Percutaneous Management of Structural Heart Disease

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Percutaneous Treatment of Valvular Heart Disease

- Aortic stenosis and regurgitation
  - valvuloplasty and replacement

- Mitral regurgitation and stenosis
  - valvuloplasty and repair/replacement
Percutaneous Treatment of Non Valvular Heart Disease

- ASD
- PFO
- VSD
- PDA occlusion
- Left atrial appendage occlusion for AF
Aortic stenosis

- Most common form of valvular disease
- Obstructs blood flow across aortic valve
- Causes of AS
  - Degenerative calcific
  - Rheumatic
  - Congenital
  - Bicuspid
Bicuspid aortic valve

- 1% population
- Progressive stenosis in 1/3
- Male preponderance
Presentation

- Calcific: > 7th decade
- Bicuspid valve: 5th-6th decade
- Rheumatic: 4th decade
- Congenital: 1st - 3rd decade
Pathophysiology of AS
Pathophysiology

Pressure overload

- AS develops slowly → impedes blood flow across the aortic valve
- Leads to “pressure overload” & elevated LVEDP
- The LV compensated by undergoing hypertrophy
  - This lead to diastolic failure → “stiff & non compliant” LV
- Elevated LV pressures → LA to hypertrophy
  - Patients dependant on atrial booster pump
  - Loss of atrial kick can cause marked deterioration
- Eventually the increase in afterload leads systolic failure
  - This further increases LV volume & pressure
Symptoms of AS

- Three major symptoms in advance AS
  - Heart failure 50%
  - Angina 35%
  - Syncope 15%
Heart failure

- Increased afterload $\rightarrow$ elevated filling pressures
  - The LV hypertrophies leads diastolic failure
  - High afterload eventually leads to systolic failure
- Ultimately the $\uparrow$LVEDP $\rightarrow$ $\uparrow$LA $\rightarrow$ $\uparrow$pulmonary congestion
Angina

- 50% have normal coronary arteries
- Increase myocardial oxygen demand due to:
  - Hypertrophy
  - Increased afterload
- Decreased myocardial supply due to:
  - Elevated LVEDP reduces perfusion to subendocardium
Syncope

- CO is normal at rest but cannot increase on exertion
- Also exercise leads to vasodilatation which increases the gradient across the aortic valve but CO cannot increase
- Syncope may also be due to arrhythmia
Sign of AS

- Systolic murmur
- $S_4$ usually heard
- ECG
  - LVH
Investigations

- Echocardiogram
- Cardiac catheter / L& R heart cath
- ECG
  - LVH
- CXR
  - Heart size normal or mildly enlarged
  - With disease progression LVF
Natural history

- **Asymptomatic**
  - Good prognosis
  - Sudden death < 2% risk
  - Less than surgical risk

- **Symptomatic**
  - Heart failure  Mean survival < 2 years
  - Angina  50% 5 year survival
  - Syncope  50% 3 year survival
Survival among Patients with Severe Symptomatic Aortic Stenosis Who Underwent Valve Replacement and Similar Patients Who Declined to Undergo Surgery
Management of AS

- Avoid strenuous exercise & stress test if symptomatic
- Regular echo surveillance - unpredictable progression
  - Mean gradient 50mmHg
- Aortic valve replacement
- Balloon valvuloplasty in congenital or palliative in adults
- ACEI / vasodilators contraindicated
Aortic valve replacement

- Operative mortality 3-5% but more in high-risk pt
- Survival
  - 80-85% at 5 years
  - 70% at 10 years
- Long term anticoagulation (mechanical valves)
  - 1 – 2% / year embolic risk
  - Valve thrombosis < 0.5% / pt. yr
- Antibiotic prophylaxis
  - SBE 0.5-1% / pt. yr
Aortic regurgitation

- Also termed aortic insufficiency
- May result from
  - Diseases of the aortic leaflets
  - Dilation of the aortic root
Causes of AR

- Dilated aortic root
  - Aortic aneurysm
  - Aortic dissection
  - Marfan’s syndrome
  - Annulo-aortic ectasia
  - Syphilis

- Diseased aortic leaflets
  - Rheumatic heart disease
  - Endocarditis
  - Bicuspid aortic valve
  - Degenerative (mixed AS/AR)
Pathophysiology of AR

ACUTE AORTIC REGURGITATION

CHRONIC AORTIC REGURGITATION
Symptoms of AR

- Asymptomatic for many years
- LVF
  - Dyspnoea, orthopnoea, PND
- Angina
  - Less common than AS
  - Due to low diastolic BP
- Syncope
  - Low diastolic BP may reduce MAP
Physical findings in AR

