Can We Prevent Conduction Disturbances?

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Real dimension of the problem……..

Up to 50% of TAVR patients develop conduction disturbances

- ✓ Complete AV block (4-11 % Edwards, 15-38% CoreValve)
- ✓ Left Bundle Branch Block LBBB (about 1/3)
- ✓ AV conduction disturbances (Variable percentage)

Permanent Pacemaker Insertion After CoreValve Transcatheter Aortic Valve Implantation : Incidence and Contributing Factors (the UK CoreValve Collaborative)

M.Z. Khawaja, R. Rajani, A. Cook, A. Khavandi, A. Moynagh, S. Chowdhary, M.S. Spence, S. Brown, S.Q. Khan, N. Walker, U. Trivedi, N. Hutchinson, A.J. De Belder, N. Moat, D.J. Blackman, R.D. Levy, G. Manoharan, D. Roberts, S.S. Khogali, P. Crean, S.J. Brecker, A. Baumbach, M. Mullen, J.-C. Laborde and D. Hildick-Smith

Circulation
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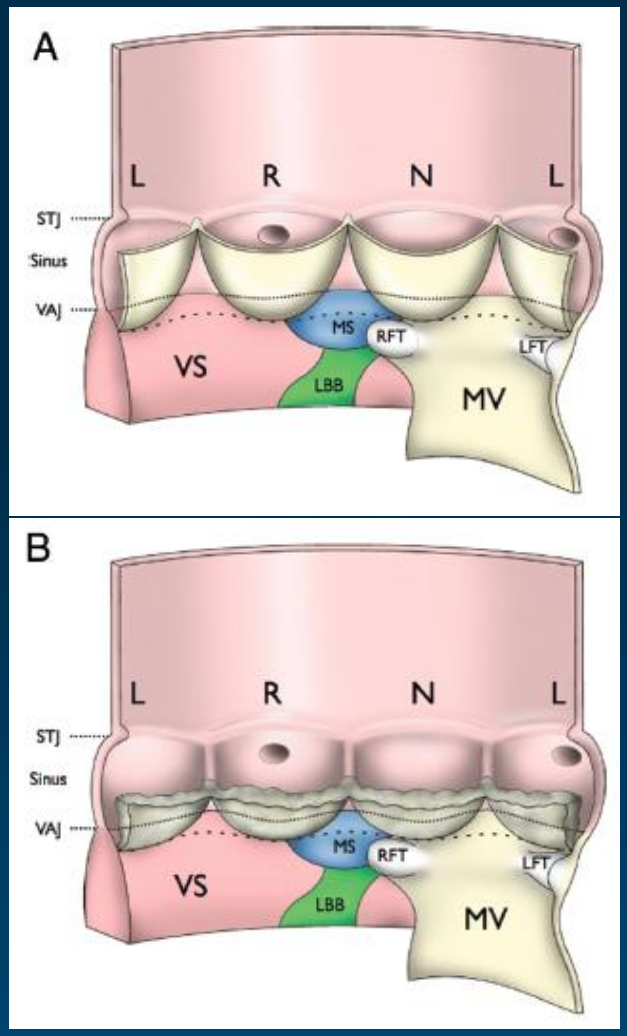
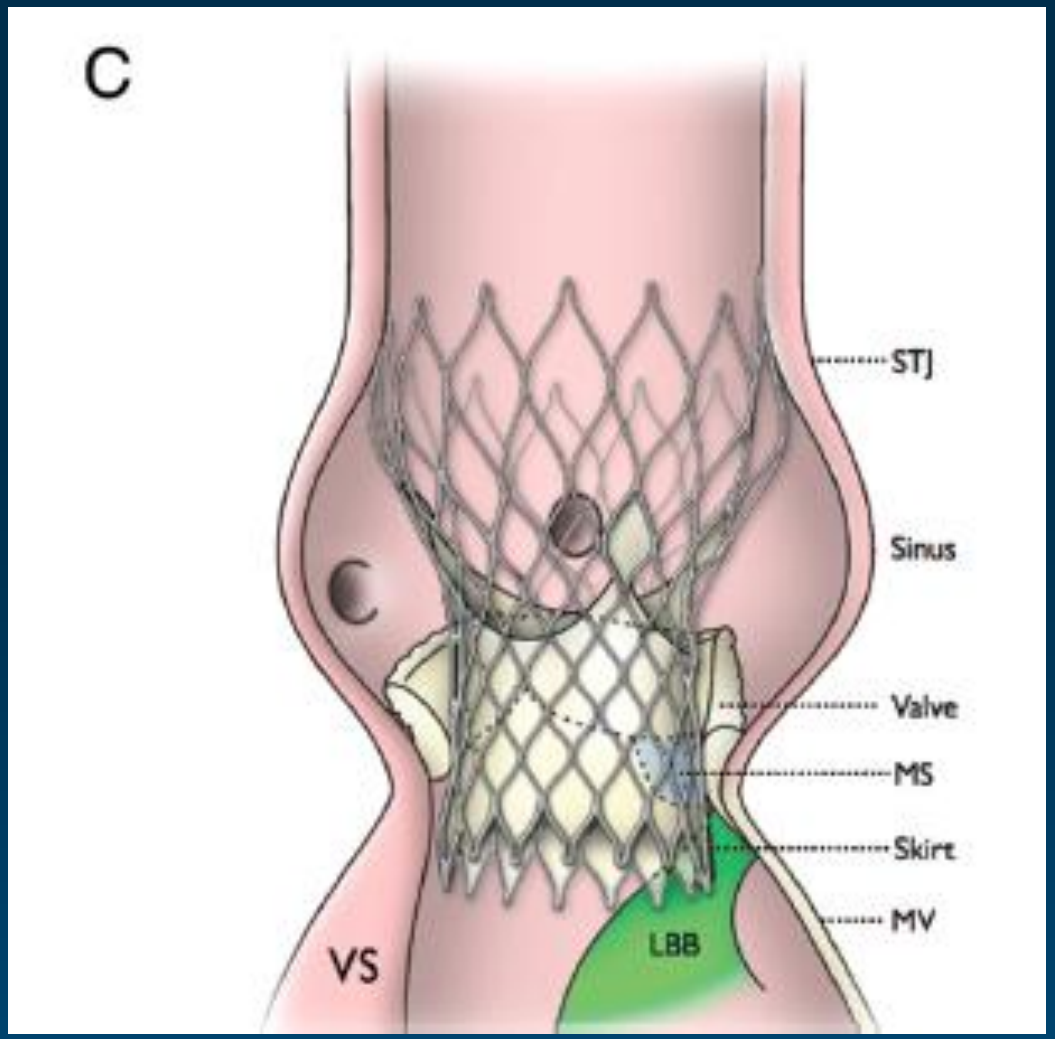
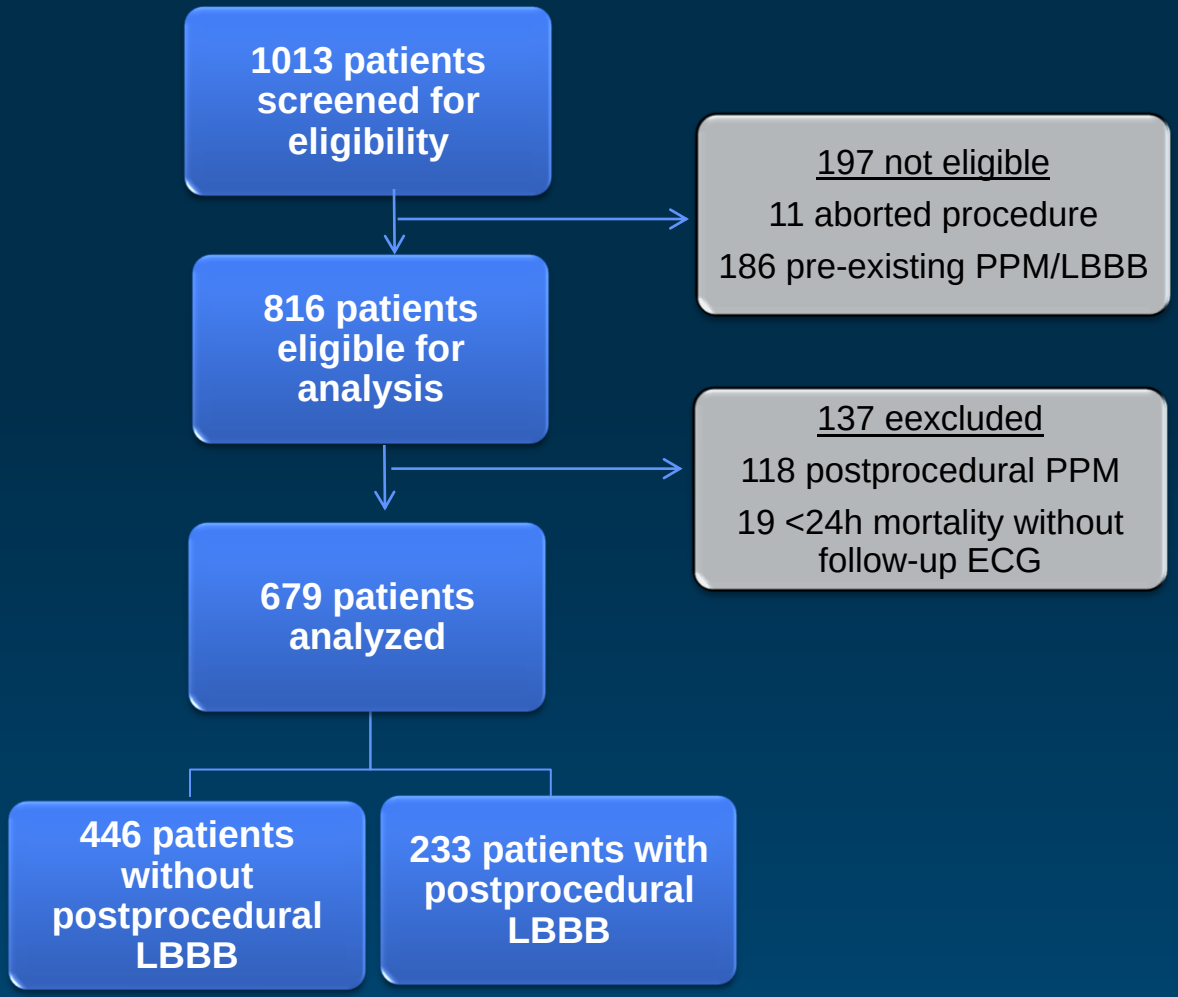
- ✓ 270 patients from 10 clinical centers in UK
- ✓ 8% of patients with prior PPM
- ✓ LBBB 13% at baseline ⟹ 61% after procedure
- ✓ 33.3% new permanent pacemaker requirement
- ✓ Baseline conduction abnormalities
  - Baseline RBBB ⟹ 65.2% PPM
  - Baseline LBBB ⟹ 43.75% PPM
  - Normal QRS complex ⟹ 27.6% PPM
- ✓ Multivariable predictors: AV block, balloon predilation, use of 29 mm valve, IV septum diameter, prolonged QRS

