Transcatheter Mitral Valve Repair and Replacement: Case Examples

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66 y/o male with severe AS and severe MR (NYHA 3-4)
Cardiopulmonary arrest, during anesthesia induction for dual valve surgery, likely secondary to severe pulmonary hypertension (PAP 80)

Patient referred for transcatheter management of severe MR and severe AS

Severe MR with flail P2

Severe AS
Simultaneous MitraClip and TAVR performed

MitraClip deployment with trivial residual MR
Simultaneous MitraClip and TAVR performed

29mm Sapien-XT deployment with trivial residual AR

Patient discharged to home on post-procedure Day 6
NYHA Class II at 1 month
Case Selection: Suitable Anatomy

- **Non rheumatic MR** originating from a localized area of the valve
- **Etiology:** degenerative or functional
- **Sufficient leaflet tissue for mechanical coaptation**
- **Valve anatomic exclusions**
  - Flail gap >10mm
  - Flail width >15mm
  - Calcified leaflet
- **MVA ≥ 4 sq cm**
Expanded indications of the MitraClip: Beyond the EVEREST criteria

- A1P1 or A3P3 flail or prolapse
- Failed surgical repair
  - Ring annuloplasty, or snapping of artificial chord
- HOCM: Systolic anterior motion with MR
- End stage heart failure with MR
  - Delay heart transplantation or VAD
Flail P2/P3 segment
MitraClip for a Flail P2/P3
71 yr old male with previous CABG underwent Mitral valve repair (artificial chords and surgical ring)  
Presents: Shortness of breath and loud systolic murmur 10 days after surgery
One clip > Trace MR

- Both patient and surgeon became less short of breath
- Patient discharged home next morning
Case 1

70 year-old Male

Presented at 8:30 AM
Sudden onset shortness of breath for last 3 weeks
Admitted in hypotension and VT 3 days ago
Acute renal failure
Cardiogenic shock needed inotropes

Urgent treatment

Past Medical History

• HIV
• HTN
• Afib
• Prior MV repair in 2008 now with severe MR and posterior flail

STS Risk of Mortality

for Repair 26.6%
for Replacement 39.2%
**Pre procedural condition**

<table>
<thead>
<tr>
<th>BP 90/60 on low dose dopamine</th>
<th>Labs</th>
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<tbody>
<tr>
<td>JVP 20 cm</td>
<td>Hemoglobin 12.6 g/dl</td>
</tr>
<tr>
<td>Urine output &lt; 100 cc in 24 hours</td>
<td>WBC 7200 /mcL</td>
</tr>
<tr>
<td>Holosystolic murmur</td>
<td>Creatinine 4.2 mg/dl</td>
</tr>
<tr>
<td>Normal coronary arteries by CTA</td>
<td>Bilirubin 3.8 mg/dl</td>
</tr>
<tr>
<td></td>
<td>ALT 933 U/L</td>
</tr>
<tr>
<td></td>
<td>AST 1145 U/L</td>
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</tbody>
</table>
Baseline TTE:
Long axis view

Dd/Ds = 58/44 mm,
LVEF = 56%,
LA diameter = 55 mm
Estimate PA pressure 49 mmHg

Post repair with an annuloplasty ring
Thickened both mitral leaflets and annular calcification
Anterior directed severe MR jet due to flail of the posterior mitral leaflet
Baseline TTE: 4 Chamber view

MV E/A 2.0,
TMPG peak/mean 6.3/2.1 mmHg,
MR EROA 0.56cm²
Previous procedure TEE

Transmitral mean gradient = 2 mmHg
Procedure

Following septal puncture, BP 78/40 mmHg, SpO₂ 45%

iatrogenic right-to-left ASD shunt
Post 3 Clips TEE

3 MitraClips in A2-P2 segment
MR was reduced from severe to trace

Transmitral mean gradient = 5 mmHg
Assessment of Septal Hole
Right to Left shunt, Hole size: 1.6 x 1.8 cm
Post ASD occluder 22-mm device
Post-procedural Assessment

Pulmonary vein flow

Pre: systolic reversal

Post: systolic dominant

Pressure Study

LA pressure 55 ➞ 25 mmHg (V wave)
22 ➞ 16 mmHg (mean)

CO 6.4 ➞ 9.3 L/min,
CI 3.5 ➞ 5.2 L/min/m²
Mean trans mitral PG 5 mmHg
Liver and kidney injuries were revealed. Follow up TTE showed trace MR. Discontinued inotropes on POD5. Vital signs were stable. Discharged home on POD7.

