Centre for
Heart Valve Innovation
St. Paul's Hospital, Vancouver

TAVR Imaging: Preprocedural CT Imaging for Transcatheter Aortic Valve Replacement

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Disclosures

Consultant to

Edwards Lifesciences Inc.

Neovasc Inc.

Tendyne

Circle Cardiovascular Imaging

SPH Cardiac CT Core Lab, providing services to

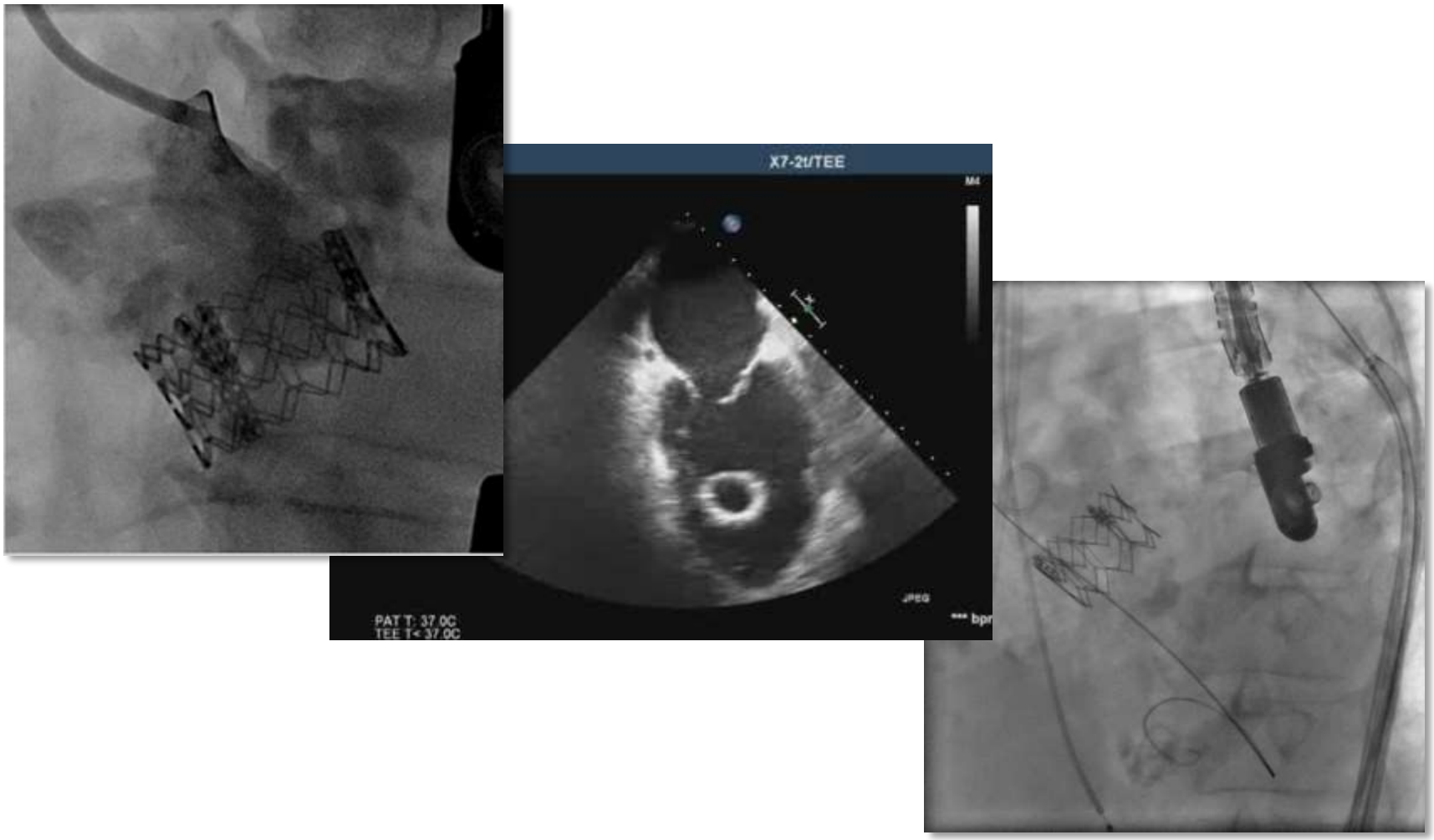
Edwards Lifesciences Inc.

Neovasc Inc.

Tendyne Holdings Inc.

Essentials of CT aortic valve assessment

… suboptimal outcome



Essentials of CT aortic valve assessment

Reason for suboptimal outcome

Among others…

- Erroneous anatomical measurements
- Measurements on suboptimal or insufficient imaging data

Five Essentials of CT aortic valve assessment

Five Essentials

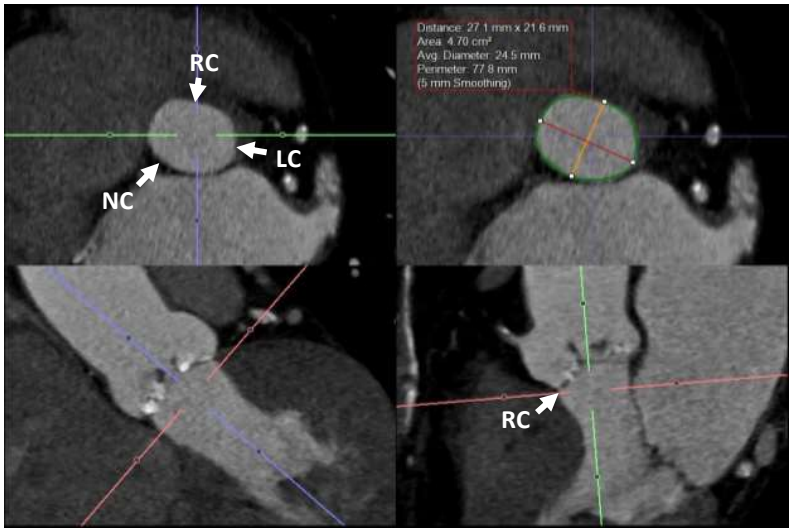
1. CT Data Acquisition

The Basis for Everything

CT Data Acquisition for TAVI-Planning

What you want…

…Combined assessment of the aortic root and iliofemoral vasculature!



