香港中文大學
The Chinese University of Hong Kong

香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong

35th Anniversary

Dr Stanley Ho Medical Development Foundation Symposium 2017

Recent Advances in Cardiac Imaging

Prof Alex Lee Pui Wai

Director of Echocardiography Laboratory

Prince of Wales Hospital

Disclosure

- St Jude
- Philips
- GE
- Medtronic
- Boston Scientific
- Abbott
- Bayer
- Boehringer Ingelheim
- Pfizer
- Merck
- MSD
- HeartWork

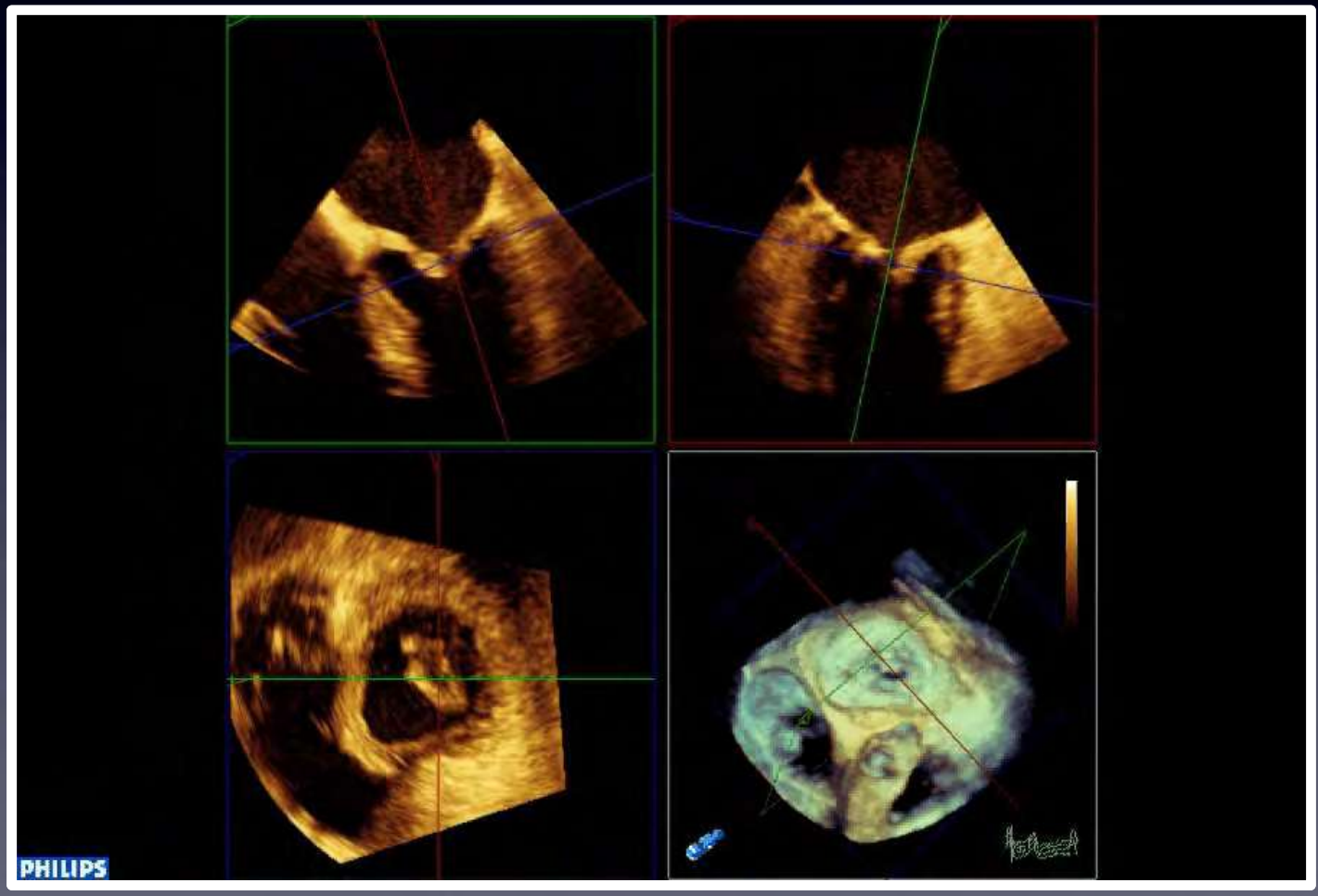
Lecture Outline

Selected latest advances in:

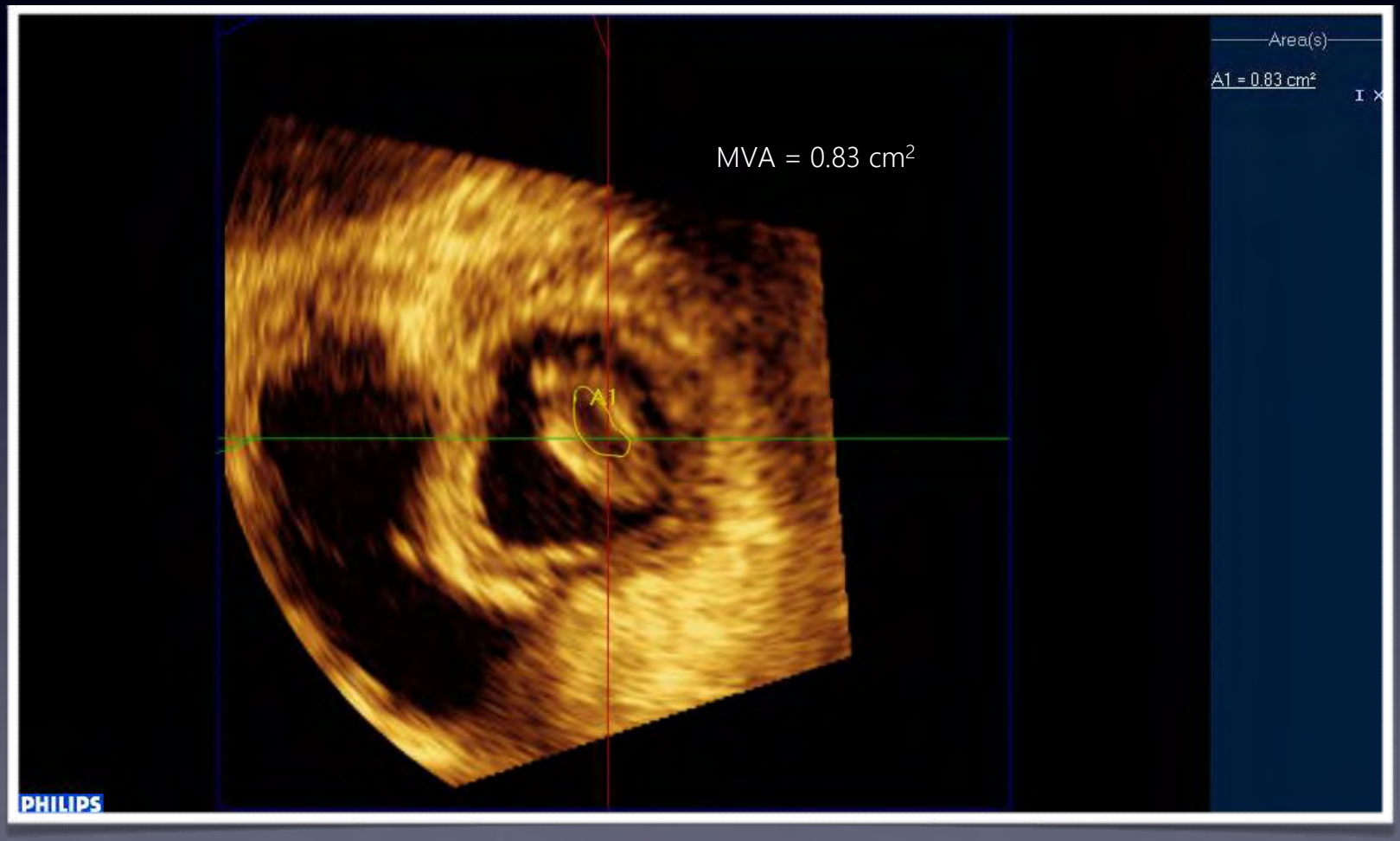
- Echocardiography
- Interventional Imaging
- Cardiac CT
- Cardiac MR

3D “Surgeon View” of Mitral Orifice from LA Perspective

Multiplanar Reconstruction (MPR) for MVA Planimetry Measurement

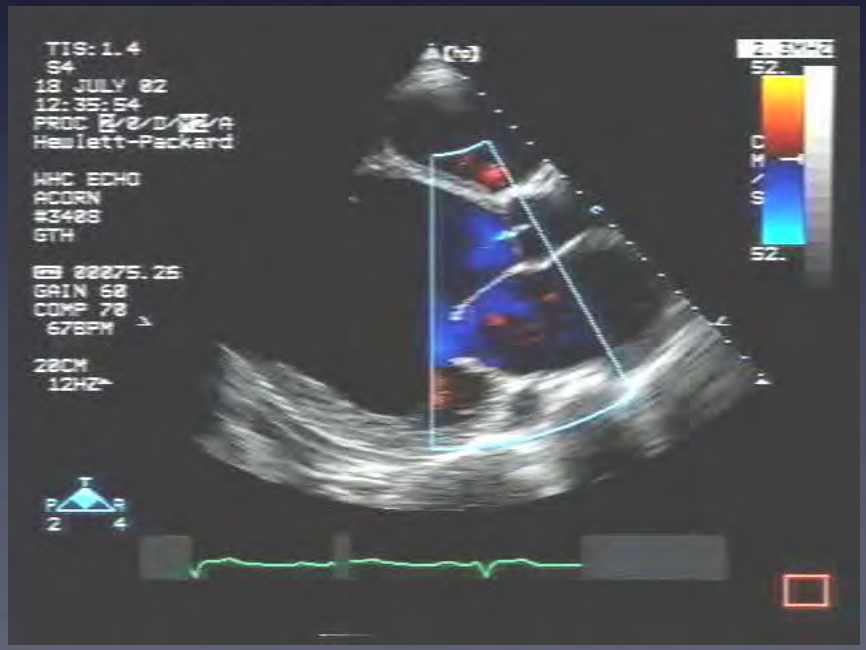


Severe Mitral Stenosis by 3D Planimetry



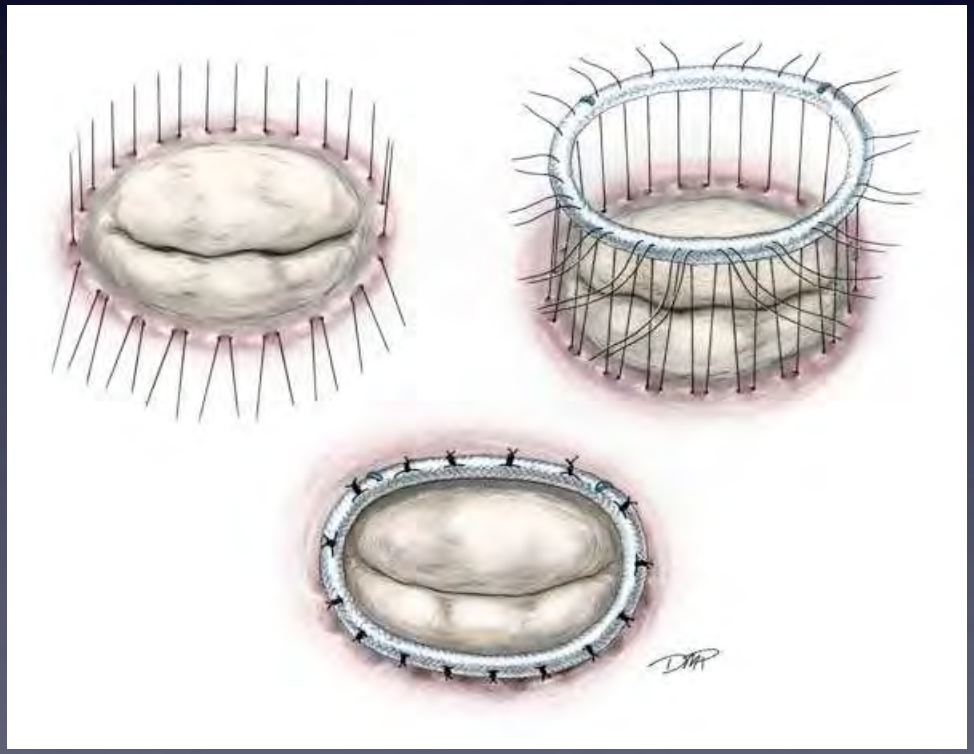
Functional MR complicates 20% of systolic heart failure

- MR secondary to left ventricular dysfunction
- Mitral valve structurally intact



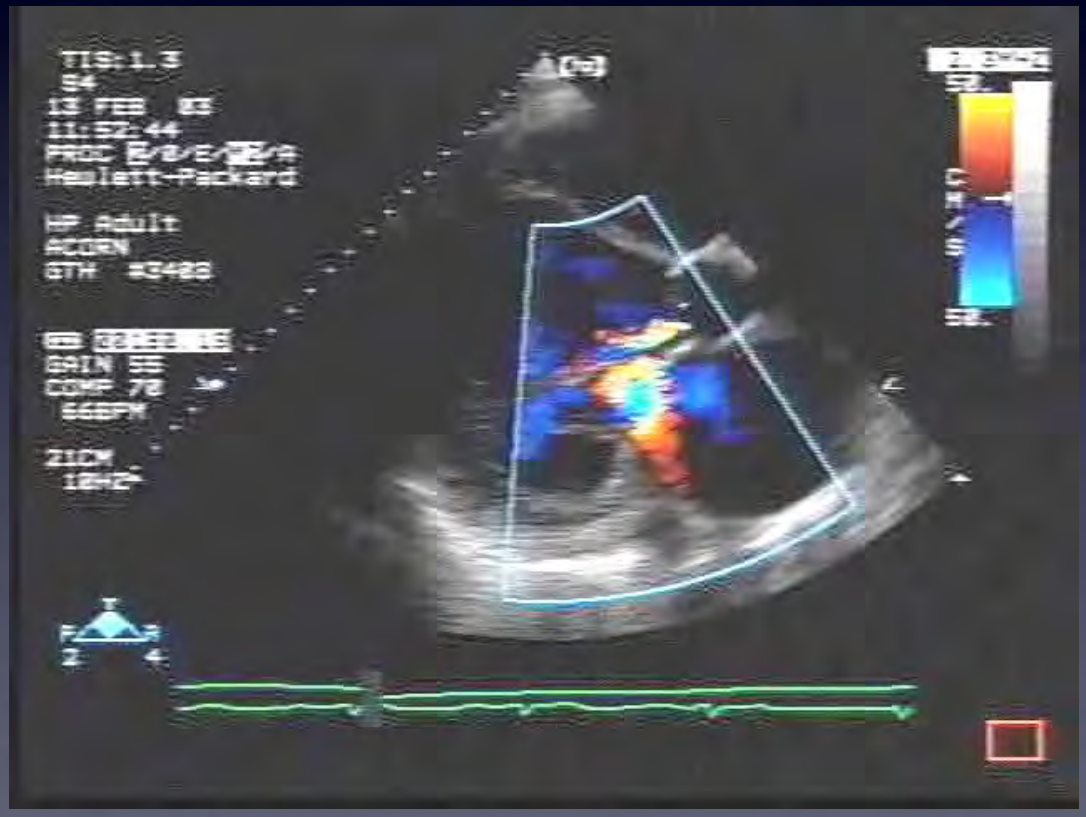
Surgical Treatment of severe FMR
Conventional Belief

Mechanism of FMR = Mitral Annular Dilatation
Surgical correction = Ring Annuloplasty



Problem with The Ring...

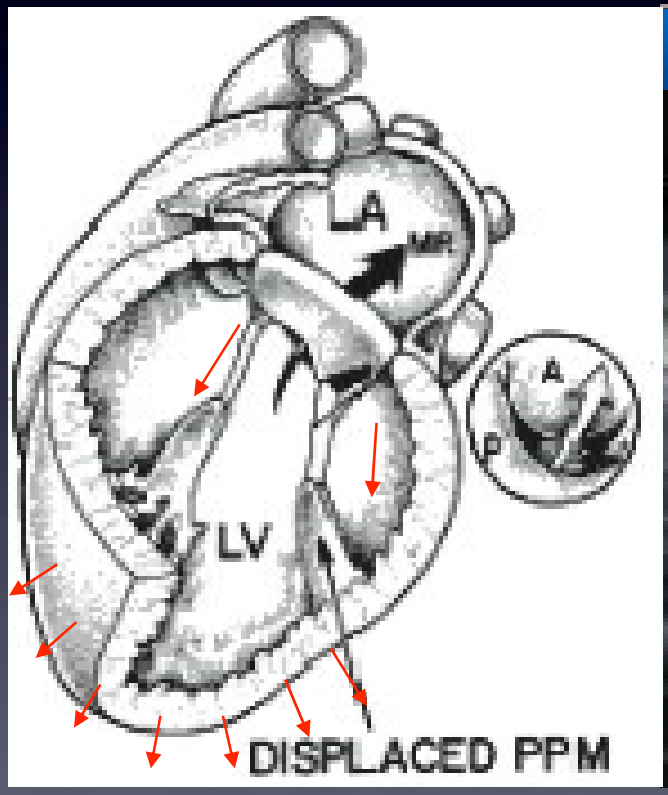
MR persists in 30%!

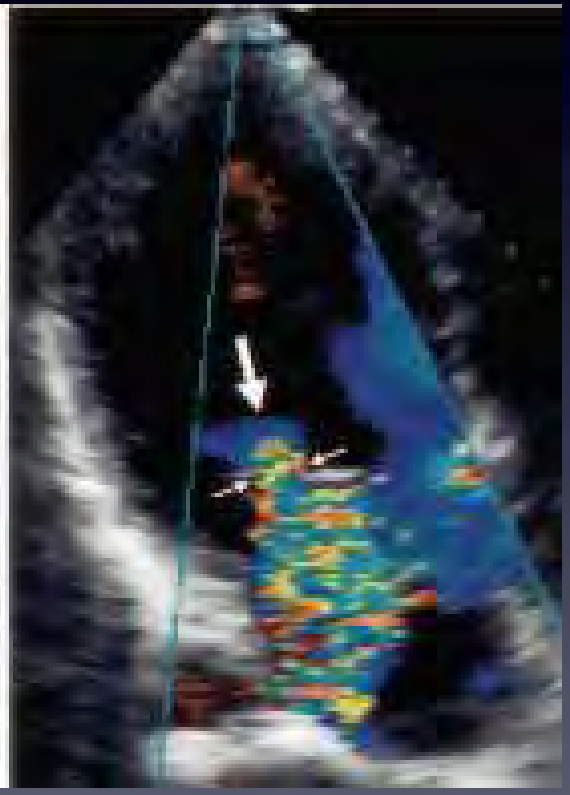


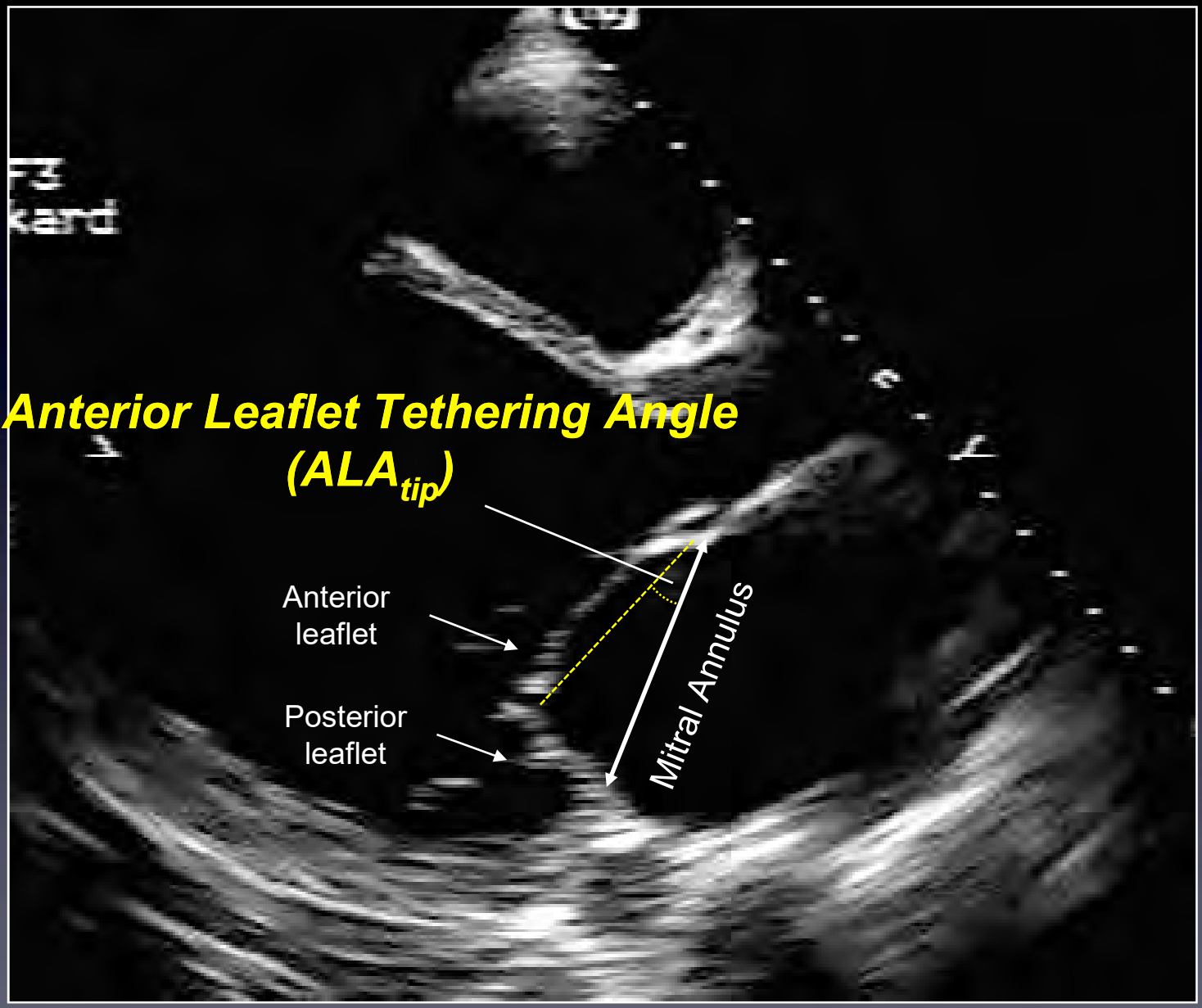
Hypothesis:

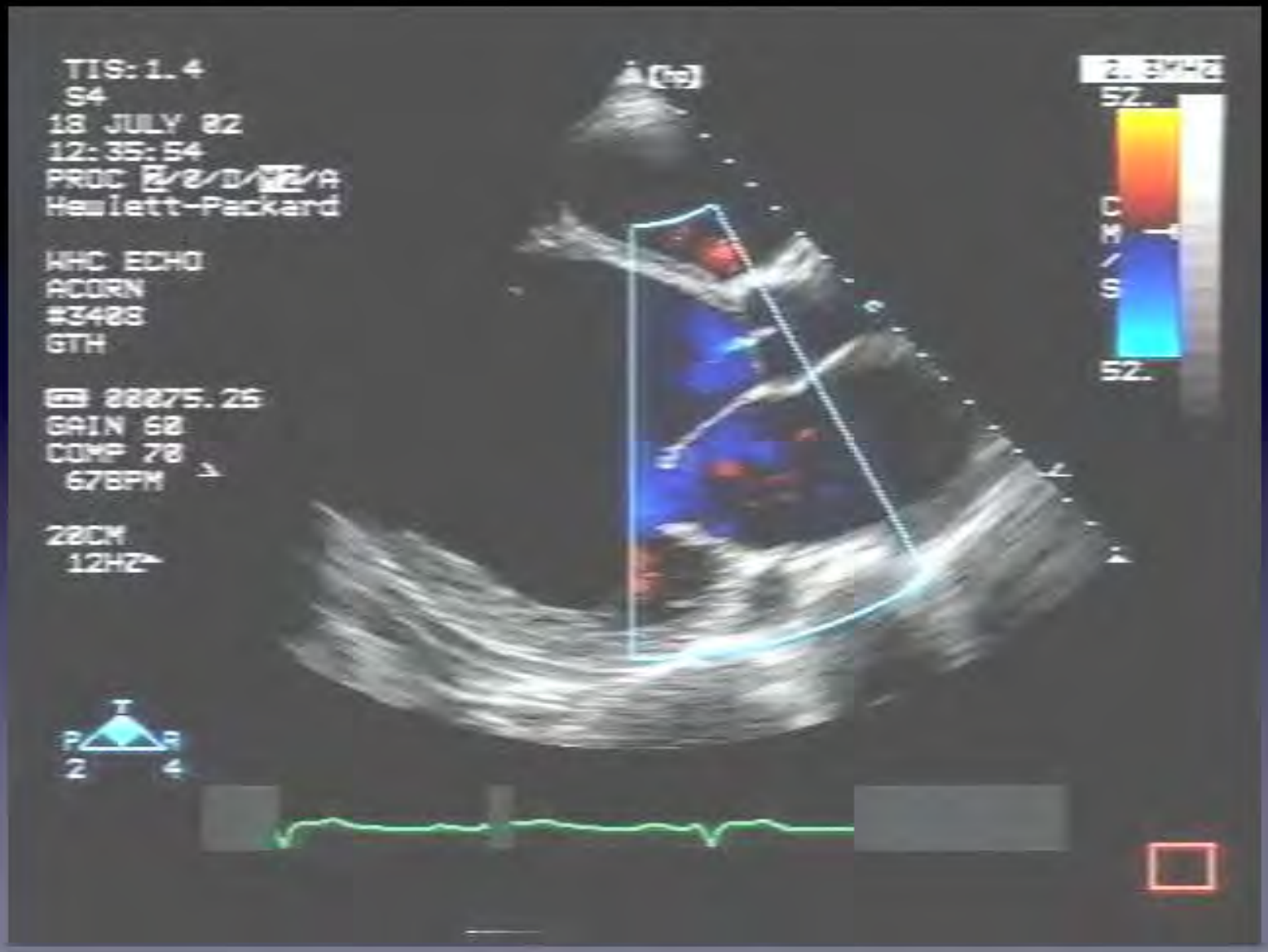
Annular dilatation is *not* the only mechanism of FMR.

The Importance of Mitral Leaflet Tethering






Anterior Leaflet Tethering Angle
(ALA$_{tip}$)
Anterior leaflet
Posterior leaflet
Mitral Annulus



Before ring implantation

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association.
Learn and Live.

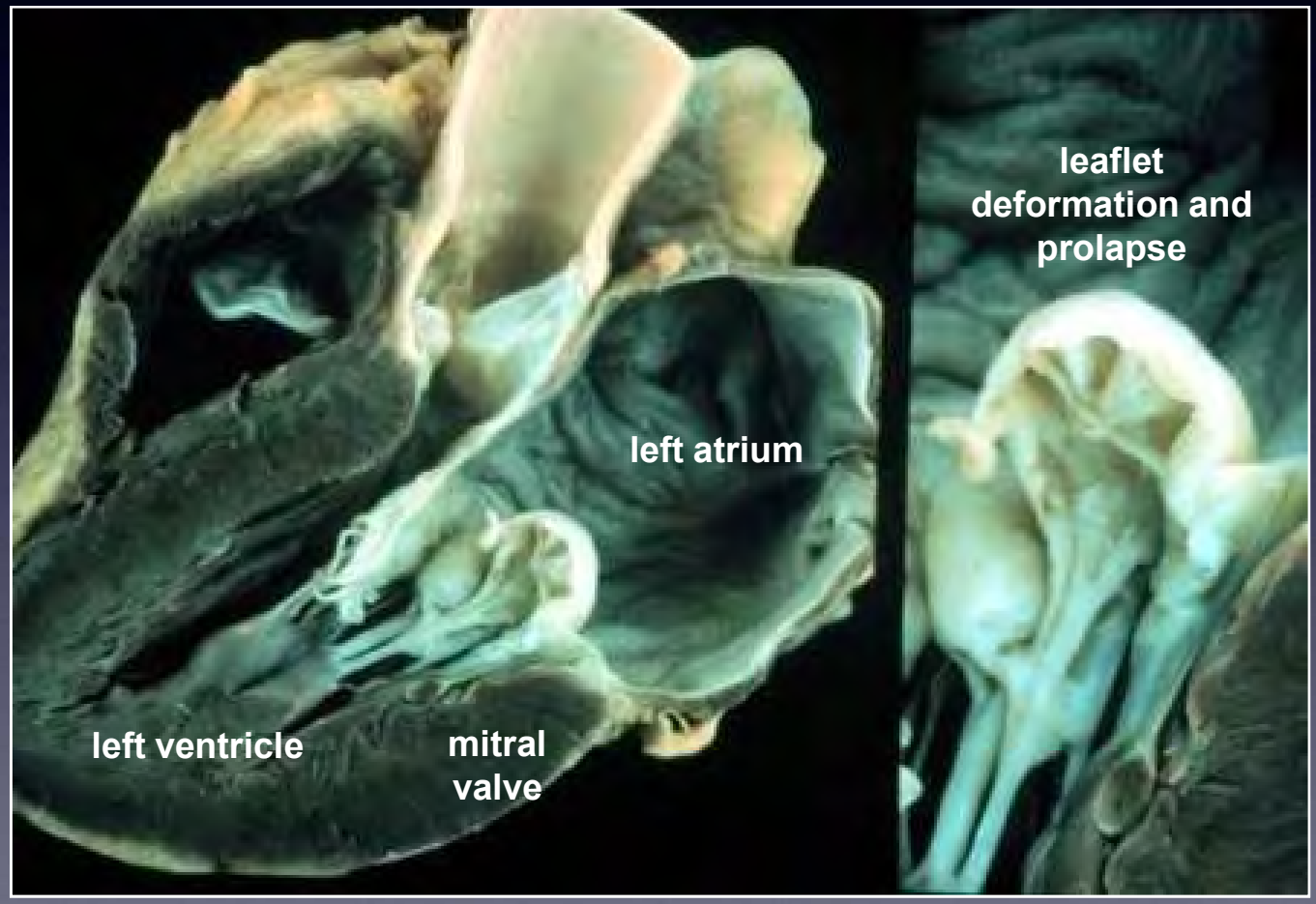
Mechanisms of Recurrent Functional Mitral Regurgitation After Mitral Valve Repair in Nonischemic Dilated Cardiomyopathy. Importance of Distal Anterior Leaflet Tethering

Alex Pui-Wai Lee, Michael Acker, Spencer H. Kubo, Steven F. Bolling, Seung W. Park, Charles J. Bruce and Jae K. Oh

Circulation published online May 4, 2009;
DOI: 10.1161/CIRCULATIONAHA.108.796151
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 0009-7322. Online ISSN: 1524-4539

Young Investigator Award - European Society of Cardiology EuroEcho Meeting 2008
Best Young Investigator - Hong Kong College of Physicians Distinguished Paper Award 2009

Mitral Valve Prolapse



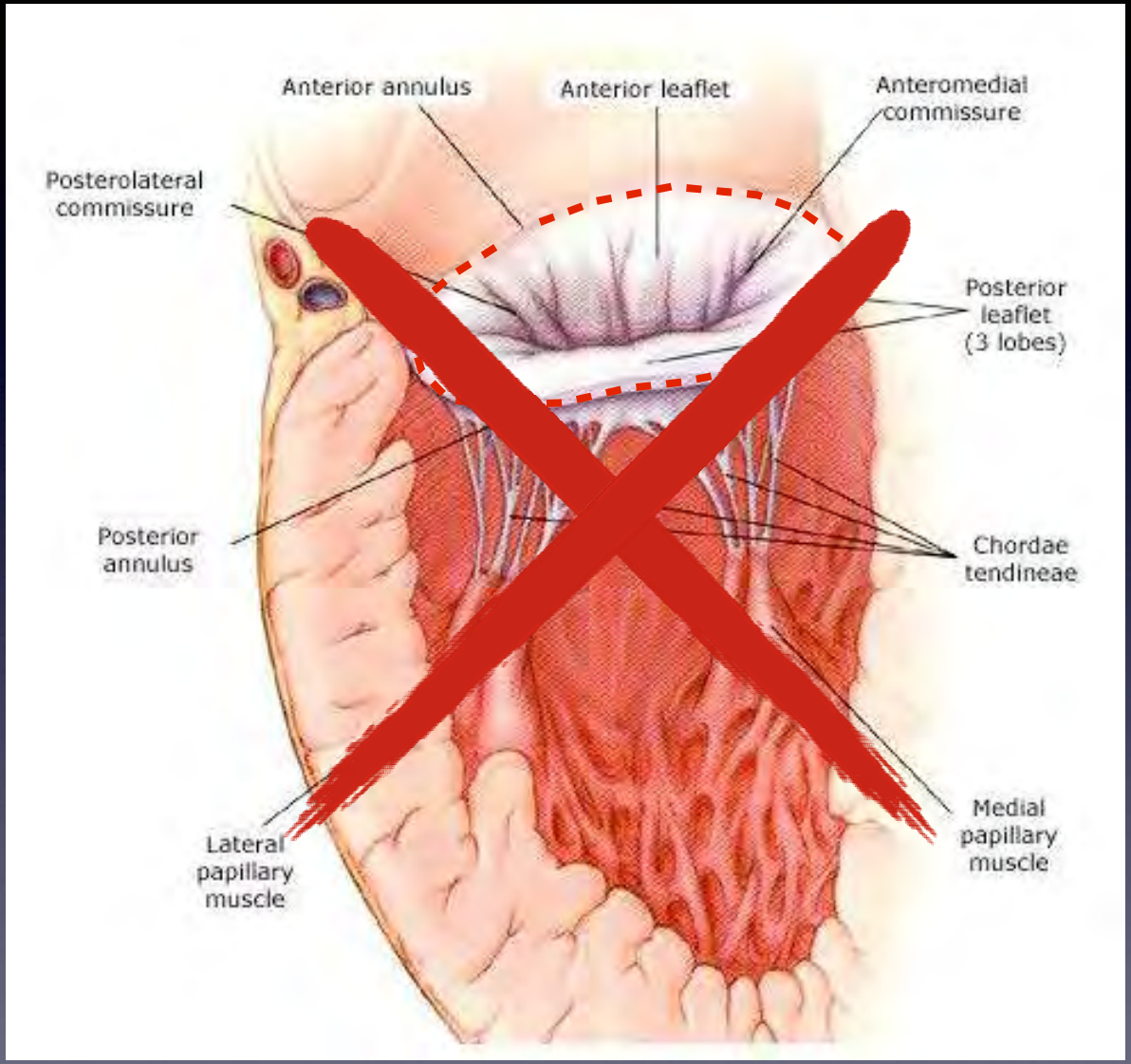
Moderate or severe mitral regurgitation

WHO?
Why?

rgery or die within 10 years

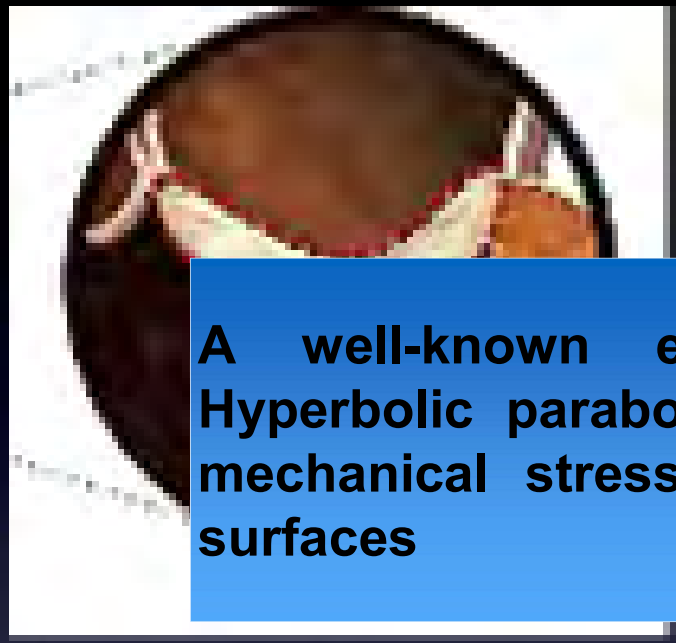
General population

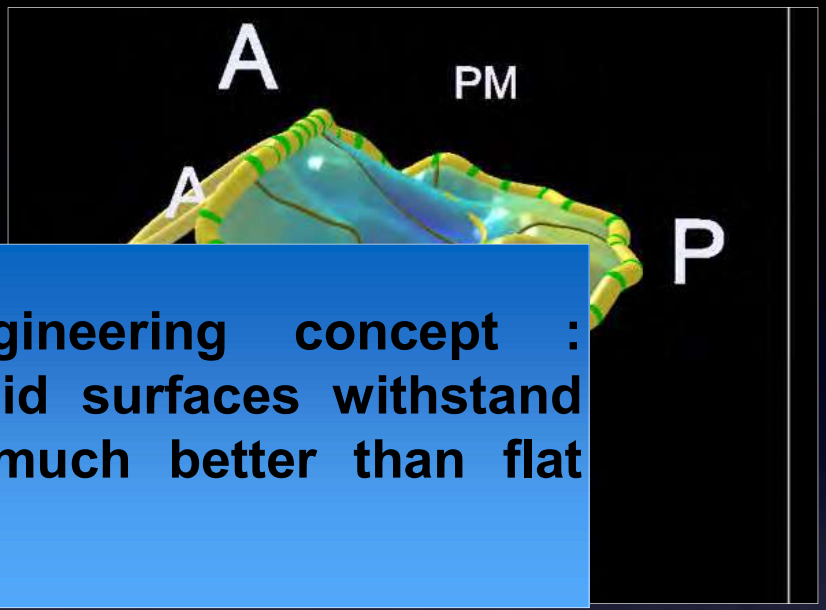
Framingham heart study JACC 2002
N Engl J Med. 1996


Anterior annulus
Anterior leaflet
Anteromedial commissure
Posterolateral commissure
Posterior leaflet (3 lobes)
Posterior annulus
Chordae tendineae
Lateral papillary muscle
Medial papillary muscle

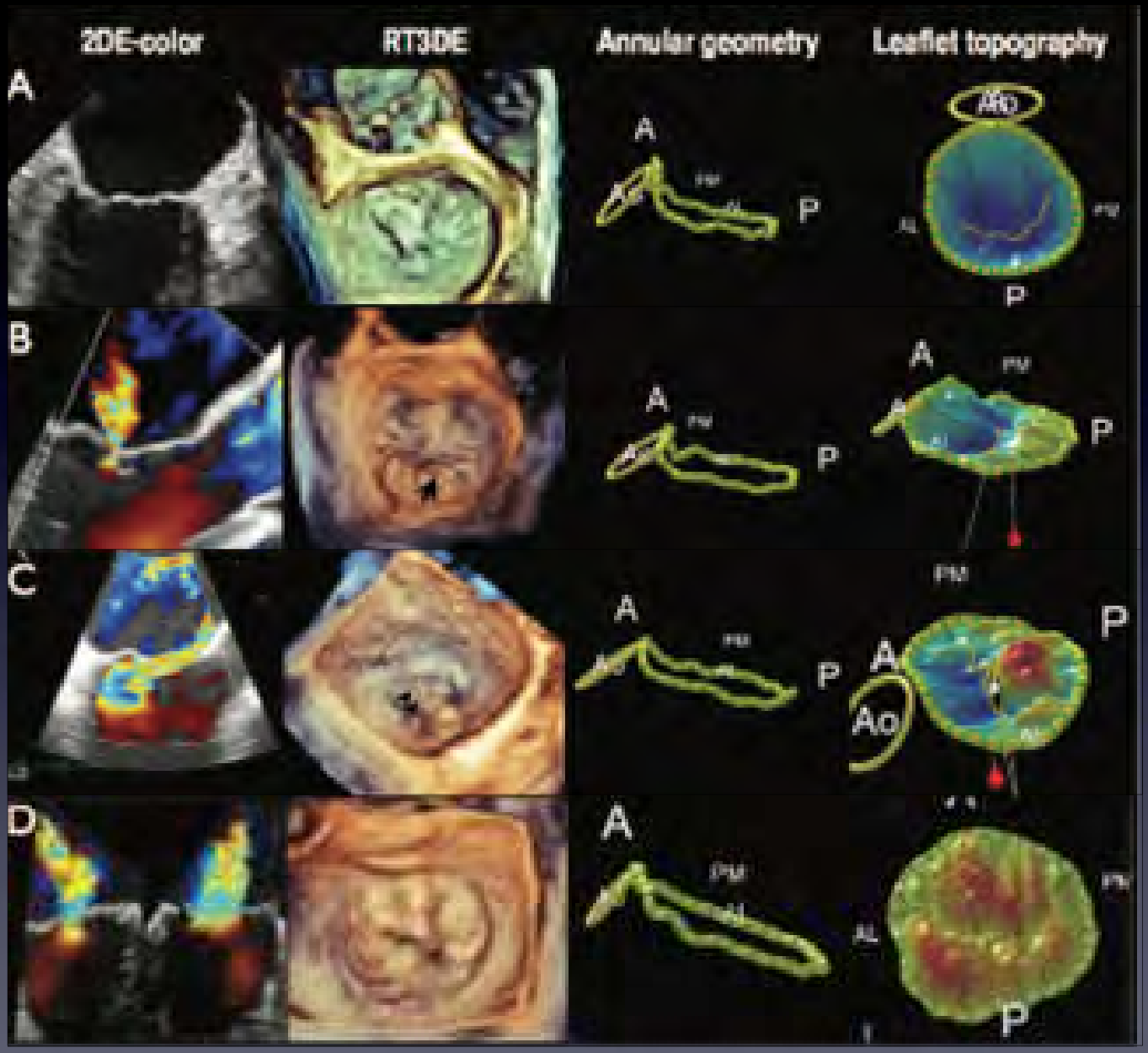
Traditional 2D echo can only see 2 points of the annulus on one plane

Real-time 3-dimensional Echocardiography of the Mitral Valve



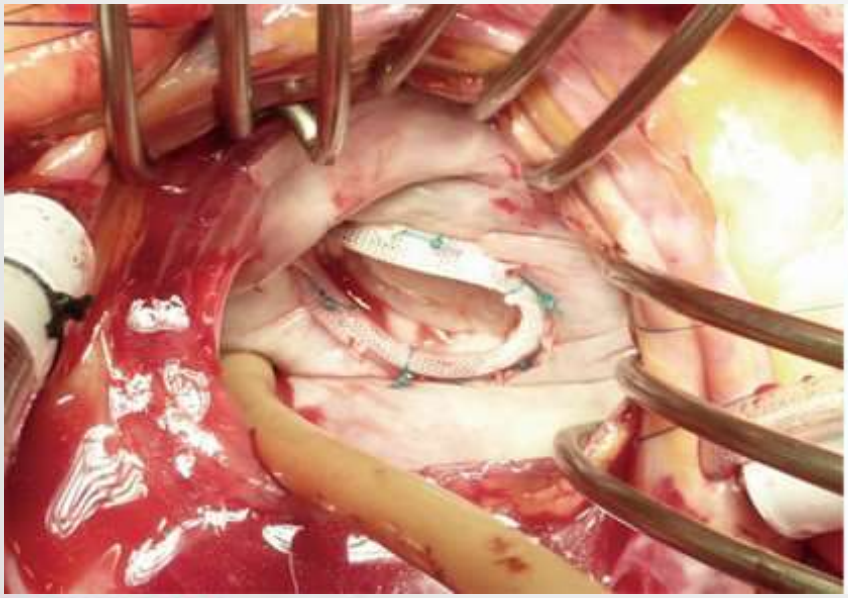


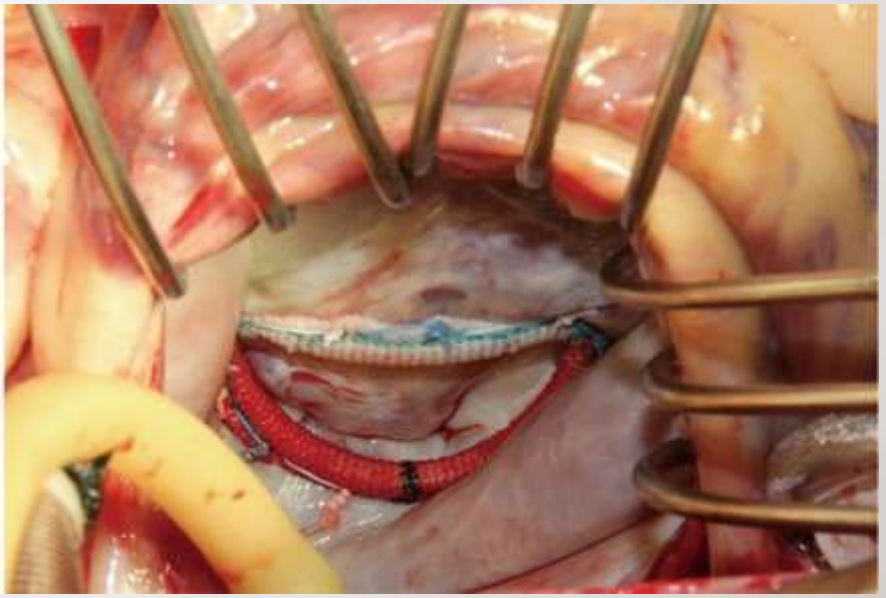
A well-known engineering concept : Hyperbolic paraboloid surfaces withstand mechanical stress much better than flat surfaces



Lee, A. P., et al. (2013). "Quantitative analysis of mitral valve morphology in mitral valve prolapse with real-time 3-dimensional echocardiography: importance of annular saddle sh

A saddle-shaped annuloplasty ring





香港中文大學醫學院
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Circulation

American Heart Association.

Quantitative Analysis of Mitral Valve Morphology in Mitral Valve Prolapse With Real-Time 3-Dimensional Echocardiography : Importance of Annular Saddle Shape in the Pathogenesis of Mitral Regurgitation

Alex Pui-Wai Lee, Ming C. Hsiung, Ivan S. Salgo, Fang Fang, Jun-Min Xie, Yan-Chao Zhang, Qing-Shan Lin, Jen-Li Looi, Song Wan, Randolph H.L. Wong, Malcolm J. Underwood, Jing-Ping Sun, Wei-Hsian Yin, Jeng Wei, Shen-Kou Tsai and Cheuk-Man Yu

Circulation. 2013;127:832-841; originally published online December 24, 2012;
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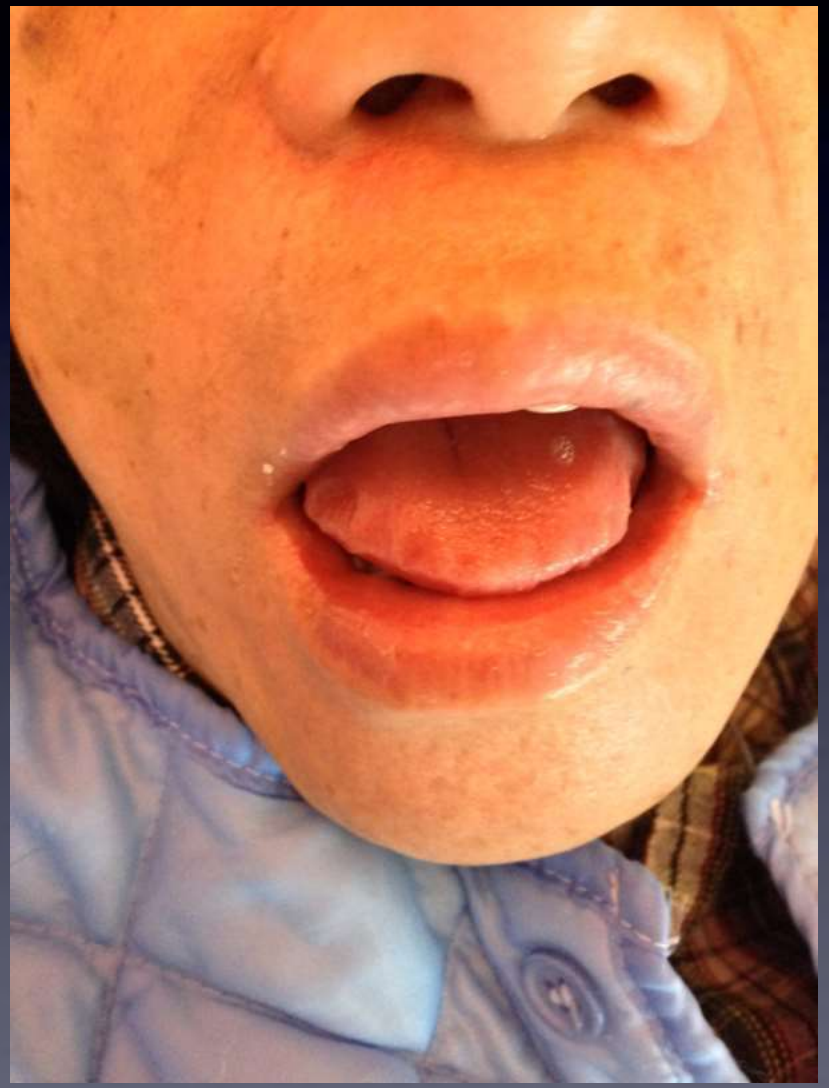
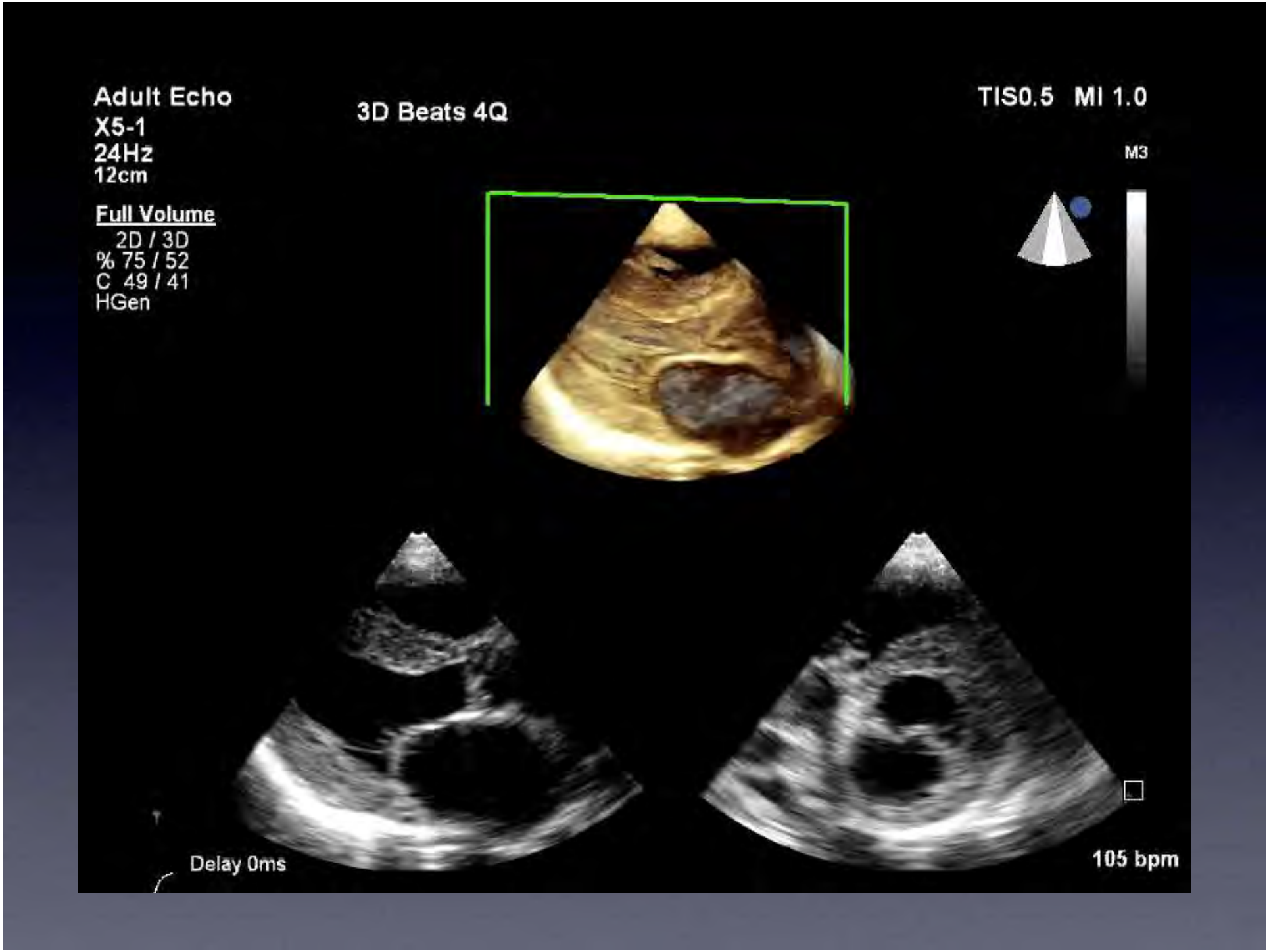
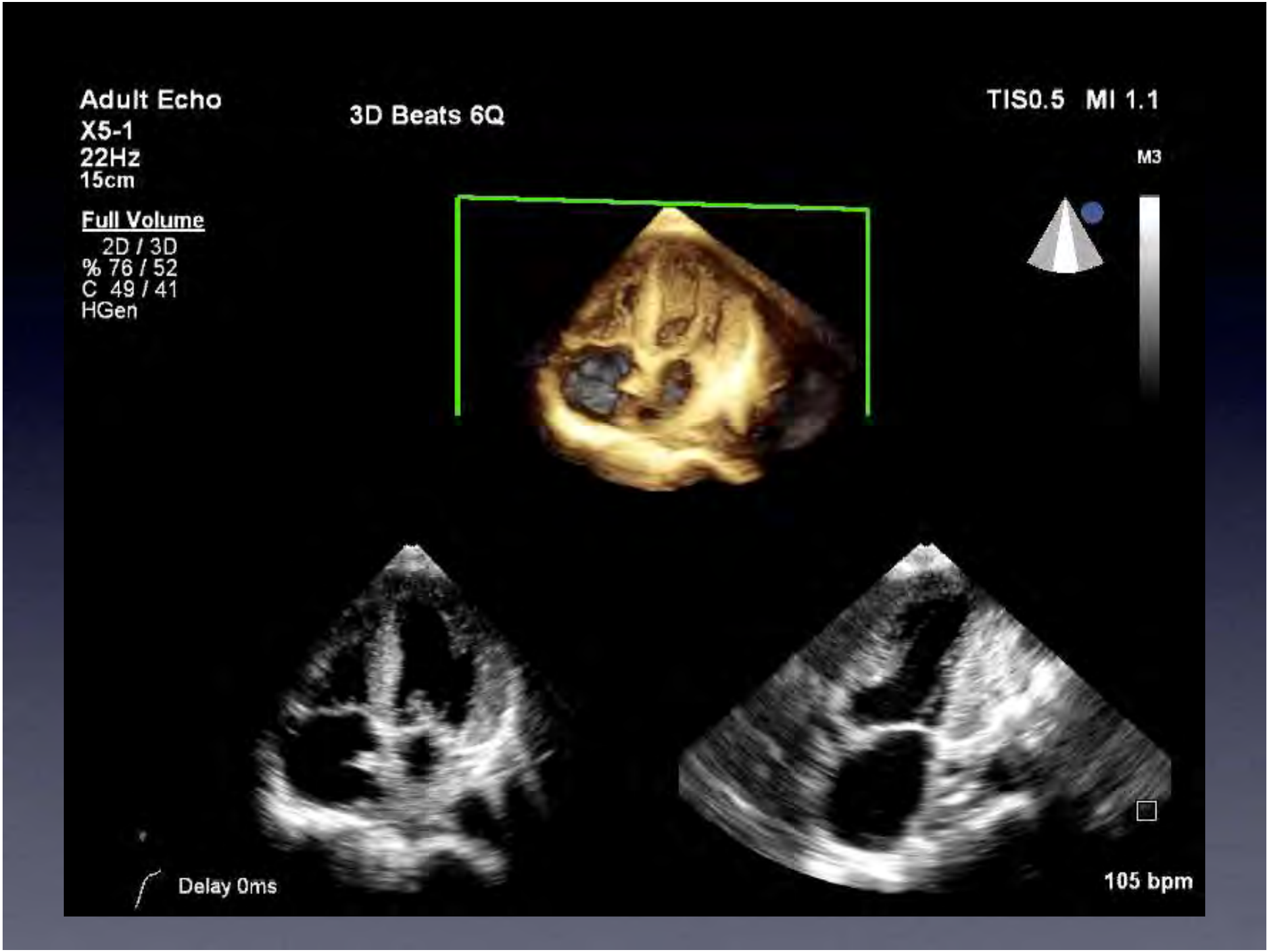
Case 4:
F/59
symptomatic AF
recurrent syncope
underwent AF ablation
recurrent syncope after ablation




Adult Echo
X5-1
24Hz
12cm
Full Volume
2D / 3D
% 75 / 52
C 49 / 41
HGen
3D Beats 4Q
TIS0.5 MI 1.0
M3
Delay 0ms
105 bpm


Adult Echo
X5-1
22Hz
15cm
Full Volume
2D / 3D
% 76 / 52
C 49 / 41
HGen
3D Beats 6Q
TIS0.5 MI 1.1
M3
Delay 0ms
105 bpm

Outside Prince of Wales Hospital

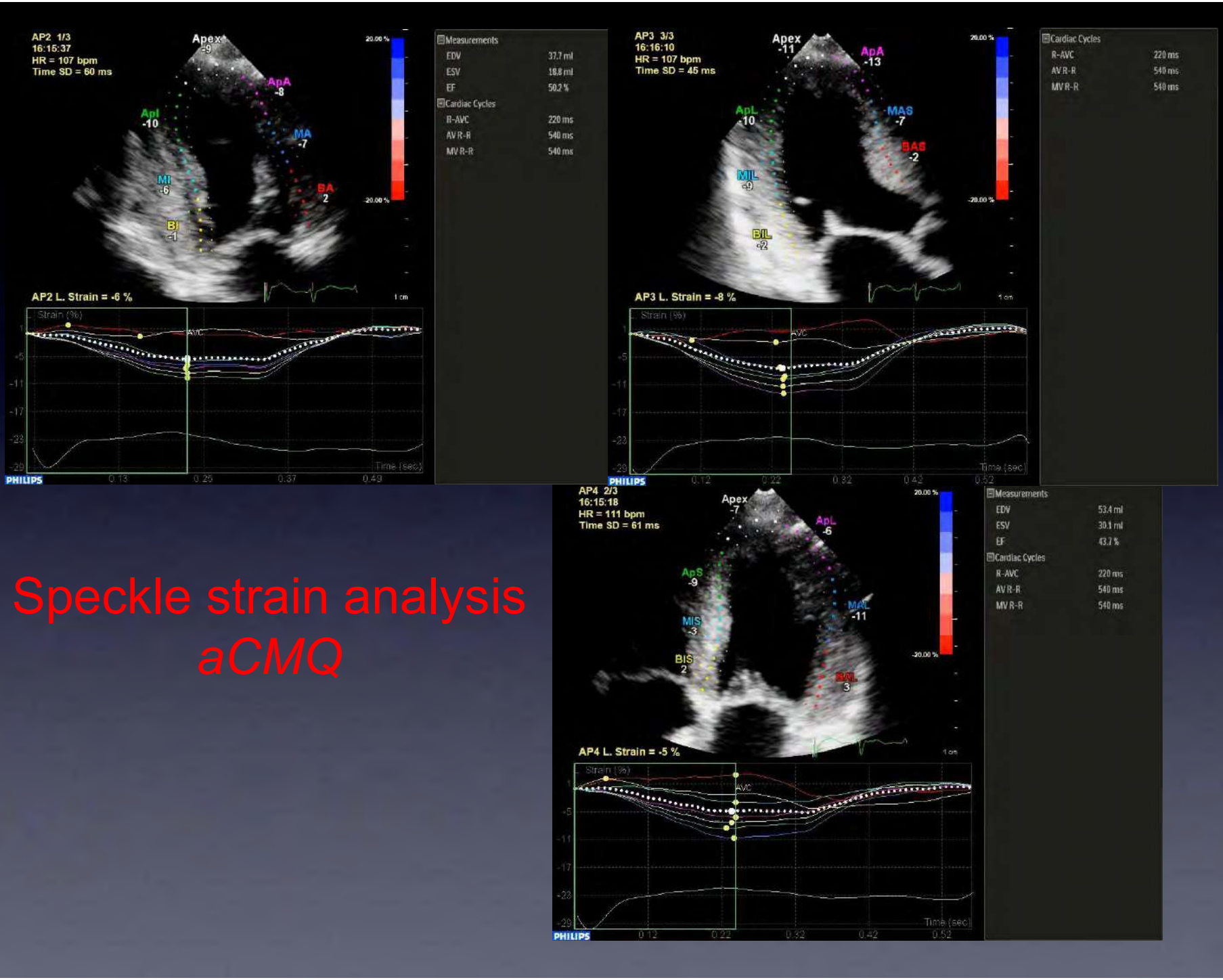
- Echo report: severe concentric LVH
- AF ablation was offered and performed
- Recurrent syncope
- Holter: ventricular flutter, AF

What would you do?

1. Repeat AF ablation
2. Antiarrhythmic drugs
3. Bone marrow biopsy

Bone Marrow Biopsy at PWH

- Plasma cell dyscrasia
- Urine analysis: Bence-Jones protein
- Dx: **AL amyloidosis**
- Diuretics
- Standard chemotherapy
- Bortezomib injection
- Anticoagulation
- May be too late for bone marrow/heart transplant…..

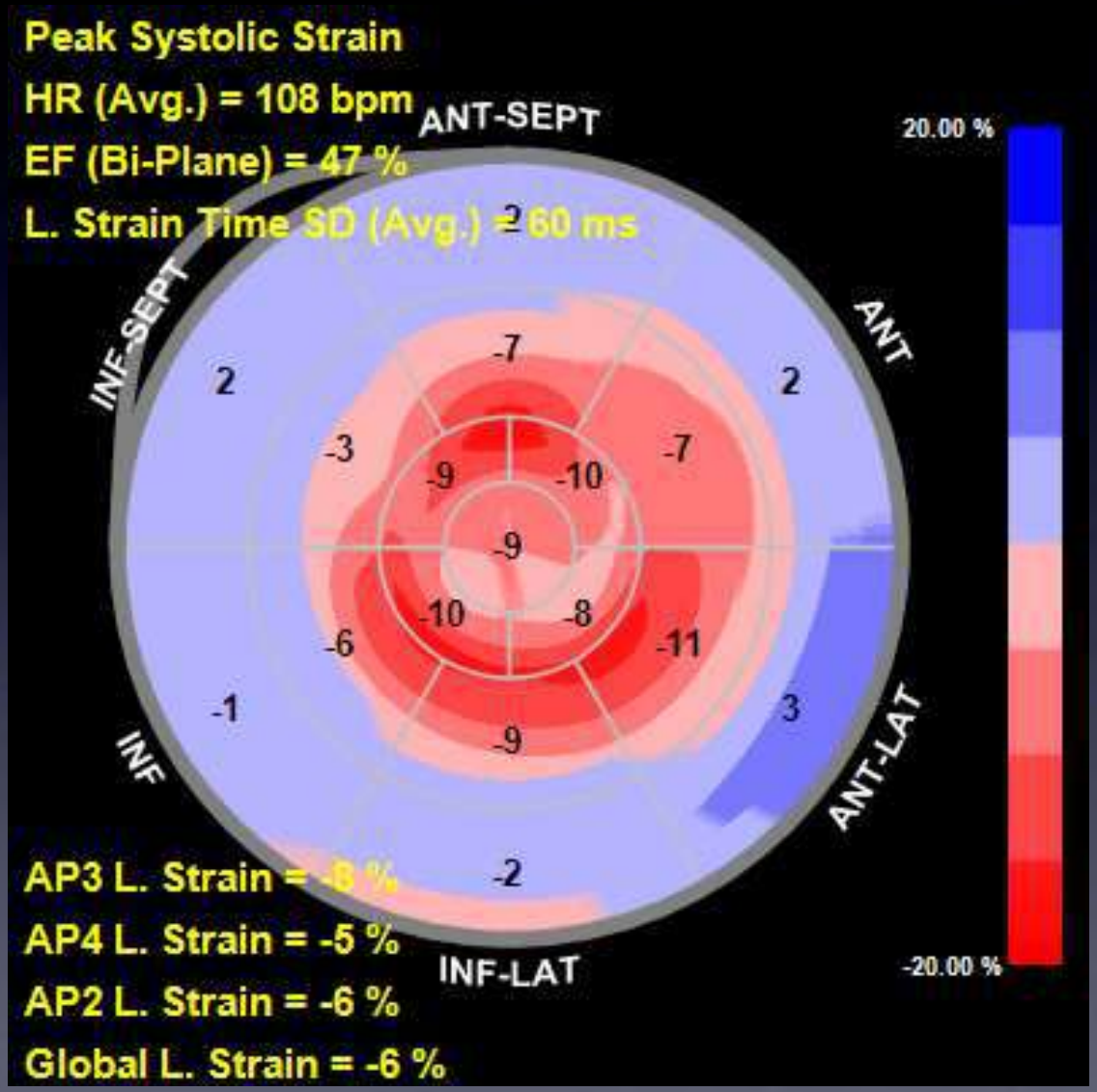


Speckle strain analysis

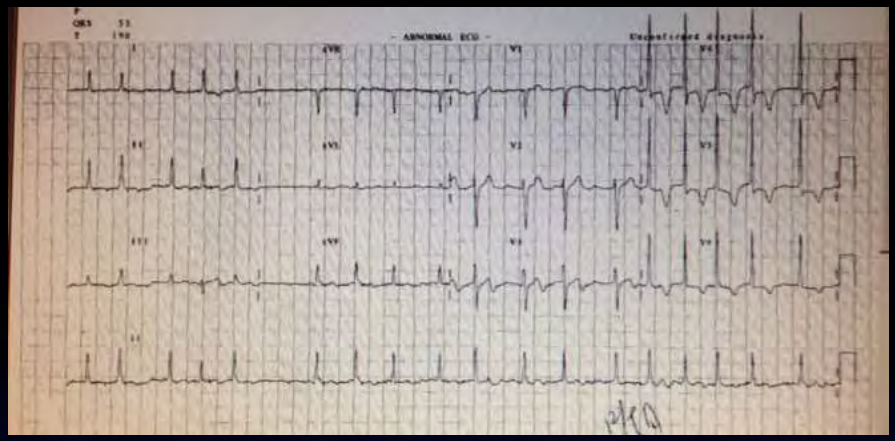
aCMQ

Speckle strain analysis

Bull's eye: relative apical sparing



Case 6-2
M/67
New onset AF
Hypertension
No history of stroke/DM/CHF



What is your anticoagulation option?

