

TAVR Complications: Stroke, Paravalvular Leak, Vascular Complication and Conduction Disturbance

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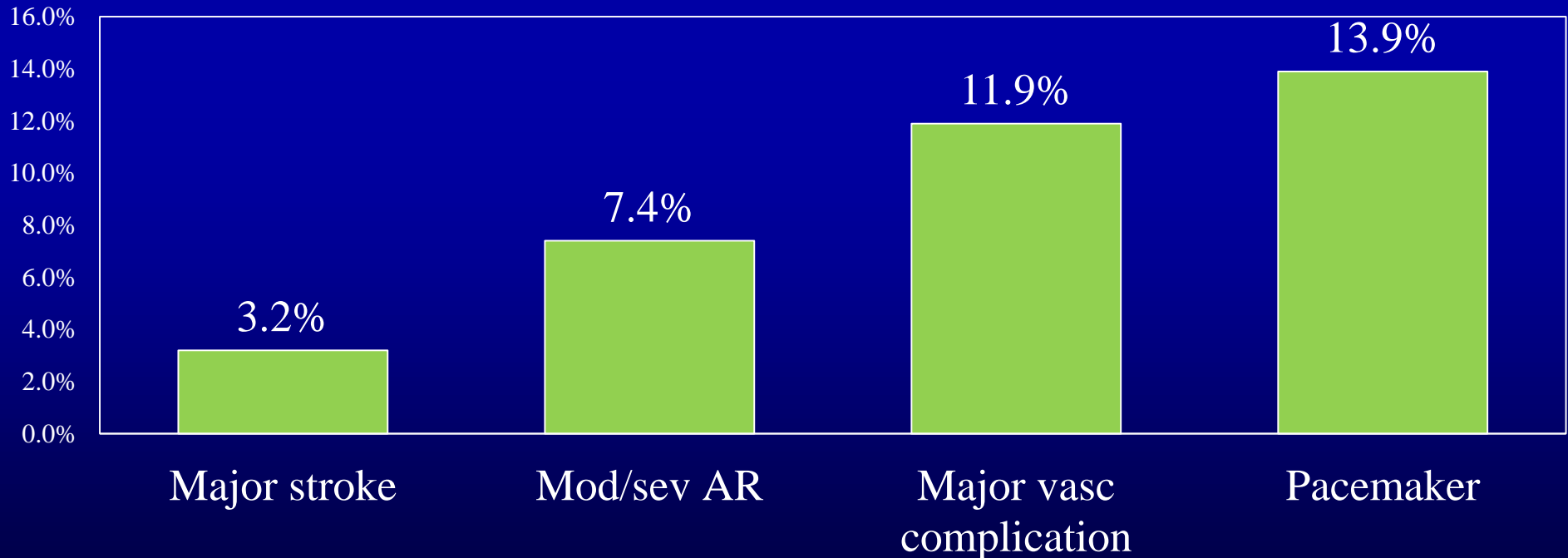
Cedars-Sinai Medical Center, Los Angeles

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Outcomes after TAVR using VARC definitions

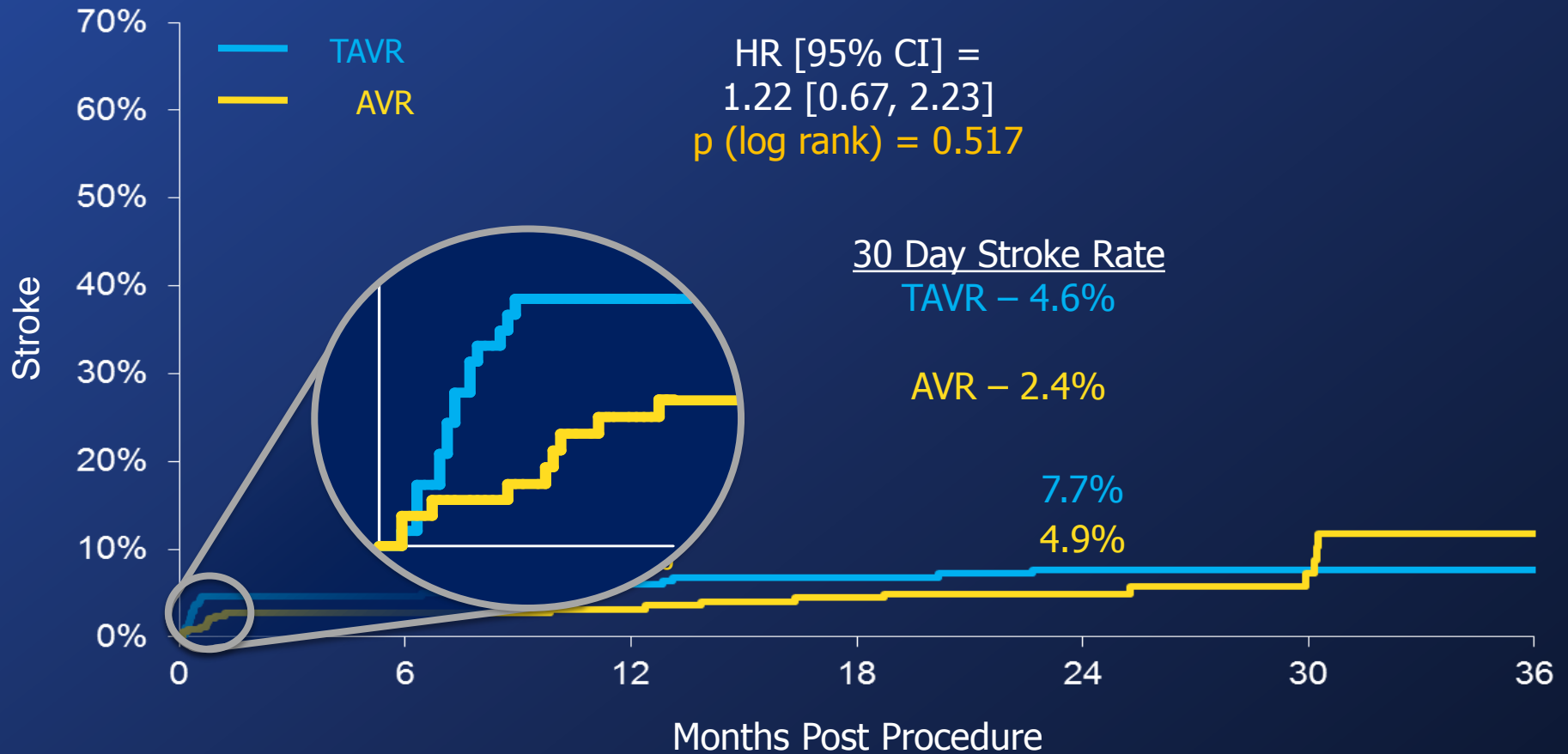
16 studies, 2519 patients

VARC End-point	Pooled estimate	95% CI
Major stroke	3.2%	2.1-4.8%
Moderate or severe AR	7.4%	4.6-10.2%
Major vascular complications	11.9%	8.6-16.4%
Permanent pacemaker	13.9%	10.6-18.9%



Stroke

Strokes (ITT) PARTNER Cohort A: High-risk patients



Numbers at Risk

TAVR	348	287	249	224	162	65	28
AVR	351	246	230	211	160	62	31

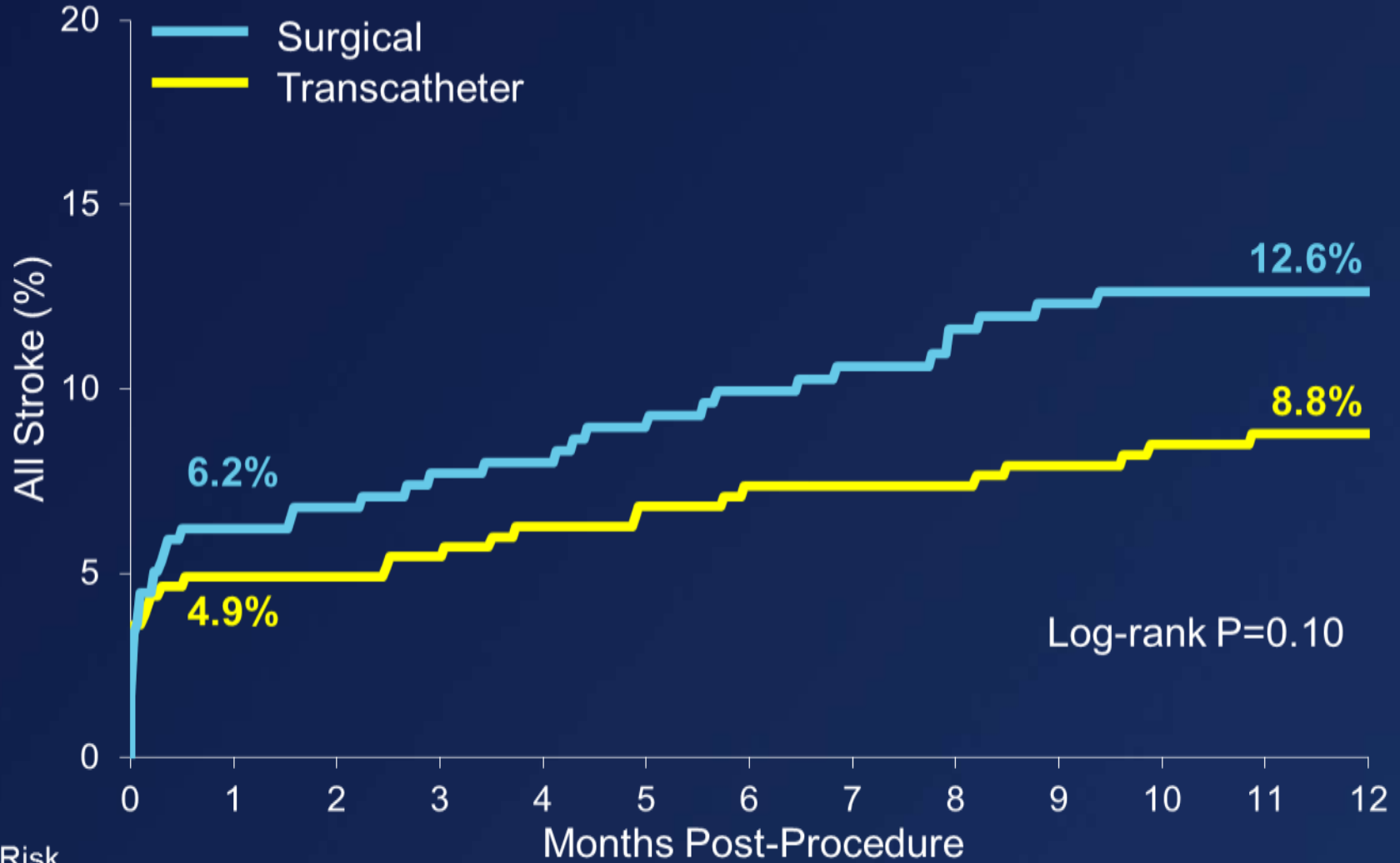
PARTNER Cohort B: Inoperable patients



Outcome	30 Days n=179			1 Year n=179		
	TAVI	Standard Rx	P-value	TAVI	Standard Rx	P-value
Death						
All (%)	5.0	2.8	0.41	30.7	49.7	0.0004
Cardiovascular (%)	4.5	1.7	0.22	19.6	41.9	<.0001
Repeat hospitalization (%)	5.6	10.1	0.17	22.3	44.1	<.0001
Death (all) or repeat hosp (%)	10.6	12.3	0.74	42.5	70.4	<.0001
Stroke or TIA						
All (%)	6.7	1.7	0.03	10.6	4.5	0.04
TIA (%)	0	0	.	0.6	0	1.00
Minor stroke (%)	1.7	0.6	0.62	2.2	0.6	0.37
Major stroke (%)	5.0	1.1	0.06	7.8	3.9	0.18
Death (all) or major stroke (%)	8.4	3.9	0.12	33.0	50.3	0.001
Myocardial infarction						
All (%)	0	0	.	0.6	0.6	1.00
Peri-procedural (%)	0	0	.	0	0	.

Stroke

CoreValve Randomized Trial of TAVR vs. SAVR

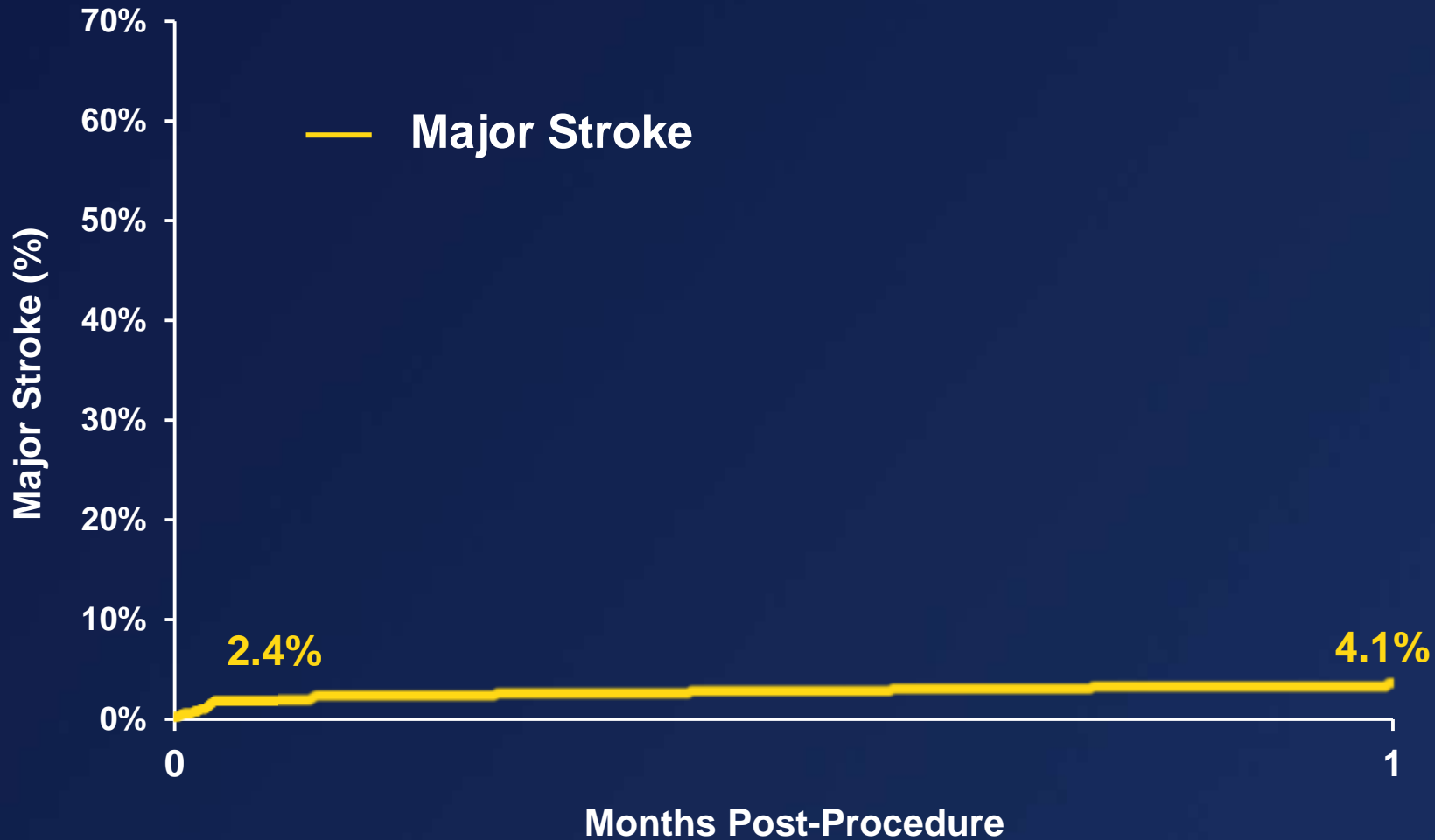


No. at Risk

Surgical	357	322	274	249
Transcatheter	390	363	334	314

Major Stroke

CoreValve Extreme Risk Study



Risk of stroke after transcatheter aortic valve implantation (TAVI): a meta-analysis of 10,037 published patients

53 studies, 10,037 patients

Lowest stroke rate with transapical TAVR

TF CoreValve (1.4±1.5%); TF Edwards (2.1±3.0%)
TA Edwards (0.7±1.5%)

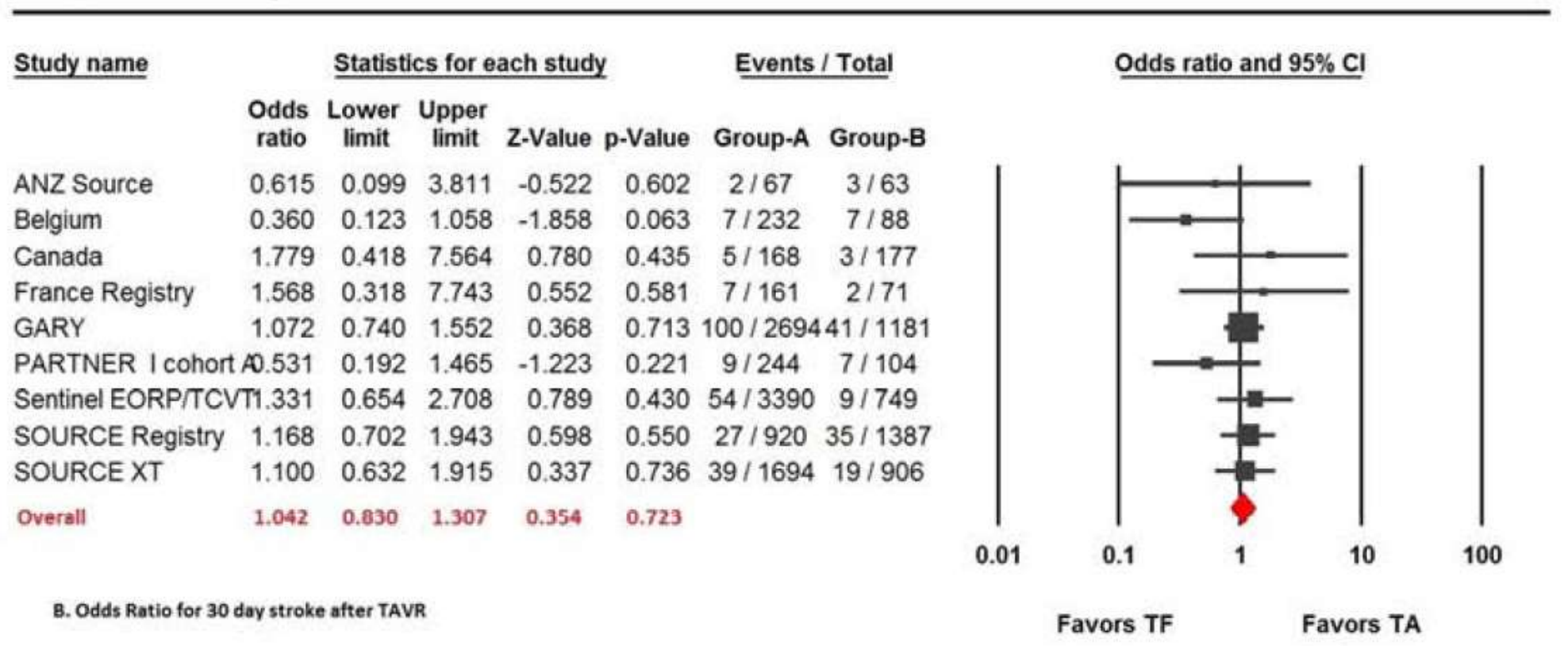
Procedural stroke (<24 hr.) 1.5±1.4%
30-day stroke/TIA 3.3±1.8%
1-year stroke/TIA 5.2±3.4%

	Medtronic/CoreValve transarterial			Edwards SAPIEN transarterial			Edwards SAPIEN transapical		
	Number of publications with available data (n)	Overall number of patients with available data (n)	Weighted mean±SD	Number of publications with available data (n)	Overall number of patients with available data (n)	Weighted mean±SD	Number of publications with available data (n)	Overall number of patients with available data (n)	Weighted mean±SD
Patient age (years)	18	3236	81.1±1.3	23	1733	82.3±2.6	22	2482	81.0±1.6
Female gender	16	2798	52.7±6.4%	22	1634	50.2±3.5%	22	2482	57.9±9.4%
Logistic EuroSCORE (%)	18	3236	22.09±3.66	20	1530	25.61±4.16	21	2305	29.10±7.54
Procedural stroke (<24h)	9	1872	1.4±1.5%	11	571	2.1±3.0%	9	382	0.7±1.5%
30-day stroke/TIA	18	3236	3.1±2.2%	24	1861	4.2±2.2%	24	2467	2.7±1.4%
30-day major stroke	14	1795	2.5±1.8%	20	1190	3.0±2.0%	17	1179	2.5±1.5%
30-day minor stroke/TIA	14	1795	0.7±1.4%	19	1091	1.7±1.8%	17	1179	0.8±1.4%
30-day overall mortality	18	3236	6.4±5.1%	22	1829	6.9±3.8%	22	2575	10.6±4.2%

	Number of publications with available data (n)	Overall number of patients with available data (n)	Number of events (n)	Weighted mean±SD
Procedural stroke (<24h)	24	3041	47	1.5±1.4%
30-day stroke/TIA	53	10037	334	3.3±1.8%
30-day major stroke	42	5514	158	2.9±1.8%
30-day minor stroke/TIA	42	5514	53	1.0±1.3%
30-day overall mortality	52	10022	812	8.1±3.9%
30-day mortality in patients suffering stroke	29	4430	41	25.5±21.9%
30-day mortality in patients without stroke	29	4430	312	6.9±4.2%
6-month stroke	9	669	29	4.3±1.6%
12-month stroke	7	1507	78	5.2±3.4%