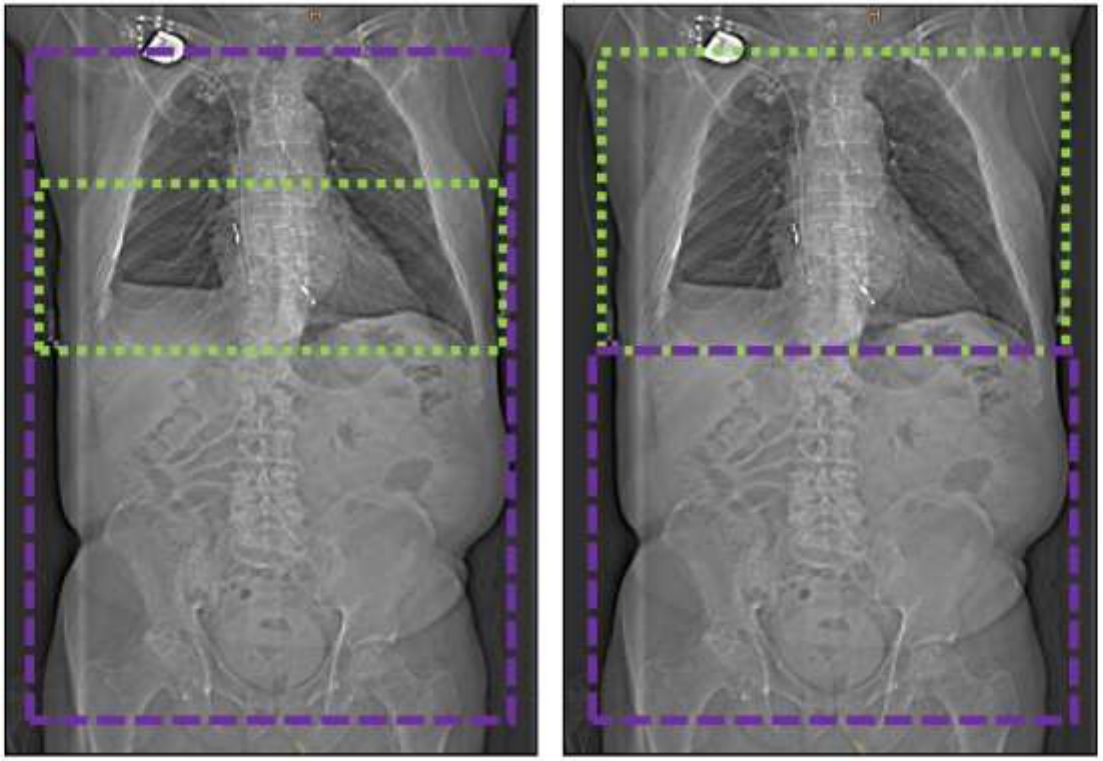
CT Data Acquisition for TAVI-Planning

What you need…

cardiac ECG-assisted data acquisition

+

Non-gated CTA of the thorax, abdomen and pelvis



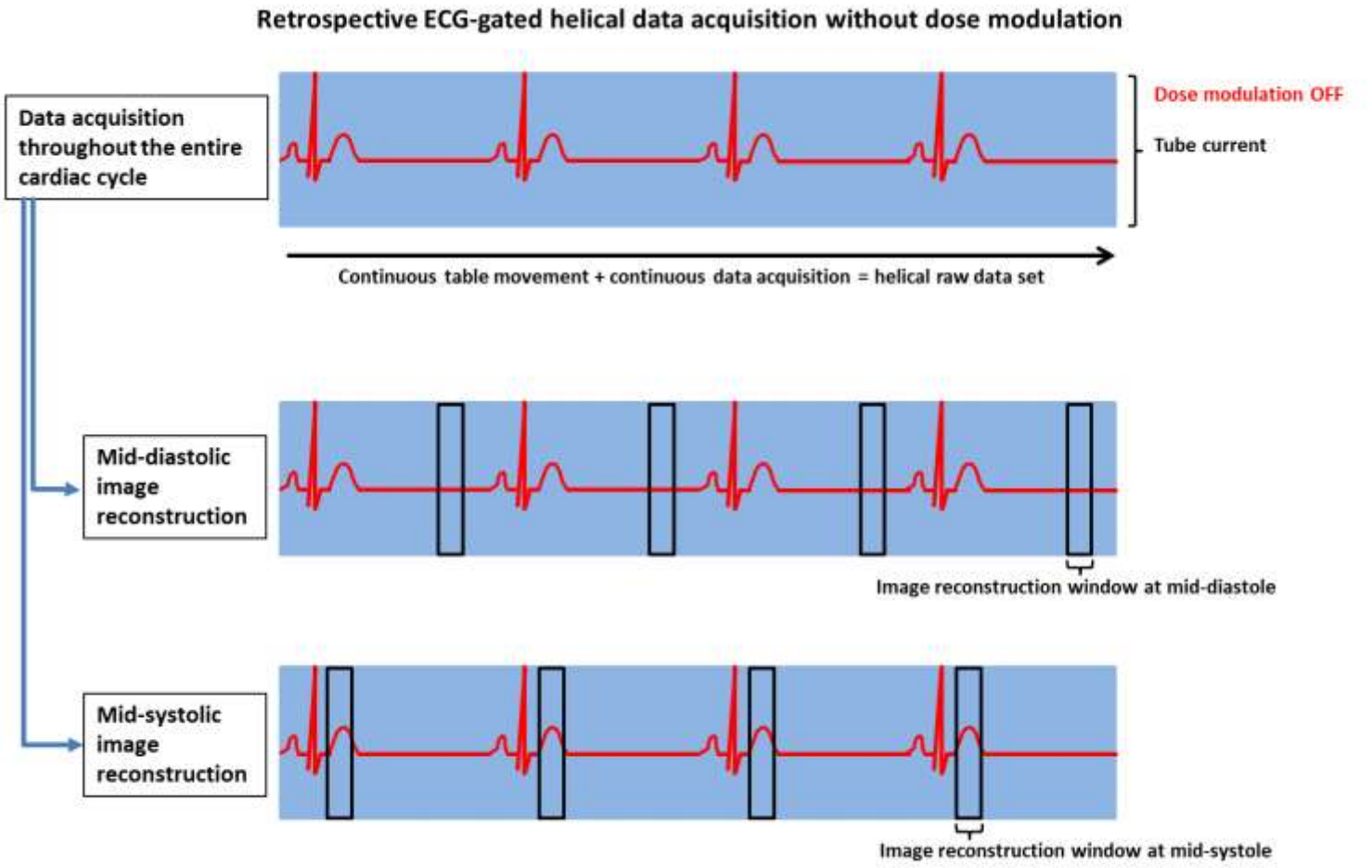
ECG-assisted data acquisition of the thorax

