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 mmHg[1]
   - 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 valve[2,3]
   - 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[4]
    - 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 Hiperlipoproteinemia[5,6]
        - Smoking
    - Abnormal valves
        - Biscuspid or unicuspid aortic valve
        - Valves scarred from rheumatic fever
        - Aortic Sclerosis[7]
    - Congenital AS
        - Increased risk with other congenital heart lesions
4. Morbidity/Mortality
    - Progression from asymptomatic to symptomatic AS varies, but averages about 5 yr[8]
    - 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[9]
        - Pulmonary HTN can develop with sever AS and indicates poor prognosis[10]
    - Asymptomatic patients have 1% mortality/year. Some may qualify for surgery[11,12]
    - 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

- 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)

     Echocardiogram needed for accurate assessment of degree of stenosis[13,14]
3. Diagnostic Testing
   - Laboratory evaluation
     - B Brain natriuretic peptide (BNP)[15]
   - 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%[10]
       - Recommended echo frequency: yearly for severe, every 1-2 yr for moderate and every 3-5 yr for mild AS[16]
     - MRI
       - Velocity- encoded MRI an option to measure antegrade velocity[17]
   - Other
     - Cardiac catheterization
       - Only in asymptomatic patient if non invasive tests inconclusive[20]

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[18]
        - 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 paradoxus, 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 diagnosisCardiac
        - Hypertrophic cardiomyopathy(murmur changes with valsalva and standing)
        - Dilated cardiomyopathy
        - Hypertensive heart disease
        - Pericarditis
        - Arrhythmias
        - Aortic sclerosis: can cause AS (echo)[7]
    - Hyperthyroid Pulmonary
    - COPDAsthma Neurological Stroke or seizures (history, physical, CT scan head, EEG)Chagas disease: parasitic cardiomyopathy endemic in South/Central America (history, serology

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%[20]
3. Possible Indications
    - Moderate AS in patients going for CABG or cardiac surgery (class 2 Indication)
    - Strong possibility of rapid disease progression[12] (especially in remote area)
    - Development of symptoms on stress test[19]
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[20]
- 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:

        - Acute HF with severe AS should treated in ICU
        - Volume status, diuretic, vasodilator[21], beta blocker
        - Nitroprusside can be considered in acute setting[22]
    - Hypertension
        - ACE inhibitors OK, diuretics, beta blockers and nitrates with caution
    - Atrial Fibrillation (AF): treated same as in patient without AS
2. Long-Term Care
    - No medical treatment proven to delay disease progression
    - Physical activity/exercise: recommendation varies with degree of stenosis and symptoms[23]
3. Endocarditis prophylaxis
    - High peak gradient across the valve carries a greater risk of IE.
    - Overall incidence is low
    - AHA/ACC recommends prophylaxis only if highest risk:[24]
        - Patients with prosthetic valves,
        - Previous IE
        - Certain types of congenital heart disease
        - Cardiac transplantation patients with valvopathy
    - Educate for dental hygiene and regular dental visits
4. Medical treatment
    - Treat high cholesterol with statins[25]
    - Control of hypertension:
        - consider ACE inhibitors[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
    - Volume status, diuretic, vasodilator **Error! Bookmark not defined.**
    - Negative ionotropes (esp. beta-blockers and nondihydropyridene CCBs [verapamil, diltiazem]) can worsen heart failure

Follow-Up

1. Asymptomatic patients
    - Mild AS: Echo every 3-5 year
    - Moderate AS: Echo every 1-2 year
    - Severe As: Annual echo **Error! Bookmark not defined.**
    - Stress test to see abnormal response (an indication for AVR)
2. Symptomatic patients
    - Refer to cardiologist for urgent evaluation for valve replacement
3. Admit to hospital
    - Uncontrolled symptoms of CHF, angina, or syncope

Prognosis

1. Usually slowly progressive until symptoms develop
    - Angina: 5-year mean survival
    - Syncope: 3-year mean survival
    - CHF: 2-year mean survival

2. Excellent prognosis following surgery

Prevention

1. Aortic stenosis cannot be prevented

Patient Education

1. Medline Plus information pages: http://www.nlm.nih.gov/medlineplus/heartvalvediseases.html
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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