Aortic Stenosis

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Can the Aortic Valve Be Replaced Without Surgery?

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Disclosures

- Boston Scientific - Consultant
- Abbott Vascular - Consultant
- Medtronic - Consultant
- Direct Flow Medical - Consultant
Aortic Stenosis

- Etiology
  - Calcific degenerative
    - Degenerative process with proliferative & inflammatory changes, lipid accumulation, up regulation ACE, infiltration with macrophages & T lymphocytes → Bone formation (vascular calcification
  - Congenital - Bicuspid
    - Turbulent flow - traumatizes leaflet → fibrosis, rigidity, calcification & narrowed orifice
  - Rheumatic
    - Adhesion & fusion of commissures & cusps → retraction & stiffening cusps borders.
    - Calcific nodules both surfaces - small round or triangular opening

Thursday, May 19, 2011
Pathophysiology

- Aortic Stenosis - Obstruction develops gradually over decades
- LV adapts to systolic pressure overload through hypertrophy
  - ↑ LV wall thickness - normal chamber volume maintained
  - ↑ relative wall thickness counters high intracavitary systolic pressure - LV systolic wall stress (afterload) remains normal
  - Inverse relation between systolic wall stress and EF maintained - as long as wall stress is normal → EF preserved
- ↑ wall thickness (low volume/mass ratio) & diminished compliance → LVEDP increases without LV dilation (diastolic dysfunction)
Pathophysiology

- Forceful atrial contraction that contributes to $↑$ LVEDP, plays an important role in ventricular filling without $↑$ LA or PCW pressure.
- AF may often be followed by clinical deterioration.
- Adaptive LVH may reduce CBF per gm of muscle & coronary vasodilator reserve.
- Exercise and tachycardia can produce maldistribution of CBF and subendocardial ischemia.
- Inappropriate degree of hypertrophy (elderly, especially women) associated with high perioperative morbidity and mortality.
Natural History - Aortic Stenosis

- Prolonged latent period - morbidity & mortality very low
- Symptomatic aortic stenosis - Cardinal symptoms
  - Angina  
  - Syncope  
  - Heart failure
- Onset of symptoms - Outlook changes dramatically
  - Average survival 2 - 3 years - High risk of sudden death
- Management decisions based on these data
  - Asymptomatic - Conservative treatment
  - Symptomatic - Aortic Valve Replacement
Asymptomatic Patient

• Asymptomatic patients with AS - outcomes similar to age matched normal
• Asymptomatic patients - no surgery, Survival free of cardiac death
  • 1 year - 99%
  • 2 years - 98%
  • 5 years - 93%
• Disease progression with symptom onset is common
  • Otto 1997 - 123 pts - Symptom development, 38% @ 3 years
  • Rosenhek 2000 - 128 pts - Event free survival, 67% @ 1 year
    33% @ 4 years
  • Pellikka 2005 - 622pts - Asymptomatic, 33% @ 5 years
• Asymptomatic patients require frequent monitoring of symptoms and progressive disease
  • Echo - yearly for severe AS, 1 - 2 years for moderate AS
    3 - 5 years for mild AS
Aortic Stenosis

- Echocardiography - Clinical Standard for evaluation of adults with AS
  - Anatomic Images
    - Etiology of Aortic Stenosis
    - Level of obstruction
    - Valve calcification
    - Leaflet motion
    - Aortic root anatomy
    - LV response to chronic pressure overload
  - Hemodynamic parameters
    - Maximum aortic velocity
    - Mean transvalvular gradient
    - Continuity equation valve area
- Validated - compared with hemodynamic data & predictors of clinical outcome

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TEE
Introduction - Aortic Stenosis

- Symptomatic Aortic Stenosis - Surgical Aortic Valve Replacement is the standard of care
- Surgical Aortic Valve Replacement - Mortality Risk
  - Isolated AVR - 3.3 to 5.7%
  - AVR with CABG - 6.8 to 7.3%
- Percutaneous Aortic Valve Implantation in high risk aortic stenosis patients - feasible and safe
- Review experience of Edwards-Cribier Valve, CoreValve, and Direct Flow Medical Valve
Assessment of Operative Risk

