Epidemiology

- Congenital malformations of the MV represent about 0.5%.
- Congenital anomalies of the MV are often associated with other congenital heart anomalies.

Normal anatomy

- It is bicuspid and marks the left AV junction.
- It is a complex comprises:
  - The annulus Saddle-shaped or D-shaped.
  - The leaflets.
    - Anterior (aortic) and posterior (mural).
    - Carpentier classification:
      - The posterior leaflet: P1 (lateral), P2 (middle), P3 (medial).
      - The anterior leaflet: A1, A2, A3.
  - The chordae tendinae.
  - The papillary muscles (AL and PM).

TEE assessment of MV
3D TEE imaging modalities of MV

Real time Live
• It refers to any 3D image that changes on the display as the probe is moved, with a limited sector size.
• It has limited temporal resolution (Low FR).

Multibeat
Full volume
Color full volume

Other
Biplane imaging
3D TEE imaging modalities of MV

- **Real time**
  - Live 3D
  - Color live 3D
  - 3D zoom

- **Multibeat**
  - Full volume
  - Color full volume

- **Other**
  - Biplane imaging

---

3D TEE imaging modalities of MV

**3D Zoom (Zoom in RT)**

- A magnified subsection of 3D pyramidal volume that is centered to the MV.
- It is kept as small as is reasonable to improve the temporal resolution.
3D TEE imaging modalities of MV

3D Zoom (Zoom in RT)

- The surgical en face view of the MV:
  - 3D rotation (Up and down) to obtain the en face view of the MV.
  - Rotate z (Clockwise) to position the AV at the top of the image (12 o'clock) and the LAA to the left (9 o'clock).

3D TEE imaging modalities of MV

- Real time
  - Live 3D
  - Color live 3D
  - 3D zoom

- Multibeat
  - Full volume
  - Color full volume

- Other
  - Biplane imaging
3D TEE imaging modes

**Full volume (FV)**

- An ECG-gated acquired over consecutive HB, stitched together and synchronized to the same cardiac cycle.

- Advantage:
  - It has high temporal resolution.
  - Can be cropped, rotated, and displayed.

- Disadvantage:
  - The demarcation lines of the stitching artifacts.
  - Avoided by endexpiratory breath holding during data acquisition.

3D TEE imaging modalities of MV

- **Real time**
  - Live 3D
  - Color live 3D
  - 3D zoom

- **Multibeat**
  - Full volume
  - Color full volume

- **Other**
  - Biplane imaging
3D TEE imaging modes

Color Doppler 3D

• By application of color to real time 3D.
• Or a gated acquisition of a small 3D volume with superimposed 3D color Doppler flow.

Applications of 3D TEE in MV assessment

1. Examination of MV anatomy.
2. Quantification of MV anatomy.
3. Assessment of MR.
4. Assessment of MS.
5. Intraoperative assessment (immediate post-repair).
6. Cardiac surgeon’s perspective.
Applications of 3D TEE in MV assessment

Examination of MV anatomy

- Detailed MV anatomy of leaflets, commissures, and subvalvular components can be seen.
- Rotation and cropping can better define complex MV pathology.

Applications of 3D TEE in MV assessment
Applications of 3D TEE in MV assessment

1. Examination of MV anatomy.

2. Quantification of MV anatomy.

3. Assessment of MR.

4. Assessment of MS.

5. Intraoperative assessment (immediate post-repair).

6. Cardiac surgeon’s perspective.

Quantification of MV anatomy

- 3D TEE allows sophisticated analyses of the nonplanar shape of the mitral annulus.
- These 3D measurements include:
  1. Annular diameters.
  2. Commissural lengths.
  3. Leaflet surface areas.
  4. Aortic to mitral annular orientation.
Applications of 3D TEE in MV assessment

1. Examination of MV anatomy.
2. Quantification of MV anatomy.
3. Assessment of MR.
4. Assessment of MS.
5. Intraoperative assessment (immediate post-repair).
6. Cardiac surgeon’s perspective.

Assessment of MR

- 3D TEE allows direct measurement of:
  1. Asymmetrical ellipsoid EROA.
  2. Eccentric MR jets.
  3. Multiple jets.

- The 3D VC area represents the ERO of MR.

- $R_{vol}$ can be measured by multiplying VC area by the MR TVI.

- Anatomic ROA can also be measured offline.

- 3D-VC area has good correlation with angiographic and MRI measurements (2).


Applications of 3D TEE in MV assessment

Assessment of MR

- 3D TEE assessment of VC area:
  - 3D TEE zoom or FV can be used.
  - Image is cropped to two long-axis views of the jet.
  - Translation of the plane perpendicular to the regurgitant jet until the en face view of the VC area (Narrowest CSA).
  - Finally, the 3D VC area is traced by manual planimetry.
Applications of 3D TEE in MV assessment

1. Examination of MV anatomy.
2. Quantification of MV anatomy.
3. Assessment of MR.
4. Assessment of MS.
5. Intraoperative assessment (immediate post-repair).
6. Cardiac surgeon’s perspective.

