Transcatheter Mitral Valve Repair and Replacement

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Disclosures

• Abbott Medical/St. Jude Medical
  – Structural Heart Advisory board
  – Executive Committee: Portico trial

• Boston Scientific
  – Advisory Board, Executive Committee (Lotus Valve Trial)
  – National Co-PI, REPRISE IV trial

• Claret Medical
  – Advisory Board

• Cryolife
  – Advisor
  – Executive Committee, PROACT II trial

• Edwards Lifesciences
  – National Co-PI: PARTNER 2 (SAPIEN 3 Trial)
  – National Co-PI: ACTIVE Trial
  – Executive Committee: PARTNER 3 trial
  – Advisory Board

• Gore Vascular
  – Advisor

• Jenavalve
  – National Co-PI TAVR trial
Surgery for Mitral Valve Disease:
Who Are We Operating on Today?

Degenerative Leaflet Prolapse 60.7%

Pure Annular Dilation 3.8%
Non-ischemic Cardiomyopathy 3%
Ischemic Disease 1.3%
Rheumatic Disease 22.5%
Treated Endocarditis 5.1%
Uncommon 3.7%

N = 87,214 Society of Thoracic Surgeons Adult Cardiac Database; 2017

2011 – 2016
44 % Growth (7.6 % / year)
Overlapping Targets, overlapping professions

SURGERY

INTERVENTIONAL CARDIOLOGY

Less invasive

Courtesy of Dr. Masiano
MULTIDISCIPLINARY COMPETENCY

HEART FAILURE SPECIALIST

PATIENT WITH MR

CARDIAC SURGEON
INTERVENTIONAL CARDIOLOGIST

HEART RHYTHM SPECIALIST

Courtesy Stephan Windecker
It’s Time to Personalize Heart Care

• To each patient

• To each institution
ABOUT STARBUCKS
TAKING ITS NAME FROM A CHARACTER IN HERMAN MELVILLE'S CLASSIC, MOBY DICK, STARBUCKS HAS GROWN FROM ITS HUMBLE BEGINNINGS (A SINGLE LOCATION IN SEATTLE) TO BE THE WORLD'S LARGEST COFFEEHOUSE

FAVOURITE BEVERAGE
- Milk Foam
- Steamed Milk
- Espresso
- 50% 50%

SIZE OF THE CUP
- Tall 12oz
- Grande 24oz
- Trento 31oz

An Illustrated History
1971: We start by selling coffee beans in Seattle's Pike Place Market.
1987: We add handcrafted espresso beverages to the menu.
1992: We become a publicly traded company.
2011: We mark 40 years and begin the next chapter in our history.

DECAF
SUGAR
CARAMEL SYRUP
Prior to TMV: 
Conversation With My Patient

- “Hi Mr. Smith for your mitral valve disease I can offer you 2 operations”:
  - Open mitral valve replacement
    - Minimally invasive MV repair or replacement
    - Sternotomy MV repair and replacement
After TMVR: Conversation With My Patient

• “Hi Mr. Smith for your mitral valve disease I can offer you 7 operations:

  - Sternotomy MV surgery
  - Mini-invasive MV surgery
  - Transapical
    - TMV replacement
    - Repair
  - Trans-septal
    - Mitraclip
    - Cardioband
    - TMV replacement

As a surgeon, I would like to be 1st operator for all procedures so I have equipoise for all techniques
Classification of MR – 2 Types

**Primary:**
Anatomic abnormality the mitral valve
- Leaflets
- Subvalvular apparatus
- Chordae and papillary muscles

**Secondary:**
LV dilation; often secondary to ischemic heart disease
- Leads to mitral annular dilation
- Incomplete coaptation of the mitral valve
Options to Treat Primary MR

Requires Arresting the Heart

- MV Repair
- MV Replacement

Does Not Require Arresting the Heart

Trans-septal

- Mitraclip
- Pascal

Transapical

- Harpoon
- NeoChord
TAVI  

TMVR  

Courtesy Stephan Windecker
<table>
<thead>
<tr>
<th><strong>REPAIR</strong></th>
<th><strong>REPLACEMENT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MITRACLIP</strong> (ABBOTT)</td>
<td><strong>TIARA</strong> (NEOVASC) (NCT02276547)</td>
</tr>
<tr>
<td><strong>CARDIOBAND</strong> (VALTECH)</td>
<td><strong>CARDIAQ</strong> (EDWARDS)</td>
</tr>
<tr>
<td><strong>MITRALIGN</strong> (MITRALIGN)</td>
<td><strong>INTREPID</strong> (MEDTRONIC)</td>
</tr>
<tr>
<td><strong>ACCUCINCH</strong> (GDS)</td>
<td><strong>TENDYNE</strong> (ABBOTT)</td>
</tr>
<tr>
<td><strong>ARTO</strong> (MVRX)</td>
<td><strong>HIGHLIFE</strong> (HIGHLIFE)</td>
</tr>
<tr>
<td><strong>CARILLON</strong> (CARDIAC DIMENSIONS)</td>
<td><strong>CAISSON</strong> (CAISSON)</td>
</tr>
<tr>
<td><strong>NEOCHORD</strong> (NEOCHORD)</td>
<td></td>
</tr>
<tr>
<td><strong>MILLIPEDE RING</strong> (MILLIPEDE)</td>
<td></td>
</tr>
<tr>
<td><strong>TSD-5</strong> (HARPOON)</td>
<td></td>
</tr>
</tbody>
</table>

