# Valvular heart disease and prosthetic valve

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### Surface anatomy









#### Figure 3. The relationships of the mitral valve are important.



Fedak P W et al. Circulation. 2008;117:963-974



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-The LV becomes increasingly hypertrophied, and coronary blood flow may become inadequate ( increased LV mass) - Ejection systolic murmur

Aortic stenosis Aetiology

causes of aortic stenosis

Infants, children, adolescents Congenital aortic stenosis Congenital subvalvular aortic stenosis Congenital supravalvular aortic stenosis Young adults to middle aged Calcification and fibrosis of congenitally bicuspid valve Rheumatic aortic disease Middle aged to elderly Calcification of bicuspid valve Senile degenerative aortic stenosis



calcification of the aortic valve







#### tricuspid and bicuspid calcifications









### Pathophysiolgy of AS

most common symptom of aortic stenosis --> angina

- Except in the congenital forms, AS develops slowly
- The LV becomes increasingly hypertrophied, and coronary blood flow may become inadequate
- The fixed outflow obstruction limits the increase in C.O required on exercise.
- The progressive LV outflow obstruction results in increased LV mass.

# Symptoms of AS

- Exertional dyspnoea
- Angina
- Pulmonary edema
- Exertional syncope
- Sudden death

E / arrhythmia /Aortic stenosis

# Signs of AS

- Ejection systolic murmur
- Slow rising carotid pulse
- Reduce pulse pressure
- LV hypertrophy
- Signs of LV failure (crepitations,

pulmonary edema)

abnormal breath sounds heard during auscultation of the lungs, typically indicating an underlying pulmonary condition Investigations

ECG
CXR
ECHO
CATH

#### **ECG** in AS



- LVH with strain (slightly wide QRS in I,II,III and have increased amplitude)
- Large S in V2 and large R in V6 with T wave inversion in V6

# **CXR** in AS

 AORTIC STENOSIS, dilated ascending aorta, normal heart size



# ECHO criteria for assessment of aortic stenosis

severity	Mean gradient(mmhg)	Aortic valve area (cm2)
mild	<25	>1.5
moderate	25-45	1-1.5
severe	>45	<1 indication for surgery
critical	>70	<0.7



mild -moderate

Medical; Medical treatment essentially is reserved for patients who have complications of AS such as heart failure, infective endocarditis, or arrhythmias.

Surgical; The primary management of symptomatic patients with valvular AS is interventional

Aortic regurgitation

LV dilated and hypertrophied

-increase in end diastolic volume, and diastolic filling pressure -collapsing pulse Bounding peripheral pulses Early diastolic murmur Systolic murmur lead to pulmonary edema and condestion

Aetiology

Congenital Bicuspid valve, or disproportionate cusps Acquired Rheumatic disease Infective endocarditis Trauma Aortic dilatation: marfan syndrome, atheroma, syphilis, ankylosing spondylitis



volume over load / thin muscle / increase stroke volume / cardiomegaly --> AR hypertrophy muscle --> AS

# pathophysiology

- The stroke output of the LV may be doubled or trebled
- LV dilated and hypertrophied
- In acute AR, The LV poorly accommodates the abrupt increase in end-diastolic volume, and diastolic filling pressure increases rapidly. The rise in LV filling pressure is transmitted to the LA, pulm. veins, and pulm. capillaries, leading to

pulm.edema and congestion.

#### Clinical features symptoms :



- palpitations
- Severe AR ;

ndication for early intervention

Symptoms of heart failure

angina

a main symptom

### Signs of AR





# ECG in AR

same to AS



- LVH with strain (slightly wide QRS in I,II,III and have increased amplitude
- Large S in V2 and large R in V6 with T wave inversion in V6
- Left atrial enlargement Left axis deviation

# CXR in AR

bovine heart

Enlarged thoracic aorta
cardiomegaly

AS --> hypertrophy or normal size



# ECHO in AR

- Dilated LV
- Hyperdynamic ventricle
- Fluttering anterior mitral leaflet
- Doppler detects reflux

om aorta to LT ventricle

# Treatment of AR

### Medical

- Vasodilator therapy.
- Treat asymptomatic patients with chronic severe AR and dilated but normal LV systolic function medically, and monitor their cases for development of indications for AVR. Patients with mild AR and normal LV size require no therapy other than endocarditis prophylaxis
- The treatment of choice for acute AR is AVR. Medical therapy can be used as a bridge to surgery but should not replace it.