- 55 yo male with severe aortic stenosis - Surgical Risk < 1%
  no other medical problems
- 85 yo female with severe aortic stenosis - Surgical Risk ~7%
  hypertension and CAD
- 80 yo male with severe aortic stenosis - Surgical Risk > 24%
  CAD, s/p CABG, renal dysfunction

- Operative Risk Assessment
  - Scoring system - Patient, Cardiac and Operation Factors
  - EUROSCORE - European System for Cardiac Operative Risk Evaluation
  - Logistic EUROSCORE
  - STS - Society of Thoracic Surgeons
  - Society of Cardiothoracic Surgeons of Great Britain and Ireland
Operative Risk

- Highest Risk Factors
  - Shock
  - Emergency surgery
  - Age - especially > 80 years
  - Renal dysfunction - worse with dialysis
  - Left Ventricular dysfunction - LVEF < 30-35%
  - Previous Cardiac Surgery
  - CHF
  - Diabetes

Adapted from - Ambler G. et al. Circulation 2005;112(2):224-231
Summary

• AVR Surgical Risk
  • Isolated AVR - 3.3 to 5.7%
  • AVR with CABG - 6.8 to 7.3%
• Age corrected survival for > 65 after AVR - similar to normal population of that age\(^1\)
  • No co-morbidities - 2 to 3% operative mortality with an 85% age-corrected 10 year survival\(^1\)
• Co-morbidities can significantly increase surgical risk
  • Highest risk - Shock, emergency, age, renal dysfunction, LV dysfunction, previous cardiac surgery

1 Lindblom D. JACC 1990;15:566
Many Patients Do Not Receive Surgery Due to Co-Morbidities

Reasons for Absence of Intervention in Symptomatic Patients (NYHA Class III / IV) Extra Cardiac Causes

<table>
<thead>
<tr>
<th>(%)</th>
<th>AS</th>
<th>≥1 Cause (%)</th>
<th>68</th>
<th>Age</th>
<th>35</th>
<th>Renal failure</th>
<th>10</th>
<th>COPD</th>
<th>21</th>
<th>Other EC</th>
<th>26</th>
<th>Short life expectancy</th>
<th>26</th>
</tr>
</thead>
</table>

SEVERE AORTIC STENOSIS

AORTIC VALVE REPLACEMENT SURGERY

NON-SURGICAL REFUSALS
MEDICAL THERAPY
ASYMPTOMATIC
BALLOON AORTIC VALVULOPLASTY
Older Aortic Stenosis Patients Are Less Likely to Have Surgery

Frequency of AVR as Function of Age in Severe AS Population

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total n</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;90 years</td>
<td>27</td>
</tr>
<tr>
<td>81-90 years</td>
<td>217</td>
</tr>
<tr>
<td>71-80 years</td>
<td>262</td>
</tr>
<tr>
<td>61-70 years</td>
<td>135</td>
</tr>
<tr>
<td>&lt;60 years</td>
<td>81</td>
</tr>
</tbody>
</table>

Loma Linda, Pai, et al; 740 patients
The Initial Targets for Percutaneous Aortic Valve Replacement

- Surgical Risk
  - LOW
  - Aortic Valve Replacement Surgery
  - HIGH
  - Non-Surgical
  - High Risk Surgical
  - Refusal of Surgery
Percutaneous Aortic Valve Implantation

- Inclusion
  - Symptomatic Aortic Stenosis
  - Aortic Valve Area ≤ 0.8 cm$^2$
  - Aortic Valve Gradient ≥ 25 mmHg
  - Logistic Euroscore ≥ 20%
  - Age ≥ 70 years
  - Trileaflet aortic valve
  - Aortic Valve annular diameter ≥ 19 and ≤ 27 mm
Screening