Relation Between Prosthesis and Conduction System





Left Bundle-Branch Block Induced by TAVI Increases Risk of Death



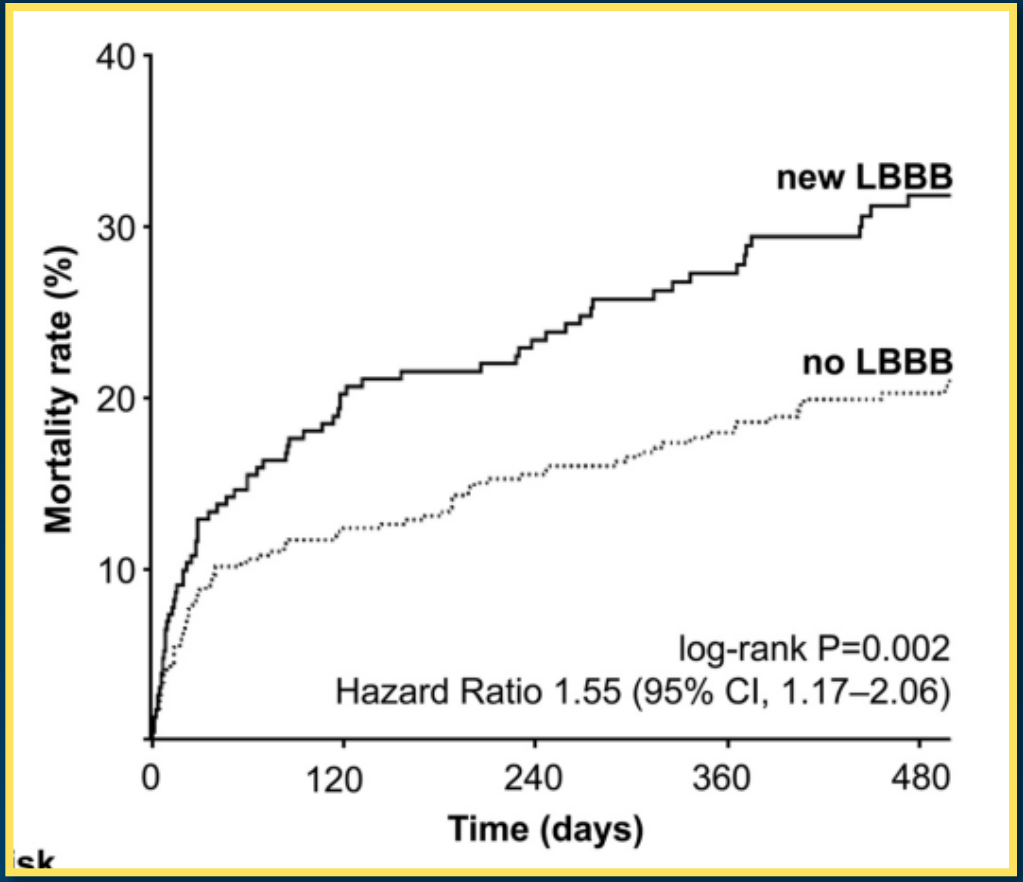
Binary Logistic Regression Analysis

	Univariate Analysis			Multivariate Analysis		
Variable	HR	CI	*P* Value	HR	CI	*P* Value
Age	0.87	0.98–1.03	0.87			
Female sex	0.84	0.61–1.16	0.30			
Baseline creatinine	0.85	0.68–1.05	0.14	0.83	0.66–1.05	0.12
Previous MI	0.71	0.47–1.09	0.12	0.78	0.49–1.24	0.29
Previous CABG	0.80	0.55–1.16	0.24			
Cerebrovascular disease	1.18	0.79–1.78	0.42			
Peripheral vascular disease	0.74	0.49–1.11	0.14	1.57	0.97–2.55	0.07
Diabetes mellitus	1.48	1.03–2.13	0.04	1.52	1.01–2.29	0.04
COPD	0.96	0.67–1.38	0.84			
LVEF ≤50%	1.10	0.77–1.56	0.60			
R(aVL) >11 mm	0.87	0.56–1.36	0.55			
$S(V_1) + R(V_{5/6})$ >35 mm	1.01	0.97–1.04	0.72			
Absent Q in V_6	1.05	0.72–1.54	0.79			
MCS prosthesis*	7.69	5.13–11.54	<0.001	8.51	5.53–13.11	<0.001

