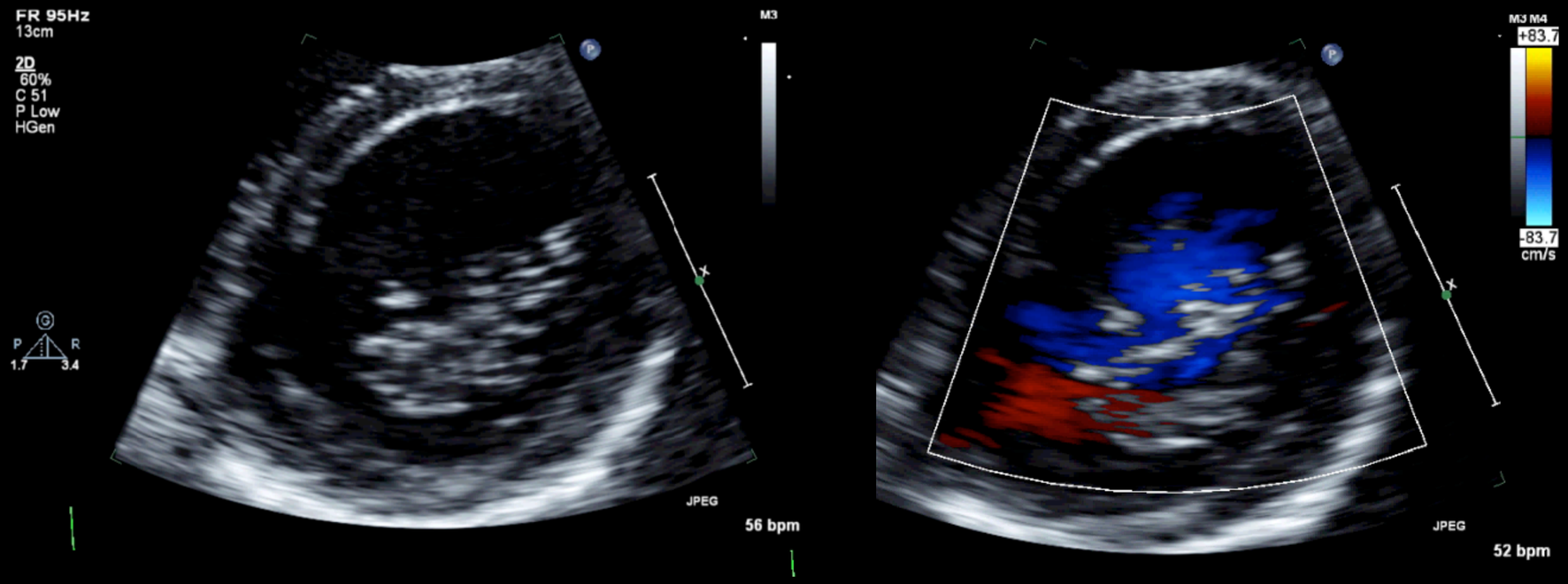
3D Echo Assessment of Valve Lesions

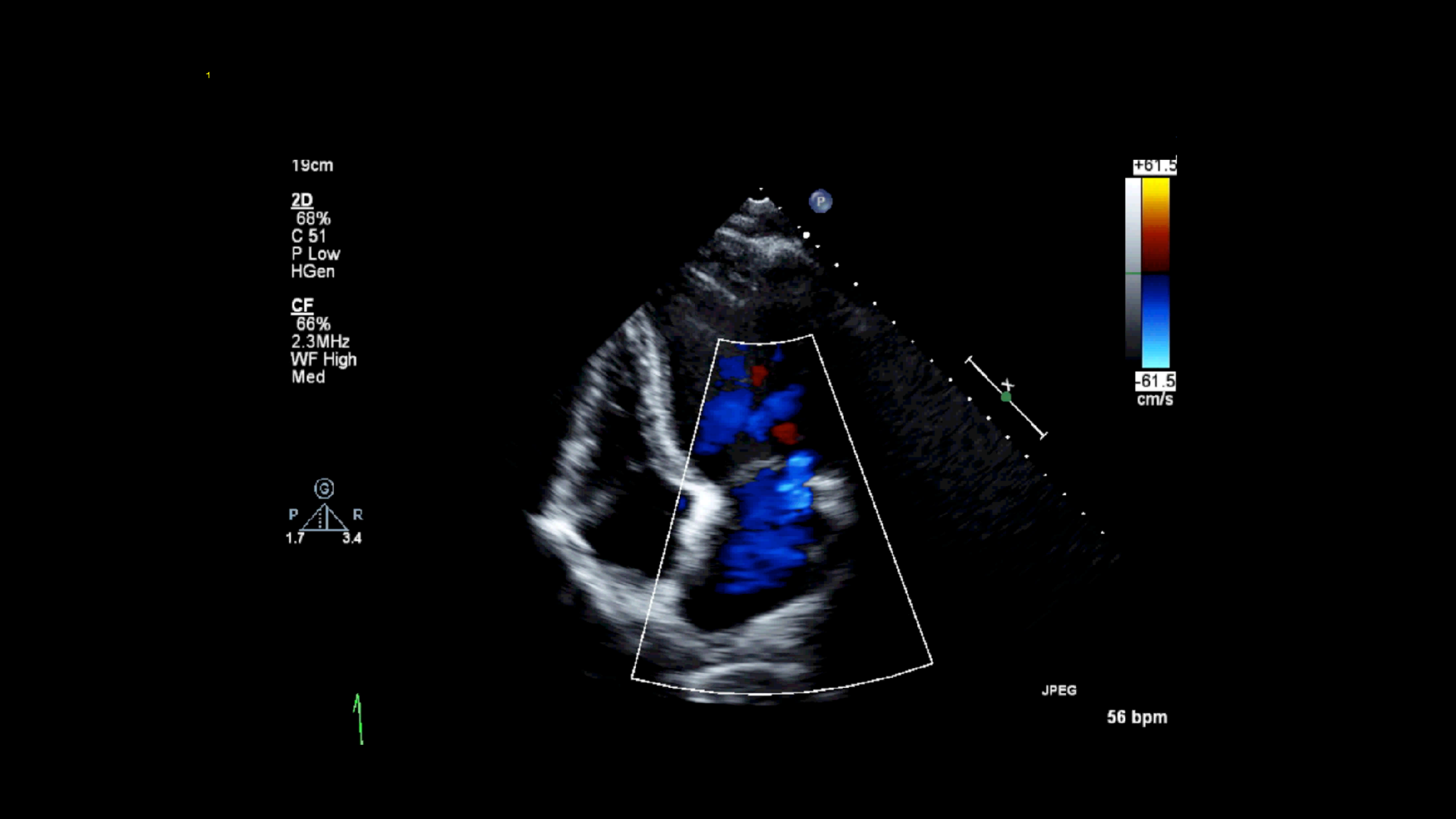
Helen Thomson
The Heart Centre at the Alfred

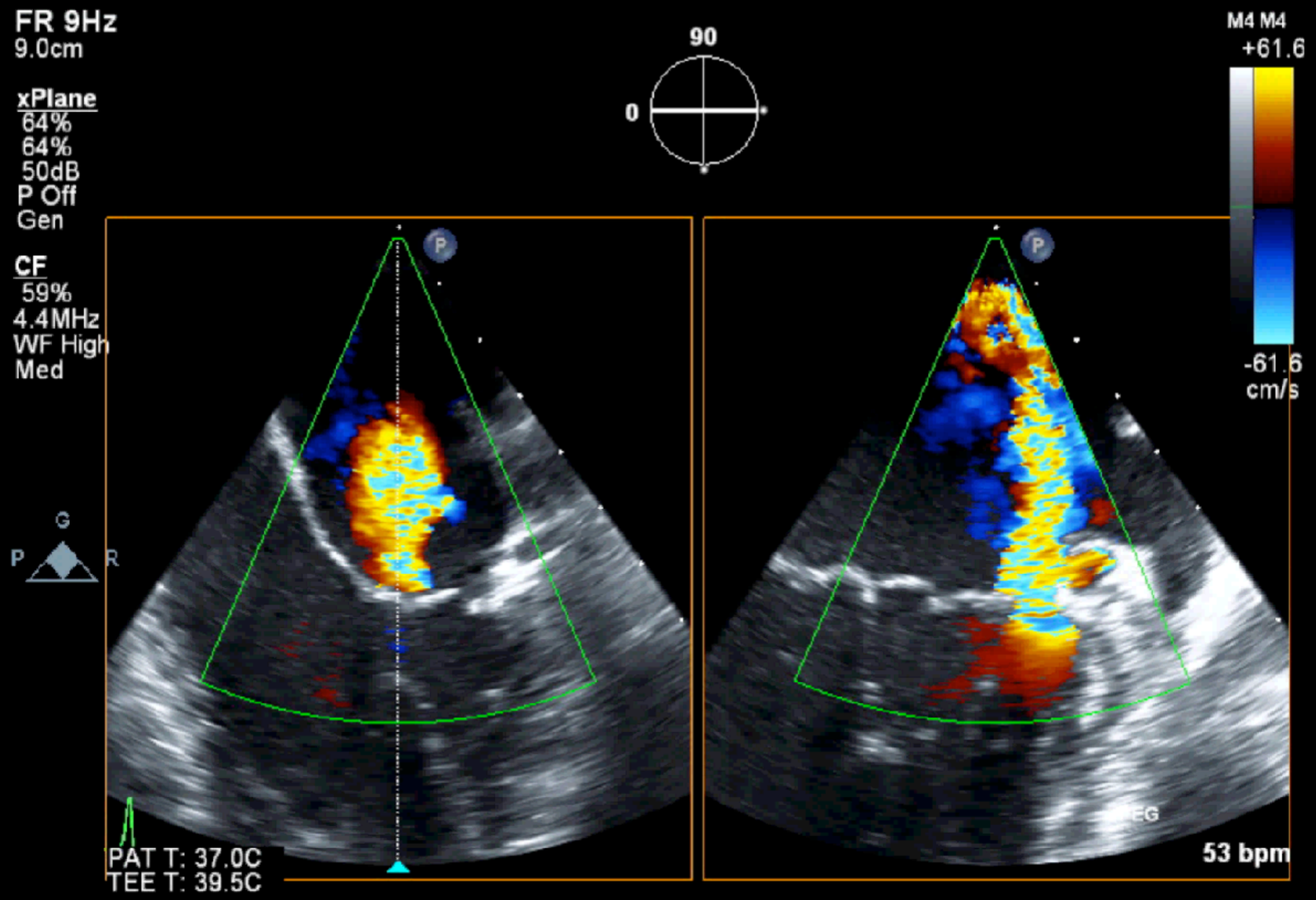
No Disclosures

Case

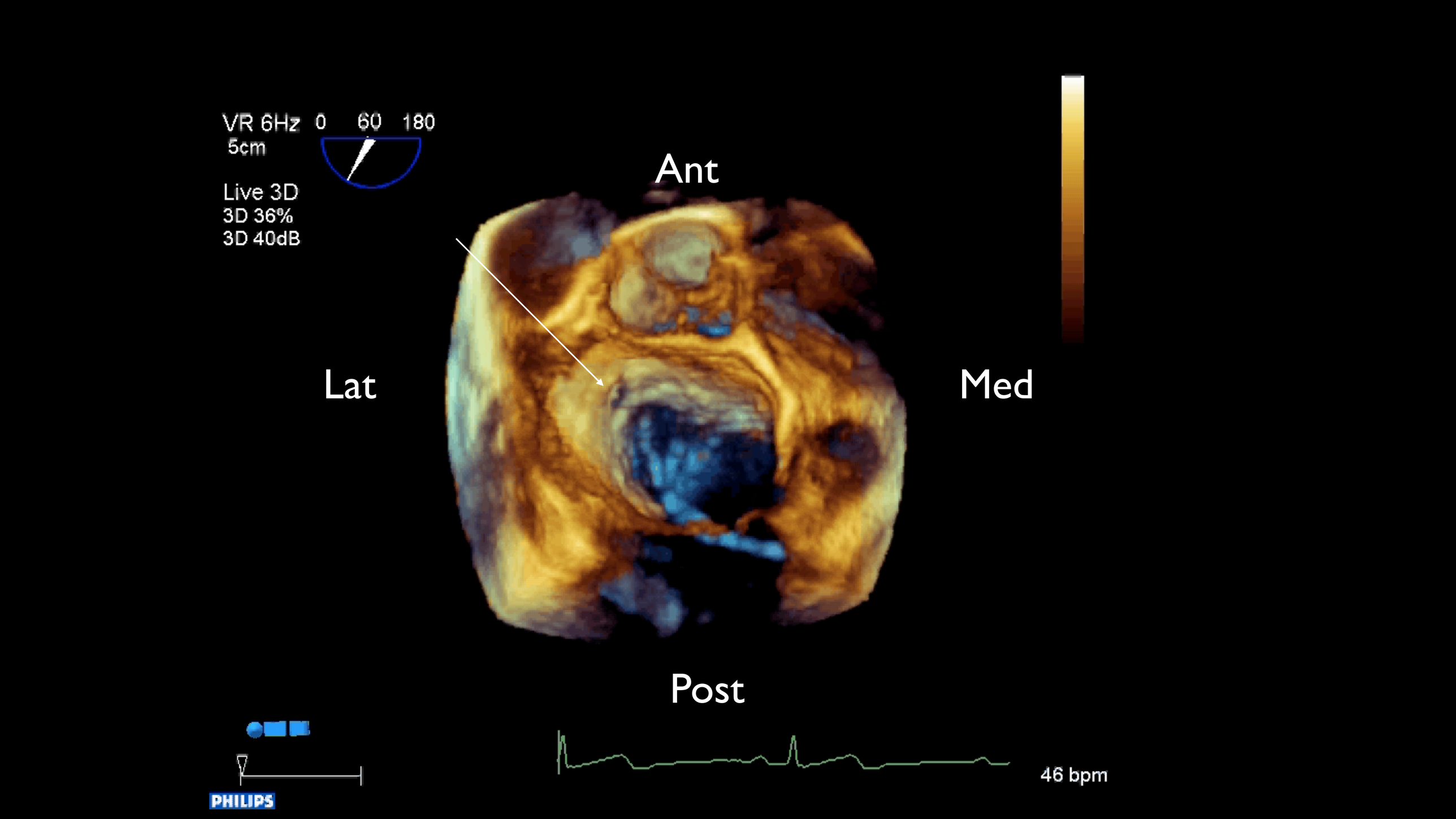

FR 18Hz
15cm
2D
60%
C 50
P Low
HGen
CF
66%
2.3MHz
WF High
Med
G
P
R
1.7
3.4
M3 M4
+83.7
-83.7
cm/s
JPEG
59 bpm

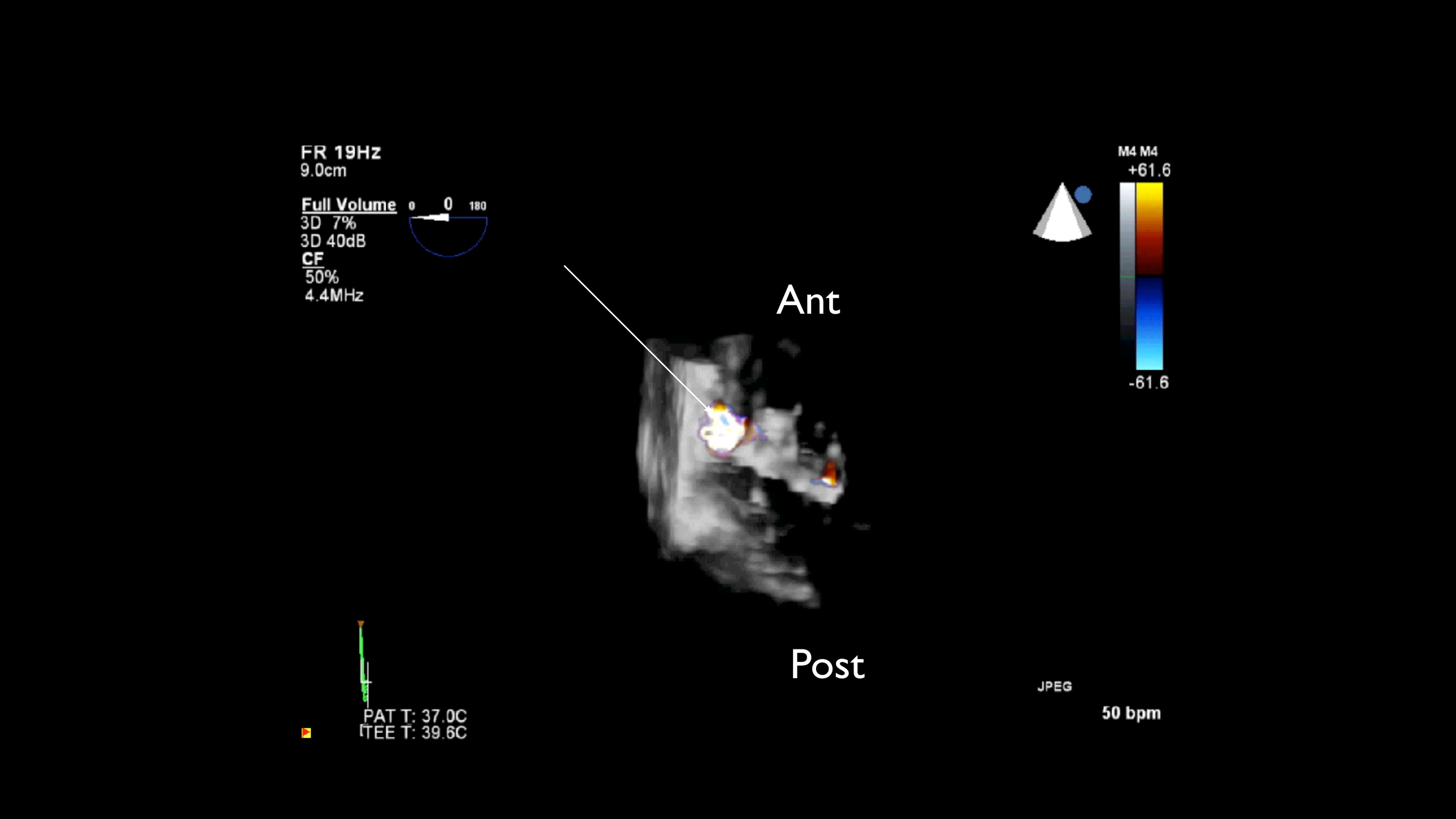

FR 95Hz
13cm
2D
60%
C 51
P Low
HGen
P
R
1.7
3.4
M3
JPEG
56 bpm
M3 M4
+83.7
-83.7
cm/s
JPEG
52 bpm


19cm
2D
68%
C 51
P Low
HGen
CF
66%
2.3MHz
WF High
Med
P
R
1.7
3.4
+61.5
-61.5
cm/s
JPEG
56 bpm


FR 9Hz
9.0cm
xPlane
64%
64%
50dB
P Off
Gen
CF
59%
4.4MHz
WF High
Med
90
0
M4 M4
+61.6
-61.6
cm/s
G
P
R
PAT T: 37.0C
TEE T: 39.5C
53 bpm

Where is the MR from?
What is the mechanism?