- Echo
  - Anatomy
  - Dimensions
  - Hemodynamics
- Cardiac and Vascular CT
  - Cardiac dimension
    - LV outflow, annulus, Coronary sinus, Sino-tubular junction
    - Vascular dimensions - 7 mm, No concentric calcification
- Cardiac catheterization and coronary angiography
- 3 D Transesophageal Echo
Desirable Features

Percutaneous Aortic Valve

- Function
  - Large effective orifice area (EOA)
  - Durable - 10+ years
  - Good apposition (No paravalvular leak)
  - Excellent securement
  - No coronary ostia obstruction
  - Ability to displace native valve
  - Safety - lack of thrombus formation - clot embolization

- Deliverability
  - Low profile
  - Flexible and trackable
  - Accurate positioning
  - Repositionable
  - Retrieveable
Cribier - Edwards

- Concept - Non-surgically implanted Stented Valve
- Therapeutic option for patients with degenerative Aortic Stenosis who are high risk or non-operable for surgery
Cribier-Edwards

- Phase I Feasibility - Antegrade approach - 23mm PHV - 24 French Equine pericardium - Validation of concept - Rouen 2002-2005
- Antegrade - Easy access (femoral vein)
  Significant learning curve
  Paravalvular leak
- Rapid pacing 220 bpm
- Compassionate Series
  - I-REVIVE 8/03 - 7/04
  - RECAST 12/04 - 4/05
  - Follow-up 5/06
    - 33 PHV implanted
    - 11 Alive - 15 to 32 mos
      - No CHF
      - No coronary occlusion
      - No secondary valve migration
      - No device dysfunction


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Cribier-Edwards

- Phase 2
  - Larger size - 26mm PHV
  - Retrograde with FLEX catheter
  - Thin Bovine Pericardium
  - European REVIVE
  - US REVIVAL
  - J. Webb (Vancouver)
    - > 100 cases
    - >90% success valve crossing and PHV delivery

Tip deflection - Arch
Tip deflection - Crossing
Cribier-Edwards
Cribier-Edwards

Retrograde Implant

Post Implant Aortogram
Cribier-Edwards

Retrograde Implant

Post Implant Aortogram
Cribier-Edwards

Retrograde Implant

Post Implant Aortogram
Cribier-Edwards

Retrograde Implant

Post Implant Aortogram
Cribier-Edwards

Retrograde Implant

Post Implant Aortogram
Trans-apical Mini-Invasive Surgical

- Ascendra Valve - Trans-apical placement (TAP)
- Mini-thoracotomy with purse string suture at apex
- Standard percutaneous technique
Ascendra Valve
PARTNER Study Design

Symptomatic Severe Aortic Stenosis

ASSESSMENT: High Risk AVR Candidate
3105 Total Patients Screened

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Symptomatic Severe Aortic Stenosis

ASSESSMENT: High Risk AVR Candidate
3105 Total Patients Screened

Total = 1058 patients

n= 700
High Risk

n= 358
Inoperable

2 Parallel Trials:
Individually Powered

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ASSESSMENT: Transfemoral Access

High Risk TF

1:1 Randomization

TAVI Trans femoral VS Surgical AVR

Primary Endpoint: All Cause Mortality (1 yr) (Non-inferiority)

High Risk TA

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TAVI Transfemoral

VS

Standard Therapy (usually BAV)

Primary Endpoint: All Cause Mortality over length of trial (Superiority)
All Cause Mortality

HR [95% CI] = 0.54 [0.38, 0.78]
P (log rank) < 0.0001

Numbers at Risk

<table>
<thead>
<tr>
<th></th>
<th>TAVI</th>
<th>Standard Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months 0</td>
<td>179</td>
<td>179</td>
</tr>
<tr>
<td>Months 20</td>
<td>138</td>
<td>121</td>
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<td>Months 40</td>
<td>122</td>
<td>83</td>
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<tr>
<td>Months 60</td>
<td>67</td>
<td>41</td>
</tr>
<tr>
<td>Months 80</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

