Total Face, Double Jaw, and Tongue Transplantation: Anesthetic Considerations & the STC Experience

Matt Fox, CRNA and Joey Sliwkowski, CRNA
Alternatively:

**The Totally Awesome Face Transplant**

*at the*

**World Famous Shock Trauma Center**
Objectives
1) List considerations relevant to the care of a patient undergoing vascular composite allotransplantation (VCA) procedure; recipient and donor preparation, donor procurement and the STC Face Transplant Careplan.
2) Define the stages of the face transplant procedure.
3) Examine considerations relevant to homeostatic maintenance, immunological suppression, and resuscitation challenges specific to this procedure.
“The strategy involved the foundation of a basic science laboratory; the cultivation of a supportive institutional clinical environment; the innovative application of technologies; cadaveric simulations; a real-time clinical rehearsal; and an informed and willing recipient who had the characteristic deformity.”²
“Why Us??” - Pretty much everyone at STC

A Multidisciplinary Team Sport

Face Transplants are now technically, immunologically, and ethically feasible\(^1\), but it’s a massive team effort.

Requires significant coordination within the clinical institution and supporting institutions, meticulous technical and logistical planning, and a crack team of flexible, hard-working providers.
Well...
Management of the “Polysurgical Patient”
Ballistic Facial Injury Experience @ STC

- These injuries are often the result of avulsive, ballistic, or blunt mechanisms requiring multistage reconstructive procedures. The volume and acuity of injuries seen at STC yield both a patient population appropriate for selection for such clinical research, and a staff experienced in handling this type of injury through to recovery.
Funding, Basic Science, & IRB Approval

- The research was funded by a grant from the Office of Naval Research (Grant #N00014-10-1-0868)\(^2\).
- Novel immunosuppression strategies in non-human primate Facial VCA models established & published\(^4,5\)
- IRB Approval obtained in 2010\(^2\).
Concurrent Patient & Donor Selection

- Recipient candidates were evaluated and placed on waiting list.
- Specialized donor consent was obtained through University of Maryland Medical Center’s Organ Procurement Organization.
Innovative Technologies for Preoperative Planning

Pre-operative CT Angiogram with 3D-Reconstruction of donor selected for procurement rehearsal.

Preoperative three-dimensional computed tomographic angiograms of the donor illustrating the vascular anatomy and a previous right frontotemporoparietal craniectomy.
Preoperative Mapping of Osteotomies

Planned osteotomies for donor include LeFort III and Mandibular Osteotomies.\(^1\)

The goal: have the soft tissue “drape” in aesthetically optimal fashion by preserving skeletal structure.
Intraoperative Fluorescent Angiography

- Indocyanine green: rapid 10mL injection of fluorescent dye given by Anesthesia.
- Utilized to ensure & demonstrate perfusion of VCA.
- In this image, full facial perfusion is demonstrated via L facial and lingual arterial pedicles, and venous outflow via the R external jugular and R thyrolinguofacial veins\(^2\).

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Recipient Profile

CMV(+), EBV(+), otherwise healthy 37 year old male.

Sustained devastating ballistic injury in 1997 with characteristic ballistic avulsive defect.²
The patient had previously undergone greater than twenty major reconstructive surgeries

- two separate free fibula tissue transfers to his maxilla and mandible
- multiple forehead flap nasal reconstructions
- multiple tissue rearrangement procedures
- Airway: Grade 1 view with Mac 3 blade…j/k.
Recipient Preparation

• CT scans were obtained to evaluate patient’s skeletal and vascular anatomy.
• Formal angiography of recipient provided a detailed vascular roadmap to the face and tongue.

• The recipient had a compromised left lingual artery, and a right common trunk that bifurcated into the facial and lingual artery, as the sole major blood supply to the tongue.\(^2\)
Donor Profile

- 21-year old male with irreversible traumatic brain injury.
- A craniofacial CT scan was performed on admission.
- The donor was confirmed to meet the criteria for brain death on March 17, 2012.\(^2\)
The donor met criteria based upon: age, general health, height, weight, skin and hair color match, facial dimensions, and dentition.

