Vascular Considerations in Composite Midfacial Allotransplantation

Bohdan Pomahac, M.D.
Benoit Lengele, M.D.
Emily B. Ridgway, M.D.
Evan Matros, M.D.
Brian T. Andrews, M.D.
Jason S. Cooper, M.D.
Richard Kutz, M.D., M.P.H.
Julian J. Pribaz, M.D.

Boston, Mass.

Background: Advances in microsurgery and immunosuppression have allowed for facial reconstruction at a qualitatively new level with facial composite tissue allografts. Although donor tissue recovery is unique for each patient, transplantation of the maxilla and overlying soft tissues will be a frequent indication. Vascularity of the maxilla and palate, supplied by facial arteries alone, has been a concern. Based on cadaver dissections and a clinical case, vascular considerations for transplantation of the entire midface are discussed.

Methods: To prepare for central facial transplantation in an identified patient, a preclinical dissection was completed on four cadavers. In April of 2009, an extended midfacial allotransplantation was performed. The flap included the entire group of facial mimetic muscles with overlying skin, sensory and motor nerves, nose, upper lip, maxilla, teeth, and hard palate.

Results: The preclinical study identified key anatomical structures for inclusion in the composite tissue allograft. Moreover, dissections showed that the facial and angular blood vessels were connected to branches of the maxillary vessels through an anastomotic network organized around the periosteum and bony canals of the midfacial skeleton. Transplantation of a central face allograft including the maxilla and palate was anticipated to be feasible. A technically successful clinical case was completed.

Conclusions: Anatomical and clinical observations elucidated several technical points related to composite tissue transplantation of the midface. Careful graft harvest, appropriate selection of donor and recipient vessels, complete allograft revascularization, and restoration of sensory and motor function are critical to making face transplant surgery safe and functional. (*Plast. Reconstr. Surg.* 125: 517, 2010.)

Advances in microvascular surgery combined with systemic immunosuppression have allowed for successful transplantation of a small number of facial composite tissue allografts.[1,2] This method of facial reconstruction has added a new rung on the reconstructive ladder as transplantation can replace "like with like." Restorative surgery is now possible, making reconstructive methods suboptimal.[3,4] Facial allotransplantation provides both functional and aesthetic reconstruction of the most difficult central facial defects that cannot easily be replaced by autologous tissues. As such, the maxilla will be a common part of transplanted tissues, with the facial vessels as the predominant source of blood supply for the central face.[4,5] This article presents lessons learned about neurovascular anatomy from preclinical cadaveric dissections and applies these principles during a single midfacial allograft transplantation.

MATERIALS AND METHODS

Cadaveric Dissection

Four cadaveric heads were procured from fresh human bodies and transected at the C7 vertebra. Neck vessels were cannulated bilaterally and washed with warm saline at 37°C to obtain uniform opening of the cephalic arterial network and to eliminate clots. The left common carotid artery was injected with Neoprene liquid (DuPont Performance Elastomers, Wilmington, Del.) colored in red. The intravascular injection was first performed under gentle hand pressure until backflow

From the Department of Surgery, Division of Plastic and Reconstructive Surgery, Brigham and Women's Hospital.
Received for publication June 27, 2009; accepted August 31, 2009.

DOI: 10.1097/PRS.0b013e3181c82e6f

Disclosure: *None of the authors has a financial interest to declare in relation to the content of this article.*

of the colored fluid was observed at the contralateral vessels, which were then ligated. Thereafter, the injection continued at higher pressure until a uniform pink filling of the subdermal arterial plexus was obvious on all face integuments. The left internal jugular vein was injected with blue Neoprene liquid to enhance the venous system. The face flap was designed to include all anatomical structures missing in a 59-year-old candidate recipient who had extensive midfacial injury.