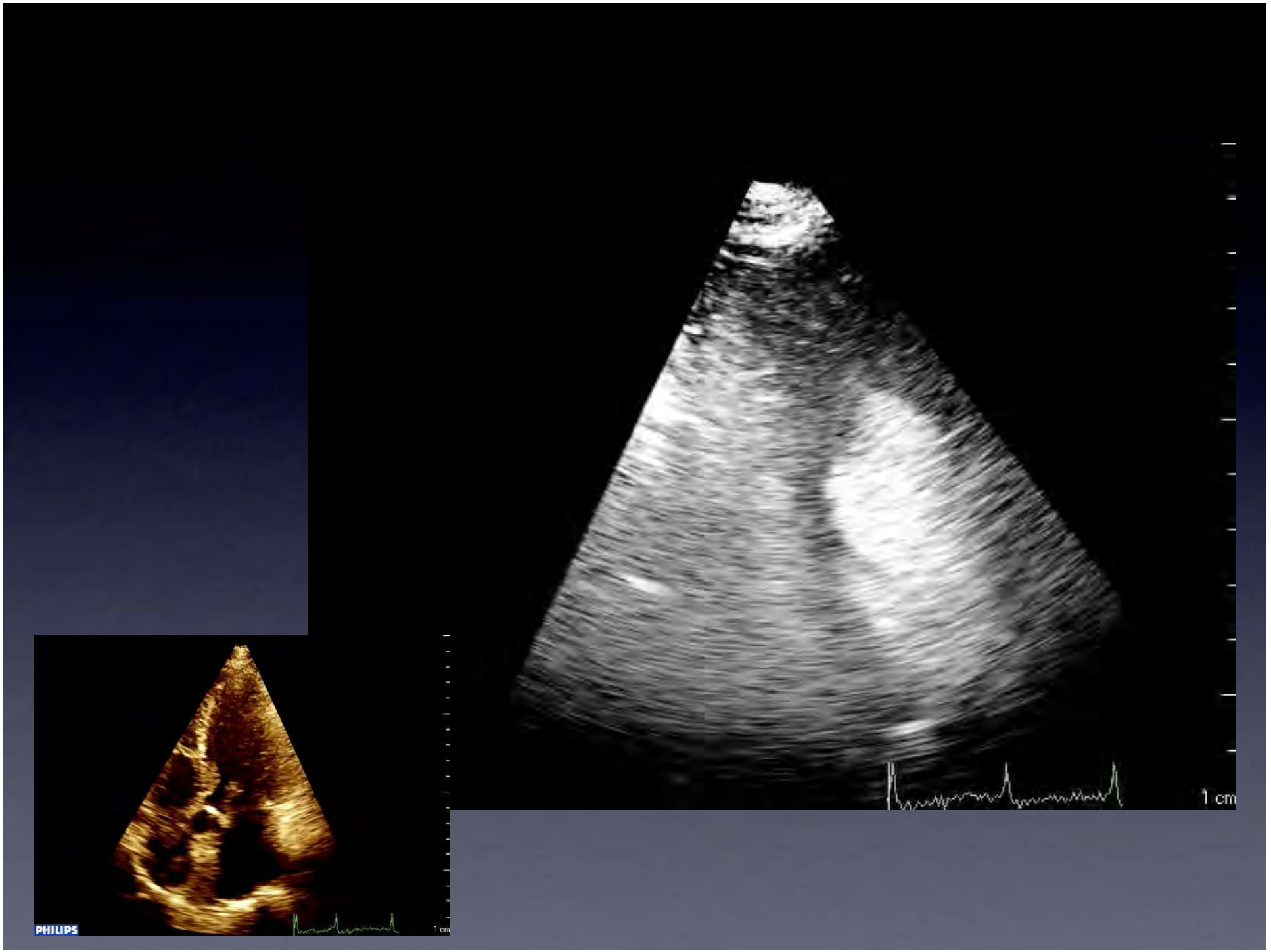
1. Nothing
2. Aspirin or warfarin
3. Warfarin
4. New oral anticoagulant

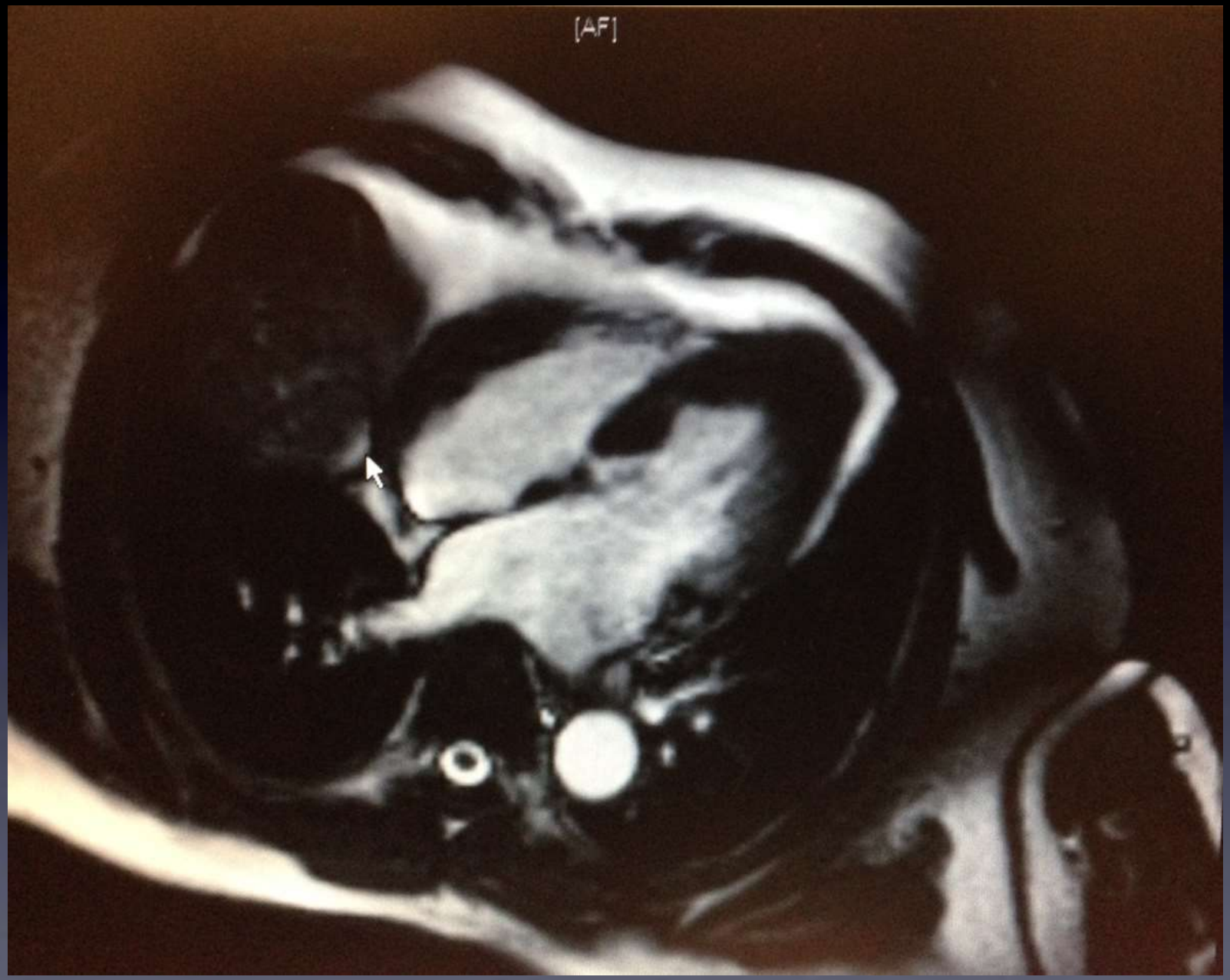
Initial Management

- Offered aspirin or warfarin
- Patient opt for aspirin
- Patient could not afford NOAC and did not want to take warfarin
- Betaloc for AF rate control

In the subsequent 6 months

- 2 strokes with fair recovery
- Ischemic bowel with resection


PHILIPS
1 cm
1 cm

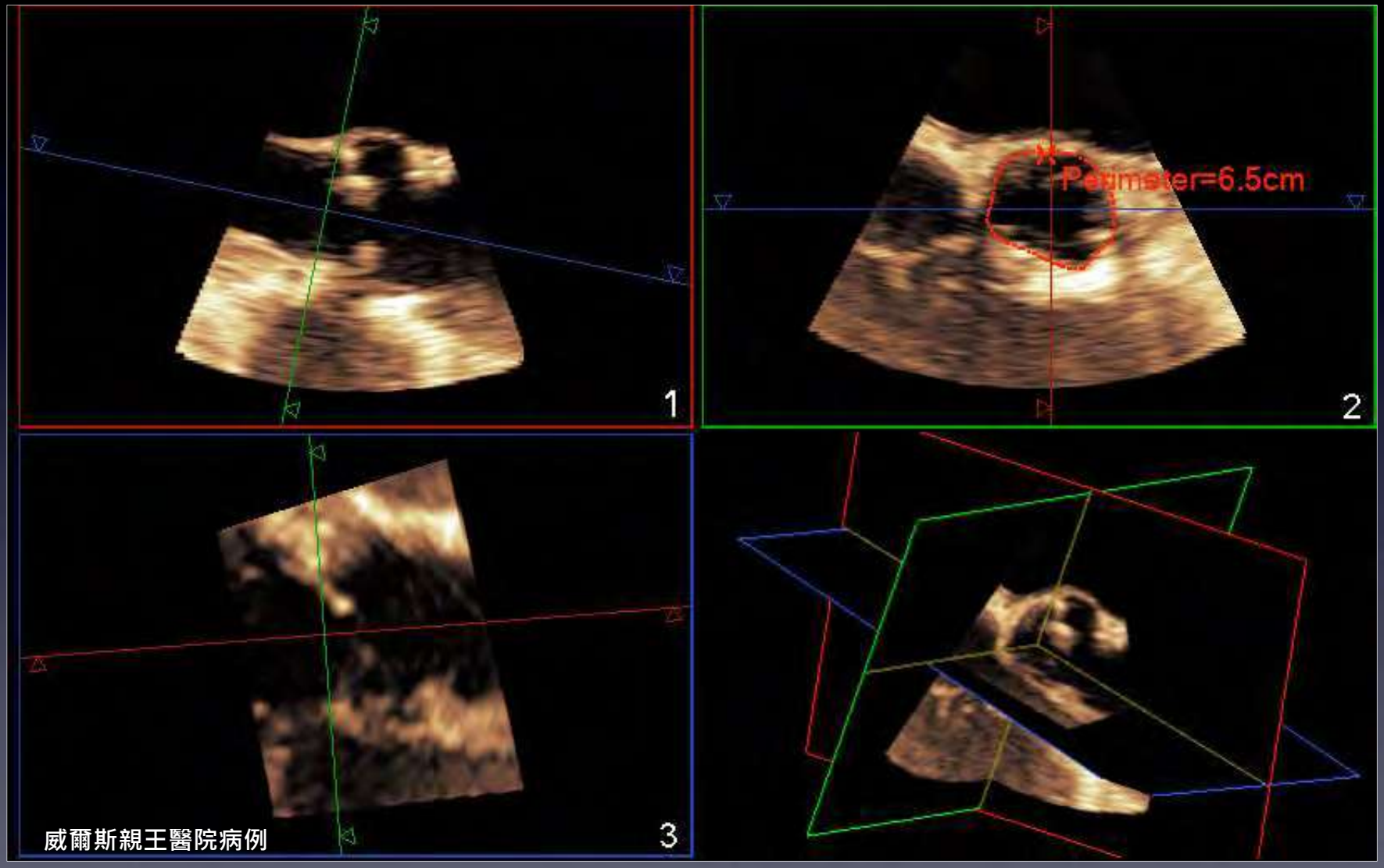

[AF]

Interventional echocardiography
介入性治療心脏超声

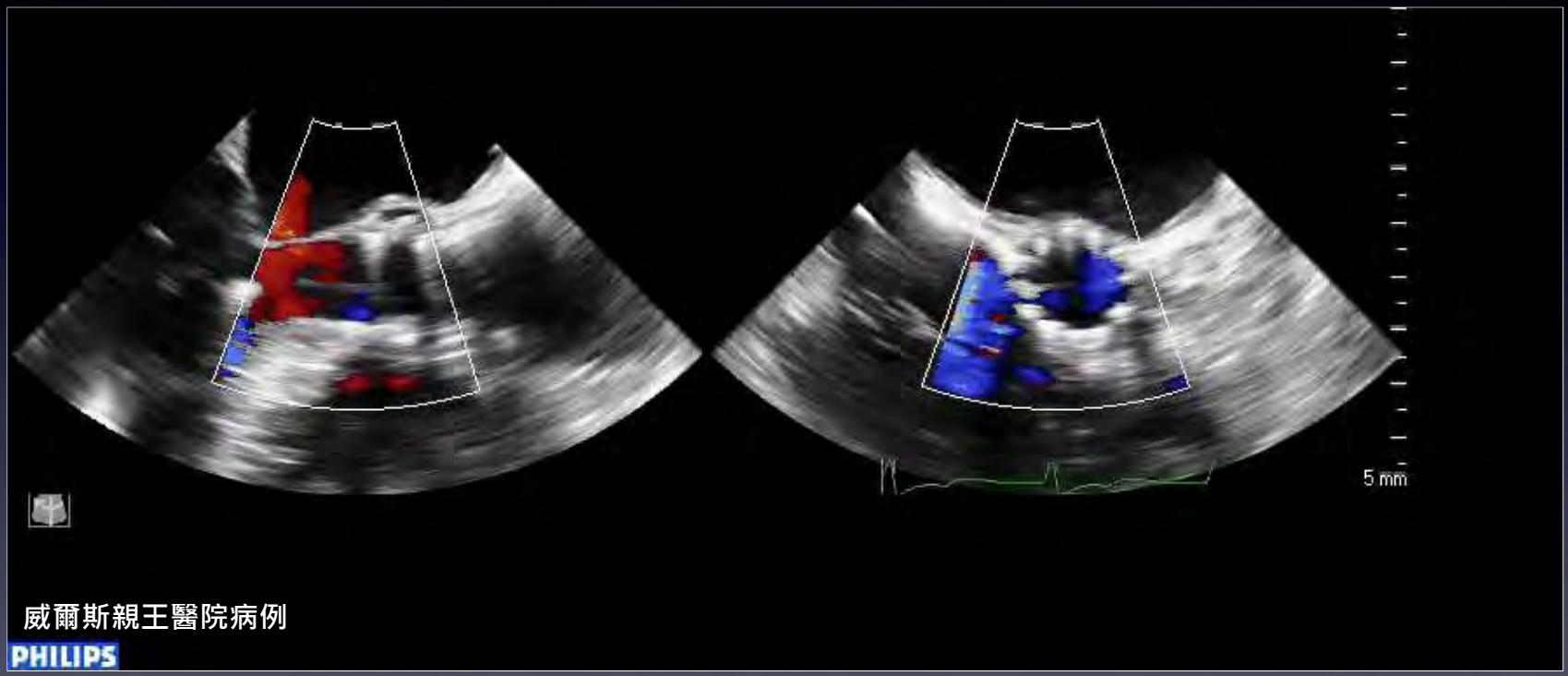
- 经导管主动脉瓣置换术 (TAVI)
- 经导管左心耳封堵术 (LAAO)
- 经导管二尖瓣修复 (MitraClip)
- 经导管心房缺損ASD闭塞术
- 经导管心室缺損VSD闭塞术
- 经导管瓣周漏封堵

经导管主动脉瓣置换术 (TAVI)

3D TEE 決定人工主动脉瓣的大小

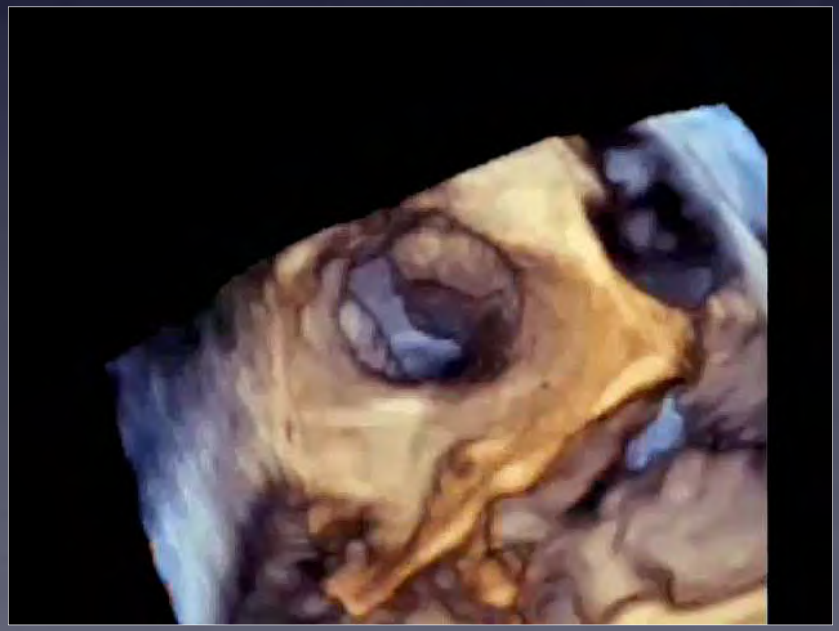


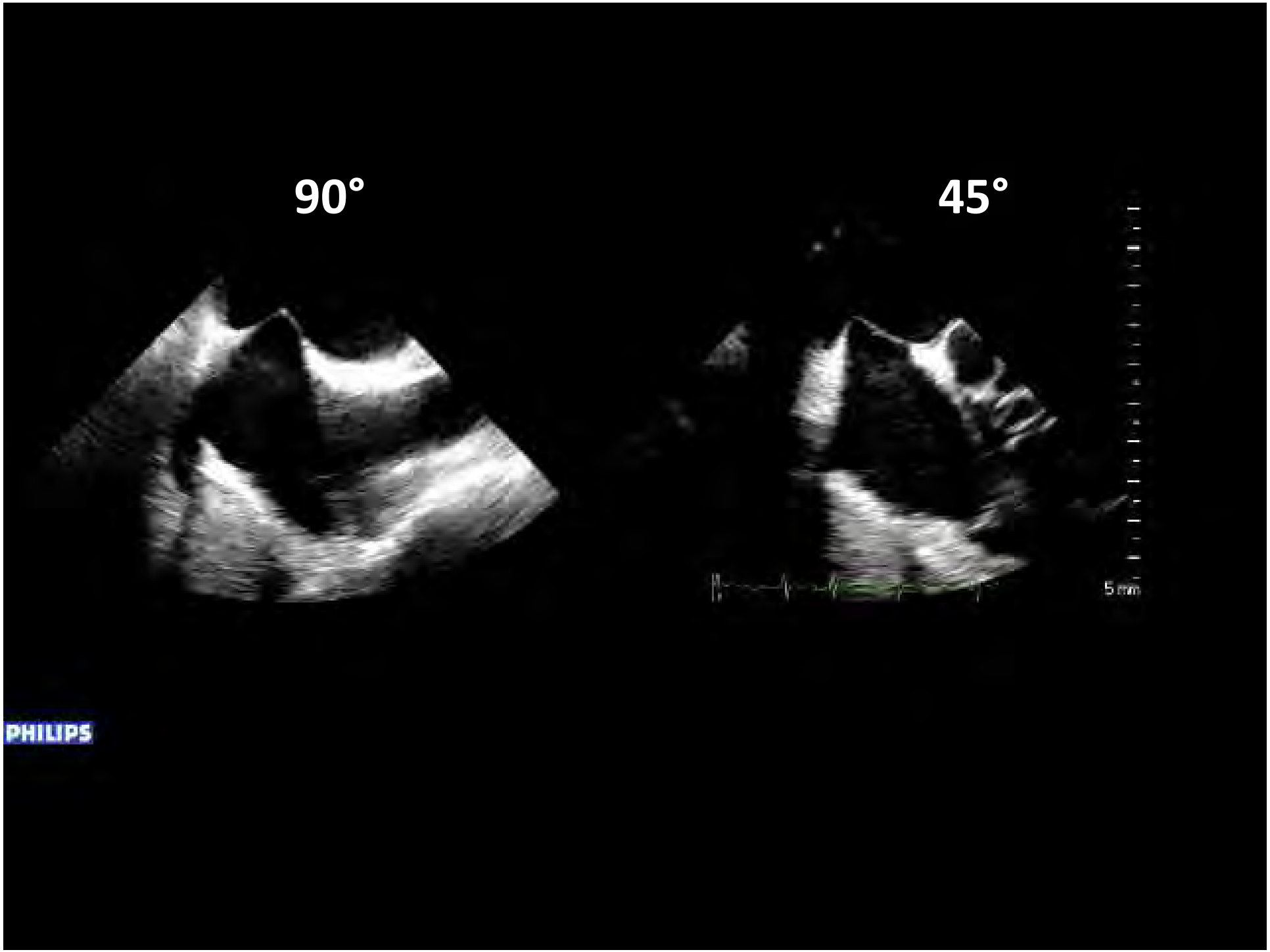
評估TAVR的成功
位置適中 沒有返流



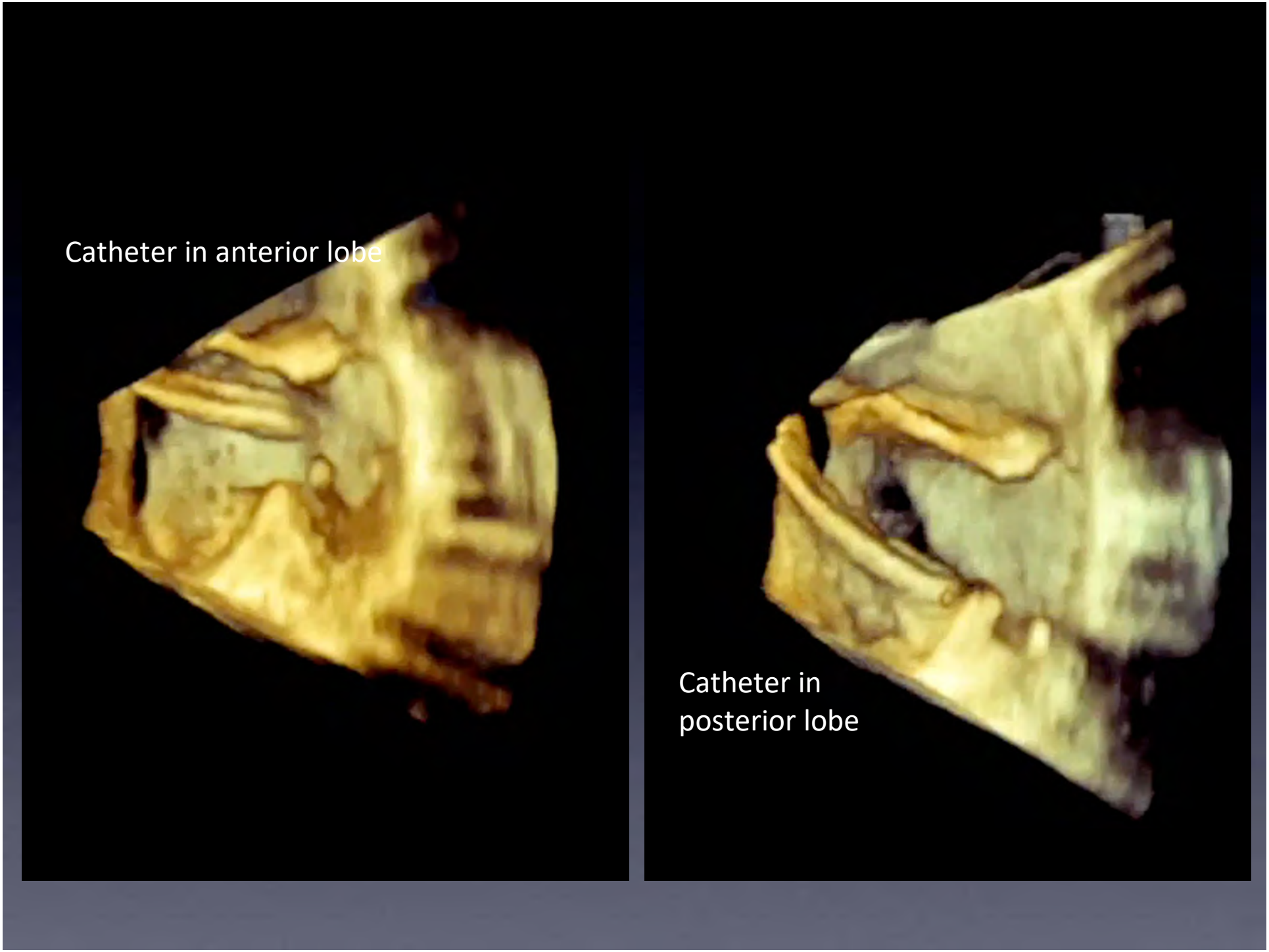
经导管左心耳闭塞 (LAAO)

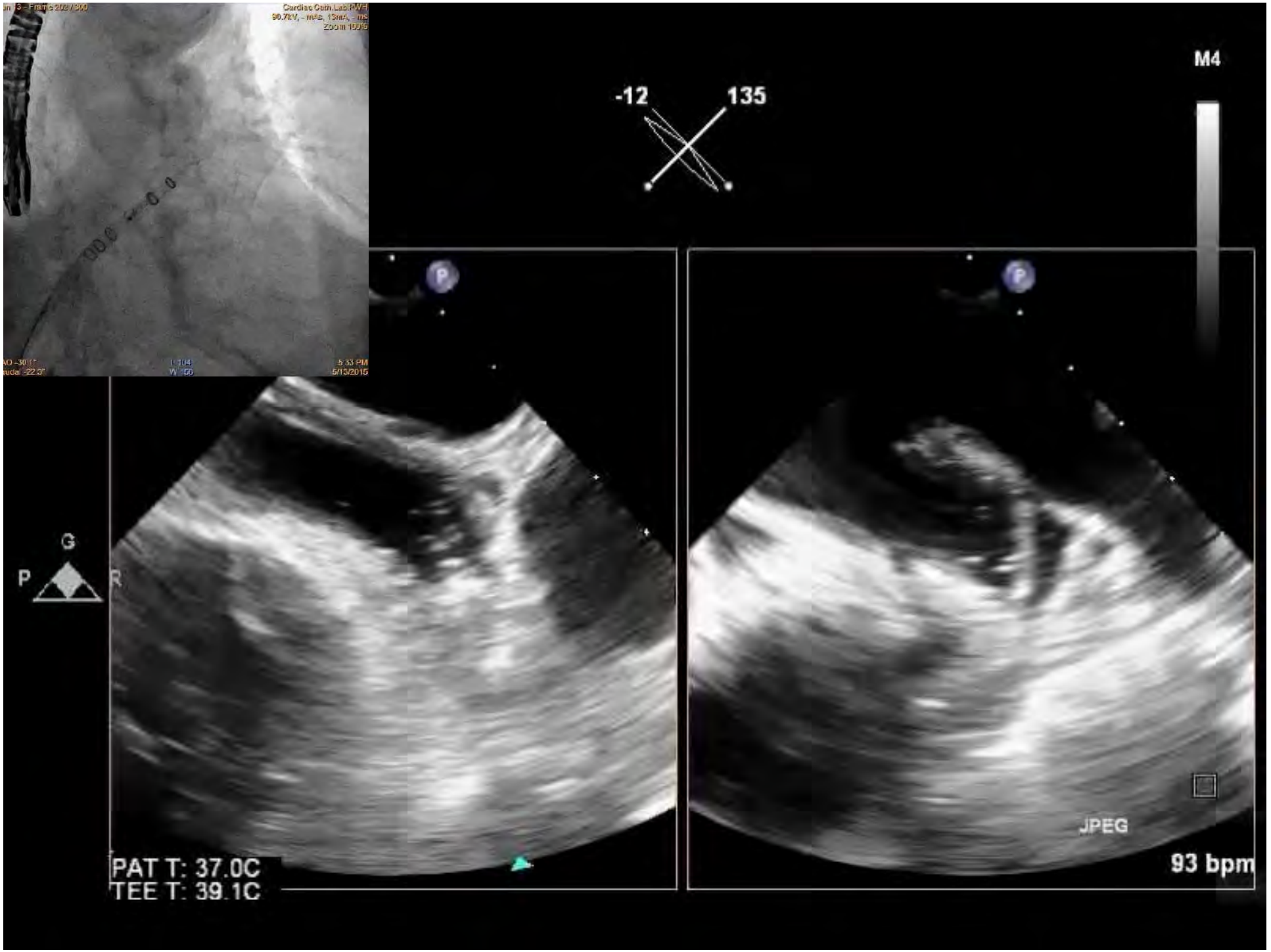
LAA thrombus

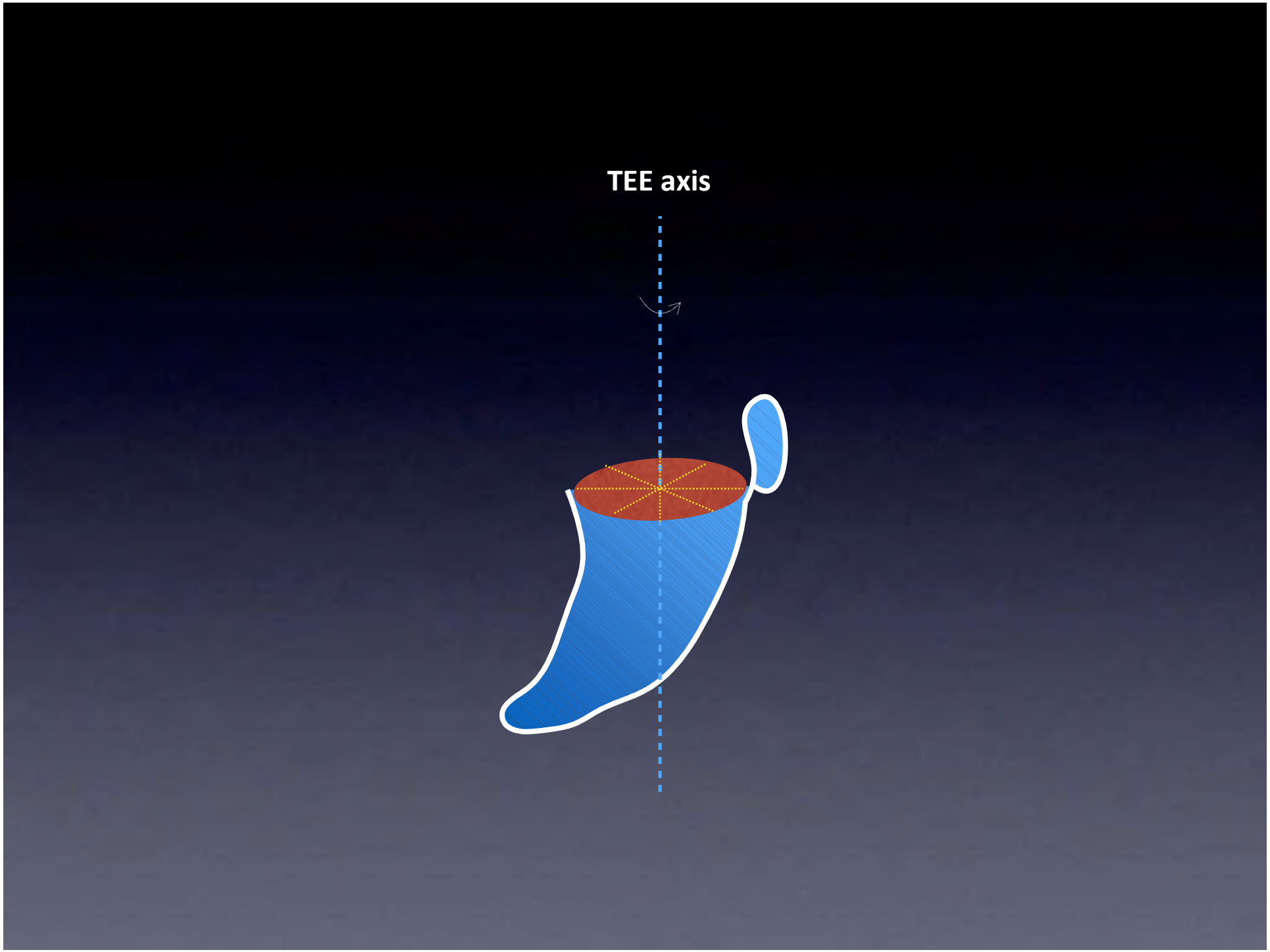


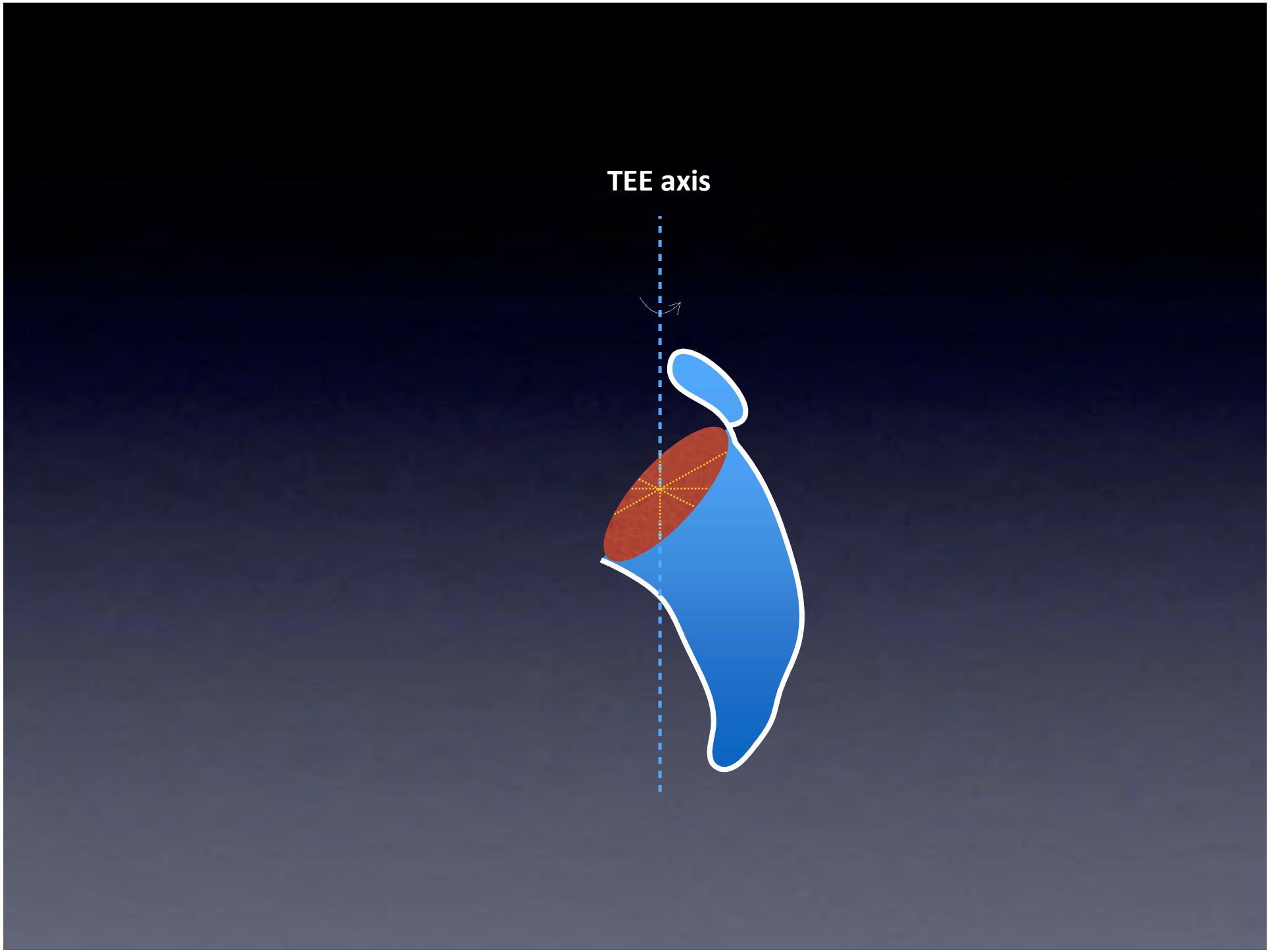

90°
45°
5 mm
PHILIPS

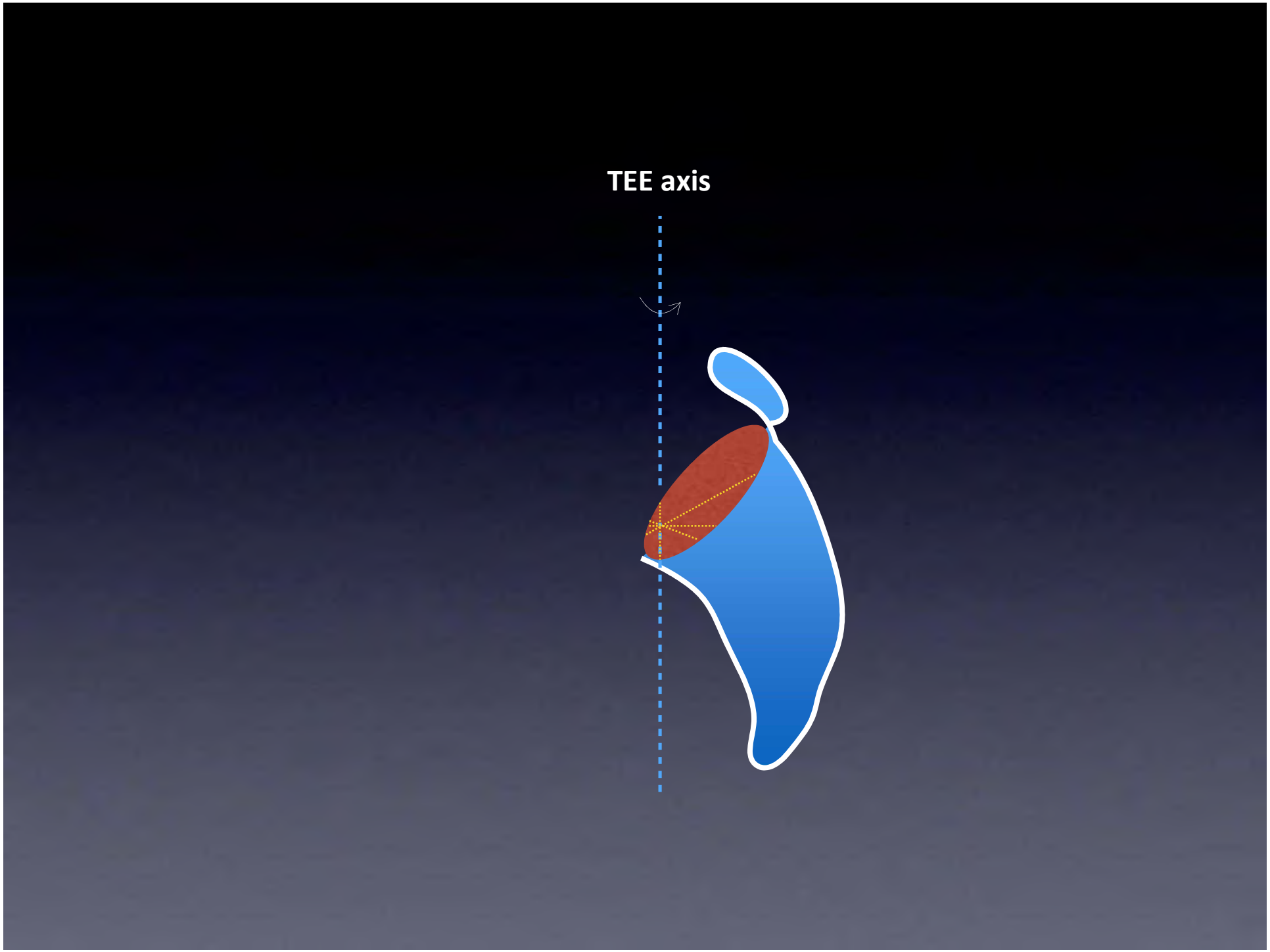

LUPV
LAA
PHILIPS


Catheter in anterior lobe
Catheter in posterior lobe


-12
135
M4
G
P
R
PAT T: 37.0C
TEE T: 39.1C
JPEG
93 bpm


TEE axis

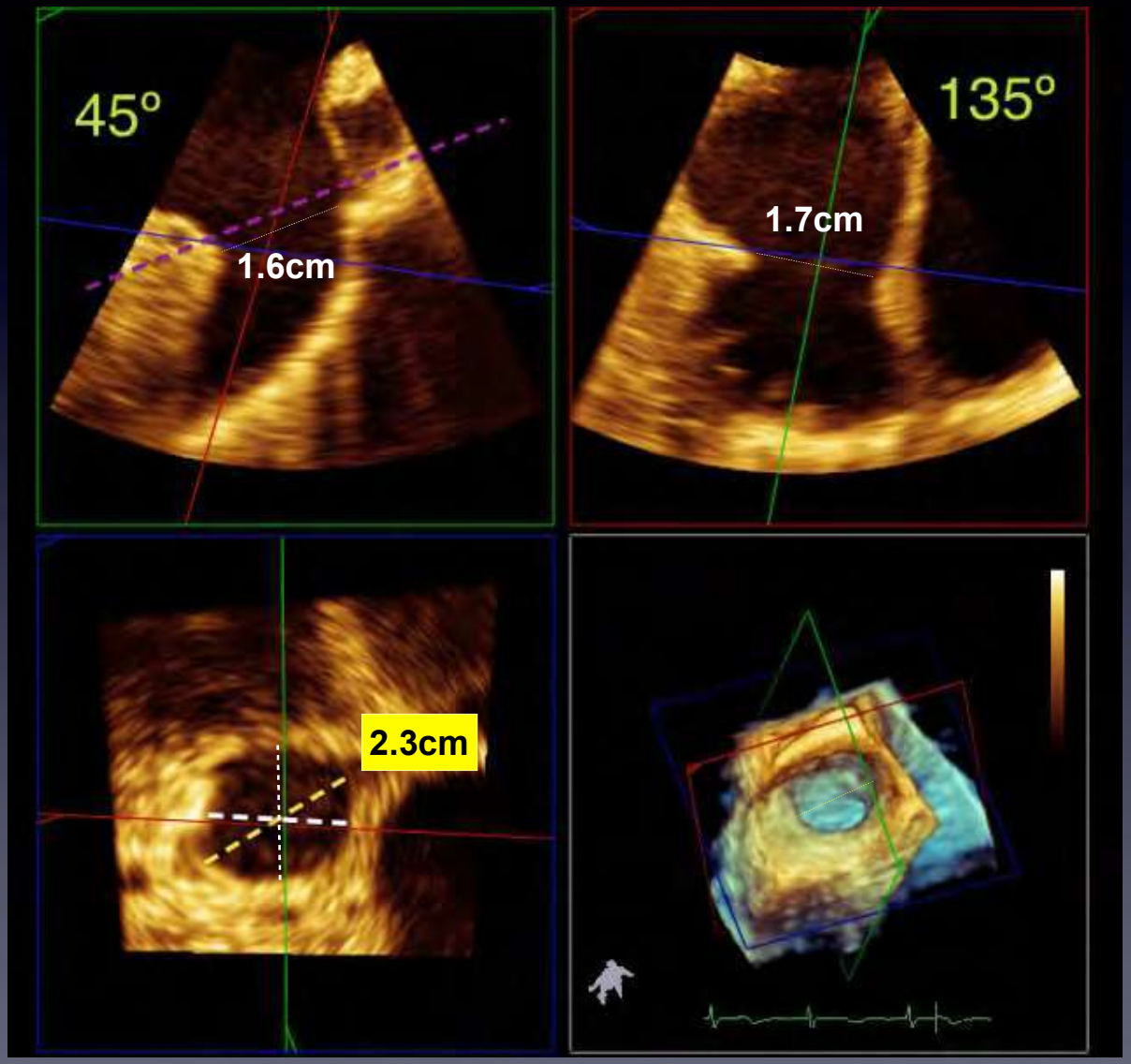

TEE axis

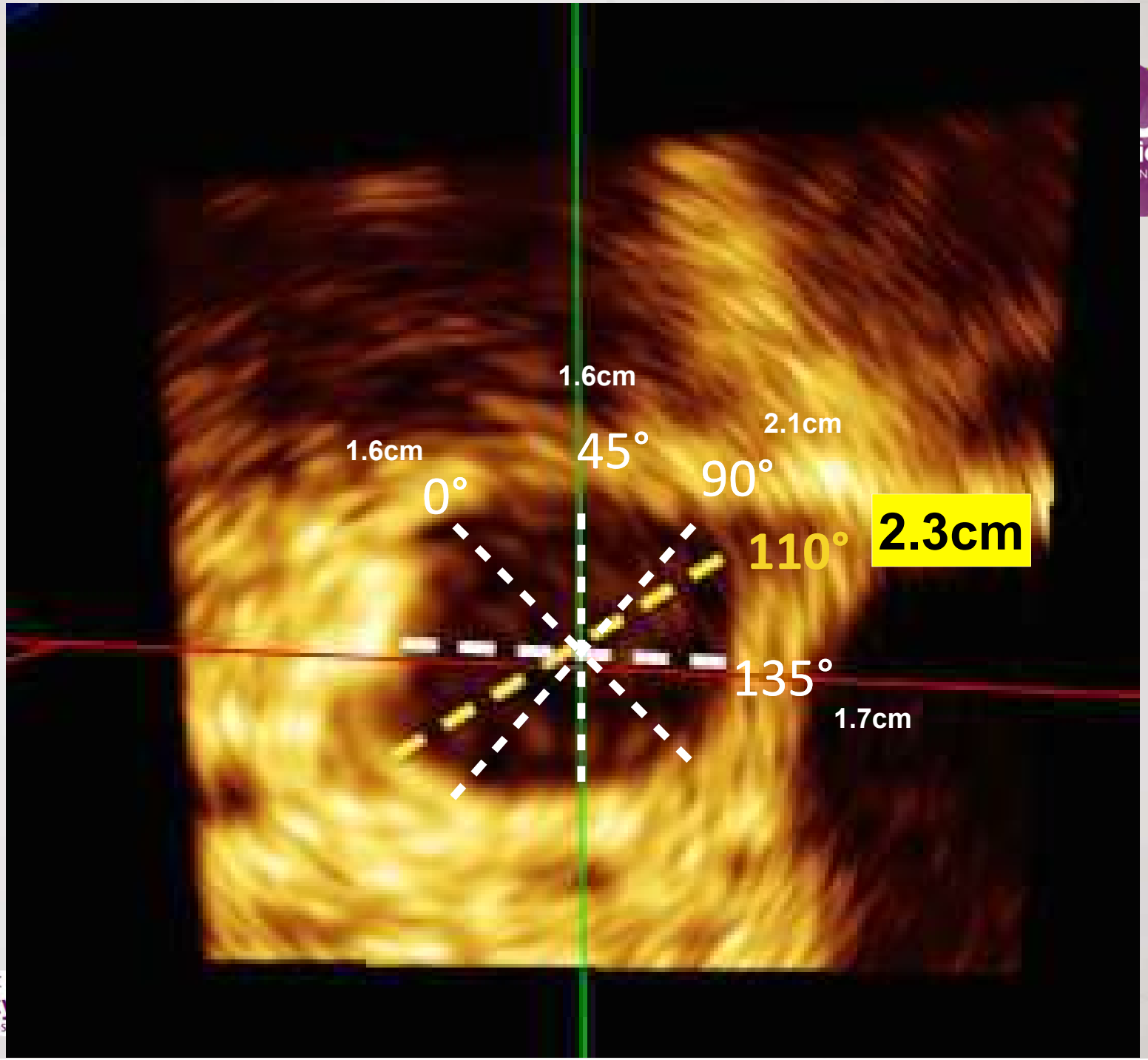

TEE axis

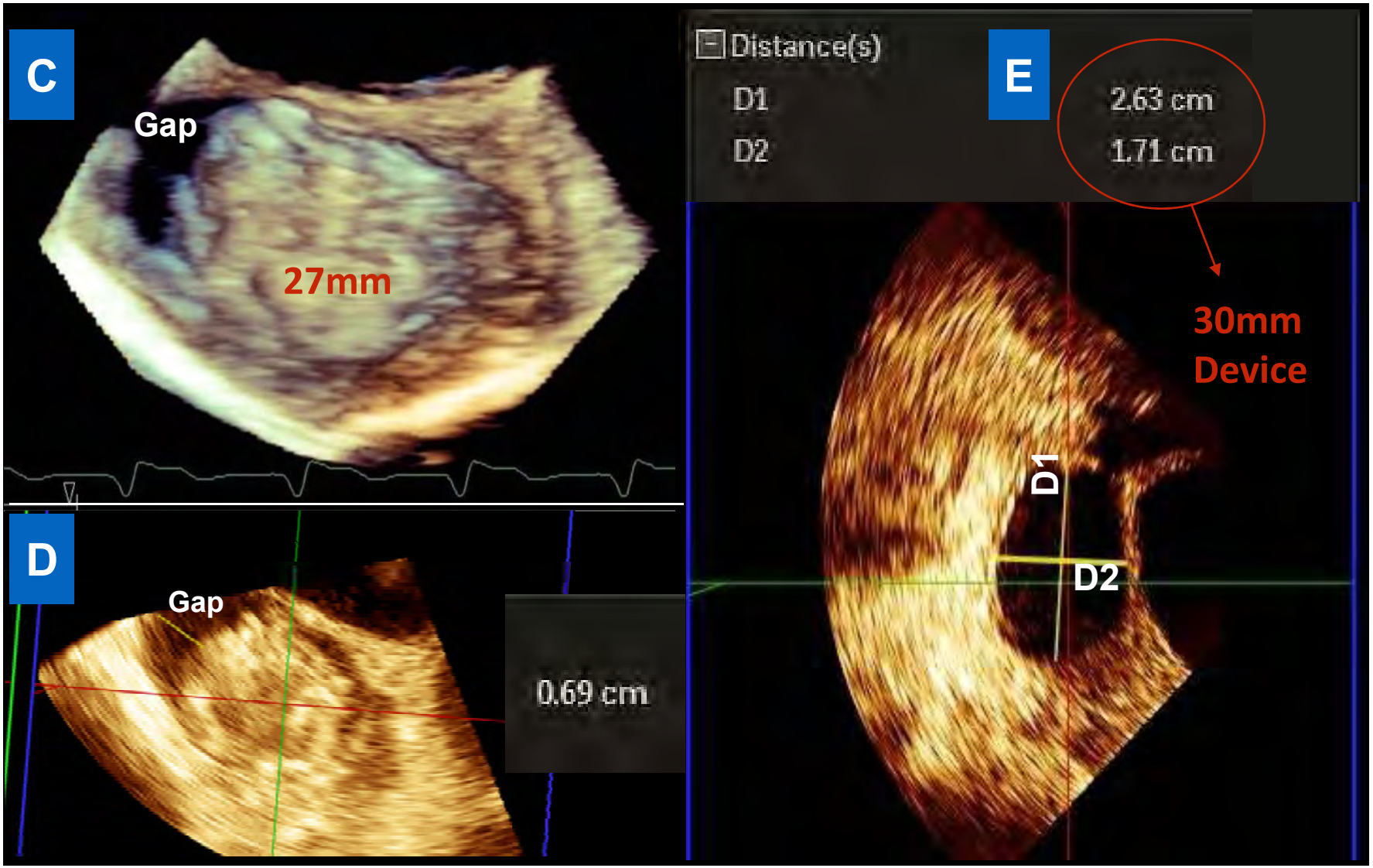
3DTEE for Device Sizing

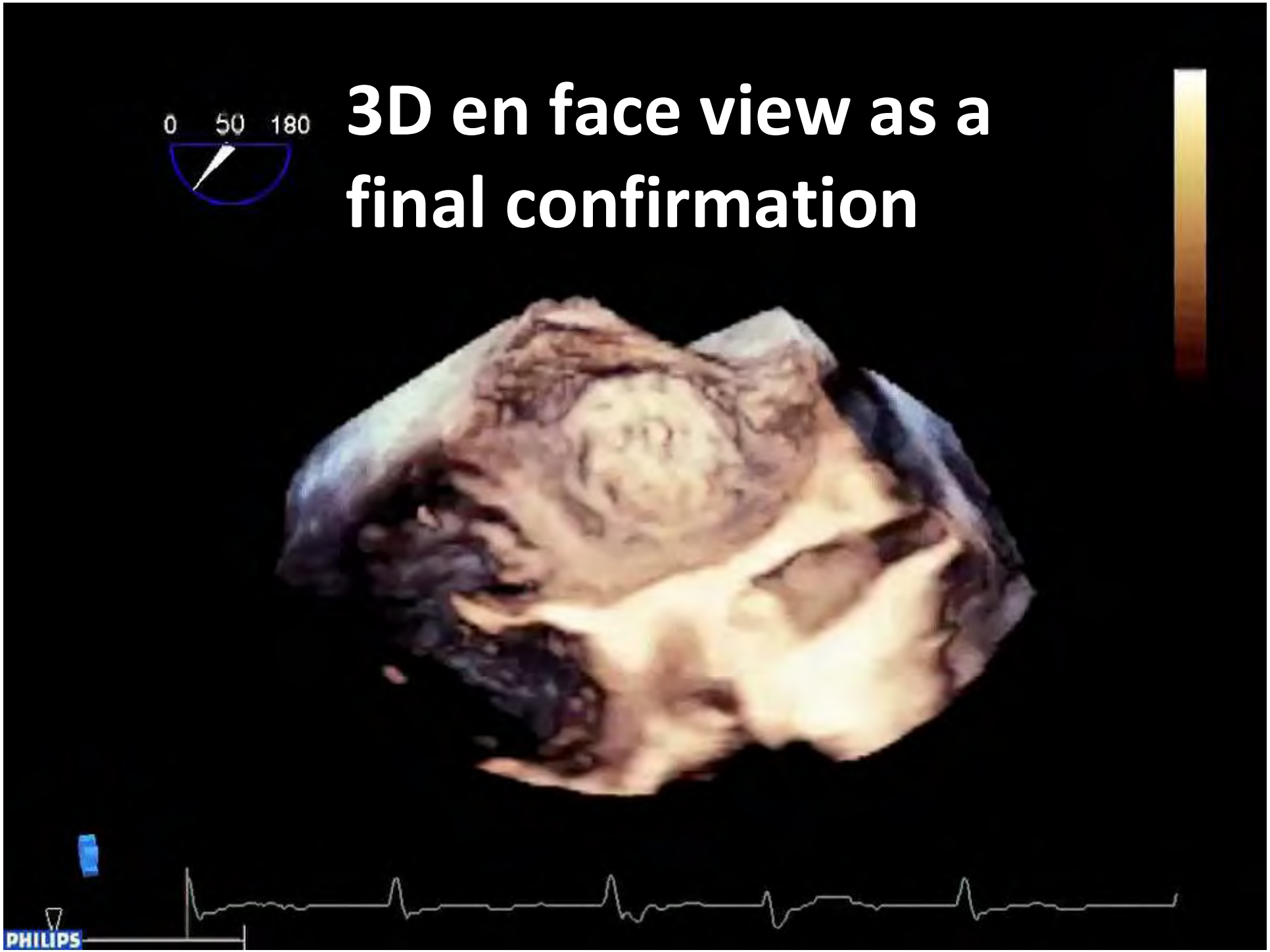
Infinite numbers of imaging planes

Avoiding undersizing of LAA orifice

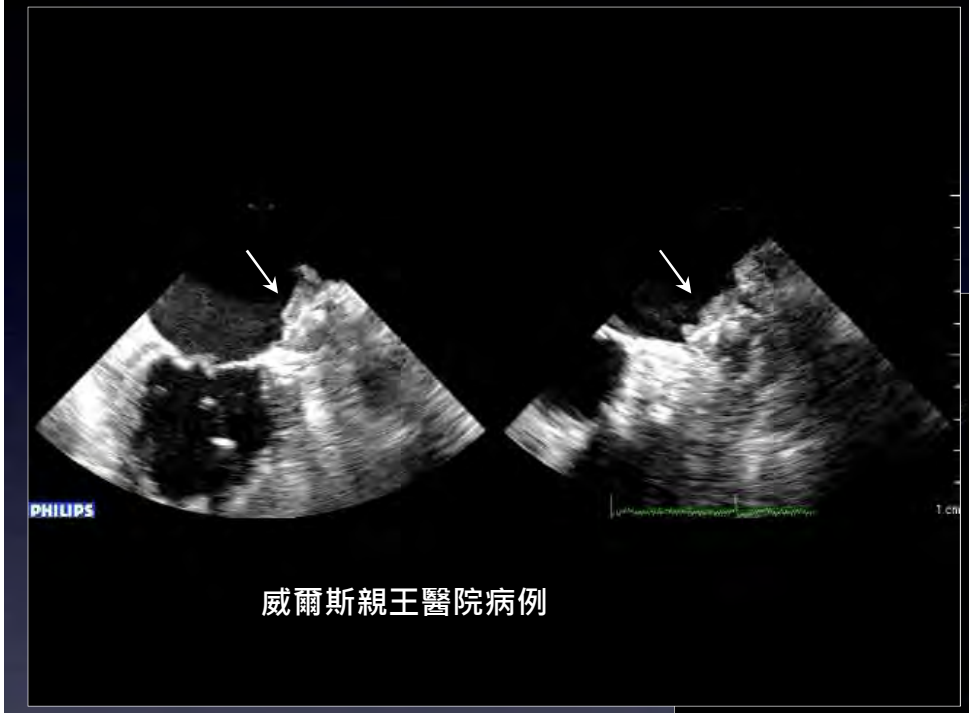



1.6cm
45°
2.1cm
1.6cm
0°
90°
110°
2.3cm
135°
1.7cm


C
Gap
27mm
D
Gap
0.69 cm
Distance(s)
D1
D2
E
2.63 cm
1.71 cm
30mm
Device
D1
D2

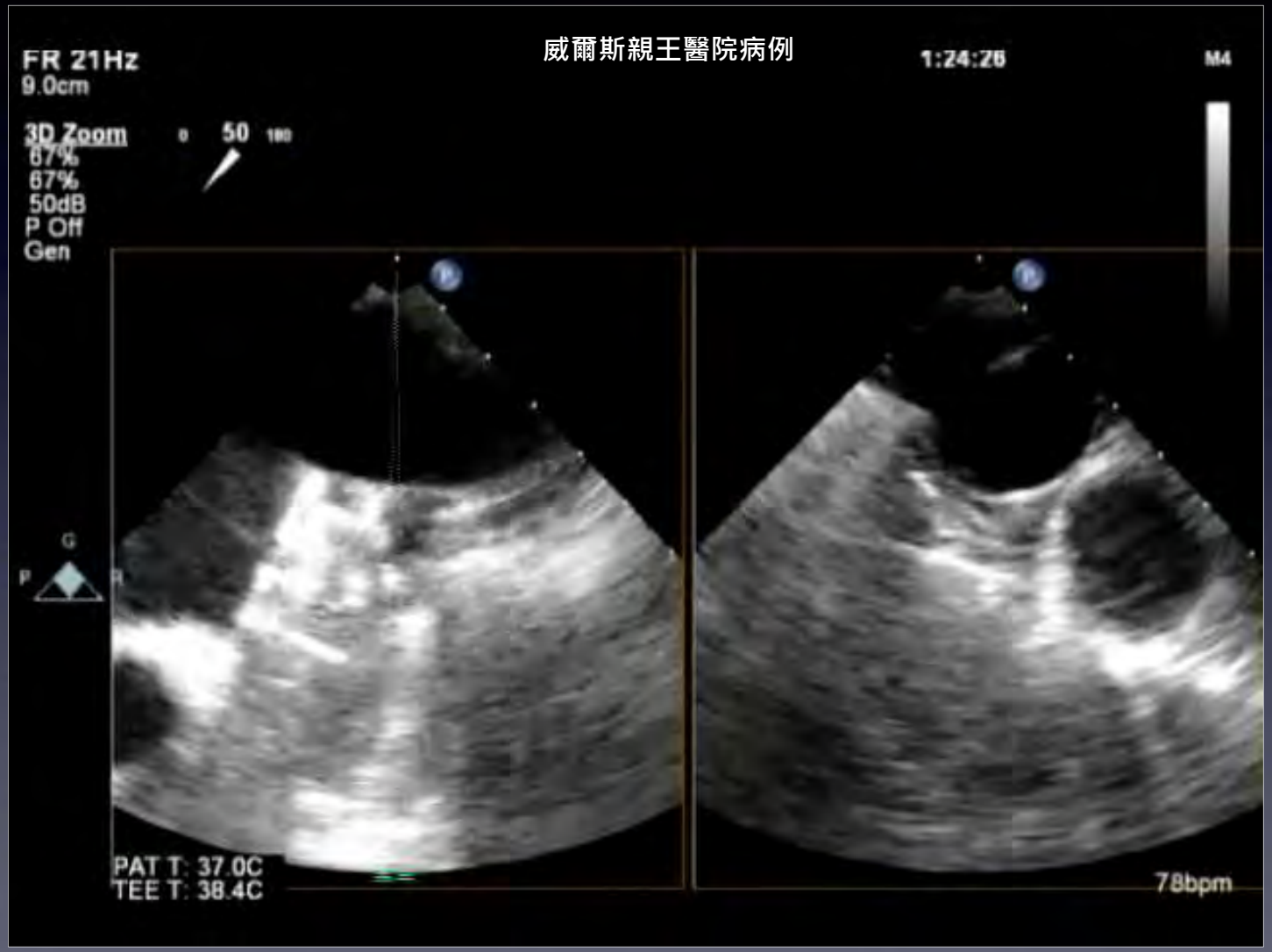

0 50 180
3D en face view as a final confirmation
PHILIPS

忌廉旦糕？

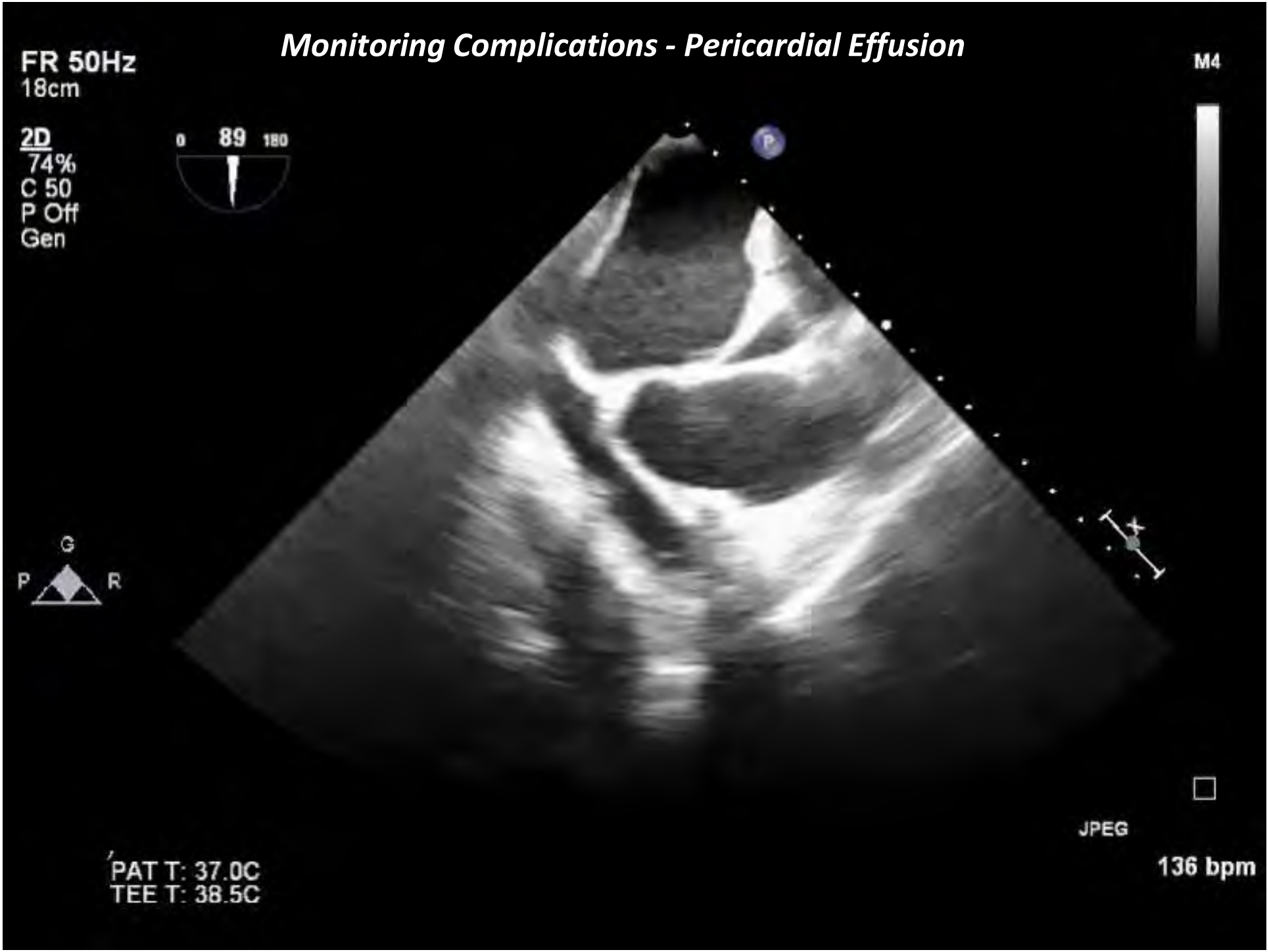

PHILIPS
威爾斯親王醫院病例


2012/09/10
10:58:55AM
EDUPWH
血栓
威爾斯親王醫院病例
3D
PHILIPS
67 bpm

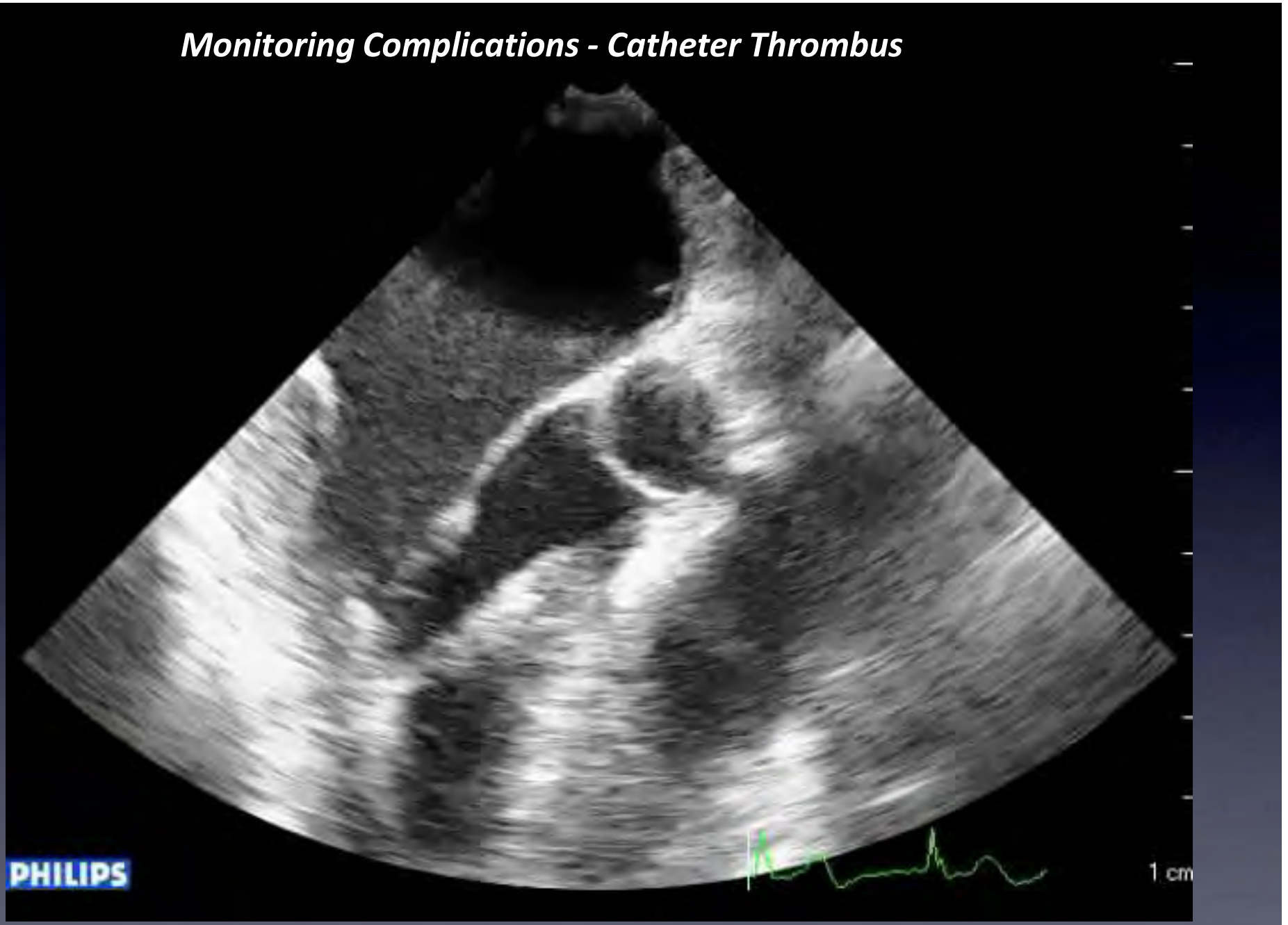
UFO ?