VR 6Hz 0 60 180
5cm
Live 3D
3D 36%
3D 40dB
Ant
Lat
Med
Post
46 bpm
PHILIPS


FR 19Hz
9.0cm
Full Volume
3D 7%
3D 40dB
CF
50%
4.4MHz
0
0
180
M4 M4
+61.6
-61.6
Ant
Post
PAT T: 37.0C
TEE T: 39.6C
JPEG
50 bpm

Operative findings

1.5 x0.5cm perforation at the base of A1 at the annulus

Chronic fibrotic process surrounding perforation

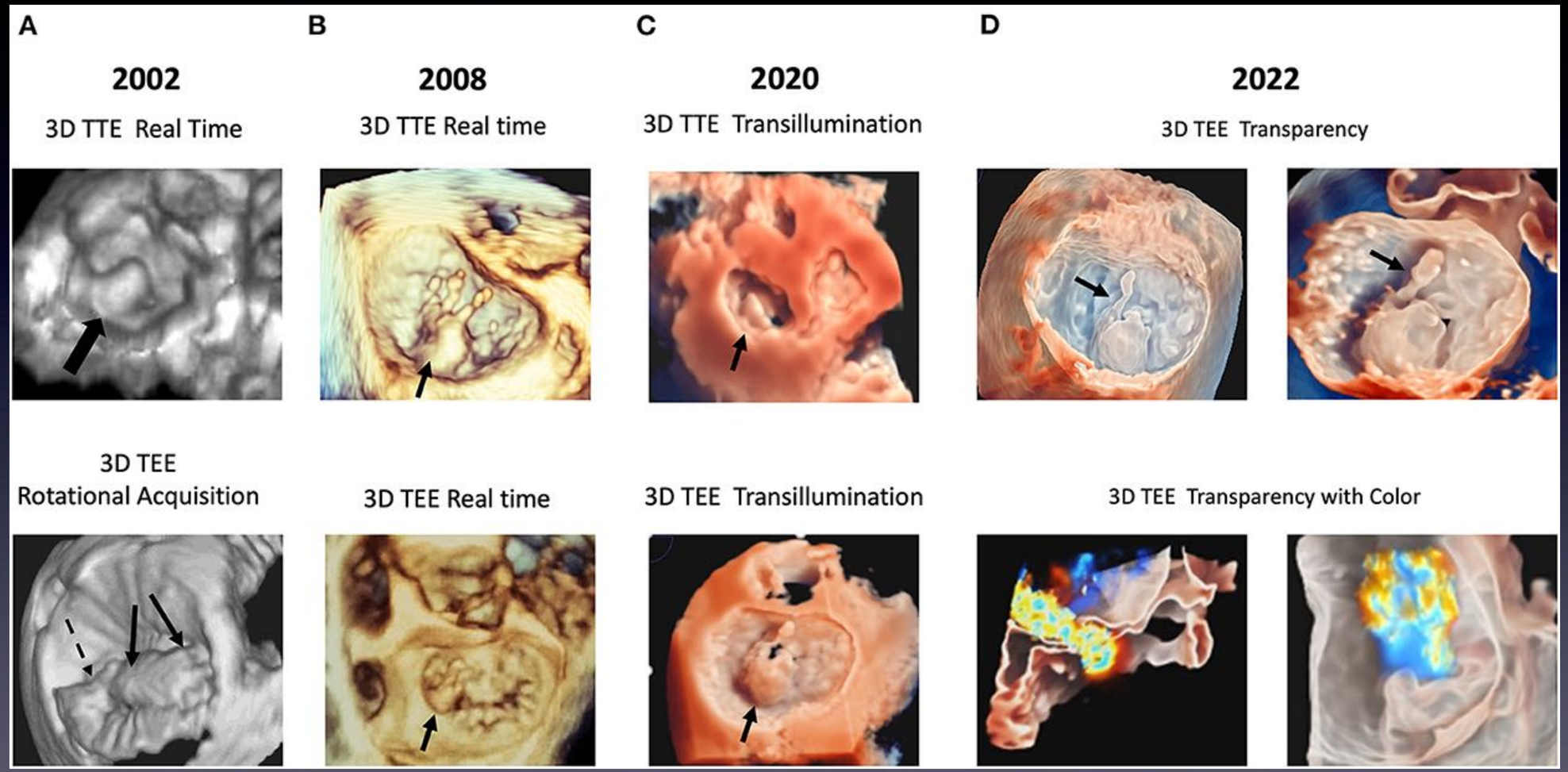
Jumped from a bridge 10 years earlier

This Case and 3D

Where

Mechanism

Likelihood of repair

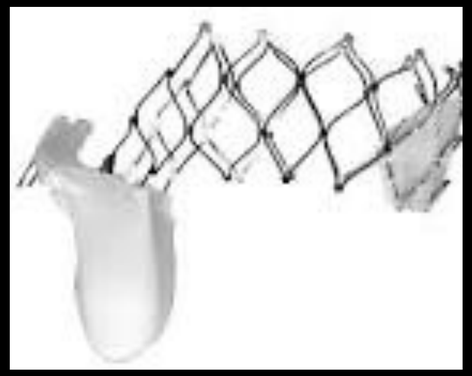

A
B
C
D
2002
2008
2020
2022
3D TTE Real Time
3D TTE Real time
3D TTE Transillumination
3D TEE Transparency
3D TEE
Rotational Acquisition
3D TEE Real time
3D TEE Transillumination
3D TEE Transparency with Color

2012

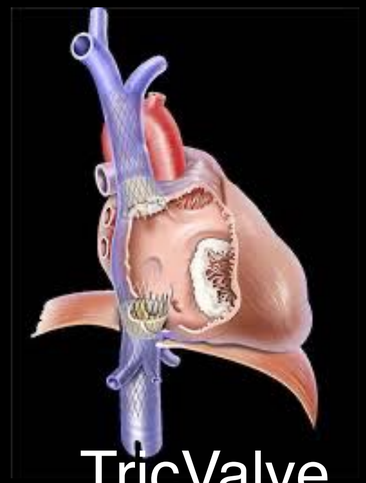
New Technologies

Pascal

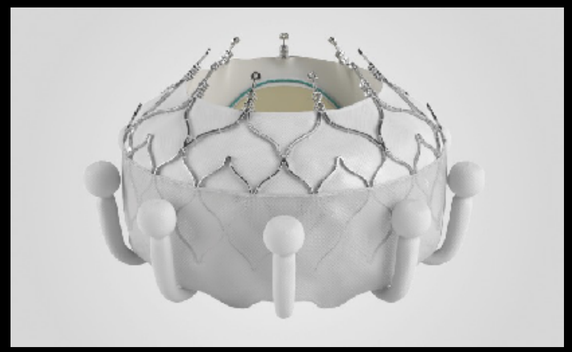
MitraClip



Half Moon



TricValve



Evoque

3D and Valves

Mitral Regurgitation

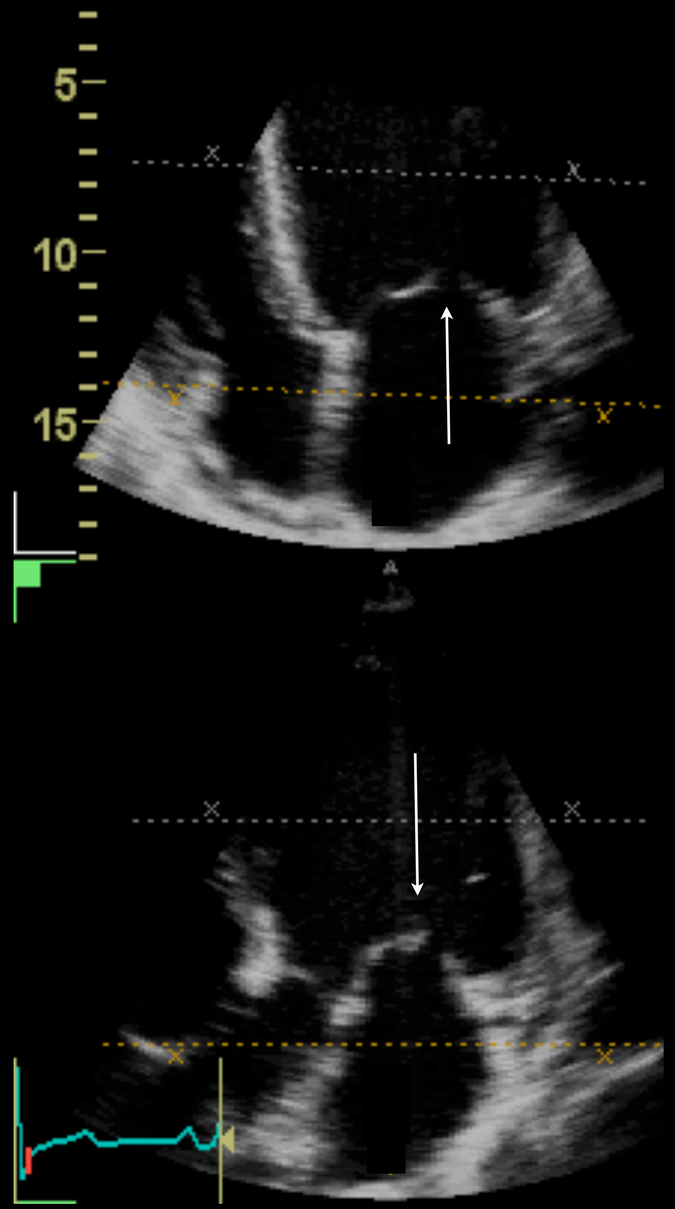
Tricuspid Regurgitation

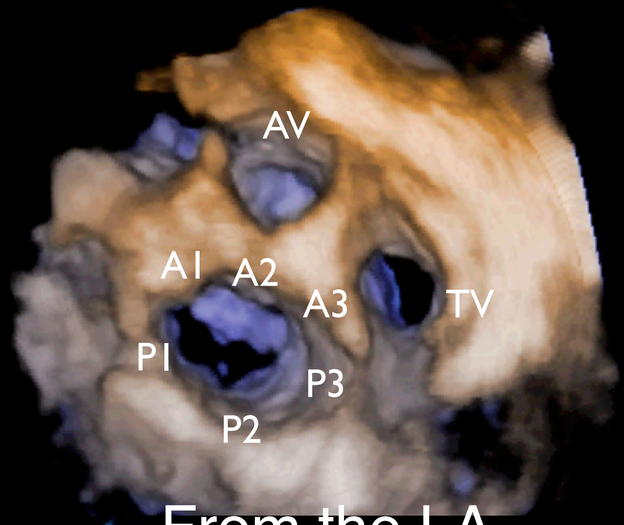
Additive value of 3D?

1. Visualise the anatomy
2. Define the mechanism of regurgitation
3. Understand the pathophysiology
4. Plan surgical repair or guide transcatheter intervention.