Clinical Case Flap Procurement

The facial flap was harvested from a 60-year-old brain-dead donor, with the endotracheal tube wired to the lower incisors. Rapid harvesting of the facial graft was necessary for timely intervention by solid organ recovery teams and coordination with the surgeons preparing the recipient for facial transplantation. One attending surgeon and one senior plastic surgery resident operated on each side of the donor face simultaneously. The surgical incision began across the glabella, continued inferiorly along the bony nasal sidewall, laterally along the lower lid-cheek junction to beyond the malar eminence, inferiorly to below the mandibular border, medially for a short distance on the neck, and ascending along the marionette lines to the lateralmost aspects of the lower lip bilaterally, including the commissures (Fig. 1). Local anesthetic with epinephrine was injected into each cheek region superficially to facilitate facial nerve dissection. The dissection began laterally within the cheek through the skin, superficial musculoaponeurotic system, and parotid fascia until branches of the facial nerve were identified and marked. After the parotid duct was ligated, dissection proceeded to its deepest level, along the investing fascia of the masseter muscle. The dissection continued caudally to identify the facial vessels running along the anterior and inferior border of the masseter. The facial vessels were followed retrograde to the inferior border of the mandible body, where the artery coursed deep to the submandibular gland. A longitudinal extension of the skin incision at the anterior border of the sternocleidomastoid muscle provided exposure of the large neck vessels. Complete dissection of the facial artery was obscured by the mandible, thereby necessitating bilateral osteotomies to improve exposure.

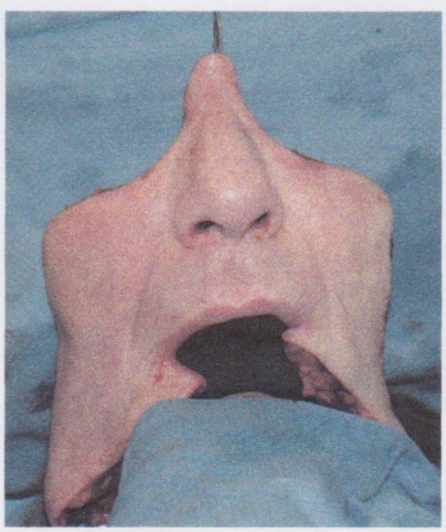

Fig. 1. Recovered donor tissue still attached on vascular pedicles.

Flap elevation proceeded by dissecting along the anterior border of the masseter to identify the buccal fat pad. This was retracted cephalad and the buccal neurovascular bundle (V_3) was identified and tagged. The buccal mucosa, buccinator, and lip were then divided just anterior to the tonsillar pillar on either side, and the junction between the hard and soft palate was divided. To avoid hemorrhage from terminal branches of the maxillary artery at the time of Le Fort III osteotomies, the external carotids were ligated cephalad to the facial artery origin. Osteotomies were performed at the body of the zygomatic bone corresponding to the anticipated defect of the recipient based on a three-dimensional skull model. Medially, bone sections were made obliquely at the nasofrontal region, and completed through the orbital floor and pterygomaxillary junctions. The infraorbital nerve was released along the orbital floor by an osteotomy, adding 2 to 3 cm of length for easier anastomosis. All tissues including palatal mucosa were uniformly perfused (Fig. 2).

Final elevation of the flap from the donor revealed brisk bleeding at all osteotomy sites, skin edges, and sinus mucosa. The flap's vascular pedicles were the right facial and left external carotid artery. The bilateral facial veins provided venous drainage. These levels were chosen to ensure ideal size match with the recipient vessels. The graft was taken from the operative field and flushed with University of Wisconsin solution. Secured in a sterile double bag containing ice slurry, the graft was brought to the recipient in an adjacent operating theater. On completion of solid organ harvest, a prosthetist fashioned a mask over the major tissue defect to restore the donor's facial appearance.

Recipient vessel dissection was performed through bilateral neck incisions. The great auricular nerve was isolated as a candidate donor nerve

Fig. 2. Perfused donor palatal mucosa after transplantation.

graft if needed. A limited neck dissection was performed to remove fibrofatty lymphatic contents in zones II and III of the neck to facilitate identification of recipient neck vessels. The external jugular vein, internal jugular vein, and retromandibular vein were dissected and isolated with vessel loops. The common carotid was dissected distally as it branched into the external carotid and internal carotid arteries. The external carotid artery was traced cephalad, revealing the superior thyroid, occipital, and facial artery branches bilaterally.

Recipient sensory and motor nerve dissections were carried out through an anterior approach. The sensory nerves included bilateral infraorbital (V_2) and buccal (V_3) nerves, and the buccal branches of the seventh cranial nerve supplied the motor component. The recipient previously had an anterolateral thigh flap for soft-tissue coverage of the midface defect. This was removed, exposing the nasal root, nasal cavity, infraorbital rims, and maxillary sinuses. Dissection was carried out laterally to identify branches of the facial nerve (seventh) outside the zone of injury. Bilateral buccal and marginal mandibular branches of the facial nerve were identified and tagged. Infraorbital nerves were identified on each side. The left nerve exited through the infraorbital foramen, which was opened with an osteotome to obtain length. The right infraorbital nerve was foreshortened from the original injury but could be identified within the maxillary sinus. Extra length obtained on the donor infraorbital nerves allowed for tension-free neurorrhaphy despite loss of length in the recipient. Finally, excision of the buccal fat pads allowed identification of the buccal sensory branch of V_3 for later neurorrhaphy.

