Aortic Stenosis (AS)

Background
1. Definitions
   - Failure of the aortic valve to open completely, resulting in left ventricular outflow obstruction during systole
   - Normal valve area is 3.0 to 4.0 cm².
   - As aortic stenosis develops, minimal valve gradient is present until the orifice area becomes less than half of normal
   - Low gradient aortic stenosis
     - severe aortic stenosis (valve area <1.0 cm²)
     - transvalvular pressure gradient of less than 30 mmHg¹
   - Severity is determined by valve area: Error! Bookmark not defined.
     - Mild AS: valve area > 1.5 cm²,
     - Moderate AS: valve area 1-1.5 cm² and
     - Severe AS: valve area <1.0 cm²
     - Critical aortic stenosis < 0.75 cm² or the Doppler aortic jet velocity over 5 m/sec
   - True stenosis
     - severe aortic stenosis with secondary LV dysfunction that results in low transvalvular pressure gradient

2. General information
   - Most common cause (USA and Europe)
     - 70 year and older: predominantly degenerative calcification of aortic valve
     - Age under 70: predominantly bicuspid valve²,³
   - Worldwide rheumatic heart disease is still the main cause
   - Guidelines: American Heart Association and American College of Cardiology Guidelines for Treatment of Valvular Heart Disease
     - www.americanheart.org

Pathophysiology
1. Pathology of disease
   - Narrowed valve orifice leads to left ventricle (LV) outflow obstruction
     - Increased LV afterload, wall stress, and myocardial oxygen demand
     - compensatory LV hypertrophy
     - Increased atrial contraction to maintain stoke volume
     - Eventually heart cannot meet increased demand
     - decreased stroke volume, cardiac output, heart failure
     - As stenosis increases aortic/mitral regurgitation may develop
   - Acquired aortic stenosis
     - Age-related degenerative calcification of anatomically normal valves
       - Most common type of aortic stenosis
     - Calcification from wear and tear of abnormal valves
       - Bicuspid or unicuspid aortic valves
       - Valves scarred from rheumatic fever
     - Calcification of valves due to systemic process
       - Paget's disease
       - Chronic renal failure
• Rheumatoid arthritis
• Chlamydia pneumonia infection

○ Congenital aortic stenosis
  ▪ Congenital defect of atrial valve in which leaflets are fused and/or
    underdeveloped
  ▪ Often accompanies other congenital heart defects such as patent ductus
    arteriosus, coarctation of the aorta

2. Incidence/prevalence
   ○ Most common valve lesion in US
   ○ 2% of US population, 3% of population above 75, and 4% percent population
     above age 85 have the disorder
   ○ 1-2% of US population has bicuspid valve
   ○ Congenital aortic stenosis male: female ratio is 4:1

3. Risk Factors
   ○ Risk factors for degenerative calcification
     ▪ Male gender
     ▪ Increased age
     ▪ Hyperlipidemia
     ▪ Chronic kidney disease
     ▪ High low density lipoprotein (LDL) and hiperlipoproteinemias
     ▪ Smoking
   ○ Abnormal valves
     ▪ Bicuspid or unicuspid aortic valve
     ▪ Valves scarred from rheumatic fever
     ▪ Aortic Sclerosis
   ○ Congenital AS
     ▪ Increased risk with other congenital heart lesions

4. Morbidity/Mortality
   ○ Progression from asymptomatic to symptomatic AS varies, but averages about 5
     yr
   ○ When symptoms develop, if untreated, mortality exceeds 90% within a few years
     ▪ Development of angina: 5-year mean survival
     ▪ Development of syncope: 3-year mean survival
     ▪ Development of CHF: 2-year mean survival
     ▪ Good prognosis with aortic valve replacement (AVR)
     ▪ High mortality if symptomatic patients do not undergo AVR
     ▪ Pulmonary HTN can develop with severe AS and indicates poor prognosis
   ○ Asymptomatic patients have 1% mortality/year. Some may qualify for surgery
   ○ Increased risk of infective endocarditis (IE)
   ○ Increased bleeding tendency
   ▪ Association of AS with gastrointestinal angiodysplasia
   ○ Severe AS is a risk factor for perioperative morbidity and mortality in noncardiac
     surgery