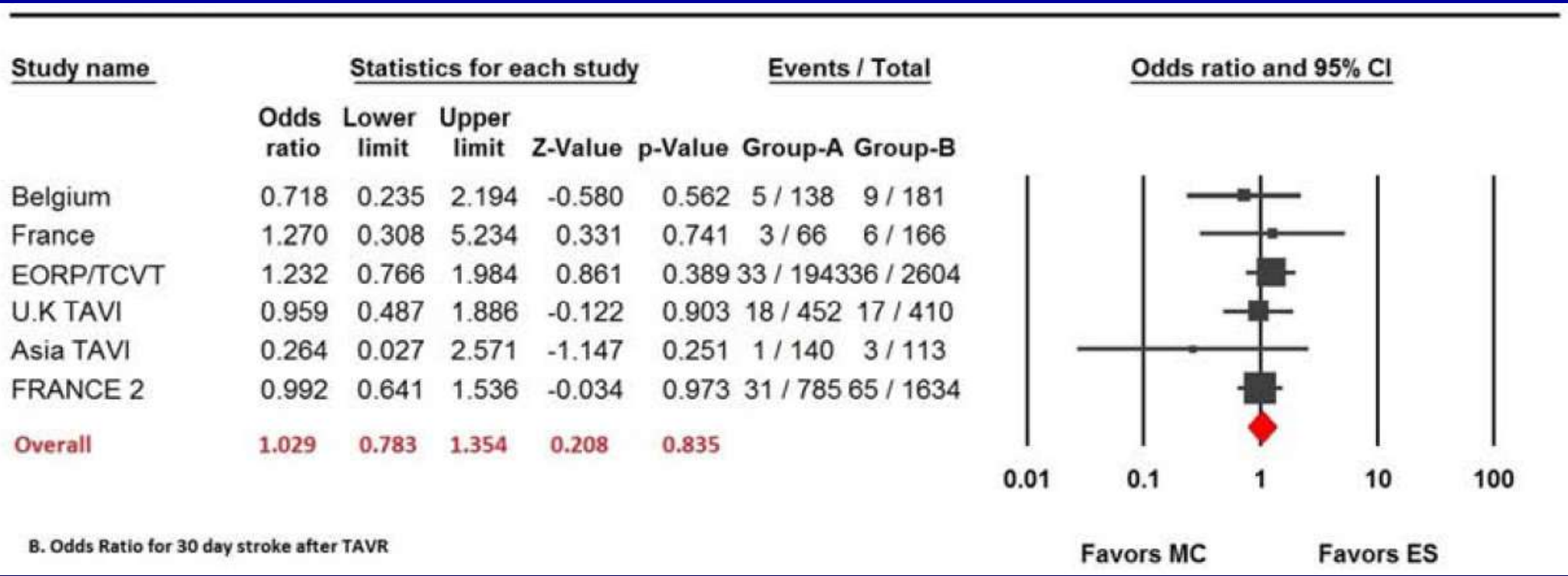
Meta-analysis of 9 studies involving 14,296 patients

Stroke rates are not different between TF and TA approach



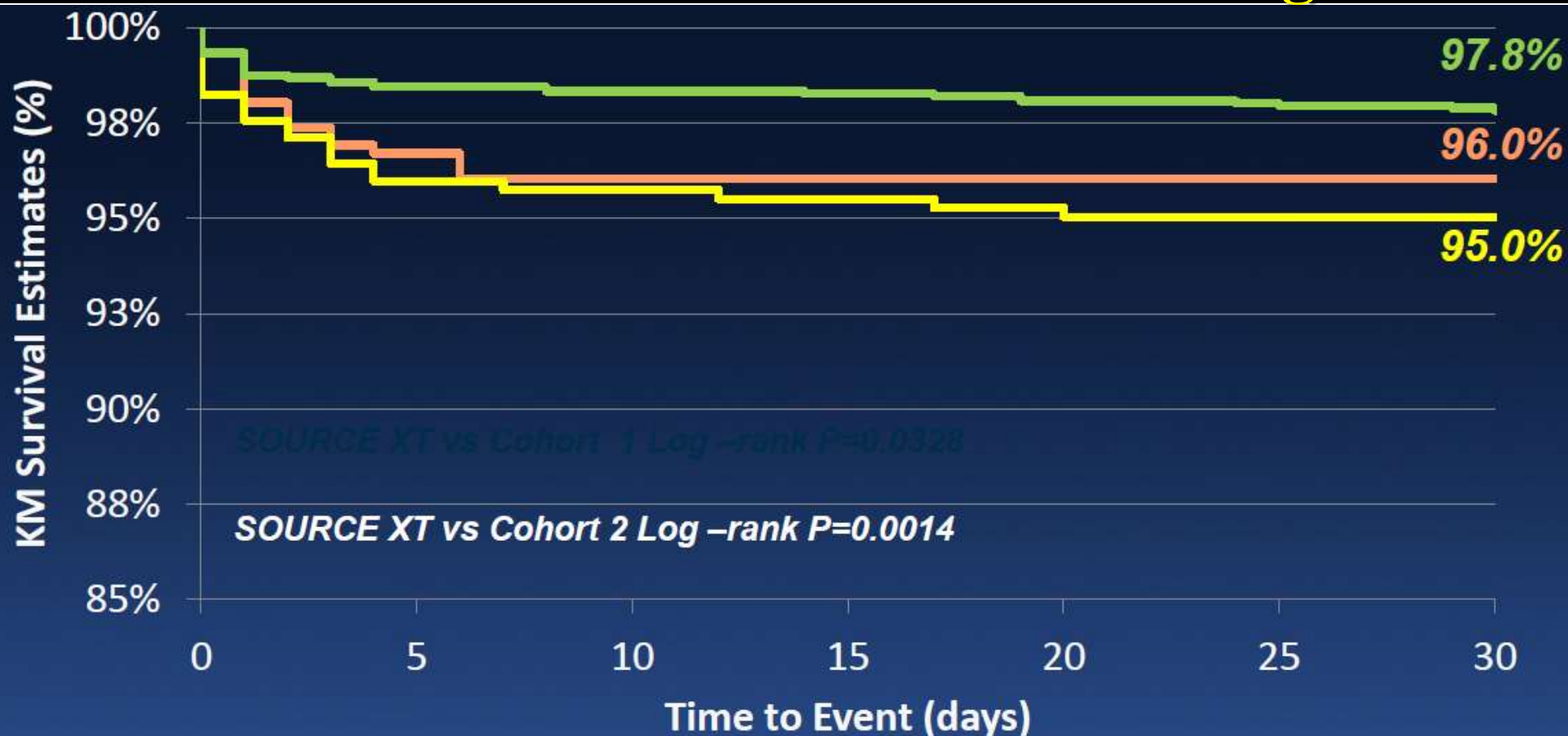
Meta-analysis of 9 studies involving 14,296 patients

Stroke rates are not different between Edwards or CoreValve



Stroke at 30 Day The TF Approach

Stroke rates after TAVR are declining



Thomas M. et al. TCT 2012

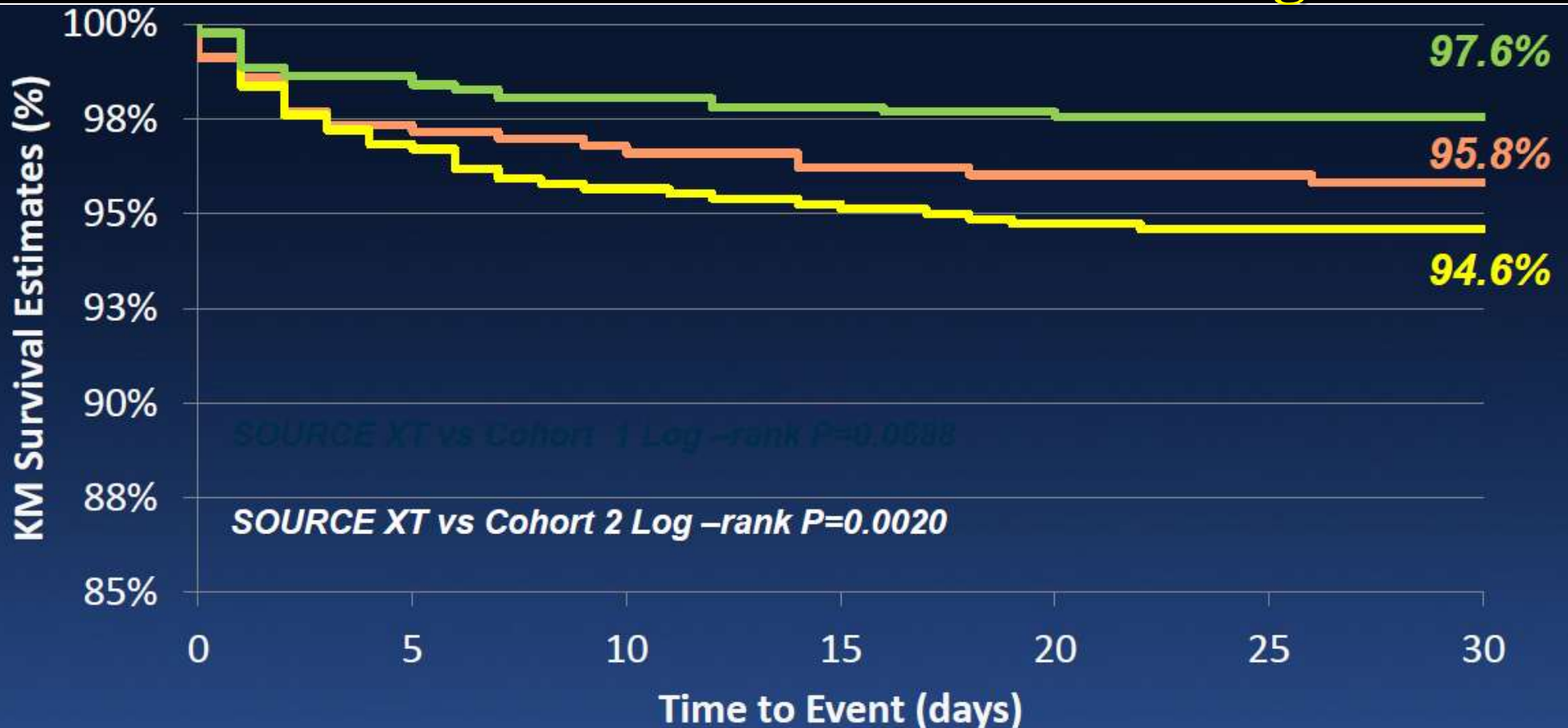
Source Cohort 1 (N=463)

Source Cohort 2 (N=457)

Source XT (N=1680)

Stroke at 30 Day The TA Approach

Stroke rates after TAVR are declining



Thomas M. et al. TCT 2012

Source Cohort 1 (N=575)

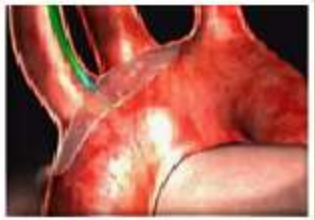


Source Cohort 2 (N=812)

Source XT (N=1680)

Stroke prevention strategies

- Embolic protection devices
- Minimize post-deployment maneuvers
- Optimizing pharmacology during and after TAVR
 - Aspirin, clopidogrel, heparin, bivalirudin, warfarin

Cerebral Protection Devices

Feature	Edwards Embrella 	SMT 	CLARET Medical 
Access	Radial	Femoral	Radial
Position	Aorta	Aorta	Brachiocephalic Left Common Carotid
Coverage Area	Brachiocephalic & LCC	Brachiocephalic & LCC & LSC	Brachiocephalic & LCC
Mechanism	Deflection	Deflection	Capture
Size	6F	9F	6F
Pore Size	100 microns	200 microns	140 microns
CE Mark	Yes	No	No

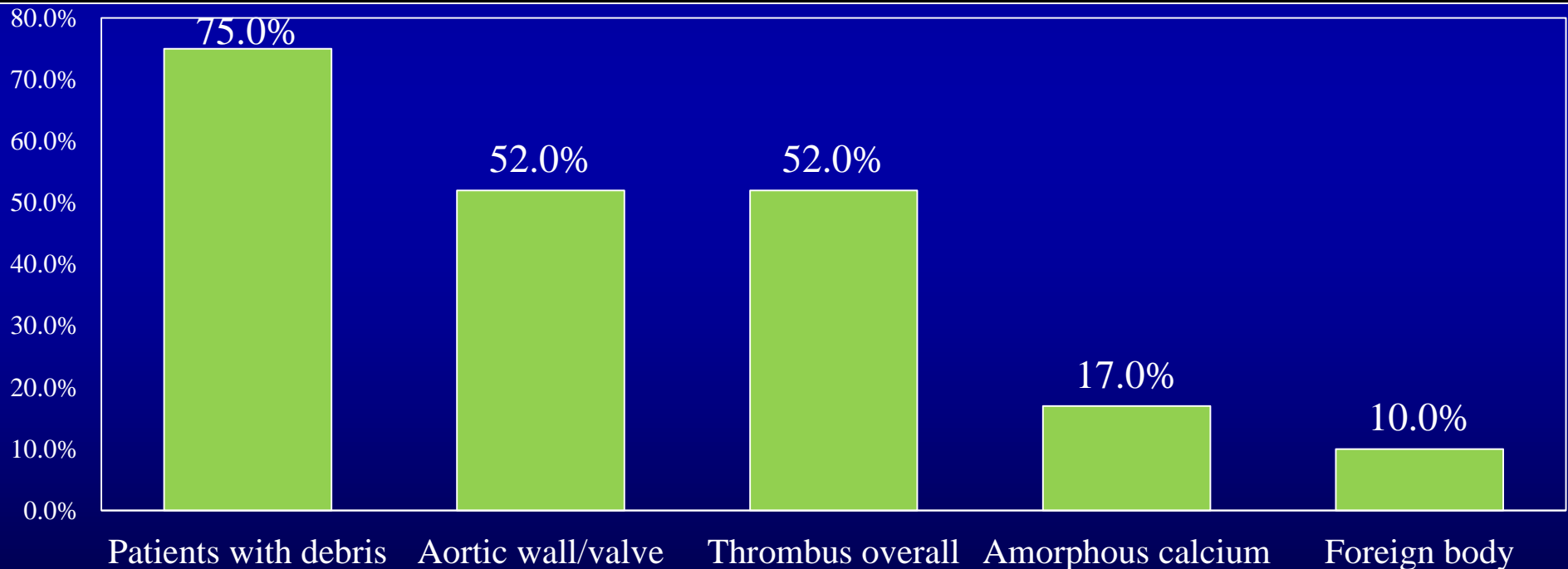
LTCS 2011

OTHERS Coming Soon!

Histopathology of Embolic Debris Captured During Transcatheter Aortic Valve Replacement

TAVR in 40 patients with Montage embolic protection device

Embolic debris captured in 75% of patients, consisting of thrombus (fibrin) or aortic wall/valve tissue.



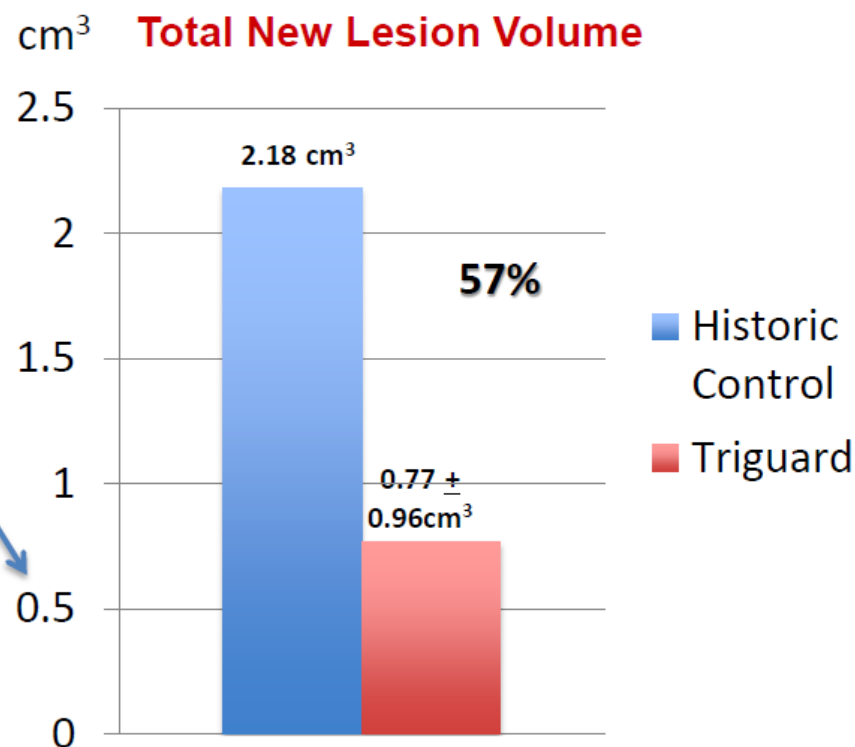
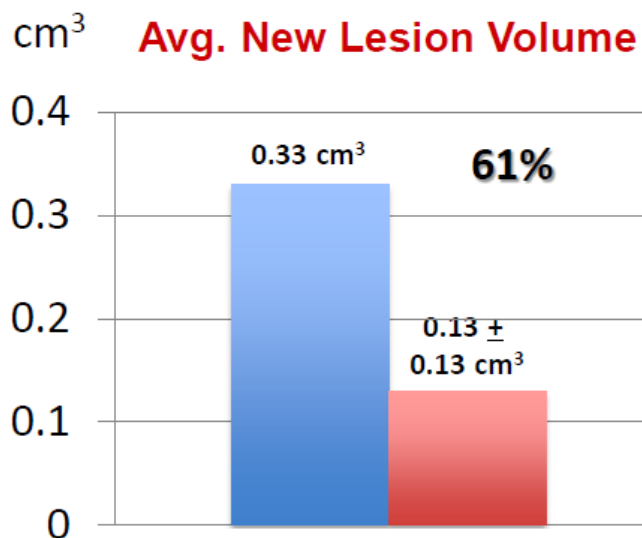
DEFLECT 1 Trial: Keystone Heart Deflector Device for embolic protection during TAVR

Lesion volume reduction vs. historic controls

Decrease in lesion volume with Keystone Heart Deflector Device

Historical Data (Kahlert 2010, Ghanem 2011, Astarci 2011, Stolz 2004)

Embolitic protxn (n=37)
Historic controls (n=150)



The PROTAVI-C Trial

PRospective **O**utcome Study in Patients undergoing **TAVI** to Examine **C**erebral Ischemia and Bleeding Complications

Embrella Protection Device

Pilot trial

- 50 patients
- Europe and Canada
- TCD & DW-MRI

Randomized trial

- 500 patients
- 1^o endpoint DW-MRI



Completed

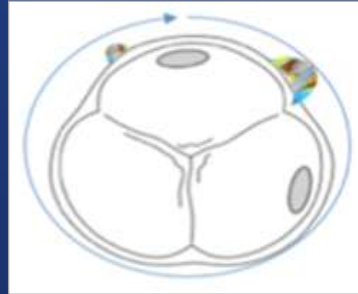
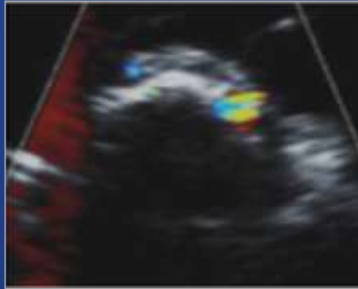
Clinical Outcomes at 7 Days

Adverse Events	TAVI+Embrella (N=41)
All-cause Mortality	1 (2.4%)
Stroke*	1 (2.4%)
TIA	0 (0.0%)
Life-threatening bleeding	2 (4.9%)
Renal insufficiency	1 (2.4%)

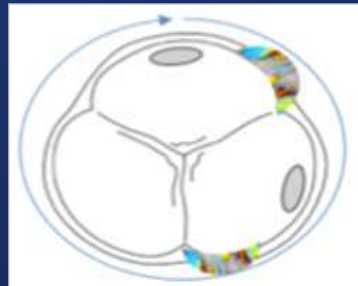
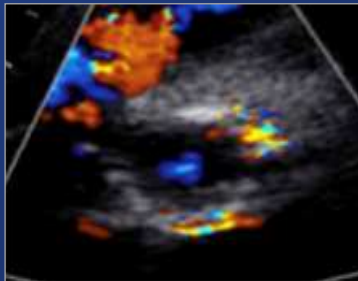
**Sentinel study : @300 patient randomized trial
with Claret device**

Paravalvular regurgitation

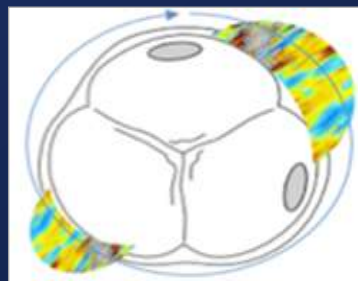
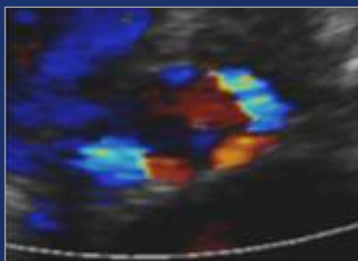
PARTNER Grading Criteria for Paravalvular AR



Circumference = 6"
AR = 0.1+0.35 = 0.45"
Ratio = 8%
Severity = Mild (< 10%)

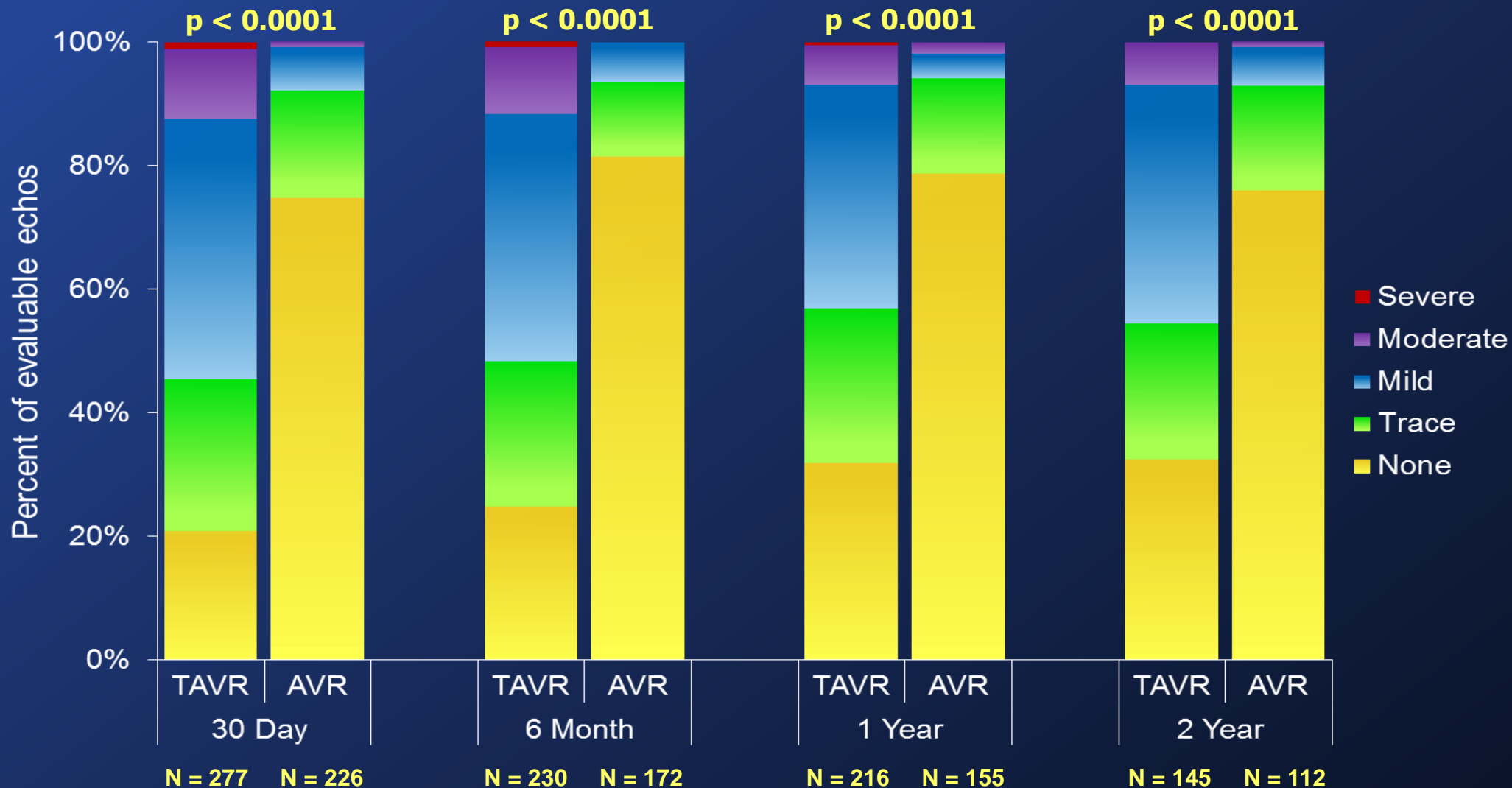


Circumference = 6"
AR = 0.5+0.5 = 1.0"
Ratio = 17%
Severity = Moderate (10 – 20%)
(Trans AR also present)