RESULTS

Cadaveric Dissection

The preclinical cadaveric dissections demonstrated that superficial collaterals of the facial vessels generously supplied all integuments of the face starting at the infrahyoid region and extending to the orbital area. Moreover, deep branches of the facial arterial stem were found, running along the mimetic muscles, down to the periosteum of the anterior maxillary surface. In addition to the well-known right-left anastomoses across the midline between labial and nasal superficial branches, we observed numerous small arterial connections running between deep facial artery branches and distal maxillary system branches. In the infraorbital region, facial vessels giving rise to maxillary connections ran in a cephalad direction, along terminal sensory branches of the maxillary nerve (V_2) and joined terminal branches of the infraorbital artery around the infraorbital foramen. A similar neurovascular anatomical disposition of faciomaxillary shunts existed on the midline between the septal branch of the superior labial artery and the distal branching of the sphenopalatine arteries. Because of this anastomotic network, organized close to the Stensen nasopalatine foramen and the corresponding nerve endings, a retrograde supply of the hard palate and the overlying mucosa could be anticipated, with revascularization based on the facial artery system only. In contrast, the deep compartments of the cheek, including the masticatory muscles and Bichat fat pad, were uniformly supplied by true terminal branches of the maxillary artery. Consequently, these structures should not be included in a midfacial allograft harvested on the facial artery (Fig. 3).

When considering the nerves to be included in the midface transplant, the zygomatic, upper, and lower buccal segmental rami of the facial nerve were identified as key motor nerves to be coapted after transfer. To restore sensation, an extended supraperiosteal undermining of the orbital floor allowed exposure and harvest of the infraorbital branch of the maxillary nerve, which when cut posteriorly close to the foramen rotundum resulted in a long stump for easy anastomosis (Fig. 4). On the contrary, no adequate nerve stumps could be obtained from the greater and lesser palatine nerves, aiming to restore sensitivity of the posterior palatal mucosa. Nevertheless, the buccal nerve was planned to be part of the neural repair of the midface allograft, because of its distribution to the cheek mucosa, posterior gingival, and parts of the palate (Fig. 5).

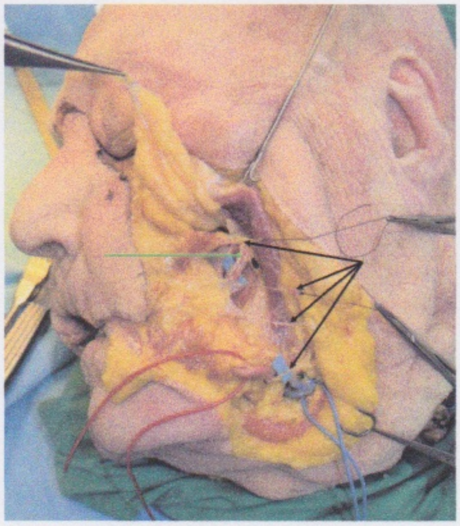

Fig. 3. Dissected mock cadaver. *Black arrows* indicate the branches of the facial nerve, and the *bright green arrow* indicates the buccal neurovascular bundle. The buccal fat pad is retracted superiorly with forceps, and vessel loops are around the facial artery and vein.

Fig. 4. Infraorbital neurovascular bundle released from the orbital floor demonstrating additional length on the pedicle gained by osteotomy (cadaver).

Clinical Case

Selection of the donor and recipient vessels was completed during the simultaneous dissections. The decision was made to dissect to the level of the left external carotid artery while preparing for a facial artery–to–facial artery anastomosis on the right side. This decision to perform a facial artery instead of an external carotid artery–to–external carotid artery anastomosis on the right side was made to maintain the external carotid artery vascular supply to the nasopharyngeal, infratemporal, and suprahyoid regions on at least one side. Once all donor and recipient vessels were clearly dissected, the graft was transferred and secured temporarily in place. A tracheostomy was also performed to ensure a secure airway throughout intraoperative manipulation and postoperative swelling.

