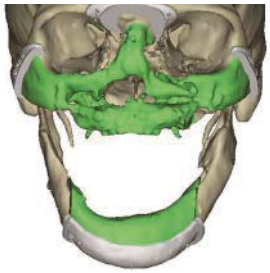


Figure 6

Donor

Prior to the donor CT scan, interim MMF (maxillary-mandibular fixation) was performed to establish Class I occlusion (Figure 7). The CT scans were uploaded to Synthes ProPlan CMF and a second web-based planning session was conducted. Osteotomies for the donor were identified to match the recipient's previously planned osteotomies. This was accomplished by virtually overlaying the donor skull over the recipient's (Figures 8–9).

The planning session was also used to confirm alignment of bony segments for facial symmetry and to perform cephalometric analysis. During cephalometric analysis, a perpendicular line was taken from the Frankfort horizontal plane (porion to orbitale) through the nasion to check the menton location (Figures 10–11).

The occlusal plane of the donor was confirmed to match that of the recipient post-transplant (Figure 11).

Maxillary position of the donor in normal occlusion was established and the mandible followed that alignment.

Figure 7

Figure 8

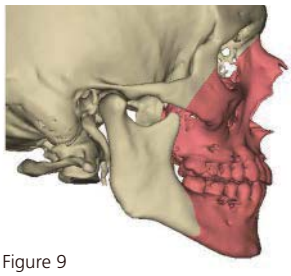


Figure 9

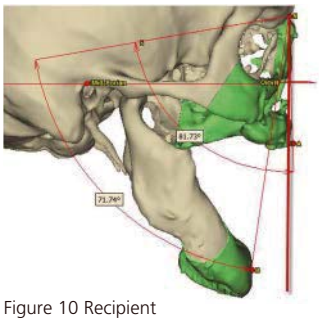


Figure 10 Recipient

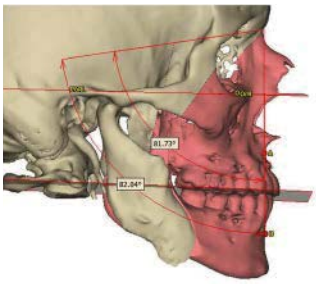


Figure 11 Donor

Bone Images Color Key Figures 8–11

Recipient

Donor

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Intraoperative Details

The recipient patient's midface, mandible, and tongue were dissected while the donor procurement was conducted simultaneously in an adjacent operating room. Total donor facial procurement took twelve hours.

Transplant Steps:

1. Skin incision
   The skin incision on the recipient began at the hairline and proceeded inferiorly, while staying anterior to the ears and down to the level of the neck above the clavicles (Figure 12).

   Bilateral periorbital incisions were performed, preserving the recipient patient's eyelids.

2. Identification of arteries and veins
   Following the skin retraction, the arteries and veins were identified and tagged with corresponding color-coded vessel loops for both the donor and recipient (Figure 13).
   - Internal jugular vein (blue) with a thyro-lingual-facial trunk (green)
   - Lingual vein (purple)
   - Facial vein (green, above lingual vein)
   - External carotid artery (yellow)
   - Lingual artery (yellow)
   - Facial artery (beige)
   - Internal maxillary artery (dark blue)

3. Identification of nerves
   Nerves for donor and recipient were identified and tagged, including the buccal and mandibular branches of the facial nerve

4. Tongue harvesting
   At the donor patient, the tongue was harvested with a perimeter incision for transplantation to the recipient. Intraoral buccal mucosa, the hard and soft palate, and floor of mouth mucosa were included in the dissection.

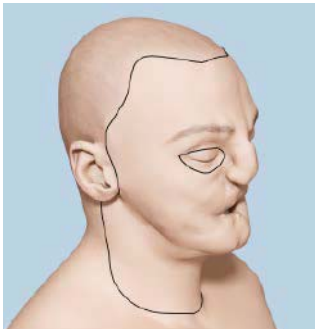

Figure 12

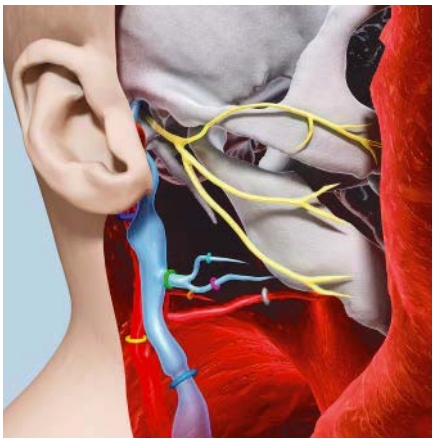

Figure 13

5. Osteotomies
   Preoperative planning using Synthes ProPlan CMF identified the exact location for the bony anatomy cuts. The planning ensured accurate alignment of the donor bone on to the recipient defect.