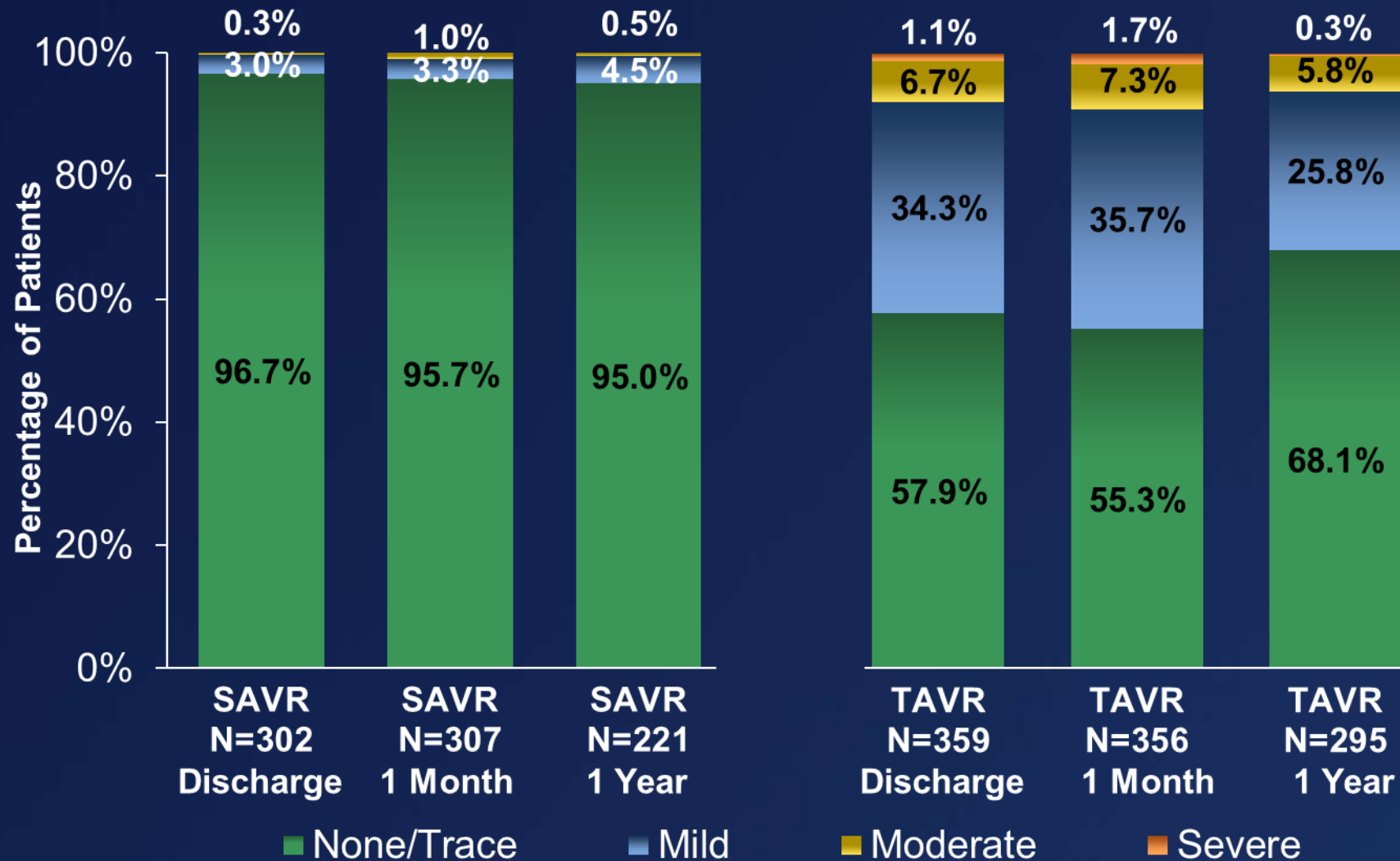
Circumference = 6"
AR = 0.6+1.1 = 1.7"
Ratio = 28%
Severity = Severe (> 20%)

Paravalvular Aortic Regurgitation (AT) PARTNER Cohort A: High-risk patients



Paravalvular Regurgitation

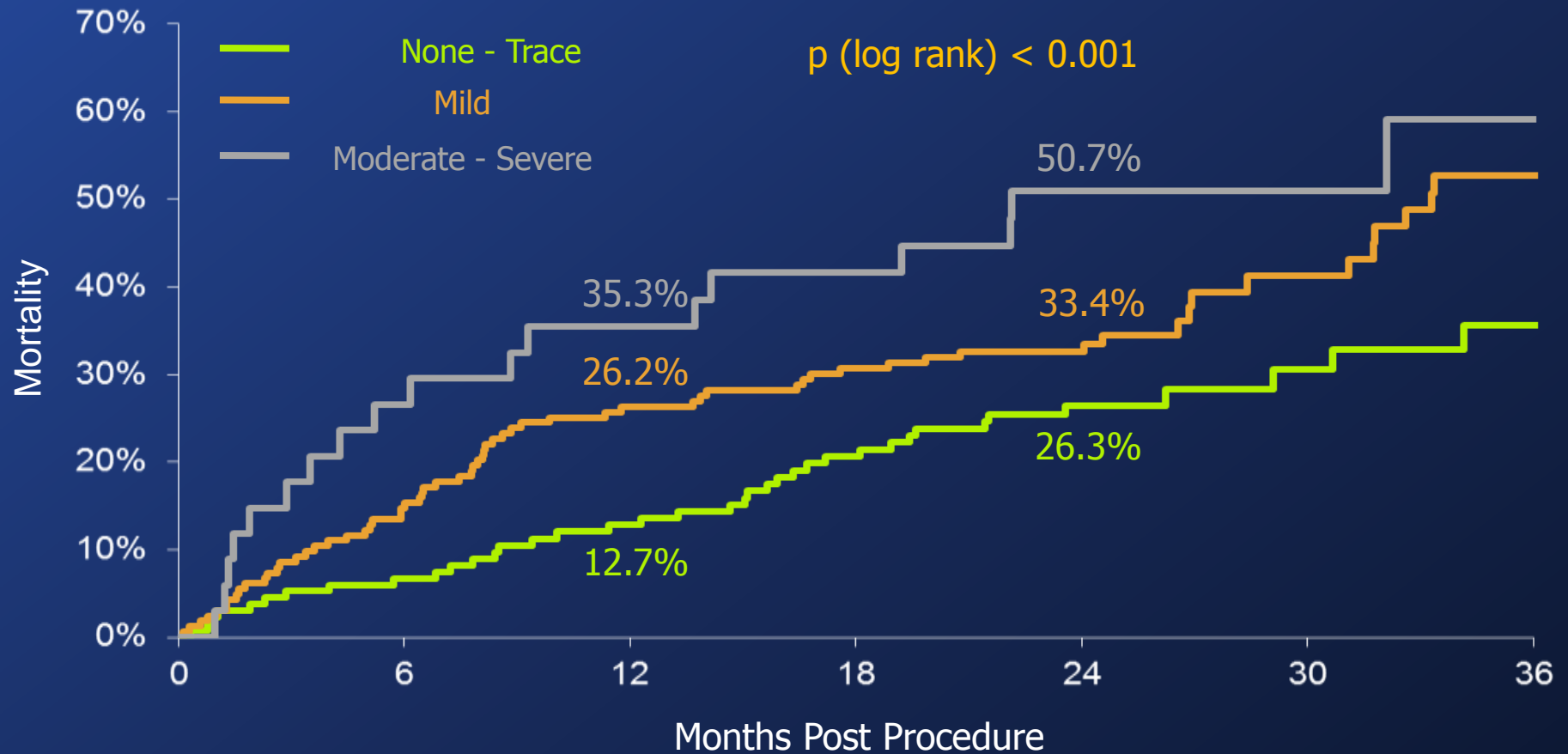
CoreValve Randomized Trial of TAVR vs. SAVR



There was significantly lower PVL with SAVR over TAVR at each time point ($P < 0.001$)

Total AR and Mortality

PARTNER (AT) Cohort A: High-risk patients



Numbers at Risk

	0	6	12	18	24	30	36
None-Tr	135	125	115	101	68	31	11
Mild	165	139	121	111	71	33	16
Mod-Sev	34	25	22	19	15	6	2

Incidence, Predictors, and Outcomes of Aortic Regurgitation After Transcatheter Aortic Valve Replacement

Meta-Analysis and Systematic Review of Literature

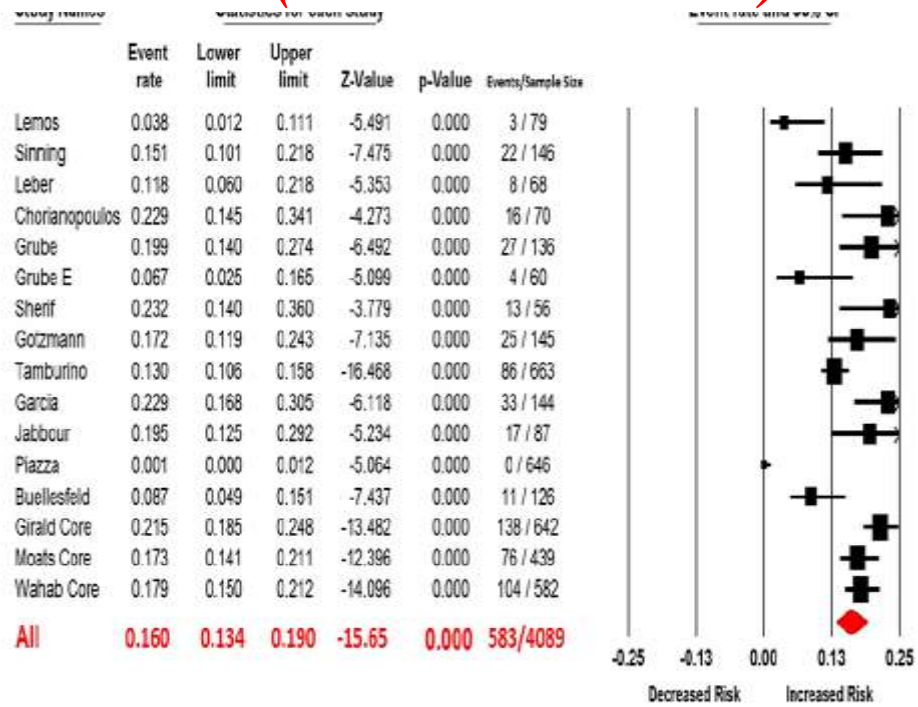
Meta-analysis of 45 studies including 12,926 patients

CoreValve, n=5261; Edwards, n=7279

Moderate/severe AR is more common with CoreValve

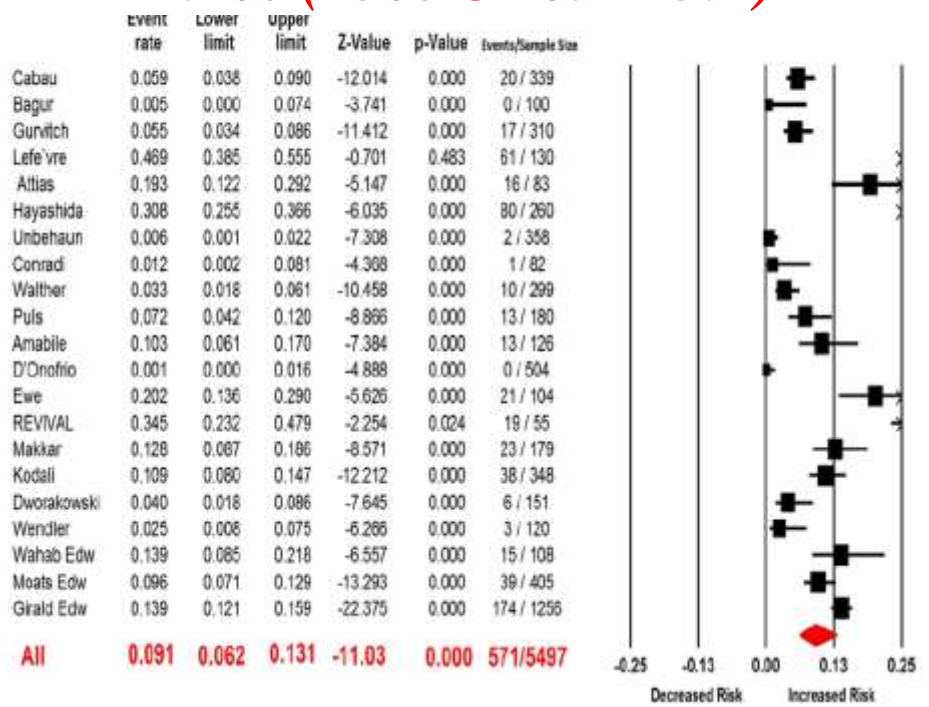
CoreValve

16% (95% CI 13.4-19.0)



Edwards Valve

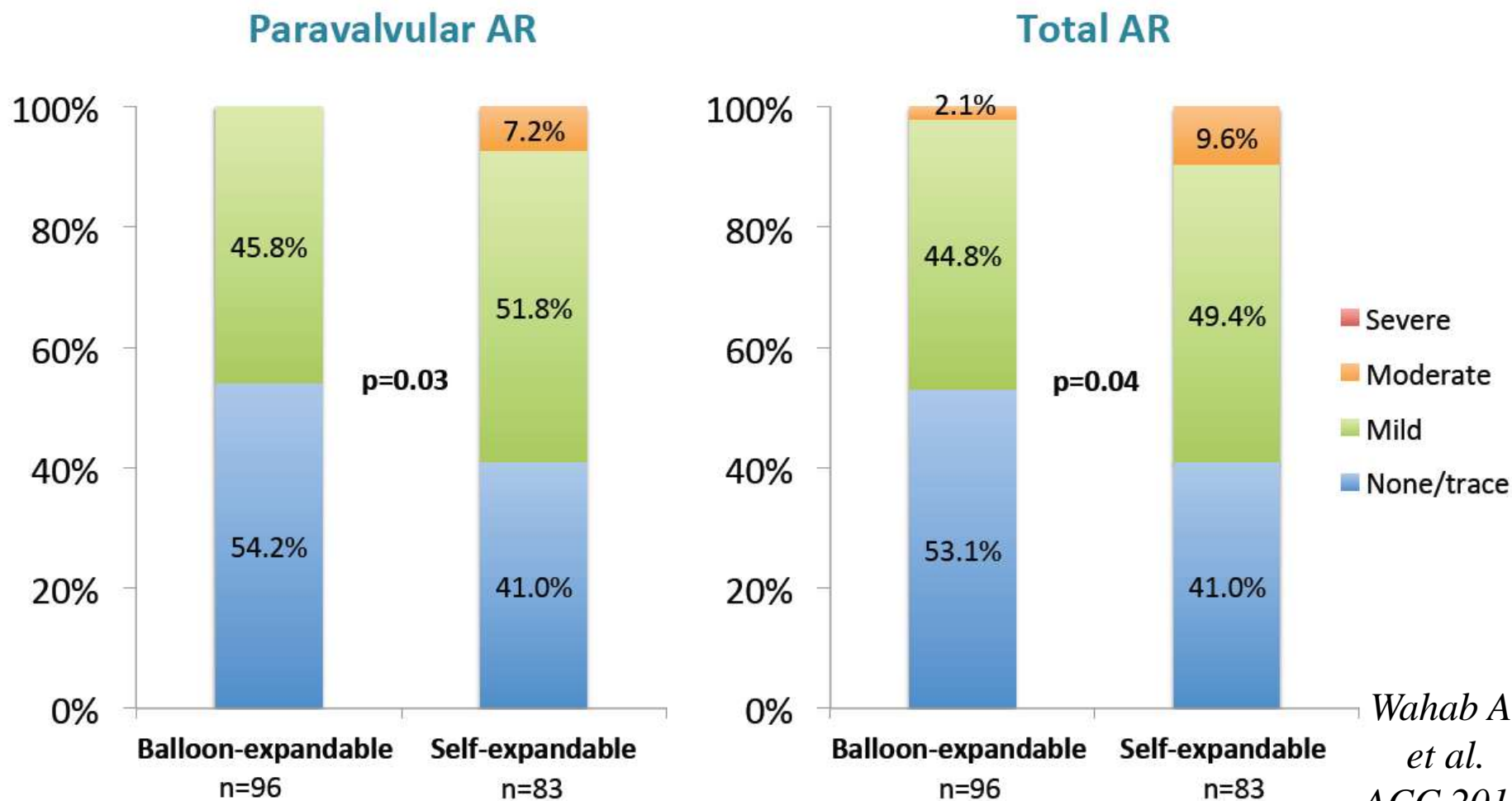
9.1% (95% CI 6.2-13.1)



Comparison of Balloon-Expandable vs Self-expandable Valves in Patients Undergoing Transcatheter Aortic Valve Replacement

The CHOICE Randomized Clinical Trial

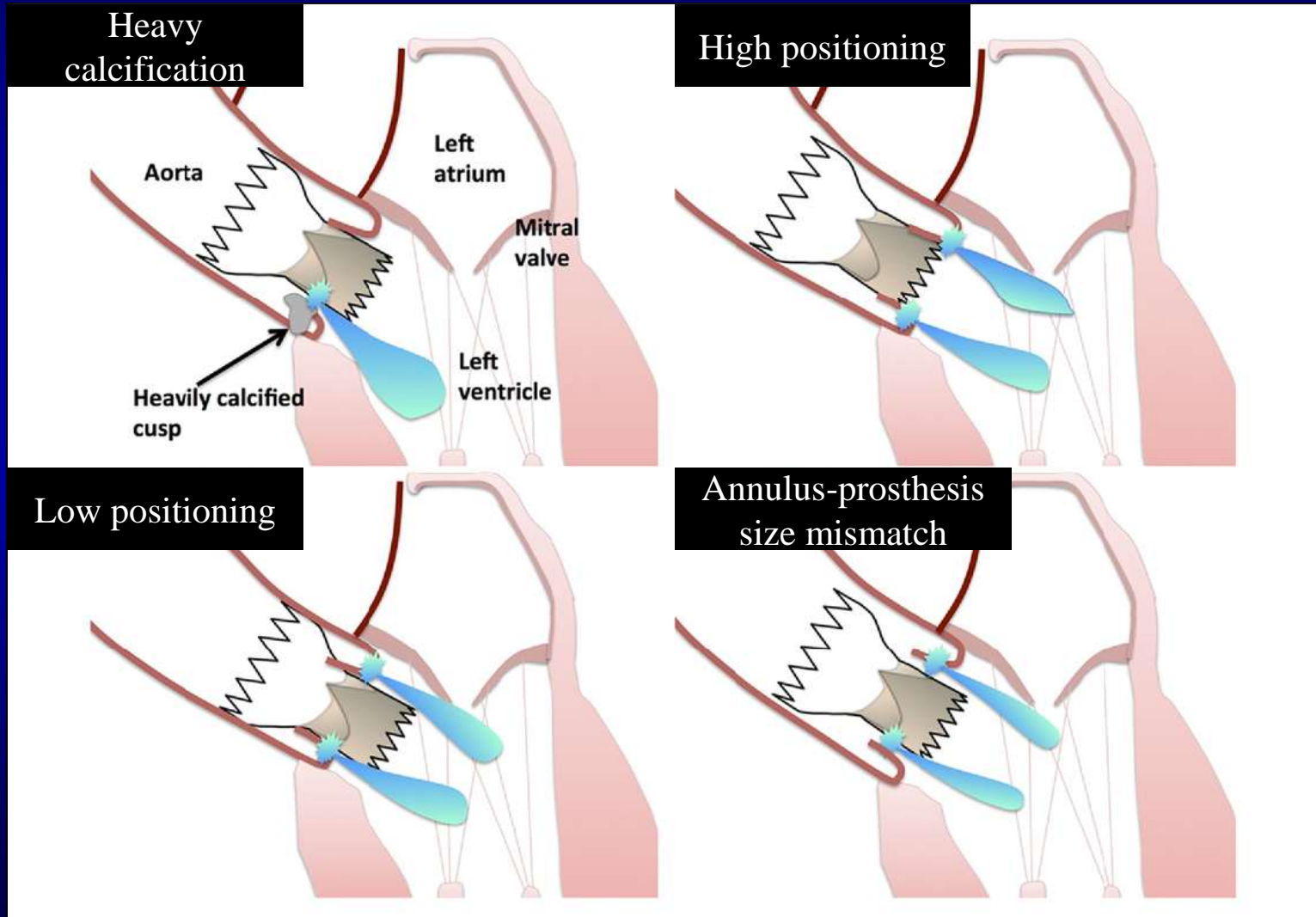
Increased rates of mod/sev AR with CoreValve (9.6% vs. 2.1%)



Wahab A.
et al.
ACC 2014

Mechanisms of AR post-TAVR

Paravalvular AR after TAVR results from under-expansion of the prosthesis stent frame, with incomplete apposition btw valve and annulus



