

Heart Transplantation

- >2100 adult heart transplants per year
- >3800 adults on waiting list registry
- Lack of sufficient donor hearts to meet the demand
- Most common adult causes (~90% of cases):
 - 1. Ischemic cardiomyopathy**
 - 2. Idiopathic dilated cardiomyopathy**
- Less common causes: viral cardiomyopathy, infiltrative cardiomyopathy, post-partum cardiomyopathy, valvular heart disease, and congenital heart disease.

Pre-Op Evaluation

1. NPO status
2. Level of CV support (PO drugs, Infusion drugs, Mechanical assist devices)
3. Presence / status of implantable devices (pacemakers, AICD's)
4. Recent deterioration of CV function (escalating level of support)
5. Previous sternotomy (CABG, valve, heart / lung Tx)
6. Anti-coagulation status
7. Lab studies (CBC, BMP, coags, PFT's)
8. CXR
9. Immunosuppressive regimen planning

Do **NOT** induce the recipient patient until harvesting team communicates the decision to proceed with the heart transplant.

Anesthesia Preparation

- Pre-induction Arterial line
- 1-2 large bore IV's
- Pre vs. post induction placement of Central Line access (communicate with surgeon about preference of PAC vs. quad lumen CVL)
- Cardiac specific infusions
- Specific plan for induction
- Surgical plan for crash on induction onto CPB
- Placement of TEE after induction

Key Points

- Significant down-regulation of the beta receptors in the recipient heart of most transplant candidates (decreases the responsiveness to a given dose of beta agonist drugs such as **Dobutamine** and **Epinephrine**).
- Donor heart will be denervated after transplant and post-CPB and bradycardia is a frequent problem (a direct-acting beta agonist drug should be available).
- Many centers use **Isoproterenol** for this purpose because of its lack of alpha and vasoconstrictive effects on the pulmonary vasculature, but Dobutamine and Epinephrine may be used as well.

Anesthetic Considerations

- The key is to achieve a stable, sustainable hemodynamic state before starting surgery by adding or adjusting support.
- Many heart transplant patients will have recently eaten and need a rapid sequence induction to prevent aspiration. When full-stomach precautions are not needed, the induction should proceed slowly and cautiously.
- Etomidate may offer some advantage as an induction agent in terms of hemodynamic stability compared with **Propofol**

Anesthetic Considerations cont.

- These drugs are usually combined with a modest dose of Fentanyl and a neuromuscular blocking agent.
- High-dose opioid induction with or without benzodiazepines for heart transplantation.
- Maintenance of anesthesia before CPB may be accomplished with a combination of a potent inhalation anesthetic agent and modest doses of opioid or a high-dose opioid technique.

Anesthetic Considerations cont.

- **Antifibrinolytic therapy** (Amicar or TXA) started before CPB
- Heparin is administered when the heart is exposed before cannulation.
- The pulmonary artery catheter is withdrawn from the heart into the sheath before the superior vena cava is cannulated for CPB.