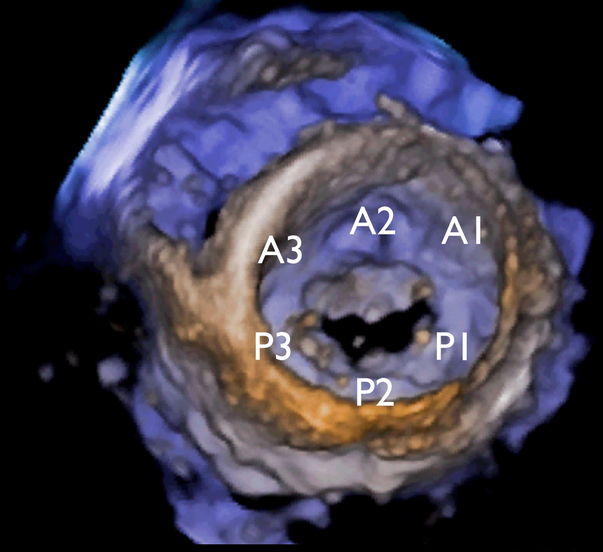
3D and MR

MV Segmental Analysis: TTE



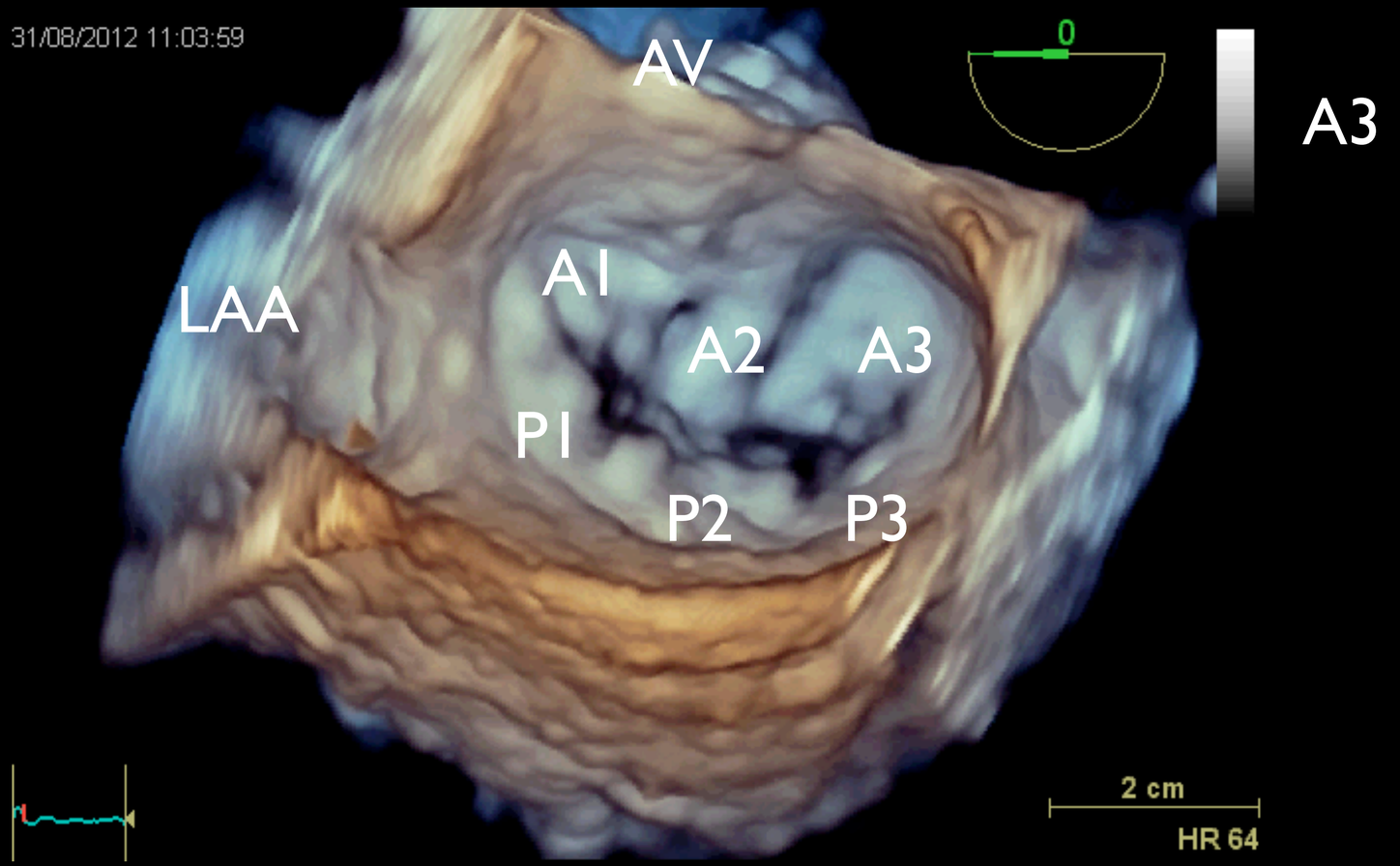


From the LA

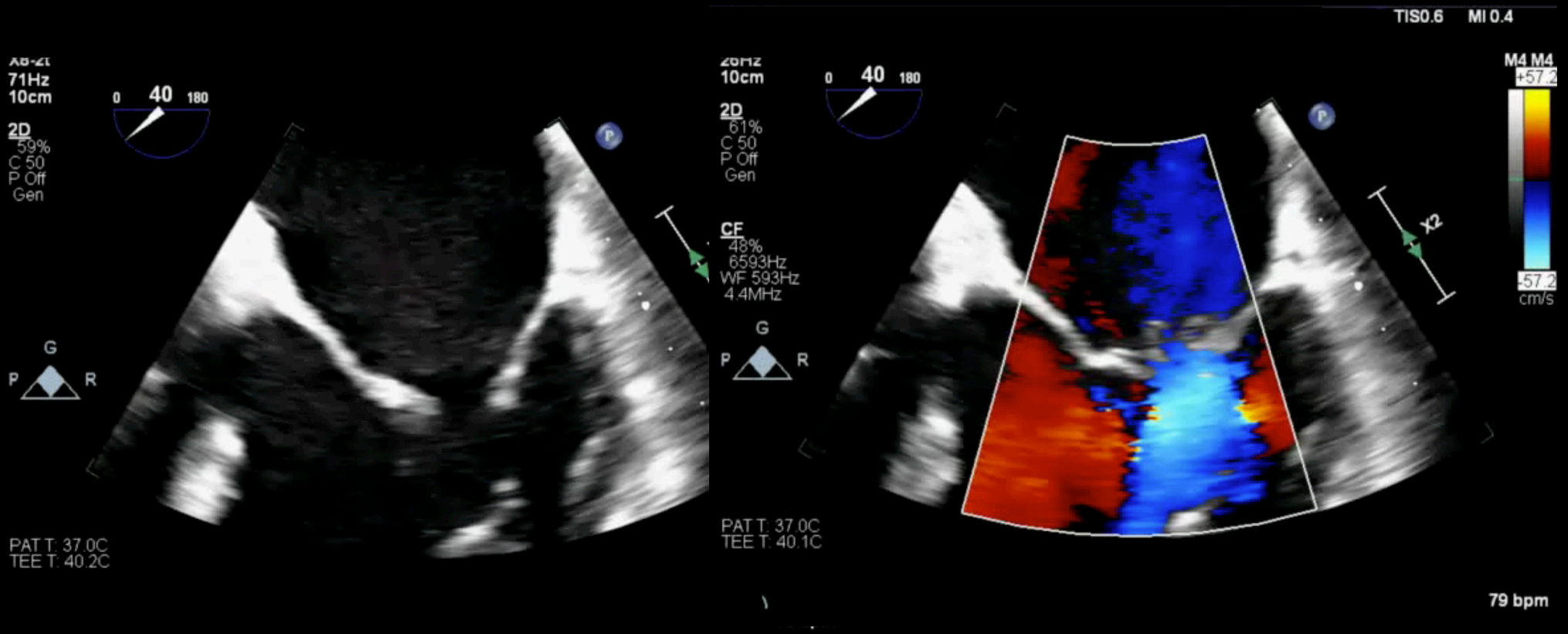


From the LV

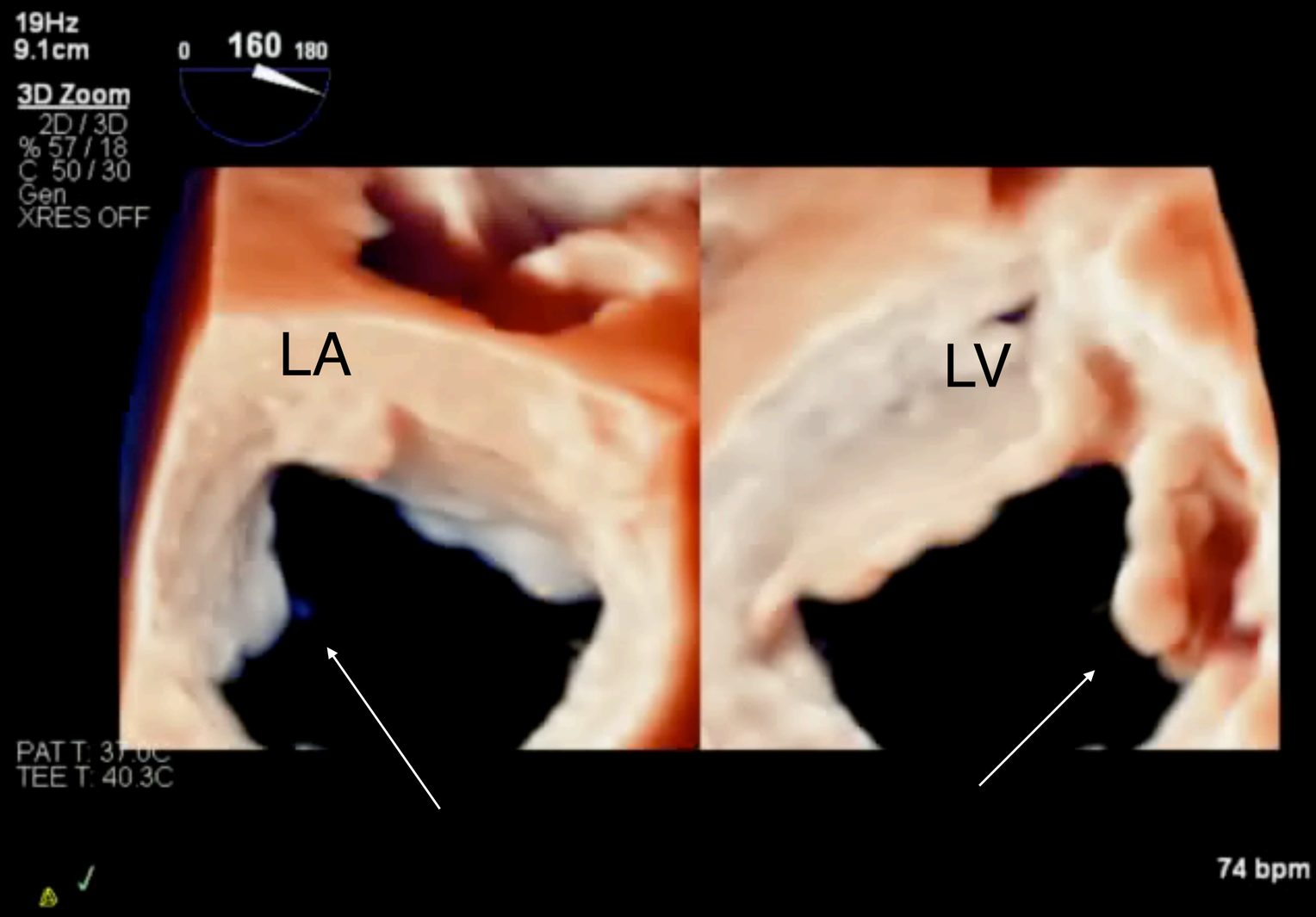
MV Segmentation: TOE



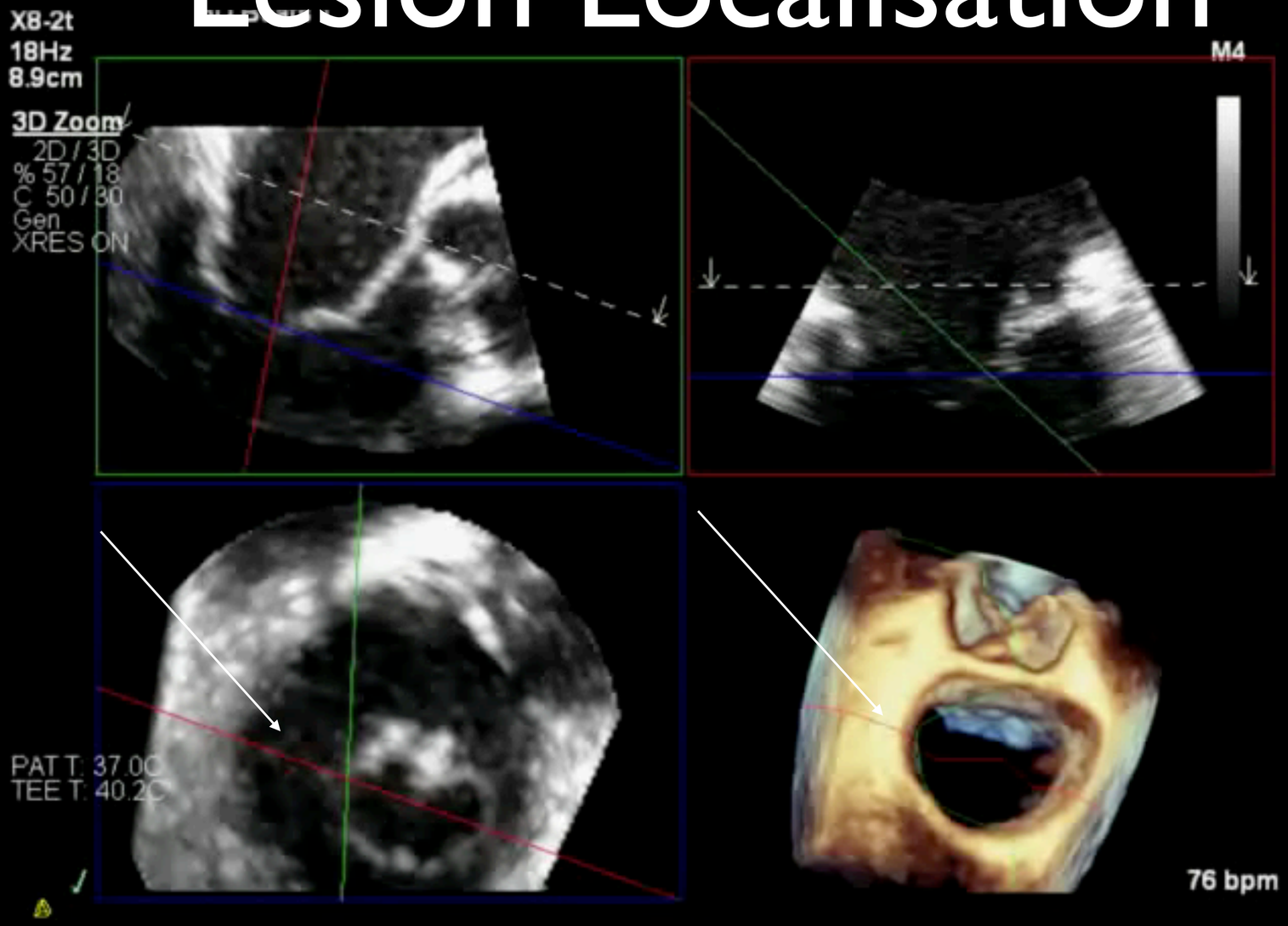
Mitral Valve Lesion Localisation



Lesion Localisation



Lesion Localisation



Evidence for Incremental Value of 3-D

Surgical findings as gold standard

Adequate visualization

- 3-D vs 2-D TOE: 97% vs 90%

Accuracy compared with

- 92% by 3-D vs 79% by 2-D TOE

McNab A et al Euro J Echo 2004; 5(3) :212-222

Commissural Lesion localisation

	3D TEE	2D TEE
Sensitivity(%)	89-92	54-66
Specificity(%)	95-99	90-95
Accuracy(%)	93-97	82-89

Ahmed S et al Echocardiography 2003;20: 203-209

Pepi M et al J Am Coll Cardio 2006;48: 2524-2530

Why is localisation important?

Probability of repair depends on being able to localise the site of the leak and understand the mechanism

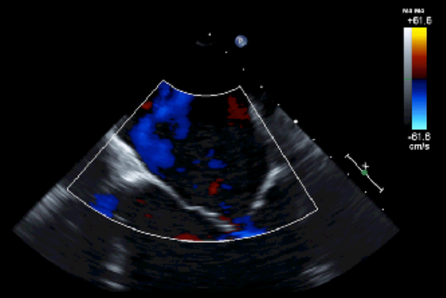
Some sites may be easier to repair

Surgical repair: P2 in DMR

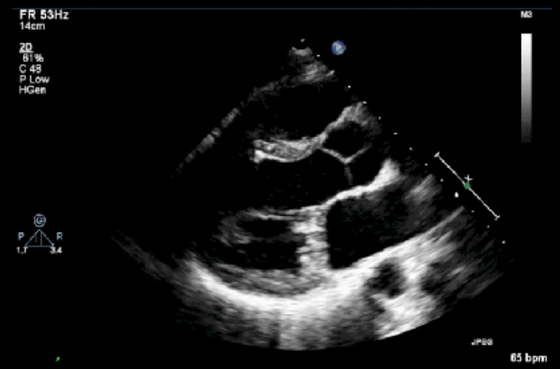
TEER: A2 and P2 in DMR and Functional MR

Insights into Mechanism of MR
Beyond Carpentier's classification

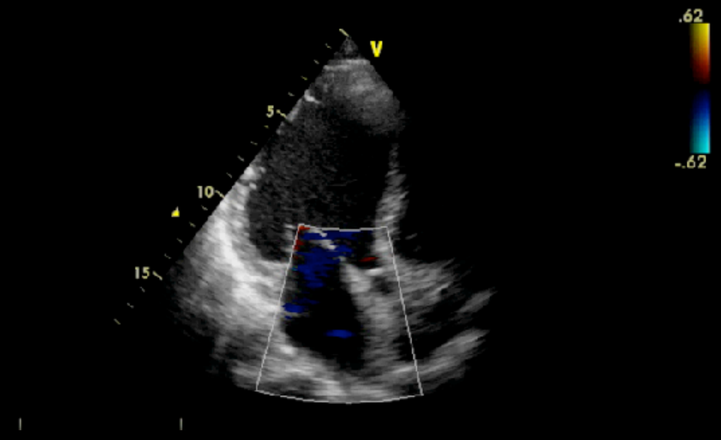
Type 1



Type 2



Type 3b



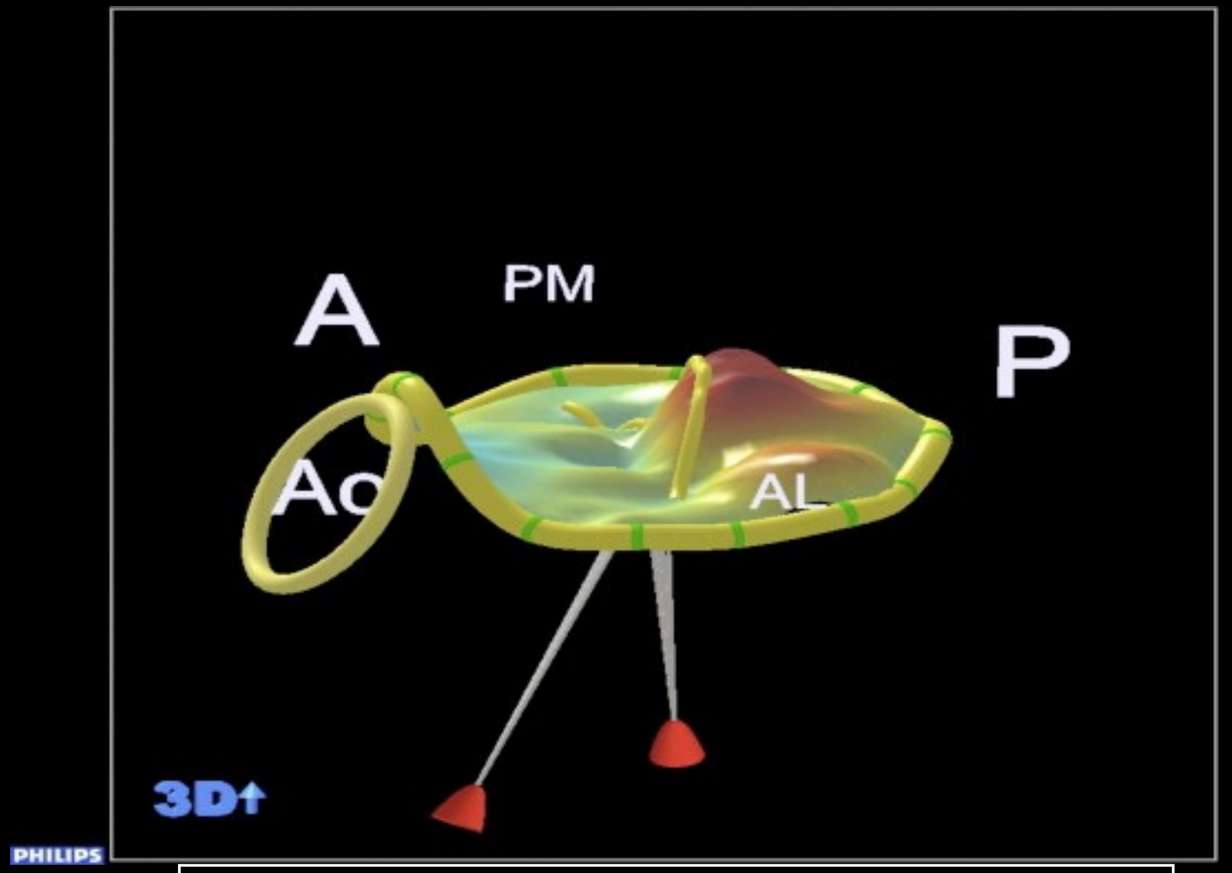
Limitations of Carpentier's Classification

Doesn't address the role of

1. Leaflet size and shape
2. Annular geometry and contraction
3. Chordal length
4. Papillary muscle length and motion
5. Maybe more than one mechanism

Better addressed with 3D

Parametric Map using MVN



Annulus
DAIPm = 45.0 mm
DAP = 44.0 mm
H = 12.5 mm
C3D = 151.1 mm
C2D = 142.1 mm
A2D = 1587.2 mm²
A3D min = 1667.7 mm²
A2D/A3D min = 95.2 %
C2D/C3D = 94.0 %
H/DAIPm = 42.5 %
E2D = 1.0 %
Leaflet
L3D Ant = 37.0 mm
L3D Post = 21.4 mm
θ Ant = 26.7 °
θ Post = 19.0 °
θ NPA = 134.3 °
L2D Ant = 24.9 mm
L2D Post = 20.0 mm
HTent = 3.5 mm
HProl = 11.1 mm
A3D Ant = 1006.4 mm²
A3D Post = 1055.0 mm²
VTent = 0.4 ml
VProl = 3.2 ml
Aortic-Mitral
θ = 108.5 °
Coaptation
L2DAIPm = 30.7

Prolapsing Height and Volume and Leaflet Area

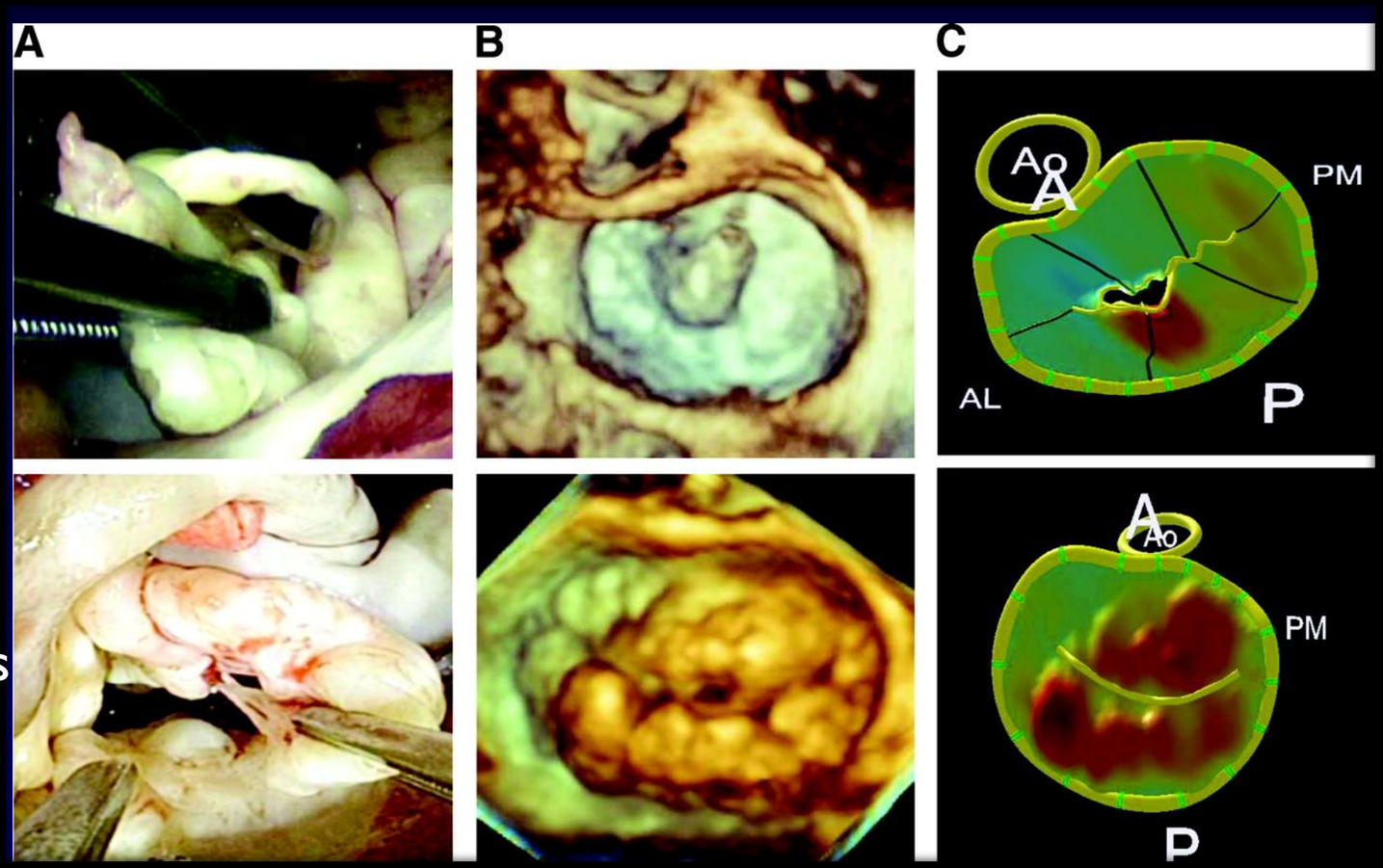
Papillary Muscle Traction and Chordal Lengthening