- Diastolic murmur
- Wide pulse pressure
- Collapsing pulse
Management of chronic AR

- **Medical**
  - Afterload reduction - vasodilators
    - Improves CO / reduces regurgitation
    - ACEI, felodipine, hydralazine, nitrates, SNP
    - Shown to slow development of LVD
  - Diuretics to reduce pulmonary congestion

- **Surgical**
  - AVR
  - Repair (very selected pts)
Timing of surgery for AR

- Class II symptoms of LVF
- Asymptomatic bet mild to moderate LV dysfunction
- ECHO parameters
  - EF < 55%
  - ESD > 50 - 55 mm
  - Increased post-op mortality > 55 mm
- Perform ECHO annually once ESD > 40mm
- Decision – delay AVR vs preventing LVF
Aortic Stenosis

- Treatment options
  - Medical therapy
  - Balloon valvuloplasty
  - Valve replacement
    - surgical
    - percutaneous
Percutaneous Aortic Valve Replacement
Swaroup Anand, 23, from Bangalore, is fully conscious as he undergoes open-heart surgery. An epidural to the neck, has numbed his body. **Dr Vivek Jawali** pioneered the technique ten years ago.

Over 400 cases have been performed, including a bypass with aortic valve replacement.

Blogger.
I don’t know. I’m not sure I could stomach the **sound of the bone saw** or, worse, if the surgeon said “Oh, crap”
Evolution of Aortic Valve Replacement

- **Homograft** – 1962
- **Mechanical heart valve** – 1962
- **Porcine valve** – 1965
- **Pericardial tissue valve** – 1969

**SAVR**

- 1960
- 1970
- 2002
- 2004
- 2006

**Surgery**

- Edwards/PVT Transapical Beating Heart AVR
  Webb, Lichtenstein – November 29, 2005

**TAVR**

- Edwards/PVT Transcatheter AVR
  by Antegrade and Retrograde Approach
  Alain Cribier – 2002/2003

- CoreValve PURE Percutaneous AVR
  Serruys, DeJaegere, Laborde
  October 12, 2006

**Transvascular**

- CoreValve Transcatheter AVR
  by Retrograde Approach
  Laborde, Lal, Grube – 2004

- CoreValve Percutaneous AVR
  WITHOUT cardiac assist or pacing
  Grube, Gerckens – November 6, 2006

**PAVR**
Optimal CoreValve Implantation

The implanted CoreValve ReValving System in the aorta.

- Ascending Aorta
- Aortic sinuses with coronary ostia
- Aortic valve annulus
- Left Ventricle
INDICATIONS: AORTIC VALVE DISEASE

- ≥ 80 years,
- or
- Surgical risk calculated with logistic EuroSCORE ≥ 20%,
- or
- ≥ 65 years with one or two (but not more than 2) of the following criteria:
  - Cirrhosis of the liver (Child class A or B),
  - Pulmonary insufficiency: VMS < 1 liter,
  - Previous cardiac surgery (CABG, valvular surgery),
  - Porcelain aorta,
  - Pulmonary hypertension > 60 mmHg and high probability of cardiac surgery for other than valve replacement,
  - Recurrent pulmonary embolus,
  - Right ventricular insufficiency,
  - Thoracic burning sequelae contraindicating open chest surgery,
  - History of mediastinum radiotherapy,
  - Severe connective tissue disease resulting in a contraindication to surgery,
  - Cachexia (clinical impression),
Percutaneous Aortic Valve Procedure

- Performed in Cath Lab
- Conscious Sedation with anaesthetist present
- Transjugular Temporary Pacing wire
- Bilateral Femoral Artery sheaths
- Initial Balloon Valvuloplasty performed
- Deployment of CoreValve
- Closure device for femoral artery
- Procedure time ~ 2 hours
- Return to coronary care
Mitral regurgitation

- Normal closure of the mitral valve requires the coordinated action of each component of the valve apparatus.
- Thus MR may result from structural abnormalities of the:
  - Mitral annulus
  - Valve leaflets
  - Chordae tendineae
  - Papillary muscle
(a) Bicuspid valve open

(b) Bicuspid valve closed
Causes of MR

- **Chronic**
  - Mitral valve prolapse
  - Myocardial ischemia
  - Rheumatic fever
  - Dilated LV
  - HCM

- **Acute**
  - AMI
  - Papillary muscle rupture
  - Chordae rupture
  - Endocarditis
Pathophysiology MR

NORMAL (SYSTOLE)