# **Treatment of AR**

Surgical

reatment of choice

- Surgical treatment of AR almost always requires
   replacement of the diseased valve with a prosthetic valve
- AVR is indicated when AR is beginning to cause sx or when an enlarging heart or progressive ECG changes give evidence of increasing LV overload

# Surgical treatment of AR

Asymptomatic patients with evidence of LV systolic dysfunction (EF < 0.50) should undergo AVR.</p>

ejection fractio

 Asymptomatic patients with severe AR and normal LV function but with severe LV dilatation (end-diastolic dimension >75 mm or end-systolic dimension >55 mm) should undergo AVR.. dont wait to di valve replacement

# **Prosthetic heart valve**

- The two main prosthetic valve designs include:
  - mechanical artificial valve made from durable materials such as metal alloys (e.g., titanium) and carbon composites.
  - bioprosthetic(tissue) heart valves
    - human (auto / homo ) OR animal (hetero / xeno)

#### Mechanical valves from carbo

#### ball and cage

#### bileaflet



### **Bioprosthetic Valves**

#### Aortic homograft





### **Animal Tissue Valves**

 The most commonly used animal tissues are: porcine, which is valve tissue from a pig, and bovine pericardial tissue, which is from a cow.

The leaflet value tissue of the animals is inspected, and the highest quality leaflet tissues are then preserved. They are then stiffened by a tanning solution, most often glutaraldehyde.



#### Transcatheter Aortic Valve Intervention tavi

minimally invasive procedure used to treat patients with severe aortic stenosis who are either high-risk or inoperable candidates for traditional open-heart surgery. TAVI/TAVR involves the implantation of a new aortic valve using a catheter-based technique, without the need for a large surgical incision.

#### Transcatheter Aortic Valve Intervention

 Recently, percutaneous valve replacement has been developed. TAVI is a reasonable alternative to surgical AVR in patients at high surgical risk.
## Procedure & Hardware

hrough aorta / apex of the heart / femoral artery (most common)

(local anesthesia) general anesthesia LA + Conscious sedation/ GA, hemodynamic stability [SBP~120]

vascular access sites : transfemoral tranapical Left ant. thoracotomy More direct, shorter cathete Septal hypertrophy

mm Hg / MAP >75 mm Hg] Vascular access Mo Percutaneous or Cut-down technique Μ Less Manipu Dr. Nithin P G









## How to choose a valve

- Mechanical valve in patients < 65years.</p>
- Tissue valves in patients > 65 years
- Tissue valves in patients whose life expectancy is < 10 year</p>
- Tissue valve in patients who have problems which are likely to cause life threatening bleeding.

# Valve types





Bioprosthetic/Tissue No lifetime warfarin Less durability

Mechanical valve

#### Need for warfarin

#### Better durability

lifespans typically ranging from 20 to 30 years or even longer, making them particularly suitable for younger patients

The surface of mechanical valves is not piological, so it can promote blood clot formation ACC/AHA guideline summary: Antithrombotic therapy in patients with mechanical heart valves

Class I - There is evidence and/or general agreement that antithrombotic therapy in indicated in patients with mechanical heart valves in the following settings:

Warfarin to achieve a goal INR of 2.0 to 3.0 after:

1. Aortic valve replacement (AVR) with bileaflet mechanical or Medtronic Hall valves if no risk factors\* are present.

Warfarin to achieve a goal INR of 2.5 to 3.5 after:

1. AVR with bileaflet mechanical or Medtronic Hall valves if risk factors\* are present.

2. AVR with Starr-Edwards or disc valves other than Medtronic Hall if no risk factors\* are present.

3. Mitral valve replacement (MVR) with any mechanical valve.

Role of aspirin:

1. After AVR or MVR in patients who cannot take warfarin, at a dose of 75 to 325 mg/day.

 At a dose of 75 to 100 mg/day in addition to warfarin in all patients with mechanical valves and in patients with biological valves who have risk factors\*.

## Class IIa - The weight of evidence or opinion is in favor of the usefulness of antithrombotic therapy in patients with mechanical heart valves in the following settings:

• In the first three months after AVR, warfarin to achieve a goal INR of 2.5 to 3.5.

#### Class IIb - The weight of evidence or opinion is less well established for the usefulness of antithrombotic therapy in patients with mechanical heart valves in the following setting:

• In high-risk patients in whom aspirin cannot be used, clopidogrel (75 mg/day) or warfarin to attain a goal INR of 3.5 to 4.5.