Accurate Measurement of Annulus Size and Shape

Mechanism of Degenerative MR

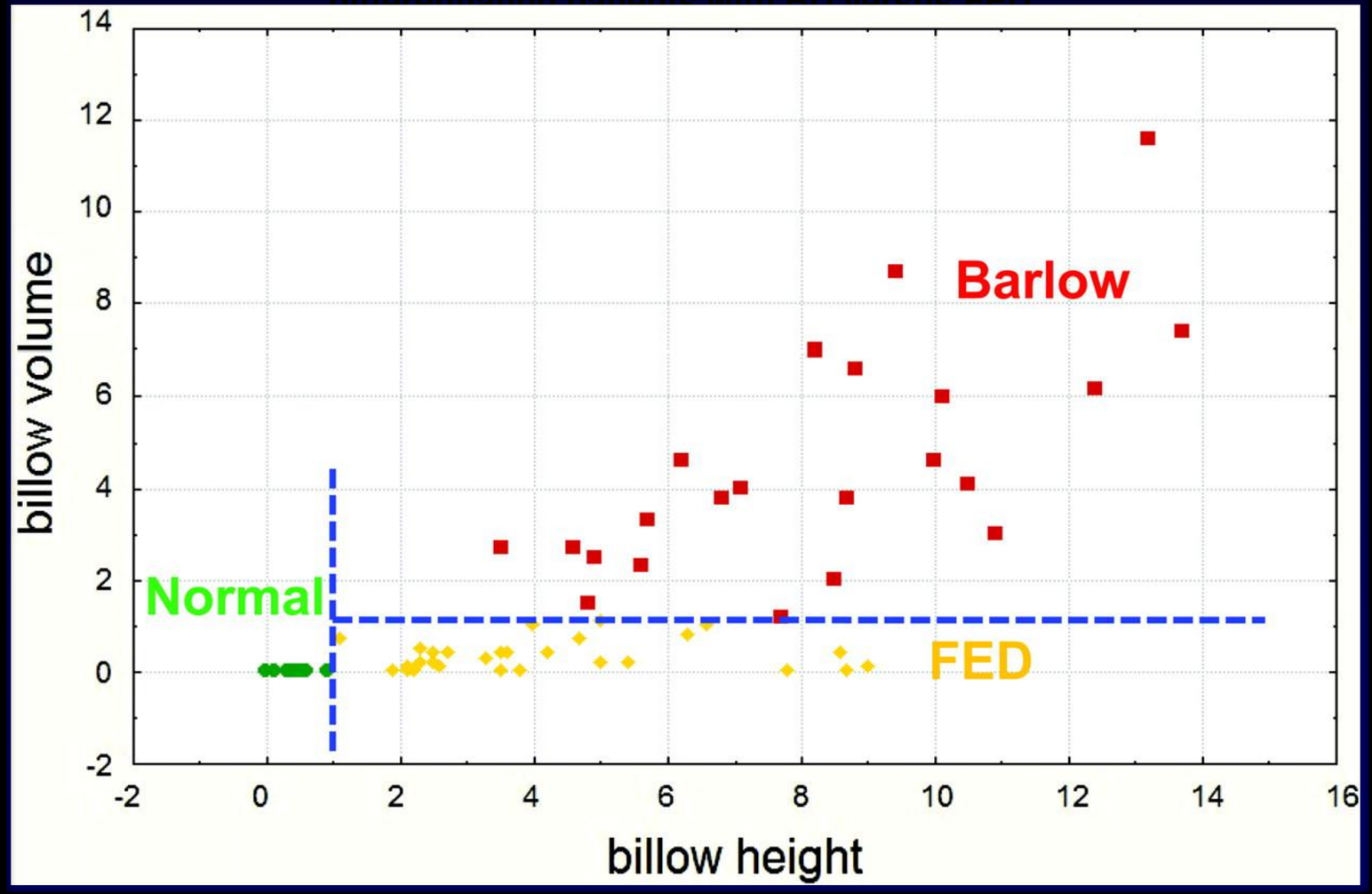
FED

Barlow's



Leaflets

Chandra S et al Circ Cardiovasc magingo 2011; 4: 24-32

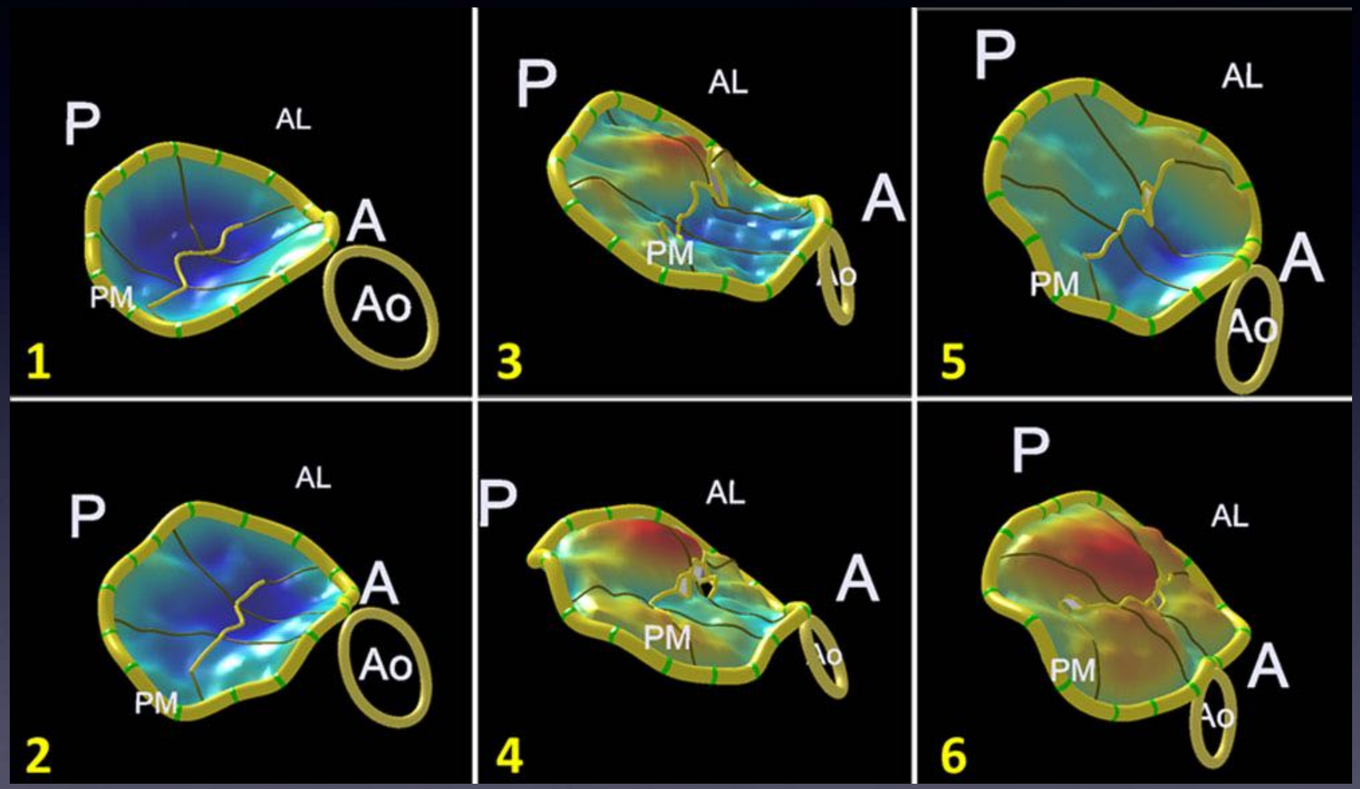


Chandra S et al Circ Cardiovasc magingo 2011; 4: 24-32

MV Annulus

Early Systole

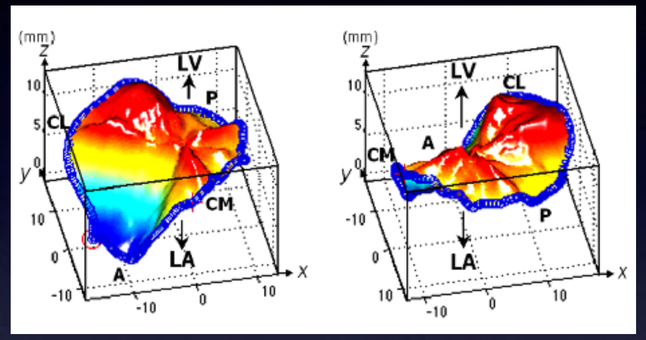
Late Systole



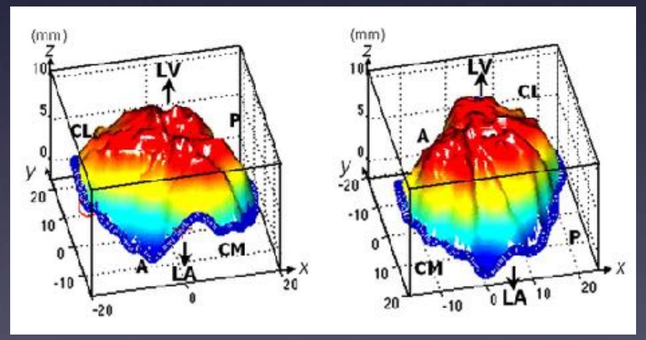
Normal FED Barlows

Antoine C et al Circ Cardiovasc Imag 2018 11(1)

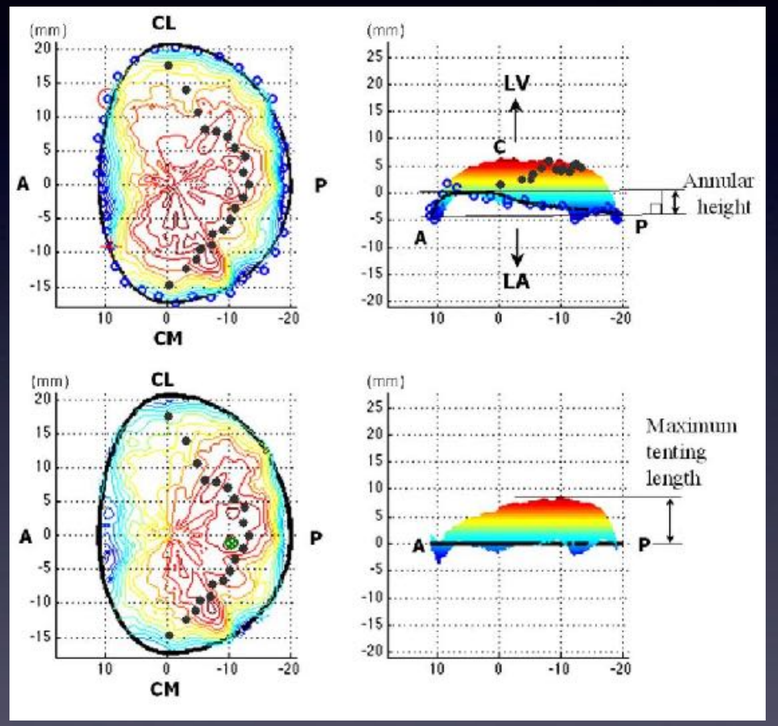
Quantification of Tenting in IMR by 3D TTE



Normal

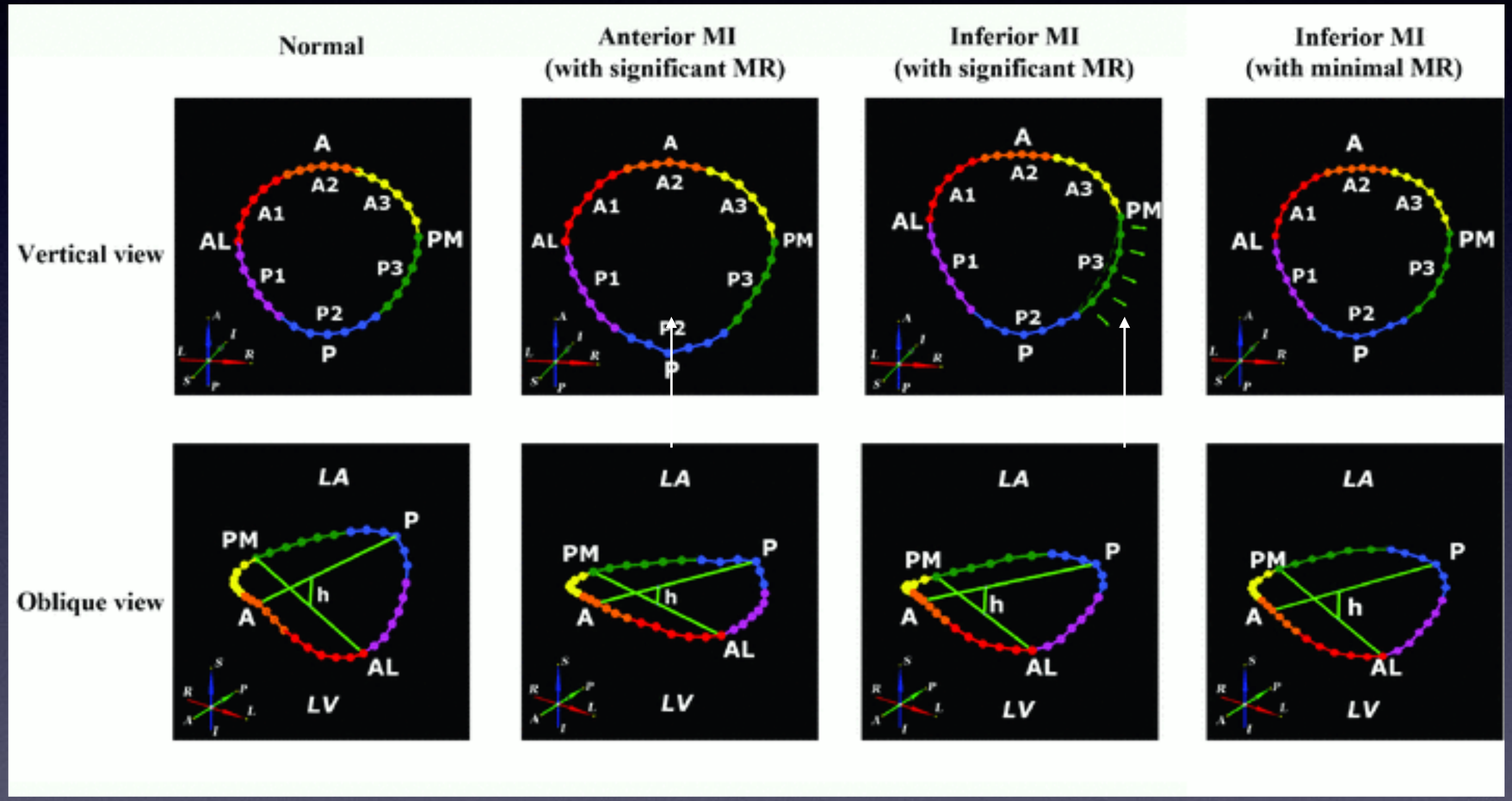


Ischemic



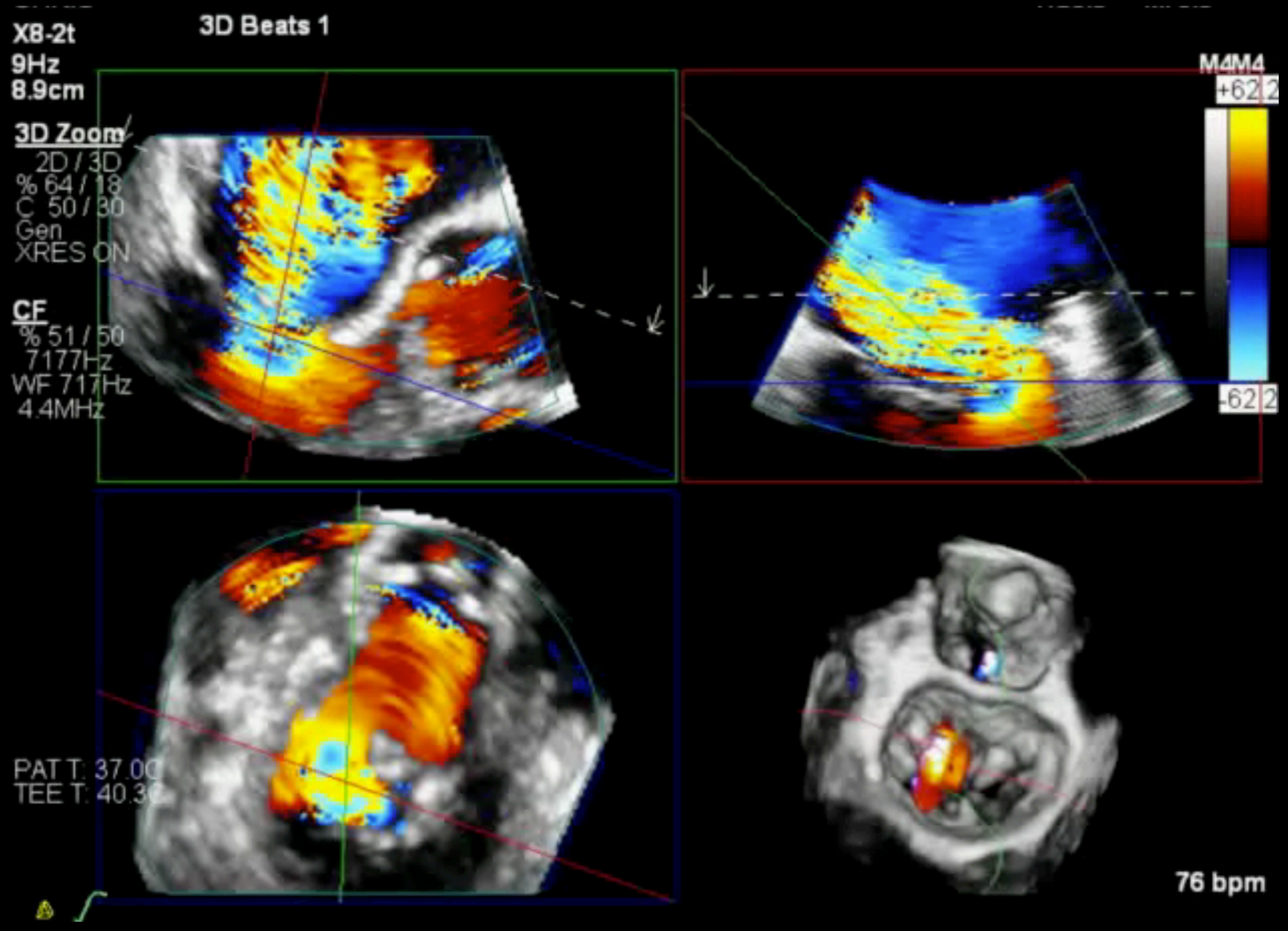
Wannabe N et al J Am Coll Cardio 2005; 45: 763-9

