

Percutaneous Mitral Valve Replacement Update

Marvin H. Eng MD FACC FSCAI

Structural Heart Disease Fellowship and Research Director

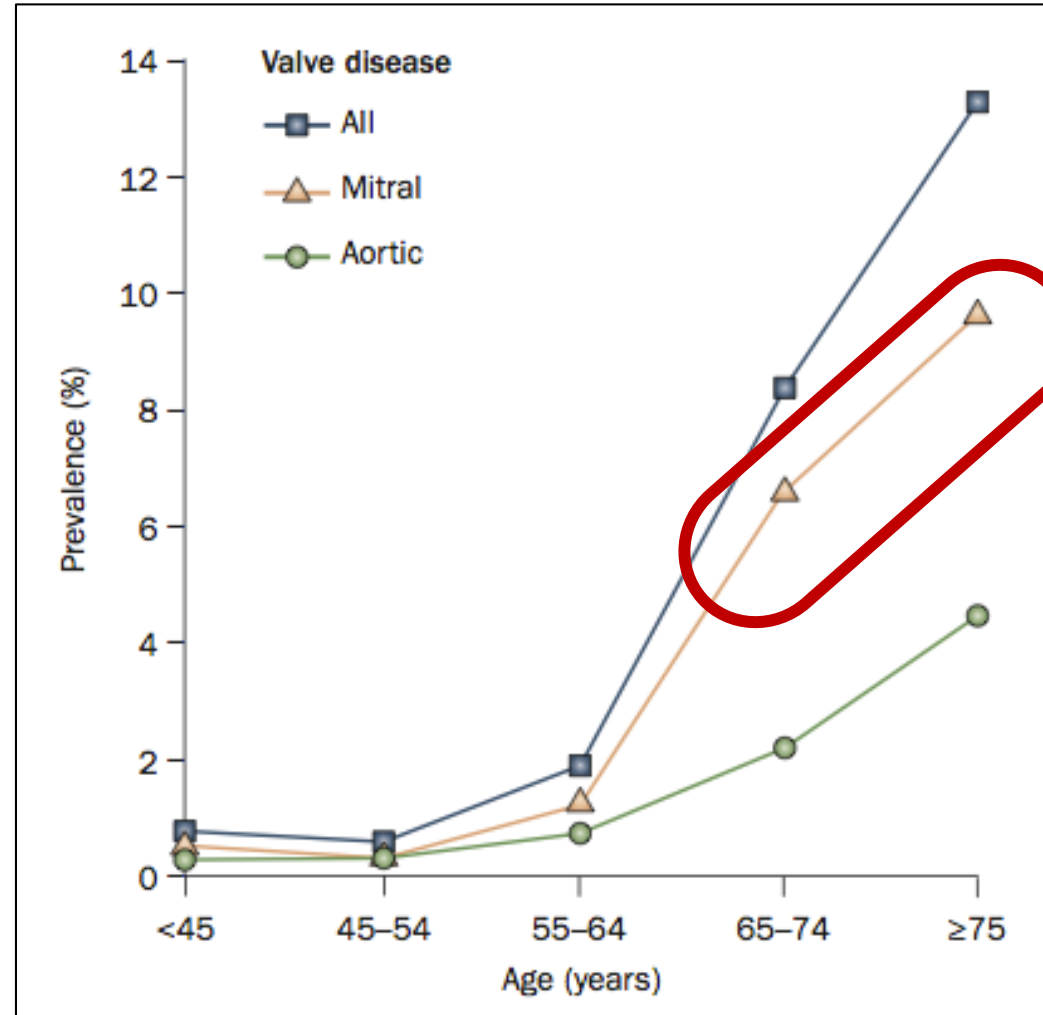
Henry Ford Hospital

Detroit, MI

DISCLOSURES

- Clinical Proctor for Edwards Lifesciences
- TMVR devices actually used:
 - Balloon Expandable Sapien 3 (Edwards Lifesciences)
 - Valve-in-valve
 - Valve-in-ring
 - Valve-in-MAC
 - M3 Docking system (Edwards Lifesciences)
 - TENDYNE (Abbott)
 - TIARA (Neovasc)

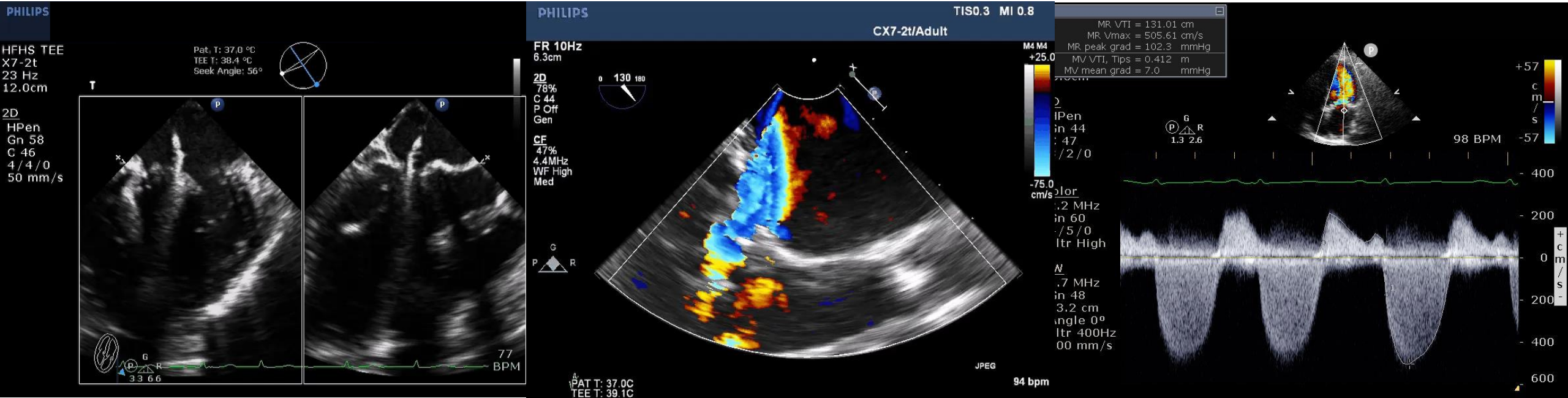
Prevalence Moderate-Severe Valvular Disease



Mitral Regurgitation Relatively Undertreated

| | All patients (n=1294) | Ejection fraction <50% (n=538) | Ejection fraction ≥50% (n=756) |
|-----------------------|--------------------------|--------------------------------------|--------------------------------------|
| Mitral surgery | | | |
| Total | 198 (15%) | 28 (5%) | 170 (22%) |
| Repair | 149 (12%) | 18 (3%) | 131 (17%) |
| Replacement | 49 (4%) | 10 (2%) | 39 (5%) |
| Tissue | 23 (2%) | 3 (<1%) | 20 (3%) |
| Mechanical | 26 (2%) | 7 (1%) | 19 (3%) |

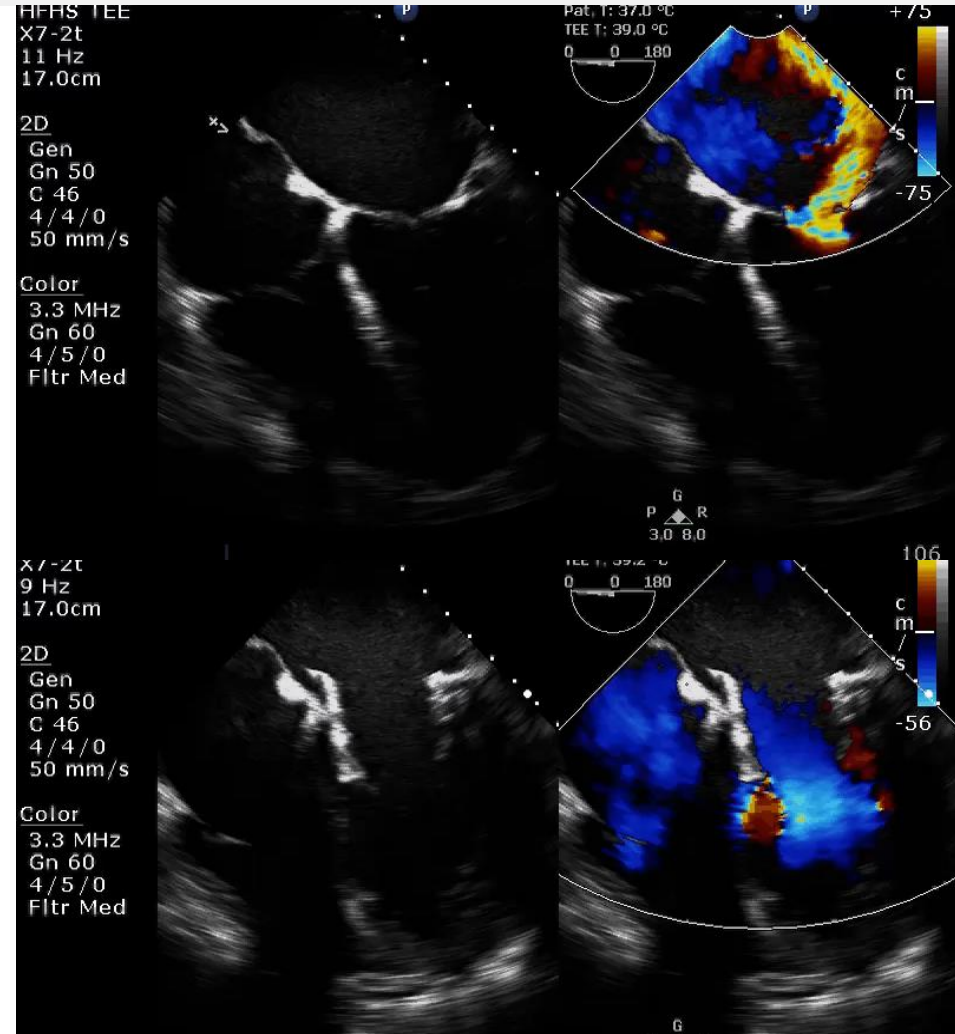
Mitral valve repair is great... But some valves need to be replaced



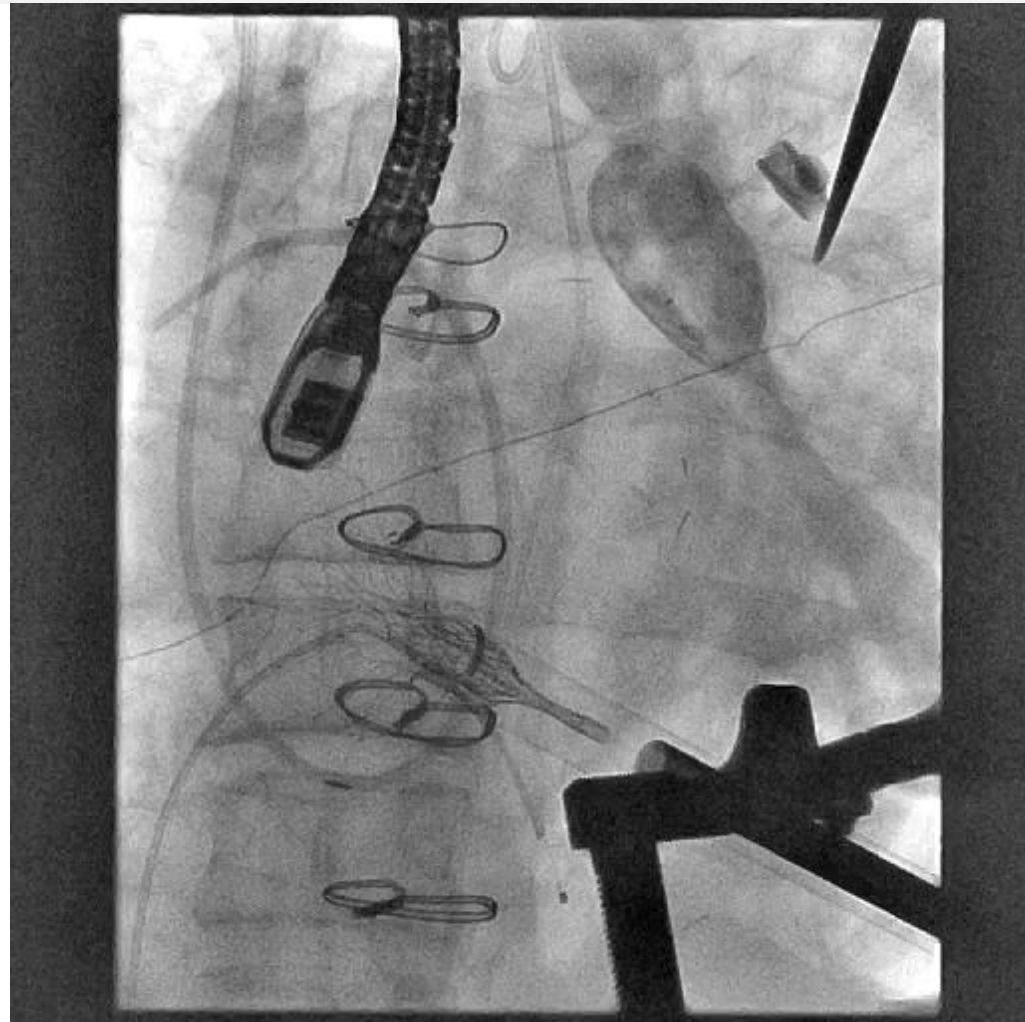
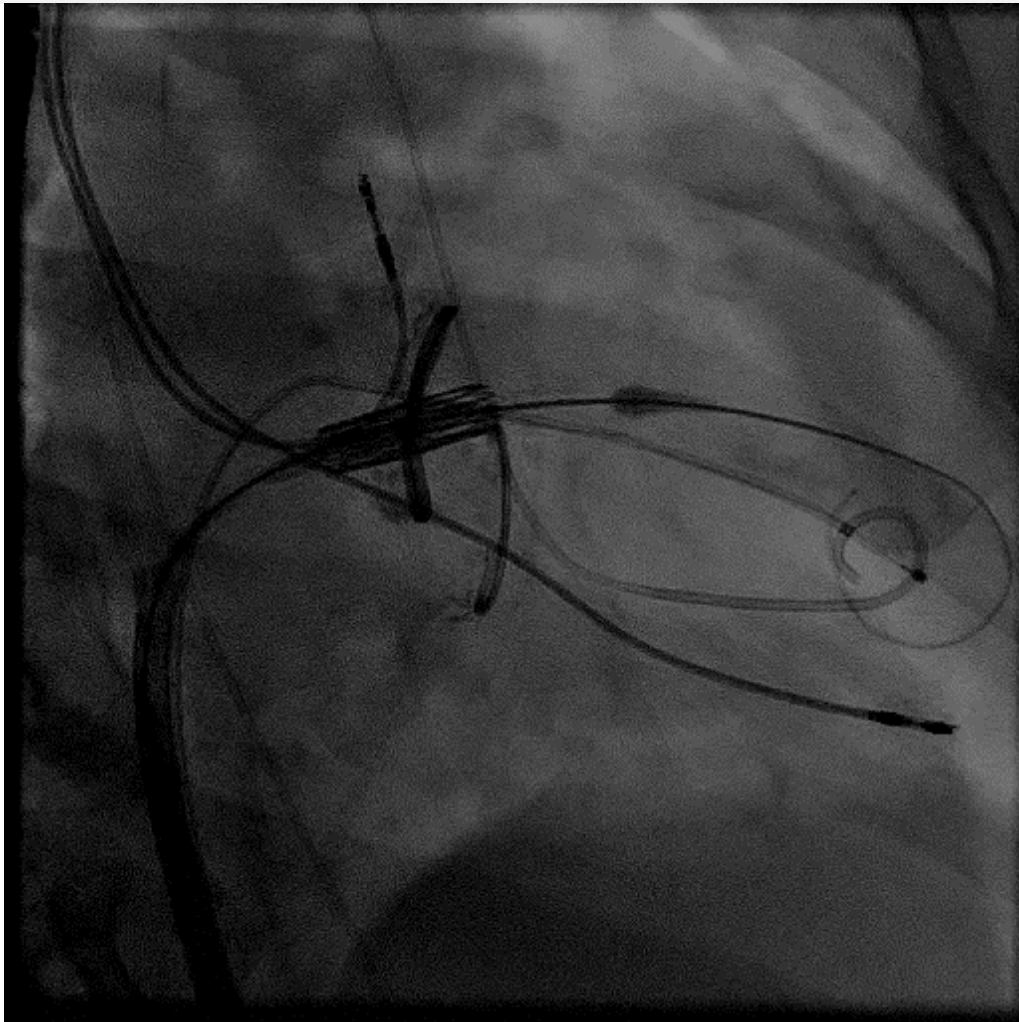
Transcatheter mitral valve replacement

