Echocardiography is inferior to computed tomography in predicting balloon expandable transcutaneous implantation valve size in routine clinical setting

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single centre study (audit)

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TAVI history

- 1 implantation 2002
- 1 implantation in CZ 12/2007
- 1 implantation in HK 1/2008

- Sapien XT
- Sapien S3 2011
- Sapien S3 Ultra 2022

- SIZING!!!!!

S3

Native Valve Annulus Size (TEE)	Native Valve Annulus Size (CT)		THV Size
	Area	Area Derived Diameter	
18-22 mm	314 – 415 mm^2	20-23 mm	23 mm
21-25 mm	415 – 530 mm^2	23-26 mm	26 mm
24-27 mm	530 – 660 mm^2	26-29 mm	29 mm

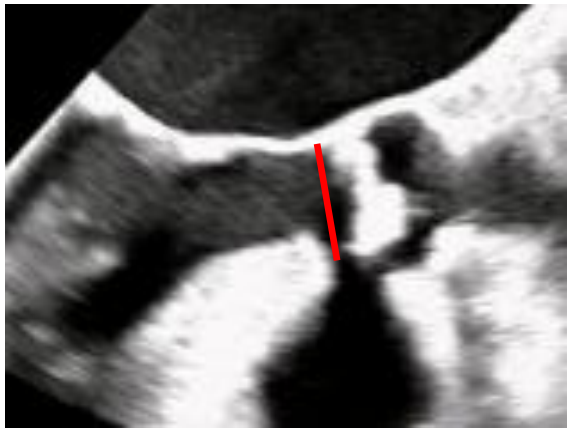
THV size recommendations are based on native valve annulus size, as measured by transesophageal echocardiography (TEE) or computed tomography (CT). Patient anatomical factors and multiple imaging modalities should be considered during THV size selection. Note: Risks associated with undersizing and oversizing should be considered.

XT

Native Valve Annulus Size (TEE)	Native Valve Annulus Size (CT)		THV Size
	Area	Area Derived Diameter	
16-19 mm	273 – 345 mm^2	18.6-21 mm	20 mm
18-22 mm	338 – 430 mm^2	20.7-23.4 mm	23 mm
21-25 mm	430 – 546 mm^2	23.4-26.4 mm	26 mm
24-28 mm	540 – 683 mm^2	26.2-29.5 mm	29 mm

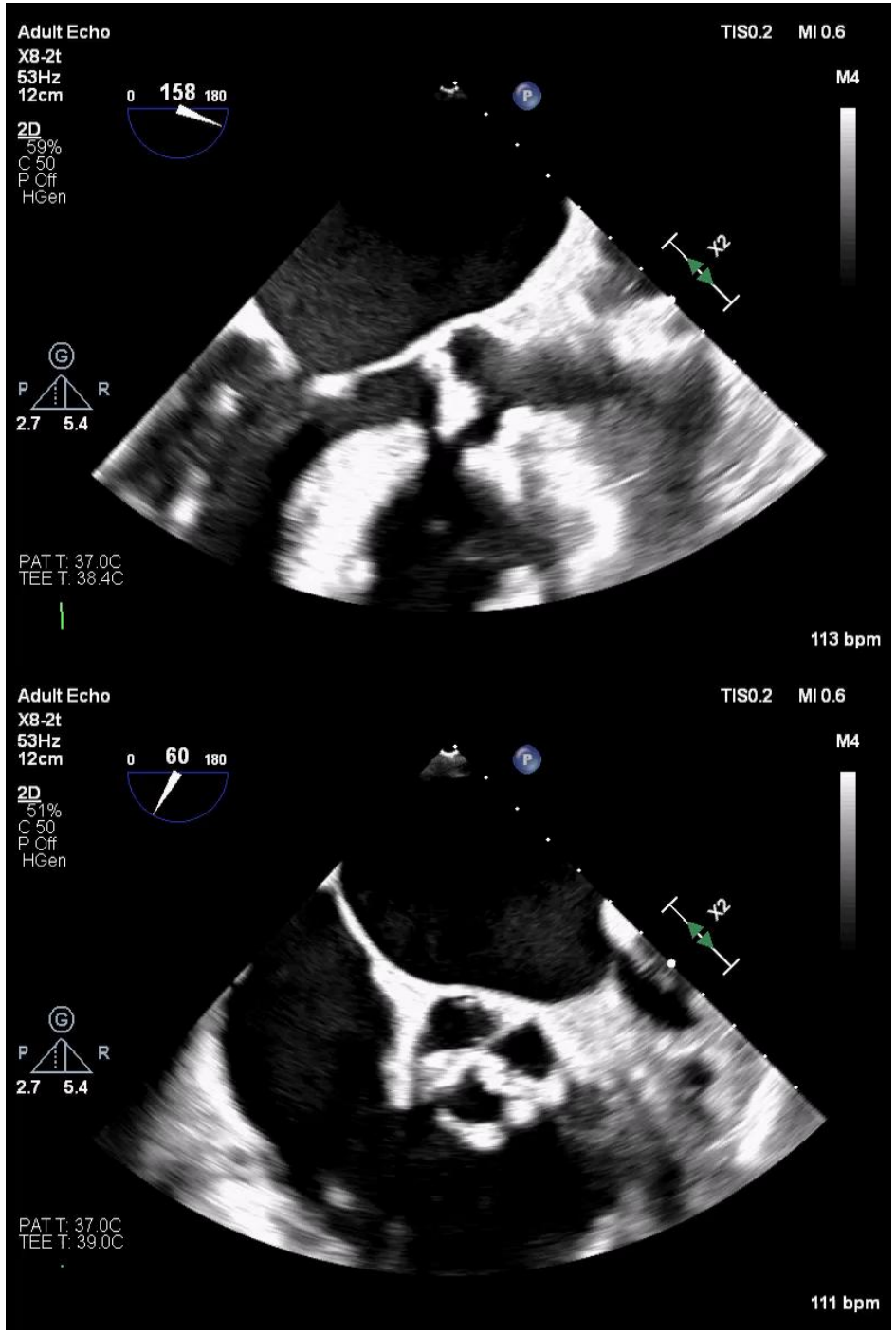
THV size recommendations are based on native valve annulus size, as measured by transesophageal echocardiography (TEE) or computed tomography (CT). Patient anatomical factors and multiple imaging modalities should be considered during THV size selection. Note: Risks associated with undersizing and oversizing should be considered.

