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Valve-in-Valve Implants for Failed Bioprosthetic Heart Valves

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Physician Name	Company/Relationship
Eberhard Grube, MD	Medtronic, CoreValve: C, SB, AB, OF Direct Flow: C, SB, AB Mitralign: AB, SB, E Boston Scientific: C, SB, AB Biosensors: E, SB, C, AB Kona: AB, E Abbott Vascular: AB InSeal Medical: AB, E, Valtech: E, SB, Claret: SB Keystone: AB Shockwave: E, AB

Key

G – Grant and or Research Support E – Equity Interests S – Salary, AB – Advisory Board
C – Consulting fees, Honoraria R – Royalty Income I – Intellectual Property Rights
SB – Speaker's Bureau O – Ownership OF – Other Financial Benefits'

Background

- Reoperation (redo) is the standard of care for failed bioprosthetic valves.
- However, for patients who are elderly or have associated comorbidities, redo surgery may not be a viable option.
  - Operative mortality for elective redo AVR ranges from 2% to 7%. It can increase to 30% in high-risk and non-elective patients[1]
  - Risk is especially high for patients with previous sternotomy and are frail.
- Transcatheter aortic valve replacement (TAVR) within a failing bioprosthesis (TAV in SAV) provides a minimally invasive alternative to redo surgery.
- While TAV in SAV procedures have been described since 2007, the largest available data set on this procedure from the Global Valve in Valve Registry was first published in 2012 and updated in 2014[2,3]. Recent prospective clinical trial experience is also now available.

[1]Piazza , et al., *J Am Coll Cardiol Cardiovasc Interv* 2011; 4(7): 721-32, [2]Dvir , et al., *Circulation* 2012; 126: 2335-2344, [3]Dvir et al., *JAMA* 2014; 312(2):162-170.

Considerations about SAV "Mode of Failure"

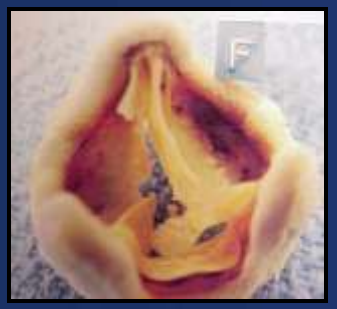
Stated Minimal Inside Diameter

Does not consider the space taken by the bioprosthetic tissue.

= valve inside diameter

Failure Presentation

Regurgitation from Tear and Wear…



…or Stenosis from Calcification or Pannus

Valve in Valve Procedure Overview

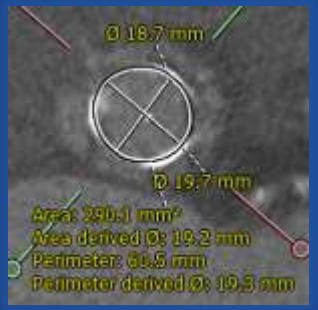
Valve in Valve Procedure Overview

1

- Identify failed SAV

2

- Measure SAV and size accordingly



3

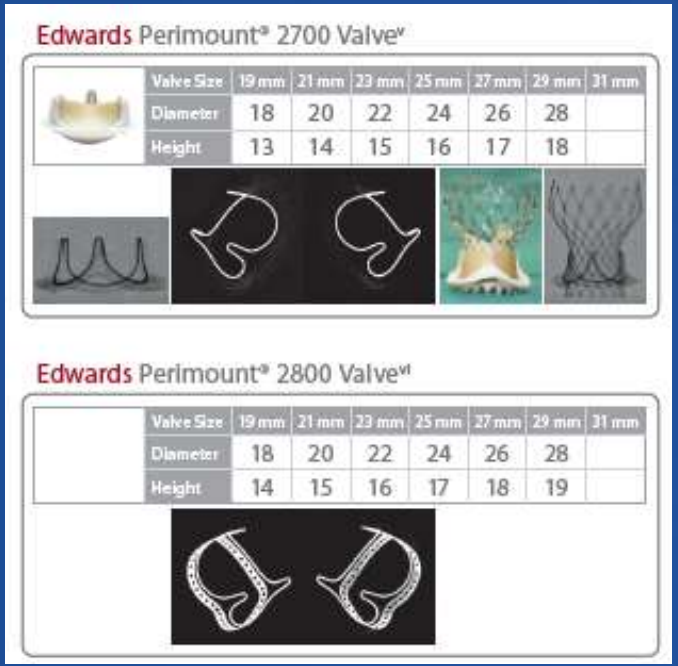
- Implant

Image from: Fariley SL, Jeganathan R, Manoharan G, et al. Early Experience of Implantation of the New CoreValve Evolut in Degenerated Bioprosthetic Aortic Valves. Catherization and Cardiovascular Interventions 00:00-00 (2013)

Valve in Valve Pre-Procedure

Pre-procedure Steps for Sizing and Orientation are Critical:

- Determine the SAV's mode of failure
- Identify the failed SAV
- Determine (inside) diameter of SAV
  - Use valve-in-valve sizing guides
  - Use CT and other imaging to measure annulus diameter
  - Use manufacturer annulus sizing chart to determine appropriate valve size