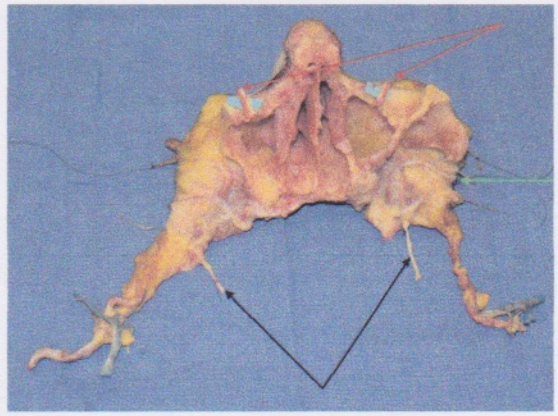

Fig. 5. Detached cadaveric midfacial composite tissue with marked buccal nerves (*black arrows*), parotid duct (*green arrow*), and infraorbital neurovascular bundles (*red arrows*).

The first anastomosis completed was an end-to-end arterial anastomosis of the left side donor external carotid artery to the recipient external carotid artery using 7-0 nylon suture. This resulted in a creeping pink revascularization from the left lateral cheek region cephalad along the nasolabial fold to the midline nasal region then crossing the midline into the right nasolabial fold, eventually providing adequate revascularization of the entire flap. This took approximately 20 seconds. The second anastomosis performed was the left facial vein to the recipient facial vein. Revascularization of the facial allograft was completed within 1 hour 15 minutes of ischemia time. On the right side, a facial artery–to–facial artery anastomosis was performed using 8-0 nylon suture. The recipient external jugular vein was selected for anastomosis but was thrombosed. Instead, a venous anastomosis was performed between the donor external jugular vein and recipient facial vein.

After reperfusion was reestablished, infraorbital (V_2) neurorrhaphy was performed bilaterally using 8-0 nylon suture. This was followed by bony fixation at the nasofrontal junction with a single

1.5-mm titanium plate and 2.0-mm titanium plates at the bilateral zygoma osteotomies. Neurorrhaphy was then performed of the buccal sensory nerves (V_3) and facial nerve branches, respectively. The soft tissues of the flap were tailored and inset into the defect, with ample soft tissues remaining for future revision. Postoperative flap monitoring was performed based on clinical evaluation and bedside Doppler examination.

DISCUSSION

In 2006, Devauchelle et al. described the first successful facial transplantation and have subsequently published an 18-month follow-up on the same patient, who continues to do well.[1–3] Six additional facial allograft transplantations have been performed.[3–6] Because of the small number of reported cases, vascular perspective on these procedures is limited.

The head and neck contains an abundant blood supply that is accessible and often redundant.[7] Facial reconstruction can be divided into three regions: (1) upper third (scalp and skull), (2) middle third (midface), and (3) lower third (mandibular). By considering the relevant anatomy and function of the facial subunit to be reconstructed, the ideal type of free tissue transfer can be designed containing various arrangements of soft tissue, fascia, and bone.[8–11] As a new rung on the reconstructive ladder, facial transplantation may involve novel combinations of tissues requiring unique vascular considerations.

Access to donor and recipient vessels requires proper and careful dissection. Donor vessels are dissected beginning at the common carotid artery extending superiorly under the mandible to reach the carotid bifurcation and facial artery. In the current case, exposure of the facial vessels was aided by a mandibular osteotomy; however, this made the endotracheal tube less secure and in the future donor tracheostomy will be performed. Takamatsu et al. discussed the selection of *recipient* vessels in head and neck microsurgical cases.[12] These authors recommend the superficial temporal vessels for upper third (scalp and skull) reconstruction, the facial and superficial temporal vessels for middle third (facial) defects, and the ipsilateral neck vasculature for lower third (mandibular) reconstruction. When the optimum vessel was not available, alternative recipients vessels were stratified into three subgroups: (1) adjacent small vessels in the area of first-choice vessels, (2) major neck vessels (i.e., external carotid and internal jugular vein), and (3) distant vessels (i.e., thyrocervical trunk). These concepts hold true in facial transplantation candidates who may have undergone previous microvascular reconstructive procedures sacrificing many first-choice vessels. In the current case, the recipient's right external jugular vein was noted to be clotted during the dissection. Preoperative imaging in such cases may provide information on vessel patency that can save valuable time intraoperatively.