<table>
<thead>
<tr>
<th>Labs base line</th>
<th>at Discharge</th>
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<tbody>
<tr>
<td>Hemogoblin</td>
<td>12.6 g/dl</td>
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<tr>
<td>WBC</td>
<td>7200 /mcL</td>
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<tr>
<td>Creatinine</td>
<td>4.2 mg/dl</td>
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<tr>
<td>Bilirubin</td>
<td>3.8 mg/dl</td>
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<tr>
<td>ALT</td>
<td>933 U/L</td>
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<tr>
<td>AST</td>
<td>1145 U/L</td>
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<tr>
<td></td>
<td>12.1 g/dl</td>
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<tr>
<td></td>
<td>3500 /mcL</td>
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<tr>
<td></td>
<td>1.5 mg/dl</td>
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<tr>
<td></td>
<td>0.9 mg/dl</td>
</tr>
<tr>
<td></td>
<td>189 U/L</td>
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<tr>
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<td>64 U/L</td>
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</tbody>
</table>
TTE 4ch

Pre

Post
Case 2

78 year-old Male

History of CAD s/p PCI, Hypertension, DM, Hyperlipidemia,

Acute left heart failure and cardiac arrest
Pt was resuscitated
IABP was inserted
TEE confirm severe MR due to P2 frail
Taken to OR found porcelain aorta then chest was closed
Transferred for Transcatheter treatment to our hospital
Baseline TEE

CO: 3.2 L/min, CI: 1.7 L/min/m²
LA pressure: V wave 16, mean 11
Transmital mean gradient = 2 mmHg
2 MitraClips in A2-P2 segment
MR was reduced from severe to trace
CO: 4.4 L/min, CI: 2.3 L/min/m²
LA pressure: V wave 11, mean 9
Transmitral mean gradient = 3 mmHg
TTE 4ch

Pre

Post
Conclusion

• MitraClip can be a life saving procedure in selected patients in cardiogenic shock.
• The procedure is safe even in near death situation.
49 y/o female referred for percutaneous management of mitral and aortic valve disease

- Severe mitral stenosis and moderate-severe mitral regurgitation
- Diastolic congestive heart failure, NYHA III
- Severe pulmonary hypertension, on supplemental oxygen at night, 2 L
- End stage renal disease, on hemodialysis
- Thrombocytopenia (platelet count 80)
- Occluded SVC
- Central retinal occlusion
- Transient ischemic attack
- Diabetes mellitus
- Frequent pneumonias
- Frailty

Patient deemed inoperable for surgical valve replacement
Severe mitral stenosis and moderate mitral regurgitation

Moderate-severe MR

Severely restricted mitral valve leaflets with severe MAC

Severe mitral stenosis

- Vmax 293 cm/s
- Vmean 207 cm/s
- Max PG 34 mmHg
- Mean PG 19 mmHg
- VTI 92.2 cm
Coexisting moderate-severe AR

Vmax: 408 cm/s
Slope: 371 cm/s²
P½t: 322 ms

65 bpm
3D TEE based mitral annular dimensions

28.6 mm

26.1 mm

Area 523 mm²
Mitral annular calcification on CT
Transcatheter mitral valve replacement with a 29mm Sapien 3 valve

Rapid pacing at 180bpm
Final result

Trace MR

Mean gradient
3 mmHg

Max PG 10 mmHg
Mean PG 3 mmHg
VTI 35.6 cm

Normal leaflet motion
Left ventriculogram
No significant MR

Baseline
Moderate-severe MR

Post-intervention
No significant MR

29mm Sapien 3 valve in mitral position
Case: Sapien in MAC in a patient with Portico valve
79 y/o male with severe aortic stenosis and severe mitral stenosis

Patient enrolled in the PORTICO trial

Severe aortic stenosis
Mean mitral gradient 49mmHg

Moderate-severe mitral stenosis
Mean mitral gradient 10mmHg
27mm Portico deployed by transfemoral approach
Final result