\* Risk factors include atrial fibrillation, prior thromboembolism, left ventricular dysfunction, and a hypercoagulable state. Data from Bonow, RO, Carabello, BA, Chatterjee, K, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. A report of the American College of Cardiology/American Heart Association Task Force on

Practice Guidelines (Writing committee to revise the 1998 guidelines for the management of patients with valvular heart disease). J Am Coll Cardiol 2006;



Loud 1st heart sound, opening snap, mid diastolic murmur



**Rheumatic Heart Disease** 

Isolated MS accounts for 25% of all rheum. Heart dis., and an additional 40% have mixed MS and MR

2/3 of cases occurs in women

Acquired MS is almost entirely rheum. in origin

# Actiology of MS

Acquired MS results from long-term damage to the mitral valve and its supporting structures.:

- In rheumatic heart disease
- **SLE**
- Amyloidosis

Postsurgical acquired MS, such as MS occurring after mitral valve annuloplasty for severe MR.

surgical procedure used to treat mitral valve regurgitation (MR), which occurs when the mitral valve does not close properly, allowing blood to leak back into the left atrium during systole







### FISH MOUTH (RHD)



# Pathophysiology of MS

The normal adult mitral valve orifice cross-sectional area is 4-6 cm2.

When reduced to 2 cm2, hemodynamically significant MS occurs. WHEN <1cm2 it is critical</p>

 As a compensating mechanism, pulmonary vasoconstriction develops, causing pulmonary hypertension.

Severe MS results in decreased cardiac output

# MS Pathophysiology

**Progressive Dyspnea** (70%): LA dilation  $\rightarrow$ pulmonary congestion (reduced emptying) worse with exercise, fever, tachycardia, and pregnancy Increased Transmitral Pressures: Leads to left atrial enlargement and atrial fibrillation. **Right heart failure symptoms:** due to Pulmonary venous HTN Hemoptysis: due to rupture of bronchial vessels due to elevated pulmonary pressure





# Investigations of MS

### **ECG**

- LA hypertrophy if not in AF
- Left atrial enlargement is illustrated by increased P
   wave duration in lead II, top
   ECG, and by the prominent
   negative P terminal force in
   lead V1, bottom tracing

o wave --> atrial contraction



# Investigations of MS







Chest radiograph of a patient with mitral stenosis shows
 pulmonary
 hypertension, mild cardiomegaly and enlargement of the left atrium (arrow) and pulmonary artery



## ECHO

- Thickened immobile cusps
- Reduced rate of diastolic filling
- Reduced valve area



## **Treatment of MS**

### medical

- Asymptomatic patients with mild MS require yearly followup
- For the patient with signs or symptoms of CHF, diuretics may provide benefit
- **RX** of Tachyarrhythmias
- Electrophysiologic ablation of atrial fibrillation or flutter circuits may be performed in the catheterization laboratory

### Percutaneous mitral balloon valvuloplasty

- Indications for this procedure are similar to those for surgery, including
- CHF unresponsive to medical management
  - asymptomatic patients with a pulmonary artery (PA) systolic pressure of 50 mm Hg or greater.
- In some centers, the procedure is successful in 80-90% of selected cases. The procedural mortality rate is 1-2%.

## Treatment surgical

### Indications:

- Symptomatic mitral stenosis especially if peripheral emboli
- Mitral value area less than 1 cm2 normal from 4-6
- Mitral valvotomy

making an incision in a heart valve, typically o relieve obstruction caused by stenosis

Commissurotomy consists of an incision of fused mitral valve commissures and shaving of thickened mitral valve leaflets .making an incision in the fused commissures of the mitral valve to increase the opening of the valve and restore normal blood flow

Fused chordae tendineae and papillary muscles can be divided to relieve subvalvular stenosis.



reatment of choice

 Mitral valve replacement with mechanical valve or bioprosthesis



**Figure 11-7** Mitral valve replacement, through a median sternotomy incision and opening into left atrium from the right side anterior to the right pulmonary veins (see legend of Fig. 11-4 for details). Two-venous cannulae are illustrated, but a single venous cannula can be used instead. A Cooley left atriotomy retractor is used (not shown).

(a) As described in the text, the incision in the mitral leaflet is begun with the knife anteriorly and about 2 mm from the anulus, where nearly always the leaflet is pliable and relatively free of disease.

(b) As the incision is carried leftward with the knife or scissors toward the anterolateral commissure, the underlying papillary muscle and fused chordae come into view and are cut.