Contemporary issues

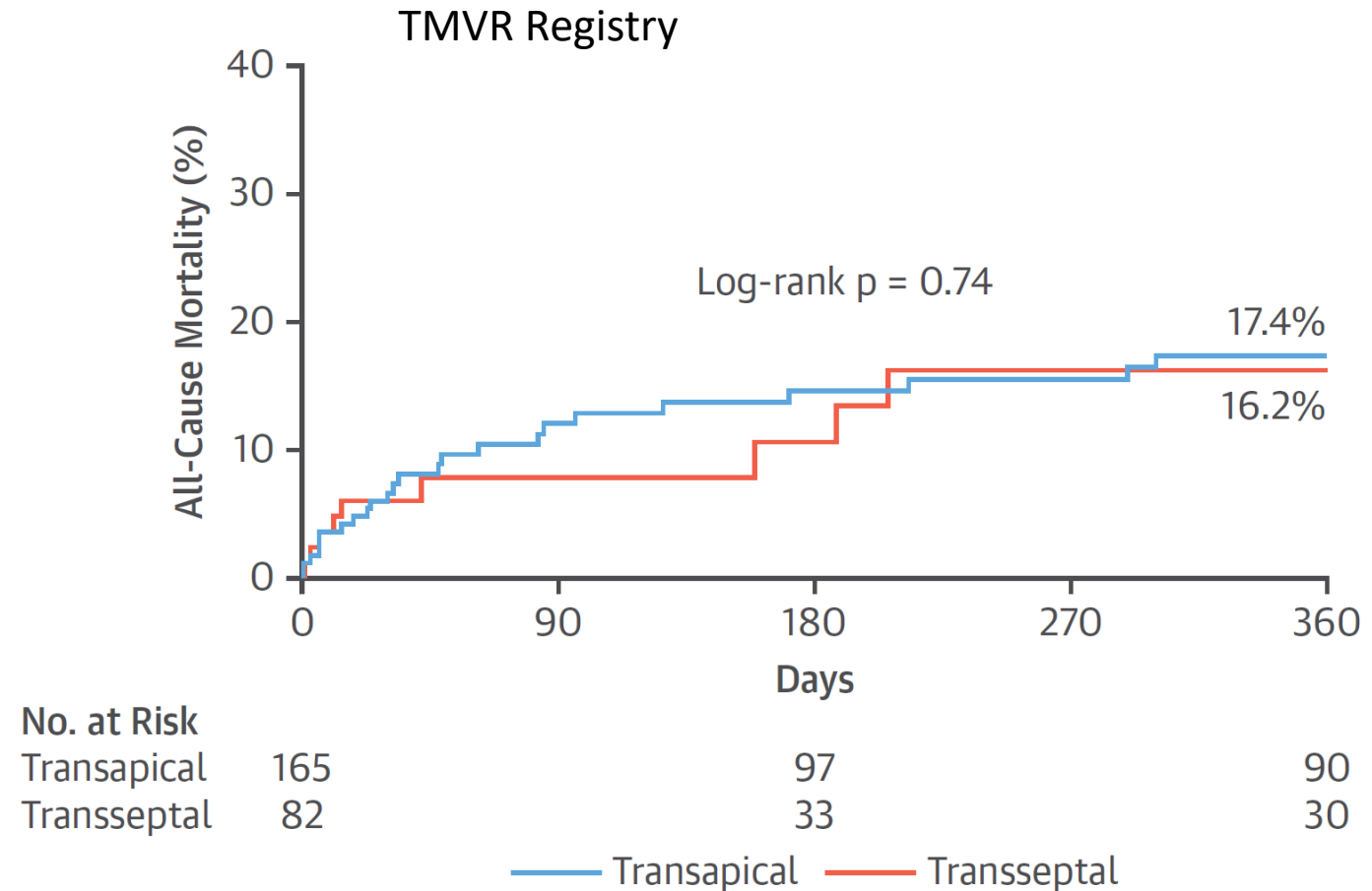
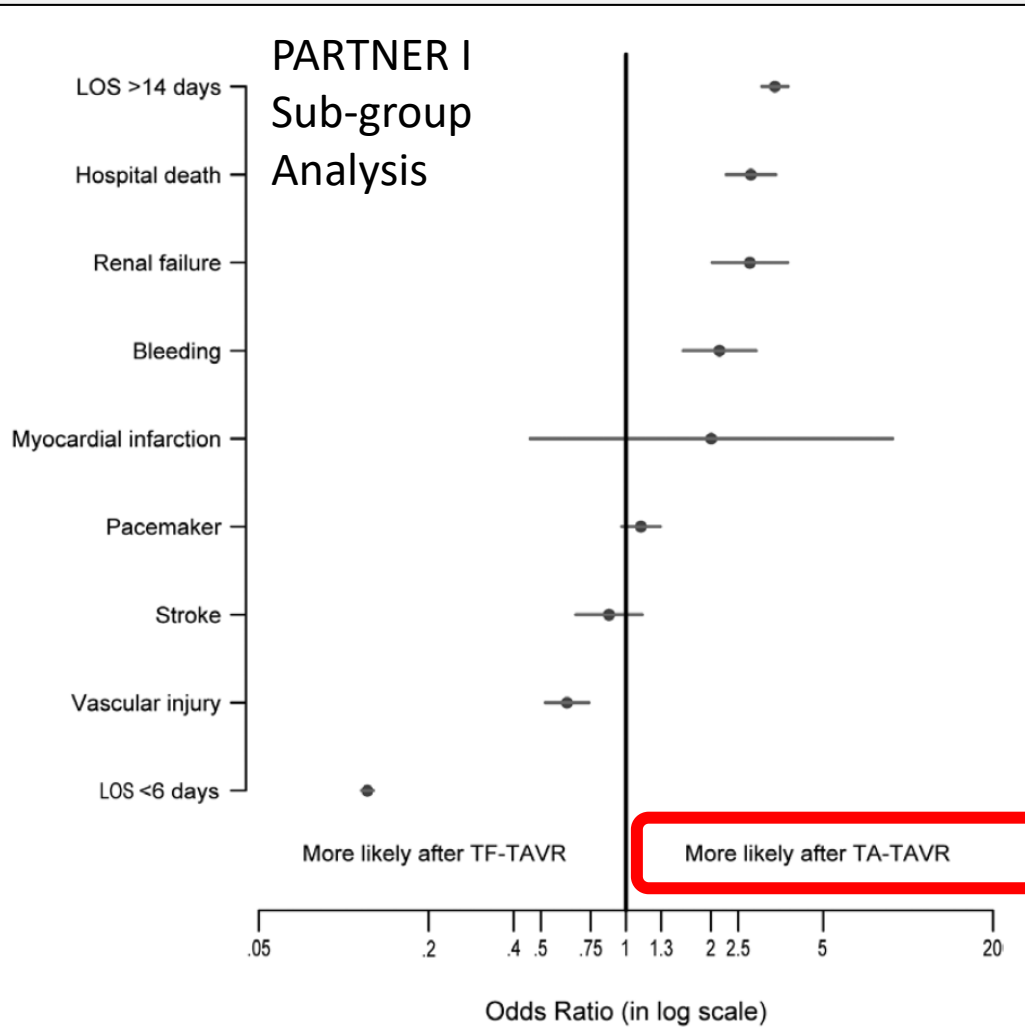
- Access
- Anatomic eligibility
 - Left ventricular outflow tract
 - Valve sizes
 - Mitral annular calcification
- Patient Selection
 - Functional mitral regurgitation
 - LVEF
 - Anticoagulation
- Recent Data



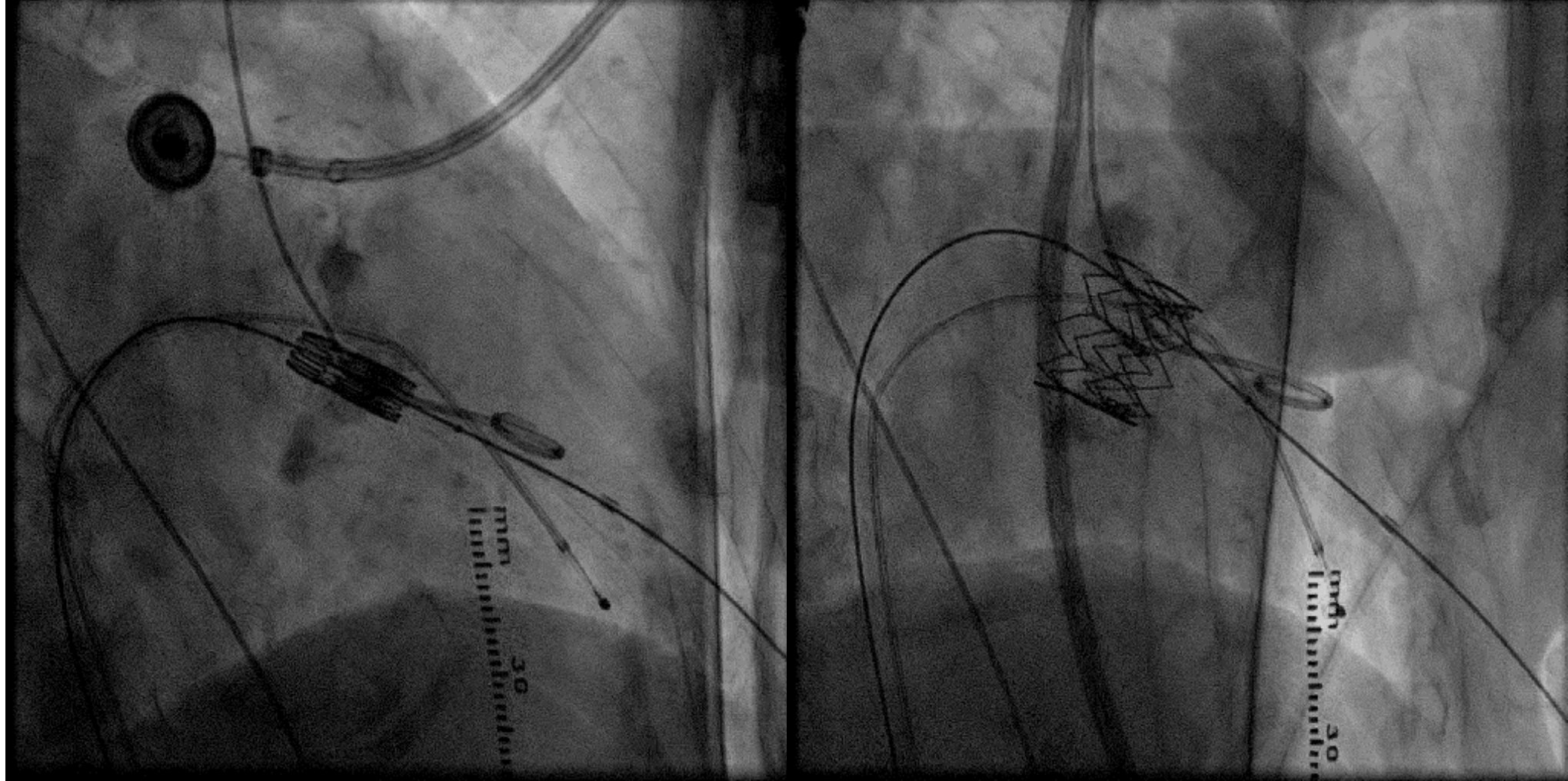
Transseptal vs. Transapical



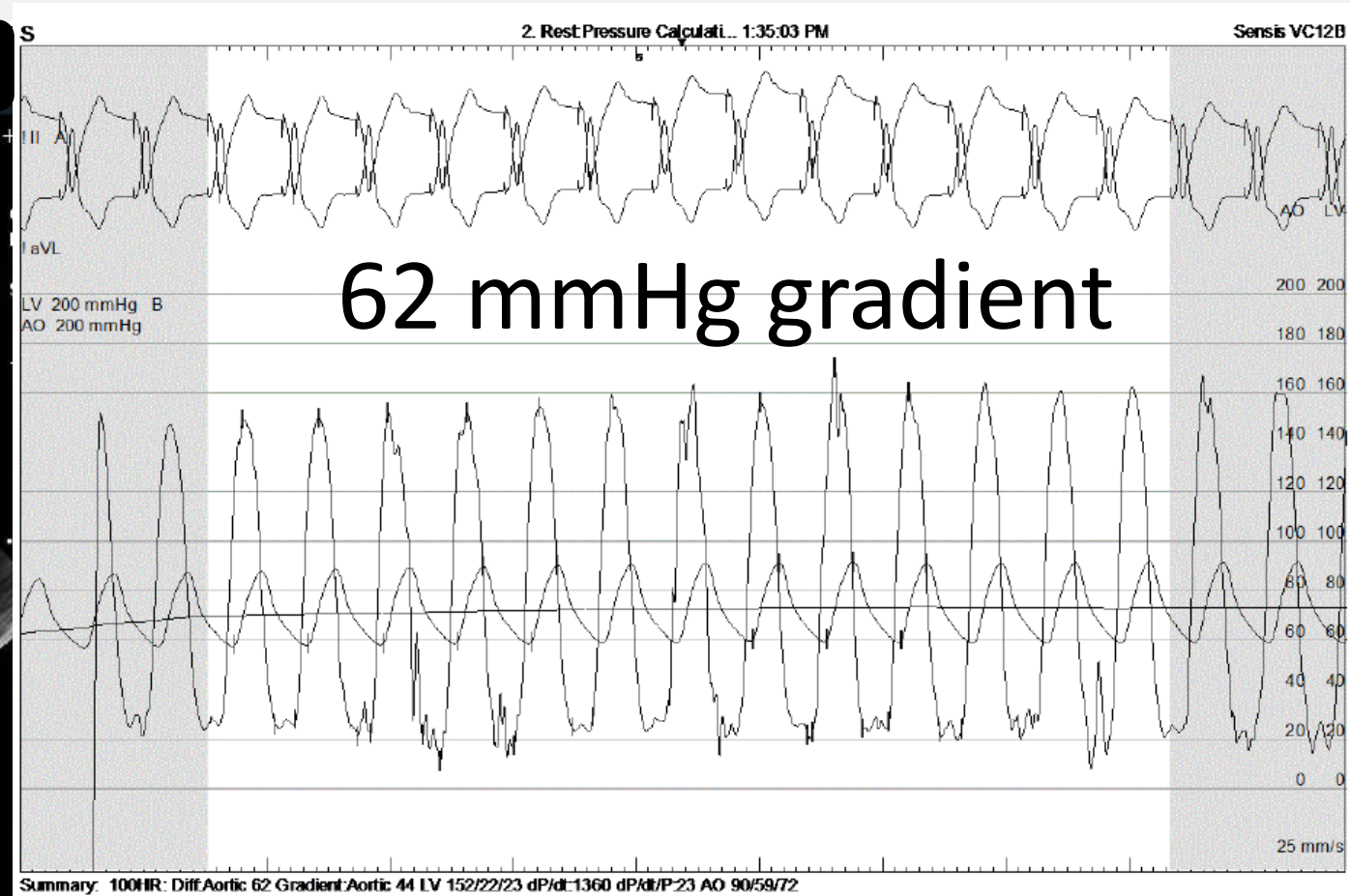
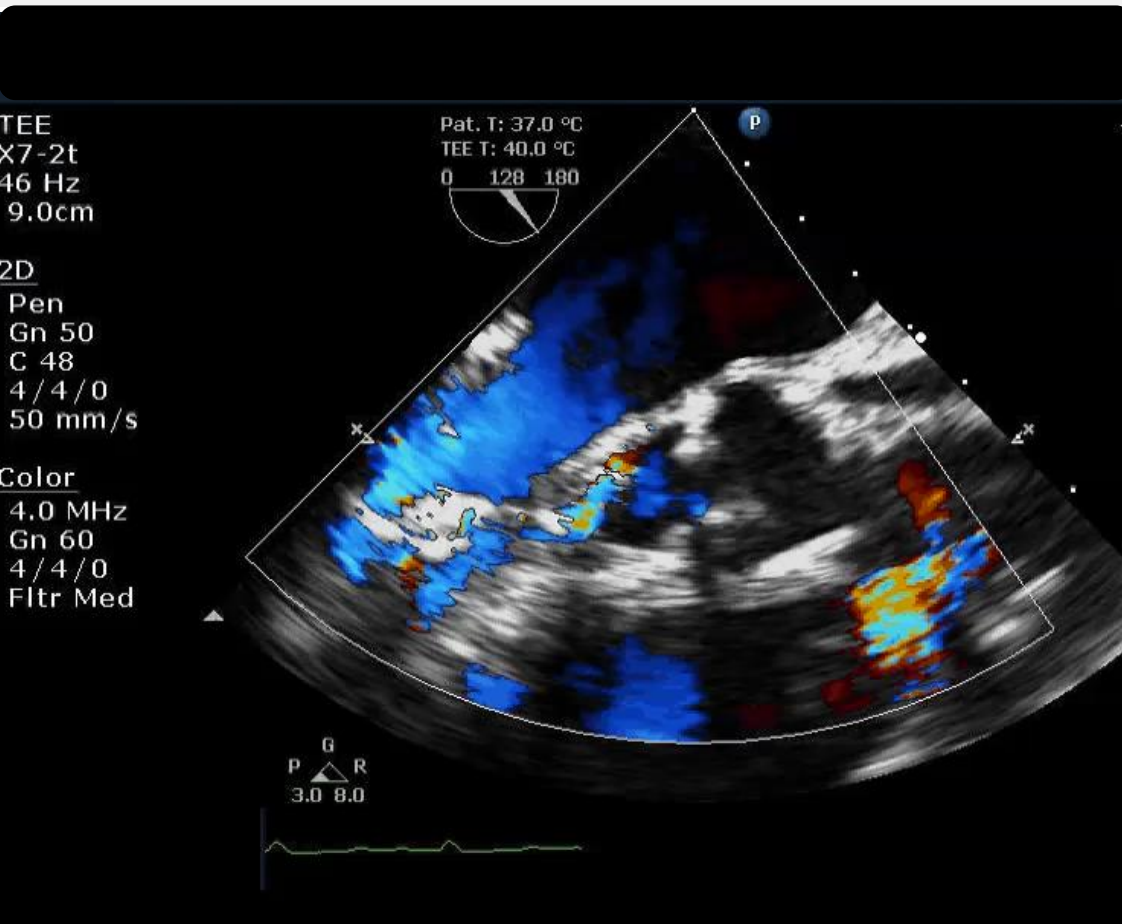
Transseptal vs. Transapical



