Cardiac Transplantation: Harvesting & Implantation, VAD Explant

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Cardiac Transplantation: Harvesting & Implantation, VAD Explant

- Discuss donor selection
- Review intra-operative donor organ evaluation
- Outline procurement surgical techniques
- Discuss timing of recipient and donor OR and transplant flow management
- Outline recipient explant +/- VAD & surgical implant techniques & considerations
Cardiac Transplantation: Donor Selection

- Age younger than 55 years
- No history of chest trauma or cardiac disease
- No prolonged hypotension or hypoxemia
- Meets hemodynamic criteria:
  - Mean arterial pressure greater than 60 mm Hg
  - Central venous pressure 6 to 10 mm Hg
  - Inotropic support less than 10 mg/kg/min (dopamine or dobutamine)
Cardiac Transplantation: Physiology of Brain Death

- Herniation occurs after rostrocaudal progression of ischemia
- Hypertension with bradycardia (Cushing response) as the pons becomes ischemic
- Medulla creates unopposed sympathetic stimuli that trigger a catecholamine "storm."
- Damages end organs by inducing both severe vasoconstriction and proinflammatory response
- Spinal cord ischemia and loss of sympathetic denervation result in severe hypotension.
- This is exacerbated by simultaneous ischemia of the pituitary and hypothalamus and the loss of homeostatic control.
Cardiac Transplantation: Donor Physiology

Management of the Brain-Dead Organ Donor

Textbook of Critical Care.

# Cardiac Transplantation: Donor Physiology

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<tr>
<th>Signs and Symptoms</th>
<th>Pathophysiologic Changes</th>
<th>Incidence</th>
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<tr>
<td>Hypertension</td>
<td>Catecholamine storm</td>
<td>80%-90%</td>
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<tr>
<td>Hypotension</td>
<td>Vasoplegia, hypovolemia, reduced coronary blood flow, myocardial dysfunction</td>
<td>80%-90%</td>
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<tr>
<td>Bradycardia and other arrhythmias</td>
<td>Catecholamine storm, myocardial damage, reduced coronary blood flow</td>
<td>25%-30%</td>
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<td>Pulmonary edema</td>
<td>Acute blood volume diversion, capillary damage</td>
<td>10%-20%</td>
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## Cardiac Transplantation: Donor Physiology

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<th>Signs and Symptoms</th>
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<tr>
<td>Diabetes insipidus</td>
<td>Posterior pituitary damage</td>
<td>45%-80%</td>
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<td>Disseminated intravascular coagulation</td>
<td>Tissue factor release, coagulopathy</td>
<td>30%-55%</td>
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<td>Hypothermia</td>
<td>Hypothalamic damage, reduced metabolic rate, vasodilation and heat loss</td>
<td>Varied</td>
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<tr>
<td>Hyperglycemia</td>
<td>Decreased insulin concentration, increased insulin resistance</td>
<td>Common</td>
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Cardiac Transplantation: Donor and Recipient Matching

- ABO blood type
- PVR at the upper limit of acceptable
- Normal PVR
- Female-to-male
- Elevated PRA
Cardiac Transplantation: Donor Management

**Conventional management:**
- Maintain CVP between 6-10mm Hg
- Correct acidosis: target pH= 7.40-7.45
- Correct hypoxemia: target pO2 > 80mm Hg, Osat > 95%
- Correct Anemia: target Hct > 30%, Hg > 10 g/dL
- Adjust Inotropes: target MAP > 60 mmHg (target dopamine/dobutamine <10 µg/kg/min)

**Initial Echo:** Rule out significant LVH, Valvular dysfunctions, congenital lesions

**Hormonal resuscitation:**
- T3: 4µg bolus + 3 µg/hr infusion
- Vasopressin: 1 unit bolus + 0.5 – 4 U/hr infusion
- Methylprednisolone: 15 mg/kg bolus
- Insulin: 1U/hr min (titrate glucose to 120–180 mg/dl)

**LVEF > 45%**

**Hemodynamic management (> 2 hr):** Float PAFC Adjust fluids/inotropes/pressors every 15 min to minimize alpha agonist and meet following:
- MAP > 60 mm Hg
- CVP 4-12 mm Hg
- CI > 2.4 L/min/m²
- Dopamine/Dobutamine <10 µg/kg/min
- SVR 800-1200 dynes/sec/cm²
- PCWP 8-12 mm Hg
- LV Stroke Work Index >15

**Criteria met**
- Retrieve organ

**Criteria not met**
- Abandon retrieval
Cardiac Transplantation: Donor Surgery

- Review of Medical Record
  - Consent for donation
  - Brain Death Declaration
  - Blood Type x 2
  - Serology assessment (CMV, HIV, Hep B and C)
  - Transfusion History

- Review ECHO, Cath Films and CXR
- Hemodynamics including drugs
- Discuss operative plans and timing of Cross Clamp
- Inform recipient center of anticipated time of return to OR
Cardiac Transplantation: Donor Surgery

- RV Function
- LV Function
- Great Vessels
- Coronary Anatomy
- Evidence of trauma
Cardiac Transplantation: Donor Surgery

- Mobilization of the SVC
- Ligation of the Azygous Vein
Cardiac Transplantation: Donor Surgery

Heart Transplantation: Donor Operation for Heart and Lung Transplantation;


Heart Transplantation: Donor Operation for Heart and Lung Transplantation


Cardiac Transplantation: Donor Surgery

Heart Transplantation: Donor Operation for Heart and Lung Transplantation;


Position the pulmonary catheter at the line of transection of the pulmonary artery.