Mitral Annulus in IMR



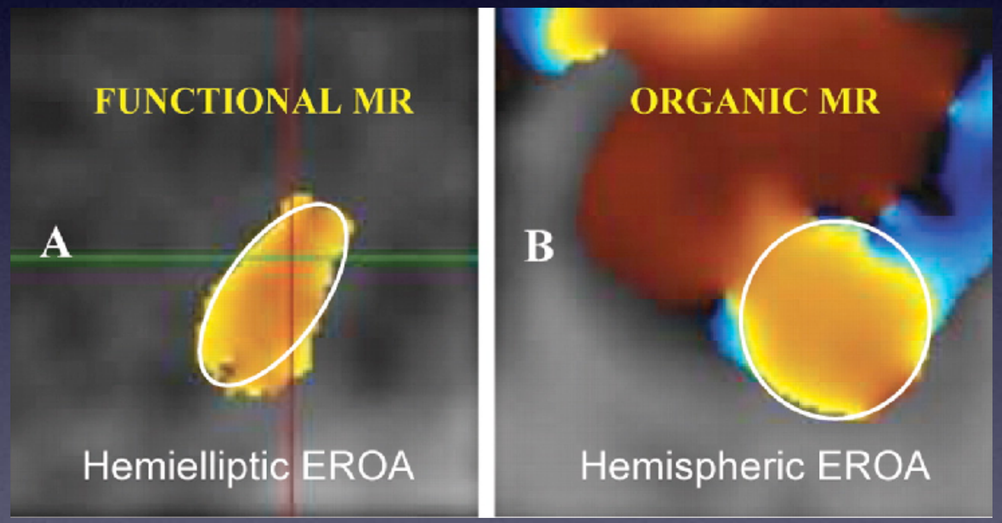
Echocardiography 2012; 29(1):42-50

Role of 3-D in Quantification of MR



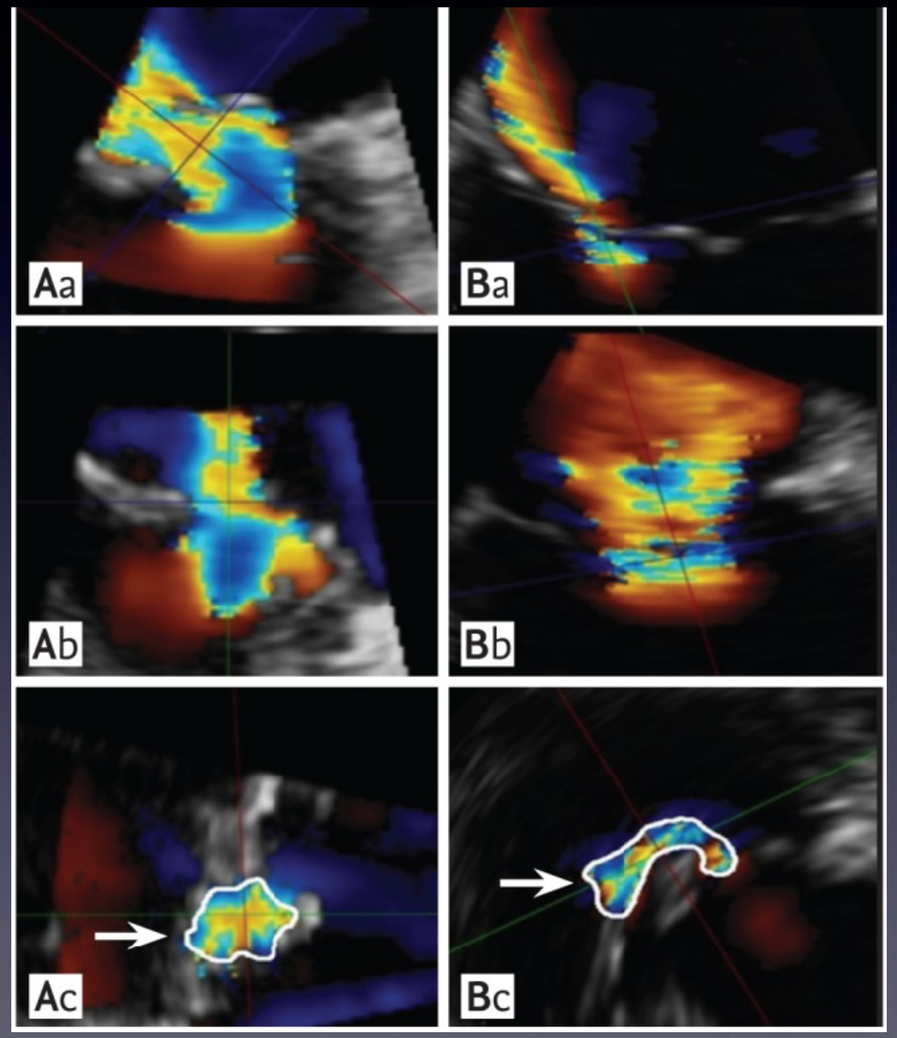
Limitations of Venacontracta

Assumes circular orifice



Lancelotti et al, European guidelines, EHJ,Vol 11(4); 307-332

DMR IMR



EAE/ASE RECOMMENDATIONS

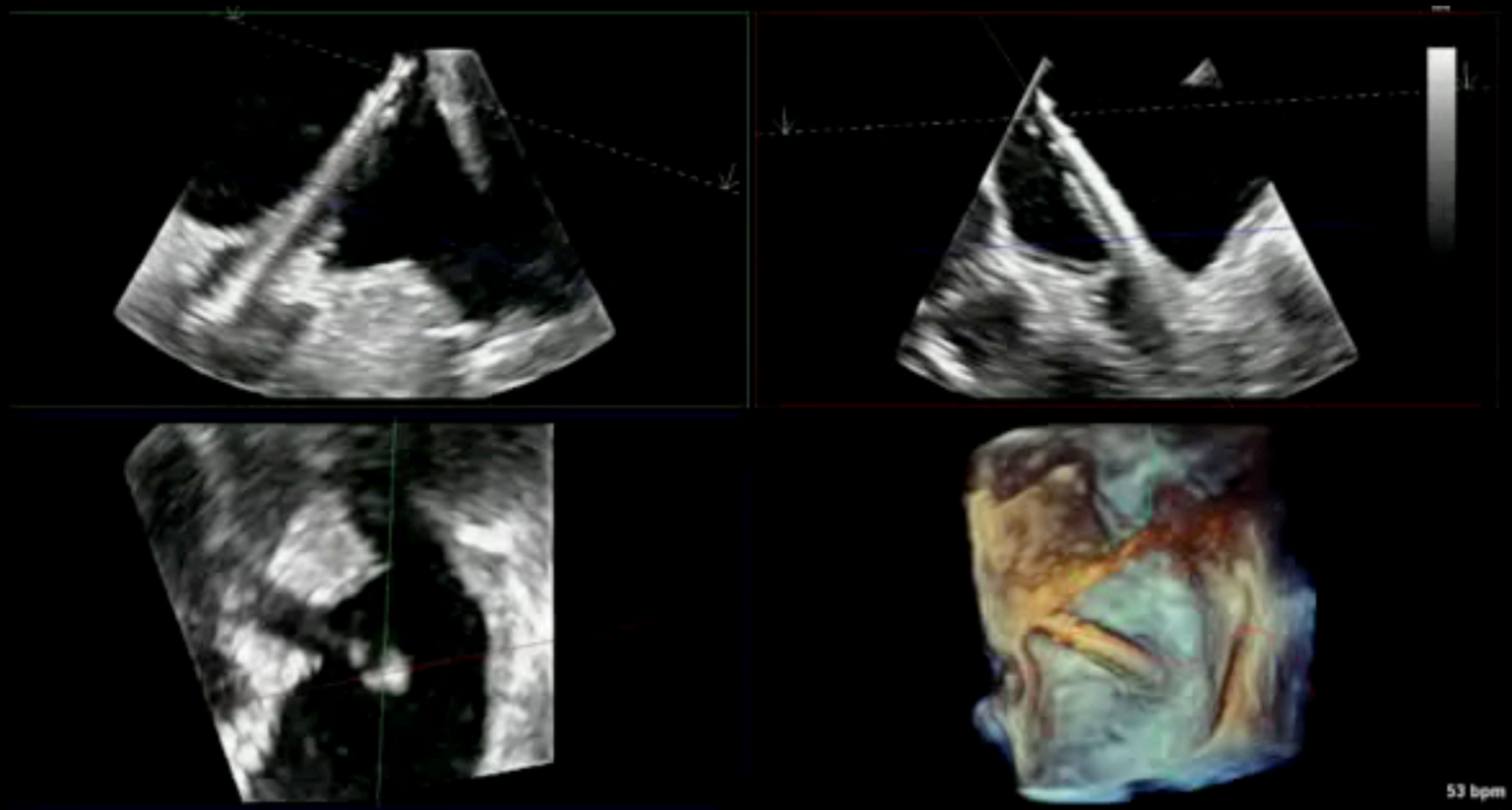
3D Quantification a valuable tool in MR assessment if it is felt to be underestimated by 2D imaging and/or is anatomically complex

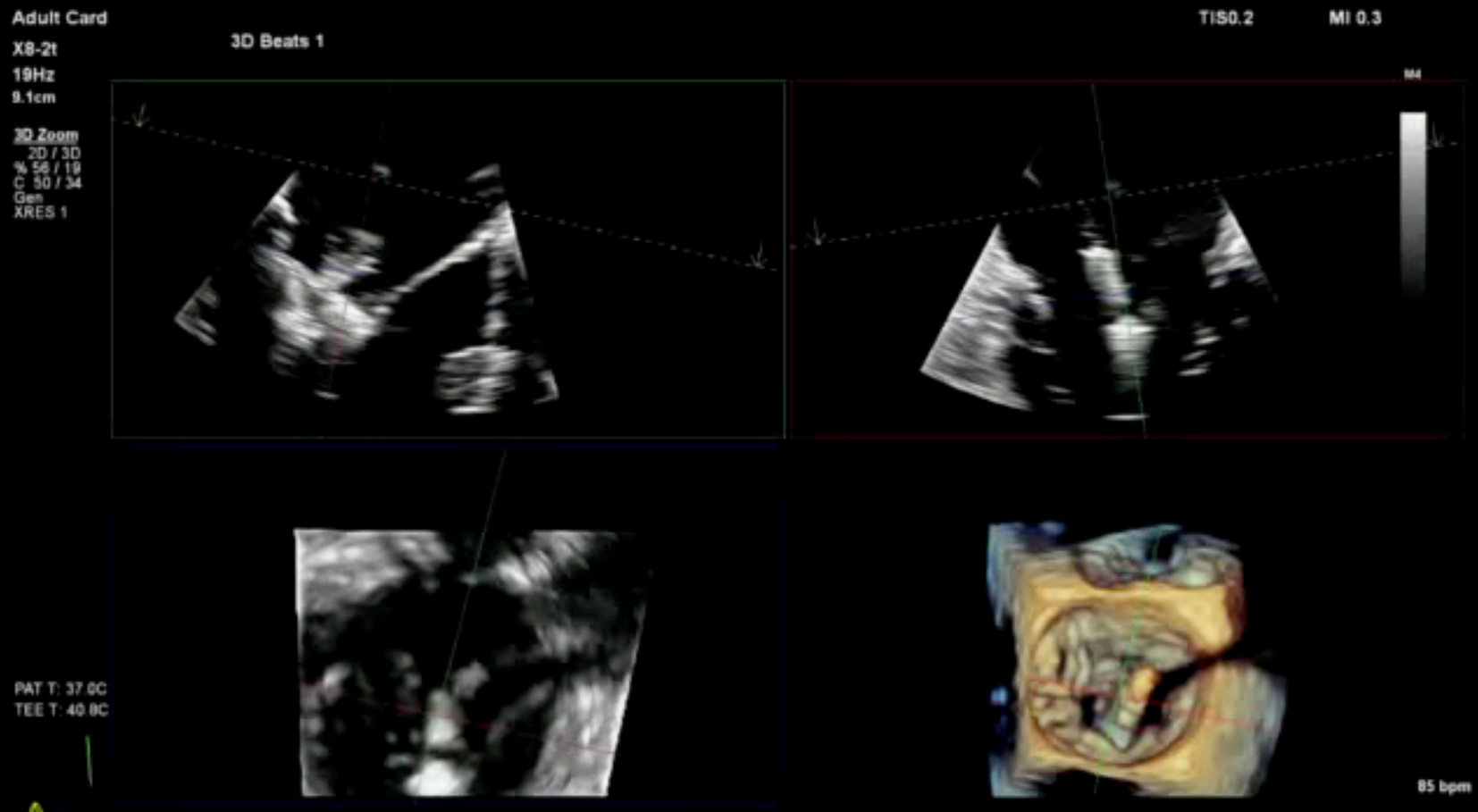
Guiding Intervention on MV

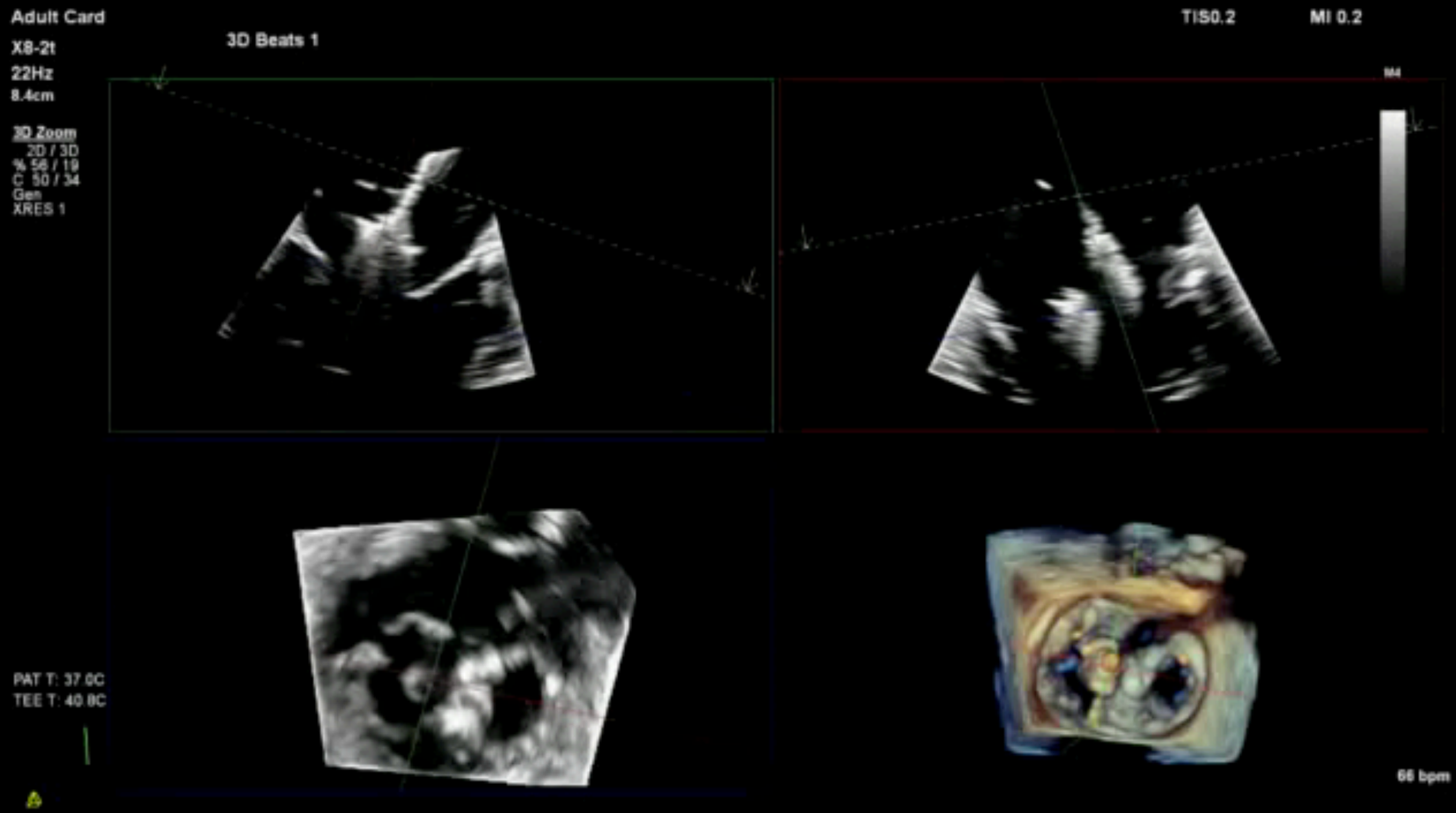
TEER

Transcatheter Mitral valve repairs/ replacement

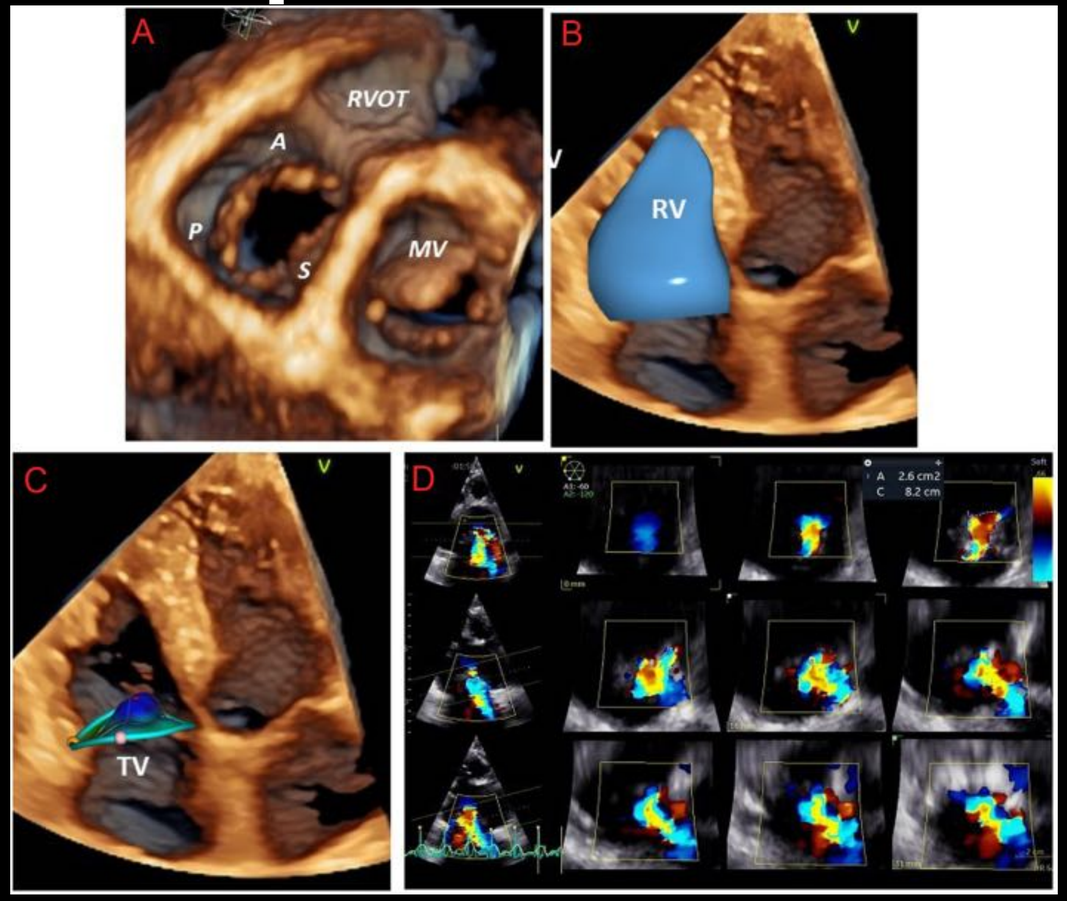
Transseptal




Adult Card
X8-2t
19Hz
9.1cm
3D Zoom
2D / 3D
% 56 / 19
C 50 / 34
Gen
XRES 1
3D Beats 1
TIS0.2
MI 0.3
M4
PAT T: 37.0C
TEE T: 40.0C
85 bpm

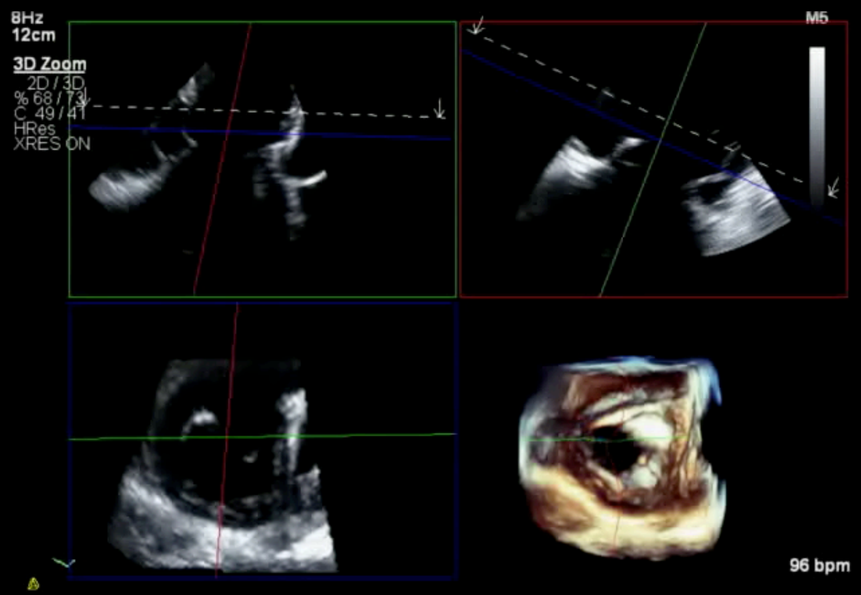

Adult Card
X8-2t
22Hz
8.4cm
3D Zoom
2D / 3D
% 56 / 10
C 50 / 34
Gen
XRES 1
3D Beats 1
TIS0.2
MI 0.2
M4
PAT T: 37.0C
TEE T: 40.0C
66 bpm

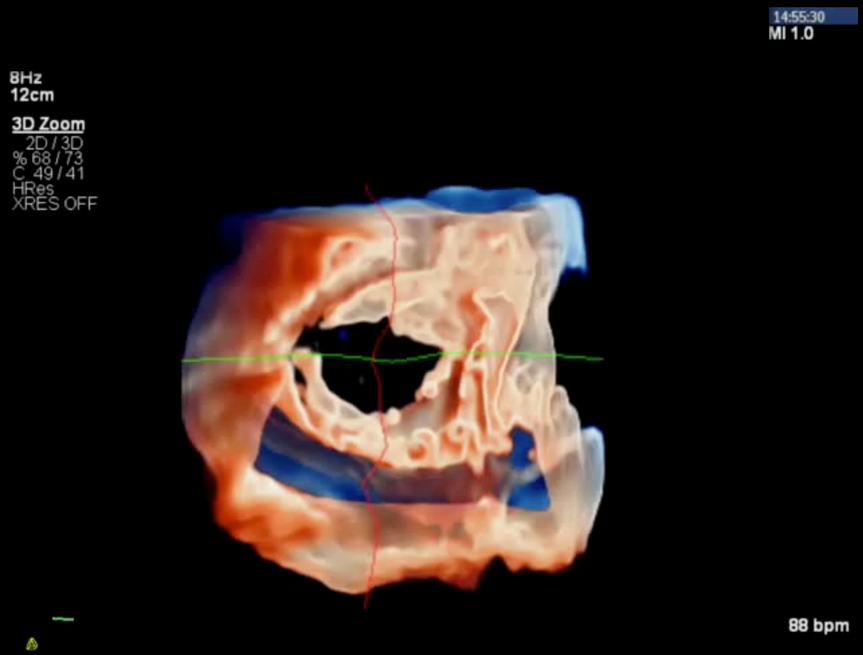
Tricuspid Valve & 3D



Zaidi A et al. Echo Res Pract. 2020 G95-122

TTE & 3D of TV


8Hz
12cm
3D Zoom
2D / 3D
% 68 / 73
C 49 / 41
HRes
XRES ON
M5
96 bpm


14:55:30
MI 1.0
8Hz
12cm
3D Zoom
2D / 3D
% 68 / 73
C 49 / 41
HRes
XRES OFF
88 bpm

3D & TV

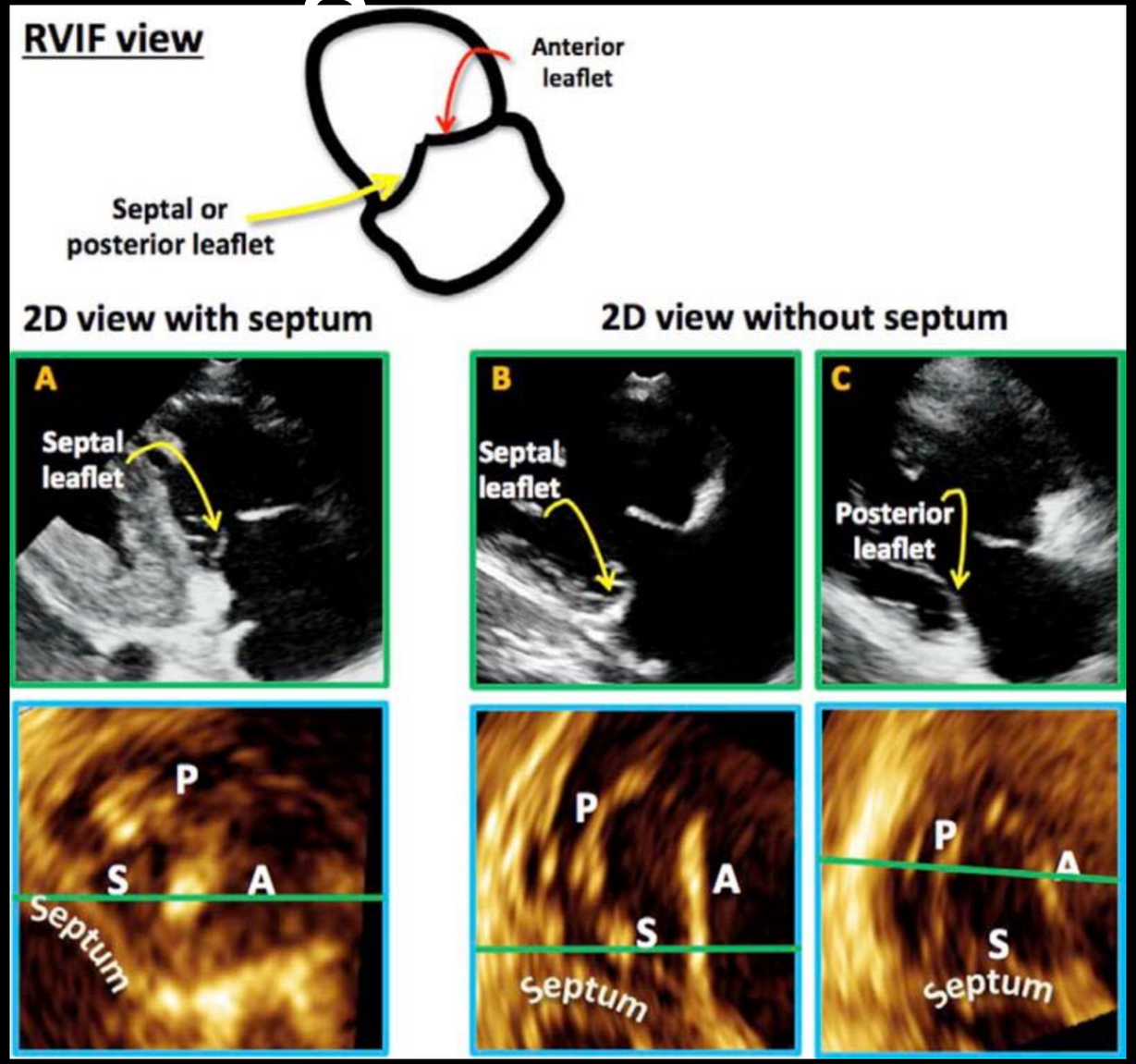
2D TTE does not allow all 3 tricuspid valve leaflets to be visualised at once

This now MATTERS!