ECHO 2D TOE



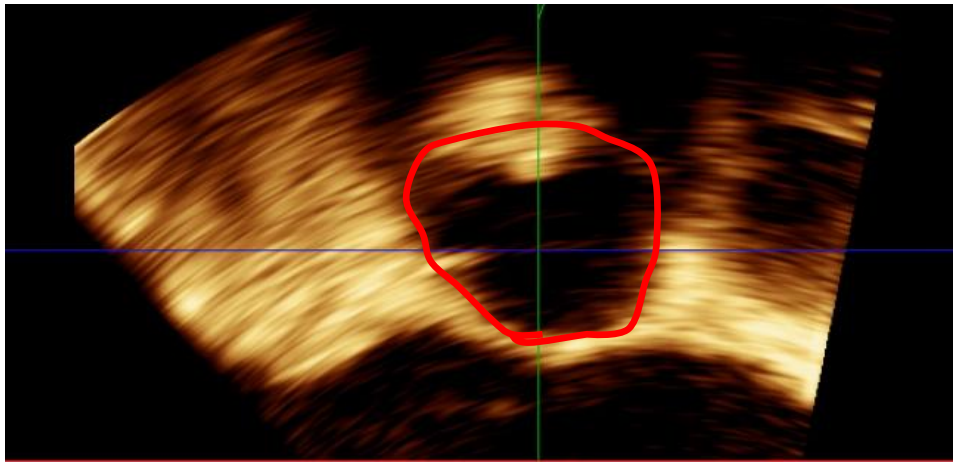
- 2D LVOT
- good temporal resolution
- in protosystole

- semiinvasive
- inferior spatial resolution
- calcium shadowing
- septal „bulging“
- „ignores“ annulus asymetry

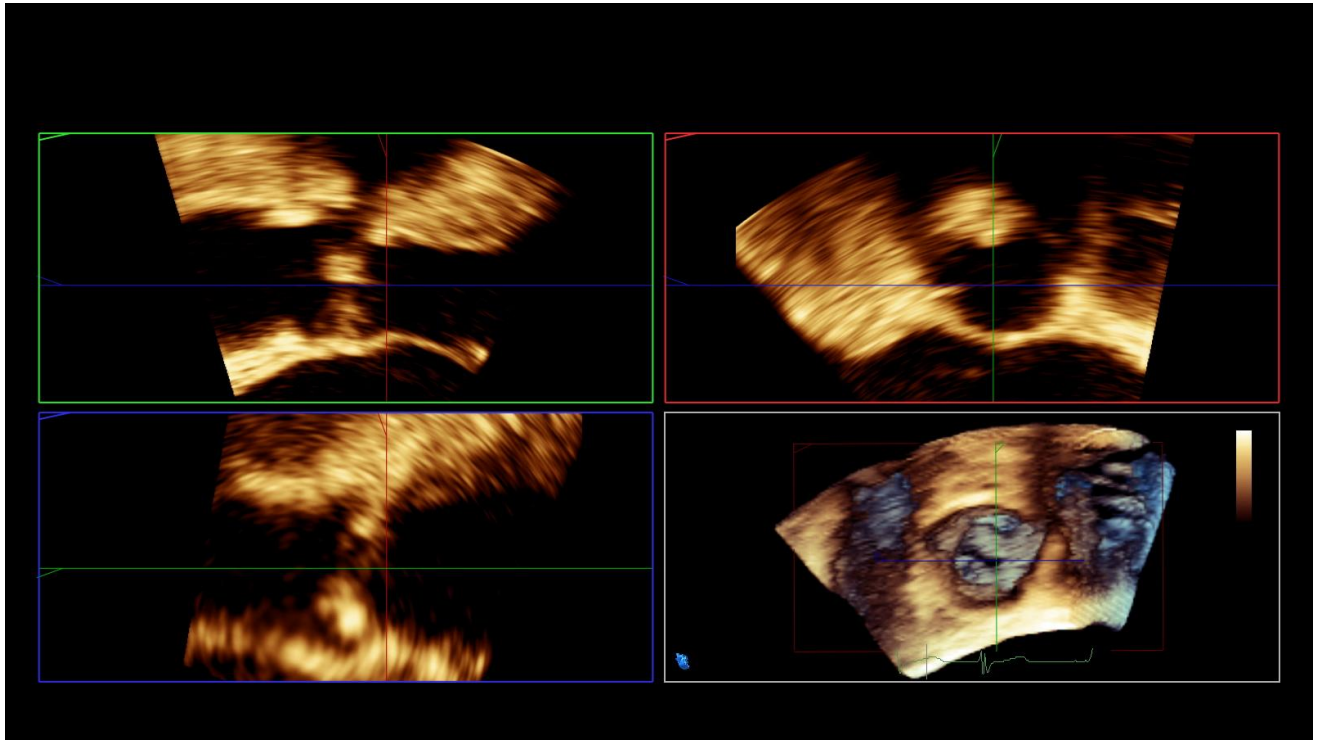


3D ECHO TOE

- area, area derived diam. by MPR



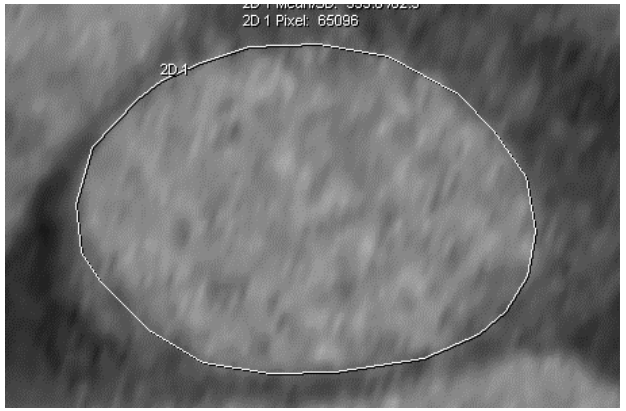
- reflects Ao annulus asymetry
- in proto-systole
- (Ao annulus-coronary arteries origin distance)