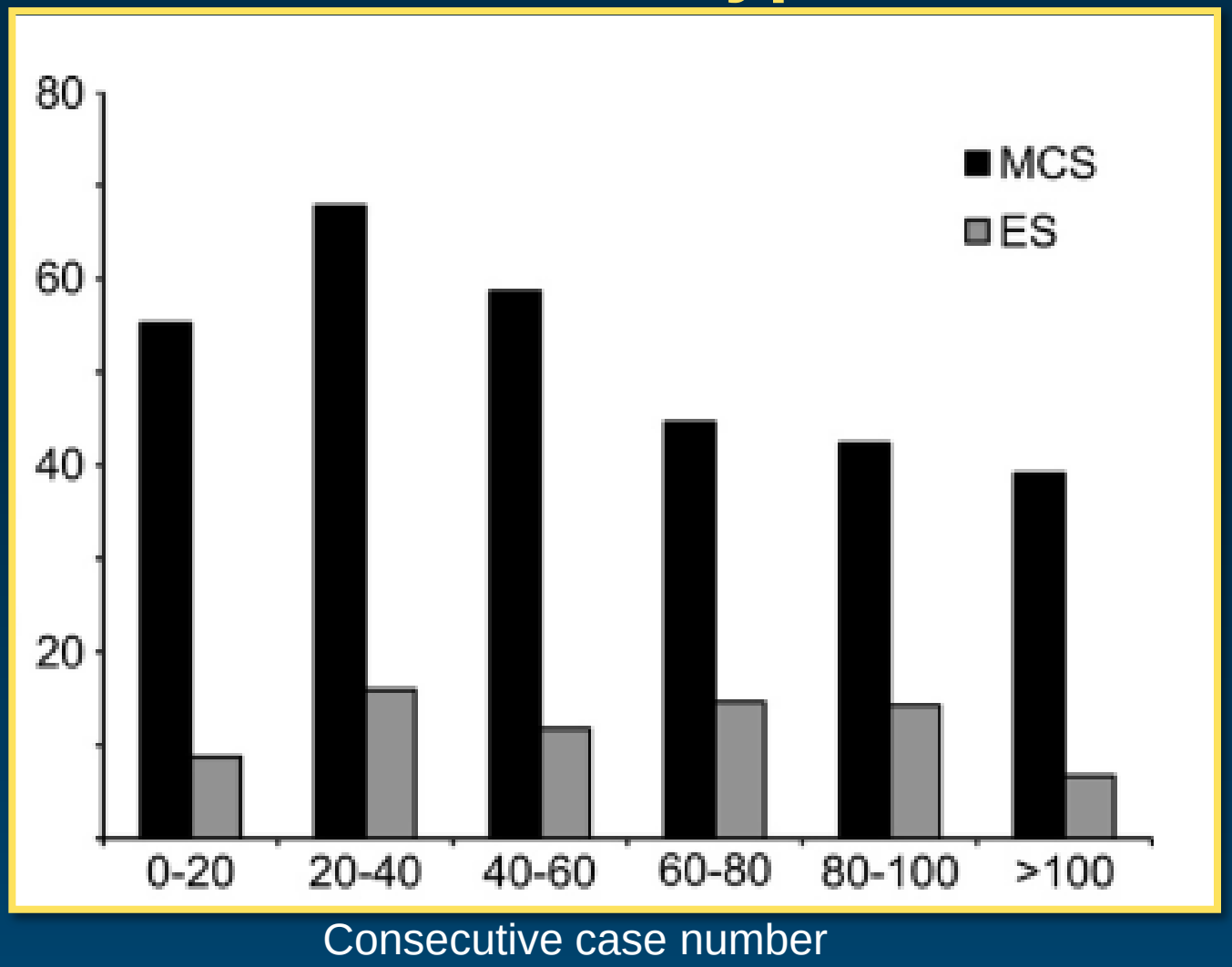
TAVI indicates transcatheter aortic valve implantation; HR, hazard ratio; CI, 95% confidence interval; MI, myocardial infarction; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction; and MCS, Medtronic CoreValve System.

*For calculation of the HR, the MCS prosthesis was compared to the Edwards SAPIEN prosthesis.

Survival for the primary end point



Incidence of TAVI–induced LBBB according to valve type



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Conclusion

Left Bundle Branch Block (LBBB) Induced by TAVI Increases Risk of Death

Registry study of 679 pts receiving either CoreValve or Sapien at 8 Dutch centers.

- About one-third (n = 233) of pts experienced new LBBB within 7 days of implantation
- At 450-day follow-up, all-cause mortality higher in patients with LBBB vs. without (37.8% vs. 24.0%; *P* = 0.002)
- New LBBB more common in CoreValve- vs. Sapien-treated patients (51.1% vs. 12.0%; *P* < 0.001)

Implications: LBBB is a serious complication of TAVR that may strongly attenuate the survival benefit of this procedure.

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Predictive Factors and Long-Term Clinical Consequences of Persistent LBBB Following TAVI With a Balloon-Expandable Valve

- ✓ 348 consecutive patients underwent TAVI with a balloon-expandable valve (Sapien or Sapien XT, Edwards Lifesciences, Irvine LLC, California)

- ✓ 146 patients were excluded
  - ✓ prior pacemaker (n = 57)
  - ✓ prior intra-ventricular conduction abnormalities (complete or incomplete right or left bundle branch block, n = 83)
  - ✓ death, or conversion to open heart surgery before the first ECG (4 and 2 patients, respectively)

- ✓ The final study population consisted of 202 patients

Baseline and Procedural Findings, According to the Occurrence of New-Onset LBBB Following TAVI

	No LBBB (n = 141)	Transient LBBB (n = 23)	Persistent LBBB (n = 38)	p Value*
Baseline characteristics				
Age (yrs)	81 ± 8	79 ± 6	77 ± 9†	0.019
Female	83 (58.9)	17 (73.9)	21 (55.3)	0.328
Body mass index (kg/m^2)	26 ± 5	26 ± 5	28 ± 6	0.125
Comorbidities				
Hypertension	119 (84.4)	22 (95.7)	37 (97.4)	0.041
Diabetes mellitus	44 (31.2)	8 (34.8)	15 (39.5)	0.615
COPD	35 (24.8)	3 (13.0)	12 (31.6)	0.261
CAD	79 (56.0)	17 (73.9)	22 (57.9)	0.277
eGFR (ml/min)	56.6 ± 22.5	54.6 ± 20.4	59.1 ± 26.3	0.742
Baseline treatment				
Beta-blockers	64 (45.4)	14 (60.9)	16 (42.1)	0.332
Calcium channel blockers	38 (27.0)	8 (34.8)	12 (31.6)	0.648
Amiodarone	8 (5.7)	2 (8.7)	3 (7.9)	0.729
STS-PROM score (%)	7.6 ± 3.8	6.1 ± 3.7	7.4 ± 3.4	0.476
ECG (ms)				
PR interval	176 ± 36	158 ± 23	174 ± 45	0.114
QRS duration	90 ± 10	92 ± 9	96 ± 10†	0.033
Echocardiography				
LVEF (%)	57 ± 12	54 ± 15	58 ± 11	0.440
Mean gradient (mm Hg)	46 ± 17	47 ± 19	49 ± 19	0.696
Aortic valve area (cm^2)	0.65 ± 0.22	0.63 ± 0.28	0.61 ± 0.17	0.547
Computed tomography				
Aortic valve calcification (Agatston units)	2,544 (1,600–4,442)	2,045 (1,666–4,209)	3,150 (1,944–5,358)	0.412
Procedural variables				
Approach				0.335
Transapical	79 (56.0)	12 (52.2)	26 (68.4)	
Transfemoral	62 (44.0)	11 (47.8)	12 (31.6)	
Ratio aortic prosthesis size/aortic annulus	1.16 ± 0.07	1.18 ± 0.09	1.18 ± 0.07	0.097
Prosthesis ventricular depth‡ (mm)	1.64 ± 2.85	1.22 ± 2.23	3.04 ± 1.72†§	0.028

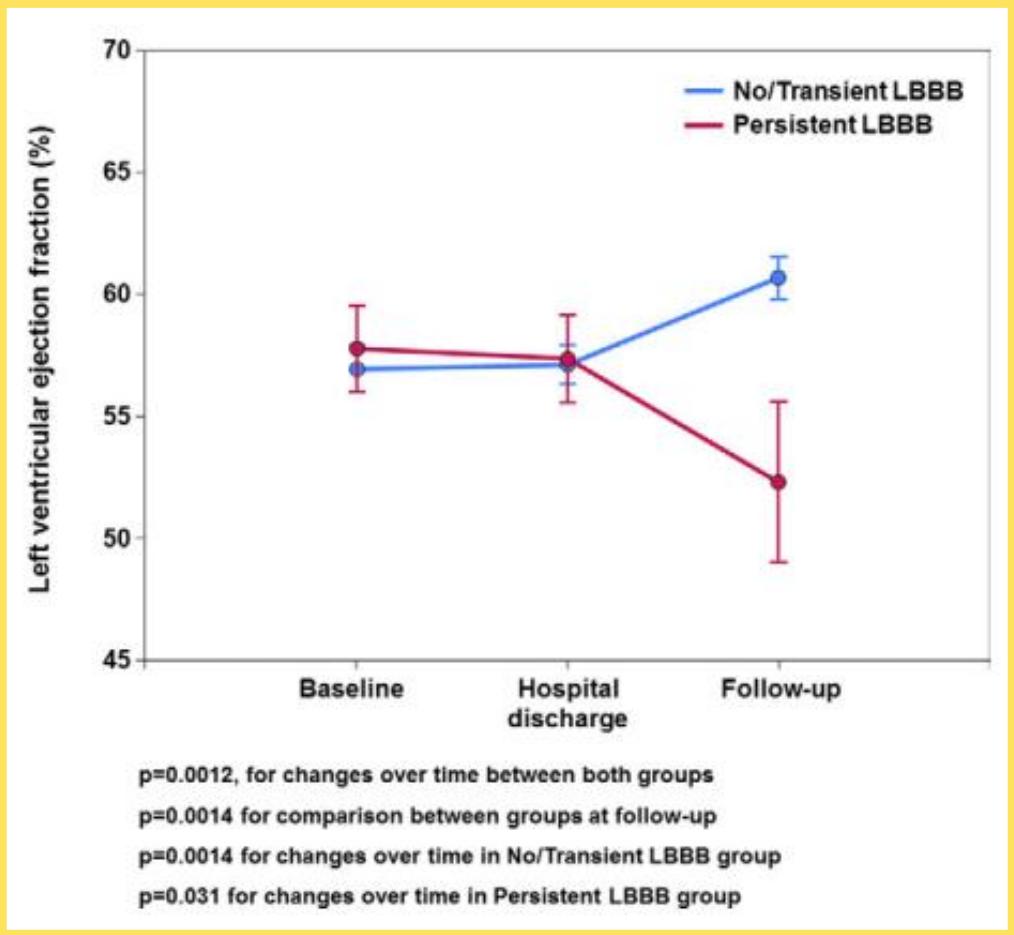
Urena et al. Journal of the American College of Cardiology . 2012