Orthotopic Heart Transplant

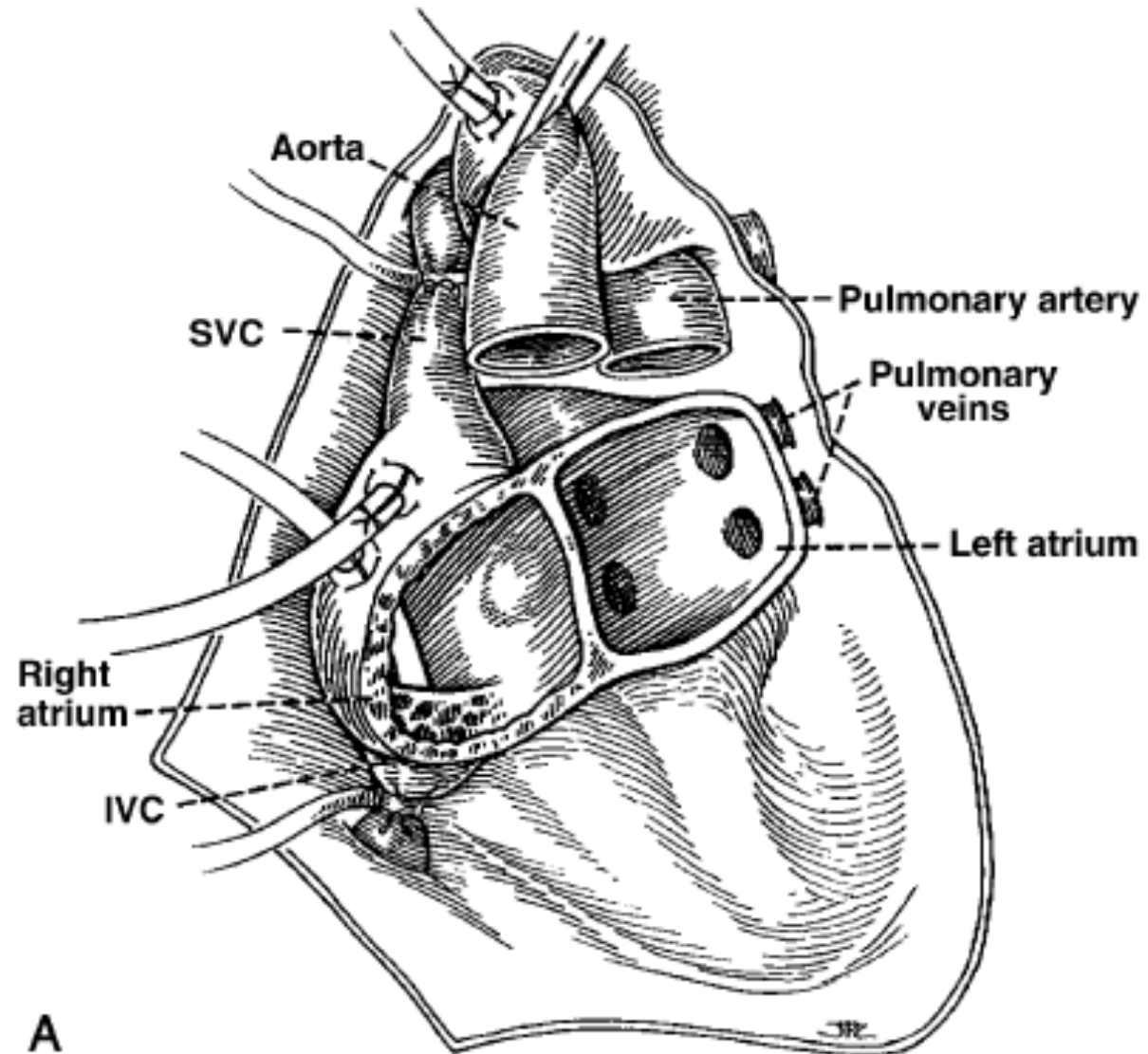
- After the sternotomy, the ascending aorta is cannulated close to the aortic arch, venous return cannulae are inserted into both the superior and inferior cavae, and the patient is placed on CPB.
- The recipient's diseased heart is removed and the donor allograft is inserted anatomically in its place.