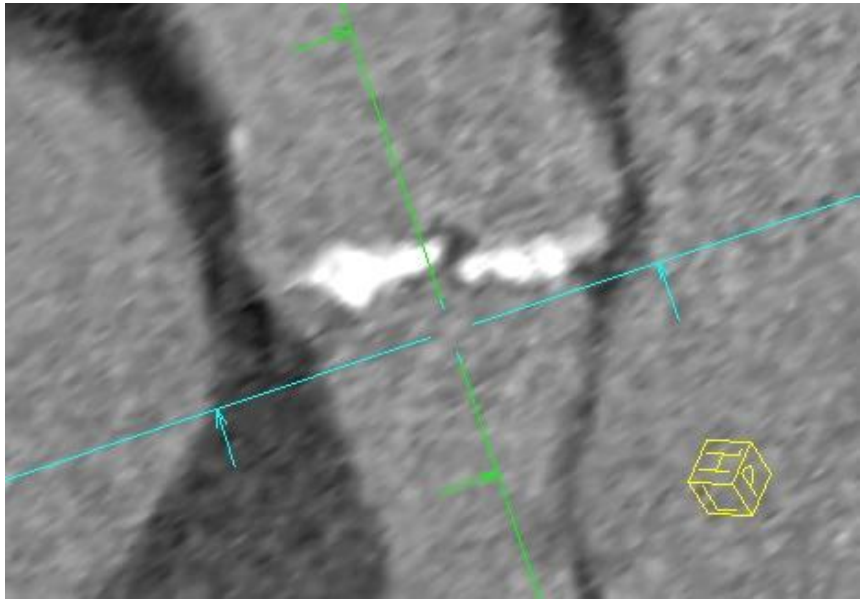


- semiinvasive
- „not ideal“ spatial resolution
- labourious
- calcium shadowing

MSCT

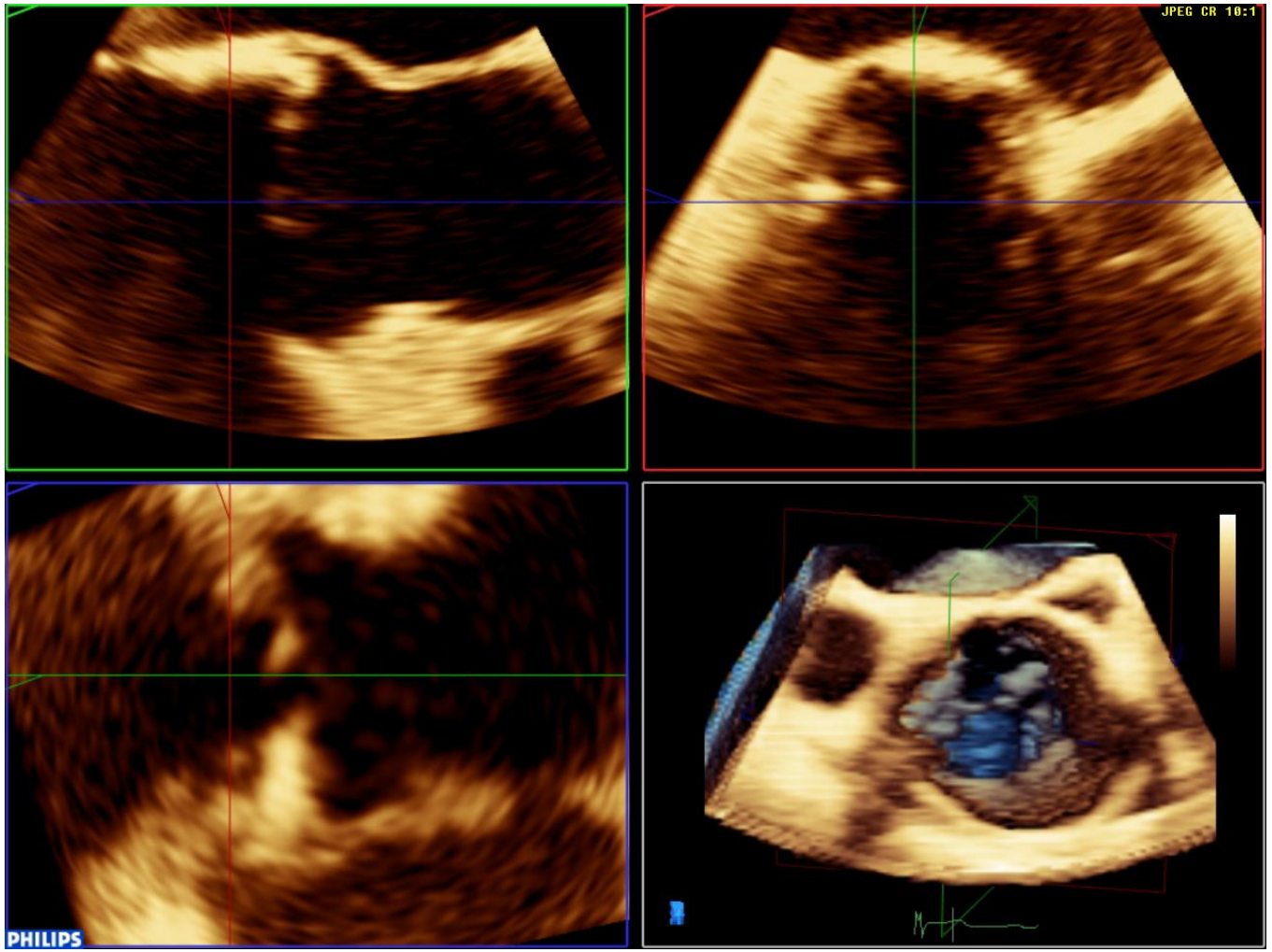
- area, area derived diameter





- non-invasive
- good spatial resolution
- short investigation
- in diastole
- coronary ostia hight measurements
- valvular calcium burden
- angiography of aorta/pelvic/femoral arteries

