

Lung Transplantation

- Only attempted / completed at a few centers of excellence.
- **Idiopathic Pulmonary Fibrosis** was the initial indication for lung transplantation.
- Recently, **COPD** has become the primary indication for lung transplant in adults.
- Other common indications for lung transplant
 1. Cystic fibrosis
 2. α -1-antitrypsin deficiency
 3. Primary pulmonary hypertension

Lung Transplant Types

- The disease process of the recipient is a major determinant in whether the patient receives a single (SLTx), bilateral-sequential-single-lung (BSSLTx), or heart-lung (HLTx) transplant.
- Patients whose transplanted lung will receive most of the ventilation and perfusion, as in COPD and idiopathic pulmonary fibrosis, usually undergo SLTx.
- Double-lung transplantation (DLTx) using a tracheal anastomosis, although still performed, is falling out of favor.
- DLTx requires CPB, and the tracheal anastomosis is more susceptible to postoperative complications than the bronchial anastomoses of BSSLTx.
- HLTx is typically reserved for patients who have primary pulmonary hypertension, unreparable congenital defects, or left ventricular failure.

Pre-Op Evaluation (very similar to Heart Transplant regimen)

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

Induction

- Similar to heart transplant regimen
- Goal to keep hemodynamic stability
- Etomidate, high-dose Fentanyl, Propofol, Thiopental
- Maintenance of anesthesia maintained with narcotics or inhalational agents
- Fluid goal: DRY, DRY, DRY!
- Maintain hemodynamic stability with cautious inotropes.

Ventilator Management

- In patients with restrictive lung disease and those with COPD-associated blebs, positive pressure ventilation can lead to barotrauma.
- Common forms of barotraumas include pneumothorax, mediastinal emphysema, or air leak through a surgical anastomosis.
- In patients with pulmonary fibrosis and low compliance, attempts to achieve normal arterial values of oxygen and carbon dioxide may result in barotraumas.
- Ventilator strategies that use tidal volumes of 6 - 8 mL/kg and allow “permissive hypercapnia” have been shown to be beneficial in patients with ARDS.

One-Lung Ventilation

- Unless the patient is going to be placed on CPB, one-lung ventilation will need to be performed until the transplanted lung is ready to be ventilated.
- **Techniques for one-lung ventilation:** double-lumen tube, a combination single-lumen tube with endobronchial blocker or insertion of an endobronchial blocker through the single lumen endotracheal tube.
- The initiation of one-lung ventilation can produce marked respiratory instability. Intrapulmonary shunt increases to varying degrees, resulting in worsening hypoxemia, hypercarbia, and acidosis.
- The strategy of permissive hypercapnia via deliberate hypoventilation may help maintain cardiopulmonary stability by reducing the hemodynamic effects of dynamic hyperinflation and auto-PEEP.

- The hemodynamic consequences of one-lung ventilation and clamping of the pulmonary artery can be severe.
- Hypotension can result from a decrease in right ventricular preload and right ventricular dysfunction due to an increase in right ventricular afterload.
- Fluid administration (surgeons do **NOT** like) can improve preload, and pulmonary vasodilators can improve afterload.

Methods to Decrease PVR

- 100% oxygen and the administration of pulmonary vasodilators (O_2 may reduce pulmonary vascular resistance by reversing hypoxic pulmonary vasoconstriction).
- Milrinone, Nitroglycerin, Nitroprusside, and Prostaglandin E-1 are effective pulmonary vasodilators but also produce systemic vasodilation.
- Selective pulmonary vasodilators such as Nitric oxide and Prostaglandin I-2 given by inhalation have been demonstrated to reduce pulmonary artery pressure and intrapulmonary shunt without affecting systemic circulation.

Pulmonary Artery Clamping

- Reduce the shunt between the two lungs; however, this comes at the expense of increased right ventricular afterload.
- If the patient remains unstable despite manipulation of the ventilator and the use of vasodilators, then mechanical assistance is indicated.
- Classically, ECMO has been used (more challenging in adults).
- CPB is likely to increase bleeding because of the need for systemic anticoagulation and may increase the risk of post-op graft dysfunction.

Pulmonary Artery Un-Clamping

- Once the lung has been implanted, a second steroid bolus is given, the pulmonary artery is de-aired, and vascular clamps are removed.
- The lung is **gently** inflated, and a period of hypotension may ensue from the washout of pulmoplegic compounds (Prostaglandin E-1) and products of ischemia from the donor lung.
- Coronary artery air embolism can also occur (RCA is particularly prone to air embolism because of its superior location).
- These changes are usually transient, lasting less than 15 minutes.
- Prolonged hypotension should prompt a search for another etiology.
- Reperfusion may lead to acute injury of the lung.
- Ischemic changes after harvesting, denervation of the lung, loss of lymphatic drainage, and acute rejection have all been postulated mechanisms in the development of reperfusion injury.

Key Points to Lung Transplant

1. Better to maintain mild fluid deficit.
2. Inotropes for hemodynamic stability.
3. Maintain as low as possible airway pressures (carefully use PEEP and CPAP).
4. Cautiously / guardedly treat PVR (RV failure can occur at tremendously quick).
5. Follow hemodynamics and surgical progress with TEE.
6. Slow and tedious adjustments!