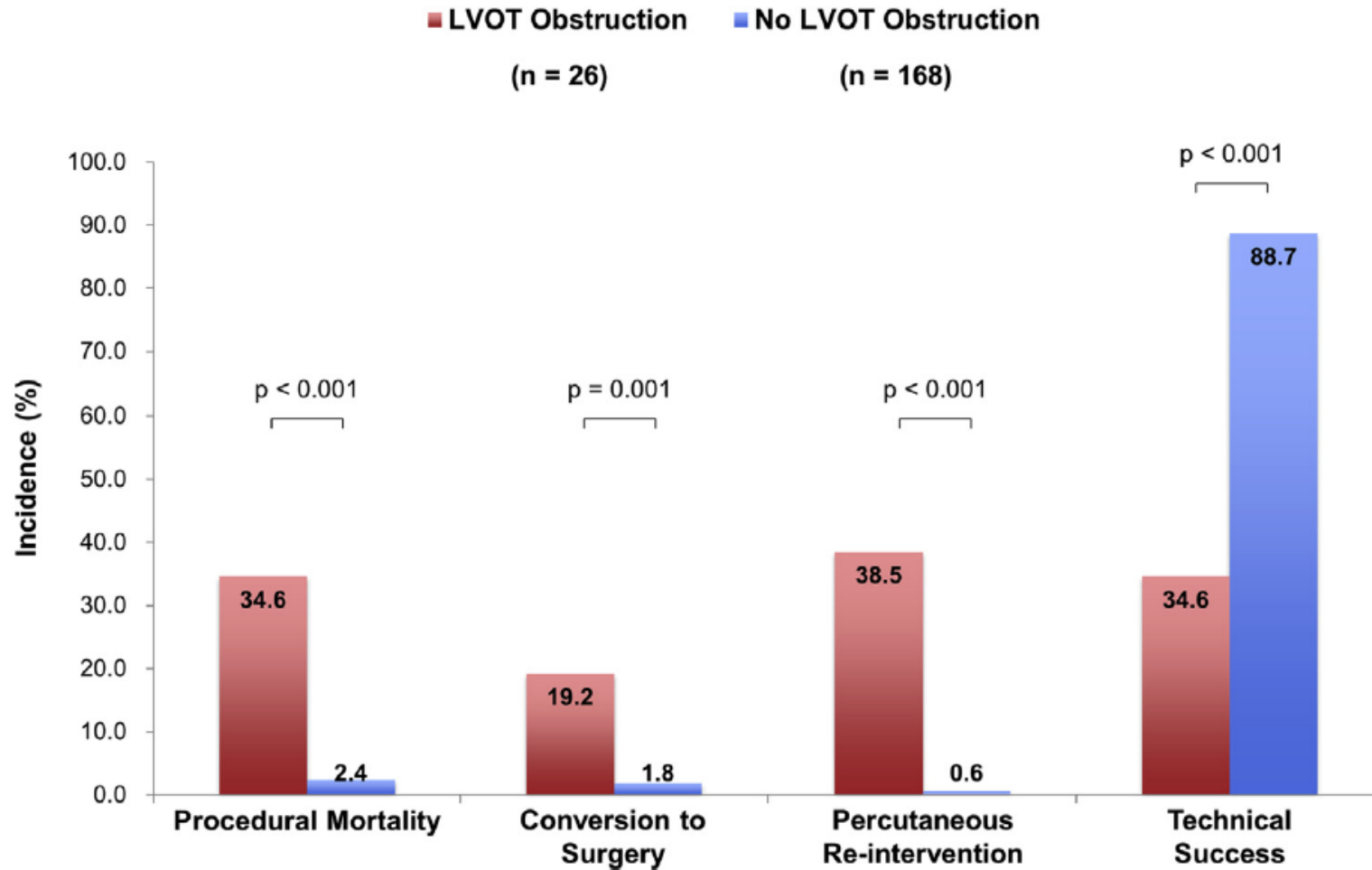
88 yo F with calcific mitral stenosis



Recovery after a PEA arrest



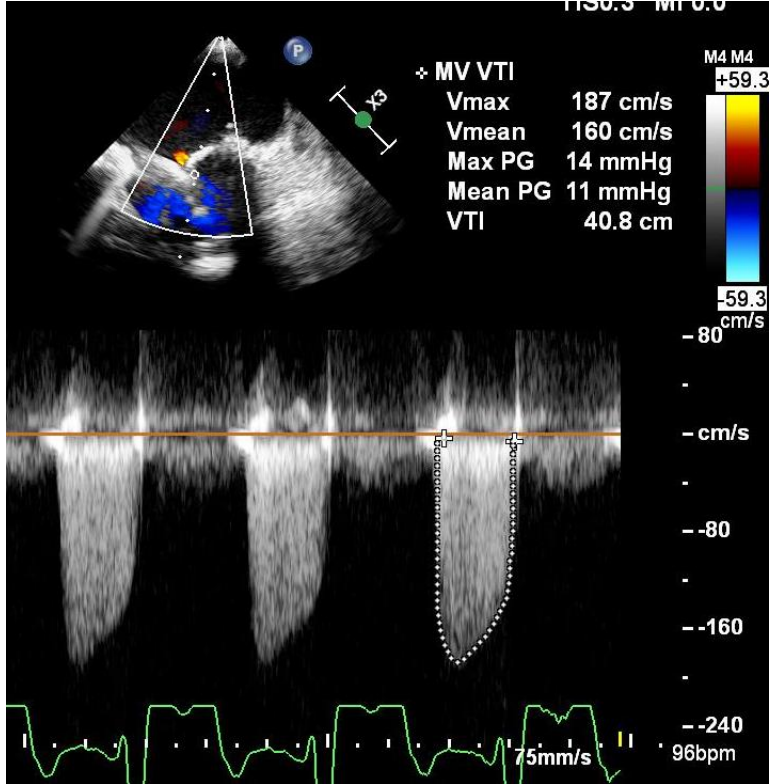
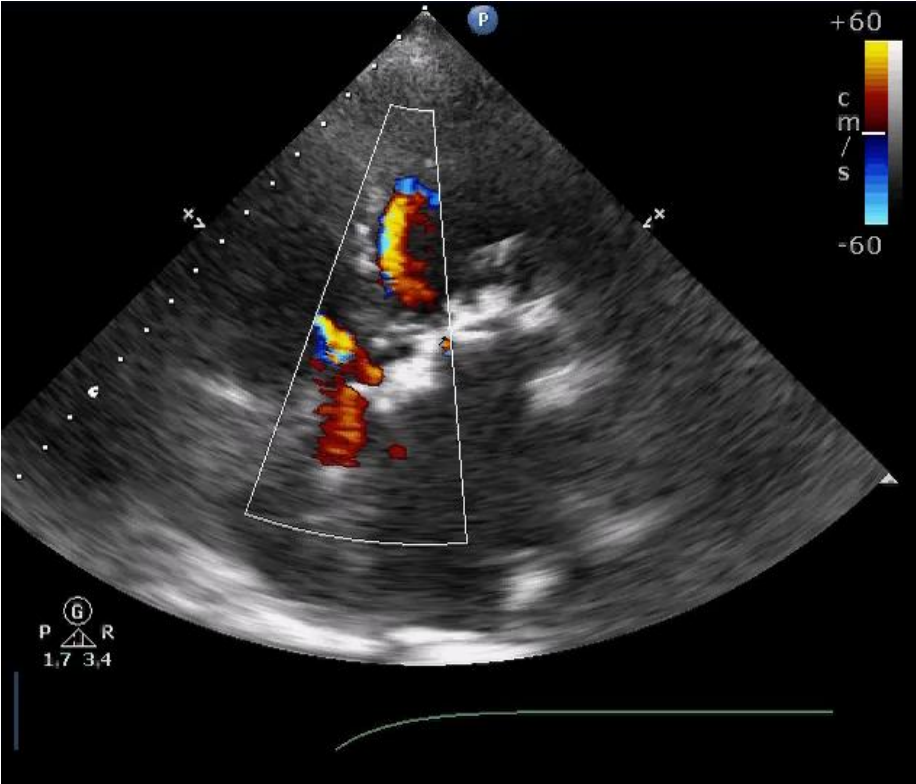
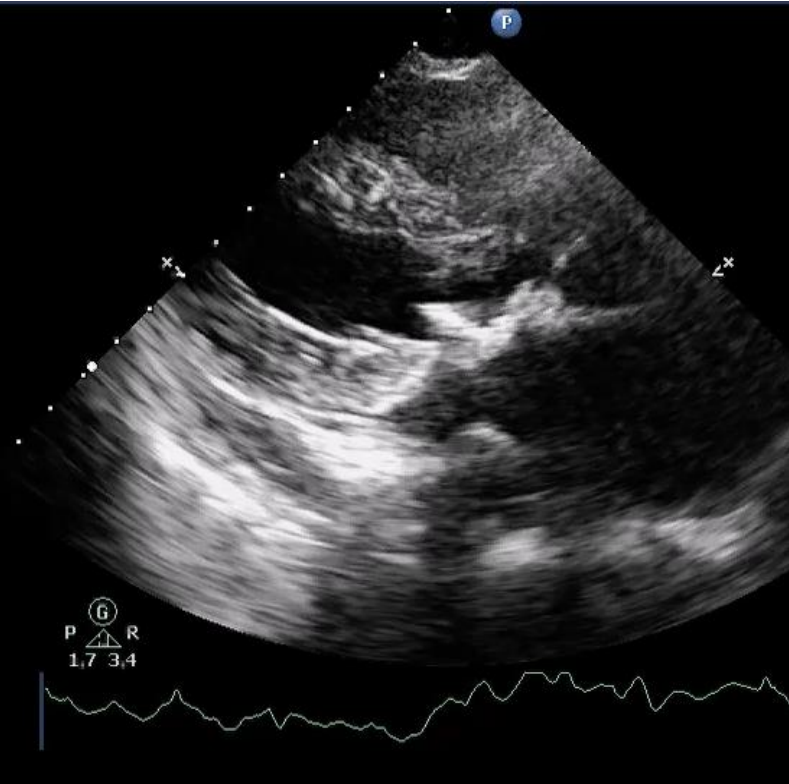
International, multi-center TMVR registry n=194



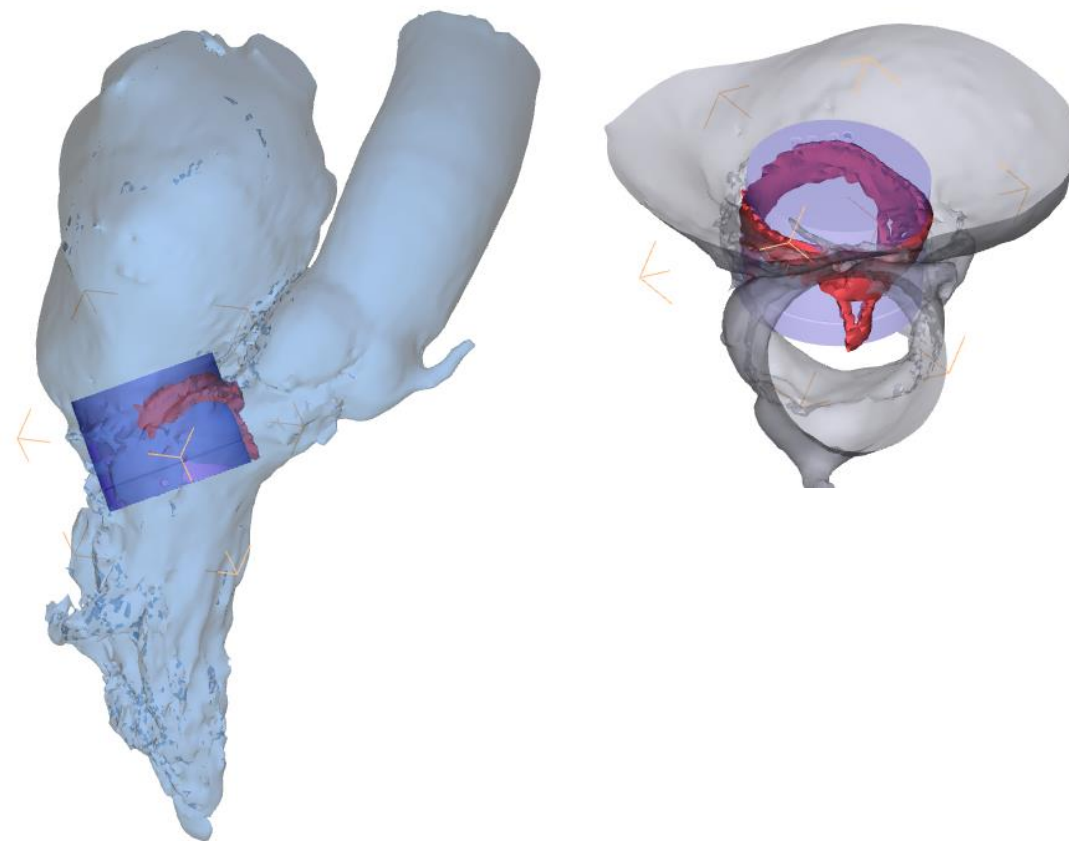
Patient

- 71 yo F with NYHA IV symptoms
 - 29 mm CE Perimount valve
 - 14 mmHg mean gradient
 - Hx of lung CA
 - Atrial fibrillation
 - HIT
- STS 6.5%

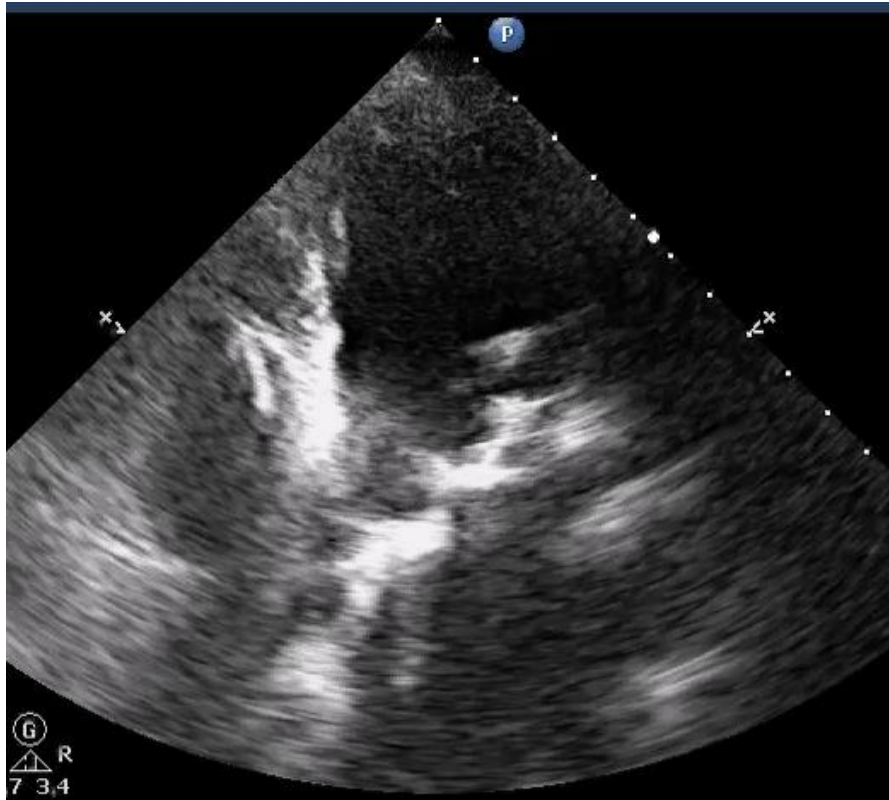
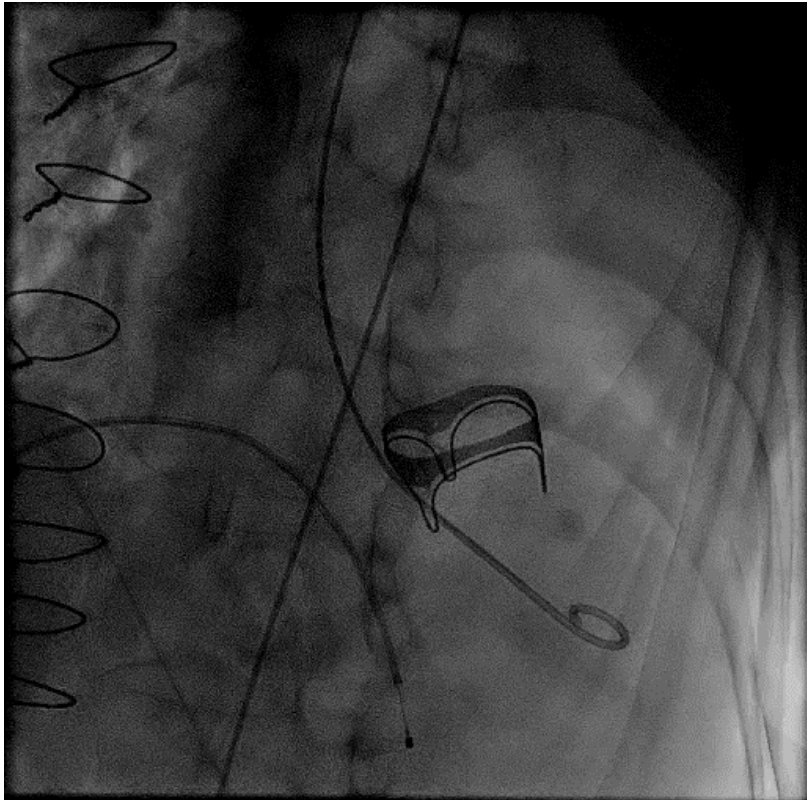