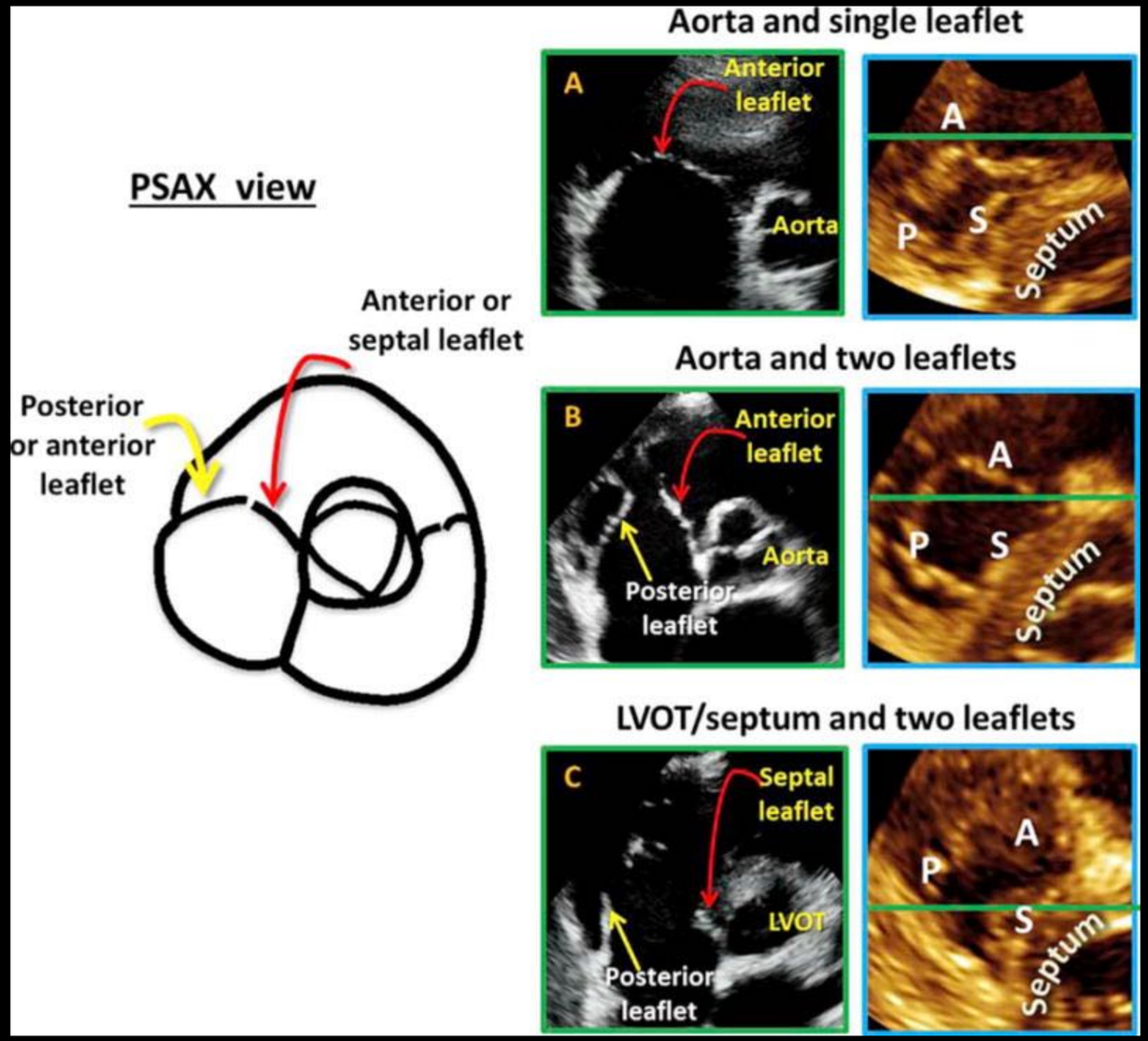
All leaflets can be visualised with 3D

Good 3D of tricuspid valve is achievable in 80-90% of TTEs

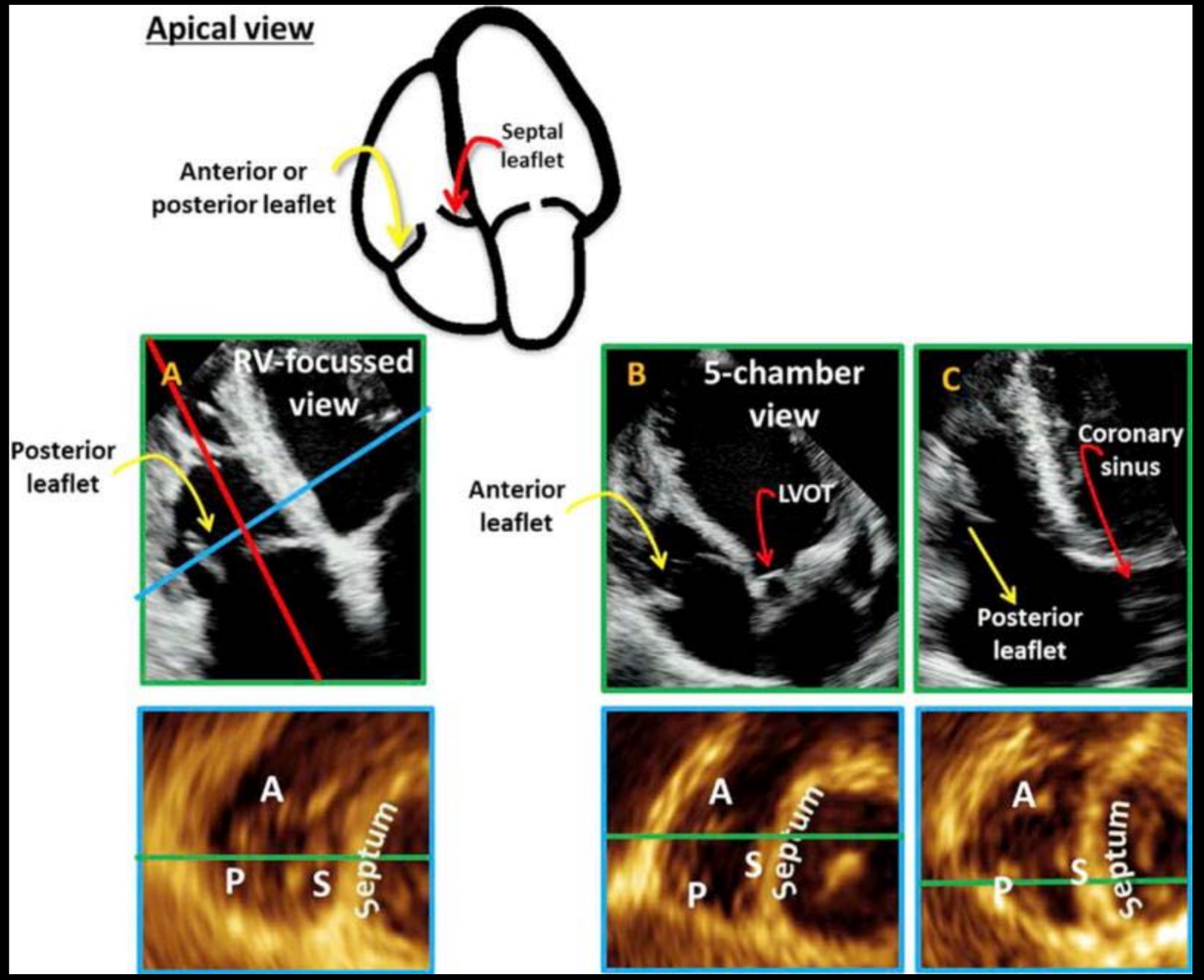
Segmentation



Addetia K et al. J Am Soc Echo 2015. 74-82

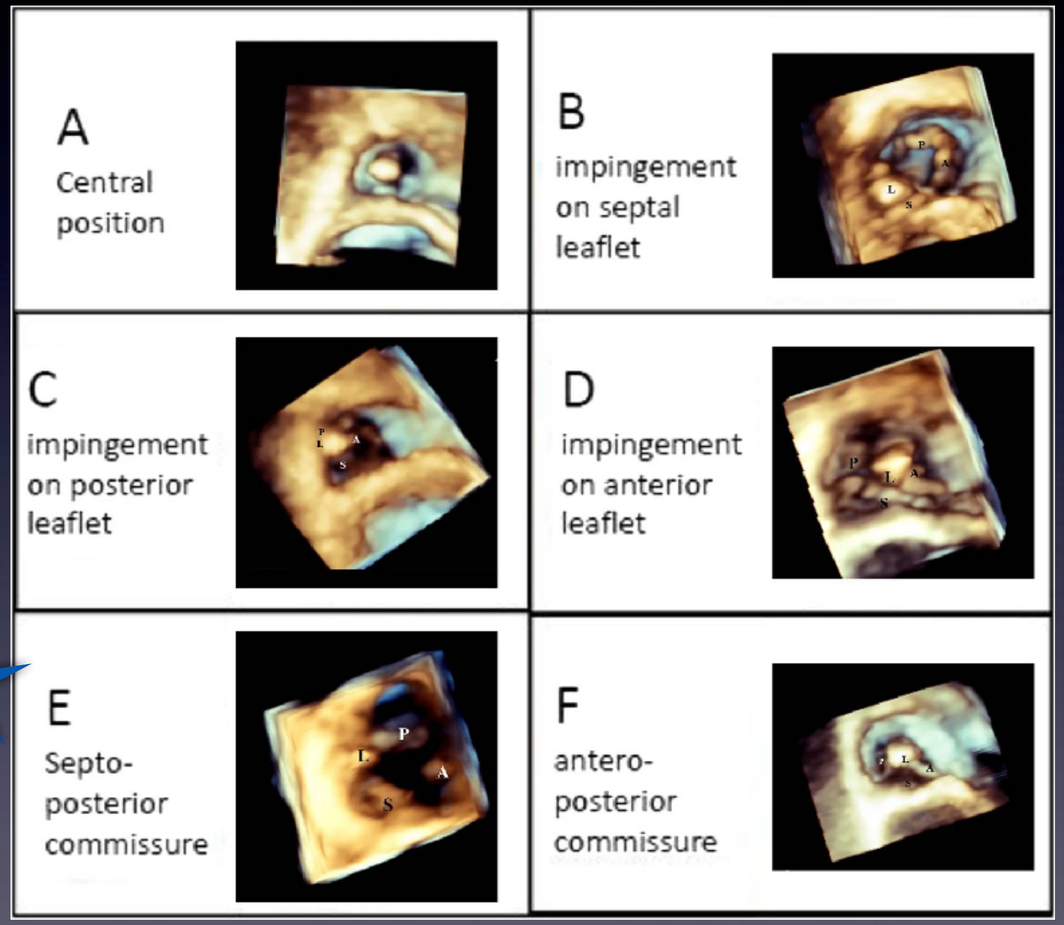


Addetia K et al. J Am Soc Echo 2015. 74-82



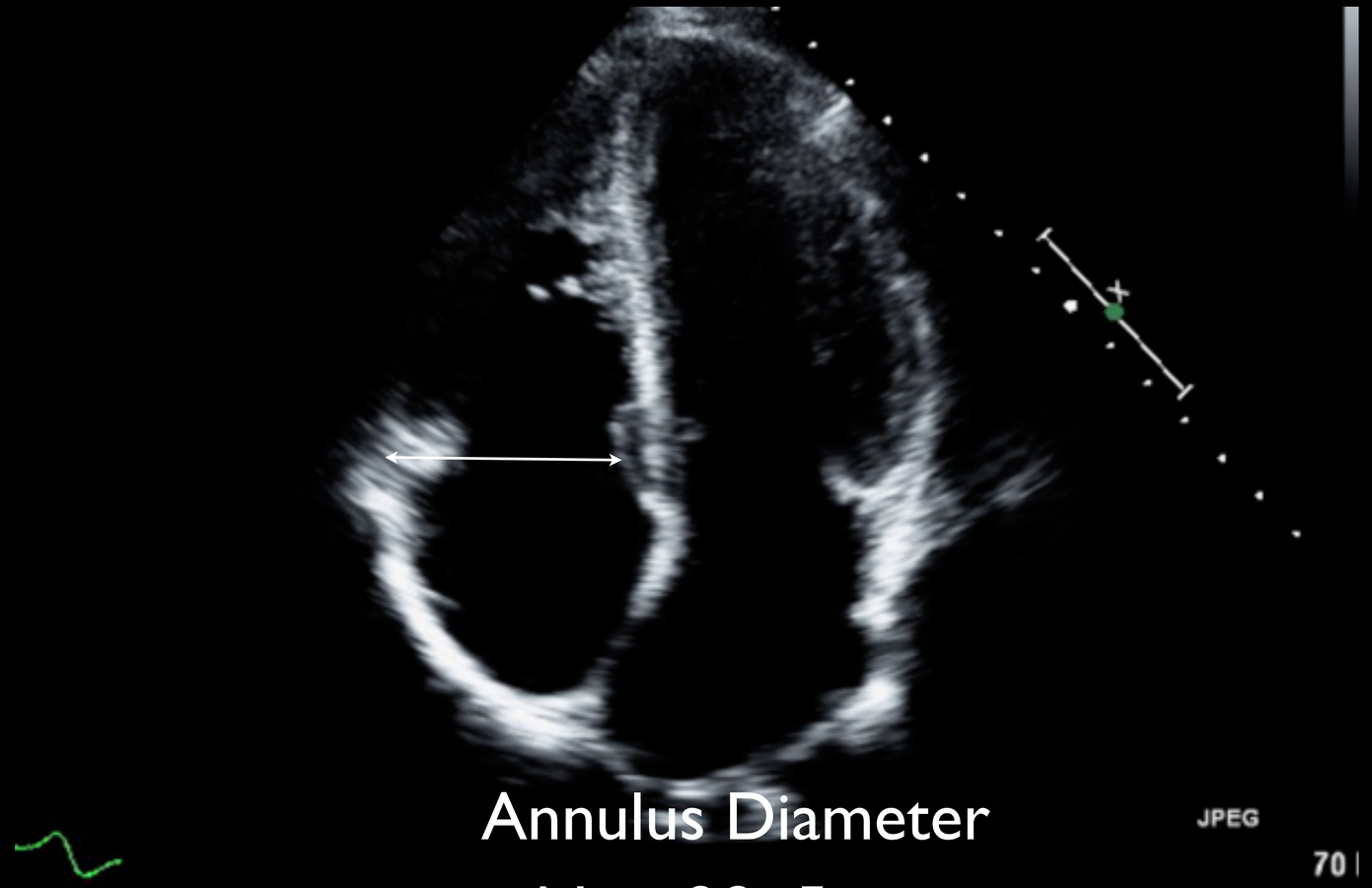
Addetia K et al. J Am Soc Echo 2015. 74-82