+

Non-gated CTA of the abdomen and pelvis

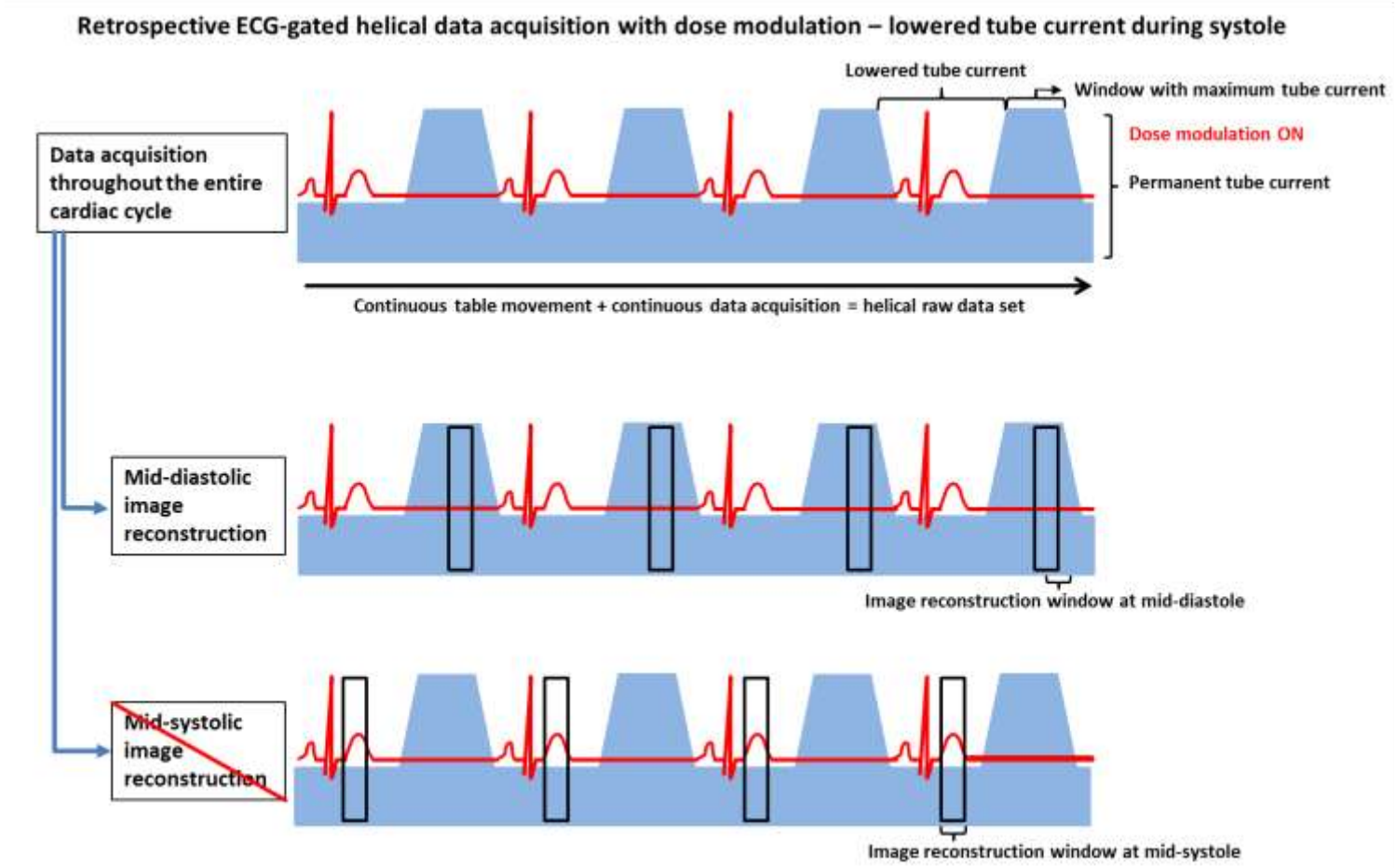
Data acquisition

Retrospectively ECG-gated CTA



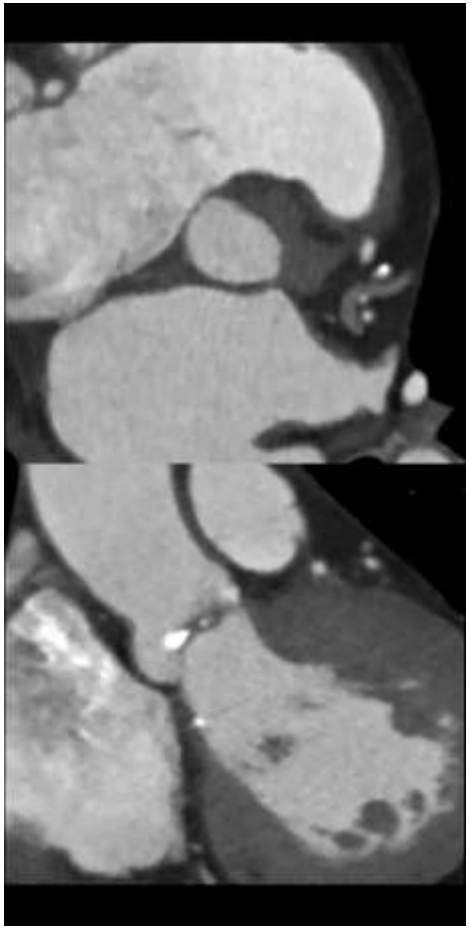
Data acquisition

Retrospectively ECG-gated CTA

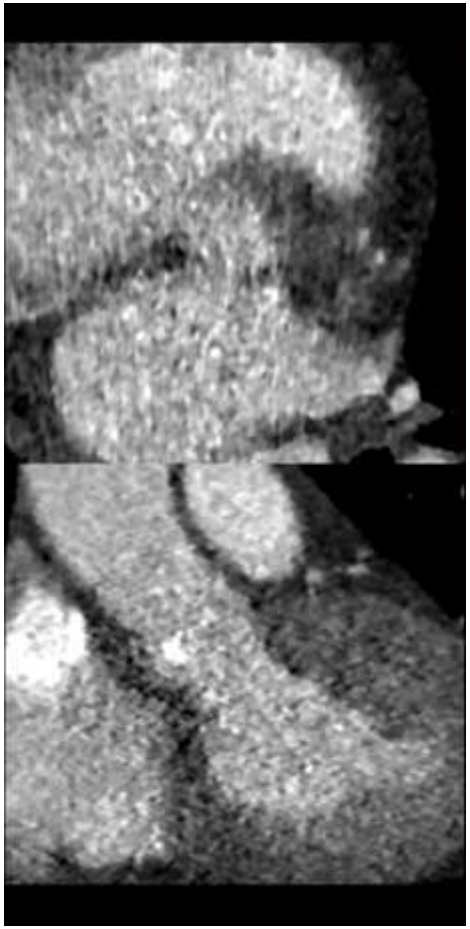


Data acquisition

Retrospectively ECG-gated CTA



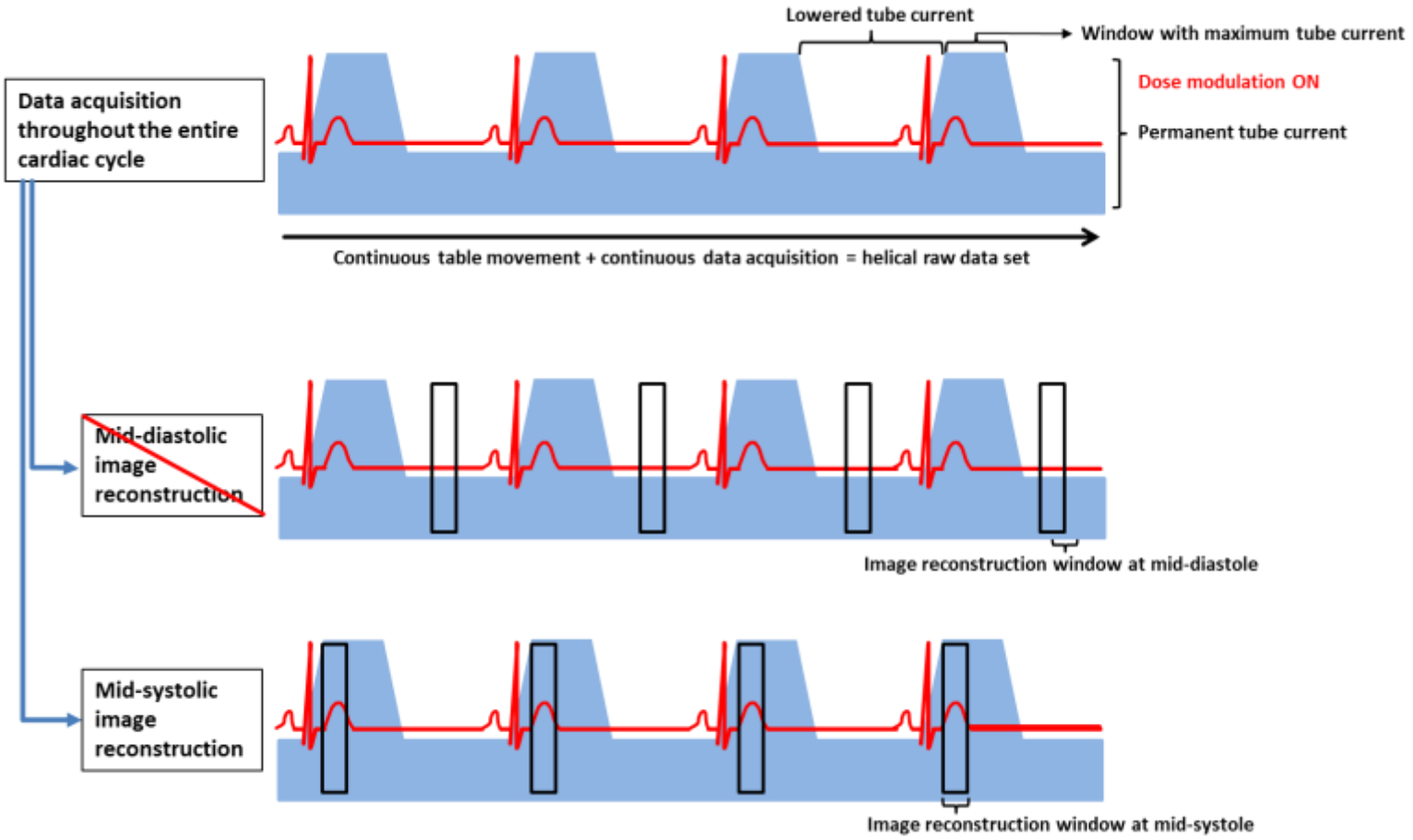
Reconstruction within window of full tube current (here diastole)



Reconstruction outside of window of full tube current (here systole)

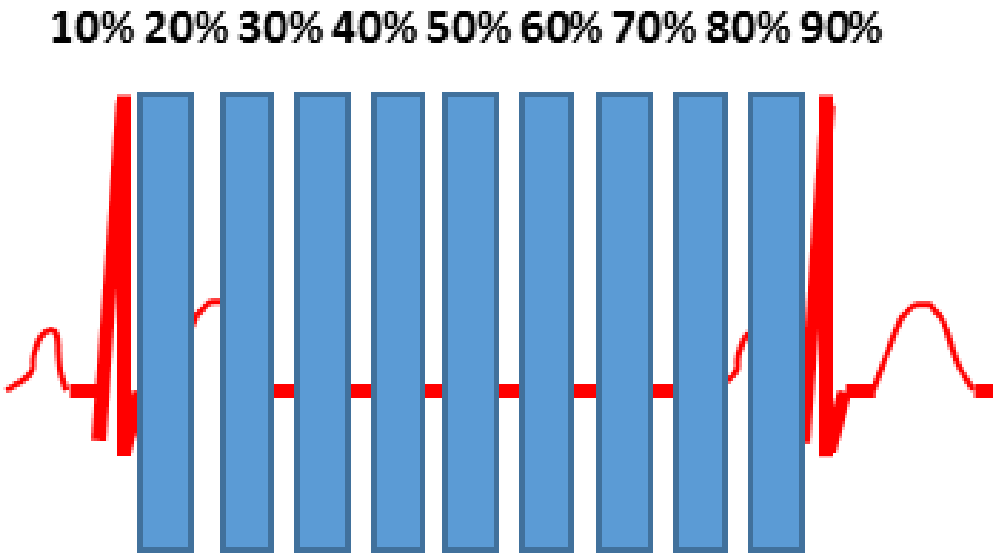
Data acquisition

Retrospectively ECG-gated CTA



Data reconstruction

Full cardiac cycle



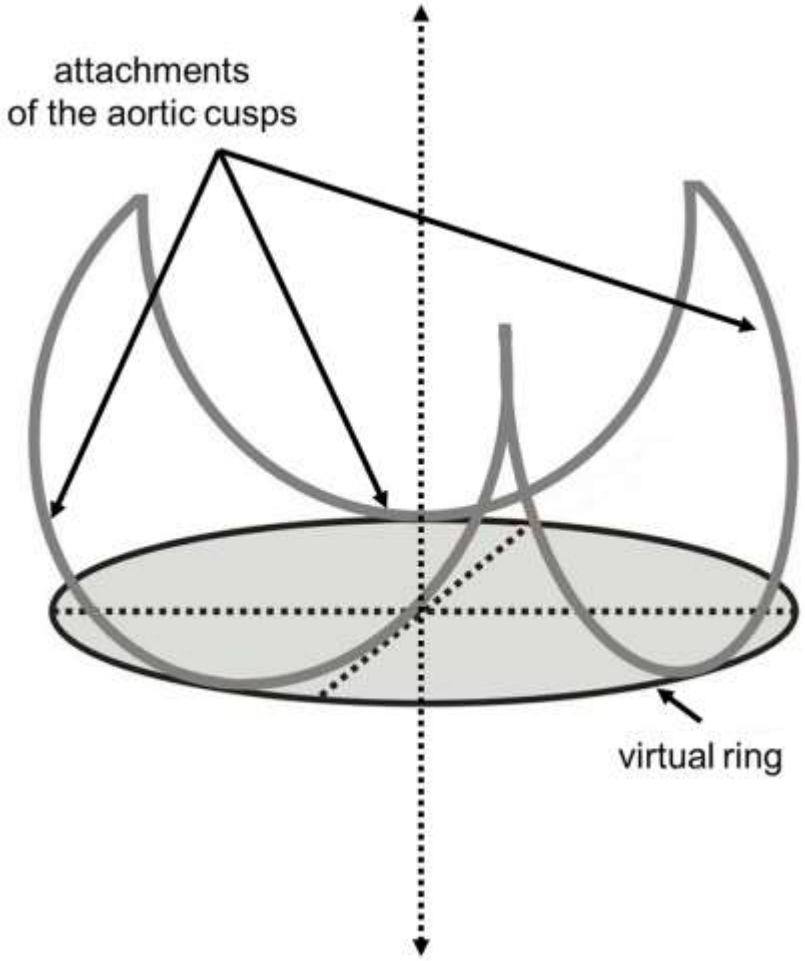
‘cine’, ‘functional’, ‘multiphase’, ‘4D-CT’