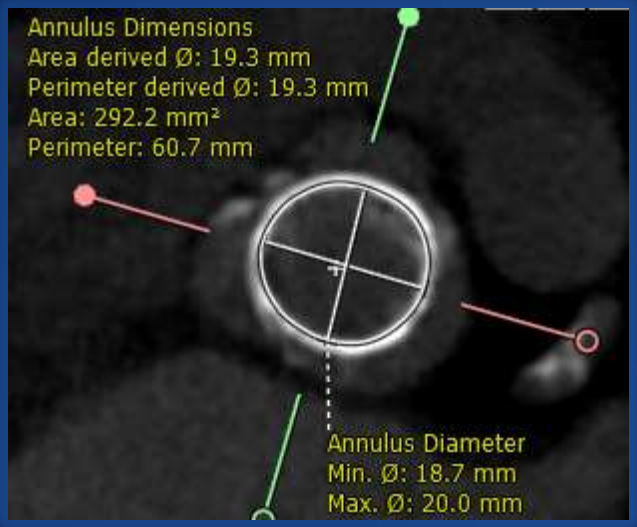
Valve in Valve Sizing

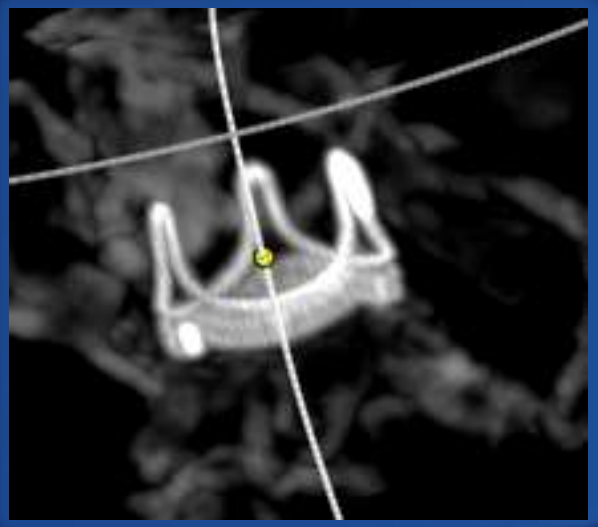
Best Practice: Utilize the Imaging techniques consistent with native TAVR implant methodology.

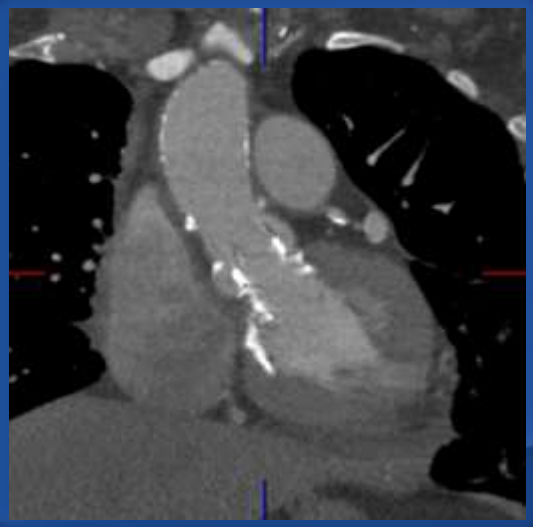
Computed tomography (CT) is required.

Instead of measuring the native annulus, measure the:

- Inside diameter of SAV inflow (at the annulus)
- Distance between left and right ostia and the valve