威爾斯親王醫院病例
FR 21Hz
9.0cm
1:24:26
M4
3D Zoom
50
67%
67%
50dB
P Off
Gen
PAT T: 37.0C
TEE T: 38.4C
78bpm

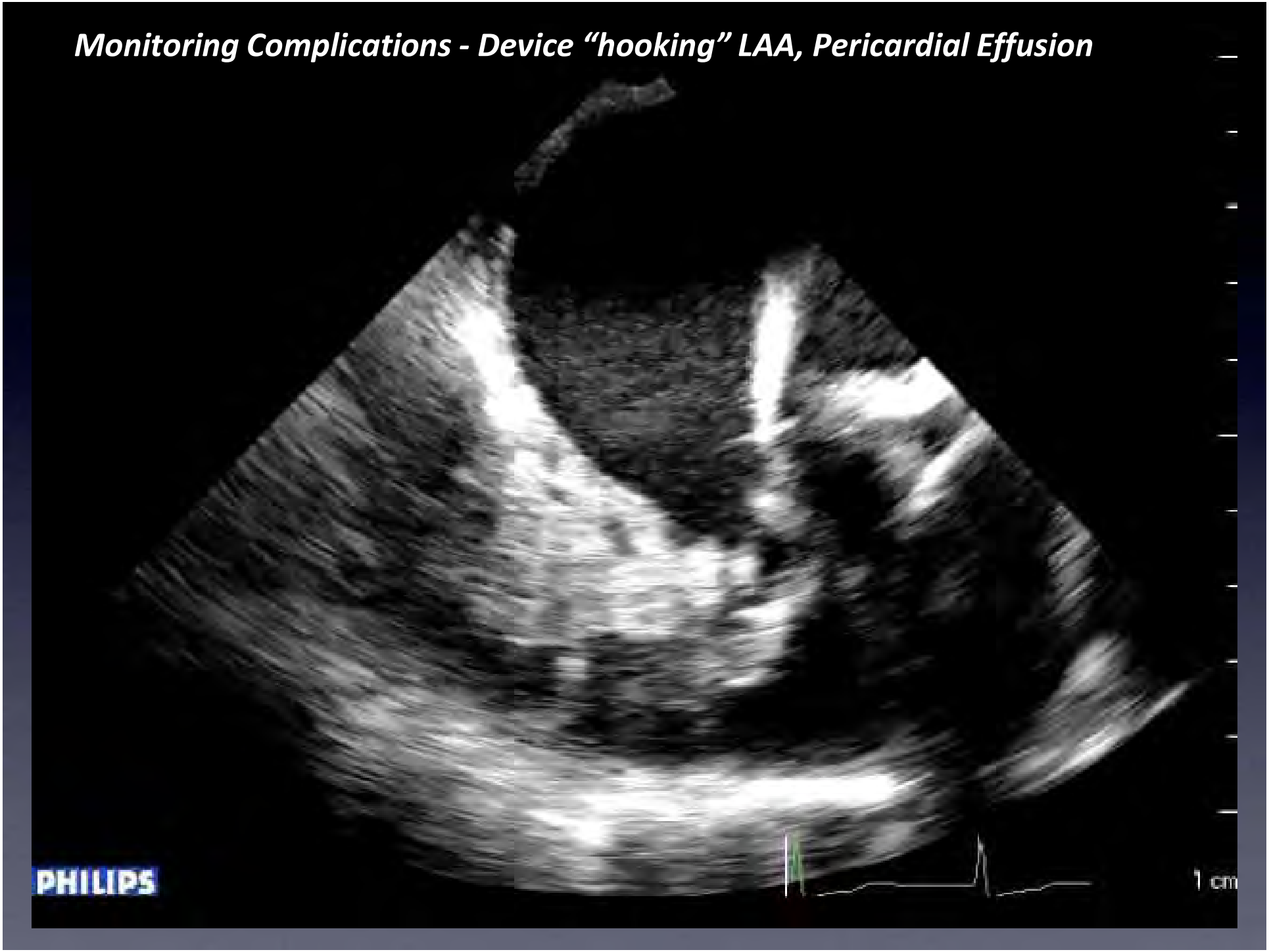
Monitoring Complications - Pericardial Effusion



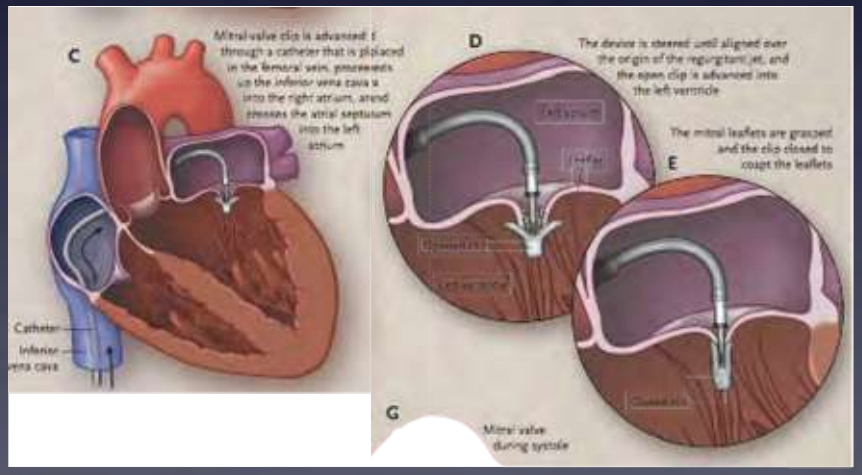
Monitoring Complications - Catheter Thrombus



Monitoring Complications - Device “hooking” LAA, Pericardial Effusion



经导管二尖瓣修复 (Mitraclip)



The NEW ENGLAND JOURNAL of MEDICINE

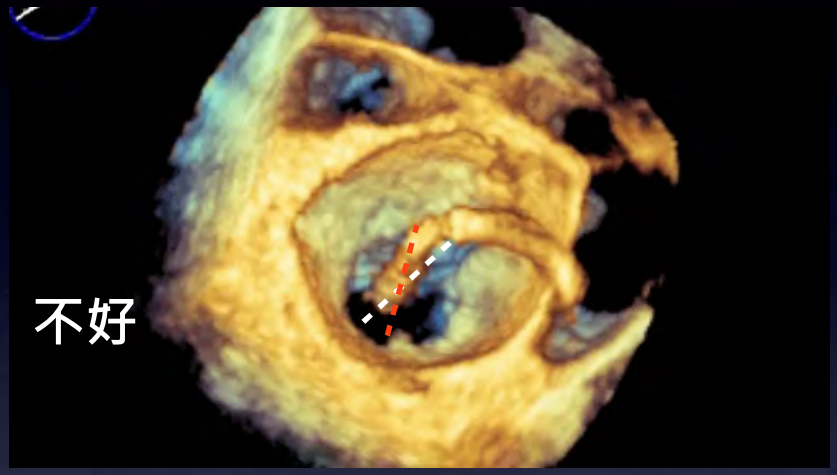
ESTABLISHED IN 1812 APRIL 14, 2011 VOL. 364 NO. 15

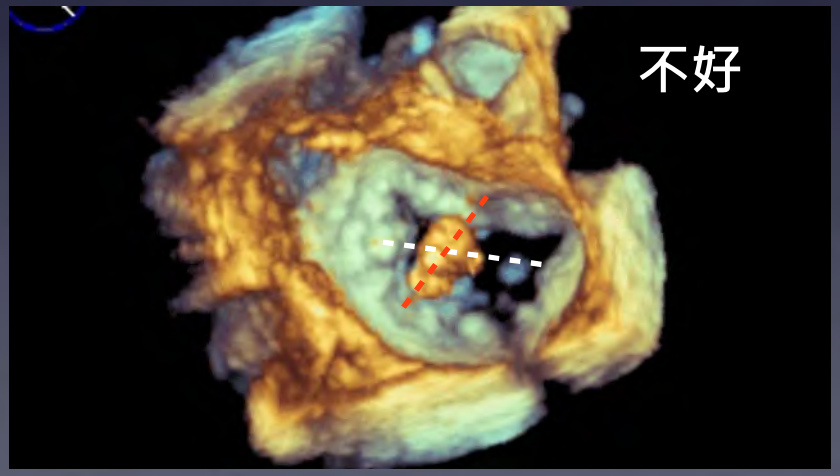
Percutaneous Repair or Surgery for Mitral Regurgitation

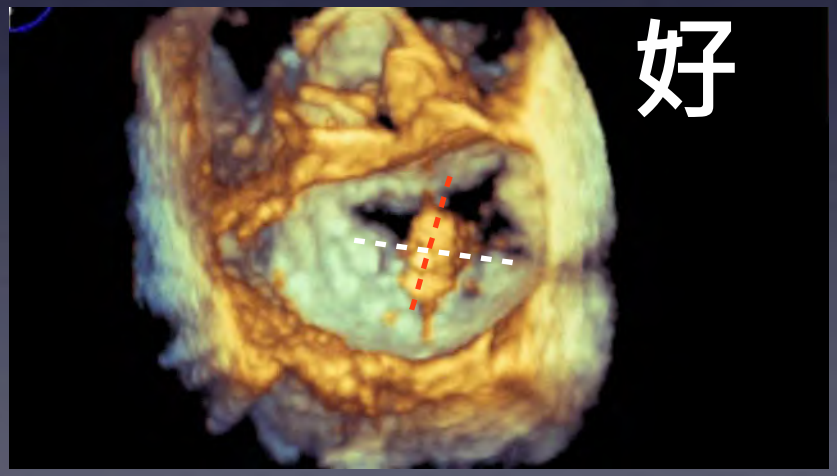
Ted Feldman, M.D., Elyse Foster, M.D., Donald D. Glower, M.D., Saibal Kar, M.D., Michael J. Rinaldi, M.D., Peter S. Fail, M.D., Richard W. Smalling, M.D., Ph.D., Robert Siegel, M.D., Geoffrey A. Rose, M.D., Eric Engeron, M.D., Catalin Loghin, M.D., Alfredo Trento, M.D., Eric R. Skipper, M.D., Tommy Fudge, M.D., George V. Letsou, M.D., Joseph M. Massaro, Ph.D., and Laura Mauri, M.D., for the EVEREST II Investigators*

在XPlane导引下Clip转向进入左心室

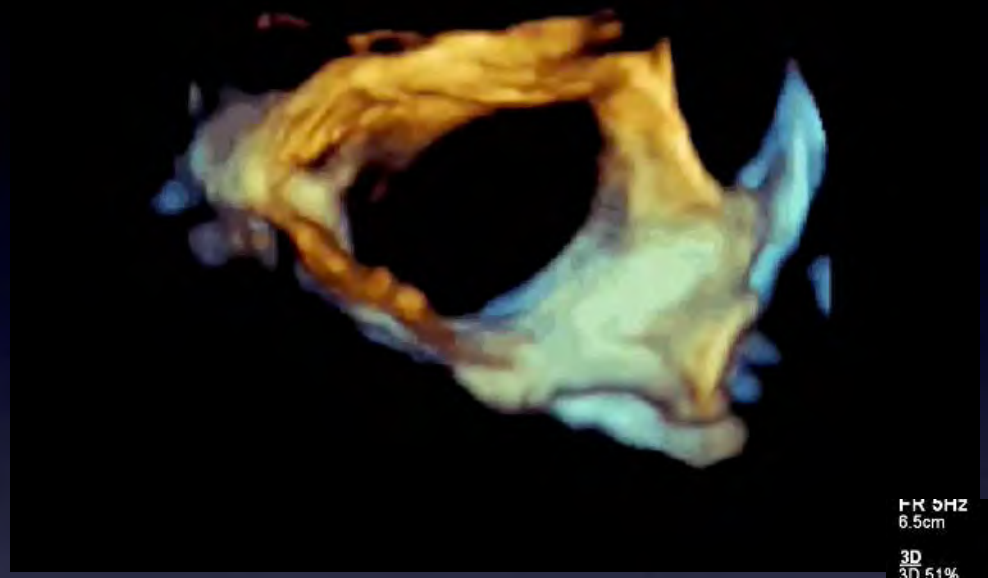
RT3D TEE是引导Clip对齐二尖瓣的最佳工具

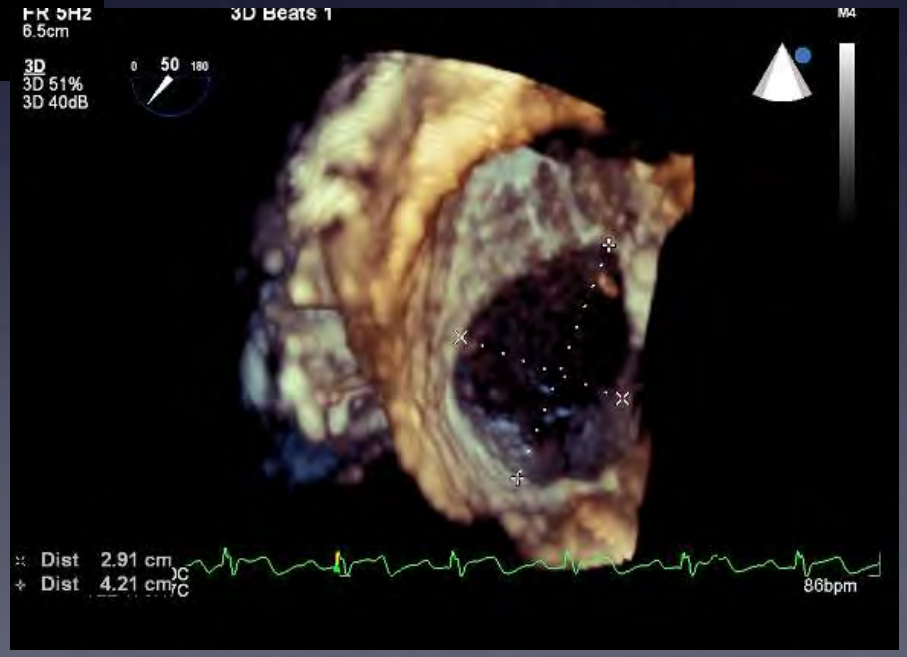




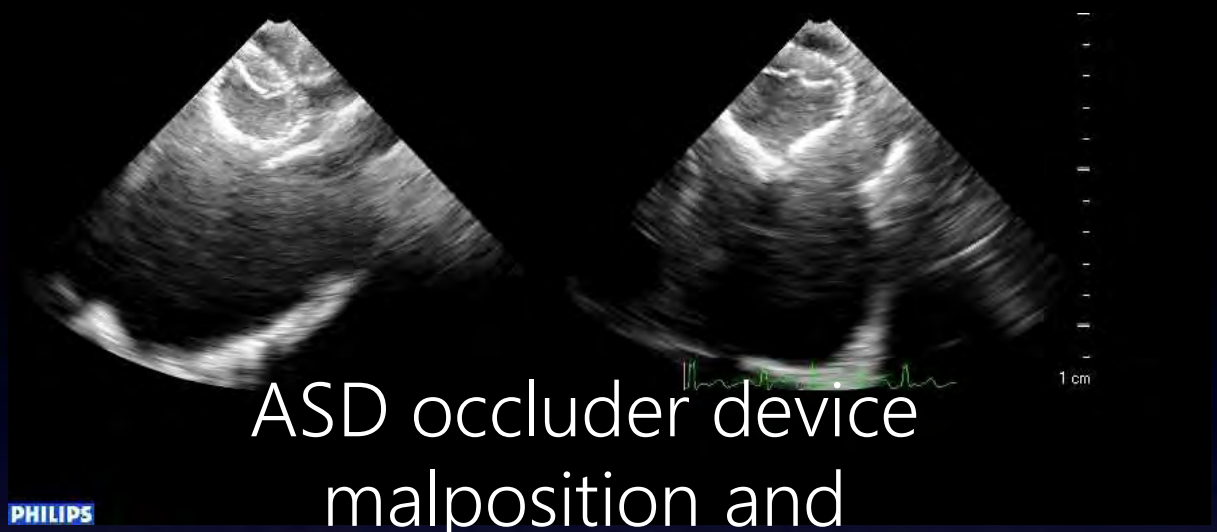


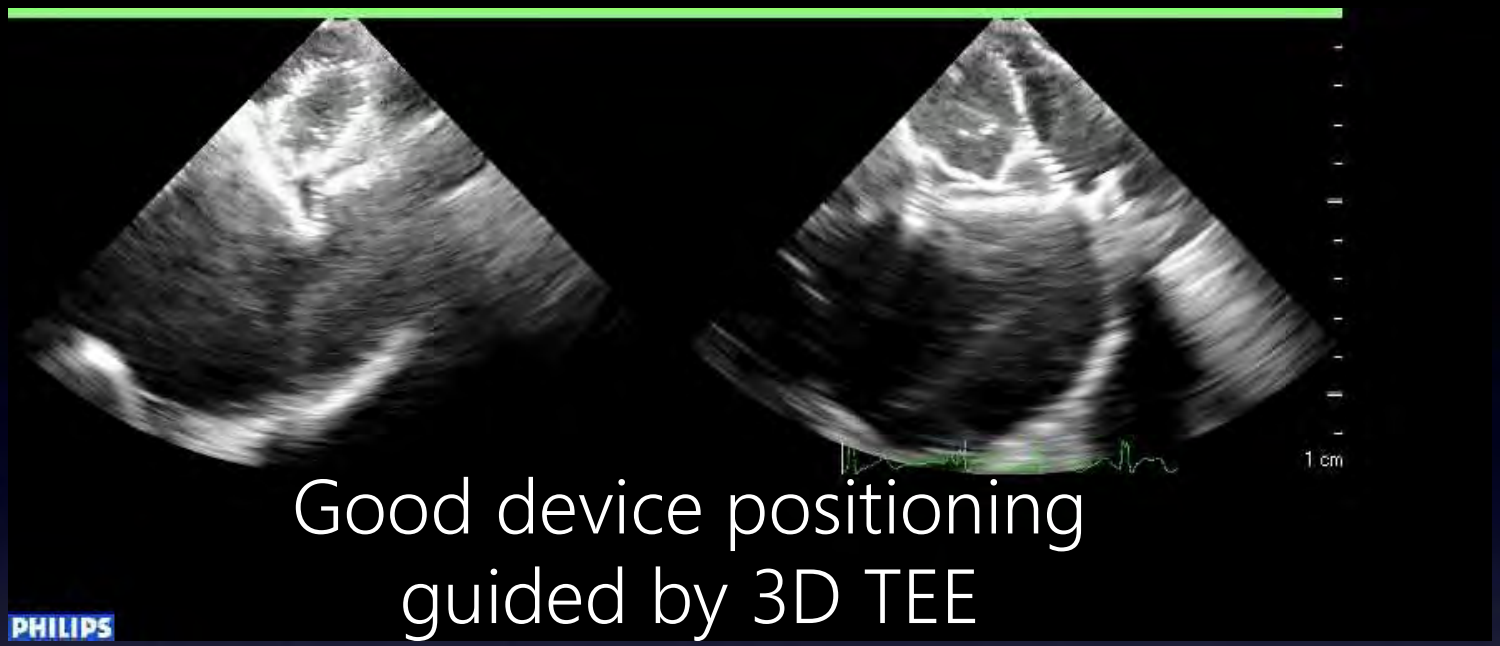
心房缺損(ASD)



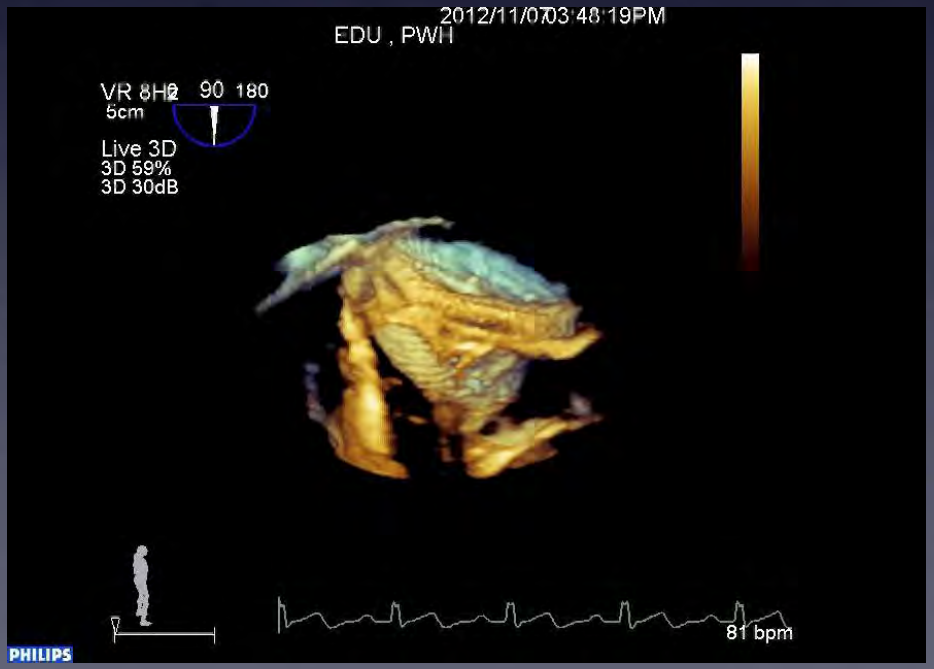

FR 5Hz
6.5cm
3D Beats 1
M4
3D
3D 51%
3D 40dB
0
50
180
Dist 2.91 cm
Dist 4.21 cm
86bpm

ASD occluder device malposition and dislodgement

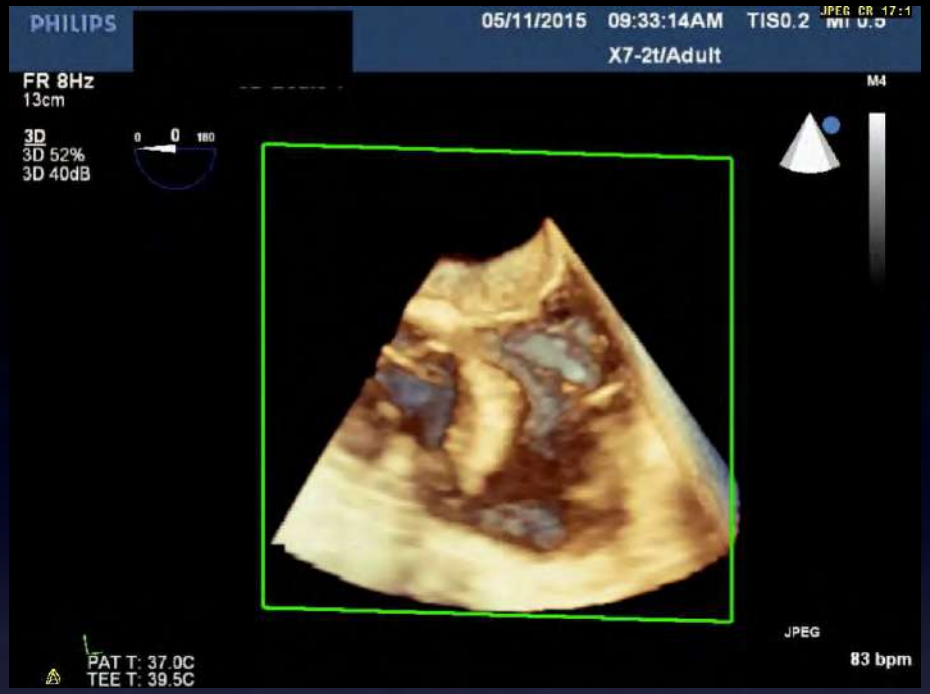


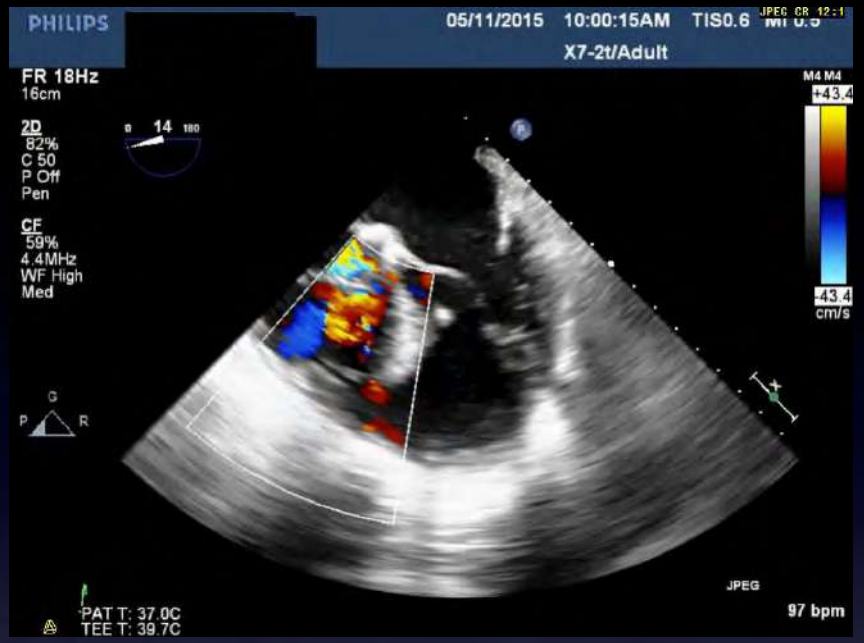


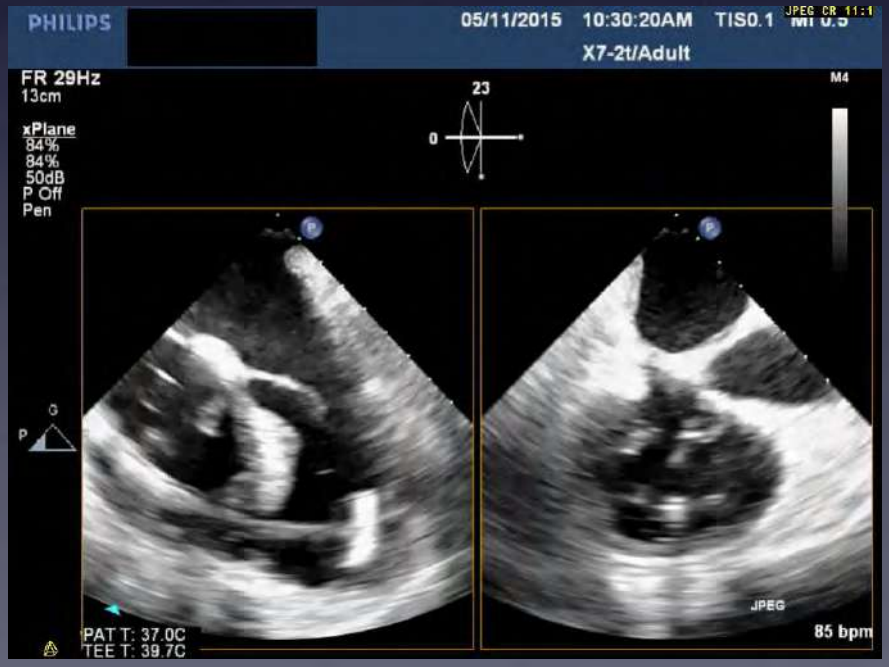
Good device positioning guided by 3D TEE

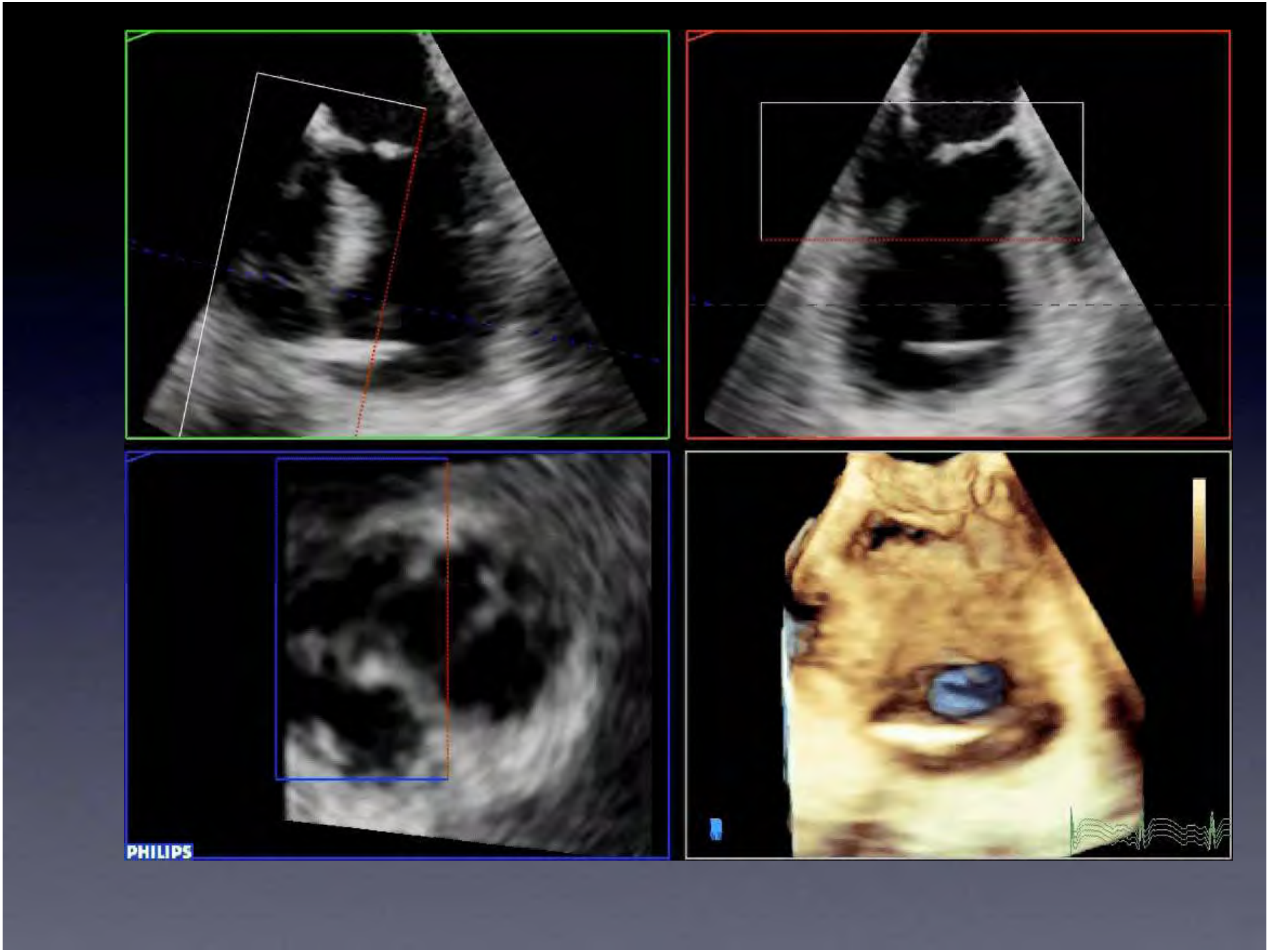


心室缺損(VSD)

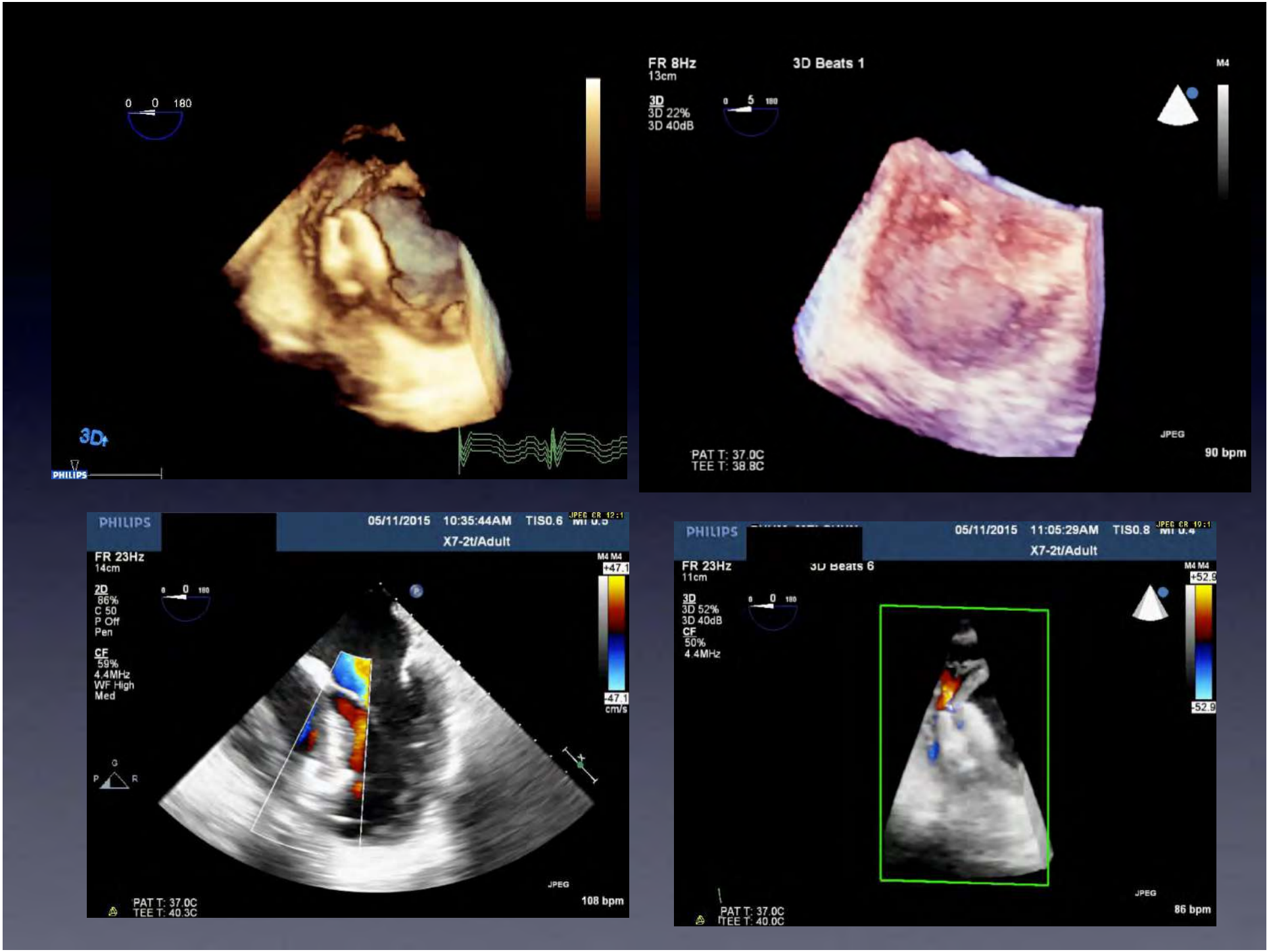

PHILIPS
05/11/2015 09:33:14AM TIS0.2
X7-2t/Adult
FR 8Hz
13cm
3D
3D 52%
3D 40dB
M4
JPEG
PAT T: 37.0C
TEE T: 39.5C
83 bpm


PHILIPS
05/11/2015 10:00:15AM TIS0.6
X7-2t/Adult
FR 18Hz
16cm
2D
82%
C 50
P Off
Pen
CF
59%
4.4MHz
WF High
Med
M4 M4
+43.4
-43.4
cm/s
JPEG
PAT T: 37.0C
TEE T: 39.7C
97 bpm


PHILIPS
05/11/2015 10:30:20AM TIS0.1
X7-2t/Adult
FR 29Hz
13cm
xPlane
84%
84%
50dB
P Off
Pen
M4
JPEG
PAT T: 37.0C
TEE T: 39.7C
85 bpm


PHILIPS


PHILIPS


0 0 180
3D
PHILIPS
FR 8Hz
13cm
3D Beats 1
3D
3D 22%
3D 40dB
M4
PAT T: 37.0C
TEE T: 38.8C
JPEG
90 bpm
PHILIPS
05/11/2015 10:35:44AM TIS0.6
X7-2t/Adult
FR 23Hz
14cm
2D
86%
C 50
P Off
Pen
CF
59%
4.4MHz
WF High
Med
M4 M4
+47.1
-47.1
cm/s
JPEG
PAT T: 37.0C
TEE T: 40.3C
108 bpm
PHILIPS
05/11/2015 11:05:29AM TIS0.8
X7-2t/Adult
FR 23Hz
11cm
3D Beats 6
3D
3D 52%
3D 40dB
CF
50%
4.4MHz
M4 M4
+52.9
-52.9
JPEG
PAT T: 37.0C
TEE T: 40.0C
86 bpm

經導管瓣周漏封堵
(Transcatheter periprosthetic leak occlusion)

Case 1

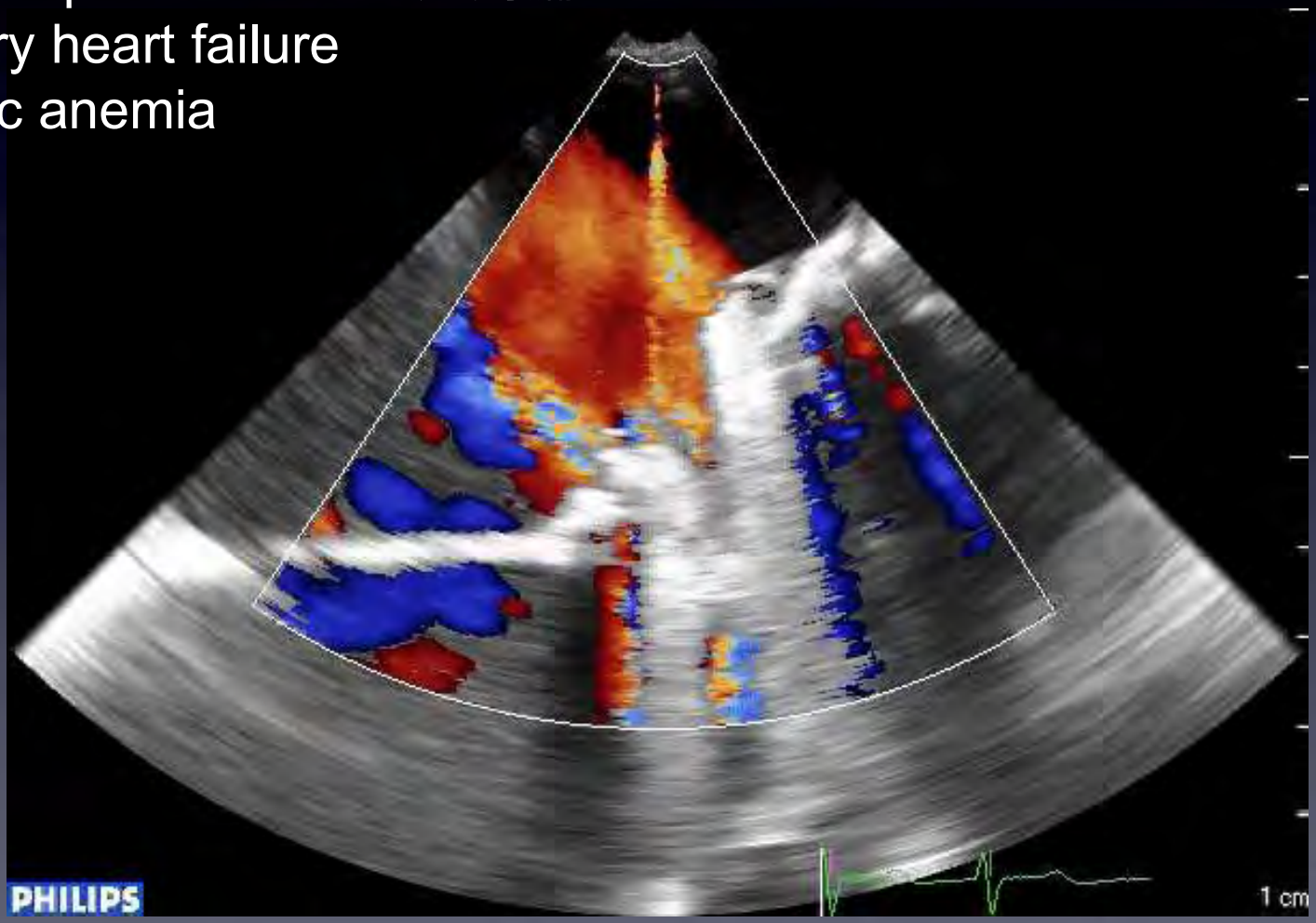
F/55

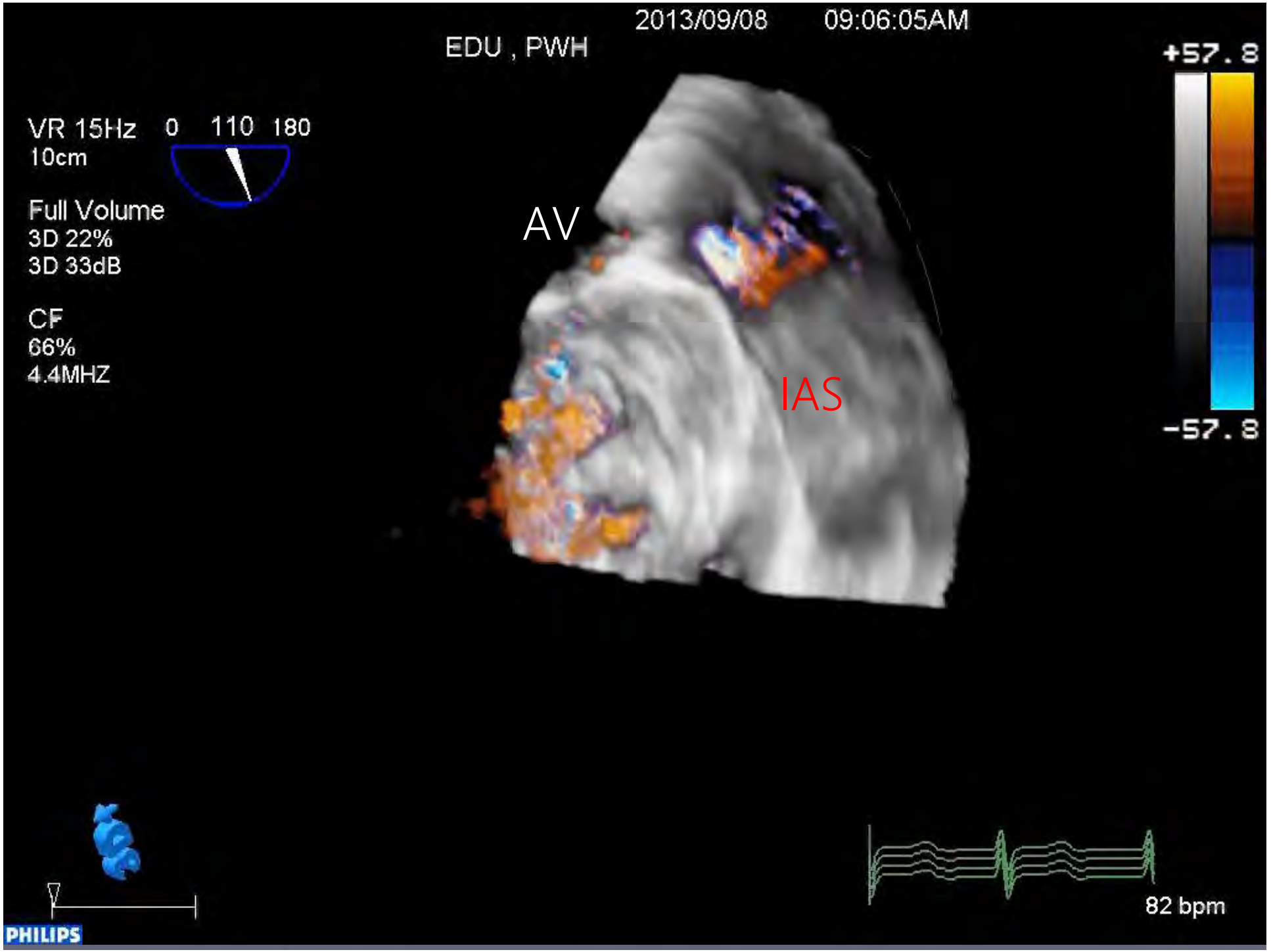
Double valve replacement

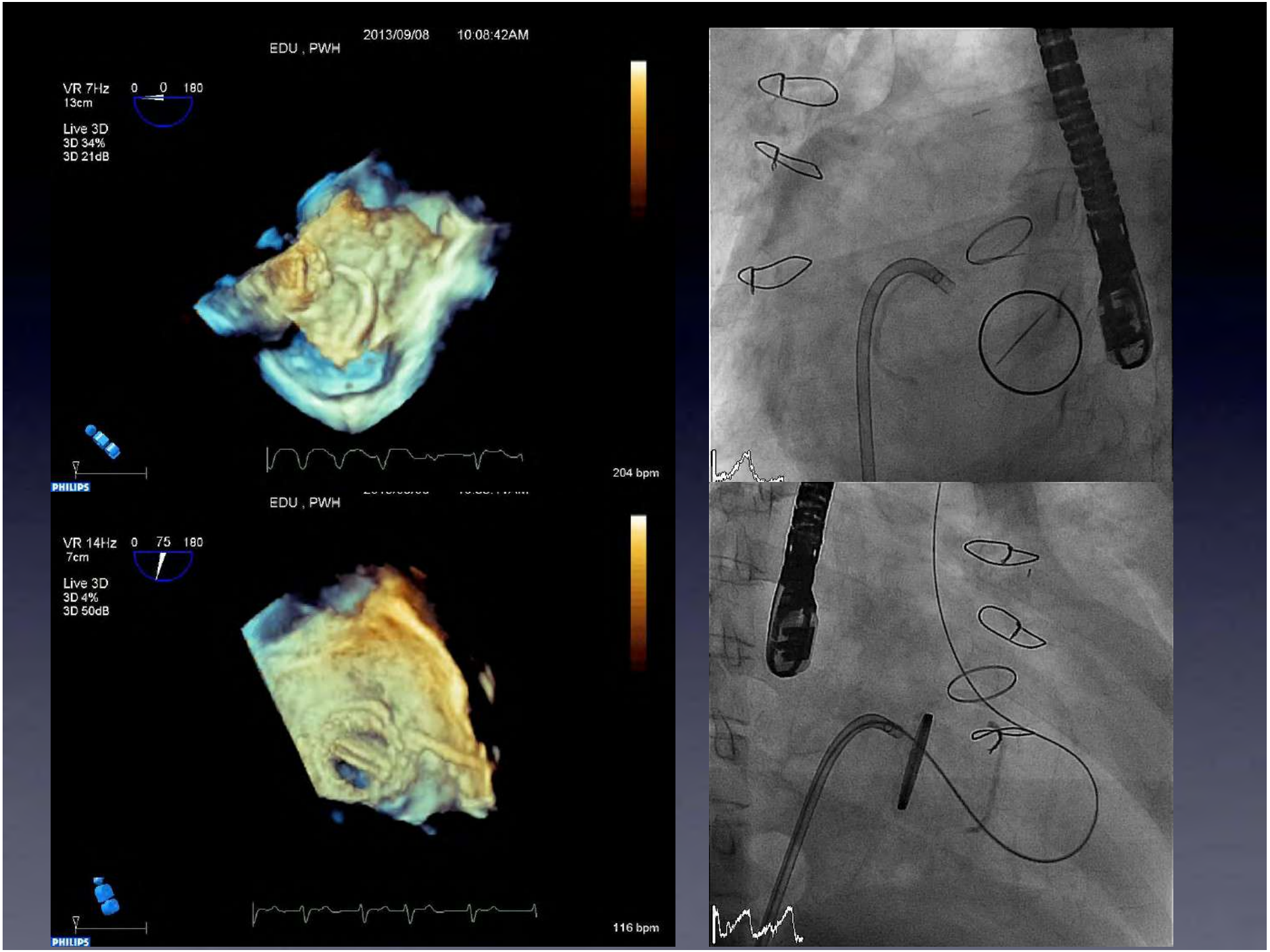
Severe periprosthetic MR 瓣周漏

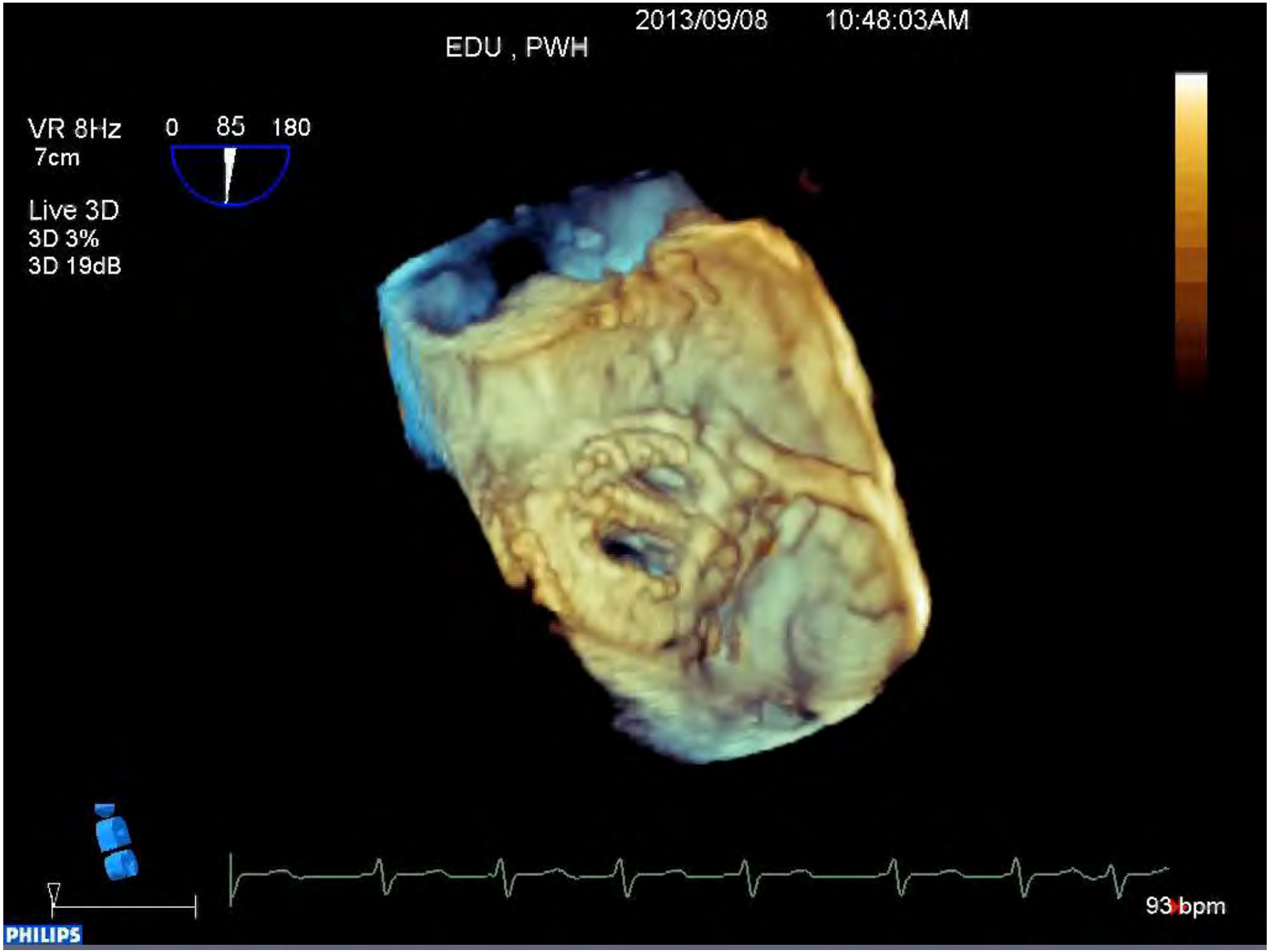
Refractory heart failure

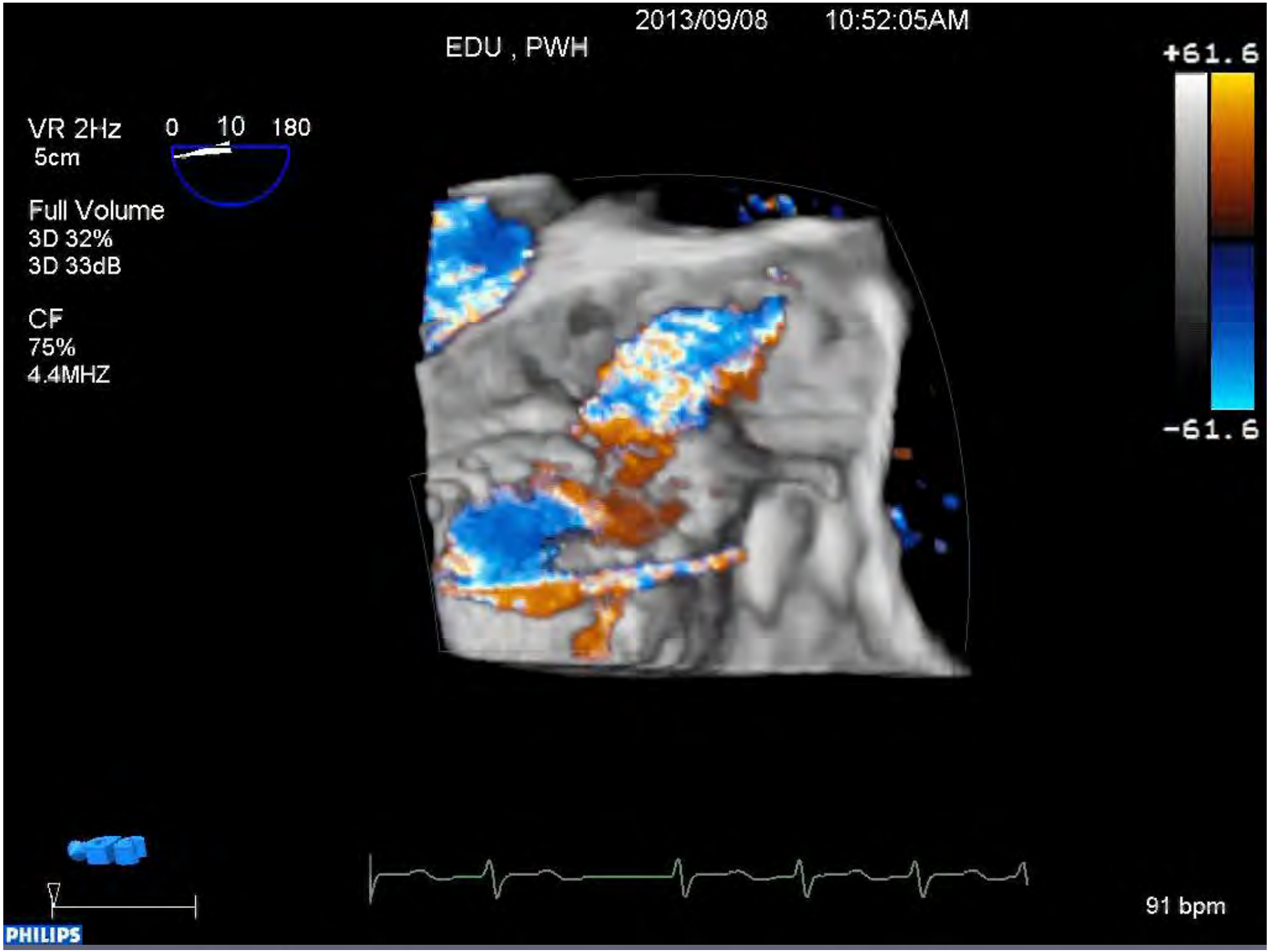
Hemolytic anemia

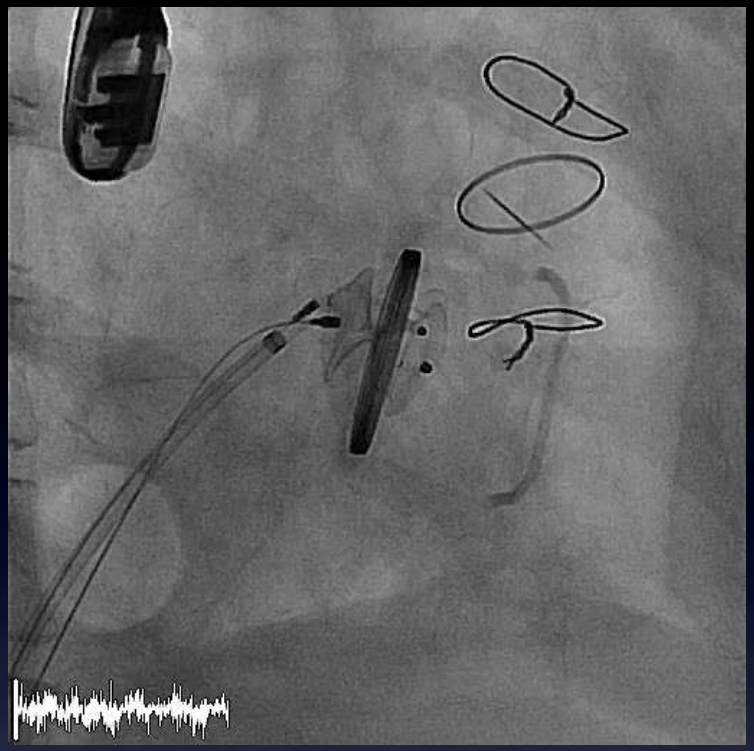



2013/09/08 09:06:05AM
EDU , PWH
+57.8
-57.8
VR 15Hz
10cm
0 110 180
Full Volume
3D 22%
3D 33dB
CF
66%
4.4MHZ
AV
IAS
82 bpm
PHILIPS

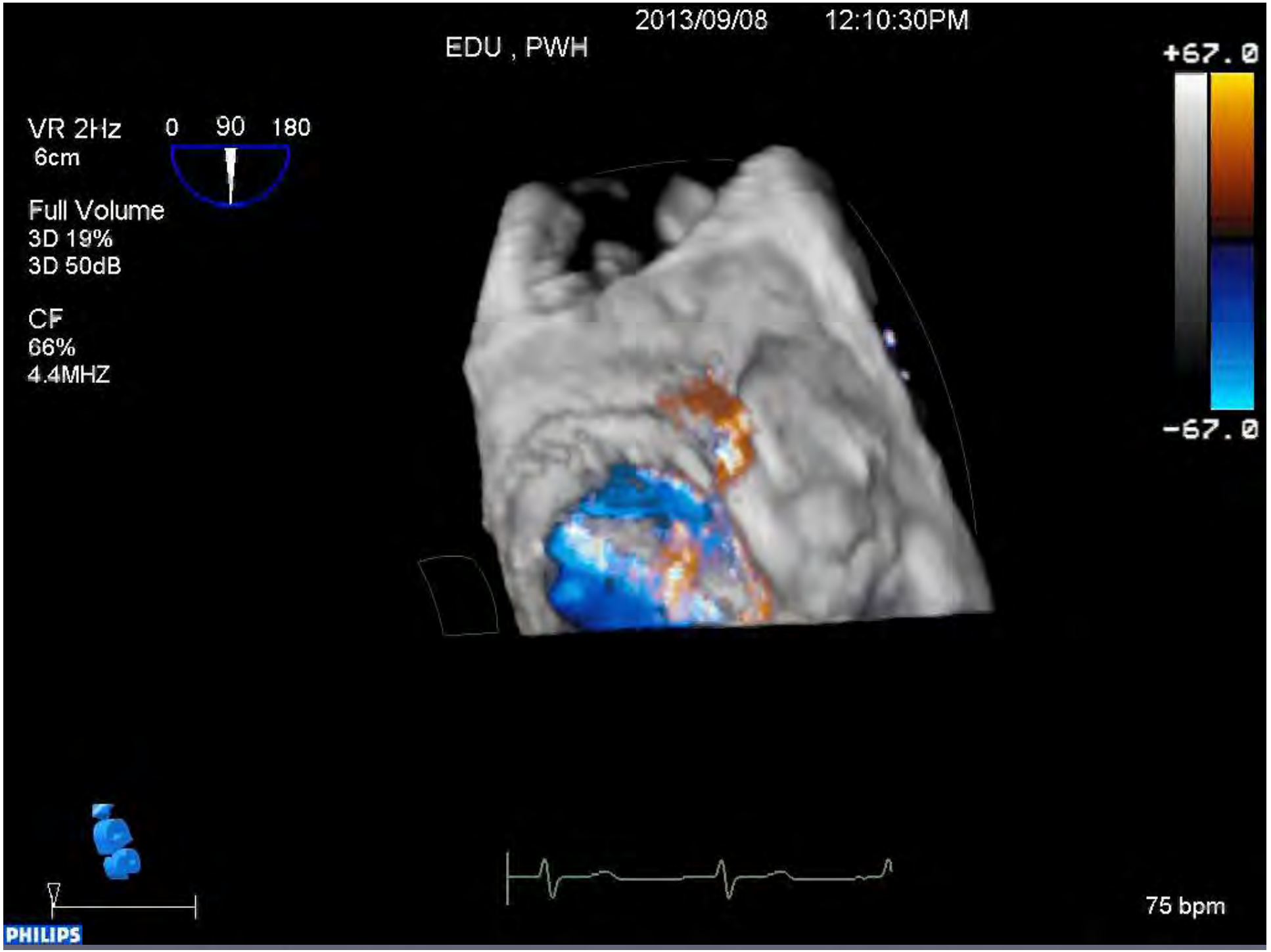

2013/09/08 10:08:42AM
EDU , PWH
VR 7Hz 0 0 180
13cm
Live 3D
3D 34%
3D 21dB
204 bpm
PHILIPS
EDU , PWH
VR 14Hz 0 75 180
7cm
Live 3D
3D 4%
3D 50dB
116 bpm
PHILIPS

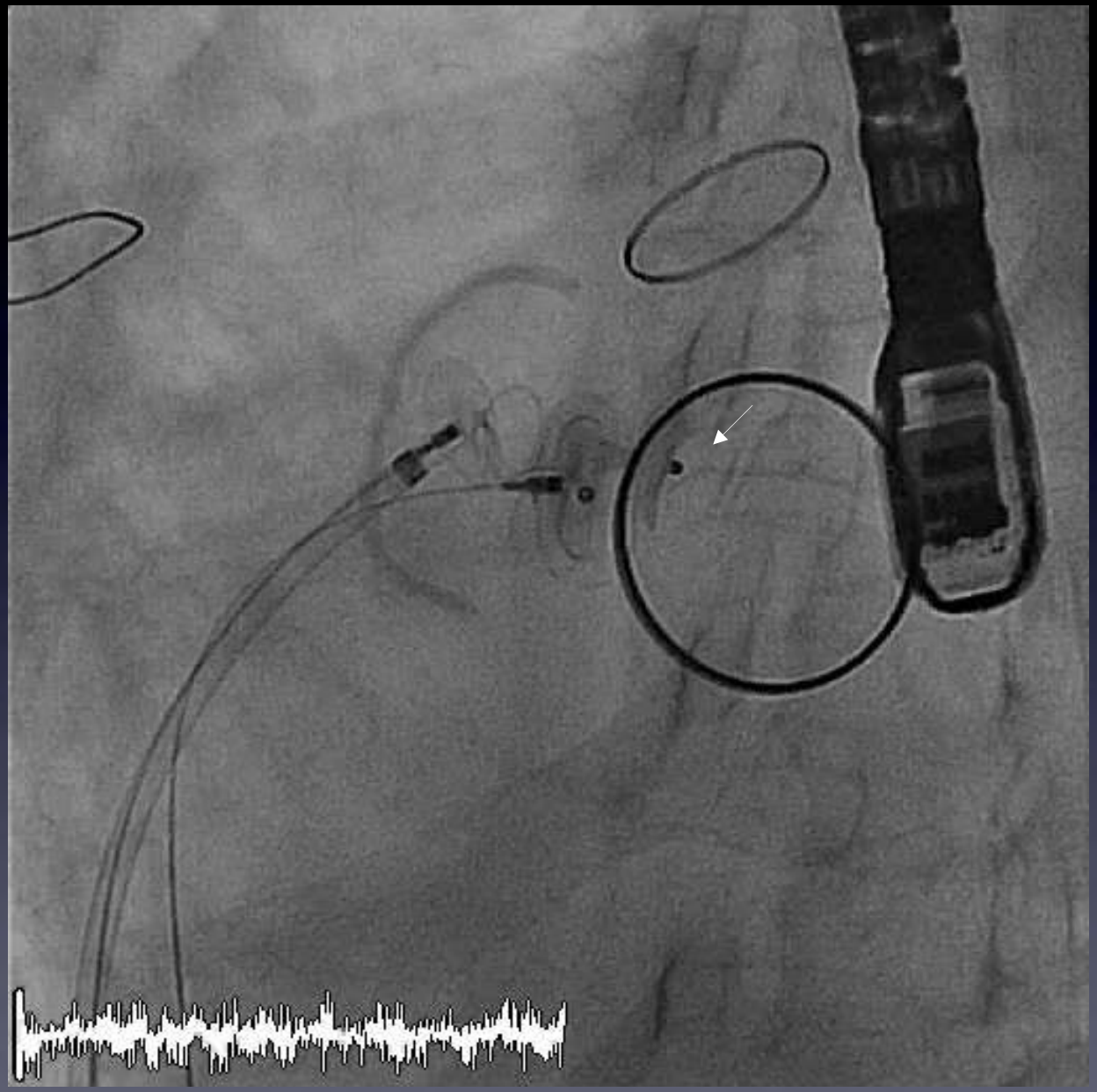

2013/09/08 10:48:03AM
EDU , PWH
VR 8Hz
7cm
0 85 180
Live 3D
3D 3%
3D 19dB
93 bpm
PHILIPS


2013/09/08 10:52:05AM
EDU , PWH
+61.6
-61.6
VR 2Hz
5cm
0 10 180
Full Volume
3D 32%
3D 33dB
CF
75%
4.4MHZ
91 bpm
PHILIPS

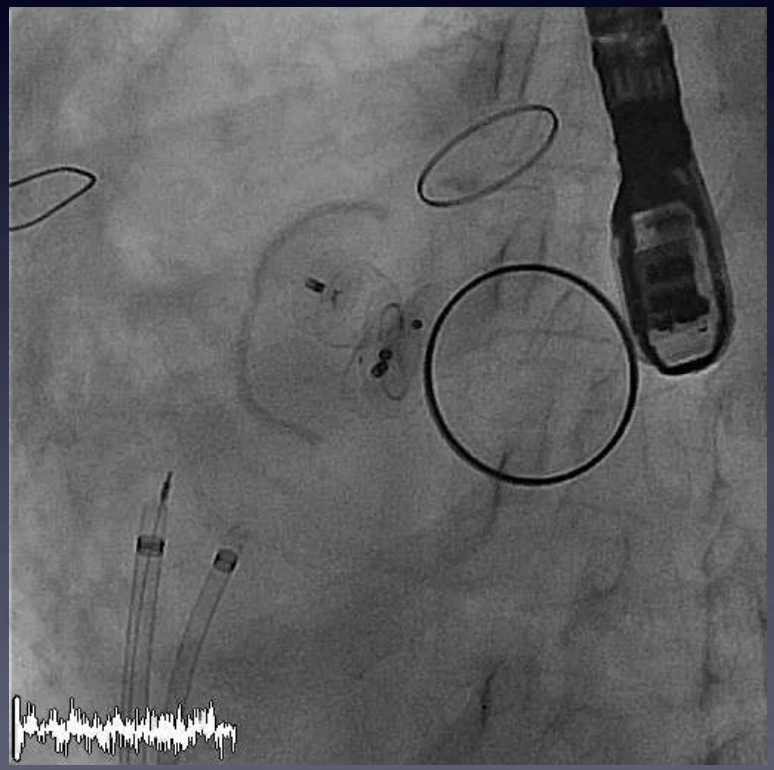


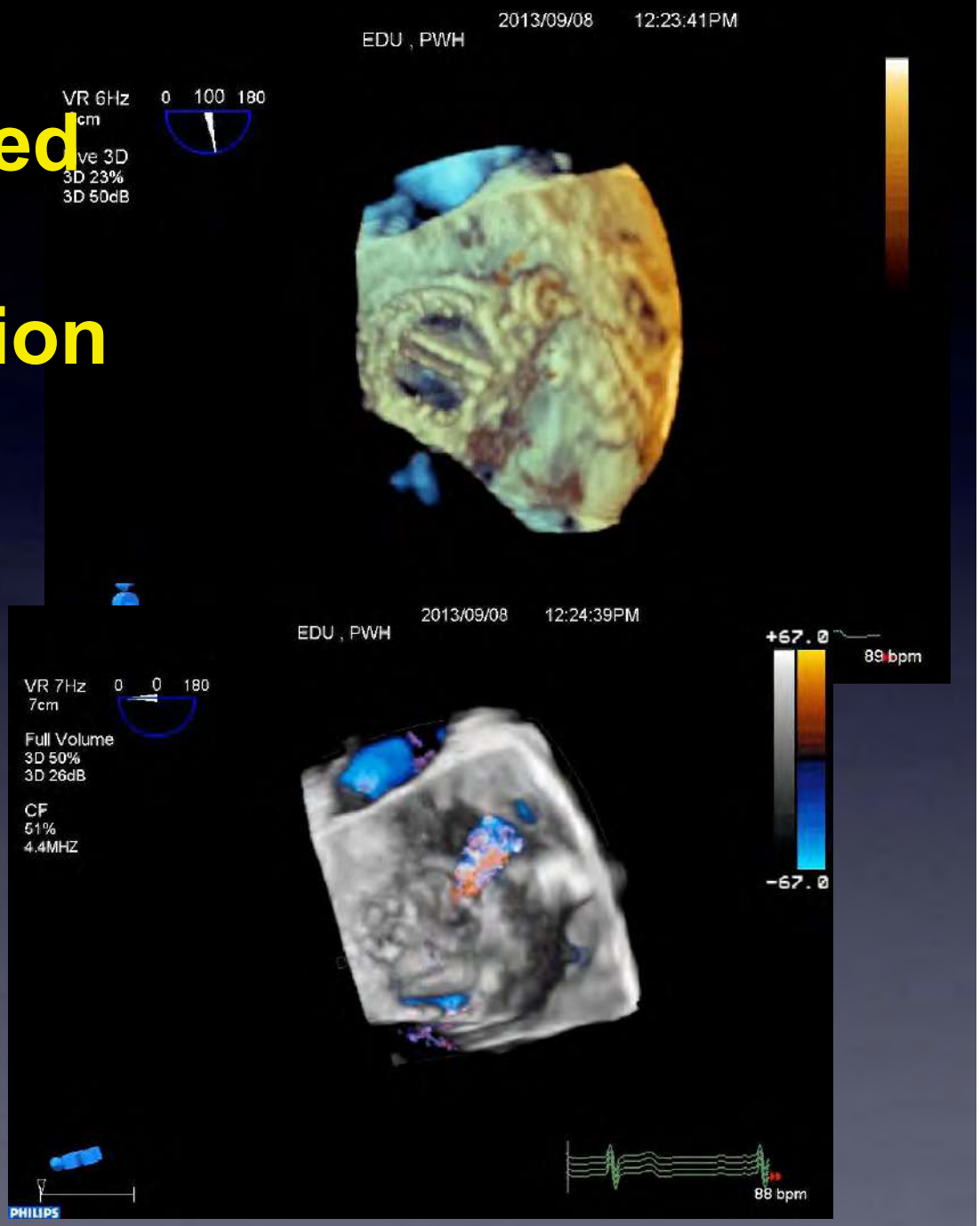

2013/09/08 12:09:38PM
EDU , PWH
VR 6Hz
6cm
0 90 180
Live 3D
3D 12%
3D 50dB
79 bpm
PHILIPS


2013/09/08 12:10:30PM
EDU , PWH
+67.0
-67.0
VR 2Hz
6cm
0 90 180
Full Volume
3D 19%
3D 50dB
CF
66%
4.4MHZ
75 bpm
PHILIPS



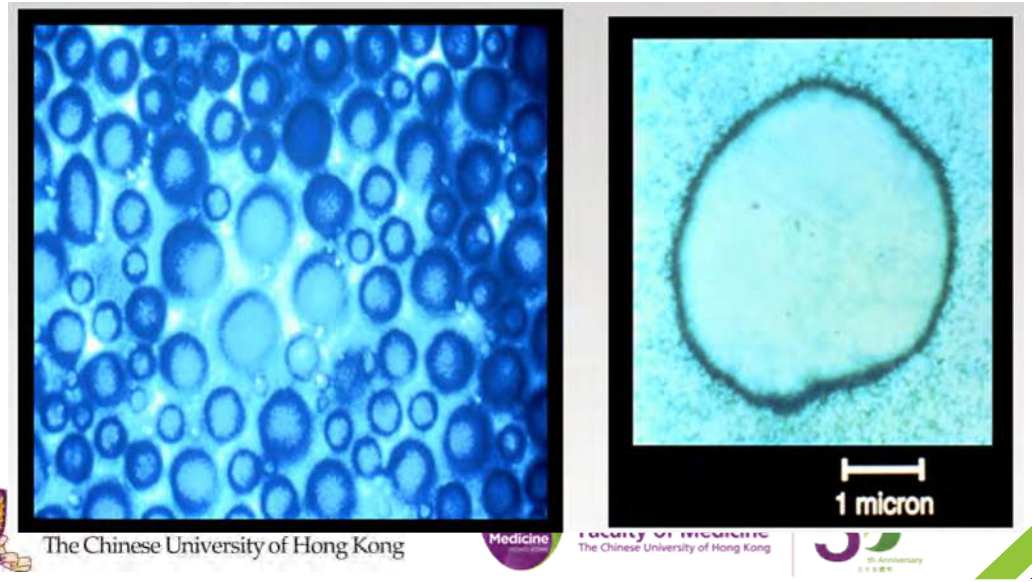
Final result
2nd device adjusted
Minimal PVL
Normal leaflet motion



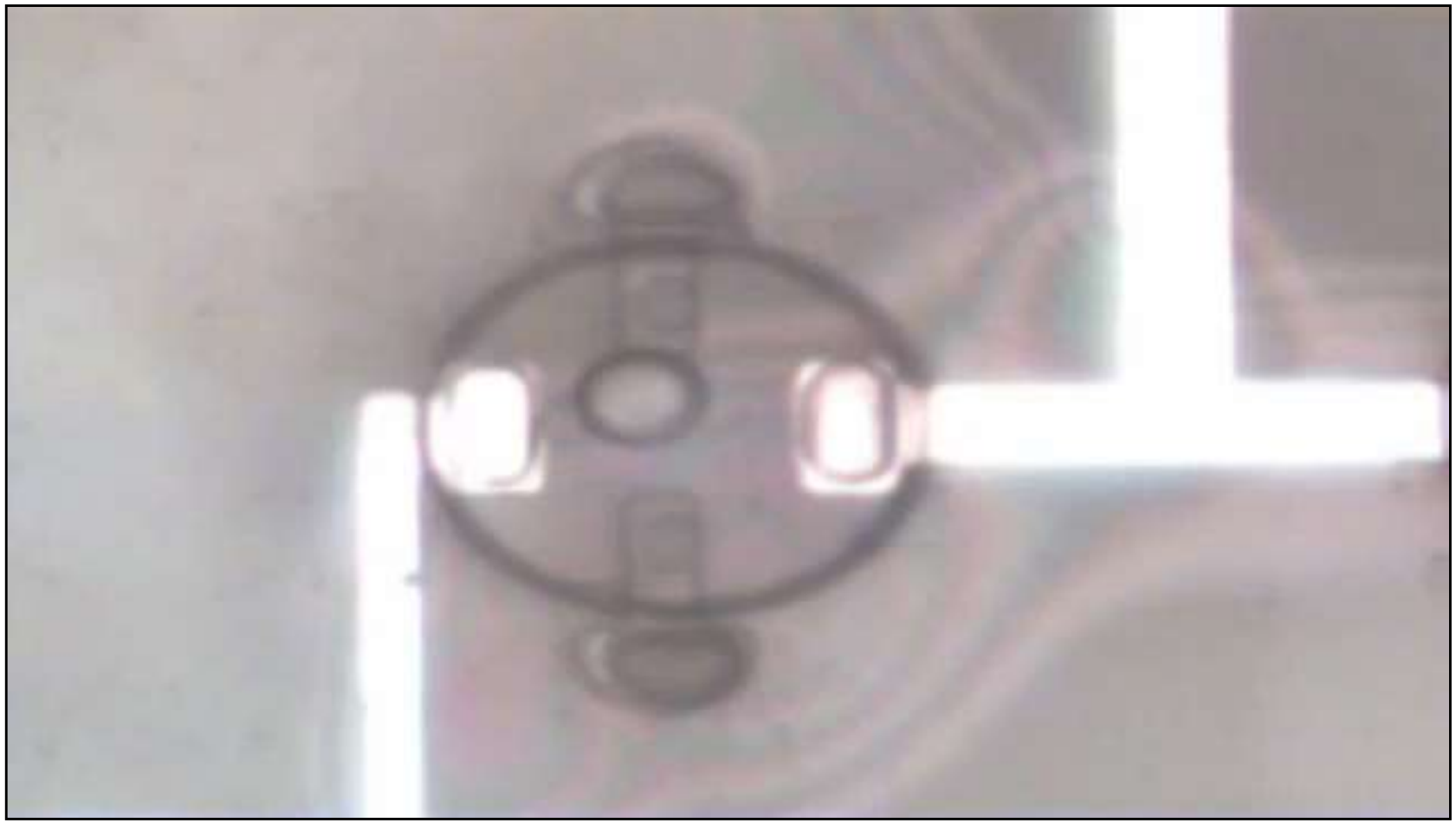


What is micro-bubble ultrasound contrast?