(c) As the incision is carried across the anterolateral (illustrated here) and posteromedial commissural areas, care is taken to stay close



#### Figure 11-7 (continued).

(h) When an interrupted suture line technique is chosen (GLH), the first suture is placed at the anterolateral commissure in the 10-o'clock position. Each stitch (No. 2 silk) is passed first through the sewing ring of the valve (the valve remains outside the chest, being held by the assistant with the aid of a valve holder) and then through the anulus of the patient, with the needle held in reverse (backhand) fashion and passed from the left ventricular to the left atrial side. Each stitch passes just inside the anulus, and emerges through the adjacent portion of the atrial wall; care is taken that it not pass deepiy enough to damage the underlying circumflex coronary artery. Suturing continues in a counterclockwise direction around exactly half the circumference of the host valve ring (to the 4-o'clock position), as well as around one-half the circumference of the sewing ring of the prosthesis. When the sutures are placed between the 6-o'clock and 4-o'clock positions, the needle is best passed forehand. The two ends of each of these sutures are clipped together with a hemostat just after the suture is placed; the handle of the hemostat is threaded onto a large "safety pin" outside the chest, to prevent the sutures from becoming crossed when they are tied later. With all the posterior sutures in position, the safety pin is closed. (*Figure continues.*)

## MVR





Apical systolic murmur, thrill



- Ruptured chordae or papillary muscle due to acute myocardial infarction or trauma
- Perforation of the mitral valve leaflet
- Acute failure of a prosthetic valve

## Mitral Regurgitation

Aetiology
Chronic MR:
Mitral valve prolapse most common cause
Rheumatic heart disease
Coronary artery disease
Connective-tissue disorder
Prosthetic valves

## MR

### Valvular Regurgitation

A condition in which blood leaks in the wrong direction because one or more heart valves closes improperly. Mitral valve prolapse (illustrated here) is a common cause of regurgitation.



## Pathophysiology

- In chronic MVR, the distensibility of the LA and LV are increased over time.
- This dilatation of the left atrium decreases left atrial pressures, thus increasing preload.
- The left ventricle dilatates and, hypertrophied generates a larger stroke volume without a significant rise in wall stress.

## CLINICAL

Symptoms

### Acute MR

- Sx of acute pulm edema and reduced CO
- Chronic progressive MR
- Exertional dyspnea, nocturnal dyspnea, palpitations(AF, atrial flutter, increased stroke volume)
- Sx of pulm edema
- Sx of diminished CO
- Sx of right sided HF



### AF/ Flutter

- Cardiomegaly- displaced hyperdynamic apex beats
- Apical systolic murmur, thrill
- Signs of raised pulm capillary pressure (crepitations, pulm edema, effusions)
- Signs of pulm HTN

# **Investigations for MR**

- G like mitral s
- LAH (if not in AF)
- 🖾 🔹 TAH



EC

- Enlarged LA, LV
- Signs of pulm venous HTN
- Signs of pulm edema if acute
- ECHO
- Dilated LA, LV
- Dynamic LV(UNLESS AF PREDOMINATE)
- Regurgitation detected on Doppler

# CXR MR



LA appendage enlargement



## **TREATMENT** of MR

### Medical

Any patient with acute or chronic mitral valve regurgitation with hemodynamic compromise should be evaluated for acute myocardial infarction.

### Afterload-reducing agents

If atrial fibrillation is encountered, digitalis therapy is considered

Prophylactic antibiotics are administered prior to any interventional treatment

## TREATMENT OF MR SURGICAL

## Indications for surgical Intervention

 Acute MR with congestive heart failure or cardiogenic shock

Acute endocarditis

Class III/IV symptoms (ie, patient symptomatic while at rest or with minimal activity)



### MITRAL RECONSTRUCTIVE SURGERY

## **REPAIR TECHNIQUES**

LEVEL	MANEUVER
fibrous ring that surrounds the	
ANNULUS providing a fixed attachment point for the valve leaflets or cusps	<b>REDUCTION</b> reducing the size of an enlarged value annulus (due to annular dilation)
LEAFLETS	RESECTION ENLARGEMENT
<b>CHORDON</b> heae anchor the valve leaflets to the papillary muscles. During systole, the left ventricle contracts, and the papillary muscles contract as well. The contraction ensures that the chordae tendineae pull on valve leaflets and prevent them from inverting or prolapsing into the atria	RESECTION SHORTENING TRANSPOSITION REPLACEMENT
<b>COMMISSURES</b> the points or areas where the leaflets (or cusps) of the	SPLITTING RESECTION heart valves come together or join
PAPPILARY MUSCLES	SPLITTING SHORTENING REPOSITIONING




Figure 4. Correction of a prolapsing anterior leaflet with placement of polytetrafluoroethylene (PTFE) neochordae. (Reprinted with permission from Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. From Valve Analysis to Valve Reconstruction. 2010 Saunders Elsevier.).



## **Repaired mitral valve**