   The osteotomies were performed on the recipient using Synthes ProPlan CMF patient specific surgical guides. (Figure 14) On the donor patient, cutting guidance was assisted with intraoperative navigation from the donor CT scans.

   A mandibular bilateral sagittal split osteotomy was performed at the margins indicated by the guide. Next the maxillary cuts were made. A LeFort III osteotomy was performed using Synthes ProPlan CMF surgical guides for the nasion and left and right zygomas. Removal of the midface was finalized with an osteotome.

   Ischemia time was minimized by harvesting the donor bone while the tissue was being perfused. After the osteotomies were made the accuracy of the cuts was checked using a sterilizable Synthes ProPlan CMF acrylic bone model of the recipient defect. (Figure 15) Synthes Electric Pen Drive System with a pear-shaped burr and medium burring attachment was used to smooth out any bony prominences that would create sharp interferences.

   Bony anatomy of the donor was temporarily fixated to the recipient bone model. MatrixMIDFACE plates were then precontoured and used to provisionally fixate the facial flap to the model. Model representation Figure 15, clinical image Figure 16.

6. Transplant of tissue to recipient site
   Once the donor bone was prepared, the blood vessels were ligated and divided. Soft tissue, bone, teeth, the tongue, and muscles of facial expression were transferred to the adjacent operating room and overlaid on the recipient.

7. Bone plating
   The donor bone was stabilized to the recipient bone with the precontoured MatrixMIDFACE plates. Two Titanium Adaption Plates, 8 holes, 0.5 mm thick were used bilaterally for stable fixation of the donor left and right maxillas to the recipient zygomas. A Titanium Y-Plate 1 x 3 holes, 0.5 mm thick provided stable fixation of the donor nasion to the frontal portion of the recipient (Figure 17).

Figure 14

Figure 15

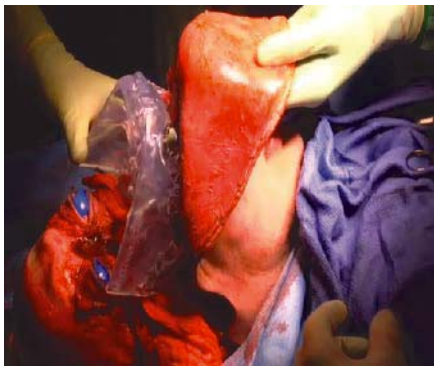

Figure 16

Figure 17

8. Reestablishment of blood supply
   Following the bone plating at the midface, the blood supply was reestablished. On the right side, end-to-end anastomosis of the donor external carotid artery to the recipient internal maxillary was completed, avoiding the trunk of the facial and lingual arteries to ensure adequate vascularity to the tongue.

   Next, end-to-end anastomosis of the right donor internal jugular vein to a branch of the right recipient internal jugular vein was performed. Anastomosis of the patient left side followed in a similar manner.

9. Stabilization of mandible
   The donor mandible was then fixated to the recipient mandible bilaterally using four 2.4 mm Titanium MatrixMANDIBLE screws, self-tapping (Figure 18).

10. Intraoral incision repair
    Intraoral repair was performed posterior to the mandibular molars and continued superiorly to the junction between the hard palate of the donor, and the soft palate of the recipient.

    The tongue was transplanted circumferentially at the tongue's base.

11. Reinnervation
    Next, the nerve coaptation was performed. The two branches of the buccal nerve were connected on either side of the upper lip and lip commisure. Additionally, two branches of the marginal mandibular facial nerve were connected, resulting in a total of four motor nerve branches reconnected on each side (Figure 19).

12. Completion
    The skin was tailored and the soft tissue sutures were made to close the procedure (Figure 20).

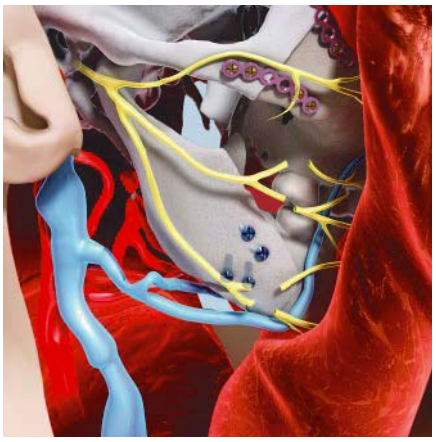

Figure 18

Figure 19

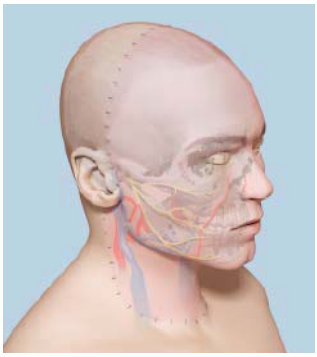

Figure 20

Results from case reports are not necessarily predictive of results in other cases.
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Results

Accurate alignment of the patient's bone using Synthes ProPlan CMF ensured that the height, width, and projection of the facial anatomy were restored as planned preoperatively.