Diagnostics
1. History
   ○ Variable asymptomatic period
   ○ Symptoms usually appear when valve area < 1 sq.cm
1. Symptoms
- Decreased exercise tolerance and dyspnea on exertion are most common symptoms
- Classic triad of angina, syncope and heart failure develop as disease progresses
- Atrial Fibrillation uncommon but can come with heart failure

2. Physical Exam
- Carotid pulse
  - Weak, late and slowly rising (parvus and tardus)
- Cardiac auscultation
  - Soft, single S2, may be split with severe disease
  - Ejection click heard with bicuspid aortic valve
  - S4 due to vigorous atrial contraction
  - Harsh ejection systolic crescendo/decrescendo murmur at right upper sternal border (RUSB), radiating to carotids
  - Mild to moderate AS has early peaking and severe stenosis has late peaking
  - Most patients with severe stenosis have grade 3, but many have grade 1-2
  - Soft diastolic murmur (if aortic regurgitation)

3. Diagnostic Test
- Laboratory evaluation
  - Brain natriuretic peptide (BNP)
- Diagnostic imaging
  - CXR
    - Normal if AS is mild or moderate
    - With severe disease
      - Calcification of aortic leaflets and aortic roots
      - LV hypertrophy (rounding of LV apex)
      - Poststenotic dilatation of ascending aorta
  - EKG
    - Non specific
    - LVH commonly, A-fib occasionally if heart failure present
  - Echocardiogram (most sensitive)
    - Thickened/calcified aortic leaflets
    - Small aortic valve orifice during systole
    - May see bicuspid aortic valve
    - LV wall hypertrophy but normal chamber size
    - Jet velocity, left V-A gradient and valve area measured with Doppler
    - Concurrent aortic or mitral regurgitation can be picked up
    - PA pressure can be high in about 15%
    - Recommended echo frequency: yearly for severe, every 1-2 yr for moderate and every 3-5 yr for mild AS
  - MRI
    - Velocity- encoded MRI an option to measure antegrade velocity
  - Other
    - Cardiac catheterization
      - Only in asymptomatic patient if non invasive tests inconclusive
Differential Diagnosis

1. Key differential diagnoses
   - Cardiac
     - Ischemic heart disease
       - EKG, cardiac enzyme and echo helpful to differentiate
       - Both AS and CAD can present with angina.
       - AS and CAD can coexist
       - AS can cause ischemia w/o CAD
     - CHF (CXR, BNP, Echo)
       - Both AS and CHF can present with dyspnea
       - HF is also a late complication of AS
     - Other valvular heart disease (auscultation, echocardiogram)
       - Pericardial tamponade (history, pulsus paradoxicus, distended neck veins, echo)
       - Infectious
         - Endocarditis (fever, positive blood cultures, echocardiogram)
         - Rheumatic fever (post streptococcal pharyngitis, elevated ASO titer)
       - Aortic dissection (exam, CT scan)
       - Pulmonary embolus (tachycardia, tachypnea, positive V/Q scan or CT angiogram)

2. Extensive differential diagnosis
   - Cardiac
     - Hypertrophic cardiomyopathy (murmur changes with valsalva and standing)
     - Dilated cardiomyopathy
     - Hypertensive heart disease
     - Pericarditis
     - Arrhythmias
     - Aortic sclerosis: can cause AS (echo)
   - Hyperthyroid Pulmonary
   - COPD Asthma
   - Neurological Stroke or seizures (history, physical, CT scan head, EEG)
   - Chagas disease: parasitic cardiomyopathy endemic in South/Central America

Surgical Treatment

1. Introduction
   - Aortic valve replacement is definitive and mainstay of treatment
   - It is the only effective treatment of severe AS

2. Strong Indications
   - Symptomatic severe AS
   - Severe AS in patients going for CABG or cardiac surgery
   - Severe AS with LVEF < 50%

3. Possible Indications
   - Moderate AS in patients going for CABG or cardiac surgery (class 2 Indication)
   - Strong possibility of rapid disease progression (especially in remote area)
   - Development of symptoms on stress test

4. Benefits of surgery
   - Excellent overall prognosis

5. Risks of Surgery
   - Asymptomatic patient with severe AS need close risk benefit assessment.
If surgical mortality is not <2-3%, the operative risk outweighs risk of sudden death in asymptomatic patient on conservative treatment.

AVR does not eliminate the risk of sudden death. Other complications: prosthesis dysfunction, paravalvular leak, thrombus formation, arterial embolism, endocarditis.