2. Aortic annulus

Fundamentals

Aortic annulus

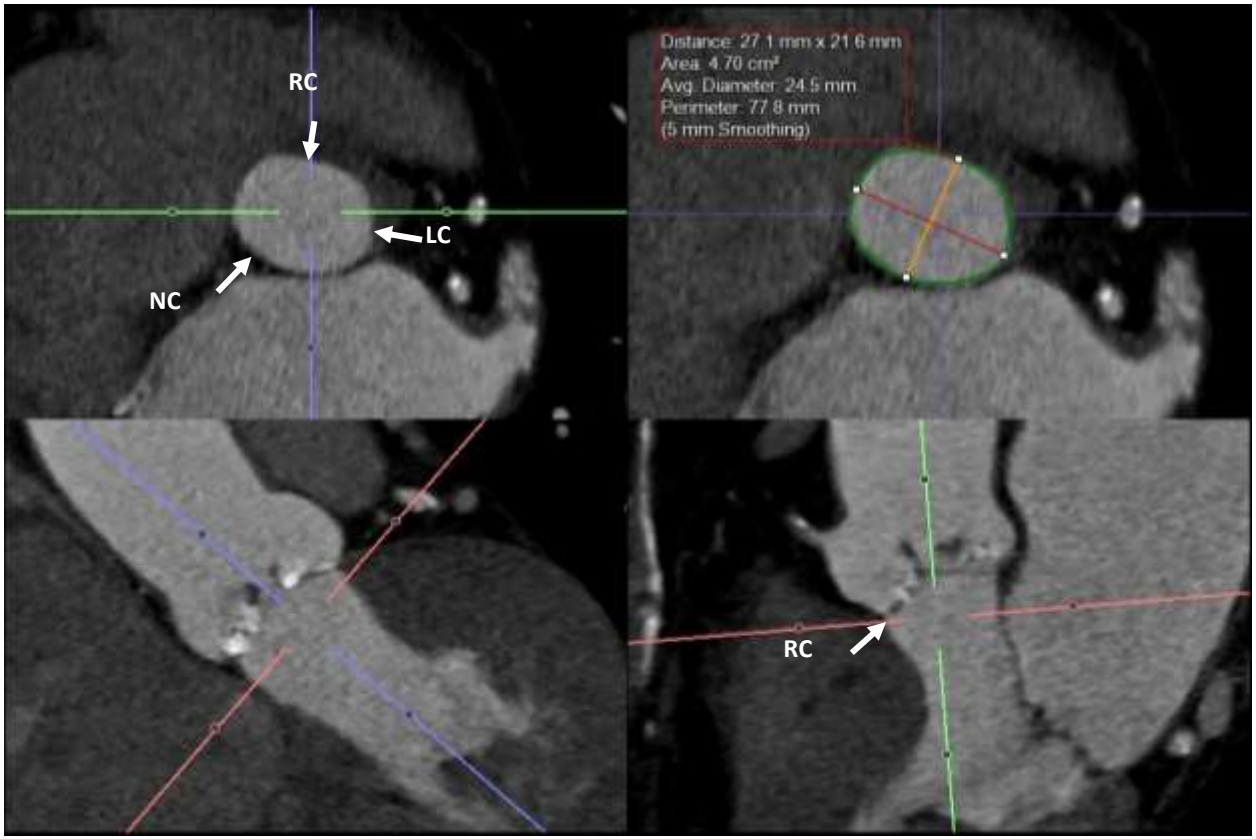
Definition



Blanke et al. *EJCTS 2010*

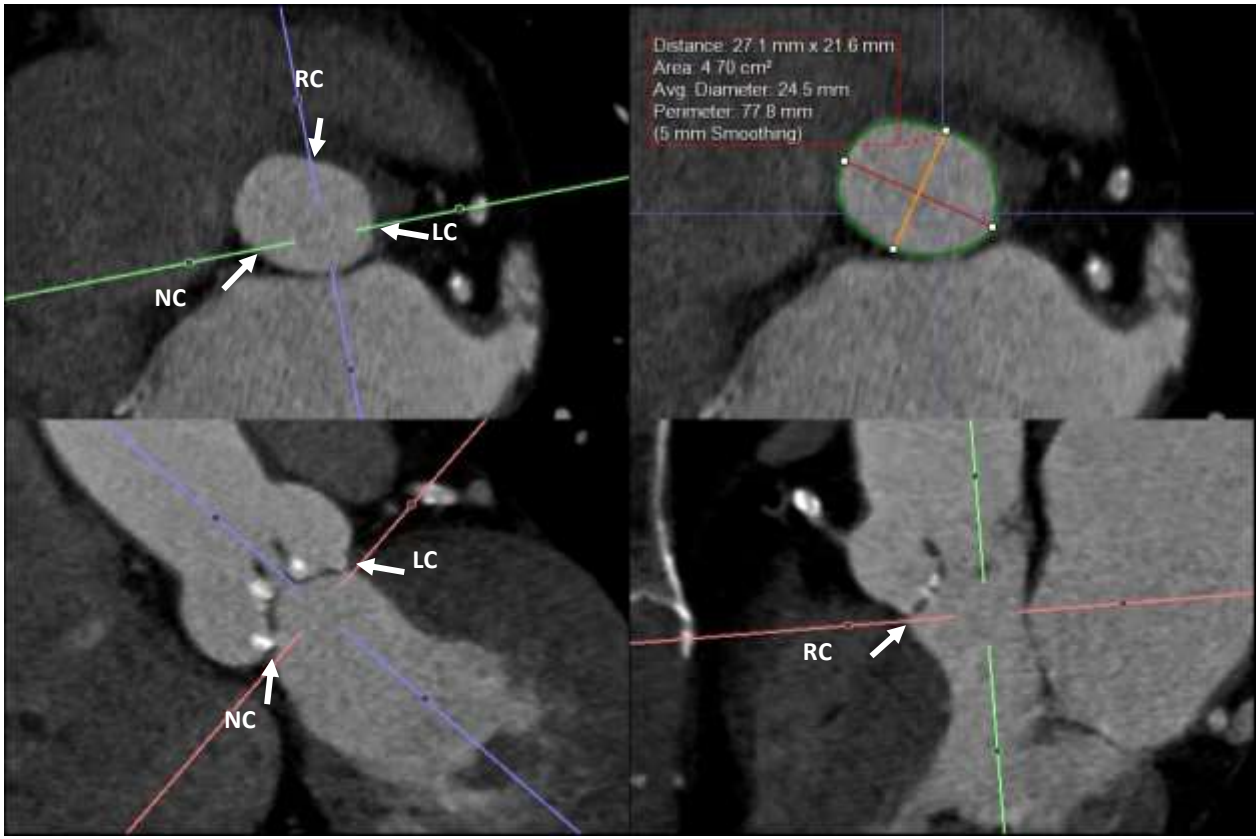
Aortic annulus

Definition



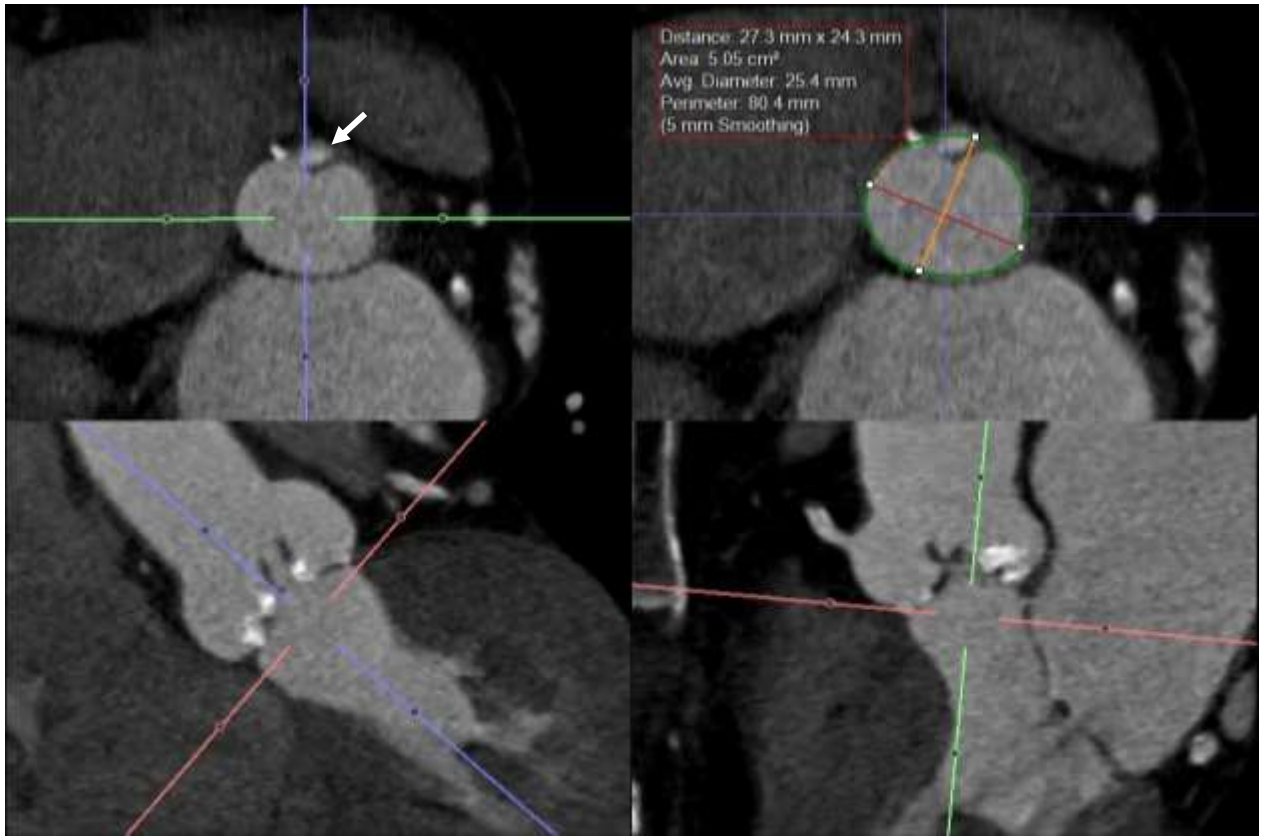
Aortic annulus

Show you work……..