- Microbubbles are bubbles >1 micrometer to <1 millimetre in diameter
- Filled with gas e.g. sulphur hexafluoride
- Liquid-gas interface reflects ultrasound waves



ASE contrast echo guidelines JASE 2008



How to perform CE?

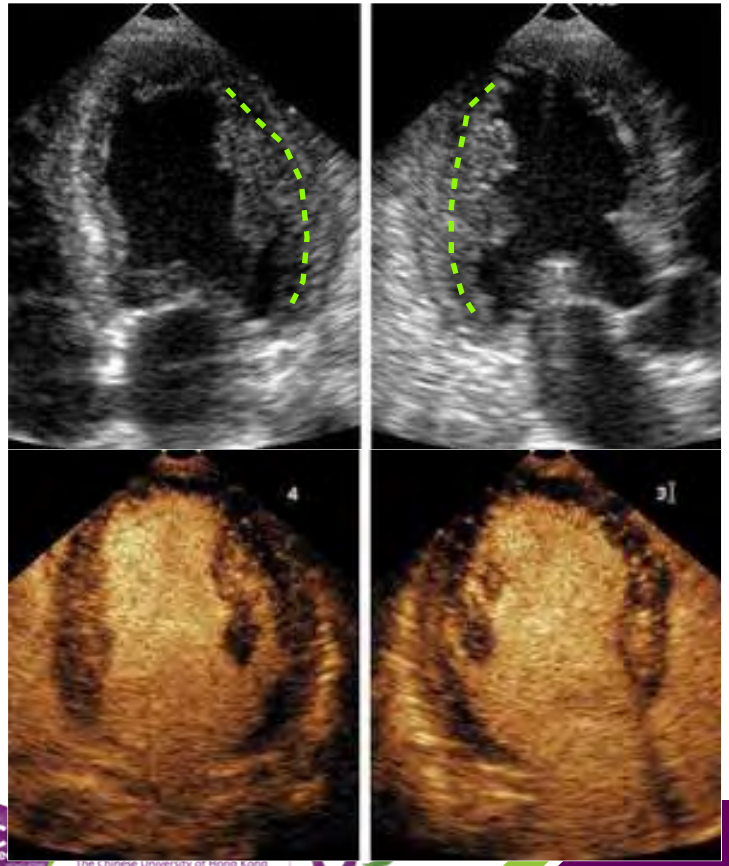
PWH dosing experience/guidelines:
- Slow bolus injections (~0.2-0.4 mL) of Sonovue followed by slow 5 mL saline flush over 5-10 seconds (low EF patients may need larger bolus ~0.5-0.6ml)
- Repeat boluses if necessary, usually <6ml per study

Overview

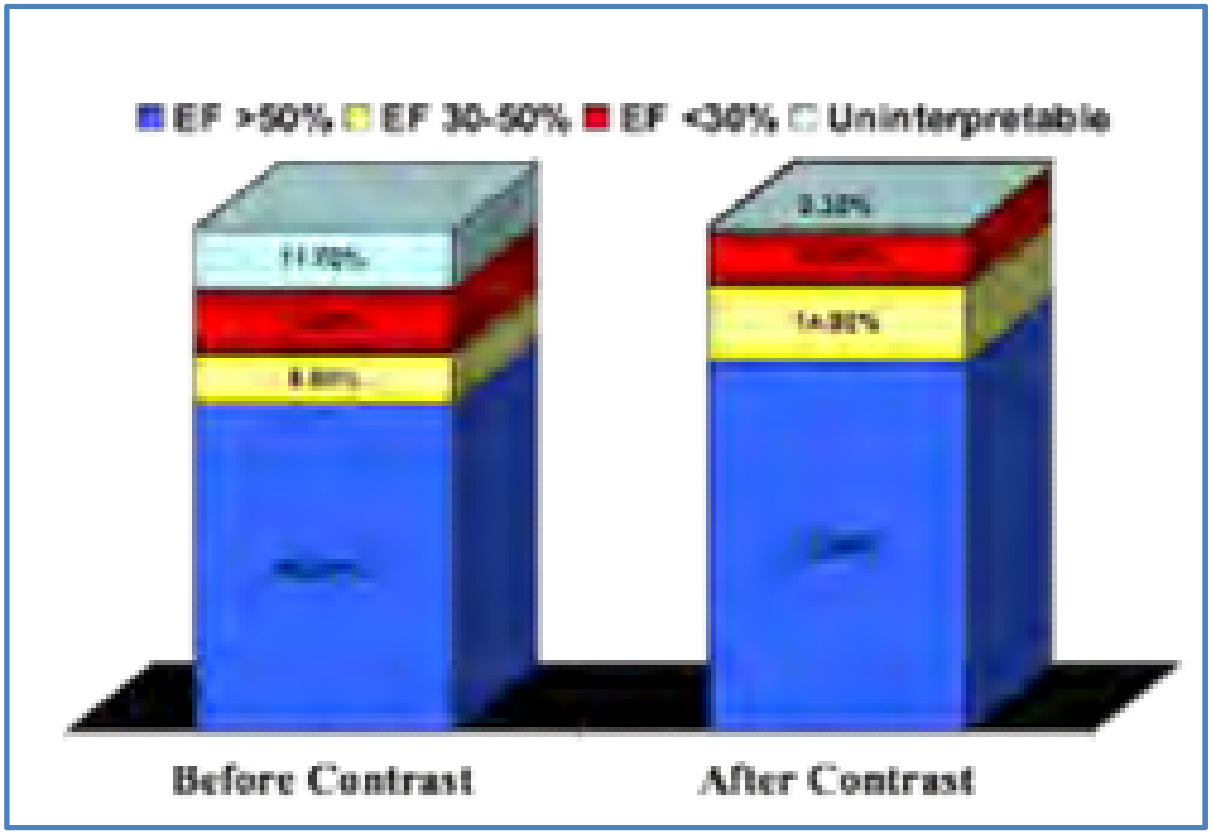
- Conventional use:
  - Endocardial border definition
  - LV opacification
  - Thrombus detection
- Innovative use:
  - Myocardial perfusion
  - Stress echo
  - Shunt detection
  - Aortic endoleak detection
  - Therapeutic contrast

Contrast Administration Reduces Interobserver Variability in Determination of Left Ventricular Ejection Fraction in Patients With Left Ventricular Dysfunction and Good Baseline Endocardial Border Delineation

Sunil Nayyar, MD, Anthony Magalski, MD, Taiyeb M. Khumri, MD, Madhuri Idupulapati, MD, Casey N. Stoner, MA, Lisa L. Kusnetzky, BA, Tina R. Coggins, RDCS, Becky A. Morris, RDCS, and Michael L. Main, MD*

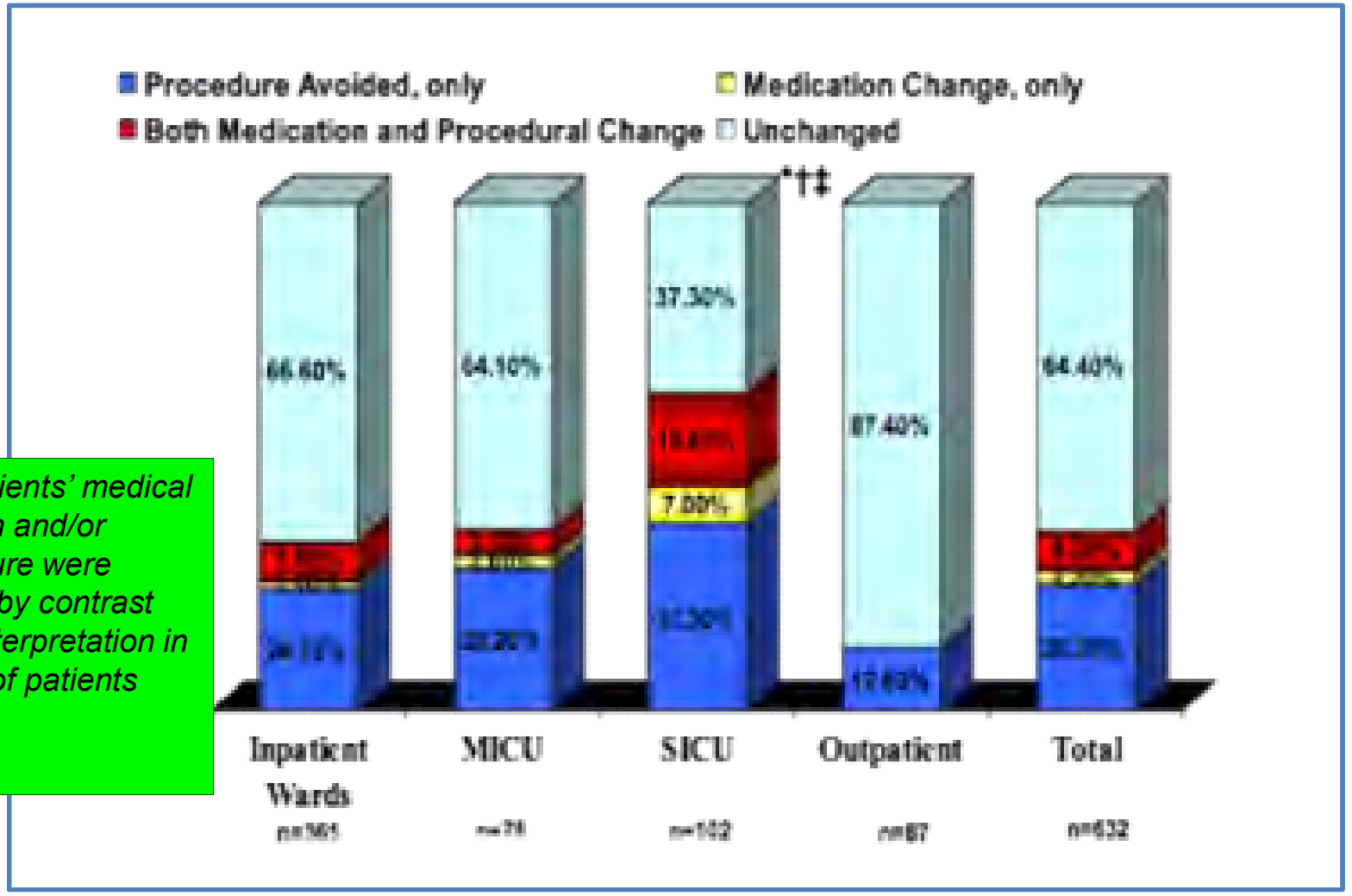


Impact of Contrast on LV EF Assessment



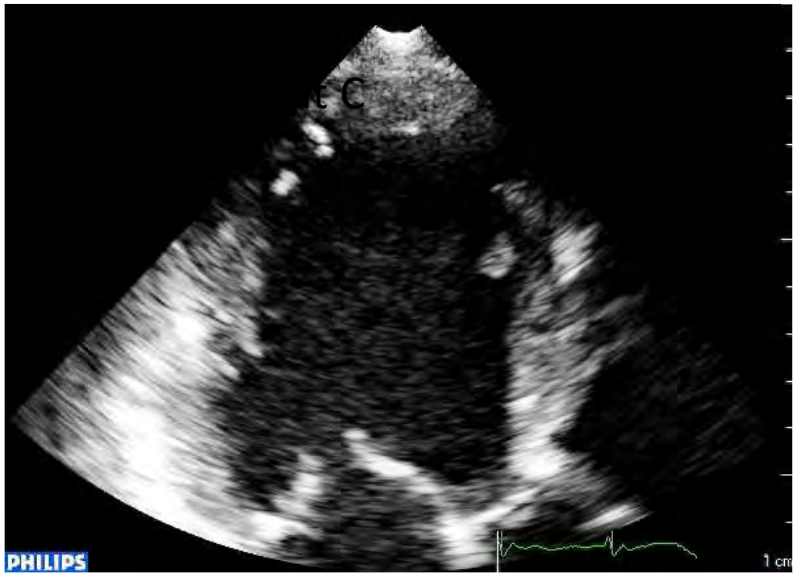
JACC 2009

Total Impact of CE on Patient Management



The patients' medical regimen and/or procedure were altered by contrast echo interpretation in 35.6% of patients

Which patient(s) have LV thrombus?




PHILIPS
1 cm


PHILIPS
1 cm


PHILIPS
1 cm

42 year-old morbidly obese patient with right heart failure

51/M
Lives in Tuen Mun; truck driver
Allergy to aspirin/penicillin

1. 2005 Morbid obesity BIB insertion in attempted twice both not tolerated; gastr
down by anaes because of high GA risk in 2005
2. OSA, RDI 15.8.
3. Asthma
4. 2004 protein losing enteropathy
- Colonoscopy(Apr-05): Patchy congestion of mucosa at ascending colon, bx no viole
- CE(7-June-06): congested SB mucosa
- CT Enteroclysis(July-06): artefacts
- Duodenal histology, culture and parasite:

PWH 23/08/11 Echocardiogram
PWH 22/12/10 Echocardiogram
PWH 27/05/10 Echocardiogram
PWH 21/03/06 Echocardiogram
PWH 20/04/05 Echocardiogram
rology Investigation
iotherapy Record
er Investigation
H 06/12/10 Pulmonary Function Tes
H 25/07/05 Pulmonary Function Tes
H 21/07/05 Pulmonary Function Tes
H 10/06/05 Pulmonary Function Tes
H 08/04/05 Pulmonary Function Tes

All images | Lossless images
PWH 12/11/10 Coronary plain, Coronary+con
PWH 13/10/10 Thorax plain, Thorax+con.
PWH 19/06/10 Brain plain
Breast Imaging
PWH 08/09/04 Mammogram, U/S Breast (Each side)
PWH 08/09/04 Mammogram, U/S Breast (Each side)
Non-Vascular Invasive & IR
Pro
PWH 29/10/04 Pre-US guided procedure diagnostic set, US Bx
Magnetic Resonance Imaging
PWH 30/11/11 MRCP plain
PWH 13/08/10 Abd-std. plain
Nuclear Medicine
PWH 28/02/05 HSA
PWH 08/09/04 HSA
Fluoro. Exam. +- Contras
PWH 28/07/06 ERCP + proced.
TMH 15/11/02 Follow through
TMH 14/08/02 Enema

Corporate Endoscopy Record

Hospital	Date	Endosco
PWH	28/07/2006	OGD
PWH	07/08/2005	OGD
PWH	30/07/2005	OGD
PWH	09/06/2005	OGD
PWH	14/04/2005	Colonosc
PWH	29/12/2004	OGD
PWH	15/11/2004	OGD

l spleen and no ascites
Albumin scan: no evidence of protein losing enteropathy

HPI:
-admitted for USG guided liver biopsy as ?NASH. Proedure done and uneventful, pending liver biopsy result
-Bedside echo was done to rule out right heart failure: RV and LV are in correct proportional dimension with mild RAE and LAE, can't exclude pulmonary embolism, so outpatient V/Q scan and D-dimer were arranged
-patient's BP/P stable, no oozing from biopsy site and no abdominal pain, fit for discharge

Case No.: HN04078954Q Hospital: PWH Admissio

Created Date: 29/10/2004 17:00 User Specialty: MED Patient Sp

Note

M/42
unemployed
ADLi
lives in Tuen Mun with

PMHx:
-Morbid obestiy FU DME
-asthma+ gout FU GP
-venous eczema FU YCH
-suspected OSA pending
-left breast cellulitis
-last admitted for incr
associated with bilater
Hypoalbuminaemia(ALB:24
leading to? transudativ
clinically improved wit

HBsAg, anti-HCV negativ
USG: moderate fatty live
Albumin scan: no evidenc

FU PWH

admitted to our unit for fever, diarrhoea, dyspnoea
with chill and rigor
on & off haemoptysis for 2/12
PND+, orthopnoea+, ankle edema
watery diarrhoea for few days
no RN, no sore throat

usually on lasix 80bd, captopril 6.25 daily, aldactone

admitted with increase fluid retention, SOB, and ches RM

BW increased from 146 (5/2010 discharge BW) -> 155 kg
CXR mild congestion
ECG low voltage same as before.
alb 22 cr 140 static
CT brain NAD

Rx IV lasix 80 q8h x4/7 and 70g albumin IV total
BW decreased gradually to 139kg. clinically no leg oe
Cr 160, K 4.4 tolerable
no reaccumulation of fluid after lasix changed to ora
stop weekly diulo
but prone to toe joint gouty attack.

HPI:
-admitted for USG guided liver biopsy as ?NASH. Proedure done and uneventful, pending liver biopsy result
-Bedside echo was done to rule out right heart failure: RV and LV are in correct proportional dimension with mild RAE and LAE, can't exclude pulmonary embolism, so outpatient V/Q scan and D-dimer were arranged
-patient's BP/P stable, no oozing from biopsy site and no abdominal pain, fit for discharge

BP 127/94
Pulse 95 regular

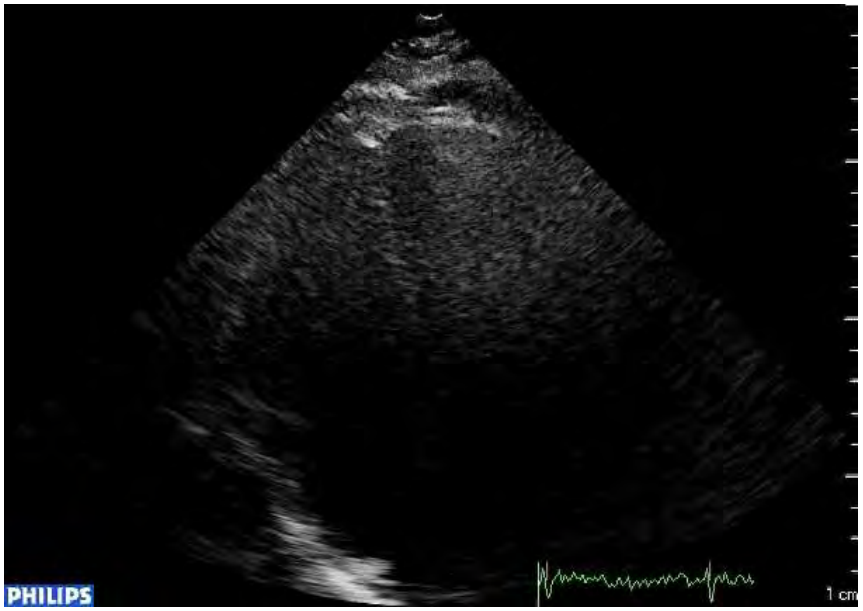
History and Physical Findings:
Mordid obesity,, asthma, OSA, hypoalbuminaemia, ?right herat failure

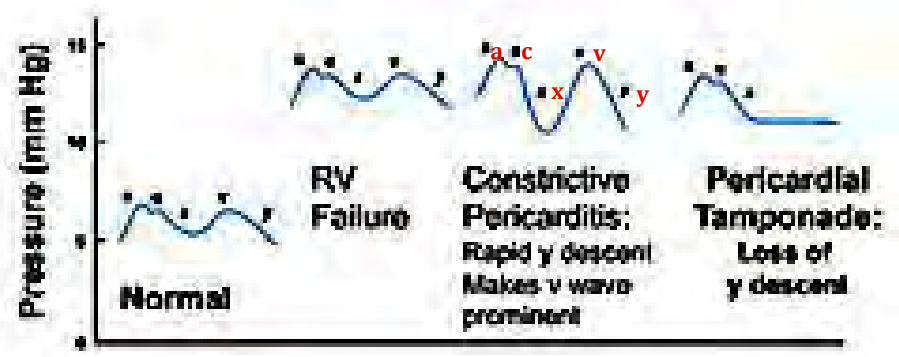
6/2005

Comments:
SUBOPTIMAL ECHO
MILD TR WITH NORMAL PASP
NORMAL LV FUNCTION

8/2007

Comments:
SUBOPTIMAL ECHO IMAGE
NORMAL LV FUNCTION.
NORMAL PASP
LAE




Pressure (mm Hg)
a
c
v
x
y
Normal
RV Failure
Constrictive Pericarditis:
Rapid y descent
Makes v wave prominent
Pericardial Tamponade:
Loss of y descent

Prince of Wales Hospital

Division of Cardiology
Routine Echocardiography Report

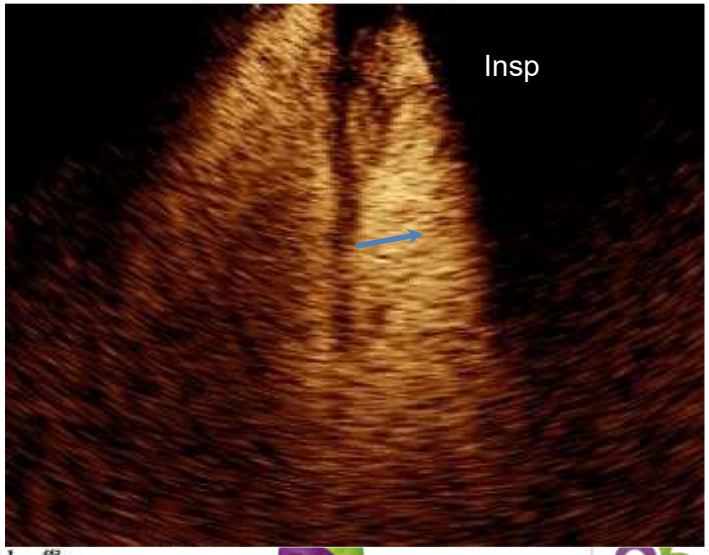
Request :

MO in charge: Dr P W Lee

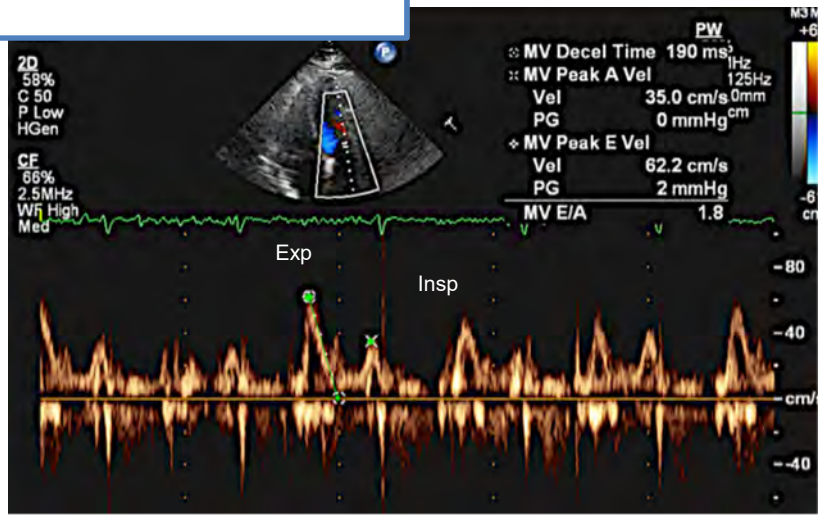
History and Physical Findings:

? constrictive heart. Repeat Echo

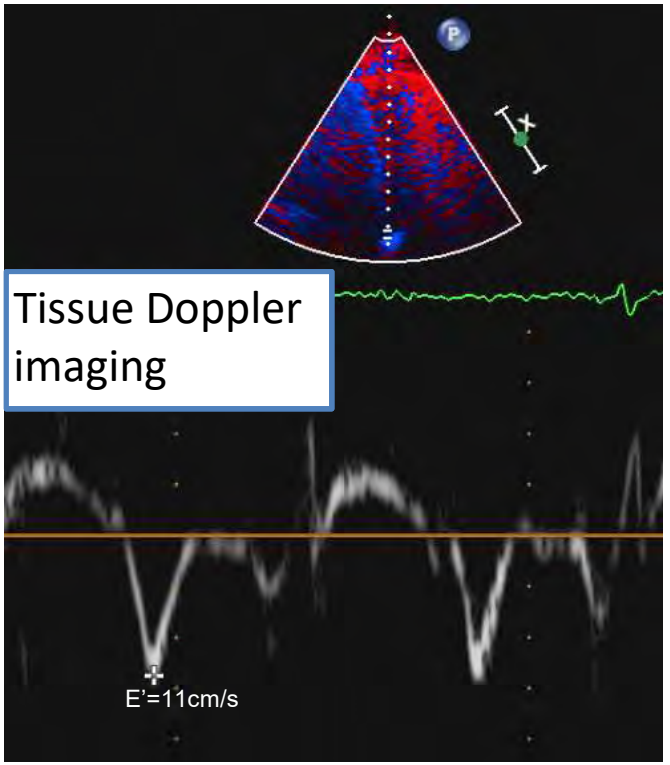
Contrast echo was finally performed



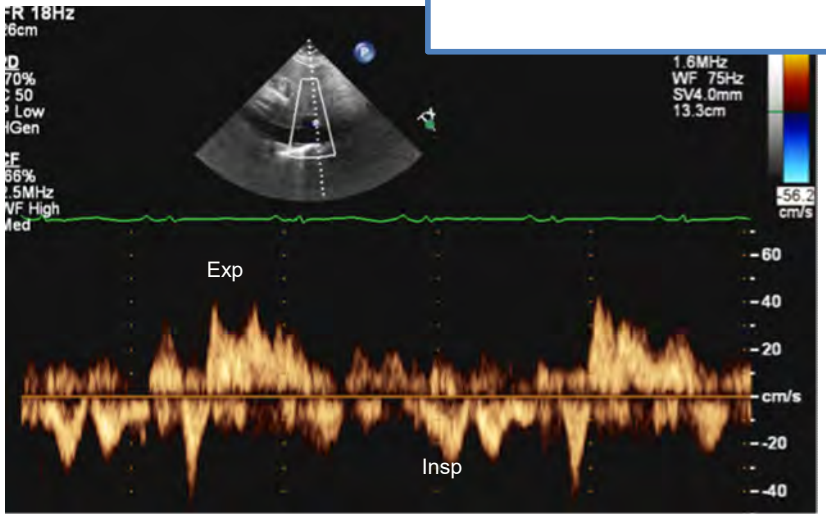
Mitral inflow Doppler

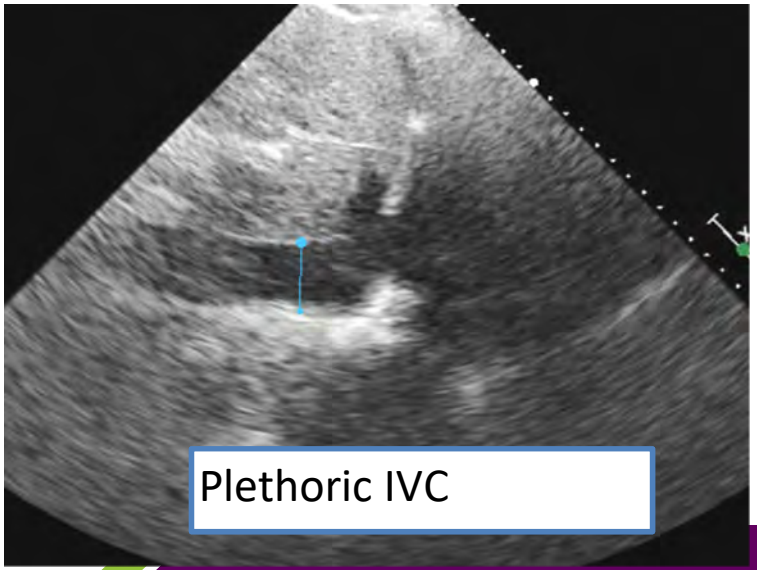


Tissue Doppler imaging



Hepatic vein Doppler





Plethoric IVC

Comments:

There are echo findings suggestive of pericardial constriction: Paradoximal septal motion changing with respiratory cycles, inspiratory decrease in mitral inflow, exaggerated medial E'=11cm/s, expiratory diastolic hepatic vein reversal, grossly dilated IVC (3.1cm).

The left ventricle is normal in size.

There is normal left ventricular wall thickness.

Left ventricular systolic function is normal.

The right ventricle is normal in size and function.

The mitral valve is grossly normal.

The tricuspid valve is not well visualized, but is grossly normal.

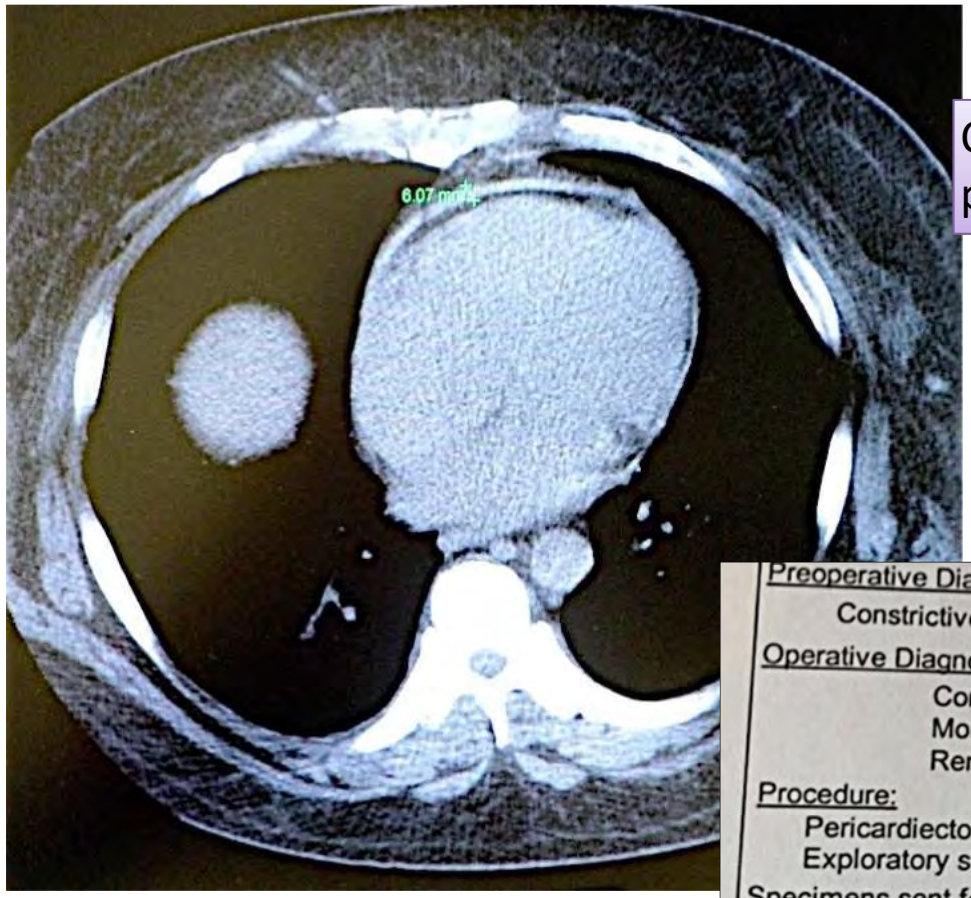
The aortic valve is not well visualized.

The pulmonic valve is not well visualized.

The aortic root is not well visualized.

Reported by Dr.: LEE, Pui Wai (LPW534)

27/5/2010



CT report: Moderately thickened pericardium (6mm)

Preoperative Diagnosis:
Constrictive Pericarditis

Operative Diagnosis:
Constrictive pericarditis (423.2)
Morbid obesity (278.01)
Renal failure (586)

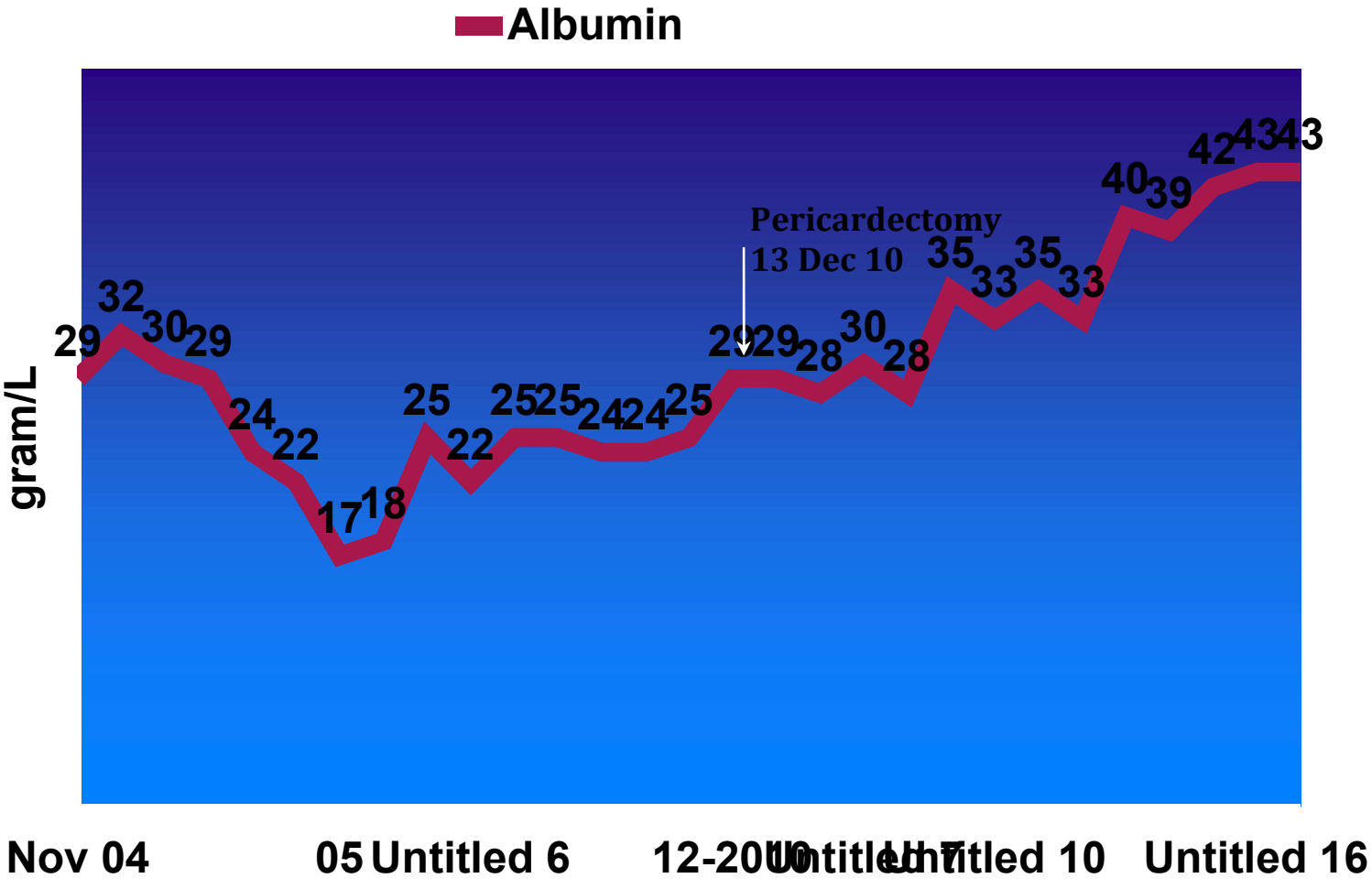
Procedure:
Pericardiectomy (37.31)
Exploratory sternotomy (77.31)

Specimens sent for Pathological Examination:

Findings:
The LV and RV, LA and RA were covered by thickened fibrous pericardium
No pericardial effusion
Marked improvement in LV and RV distension after resection of the pericardium

OT: 13/12/201

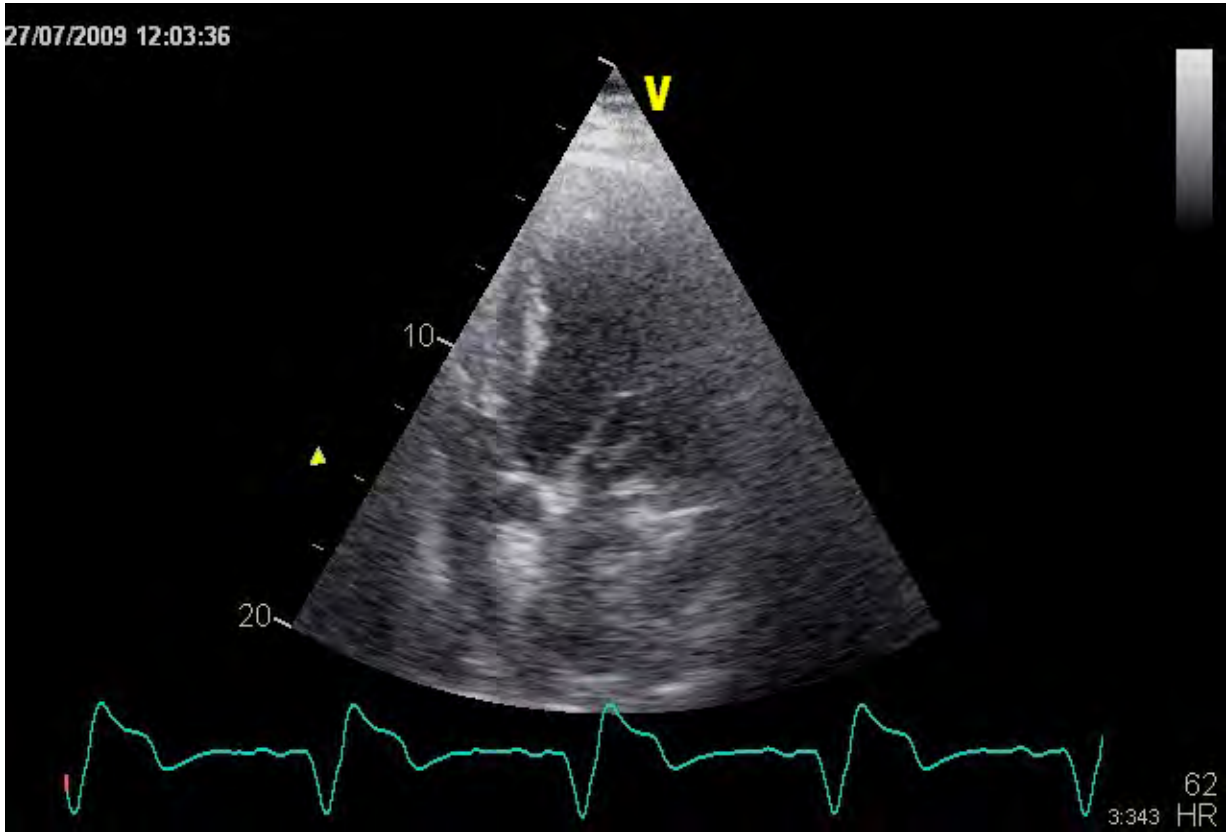
Histology report: chronic pericardial inflammation and fibrosis but etiology unknown

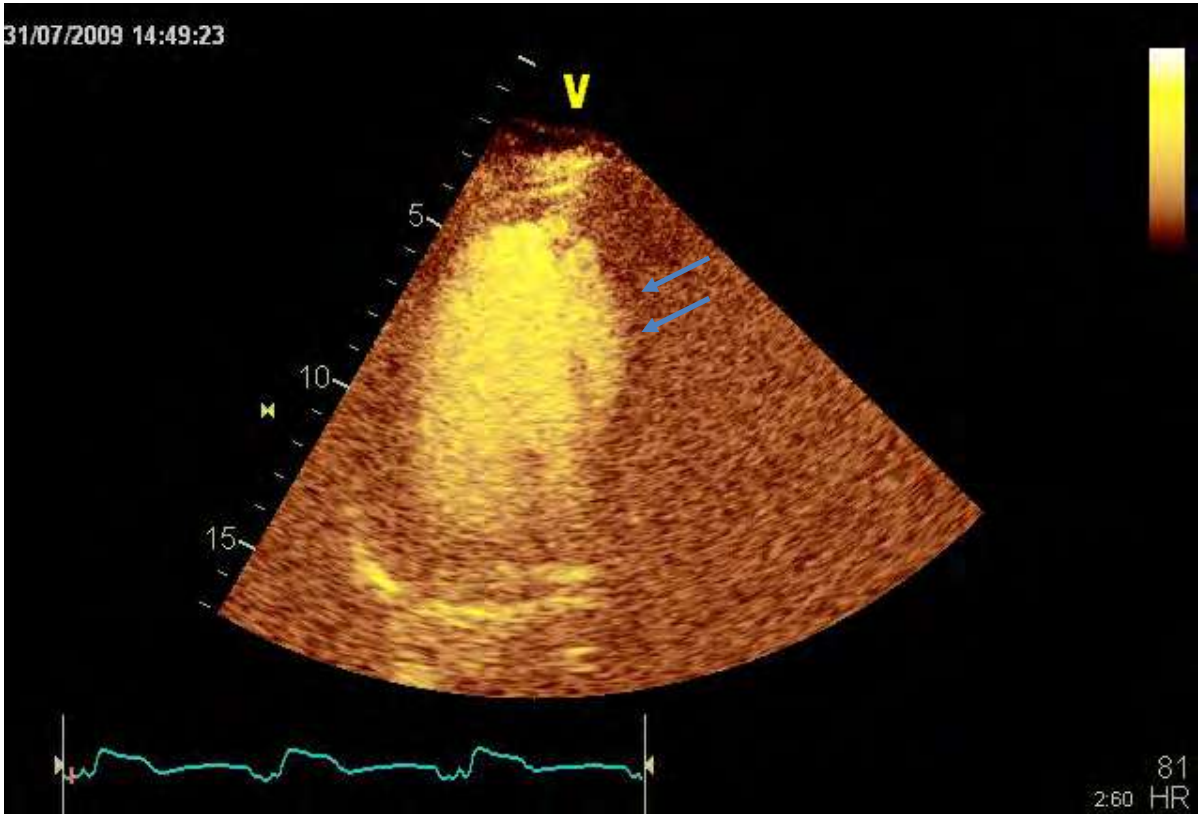


香港中文大學
The Chinese University of Hong Kong

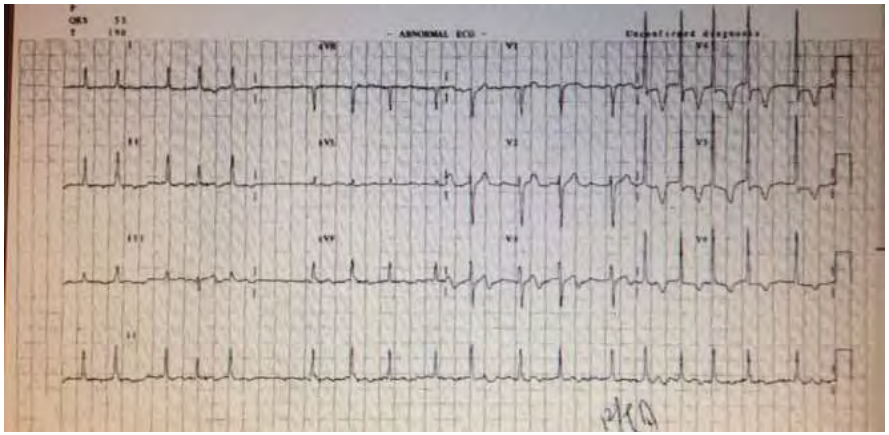
Faculty of Medicine
The Chinese University of Hong Kong

1. Is the LV function normal?
2. Is there an regional wall motion abnormality?




31/07/2009 14:49:23
V
5
10
15
81
2:60 HR

Case 1
M/67
New onset AF
Hypertension
No history of stroke/DM/CHF



What is your anticoagulation option?

1. Nothing
2. Aspirin or warfarin
3. Warfarin
4. New oral anticoagulant

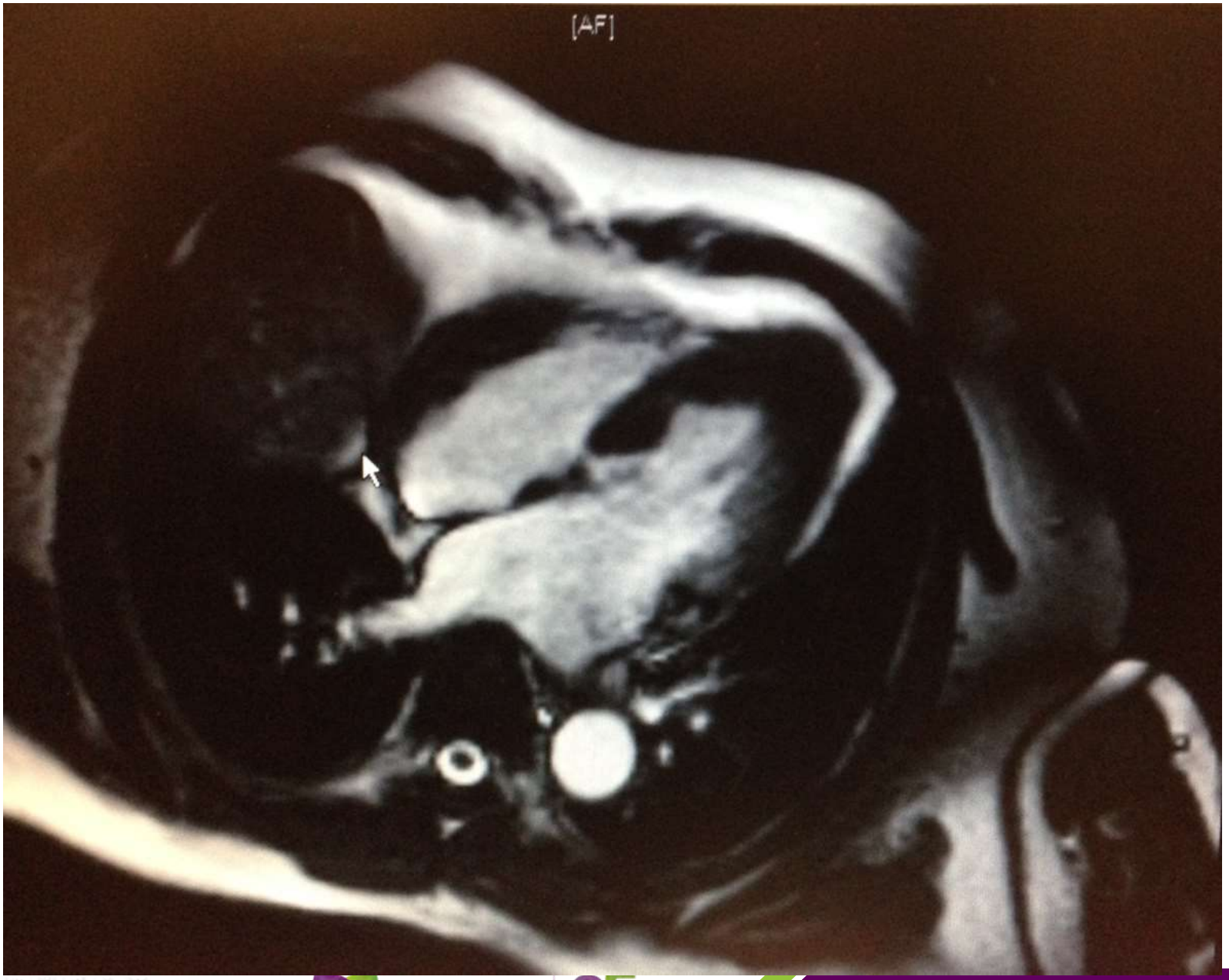
Initial Management

- Offered aspirin or warfarin
- Patient opt for aspirin
- Patient could not afford NOAC and did not want to take warfarin
- Betaloc for AF rate control

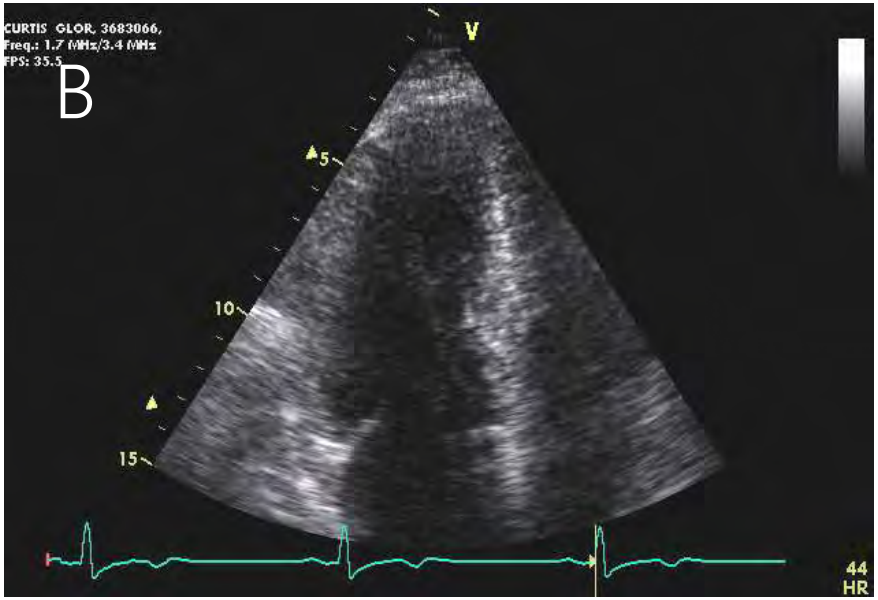
In the subsequent 6 months

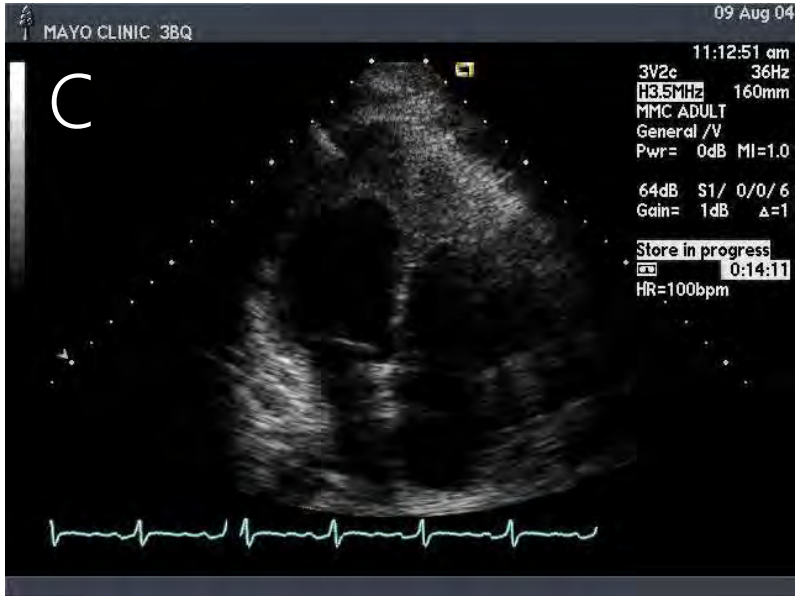
- 2 strokes with fair recovery
- Ischemic bowel with resection


PHILIPS
1 cm


[AF]


A


CURTIS GLOR, 3683066,
Freq.: 1.7 MHz/3.4 MHz
FPS: 35.5
B
V
5
10
15
44
HR

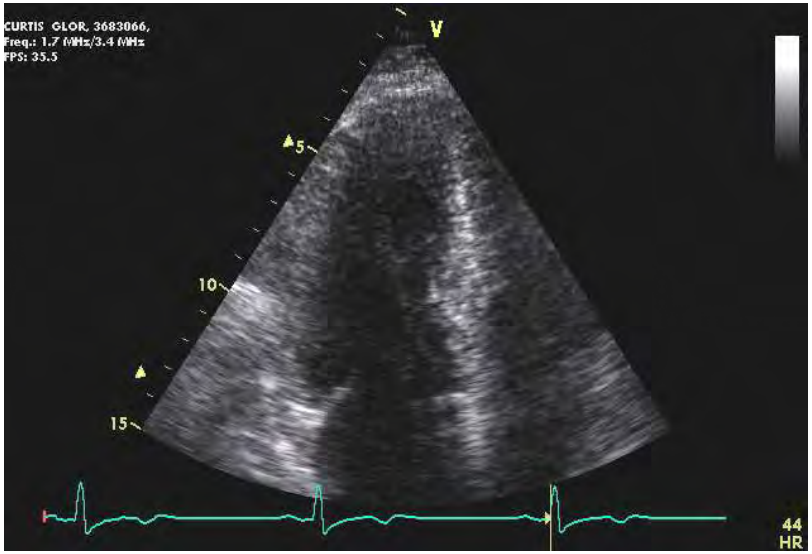

MAYO CLINIC 3BQ
09 Aug 04
11:12:51 am
C
3V2c
36Hz
H3.5MHz
160mm
MMC ADULT
General /V
Pwr= 0dB MI=1.0
64dB S1/ 0/0/6
Gain= 1dB Δ=1
Store in progress
0:14:11
HR=100bpm

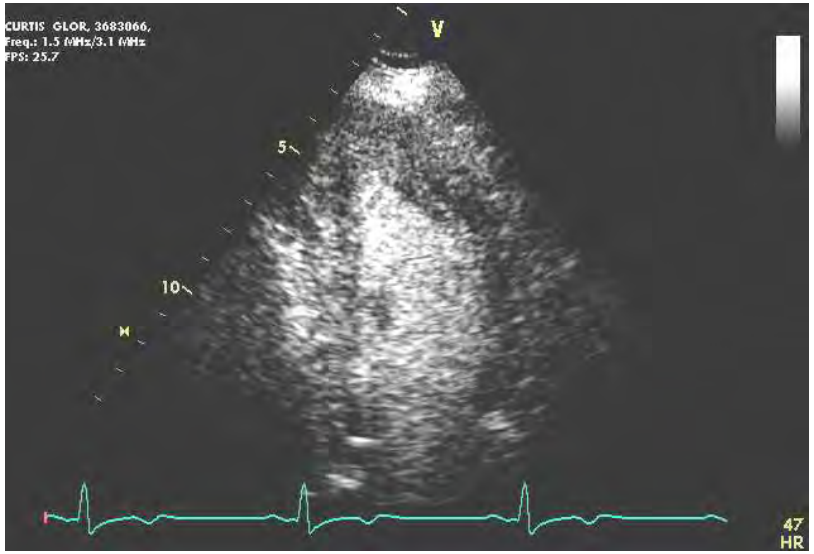
Non-compaction cardiomyopathy

M/32
Shortness of breath

Apical hypertrophic cardiomyopathy

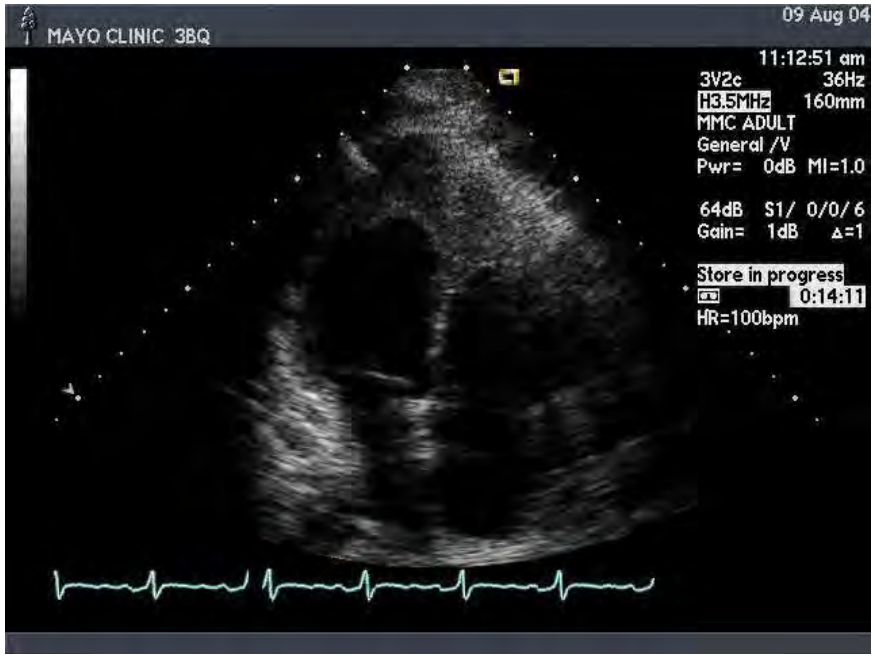
M/65
AF
Transient right hemiplegia

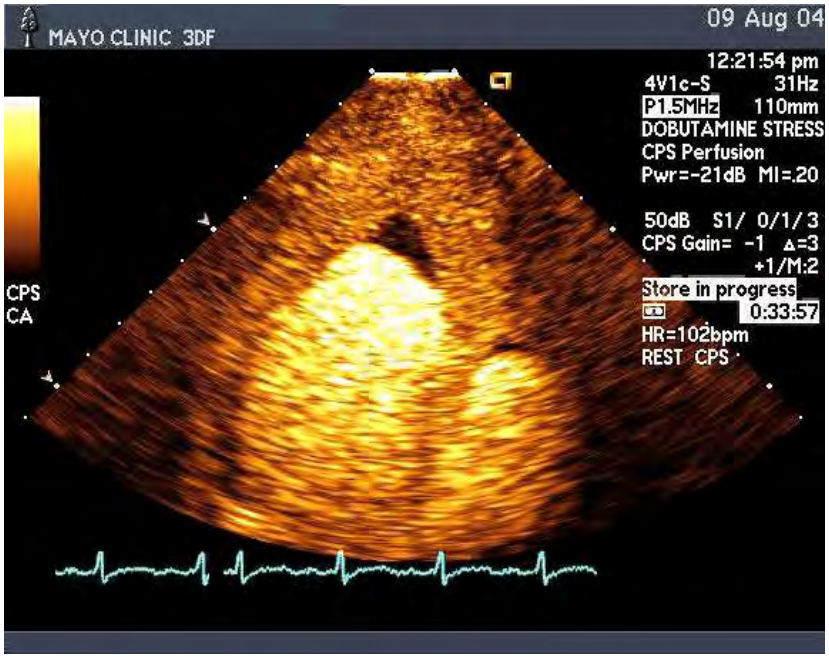




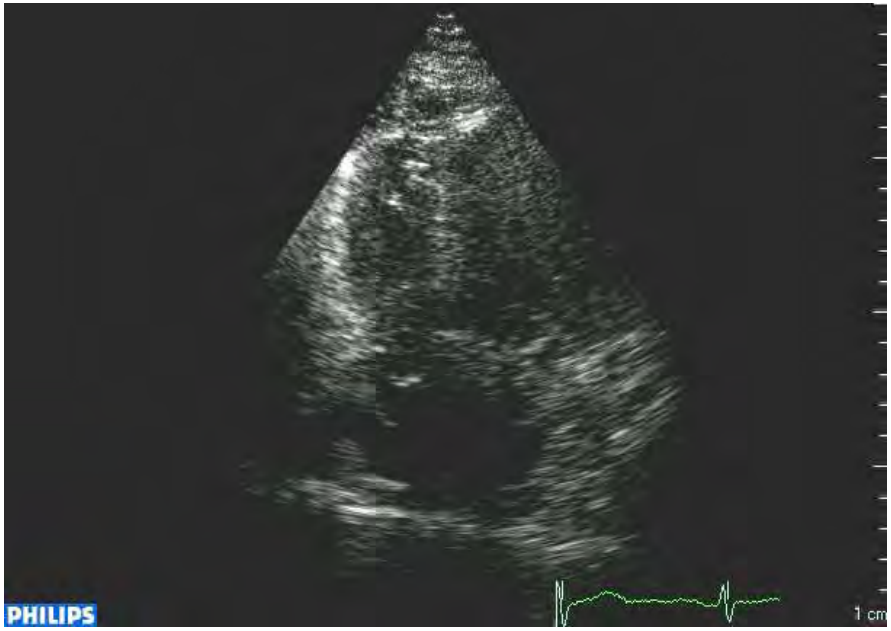
Hypereosinophilic cardiomyopathy

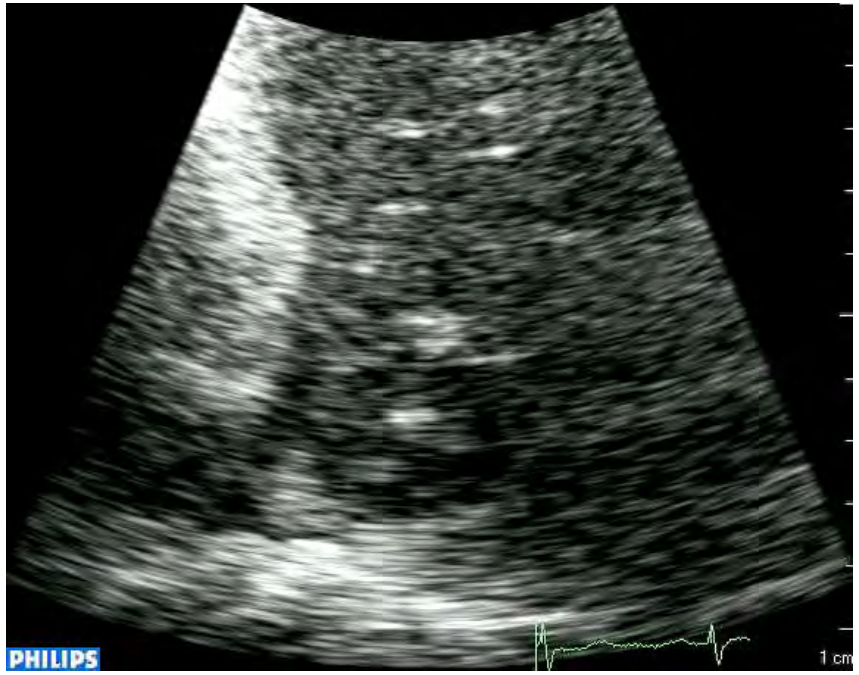
F/42
Shortness of breath
Asthmatic attack