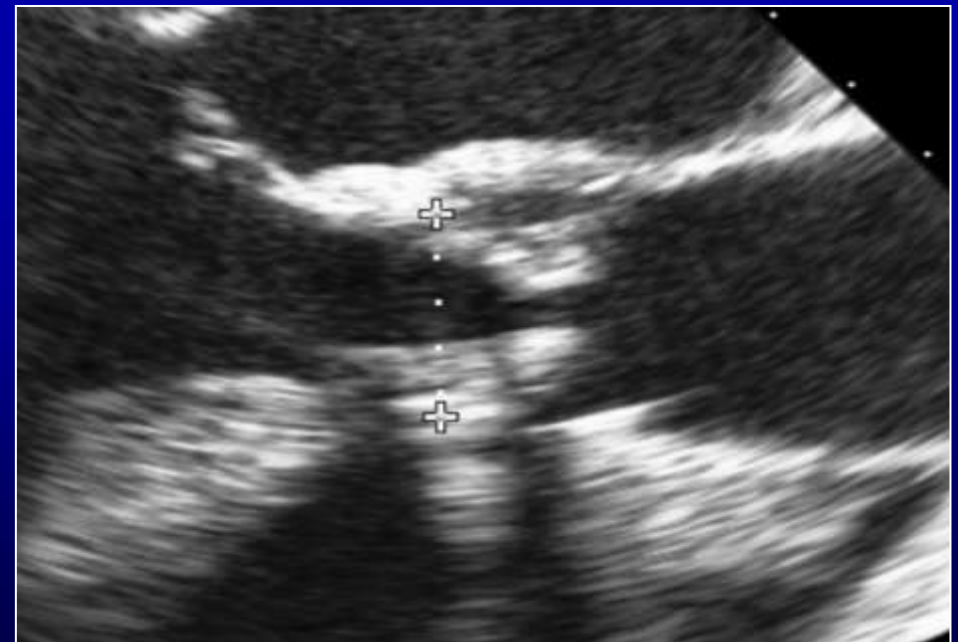
TAVI annulus sizing in 2010

Intraprocedural TEE

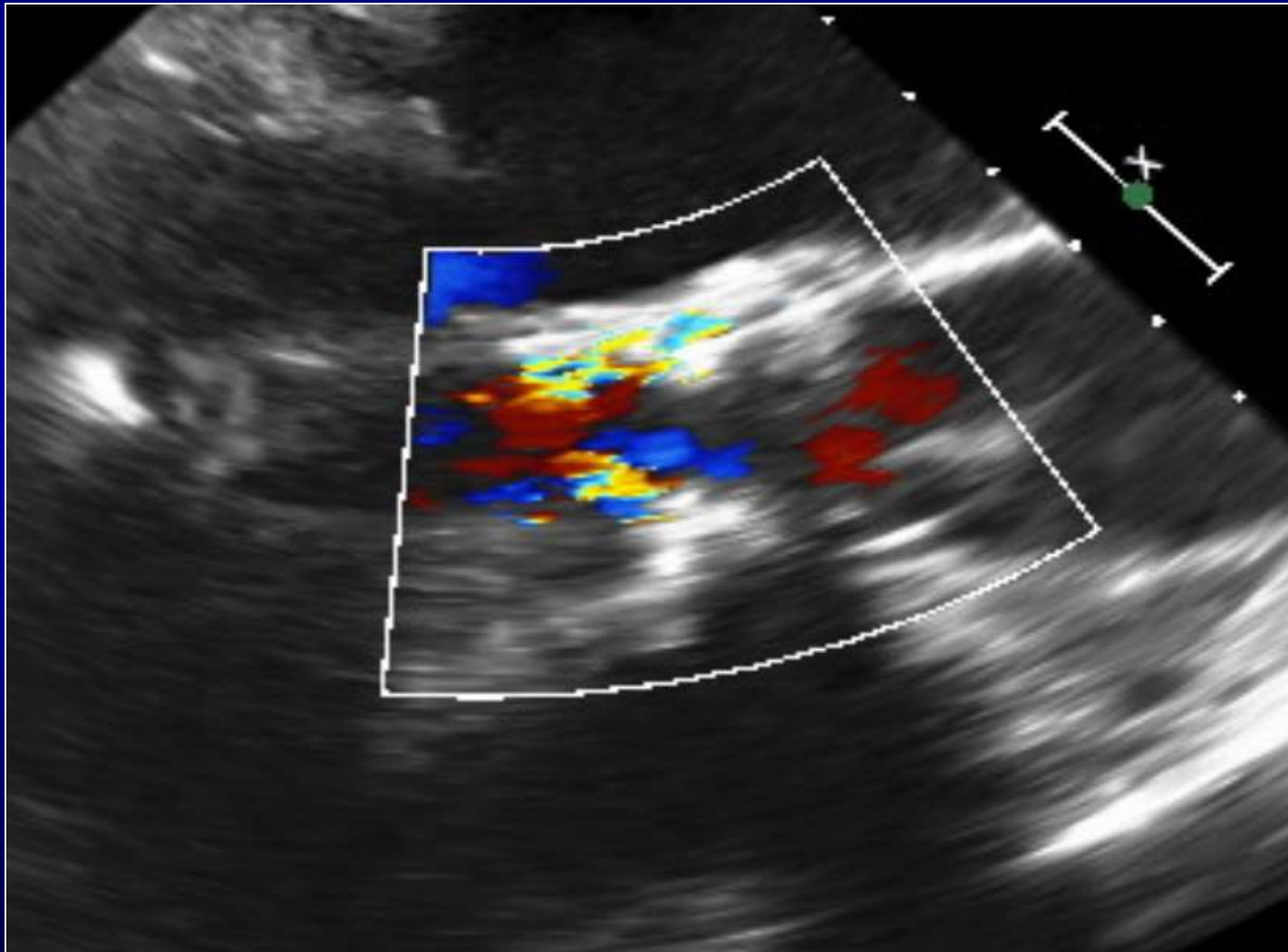


*Hinge-to-hinge
18.5 mm*

20.7 mm

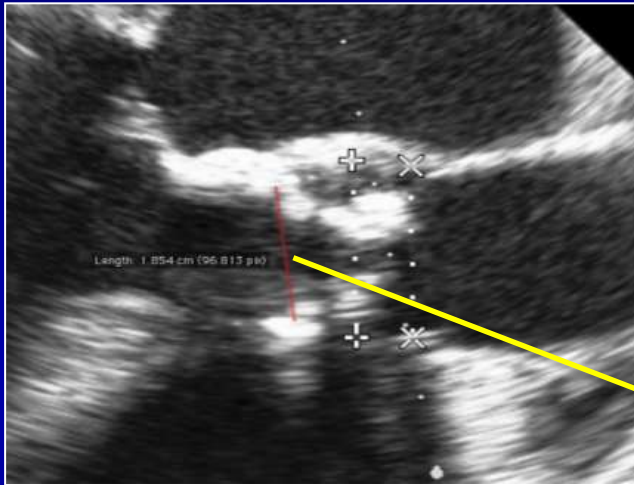


23 mm Sapien
Moderate PV AI

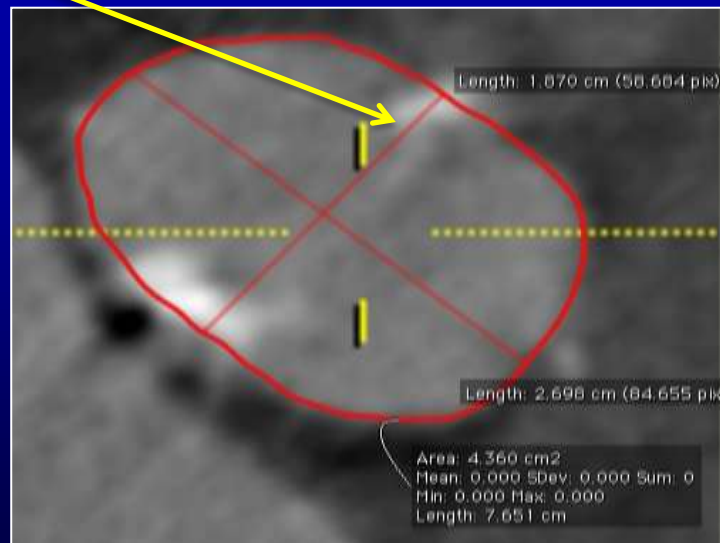


TAVI annulus sizing in 2011

Retrospective analysis of baseline CT



Hinge-point-hinge-point
18.5 mm



D_{\max} = 27.0 mm

D_{\min} = 18.7 mm

D_{mean} = 22.9 mm

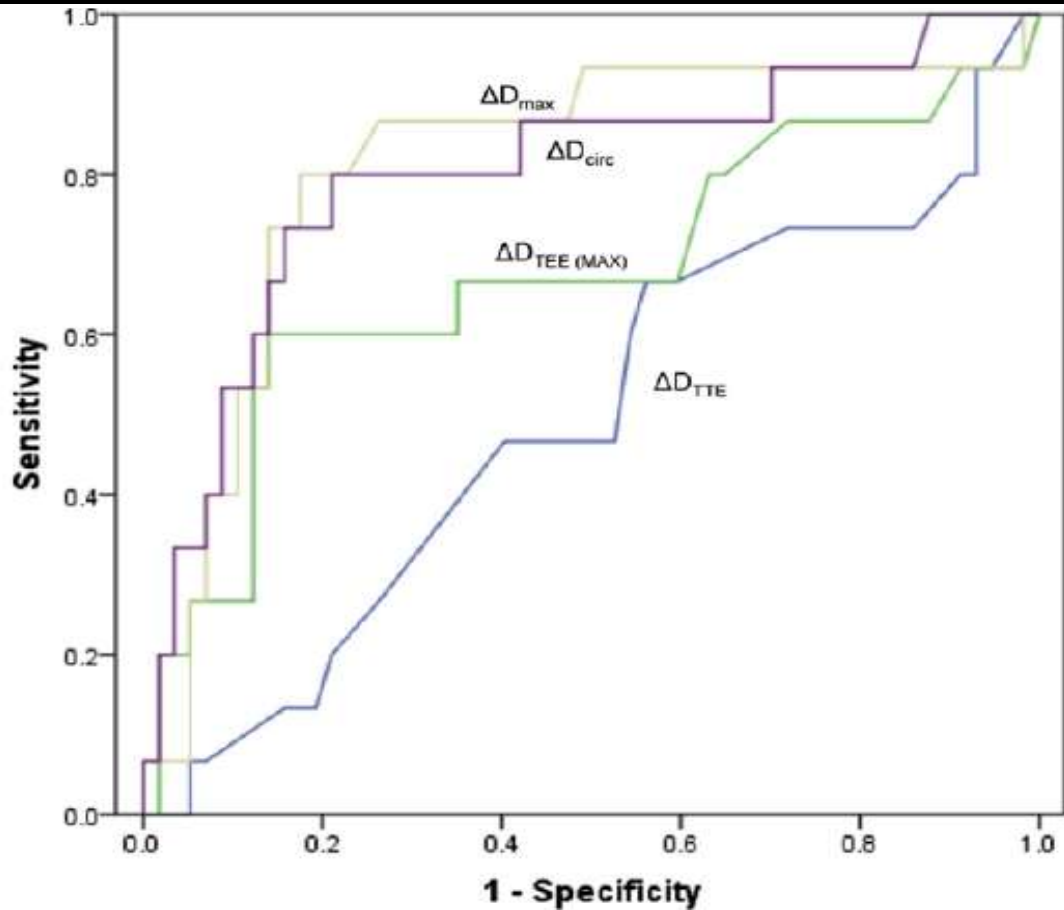
D_{circ} = 24.3 mm

D_{CSA} = 23.6 mm

Cross-Sectional Computed Tomographic Assessment Improves Accuracy of Aortic Annular Sizing for Transcatheter Aortic Valve Replacement and Reduces the Incidence of Paravalvular Aortic Regurgitation

**Cedars-Sinai
Experience**

CT versus 2D TEE/TTE



**Cross-sectional CT
measures result in
decreased rates of
paravalvular AR than
2D TEE or TTE**

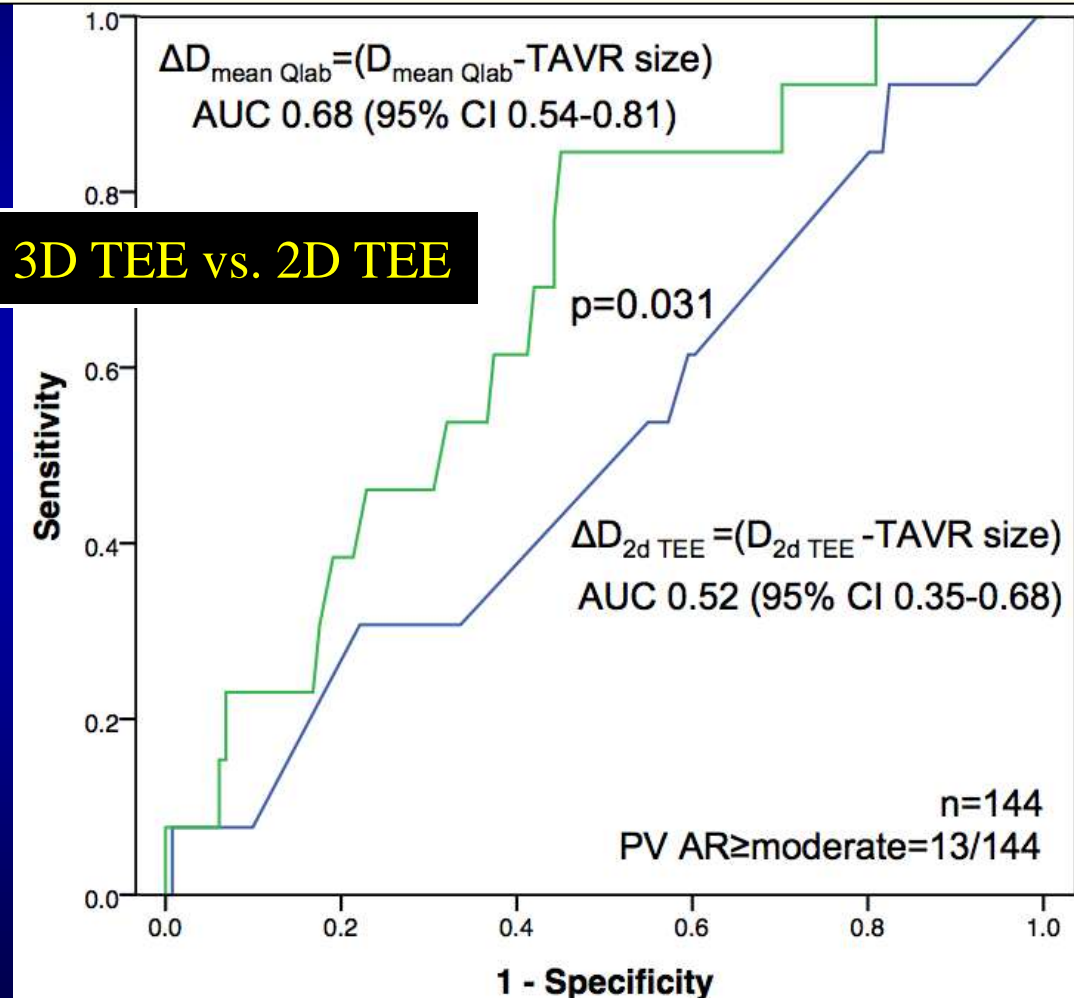
CT-guided Cross-sectional Annular Sizing results in Decreased rates of peri-valvular AR

Retrospective single center study of 136 patients undergoing TAVR with Edwards-SAPIEN valve: Cedars-Sinai Experience

Outcomes	All Studied Patients (n=136)	2D TEE-guided Annular Sizing (n=96)	CT-guided Annular Sizing (n=40)	p Value
PV AR				0.001
None	41 (30.1)	23 (24)	18 (45)	
Trivial or mild	71 (52.2)	52 (54.1)	19 (47.5)	
Mild-moderate	9 (6.6)	8 (8.3)	1 (2.5)	
Moderate	12 (8.8)	10 (10.4)	2 (5)	
Moderate-severe	3 (2.2)	3 (3.1)	0	
Severe		0	0	
PV AR > mild	24 (17.6)	21 (21.9)	3 (7.5)	0.045
Bail-out valve-in-valve	1 (0.7)	1 (1)	0	0.52
Annular rupture	1 (0.7)	1 (1)	0	0.52
Prosthesis instability	1 (0.7)	1 (1)	0	0.52
Peri-procedural mortality	4 (3)	3 (3.2)	1 (2.5)	0.82

Aortic Annular Sizing for Transcatheter Aortic Valve Replacement Using Cross-Sectional 3-Dimensional Transesophageal Echocardiography

**Cedars-Sinai
Experience**



**Cross-sectional 3D
TEE measures result
in decreased rates of
paravalvular AR
than 2D TEE**

Impact of CT-guided valve sizing on post-procedural aortic regurgitation in transcatheter aortic valve implantation

CT-guided sizing (n=175), TEE-guided sizing (n=175)

Decreased rates of AR \geq 2 and need for open heart surgery with CT-guided approach

CT-guided valve sizing is a significant predictor of post-procedural AR

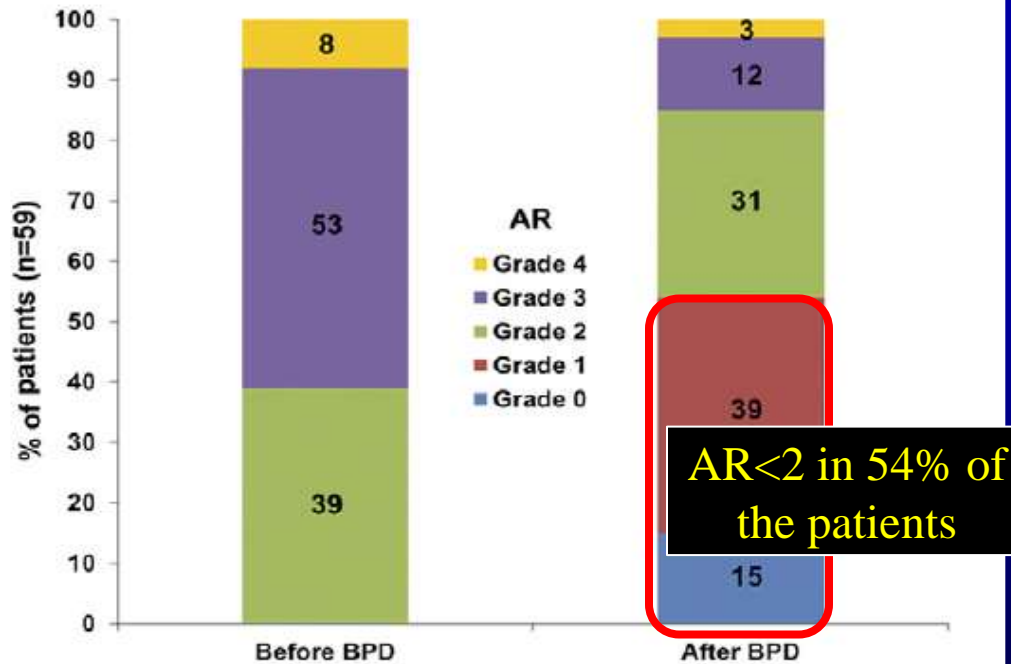
	CT-based (n=175)	TEE-based (n=175)	P-value
Post-dilatation	21 (12.0%)	17 (9.7%)	0.49
Tamponade	5 (2.9%)	4 (2.3%)	0.74
Annulus rupture	1 (0.6%)	3 (1.7%)	0.31
Valve migration	1 (0.6%)	4 (2.3%)	0.19
Need for open heart surgery	1 (0.6%)	5 (2.9%)	<0.01
Mean gradient	10.1 \pm 4.0	11.3 \pm 4.8	0.02
AR \geq 2	27 (15.4%)	42 (24.0%)	0.04
MR (0-4)	0.91 \pm 0.66	1.02 \pm 0.83	0.27
Pacemaker	14 (8.0%)	13 (7.4%)	0.84

Variables	Univariate		Multivariate	
	Odds ratio	95% CI	Odds ratio	95% CI
Valve/mDiam-CT ratio	0.31	0.14-0.70	0.36*	0.17-0.77
Valve/lDiam-CT ratio	0.45	0.25-0.83	0.56	0.23-1.38
Valve/sDiam-CT ratio	0.45	0.15-1.07	0.67	0.23-2.00
Valve/Diam-TEE ratio	0.82	0.62-1.08		
Annulus calcification score	1.46	0.92-2.31		
Valve calcification score	1.03	0.97-1.08		
Early experience	0.34	0.09-1.16		
Aortic valve area	0.20	0.01-9.92		

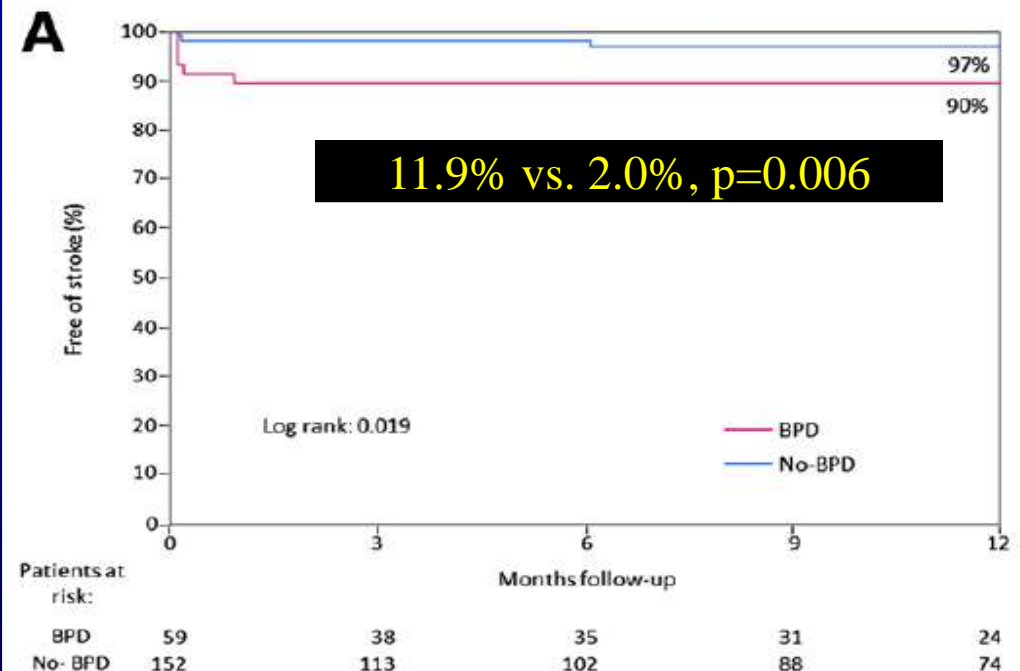
Efficacy and Safety of Balloon post-dilatation after TAVR with Balloon-expandable Valves