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**All Cause Mortality**

- **All-cause mortality (%)**
  - Standard Rx: 50.7%
  - TAVI: 30.7%

- **Numbers at Risk**
  - TAVI: 179, 138, 122, 67, 26
  - Standard Rx: 179, 121, 83, 41, 12

- **NNT = 5.0 pts**

- **∆ at 1 yr = 20.0%**

*Thursday, May 19, 2011*
Conclusions - 1

In patients with severe AS and symptoms, who are not suitable candidates for surgery...
Conclusions - 1

In patients with severe AS and symptoms, who are not suitable candidates for surgery...

- Standard therapy (including BAV in 83.8% of pts) did not alter the dismal natural history of AS; all-cause and cardiovascular mortality at 1 year was 50.7% and 44.6% respectively
In patients with severe AS and symptoms, who are not suitable candidates for surgery...

- Standard therapy (including BAV in 83.8% of pts) did not alter the dismal natural history of AS; all-cause and cardiovascular mortality at 1 year was 50.7% and 44.6% respectively.

- Transfemoral balloon-expandable TAVI, despite limited operator experience and an early version of the system, was associated with acceptable 30-day survival (5% after randomization in the intention-to-treat population).
Conclusions - 2

• TAVI was superior to standard therapy, markedly reducing the rate of...
  ➢ all-cause mortality by 46%, $P < 0.0001$, NNT = 5.0 pts
  ➢ cardiovascular mortality by 61%, $P < 0.0001$, NNT = 4.1 pts
  ➢ all-cause mortality and repeat hospitalization
    ▪ hierarchical (FS method), $P < 0.0001$
    ▪ non-hierarchical (KM analysis) by 54%, $P < 0.0001$, NNT = 3.4 pts
• TAVI improved cardiac symptoms (NYHA class, $P < 0.0001$) and six minute walking distance ($P = 0.002$), after 1-year follow-up
Conclusions - 3

- TAVI improved cardiac symptoms (NYHA class, \(P < 0.0001\)) and six minute walking distance (\(P = 0.002\)), after 1-year follow-up
- TAVI resulted in more frequent complications at 30 days, including...
  - major vascular complications, 16.2\% vs. 1.1\%, \(P < 0.0001\)
  - major bleeding episodes, 16.8\% vs. 3.9\%, \(P < 0.0001\)
  - major strokes, 5.0\% vs. 1.1\%, \(P = 0.06\)
Serial echocardiograms in TAVI patients indicated...

- reduced mean gradients (P < 0.0001) which were unchanged during 1-year FU
- frequent paravalvular AR, which was usually trace or mild (~90%), remained stable during 1-year FU, and rarely required further Rx.
Clinical Implications

• Balloon-expandable TAVI should be the new standard of care for patients with aortic stenosis who are not suitable candidates for surgery!
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• Balloon-expandable TAVI should be the new standard of care for patients with aortic stenosis who are not suitable candidates for surgery!

• Next generation devices (e.g. SAPIEN XT) may help to reduce the frequency of procedure-related complications in the future.
Clinical Implications

• *Balloon-expandable TAVI should be the new standard of care for patients with aortic stenosis who are not suitable candidates for surgery!*

• Next generation devices (e.g. SAPIEN XT) may help to reduce the frequency of procedure-related complications in the future.

• The ultimate value of TAVI will depend on careful assessment of bioprosthetic valve durability, which will mandate obligatory long-term clinical and echocardiography FU of all TAVI patients.
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1:1 Randomization

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TAVI Trans femoral

Surgical AVR

TAVI Trans femoral

Surgical AVR

Primary Endpoint: All Cause Mortality (1 yr)
(Non-inferiority)
Randomized = 699 patients