Depending on which types of tissues are included in the facial allograft, vascular supply to the flap may vary. Studies of the facial angiosomes suggest that multiple arteries would be necessary to adequately perfuse an entire panfacial flap; however, clinical and experimental data have suggested otherwise.[7] Case reports have demonstrated successful perfusion of large segments of the facial soft tissues and scalp on a single vessel.[13] In the second successful face transplant, Meningaud et al. confirmed that complete revascularization of the soft tissues from the lower two-thirds of the face was possible by a single facial artery coaptation.[14] For flaps that intend to include soft tissues of the lateral cheek, ear, scalp, and forehead, inclusion of both the superficial temporal and facial artery branches would be necessary, with the external carotid as the source vessel.[7]

Although understanding of the perfusion of facial soft tissues has been aided by replantation in traumatic cases, there is a paucity of information available about the blood supply necessary to support composite facial flaps. Successful facial transplantation of our patient provides the strongest evidence that the facial artery alone can adequately supply both the overlying soft tissues and bony elements of midfacial allografts that include the maxilla and zygoma.[15] Perfusion of bony elements in these flaps is from filling by means of communications between the facial artery and maxillary system observed during our cadaver dissections. These findings are further supported by anatomical studies showing that the Le Fort I maxillary segment receives its blood supply from the ascending palatine branch of the facial artery and is conceptually analogous to iliac crest and fibula free flaps wherein the blood supply to the bone is derived from periosteal rather then endosteal vessels.[16,17] Therefore, during allograft harvest, it is critical to ensure that the periosteum remains attached to the maxilla. We have performed nasal endoscopy (pictures not shown) confirming healthy pink maxillary sinus mucosa from the current patient based on perfusion by bilateral facial arteries. The difference between clinical and in vivo studies is highlighted by the selective injection study by Banks et al., suggesting that perfusion of the maxilla and soft tissues is inadequate by the facial artery alone.[18] These authors recommend preservation of the internal maxillary artery for allografts that include the maxilla. Alternatively, Yazici et al. suggest that retrograde perfusion from the internal maxillary artery alone can fill the facial soft tissues by means of the facial and superficial temporal artery systems, but there are currently no in vivo or clinical data to support this contention.[19]

Lastly, in cases of allografts that include the maxilla *without overlying soft tissues*, the facial artery is not the vessel of choice. Rather, such a flap would be dependent on endosteal supply from the bilateral internal maxillary arteries as source vessels because the periosteum is excluded and midline crossover at the palate is poor.[7,18] Regardless of the vessel chosen to supply a flap, if possible, the vessel should be dissected to a more proximal level where the caliber is greater and chances of technical failure are reduced. In the current case, the left facial artery supplied the flap, but it was dissected to the level of the external carotid origin where the anastomosis was performed.

One final technical consideration in midface transplantation is to perform osteotomies as the final step in the flap harvest. Ligation of the distal external carotid artery before the zygoma osteotomies avoids potential hemorrhage from the pterygoid plexus. This is critical to ensure that patients remain hemodynamically stable while solid organs are harvested by transplant teams.

CONCLUSIONS

Allograft transplantation of the midface including the maxilla and surrounding soft tissues is feasible based on the facial vessels. Maxillary perfusion is excellent and at this point we recommend anastomosing both sides of neck vessels. Because of its high-stakes nature, microvascular considerations of this form of microsurgery should be well elucidated preoperatively with cadaveric dissections. Despite our preclinical cadaver experience, further technical points regarding flap harvest and recipient anatomy were garnered during the clinical case that will make future facial transplantation more efficient and predictable.

Bohdan Pomahac, M.D.
Department of Surgery
Division of Plastic and Reconstructive Surgery
Brigham and Women's Hospital
Harvard Medical School
75 Francis Street
Boston, Mass. 02215
bpomahac@partners.org