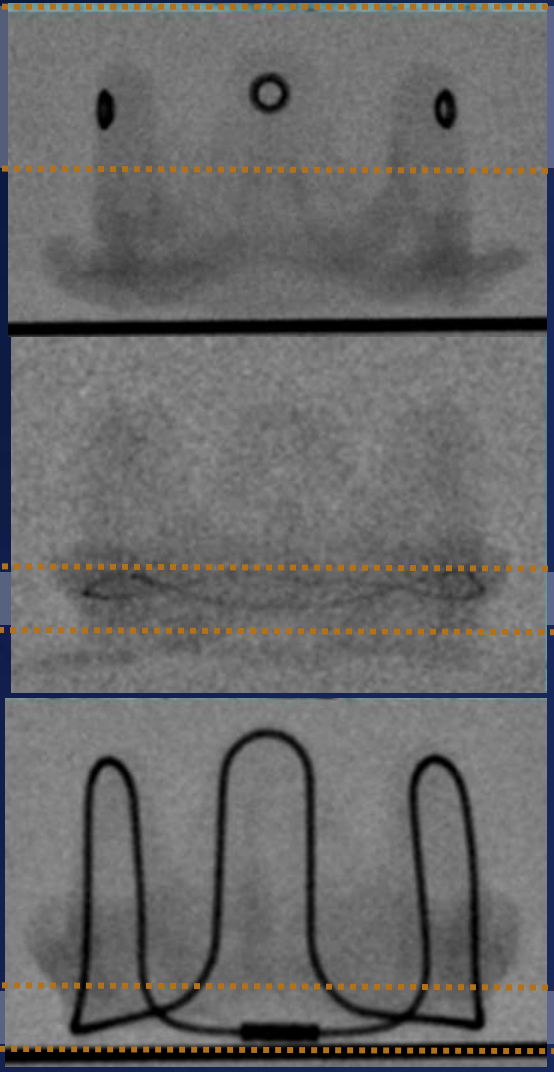






Valve Positioning

Location of Angiographic Markers in Surgical Valves Varies



Markers located in crown

Markers located in sewing ring

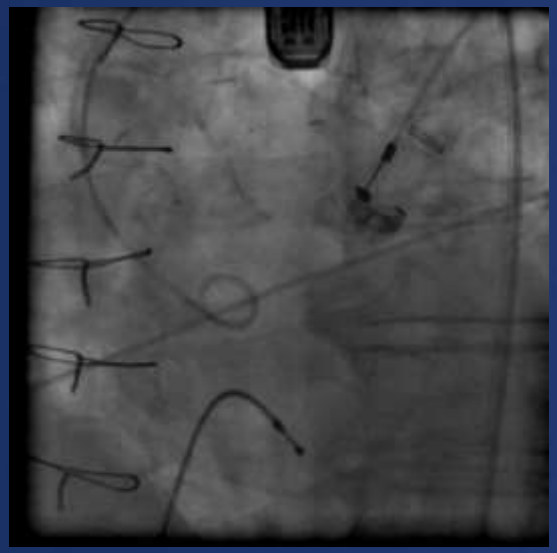
Markers located below sewing ring

Case Examples

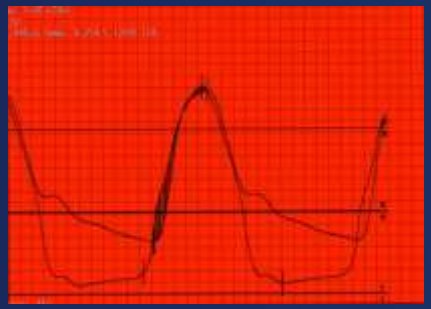
Structural Valve Deterioration

Aortic Regurgitation

- Wear and Tear



- minimum PPM

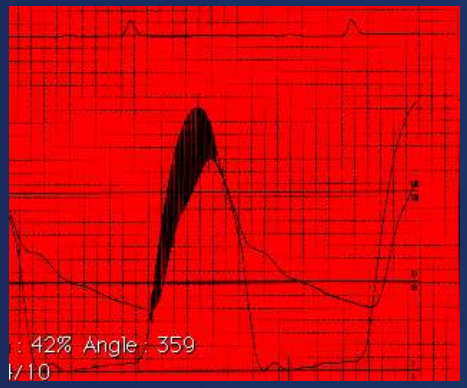


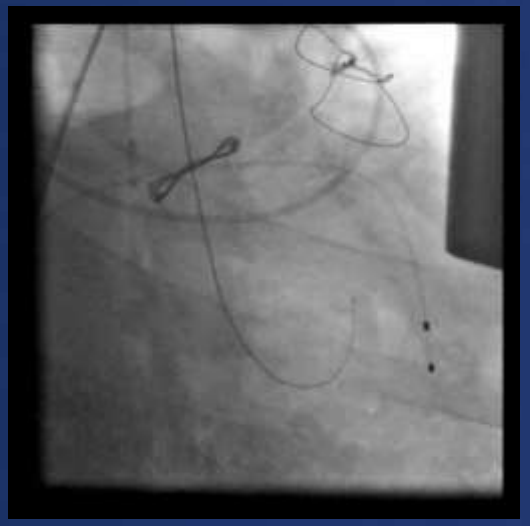
Minimum intrapped material between the 2 valves positively influence the resulting EOA and PPM +

Structural Valve Deterioration

Aortic Stenosis

- Pannus
- Calcification
- PPM increase





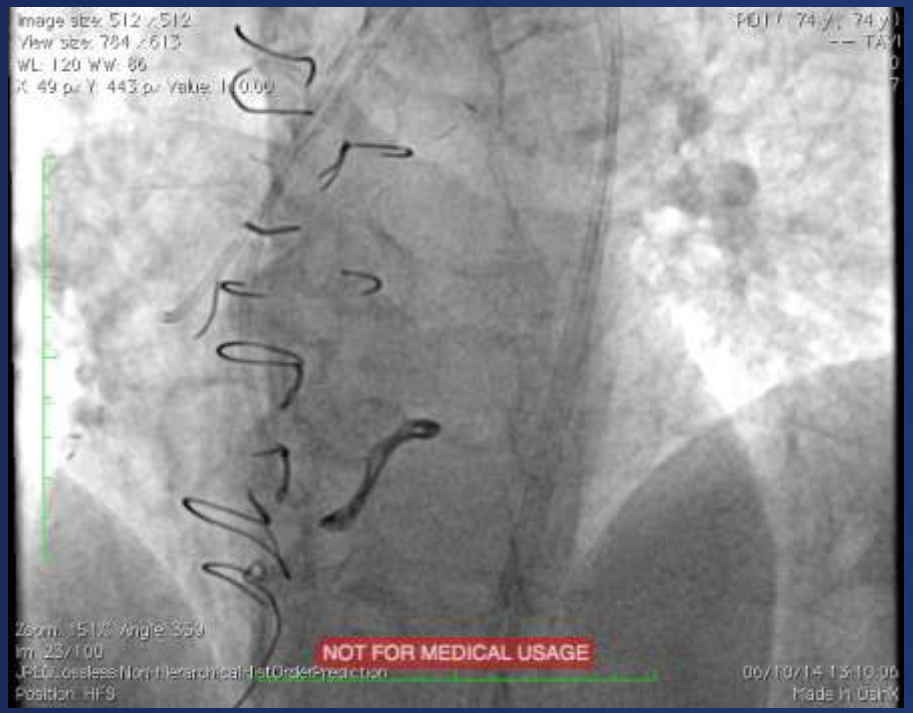
Intrapped material between the 2 valves affect significantly the resulting EOA and PPM ++

Lotus valve in Failed Surgical Bioprosthesis (Mosaic)