211 patients undergoing Edwards valve implantation, f/u 12 months
 Post-dilatation performed in patients with $AR \geq 2$: n=59 (28%)

Reduction of at least 1 degree of AR in 71% of the patients

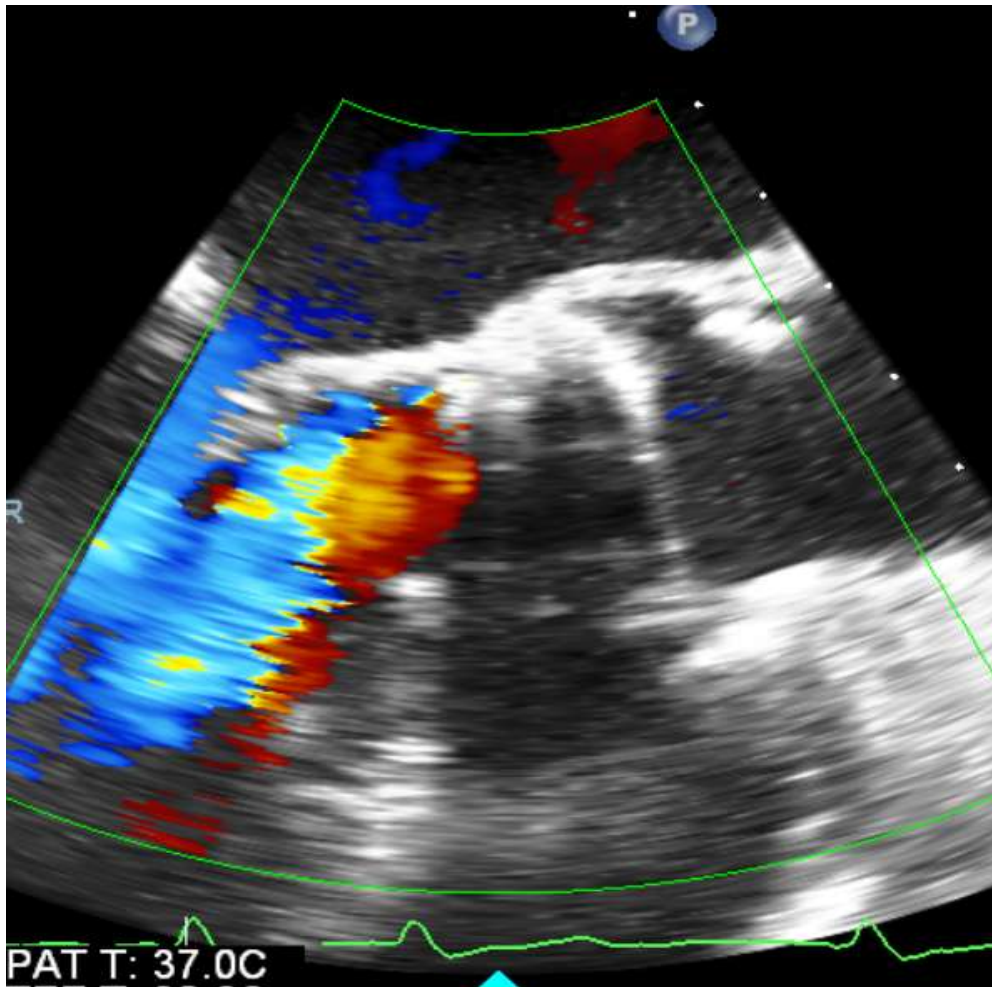


Increased stroke rates after balloon post-dilatation

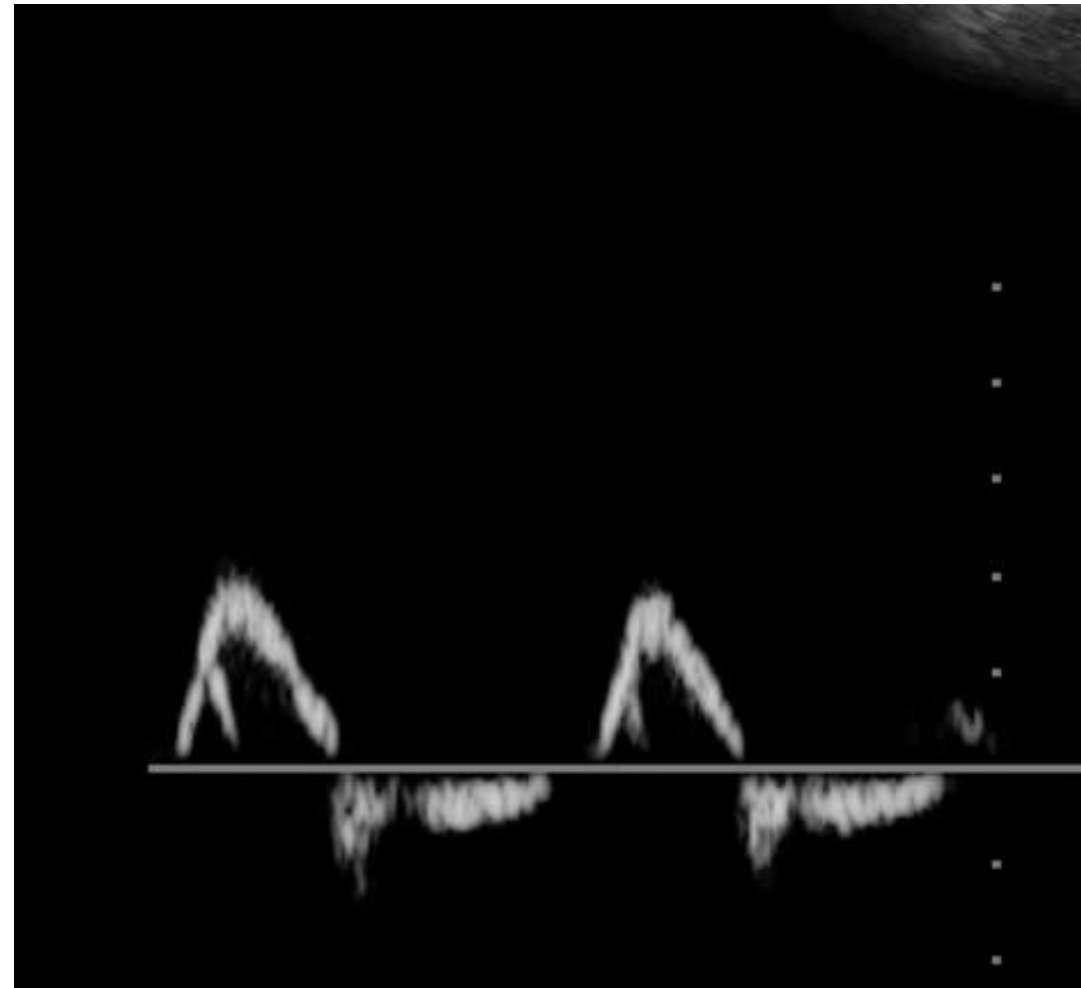


Moderate AI despite good sizing and post-dilatation

CFD



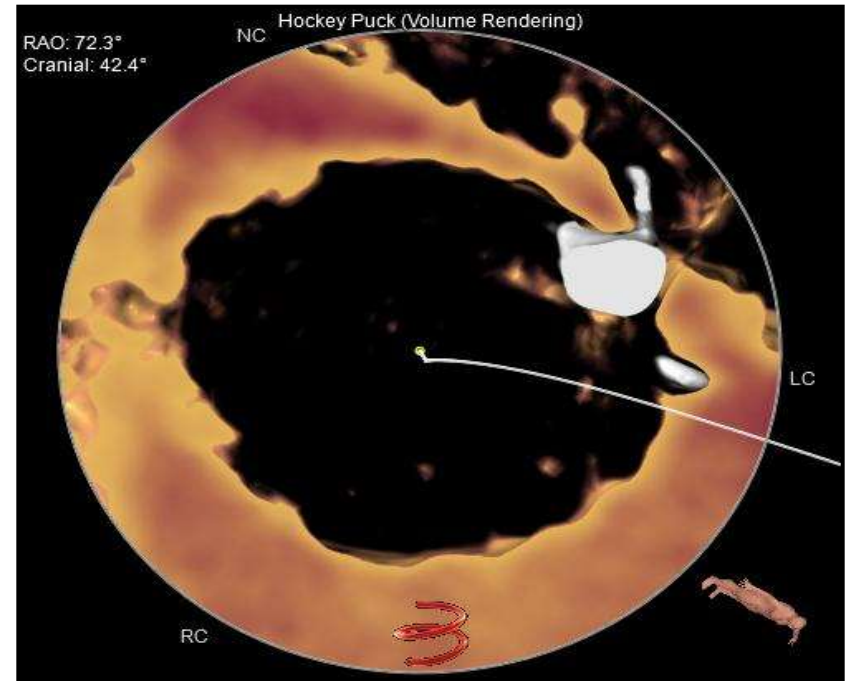
Flow wave reversal



Explanation: Posterior column of LVOT calcium Limits stent frame apposition



Longitudinal view



**Cross-section of
LVOT**

Transcatheter Aortic Valve Replacement With the SAPIEN 3

A New Balloon-Expandable Transcatheter Heart Valve



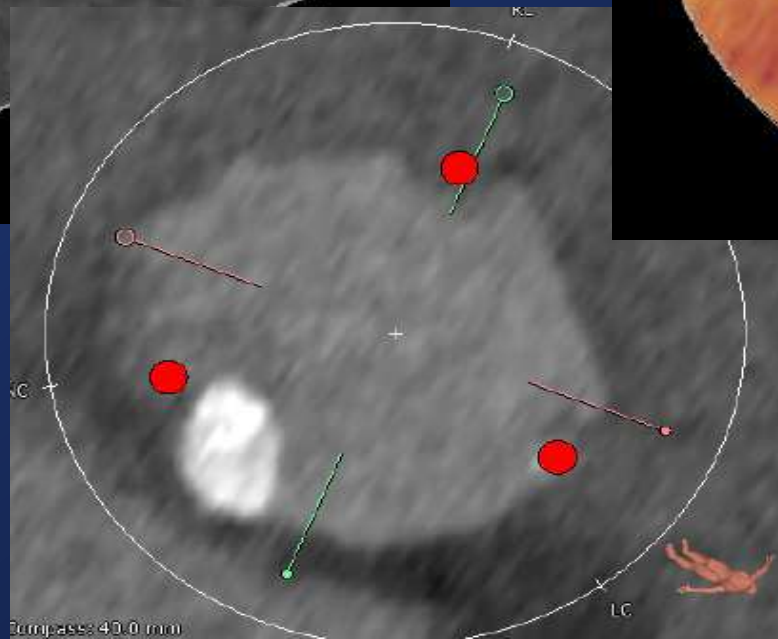
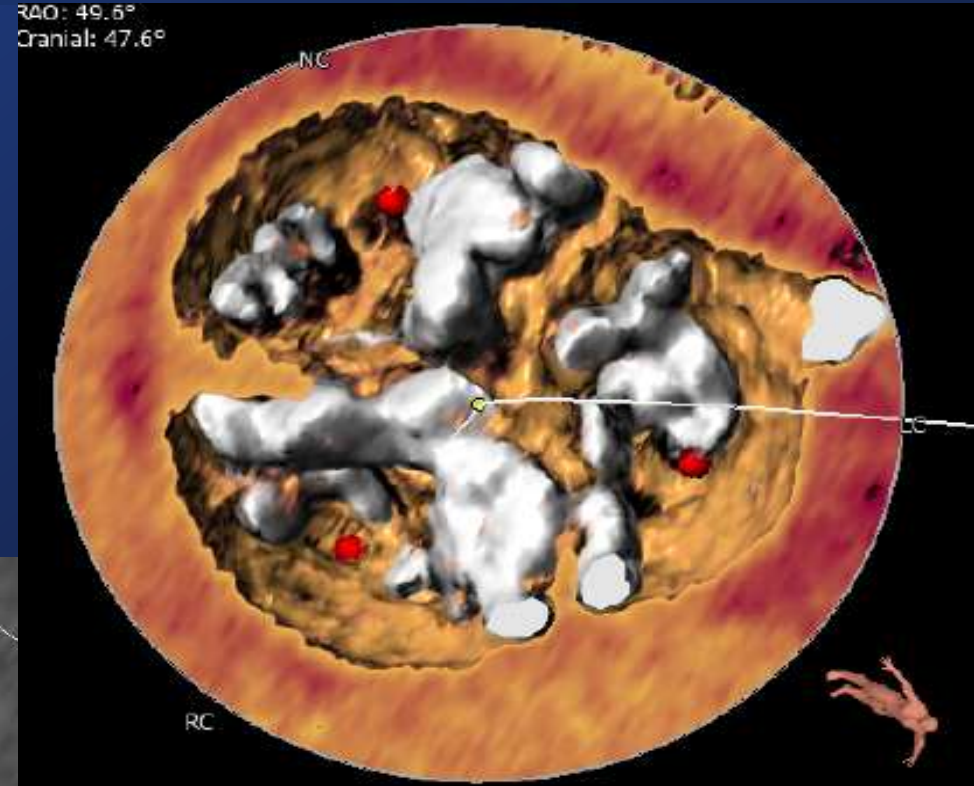
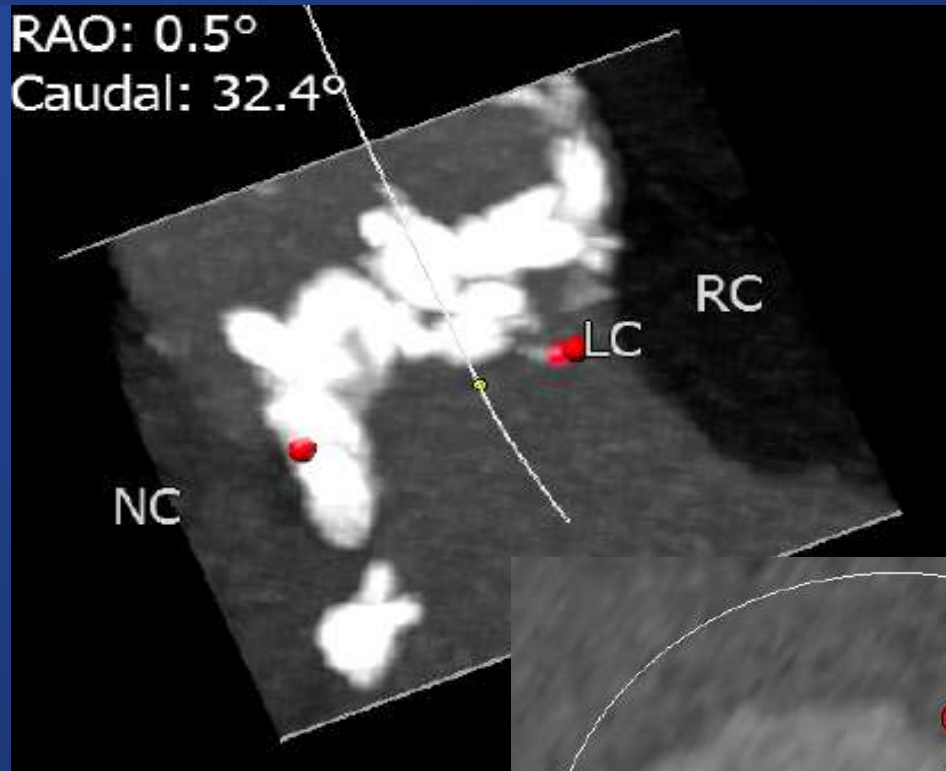
15 patients undergoing TAVR with SAPIEN 3 Valve

**MDCT based AVA $4.9 \pm 0.4 \text{ cm}^2$
with $9.7 \pm 6.9\%$ THV oversizing.**

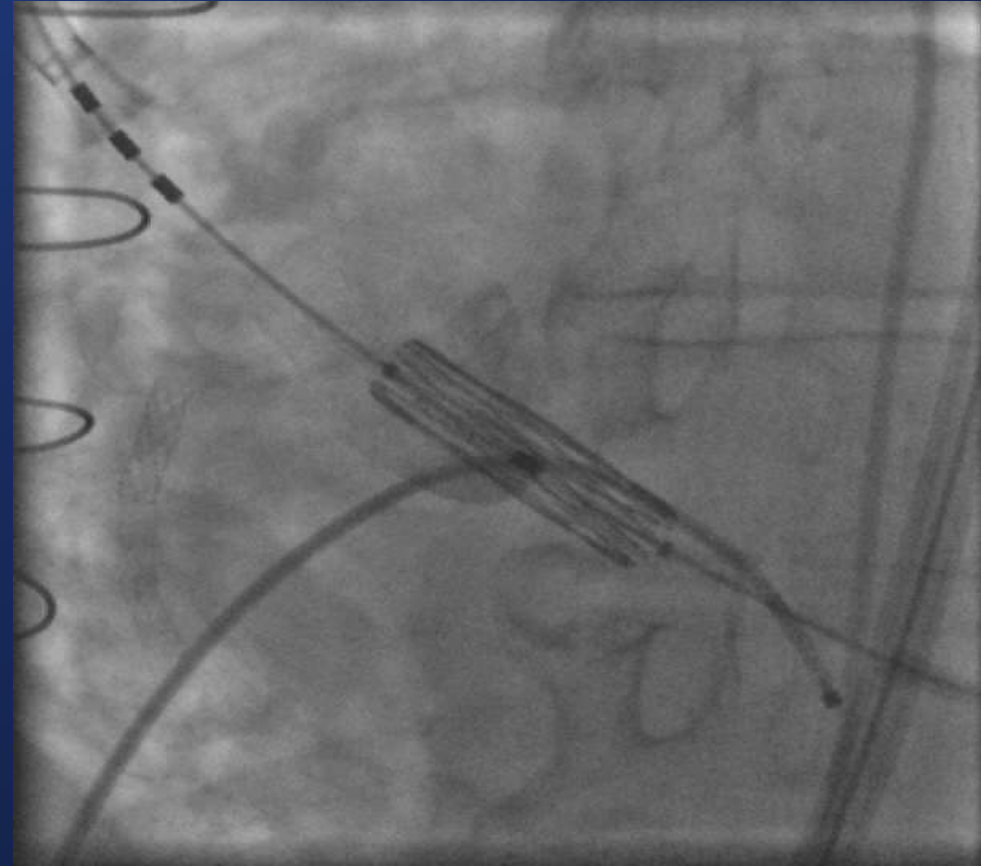
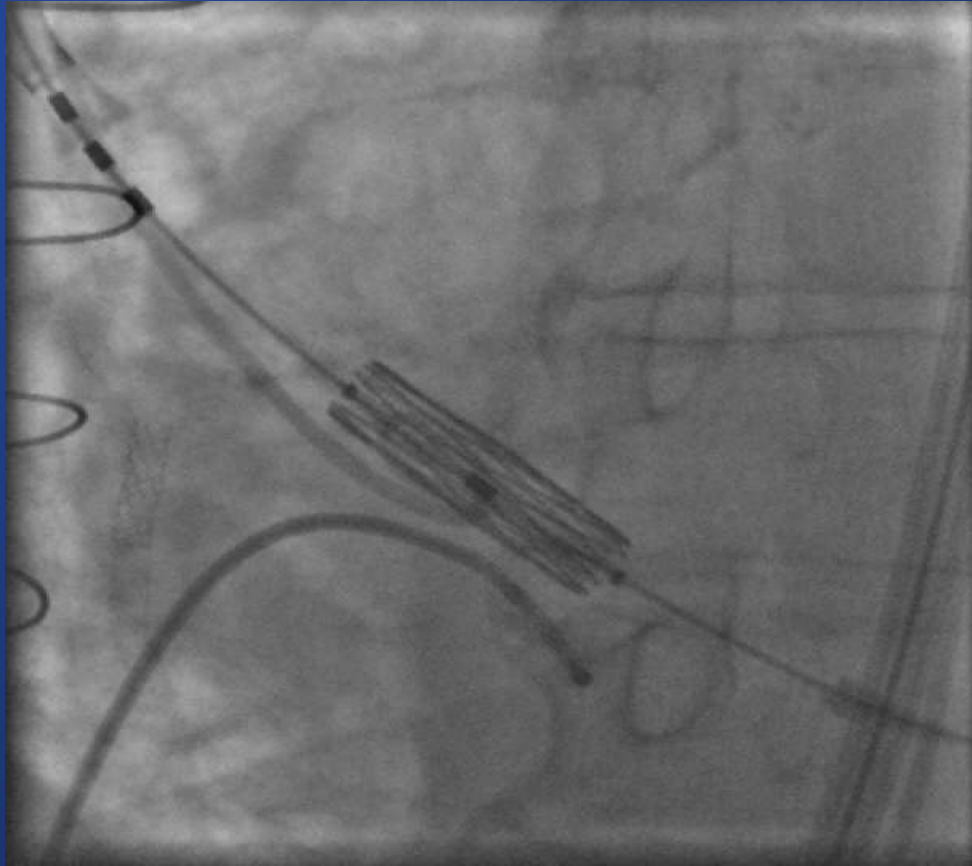
Annular Area (mm ²)	Percent Oversizing
400	NR
410	29.5
420	26.4
430	23.5
440	20.7
450	18.0
460	15.4
470	13.0
480	10.6
490	8.4
500	6.2
510	4.1
520	2.1
530	0.2
540	NR

Variable (n=15)	Outcome
AVA	Baseline: $0.7 \pm 0.2 \text{ cm}^2$ Post-TAVR: $1.5 \pm 0.2 \text{ cm}^2$
Mean gradient	Baseline: $42.2 \pm 10.3 \text{ mmHg}$ Post-TAVR: $11.9 \pm 5.3 \text{ mmHg}$
> Mild AR	0/15
Hospital discharge	Median 3 (Range 2-12) days
30-day outcomes	
Death	0/15
Stroke	0/15
Vascular complications	0/15
Bleed/transfusion	0/15
Pacemaker	1/15 (6.7%)
NYHA Class I/II	15/15 (100%)