Neo-LVOT 166.2 mm²

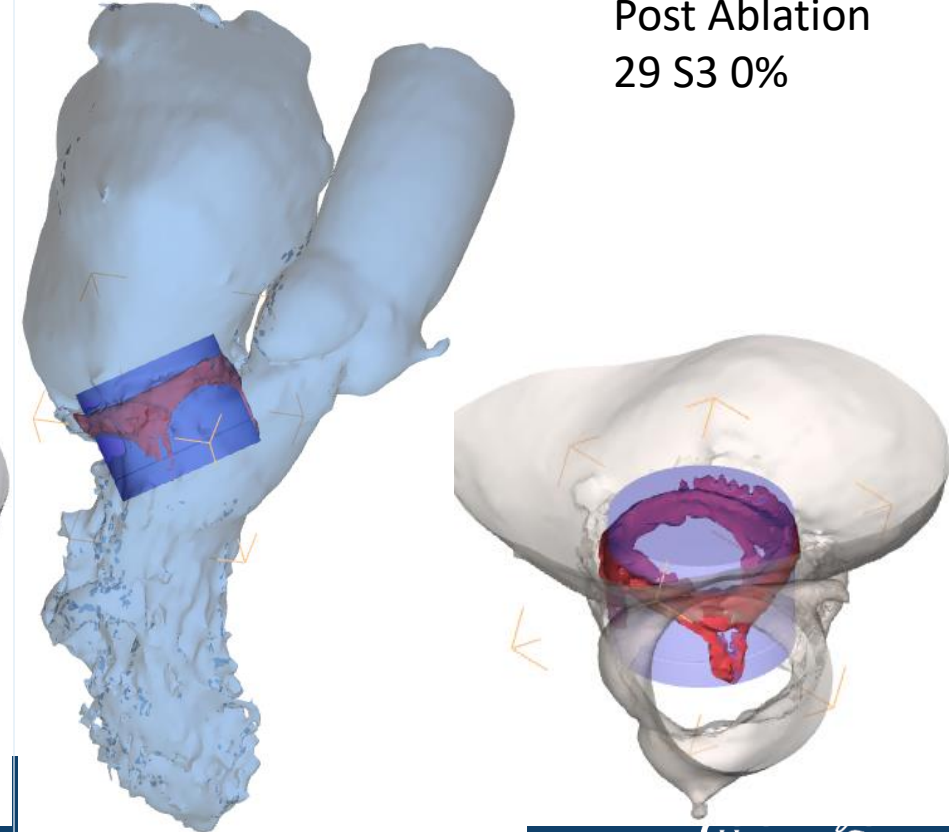
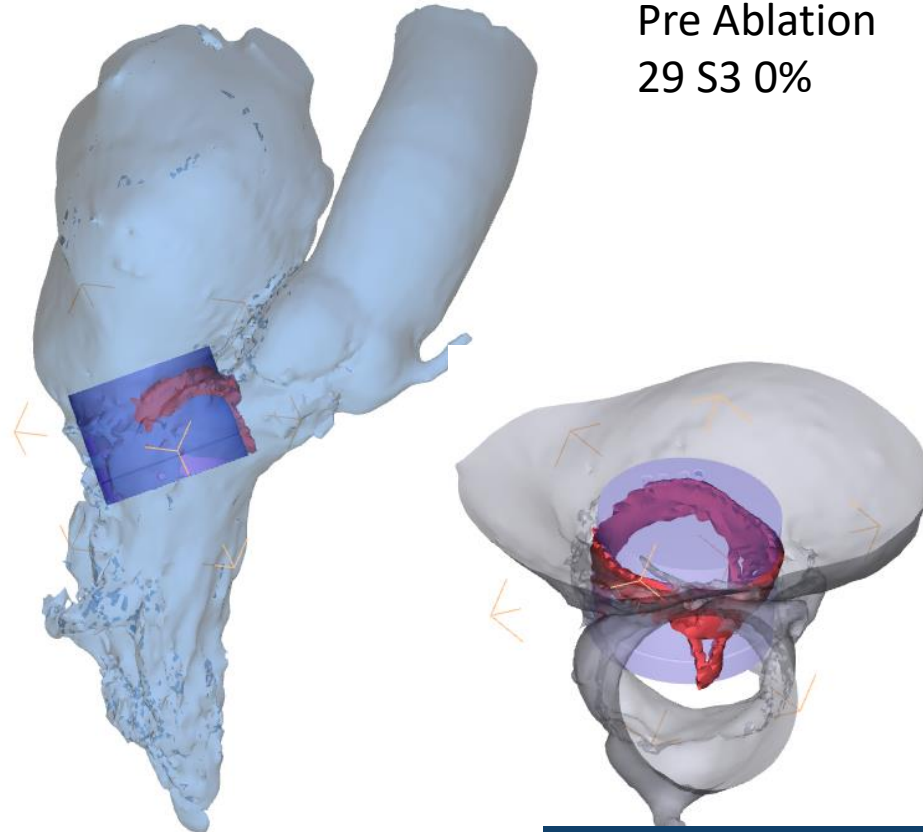


Elective ETOH ablation

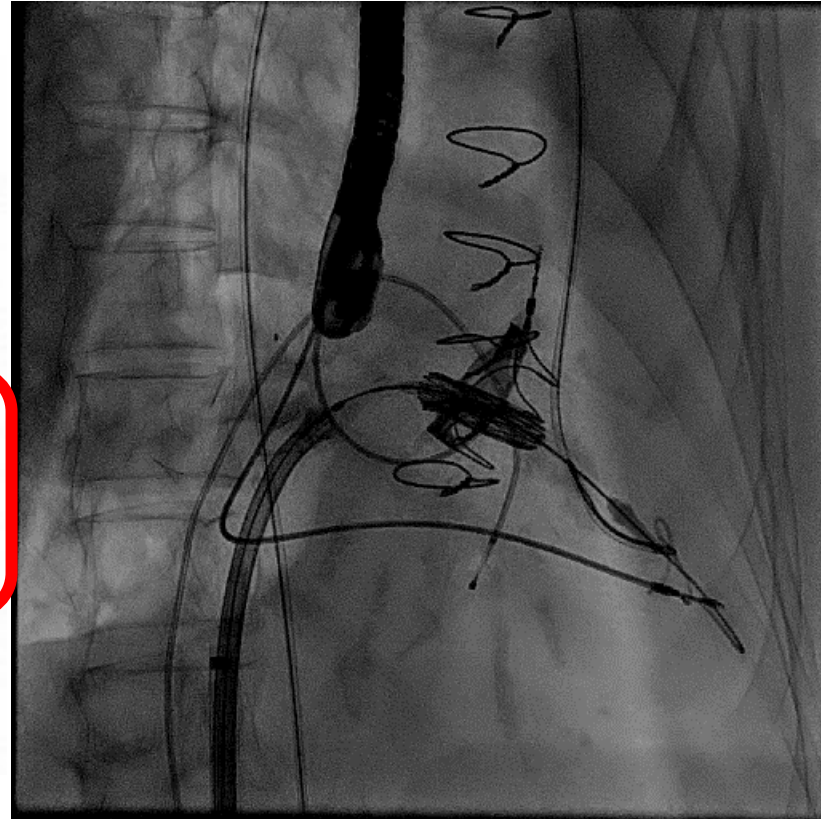


CT LVOT prediction modeling: 29 S3

| Valve | Position | Baseline LVOT surface area (mm ²) | Predicted Neo-LVOT surface area (mm ²) |
|------------------------|----------|---|--|
| 29 S3 Pre Ablation | 0% | 345.2 | 166.2 |
| 29 S3 Post Ablation | 0% | 493.3 | 284.2 |
| | 20% LV | 585.1 | 220.1 |



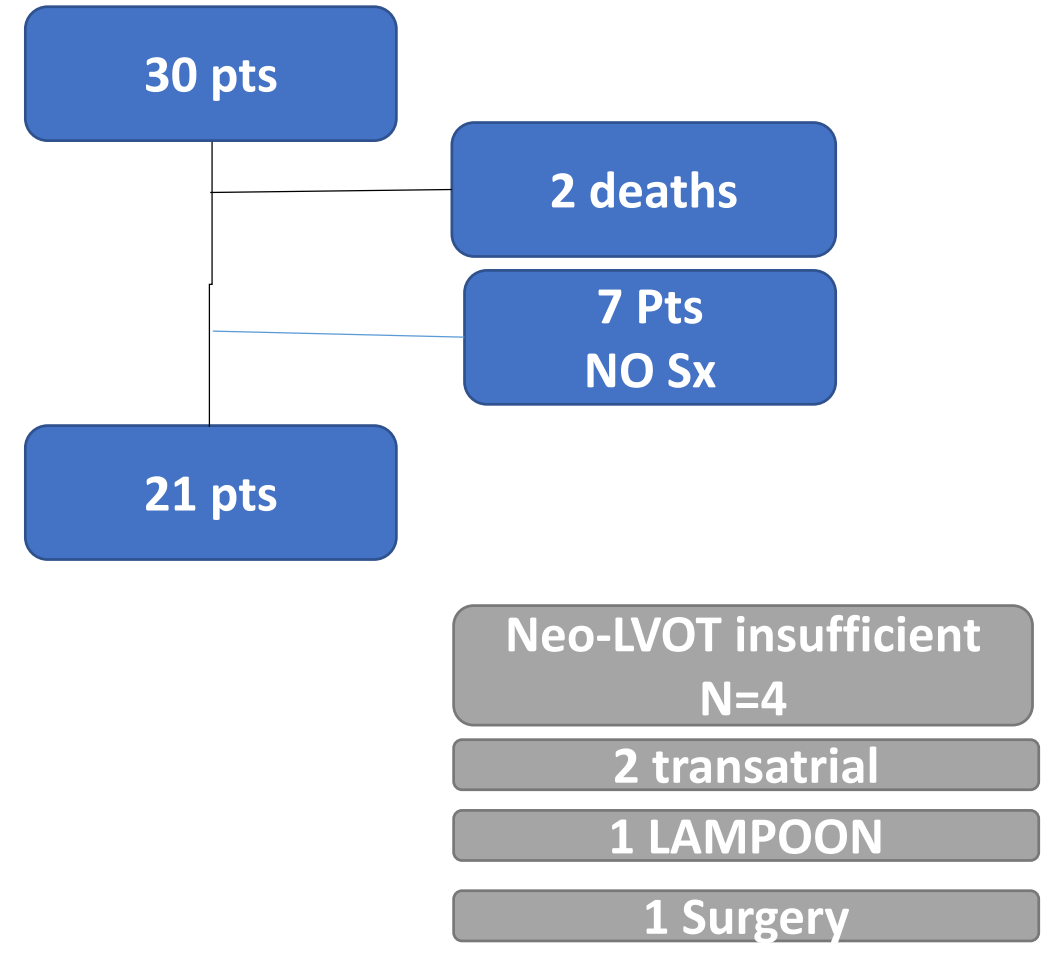
TMVR Sapien 3 29 mm



Pre-emptive ETOH Ablation for TMVR

30 patients

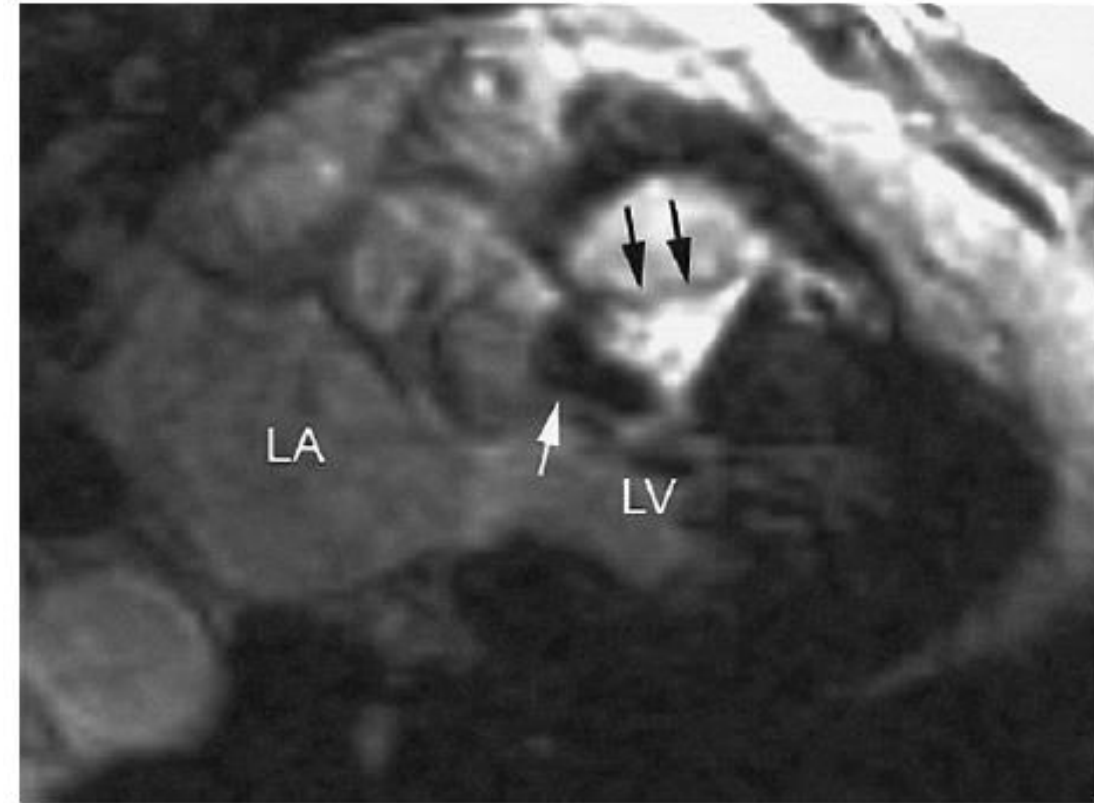
- Mean **1.6±0.7ml** ETOH
- Median Δ neo-LVOT **111.2mm²** (71.4-193.05mm²)
- 5/30 (16.7 %) required PPM
- 2/30 (6.7%) died before TMVR



ETOH ablation

Inconsistency

- 24 patient MRI study with ETOH ablation
- MRI 3-7 days post-procedure
- 1.7 ± 0.4 mL
- Infarct
 - **25% had no effect of basal anterior septum**
 - 16 ± 7 grams ablated
 - Often extends into RV septum at mid-ventricular level



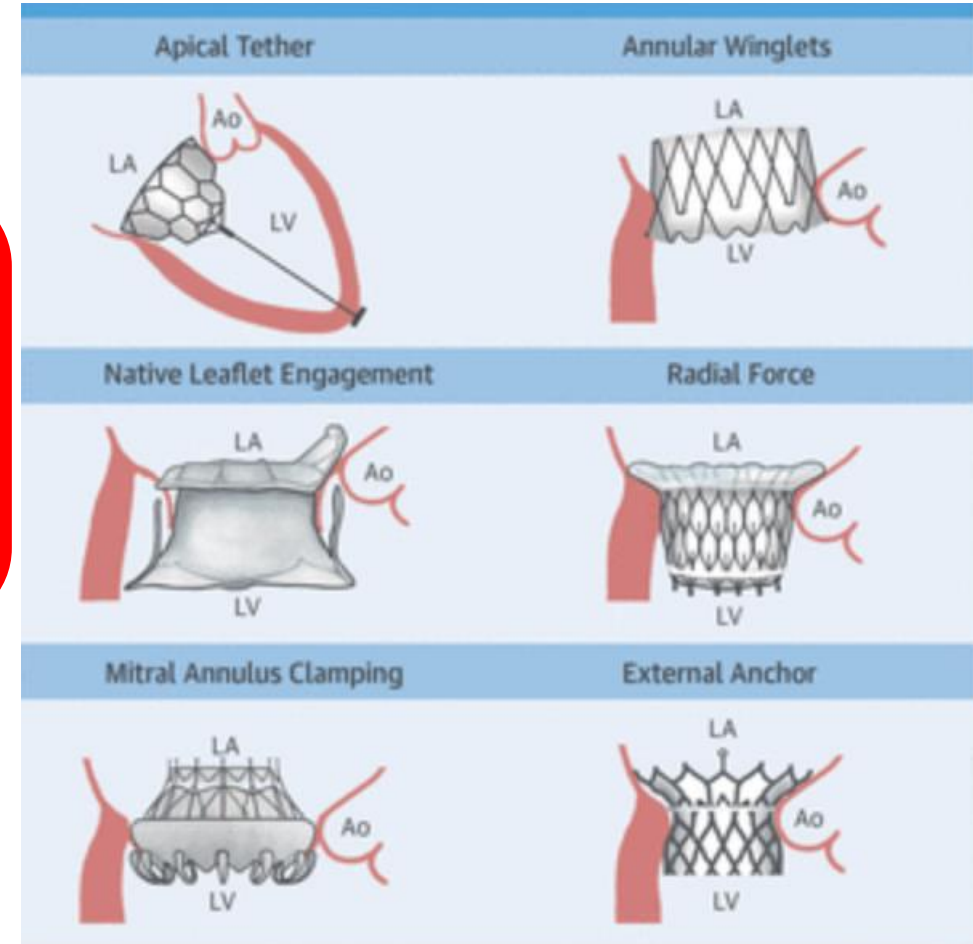
Specific valve sizes and fixation mechanisms