After specialized consent was obtained from the patient’s family, Donor blood samples underwent serologic evaluation and recipient virtual crossmatching.

Flow cytometric crossmatch, and repeat crossmatch using donor lymph node tissue confirmed the negative virtual crossmatch.
Donor Preparation

• Inter-maxillary fixation screws were placed to facilitate surgical navigation.
• The donor was re-scanned and the data uploaded to surgical modeling software for virtual surgical planning.
The donor facial skeleton was superimposed onto that of the recipient, and virtual osteotomies were designed. Upon final conformation of donor, a bedside tracheostomy and facial impression were performed.
STC Anesthesia at ICU bedside for tracheostomy.

Upon completion of tracheostomy, left femoral 7-french Cordis and left femoral triple lumen central lines were placed by STC Anesthesia. A right femoral arterial line placed, in addition to in situ right radial a-line.

Any positional lines must be replaced.
Large bore venous access must be available.
Donor’s Arrival to OR

• The donor was brought to the operating room on March 19, 2012 at about 0400.
• Prepped and draped from head to groin in preparation for simultaneous recovery of facial VCA and solid organ allografts.
• Intra-operative navigation was used to perform the Le Fort III type osteotomy based on the virtual surgical plan.
• The solid organ teams began recovery concomitantly following midfacial osteotomies.
Anesthesia Considerations upon arrival to OR

- T&C for 10PRBC/10FFP/Platelets.
- Supine position, slight reverse Trendelenburg, with arms carefully tucked to maintain line patency (no need for padding, necessarily).
- Lower body forced air warmer. Passive cooling will be requested toward the end of VCA harvest.
- High-Flow Hot Line to femoral cordis.
- Additional Maintenance Lines to femoral TLC, with port access for infusions.
Donor: Some nitty gritty.

- OR Table 90° from Anes.
- Surgeons accessed chest and abdomen from both sides, requiring several feet of clearance.
- All lines and tubes arranged to come off table at patient’s shoulder, with monitors and lines coming off opposite side of bed running under OR table.
- Miles of extensions for IV, Ventilator Circuits…
- Airway circuit included trach + accordion extension + humidifier extension + straight ETCO₂ connector
• The dissection begins at the neck and moves cephalad.
• Mandibular splitting and maxillary sinus dissection heralds increased blood loss, with concurrent solid organ harvest and clinical deterioration of the donor complicating homeostasis.³
Donor Homeostatic Management

• Little if any anesthetic is administered to donor, except to control reflex HTN during sternal splitting.
• Resuscitative efforts must be aimed at maintaining homeostasis in light of progressive clinical deterioration (DI, inflammatory/capillary leak state, progressing renal insufficiency).³
• Complete set of labs every 90 min or PRN
  – HCT goal 26-28%³
• INR kept as normalized as possible so as to assist in preserving a “dry” surgical field, ultimately expediting graft harvest and promoting viability.¹
Final Steps: Donor VCA procurement

- Fluorescent Angiography performed prior to division of vascular pedicles, demonstrating normal blood supply.
- 30K U Heparin IV prior to division.
- After division, VCA moved to back table, iced and flushed with U of Wisconsin solution.
Prior to division of the vascular pedicles, the donor maxillary segment was tailored to a stereolithographic model representing the planned donor skeletal resection. This allowed for modification of the skeletal interface and pre-bending of the plates prior to ischemia.
Donor: Blood Component Therapy Requirements

- The total face, double jaw, and tongue allograft (VCA) was procured in approximately 12 hours. The donor required 5 units PRBC and 2 units FFP².
Meanwhile, in the adjacent OR…