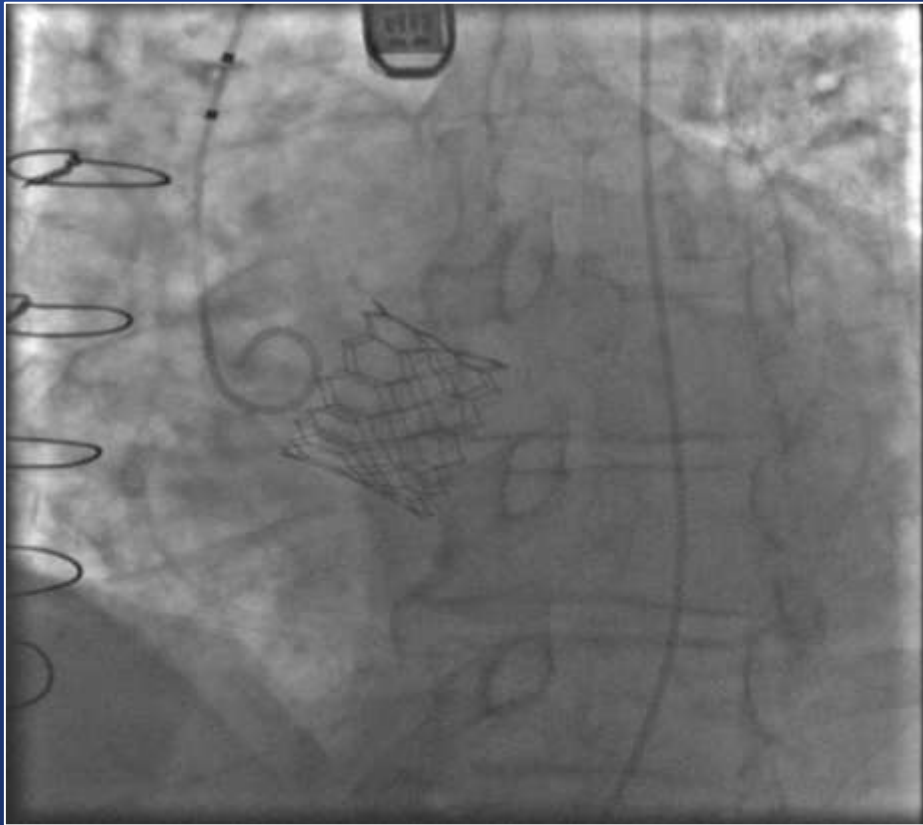
S3 in heavily calcified AS with LVOT calcium



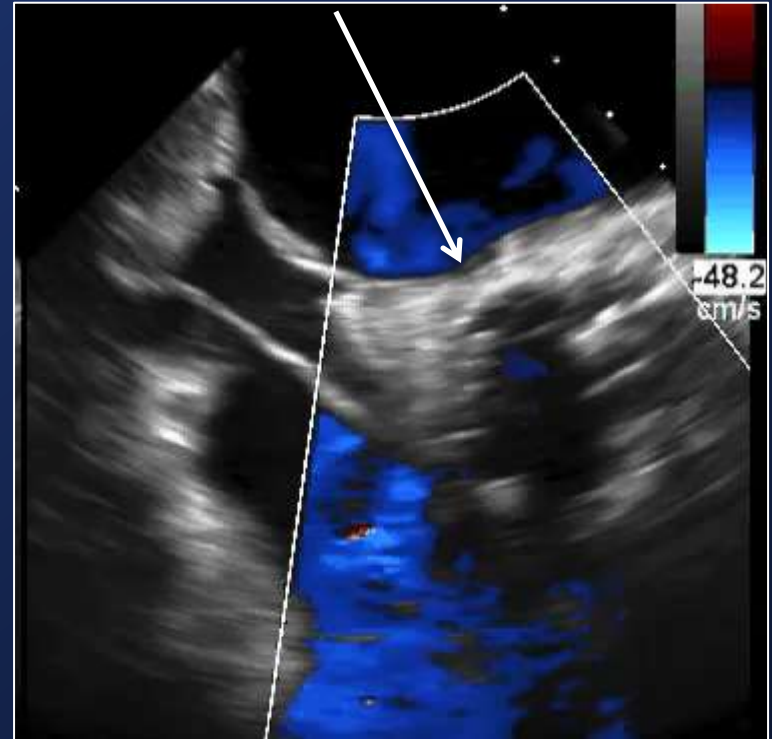
S3 in heavily calcified AS with LVOT calcium



S3 in heavily calcified AS with LVOT calcium

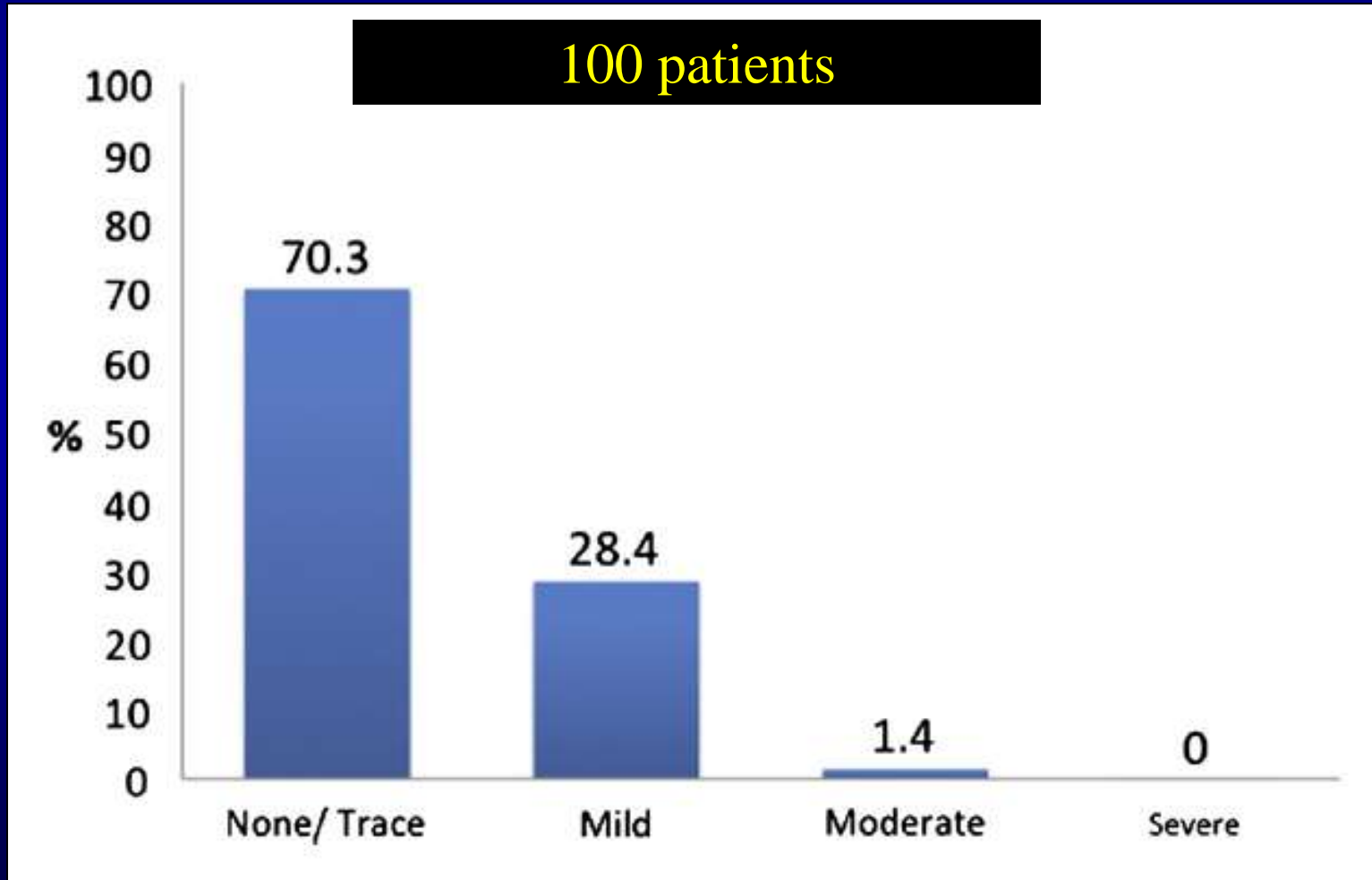


Nodule of calcium prevents full expansion
BUT Zero PVL=no malapposition



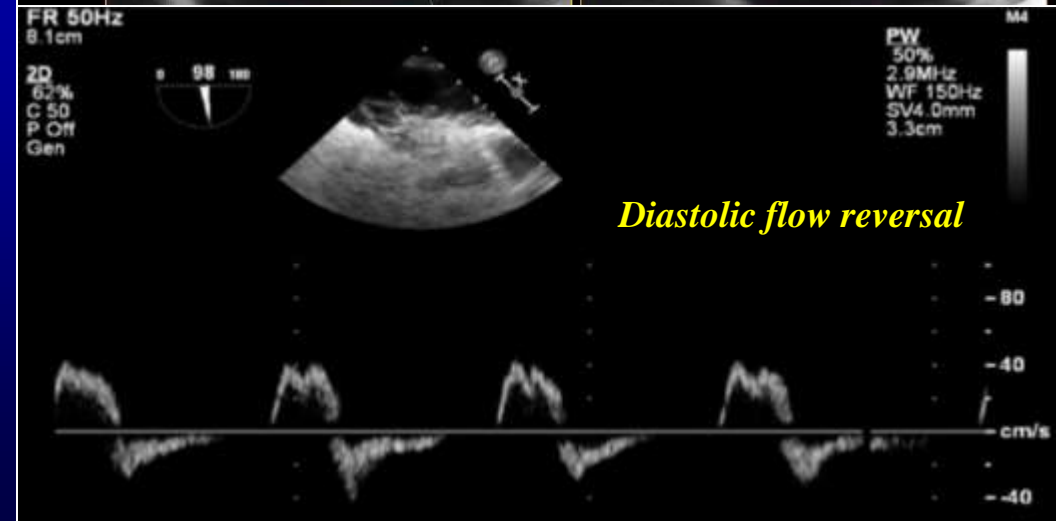
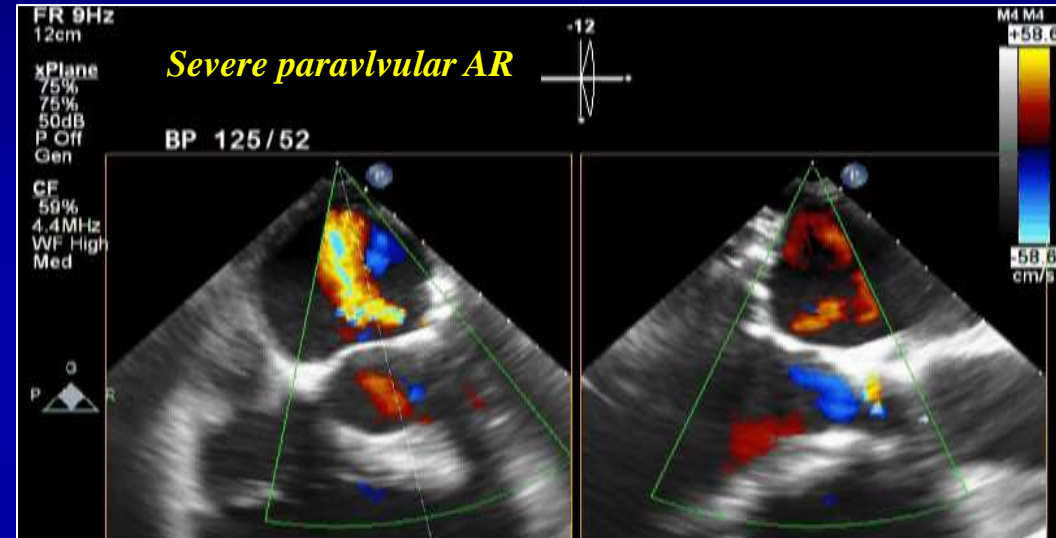
Incidence of PVAR with Lotus Valve

None-mild AR in > 98% of patients



81 y/o male s/p TAVR with 26mm Edwards-SAPIEN valve p/w worsening CHF, NYHA III

Severe paravalvular AR noted



Paravalvular AR closed with Amplatzer Vascular Plug II 8-mm device

Amplatzer vascular plug



Mild residual paravalvular AR

- *Discharged home on Day#6 post-procedure*
- *NYHA Class 2 on 2 month follow-up*

No residual paravalvular AR

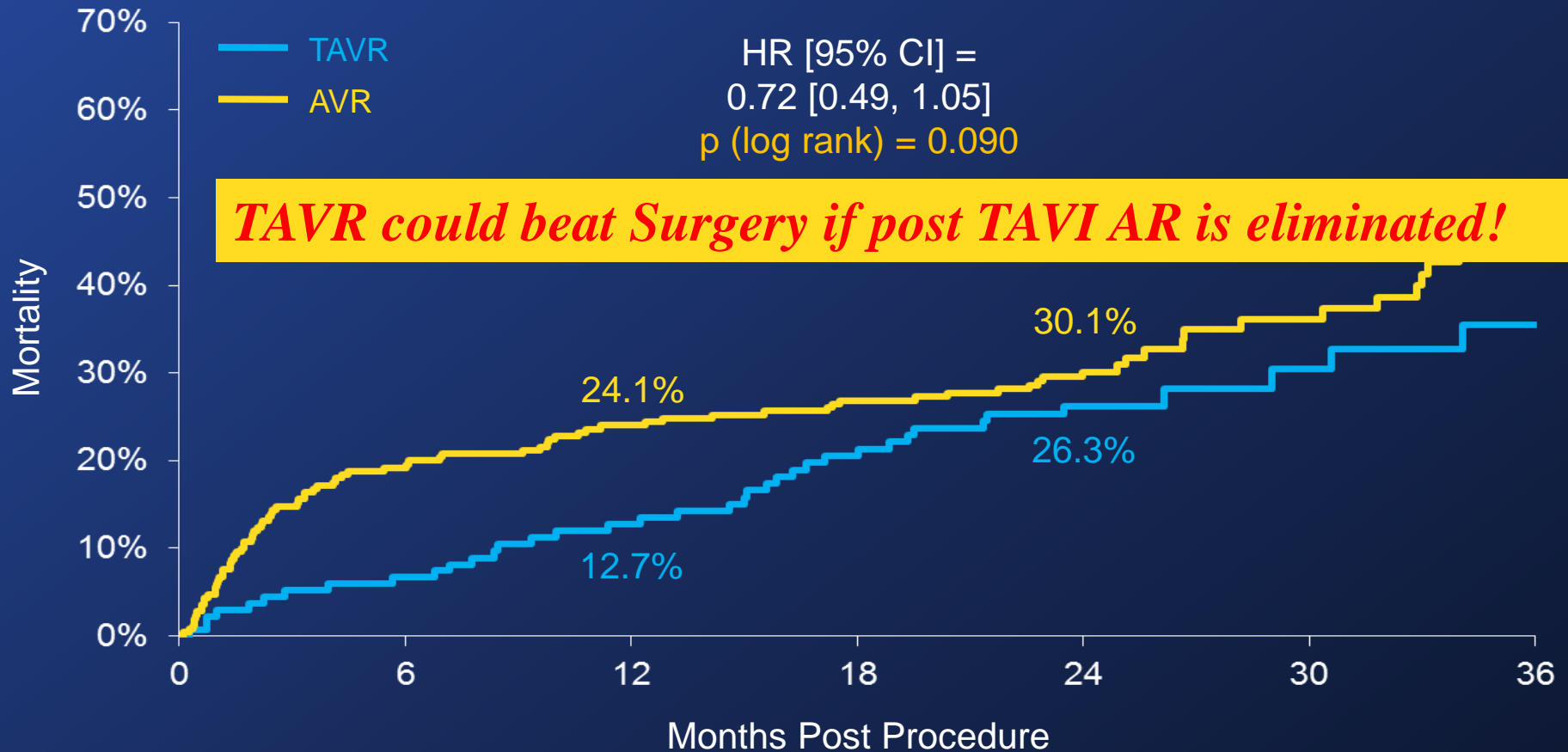
M4 M4
54.2
cm/s

No diastolic flow reversal noted

74 bpm

Mortality in Patients with None-Trace AR

TAVR vs AVR:



Numbers at Risk

	0	6	12	18	24	30	36
TAVR	135	125	115	101	68	31	11
AVR	252	201	189	176	118	52	22

Paravalvular AR is a significant predictor of mortality after TAVR

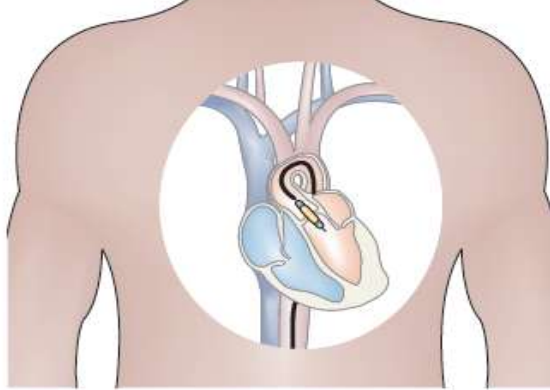
Study	No. of patients	Significant PV AR, n (%)	Follow-up	HR (95% CI) (multivariable)
Sinning et al	146	22 (15.0)	Up to 1 year	2.4 (1.0–5.4)
Tamburino et al	663	139 (21.0)	Median 18 months	3.79 (1.57-9.10)
Moat et al				0.55 (0.1-1.1)
Gilard et al				0.5 (0.1-1.5)
Abdel-Wahab	690	119 (17.2)	In-hospital	2.43 (1.22-4.85)
Vasa-Nicotera et al	122	20 (16.3)	1-year	4.19 (2.05-8.59)

HR of TAVR vs. Medical treatment was 0.55 in PARTNER B trial suggesting >moderate post TAVR AI could lead to loss of all survival gains from TAVR in the real world TAVI

