“Critical role of multi-modality planning in Transcatheter Mitral Valve Replacement”

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Disclosures

Grant support:
- Director CT CoreLab: MITRAL trial,
  NIH LAMPOON clinical trial
- Director Echo CoreLab: NIH LAMPOON clinical trial

Patent(s):
- co-inventor on a patent application, assigned to employer Henry Ford Health System, on software to predict LVOTO

Consultant:
- Edwards LifeSciences
- Materialise
Poll: My institution plans on starting a TMVR program

A. within the next 6 months
B. within the next 12 months
C. already doing TMVR
D. not interested in doing TMVR
Poll: I have seen

A. A valve embolize after Transcatheter Mitral Valve Replacement

B. LVOT obstruction after TMVR

C. All of the above

D. None of the above
Goals

Discuss risks of TMVR

Identify key steps in planning safe TMVR

Create awareness on new imaging technology
Risks of TMVR

Undersized valve
- Valve embolization

Oversized valve
- LVOT obstruction
- Death

Difficult landing zone for the valve
- Severe peri-valvular leak

Death
First in Human Percutaneous Implantation of a Balloon Expandable Transcatheter Heart Valve in a Severely Stenosed Native Mitral Valve

Mayra Guerrero, MD, FACC, FSCAI, Adam Greenbaum, MD, FACC, and William O’Neill, MD, FACC, FSCAI

Transcatheter implantation of a balloon expandable valve in calcified severely stenosed native mitral valves has recently been described. The two cases reported so far utilized the surgical transapical approach generally used for transapical transcatheter aortic valve replacement. A percutaneous approach has not been published. We report the first successful percutaneous implantation of a balloon expandable transcatheter valve in the native mitral valve without a surgical incision.

Key words: mitral valve disease; percutaneous intervention; mitral valve disease; transcatheter valve implantation
Echo and CT not enough, need depth perception
Risks: Trends in TMVR deployment

Oversize to avoid embolization

Flare the valve in the ventricle to anchor
Case #3: “One shot”
Deployed
Deployed

Wang et al. Catheter Cardiovasc Interv 2017
Goals

Discuss risks of TMVR

Identify key steps in planning safe TMVR

Create awareness on new imaging technology
Reassessing TMVR planning

Sizing
Predicting LVOT obstruction
Landing
Project
Sizing: area 369 sqmm
Sizing: area 503 sqmm
4D CT cine:
Subvalvular calcification:

- LA (left atrium)
- LV (left ventricle)
- aorta
- LAA (left atrial appendage)
- LVOT (left ventricular outflow tract)

28 mm flexible CarboMedics
TMVR planning

Sizing
Predicting LVOT obstruction
Landing
Project
Baseline LV AO gradient
Immediately post valve deployment
LVOT – TMVR “kissing balloon” inflations
Lessons from Echo: size mitral annulus in diastole
Lessons from Echo: obstruct in mid to end-systole
Mission: LVOT prediction modeling

August 2013 to August 2017

Pre-TMVR Mitral CT
Valve sized in diastolic phase
Worse end-systolic phase identified
Science: LVOT prediction modeling

Transcatheter heart valve modeled

60% ventricular / 40% atrial
80% ventricular / 20% atrial
LVOT surface pre – post valve recorded

Post-TMVR Mitral CT
LVOT prediction modeling

Intraprocedural cath gradients
Intraprocedural TEE gradients
Post-procedural TTE gradients
MACE
Patient specific 3D Printed Anatomy

CAD model of patient specific anatomy: pre-TMVR LVOT area

CAD model of LVOT obstruction with proposed THV deployed

Dark green: LVOT obstruction
Light green: preserved LVOT flow

Mitral annular calcification

LVOT obstruction

Post TMVR preserved LVOT flow

Surgical mitral bioprosthesis

Transcatheter heart valve

Surgical aortic bioprosthesis

Wang et al. JACC: Cardiovascular Imaging Nov 2016, 9 (11) 1349-1352.
Predicting LVOTO after TMVR

27mm carpentier edwards

Baseline LVOT surface area without TMVR

Predicting LVOTO after TMVR

Predicted residual LVOT surface area post TMVR: “Neo LVOT”

Wang et al. JACC: Cardiovascular Imaging Nov 2016, 9 (11) 1349-1352.
Wang et al. JACC: Cardiovascular Imaging Nov 2016, 9 (11) 1349-1352.
ROC Curve for LVOT prediction modeling

AUC = 0.986
P value < 0.0001
Critical role of 3D computer aided design in personalized TMVR planning
Introducing ‘PAM’
Personalizing procedural planning

Wang et al. JACC: Cardiovasc Imaging Nov 2016
A. Predicted neo-LVOT surface area: 59.8 mm²
Post-TMVR LVOT gradient: 82 mmHg

B. Predicted neo-LVOT surface area: 537.6 mm²
Post-TMVR LVOT gradient: 3 mmHg

LVOT gradient (peak-peak cath) (lv/aorta)
Pre versus post CT neo-LVOT

Wang et al. Catheter Cardiovasc Interv 2017

\[ y = 1.27x - 45.95 \]

\[ R^2 = 0.8169 \]

\[ P \text{ Value} < 0.0001 \]
TMVR planning

Sizing
Predicting LVOT obstruction
Landing & Project
Fluoro overview

• Applying it clinically
<table>
<thead>
<tr>
<th>RAO 42</th>
<th>CAU 27</th>
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<tbody>
<tr>
<td>Baseline Ivot surface area</td>
<td>Neo-Ivot surface area</td>
</tr>
<tr>
<td>26 S3 20%LA, 80%LV</td>
<td>239.8</td>
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Never know what you will see
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<thead>
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<tbody>
<tr>
<td>Max Diameter (mm)</td>
<td>36.3 mm</td>
</tr>
<tr>
<td>Min Diameter (mm)</td>
<td>19.0 mm</td>
</tr>
<tr>
<td>Annular Area (mm²)</td>
<td>714 mm²</td>
</tr>
</tbody>
</table>

![CT scan image with measurements]
3D CAD Analysis: transseptal access???
Take home points

TMVR can be dangerous
Risks can be decreased and avoided
  shown by MITRAL trial investigators

Critical role of computer aided design in successful TMVR outcomes
Thank you
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