With the bone as an underlying foundation for the soft tissue drape, the final outcome resulted in a dramatic improvement for the recipient patient

By postoperative day six, the patient was able to open and close his jaws and had some facial movement. He could also perform ordinary tasks such as shaving and brushing his teeth. He regained his sense of smell almost immediately (Figure 21).

At seven months postoperative the patient is successfully reintegrating into society and can move on with his life. He has made great improvements through physical and speech therapy sessions. With hours of practicing his speech and strengthening his new facial muscles, he has now regained his speech and can smile and show expression. He is also able to taste food again and eat mainly by mouth (Figure 22).

The patient will have to take immunosuppressants for the rest of his life to keep his body from rejecting the donated face, but the sizeable quantity of vascularized bone marrow in the donor mandible transplant could mean he may need less immune suppression over time.

Figure 21

Figure 22

Results from case reports are not necessarily predictive of results in other cases. Results in other cases may vary.

Discussion

A total of 10 cadaveric lab dissections were performed (20 total cadavers: 10 recipient and 10 donor cadavers) to ensure successful clinical translation of the surgical procedure and the preoperative planning protocol. These dissections were performed with the entire surgical team under strict time requirements. One of the paired dissections was performed in adjacent operating rooms with the entire peri-operative personnel. Lastly, through the generous gift of another donor family, a research procurement and surgical rehearsal was previously performed on a patient with irreversible brain damage.

Grant funding was provided from the Office of Naval Research (ONR). This grant provided the financial support of the clinical research face transplant program as well as 10 grant cycles of basic science research support in pre-clinical vascularized composite allotransplantation models leading up to and supporting this extensive face transplant. A novel immunosuppressive protocol was developed from the research to lower the levels of immunosuppression necessary and maintain the integrity of the vascularized composite allograft.

The University of Maryland is expanding their facial transplant program to help more patients, including veterans injured in action.

The generosity of the donor's family must be recognized. Five other lives benefited from organs donated for lung, liver, kidney and heart transplants also performed at the University of Maryland.

A full scientific manuscript was submitted with further details of the procedure.

Osteotomy Guides

SD900.104	Nasion Guide	
SD900.104	Right Zygoma Guide	
SD900.104	Left Zygoma Guide	
SD900.101	Mandible Guide	

Acrylic Bone Models

SD900.234	Skull without Midface	
SD900.234	Midface	
SD900.201	Mandible	

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Implants

04.503.377	Titanium MatrixMIDFACE Y-Plate, 1 x 3 holes, 0.7 mm	
04.503.373	Titanium MatrixMIDFACE Orbital Rim Plate,12 holes, 0.7 mm	
	Titanium MatrixMIDFACE, self-drilling screws	
04.503.225	5 mm length	
04.503.226	6 mm length	
04.503.228	8 mm length	
	2.4 mm Titanium MatrixMANDIBLE, self-tapping screws	
04.503.442	12 mm length	
04.503.444	14 mm length	

Synthes Power Tools

01.001.580	Electric Pen Drive Set	
03.000.303S	Saw Blade for Sagittal Saw Attachment	
03.000.321S	Saw Blade for Reciprocating Saw Attachment	
03.000.071S	Egg-Shaped Burr for Burring Speed Attachment	

Face Transplant Team:
From left to right: Amir Dorafshar, MBChB,
Michael Christy, MD, MA, Eduardo Rodriguez, MD, DDS,
Branko Bojovic, MD, Daniel Borsuk, MD

Photograph Courtesy of Coos Hamburger

Lead surgeon:
Eduardo D. Rodriguez, M.D., D.D.S.
Chief, Plastic, Reconstructive, and Maxillofacial Surgery
R Adams Crowley Shock Trauma Center

Professor
University of Maryland School of Medicine

Associate Professor
Department of Plastic Surgery
Johns Hopkins School of Medicine
Baltimore, Maryland

SYNTHES® CMF

Synthes USA
1302 Wrights Lane East
West Chester, PA 19380
Telephone: (610) 719-5000
To order: (800) 523-0322
Fax: (610) 251-9056

Synthes (Canada) Ltd.
2566 Meadowpine Boulevard
Mississauga, Ontario L5N 6P9
Telephone: (905) 567-0440
To order: (800) 668-1119
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