REFERENCES

1. Devauchelle B, Badet L, Lengele B, et al. First human face allograft: Early report. *Lancet* 2006;368:203–209.
2. Dubernard JM, Devauchelle B. Face transplantation. *Lancet* 2008;372:603–604.
3. Dubernard JM, Lengele B, Morelon E, et al. Outcomes 18 months after the first human partial face transplantation. *N Engl J Med.* 2007;357:2451–2460.
4. Kanitakis J, Badet L, Petruzzo P, et al. Clinicopathologic monitoring of the skin and oral mucosa of the first human face allograft: Report on the first eight months. *Transplantation* 2006; 82:1610–1615.
5. Lantieri L, Meningaud JP, Grimbert P, et al. Repair of the lower and middle parts of the face by composite tissue allotransplantation in a patient with massive plexiform neurofibroma: A 1-year follow-up study. *Lancet* 2008;372:639–645.
6. Lengele BG, Testelin S, Dakpe S, et al. "Facial graft": About the first facial allotransplantation of composite tissues (in French). *Ann Chir Plast Esthet.* 2007;52:475–484.
7. Houseman ND, Taylor GI, Pan WR. The angiosomes of the head and neck: Anatomic study and clinical applications. *Plast Reconstr Surg.* 2000;105:2287–2313.
8. Cordeiro PG, Disa JJ. Challenges in midface reconstruction. *Semin Surg Oncol.* 2000;19:218–225.
9. Cordeiro PG, Santamaria E. A classification system and algorithm for reconstruction of maxillectomy and midfacial defects. *Plast Reconstr Surg.* 2000;105:2331–2346; discussion 2347–2348.
10. Parrett BM, Pomahac B, Orgill DP, Pribaz JJ. The role of free-tissue transfer for head and neck burn reconstruction. *Plast Reconstr Surg.* 2007;120:1871–1878.
11. Pribaz JJ, Weiss DD, Mulliken JB, Eriksson E. Prelaminated free flap reconstruction of complex central facial defects. *Plast Reconstr Surg.* 1999;104:357–365; discussion 366–367.
12. Takamatsu A, Harashina T, Inoue T. Selection of appropriate recipient vessels in difficult, microsurgical head and neck reconstruction. *J Reconstr Microsurg.* 1996;12:499–507; discussion 508–513.
13. Wilhelmi BJ, Kang RH, Movassaghi K, Ganchi PA, Lee WP. First successful replantation of face and scalp with single-artery repair: Model for face and scalp transplantation. *Ann Plast Surg.* 2003;50:535–540.
14. Meningaud JP, Paraskevas A, Ingallina F, Bouhana E, Lantieri L. Face transplant graft procurement: A preclinical and clinical study. *Plast Reconstr Surg.* 2008;122:1383–1389.
15. Siemionow M, Papay F, Alam D, et al. Near-total human face transplantation for a severely disfigured patient in the USA. *Lancet* 2009;374:203–209.
16. Dodson TB, Bays RA, Neuenschwander MC. Maxillary perfusion during Le Fort I osteotomy after ligation of the descending palatine artery. *J Oral Maxillofac Surg.* 1997;55:51–55.
17. Siebert JW, Angrigiani C, McCarthy JG, Longaker MT. Blood supply of the Le Fort I maxillary segment: An anatomic study. *Plast Reconstr Surg.* 1997;100:843–851.
18. Banks ND, Hui-Chou HG, Tripathi S, et al. An anatomical study of external carotid artery vascular territories in face and midface flaps for transplantation. *Plast Reconstr Surg.* 2009;123:1677–1687.
19. Yazici I, Cavusoglu T, Comert A, et al. Maxilla allograft for transplantation: An anatomical study. *Ann Plast Surg.* 2008;61: 105–513.

Discussion: Vascular Considerations in Composite Midfacial Allotransplantation

David Mathes, M.D.
Dallas, Texas

The article by Pomahac et al. from the Brigham and Women's Hospital in Boston, Massachusetts, describes the technical aspects central to facial transplantation derived from both their recent partial face transplant and the four cadaveric dissections that had been performed to prepare for the transplant. Their transplant, the second in the United States, involved the restoration of the midface after a severe electrical injury. The tissues transplanted included the soft tissue of the midface and hard palate and maxilla. The transplant procedure including the donor harvest and the composite tissue transplant inset are described in detail.

The harvest of the transplant was modeled on a three-dimensional reconstruction that they had made before the transplant to simulate the tissues needed. The design of the composite tissue allograft was based in part on their findings from the cadaveric dissections. During the mock dissection with injections of the facial artery, they observed that the maxilla and the palate could be perfused in much the same way as a free fibula by means of periosteal perfusion from the branches of the facial artery. This allowed for the design of the transplant to be based on the facial artery rather than including the maxillary artery as had been suggested in previous dissections. In addition, they noted that the deep compartment of the cheek including the Bichat fat pad and the muscles of mastication appear to be supplied by the terminal branches of the maxillary artery and as such was not included in the face transplant.