May also be injected into the pulmonary artery
The left atriotomy should be placed between the coronary sinus and the bifurcation of the left pulmonary veins. If the lungs are not procured for transplant, the pulmonary veins are transected at the pericardial reflection.
Cardiac Transplantation: Donor Surgery

- Initial Assessment (Visual)
- Understanding the requirements of the recipient
- Hemodynamic Monitoring/drips
- Heparinization (30,000 Units)
- Cooperation and Coordination with other teams
- Communication to your recipient surgeon
- Root Cardioplegia and Avoid Distension
- Explant examination (PFO, Valvular anatomy)
- Storage
# Cardiac Transplantation: Surgical Coordination

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- **OPO Communication**
  - Initial Organ Offer
- **Transplant Team Communication**
  - Organ Accepted
  - Recipient Notified
  - Donor Team Modified
- **Donor Surgeon Communication**
  - Notified of Impending TX
  - Donor Team Modified
- **Implant Surgeon Communication**
  - Organ Accepted
  - Updated
  - Updated
  - Updated

**Timeline:**
- **0-2:** Initial communication about organ offer.
- **4-6:** Updates on donor surgery time.
- **10:** Communication with transplant team about organ acceptance.
- **12:** Communication with donor team about transportation.
- **13-15:** Donor team transported.
- **16:** Recipient in OR and transplant surgery.

**Surgical Coordination:**
- Coordinating teams across various stages of organ donation and transplantation.

**Key:**
- **OPO:** Organ Procurement Organization
- **DONOR:** Donor
- **Surgery:** Surgery time
- **Time:** Time stamps for each stage of the process.
Cardiac Transplantation: Surgical Coordination

- MultiOrgan Procurement
  - Timing
  - Distance
  - “Possible other Organs”
  - Efficiency of other Teams
  - Delays once Donor surgery started
  - Bumped for emergency

- Donor Family Requirements

- Recipient Requirements
  - Primary Sternotomy
  - AICD
  - VADS
  - Local Emergencies
Cardiac Transplantation: Surgical Coordination

Timing procurement

- Local in House (walking across the hall)
- Local another hospital in the city (Ambulance Ride)
- In-State Procurement (Short flight ground transportation)
- Out of State (Long Flight...Ischemic Time Clock ticking away)
Orthotopic Heart Transplantation


Orthotopic Heart Transplantation

Cardiac Transplantation:
Surgical Technique

Orthotopic Heart Transplantation


Orthotopic Heart Transplantation


Cardiac Transplantation: Surgical Technique

Orthotopic Heart Transplantation


Orthotopic Heart Transplantation


Orthotopic Heart Transplantation


Cardiac Transplantation: Surgical Technique

- Traction Sutures
  - Left Atrium
  - SVC
  - Pulmonary Artery

- Systemic Hypothermia

- Deairing and venting

- Retrograde warm GA Solution

- Recovery Time (30 minutes)

- Immunosuppression
Cardiac Transplantation: Hemodynamics

Heart Rate = 110
Systolic Blood Pressure = 90
Mixed venous Saturation = 70
CVP = 10 – 12
Cardiac Transplantation: Explantation of VAD

Heart Transplantation After Left Ventricular Assist Device


Southerland, Kevin W., MD; Milano, Carmelo A., MD. Published March 1, 2014.
Volume 19, Issue 1. Pages 47-63. © 2014
Plan the Explant Surgery at the VAD implant Surgery

Consider options for CPB Cannulation
- Axillary
- Femoral
- Inflow graft
- SVC/IJ/Fem
Cardiac Transplantation: Explantation of VAD

- Venous cannulation and Bypass initiation
- Femoral Venous Duel stage cannula
- Decompress the heart
- SVC cannulation (24 Fr)
Cardiac Transplantation: 
Explantation of VAD

Arterial cannulation via the outflow graft

- Allow initiation of CPB
- Avoids peripheral issues
- Allows for mobilization of the native aorta
- Reposition the arterial cannula in the arch
- Resect the grafted aorta
Cardiac Transplantation: Explantation of VAD

- Donor heart in the operating room
- Aorta is cross clamped
- SVC and IVC isolated
- Heart is excised at the level of the right and left atrioventricular grooves (Biventricular resection)
- Aorta divided at the level of the sinotubular junction
- Main pulmonary artery is divided at the level of the pulmonic valve (Leave the commissures on the pulmonary artery side of the resection)
Cardiac Transplantation: Explantation of VAD

Heart Transplantation After Left Ventricular Assist Device


Southerland, Kevin W., MD; Milano, Carmelo A., MD. Published March 1, 2014. Volume 19, Issue 1. Pages 47-63. © 2014
Cardiac Transplantation: Explantation of VAD