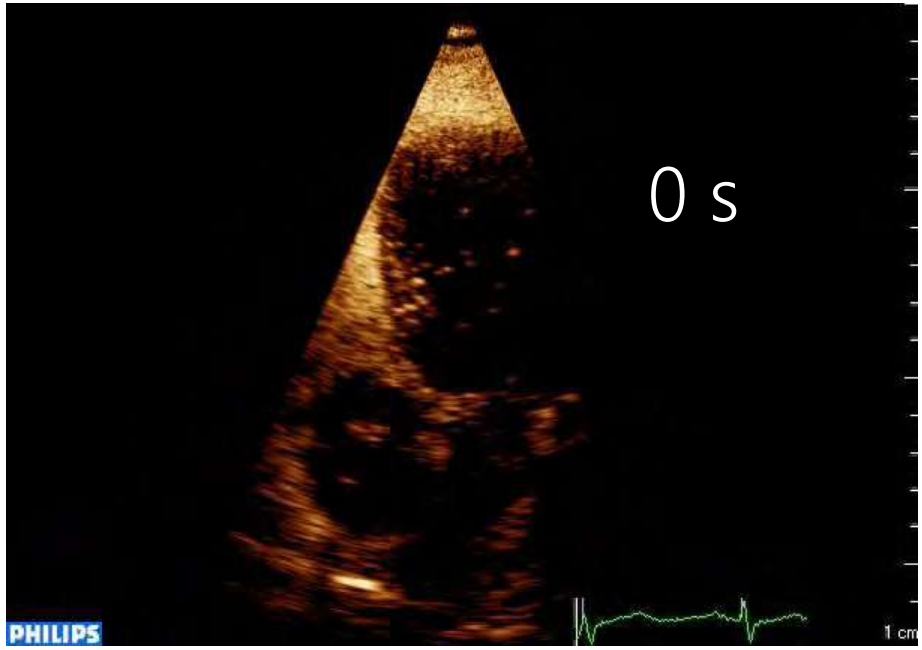


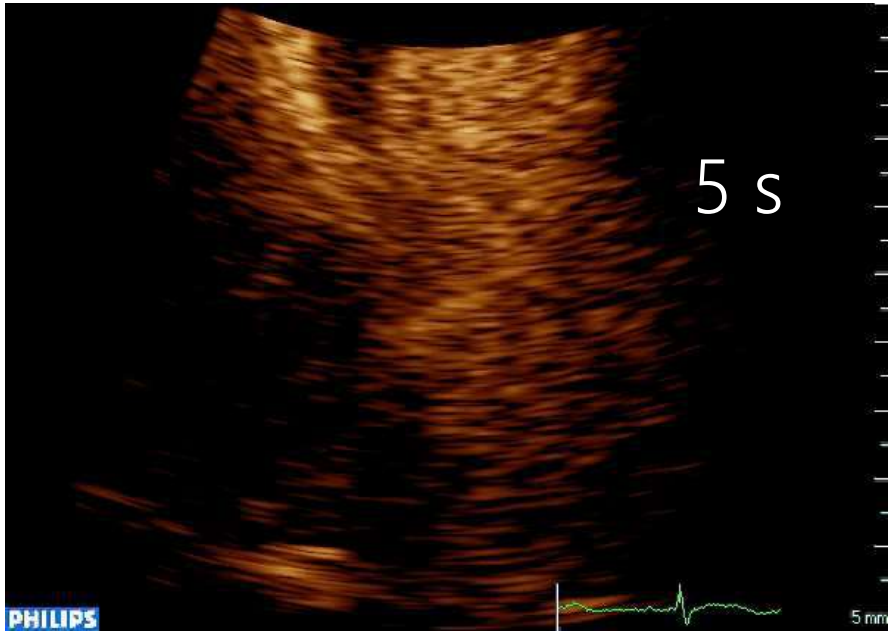


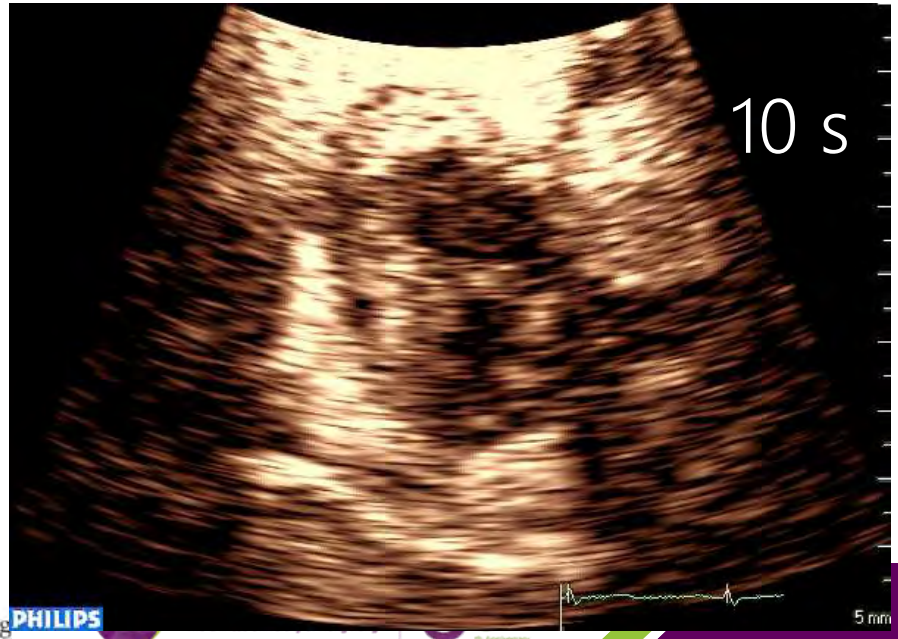
F/72
Chest discomfort

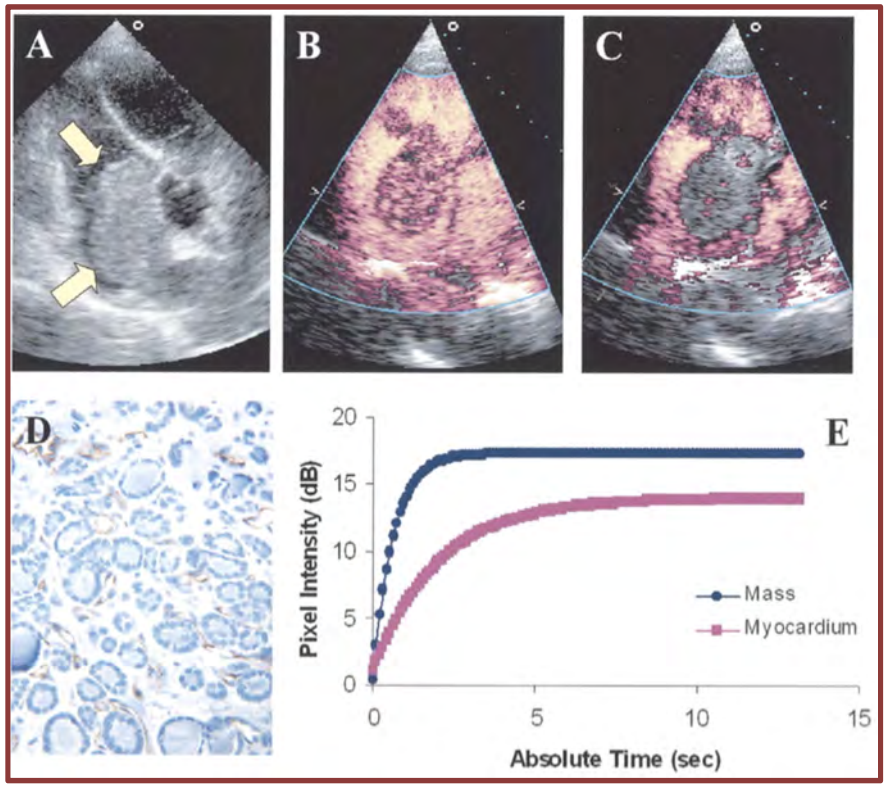




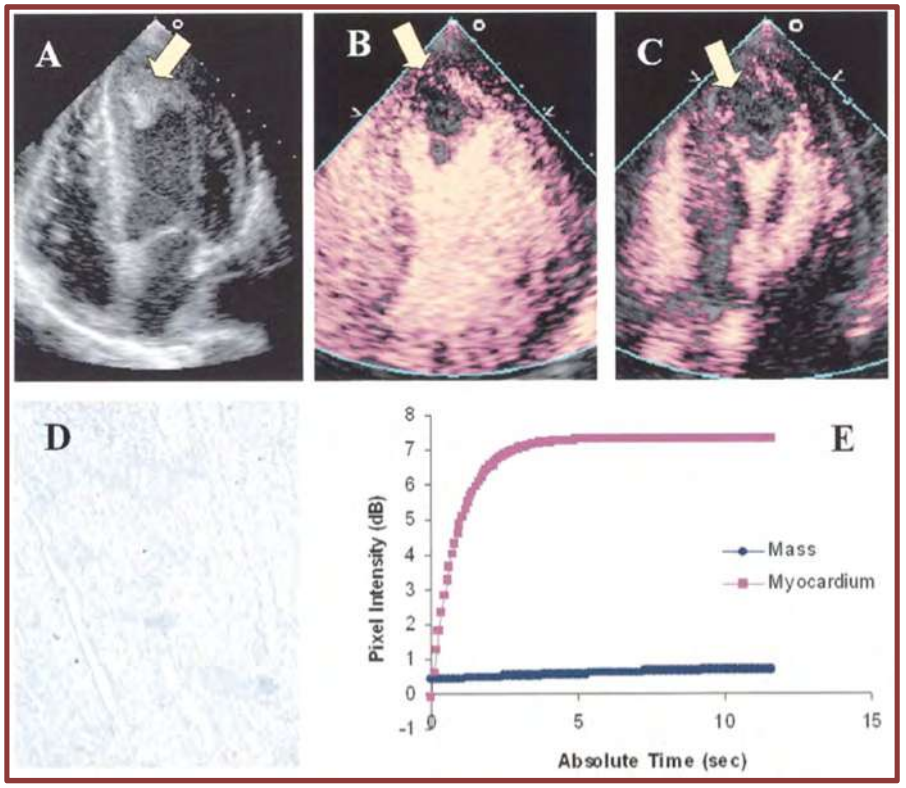

0 s
PHILIPS


5 s
PHILIPS

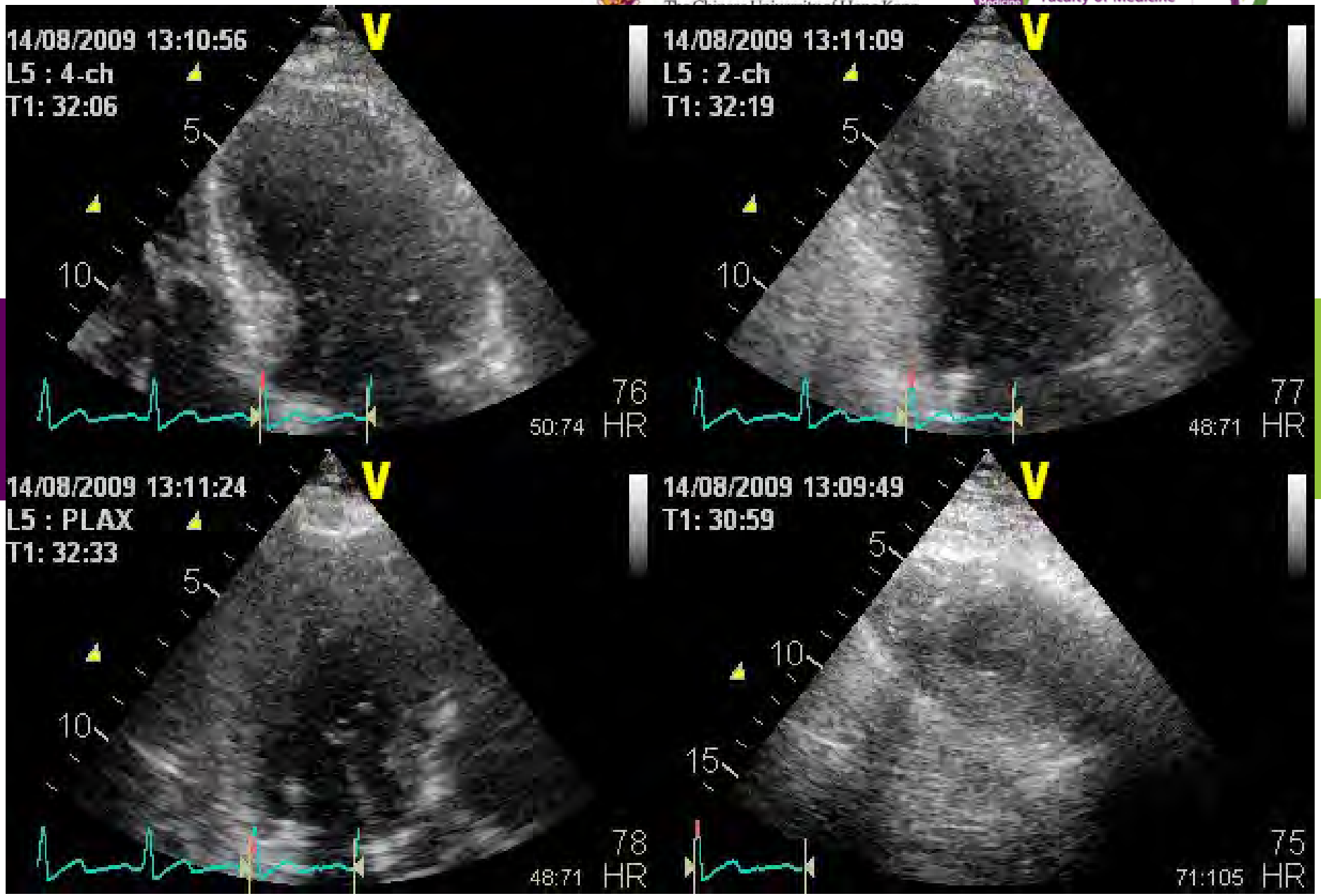

10 s
PHILIPS

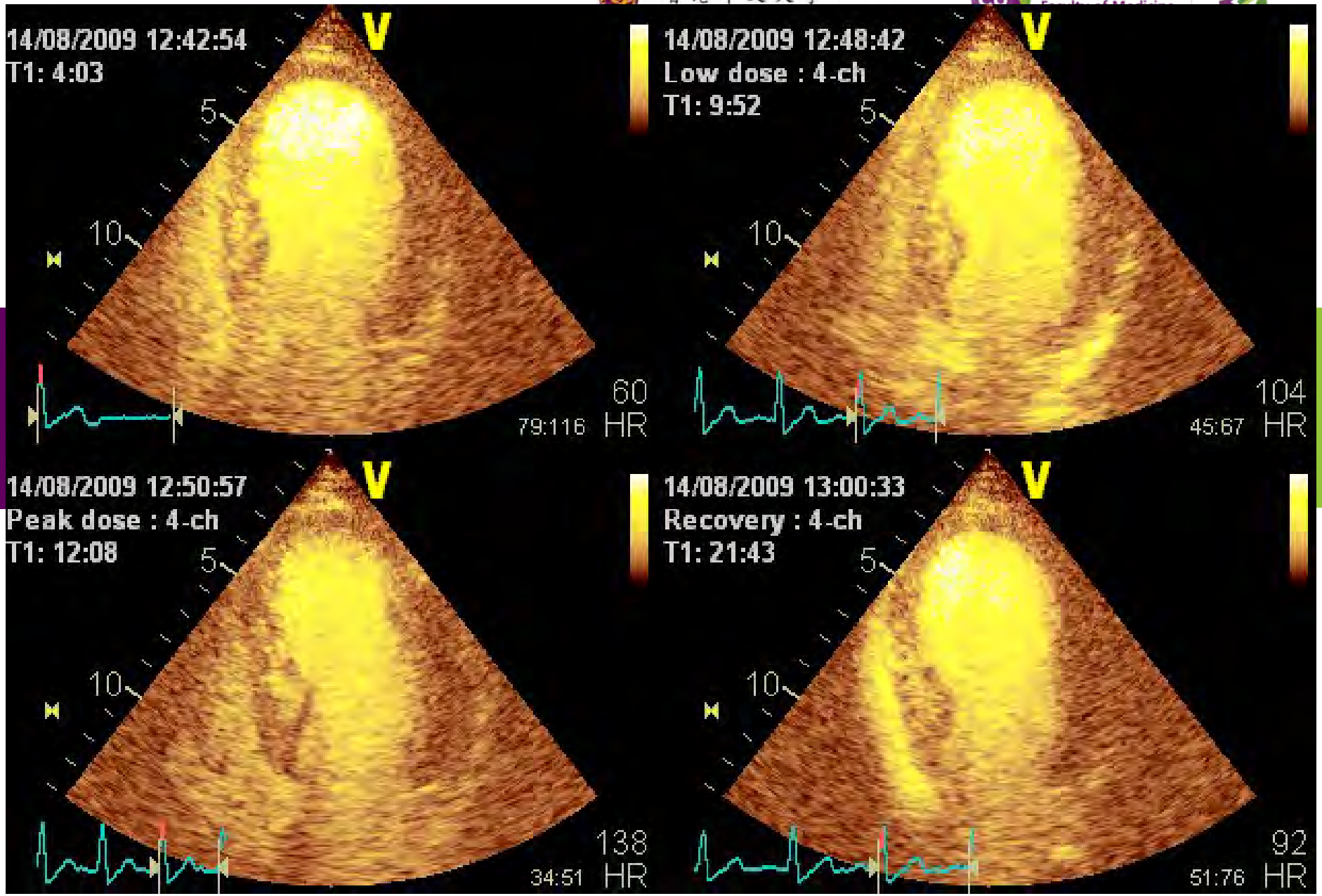


Vascular tumour

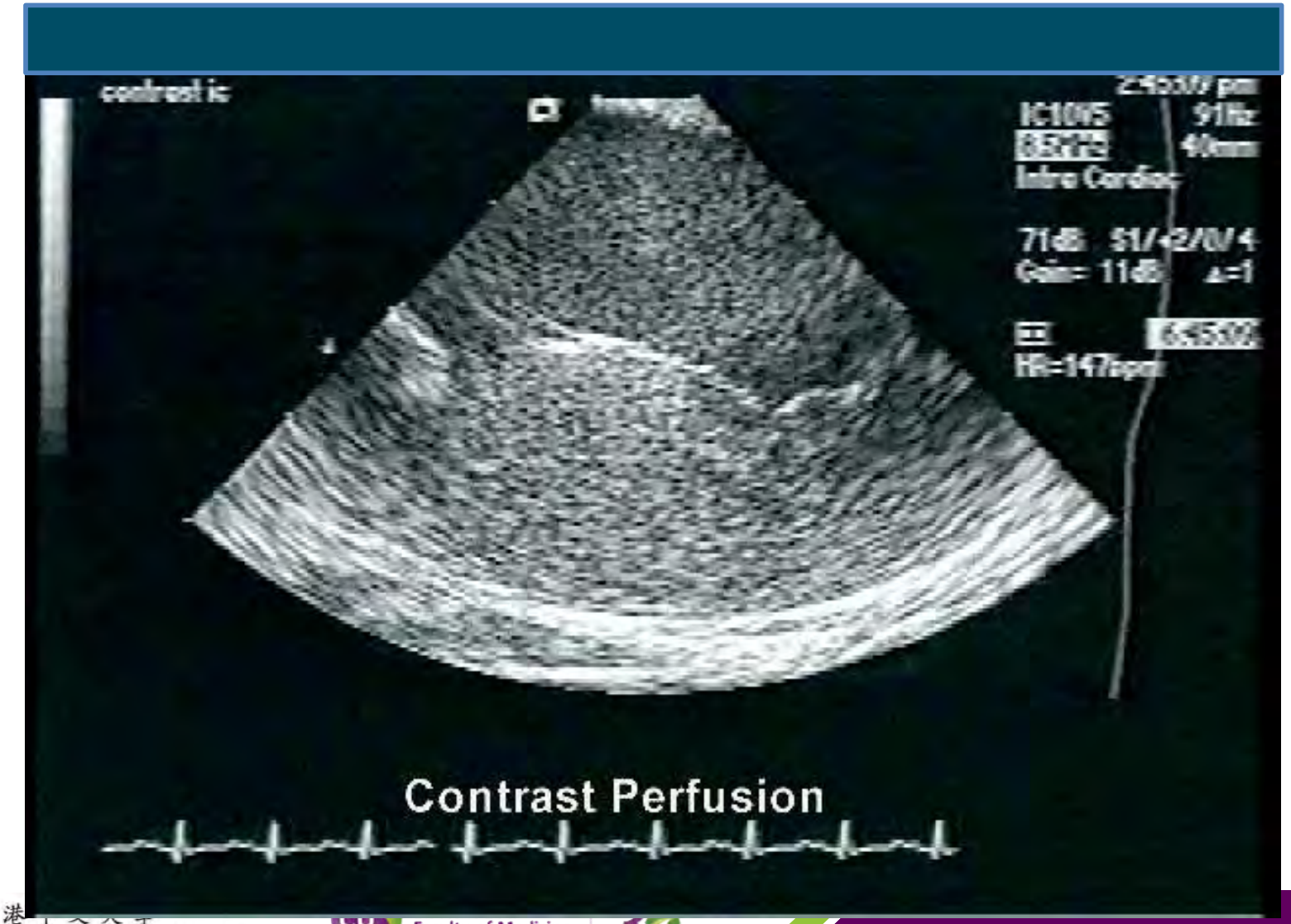


Thrombus

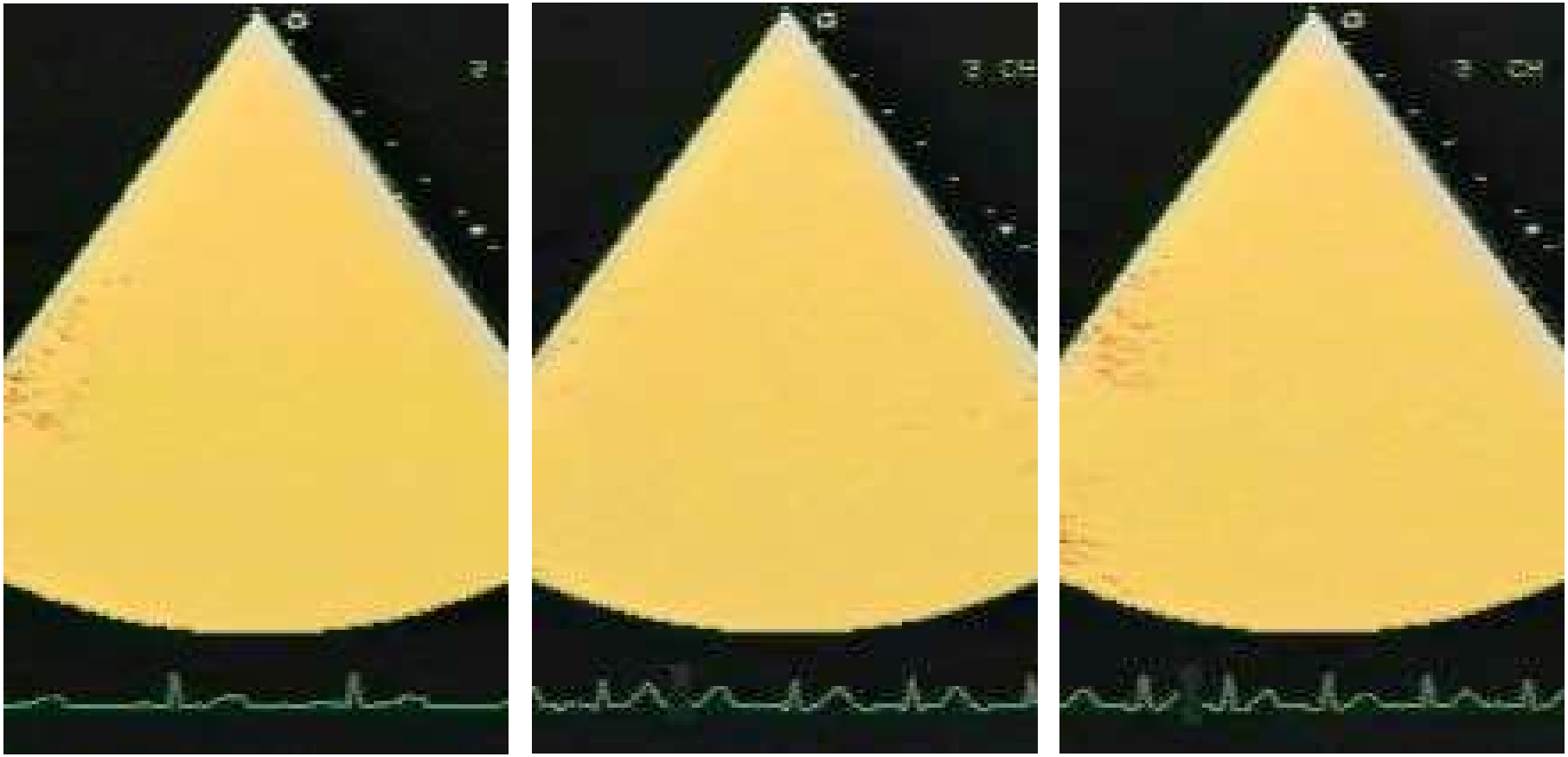

14/08/2009 13:10:56
L5 : 4-ch
T1: 32:06
76
50:74 HR
14/08/2009 13:11:09
L5 : 2-ch
T1: 32:19
77
48:71 HR
14/08/2009 13:11:24
L5 : PLAX
T1: 32:33
78
48:71 HR
14/08/2009 13:09:49
T1: 30:59
75
71:105 HR

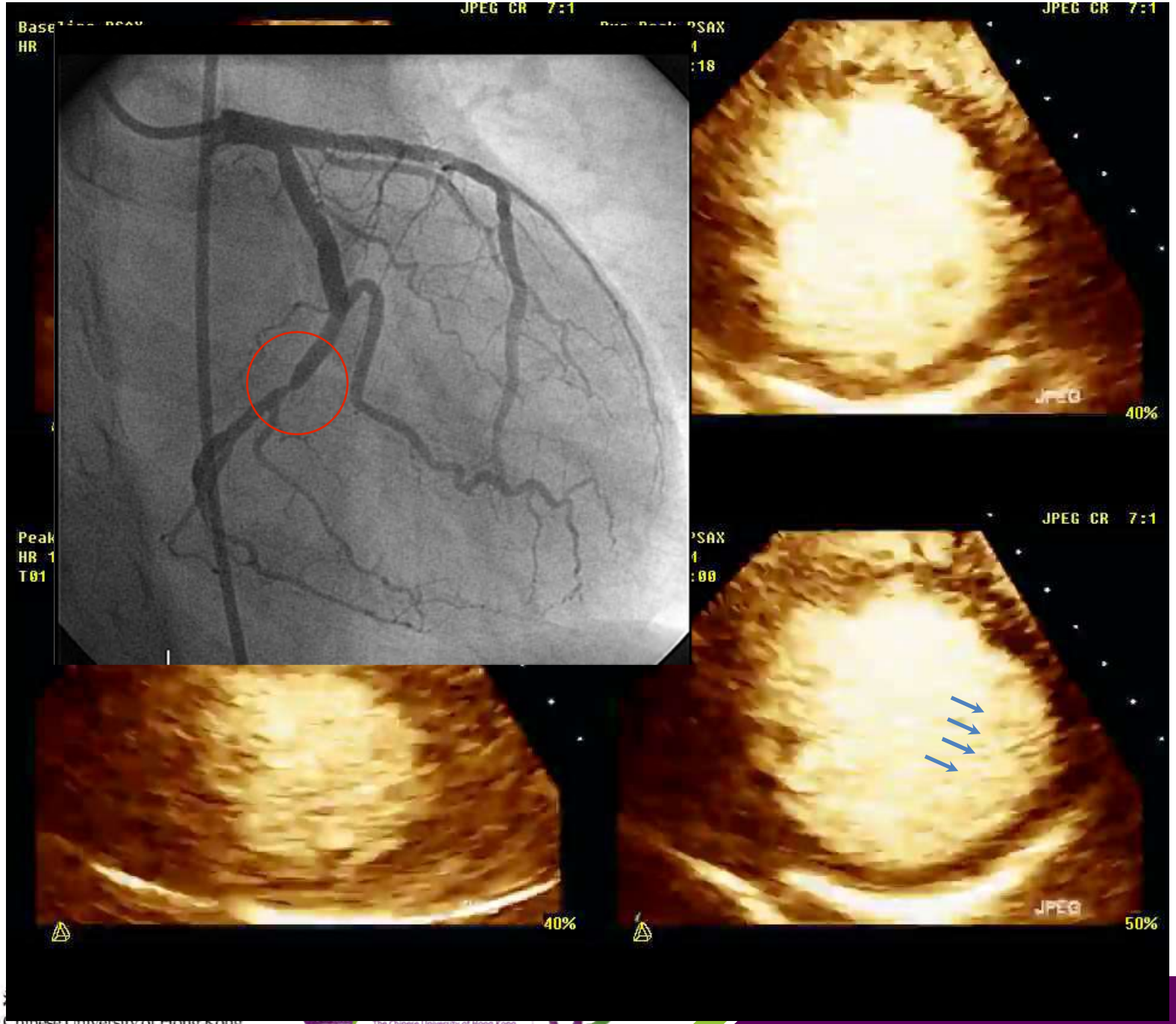

14/08/2009 12:42:54
T1: 4:03
5
10
60
79:116 HR
14/08/2009 12:48:42
Low dose : 4-ch
T1: 9:52
5
10
104
45:67 HR
14/08/2009 12:50:57
Peak dose : 4-ch
T1: 12:08
5
10
138
34:51 HR
14/08/2009 13:00:33
Recovery : 4-ch
T1: 21:43
5
10
92
51:76 HR

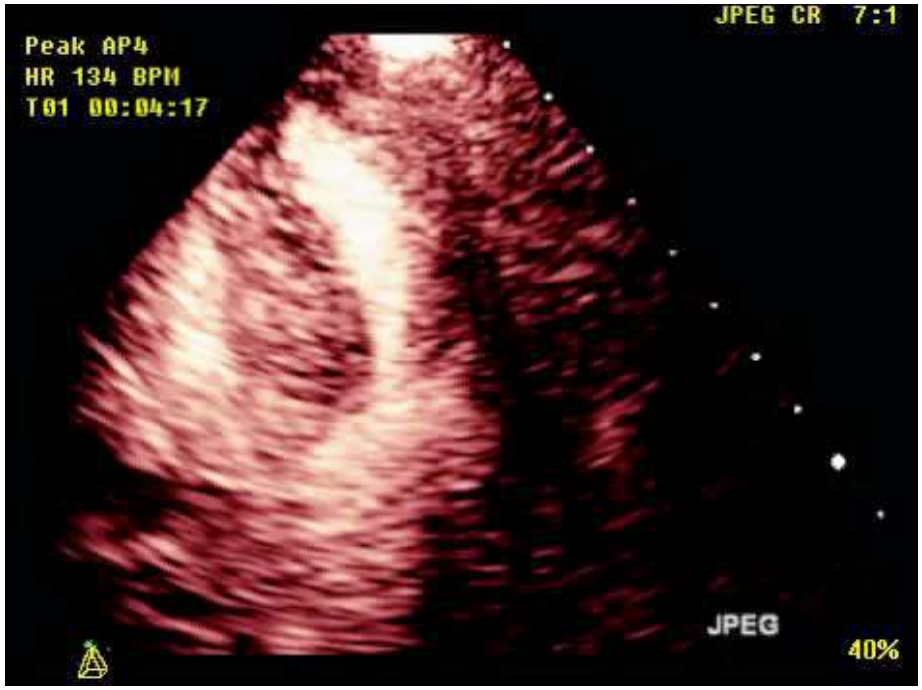
Myocardial Contrast Echocardiography (MCE)

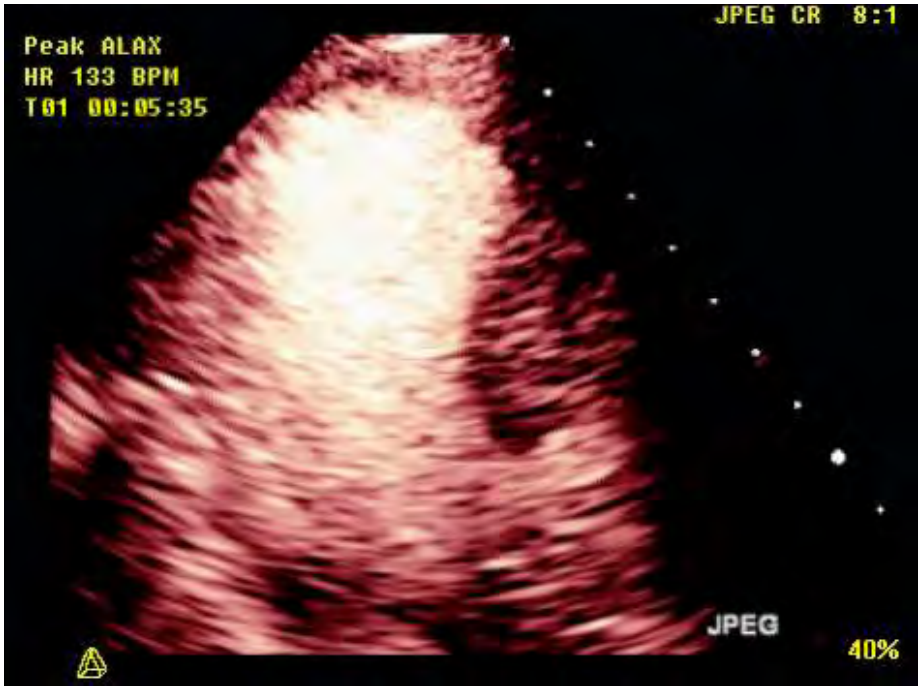


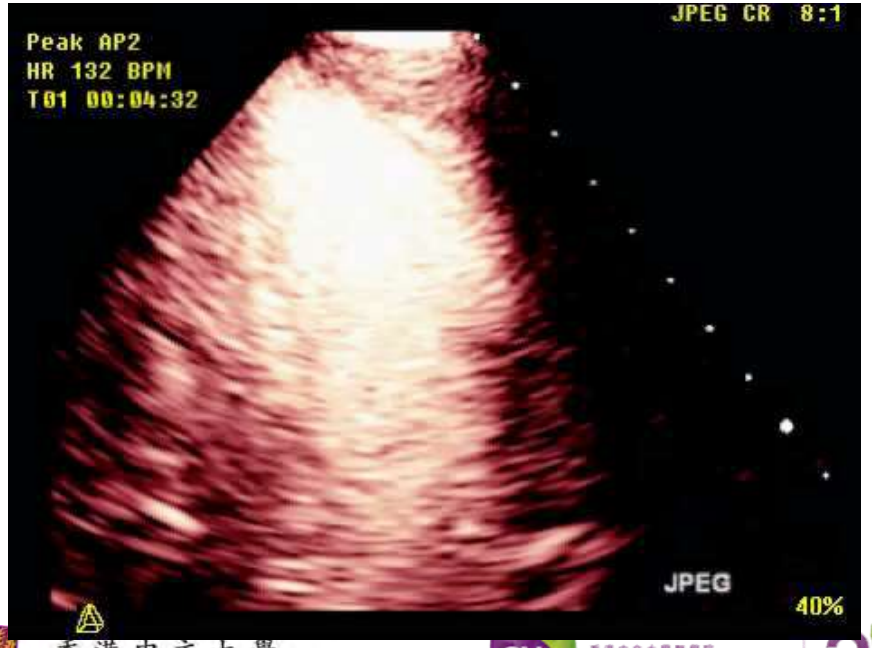
Hypoperfusion of LCx territory on MCE




JPEG CR 7:1
HR
JPEG CR 7:1
40%
JPEG CR 7:1
40%
JPEG
50%

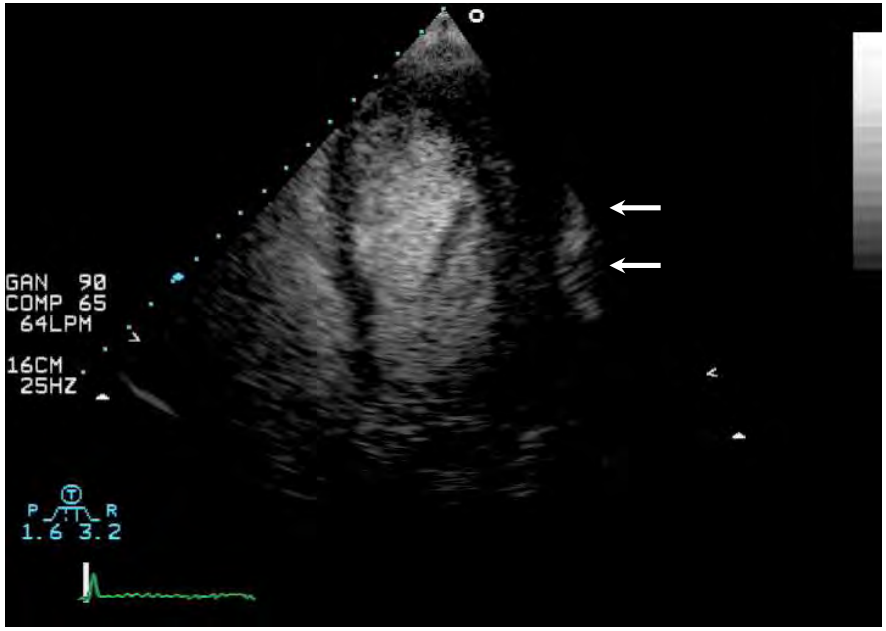

JPEG CR 7:1
Peak AP4
HR 134 BPM
T01 00:04:17
JPEG
40%


JPEG CR 8:1
Peak ALAX
HR 133 BPM
T01 00:05:35
JPEG
40%


JPEG CR 8:1
Peak AP2
HR 132 BPM
T01 00:04:32
JPEG
40%


JPEG CR 10:1
Pre-Peak APEX
HR 129 BPM
T01 00:02:26
JPEG
40%

F/64
3 days post STEMI
Hypotension

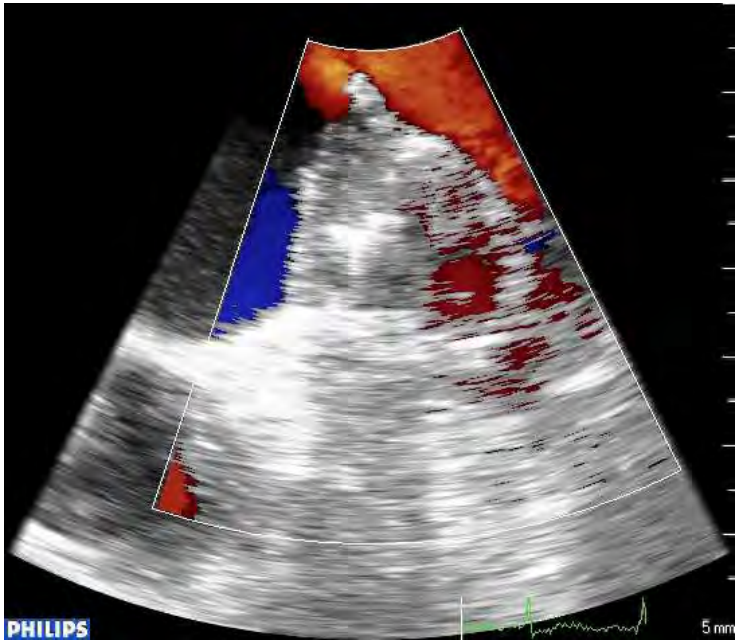

GAN 90
COMP 65
64LPM
16CM
25HZ
P R
1.6 3.2


2DG
83
DR
55
24 fps
F: 1
E: 9
01:40
AP100%
Flash Recording
Flash CINE Stored

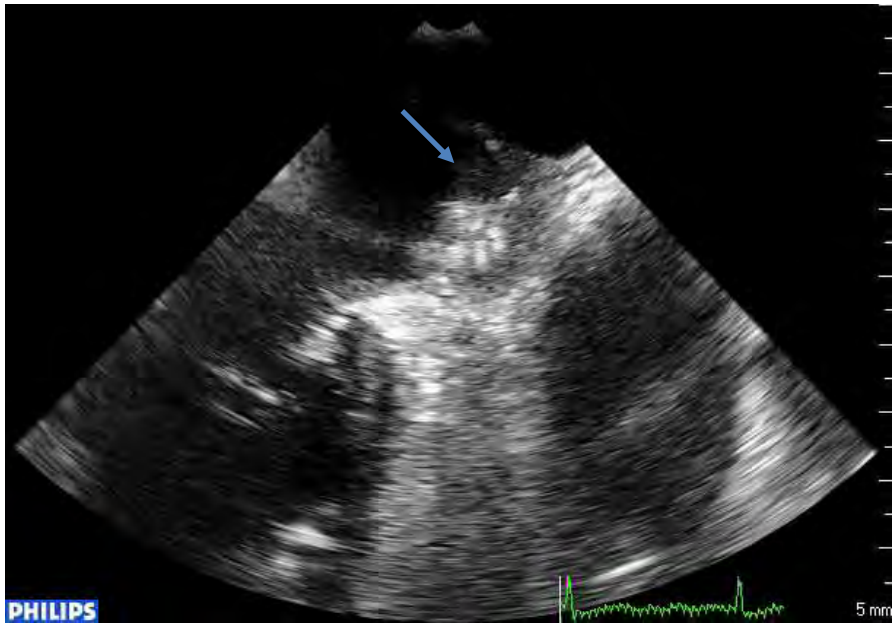

19.3
19.3
cm/s
552
T3.6
CF 2.5
20 fps
2DG
84
DR
60
CG
50
PRF
3.8k
Filter
5

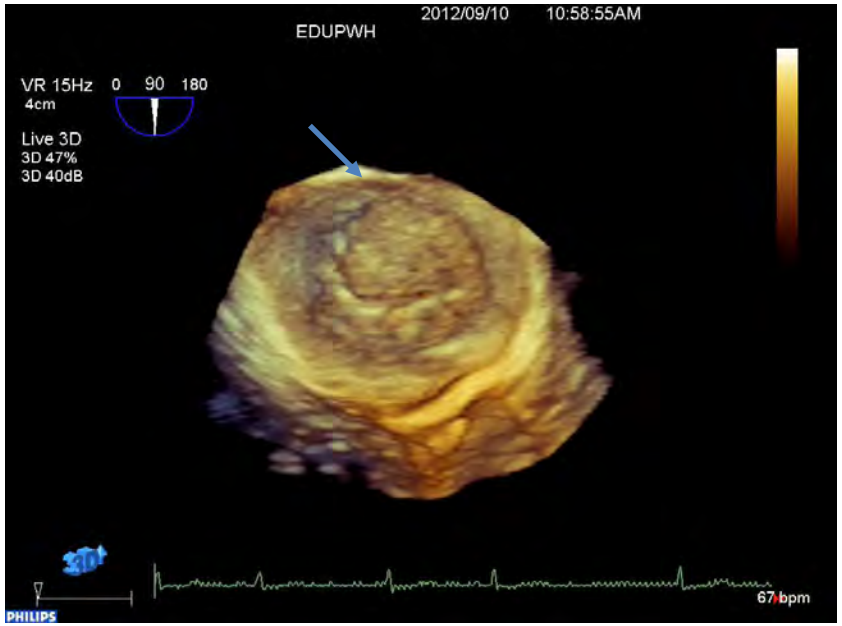
M/81 AF CHADS2=4, HASBLED=4
LAA occlusion with Watchman
Day 40 TEE

Persistent LAA opacification with contrast



TEE
Day 60


PHILIPS
5 mm


EDUPWH
2012/09/10
10:58:55AM
VR 15Hz
4cm
0
90
180
Live 3D
3D 47%
3D 40dB
PHILIPS
67 bpm

History

- A 52-year-old woman underwent radiofrequency ablation for paroxysmal AF
- After transeptal puncture, heparin 5,000 IU was given followed by continued infusion
- Activated clotting time ~ 270s
- Became suddenly hypotensive during the procedure

TTE 1 day before the procedure

Focused TTE (performed by electrophysiologist) during AF ablation

- Described: “A large left atrial mass suspicious of a thrombus; pericardial effusion”
- AF ablation was abandoned
- Urgent cardiac CT performed

CT

Question 1: Where is the mass?

A. Inside the LA (intra-cardiac)
B. Outside the LA (extra-cardiac)

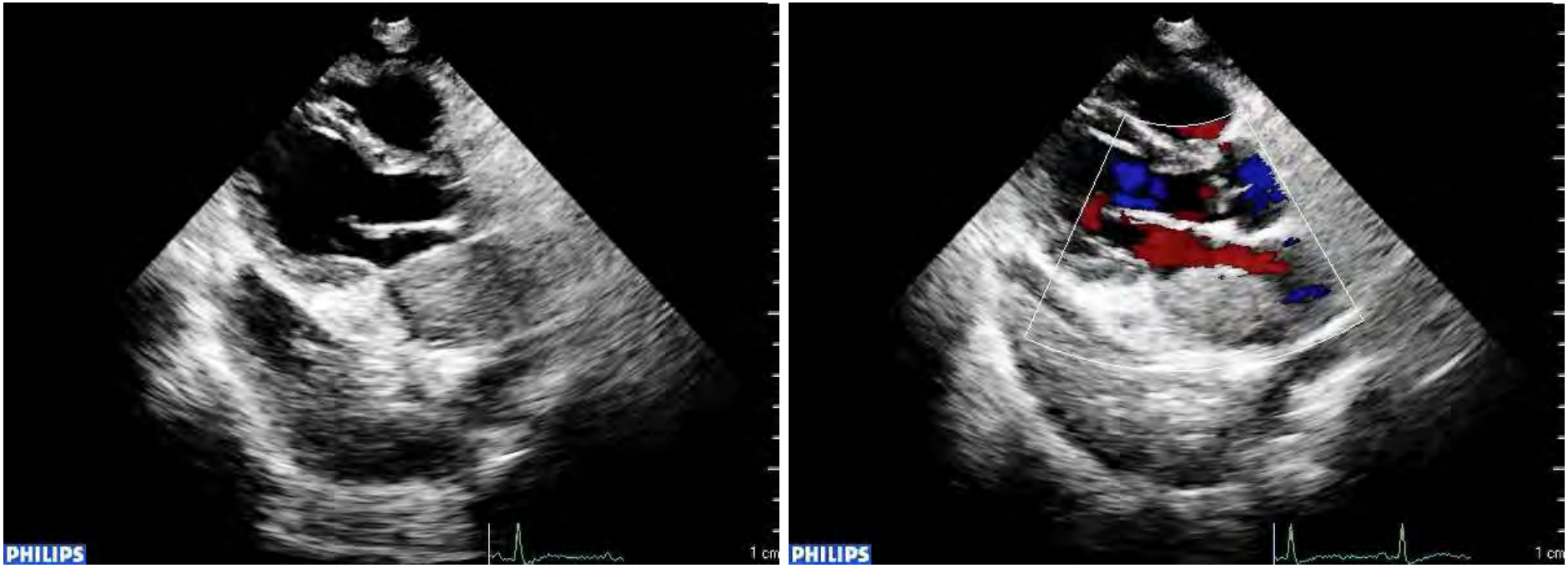
CT report

- A large ***extracardiac*** mass compression on the LA
- Consistent with ruptured LA with hemopericardium

Question 2: What to do next?

A. TTE (by an echo expert)
B. TEE
C. MRI
D. Not necessary, the CT findings are definitive, call the surgeon

TTE 3 days after AF ablation



TTE 3 days after AF ablation

TTE 3 days after AF ablation

Apical 4Ch view

Parasternal basal SAX view

Question 3: Where is the mass?

A. Inside the LA (intra-cardiac)
B. Outside the LA (extra-cardiac)

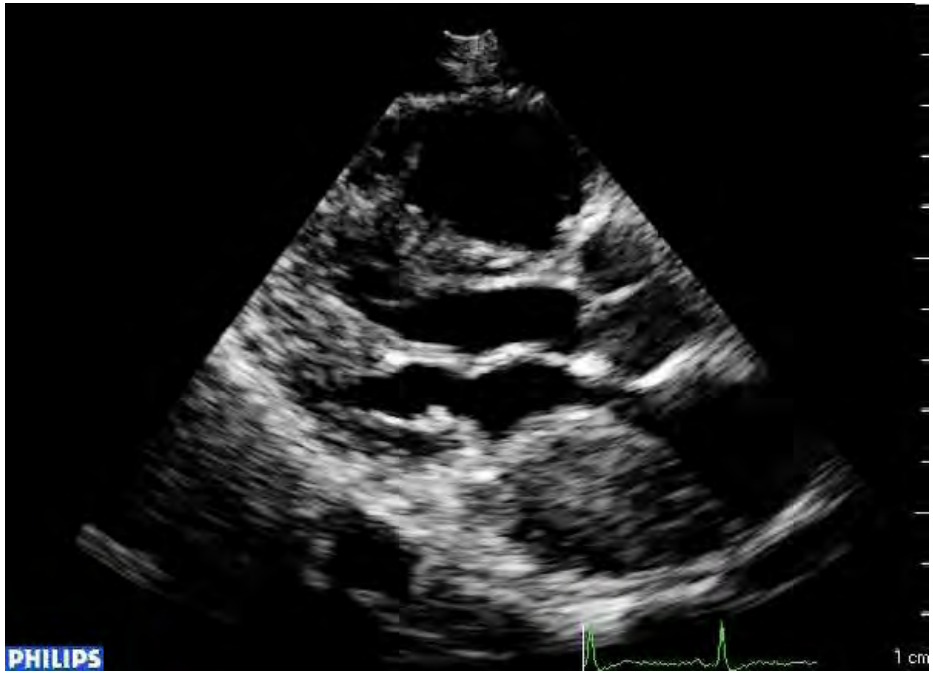
Question 4: What would be your anti-coagulation strategy?

A. Continue anticoagulation
B. Stop anticoagulation

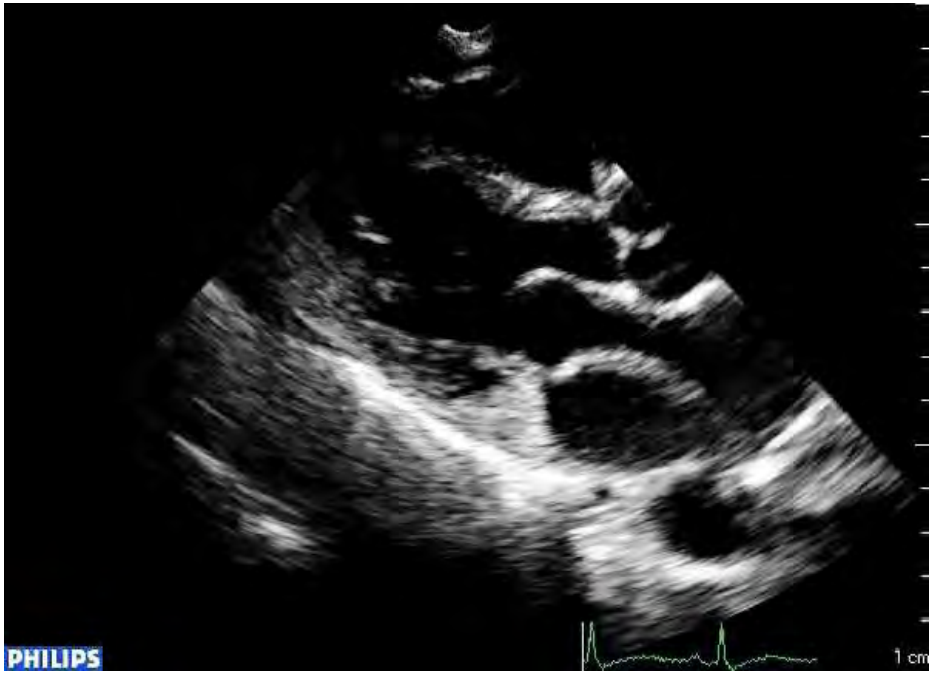
Progress

- Based on clinical consideration and the imaging findings, a certain diagnosis was made and anticoagulation was stopped

Follow-up TTE 2 weeks later

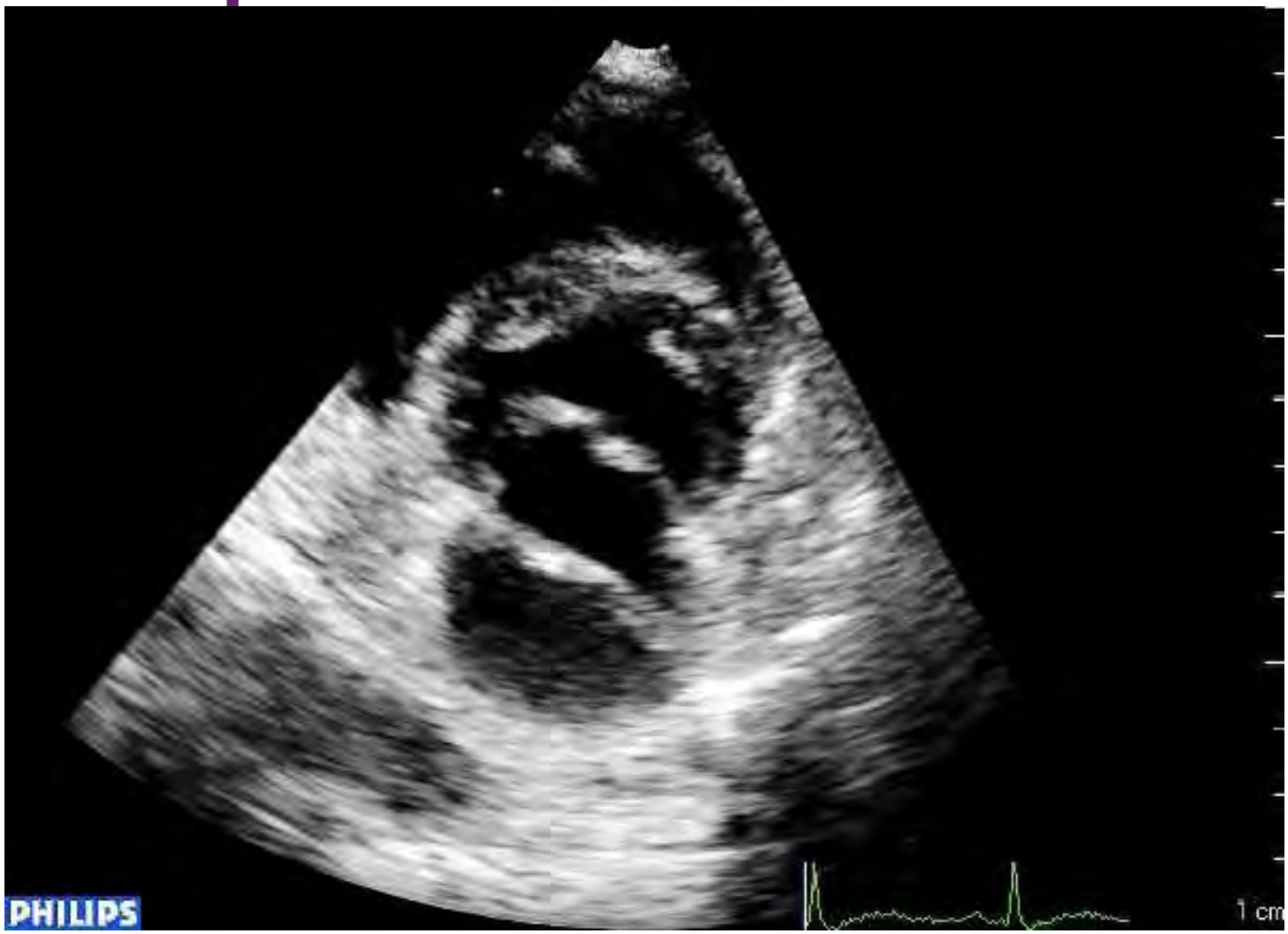


3 days after AF ablation



2 weeks after AF ablation

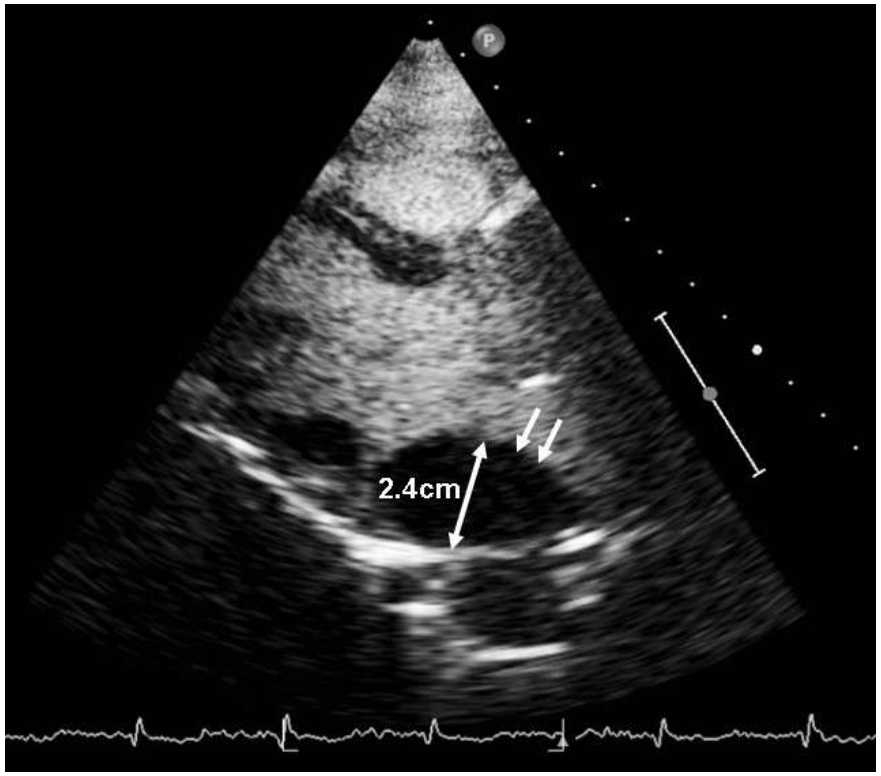
Follow-up TTE 2 weeks later



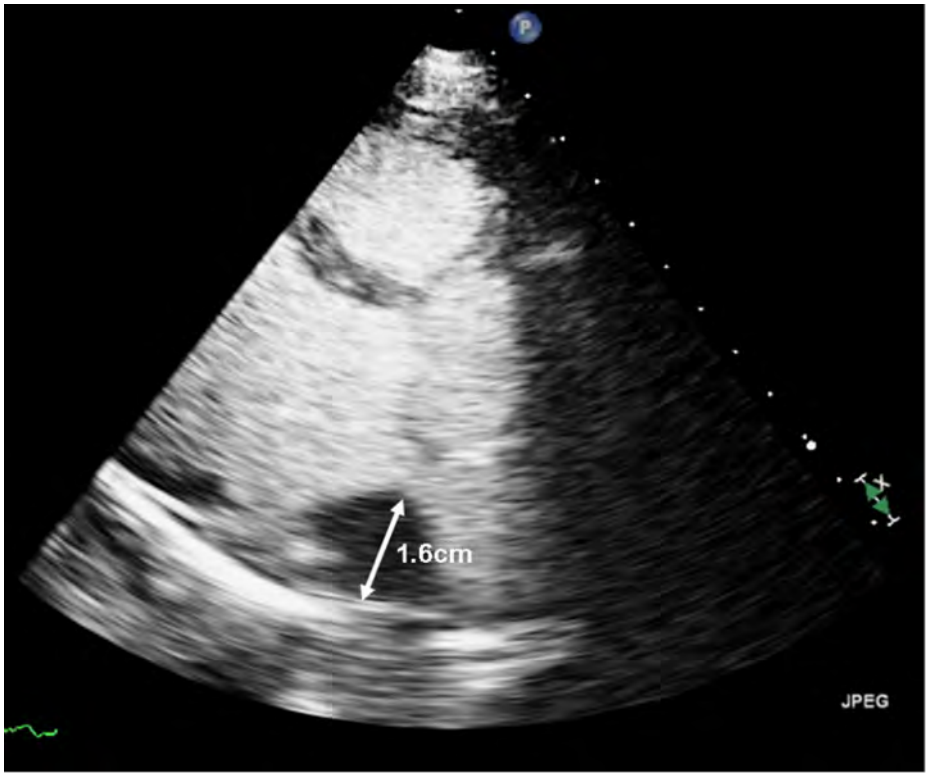
Contrast (Sonovue) echo

3 months later

The cystic structure has significant reduced in size



2 weeks



3 months

Question 5: Where is the mass?

A. Inside the LA (intra-cardiac)
B. Outside the LA (extra-cardiac)
C. Neither inside nor outside

Question 6: What is the mass?

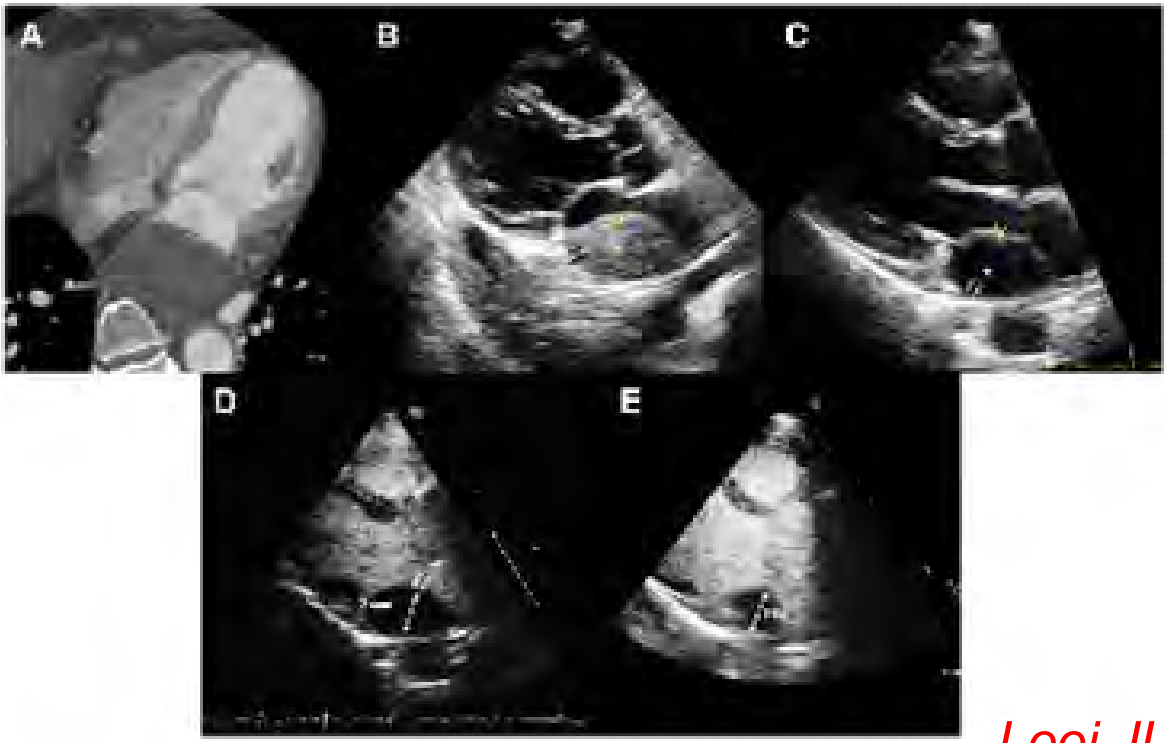
A. LA thrombus
B. LA bleeding
C. LA myxoma
D. Artefact

IMAGES IN CARDIOLOGY

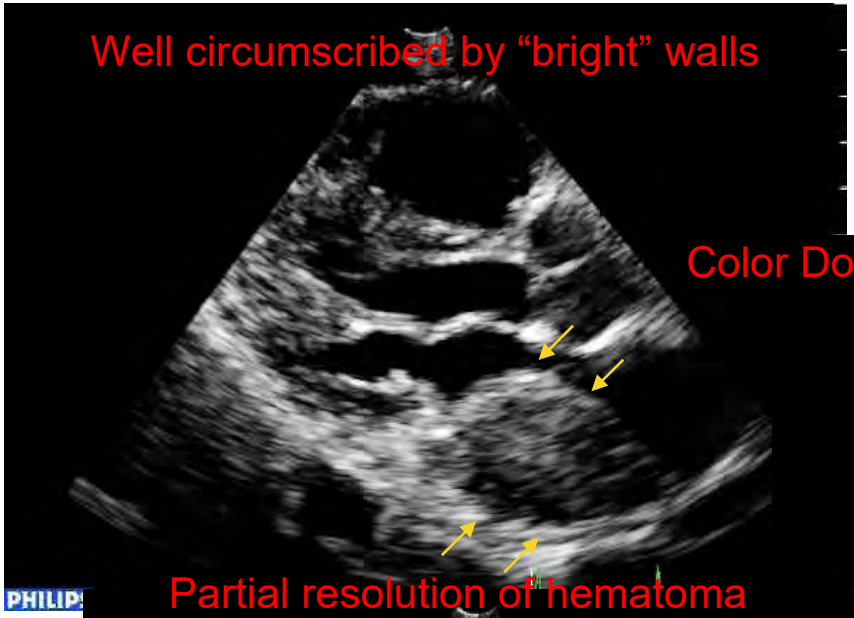
Intramural Left Atrial Hematoma Complicating Catheter Ablation for Atrial Fibrillation

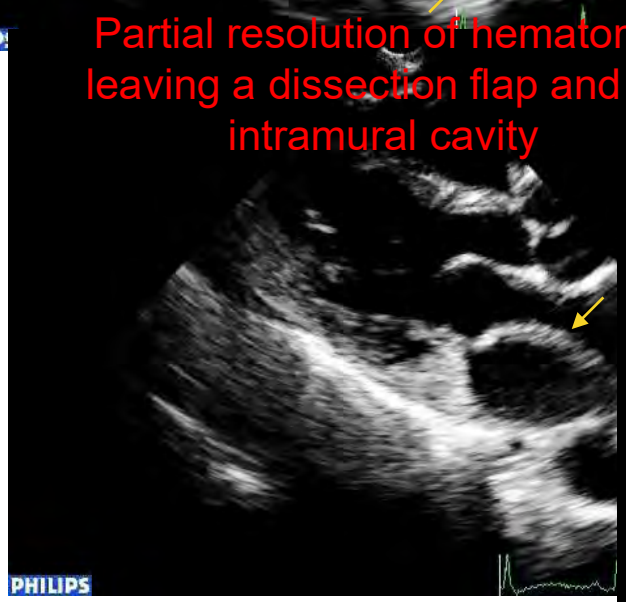
Jen-Li Looi, MB, ChB,* Alex Pui-Wai Lee, MB, ChB,* Chin-Pang Chan, MB, ChB,* Joseph Yat-Sun Chan, MB, ChB,* Anna Kin-Yin Chan, MB, ChB,* Mable Tong, MB, ChB,† Ka-Tak Wong, MB, ChB,† Cheuk-Man Yu, MB, ChB, MD*

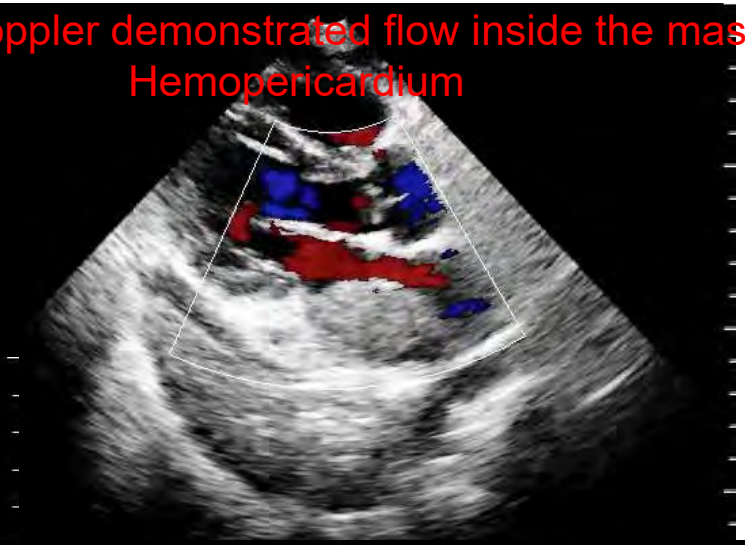
Hong Kong

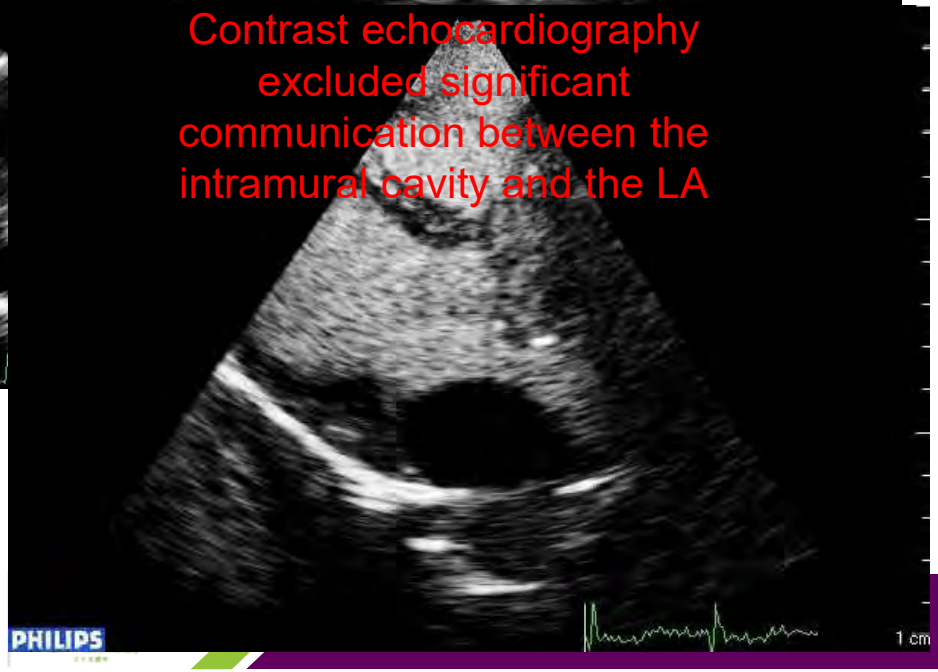


Looi JL. JACC 2013


Well circumscribed by “bright” walls
PHILIPS


Partial resolution of hematoma leaving a dissection flap and an intramural cavity
PHILIPS


Color Doppler demonstrated flow inside the mass
Hemopericardium


Contrast echocardiography excluded significant communication between the intramural cavity and the LA
PHILIPS
1 cm

Left atrial intramural hematoma complicating AF ablation

- Uncommon
  - but may be increasingly common with complex LA procedure in patients on anticoagulation
- May occur spontaneously[1] or iatrogenically[2,3]
- Potential mechanisms[4]:
  - LA wall injury during transeptal puncture
  - Laceration of right lower pulmonary vein
  - Continued anticoagulation
- Unless causing hemodynamic compromise, literature suggested that LAIMH can be managed conservatively[5]

1. *Shaikh N. J Am Soc Echocardiogr. 1999*
2. *Kelly S. Am J Roentgenol. 2006*
3. *Sah R. Circulation. 2007*
4. *Echahidi N. J Cardiovasc Electrophysiol. 2008*
5. *Looi JL. J Am Coll Cardiol. 2013*

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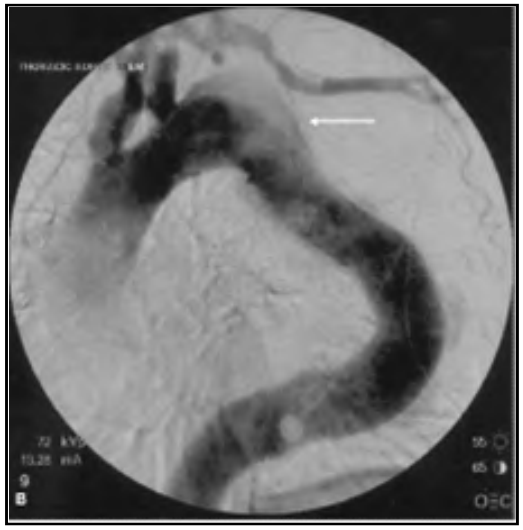
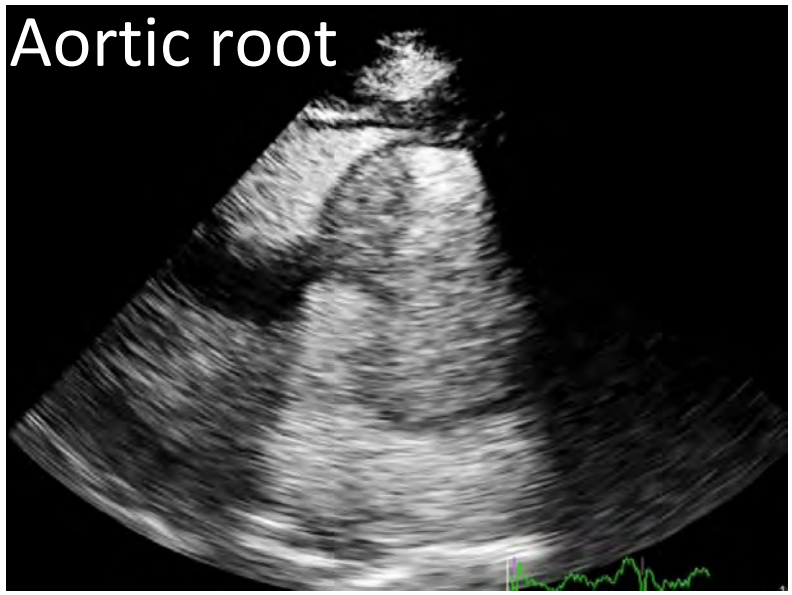
Aortic post TEVAR endoleak detection

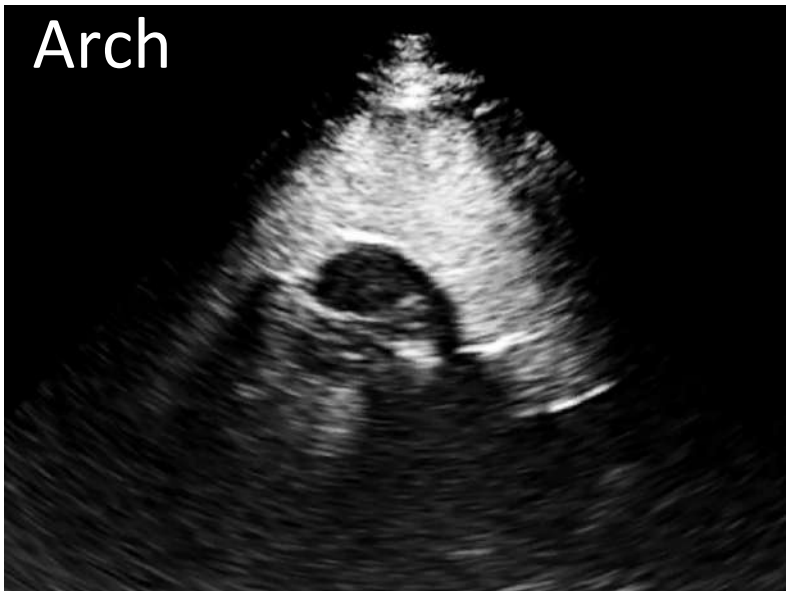
What are endoleaks?