Transfemoral
n = 492

- 30 Days (236)
  - Dead = 8
  - Withdrawal = 0

- 1 Year (189)
  - Dead = 46
  - Withdrawal = 1

Transapical
n = 207

- 30 Days (223)
  - Dead = 15
  - Withdrawal = 10

- 1 Year (168)
  - Dead = 47
  - Withdrawal = 8

TF = 492
TA = 207
Primary Endpoint: All-Cause Mortality at 1 Year

<table>
<thead>
<tr>
<th>Months</th>
<th>No. at Risk</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>348</td>
</tr>
<tr>
<td>6</td>
<td>298</td>
</tr>
<tr>
<td>12</td>
<td>260</td>
</tr>
<tr>
<td>18</td>
<td>147</td>
</tr>
<tr>
<td>24</td>
<td>67</td>
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<td>0</td>
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<td>65</td>
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</tbody>
</table>
Primary Endpoint: All-Cause Mortality at 1 Year

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Primary Endpoint: All-Cause Mortality at 1 Year

HR [95% CI] = 0.93 [0.71, 1.22]
P (log rank) = 0.62

No. at Risk

<table>
<thead>
<tr>
<th></th>
<th>TAVR</th>
<th>AVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
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<td>298</td>
<td>252</td>
</tr>
<tr>
<td>0</td>
<td>348</td>
<td>351</td>
</tr>
</tbody>
</table>
All-Cause Mortality
Transfemoral (N=492)

HR [95% CI] = 0.83 [0.60, 1.15]
P (log rank) = 0.25
All-Cause Mortality
Transapical (N=207)

HR [95% CI] = 1.22 [0.75, 1.98]
P (log rank) = 0.41

<table>
<thead>
<tr>
<th>No. at Risk</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVR</td>
<td>104</td>
</tr>
<tr>
<td>AVR</td>
<td>103</td>
</tr>
</tbody>
</table>

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Conclusions (1)

• The primary endpoint of the trial was met:
  – In patients with aortic stenosis at high risk for operation, TAVR was non-inferior to AVR for all-cause mortality at 1 year (24.2% vs. 26.8%, p=0.001 for non-inferiority)
  – Transfemoral TAVR subgroup was also non-inferior to AVR (p=0.002 for non-inferiority)

• Death at 30 days was lower than expected in both arms of the trial:
  – TAVR mortality (3.4%) was the lowest reported in any series, despite an early generation device and limited previous operator experience
  – AVR mortality (6.5%) was lower than the expected operative mortality (11.8%)
Conclusions (2)

• Both TAVR and AVR were associated with important but different peri-procedural hazards:
  – Major strokes at 30 days (3.8% vs. 2.1%, p=0.20) and one year (5.1% vs. 2.4%, p=0.07) and major vascular complications were more frequent with TAVR (11.0% vs. 3.2%, p<0.001)
  – Major bleeding (9.3% vs. 19.5%, p<0.001) and new onset atrial fibrillation (8.6% vs. 16.0%, p<0.001) were more frequent with AVR

• TAVR and AVR are both acceptable therapies in these high-risk patients; differing peri-procedural hazards may impact case-based decision-making
Conclusions (3)

• Symptom improvement (NYHA class and 6-min walk distance) favored TAVR at 30 days and was similar to AVR at one year

• Echo findings indicate:
  – Small hemodynamic benefit with TAVR vs. AVR at 1 year (mean gradient p=0.008, AVA p=0.002)
  – Increased para-valvular regurgitation associated with TAVR (p<0.001)

• Preliminary subgroup analyses should be interpreted cautiously:
  – Possible TAVR benefit in women and patients without prior CABG
CoreValve