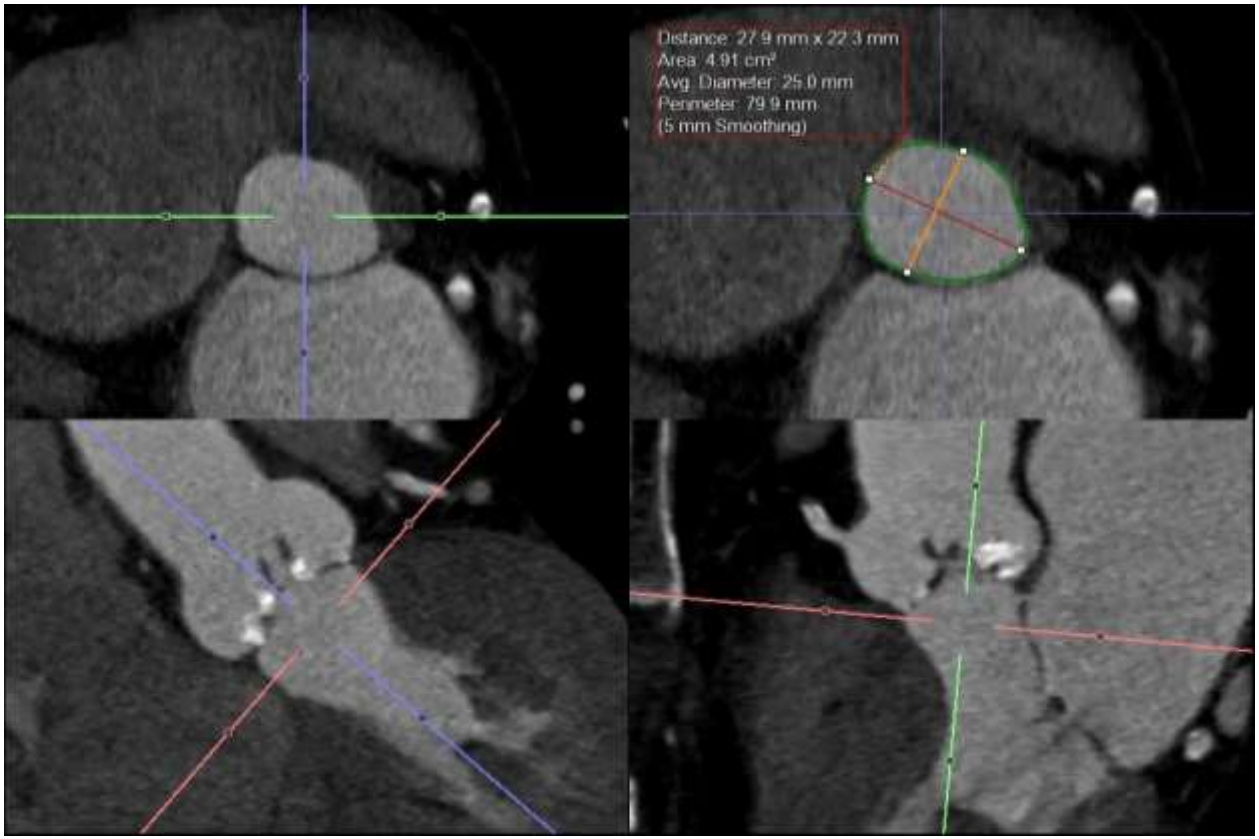
Incorrect Plane

Wrong orientation



Incorrect Plane

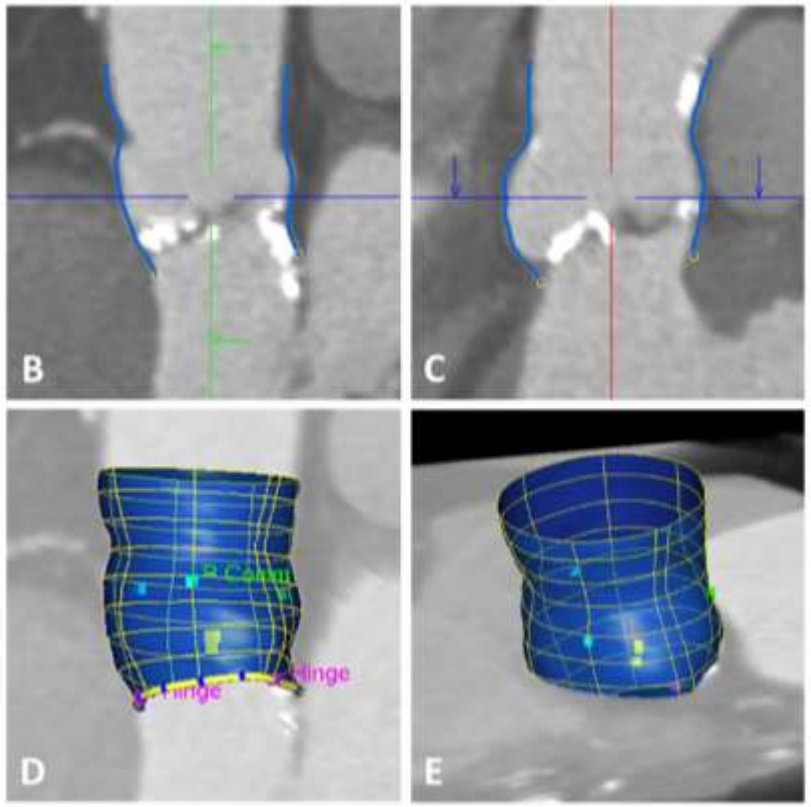
Wrong orientation and Too low



Aortic annulus

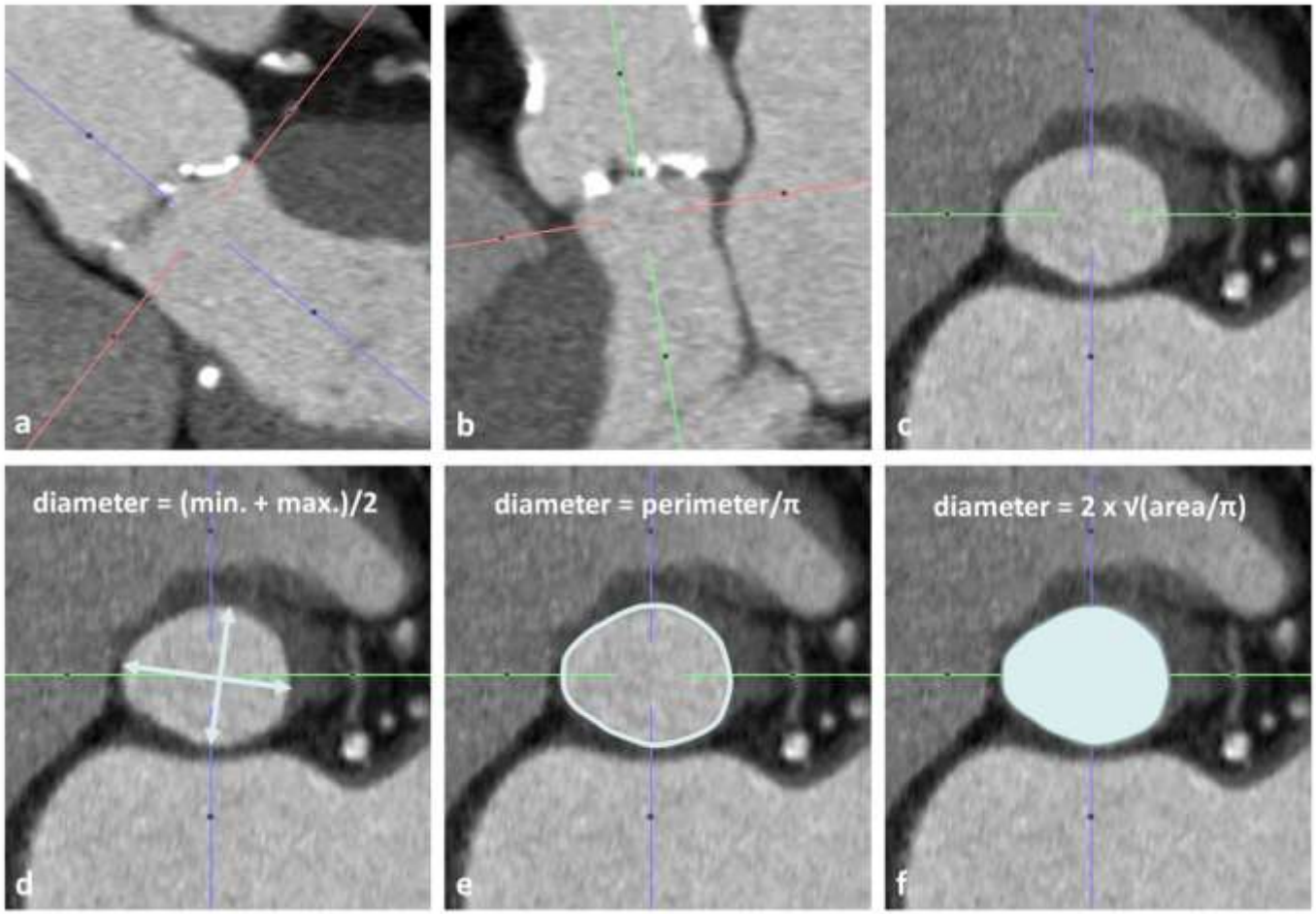
Different approaches

- Manual segmentation with MPRs
- “facilitated” segmentation by placing landmark points
- “semi-automated” segmentation (computer-based algorithms)