ACUTE MITRAL REGURGITATION

Pulmonary edema

High LA pressure

CHRONIC MITRAL REGURGITATION

Dilated LA with less elevated pressure
Symptoms of chronic MR

- Low cardiac output
  - Fatigue & weakness
- Pulmonary congestion
  - Dyspnoea, orthopnoea, PND
- Pulmonary hypertension & RVF
  - Peripheral oedema & ascites
- Palpitations
Physical findings in MR

- Systolic murmur
- $S_3$ reflecting an increased volume of blood returning during early diastole to the LV
- ECG
  - LVH & LA enlargement
- CXR
  - Demonstrate LV enlargement & failure
Investigation of MR

- Echocardiogram
  - TEE better than TTE for viewing MV
- Cardiac catheter / L& R heart cath
- ECG
  - LVH / LA enlargement
- CXR
  - Cardiac enlargement / pulmonary oedema
Management of chronic MR

- **Medical**
  - As for AR > afterload reduction - vasodilators
    - Improve CO / reduces regurgitation
    - ACEI, felodipine, hydralazine, nitrates, SNP
  - Diuretics to reduce pulmonary congestion
  - Rate or rhythm control & anticoagulation for AF
  - Prevention of endocarditis

- **Surgery**
  - Mitral repair / replacement
Timing of surgery for MR

- Before significant LV dysfunction & PHT occur
- Severe MR who are symptomatic or asymptomatic
- Evidence of mild-moderate LV dysfunction
- If LVEF < 30% medical management preferable
  - Surgical results much worse for ischaemic MR – associated poor LV
Mitral stenosis

NORMAL (DIASTOLE)

MITRAL STENOSIS

Elevated pulmonary & right-heart pressures

Pressure ↑
Volume ↑
Causes of mitral stenosis

- Rheumatic – almost invariably
- Congenital stenosis
- Calcification in the elderly
- Endocarditis with large vegetation → obstruction
- LA myxoma obstruction of the mitral valve - mimic MS
Balloon Valvuloplasty

- Percutaneous mitral catheter balloon valvuloplasty
  - Indicated for rheumatic mitral stenosis
  - Catheter inserted via femoral vein, transeptal approach
  - Inflation of balloon separates fused commissures
  - Complications: embolization 1-3%, MR 3-5%, ASD 10%
Mitral valve repair

- Annular size reduction (annuloplasty)
- Post. leaflet segmental resection
- Chordal shortening, transfer
- Highly durable, no anticoagulation
- Ant. leaflet repair less reliable
- Preferred method for addressing MR
Mitral valve repair
Mechanical valves

- Nearly unlimited structural durability
- Excellent flow characteristics
- Require anticoagulation with warfarin
- Major morbidity related to
  - Thromboemboli, bleeding
- Best placed in younger patients
  - No contraindication to anticoagulation
  - Good medical follow-up
  - Wish to avoid repeat operation
Bioprosthetic (tissue) valves

- There are several manufacturers, styles and sizes including:
  - hetero- or xenograft from a different species, e.g. porcine (pig) or bovine (cow)
  - homograft from a different individual, e.g. cadaveric
  - autografts from the same individual, e.g. pulmonary to aortic

- No anticoagulation required

- Limited lifespan
  - Median lifespan 15-20 years, less for MVR

- Inherently stenotic
Bioprosthetic valves

A
CE Perimount
CE Perimount Magna
CE Perimount Magna Ease
Sorin Mitroflow

B
Medtronic Hancock II
Medtronic Mosaic
CE Porcine SAV
Biocor

C
Edwards Prima Plus
Medtronic Freestyle
St. Jude Toronto SPV
Sorin Freedom
Mechanical valves

(a)  (b)  (c)
Selection of prosthetic valve

**Tissue**
- History of bleeding
- Inability to take warfarin
- Desire to become pregnant
- History of thrombosis with mechanic valve
- Age > 65 years

**Mechanical**
- Age < 65 years
- Already on anticoagulation
- History of embolic CVA
- History of AF
Complications of prosthetic valves

- Postoperative AF
- Damage to His bundle or bundle branches
- Thromboembolism / bleeding
- Prosthetic valve thrombosis
- Endocarditis
- Perivalvular leaks
- Hemolysis
- Malfunction
Mortality rates

- Isolated CABG 1.8%
- Valve surgery 2.0%
- CABG & valve 4.4%

*May increase with combined valve surgery & poor LV function*

ASCTS Surgeons’ Comprehensive Report 2005-2006
Percutaneous Mitral Valve Repair using the MitraClip
Percutaneous Mitral-Valve Repair

MitraClip® System (Abbot Vascular)
Take Home Messages

• Aortic stenosis will become more prevalent as the population ages

• Transcatheter approaches to correcting valvular heart disease will become more common