**EVEREST II**, European Sentinel, ACCESS-EU, TRAMI, MARS

CE Mark Trial, REPAIR (NCT02703311)

CE Mark trial completed

FIM (NCT02624960)

MAVERIC (NCT02302872)

AMEDEUS; TITAN; TITAN-II; REDUCE FMR

Preclinical studies

FIM

FIM

FIM

Global Feasibility Study

FIM

FIM
GLOBAL MITRACLIP® EXPERIENCE

OVER 45,000 PATIENTS TREATED GLOBALLY

<table>
<thead>
<tr>
<th>Implantation Procedures</th>
<th></th>
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<tbody>
<tr>
<td>Treating Centers</td>
<td>831</td>
</tr>
<tr>
<td>Patients (clinical and commercial)</td>
<td>Over 45,000</td>
</tr>
<tr>
<td>Implant Rate(^1)</td>
<td>97%</td>
</tr>
<tr>
<td>Functional MR(^2)</td>
<td>64%</td>
</tr>
<tr>
<td>Degenerative MR(^2,3)</td>
<td>22%</td>
</tr>
<tr>
<td>Mixed</td>
<td>14%</td>
</tr>
</tbody>
</table>

Includes clinical and commercial procedures as of 03/31/2017. Source: Data on file at Abbott Vascular
TEE before and after 2 Clips

Pre Procedure

Post MitraClip
Mitraclip
Team Work

all you need is teamwork
CAUTION: Investigational Device Limited by Federal (United States) Law to Investigational Use
Baseline echo
Five neochords placed
Preoperative TEE

MV Anatomical type definition

TYPE A
Preoperative TEE

MV Anatomical type definition

TYPE B
Preoperative TEE
MV Anatomical type definition
TYPE C
PATIENT SUCCESS

Colli et al, STS 2017
MR for Type A

Colli et al, STS 2017

87% ≤ MILD
MR for Type C

Colli et al, STS 2017

28% ≤ MILD
IDE Trial

Roll-In Cohort
- 60 Subjects
- Up to 3 subjects/center

Pivotal Cohort

High-Risk Registry
- 75 Subjects

Control Arm

Treatment Arm
- 585 Subjects
- Up to 20 Centers*

* Two (2) subjects required per site per month

All Subject Eligibility Confirmed by Central Screening Committee
Harpoon Procedure

1. Simplified off-pump repair of degenerative MR
2. Image-guided placement & anchoring of ePTFE cords
3. Real-time titration of cords on the beating heart to maximize coaptation
The Harpoon Device

Courtesy of Harpoon Medical
Patient # 1: Harpoon Device

Intraprocedural TEE (ePTFE neochords tightened)

MR Grade: TRACE

Courtesy of Harpoon Medical
Harpoon Mitral Valve Repair

EFS (N = 13) + CE (N = 30) = 43

First 43 consecutive patients treated

Inclusion Criteria:
• Severe degenerative Mitral Regurgitation
• Isolated posterior leaflet prolapse
• Good predicted surface of coaptation

Exclusion Criteria:
• EuroSCORE > 8 %
• FMR
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%) or Mean</th>
<th>Cardiac Structure/Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62 ± 13 (40 - 89)</td>
<td>LV Ejection Fraction, mean, % 69 ± 7</td>
</tr>
<tr>
<td>Male gender</td>
<td>33 (77 %)</td>
<td>LA Diameter, mm 46 ± 7</td>
</tr>
<tr>
<td>NYHA Class – no. (%)</td>
<td></td>
<td>LV end-diastolic diameter, mm 53 ± 6</td>
</tr>
<tr>
<td>I</td>
<td>19 (44 %)</td>
<td>LV end-systolic diameter, mm 32 +/- 5</td>
</tr>
<tr>
<td>II</td>
<td>16 (37 %)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>8 (19 %)</td>
<td></td>
</tr>
<tr>
<td>STS PROM (%)</td>
<td>0.88 ± 1.18</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>13 (30 %)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>32 (74 %)</td>
<td></td>
</tr>
<tr>
<td>GFR</td>
<td>83 ± 20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mL/min/m²</td>
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</tbody>
</table>
Results: MR Grades

Mass General Core Lab Adjudicated Harpoon Patients MR Grades

- Baseline (43): 100%
- Procedure (41): 100%
- Discharge (38): 100%
- 30-Day (40): 87.5%

Excludes 3 conversions to conventional surgery
Edwards PASCAL Mitral Repair System

**Designed to reduce mitral regurgitation**

- Transseptal approach
- Paddles designed to reduce stress on native leaflets
- Spacer designed to reduce the regurgitant orifice area
- Optional independent leaflet capture