- radiation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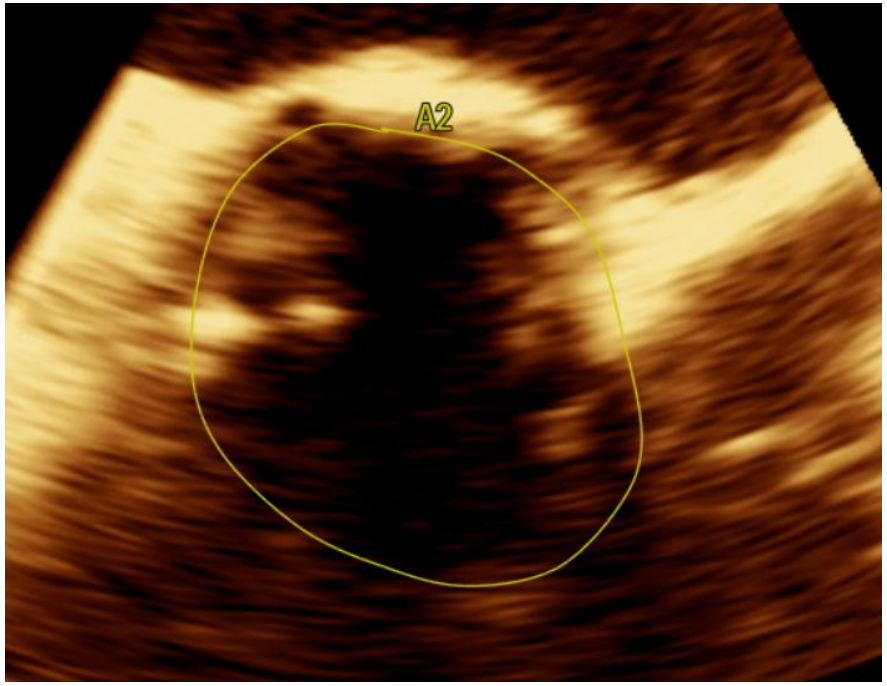
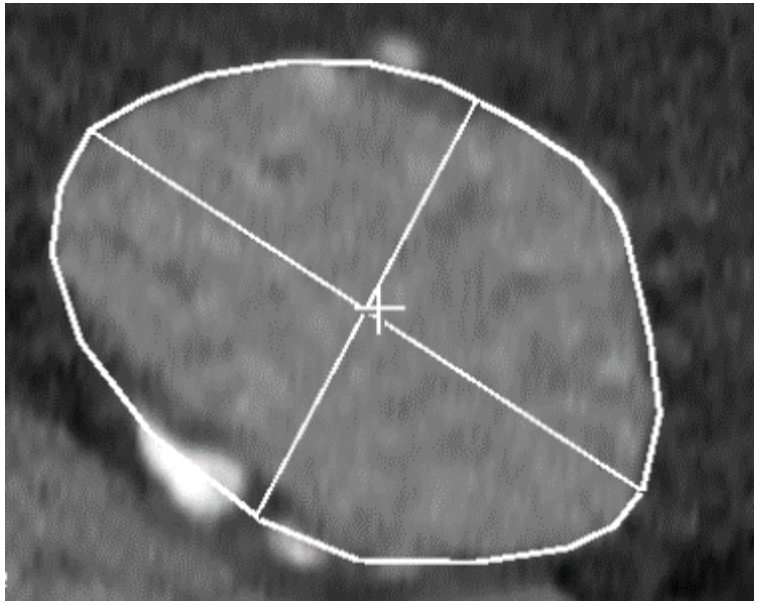
PHILIPS


A2



systolic vs diastolic MSCT Ao annulus diameter

- in healthy young adults can differ by 5mm (1)
- in severe AS (2)

  difference 0.4 mm (1.9%, p=0.008) – the smallest diamater

  difference 0.75 mm (3.4%, p=0.004) – the largest diamater

- aortic anulus shape – eliptic in diastole vs more circular in systole (3)

