Valve Surgery

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- Mitral Valve
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Anatomy of Heart Valves

- Aorta
- Pulmonary artery
- Superior vena cava
- Pulmonary veins
- Right atrium
- Mitral valve
- Pulmonary valve
- Aortic valve
- Tricuspid valve
- Left atrium
- Left ventricle
- Right ventricle
Common causes of valve disease

- Degeneration
- Congenital
- Rheumatic heart disease
- Ischaemic heart disease
- Infective endocarditis
- Aortic root aneurysm
- Marfan’s syndrome or other connective tissue disease
Abnormal Physiology

- **T = pr/2h**
- **Pressure load hypertrophy**
  - Increased systolic stress
  - Wall thickening
  - Reduced mitochondrial to myofibrillar volume ratio
  - Supply less than demand
- **Volume load hypertrophy**
  - Increased diastolic stress
  - Dilated chamber
  - Hypertrophic wall
Pressure overload

Systolic stress

Wall thickening

Concentric hypertrophy

Volume overload

Diastolic stress

LV volume

Eccentric hypertrophy

Normal

R/H 3.5

1.5

3.5
Aortic Valve
Aortic Valve diseases

- Rheumatic
- Senile Calcification
- Infected endocarditis
- Annuloaortic ectasia
- Bicuspid valve
Aortic Stenosis

- LV pressure overload → Concentric LV hypertrophy
- Normal valve area is 2.5-3.5 cm²
- Severe AS: valve area < 1 cm², mean gradient > 40mmHg, Vmax > 4 m/s
- Symptoms:
  - angina, syncope, heart failure, sudden death
- Signs:
  - Holosystolic murmur in aortic area, displaced apex
- Investigations
  - CXR, ECG, Blood, 2DE, Coronary angiogram, Vascular studies.
Natural History

- Average survival after onset of
  - angina 4 yrs, syncope 3 yrs, CCF 2 yrs
- Indications for surgery:
  - Presence of symptoms
  - Asymptomatic severe AS
    - Impaired LV function on 2DE (<50%)
    - Severe calcification,
    - Rapid progression
  - ? moderate AS + CABG
Surgery

- There is no effective medical treatment for aortic stenosis.
  - Diuretics and digoxin may be used for heart failure
  - Percutaneous balloon valvoplasty is only used as a temporary measure
- The valve in AS almost always require replacement
- Percutaneous AVR is a new approach for patients deemed unsuitable for open surgery.
Aortic Regurgitation

- Acute – poorly tolerated - often requires urgent surgery
- Chronic –
  - pressure and volume overload → dilatation and progressive hypertrophy. EF may remain normal even with impairment in systolic function.
  - When decompensation occurs – LVEDP↑, ESV↑, EF↓, compliance↓.
- Symptoms – SOB, CCF
- Signs – diastolic murmur, bounding pulse with wide pulse pressure, low diastolic pressure, displaced apex.
- Investigations – CXR, ECG, Blood, 2DE, angiogram, others.
Natural History of AR

- Mild-mod – 90% 10 yr survival
- Mod-severe – 75% 5 yr and 50% 10-yr survival
- Angina – avg survival 5 yr
- CCF- avg survival 2 yr
Aortic Regurgitation

• Indications for surgery
  ◦ Angina / CCF / Syncope
  ◦ Acute AR
  ◦ Endocarditis not responding to medical treatment
  ◦ Asymptomatic
    • Progressive cardiac enlargement
    • Progressive LVH on ECG
    • EF <45% or fractional shortening <25% and
      • EDD approaching 75mm or 38mm/m²
      • ESD approaching 55mm or 26mm/m²
Aortic Valve replacement

Ascending aorta opened after cross-clamping
Valve leaflets excised
Annulus debrided
Risk of calcific debris embolisation
Need to de-air the heart
Aortic Valve Replacement
Aortic Root Replacement

Ascending aortic aneurysm

Aortic regurgitation commonly present

Aortic root replacement

Valved conduit used

Coronaries re-implanted
Bentall’s Operation

- Enlarged aorta (aneurysm)
- Mechanical valve
Mitral Valve
Mitral Stenosis

- 2/3 are female
- Symptoms begin when valve area < 1.5 cm$^2$
- Occurs 10-20 yrs after rheumatic fever
- Left atrium dilates – AF may result
- Pulmonary venous congestion – CCF with symptoms of dyspnoea, orthopnoea, PND, cough and haemoptysis.
- PA pressures may increase from passive transmission of LAP, reactive arterial vasoconstriction, pulmonary interstitial fibrosis or from morphological changes in pulmonary arterioles.
- RV dilatation and TR.
Signs and Symptoms

• Symptoms
  ◦ Cough, SOB, Orthopnoea, PND
  ◦ Palpitations
  ◦ Haemoptysis
  ◦ Thromboembolism

• Signs
  ◦ Jugular venous pulse - Prominent a wave
  ◦ Right ventricular heave
  ◦ Apex beat - tapping S1
  ◦ Auscultation - P2 (2nd Left ICS) , MDM
  ◦ A loud S1 with the opening snap at LSE. Low-pitched, rumbling, diastolic murmur over the apex best heard while the patient is in the left lateral decubitus position.