Baseline and Procedural Findings, According to the Need for PPI (In-Hospital or During the Follow-Up Period)

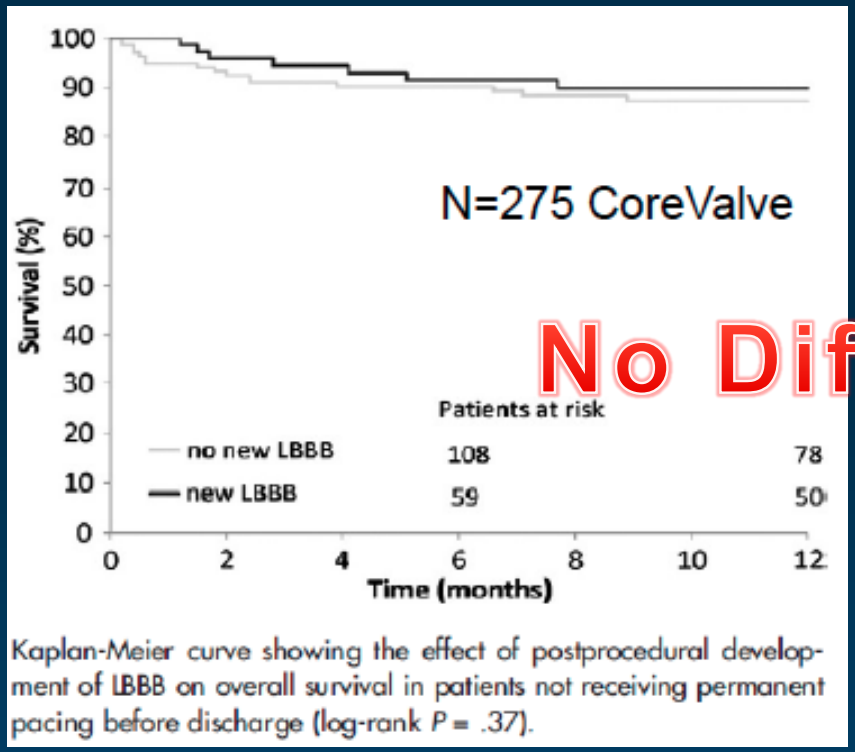
	PPI (Cumulative) (n = 20)	No PPI (n = 182)	HR (95% CI)	p Value
Clinical characteristics				
Age (yrs)	81 ± 6	80 ± 8	1.02 (0.96–1.09)	0.454
Female	12 (60.0)	109 (59.9)	0.90 (0.37–2.22)	0.803
Body mass index (kg/m^2)	27 ± 6	27 ± 5	1.01 (0.92–1.11)	0.762
Comorbidities				
Hypertension	17 (85.0)	161 (88.5)	0.59 (0.17–2.04)	0.406
Diabetes mellitus	6 (30.0)	61 (33.5)	0.96 (0.37–2.51)	0.938
COPD	5 (25.0)	45 (24.7)	1.16 (0.42–3.22)	0.778
CAD	11 (55.0)	107 (58.8)	0.95 (0.39–2.30)	0.903
eGFR (ml/min)	51.9 ± 20.6	57.3 ± 23.2	0.99 (0.97–1.01)	0.343
Baseline treatment				
Beta-blockers	8 (40.0)	86 (47.3)	0.70 (0.28–1.72)	0.434
Calcium channel blockers	8 (40.0)	50 (27.5)	1.64 (0.67–4.01)	0.281
Amiodarone	2 (10.0)	11 (6.0)	1.80 (0.41–7.81)	0.433
STS-PROM score	6.9 ± 2.8	7.6 ± 3.8	0.94 (0.79–1.11)	0.457
ECG (ms)				
PR interval	191 ± 59	172 ± 35	1.01 (0.99–1.02)	0.354
QRS duration	94 ± 10	92 ± 10	1.02 (0.97–1.07)	0.500
Echocardiography				
LVEF (%)	62 ± 8	57 ± 12	1.03 (0.99–1.08)	0.137
Mean gradient (mm Hg)	44 ± 21	47 ± 17	0.99 (0.97–1.02)	0.491
Aortic valve area (cm^2)	0.61 ± 0.19	0.64 ± 0.22	0.50 (0.40–6.26)	0.591
Computed tomography				
Aortic valve calcification (Agatston units)	3,362 ± 2,345	3,209 ± 2,104	—	0.854
Procedural variables				
Approach			1.66 (0.63–4.33)	0.303
Transapical	14 (70.0)	103 (56.6)	—	—
Transfemoral	6 (30.0)	79 (43.4)	—	—
Ratio prosthesis/aortic annulus	1.17 ± 0.09	1.16 ± 0.07	—	0.407
Ventricular depth of prosthesis* (mm)	3.19 ± 1.65	1.71 ± 2.68	1.27 (0.96–1.68)	0.100
Residual AR ≥2	1 (5.0)	27 (14.8)	1.02 (0.79–1.31)	0.877
New-onset LBBB	14 (70.0)	47 (25.8)	5.99 (2.29–15.61)	<0.001

Urena et al. Journal of the American College of Cardiology . 2012

Changes in Left Ventricular Ejection Fraction Following TAVI



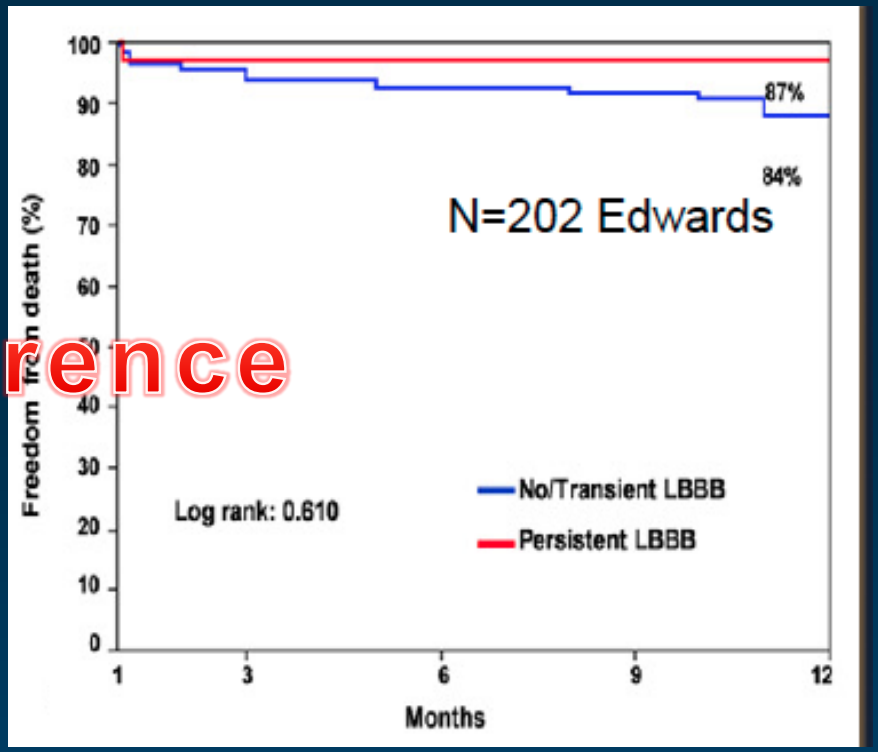
Other Studies about LBBB and Mortality



Kaplan-Meier curve showing the effect of postprocedural development of LBBB on overall survival in patients not receiving permanent pacing before discharge (log-rank $P = .37$).