High rate of anatomic screen failure

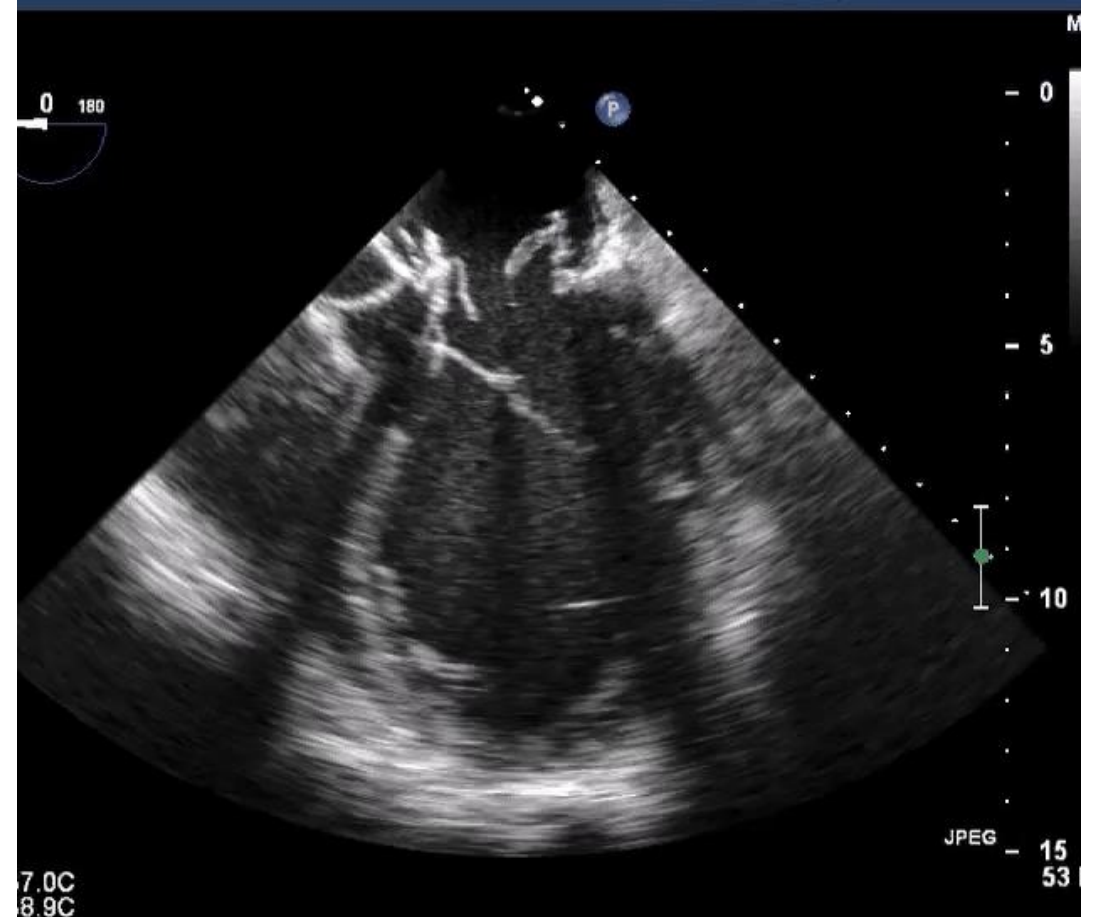
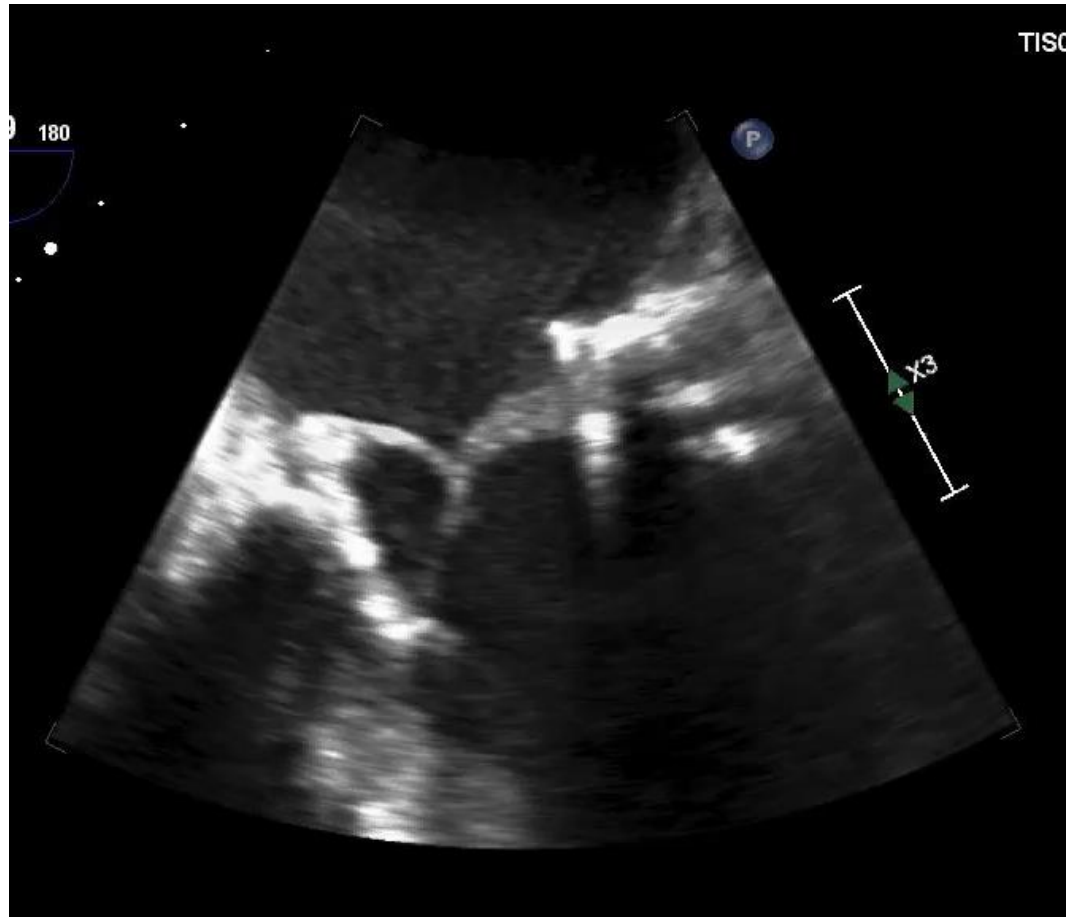
Enrolled
N = 332 Enrolled
N = 100 Treated

Baseline Evaluation
N = 100
Followed at Visit: 100

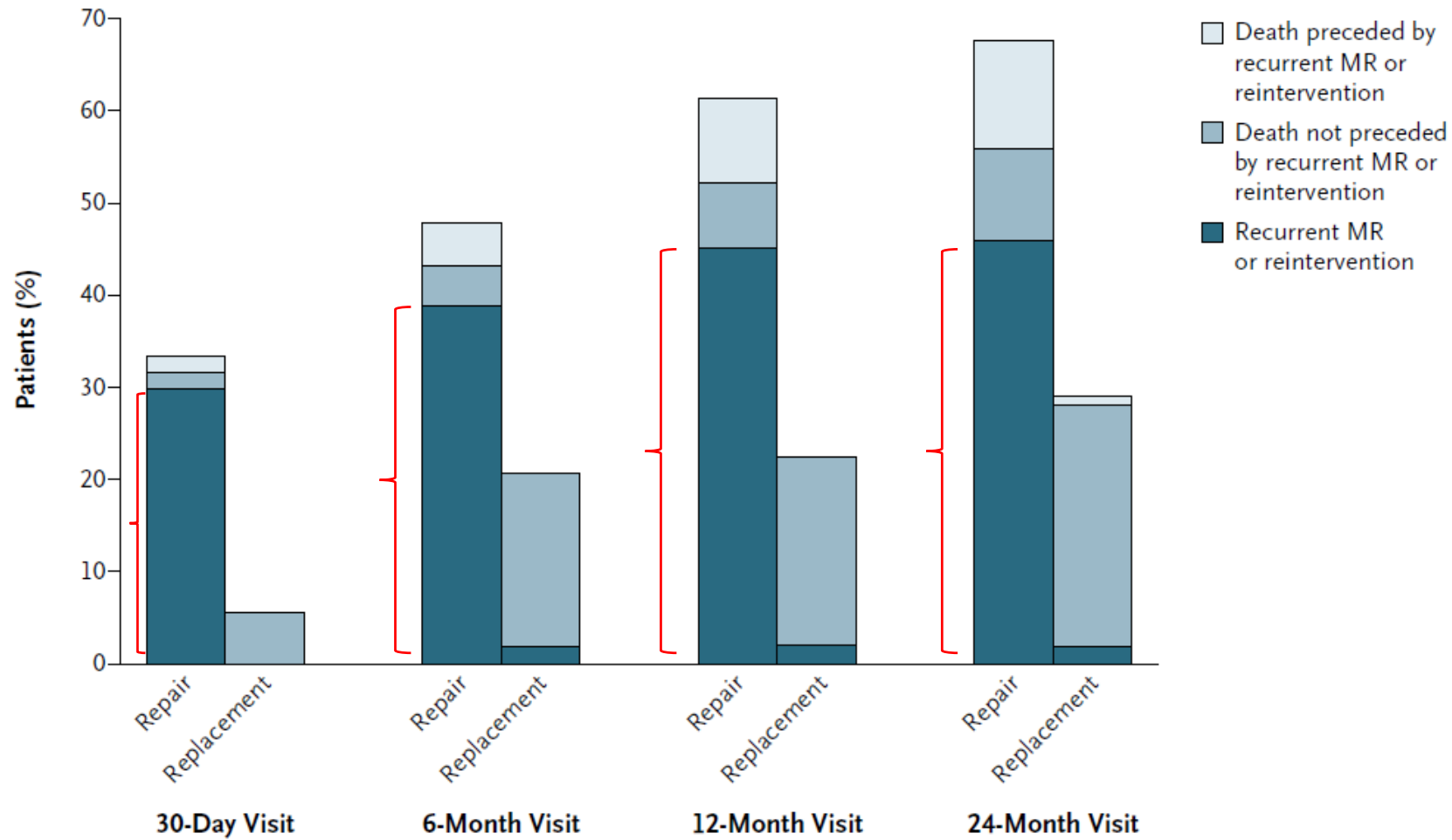
Screen fails: 212
On hold: 13
Pending decision or awaiting treatment: 7



Need for anticoagulation Duration?



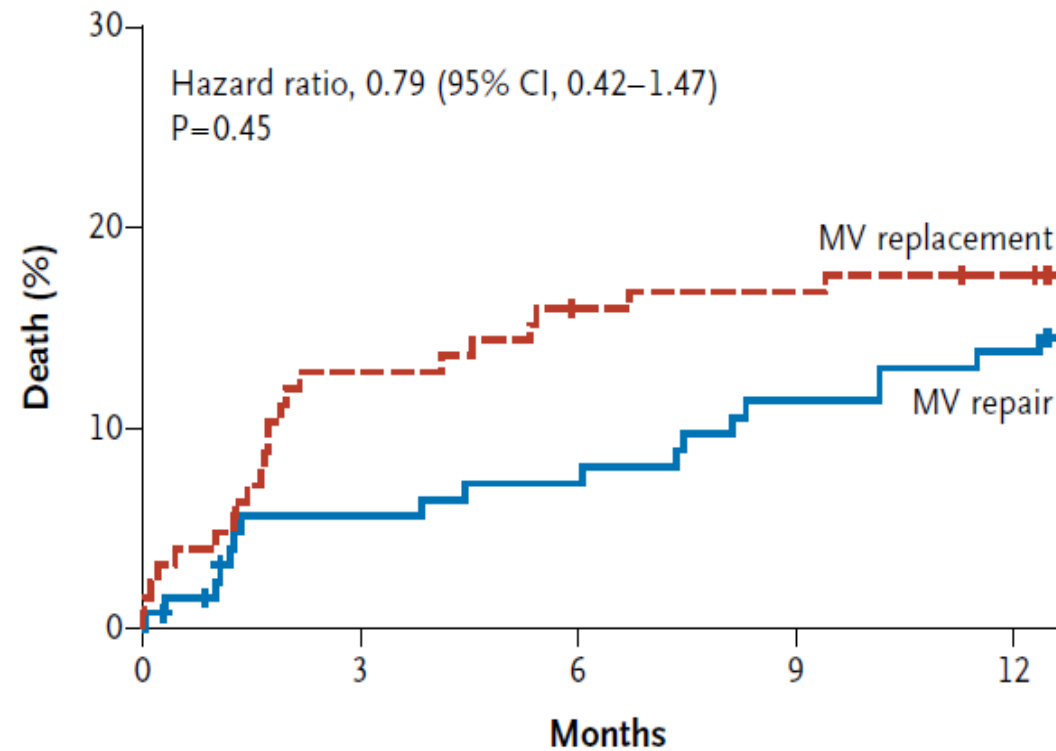
Repair in Functional MR (Ischemic) Prone to Recurrent MR



Mitral Valve Replacement in ICM

Higher Early Mortality Compared to Repair

A Death

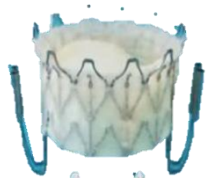


No. at Risk

| | | | | | |
|----------------|-----|-----|-----|-----|-----|
| MV repair | 126 | 116 | 114 | 109 | 106 |
| MV replacement | 125 | 109 | 104 | 103 | 101 |

Transcatheter mitral valves

Sampling



**SATURN
TMVR**



**Braile
Biomedica**



**Braile
Biomedica**



**Sapien M3
Edwards**



**CardiAQ
Edwards**



Cephea



Mitraltech



**Direct Flow
Medical**



**Twelve
Medtronic**



M-Valve



**Edwards
Fortis**



HighLife



Caisson



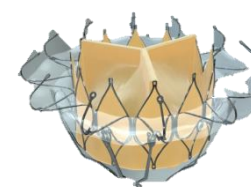
Navigate



**Neovasc
Tiara**



**PermaValve
MID**



Sinomed



**Tendyne
Abbott**

TMVR

Sapien for Failed Surgical Prosthesis

2,144 TMVR procedures using SAPIEN 3 in TVT Registry
(June 2015 – Aug 2019)

MViR
n=206

MAC
n=183

Unknown
n=179

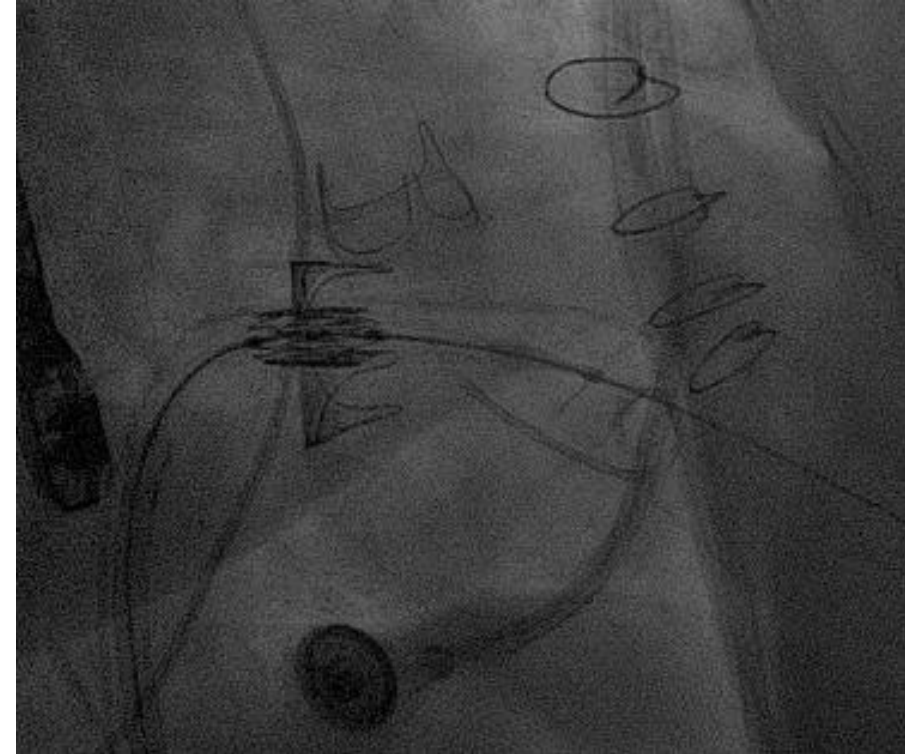
MViV with S3 *
n = 1,576

Transseptal
n = 1,326

Transapical
n = 203

Transatrial
n=6

Unspecified
n=41



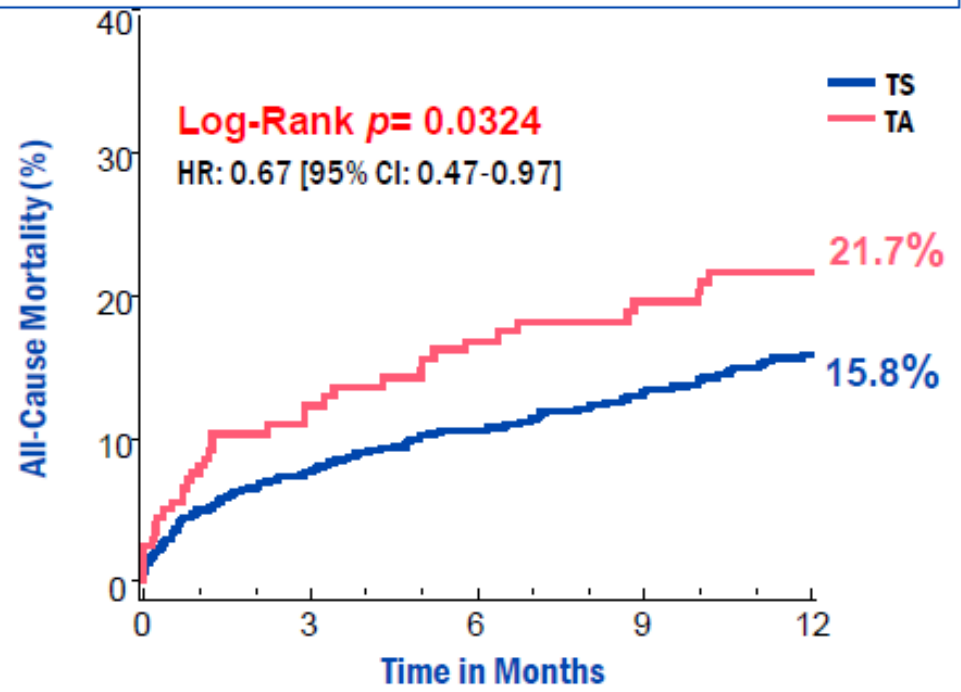
30-Day and 1-Year Outcomes

| % or mean (\pm SD) | 30-DAY | | | 1-YEAR* | | |
|-----------------------------|------------------------|----------------------|----------------|----------------------|----------------------|----------------|
| | TRANSSEPTAL n=1,326 | TRANSAPICAL n=203 | <i>p</i> value | TRANSSEPTAL n=865 | TRANSAPICAL n=171 | <i>p</i> value |
| All-Cause Mortality | 5% | 8.1% | 0.07 | 15.8% | 21.7% | 0.03 |
| Cardiovascular death | 2.1% | 5.1% | 0.01 | 3.7% | 5.7% | 0.07 |
| Stroke | 1.1% | 1% | 0.91 | 3.3% | 3.5% | 0.95 |
| Mitral Valve Reintervention | 0.4% | 0.5% | 0.82 | 0.8% | 0.5% | 0.78 |
| New dialysis requirement | 1.5% | 3.1% | 0.1 | 1.6% | 3.1% | 0.13 |
| New Pacemaker | 1.4% | 2% | 0.44 | 2% | 2.8% | 0.44 |
| Device thrombosis | 0.2% | 0.5% | 0.49 | 0.3% | 1.2% | 0.17 |
| LV Ejection fraction | 54.2 (\pm 11.73) | 52.7 (\pm 12.55) | 0.17 | 53.3 (\pm 11.52) | 52.8 (\pm 13.11) | 0.77 |
| Mean MVG (mmHg) | 7.4 (\pm 2.75) | 7.2 (\pm 2.69) | 0.5 | 7.0 (\pm 2.94) | 7.0 (\pm 2.61) | 0.99 |