Surgical Techniques

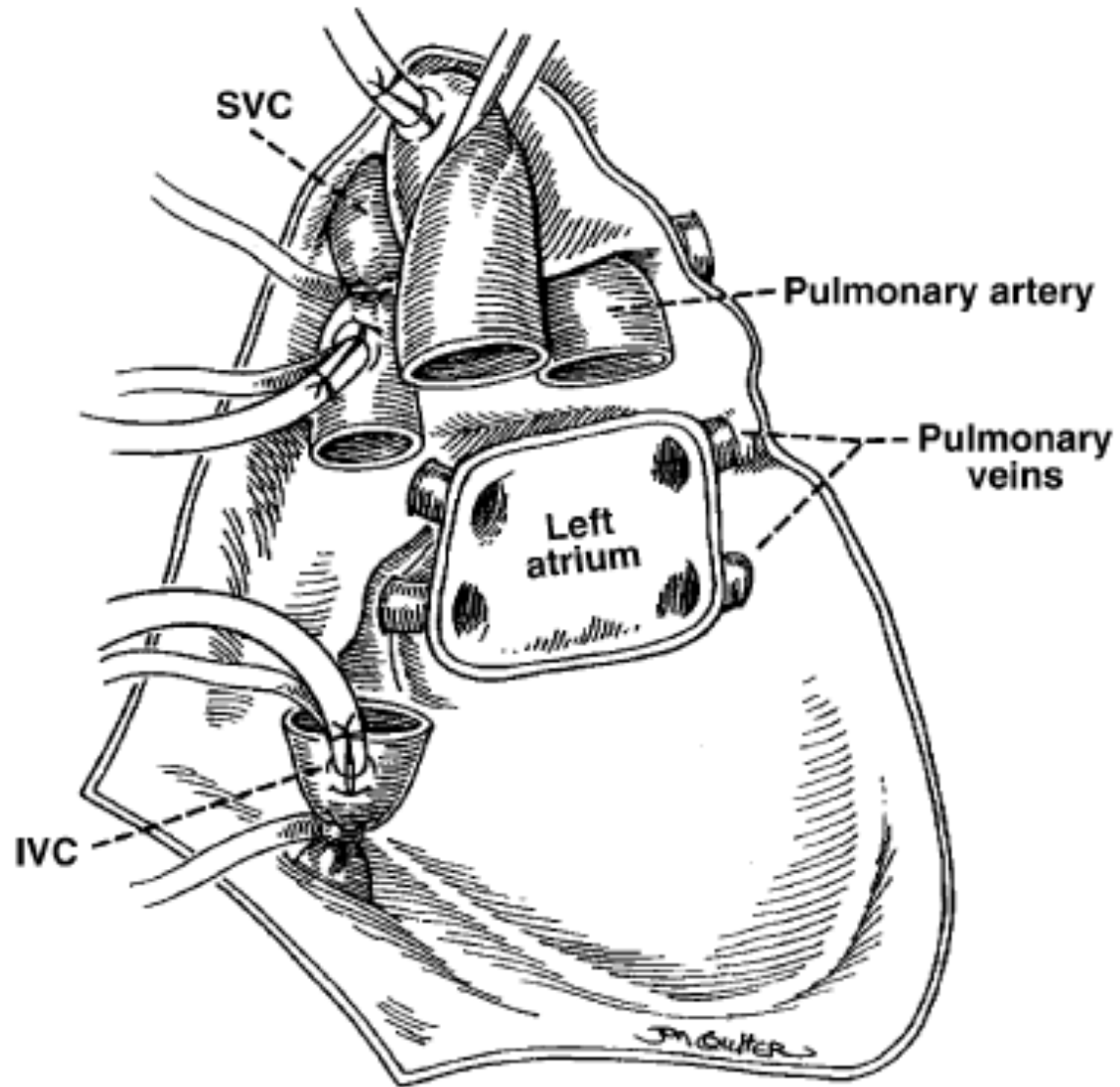
Two surgical techniques for orthotopic heart transplantation:

1. Classic / **Biatrial** method
2. **Bicaval** method

Classic / **B**atrial Suture Line



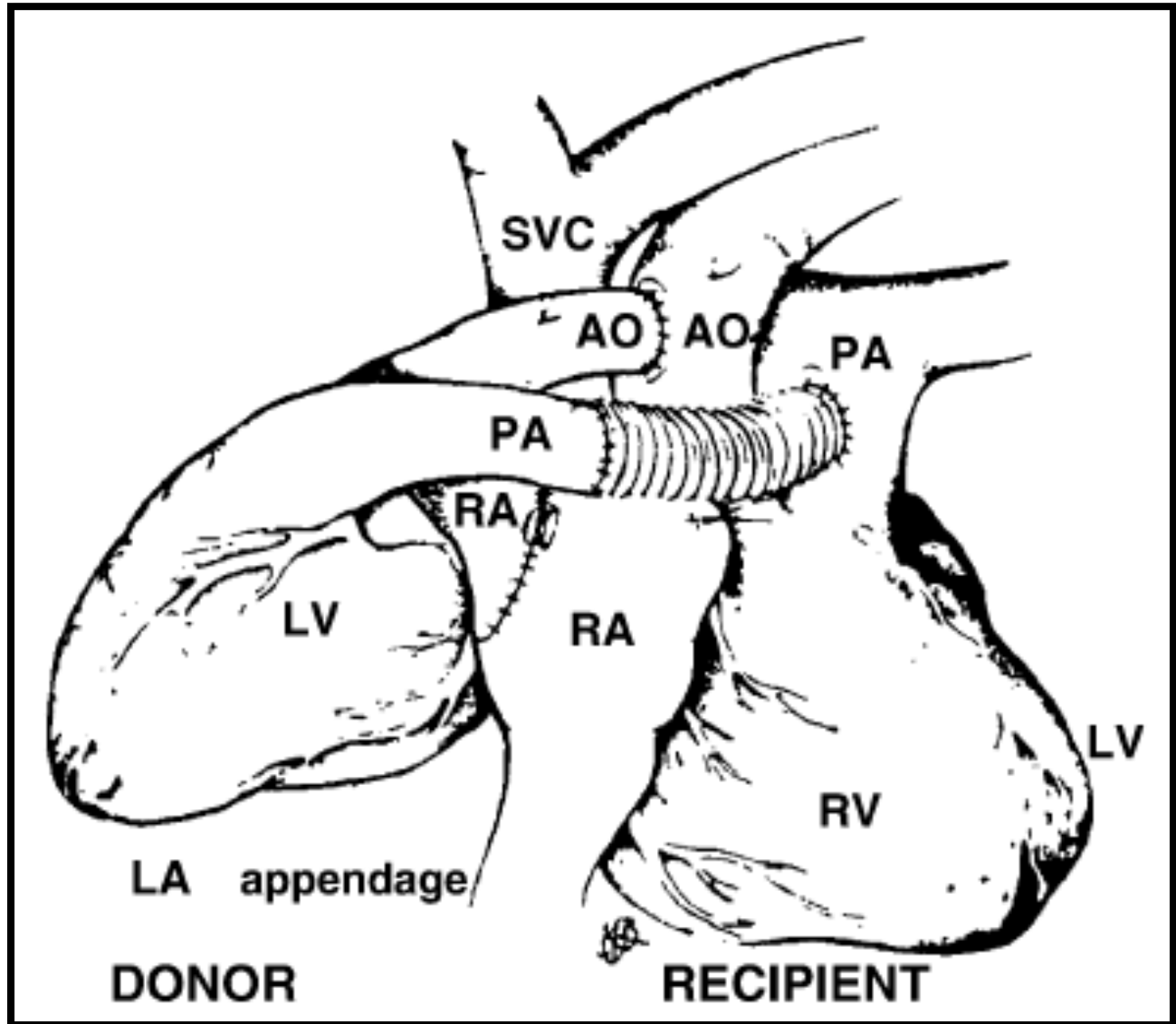
Bicaval Suture Line



Heterotopic Heart Transplant

- Rarely performed procedure
- Recipient's heart remains in place, and the donor heart is attached to its right side so that the flow in each is in parallel, permitting the recipient's heart to continue to pump blood, particularly through the lungs.
- Reserved for patients with pulmonary hypertension.
- Used as a strategy to avoid acute right heart failure in the unconditioned donor heart and in cases in which there is a marked size mismatch of the donor and recipient.

Heterotopic Heart Transplant



Coming Off CPB

- **Key Point**: the **implanted donor heart is denervated** so that reflex-mediated heart rate responses to hemodynamic changes will be absent, and drugs acting indirectly on the heart through the nerves will be ineffective.
- It usually takes several minutes for spontaneous rhythm to return in the donor heart after completion of the aortic anastomosis and release of the aortic cross clamp.
- Infusion of a direct-acting, chronotropic drug (**Isoproterenol**).
- Sometimes two sets of P-waves after cardiac transplantation, one set from the donor heart and the other from the posterior walls of the recipient atria, which remain in situ.
- **Pacing**, at least initially, to achieve an adequate HR of 90 - 110 beats per minute.

Coming Off CPB cont.

- Vasoactive and inotropic drugs are used as needed to discontinue CPB after heart transplantation (similar to other types of cardiac operations).
- **Short-acting, easily titratable drugs** are used when possible.
- An indication of the vasomotor tone is given by the mean blood pressure at full flow on CPB. If the mean blood pressure is lower than 60 mm Hg, a vasopressor may be needed, but if it is above 80 mm Hg, a vasodilator is used.
- The condition of the recipient heart before CPB has **no bearing** on the contractility of the donor heart, which may range from excellent (requiring minimal or no support) to extremely poor (requiring maximum support).
- Generally, the longer the **ischemic time** of the donor heart, the poorer is its initial function.

Failure to Wean Off CPB

- Usually caused by **Right Heart Failure**, which is evidenced by low cardiac output in the face of rising central venous pressure (easily seen on TEE).
- The right heart can be seen in the surgical field to dilate and contract poorly. TEE shows a dilated, poorly contracting right ventricle and an underfilled, vigorously contracting left ventricle.
- **Rx**: Epinephrine, Norepinephrine, Milrinone, iNO, adequate O₂ and avoidance of hypercarbia.
- Vasodilators such as nitroglycerine, sodium nitroprusside, prostaglandin E1, and prostacyclin may be infused to reduce PVR, but they also lower systemic vascular resistance and can cause hypotension.
- If unable to improve RV function, an **RVAD** may be necessary.