Aortic annulus

Measurements



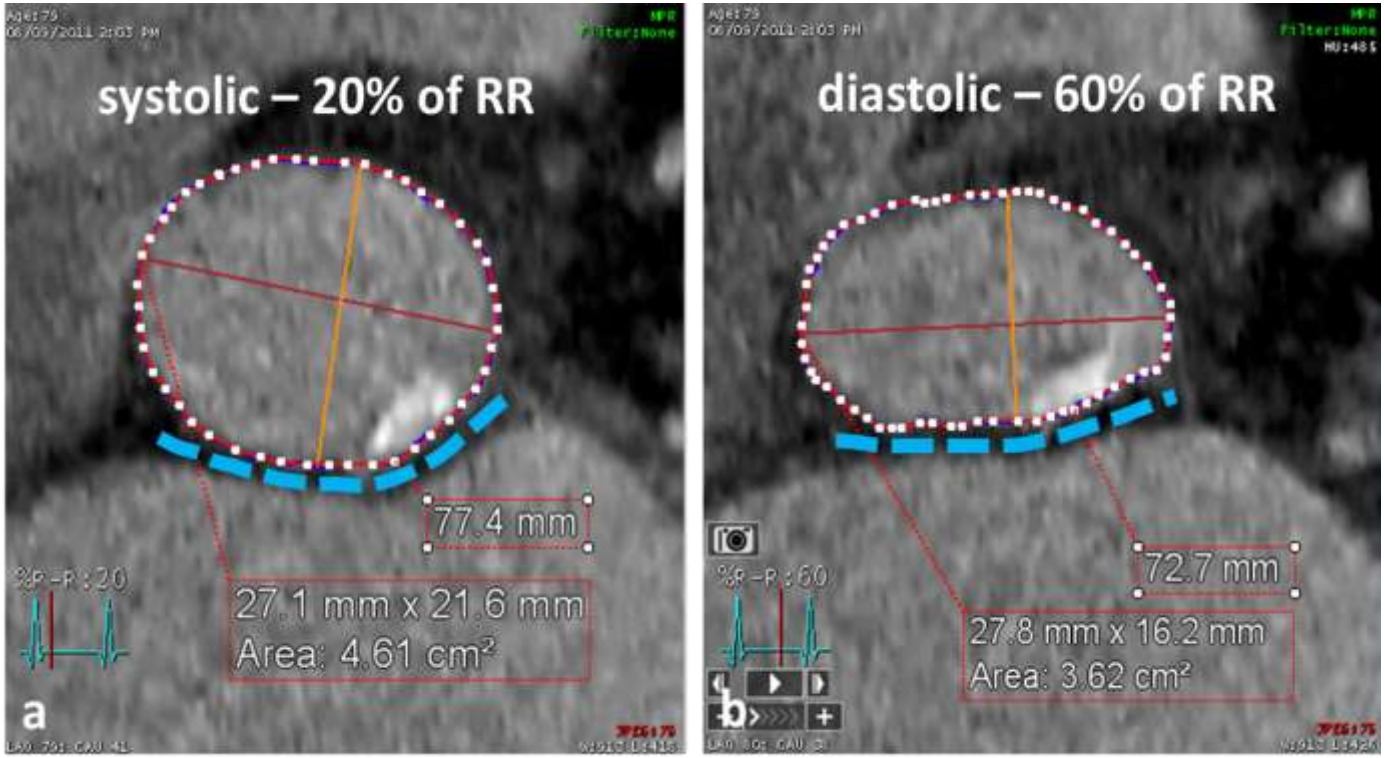
Blanke, Leipsic *Radiology 2013*

3. Annular dynamism

Changes throughout cardiac cycle

Annular dynamism

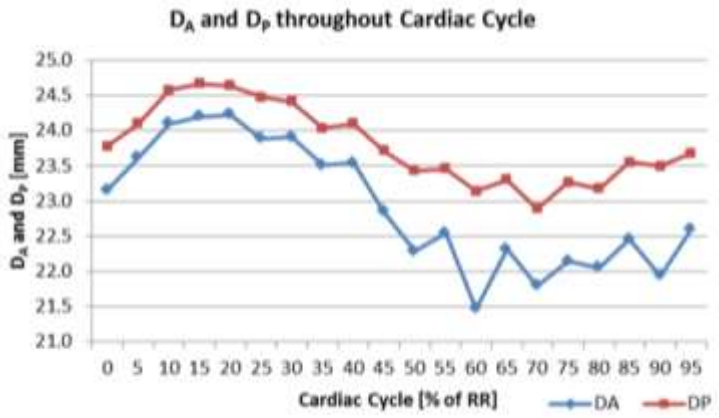
Changes throughout cardiac cycle

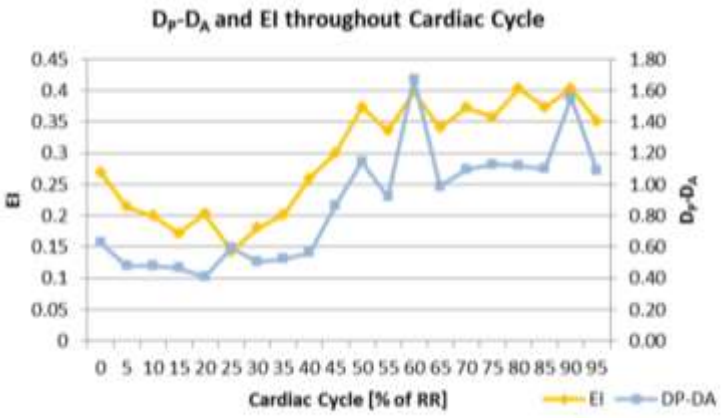


Blanke et al. *JACC Interv. 2012*

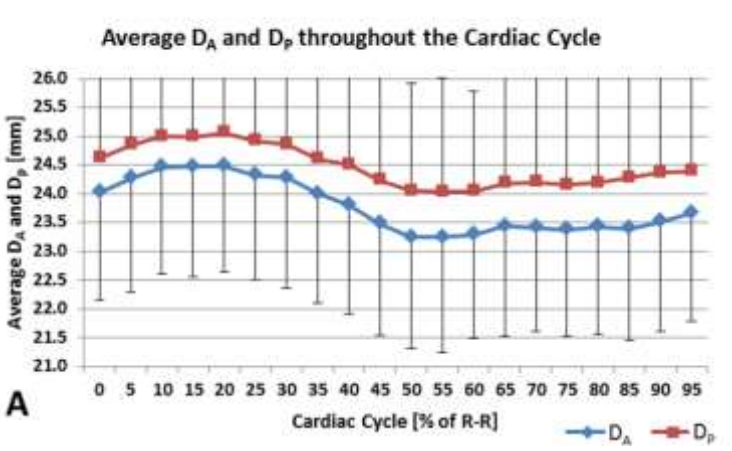
Annular dynamism

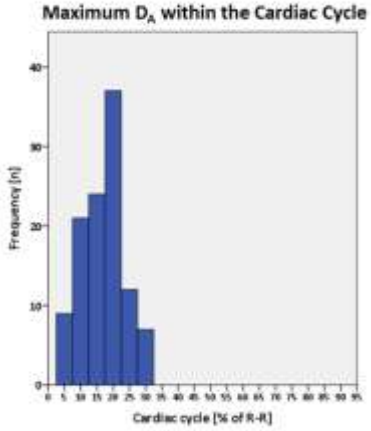
Changes throughout cardiac cycle

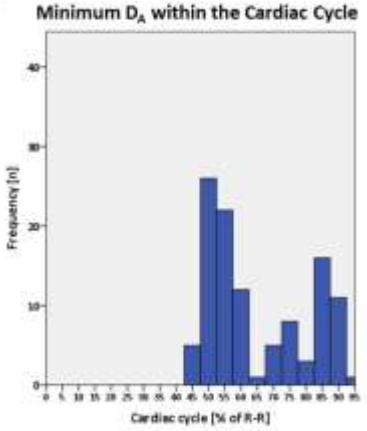




N= 112







Blanke et al. *JACC CV Interv. 2012*

4. Oversizing

Know what this means

Oversizing

Annular geometry

Relative oversizing by area [%] = [(nominal prosthesis area/CSA)-1] *100

Relative oversizing by D_A [%] = [(nominal prosthesis diameter/D_A)-1] *100

Relative oversizing by perimeter [%] = [(nominal prosthesis perimeter/P)-1] *100.

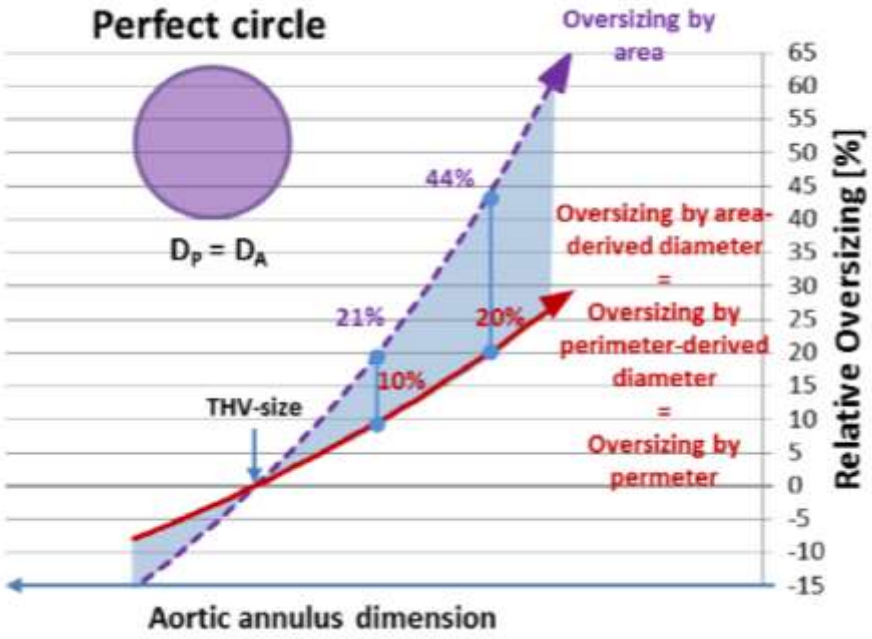
Relative oversizing by D_P [%] = [(nominal prosthesis diameter/D_P)-1] *100.

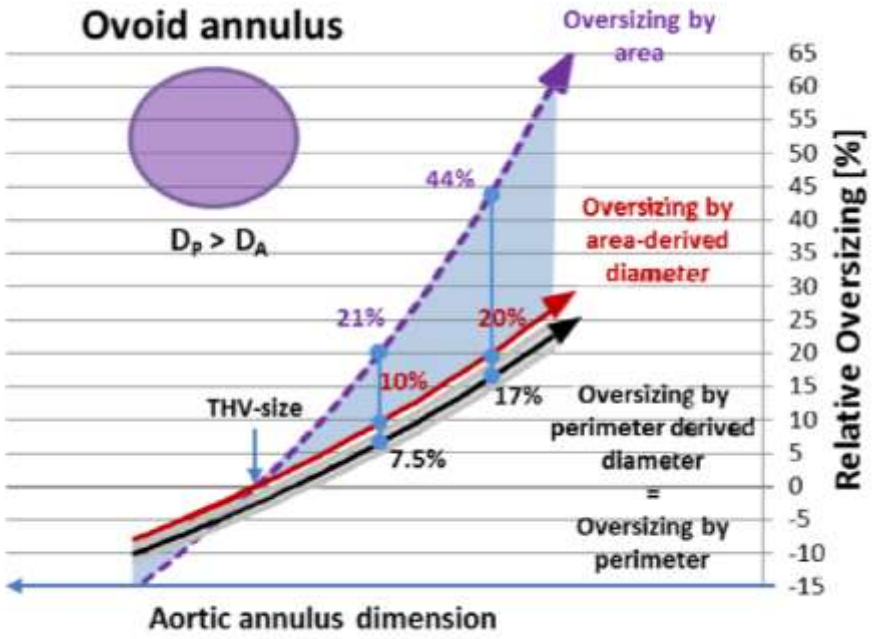
Relative oversizing by TEE [%] = [(nominal prosthesis perimeter/ $TEE_{Annulus}$)-1] *100.

Blanke et al. *JCCT 2014*

Oversizing

Dependency on geometrical measurements





$$A = \pi r^2$$

Blanke et al. JCCT *2014*

Integration of CT

SAPIEN XT - Area-based sizing

Vancouver Sizing Guidelines

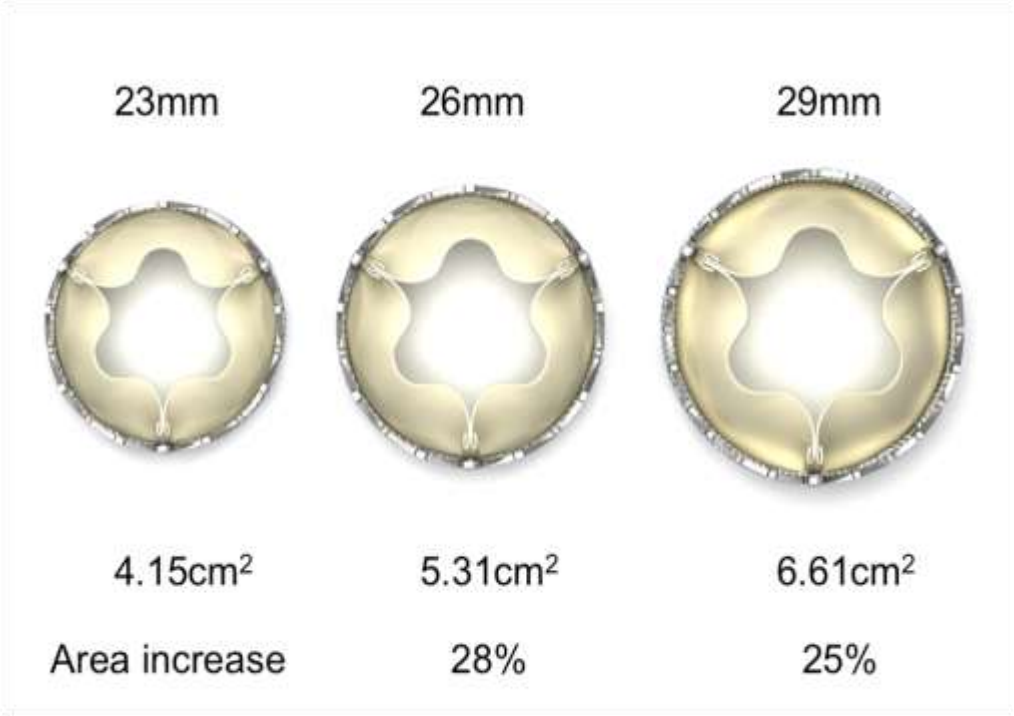


Table 1 Multidetector Computed Tomography Annular Area Sizing Algorithm

	Percentage of Annular Area Oversizing, %			
Annular Area, mm²	20-mm THV	23-mm THV	26-mm THV	29-mm THV
230	NR			
240	NR (30.9)			
250	25.7 UE			
260	20.8 UE			
270	16.4			
280	12.2			
290	8.3			
300	4.7			
310	1.3	NR		
320	NR (−1.9%)	29.8 UE		
330		25.9 UE		
340		22.2 UE		
350		18.7		
360		15.4		
370		12.3		
380		9.3		
390		6.5		
400		3.9	NR	
410		1.3	NR (29.5)	
420		NR (−1.1)	26.4 UE	
430			23.5 UE	
440			20.7 UE	
450			18.0	
460			15.4	
470			13.0	
480			10.6	
490			8.4	
500			6.2	
510			4.1	NR
520			2.1	NR (27.0)
530			0.2	24.6 UE
540				22.3 UE
550				20.1 UE
560				17.9
570				15.9
580				13.9
590				12.0
600				10.1
610				8.3
620				6.5
630				4.8
640				3.2
650				1.6
660				0.1
670				NR

