New Imaging Technologies in Structural Heart Disease:
Guiding Cardiac Intervention

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Disclosure

Relevant Financial Relationships
None

Off-Label / Investigational Uses
No specific FDA approval for catheter deployed mitral valve prostheses.
CT of SHD Intervention: Objectives

Learning Goals:

• Discuss how emerging imaging technologies could help guide cardiac interventions in patients with structural heart disease

• Describe a potential role for anatomic modeling in virtual simulation of complex interventional procedures
CT of SHD Intervention: Outline

- Background

- Specific SHD Interventions
  - Native valve disease
  - Mitral annulus Ca\(^{2+}\)
  - Valve-in-valve / ring

- Procedure Simulation
Pre-proc Imaging Goals:

• Confirm pathology
• Assess access site & route
• Obtain necessary data to guide specific procedure

✓ Imaging “dry run”
CT Advantages:

• High spatial resolution
• Volumetric acquisition
• Multiplanar reconstructions
• Multiphasic dataset
CT Advantages:

- Can visualize Ca$^{2+}$, surgical material (metal), air
- Accurate measurements in any plane
- Evaluate adjacent structures
  - Coronary arteries, chest wall / sternum, etc
CT Disadvantages:

- Radiation exposure
- Iodinated contrast
- ECG-gating

Variable... but very important
CT of SHD Intervention: Background

CT Scan Protocol

- ECG-gated noncon CT
  - Valve prosthesis / Ca$^{2+}$
- ECG-gated chest CTA
CT Scan Protocol

- ECG-gated noncon CT
- ECG-gated chest CTA
- CTA abdomen/pelvis
- Delayed chest CT
CT of SHD Intervention: Outline

• Background

• Specific SHD Interventions
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  • Mitral annulus Ca\(^{2+}\)
  • Valve-in-valve / ring

• Procedure Simulation
CT of SHD Intervention: Native Valves

Aortic Valve Disease

- Complex structure of aortic root

“Tri-radiate crown”
CT of SHD Intervention: Native Valves

Mitral Valve Challenges

- Nonplanar annulus
- Lack of a fibrous ring
- Variable leaflet & subvalvular apparatus
- Proximity to LVOT
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CT of SHD Intervention: TMVI

Tiara (Neovasc)  FORTIS (Edwards)  Tendyne (Tendyne)

CardiAQ (CardiAQ)

Blanke, JACC CVI 2015
CT of SHD Intervention: TMVI

Mitral Valve Prostheses

- Trans-apical access
- Nitinol frame (self-expanding)
- Bovine pericardium, trileaflet valve
- Sealing cuff

Blanke, JACC CVI 2015
CT of SHD Intervention: TMVI

Transcatheter Mitral Valve Fixation

A. Native Anatomy
B. Tabs to Anchor at Basal Myocardial Shelf and Fibrous Trigones
C. Paddles for Attachment to Native Leaflets
D. Opposing Barbs for Anchoring at Annulus and Native Leaflets
E. Apical Tether (Neochord)
CT of SHD Intervention: TMVI

A. Tiara (Neovasc)
B. FORTIS (Edwards)
C. Tendyne (Tendyne)
D. CardiAQ (CardiAQ)

Blanke, JACC CVI 2015
CT of SHD Intervention: TMVI

Role of CT

- Sizing of annulus
- Evaluation of Ca$^{2+}$
- Define landing zone, leaflets & subvalvular apparatus
- Impingement on LVOT
CT of SHD Intervention: TMVI

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CT of SHD Intervention: TMVI

Mitral Valve – Annulus Sizing

IC = intercommisural distance
SL = septo-lateral distance

Blanke, JACC CVI 2015
CT of SHD Intervention: TMVI

Mitral Valve – Device Sizing

IC

SL
CT of SHD Intervention: TMVI

Mitral Valve – Device Sizing
CT of SHD Intervention: TMVI in Ca$^{2+}$

Clinical Case

- 86 year old woman
- Severe mitral stenosis
  - Heart failure
  - Not a surgical candidate
  - ? Percutaneous mitral valve placement

Edwards Sapien (TAVR) valve
CT of SHD Intervention: TMVI in Ca^{2+}

Clinical Case – Prosthesis Sizing

29 mm Valve | 26 mm Valve | 23 mm Valve
CT of SHD Intervention: TMVI in Ca^{2+}

Clinical Case – Prosthesis Sizing
CT of SHD Intervention: TMVI in Ca^{2+}

Clinical Case – Prosthesis Sizing
CT of SHD Intervention: TMVI in Ca\textsuperscript{2+}

Role of CT

- Sizing prosthesis
- Define landing zone & adjacent structures
- Assess potential LVOT impingement
CT of SHD Intervention: TMVI in Ring

Role of CT

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CT of SHD Intervention: TMVI in Ring

Distance: 27.5 mm x 18.1 mm
Area: 3.89 cm²
Avg. Diameter: 22.3 mm
Perimeter: 74.9 mm
Role of CT

- Sizing prosthesis
- Define landing zone & adjacent structures
- Assess potential LVOT impingement...& other contraindications
CT of SHD Intervention: Other Valves

Clinical Case

- 72 year old woman
  - Prior tricuspid valve repair with annuloplasty band
  - Now severe, symptomatic tricuspid regurgitation
  - Not a surgical candidate
  - ? Percutaneous valve

Edwards Sapien (TAVR) valve
CT of SHD Intervention: Other Valves

Clinical Case – Tricuspid valve in ring
CT of SHD Intervention: Other Valves

Clinical Case – Tricuspid valve in ring
CT of SHD Intervention: Other Valves

Clinical Case – Tricuspid valve in ring
CT of SHD Intervention: Other Valves

Clinical Case – Tricuspid valve in ring
CT of SHD Intervention: Other Valves

Clinical Case – Tricuspid valve in ring
CT of SHD Intervention: Other Valves
CT of SHD Intervention: Proc Planning

Simulated Device Deployment
CT of SHD Intervention: Proc Planning
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CT of SHD Intervention: Proc Planning

Role of CT – Material properties
CT of SHD Intervention: Proc Planning

Role of CT – Prediction of complications

Valve Deployment Simulation

Actual Valve Deployment
CT of SHD Intervention: Proc Planning

Role of CT – Prediction of complications

Valve Deployment Simulation

Actual Valve Deployment
Preprocedural Guidance:

• Confirm diagnosis made using other modalities
• Measurements for device selection
• Evaluate potential complications
• Future role in “virtual simulation” of procedures
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