De Carlo, et al. American Heart Journal . 2012

No Difference

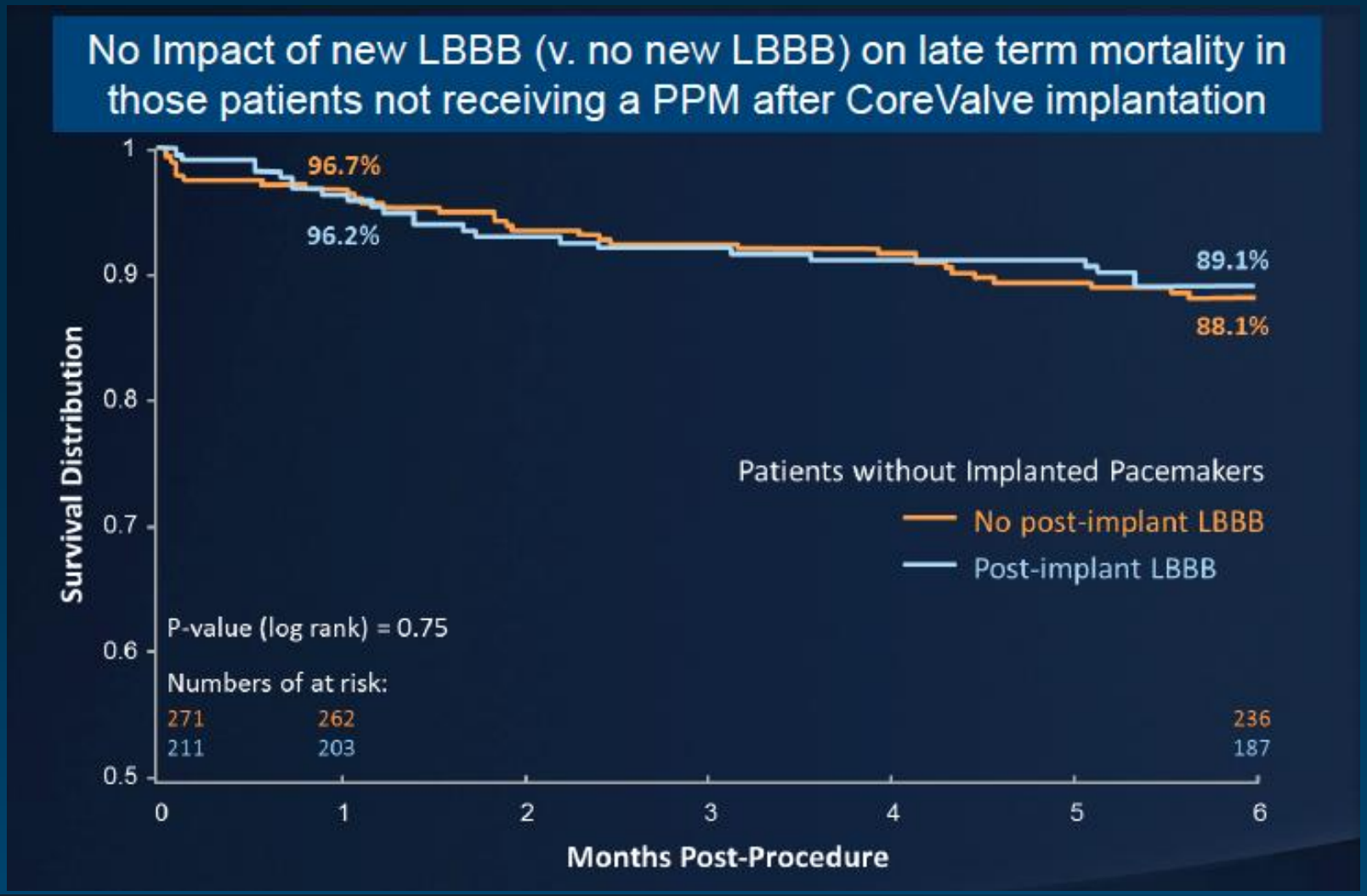


Urena et al. Journal of the American College of Cardiology . 2012

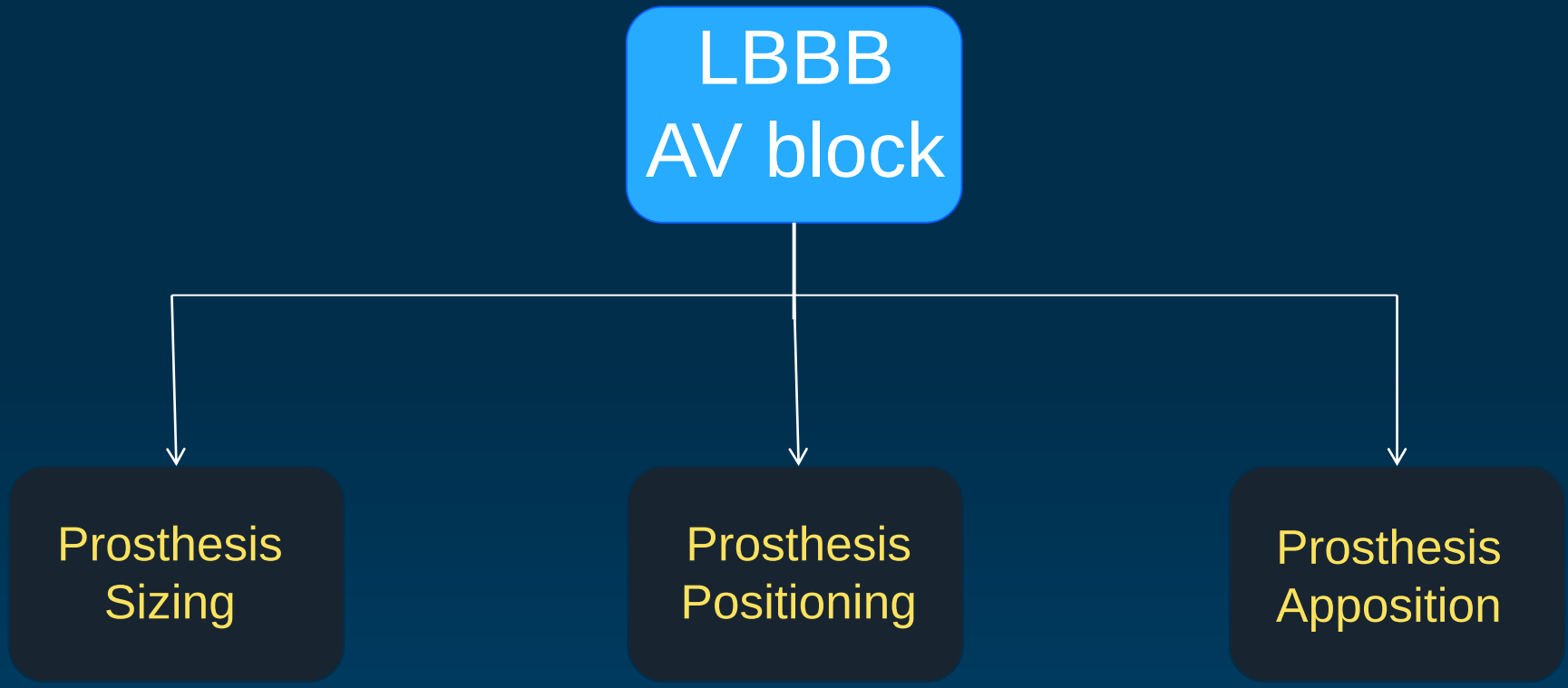
CoreValve ADVANCE 30-day Outcomes

Additional VARC Endpoints N=996	Kaplan-Meier Estimates, %
Cardiovascular Mortality	3.4
Major Bleeding	9.7
Life Threatening Bleeding	4.0
Major Vascular Complications	10.7
Acute Kidney Injury – Stages I/II/III	5.7
Acute Kidney Injury – Stage III only	0.4
New Pacemaker Implantation	26.3
AccuTrak Delivery System	24.2
Pre-AccuTrak Delivery System	34.1