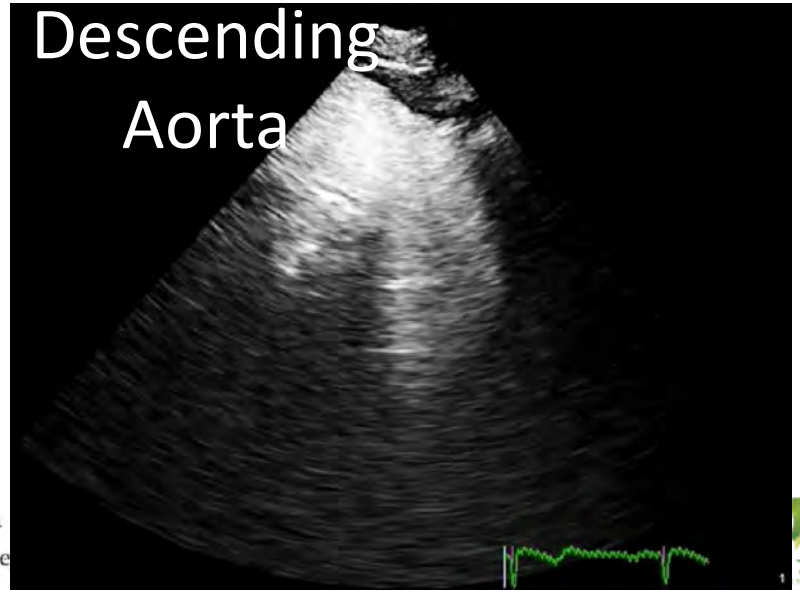
- Endoleaks are defined as blood flow outside the lumen of the stent graft but within the aneurysm sac



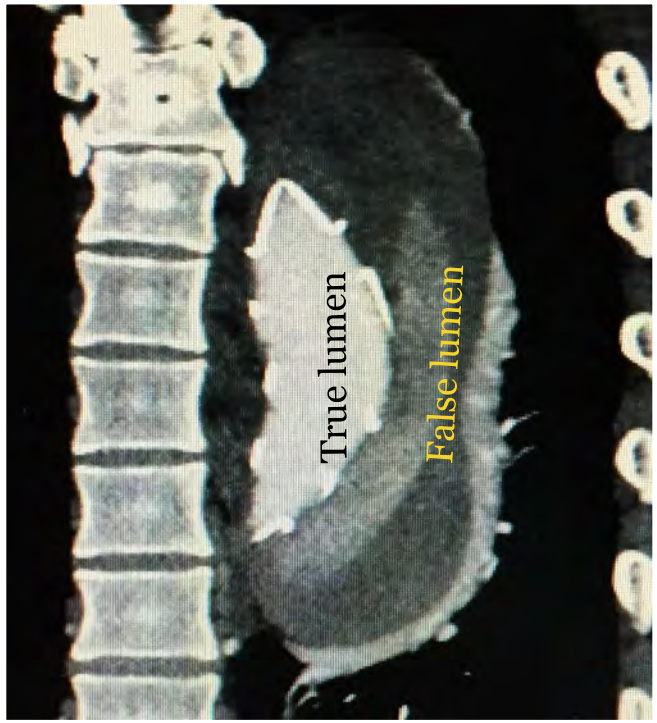
CEUS Imaging of the Thoracic Aorta and Branches



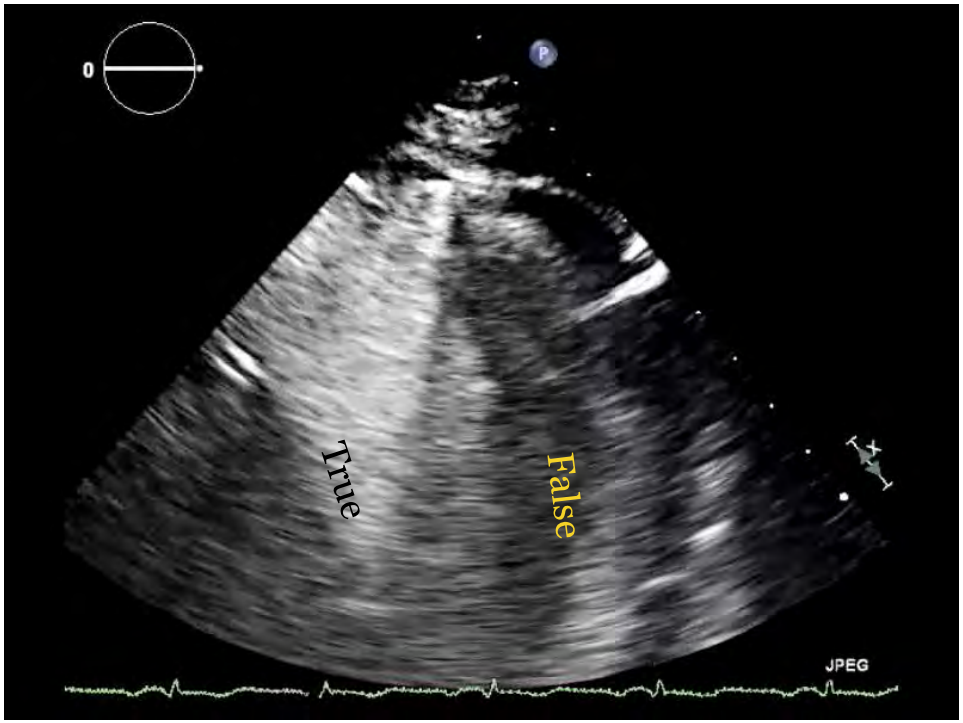




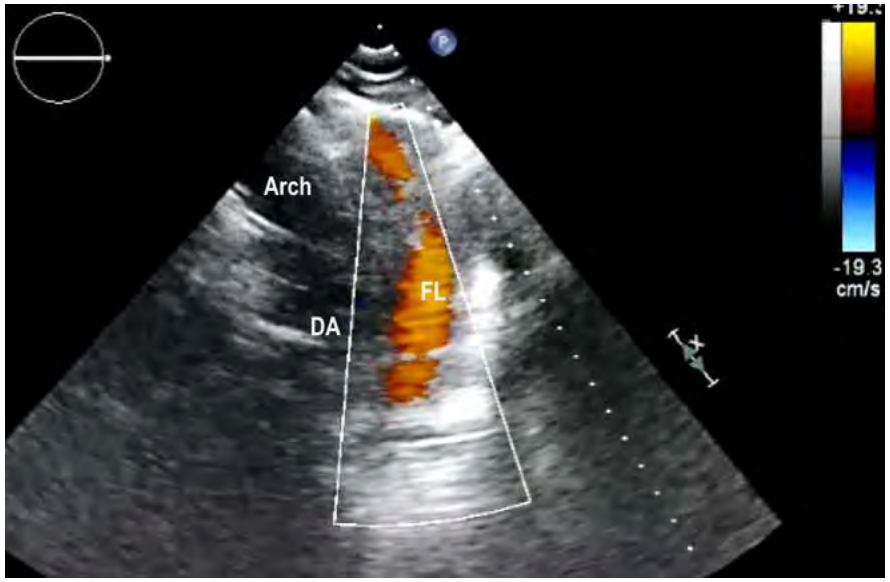
Contrast-enhanced ultrasound confirms the retrograde flow direction in the false lumen



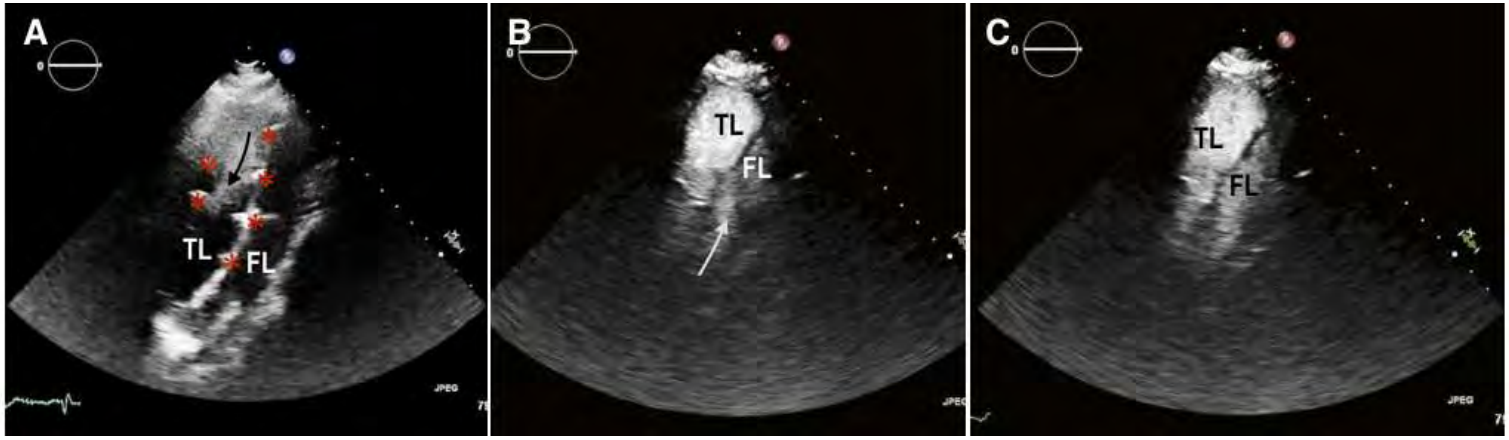
CT contrast



Microbubble contrast



Lee AP, et al. Contrast-Enhanced Transthoracic Aortic Ultrasound For Endoleak Detection After Thoracic Endovascular Aortic Repair. The Annals of Thoracic Surgery 2016 (In press).



EXPEDITED PUBLICATION

Impact of Contrast Echocardiography on Evaluation of Ventricular Function and Clinical Management in a Large Prospective Cohort

JACC 2009

Mustafa Kurt, MD, Kamran A. Shaikh, MD, Leif Peterson, PhD, Karla M. Kurrelmeyer, MD, FACC, Gopi Shah, MD, FACC, Sherif F. Nagueh, MD, FACC, Robert Fromm, MD, Miguel A. Quinones, MD, FACC, William A. Zoghbi, MD, FACC

Houston, Texas

Objectives The aim of this study was to evaluate the impact of echocardiographic contrast utilization on patient diagnosis and management.

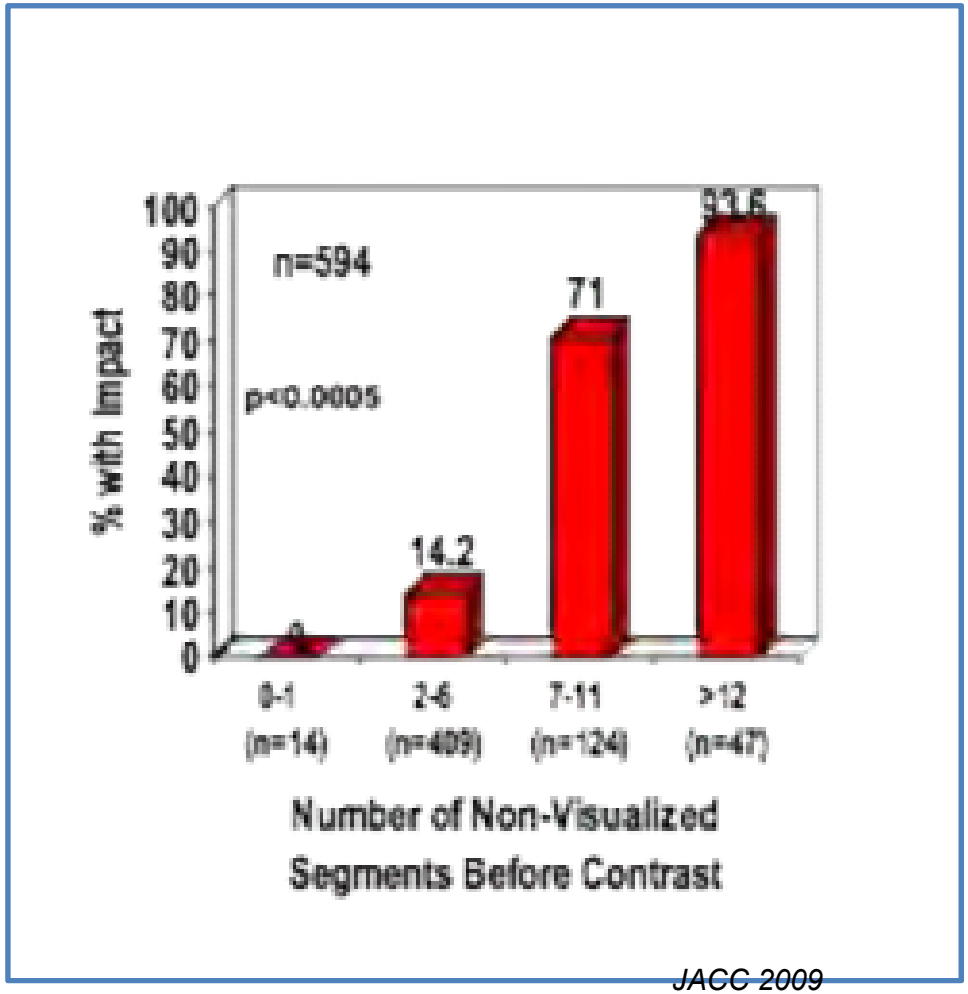
Background Contrast echocardiography (CE) has improved visualization of endocardial borders. However, its impact on patient management has not been evaluated previously.

Methods We prospectively enrolled 632 consecutive patients with technically difficult echocardiographic studies who received intravenous contrast (Definity, Lantheus Medical Imaging, Billerica, Massachusetts). Quality of studies, number of left ventricular (LV) segments visualized, estimated ejection fraction, presence of apical thrombus, and management decisions were compared before and after contrast.

Results After CE, the percent of uninterpretable studies decreased from 11.7% to 0.3% and technically difficult studies decreased from 86.7% to 9.8% ($p < 0.0001$). Before contrast, 11.6 ± 3.3 of 17 LV segments were seen, which improved after CE to 16.8 ± 1.1 ($p < 0.0001$). An LV thrombus was suspected in 35 patients and was definite in 3 patients before CE. After contrast, only 1 patient had a suspected thrombus, and 5 additional patients with thrombus were identified ($p < 0.0001$). A significant impact of CE on management was observed: additional diagnostic procedures were avoided in 32.8% of patients and drug management was altered in 10.4%, with a total impact (procedures avoided, change in drugs, or both) observed in 35.6% of patients. The impact of contrast increased with worsening quality of nonenhanced study, the highest being in intensive care units. A cost-benefit analysis showed a significant savings using contrast ($122/patient).

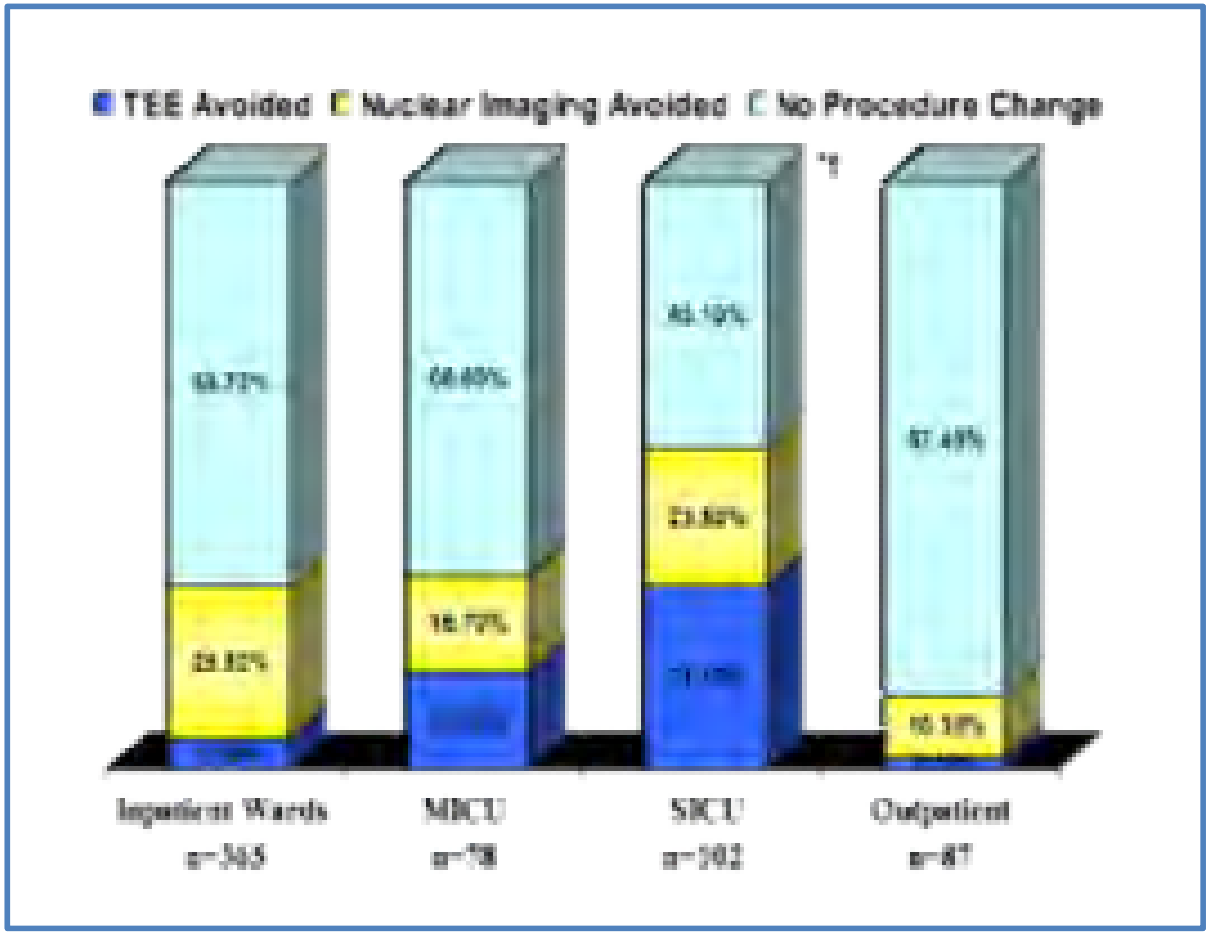
Conclusions The utilization of CE in technically difficult cases improves endocardial visualization and impacts cardiac diagnosis, resource utilization, and patient management. (J Am Coll Cardiol 2009;53:802–10) © 2009 by the American College of Cardiology Foundation

Relation of Extent of Nonvisualized LV Segments to Impact of Contrast on Management



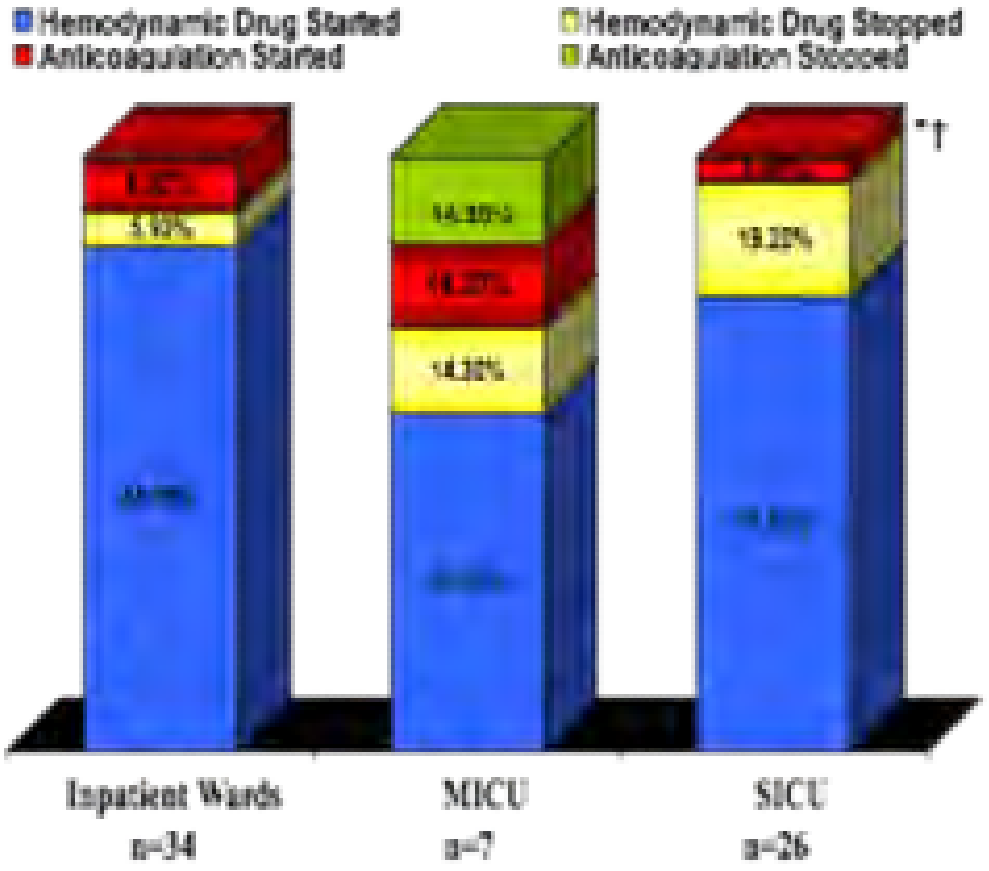
JACC 2009

Impact of Contrast on Patient Management: Avoidance of Additional Diagnostic Procedures

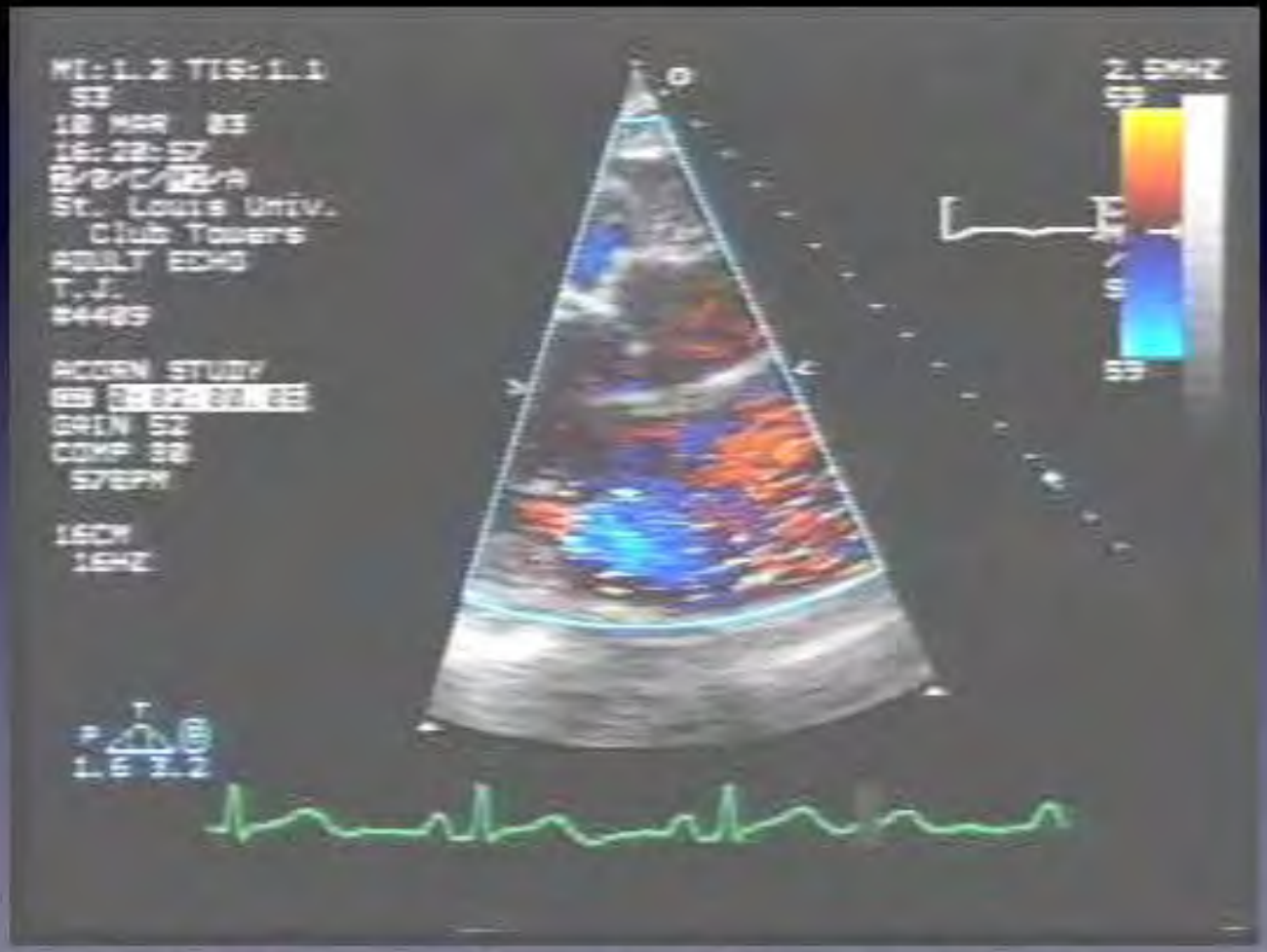


JACC 2009

Impact of Contrast on Medication Changes



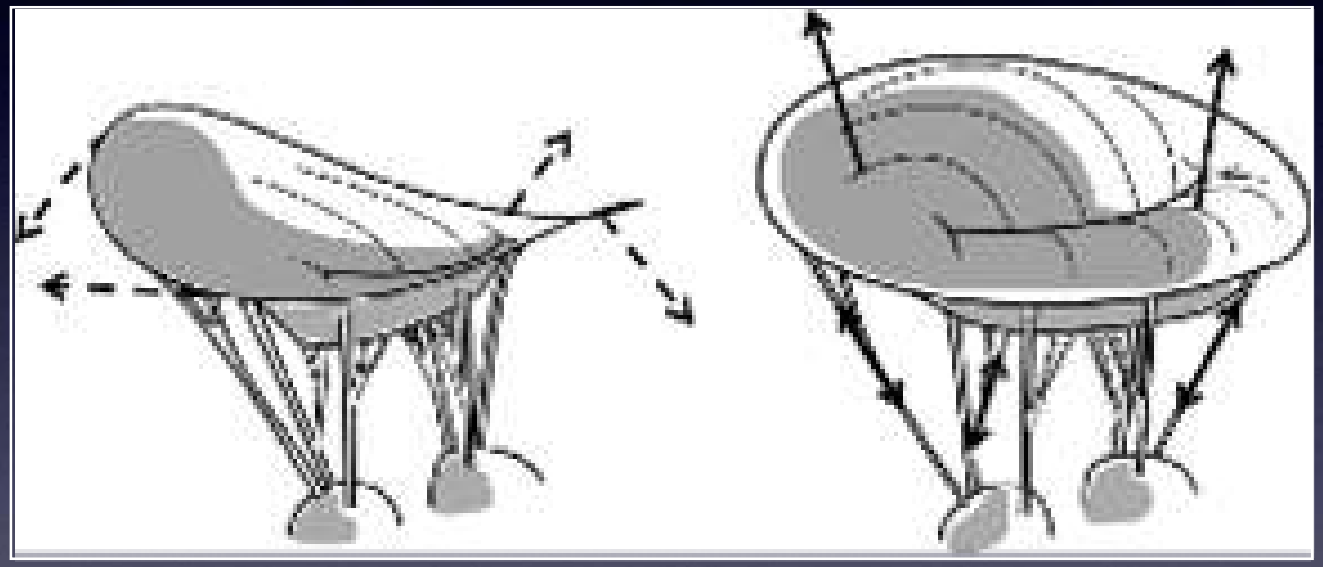
The patients' medical regimen was altered in 67 patients (10.6%) after interpretation of CE images (Ho: p=0, p<0.0001)



Before ring implantation

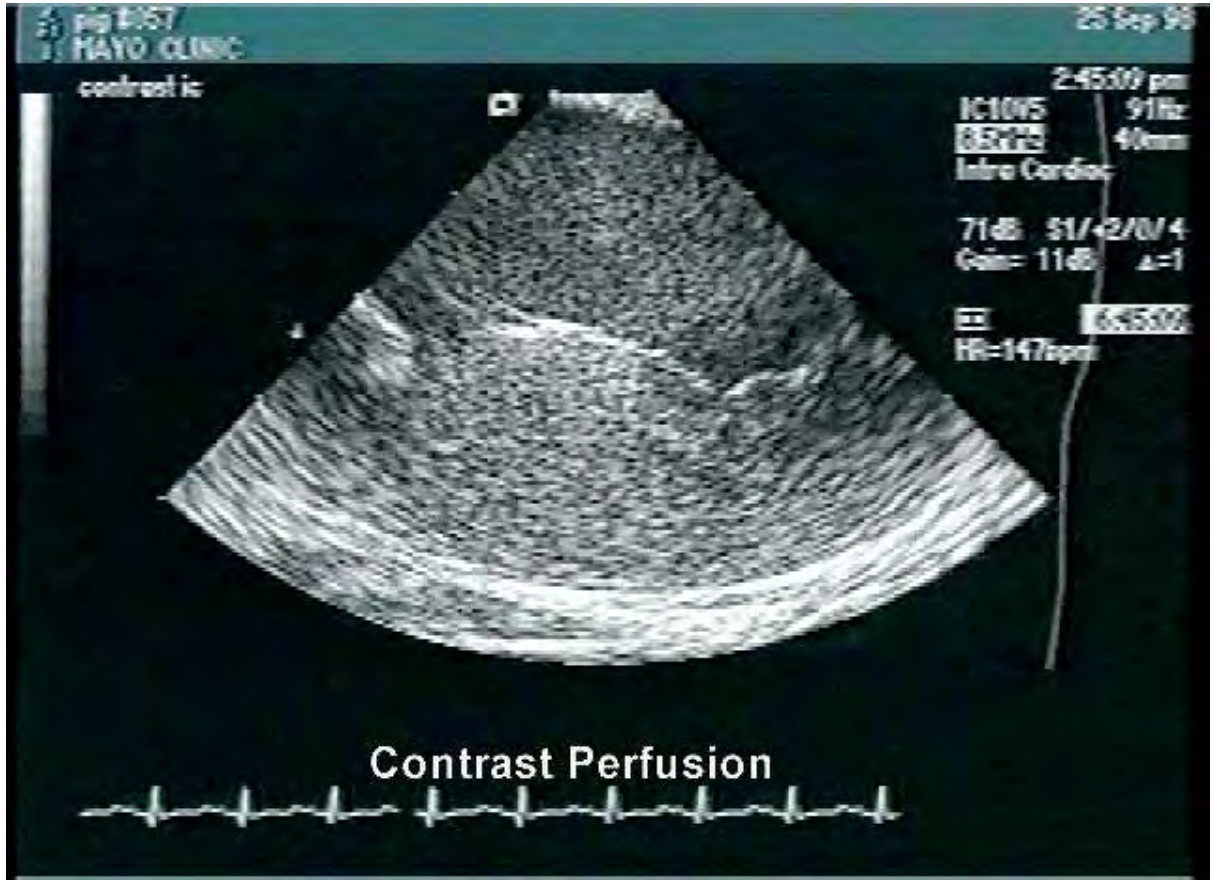
Tethering is The Problem

Viewing mitral valve in a biomechanical model



Annular flattening may predispose the mitral valve to increased wear and tear?

Myocardial Contrast Echocardiography

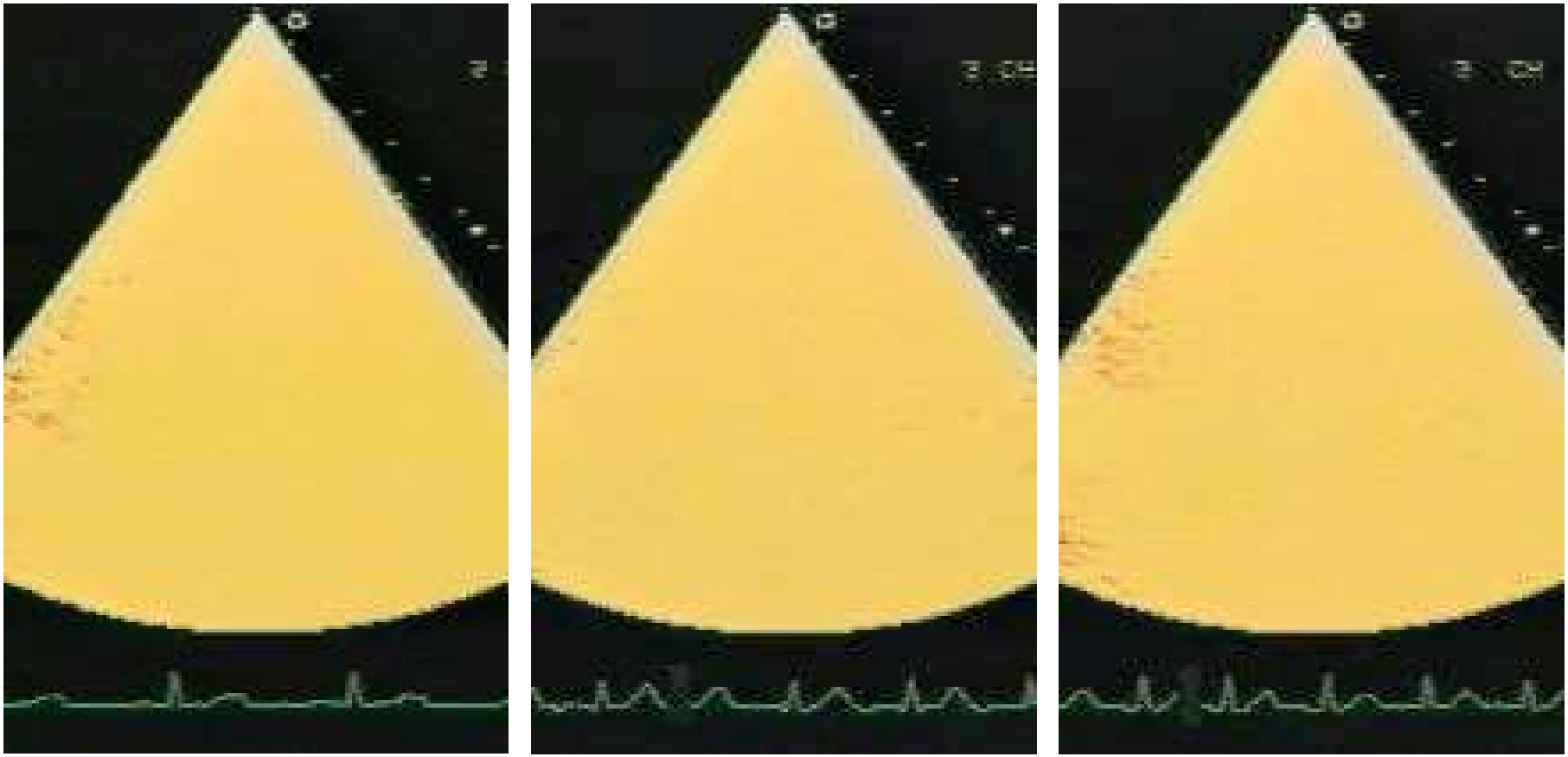


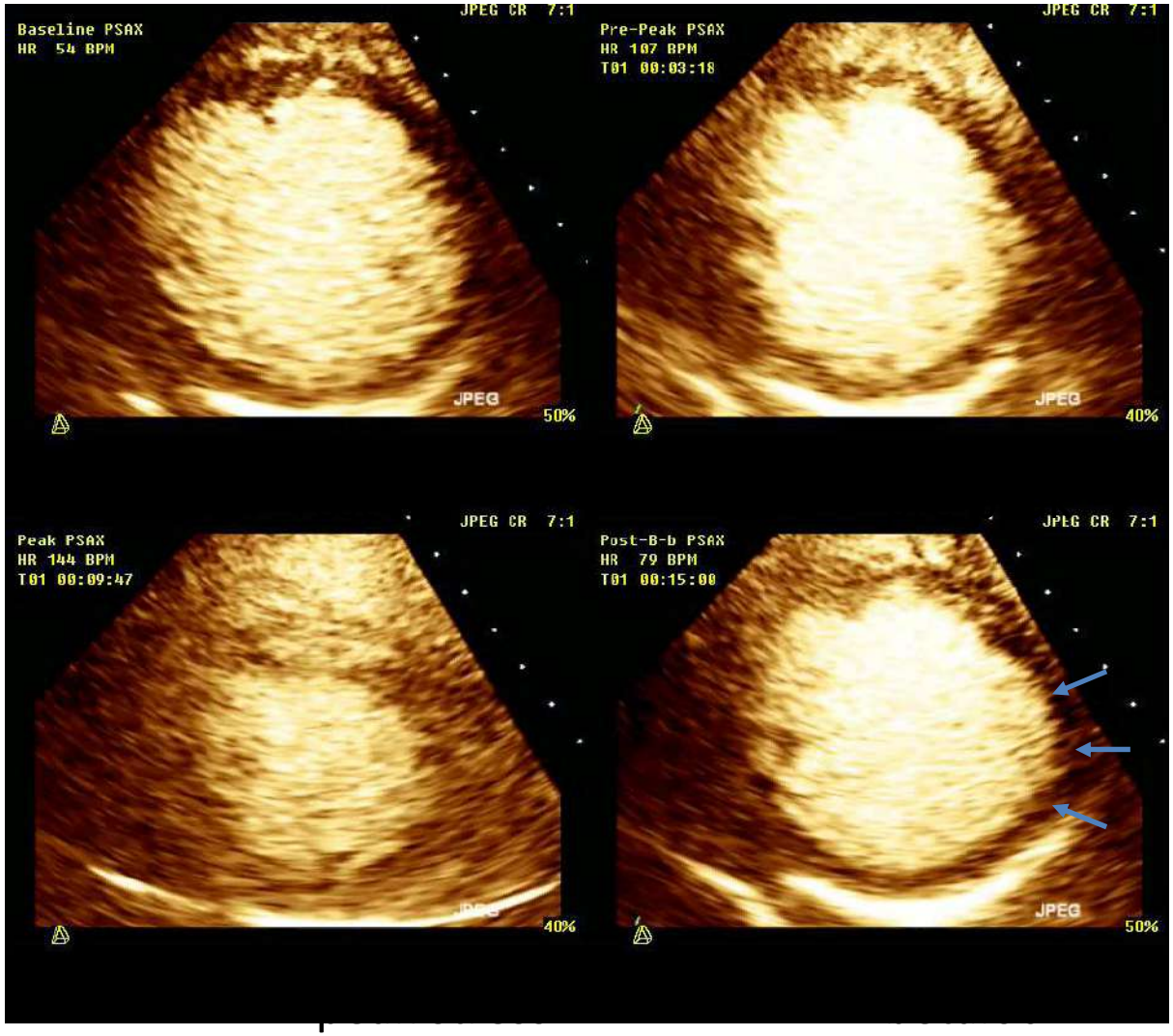
Hypoperfusion and hypokinesis of LCx territory on MCE

Rest

Dob 20 mcg

Dob 40 mcg




Baseline PSAX
HR 54 BPM
JPEG CR 7:1
JPEG
50%
Pre-Peak PSAX
HR 107 BPM
T01 00:03:18
JPEG CR 7:1
JPEG
40%
Peak PSAX
HR 144 BPM
T01 00:09:47
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HR 79 BPM
T01 00:15:00
JPEG CR 7:1
JPEG
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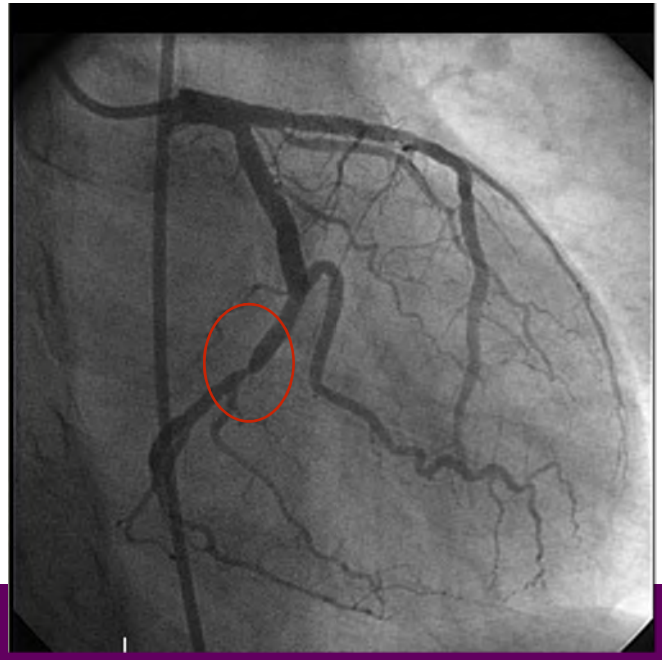


What is 3D printing?

1984
THE BIRTH OF 3D PRINTING

Charles Hull, later the co-founder of 3D Systems, invents stereolithography, a printing process that enables a tangible 3D object to be created from digital data. The technology is used to create a 3D model from a picture and allows users to test a design before investing in a larger manufacturing program.

1990s

'92 BUILDING PARTS, LAYER BY LAYER

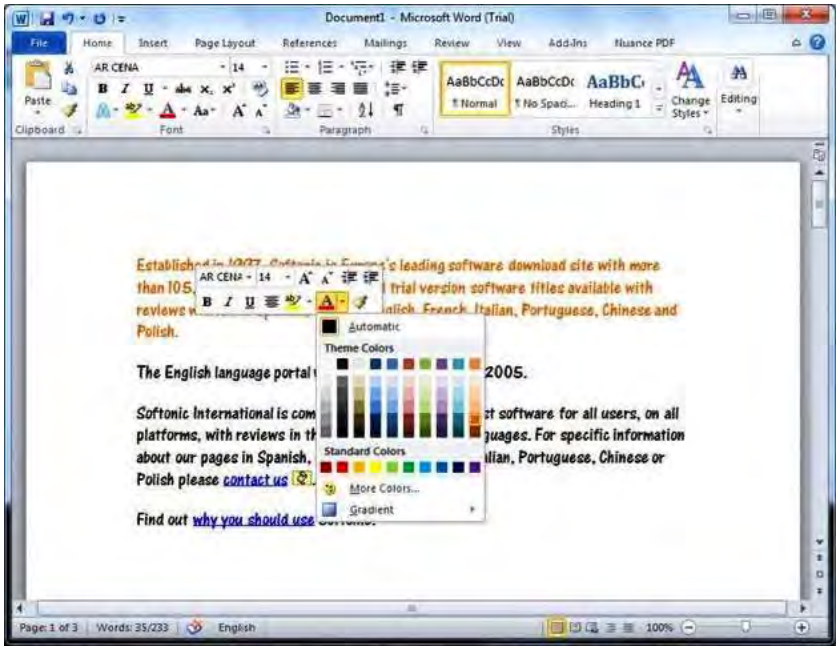
The first SLA (stereolithographic apparatus) machine is produced by 3D Systems. The machine's process involves a UV laser solidifying photopolymer, a liquid with the viscosity and color of honey that makes three-dimensional parts layer by layer. Although imperfect, the machine proves that highly complex parts can be manufactured overnight.

'09 DIY KITS FOR 3D PRINTERS ENTER THE MARKETPLACE

MakerBot Industries, an open-source hardware company for 3D printers, starts selling DIY kits that allow buyers to make their own 3D printers and products.

Explaining 3D printing by way of 2D printing

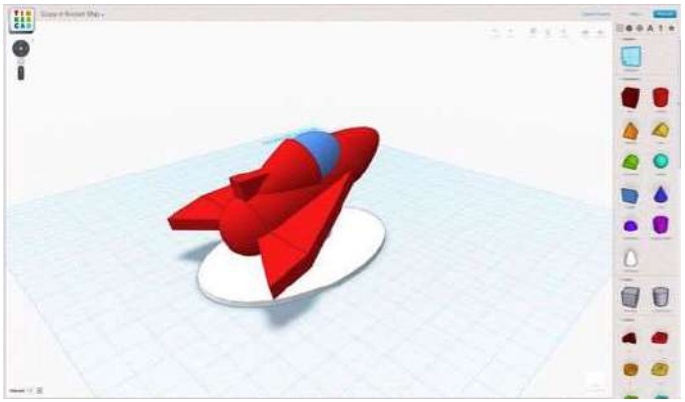
1. Create content using text editing software



2. Content transmitted to device that creates physical copy

Explaining 3D printing by way of 2D printing

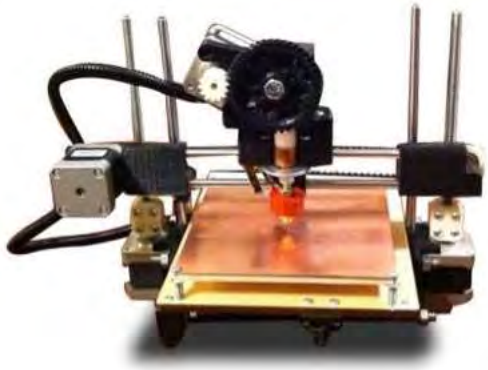
1. Create content using 3D modelling software



2. Content transmitted to device that creates physical copy

What does a 3D printer look like?

Hobby grade printers

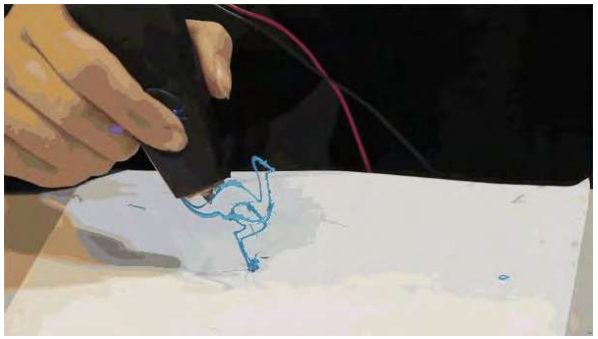


Commercial grade printer

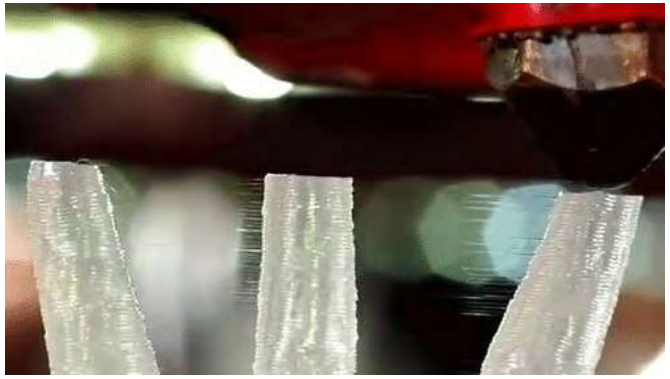
How does a 3D printer work?

1. Heat and extrude material, similar to hot glue gun

2. Build object up in subsequent layers

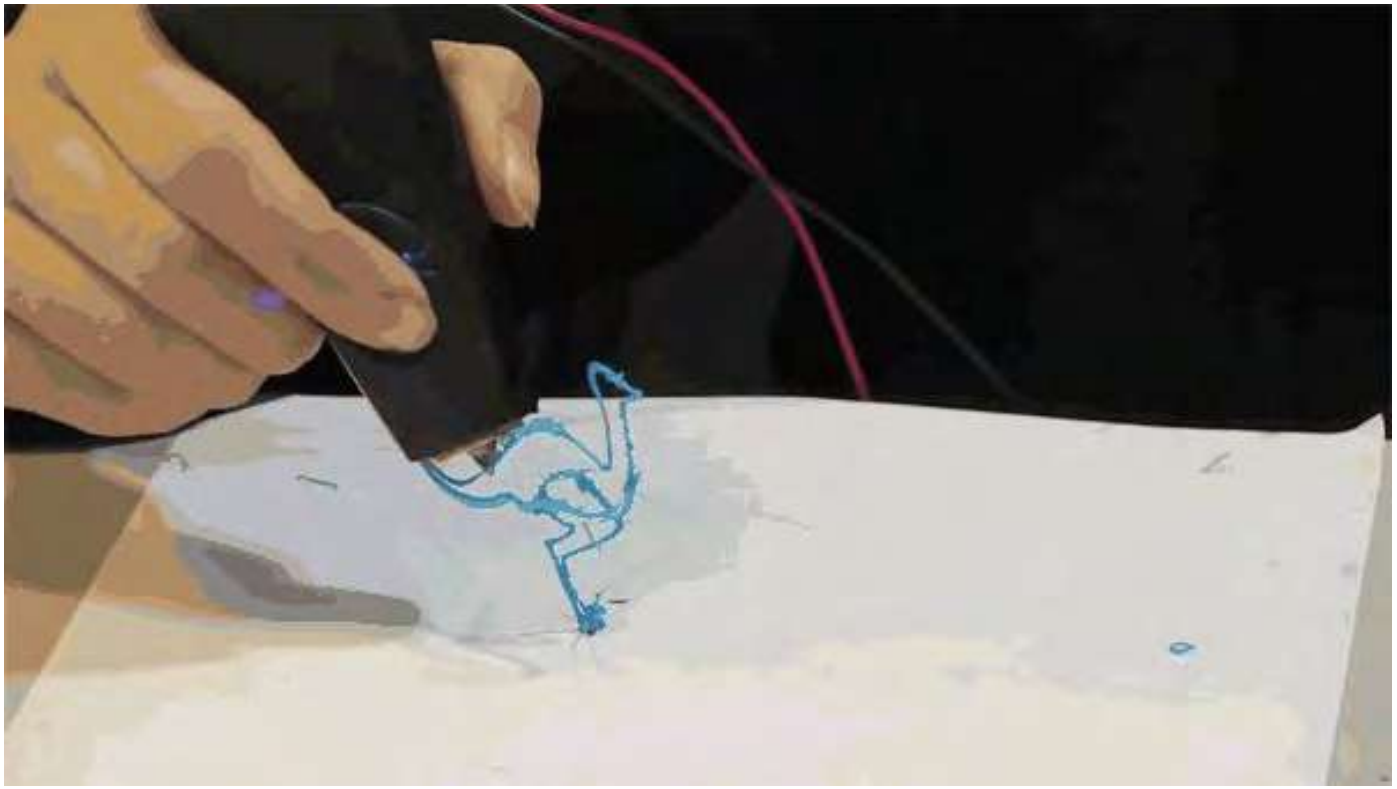


3. Use computer controlled gantry to extrude material in precise locations



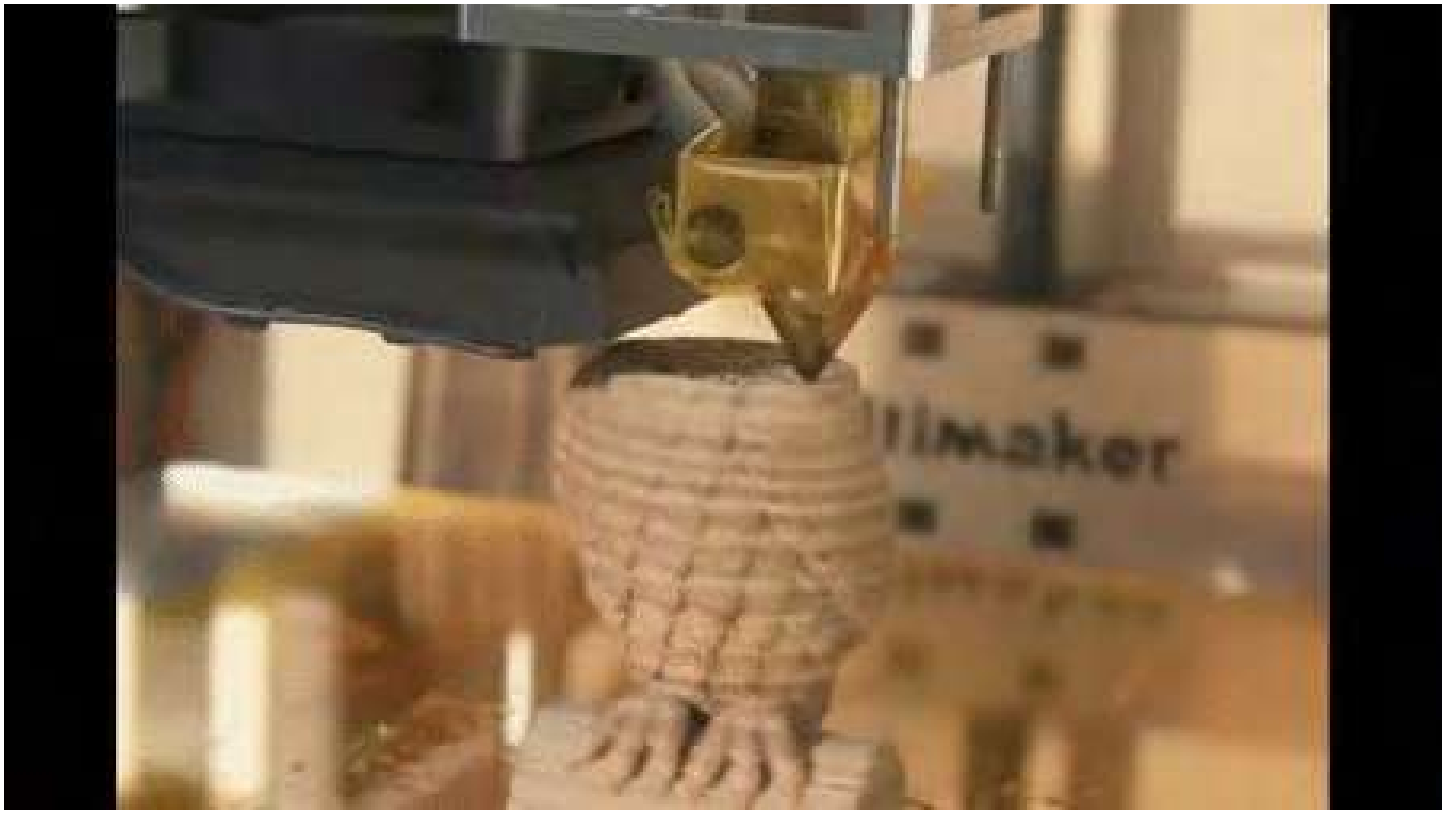
How does a 3D printer work?

- 3D pens
- Heat and extrude material
- Build object up in subsequent layers

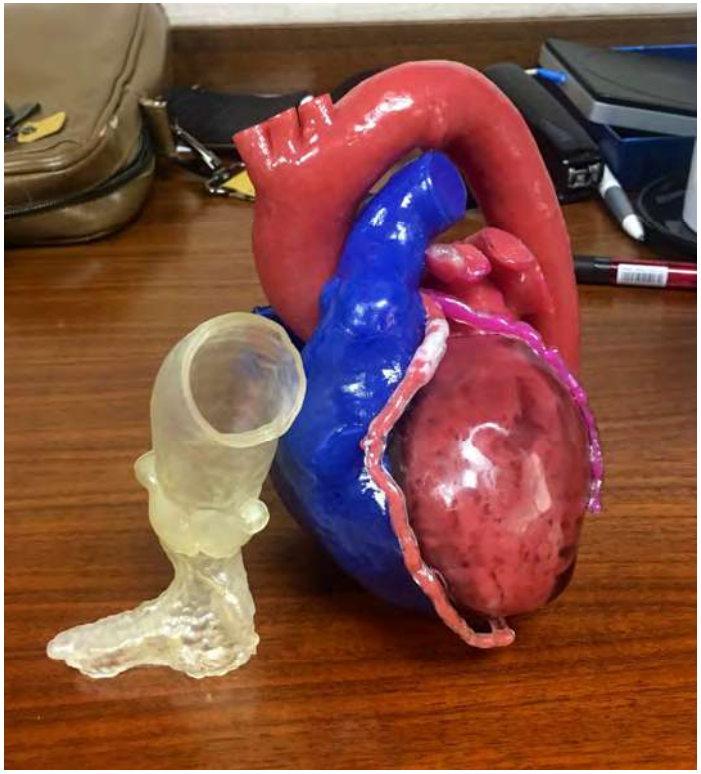


How does a 3D printer work?

- 3D printers
- computer controlled gantry to extrude material in precise locations



What is cardiovascular 3D printing?



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From medical images to objects
Segmentation

Medical scanner (CT/MR/US)

Your own PC or laptop

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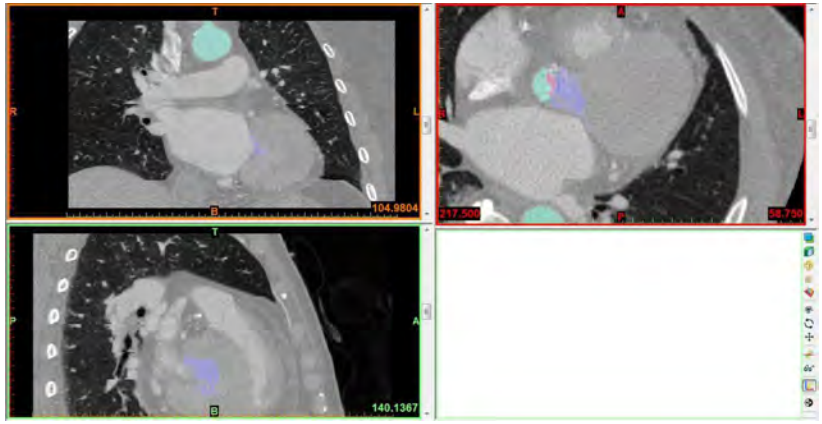
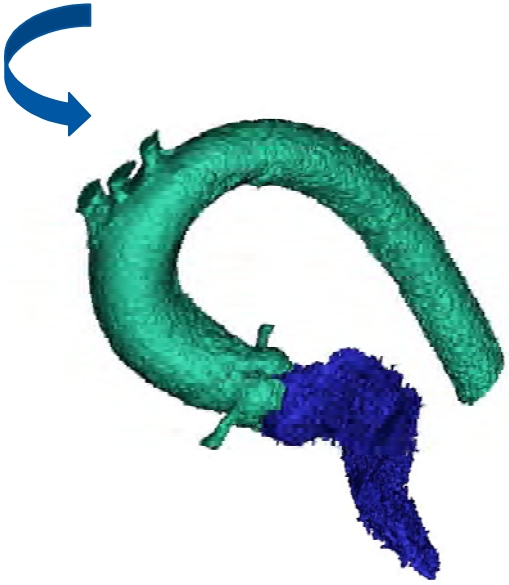
Data courtesy of Helmholtz Institute Aachen, AME, Germany

Process of reconstructing from CT data





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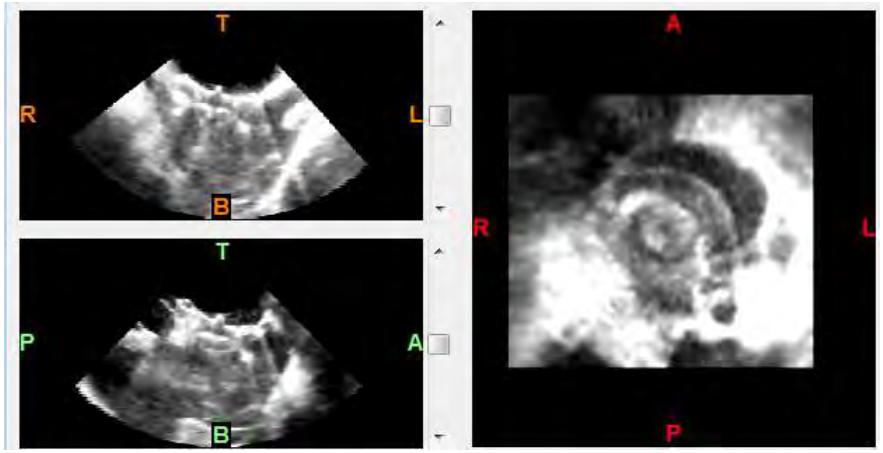
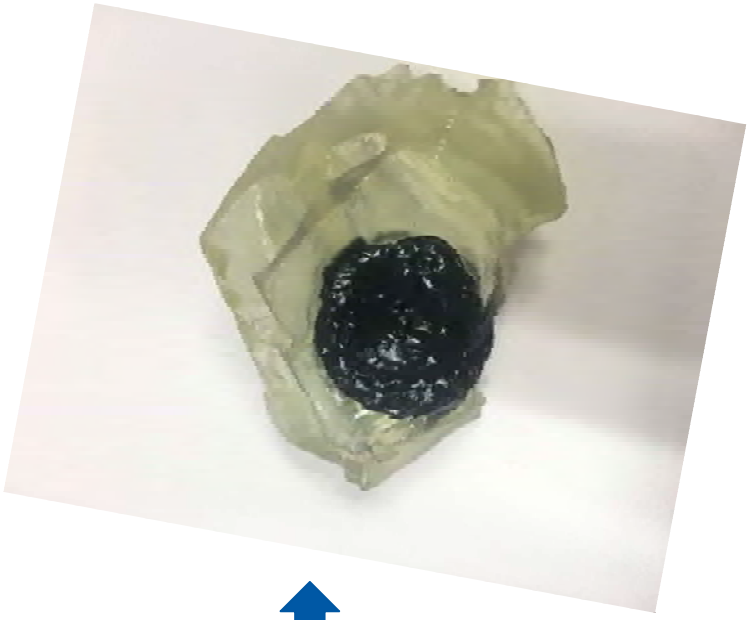
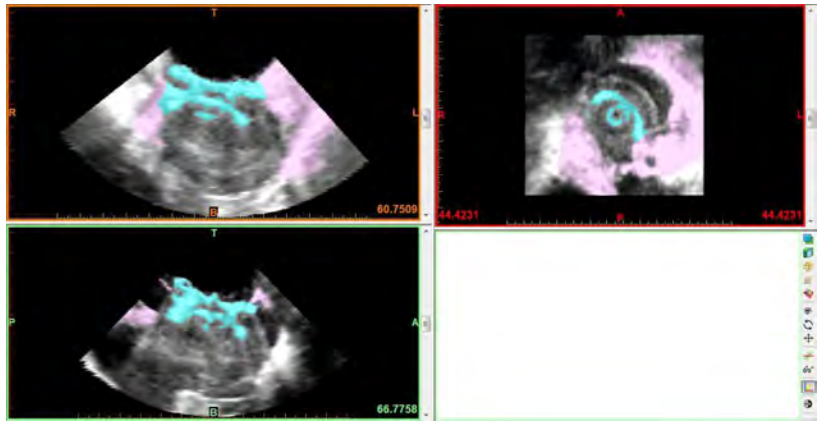
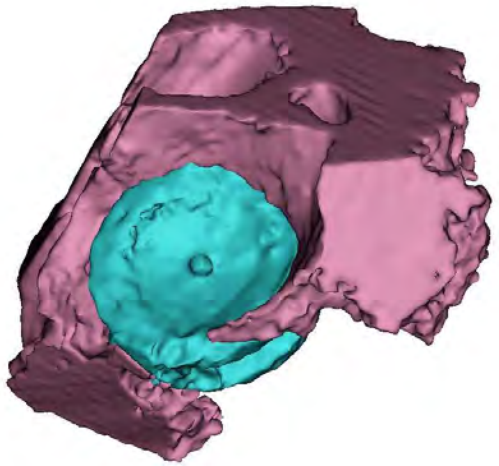
Process of reconstructing from 3D Echo Data







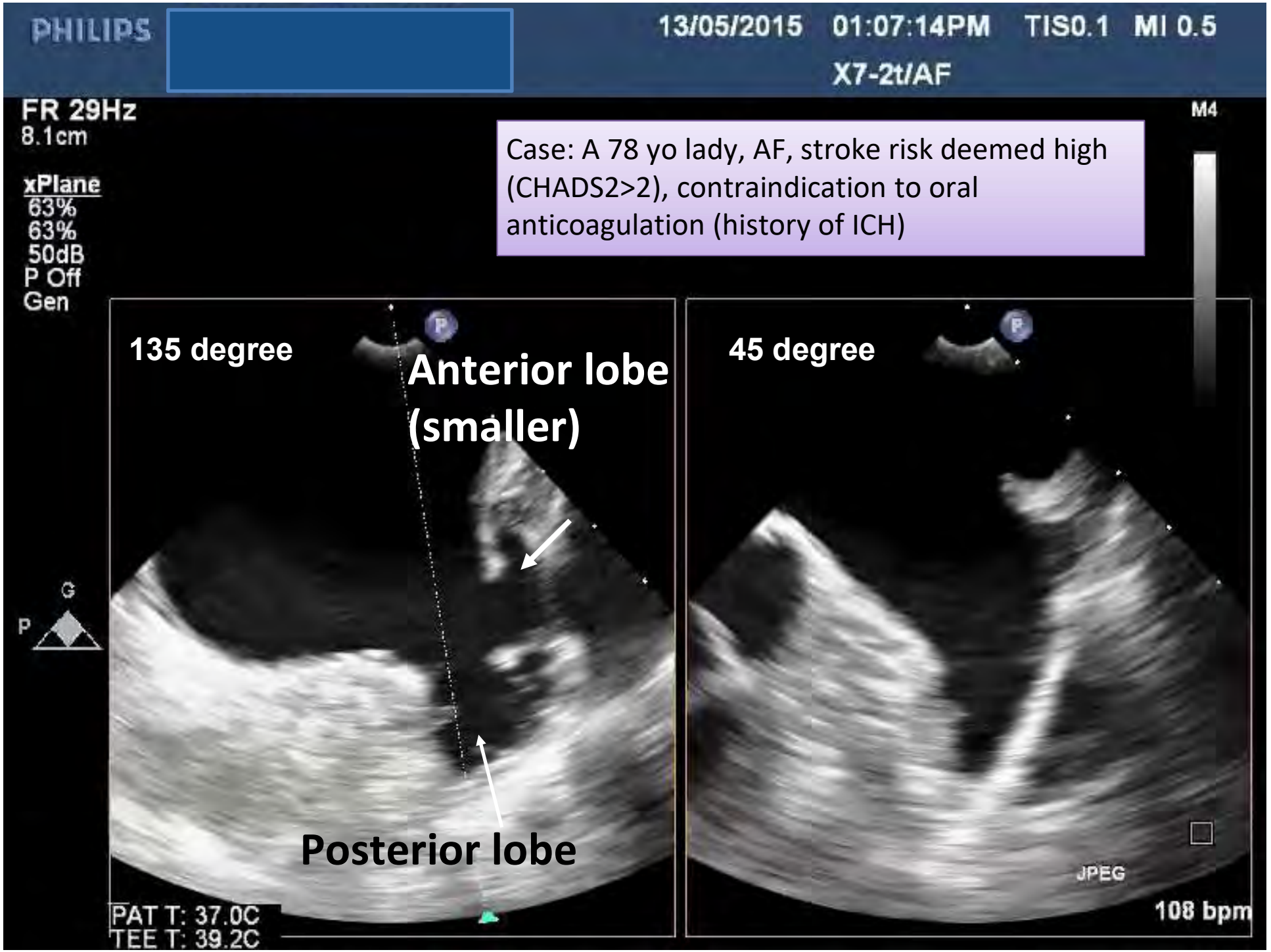


Personalised surgical planning

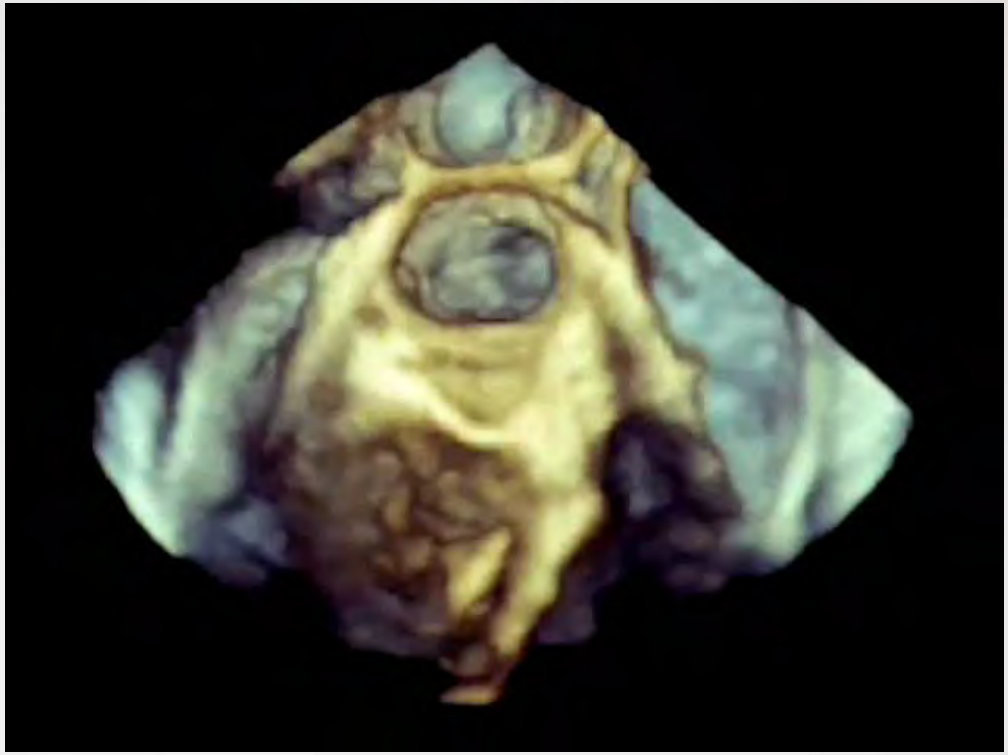
Anatomic teaching tools for students and patients

- Advantages:
  - True spatial relationship to allow tangible manipulation of the cardiac structures.
  - Medical students may be able to “feel” the anatomy and pathology
  - Patients can be better explained regarding the surgical or interventional technique.