Direct valve implantation

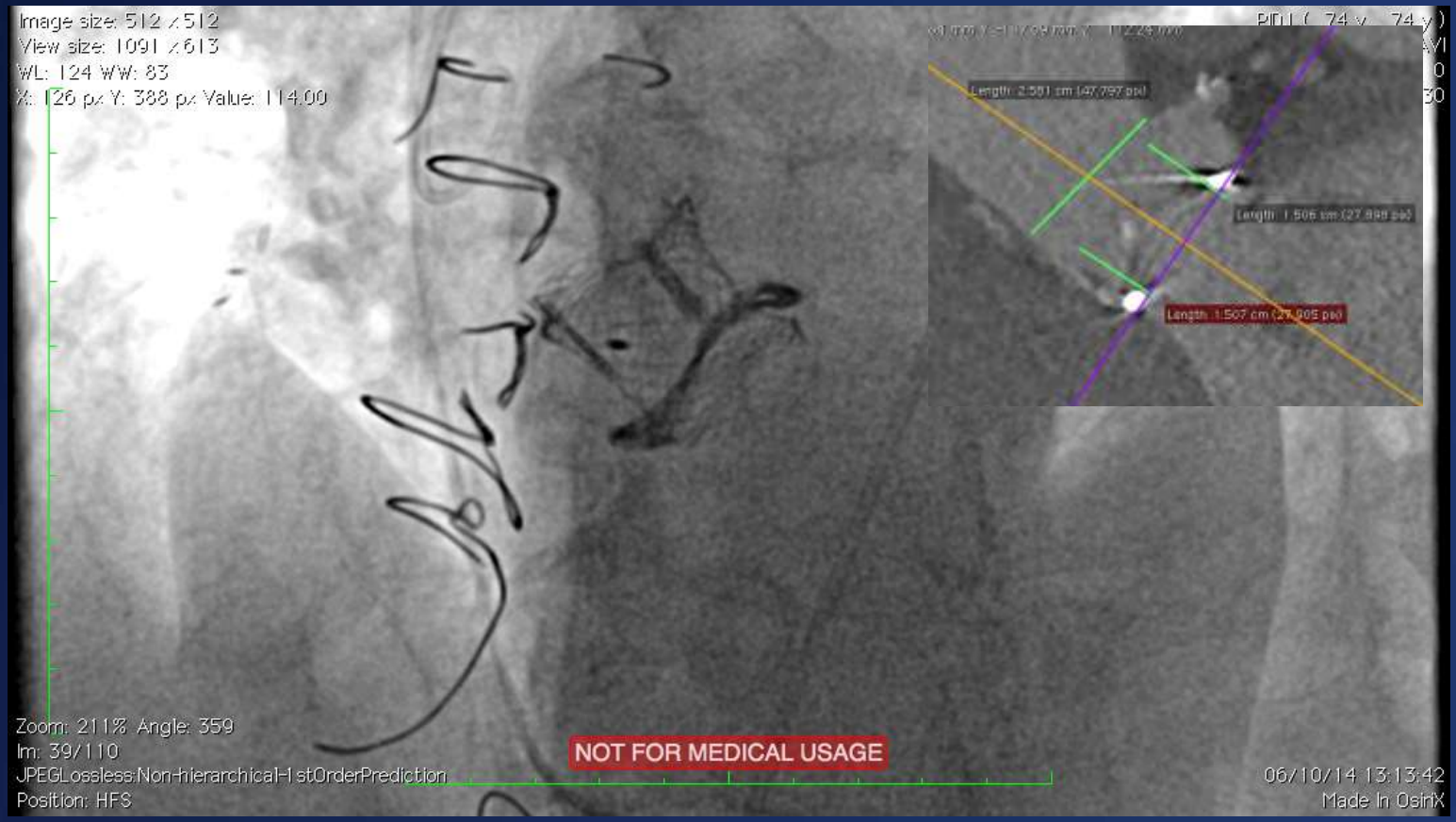
23mm Lotus

Marker at 4 mm above annulus



Lotus valve in Failed Surgical Bioprosthesis (Mosaic)

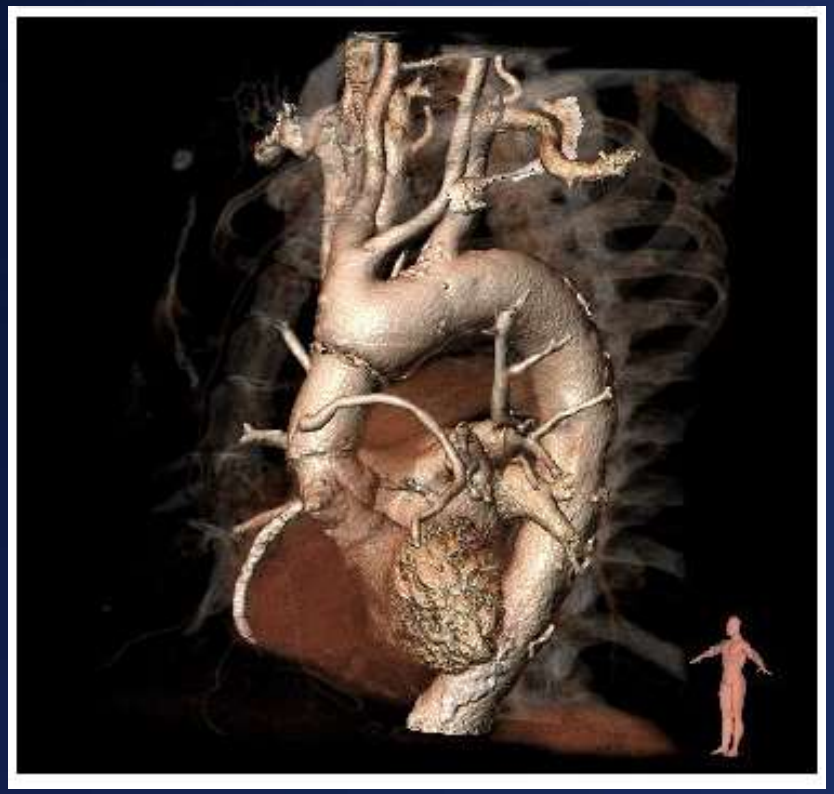
Final Result



Hemodynamic peak to peak Gradient : **5-7 mm Hg**

Lotus valve in Failed Surgical Bioprosthesis (Freestyle)

Case 2: Stentless valve
Dacron Graft + Freestyle 27 (2010)

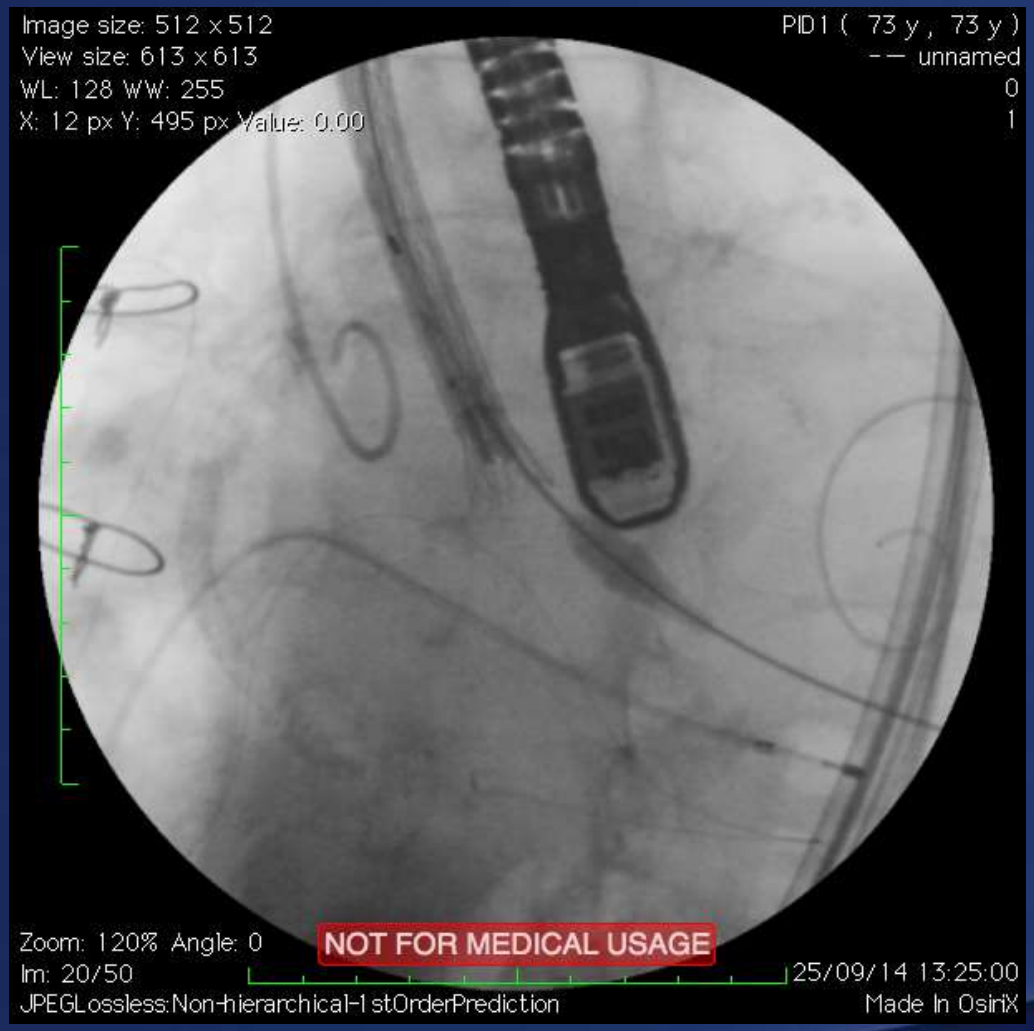


Lotus valve in Failed Surgical Bioprosthesis (Freestyle)