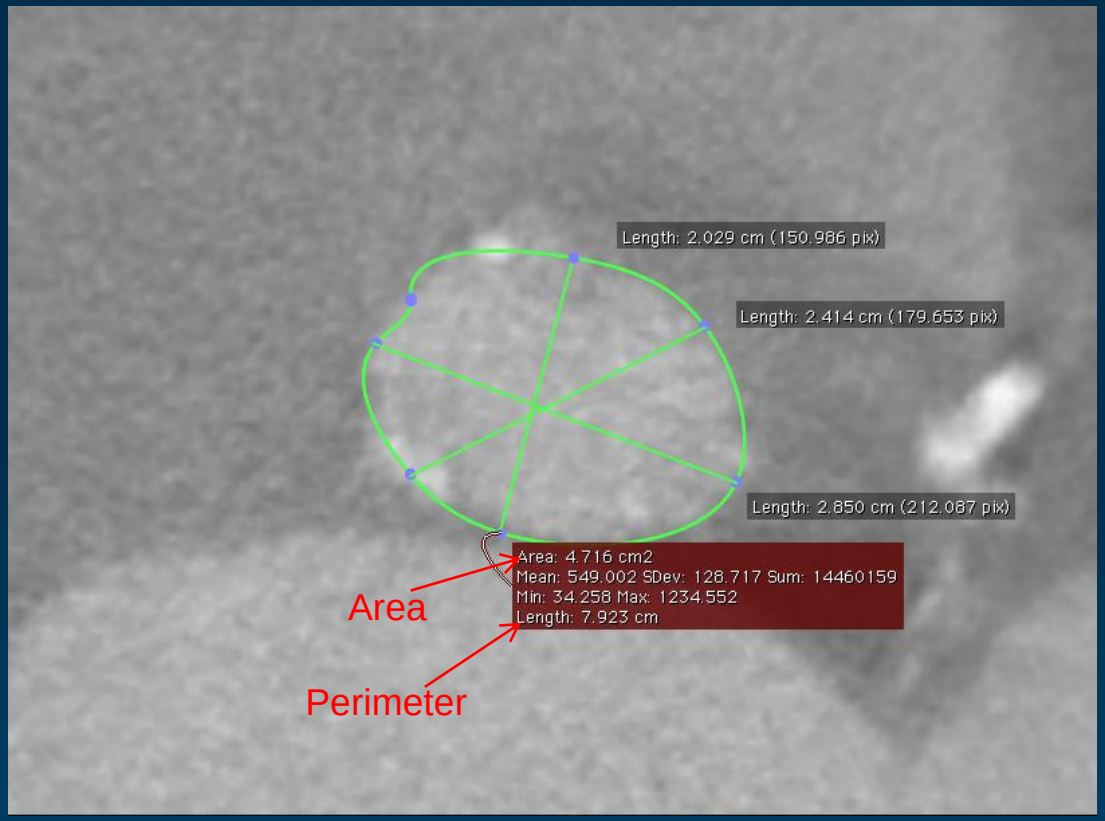
CoreValve ADVANCE Impact of LBBB

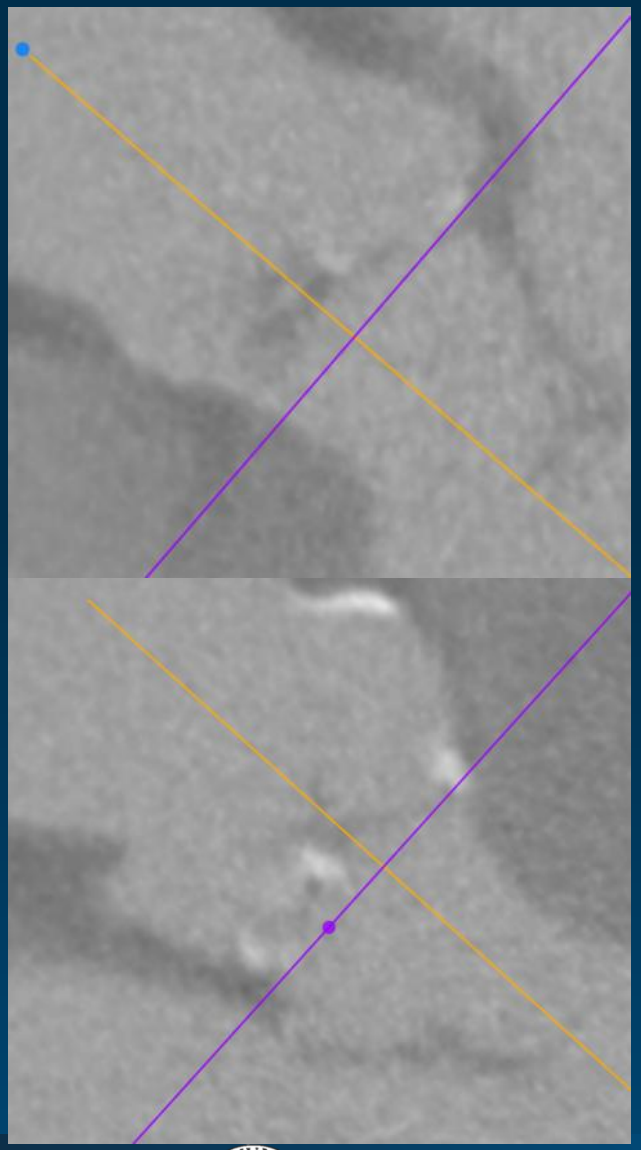


Origin of Conduction Disturbances



Optimal MSCT Sizing





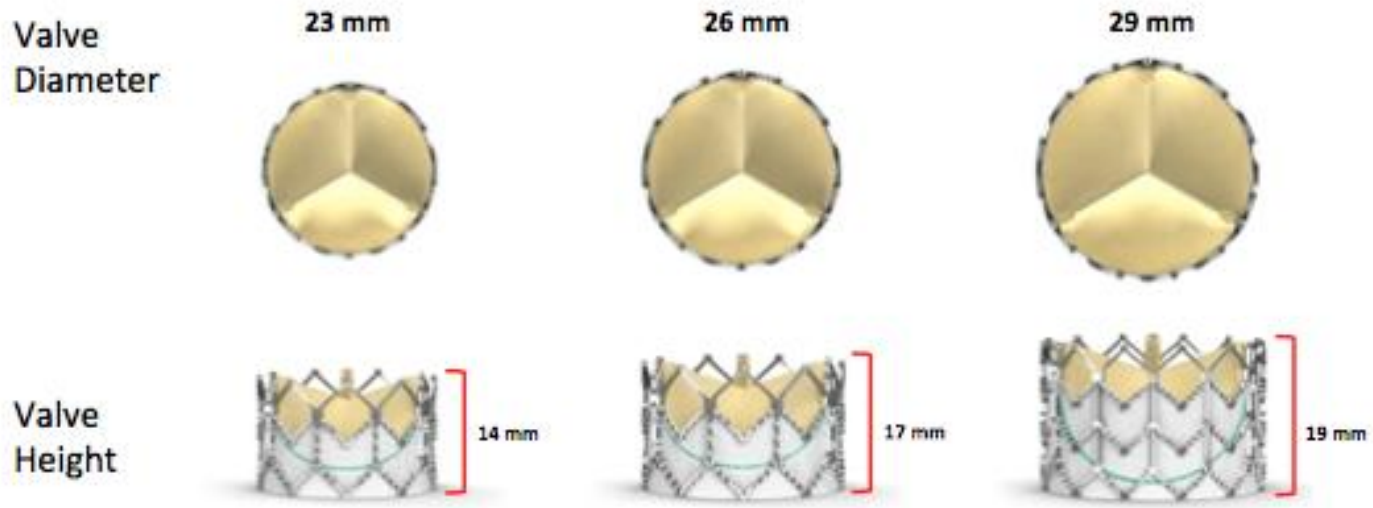
Elliptical Shape: Max dia. 28,5 mm; Min dia. 20 mm
Area 4,71 cm^2, Perimeter 7,9 cm

Sizing CoreValve Revalving System

	23mm	26mm	29mm	31mm
Annulus Diameter [mm]	D≥18 D≤20	D≥20 D≤23	D≥23 D≤27	D≥26 D≤29
Annulus Area [cm2]	A≥2,54 A≤3,14	A≥3,14 A≤4,15	A≥4,15 A≤5,72	A≥5,31 A≤6,60
Annulu Perimeters [cm]	P≥5,65 P≤6,28	P≥6,28 P≤7,22	P≥7,22 P≤8,48	P≥8,16 P≤9,11