- Recipient is brought to adjacent Operating Room 3/19/12 @ 0540, shortly after the donor.
  - T&C for 10/10/Plt…
  - IV/Inhalational induction via in situ 5.0mm trach.
  - 2 mg midaz, 100 mcg fent, 100 mg propofol, 30mg rocuronium, Isoflurane.
- Tracheostomy stoma enlarged to accommodate 8.0mm reinforced ETT, which was secured caudally.
- Femoral venous (9Fr Cordis) and radial arterial (20g angiocath) access obtained.
  - Previous radial access failed intra-operatively on rehearsal procedures.³
- Very careful padding/tucking of extremities. Gel roll under shoulders (rolled-up sheet won’t do).
- Bair Hugger, temperature sensing Foley.
- Extensions for Hot line, plus maintenance/infusion lines. Alaris Pump with channels, Baxter syringe pump.
Recipient: Pre-Incision Anesthesia
Considerations for Recipient

- Excellent compliance on ventilator
  - Volume Control 550 TV, 10 PEEP (PIP 19-21cmH₂O)
- Fentanyl drip initiated @ 3 mcg/kg/hr.
- Cefazolin 1 gm (q 6 interval dosing)
- Cell-saver standing by.
- EV-1000© Module for Vigileo™ Monitor with FloTrac™ sensor for continuous cardiac output (CCO), stroke volume (SV), stroke volume variation (SVV), and Stroke Volume Index (SVI) via a-line.
- A proper music playlist.
  - A true multidisciplinary challenge.
Recipient Dissection

Due to the extensive scarring from the initial injury and multiple previous surgeries, preparation of the recipient face required approximately 17 hours.

- Cutting guides based on computer models.
Phases of Transplant

- Skeletal fixation
- Microvascular Anastamoses & Graft Reperfusion
  - Donor IJ/EC to Recipient IJ/EC
  - Donor EC to Recipient MA
  - Donor RIJ to the Recipient R thyro-lingual-facial trunk of IJ
- Nerve Coaptations
Nerve Coaptations

- Nerve stimulator used to identify middle and lower divisions of the facial nerves.
- Specific facial nerve branches were coapted under microscope, where possible.
The facial nerves of the recipient are coapted with motor nerve grafts to the middle division, while the lower division is coapted primarily.
Immunosuppression prior to Reperfusion

• Induction therapy consisted of alemtuzumab (Campath) 30mg prior to revascularization of the allograft.
  – methyprednisolone 500 mg, diphenhydramine 50 mg
• Thymoglobulin has been the primary induction therapy in previously published facial VCA's.²
• Alemtuzumab provides comparably more durable T-cell depletion with one intra-operative dose and without requirements for daily administration and monitoring²,⁴
• UMMC Drug of Choice⁵.
Alemtuzumab (Campath®)

- Antineoplastic agent; anti-CD52 monoclonal antibody.
  - Induces severe, prolonged lymphopenia.
  - Off-label indication as one-time dose for immunosuppressive induction prior to organ transplantation
- 30 mg in 100mL NS, initiated at 50 mL/hr.
  - 50 mg IV diphenhydramine premedication recommended by manufacturer
- Infusion reactions
  - pulmonary infiltrates, acute respiratory distress syndrome (ARDS), respiratory arrest, cardiac arrhythmias, myocardial infarction, acute cardiac insufficiency, cardiac arrest, angioedema, and anaphylactoid shock, pyrexia, chills, hypotension, urticaria, nausea, rash, tachycardia, dyspnea.
VCA Revascularization & Reperfusion

HOLD ONTO YOUR BUTTS...
VCA Revascularization & Reperfusion Management:

- After arterial anastomosis, the graft was allowed to “drink” via arterial blood flow with venous egress...into the drapes.
  - Allows for graft inflow equilibration, vasodilatation, and discharge of preserving solutions.
  - SVV from <5% to 30%.
  - Careful and rapid resuscitation initiated.
  - 10 U PRBC, 10 U FFP, and 7 pack platelets, with additional autologous via cell saver transfused.
  - Systemic hyperkalemia/free radical washout/hypotension anticipated from reperfusion.
    - 50 mg Furosemide, 60 mEq NaHCO₃, 12.5gm Mannitol, 2 gm CaCl₂.
  - Minute ventilation increased from 7 to 9 LPM to maintain normocapnea.
  - FiO₂ maintained at 40%.
VCA Revascularization & Reperfusion Management:

• Goal directed volume resuscitation titrated to hemodynamic parameters and observed blood loss, according to 1:1:1 resuscitation paradigm\(^6,7\) commonly employed at our institution.
  – HCT maintained about 26%
  – SVV < 15%, SVI WNL

• Physiologic resuscitation was goal-directed, guided with q 30 minute ABG and hourly CBC & Coagulation during graft reperfusion and subsequent resuscitation.
  – Base deficit, INR*, iCa\(^{2+}\)

• Critical hyperkalemia requiring additional treatment with insulin was not encountered.
  – Peak serum K\(^+\) recorded during reperfusion 4.7
Vascularity confirmed with Fluorescent Angiography

Total ischemia time: 4hr 26min.

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• Adhering to aesthetic surgical principles, coronal, preauricular, and neckline incisions were intended to be easily hidden with hair and clothing.
A side-by-side image demonstrated the donor face attached to the underlying skeletal architecture on the left, and the recipient face on the right.²
Totals for Recipient

- 2500 mL EBL
- 12 U PRBC, 12 U FFP, 7pk PLT
- 12 L P-lyte
- 750 mL 5% Albumin, 200 mL 25% Albumin
- 2 mg Midazolam
- 5275 mcg Fentanyl
- 16 mg Dilaudid
- 6 gm CaCl$_2$
- 11 gm Ancef
- 2700 mg Clindamycin
- 4600 UO
Survey: Perioperative Management of Face Transplant

- Edrich, TE et al., *Anesthesia & Analgesia*, Sept 2012 vol.115 no. 3 pp. 668-670
- Survey to assess anesthesia-related management and rationale of VCA.
- Respondents were 13 anesthesiologists of the first 14 face transplants performed worldwide.
Survey: Perioperative Management of Face Transplant

- Edrich’s 2 Major Findings:
  - Procedures were typically long (median 19 hours)
  - Blood loss tended to be high, specifically during graft reperfusion (median 20 U of PRBC’s, 13 U of FFP, 2 U PLT, and 13 L of crystalloid).
Most cases followed similar course

- Excruciatingly meticulous dissection of recipient’s facial structures.
- Surgical pre-planning critically important, as the recipient’s vascular structures and nerve supply can be severely distorted from initial injury and previous reconstructive procedures.
- In most cases, the “blood-letting” begins during reperfusion of donor facial graft.
Survey: Perioperative Management of Face Transplant

• Factors related to Blood Loss
  – After 1-sided arterial and/or venous anastomosis of the graft, the *contralateral side was often allowed to bleed*.
  – In most cases, *4 vascular anastomoses* were completed (2x typical microsurgical reconstructive cases), thereby accounting for the long duration of this phase.
  – Anesthesia teams reported *difficulty in recognizing blood loss* in a timely manner. Bleeding into folded drapes and poor visibility of the surgical site for the anesthesia team (probably thanks to all the extra staff) were reported.
• Other factors considered by authors:
  – Airway Management
    • 11 of 13 patients had preexisting tracheostomy
    • Most often (as in STC experience) tracheostomy stoma was intubated with armored ETT.
  – Vasopressor use
  – Cell-saver
Preserving donor dignity:

- A professionally rendered facial mask was created during the procurement of the donor face.
- The impression was taken at ICU bedside the evening prior to surgery, and the final mask completed and placed on the donor following VCA procurement.
Conclusions:

- The VCA Procedure is a massive undertaking, requiring systematic considerations from bench to bedside.
- Anesthesia key points include: emphasis on preoperative donor and recipient preparation, anticipation of a long procedure with progressive intensity of blood loss for donor, and potential for abrupt exsanguination upon graft reperfusion. Immunosuppressive regimens are evolving and may be institution specific.
- Institutional and Interdisciplinary cooperation, communication, and mutual respect facilitate successful outcome.
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