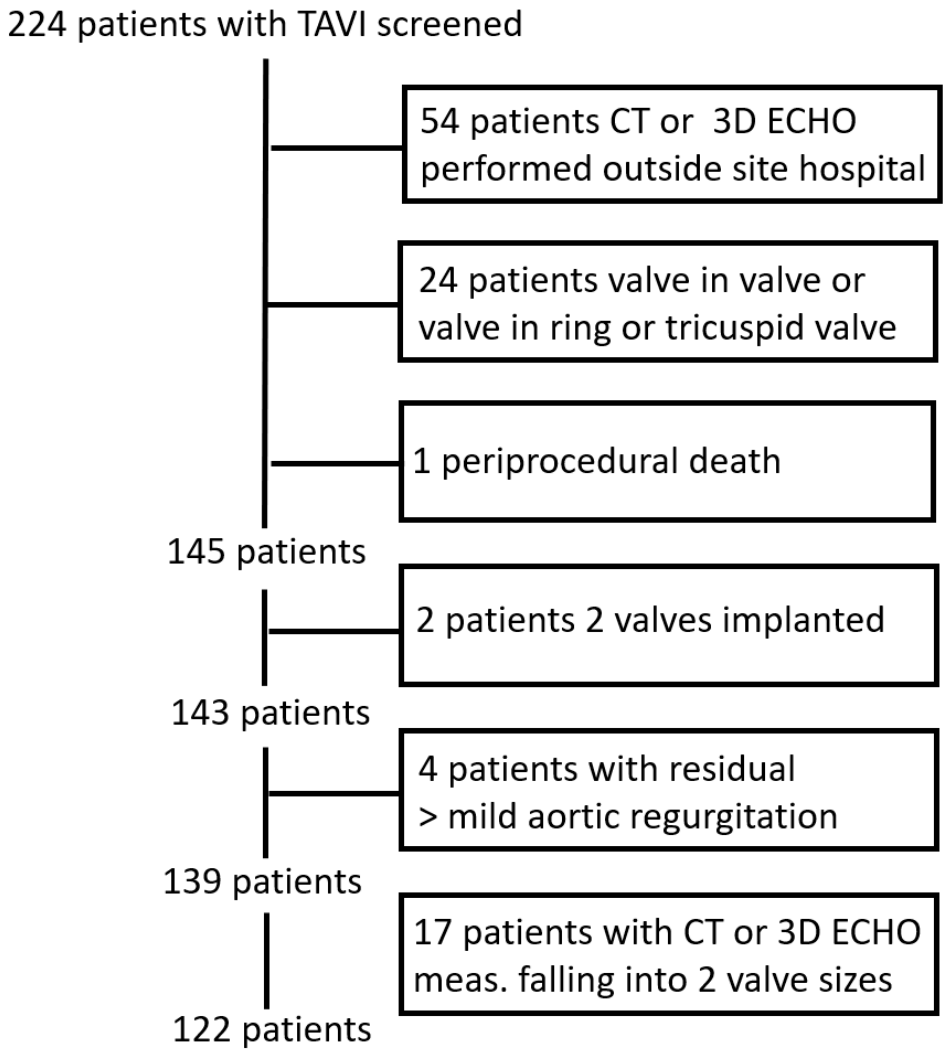
1. de Heer LM et al. Aortic root dimension changes during systole and diastole: evaluation with ECG-gated multidetector row computed tomography. Int J Cardiovasc Imaging. 2011;27:1195–1204

2. Bertaso et al. Aortic annulus dimension assessment by computed tomography for transcatheter aortic valve implantation: differences between systole and diastole. Int J Cardiovasc Imaging. 2012;28:2091–2098

3. Hamdan et al. Deformation dynamics and mechanical properties of the aortic annulus by 4-dimensional computed tomography: insights into the functional anatomy of the aortic valve complex and implications for transcatheter aortic valve therapy. J Am Coll Cardiol. 2012;59:119–27

study design

- TAVI 2018-2020
- 1 radiologist MSCT
- 6 cardiologists ECHO



baseline characteristics (n=145)

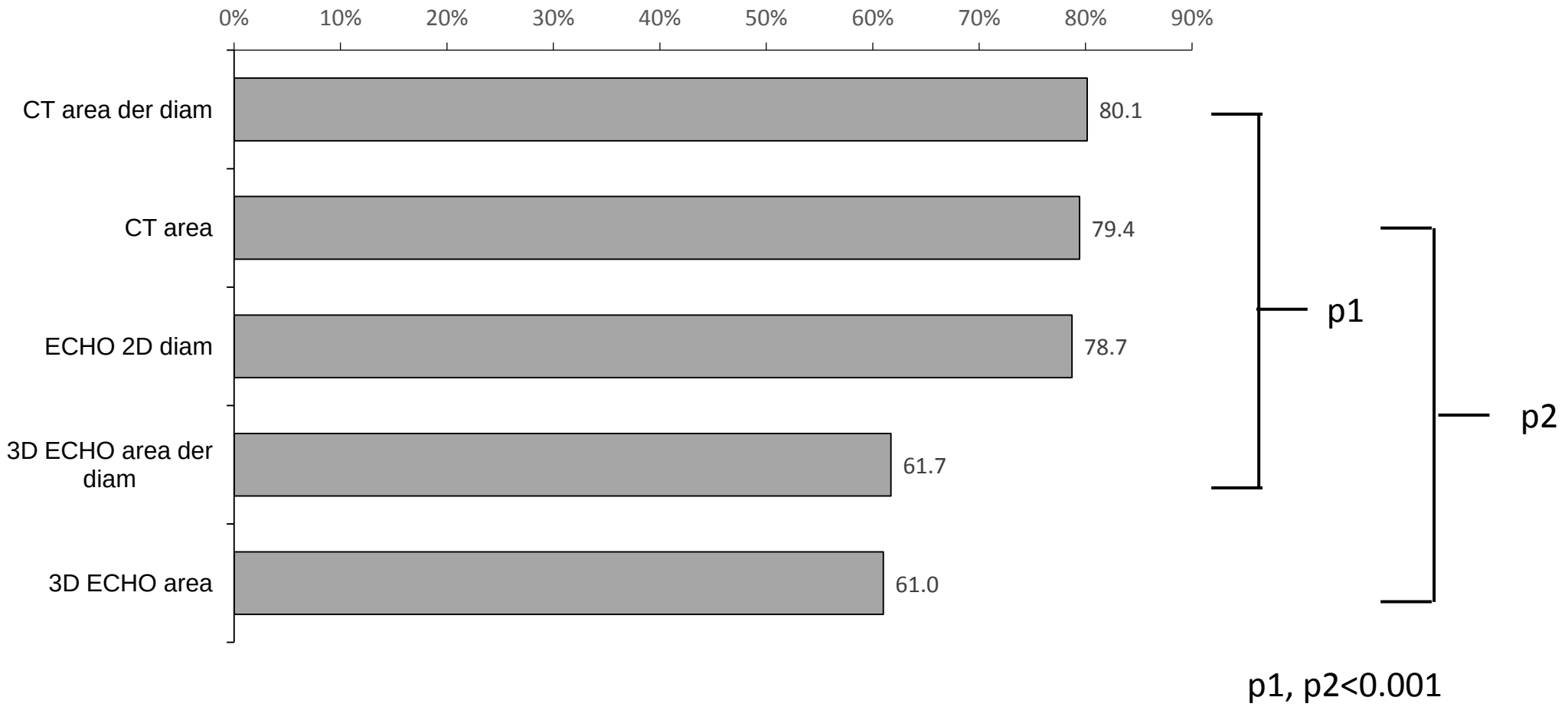
	Mean (±SD), n (%)
Age	78.8 (±6)
Men	79 (54.5%)
Implanted valve	
Sapiens XT 23	25 (17.2%)
Sapiens XT 26	40 (27.6%)
Sapiens XT 29	18 (12.4%)
Sapiens S3 20	2 (1.4%)
Sapiens S3 23	12 (8.3%)
Sapiens S3 26	29 (20.0%)
Sapiens S3 29	19 (13.1%)
IHD	96 (66.2%)
% intervention (PCI or CBG)	66 (68.8%)
AF	69 (47.6%)
Pre-implant mitral regurgitation ≥moderate	99 (68.3%)
CVA/TIA	15 (10.3%)
DM	70 (48.3%)
Hypertension	121 (83.4%)
Creatinine (umol/L)	117.1 (±73)
(on dialysis)	6 (4.1%)
Haemoglobin (g/L)	123.4 (±17)
Left Ventricle Ejection fraction	
>50%	84 (60.9%)
30-49%	39 (28.3%)
<30%	15 (10.9%)
AR pre-implant	
mild or less	113 (77.9%)
moderate	28 (19.3%)
severe	4 (2.8%)