Assessment of MS

- 3D TEE seems of interest for evaluation of MVA as it combines the advantages of TEE (excellent visualization of MV) and of 3D (acquisition of a 3D volume of the entire MV).
Applications of 3D TEE in MV assessment

Assessment of MS

3D TEE assessment of MV:
• 3D zoom or full volume can be used.
• The ideal MV A is the cross section of the MV at the tips of the leaflets (the smallest orifice).
Applications of 3D TEE in MV assessment

**Intraoperative assessment**

- Aspects addressed immediately after MV repair (Surgical, minimally invasive or transcatheter):
  1. Residual MR.
  2. Adequacy of coaptation.
  3. SAM of the anterior mitral leaflet. It results from a mismatch of annular dimension and the residual leaflet height. (Sometimes volume loading minimizing SAM, or placement of a larger ring, leaflet shortening or even valve replacement is required).

---

Applications of 3D TEE in MV assessment

**Intraoperative assessment**

- After MV replacement:
  - Paravalvular leak is important to be assessed by 3D zoom and color 3D post replacement of prosthetic, bioprosthetic or Melody valve.
Applications of 3D TEE in MV assessment

Intraoperative assessment

1. Examination of MV anatomy.
2. Quantification of MV anatomy.
3. Assessment of MR.
4. Assessment of MS.
5. Intraoperative assessment (immediate post-repair).
6. Cardiac surgeon’s perspective.
Applications of 3D TEE in MV assessment

Cardiac surgeon’s perspective

• Most prolapses can be repaired by experienced cardiac surgeons, while most complex valves can be repaired by MV specialized surgeons.

• 3D TEE allows identification:
  1. Lesion localization.
  2. Mechanism of MR.
  3. Severity of MR.
  4. Selection of best surgical approach.

• Finally, most valves can be successfully repaired.

Anomalies of the mitral valve

• Anomalies of the leaflets
  ➢ Mitral valve prolapse.
  ➢ Isolated cleft.
  ➢ Double orifice mitral valve.
  ➢ Mitral ring.
  ➢ Ebstein’s malformation of the mitral valve.

• Anomalies of the tensor apparatus
  ➢ Arcade or hammock valve.
  ➢ Straddling mitral valve.

• Anomalies of the papillary muscles
  ➢ Parachute mitral valve.
Anomalies of the leaflets

Mitral valve prolapse.

• Definition:
A single or bileaflet prolapse at least 2 mm beyond the long-axis annular plane during ventricular systole.

Types:
1. A classic prolapse: Leaflet thickening > 5mm.

Mitral valve prolapse.

• Aetiology:
1. Adolescence: Myxomatous degeneration (Posterior or both).
2. Childhood:
   ▪ Connective tissue diseases such as Marfan syndrome and Ehler-Danlos syndrome.
   ▪ Secondary to a distortion of LV geometry, as in unrepaired ASD.
Mitral valve prolapse.
Mitral valve prolapse.
Cleft mitral valve

- **Definition:**
  A division of one of the leaflets (usually the anterior leaflet).

- **Types:**

<table>
<thead>
<tr>
<th>Isolated MV cleft</th>
<th>Associated with AVSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two separate AV valves.</td>
<td>Five-leaflet common AV valve.</td>
</tr>
<tr>
<td>Inlet and outlet lengths of the LV septal surface are equal.</td>
<td>Partial or incomplete form:</td>
</tr>
<tr>
<td>Normal position of PM.</td>
<td></td>
</tr>
<tr>
<td>Cleft directed towards the aortic root.</td>
<td></td>
</tr>
</tbody>
</table>

Mitral valve prolapse.
Cleft mitral valve
Cleft mitral valve

Double orifice mitral valve (DOMV)

• Definition:
  A single fibrous annulus with two orifices opening into the LV.

• Classification:
  1. The incomplete type: At the leaflet edge level.
  2. The complete type: From the leaflet edge all the way through the valve annulus.
  3. The hole type (eccentric): Secondary orifice occurs in the lateral commissure of the mitral valve.
Double orifice mitral valve (DOMV)
Mitral ring

• **Definition:**
  It is often associated with Shone’s syndrome and exceptionally isolated.

• **Types:**
  - The supramitral ring: A fibrous membrane just above the mitral annulus, beneath the LAA, not adhering to the leaflets and associated with a normal subvalvular apparatus.
  - The intramitral ring is a thin membrane located within the funnel of the MV, closely adherent to the leaflets, always combined with abnormal subvalvular apparatus.
  - The ring can be either complete, circumferential or partial.
Mitral ring

Ebstein’s malformation of the MV

• Definition:
  ➢ Downward displacement of the MV orifice into LV.
  ➢ Unlike Ebstein’s malformation of the tricuspid valve, the atrialized inlet portion is usually not thinned.
  ➢ This exceedingly rare anatomical condition causes MI.
Anomalies of the tensor apparatus

Arcade or hammock valve

• Definition:
  ➢ Connection of the PMs to the mitral leaflets either directly or through short chordae.

• Types:
  ➢ The most severe form: With no chordae tendinae, the papillary muscles are directly fused with the free edge of the leaflet.
  ➢ The less severe form: The tendinous cords are thickened and extremely short, may cause both stenosis and insufficiency.
**Arcade or hammock valve**

- **Definition:**
  - An abnormal attachment of the mitral chordae to both ventricles.
  - SMV is almost always associated with AVSD and conotruncal anomalies (DORV, TGA).

---

**Straddling of MV**

- **Definition:**
  - An abnormal attachment of the mitral chordae to both ventricles.
  - SMV is associated with AVSD and conotruncal anomalies.
Anomalies of the papillary muscles

Parachute mitral valve

• Definition:

  Unifocal attachment of MV chordae to a single (or fused) papillary muscle. This single papillary muscle is usually centrally placed and receives all chordae from both MV leaflets.