TMVR

Sapien for failed Surgical Prosthesis

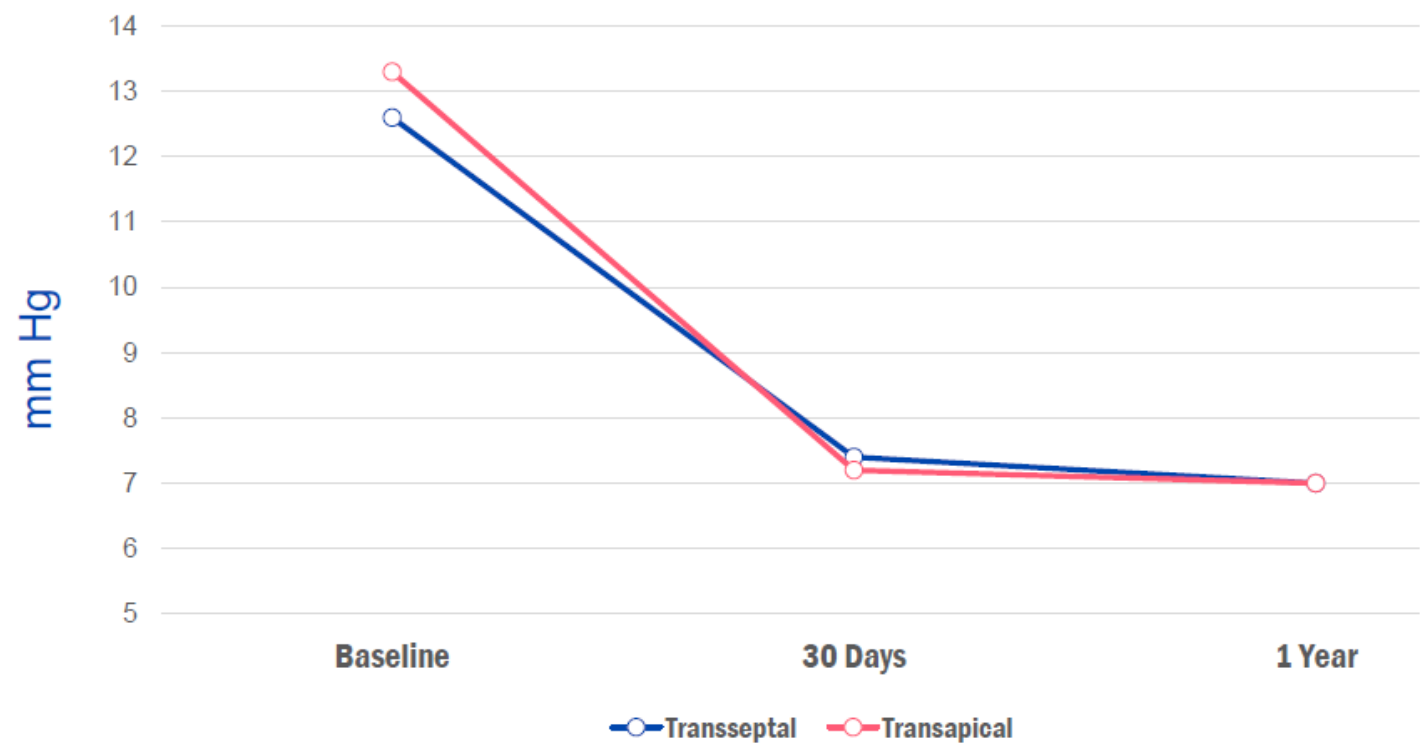
Primary Effectiveness Endpoint: All-Cause Mortality at 1 year



Number at risk:

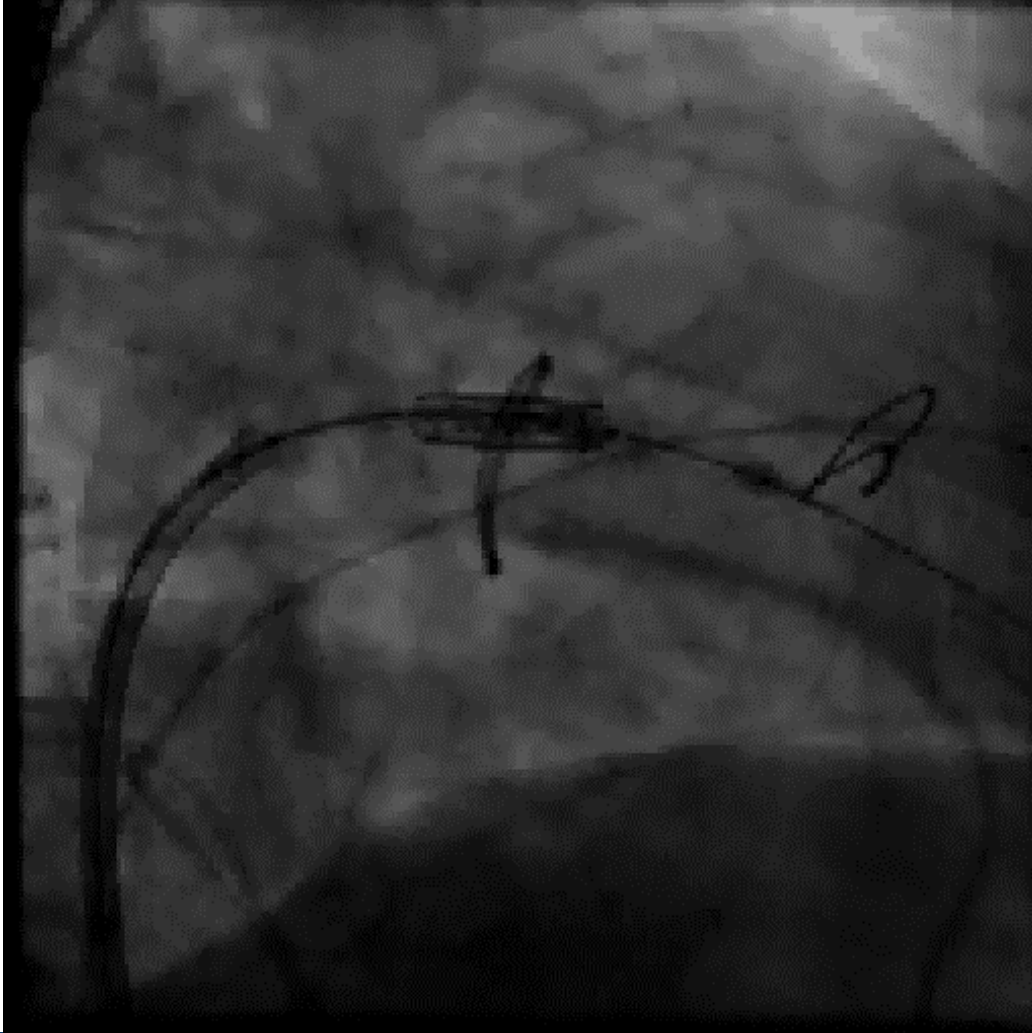
| | 0 | 3 | 6 | 9 | 12 |
|----|-------|-----|-----|-----|-----|
| TS | 1,326 | 662 | 610 | 551 | 438 |
| TA | 203 | 135 | 125 | 115 | 97 |

Mean Mitral Valve Gradient

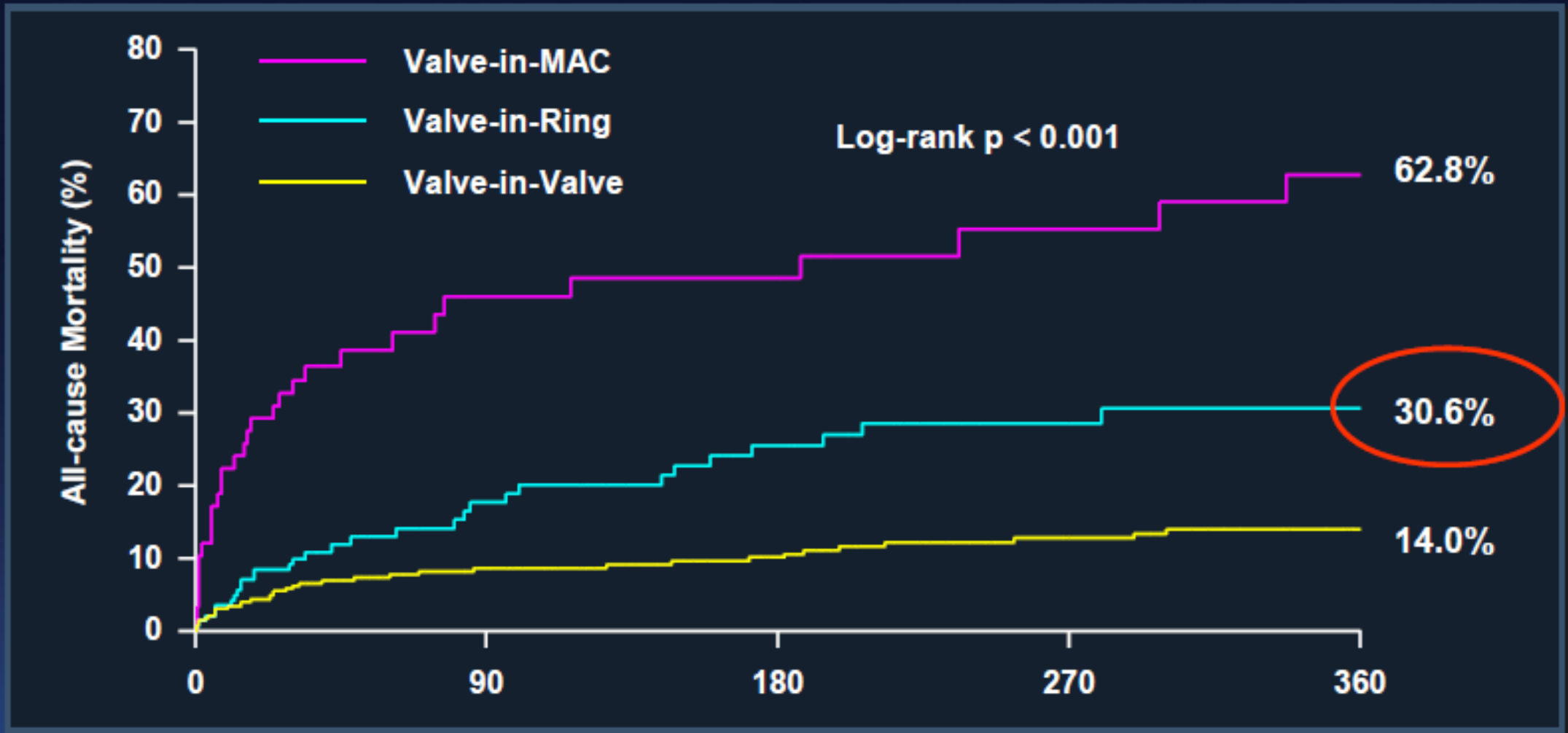


TMVR

Sapien for Failed Surgical Repair (annuloplasty ring)

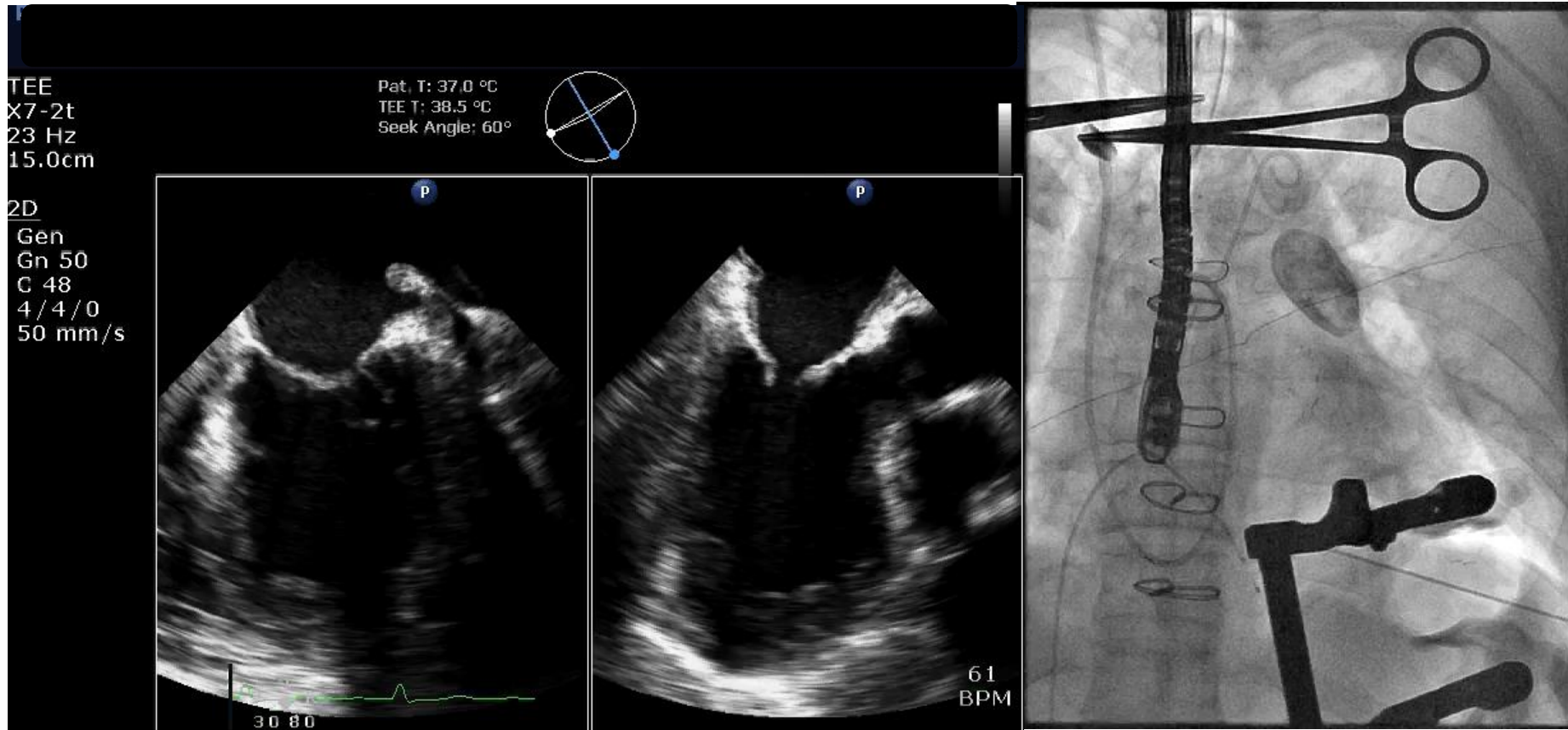


| | ViR (n = 141) |
|--------------------------------|--------------------------|
| Conversion to surgery | 2.8% |
| Valve embolization | 1.4% |
| LV perforation | 0.0% |
| Need for second valve | 12.1% |
| LVOT obstruction | 5.0% |
| Technical Success * | 80.9% |
| MR ≥ moderate | 18.4% |
| PVL closure | 7.8% |
| Alcohol septal ablation | 0.7% |
| ASD closure | 5.0% |
| Device success | 70% |