results 1 (n=143)

- aortic annulus area 3D TOE vs MSCT 464±99 vs 479±88 mm2, p<0.001
- aortic area derived diameter 3D TOE vs MSCT 24.2±2.7 mm vs 25.0±5.5, p=0.002
- sphericity index 3D TOE vs MSCT 1.2±0.1 vs 1.3±0.1, p<0.001
- in 14% final valve size implanted differed from the MDT meeting selection of the valve size

results 2 (n=139)

concordance of MSCT and 3D TOE aortic annulus area/diameter with manufacturer recommended ranges



p1, p2<0.001

results 3 (n=122)

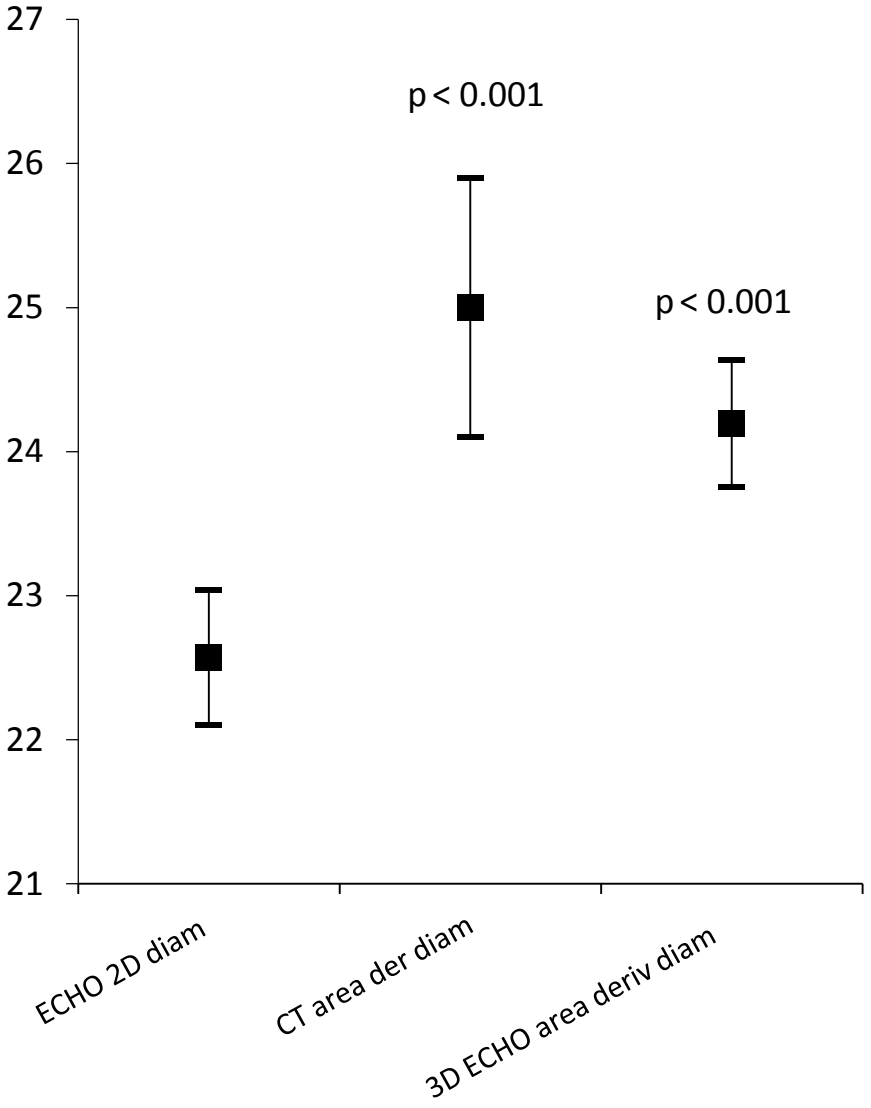
hypothetical valve size selection according to MSCT and 3D TOE measurements