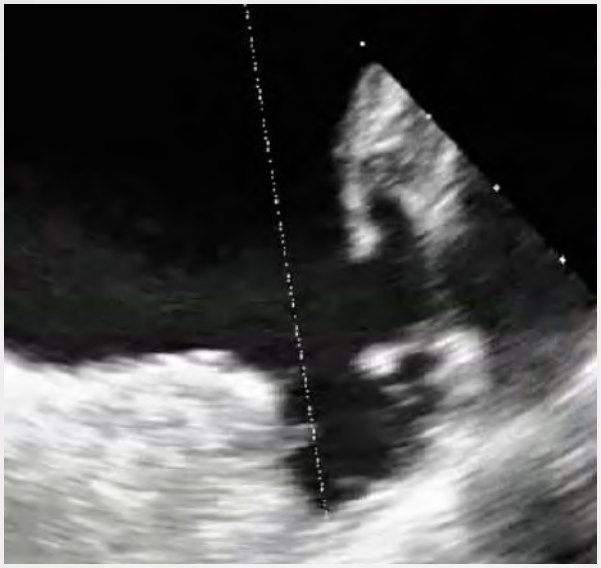
Mishra et al. Indian Heart J. 2016.

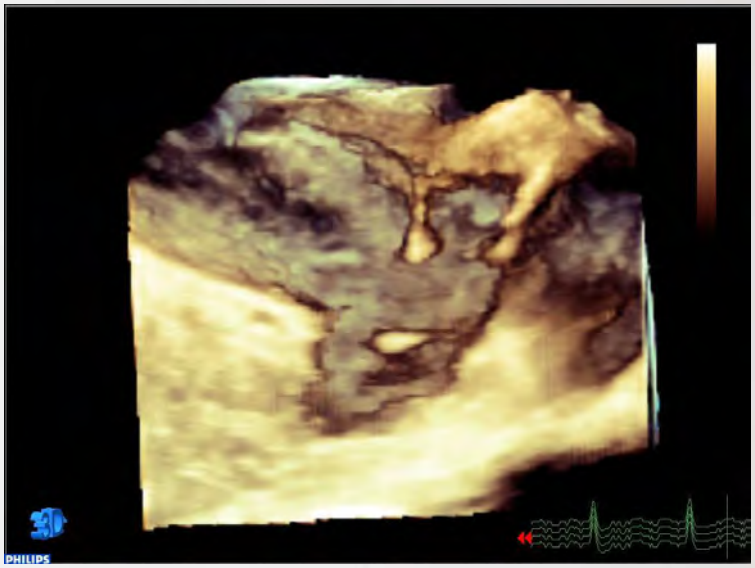

PHILIPS
13/05/2015 01:07:14PM TIS0.1 MI 0.5
X7-2t/AF
FR 29Hz
8.1cm
xPlane
63%
63%
50dB
P Off
Gen
M4
Case: A 78 yo lady, AF, stroke risk deemed high (CHADS2>2), contraindication to oral anticoagulation (history of ICH)
135 degree
Anterior lobe (smaller)
Posterior lobe
45 degree
G
P
PAT T: 37.0C
TEE T: 39.2C
JPEG
108 bpm

3D TEE image of the patient's LAA

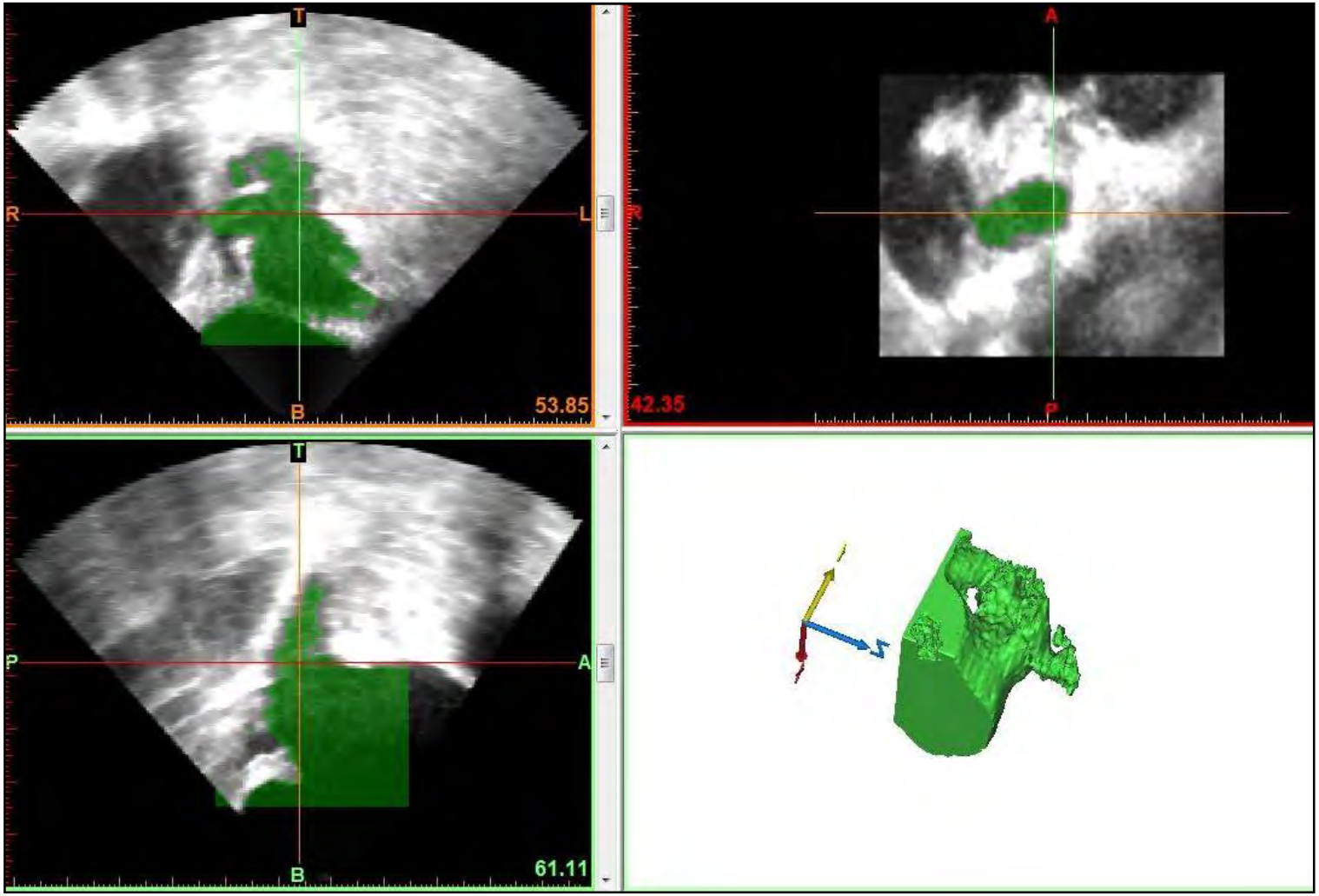


3D Printing for Personalised Cardiac Intervention

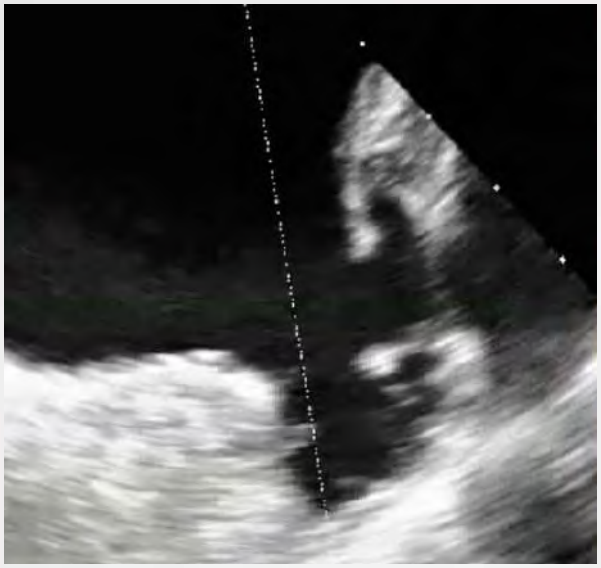


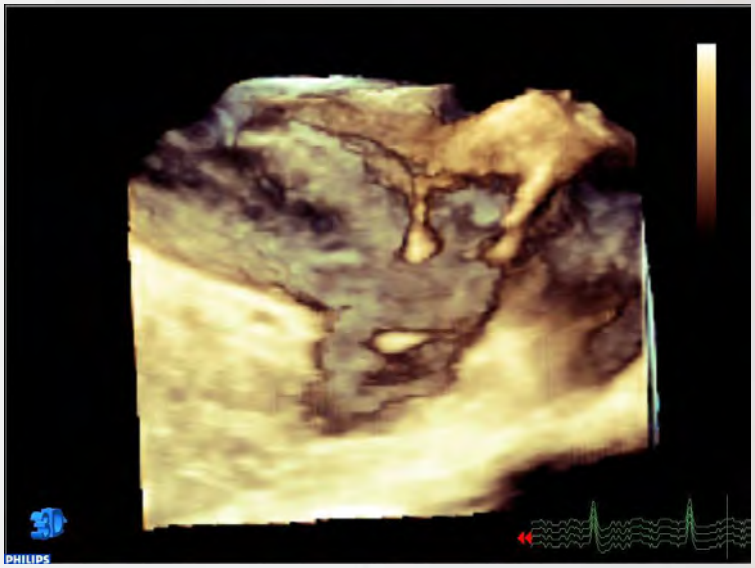


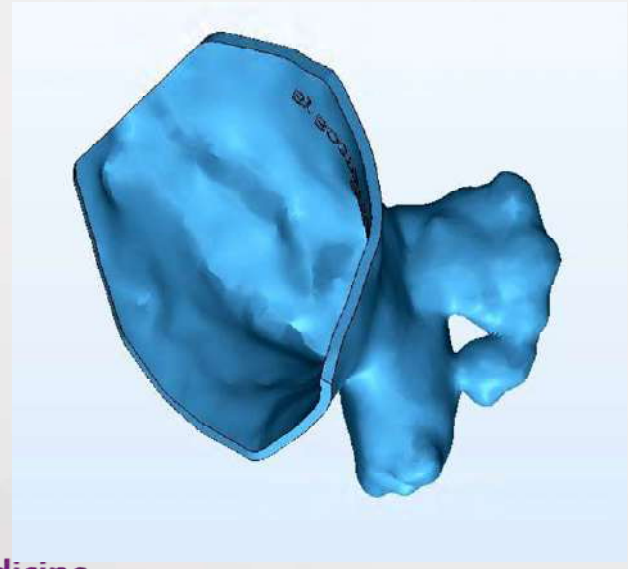
From 3D echocardiographic data to 3D digital model

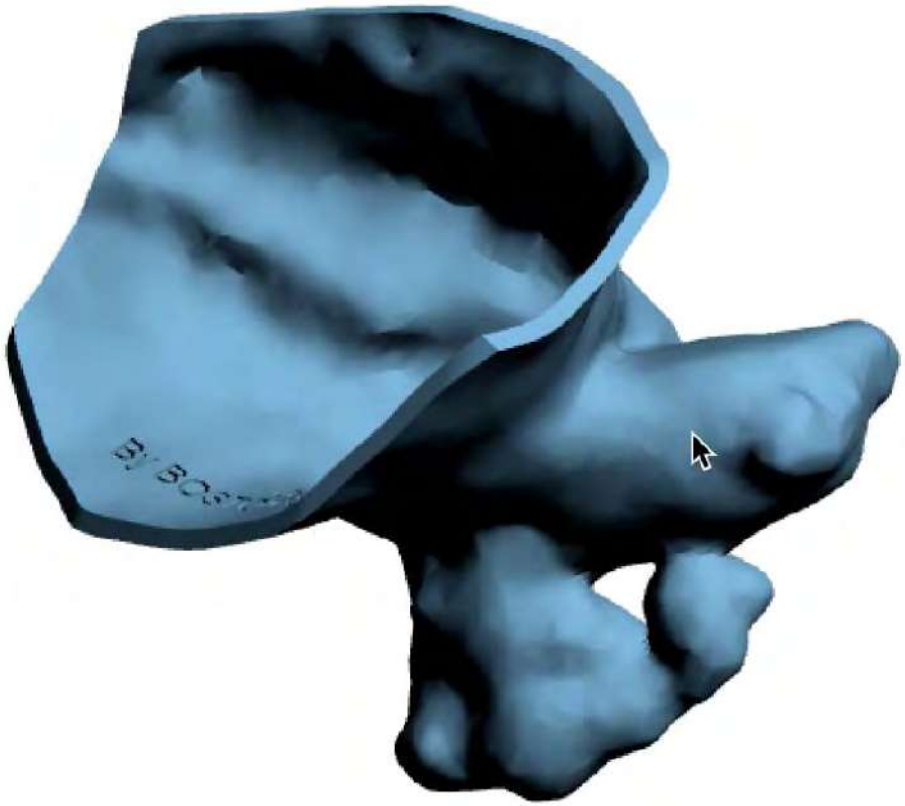


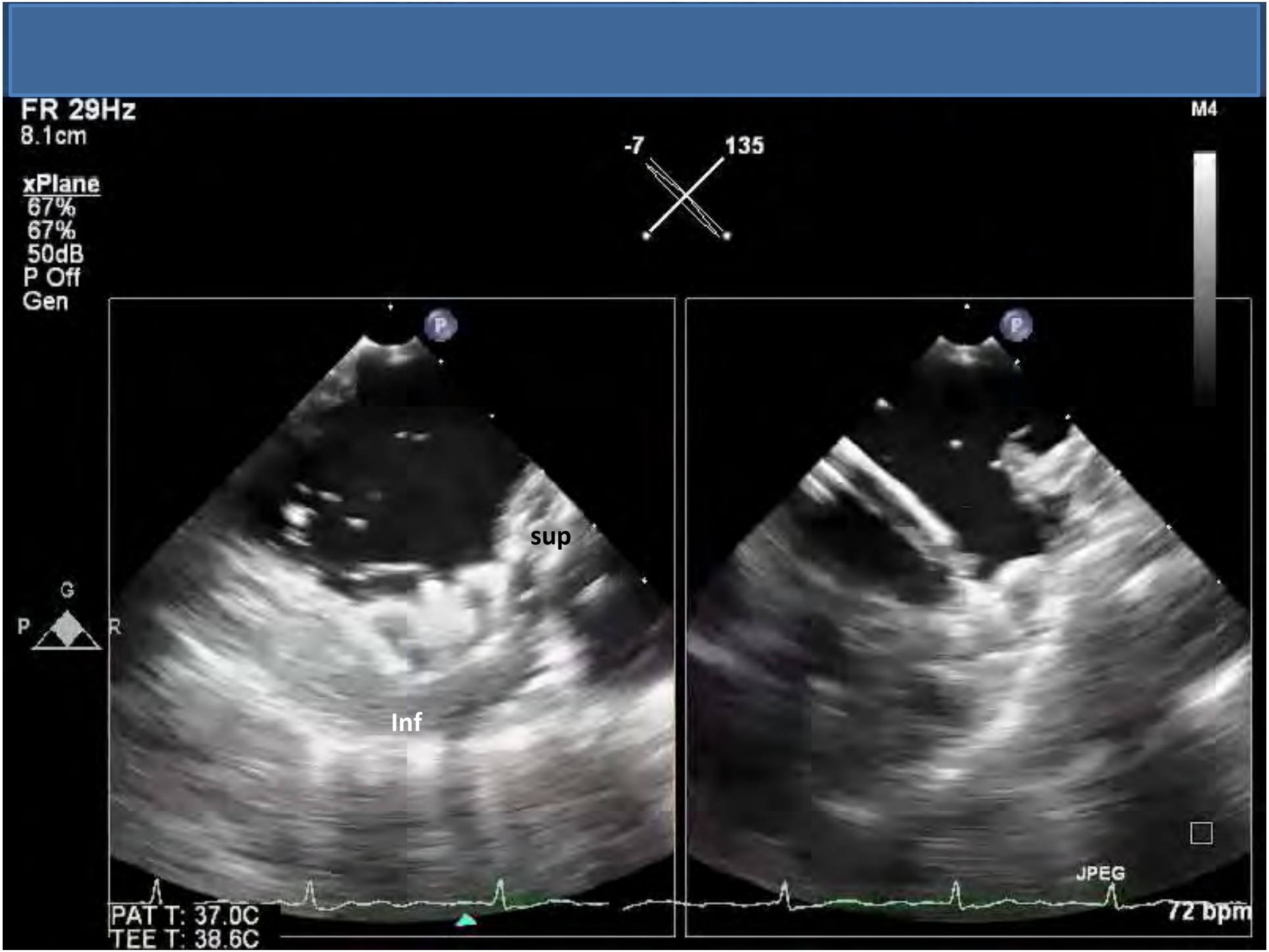
3D Printing for Personalised Cardiac Intervention










FR 29Hz
8.1cm
xPlane
67%
67%
50dB
P Off
Gen
-7
135
M4
sup
Inf
G
P
R
JPEG
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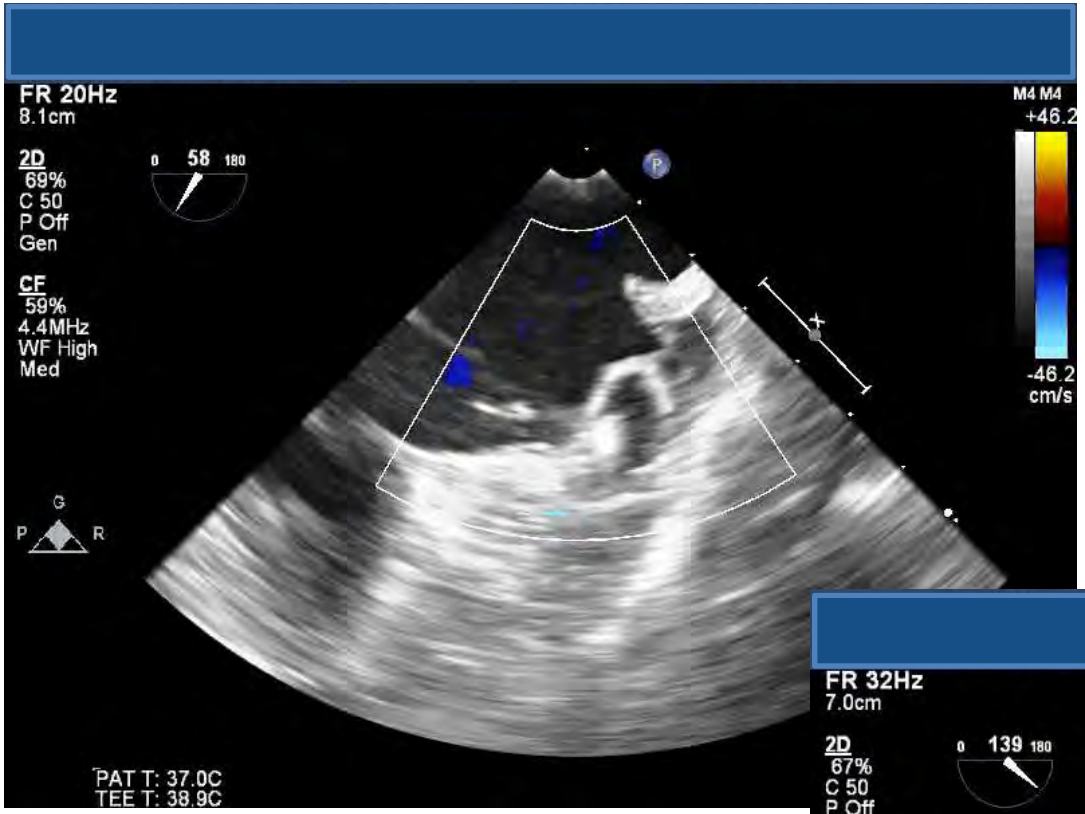
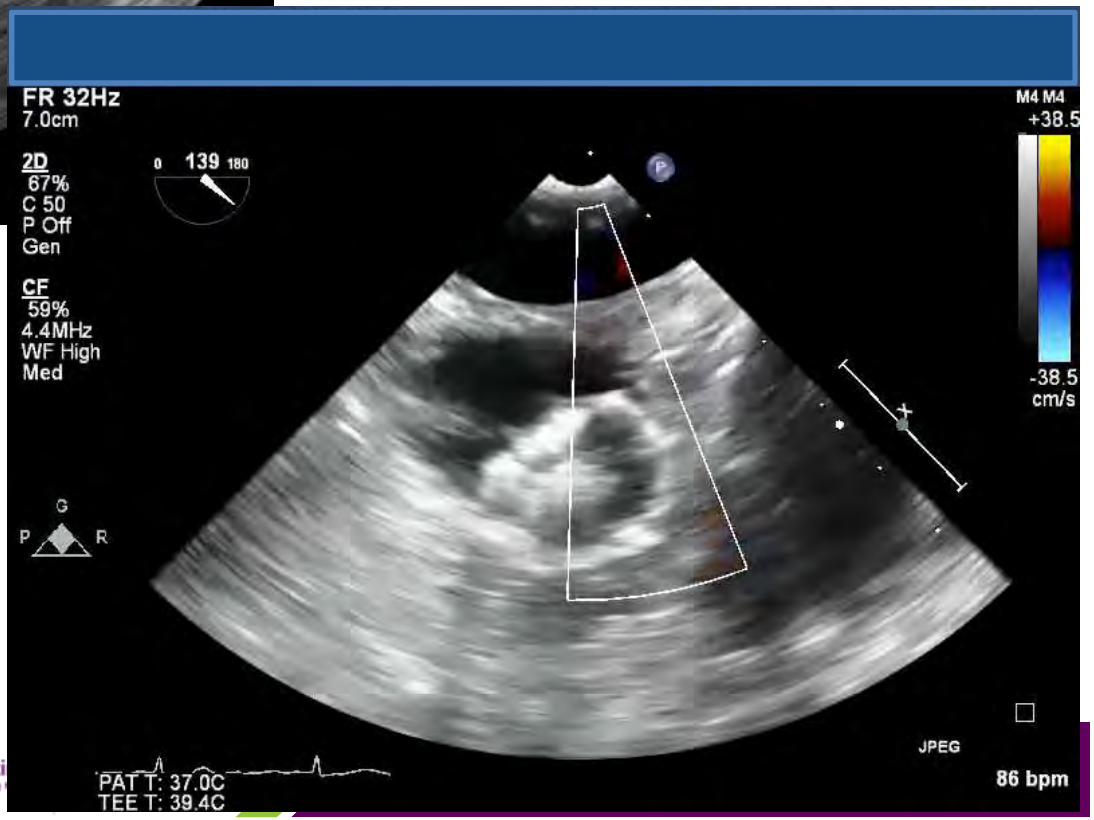
PAT T: 37.0C
TEE T: 38.6C





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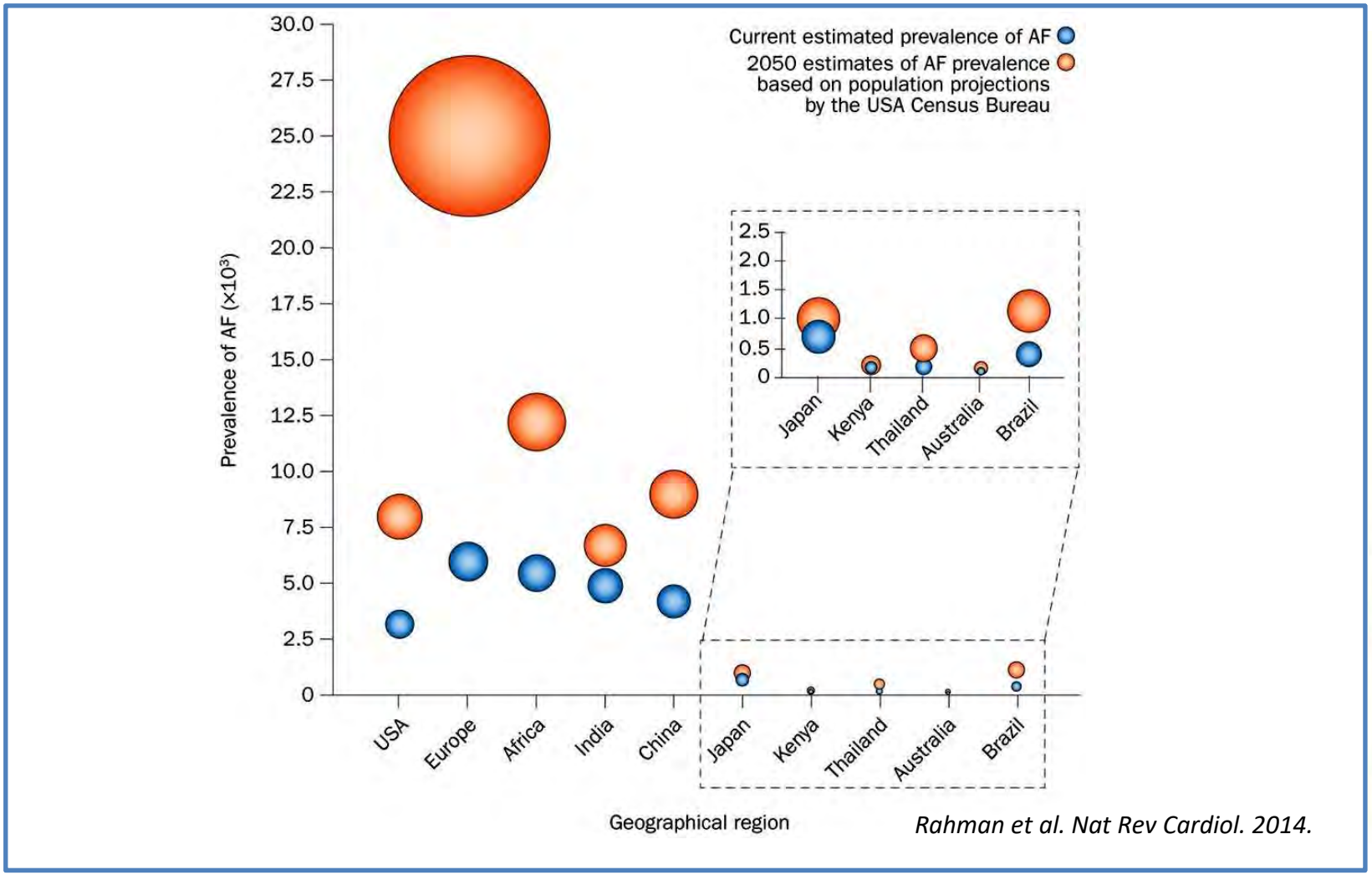
香港中文大學醫學院
Faculty of Medici
The Chinese University of Hong

Real patient cases demo

Atrial fibrillation is a major cause of stroke



Rahman et al. Nat Rev Cardiol. 2014.

左心耳封堵術 LAA occlusion

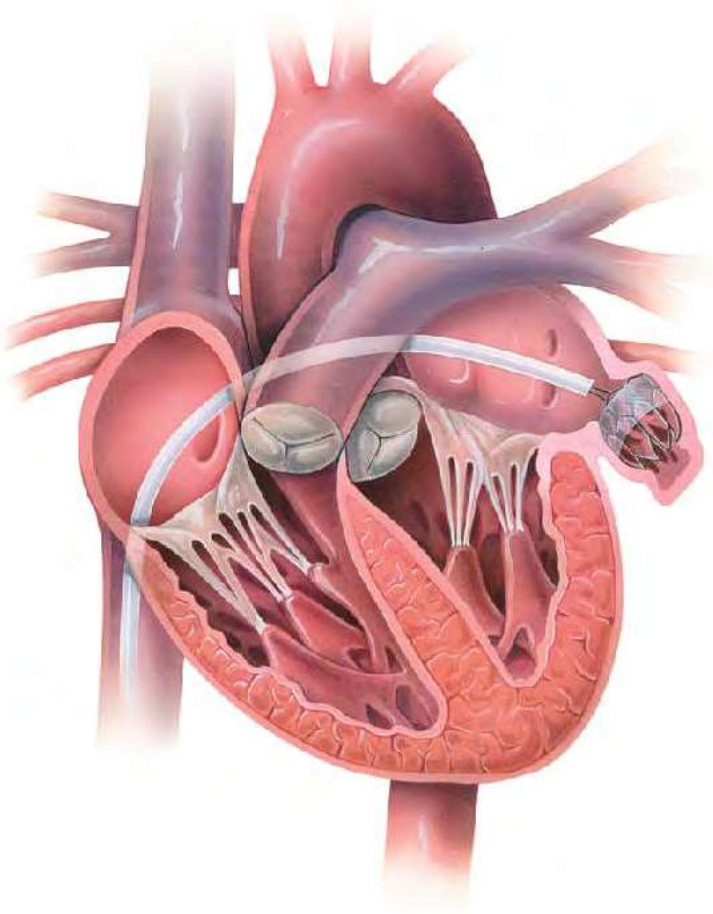
- CHA2DS2-VASc 分數 = 8

(每年中風機會率)

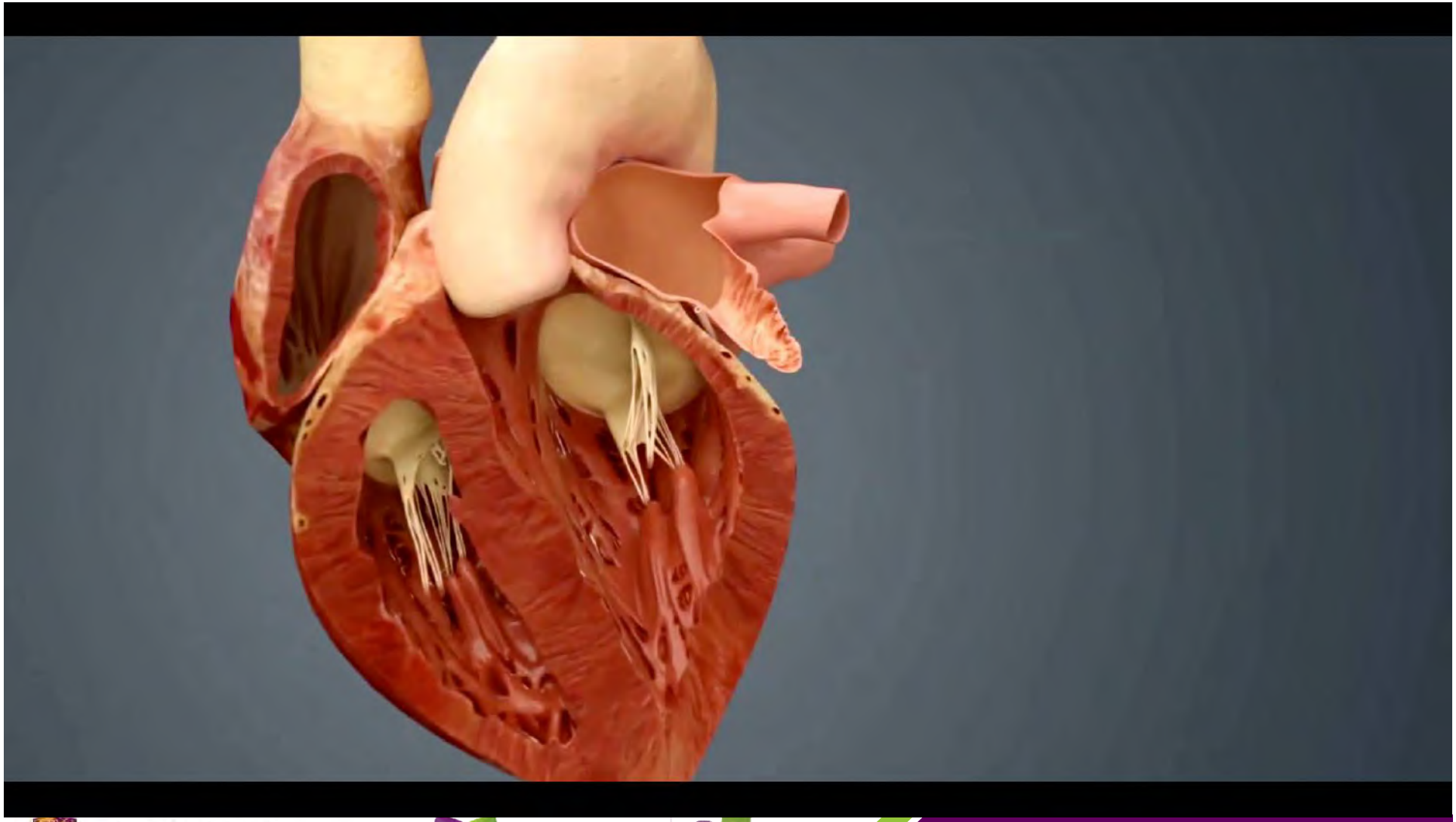
- HAS-BLED 分數 = 4

(每年出血機會率)

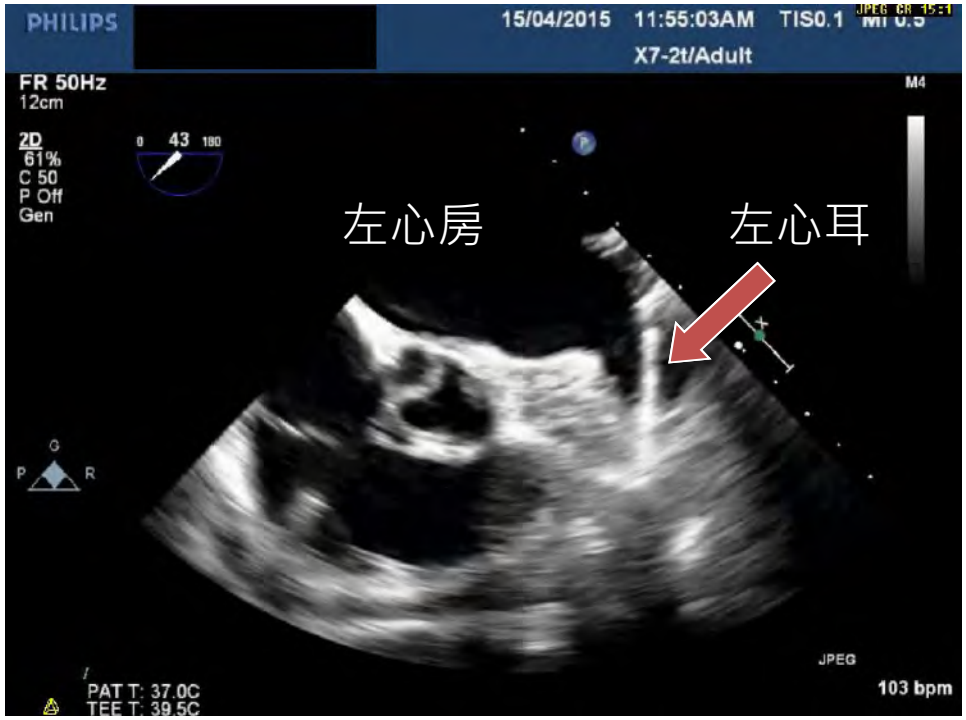
=> 終身服用抗凝血藥將增加出血性中風的機會

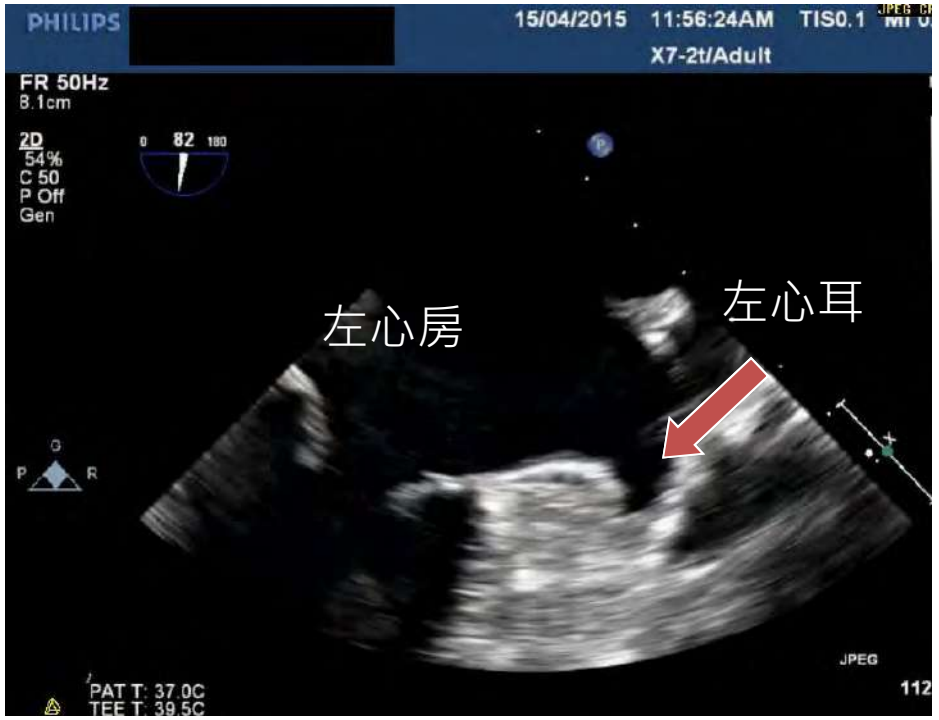


Transcatheter left atrial appendage occlusion procedure



手術前心臟超聲波圖像


PHILIPS
15/04/2015 11:55:03AM TIS0.1
X7-2t/Adult
FR 50Hz
12cm
2D
61%
C 50
P Off
Gen
M4
左心房
左心耳
JPEG
PAT T: 37.0C
TEE T: 39.5C
103 bpm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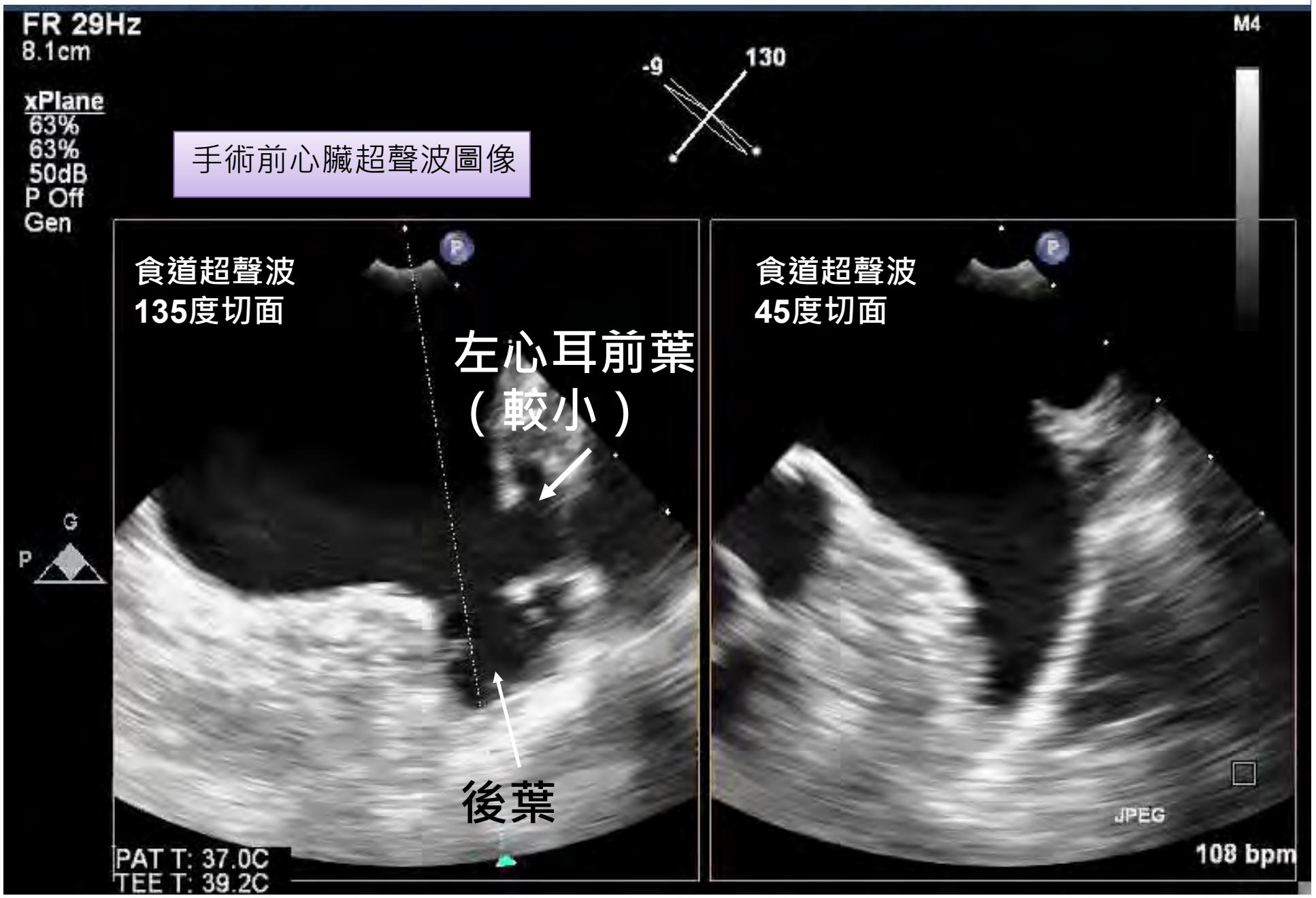
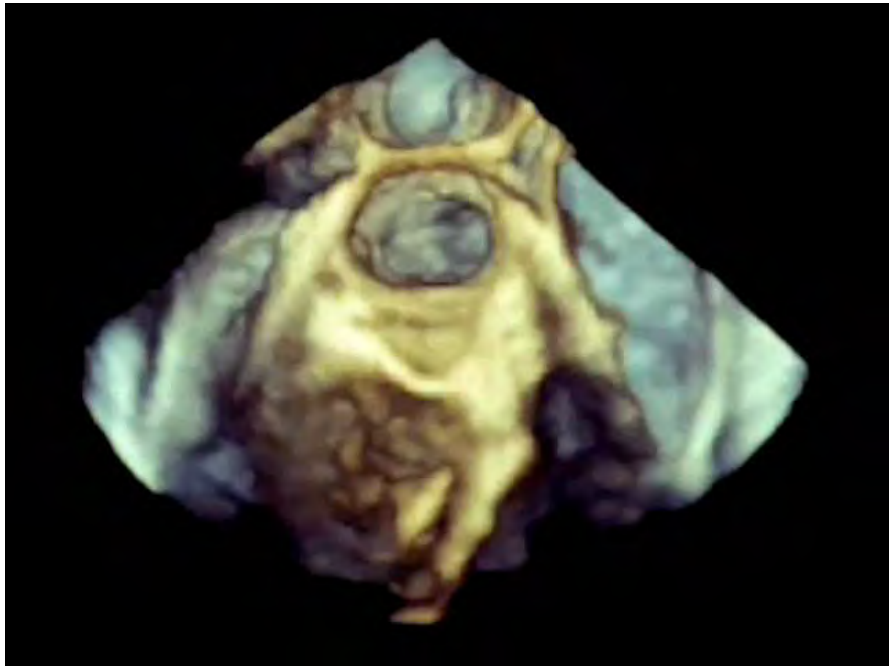
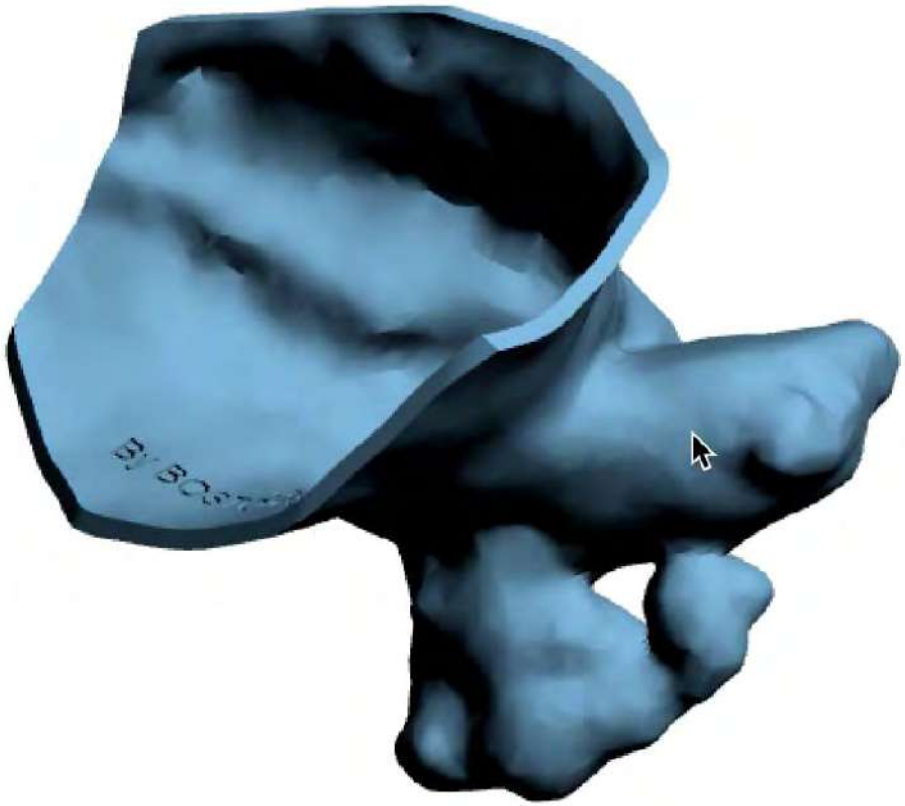
15/04/2015 11:56:24AM TIS0.1
X7-2t/Adult
FR 50Hz
8.1cm
2D
54%
C 50
P Off
Gen
左心房
左心耳
JPEG
PAT T: 37.0C
TEE T: 39.5C


FR 29Hz
8.1cm
xPlane
63%
63%
50dB
P Off
Gen
M4
-9
130
手術前心臟超聲波圖像
食道超聲波
135度切面
左心耳前葉
（較小）
後葉
食道超聲波
45度切面
G
P
JPEG
108 bpm
PAT T: 37.0C
TEE T: 39.2C

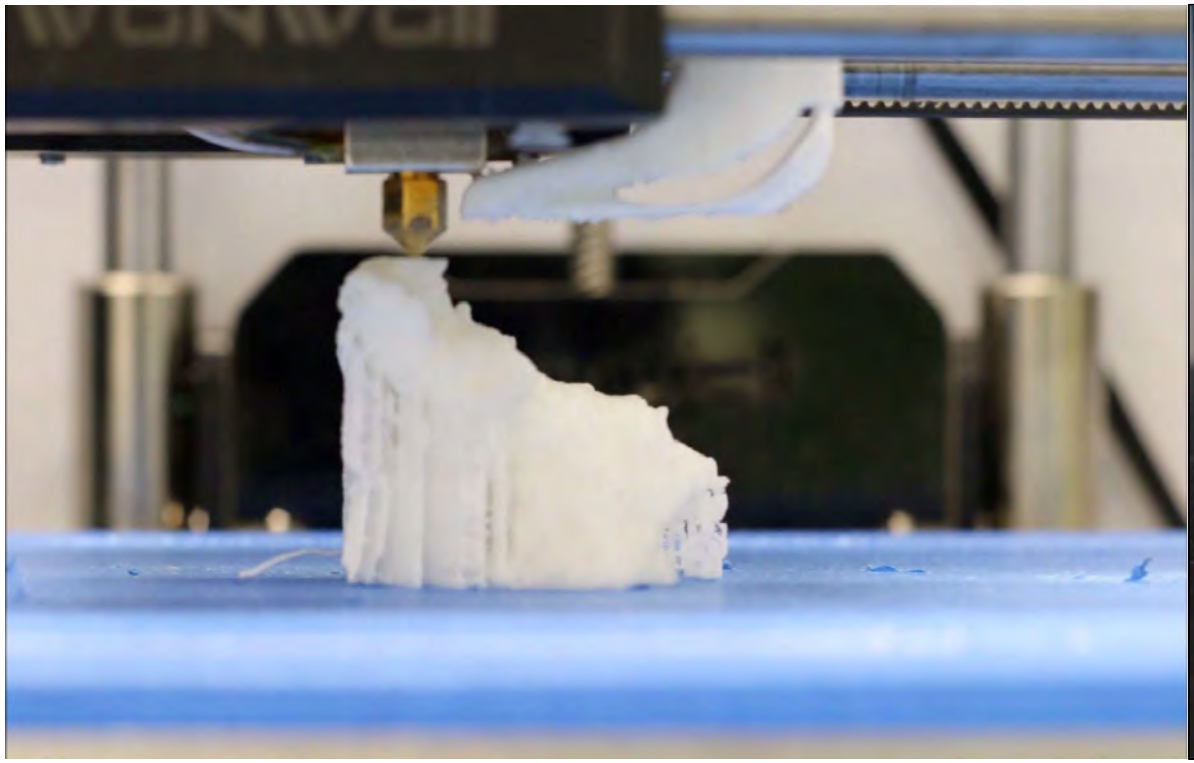
3D食道超聲波患者
左心耳成像

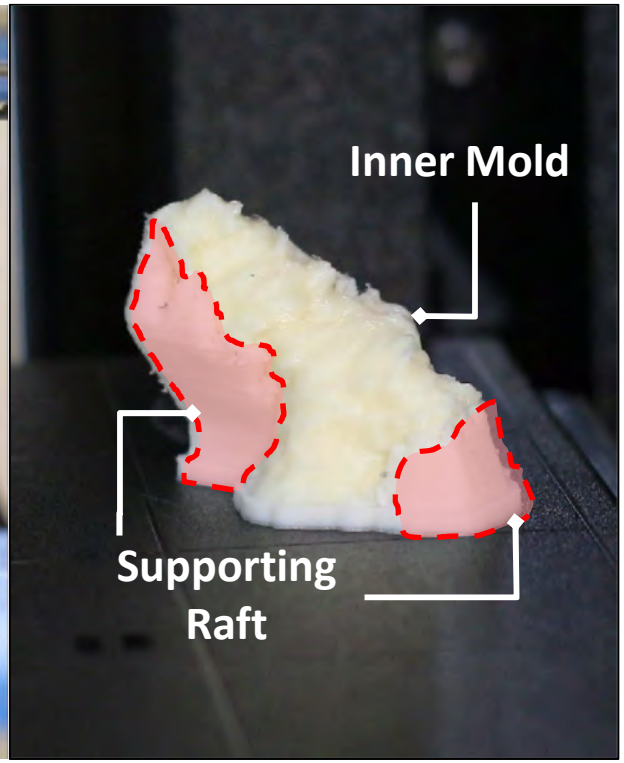




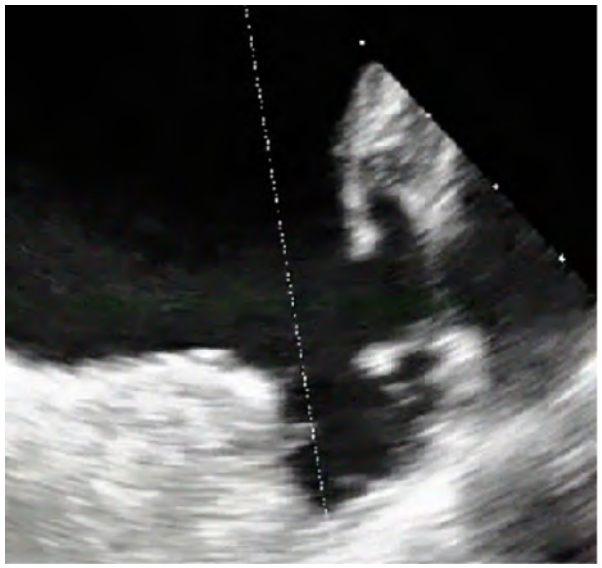
模具快速成型

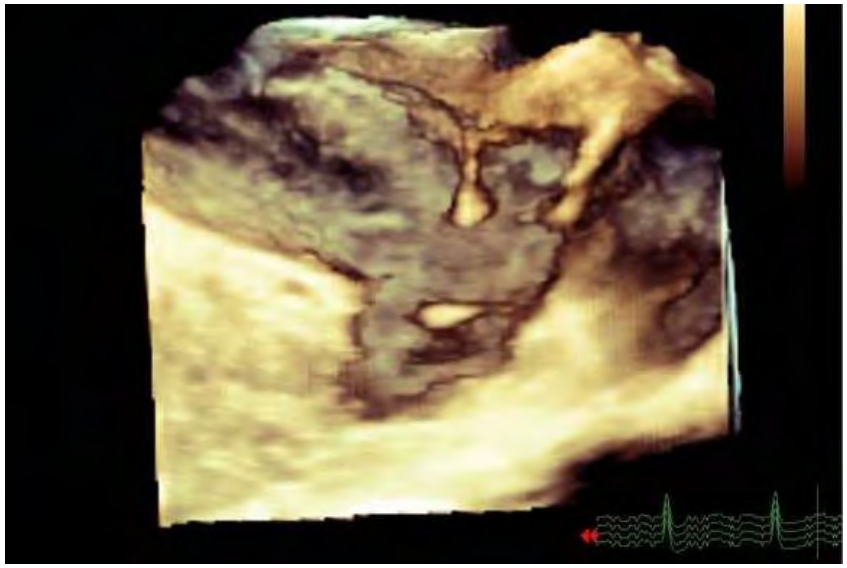
- 內模通過3D打印技術製作，如視頻所展示：

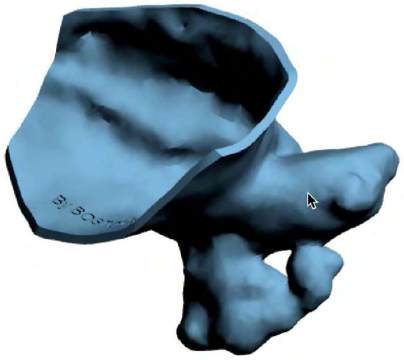




在3D打印技術輔助下進行個人化心臟介入治療



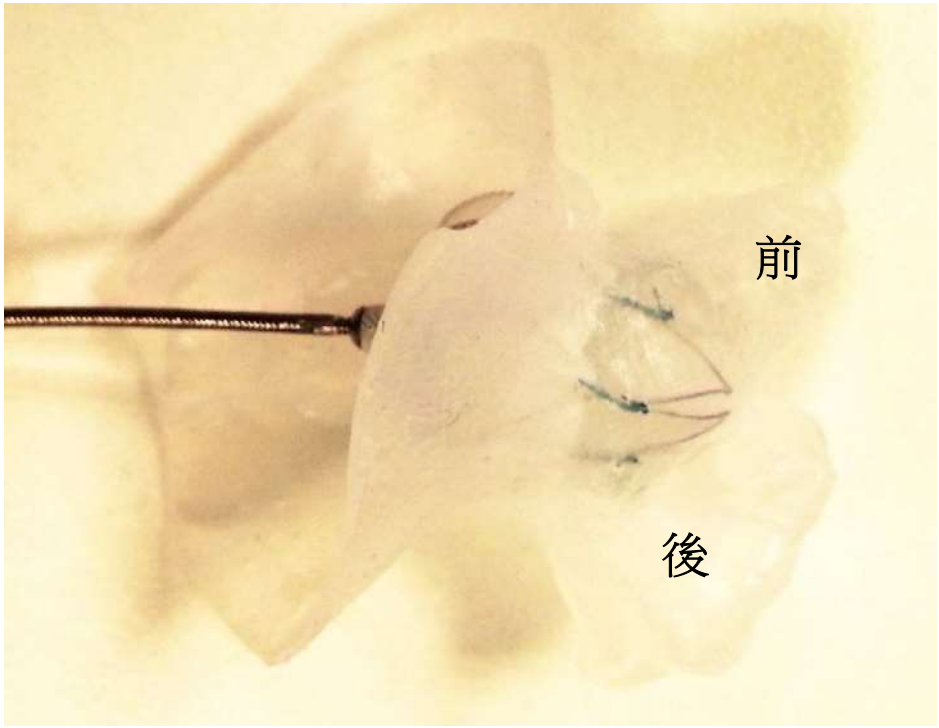


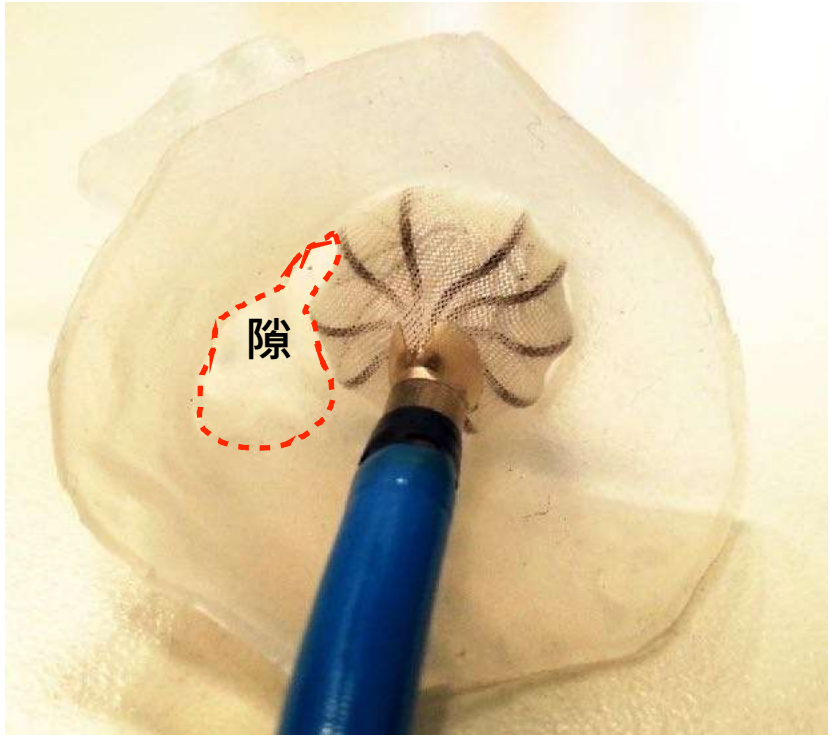


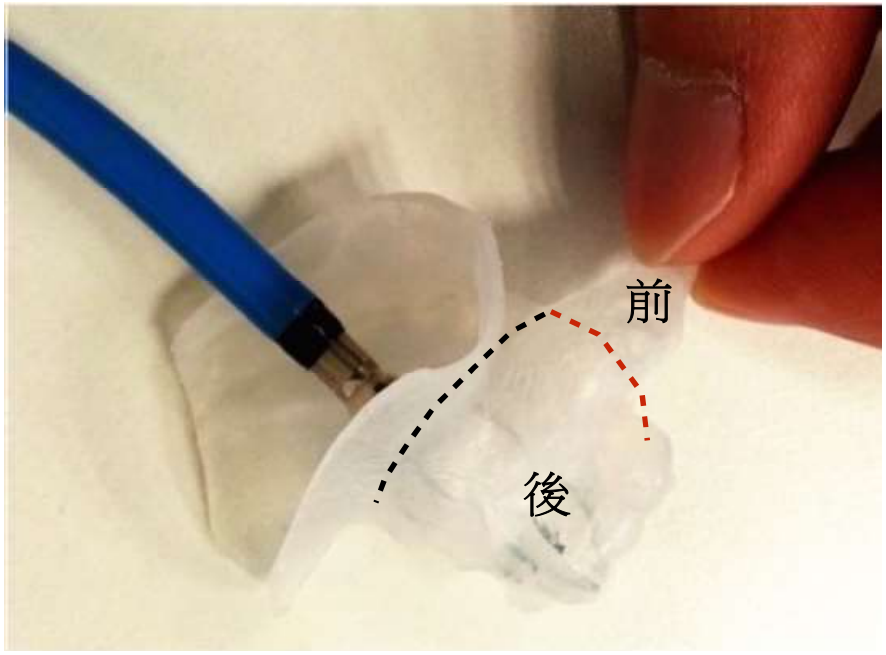
在3D打印技術輔助下進行個人化心臟介入治療

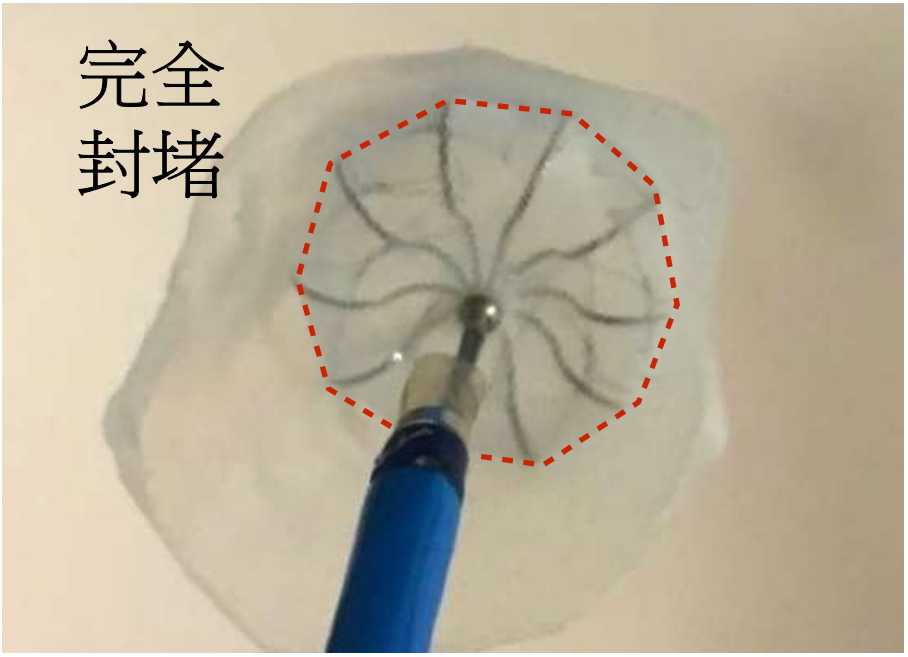
在3D打印左心耳模型上進行個人化導管手術模擬

24mm封堵器放在左心耳前葉



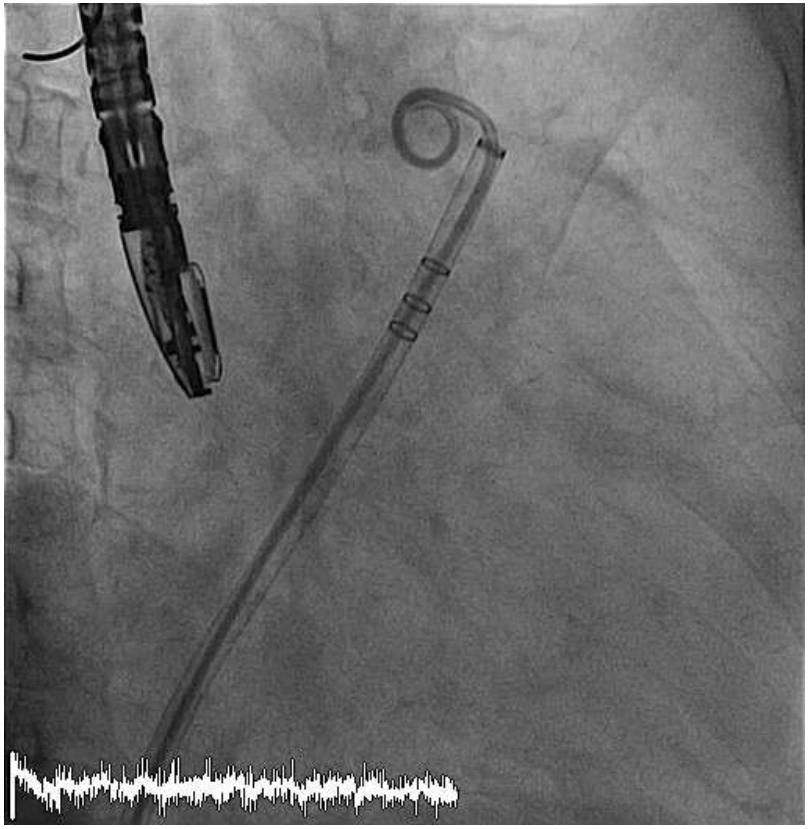


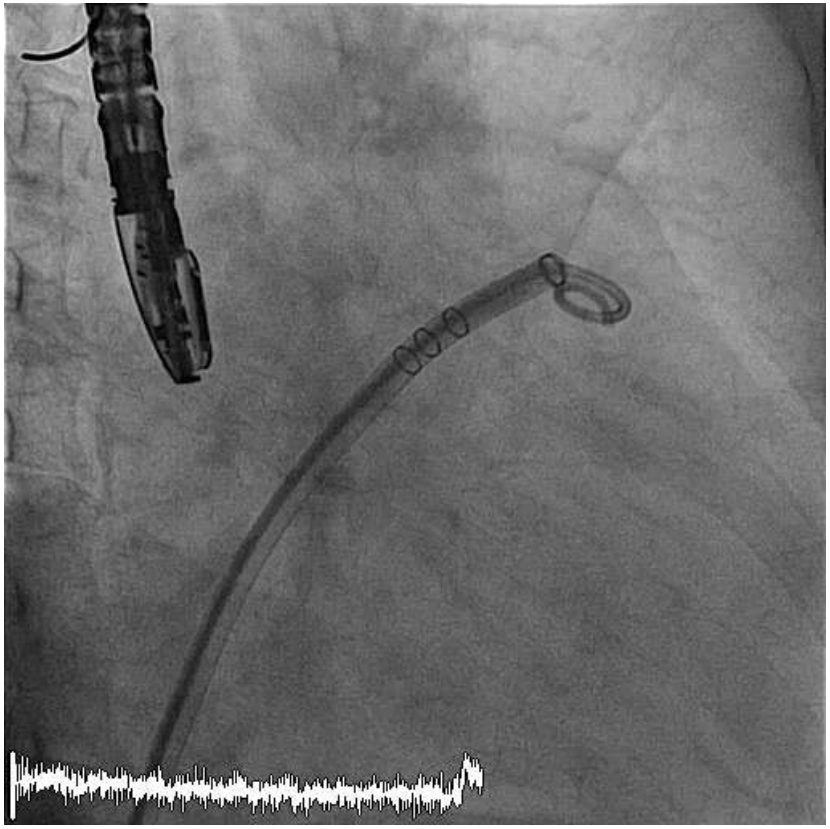




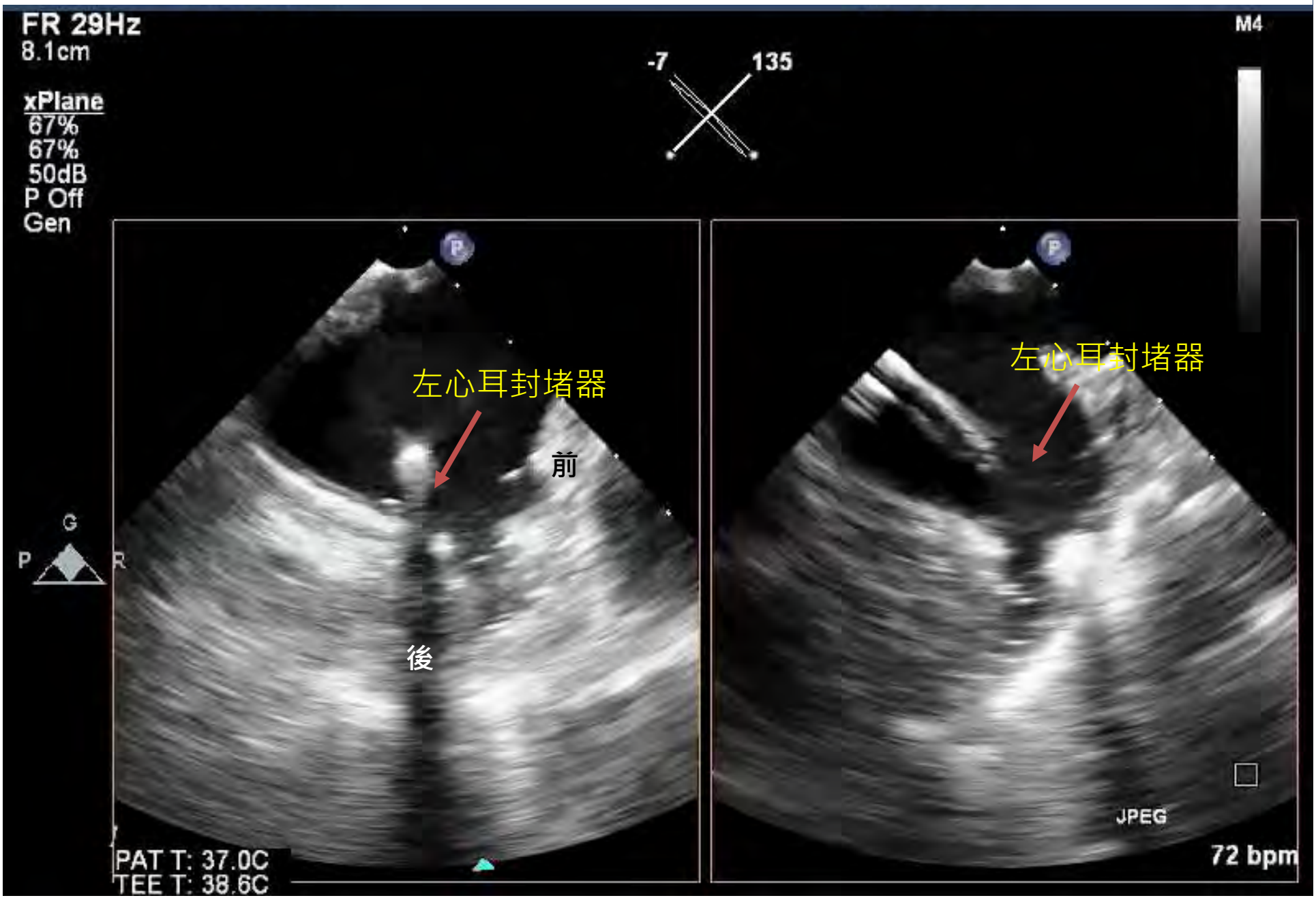
24mm封堵器放在左心耳後葉

手術中左心耳顯影影像

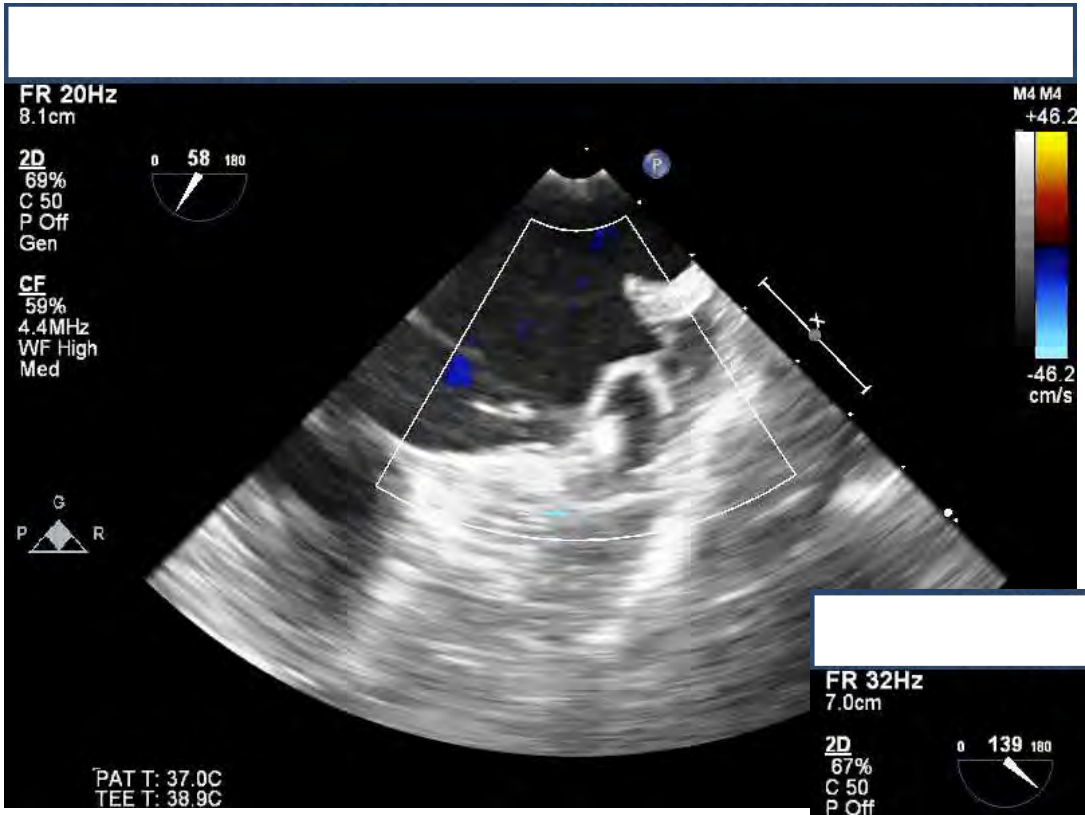


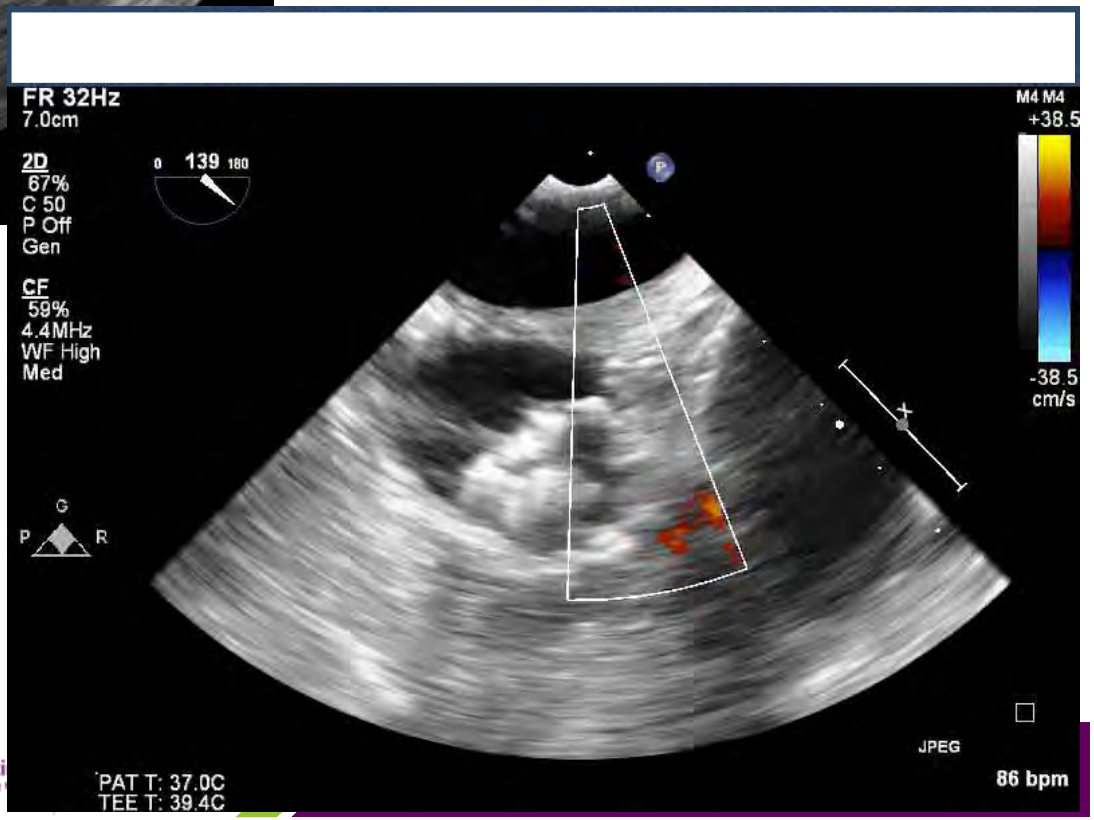


手術中心臟超聲波圖像


FR 29Hz
8.1cm
xPlane
67%
67%
50dB
P Off
Gen
-7
135
M4
左心耳封堵器
前
後
G
P
R
PAT T: 37.0C
TEE T: 38.6C
左心耳封堵器
JPEG
72 bpm