Trivial paravalvular AR
Invasive hemodynamics

Baseline
Mean gradient 47.5mmHg

s/p 29mm Portico
Mean gradient 10.7mmHg
Patient continued to experience worsening heart failure

Rising mitral gradients (12mmHg)
Patient brought to the cath lab for transseptal Sapien in MAC implantation

Atrial septostomy performed with a 12mmx4cm Z Med balloon

26mm Sapien 3 in mitral annular calcium
Moderate paravalvular MR after TMVR
Post-dilation performed with the valve balloon
Final result s/p 26mm Sapien 3 in MAC
No significant MR
Final result

**Baseline**
Mean gradient 12mmHG

**Final result**
Mean gradient 2mmHG
Dual valve replacement
### 75 y/o male presenting with heart failure

Patient evaluated for transcatheater mitral ViV implantation

<table>
<thead>
<tr>
<th>Severe mitral stenosis of #25 Magna valve</th>
<th>Moderate restriction of #19 Magna aortic valve and prosthesis-patient mismatch</th>
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</table>

<table>
<thead>
<tr>
<th>Mean mitral gradient 13mmHg</th>
<th>Severe restriction of mitral valve leaflets</th>
</tr>
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<tbody>
<tr>
<td>Mean aortic valve gradient 50mmHg</td>
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</table>
Atrial septostomy performed with a 12mm x 3cm Z Med balloon

- Transseptal puncture performed with a BRK1 needle
- Mitral valve crossed with a Multipurpose catheter advanced through a Agilis catheter
- Atrial septostomy performed with a 12mm x 3cm Z Med balloon
Mitral valve-in-valve performed with a 26mm Sapien 3 valve

No residual MR

Normal leaflet motion

Final mitral valve gradient 4mmHg
Hemodynamics of the mitral valve

Baseline mitral valve gradient
12mmHg

Final mitral valve gradient
4mmHg
Aortic valve gradient increased following mitral valve in valve implantation

Aortic valve gradient pre-mitral
ViV: 43mmHg

Aortic valve gradient post-mitral
ViV: 69.4mmHg
Aortic valve-in-valve performed with a 23mm Sapien 3 valve
Hemodynamics of the aortic valve

Baseline aortic valve gradient
69.4mmHg

Final aortic valve gradient
20mmHg
Mitral valve replacement and PVL closure
78 y/o male referred for mitral valve in valve
Degenerative Mosaic mitral valve with flail leaflet and severe central and paravalvular MR

Past medical history

- Surgical mitral valve replacement (33mm Mosaic)
- Acute on chronic decompensated diastolic heart failure NYHA 4
- Severe frailty
- CAD s/p CABG (LIMA to LAD)
- Chronic kidney disease (Cr 2.8)
- Severe pulmonary hypertension (PA systolic pressure 67mmHg)

Patient determined to be inoperable by 2 CT surgeons
78 y/o male referred for mitral valve in valve
Degenerative Mosaic mitral valve with flail leaflet and severe central and paravalvular MR

- Flail of Mosaic mitral valve
- Thickened and restricted mitral valve leaflets
- Systolic flow reversal of pulmonary veins
- Severe central MR
- Severe paravalvular MR
- Mean mitral valve gradient 8mmHg

8mmHg
Severely dilated (6.2cm) and depressed RV
Valve internal dimensions
Stent internal diameter 30mm, True ID 28mm

Stent Internal Diameter
- 30

True ID
- 28

Height
- 23

Suggested TAVI Valve Size
Sapien Size
- 29

Non-contrast CT
Valve dimensions 29.2x28.6mm

Custom Distance 29.2 mm
Area 6.7 cm²
Perimeter 28 mm
- (projected) 28 mm

Max 28.6 mm

TEE
Valve dimensions 29.8x26.7mm
Patient brought to the cath lab for mitral valve in valve

• Drop in BP immediately following induction for intubation

• CPR performed x 5 minutes and epinephrine boluses, with return of pulsatility
Trans-septal puncture performed in mid-mid position
CPR performed again, just before transseptal puncture
Baylis sheath and needle
Procedural steps