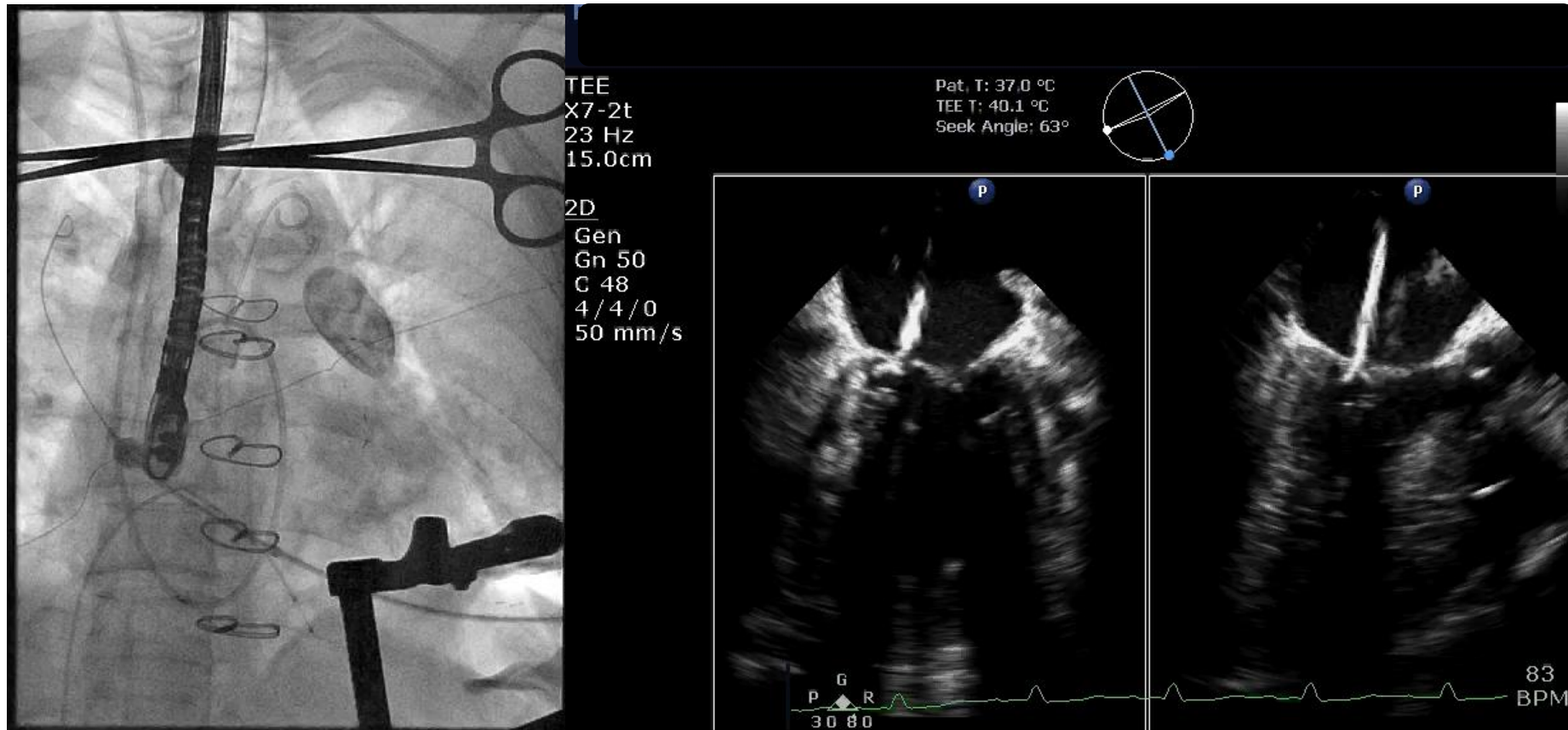
| No. at Risk | Days | Days | Days |
|----------------|------|------|------|
| Valve-in-MAC | 58 | 20 | 10 |
| Valve-in-Ring | 141 | 53 | 34 |
| Valve-in-Valve | 322 | 180 | 127 |

TMVR- Functional MR Apical Access

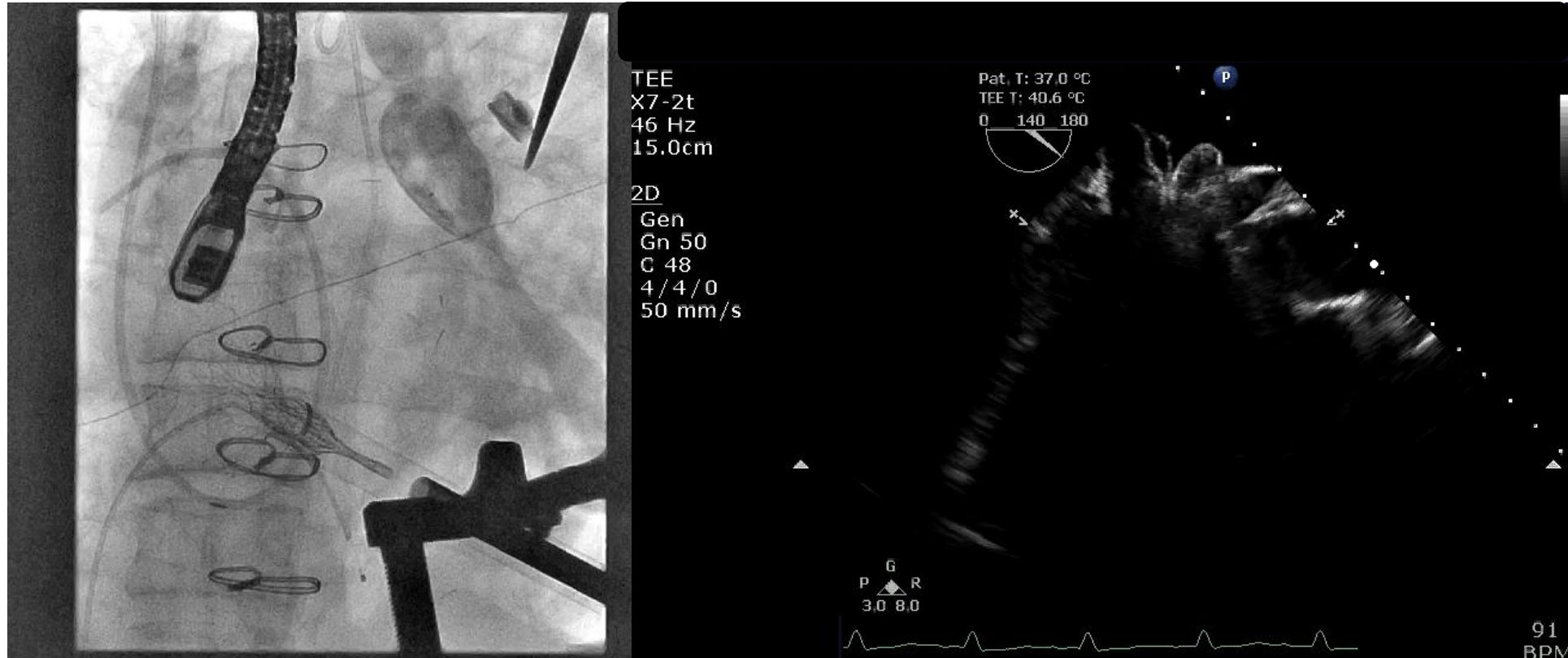


TMVR- Functional MR

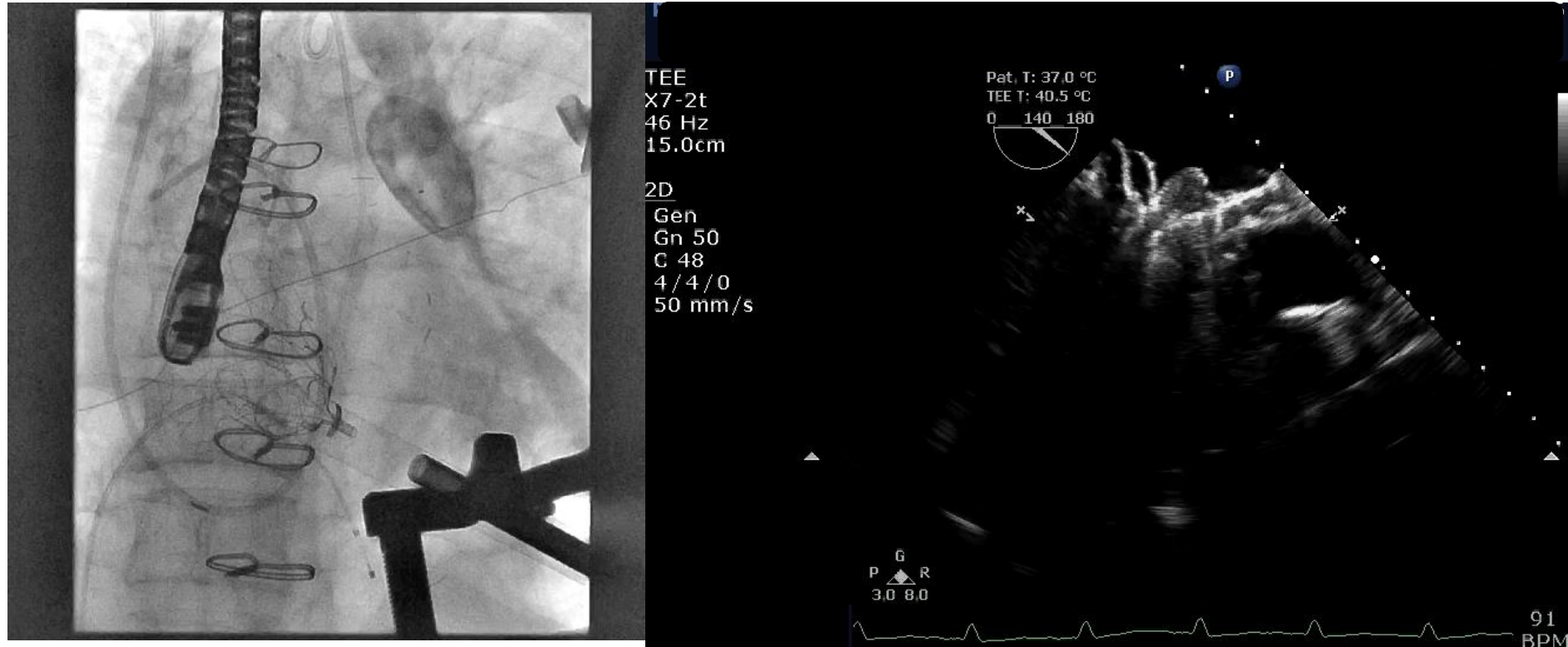
Ensure no sub-mitral apparatus interaction



TMVR- Functional MR Valve Deployment

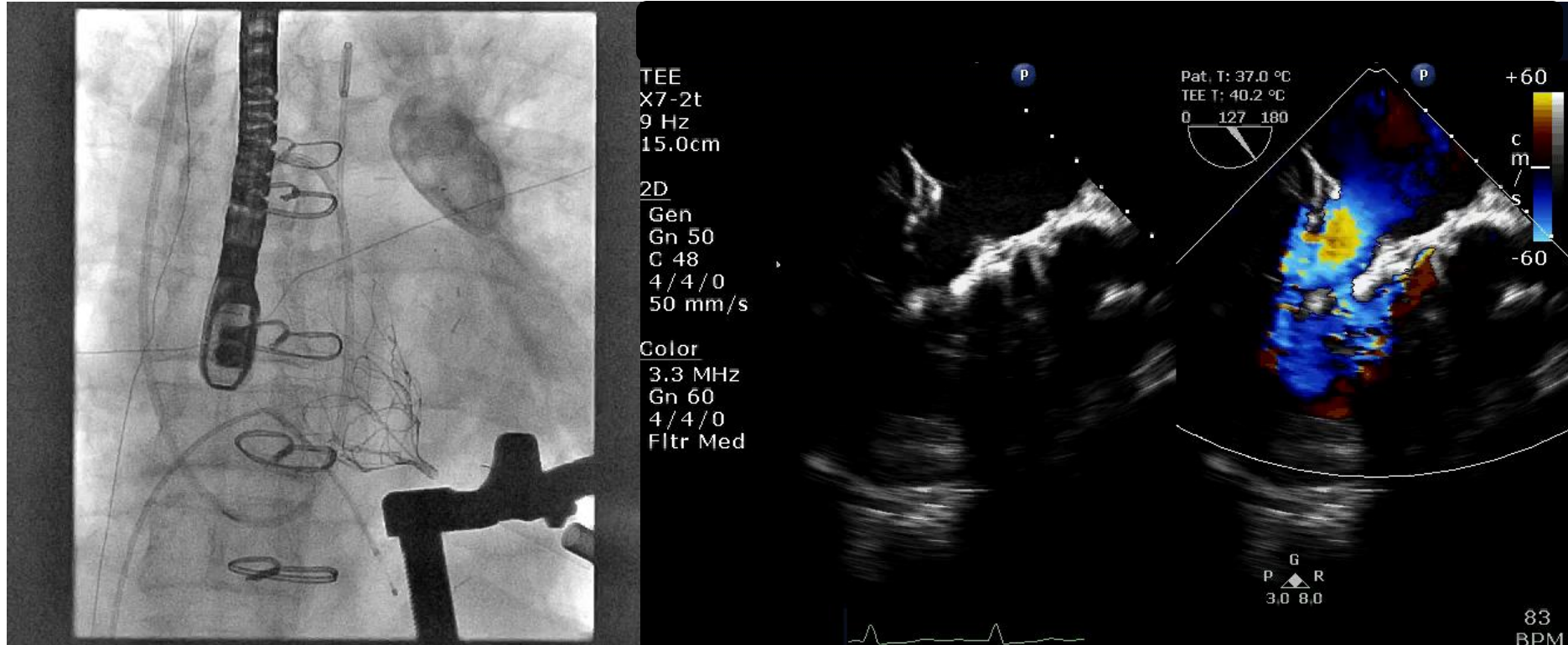


Retraction to mitral annulus



TMVR- Functional MR

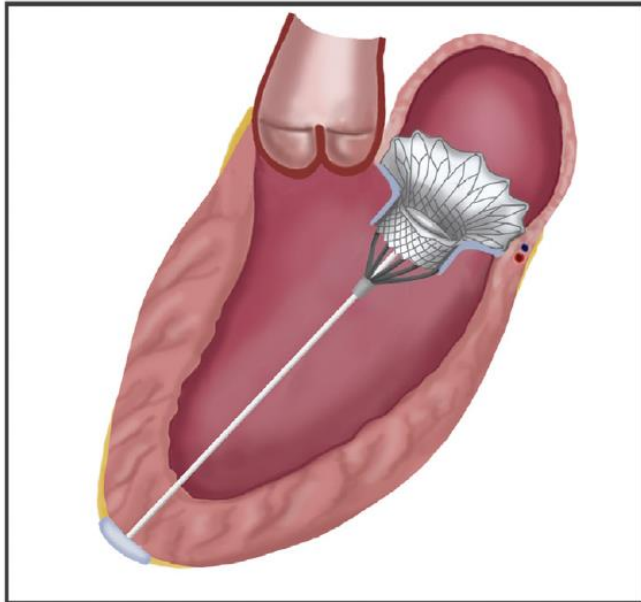
Tether tightened



Tendyne Global Registry (CE)

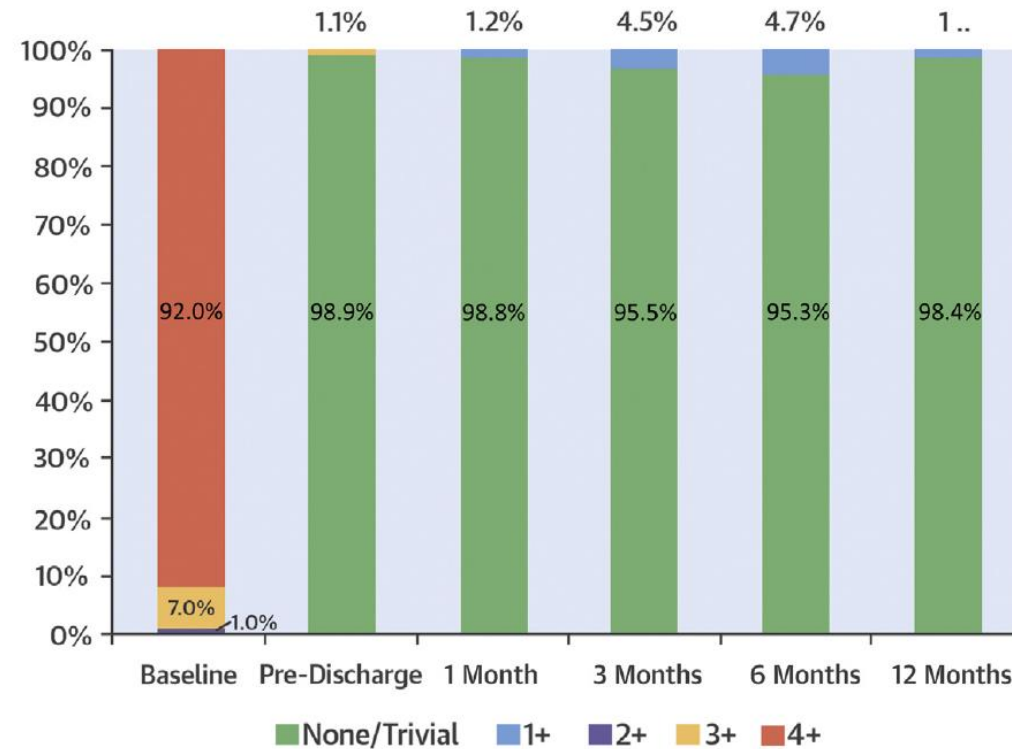
n=100

First 100 Patients Treated



- No intra-procedural deaths
- Technical success in 96%
- 30-day death, 6%; 1-year mortality, 26%
- Among survivors at 1 year, 88.5% with mild or no symptoms

