Advanced Transesophageal Echocardiography

INTERVENTIONAL TEE
Objectives

- Discuss anesthesia considerations for transcatheter aortic valve replacement (TAVR)
- Discuss anesthesia considerations for transcatheter mitral valve repair (Mitraclip)
- Discuss anesthesia considerations for atrial appendage closure devices (Watchman, Amulet, Lariat)
- Describe the use of transesophageal echocardiography (TEE) for electrophysiology procedures
TAVR Overview

- Replacement valve is delivered via catheter using:
  - Transfemoral
  - Transapical
  - Subclavian
  - Direct aortic

- Valve types:
  - Core (Medtronic)
  - Sapien (Edwards)
Hemodynamic Management

- **Predeployment**
  - Normal-high BP
  - Slow HR
  - Maintain contractility

- **Deployment**
  - Rapid ventricular pacing
  - Avoid hypercontractility

- **Postdeployment**
  - Normal-high BP
  - HR 70-80’s
  - Aggressively treat dysrhythmias
Role of TEE in TAVR

- Predeployment
  - LV function, aorta measurements
  - Transvalvular gradient, AVA
  - Other valve lesions
  - Measure aortic annulus

- Deployment/Postdeployment
  - Assist in assessing valve position and function
  - Assess for AI, paravalvular leak, gradient, complications
  - Hemodynamic management
ME Short Axis Aortic Valve, ME RVIFOF and ME Bicaval Views

- Color flow mapping and planimetry of the aortic valve
- Color flow mapping of the tricuspid and mitral valve
- Assess right ventricular function (qualitative)
- Color flow mapping of the intra-atrial septum (Nyquist 30) to rule out PFO/ASD
ME Long Axis and ME Aortic Valve

- Wall motion evaluation
- Color flow mapping of MV, AV
- Measure VC if MR, AI if present
- Measure PISA radius if significant mitral regurgitation or stenosis present
- Measure LVOT, annulus, sinuses of Valsalva, STJ, ascending aorta diameters
Transgastric and Deep Transgastric Views

- TG mid-papillary/basal and TG two chamber/long axis for wall motion and chamber dimensions

- Deep Transgastric View:
  - CFM and Doppler (CW)
  - PHT for AI (Normal >500 ms)
  - Mean and peak gradient for AS
  - Calculate aortic valve area using continuity equation
TAVR: Markers of Good Implantation

- Valve shape and location
  - Short axis: circular rather than ovoid
  - Long axis: proximal end 2-6 mm in LVOT

- Valve gradient ($V_{\text{max}} < 2 \text{ m/s}$)

- Valve regurgitation
  - No significant paravalvular or transvalvular AI

- If suboptimal consider:
  - Repositioning/Post-dilation
  - Reimplantation
TAVR Valve Shape: Circular
TAVR Valve Shape: Oviod
Constrained TAVR Valve
TAVR Valve 80% Deployed
TAVR Valve 80% Deployed
Low TAVR Valve Location
High TAVR Valve Location
High TAVR Valve Location
Constrained TAVR Valve
Constrained TAVR Valve
Aortic Valve Gradients | Pre & Post TAVR

**Before TAVR**
(Severe native valve stenosis)

Vmax = **4.3** m/sec

**After TAVR**
(Minimal aortic valve gradients)

Vmax = **1.4** m/sec
**TAVR Valve Gradients**

**Optimal Gradient**

\[ V_{\text{max}} \leq 2.0 \text{ m/sec} \]

**Suboptimal Gradient**

\[ V_{\text{max}} > 2.0 \text{ m/sec} \]

**Images**

- **Optimal Gradient Image**
  - \( V_{\text{max}} = 1.4 \text{ m/sec} \)
  - 75mm/s, 60bpm

- **Suboptimal Gradient Image**
  - \( V_{\text{max}} = 2.6 \text{ m/sec} \)
Post-Procedure Aorta Views

- Descending aorta LAX and SAX (use X-plane)
- Aortic arch LAX and SAX
- Ascending aorta LAX and SAX
- ME AV and ME LAX
Anesthesia for MitraClip

- Percutaneous alternative to mitral valve replacement for mitral regurgitation
  - Used for high-risk patients only
  - Similar to Alfieri repair
- Mitral regurgitation and left ventricular volume is reduced and NYHA class is improved
- Repair is performed under fluoroscopy and 3-D echo

TEE Acquisition for MitraClip

- Each view should be performed with and without color flow Doppler
- Ensure capture of the MR jet at the valve
  - Visualize the entire jet within the LA
  - Multiple cardiac cycles should be captured
- Implement 3D imaging when appropriate but not to the exclusion of traditional 2D image acquisition
Role of TEE with Mitraclip

- Steerable guide catheter from femoral vein across atrial septum
- For degenerative MR flail gap should be measured in ME 4 chamber and ME LAX
- Left and right upper pulmonary veins should be assessed for flow reversal (PW Doppler 2 cm into vein)
- TG Basal SAX should assess mitral valve
- 3D images of MV should be used to supplement and confirm diagnosis and result
Mitraclip: 2D Proximal Isovelocity Surface Area (PISA) Calculation

PISA radius 0.78

VTI 140 cm, Velocity 4.7 m/s

\[ \text{EROA} = \frac{2\pi r^2 \cdot \text{aliasing velocity}}{M} \]
\[ \text{Vmax} = \frac{[6.28 \times (0.79)^2 \times 38.2]}{472} = \frac{150}{472} = 0.32 \text{ cm}^2 \text{ (moderate MR)} \]
Mitraclip: ME Long Axis View
Use of TEE in Guiding Trans-Septal Puncture

AV SAX

Bicaval View

Posterior

LA

AV

Anterior

Inferior

Superior

RA

LA

SVC
Mitraclip Positioning - Fluoro and 2D TEE
TEE Use with MitraClip: Before and After
3D TEE with Mitraclip Before and After
Mitraclip Procedural Complications

- New intracardiac thrombus
- Ruptured chordae
- Atrial septal defect
- Leaflet perforation
- Mitral stenosis
Percutaneous Appendage Occlusion Occlusion Devices

Endocardial

Epicardial

WATCHMAN

AMULET

LARIAT
1. Femoral venous access

2. Trans-septal puncture

3. Device Deployment

LAA Sizing
Left Atrial Appendage Morphologies

A = Windsock
B = Chicken Wing
C = Cactus
D = Cauliflower

E = Windsock
F = Chicken Wing
G = Cactus
Use of TEE for Watchman and Other Atrial Occlusion Devices

- Assess anatomy and sizing of left atrial appendage
- Map device landing site
- Trans-septal puncture
- Assess position along with fluoroscopy
- Verify occlusion by Doppler of flow
LAA Sizing for Endocardial Devices

Sizing Based on LAA Diameter and Depth

Diameter Measurements

Anatomic Orifice Diameter

Sizing Orifice Diameter
Trans-septal Puncture | Optimal Location
LAA Fluoroscopy View

RAO Cranial
('Short axis')

RAO Caudal
('Long axis')
Hooked LAA with Doppler
Hooked LAA with Watchman
Hooked LAA/Watchman with Doppler
Summary

- TEE is not essential for TAVR deployment but is useful in assessing for paravalvular leak and gradients.
- TEE is essential for mitraclips to gauge effect of clip deployment including reduction of mitral regurgitation and gradients across the mitral valve.
- TEE is no longer essential for Watchman if intracardiac echo (ICE) is used and previous TEE study demonstrates LAA anatomy.
- TEE continues to have evolving utility in surgical decision-making.