Aortic Valve Surgery

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Patients presenting for aortic valve surgery may have abnormalities of the aortic leaflets themselves, the annulus or the aortic root. This pathology may manifest as aortic stenosis, aortic regurgitation or a combination of the two processes.

Aortic stenosis (AS) is the most common cardiac valvular lesion affecting U.S. adults. It is characterized by abnormal valve function creating an impedance to flow between the left ventricular (LV) outflow tract and the aorta. The most common cause of AS is senile calcific degeneration which typically presents in the eighth decade of life. The other two major causes of AS are a bicuspid aortic valve and Rheumatic disease, a sequelae of prior group A streptococcal bacterial infection. Prolonged exposure of the left ventricle to increased systolic pressure overload results in concentric LV hypertrophy. LV compliance is reduced and higher LV end-diastolic pressure is required for adequate filling. Any loss of atrial kick due to atrial fibrillation or arrhythmia leads to dramatic decrease in stroke volume and C.O. Asymptomatic patients with AS may be followed over time and typically progress with a decrease in aortic valve area of 0.1 cm squared per year[1]. The onset of angina, syncope and dyspnea has been shown to correlate with average times to death of 5, 3 and 2 years, respectively[2]. Aortic valve replacement is indicated for patients with symptomatic severe AS (valve area <1.0 cm2, mean gradient > 40 mmHg, or jet velocity>4.0 m/sec) and those with severe AS undergoing coronary artery bypass grafting or other heart valve surgery. Asymptomatic patients with depressed LV function or rapid progression may also be considered for AVR.

(See management chart below.)
Aortic regurgitation (AR) is characterized by reflux of blood from the aorta back into the left ventricle during diastole. It may be acute or chronic with variable clinical presentation. Causes of AR are numerous and include a bicuspid aortic valve, atherosclerotic degeneration, rheumatic disease, aortic dissection, endocarditis, inflammatory diseases and connective tissue diseases. Patients with chronic severe AR may be compensated with eccentric hypertrophy, increased wall stress and systolic hypertension or uncompensated with progressive LV dilation decreased systolic function and poor diastolic compliance. Uncompensated individuals most commonly experience dyspnea on exertion but may also experience angina. Acute AR invariably leads to low cardiac output, pulmonary congestion and rapid decompensation. Aortic valve replacement is indicated for those symptomatic patients with chronic
severe AR or asymptomatic patients with an EF < 55% or an end systolic diameter of > 55mm[4]. Acute AR requires immediate surgical intervention; however, vasodilator therapy may provide some temporizing benefit.

**Aortic insufficiency Severity Scales**

**Quantification of Aortic insufficiency by Cardiac Catheterization**

Severe (grade 4+): Complete, dense opacification of the ventricular chamber on the first beat, and the left ventricle is more densely opacified than the ascending aorta

PW Doppler: mapping technique

Severe (grade 4+): The regurgitant jet extends beyond the papillary muscle level

Jet height / LVOT height

Severe (4+): ≥ 65%

Regurgitant jet area/LVOT area

Severe (4+): ≥ 60%

**Descending Thoracic Aortic Flow Pattern**

Reversal of flow in the descending thoracic aorta and/or abdominal aorta indicates aortic insufficiency is 3+ or 4+. This may also be detected by PW or CW Doppler.
Aortic Stenosis and Anesthetic Considerations – The intracavitary pressure required to overcome a stenotic aortic valve results in an increase in myocardial wall tension. According to the Law of Laplace, wall tension is directly proportional to intracavitary pressure and radius; and inversely proportional to wall thickness. Chronic pressure overload leads to concentric hypertrophy of the LV which decreases ventricular compliance and may lead to an imbalance of myocardial oxygen supply and demand. Diastolic dysfunction follows with a prolonged isovolumic relaxation time, higher filling pressures and an increased dependence on atrial kick.
The anesthetic goals for management of AS are as follows:

- Maintain preload
- Maintain afterload
- Sinus rhythm
- Normal rate, avoid tachycardia and bradycardia
- Maintain contractility (typically not a problem)

Aortic Regurgitation and Anesthetic Considerations – The extent of regurgitant flow with AR is dependent upon the size of the regurgitant orifice, the aorta-ventricular pressure gradient and the diastolic time. Chronic AR leads to state of LV volume and pressure overload. Progressive volume overloading increases LV end diastolic volume (EDV) and wall tension resulting in compensatory eccentric hypertrophy. Initially this increased LV mass helps to maintain a normal EF with normal filling pressures despite a very large stroke volume. However, over time, progressive increases in wall stress lead to LV dilation, systolic dysfunction and a reduced EF.

The anesthetic goals for management of AR are as follows:

- Maintain preload
- Controlled reduction of afterload
- Sinus rhythm
- High normal heart rate, avoid bradycardia
- Maintain contractility or increase if signs of cardiogenic shock present- milrinone/epi or dobutamine

Pre Aortic Valve Replacement TEE exam - Perform ASE/SCA recommended intra-operative TEE exam Describe Aortic leaflet motion, thickening, calcification and the presence or absence of AR including its severity Quantify the dimensions of the annulus, the sinus of valsalva and the sinotubular junction as well as the dimensions of the ascending Aorta at the level of the main PA Quantify the peak and mean pressure gradients across a stenotic valve with a calculated valve area using the continuity equation. If an aortic dissection is present, document the presence of blood flow in the coronaries, attempt to identify the origin of the dissection flap, and look for evidence of an effusion.

Post Aortic Valve Replacement TEE exam - Evaluate the LA and the LV for the presence of air prior to separating from cardiopulmonary bypass. Make an assessment of the valve function including type of valve (bioprosthetic or mechanical), whether or not the valve is well seated, leaflet mobility, the presence or absence of AR and paravalvular leaks. Recognize normal “washing jets” vs. true pathological leaks. Obtain a peak and mean gradient across the prosthetic valve. Rule out an aortic dissection post decannulation of the aorta.

Other Considerations:
- Minimally invasive aortic valve replacement via mini-thoracotomy or upper hemisternotomy.
  - Anesthetic considerations similar to median sternotomy.
  - May require double lumen ETT.
  - TEE essential for positioning of catheters, possible epi-aortic scan to find aortic cannulation site.
  - Earlier extubation may be possible.
- Percutaneous aortic valve replacement.
  - Transcatheter approach.
  - Anesthetic preparation as for CPB case: A-line and CVP, General Anesthetic with CT room and surgeon backup. Fluoro and TEE used to evaluate valve position and function.