• Investigations - ECG, CXR, 2DE, Angiogram, others
Mitral Stenosis
If in sinus, a broad notched p wave best seen in II with negative terminal force in V1. With pulmonary HPT, RVH and right axis deviation can be seen.
Straightened left heart border, splaying of bronchi from LA dilatation. Pulmonary venous congestion with prominent hilar vessels.
Periodical calcification is seen in up to 50% of patients with Marfan's syndrome and is a useful indication of the presence of Ehlers-Danlos and Marfan's syndrome in these patients. The calcification is most pronounced at the mitral valve and in the aorta. The calcification is described as calcification of the valve, which is an important sign. The calcification may be present in the aorta and in the mitral valve, and may be seen in the aorta and in the mitral valve, and may be seen in cases of Marfan's syndrome, Ehlers-Danlos and Marfan's syndrome, and in cases of Marfan's syndrome and Ehlers-Danlos. The calcification is described as calcification of the valve, which is an important sign. The calcification may be present in the aorta and in the mitral valve, and may be seen in the aorta and in the mitral valve, and may be seen in cases of Marfan's syndrome, Ehlers-Danlos and Marfan's syndrome, and in cases of Marfan's syndrome and Ehlers-Danlos.
Mitral Stenosis

- Normal MVA 4-6 cm²
- Mild MS 1.5-2.0 cm² – LAP rise with exertion. PAP usually < 35mmHg
- Moderate MS 1.0-1.5 cm² – LAP may be elevated at rest but PAP usually < 50mmHg and PCWP <25mmHg
- Critical MS <1.0 cm² – markedly increased LAP at rest, decreased cardiac output. With exercise, PAP >50mmHg and PCWP>25mmHg.
Mitral Stenosis

• Indications for surgery
  ◦ NYHA III-IV
  ◦ NYHA II if MVA<1.0 cm²
  ◦ History of thromboembolism
Mitral Regurgitation

• Causes
  ◦ Degenerative, ischaemic, rheumatic, endocarditis

• Pathophysiology
  ◦ LV volume overload → LV dilatation
  ◦ Atrial fibrillation
  ◦ Pulmonary oedema
  ◦ Pulmonary hypertension
  ◦ Left & right heart failure
Treatment for MV disease

- Valvotomy for mitral stenosis
  - Percutaneous
  - Closed – thoracotomy without CPB
  - Open – with heart lung bypass
- Repair for mitral regurgitation
- Replacement
  - Mechanical
  - Bioprosthetic
Mitral Valve repair

- Mitral valve repair techniques have developed recently and the number of repairs is increasing.
- Procedure of choice where possible.
- Better preservation of LV function.
- Lower mortality and good long term results.
- Techniques
  - Leaflet resection/reconstruction
  - Chordal transfers/reconstruction/shortening
  - Annuloplasty rings/bands
Mitral Valve Repair
Mitral Valve Replacement
Ideal Replacement Valve

- Non-obstructive
- Non-regurgitant
- Non-thrombotic
- Non-traumatic to blood elements
- Resists infection
- Durable
- Silent
- Easily available
- Affordable
### Types of valve replacement

**Mechanical valve**
- Long lasting
- Lifelong warfarin

**Types**
- Bileaflet
- Tilting disc
- Ball and Cage

**Bioprosthetic valve**
- 40-80% fail by 15 yrs
- Warfarin not required

**Types**
- Xenograft (animal)
  - Stented
  - Non stented
- Homograft (Human)
- Autograft (Self)
Bileaflet Valves

- Low profile
- Low gradient
- Some regurgitation
- Most widely used worldwide
- Manufacturers:
  - St Jude
  - Carbomedics
  - ATS
Tilting Disc Valve

- Low profile
- Hingeless
- Good haemodynamics
- Risk of occluder obstruction in mitral position
- Medtronic Hall
Ball and Cage Valves

- Starr Edwards
- First implanted 1960
- High profile
- Obstructive
- Thromboembolism
- Good sewing ring
- Used in third world countries now
Stented Bioprosthetic valves

- Easier to implant
- Stent narrows the effective orifice
- Degenerates
- Porcine
  - CE, Mosaic
- Bovine pericardial
  - Perimount
Stentless Valves

- Technically more difficult to implant
- Larger EOA

Toronto SPV

Freestyle

3F
Homografts

- Human valve
- Cadavers or transplant recipients
- Stentless
- Root replacement or subcoronary implant
- Excellent haemodynamics
- ? Resists infection
- Immune rejection: degenerates
Ross Procedure

- Pulmonary autograft to replace aortic valve
- Homograft to replace pulmonary valve
- Best haemodynamics
- Good durability
- Turns single valve disease into double valve disease
- Technically demanding
Choosing A Valve

Life expectancy
Ability to take warfarin
Level of activity
Atrial fibrillation
Pregnancy
Patient–prosthesis mismatch
Surgeon’s capability

Which valve would you have?
Post-op Problems: AVR

Bleeding
Stroke
Heart block
Paravalvular leak
Aortic regurgitation
Myocardial ischaemia
High filling pressures
Post-op Problems: MVR

- Low cardiac output
- Atrial fibrillation
- Heart block
- Bleeding
- Stroke
- Respiratory failure
- AV groove rupture
- Circumflex artery injury
Prosthetic Valve Complications

- Thromboembolism
- Anticoagulant related haemorrhage
- Prosthetic valve endocarditis
- Structural valve degeneration
- Paravalvular leak
  - Haemolysis
- Valve obstruction
- Clicking Sound
Future Directions

Robotic repair

Smaller incisions

Transapical method

Percutaneous methods

Stentless bioprosthetic valves

Anti-mineralisation treatments for bioprostheses

Design improvements - thinner stent for better EOA, “cinch” mechanism to facilitate implant

Improved anticoagulation
The End

Any Questions?