Direct valve implantation

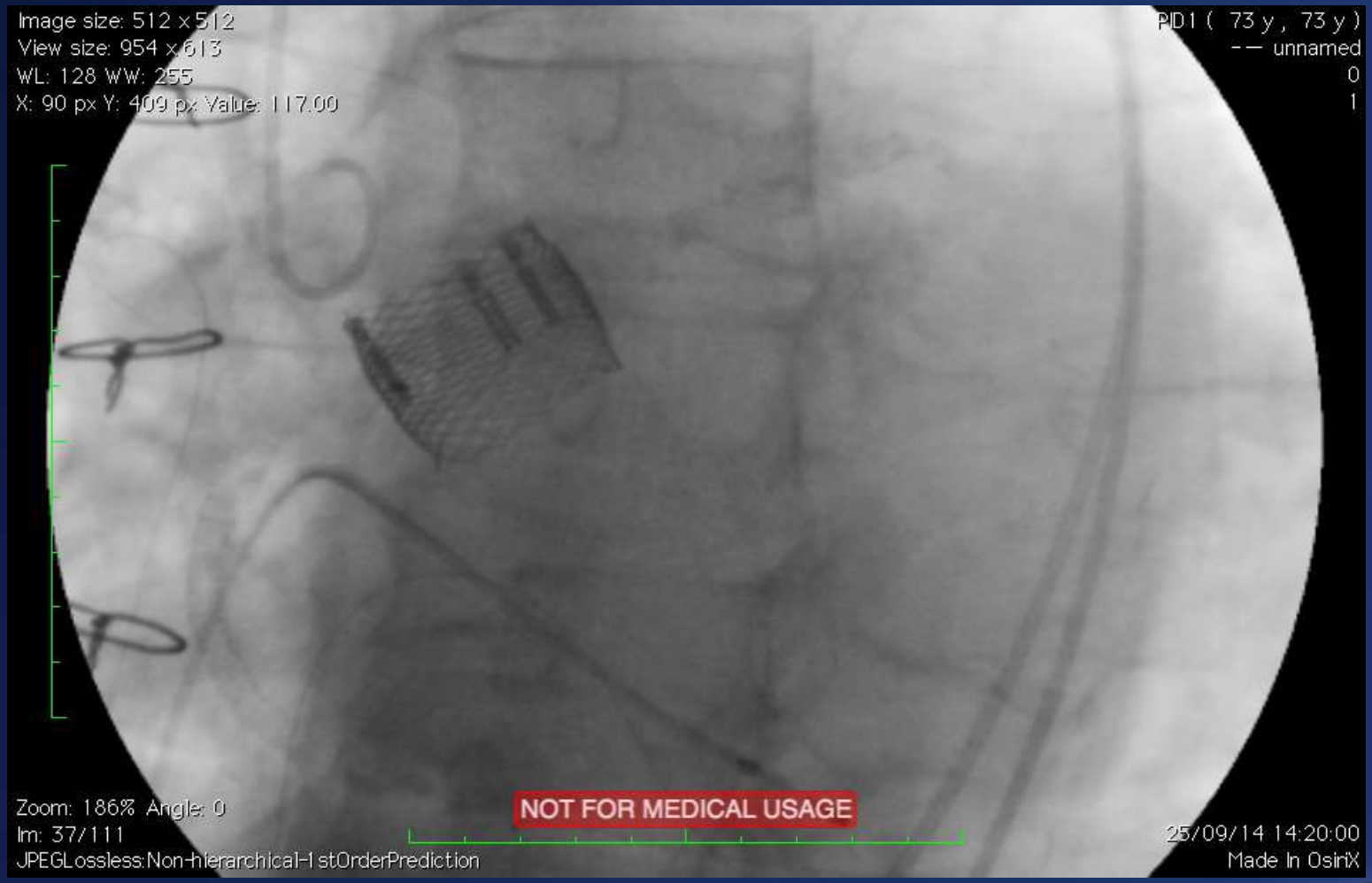
23mm Lotus

Marker at 2mm above annulus



Lotus valve in Failed Surgical Bioprosthesis (Freestyle)

Final result



Hemodynamic peak to peak Gradient : **0 mm Hg**

Clinical Evidence

Valve in Valve Impact of Design

Increased post procedural gradient may be anticipated in smaller bioprostheses due to small EOA for the TAVI device[1].

Supra-annular design maximizes the available orifice area within the bioprosthesis[2]

Intra-annular design may lead to under-expansion, reducing the potential orifice area[2]

[1]Fairley, et al., *Cath Card Interventions* 2013; epub; [2]Kornowski, et al., presented at EuroPCR 2013

Valve in Valve Global Registry

- 2012 (*Circulation*) Global Valve in Valve registry: 202 patients from 38 sites[1].
- 2013 update (TCT): 554 patients from 55 sites[2].
- 2014 *(JAMA)*:1-year outcomes 459 patients from 55 sites[3].