Lead Placement and Predicting increase in TR



Poorzand H et al Cardiovascular Ultrasound 2021

Tricuspid Valve Annulus



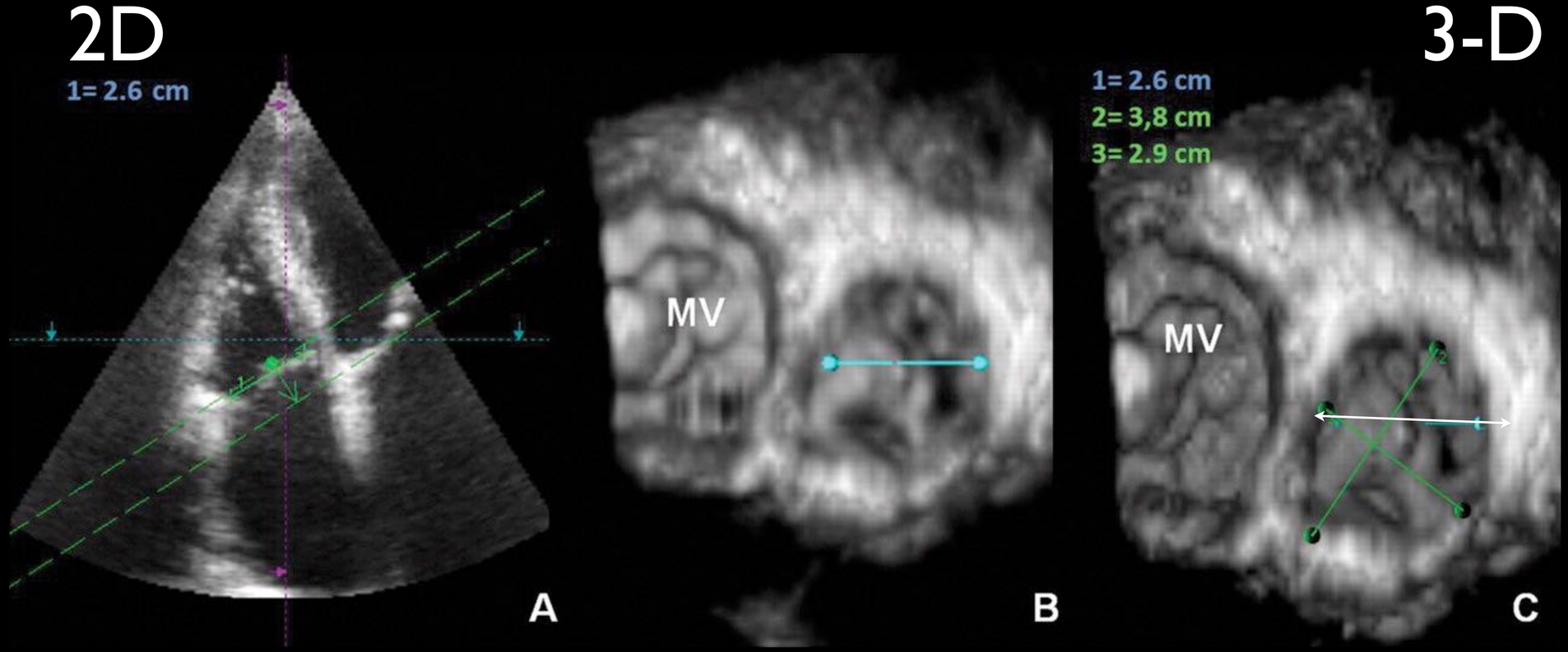
Annulus Diameter

N = 28±5mm

Dilated≥35mm

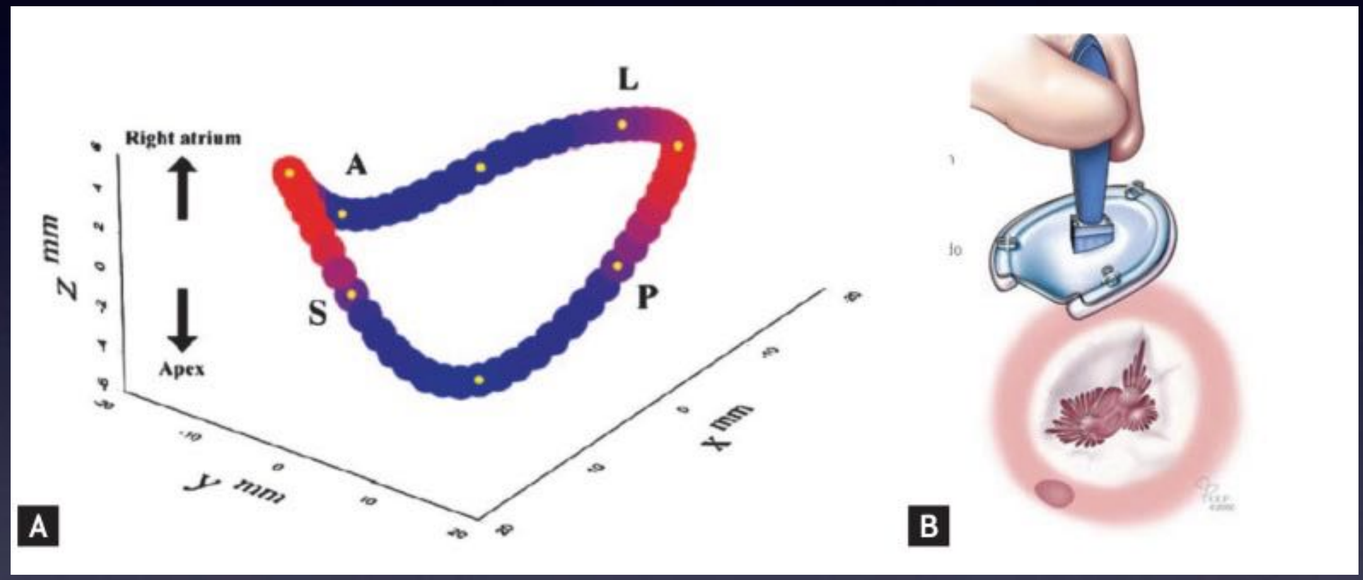
TAFS=25%

Tricuspid Valve Annulus



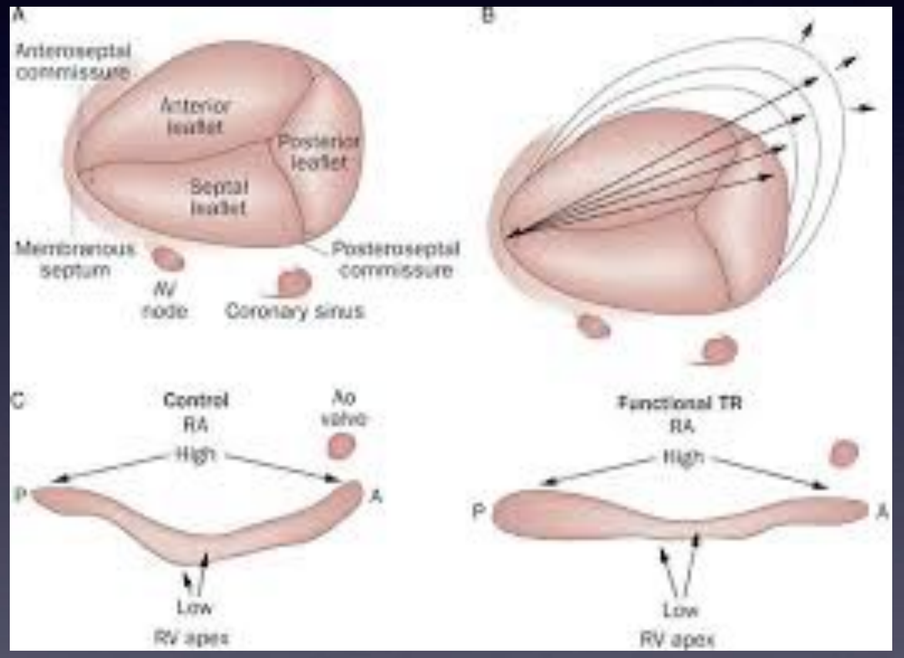
Badano L et al. EHJ CV imaging 2009:10(4);477-484.

Tricuspid Valve Annulus

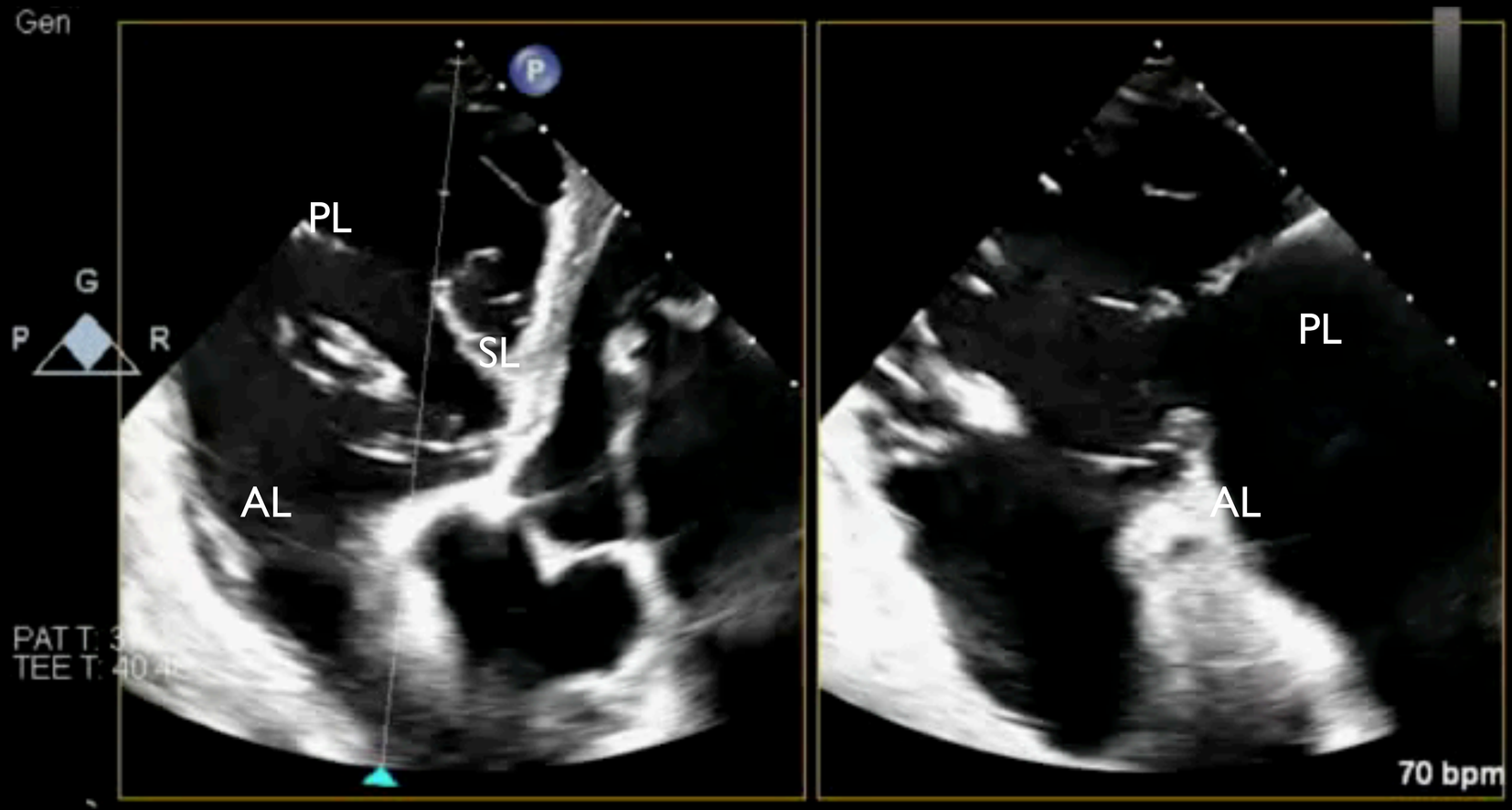


Shiota T. Role of modern 3D Echocardiography in valvular disease 2014

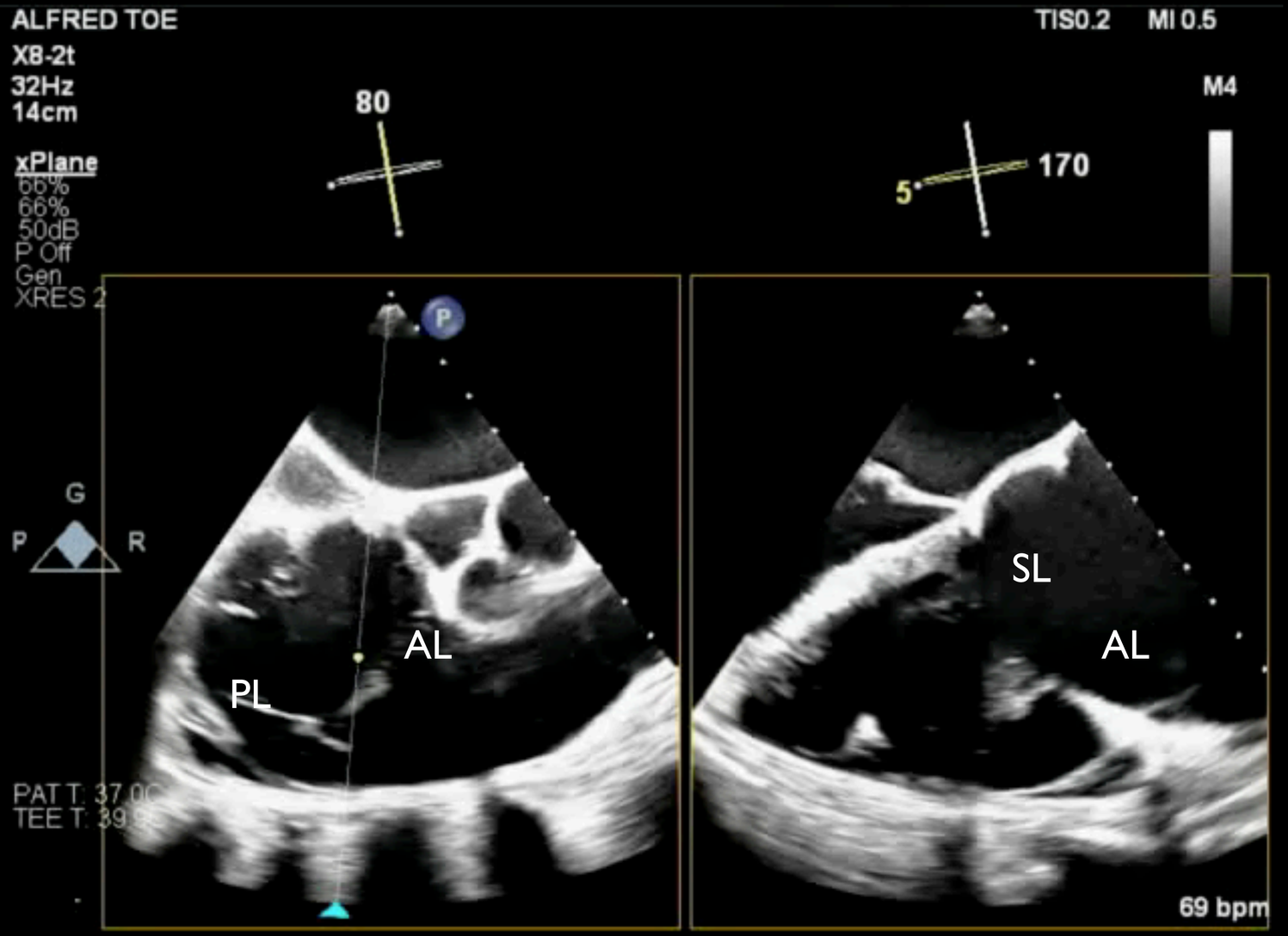
Functional TR



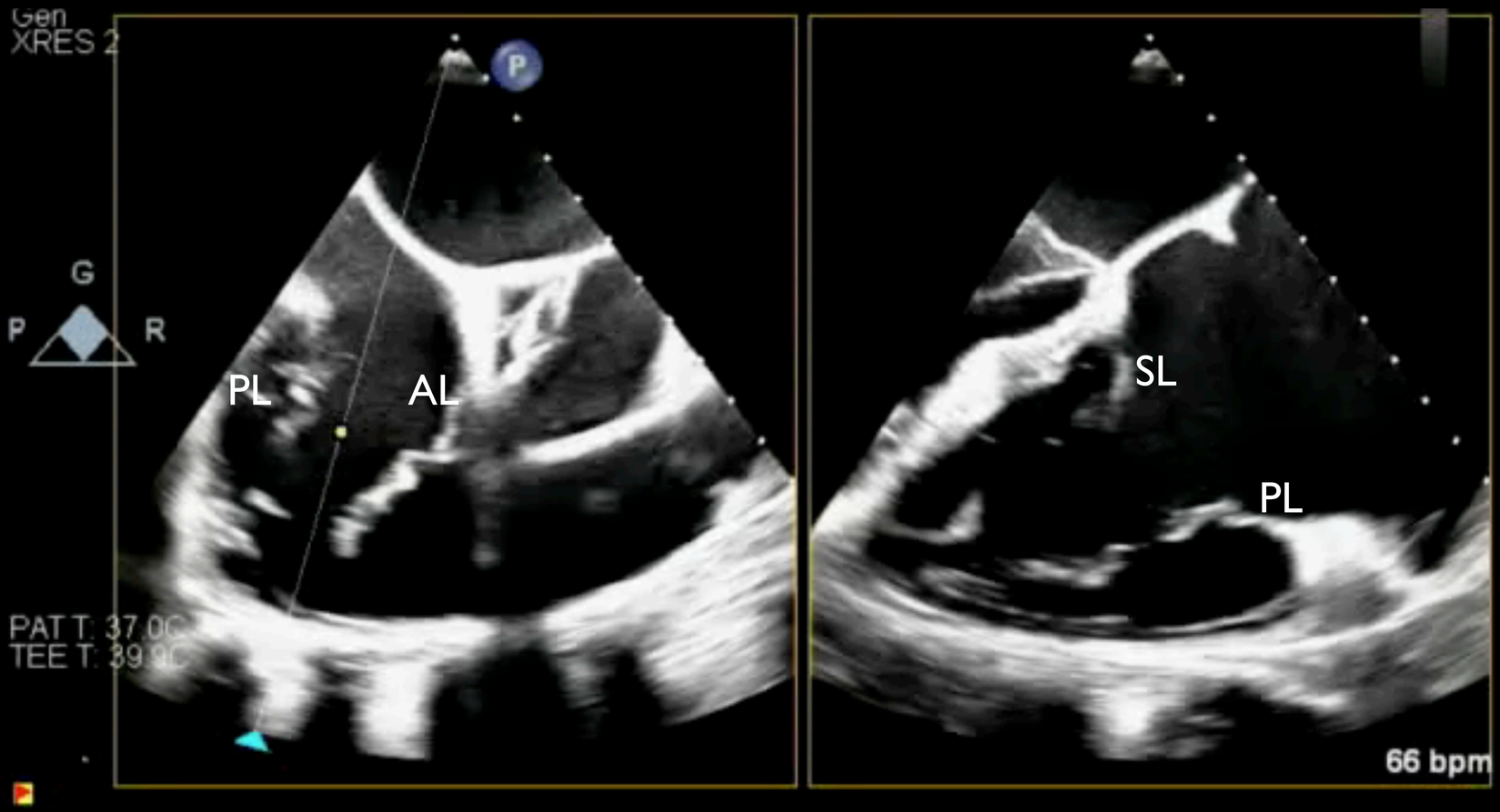
How about TOE of TV & 3D?