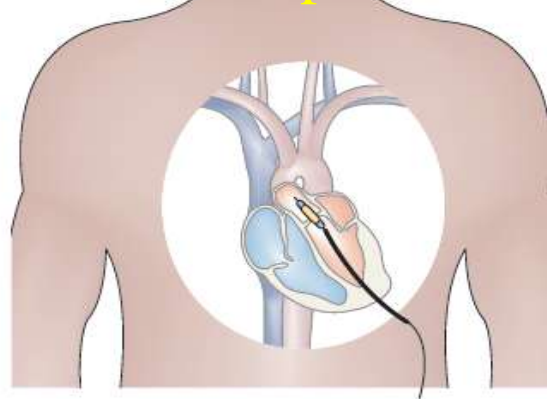
Vascular Complications

Approaches for TAVR

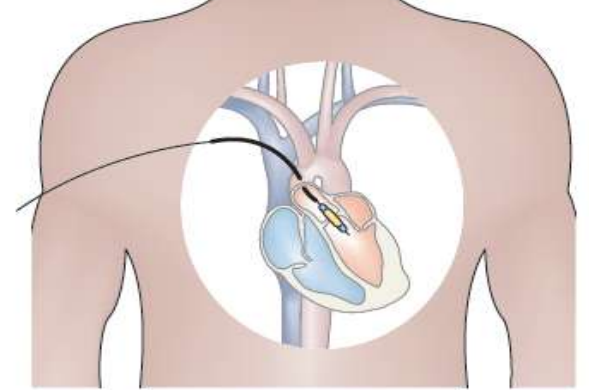
Transfemoral



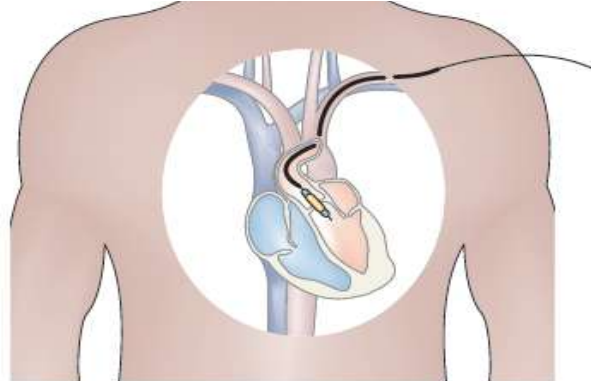
Transapical



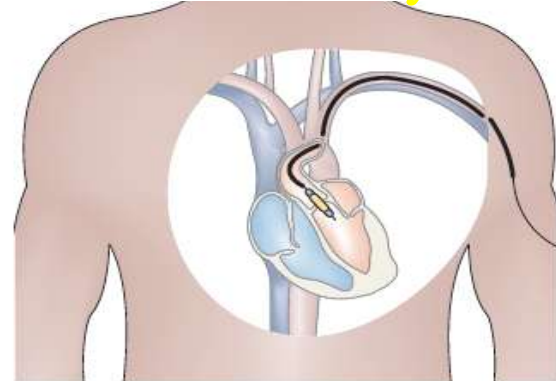
Transaortic



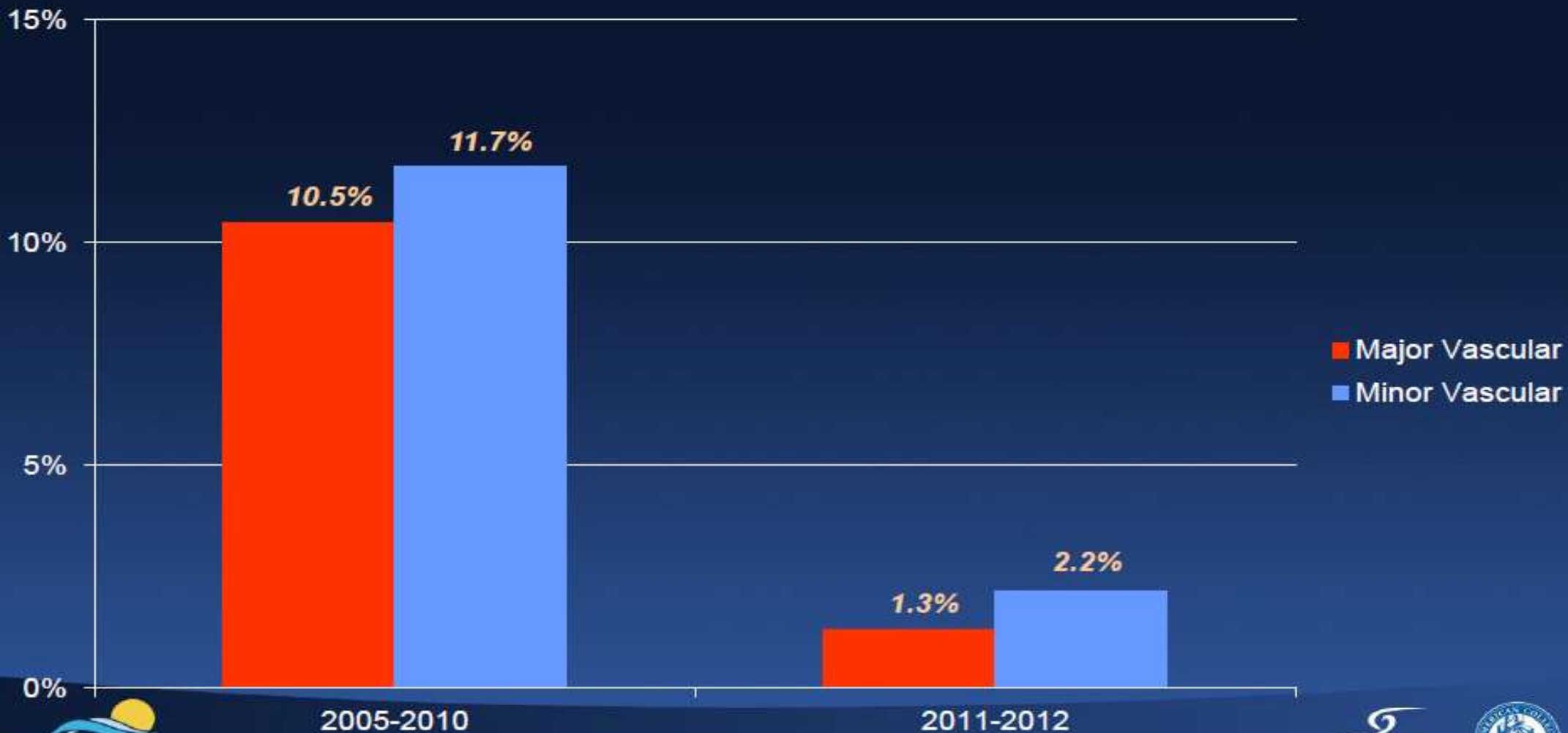
Subclavian



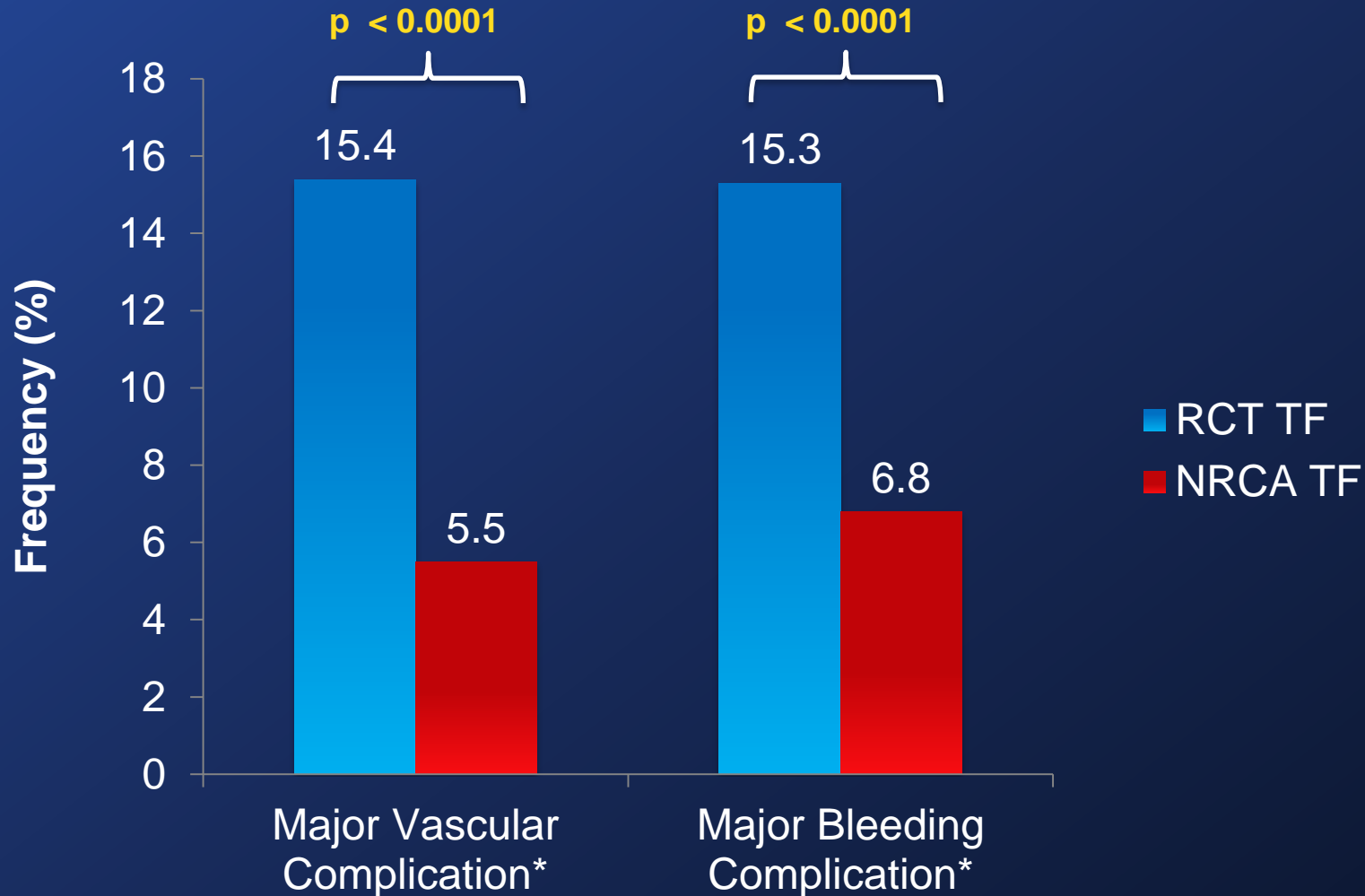
Transaxillary



Vascular Complication according to the period Vancouver



Progress from RCT to Continued Access Registry



*Based on Modified VARC 1 Definitions

Edwards SAPIEN vs SAPIEN XT Transcatheter Heart Valves



NEW FRAME GEOMETRY

- Less metal content
- Lower crimp profile

NEW FRAME MATERIAL

- Cobalt-chromium
- Greater tensile and yield strength

NEW LEAFLET GEOMETRY

- Partially closed

SAPIEN THV

Stainless Steel



SAPIEN XT THV

Cobalt-chromium



RetroFlex 3



NovaFlex

Sheath Size Comparison

Valve	Valve Size	Sheath ID	Sheath OD	Minimum Vessel Diameter
SAPIEN THV	23mm	22F	25F (8.4mm)	7.0mm
SAPIEN XT THV	23mm	18F	22F (7.2mm)	6.0mm
SAPIEN THV	26mm	24F	28F (9.2mm)	8.0mm
SAPIEN XT THV	26mm	19F	23F (7.5mm)	6.5mm



33% reduction in CSA

Vascular and Bleeding Events: At 30 Days (AT) in PARTNER II Trial



Events	SAPIEN (n=271)		SAPIEN XT (n=282)		p-value
	n	%	n	%	
Vascular:					
Major	42	15.5	27	9.6	0.04
Minor	20	7.4	14	5.0	0.23
Bleeding:					
Disabling	34	12.6	22	7.8	0.06
Major	44	16.4	44	15.7	0.84
Patients with transfusions	80	29.5	73	25.9	0.40

Secondary Endpoints

CoreValve Randomized Trial of TAVR vs. SAVR

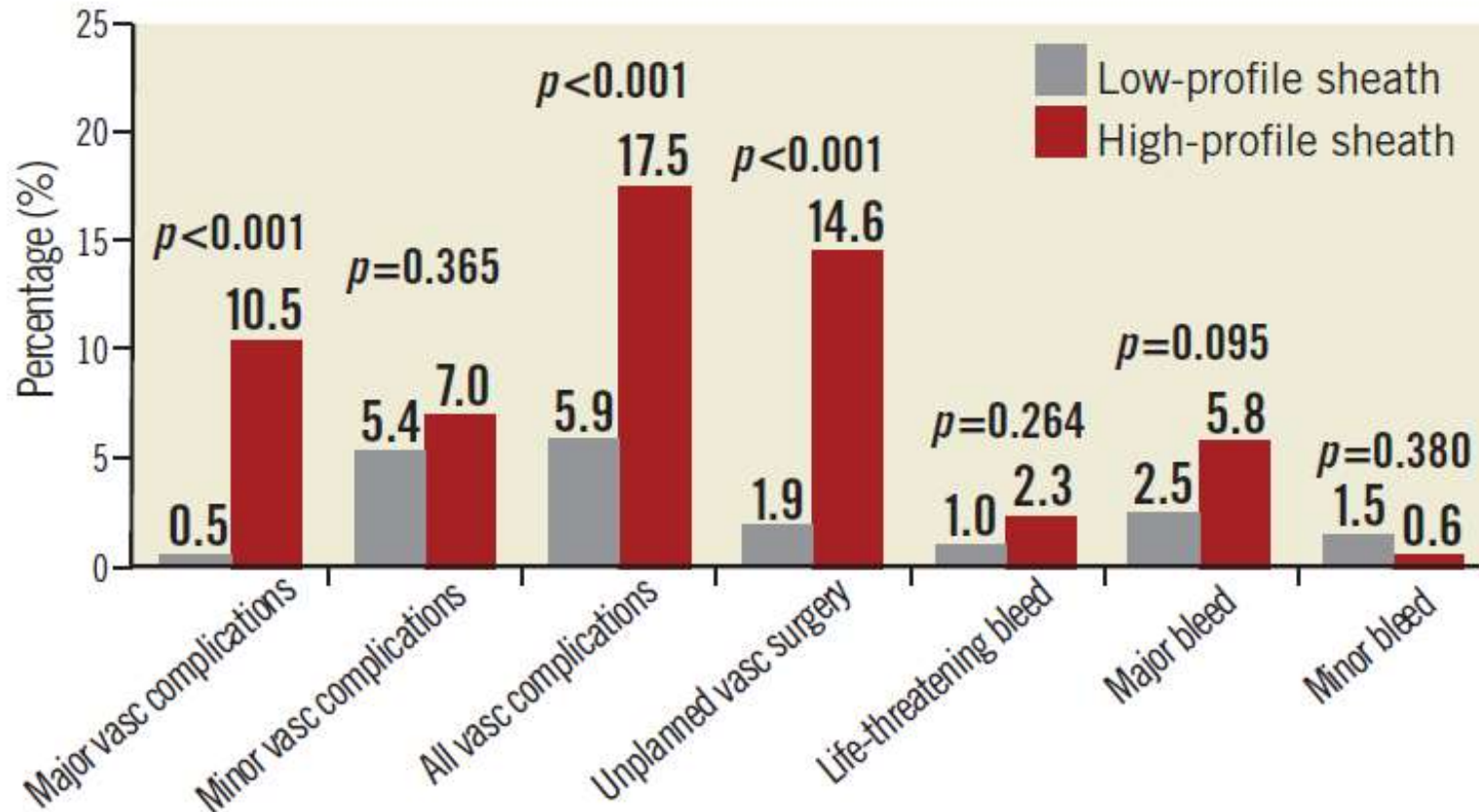
Events*	1 Month			1 Year		
	TAVR	SAVR	P Value	TAVR	SAVR	P Value
Vascular complications (major), %	5.9	1.7	0.003	6.2	2.0	0.004
Pacemaker implant, %	19.8	7.1	<0.001	22.3	11.3	<0.001
Bleeding (life threatening or disabling), %	13.6	35.0	<0.001	16.6	38.4	<0.001
New onset or worsening atrial fibrillation, %	11.7	30.5	<0.001	15.9	32.7	<0.001
Acute kidney injury, %	6.0	15.1	<0.001	6.0	15.1	<0.001

* Percentages reported are Kaplan-Meier estimates and log-rank P values

Impact of low-profile sheaths on vascular complications: Canadian experience

Low profile sheath 14-18F (n=204); high-profile sheath 19-24F(n=171)

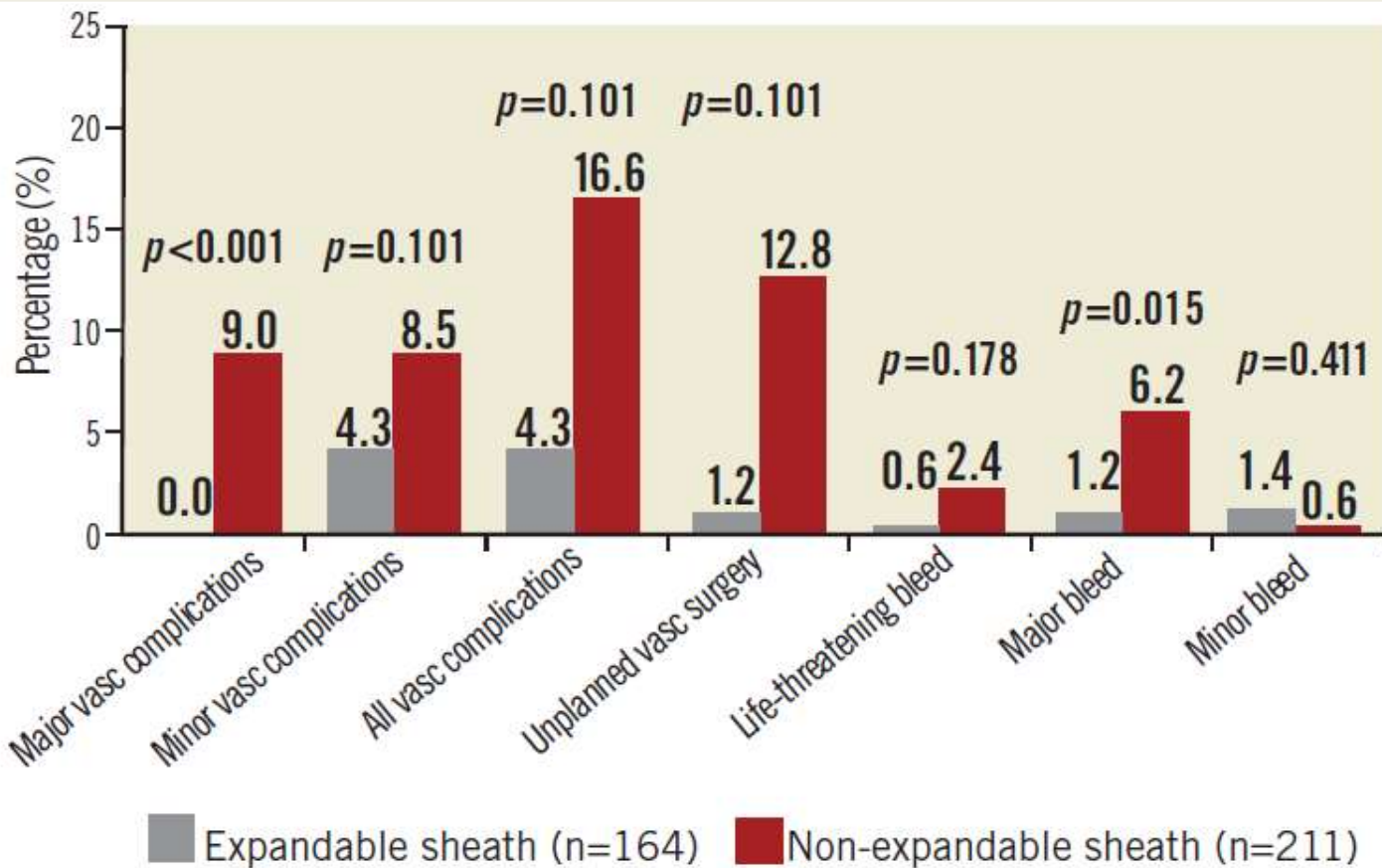
Significant reduction in VARC2 major vascular complications



Impact of expandable sheaths on vascular complications: Canadian experience

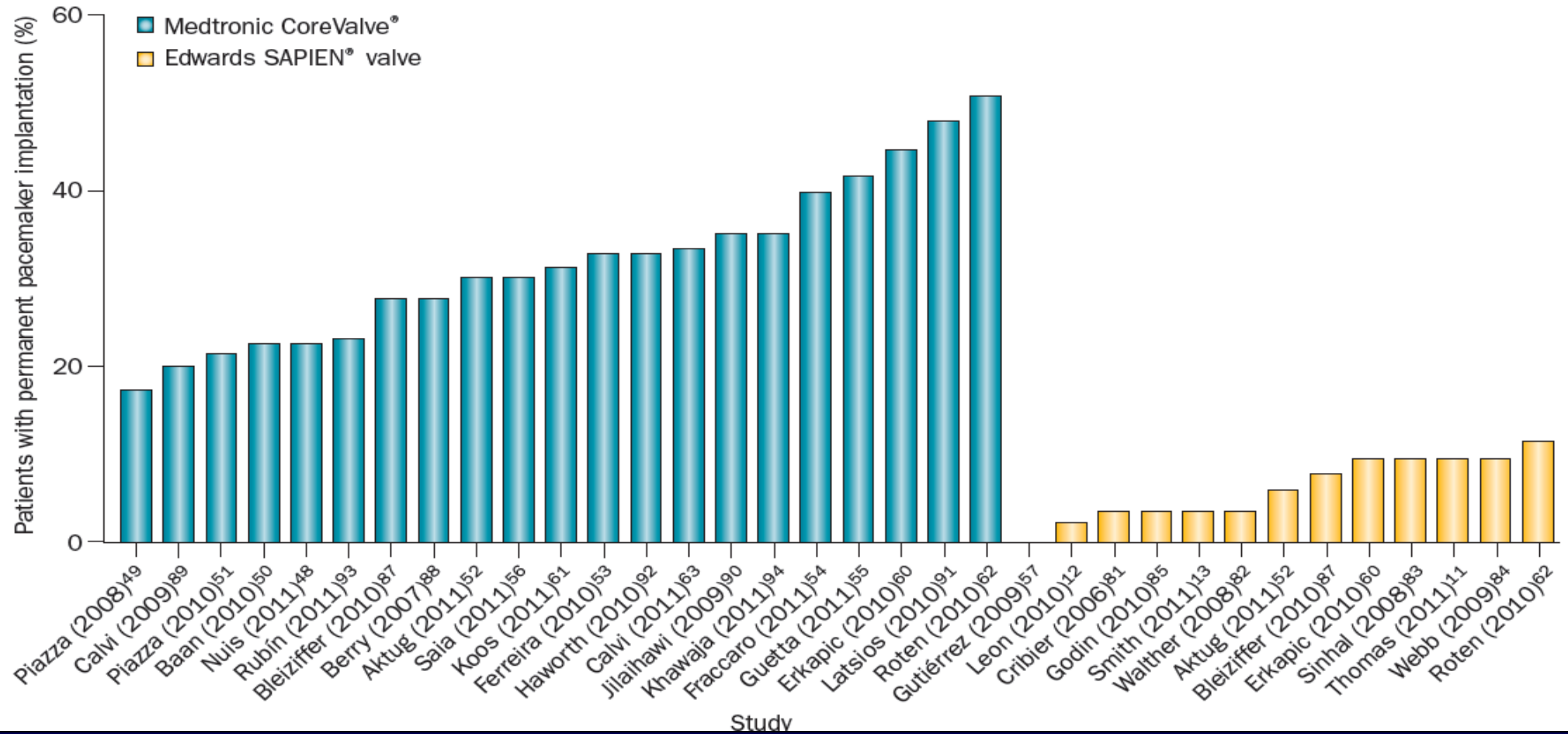
Expandable sheath (n=188); standard sheaths (n=187)

Significant reduction in VARC2 major vascular complications

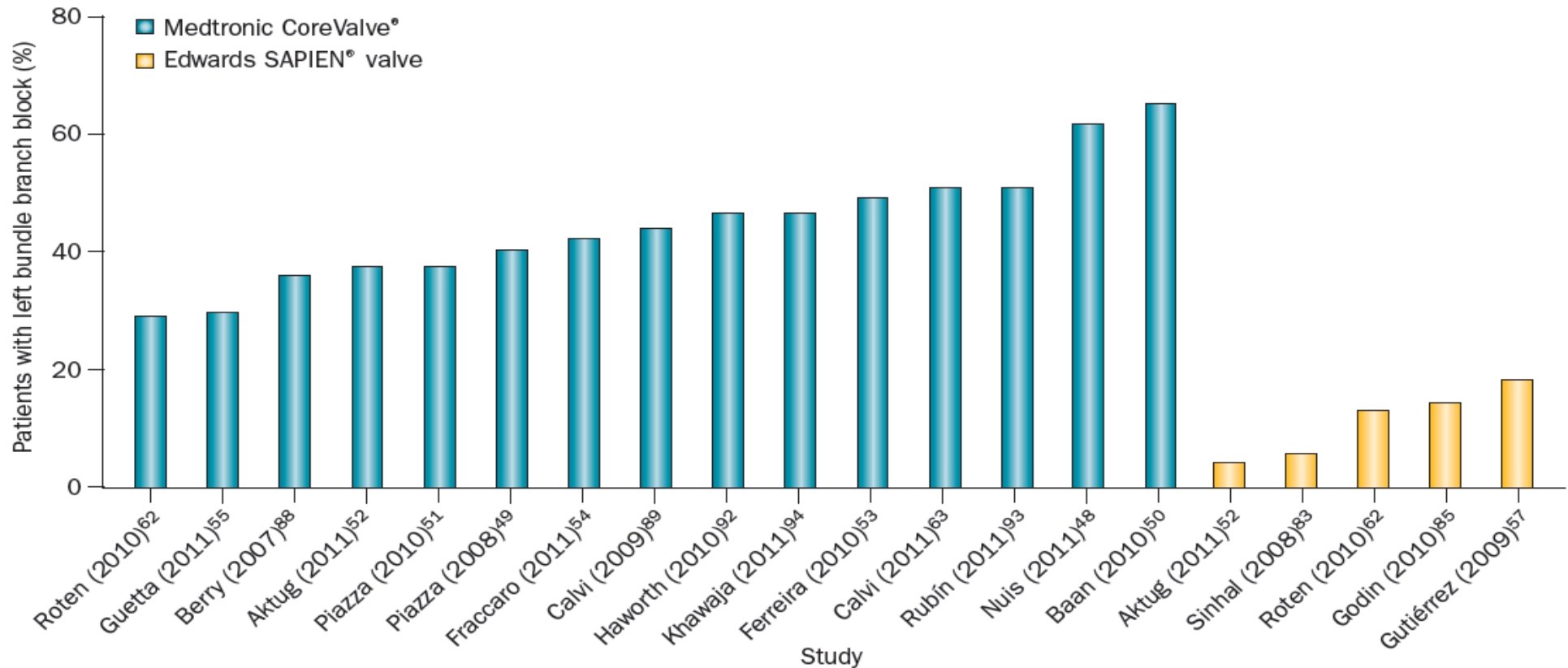


Conduction abnormalities

Incidence of Permanent Pacemaker Implantation after TAVR with Medtronic CoreValve or Edwards-SAPIEN valve