The authors also outline several important technical issues that they found important during the clinical transplant. The first is that during the dissection of the facial artery, an osteotomy of the mandible allowed for easier harvest of the length of artery needed for the transplant. In addition, the authors ligated the external carotid artery above the takeoff of the facial artery to reduce blood loss during the Le Fort III osteotomies. This is important, as the donor must remain stable for the other organs to be harvested. During the transplant, they performed external carotid artery–to–external carotid artery anastomosis on one side and facial artery–to–facial artery anastomosis on the other. This was done to preserve the outflow of the native external carotid artery on one side of the recipient's face. Finally, they found that one of the jugular veins was thrombosed in the recipient at the time of transplant and suggest that the recipient patients should undergo preoperative computed tomographic angiography to evaluate the recipient vessels. This would be especially true in those patients who have undergone multiple attempts at reconstruction.

This article demonstrates both the importance and the limitations of cadaveric dissection to prepare for facial transplantation. Although hand transplantation has a clinical correlation with the practice of replantation after trauma, there are very few clinical examples of facial replantation.[1] Thus, although microsurgeons have experience with complicated dissections such as those seen in perforator flaps, they do not have experience with the type of decisions that need to be made in facial transplantation. This article explores some of the technical decision making that goes on in a facial transplantation case. It also reinforces the need for those groups that wish to enter into the field of reconstructive transplantation to prepare with mock operations to mimic the tissues needed on cadavers.[2] However, there are limitations to the details cadaveric work can reveal. Most studies had suggested that to perfuse the maxilla a branch of the maxillary artery would be needed in the flap.[3] However, in both of the transplants performed in the United States, the perfusion of the maxilla and palate is based on periosteal diffusion from the facial artery, and thus far it appears to be adequate.[4,5]

From the Division of Plastic and Reconstructive Surgery, University of Washington Medical Center.
Received for publication October 9, 2009; accepted October 13, 2009.

DOI: 10.1097/PRS.0b013e3181c91bfa

Disclosure: *The author has no financial interest to declare in relation to the content of this Discussion or of the associated article.*

Facial transplantation is now a clinical reality. There have been a total of eight cases worldwide within the past 3 years, including the case presented in the article by Pomahac et al.[4,6–8] These cases demonstrate the potential of facial transplantation for performing reconstruction in those patients whose defects involve complex facial structures such as the nose, lips, and even the maxilla. As worldwide experience continues to expand, the technical aspects of the transplant will become more refined. However, the issue that will continue to keep reconstructive transplantation from becoming a viable option on the reconstructive ladder is immunologic.

David Mathes, M.D.
Division of Plastic and Reconstructive Surgery
University of Washington Medical Center
1959 Northeast Pacific Street
Seattle, Wash. 98195

REFERENCES

1. Lee WP, Mathes DW. Hand transplantation: Pertinent data and future outlook. *J Hand Surg (Am.)* 1999;24:906–913.
2. Siemionow M, Unal S, Agaoglu G, Sari A. A cadaver study in preparation for facial allograft transplantation in humans: Part I. What are alternative sources for total facial defect coverage? *Plast Reconstr Surg.* 2006;117:864–872; discussion 873–875.
3. Banks ND, Hui-Chou HG, Tripathi S, et al. An anatomical study of external carotid artery vascular territories in face and midface flaps for transplantation. *Plast Reconstr Surg.* 2009; 123:1677–1687.
4. Siemionow M, Papay F, Alam D, et al. Near-total human face transplantation for a severely disfigured patient in the USA. *Lancet* 2009;374:203–209.
5. Siemionow MZ, Papay F, Djohan R, et al. First U.S. near-total human face transplantation: A paradigm shift for massive complex injuries. *Plast Reconstr Surg.* 2010;125:111–122.
6. Guo S, Han Y, Zhang X, et al. Human facial allotransplantation: A 2-year follow-up study. *Lancet* 2008;372:631–638.
7. Lantieri L, Meningaud JP, Grimbert P, et al. Repair of the lower and middle parts of the face by composite tissue allotransplantation in a patient with massive plexiform neurofibroma: A 1-year follow-up study. *Lancet* 2008;372:639–645.
8. Dubernard JM, Lengele B, Morelon E, et al. Outcomes 18 months after the first human partial face transplantation. *N Engl J Med.* 2007;357:2451–2460.