Original Investigation

Transcatheter Aortic Valve Implantation in Failed Bioprosthetic Surgical Valves

Danny Dvir, MD; John G. Webb, MD; Sabine Bleiziffer, MD; Miralem Pasic, MD, PhD; Ron Waksman, MD; Susheel Kodali, MD; Marco Barbanti, MD; Azeem Latib, MD; Ulrich Schaefer, MD; Josep Rodés-Cabau, MD; Hendrik Treede, MD; Nicolo Piazza, MD, PhD; David Hildick-Smith, MD; Dominique Himbert, MD; Thomas Walther, MD; Christian Hengstenberg, MD; Henrik Nissen, MD, PhD; Raffi Bekeredjian, MD; Patrizia Presbitero, MD; Enrico Ferrari, MD; Amit Segev, MD; Arend de Weger, MD; Stephan Windecker, MD; Neil E. Moat, FRCS; Massimo Napodano, MD; Manuel Wilbring, MD; Alfredo G. Cerillo, MD; Stephen Brecker, MD; Didier Tchetche, MD; Thierry Lefèvre, MD; Federico De Marco, MD; Claudia Fiorina, MD; Anna Sonia Petronio, MD; Rui C. Teles, MD; Luca Testa, MD; Jean-Claude Laborde, MD; Martin B. Leon, MD; Ran Kornowski, MD; for the Valve-in-Valve International Data Registry Investigators

[1]Dvir , et al., *Circulation* 2012; 126: 2335-2344; [2]Dvir et al., presented at TCT 2013; [3]Dvir et al., *JAMA* 2014; 312(2):162-170.

Valve in Valve Global Registry

Most recent publication (now VIVID) show high survival and low rates of major stroke.

Transcatheter Aortic Valve Implantation in Failed Bioprosthetic Surgical Valves

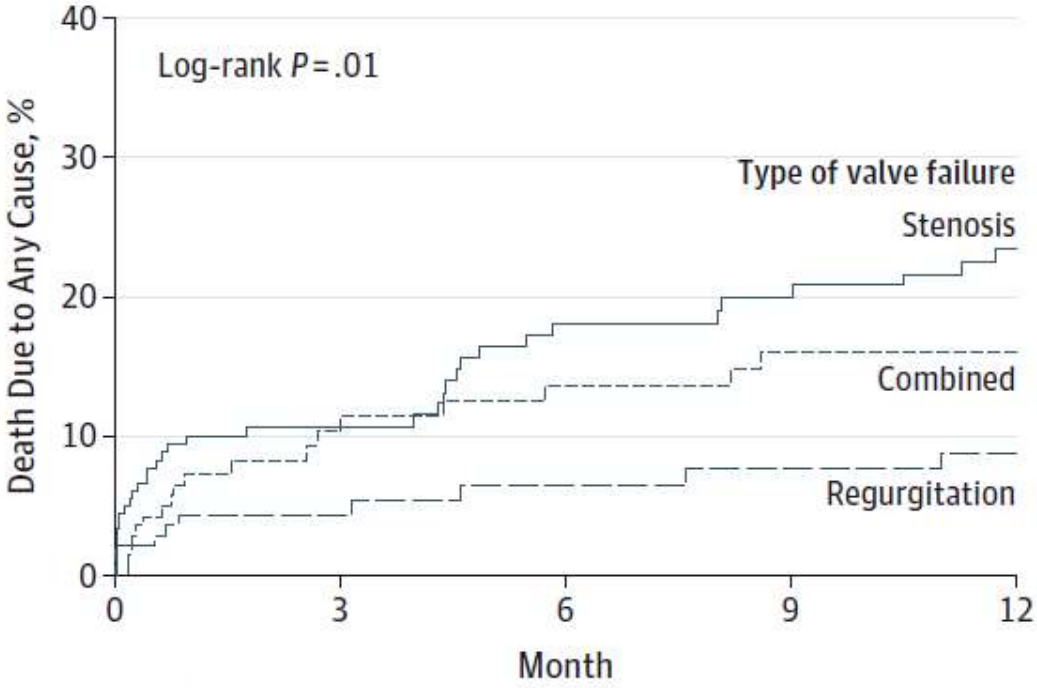
Table 3. Clinical Outcomes

Outcomes	All (n = 459)
Thirty-day outcomes	
Death, No. (%)	35 (7.6)
Cardiovascular death, No. (%)	30 (6.5)
NYHA functional class, No. (%)	
I/II	313 (92.6)
III/IV	25 (7.4)
Major stroke, No. (%)[a]	8 (1.7)
One-year outcomes	
Death, No. (%)	62 (16.8)
NYHA functional class, No. (%)	
I/II	163 (86.2)
III/IV	26 (13.8)
AV area, mean (SD), cm^2	1.38 (0.42)
AV maximal gradient, mean (SD), mm Hg	30 (14.7)
AV mean gradient, mean (SD), mm Hg	16.9 (9.1)

[1]Dvir et al., *JAMA* 2014; 312(2):162-170.

Valve in Valve Global Registry

Survival was greater among patients with baseline regurgitation vs. stenosis[1].



No. at risk by type of valve failure

Stenosis	181	112	98	91	86
Regurgitation	139	92	84	78	76
Combined	139	85	76	68	66

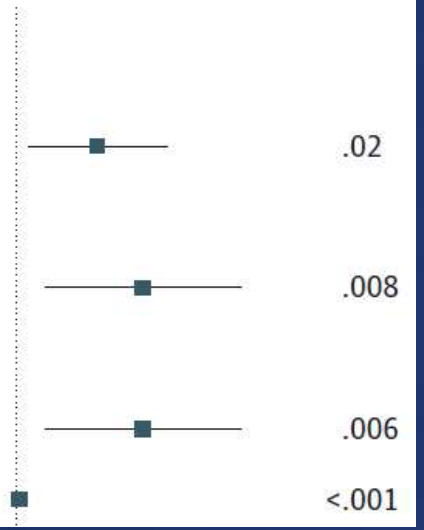
[1]Dvir et al., *JAMA* 2014; 312(2):162-170.

Valve in Valve Global Registry

In addition to prosthetic valve failure mode, smaller surgical bioprostheses (<21mm), transapical access, and a higher STS score also contributed to mortality[1].