Binder et al 2013 JACC
Willson et al JCCT 2012

Different Sizing Algorithms for Different Valves

SAPIEN 3

It may not always be possible to implant the larger THV size for borderline annulus diameters. Consider the smaller THV in the following special situations:

- Severe annulus calcification
- Narrow root and low coronary ostia
- Narrow sinotubular junction
- Mitral annular calcification
- Porcelain aorta
- Bulky leaflet and low coronary ostia

If/when outside of recommended range:

1) Reference alternative sizing modalities (echocardiography, balloon sizing)
2) Consider the following factors in valve size selection
   - Clinical: very advanced age, corticosteroids, chest radiation, extensive calcification, calcium extending into the LVOT, etc

Bold = recommended Sealing Zones relate only to valves that are deployed with nominal volumes

3D Area-derived Diameter (mm)		20.0	20.2	20.5	20.7	21.0	21.1	21.4	21.7	22.0	22.3	22.6	22.8	23.0	23.1	23.4	23.7	23.9	24.0	24.2	24.5
3D Annular Area (mm^2)		314	320	330	338	346	350	360	370	380	390	400	410	415	420	430	440	450	452	460	470
% Annular Area Over (+) or Under (-) Nominal by 3D CT	23 mm	29.3	26.9	23.0	**20.1**	**17.3**	**16.0**	**12.8**	**9.7**	**6.8**	**4.1**	**1.5**	**-1.0**	**-2.2**	**-3.3**	**-5.6**	-7.7	-9.8			
	26 mm											29.8	26.6	25.1	23.6	**20.7**	**18.0**	**15.3**	**14.8**	**12.8**	**10.4**
	29 mm																				

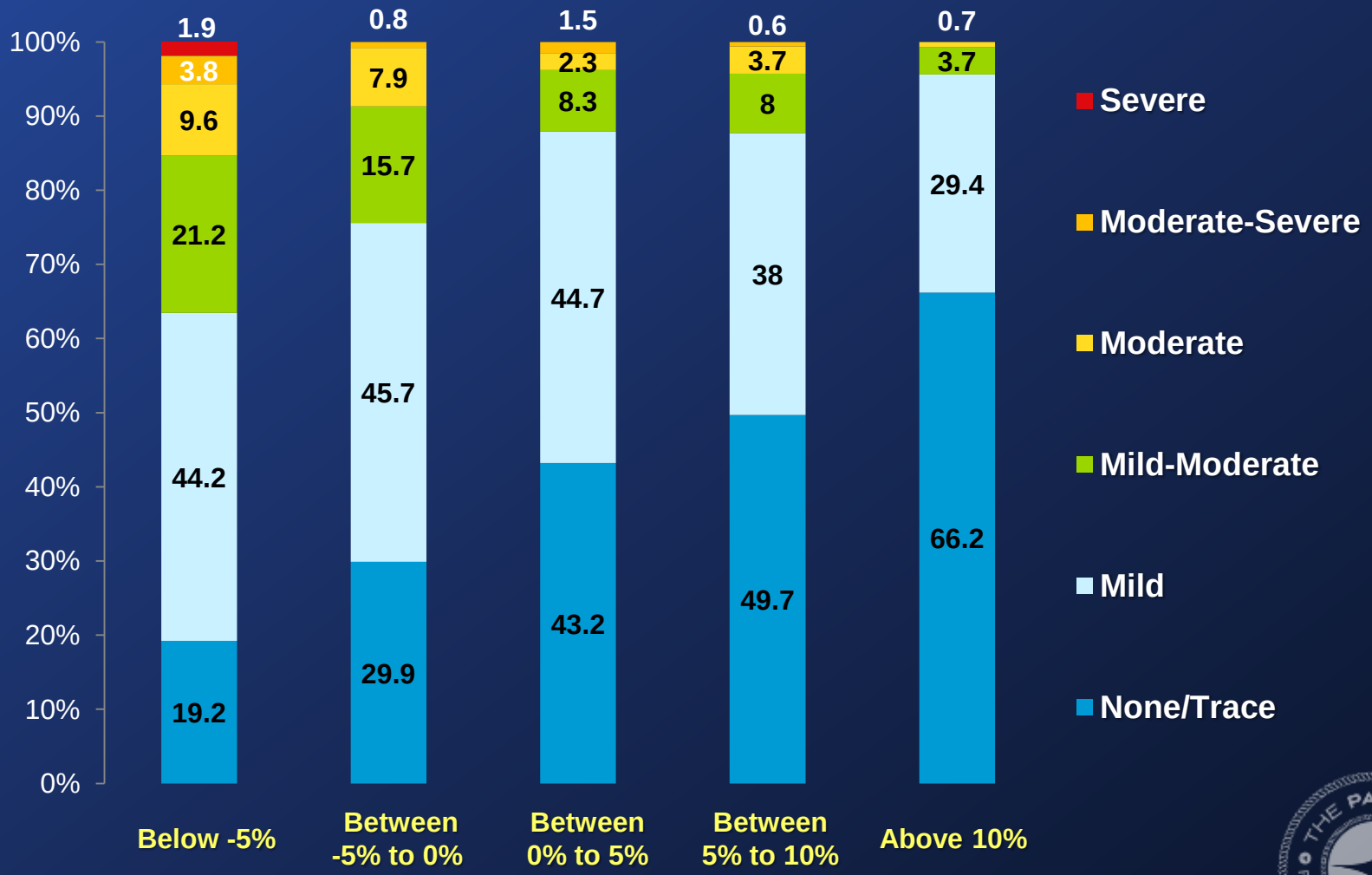
ALL VALUES PRESENTED ARE BASED ON NOMINAL/RECOMMENDED INFLATION VOLUMES.

SYSTOLIC MEASURES ARE RECOMMENDED

24.5	24.7	25.0	25.2	25.5	25.7	26.0	26.2	26.4	26.5	26.7	26.9	27.2	27.4	27.6	27.9	28.0	28.1	28.3	28.5	28.8	29.0	29.2	29.4	29.5	29.6	29.9	30.1	30.3
470	480	490	500	510	520	530	540	546	550	560	570	580	590	600	610	615	620	630	640	650	660	670	680	683	690	700	710	720
10.4	**8.1**	**5.9**	**3.8**	**1.8**	**-0.2**	**-2.1**	**-3.9**	**-4.9**	-5.6	-7.3	-8.9																	
			29.8	27.3	24.8	22.5	**20.2**	**18.9**	**18.0**	**15.9**	**13.9**	**11.9**	**10.0**	**8.2**	**6.4**	**5.5**	**4.7**	**3.0**	**1.4**	**-0.2**	**-1.7**	**-3.1**	**-4.6**	-5.0	-5.9	-7.3	-8.6	-9.9

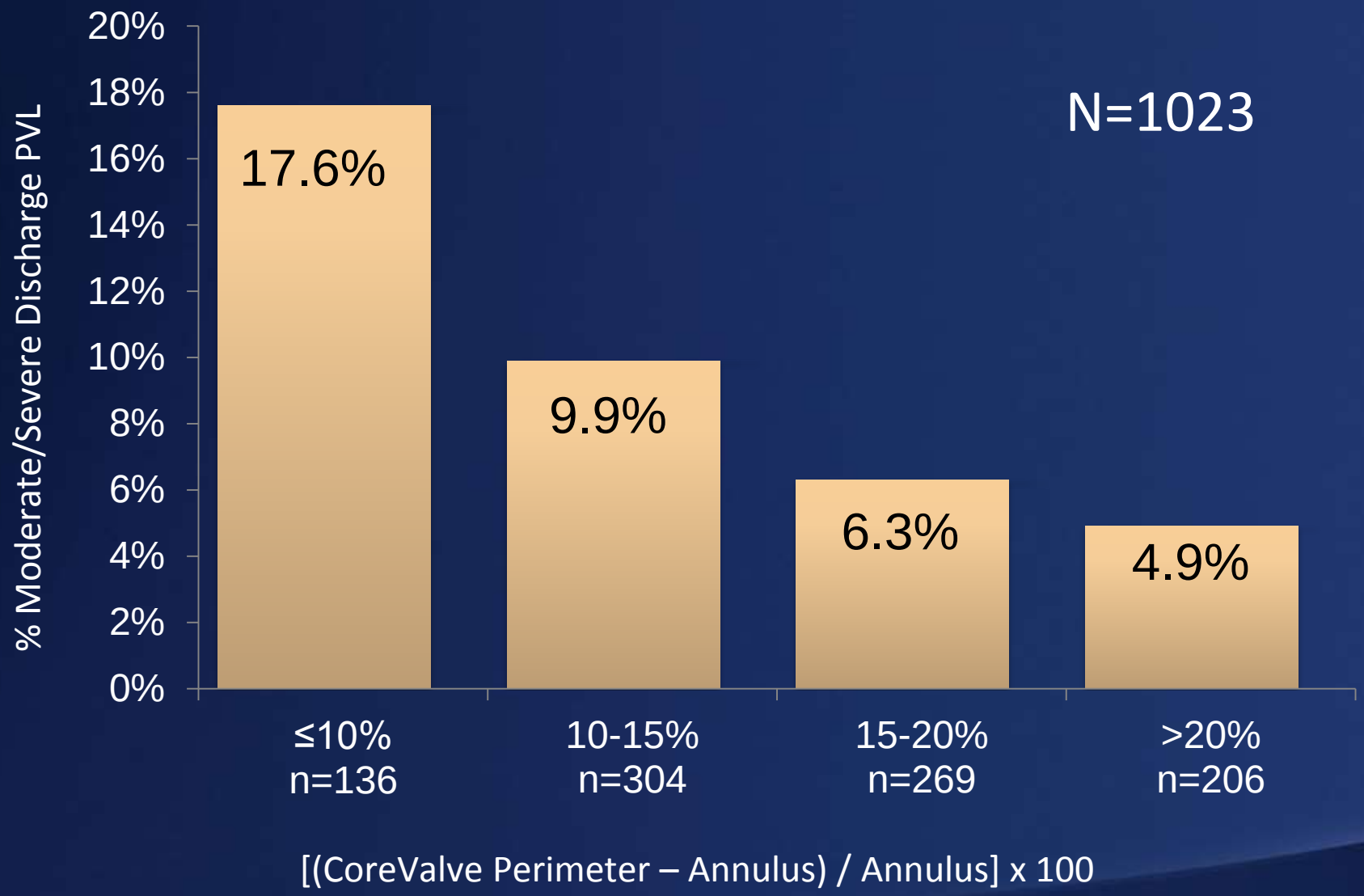
Results (2)