**HIGHER PART**: low radial force
axes the system and improves anchoring

**MIDDLE PART**: valve area
convexo-concave – away from coronary ostia

**LOWER PART**: high radial force
secures anchoring on native valve
avoids recoil and para-valvular leaks
CoreValve

- Revalving™ System
  - Self-expanding support frame
  - Tri-leaflet porcine pericardial tissue valve
  - Third generation - 18 French
  - Disposable loading system
<table>
<thead>
<tr>
<th>Event</th>
<th>18F S&amp;E Study (N = 116)</th>
<th>18F EE Registry (N = 948)</th>
</tr>
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<tbody>
<tr>
<td><strong>30-Day All Mortality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac Deaths</td>
<td>13 (11.2%)</td>
<td>42 (4.4%)**</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td>4 (3.4%)</td>
<td>6 (0.6%)</td>
</tr>
<tr>
<td>Major Arrhythmias</td>
<td>22 (19.0%)</td>
<td>30 (3.2%)</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>32 (27.6%)***</td>
<td>84 (8.9%)</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>6 (5.2%)</td>
<td>10 (1.1%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>8 (6.8%)</td>
<td>14 (1.5%)</td>
</tr>
<tr>
<td>TIA</td>
<td>7 (6.0%)</td>
<td>5 (0.5%)</td>
</tr>
<tr>
<td>Structural Valve Dysfunction</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Valve Migration</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
</tr>
</tbody>
</table>

* Multiple events in same patients = data not cumulative
** Includes 4 deaths where cause is not known
*** Includes pre-procedural permanent pacemakers
Trancatheter Aortic Valve Implantation

- TAVI experience has been impressive with Edwards-Sapien & Medtronic CoreValve
- Important features of ideal transcatheter aortic valve
  - Large Effective Orifice Area
  - Durability - Safety
  - Securement
  - No coronary obstruction
  - Multiple sizes
  - Delivery profile - ≤18 French
Next Generation TAVI Devices

- Potential for improvement
  - Improved Delivery
    - More flexibility and trackability
    - Lower profile
  - Reduce need for pacemaker
  - Sealing - Reduced paravalvular insufficiency
  - Precise positioning
    - Annular placement
    - Clear coronary ostia
    - Avoid LVOT and mitral leaflet
  - Repositionable
  - Retrieveable
  - Functional assessment prior to final deployment
Next Generation TAVI Devices

- Direct Flow Medical - Percutaneous Aortic Valve

- Boston Scientific - Sadra Lotus™ Valve

- Bracco - Heart Leaflet Technology Valve

- St. Jude Medical TAVI System
Next Generation TAVI Devices

• Desireable features
  • Precise positioning
  • Repositionable
  • Retrievable
  • Functional assessment before final deployment

More Features = More Complexity
• Balloon supported polyester fabric cuff - stentless
  • Initial inflation deployment with saline/contrast
  • After final position and function is confirmed, saline/contrast replaced with inflation polymer media under constant pressure
• Bovine pericardium leaflets (anti-calcification therapy)
• 18 French
• Sizes - 23 mm, 25 mm, 27 mm
• 3 positioning and fill lumen - PFL’s
• 3 one way check valves
• Valve is immediately functional when unsheathed and distal ring is inflated
Direct Flow Medical

- Design Features
  - Delivery System
    - Polymer nylon sleeve
    - Multi-lumen catheter
      - 3 position and fill lumen
      - 1 guide wire lumen
    - Flexible nose cone
  - Non-metallic delivery system and valve
    - Flexible and trackable
  - Precise positioning
  - Retrievable with deflation and withdrawal into retrieval basket

- Timeline:
  - 2007: First in Man 22 French
  - 2008: First in Man 18 French
  - 2009: European Trial 22 French
  - 2010: European Trial 22 French
  - 2011: CE Mark
  - 2012:
Direct Flow Medical

- Valve loaded in Delivery System
- Valve Unsheathed
- Valve Inflated & Steering System
- Valve in Retrieval Basket
Positioning, Securement & Sealing

UC Davis

Thursday, May 19, 2011
Deliverability and Sealing

Delivery over arch and across valve
Aortogram after final deployment
CT at 6 months
Deliverability and Sealing

- Delivery over arch and across valve
- Aortogram after final deployment
- CT at 6 months
Deliverability and Sealing

Delivery over arch and across valve
Aortogram after final deployment
CT at 6 months
• 87 year old male
• Euroscore = 36.2