Valve size	CT area	3D ECHO area		CT area der.diam	3D echo area der. diam.	
20	3 (2.5)	4 (3.3)	**$p^1 < 0.001$**	3 (2.5)	4 (3.3)	**$p^1 < 0.001$**
23	26 (21.3)	39 (32.0)	discordant	26 (21.3)	39 (32.0)	discordant
26	59 (48.4)	55 (45.1)	size	59 (48.4)	55 (45.1)	size
29	34 (27.9)	24 (19.7)	selection 32.8%	34 (27.9)	24 (19.7)	selection 33.6%

discordant size in 1/3 of cases

results 4 (n=145)

comparison of aortic annulus measurements (2D TOE, 3D TOE, MSCT)

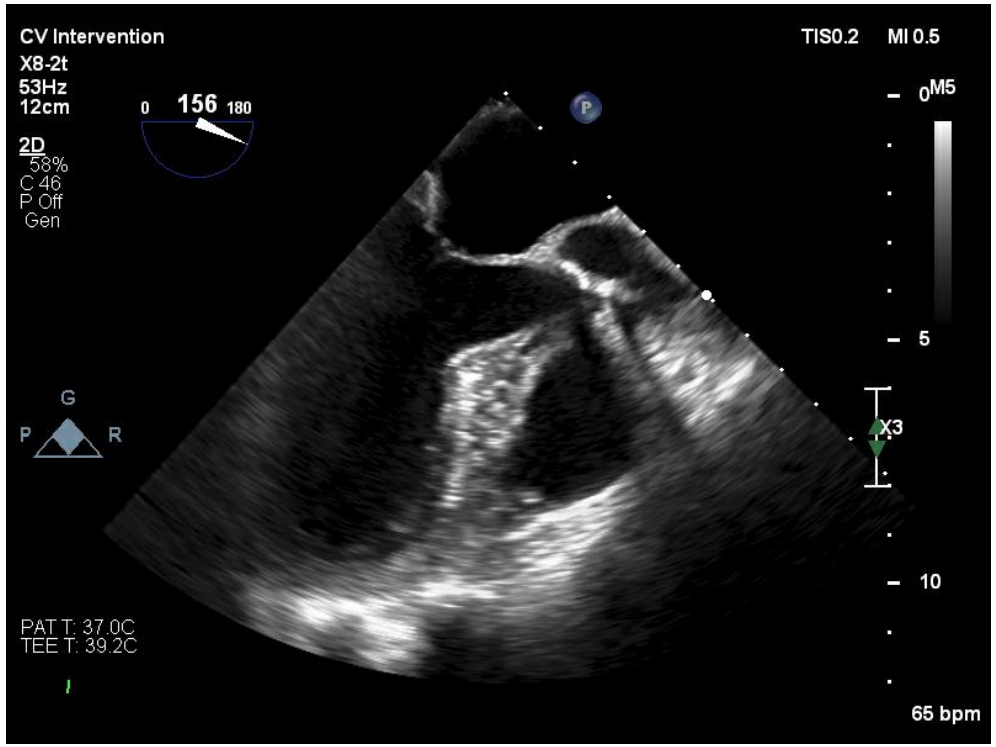


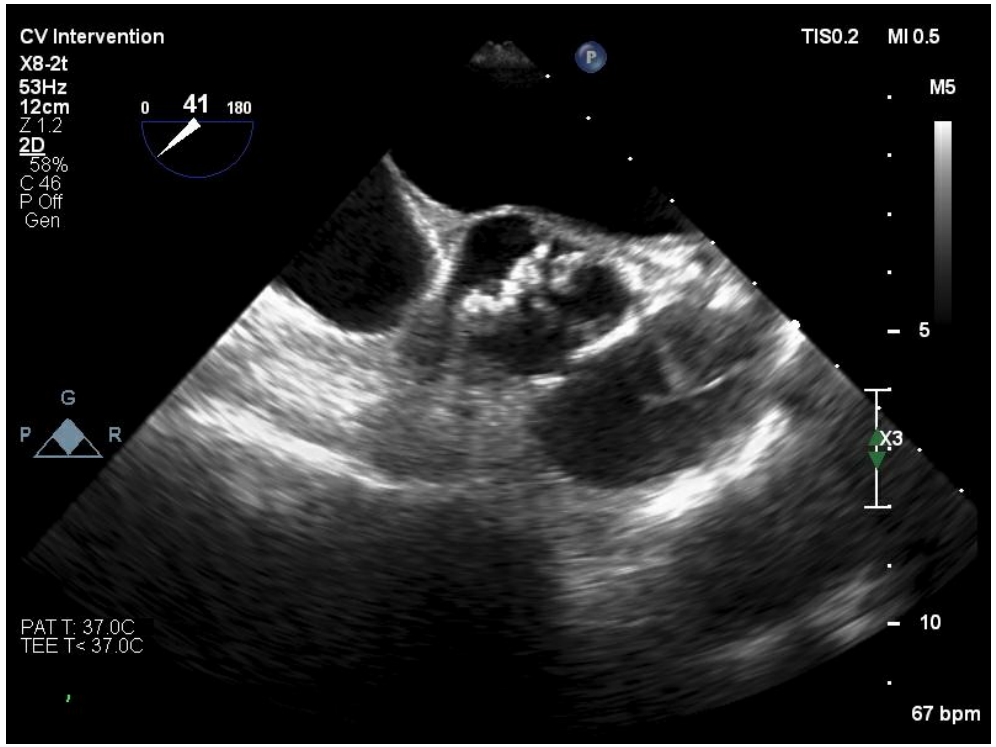
summary

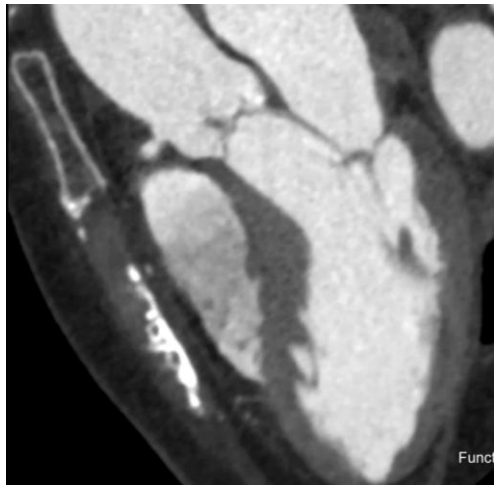
- 3D TOE underestimates aortic annulus diamater and its asymetry
- in implanted valves with favourable results MSCT diamaters matched with recommended ranges in 20% more cases in comparison to 3D TOE
- 3D TOE measurements would have led to inappropriate (smaller) valve size selection in 1/3 of patients