Sizing Edwards Sapien XT

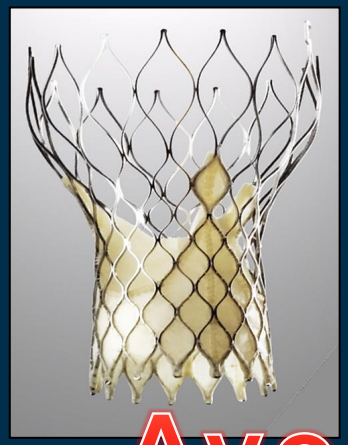
Edwards Sapien XT Valve Sizes



Perimeter	7.23 cm	8.17 cm	9.11 cm
Area	4.15 cm^2	5.31 cm^2	6.61 cm^2

Area (cm^2) Oversizing

29 mm



(5,72 - 4,71) / 4,71 x 100 = 21,5 %

Avoid area oversizing > 20 %

26 mm

(5,31- 4,71) / 4,71 x 100 = 12,7 %

Early and Persistent Intraventricular Conduction Abnormalities and Requirements for Pacemaking After Percutaneous Replacement of the Aortic Valve

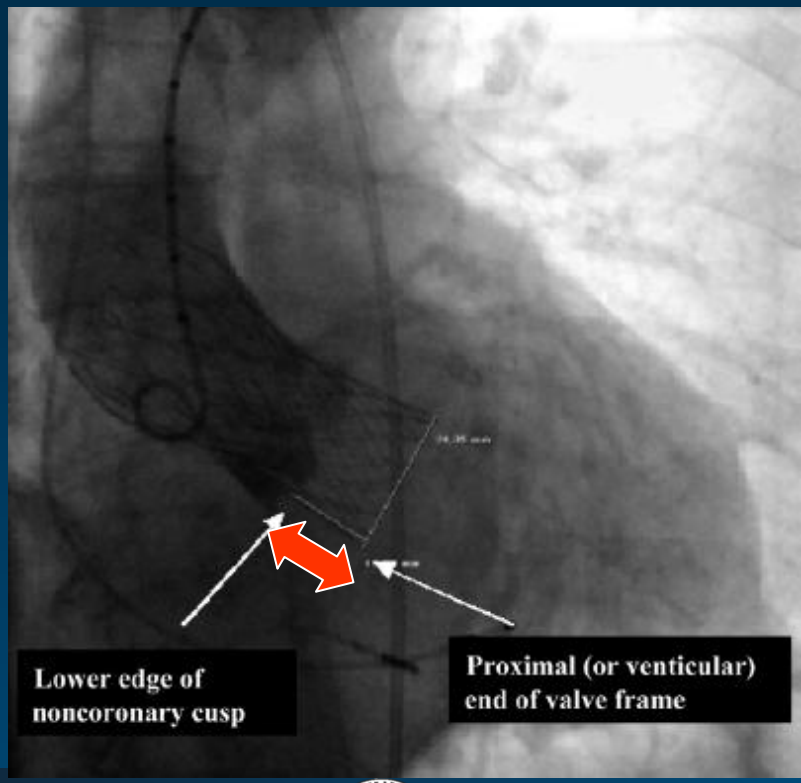
Nicolo Piazza, MD,* Yoshinobu Onuma, MD,* Emile Jesserun, MD,* Peter Paul Kint, RN,†
Anne-Marie Maugenest, RN,* Robert H. Anderson, MD, FRCPath,‡
Peter P. Th de Jaegere, MD, PhD,* Patrick W. Serruys, MD, PhD*