- Agilis catheter advanced into the left atrium
- Mitral valve crossed with a pigtail catheter advanced through an Agilis catheter
- Baseline mitral valve gradient measured with a dual-lumen pigtail
- Confida wire advanced into the LV and pigtail catheter and Agilis catheter removed
- 16 French Edwards esheath advanced into the femoral vein
Atrial septostomy performed with a 14mm x 4cm Z-Med balloon
Trans-septal mitral ViV performed with a 29mm Sapien 3 valve
s/p mitral ViV with 29mm Sapien 3
No central MR; residual severe paravalvular MR
Paravalvular leak crossed with a 0.035inch Terumo glidewire and a 6 French Multipurpose catheter
A 0.035 inch Confida wire advanced into the LV through the paravalvular leak
6 French Multipurpose diagnostic catheter exchanged for a 6 French Multipurpose guide catheter
12mm AVP2 plug deployed in the paravalvular space
s/p paravalvular leak closure with 12mm AVP2 plug

No significant paravalvular MR
Iatrogenic ASD closed with a 25mm Cardioform

Concern for right to left shunting due to pulmonary HTN and severe RV failure

No residual interatrial shunting
Mitral valve replacement with buddy balloon
76 y/o female presenting with severe mitral stenosis due to degenerative bioprosthetic mitral valve

Deemed inoperable due to comorbidities

- h/o CABG
- s/p MVR with Edwards CE valve
- NYHA IV CHF
- Peripheral arterial disease s/p aortoiliac bypass
- COPD, on home oxygen
- Frailty
- Autoimmune hemolytic anemia, requiring immunosuppression
- Pulmonary hypertension
- Non-hodgkin lymphoma
Severe mitral stenosis and severe paravalvular MR of bioprosthetic valve

- Severely thickened and restricted mitral leaflets
- Mean transmitral gradient 20mmHg
- Severe paravalvular MR
- Systolic flow reversal in pulmonary veins
Plan for trans-septal mitral valve-in-valve implantation with Sapien-XT 26mm valve

Internal dimensions of the valve
20.4mm x 22.4mm
Trans-septal puncture, followed by balloon atrial septostomy with 16 x 4mm Z-med Balloon

Confida wire in the LV across the mitral bioprosthesis

Balloon atrial septostomy
26mm Sapien-XT valve deployment by trans-septal approach

Buddy balloon technique to advance the valve across the septum

Valve deployment
Final result
No significant central MR, persistent severe paravalvular MR
Normalization of transmitral gradient

Normal transcatheter valve function
Persistent severe PV MR

Mean transmitral gradient
3 mmHg
Patient brought back to the cath lab 1 month later for mitral PVL closure

14mm AVP2 plug

Trivial residual mitral PVL
Transcatheter mitral and aortic ViV
72 y/o female presenting with NYHA III heart failure

Severe bioprosthetic mitral stenosis
29mm Bovine Edwards

Severe bioprosthetic aortic stenosis
23mm Bovine Edwards

Deemed inoperable due to critical pulmonary hypertension
Patient worked-up for transcatheter aortic and mitral ViV implantation

Plan for 29mm Sapien 3 for mitral ViV
Patient worked-up for transcatheter aortic and mitral ViV implantation

Plan for 23mm Sapien 3 for aortic ViV
Patient brought to the cath lab for transcatheter aortic and mitral valve replacement

Trans-septal puncture for Transcatheter mitral ViV performed at the time of arterial access for Transcatheter aortic ViV

Transseptal sheath

TAVR sheath
Transcatheter aortic ViV with 23mm Sapien 3 valve

No significant AR
Immediately after aortic ViV, Preparation for transcatheter mitral ViV

- Pigtail across the mitral valve
- Safari across the mitral valve
- Atrial septostomy with Z-med II 15 x 4 cm
Trans-septal transcatheter Mitral ViV implantation with a 29mm Sapien 3 valve
Final result s/p simultaneous transfemoral aortic and mitral ViV implantation

Pre-Mitral ViV

Post-Mitral ViV
Final result s/p simultaneous transfemoral aortic and mitral ViV implantation

Pre-Aortic ViV

Post-Aortic ViV