PAR Stratified by % Oversizing by Area



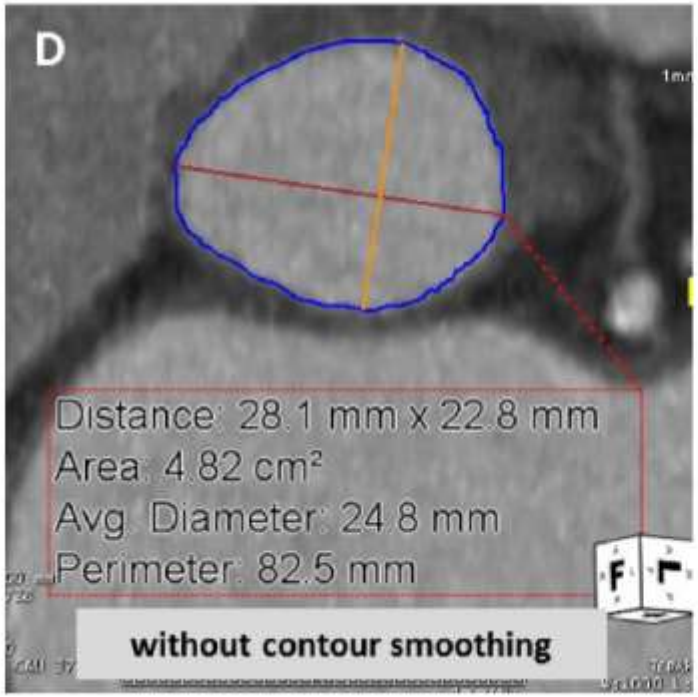
No annular rupture

CoreValve Sizing Ratio and Mod/Severe PVL



Annulus sizing

Perimeter



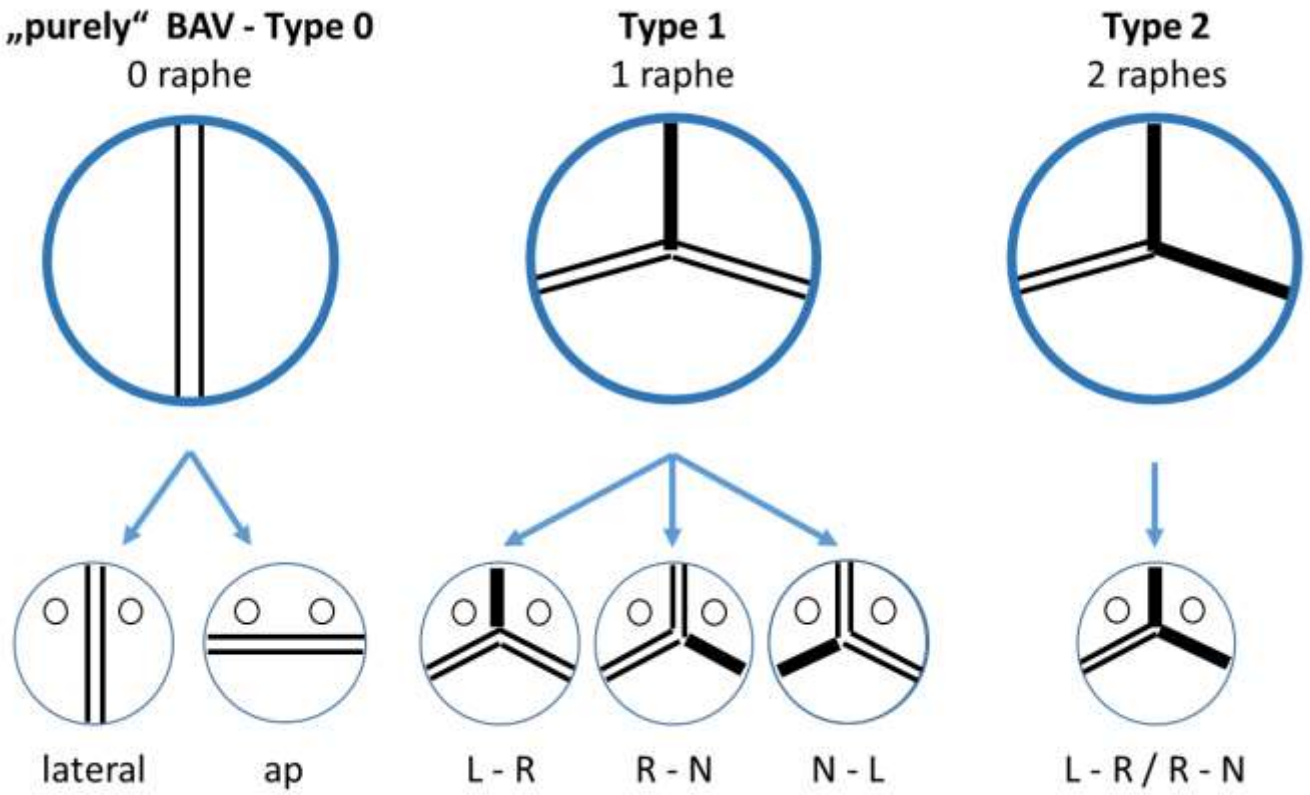
Blanke et al. JCCT *2014*

5. Valve morphology

Know what this means

Bicuspid aortic valves

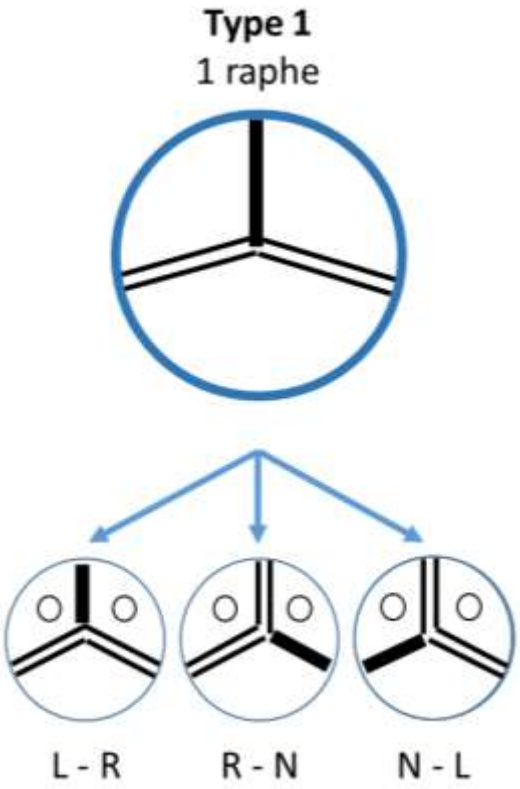
Classification

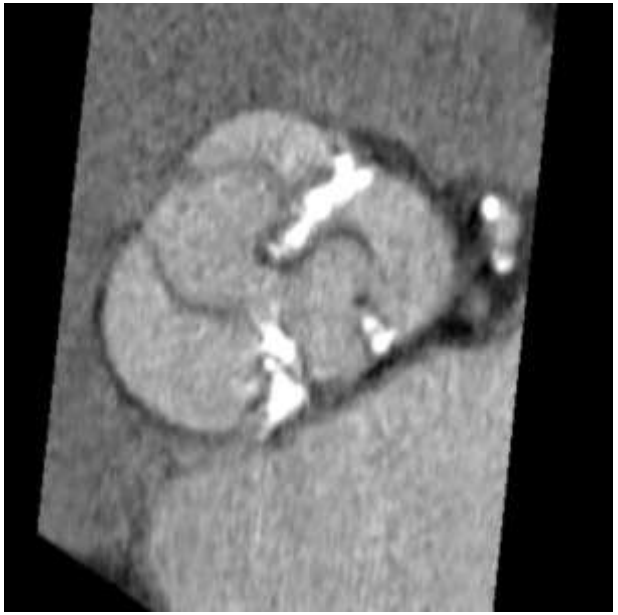


Adapted from Sievers et al. 2007

Bicuspid aortic valves

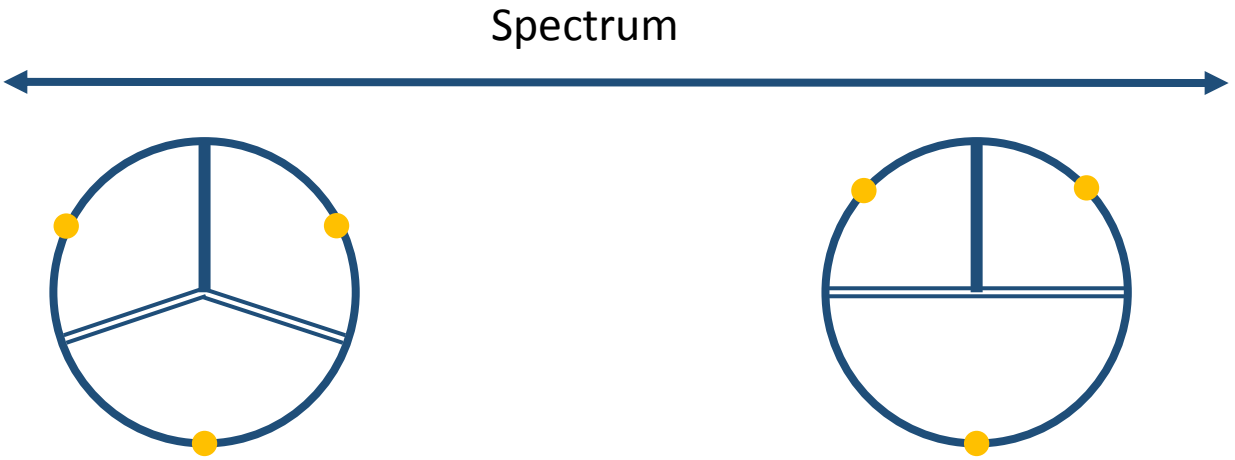
Type 1





Bicuspid aortic valves

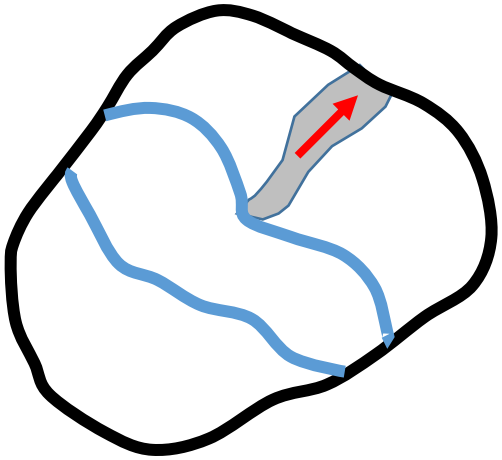
‘Many faces of Type 1’



Unifying characteristic: Raphe

Valve anatomy

Bicuspid



Essentials of CT aortic valve assessment

Thanks for you attention!