- 3D TOE aortic annulus measurements abandoned

- TOE still needed for aortic valve morphology….


CV Intervention
X8-2t
53Hz
12cm
2D
58%
C 46
P Off
Gen
156
TIS0.2
MI 0.5
M5
X3
PAT T: 37.0C
TEE T: 39.2C
65 bpm


CV Intervention
X8-2t
53Hz
12cm
Z 1.2
2D
58%
C 46
P Off
Gen
41
TIS0.2
MI 0.5
M5
X3
PAT T: 37.0C
TEE T< 37.0C
67 bpm

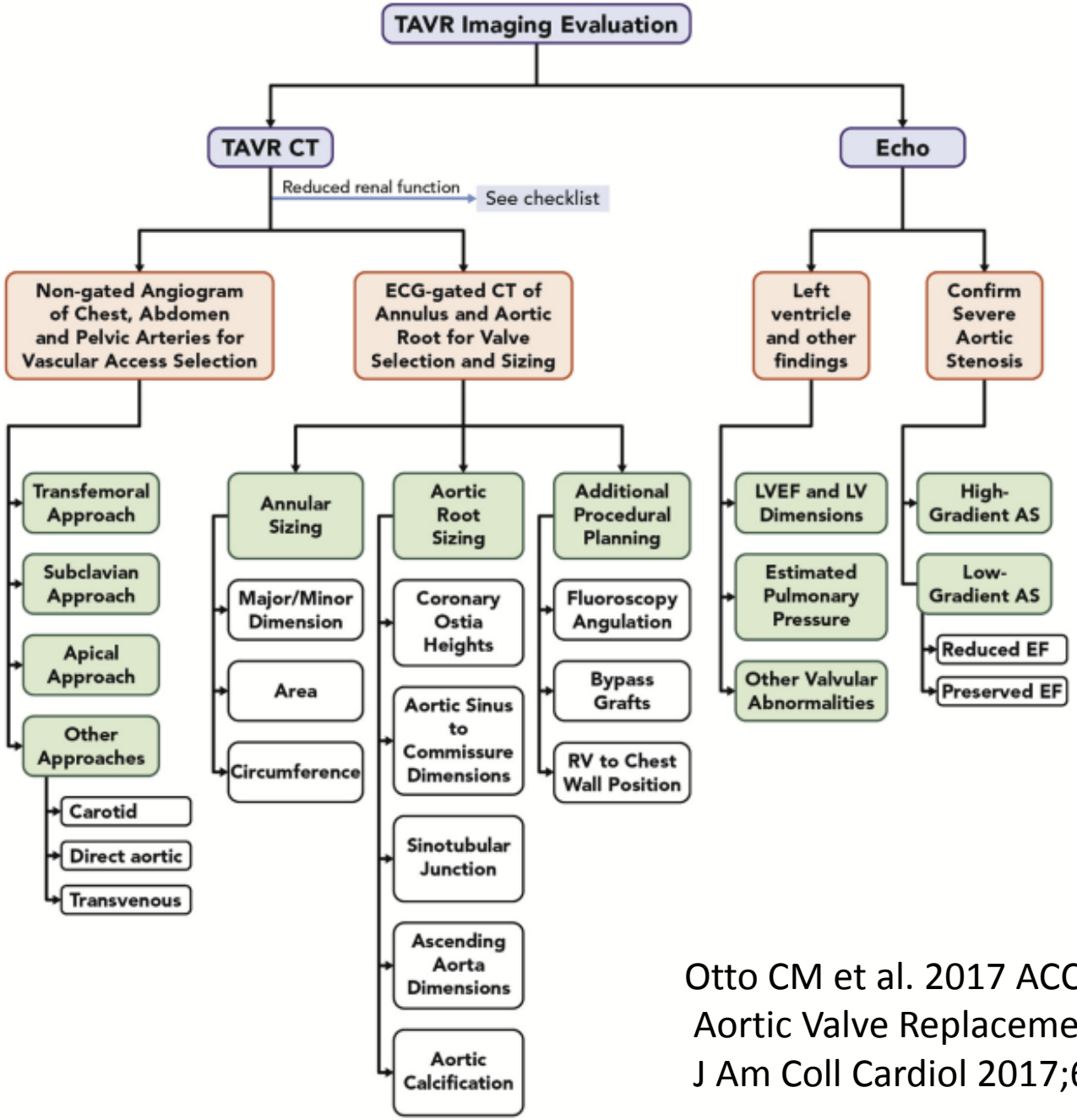


summary 2

- TTE for AS quantification, LV and RV function, other valvular disease asesment, (Ao valve anatomy)
- MSCT for aortic anulus measurement, Ao valve anatomy, angiography for arterial access

- MDT meeting

- TOE shall discrepancy between TTE and MSCT



2017 ACC Expert consensus statement

Otto CM et al. 2017 ACC Expert Consensus Decision Pathway for Transcatheter Aortic Valve Replacement in the Management of Adults With Aortic Stenosis. J Am Coll Cardiol 2017;69:1313-1346