*Not approved for sale in any country*
Classification of MR – 2 Types

Primary:
Anatomic abnormality the mitral valve
- Leaflets
- Subvalvular apparatus
- Chordae and papillary muscles

Secondary:
LV dilation; often secondary to ischemic heart disease
- Leads to mitral annular dilation
- Incomplete coaptation of the mitral valve
Options to Treat Secondary MR

Requires Arresting the Heart
- MV Repair
- MV Replacement

Does Not Require Arresting the Heart
- Trans-septal
  - Mitraclip
  - Carillon
  - Pascal
- Transapical TMVR
  - Tendyne
  - Cardioband
  - TMVR
Edwards Cardioband™
Mitral Valve Repair System

- Transcatheter mitral annular reduction
- Restores leaflets to a more functional position
- Unique segmental deployment and adjustable size allows for customization to each patient's annular geometry
Cardioband + Mitraclip implantation: Pre- and post-adjustment

Courtesy of Valtech
Patients with Symptomatic Functional Mitral Regurgitation

Functional MR ≥ 3+ as assessed by echocardiography; NYHA class II-IVa (ambulatory)

Heart Team Assessment

Patient deemed appropriate for the Edwards Cardioband System by Heart Team and the Central Screening Committee

N=375

2:1 Randomization

Edwards Cardioband + GDMT n = 250

vs

GDMT n = 125

Primary Endpoint: Prevalence of MR ≤ 2+ and hierarchical comparison including cardiovascular death, heart failure hospitalization, improvement in 6 MWT and KCCQ at 1 year

Currently enrolling patients
Cardiac Dimensions Carillion

Indirect annuloplasty with nitinol device anchored into the coronary sinus to reduce annulus dimensions

Transjugular approach

- 700 pts treated for commercial use
- 113 pts implanted in prospective trials
- FMR
- Safe (Death @30d 0% device related)
- Results @12 mo
  - 1 grade of MR reduction
  - 1 NYHA Class improvement (from III to II)
- indirect CS approach
- annular reduction around 15-20%
# Transcatheter Mitral Valves in Early Clinical Studies

<table>
<thead>
<tr>
<th></th>
<th>Both Transseptal and Transapical</th>
<th>Transapical Only</th>
<th>Transseptal Only</th>
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</thead>
<tbody>
<tr>
<td><strong>CardiAQ-Edwards</strong></td>
<td><img src="image" alt="CardiAQ-Edwards" /></td>
<td><img src="image" alt="Tendyne" /></td>
<td><img src="image" alt="Twelve" /></td>
</tr>
<tr>
<td><strong>Tendyne</strong></td>
<td><img src="image" alt="CardiAQ-Edwards" /></td>
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<tr>
<td><strong>Twelve</strong></td>
<td><img src="image" alt="CardiAQ-Edwards" /></td>
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<td><strong>Valve Size</strong></td>
<td><img src="image" alt="CardiAQ-Edwards" /></td>
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<td><img src="image" alt="Twelve" /></td>
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<tr>
<td>Delivery System Size</td>
<td><img src="image" alt="CardiAQ-Edwards" /></td>
<td><img src="image" alt="Tendyne" /></td>
<td><img src="image" alt="Twelve" /></td>
</tr>
<tr>
<td>33 Fr</td>
<td>32 Fr</td>
<td>35 Fr</td>
<td>32 Fr</td>
</tr>
<tr>
<td>40 mm</td>
<td>27 mm</td>
<td>27 mm</td>
<td>35, 40 mm</td>
</tr>
</tbody>
</table>
Transapical TMVR
Procedure Animation

CAUTION - Investigational device. Limited by Federal (or United States) law to investigational use.

Courtesy of Dr. Williams
CardiAQ-Edwards TMVR: Transseptal Valve Release
Results
Pilot Study Clinical experience

MR Grade

Pre-Procedure

0 1+ 2+ 3+ 4+

0 0 0 12 24

Latest f/u

0 1+ 2+ 3+ 4+

32 4 0 0 0

CAUTION: INVESTIGATIONAL DEVICE. LIMITED BY FEDERAL LAW (USA) TO INVESTIGATIONAL USE.
Conclusions

• The adoption of transcatheter techniques for MR will be slower than for AS (but it WILL happen)
• Predominant approach will be transseptal
• Functional MR will be treated mainly by catheter approaches (TMVR and TMVRepair) not open surgery
• Primary MR in high (and intermediate ?) risk patients will be more commonly treated by a variety of techniques and combinations including edge to edge, artificial chords, annuloplasty)
• Most patients with valve disease will be treated in a tiered national system of advanced and comprehensive valve centers
Conclusions

- The future of cardiac surgery is an important crossroads
- Role of the cardiac surgeon has changed forever
  - We are required to perfect our open techniques in high-risk patients with the utmost concentration with high quality outcomes
  - Additional training may be required to possess interventional or other out-of-the-box skills
- We must continue to innovative WITH our cardiologist colleagues
- Success can only be achieved with a collaborative and dedicated team
- The future is dependent on technologic education of residents, fellows, and practicing surgeons
In 2017, The Toolbox for MR
Thank You

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