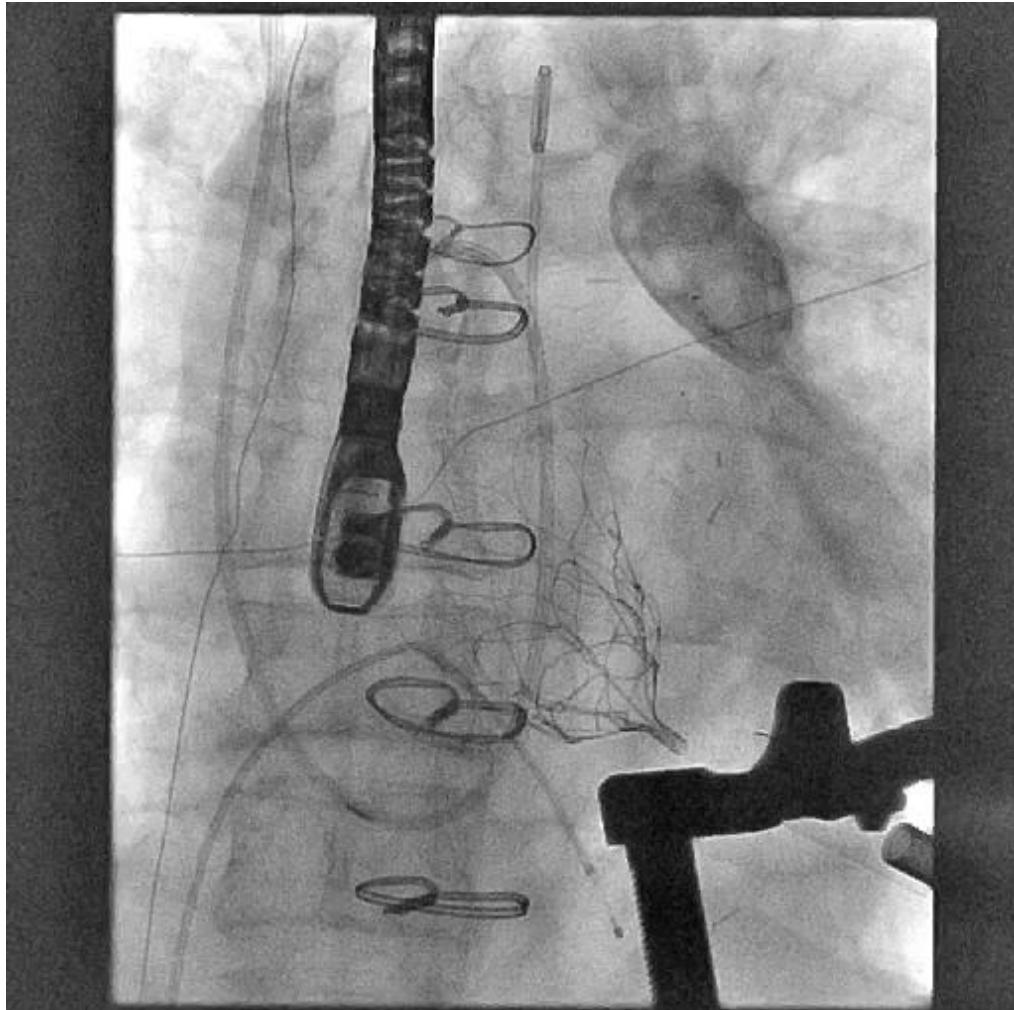
Change in Mitral Regurgitation



Sorajja, P. et al. J Am Coll Cardiol. 2019;73(11):1250-60.

Tendyne

n=100



| | 30 Days | 1 Year |
|---------------------------------|---------|---------|
| Any mortality | 6 (6) | 26 (26) |
| Cardiovascular mortality | 4 (4) | 22 (22) |
| Disabling stroke | 2 (2) | 3 (3) |
| TIA | 0 (0) | 3 (3) |
| Myocardial infarction | 2 (2) | 4 (4) |
| Heart failure hospitalization | 12 (12) | 31 (31) |
| Reintervention for MV* | 1(1) | 4 (4) |
| BARC 2, 3, or 5 bleeding | 20 (20) | 32 (32) |
| Device-specific adverse events | 4 (4) | 12 (12) |
| Bioprosthetic valve dysfunction | 0 (0) | 0 (0) |
| Hemolysis | 1 (1) | 3 (3) |
| Embolization | 0 (0) | 0 (0) |
| Thrombosis | 1 (1) | 6 (6) |
| Erosion, migration, malposition | 2 (2) | 4 (4) |
| Fracture | 0 (0) | 0 (0) |
| Endocarditis | 1 (1) | 2 (2) |

Intrepid

Transapically implanted self-expanding valve



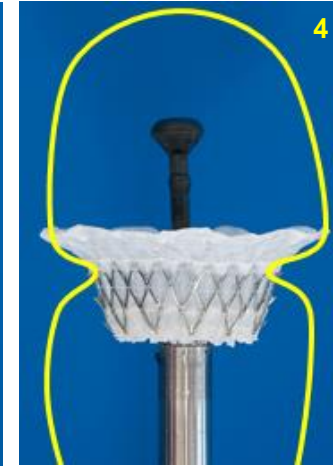
**Advance
across mitral
valve**



Deploy brim



**Retract to
desired
position**



**Expand
fixation ring**



Release

Percutaneous Replacement- Intrepid Valve

50 patients- 72% FMR

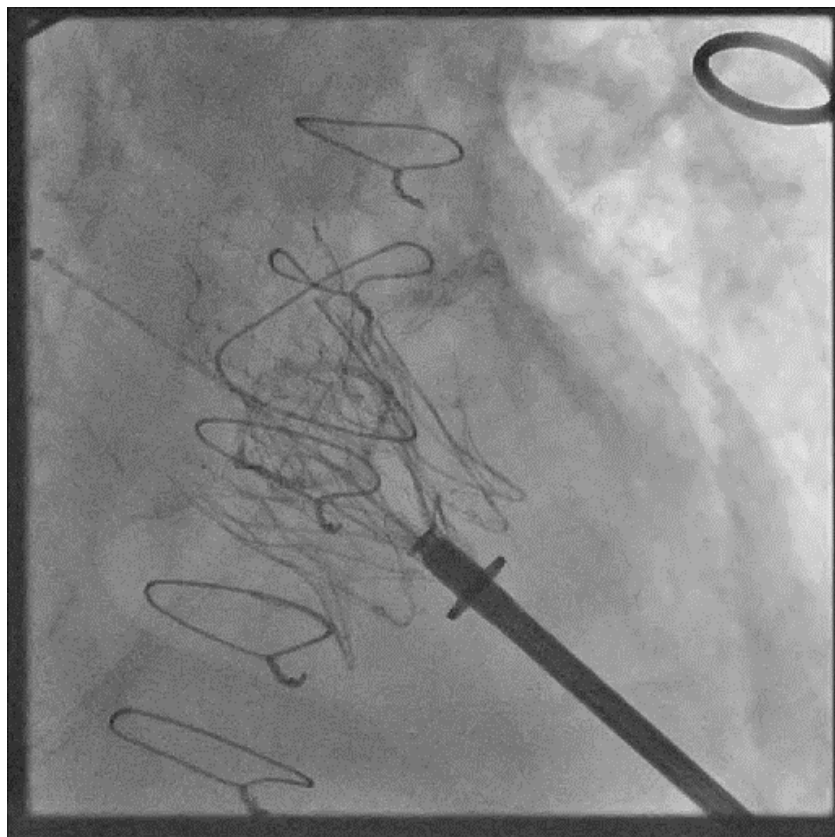


TABLE 2 Adverse Events

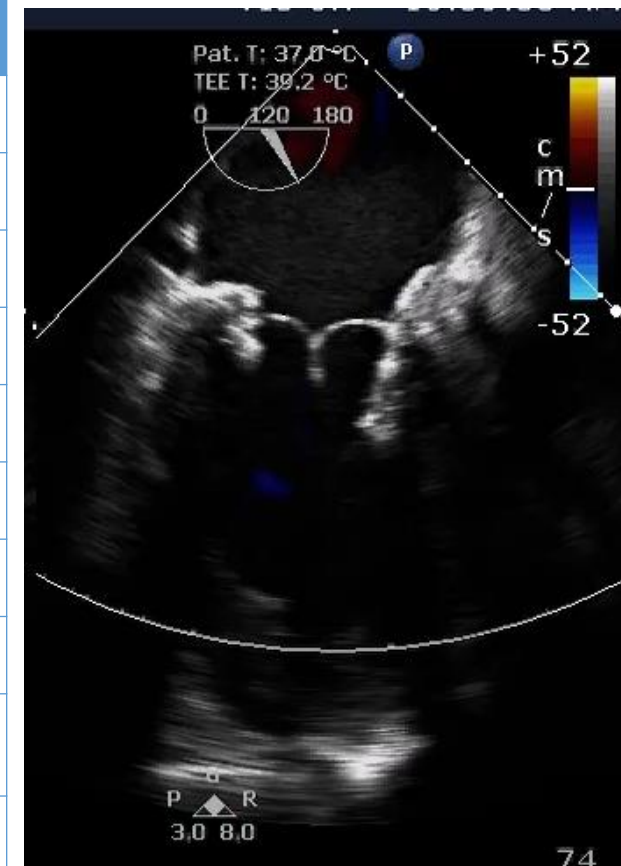
| | 0-30 Days (n = 50) | >30 Days (n = 41) |
|---------------------------------------|-----------------------|----------------------|
| Death | 7 (14.0) | 4 (9.8) |
| Cardiovascular | 7 (14.0) | 4 (9.8) |
| Noncardiovascular | 0 (0.0) | 0 (0.0) |
| Stroke | 2 (4.0) | 1 (2.4) |
| Disabling stroke | 0 (0.0) | 0 (0.0) |
| Nondisabling stroke | 2 (4.0) | 1 (2.4) |
| Myocardial infarction | 0 (0.0) | 0 (0.0) |
| Acute renal impairment, stage 3 | 5 (10.0) | 0 (0.0) |
| Major vascular complications | 0 (0.0) | 0 (0.0) |
| Major cardiac structural complication | 2 (4.0) | 0 (0.0) |
| Major bleeding | 9 (18.0) | 0 (0.0) |
| Reoperation for any reason | 5 (10.0) | 1 (2.4) |
| Reoperation for bleeding | 5 (10.0) | 0 (0.0) |
| Reoperation for other* | 0 (0.0) | 1 (2.4) |

TIARA

Global Early Feasibility (Total implants 59)



| Event | TIARA-I N=20 | TIARA-II N=17MR |
|--------------------------|-----------------|--------------------|
| Peri-procedural Death | 0 | 0 |
| Cerebrovascular Event | 2 (10%) | 0 |
| Myocardial Infarction | 1 (5%) | 0 |
| Access Site Complication | 2 (10%) | 2 (11%) |
| MR / PVL (>2+) | 1 (5%) | 0 |
| LVOT Obstruction | 0 | 0 |
| Acute Kidney Injury | 11 (55%) | 1 (6%) |
| Device Migration | 2 (10%) | 0 |
| Conversion to Open | 2 (10%) | 0 |
| 30-day Overall Mortality | 3 (15%) | 1 (6%) |
| 90-day Overall Mortality | 5 (26%) | 2 (13%) |



Edwards Sapien M3 Transseptal Delivery

Dock Delivery

SAPIEN M3 Dock

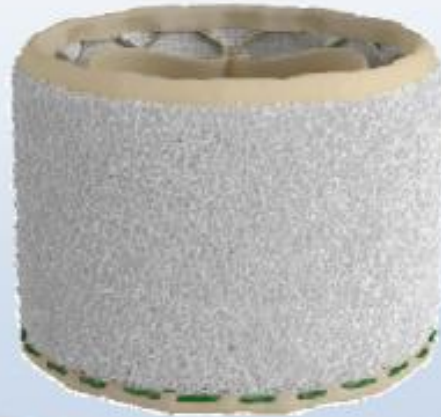


SAPIEN M3 Dock Delivery System



Valve Delivery

SAPIEN M3 Valve



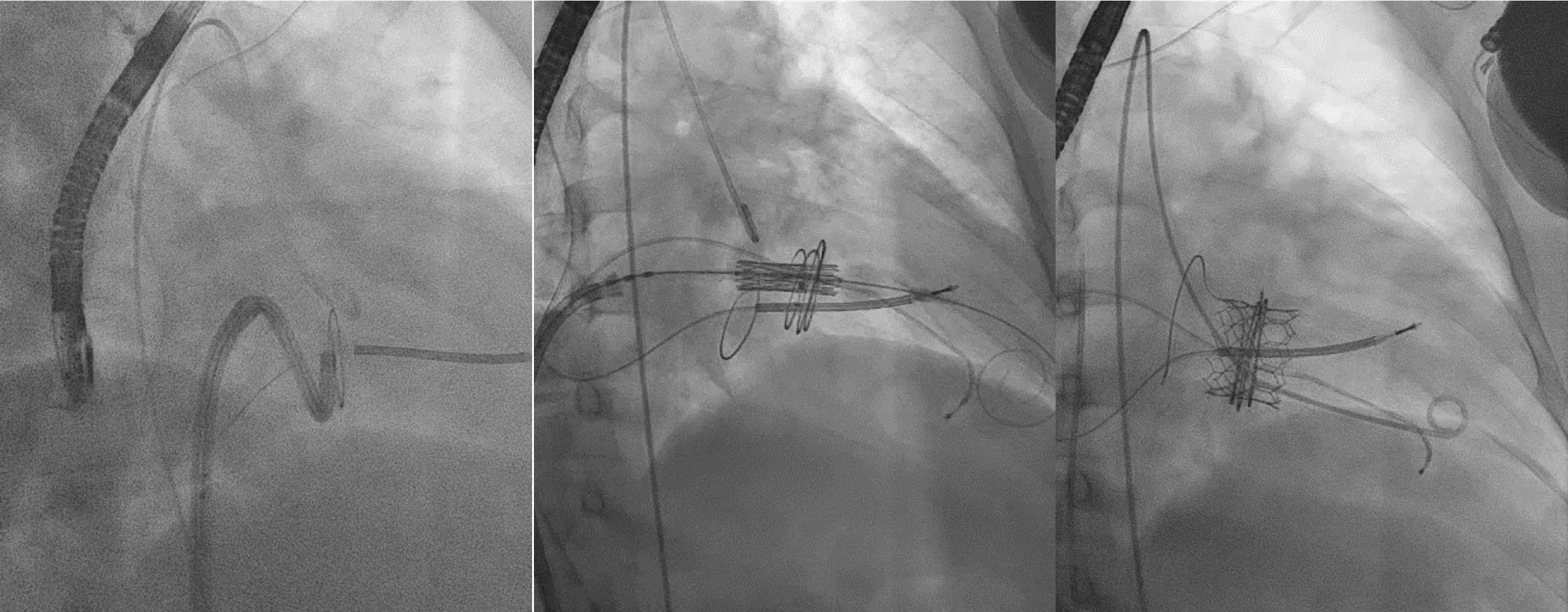
Commander Delivery System



Final Implant



M3 Docking system



M3

EFS and Canadian data

| Primary Endpoint | CU (N=10) % (n/N) | EFS (N=35) % (n/N) | Total (N=45) % (n/N) |
|--|----------------------|-----------------------|-------------------------|
| Technical Success | 90 (9/10) | 88.6 (31/35) | 88.9 (40/45) |
| Alive | 100 (10/10) | 100 (35/35) | 100 (45/45) |
| Successful access, delivery, and retrieval of delivery systems | 90 (9/10)* | 91.4 (32/35)** | 91.1 (41/45) |
| Deployment of devices in intended position | 90 (9/10)* | 94.3 (33/35)† | 93.3 (42/45) |
| Freedom from emergency surgery or reintervention related to the device or access procedure | 100 (10/10) | 97.1 (34/35)‡ | 97.8 (44/45) |

* One patient had an aortic hematoma during encircling and case was aborted

** One patient had separate transseptal punctures for deployment of the docking system and valve; one patient's left ventricle was too small to allow for encircling of chordae; one patient had an aortic hematoma during encircling and case was aborted

† Same as latter two cases above with unsuccessful delivery

‡ One patient underwent percutaneous PVL closure during the index procedure

Mitral Stenosis Senile Calcific



Balloon-Expandable Valve in MAC

1-year results

| | 30 Days (n = 116) | 1 Year (n = 106) | | 30 Days (n = 116) | 1 Year (n = 106) |
|-----------------------|----------------------|---------------------|--------------------------------------|----------------------|---------------------|
| Death | | | Complications | | |
| All-cause | 29/116 (25.0) | 57/106 (53.7) | Stroke | 5 (4.3) | 7 (6.6) |
| Cardiovascular | 15 (13.0) | 25 (23.5) | Myocardial infarction | 1 (0.85) | 2 (1.8) |
| LVOT obstruction | 6 (5.2) | 7 (6.6) | MV reintervention | 9 (7.7) | 13 (12.3) |
| LV perforation | 2 (1.7) | 2 (1.8) | Valve embolization | 5 (4.3) | 5 (4.7) |
| Late embolization | 2 (1.7) | 2 (1.8) | Valve migration without embolization | 2 (1.7) | 3 (2.8) |
| Myocardial infarction | 1 (0.85) | 2 (1.8)* | Endocarditis | 1 (0.85) | 4 (3.8) |
| Heart failure | 1 (0.85) | 4 (3.8) | Hemolytic anemia | 4 (3.4) | 4 (3.8) |
| Valve thrombosis | 0 (0) | 2 (1.8)* | Valve thrombosis | 0 (0) | 2 (1.8) |
| Endocarditis | 0 (0) | 3 (2.8) | | | |
| Stroke | 1 (0.85) | 2 (1.8) | | | |
| Complete AV block | 1 (0.85) | 1 (0.9) | | | |
| Sudden death | 1 (0.85) | 1 (0.9) | | | |
| Noncardiac | 14 (12.0) | 32 (30.2) | | | |

Summary

- Access
- Anatomic eligibility
 - Left ventricular outflow tract
 - Fixation
 - Fit (sterics)
- Patient Selection
 - Functional mitral regurgitation
 - LVEF
 - Anticoagulation
- Valve
 - Hemodynamic Profile
 - Durability
 - Paravalvular leak