Incidence of LBBB after TAVR with Medtronic CoreValve or Edwards-SAPIEN valve



Clinical Significance of persistent LBBB after TAVR with Balloon-expandable valves

202 patients, 100% follow-up, median f/u 12 months

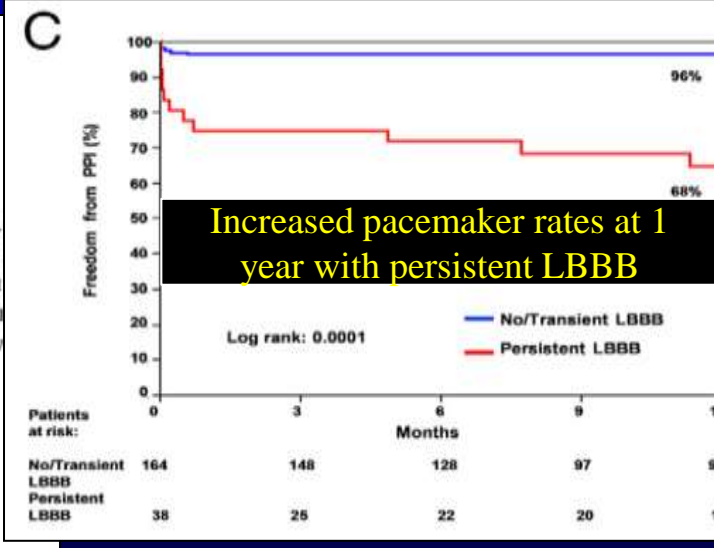
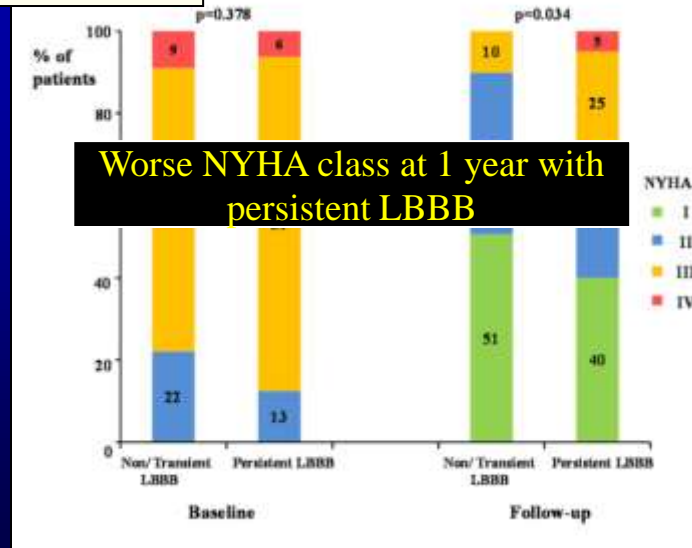
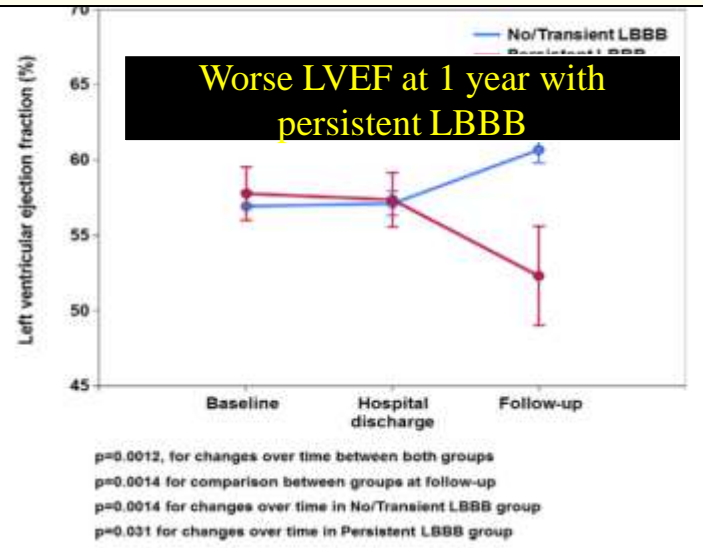
New LBBB, n=61 (30.2%)

Variable	New-Onset LBBB (n = 61)	No LBBB (n = 142)	p Value
Complete AVB	8 (13.1)	6 (4.3)	0.023
Need for PPI	8 (13.1)	6 (4.3)	0.023
Major vascular complications	4 (6.6)	3 (2.1)	0.202
Major bleeding	9 (14.8)	14 (9.9)	0.194
Myocardial infarction	0	2 (1.4)	0.998
Stroke	3 (4.9)	1 (0.7)	0.083
Death	6 (9.8)	8 (5.7)	0.285
Hospital length of stay (days)	8 (5-13)	7 (6-9)	0.091

Independent predictors of LBBB

- Baseline QRS duration
- Ventricular depth of the prosthesis

New-onset LBBB was the **only** predictor of pacemaker implantation after TAVR



Incidence and Persistence of New-onset LBBB



PARTNER Trial: Cohort A and B and Continued Access Cohort

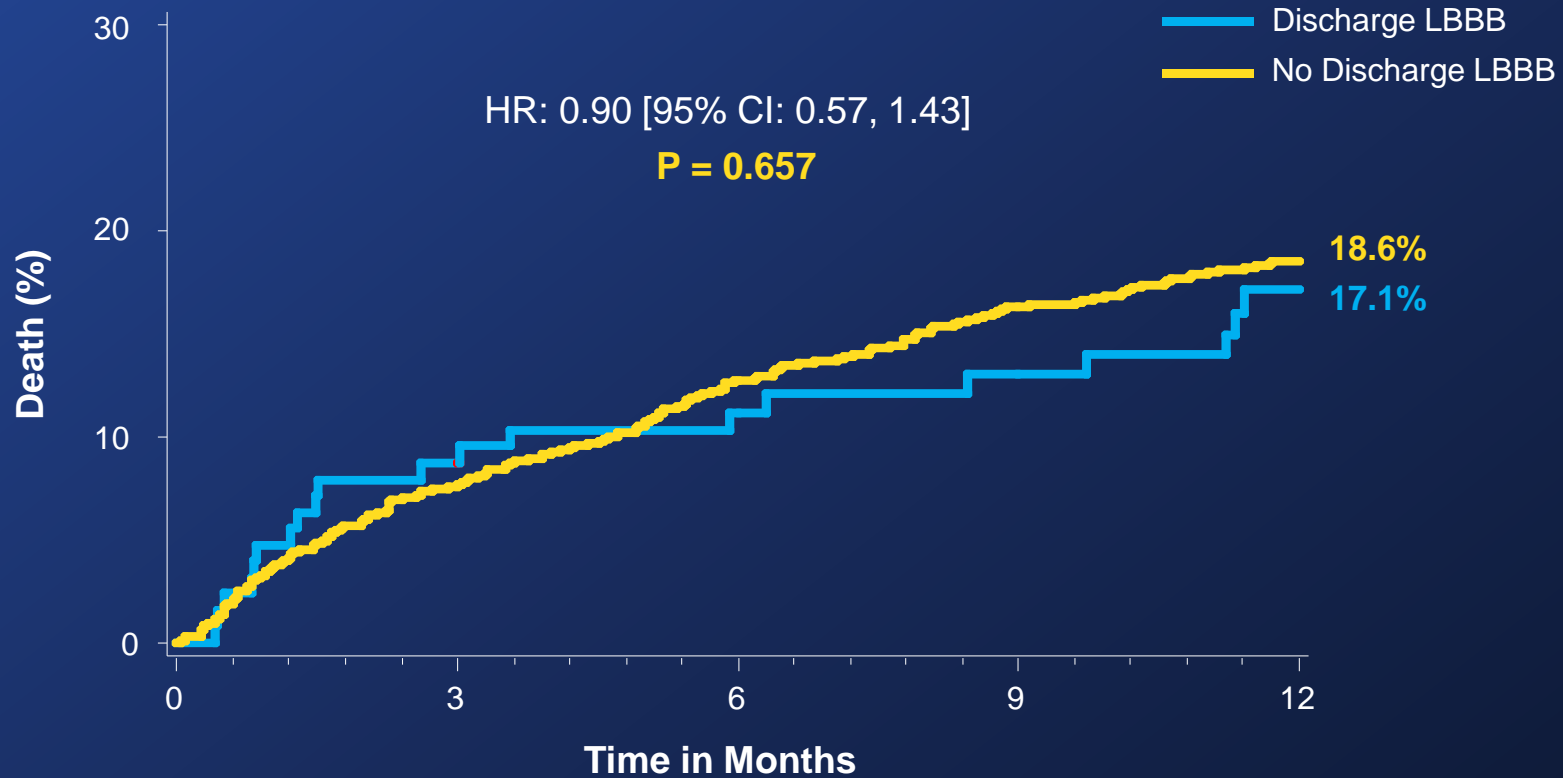
- Incidence of new LBBB at discharge / 7-days
 - 10.4% (127/1222)

- Persistence of LBBB
 - 6.0% (64/1068) at 30-days
 - 5.9% (55/939) at 6 months to 1 year



All-Cause Mortality

PARTNER Trial: Cohort A and B and Continued Access Cohort



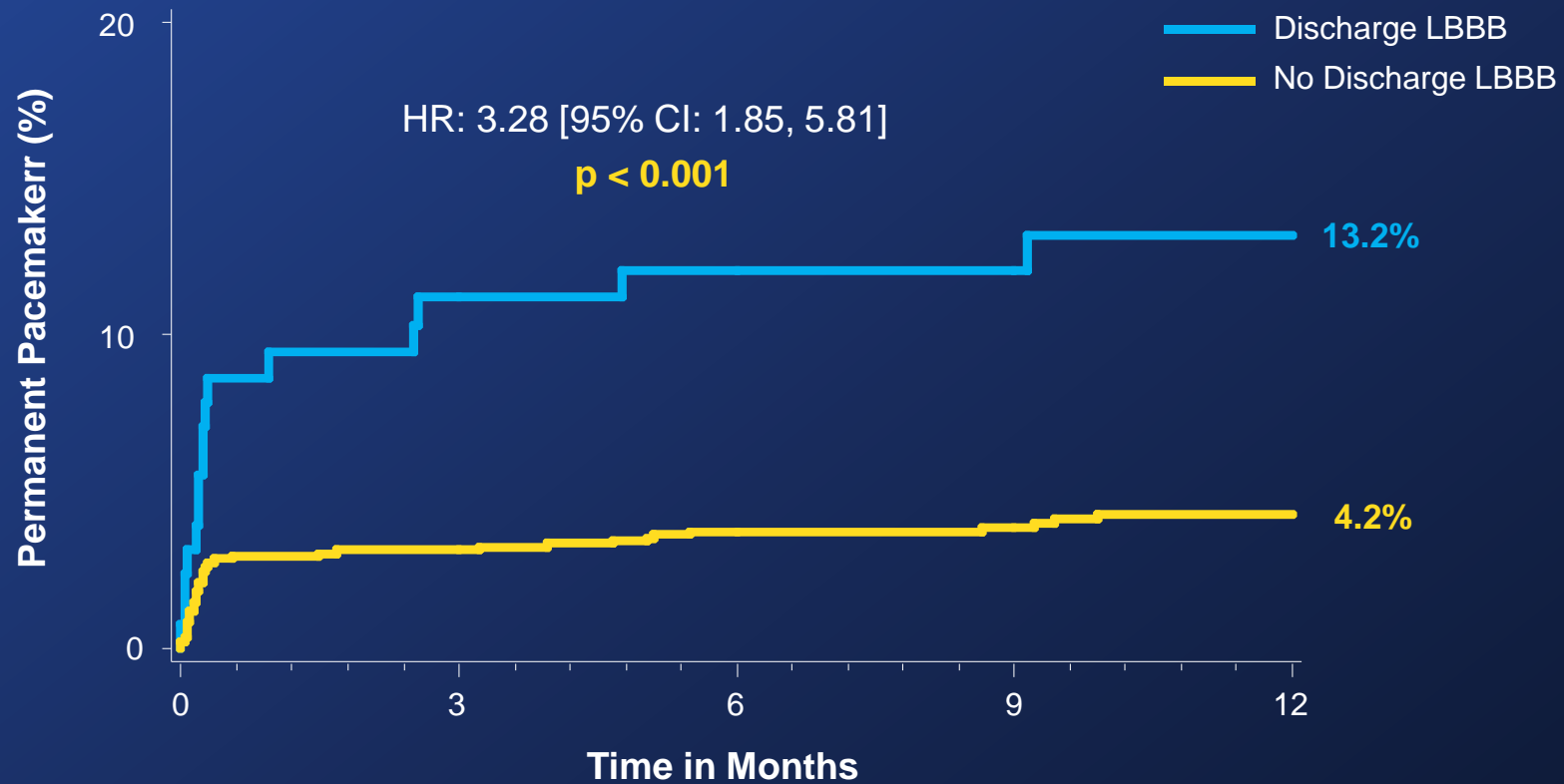
Numbers at Risk

Discharge LBBB	127	114	102	94	71
No LBBB	1095	998	891	798	617



Permanent Pacemaker

PARTNER Trial: Cohort A and B and Continued Access Cohort



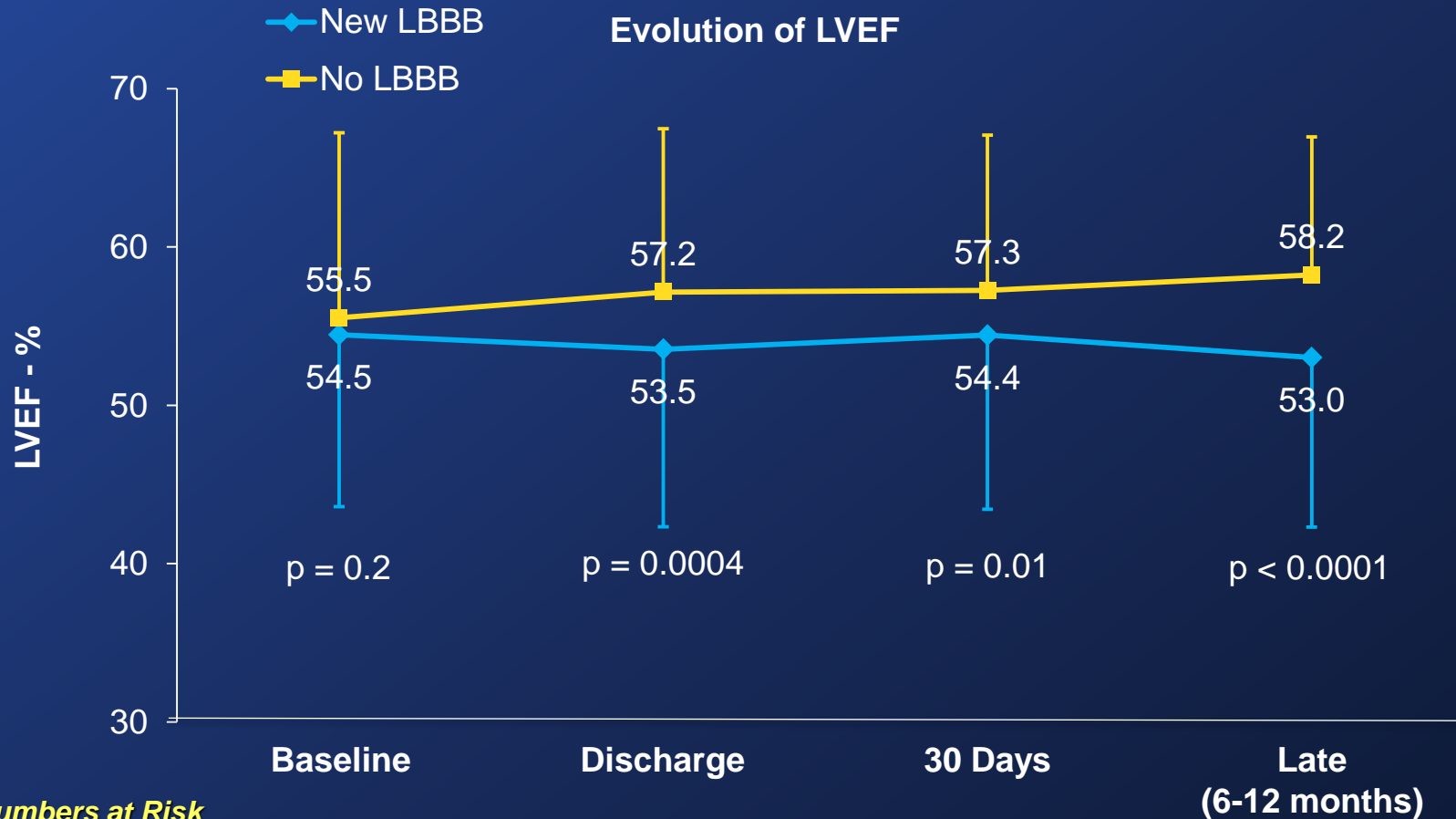
Numbers at Risk

Discharge LBBB	127	102	88	80	62
No LBBB	1095	970	858	766	595



Impact of New-Onset LBBB on Evolution of LVEF

PARTNER Trial: Cohort A and B and Continued Access Cohort



Numbers at Risk

	Baseline	Discharge	30 Days	Late (6-12 months)
New LBBB	121	119	113	82
No LBBB	1039	1034	957	682

CoreValve Randomized Trial of TAVR vs. SAVR



Events*	1 Month			1 Year		
	TAVR	SAVR	P Value	TAVR	SAVR	P Value
Vascular complications (major), %	5.9	1.7	0.003	6.2	2.0	0.004
Pacemaker implant, %	19.8	7.1	<0.001	22.3	11.3	<0.001
Bleeding (life threatening or disabling), %	13.6	35.0	<0.001	16.6	38.4	<0.001
New onset or worsening atrial fibrillation, %	11.7	30.5	<0.001	15.9	32.7	<0.001
Acute kidney injury, %	6.0	15.1	<0.001	6.0	15.1	<0.001

* Percentages reported are Kaplan-Meier estimates and log-rank P values



CoreValve Extreme Risk Study



Events*	1 Month	1 Year
Any Stroke, %	3.9	6.7
Major, %	2.4	4.1
Minor, %	1.7	3.1
Myocardial Infarction, %	1.3	2.0
Reintervention, %	1.3	2.0
VARC Bleeding, %	35.1	41.4
Life Threatening or Disabling, %	11.7	16.6
Major, %	24.1	27.6
Major Vascular Complications, %	8.3	8.5
Permanent Pacemaker Implant, %	22.2	27.1
Per ACC Guidelines, %	17.4	19.9

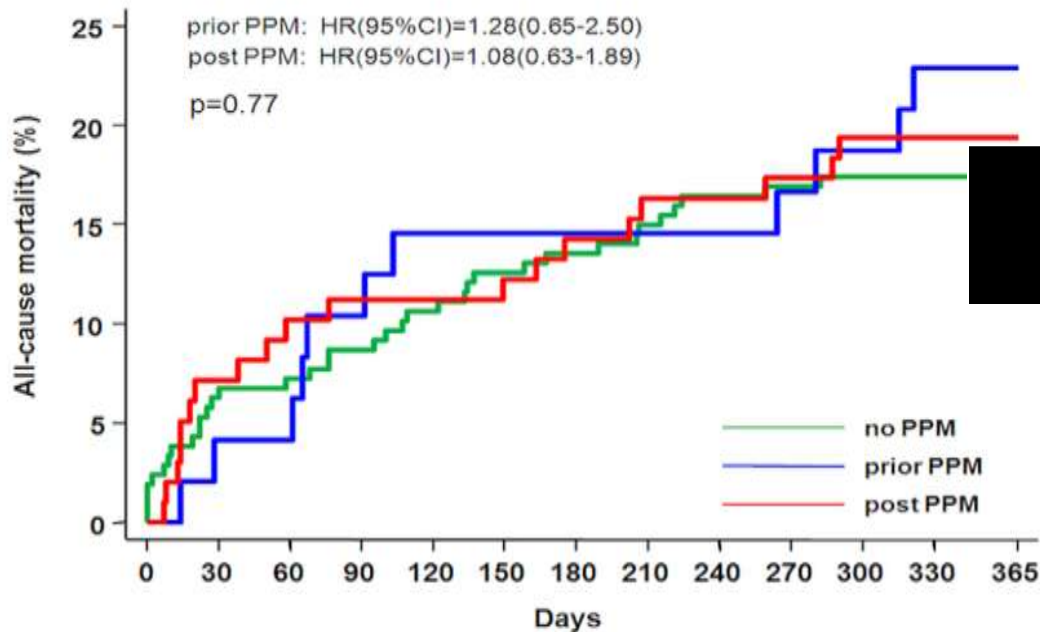
* Percentages obtained from Kaplan Meier estimates



Clinical Significance of Permanent Pacemaker (PPM) Implantation after TAVR

353 patients, 2 centers, 12 month follow-up

	PPM after TAVR	PPM before TAVR	No PPM
N (%)	98 (27.8%)	48 (13.6%)	207 (58.6%)
1-year mortality	19.4%	22.9%	18.0%



Number at risk	0	30	60	90	120	150	180	210	240	270	300	330	365
no PPM	207	194	191	188	184	180	178	175	172	171	170	170	169
prior PPM	48	46	46	43	41	41	41	41	41	40	39	37	37
post PPM	98	91	88	87	87	86	84	82	82	81	79	79	79

PPM implantation does not affect survival after TAVR

Procedural Predictors of Mortality



Edwards valve versus CoreValve CHOICE Randomized Trial

Compared with balloon-expandable Edwards valve, CoreValve was associated with

- Increased moderate/sev AR (18.3% vs. 4.1%)
- Increased pacemaker rates (37.6% vs. 17.3%)
- Decreased stroke rates (2.6% vs. 5.8%)
- Similar vascular complications rates (11.1% vs. 9.9%)

Conclusions

- Proper vascular screening and advances in technology (expandable sheaths and stent design modification) have reduced major vascular complications to 4-7% range down from 15-20% range
- We have good understanding of mechanisms of paravalvular AI. CT guided sizing has made an impact and we are better at treating paravalvular AI in the cath lab (post-dilatation, valve in valve, vascular plugs etc). Sealing technology in Sapien 3 is a major advance
- Lower stroke rates with TAVR compared to SAVR is great news from pivotal Core valve trial but the distal protection devices and perhaps adjunctive pharmacotherapies may present opportunities which will be tested in the near future
- Pacemaker rates continue to be high in 20% range with Corevalve. PPI does not affect survival. LBBB predicts higher pacemakers and less improvement in LVEF