Figure 2. Results of Multivariable Analyses for Correlates for 1-Year Mortality After Valve-in-Valve Implantation

	No. of Events	Total	Hazard Ratio (95% CI)	*P* Value
Overall mortality				
Surgical valve label size				
≤21 mm	28	133	2.04 (1.14-3.67)	.02
>21 mm	34	315		
Type of valve failure				
Stenosis	34	181	3.07 (1.33-7.08)	.008
Regurgitation	12	139		
Transapical access				
Yes	34	171	2.25 (1.26-4.02)	.006
No	30	288		
STS score (per 1% increment)[a]			1.01 (1.00-1.01)	<.001

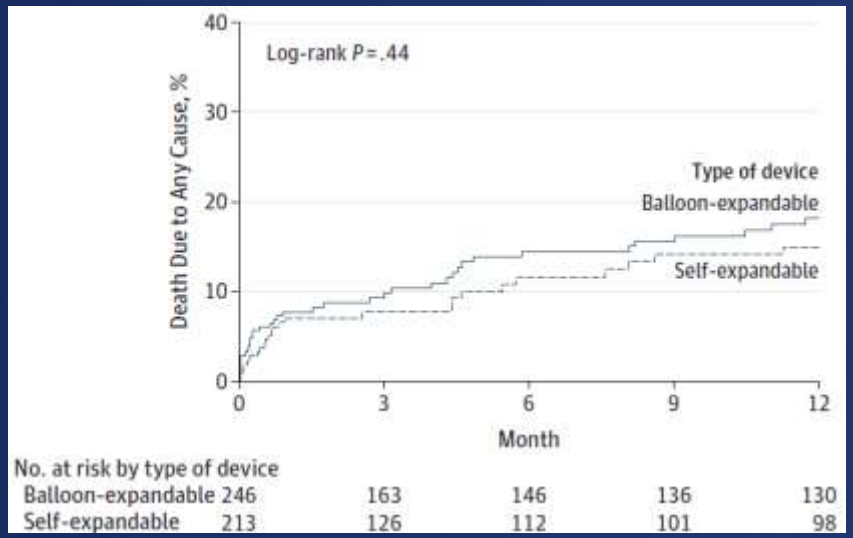


[1]Dvir et al., *JAMA* 2014; 312(2):162-170.

Valve in Valve Global Registry

Primary outcomes were equivalent across devices at one year, but self-expandable valves showed more favorable hemodynamics[1]

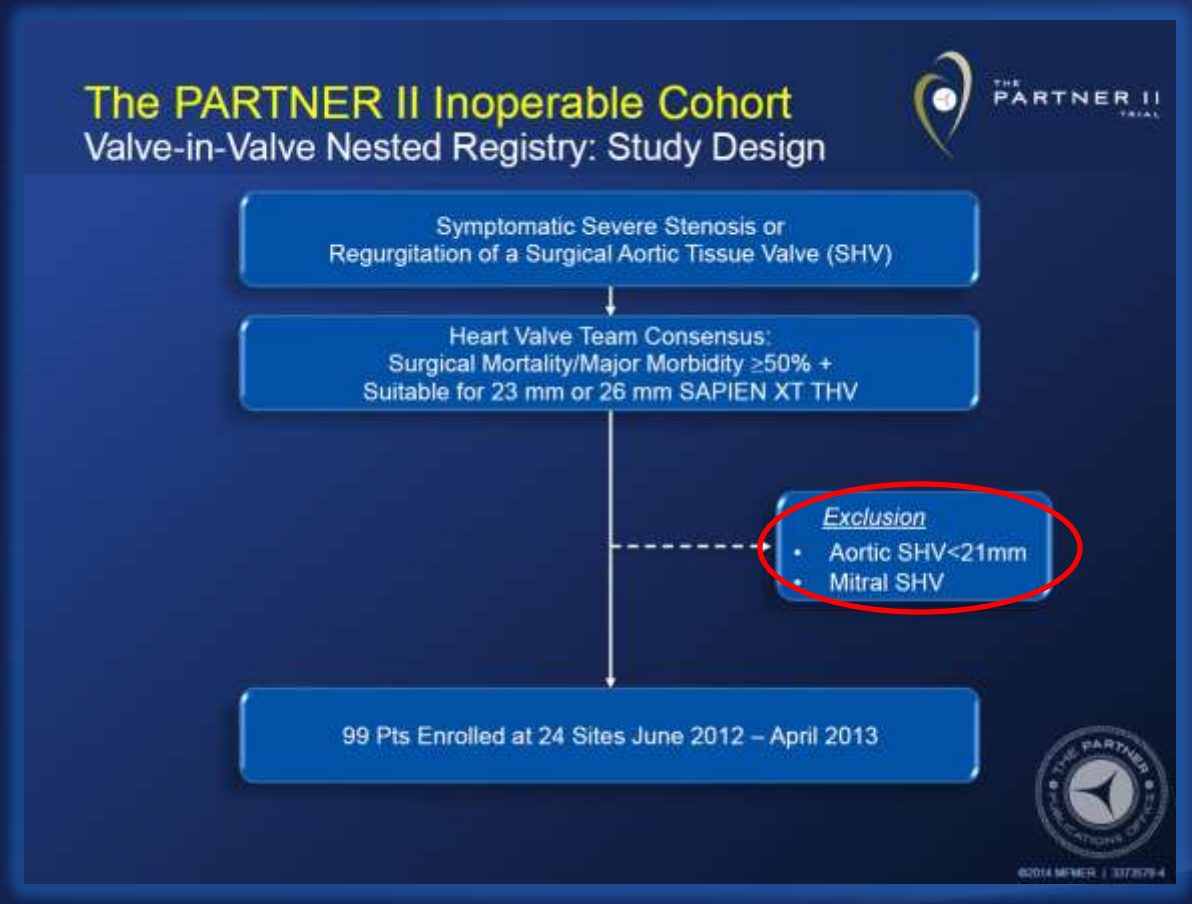
Outcomes	All (n = 459)	Device Used, No. (%) Self-Expandable (n = 213)	Balloon-Expandable (n = 246)	*P* Value
One-year outcomes				
Death, No. (%)	62 (16.8)	25 (15)	37 (18.7)	.44
NYHA functional class, No. (%)				
I/II	163 (86.2)	88 (81.6)	75 (82.4)	.89
III/IV	26 (13.8)	10 (18.4)	16 (17.6)	.89
AV area, mean (SD), cm^2	1.38 (0.42)	1.55 (0.41)	1.29 (0.39)	.006
AV maximal gradient, mean (SD), mm Hg	30 (14.7)	25.3 (11.9)	33.3 (16)	<.001
AV mean gradient, mean (SD), mm Hg	16.9 (9.1)	13.5 (7)	19.4 (9.6)	<.001



[1]Dvir et al., *JAMA* 2014; 312(2):162-170.