Transgastric

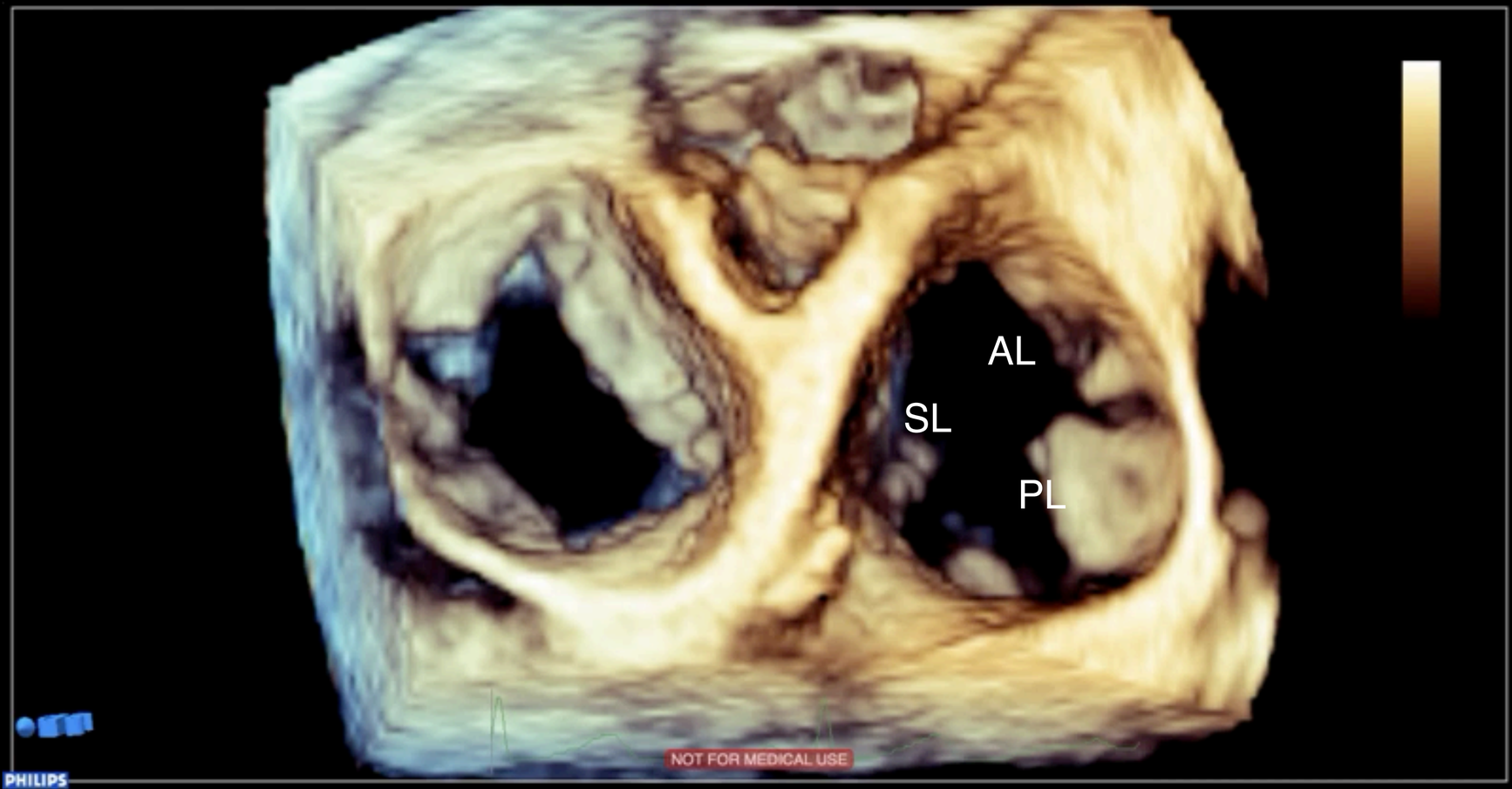


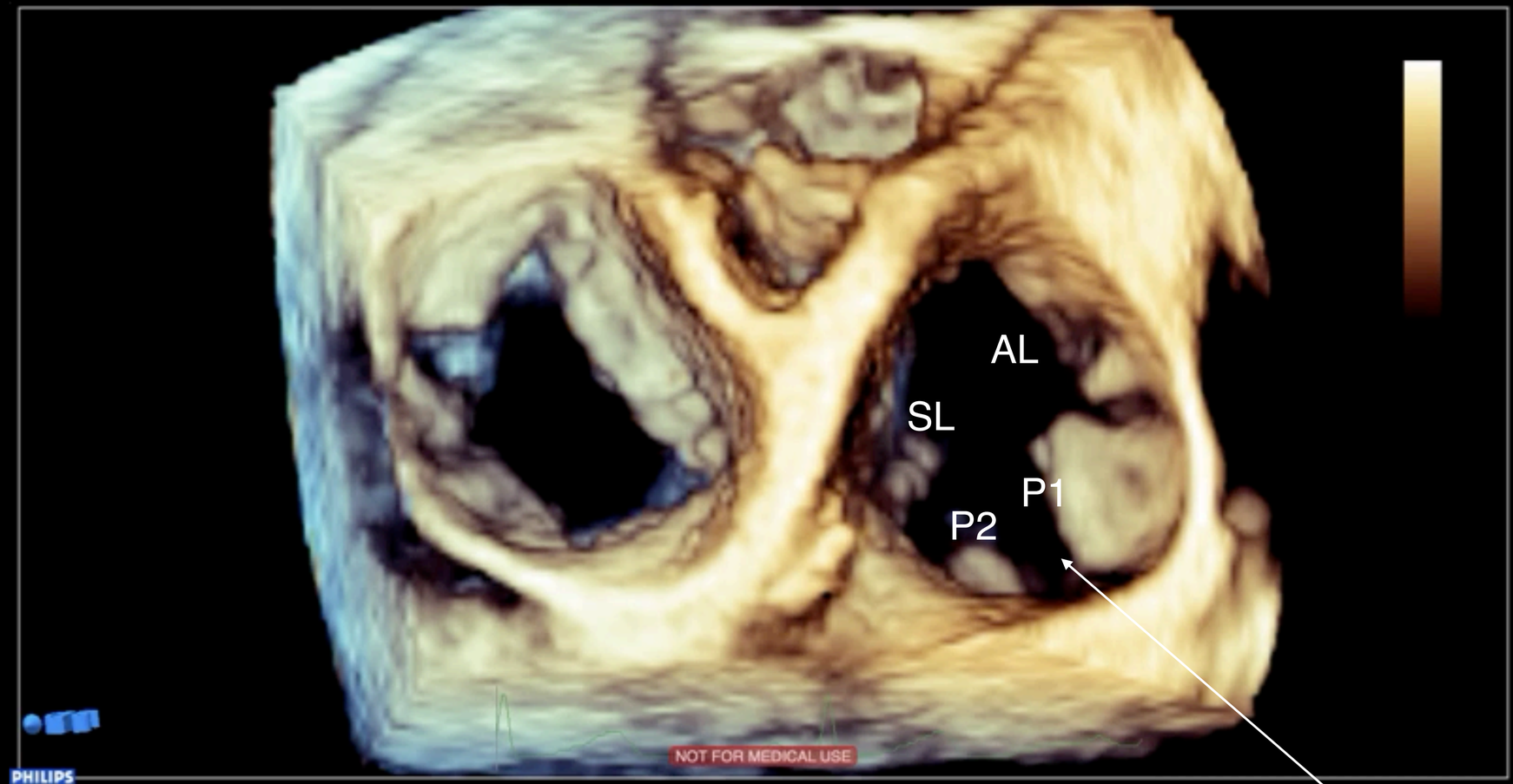
Inflow X-plane

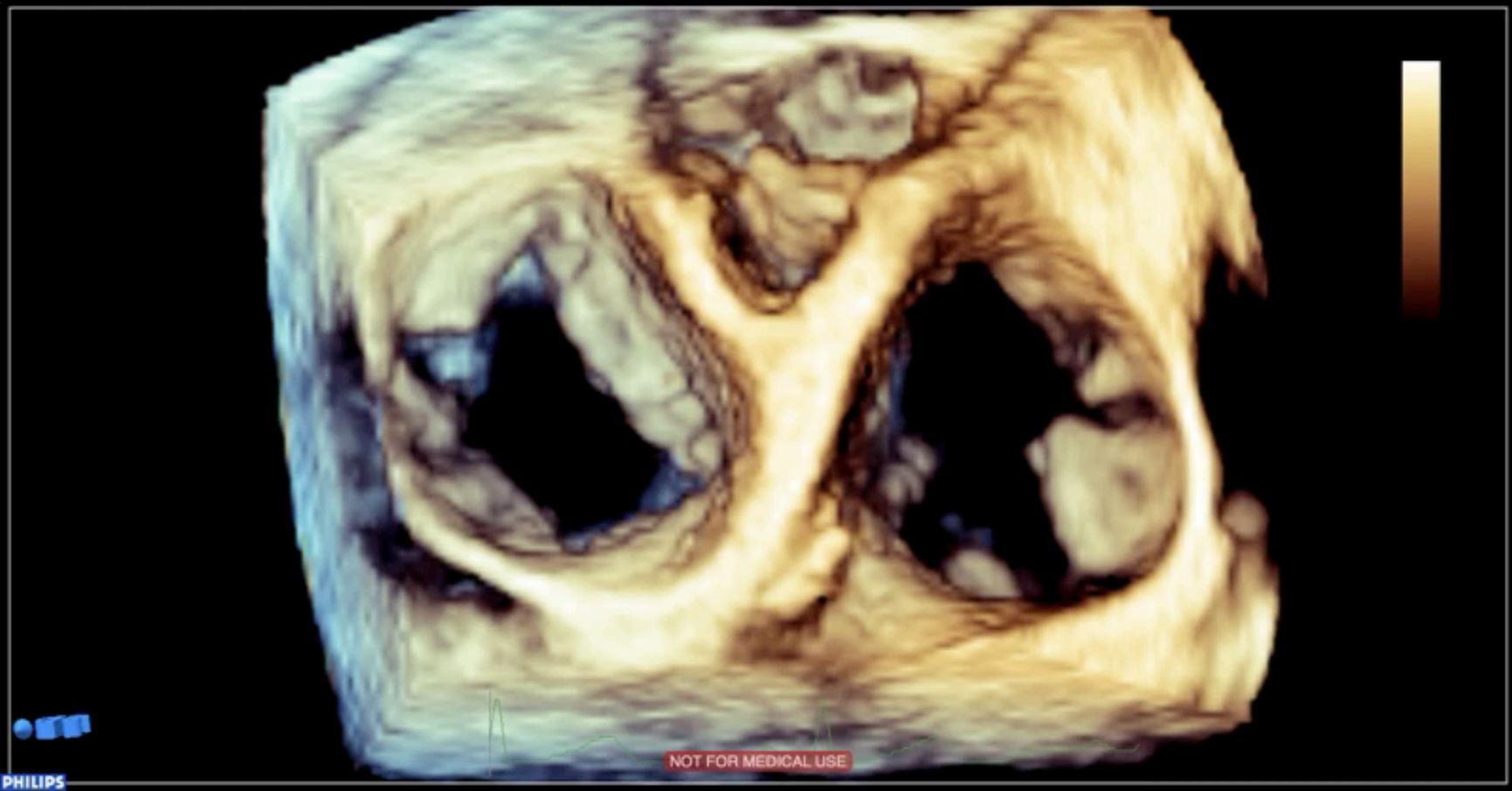

Gen
XRES 2
G
P
R
PL
AL
SL
PL
66 bpm

Key: Yellow=SL, Blue=AL, Green=PL

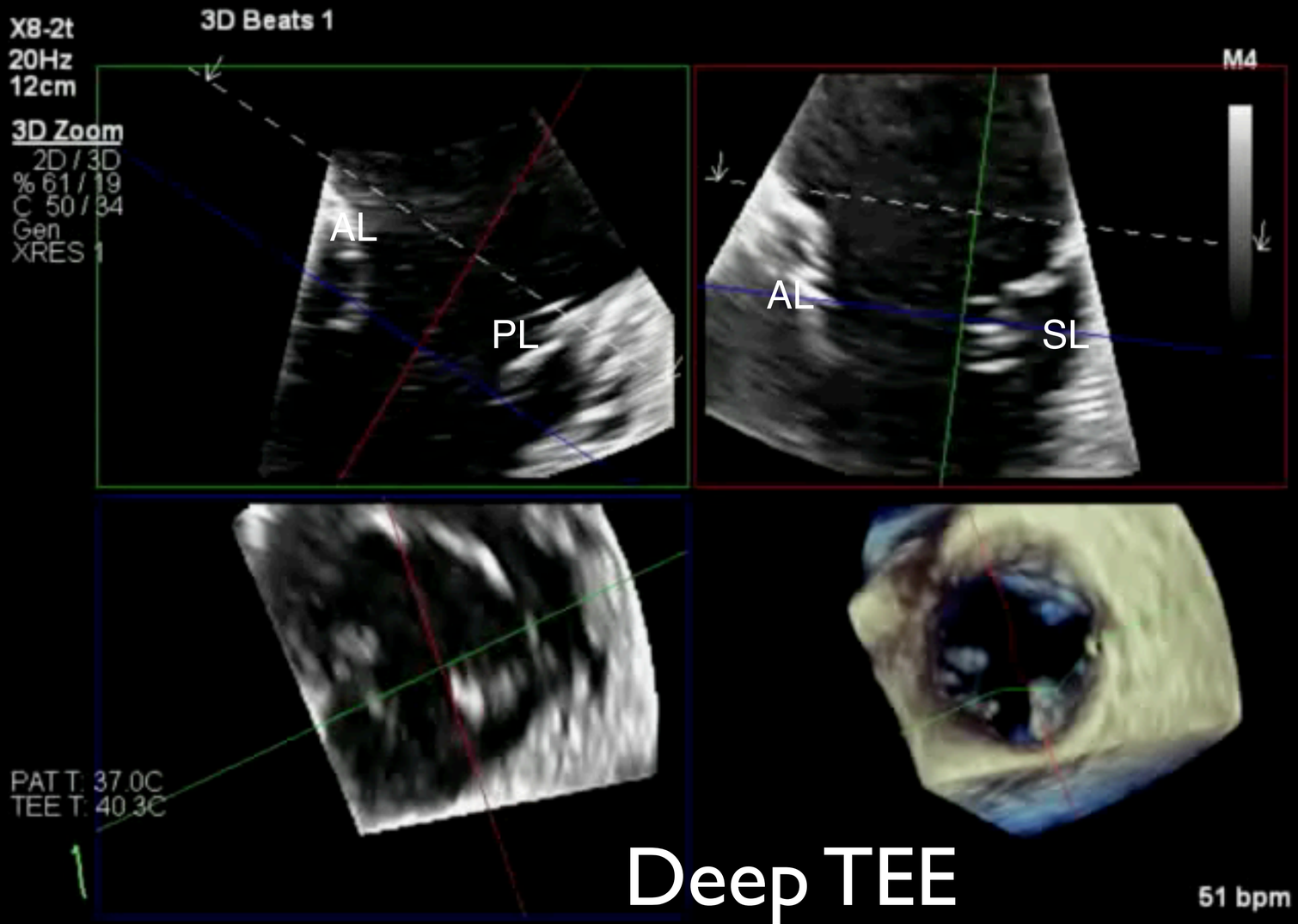
Hahn R. State of the Art Review of Echo imaging of Functional Tricuspid Regurgitation. Circ Cardiovasc Imag 2016


AL
SL
PL
NOT FOR MEDICAL USE
PHILIPS


AL
SL
P1
P2
NOT FOR MEDICAL USE
PHILIPS
IIIB

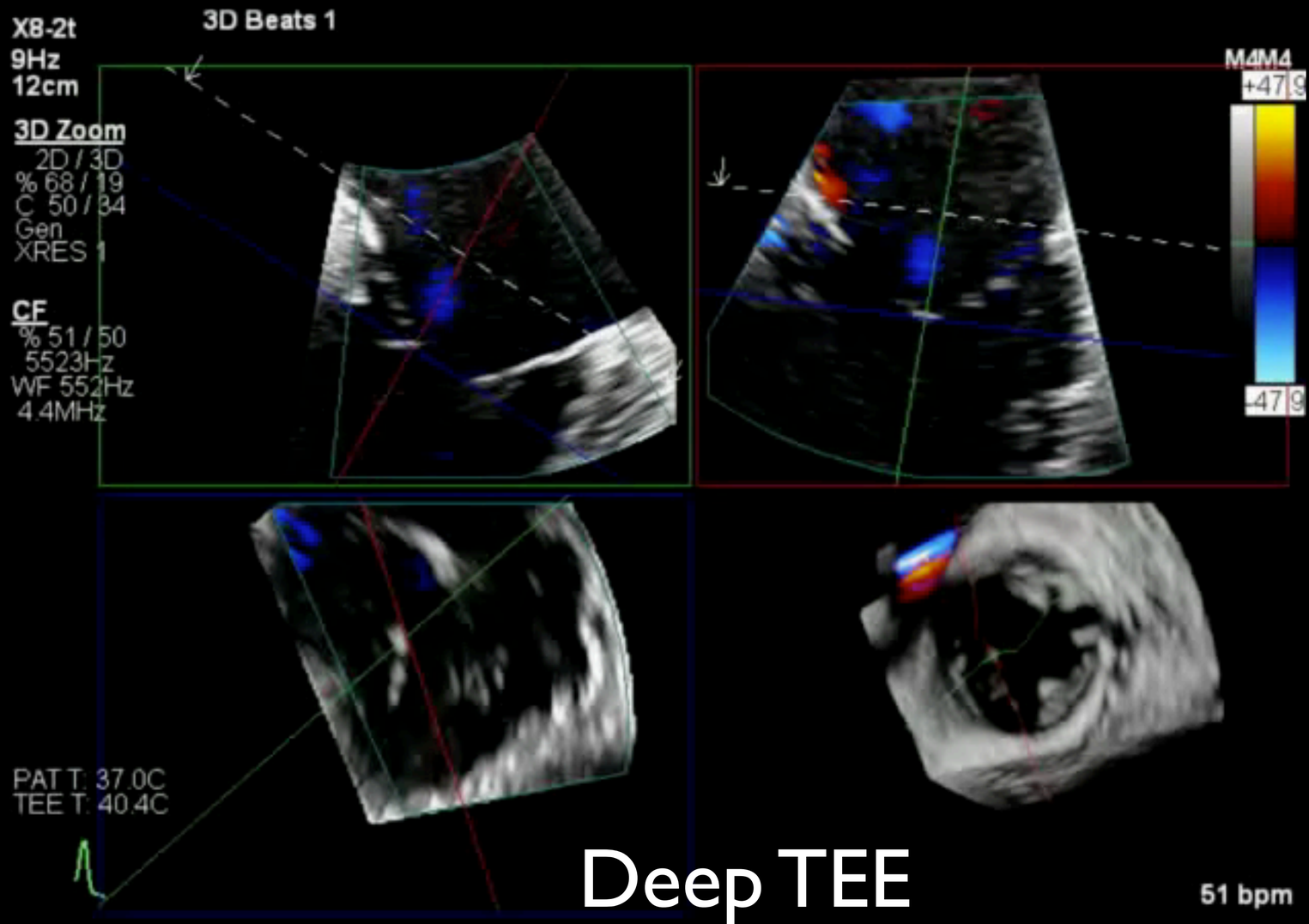

PHILIPS
NOT FOR MEDICAL USE

MPR


X8-2t
20Hz
12cm
3D Zoom
2D / 3D
% 61 / 19
C 50 / 34
Gen
XRES 1
3D Beats 1
AL
PL
M4
AL
SL
PAT T: 37.0C
TEE T: 40.3C
51 bpm

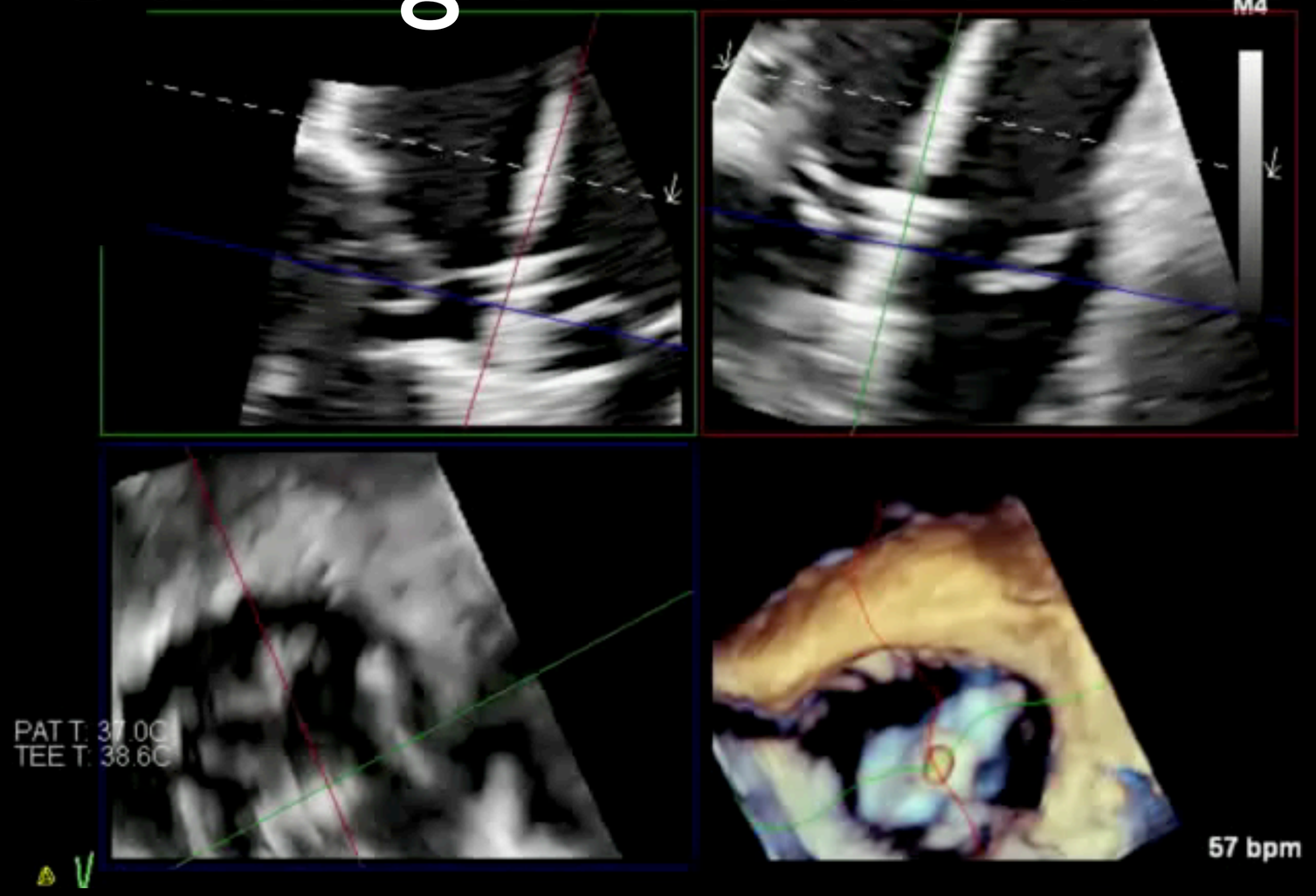
Deep TEE

MPR


X8-2t
9Hz
12cm
3D Beats 1
3D Zoom
2D / 3D
% 68 / 19
C 50 / 34
Gen
XRES 1
CF
% 51 / 50
5523Hz
WF 552Hz
4.4MHz
M4M4
+47
-47
PAT T: 37.0C
TEE T: 40.4C
51 bpm

Deep TEE

Guiding TEER & TCVR



Conclusions

3D assessment of MR and TR is of incremental value in

1. Assessing anatomy
2. Shedding light on pathology
3. Guiding interventions

Good to have more 3D TTE assessments of the Tricuspid valve

Must be mainstream