Increased bleeding risk with anticoagulation.

### 6. Types of Valve Replacements

- **Mechanical**
  - Benefits
    - Long lasting
  - Drawback
    - Need for anticoagulation

- **Tissue**
  - Benefits
    - No need for anticoagulation
  - Drawback
    - Need to be replaced after 10-15 years

**Types of tissue valves**
- Porcine transplant from pig
- Bovine transplant from cow
- Homograft (allograft)-human cadaveric transplantation

### Procedures

1. **Ross procedure**- First performed in 1967, the Ross procedure has been the preferred method for pediatric aortic valve replacement. The patient's own pulmonic valve is used to replace the aortic valve. A cadaveric pulmonic valve is then used to replace the patient's pulmonic valve.
   - Benefits
     - The valve grows with the patient
     - Reduced risk of thromboembolism
     - No need for anticoagulation.
     - Favourable hemodynamics
   - Drawbacks
     - Often require re-operation in later life
     - Single valve disease treated with a two valve procedure

2. **Bentall procedure**- First performed in 1968, a graft is used to replace the aortic valve and/or the ascending aortic root with reimplantation of the coronary arteries into the graft.

3. **Percutaneous Valve Replacement**- Widely used in Europe in patients who aren't candidates for open heart procedure, clinical trials are ongoing in the United States (see the PARTNER trial at http://www.clinicaltrials.gov/ct/show/NCT00530894?order=4)

### Therapeutics

1. **Acute Therapy**
   - ABCs, IV, O2, monitor
   - Acute angina should be treated with ACS protocol
   - Heart Failure:

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• Acute HF with severe AS should treated in ICU
• Volume status, diuretic, vasodilator\textsuperscript{21}, beta blocker
• Nitroprusside can be considered in acute setting\textsuperscript{22}
  o Hypertension
    ▪ ACE inhibitors OK, diuretics, beta blockers and nitrates with caution
  o Atrial Fibrillation (AF): treated same as in patient without AS

2. Long-Term Care
  o No medical treatment proven to delay disease progression
  o Physical activity/exercise: recommendation varies with degree of stenosis and symptoms\textsuperscript{23}

3. Endocarditis prophylaxis
  o High peak gradient across the valve carries a greater risk of IE.
  o Overall incidence is low
  o AHA/ACC recommends prophylaxis only if highest risk:\textsuperscript{24}
    ▪ Patients with prosthetic valves,
    ▪ Previous IE
    ▪ Certain types of congenital heart disease
    ▪ Cardiac transplantation patients with valvopathy
  o Educate for dental hygiene and regular dental visits

4. Medical treatment
  o Treat high cholesterol with statins\textsuperscript{25}
  o Control of hypertension:
    ▪ consider ACE inhibitors\textsuperscript{26}
    ▪ Vasodilators (esp. nitrates) can decrease preload and cause hypotension
    ▪ Avoid (esp. in severe AS)
    ▪ Heart Failure
    ▪ Cardiac arrhythmias are poorly tolerated and should be treated
  o Volume status, diuretic, vasodilator \textbf{Error! Bookmark not defined.}
  o Negative inotropes (esp. beta-blockers and nondihydropyridene CCBs [verapamil, diltiazem]) can worsen heart failure

\textbf{Follow-Up}
1. Asymptomatic patients
  o Mild AS: Echo every 3-5 year
  o Moderate AS: Echo every 1-2 year
  o Severe As: Annual echo \textbf{Error! Bookmark not defined.}
  o Stress test to see abnormal response (an indication for AVR)

2. Symptomatic patients
  o Refer to cardiologist for urgent evaluation for valve replacement

3. Admit to hospital
  o Uncontrolled symptoms of CHF, angina, or syncope

\textbf{Prognosis}
1. Usually slowly progressive until symptoms develop
  o Angina: 5-year mean survival
  o Syncope: 3-year mean survival
  o CHF: 2-year mean survival
2. Excellent prognosis following surgery

Prevention
1. Aortic stenosis cannot be prevented

Patient Education
1. Medline Plus information pages:
2. AAFP information page: http://www.aafp.org/afp/2008/0915/p725.html

Evidence-Based Inquiry
1. When should patients with asymptomatic aortic stenosis be evaluated for valve replacement?

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