Relation between deep of implantation and conduction abnormalities

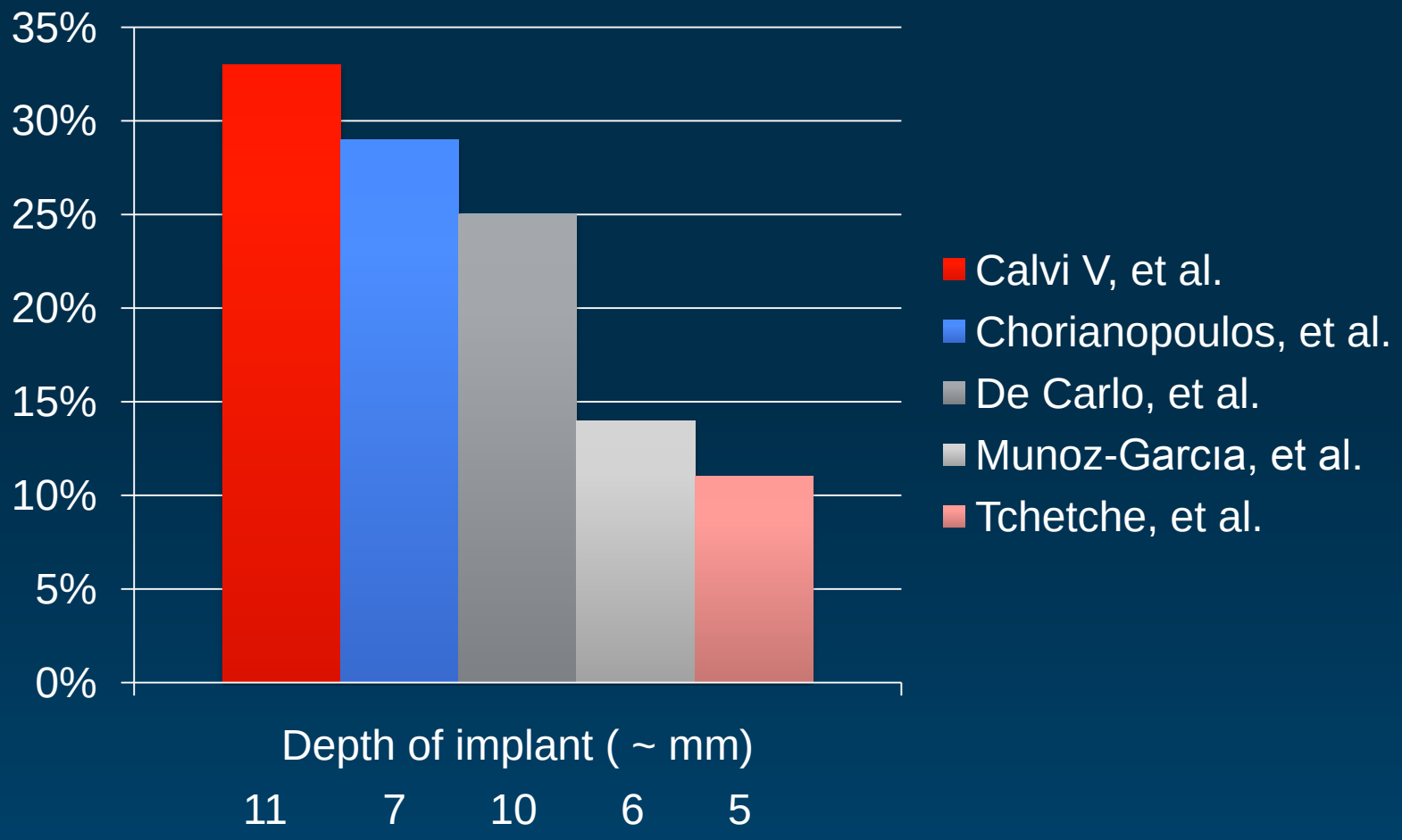
- ✓ New LBBB 10,3 mm ± 2,7 mm

P = 0.005

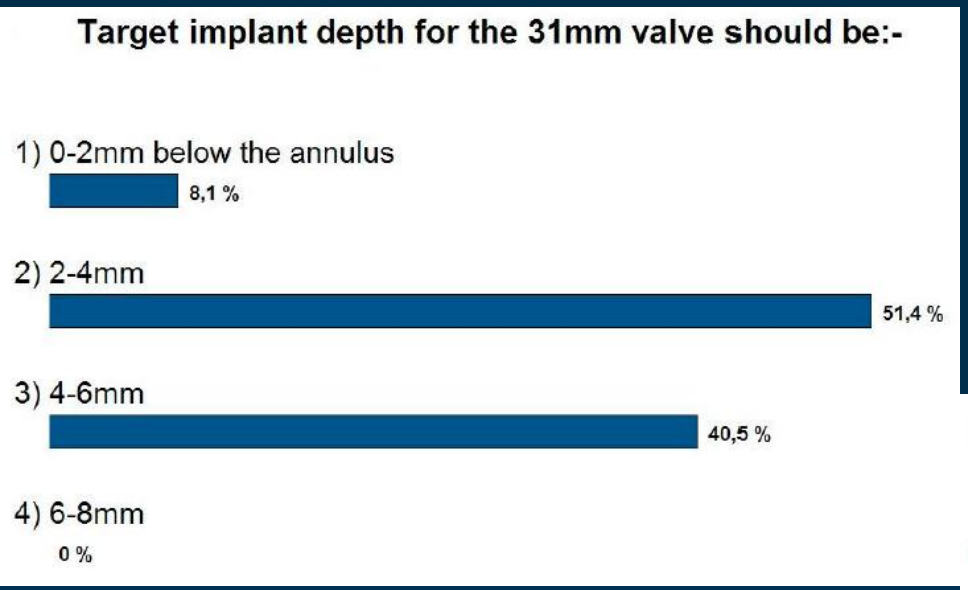
- ✓ No LBBB 5,5 mm ± 3,4 mm

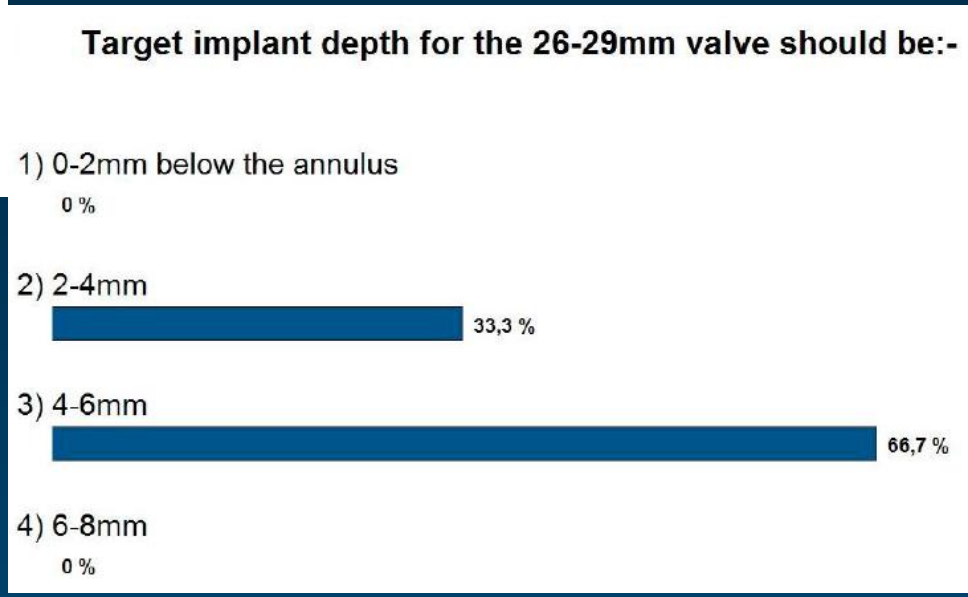


Rate of PPM implantion Vs Depth of implantion

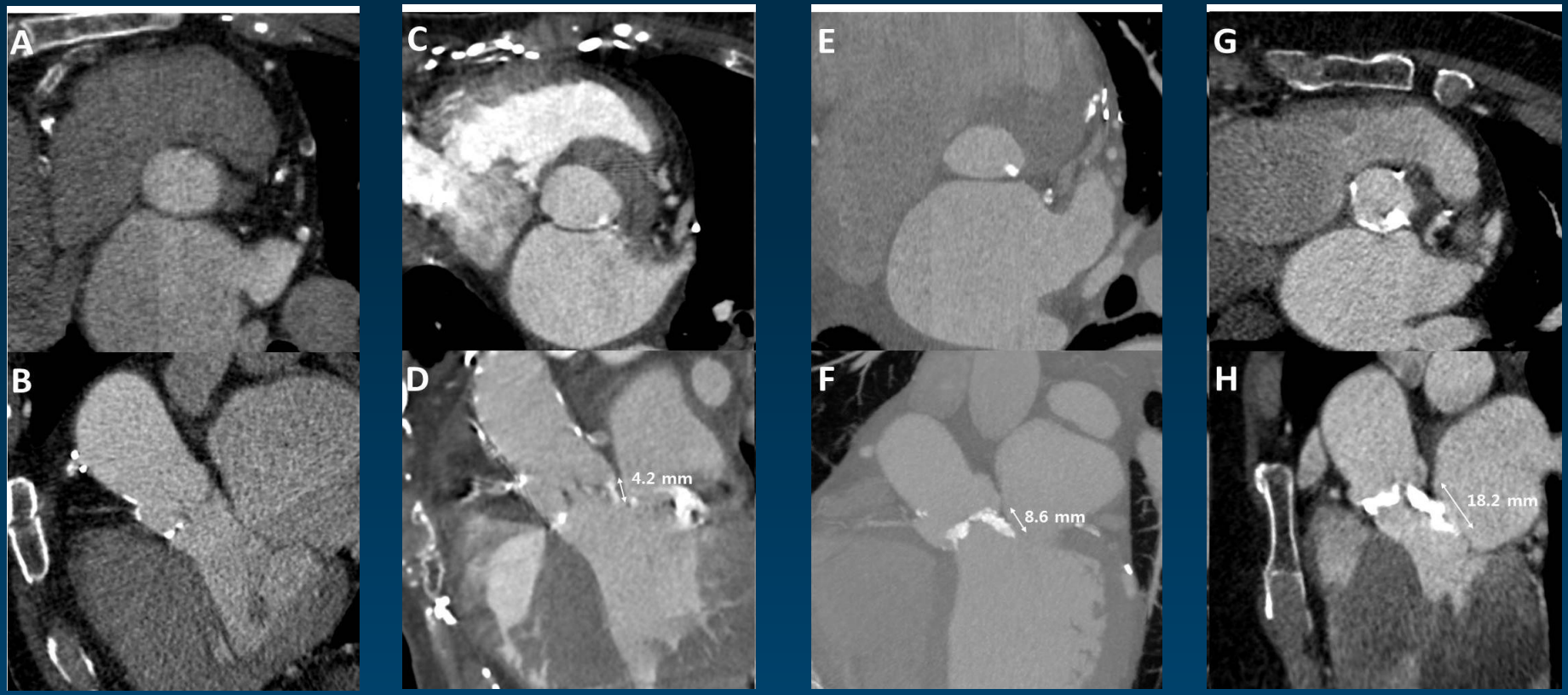


Optimal Depth of CoreValve Implantion



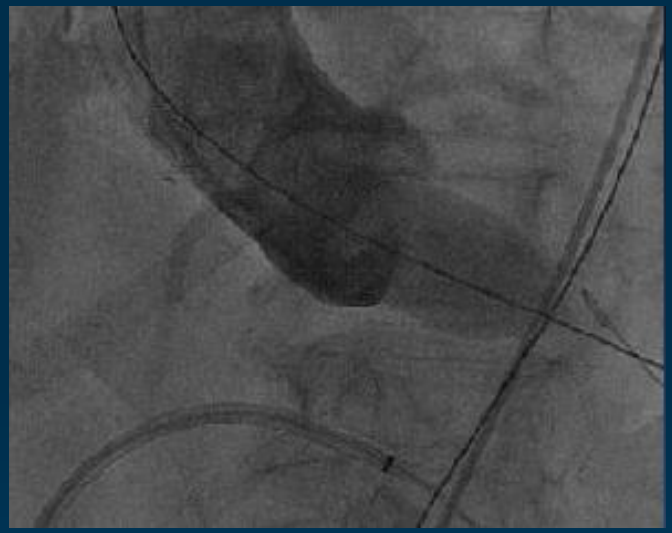


LVOT Calcification and Conduction Distrurbances are Directly Related



BAV as Bridge to TAVI or BAV during TAVI

- ✓ Avoid long Balloon (>40 mm)
- ✓ Use smallest balloon as possible (already 18 mm balloon have 2,5 cm^2 area during inflation)
- ✓ Always use rapid pacing during BAV (>180) in order to stabilize balloon and avoid excessive stress on membranous septum
- ✓ Avoid extended and repeated inflations



Conclusion

- ✓ Conduction disturbances are very frequent in TAVI patients, mainly AV block and LBBB
- ✓ The anatomical relation between conduction system, implant site and depth are the explanation of the problem
- ✓ The CT scan is mandatory to perform precise measurements and avoid area oversizing > 20%
- ✓ The presence of massive LVOT calcification can play an important role in conduction system damage during TAVI and BAV
- ✓ During BAV avoid using long and large balloons
- ✓ Always perform BAV during rapid ventricular pacing
- ✓ Avoid prolonged and repeated BAV