Complex Valve and Vascular Anatomy

- Extensive Calcification
- Moderately Calcified Native Annulus
- Marked Tortuosity

Current Status: 20 Months Post-Procedure

Final Position

6 Month CT

Thursday, May 19, 2011
83 y. o. female
  - CVA - hemiparesis, walking impairment
  - Symptomatic aortic stenosis
    - Chest pain
    - CHF
  - Echo gradient - 99/64 mmHg (peak/mean)
  - AVA - 0.42cm²
  - Logistic EUROSCORE: 29.3
Peripheral Access Assessment
Universitäres Herzzentrum Hamburg Germany
Schofer, Tubler, Treede, Franzen, Low
First Permanent Implant (10-1-2007)

- University Medical Center Hamburg-Eppendorf
First 18 French European Case
Professor Schofer - St. Georg Hospital, Hamburg

- Patient
  - 84 year old female
  - EuroSCORE - 26.2
  - Echo - 71 mmHg Peak 39 mmHg Mean Gradient
  - AVA - 0.7cm²
  - NYHA - Class III
  - Symptomatic AS

- Procedure
  - 18 French percutaneous access with 2 ProGlide
  - Direct Flow Medical - 18 F sheath
  - Balloon Valvuloplasty x 2 - Nucleus 25 mm Nucleus
  - Time - 1 hr 22 min, DFM Catheter time - 21 min
  - 2 month follow-up
    - NYHA Class I
    - Trace paravalvular leak
    - Mean gradient 19 mmHg, AVA 1.22 cm²
  - First completely percutaneous procedure

Pre

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Baseline

Post Implant

Post Implant

Saline & Contrast

Rotational View Pre-detach

Inflation Media & Detached

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Thursday, May 19, 2011
Boston Scientific - Sadra Lotus™ Valve

- Braided nitinol stent structure
- Radial expansion as it shortens
- Bovine pericardial valve
- Valve leaflets function during deployment
- Repositionable
- Retrievable at any point prior to release
- 18 French

2007 2008 2009 2010 2011 2012

First in Man 21 French
First in Man 18 French
European Trial
European Trial
European Trial
CE Mark

Adaptive Seal

Deploy Retrieve
Boston Scientific - Sadra Lotus™ Valve

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First in Man 18 French
European Trial

First in Man 21 French
European Trial

European Trial

Adaptive Seal

Deploy
Retrieve
Bracco - Heart Leaflet Technology

- Nitinol support structure
- Porcine pericardial valve
- Braided polyester liner
- Repositionable
- Retrievable
- Design separates valve from support structure
- 17 French

First in Man

European Trial

2009  2010  2011  2012
St. Jude Medical TAVI System

- Nitinol self expanding stent
- Bovine and porcine pericardial valve (Linx™ anticalcification technology)
- Minimal protrusion into the LVOT
- Fully secured to delivery system - allows for re-sheathing and repositioning
- Retrievable valve
- 18 French

2010          2011          2012          2013

Pre-IDE meetings          European Trial          CE Mark
First in Man              US IDE Submission

12F          18F
Summary

- Edwards Lifesciences and Medtronic have set a very high standard for TAVI
  - Sapien & CoreValve have already evolved several generations
- Next generations TAVI devices have been developed and have some added features
  - Precise positioning
  - Repositioning
  - Retrievable
  - Improved sealing
  - Functional assessment prior to final deployment
- Proof of concept of next generation TAVI Systems have been validated in patients
- Await results of clinical trials for next generation TAVI Systems
Where are we?

- Reasonable alternative for “in-operable” disease
- Unknown durability in patients
- Deliverability remains an issue
- Paravalvular leak may be an under estimated problem
- Must be able to displace native diseased valve or remove native valve
- Percutaneous Aortic Valve Implantion in high risk aortic stenosis patients - feasible and safe
- Next generation devices will be retrievable and repositionable
- Surgical replacement of percutaneous valve should be feasible