PARTNER II: Valve in Valve

At TCT 2014, Rakesh Suri reported on 1 year results from the PARTNER II Nested Valve in Valve Registry

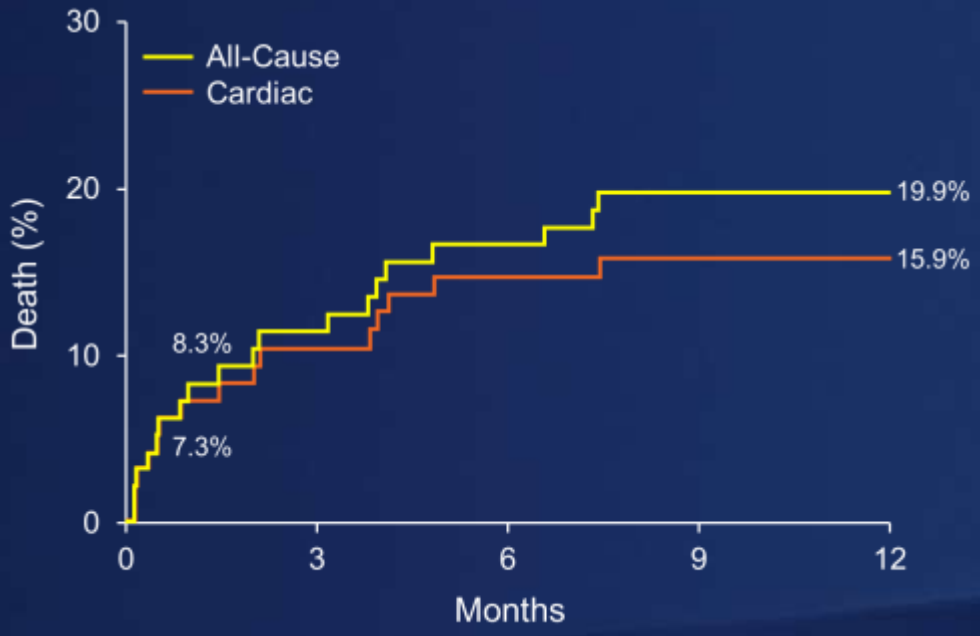


Suri, et. al., presented at TCT 2014

PARTNER II: Valve in Valve One Year Mortality

- All-cause and cardiac mortality at 30 days are slightly higher in valve in valve patients from PARTNER II, compared with previous reports on PARTNER II.
- However, the 30 day and 1 year mortality rates are comparable with data from the Global Valve in Valve Registry.

PARTNER II Valve in Valve Nested Registry: All-Cause and Cardiovascular Mortality



Suri, et. al., presented at TCT 2014

CoreValve US Pivotal Expanded Use Study Valve in Valve Results

Low rates of mortality and stroke at 30 days and 6 months

Safety Outcomes

Outcome, %	30 Days	6 Months
All-Cause Mortality	3.5	9.0
Cardiovascular	2.8	4.7
Reintervention	0.8	1.7
Surgical	0.8	1.7
Neurological Events	1.4	4.5
All Stroke	0.7	2.8
Major Stroke	0.7	1.8
Minor Stroke	0.0	1.0

CoreValve US Pivotal Expanded Use Study Valve in Valve Results

55.3% of patients had a 17-20mm annulus.
Hemodynamic outcomes are consistent with the pre-existing surgical bioprostheses

Reported SAV Gradients at 1 Year (Mean ± SD, mmHg)

Valve	19 mm	21 mm
Mosaic (*n* = 14, 189)	15.3 ± 5.3	14.5 ± 5
Hancock II (n = 9)	NA	12.9 ± 4.2
Perimount† (*n* = 9, 16)	15	15
Magna (*n* = 16, 34)	16.7 ± 4	13.8 ± 5
Mitroflow (*n* = 34, 143)	13.4 ± 5.0	11.4 ± 4
Biocor & Supra (*n* = 40)	NA	18.8 ± 6
Epic & Supra (*n* = 49)	NA	19.1 ± 8

Expanded Use TAV in SAV Echo Findings

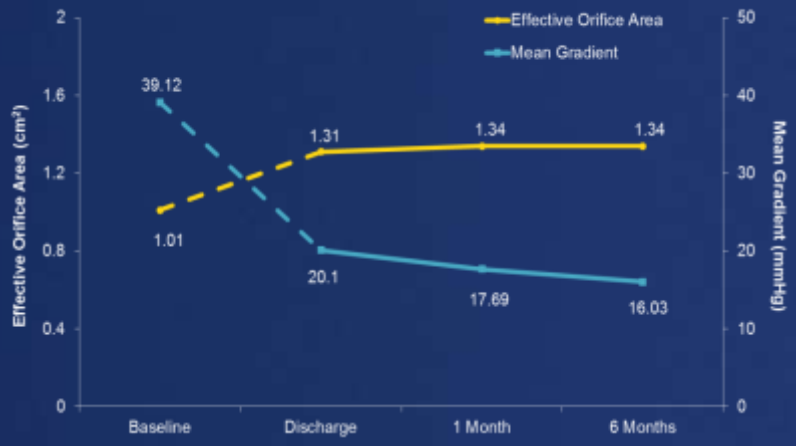


Table Data Source: Each of the Surgical Valve US Instructions for Use. † IFU only reports velocities, extrapolated from published report of FDA approval experience, Frater E, Salomon N, Rainer G, et al. The Carpentier-Edwards Pericardial Aortic Valve: Intermediate Results. Ann Thorac Surg 1992;53:764.71

Valve in Valve with Other Devices

Positive outcomes have been achieved (100% procedural success and 100% 30-day survival)[1,2], but increased mean gradient observed with JenaValve implantation[1] possibly due to incomplete stent expansion.

JenaValve 23mm implanted within a 25 mm Sorin Mitroflow bioprosthesis[1]

Portico 23 mm implanted within a 19 mm Sorin Mitroflow bioprosthesis[2]

[1]Conradi, et al. *EuroIntervention* 2014; epub ahead of print; epub ahead of print; [2]Jeger, et al. *EuroIntervention* 2014; epub ahead of print.

Conclusions

- Valve-in Valve is a safe and effective treatment for degenerative surgical bioprostheses with low rates of mortality, stroke, and other safety outcomes.
- Hemodynamics after valve-in-valve are improved relative to baseline, with supra-annular valve design showing advantages to intra-annular valves.
- Detailed pre-procedure planning and proper procedural technique is essential to achieve a successful outcome:
  - Identifying and assessing the degenerative bioprosthesis
  - Using CT imaging to assess the inner diameter of the valve and the height and location of the coronary ostia relative to the valve commissure posts
  - Using manufacturer guidelines to select the appropriate transcatheter valve size

Thank you very much for Your Attention!