- Trim the Left Atrium
- Traction Sutures for orientation and elevation
- Start at the LA Appendage
- If a vent is used position prior to Closure of the LA Anastomosis
Cardiac Transplantation: 
Explantation of VAD

• If ischemic time is prolonged consider cardioplegia

• Excise the native aorta to eliminate any foreign material (Outflow Cannula)

• Start at the 3 o’clock position to avoid transition point leakage

Heart Transplantation After Left Ventricular Assist Device
Southerland, Kevin W., MD; Milano, Carmelo A., MD. Published March 1, 2014. Volume 19, Issue 1. Pages 47-63. © 2014
Cardiac Transplantation: Explantation of VAD

- Orient the pulmonary artery anastomosis with the native commissures
- Small rotation of the anastomosis will induce RV outflow tract gradient and may potentiate RV Failure

*Heart Transplantation After Left Ventricular Assist Device*


Southerland, Kevin W., MD; Milano, Carmelo A., MD. Published March 1, 2014. Volume 19, Issue 1. Pages 47-63. © 2014
Cardiac Transplantation: Explantation of VAD
Cardiac Transplantation: Explantation of VAD

- Planning of the Explant at the Implant operation
- Preformed Antibodies  Positive PRA
- Reversal of Anticoagulation
- Adequate time for dissection of the VAD and Native Heart
- Cannulation Strategy
- Moderate Hypothermia
- Donor Heart with Extras (Aorta, Pulmonary Artery, SVC)
- Know the ischemic time of the donor heart and administer cardioplegia
- Immunosuppression
- Weaning and support after implantation
- Watch out for RV Failure especially if elevated PVR prior to LVAD implant
- De-airing and Retrograde warm GA
The 4 most common congenital abnormalities that require reconstruction at the time of transplantation, including:
(1) Management of the left superior vena cava
(2) Management of transposition of the great arteries
(3) Pulmonary artery reconstruction following prior congenital procedures
(4) Comprehensive reconstruction after prior hybrid-type palliation
Cardiac Transplantation: Congenital Heart Disease

Hostile reoperative surgical field

(1) performing the cardiectomy under deep hypothermic circulatory arrest simply to obtain a clearer sense of the underlying anatomy

(2) reconstruction to allow for bicaval (or tricaval) cannulation

(3) reinstitution of bypass with rewarming to moderate hypothermia before the arrival of the donor heart
Cardiac Transplantation: 
Congenital Heart Disease 

Left Superior Vena Cava

Depending on the course of the L-SVC drainage within the heart, several different techniques may be applied. However, often the easiest is to reconstruct the L-SVC drainage using donor innominate vein.
Cardiac Transplantation: Congenital Heart Disease (L-SVC)

Heart Transplant: Transplantation for Congenital Heart Disease


Chen, Jonathan M., MD. © 2014
Cardiac Transplantation: Congenital Heart Disease (L-SVC)

Heart Transplant: Transplantation for Congenital Heart Disease


Chen, Jonathan M., MD. © 2014
Cardiac Transplantation: Congenital Heart Disease (L-SVC)

Heart Transplant: Transplantation for Congenital Heart Disease


Chen, Jonathan M., MD. © 2014
Transposed great arteries may pose little problem for reconstruction. However, often their more anterior-posterior orientation (compared with a more rightward-leftward orientation of the donor heart) can result in a twist. Allowing for extra donor and recipient aorta and pulmonary artery can afford this twist without creating areas of stenosis.
Cardiac Transplantation: Congenital Heart Disease (Hybrid)

Heart Transplant: Transplantation for Congenital Heart Disease


Chen, Jonathan M., MD. © 2014
Cardiac Transplantation: Congenital Heart Disease (Hybrid)
Cardiac Transplantation: Orthotopic cardiac transplantation, hypoplastic left heart physiology

Cardiac Transplantation

Kirklin/Barratt-Boyes Cardiac Surgery.

Kouchoukos, Nicholas T., MD; Blackstone, Eugene H., MD; Hanley, Frank L., MD; Kirklin, James K., MD. Published January 1, 2013. Pages 809-872. © 2013
Cardiac Transplantation: Harvesting & Implantation, VAD Explant

- Confirm and verify donor information
- Assess the clinical status of the donor
- Discussion and coordinate all planned interventions
- Confirm the appropriateness of the donor
- Communicate to the recipient Surgeon
- Establish timing of cross clamp
- Understand the recipient’s anatomical needs
Cardiac Transplantation: Physiologic Endpoint Goals in a Potential Organ Donor

- Mean arterial pressure: 60-100 mm Hg
- Central venous pressure: 4-10 mm Hg
- Left ventricular ejection fraction: >50%
- Use of ≤1 vasopressor at a low dose
  * Dopamine ≤10 µg/kg/min, neosynephrine ≤60 µg/kg/min, or norepinephrine ≤10 µg/kg/min.

Cardiac Transplantation: Harvesting & Implantation, VAD Explant

Success

• Anticipate needs of the recipient
• Be professional and respect the other teams
• Communicate with the recipient team as well as donor team(s)
• Define anatomical variation and time constraints
• Efficient in delivery of a well preserved organ