手術後心臟超聲波圖像





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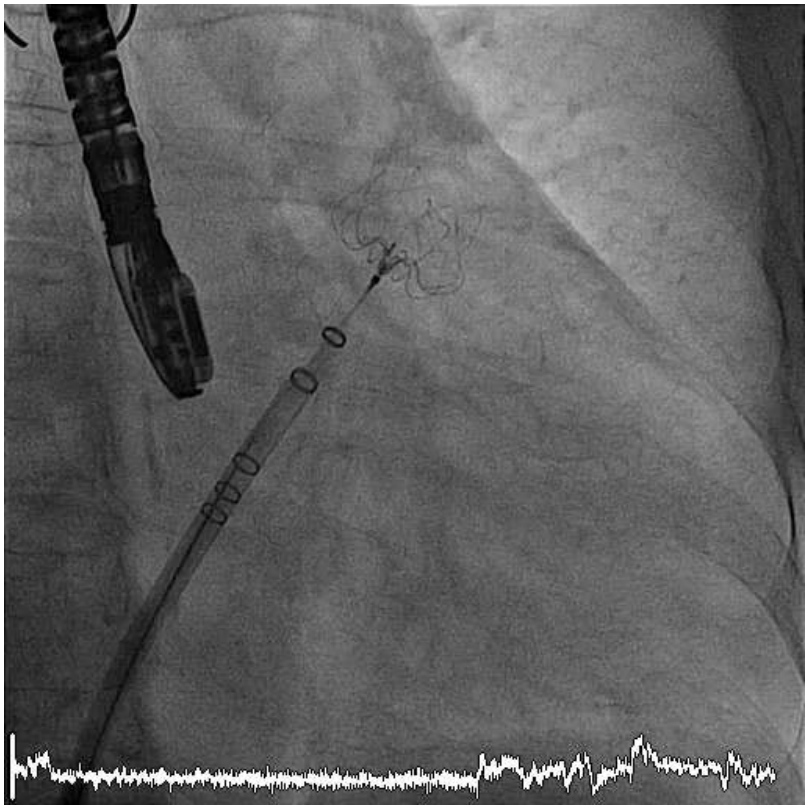
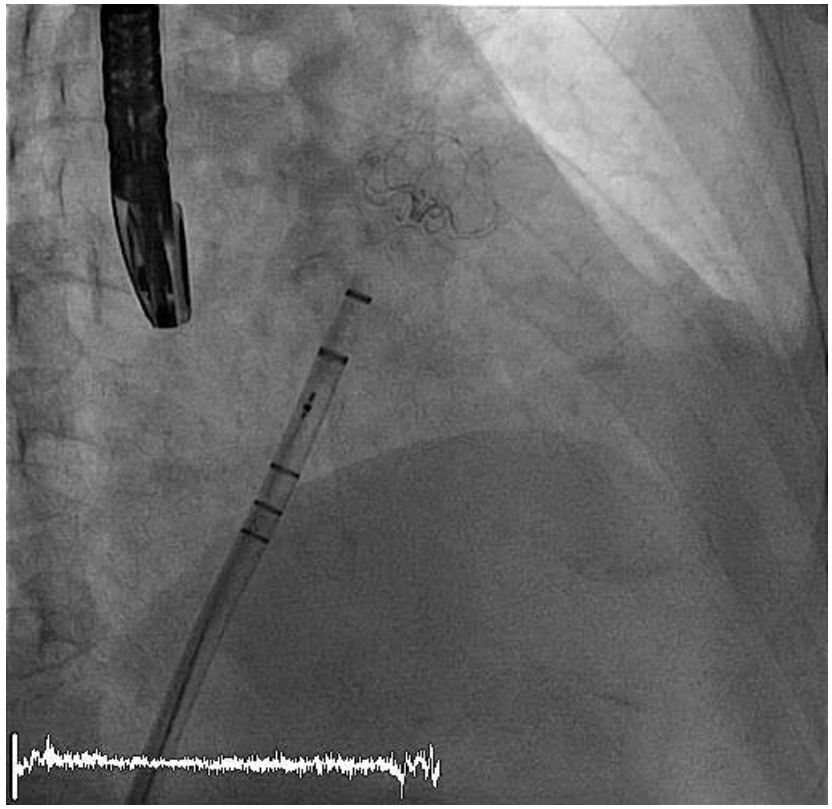
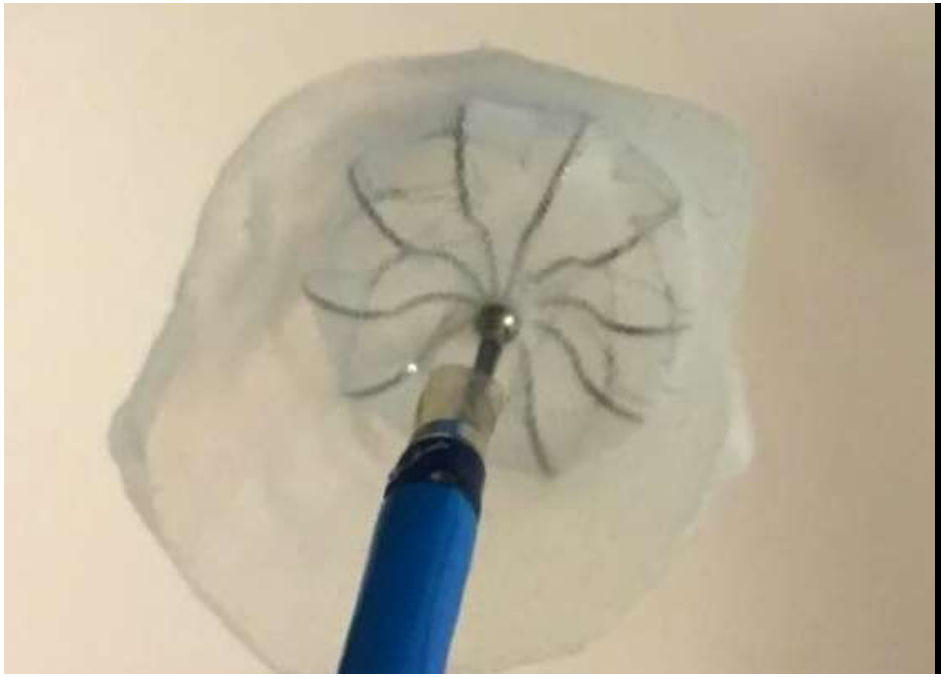
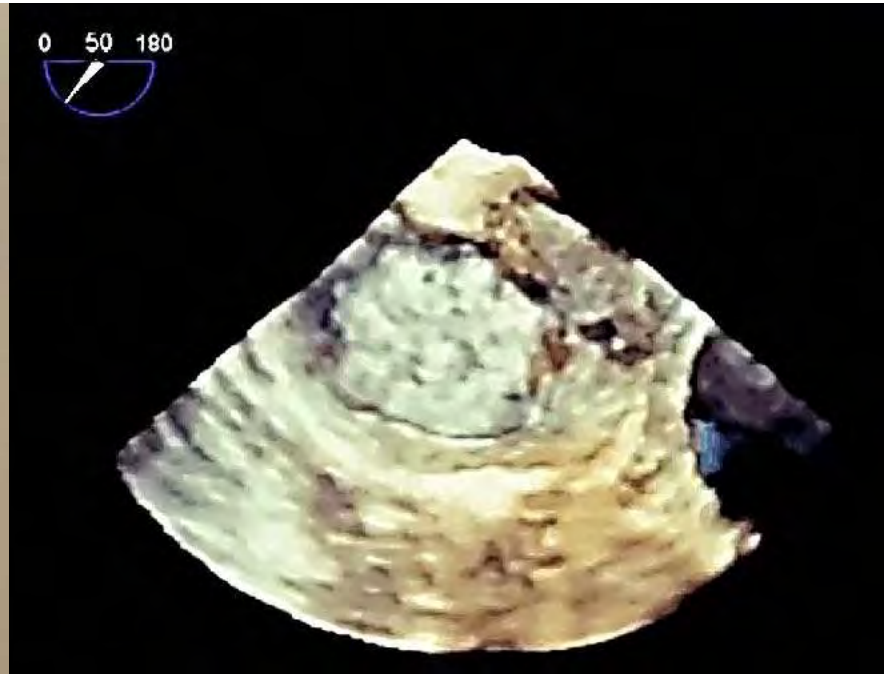




24mm封堵器放在左心耳, 牢固地封堵整個心耳!

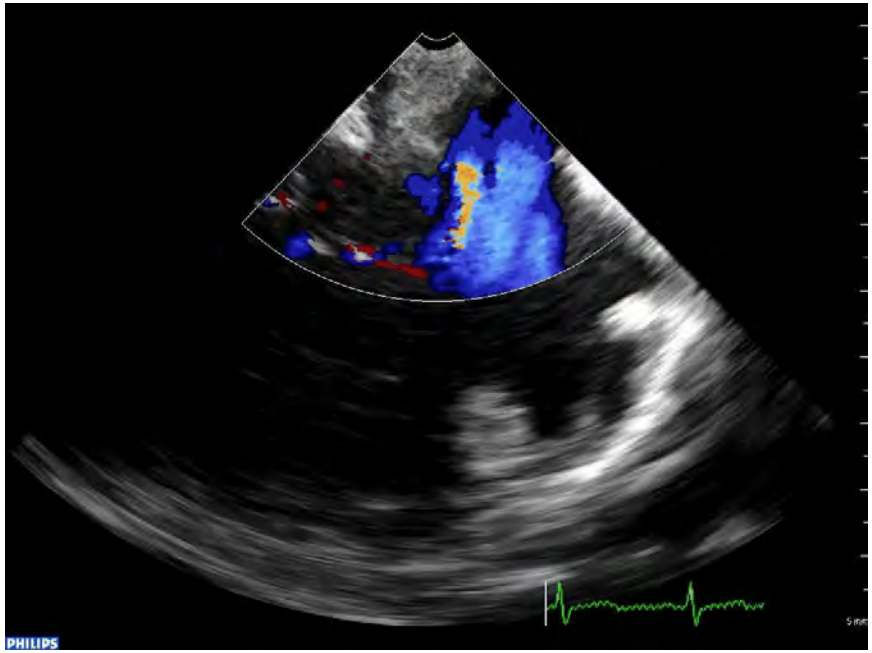
手術前個人化模擬 = 真實手術成果

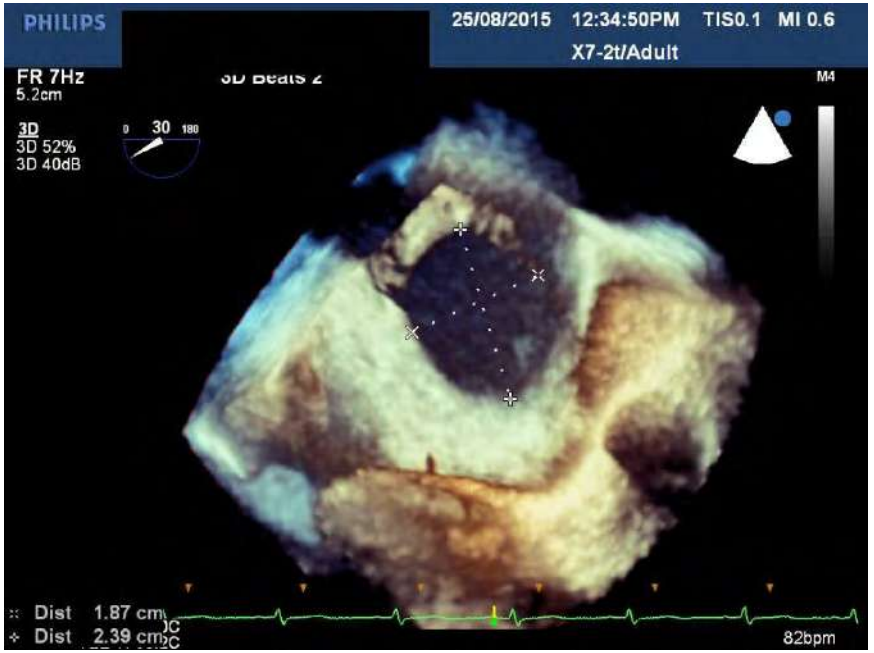




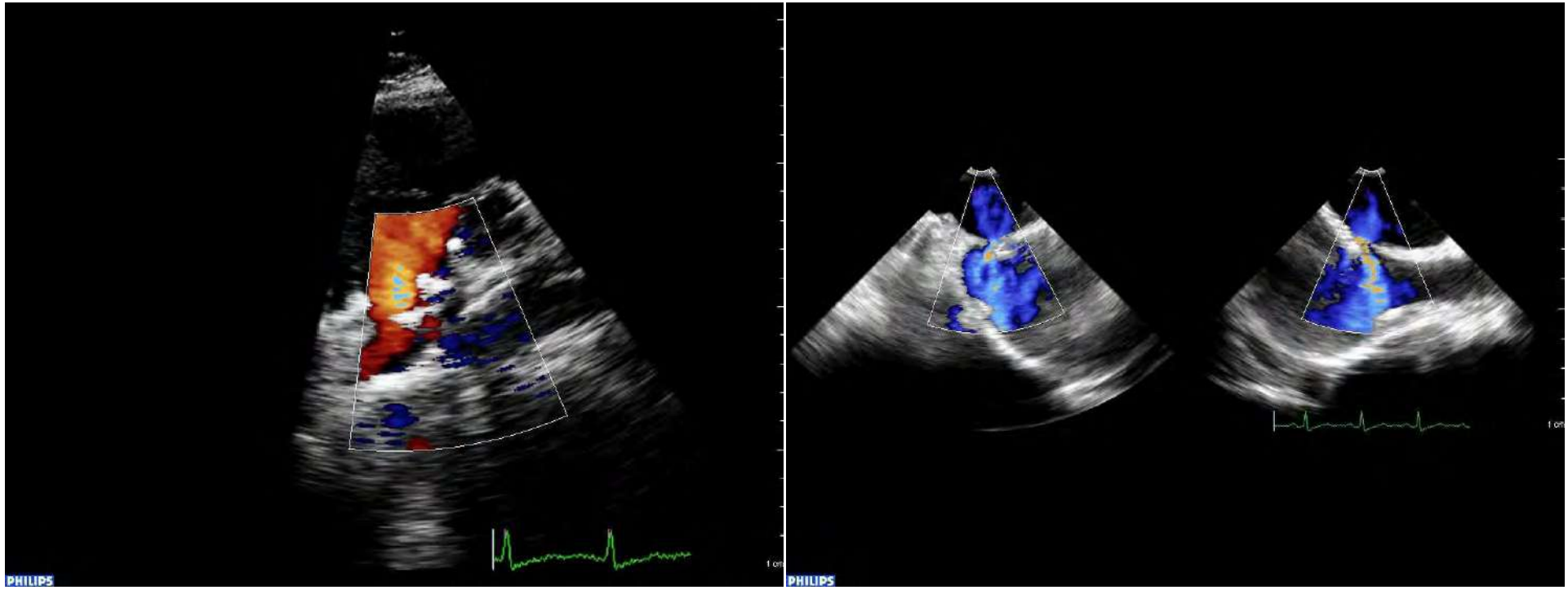
Case 2
F/56

- Shortness of breath x 6 months
- Echo showed large ASD with hemodynamically significant left to right shunt
- Percutaneous ASD closure with 30mm Cocoon ASD device in Sep 2015

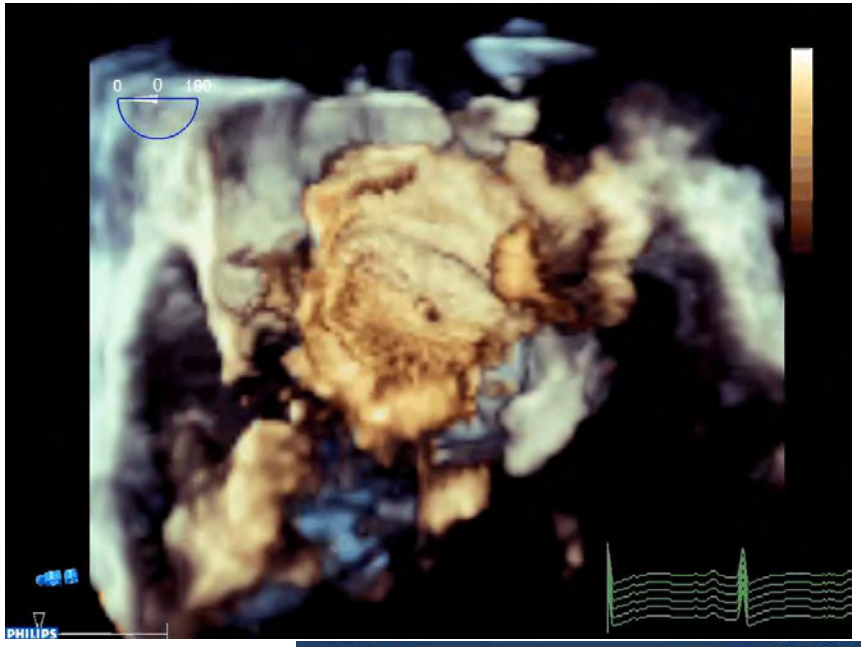


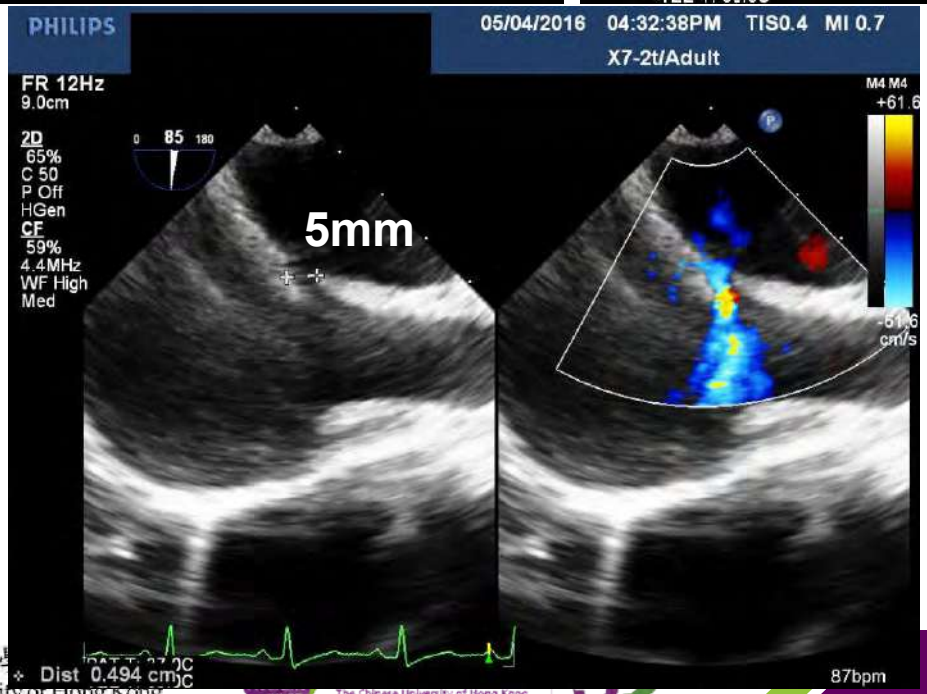


Persistent shortness of breath on exertion 6 months after ASD closure

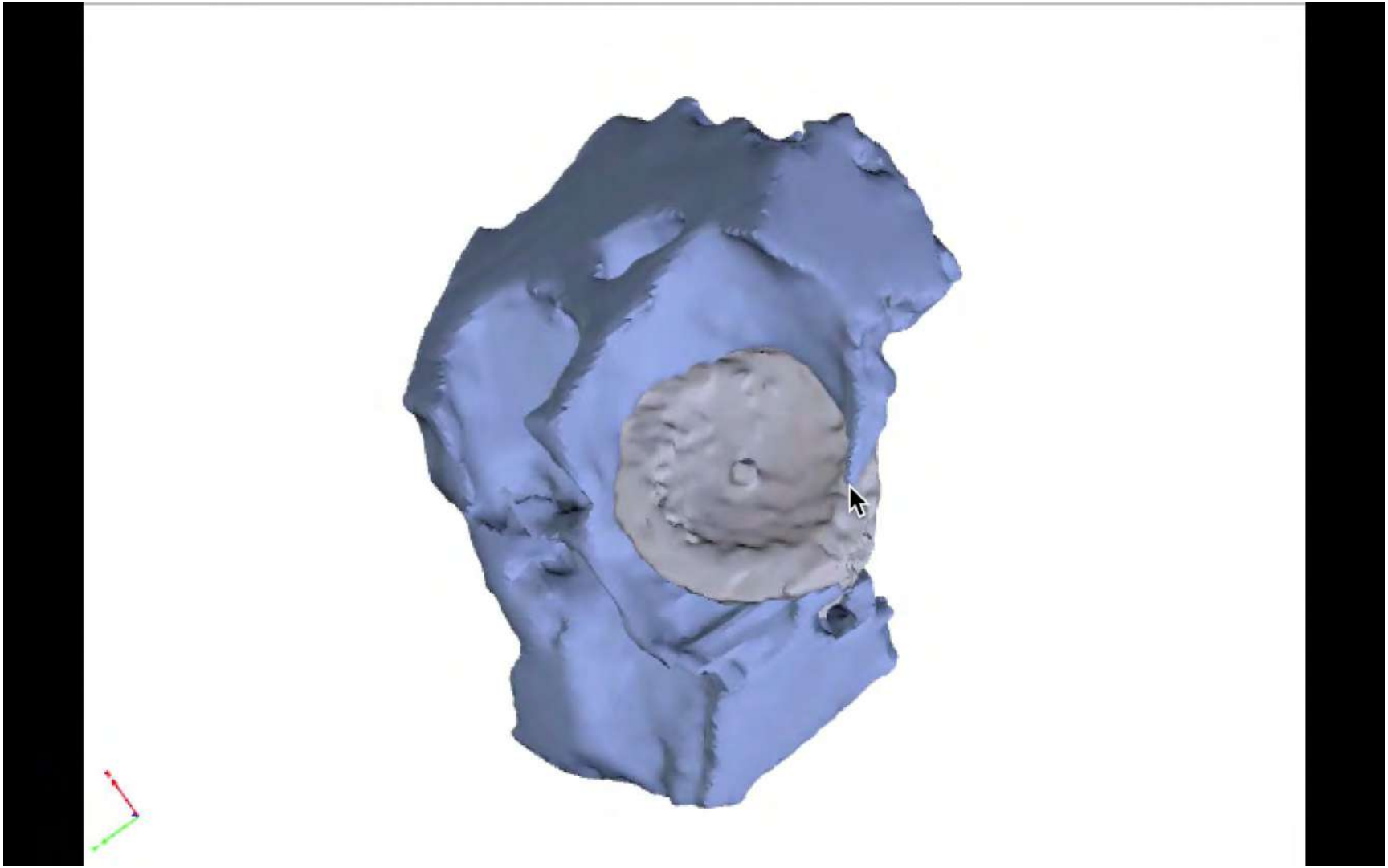


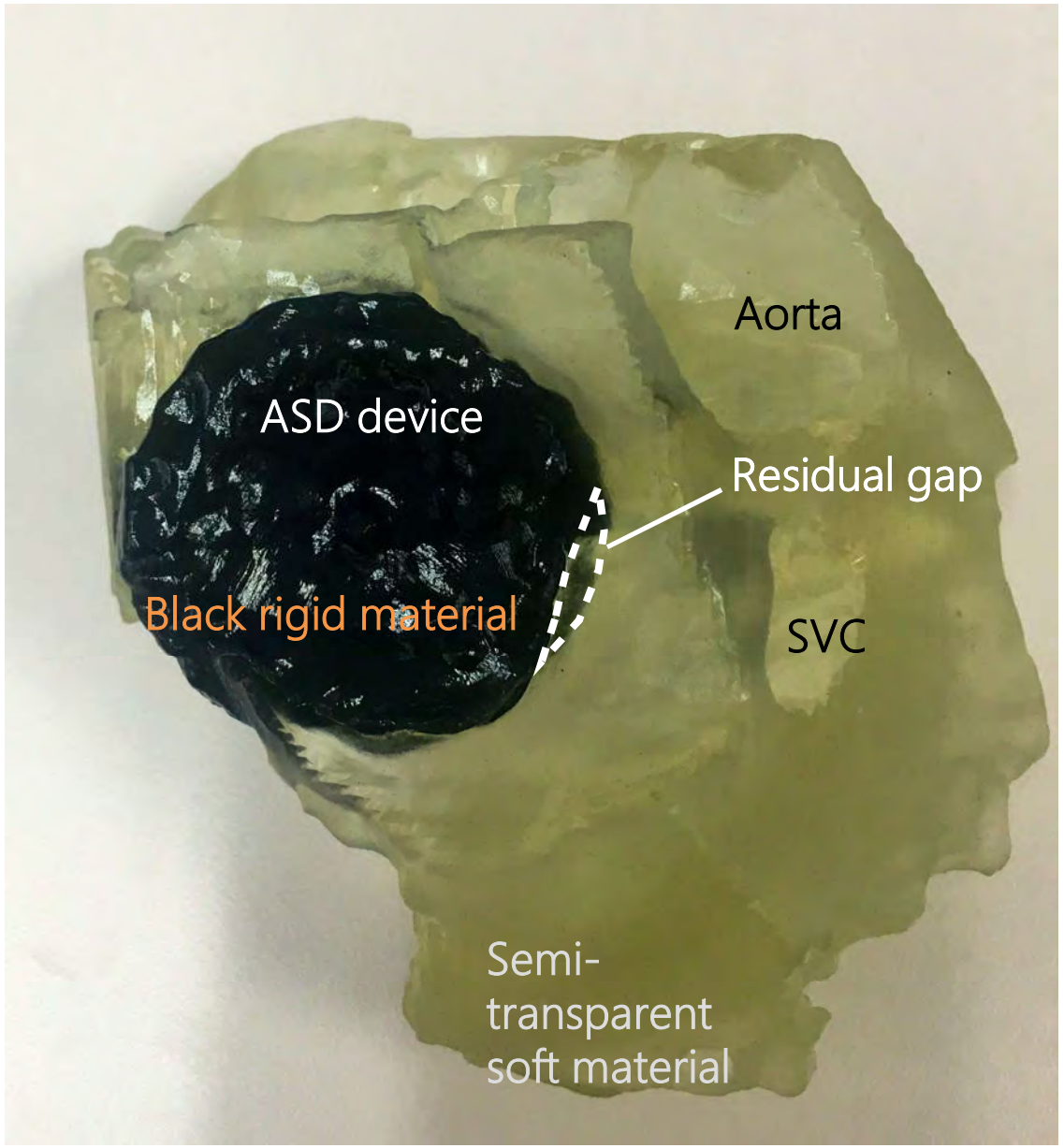
Echo at 6 months confirmed significant residual leak around the upper and posterior edge of the device

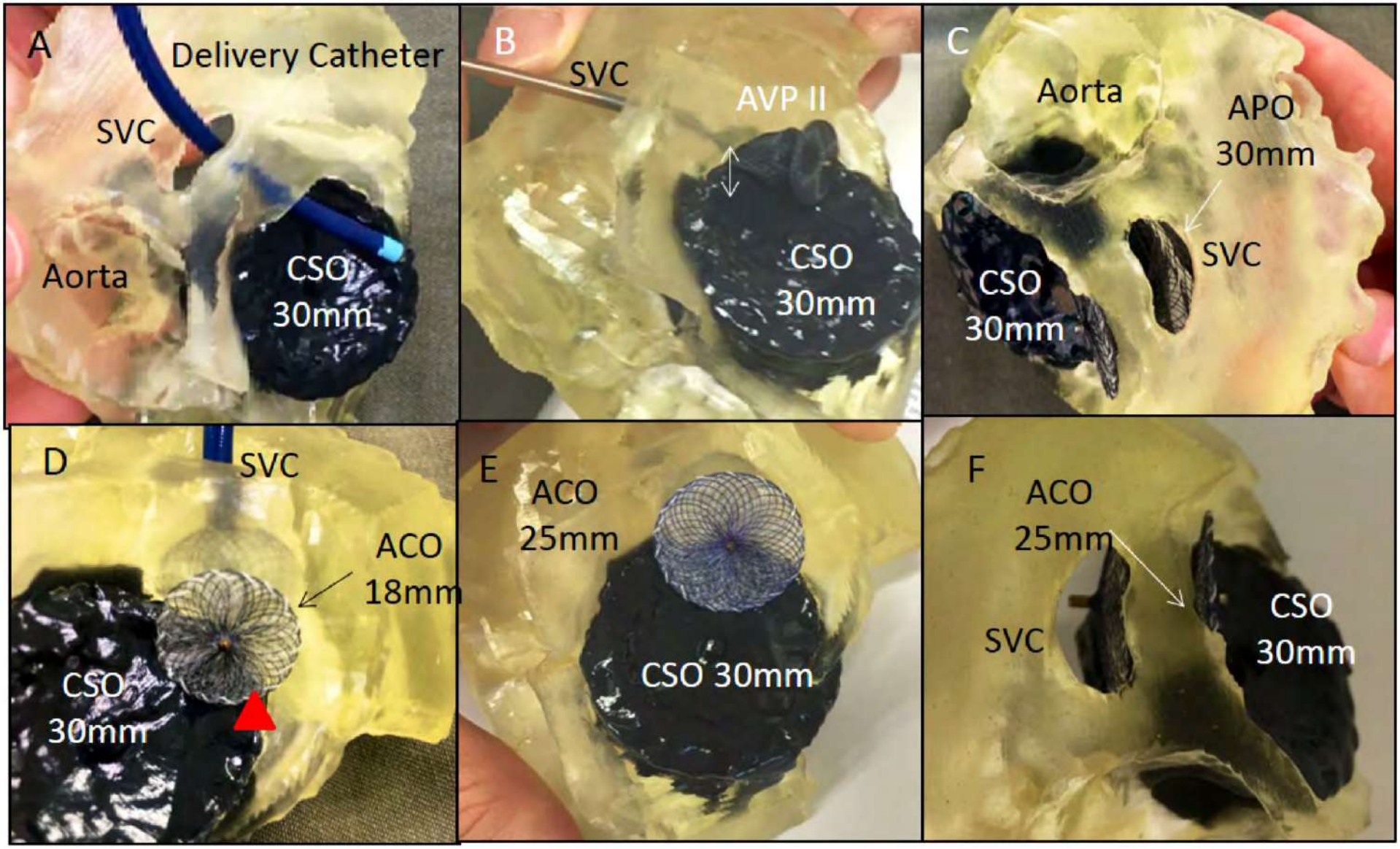


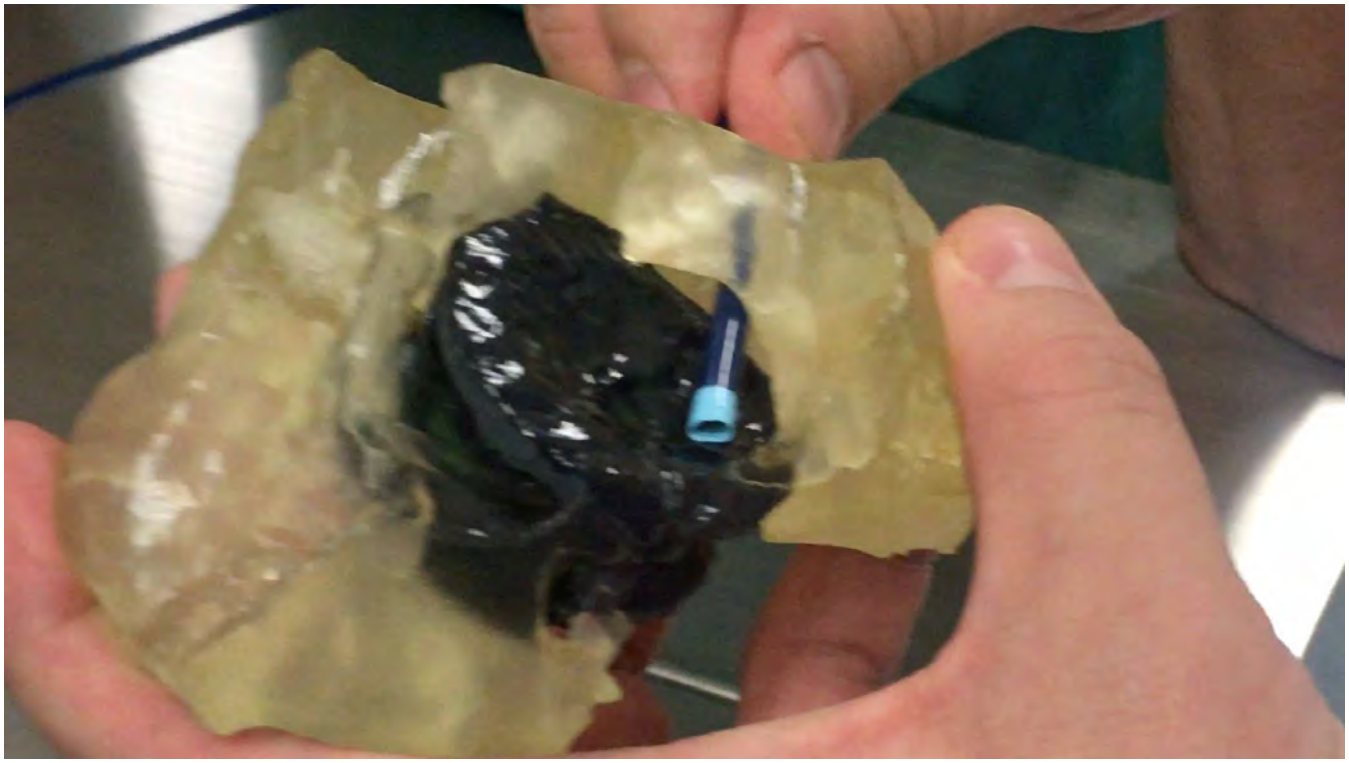


3D TEE shows a crescent-shaped gap 17 x 5mm




Aorta
ASD device
Residual gap
Black rigid material
SVC
Semi-
transparent
soft material


A
Delivery Catheter
SVC
Aorta
CSO
30mm
B
SVC
AVP II
CSO
30mm
C
Aorta
APO
30mm
SVC
CSO
30mm
D
SVC
ACO
18mm
CSO
30mm
E
ACO
25mm
CSO 30mm
F
ACO
25mm
SVC
CSO
30mm



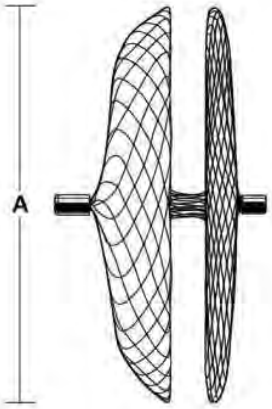
<u>Testing result</u>

Defect coverage - Ok

Device stability - Ok

Device endothelialization - Ok

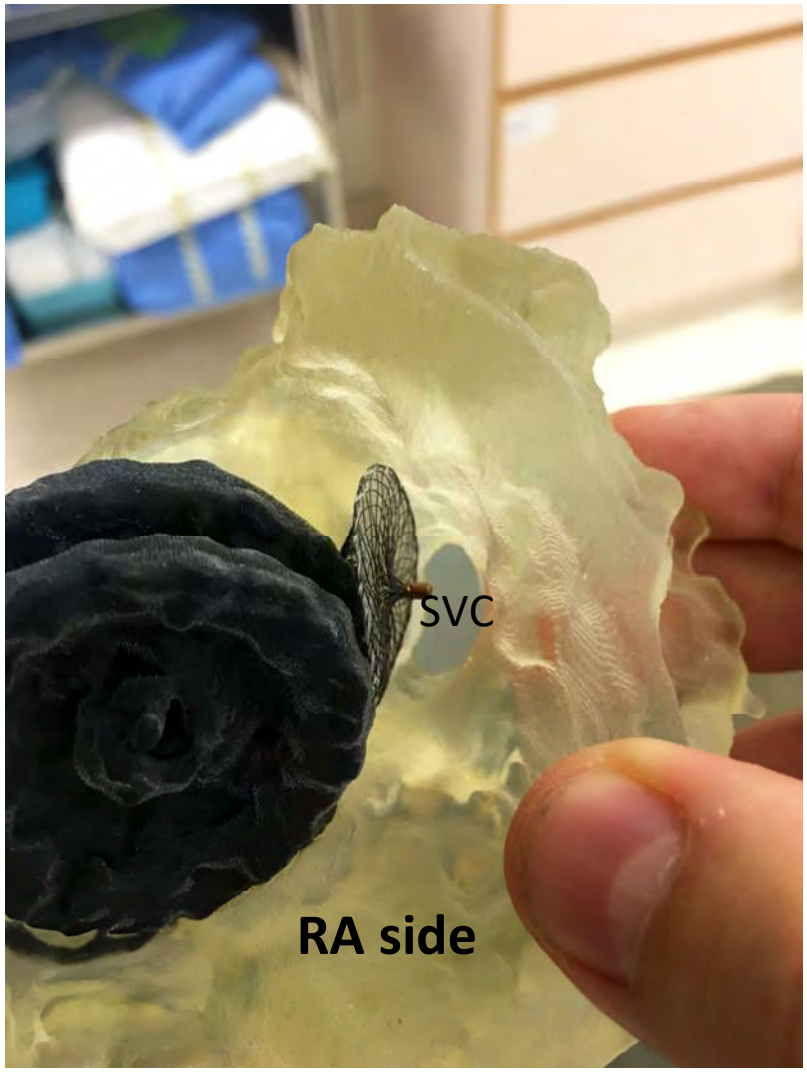
Device impingement - Ok

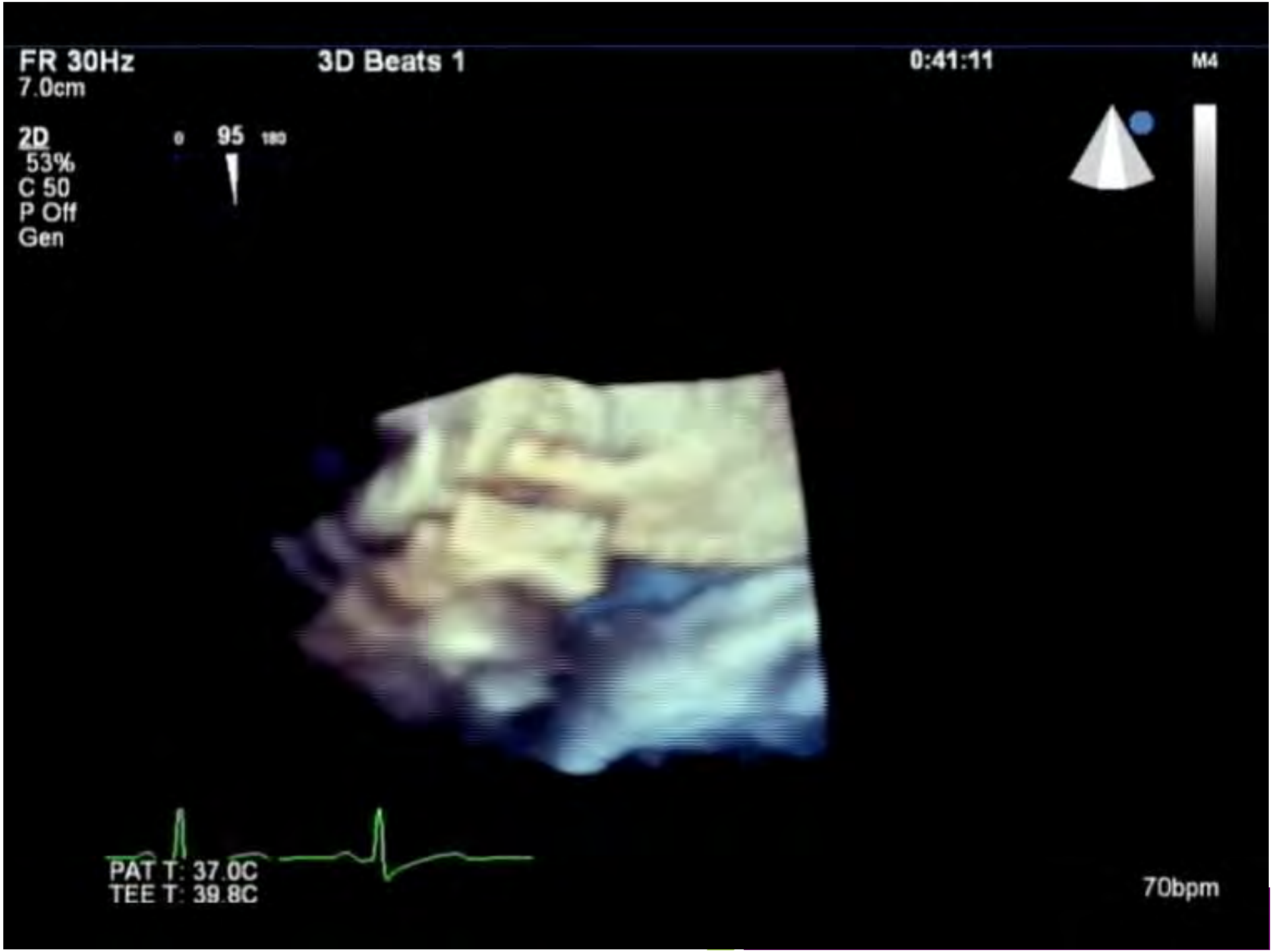


“Cribriform” septal occluder

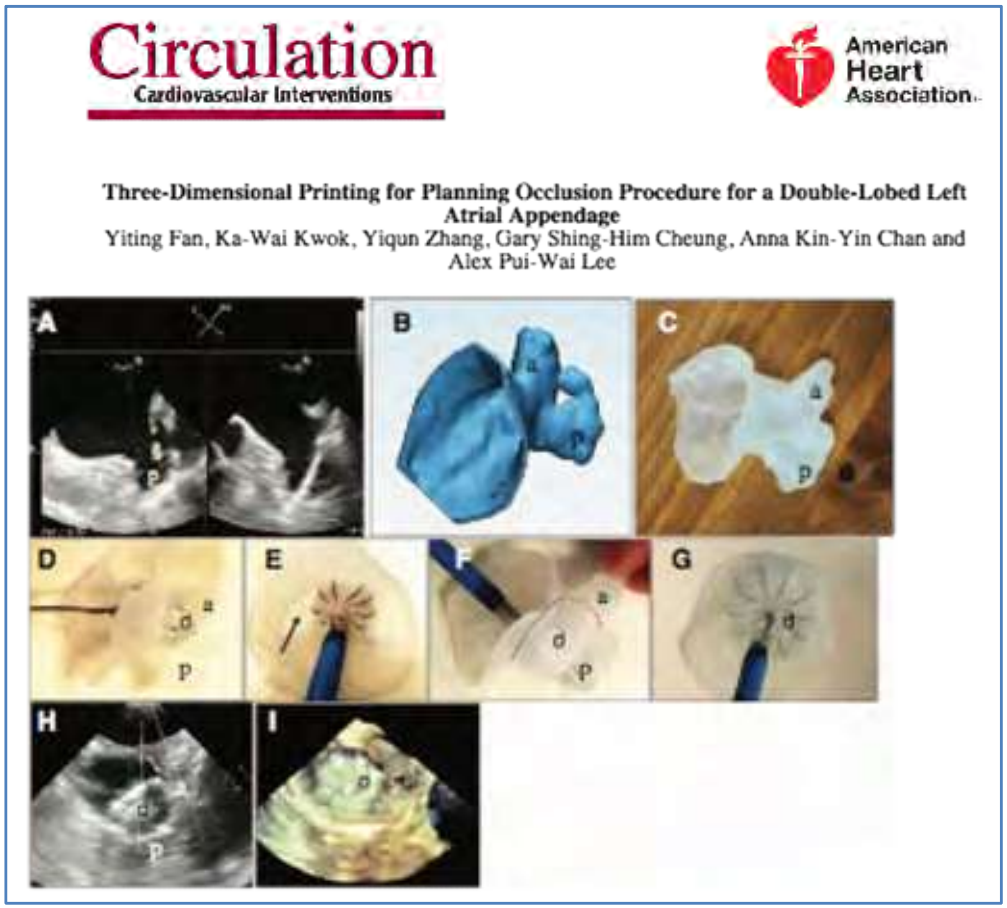
Left disc = Right disc = 18mm


Superior
vena
cava
LA side


SVC
RA side


FR 30Hz
7.0cm
3D Beats 1
0:41:11
M4
2D
53%
C 50
P Off
Gen
0
95
180
PAT T: 37.0C
TEE T: 39.8C
70bpm

Personalised planning for percutaneous structural heart intervention

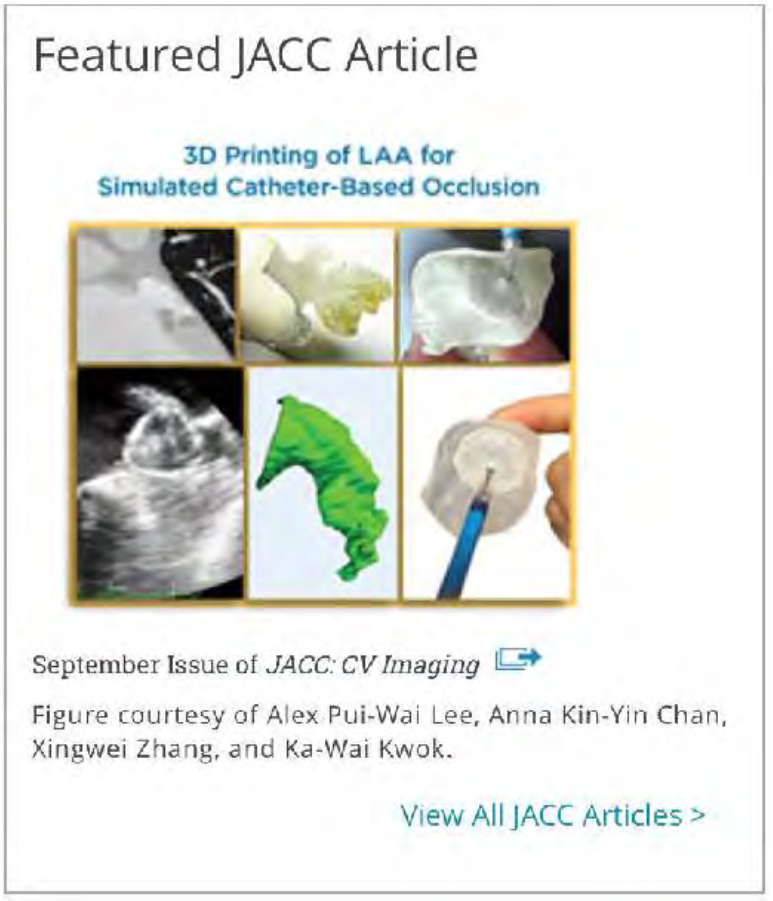


Circulation
Cardiovascular Interventions

American Heart Association.

Three-Dimensional Printing for Planning Occlusion Procedure for a Double-Lobed Left Atrial Appendage

Yiting Fan, Ka-Wai Kwok, Yiqun Zhang, Gary Shing-Him Cheung, Anna Kin-Yin Chan and Alex Pui-Wai Lee



Featured JACC Article

3D Printing of LAA for Simulated Catheter-Based Occlusion

September Issue of *JACC: CV Imaging*

Figure courtesy of Alex Pui-Wai Lee, Anna Kin-Yin Chan, Xingwei Zhang, and Ka-Wai Kwok.

View All JACC Articles >

3D Printing Projected Industry Growth

Exhibit 11: Primary Global AM Market

US$ in millions, unless otherwise stated

20: US$11 Billions

Source: Credit Suisse estimates.

R&D

some updates

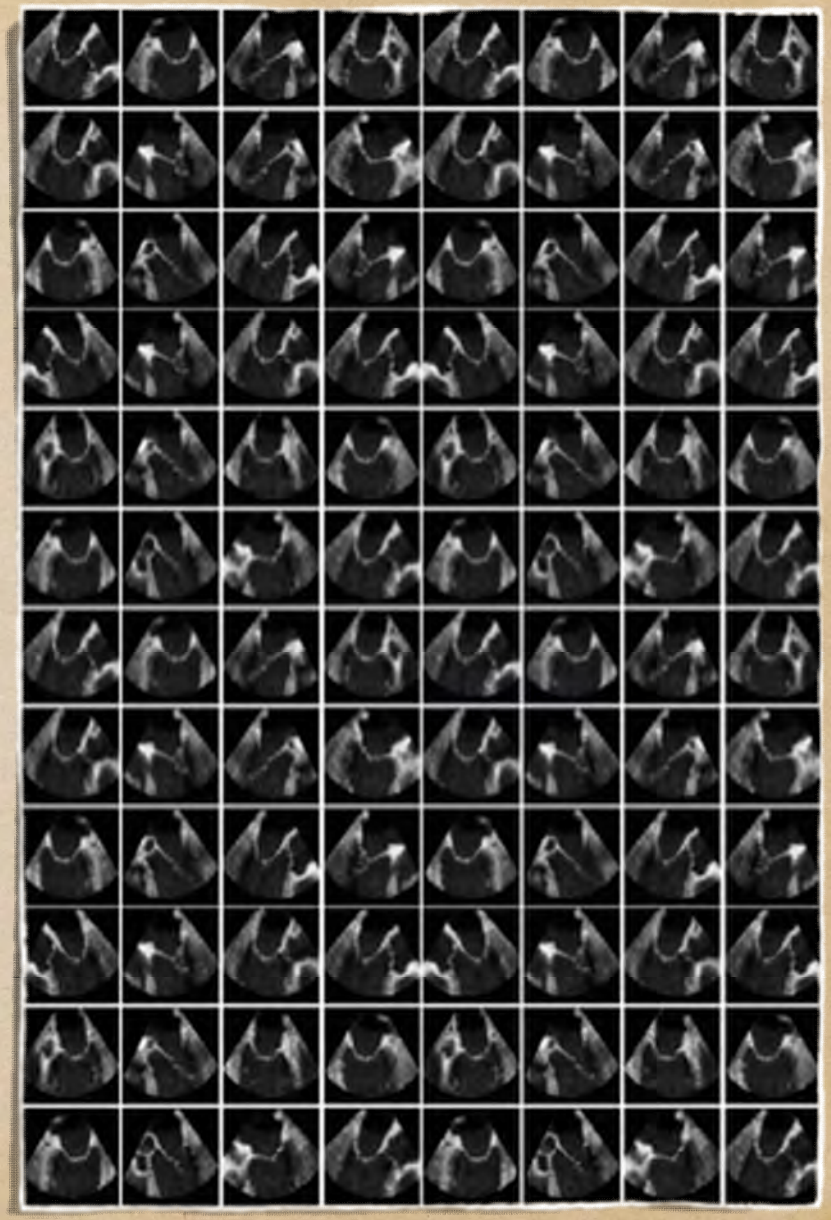
The Heart Print Project Team
編心計劃

- **Cardiology (Interventional Imaging):** Alex Lee
- **Cardiac surgery:** Randolph Wong
- **Radiology:** Simon Yu
- **Cardiology (Heart failure):** Erik Wong
- **Cardiology (interventionists):** Gary Cheung, Eugene Wu, Anna Chan
- **Post-doc/PhD students:**
  - Yiting Fan
  - Fan Yang

- **Mechanical engineering:** Ka-wai Kwok, Paddy Chan (HKU)
- **Computer sciences:** Kenneth Wong (HKU), Pheng Ann Heng (CUHK), Liang Zhao (University of Technology, Sydney)
- **RA:** Zhiyang, Martin

Research and Development on Techniques for Automatic Segmentation, Tracking and Reconstruction of Mitral Valve from 4D Echocardiogram (ITS/089/14)

Progress Review Meeting
28th September 2016

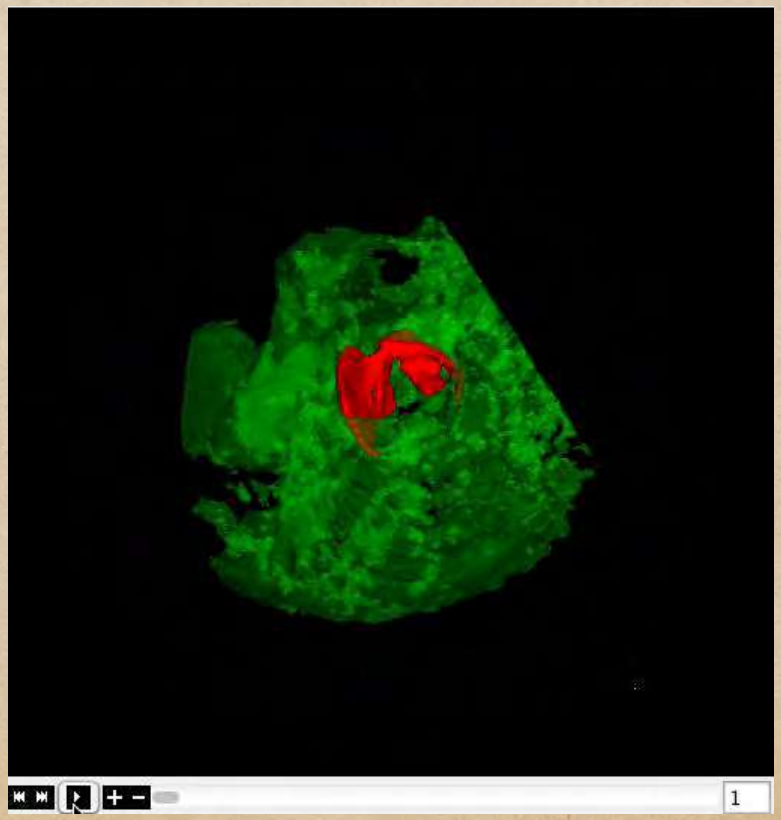


DEPARTMENT OF COMPUTER SCIENCE

Division of Cardiology
心臟科

4D Visualisation Result

- Patient #23 (functional mitral regurgitation)



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香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong

35th Anniversary

Development of 3D-Printed Cardiovascular Models for Personalised Structural Intervention

Project Coordinator:

Prof. Alex Lee, Department of Medicine and Therapeutics, CUHK

Research Team Members:

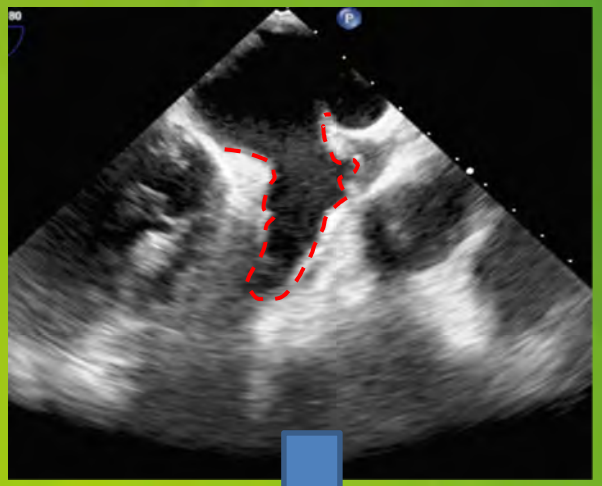
Prof. Ka-Wai Kwok, Prof Paddy Kwok-Leung Chan, Department of Mechanical Engineering, HKU

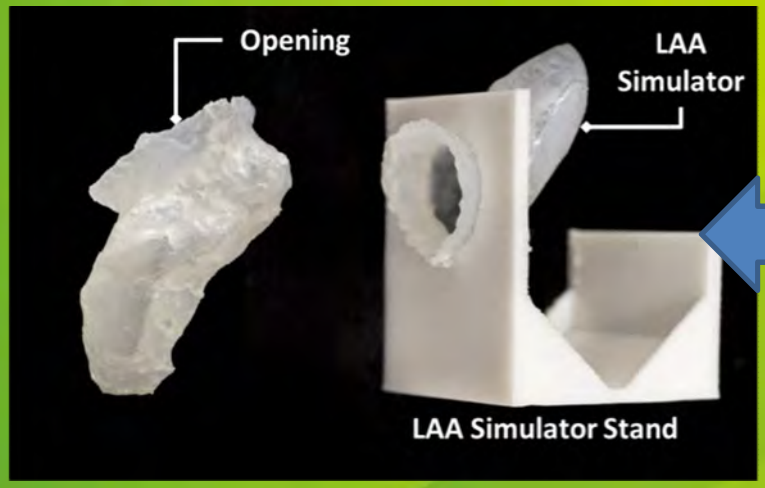
Prof Simon Yu, Department of Diagnostic and Interventional Radiology, CUHK

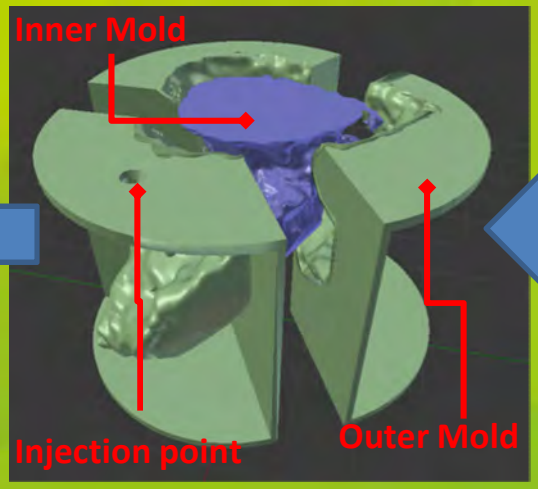
Dr Randolph Wong, Department of Surgery, CUHK

Intra-LAA Model Fabrication for Occluder Placement

- Left atrium appendage (LAA) of heart in 3D can be obtained through 3D-TEE imaging data
- Features of the LAA model will be extracted/segmented using our computer interface
- Silicone elastomer cured at a slightly raised temperature (at ~45°C)
- Software will be developed to *optimize* the CAD design of inner and outer mold for casting the silicone







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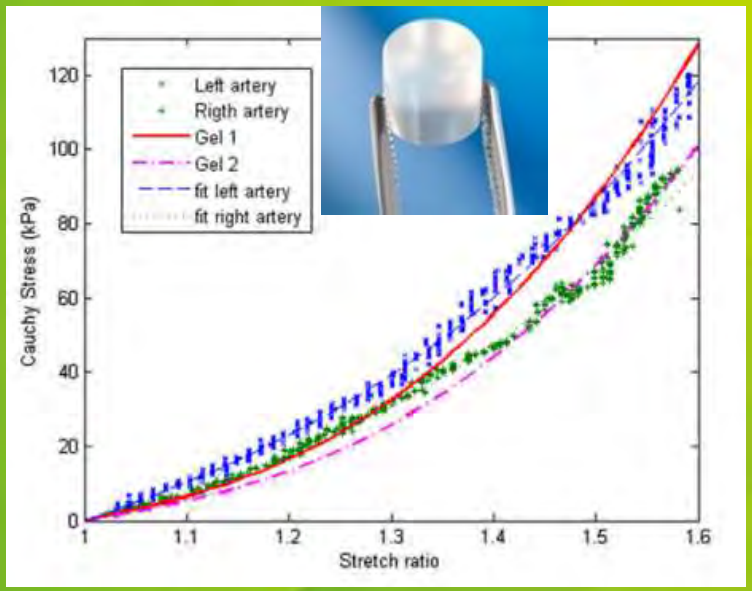
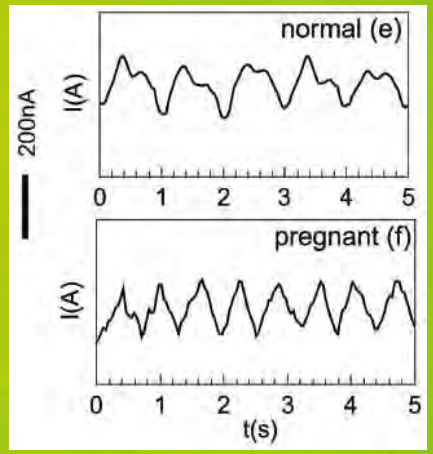
Faculty of Medicine
The Chinese University of Hong Kong

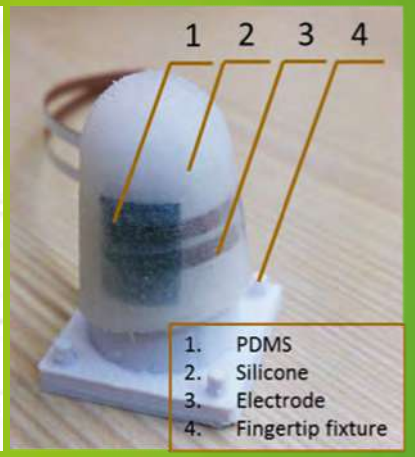
- Tsui GKW, Wong K-YK, Lee APW, *"Automatic systole-diastole classification of mitral valve complex from RT-3D echocardiography based on multiresolution processing,"* **International Society for Optical Engineering, 2013**
- A.P.W. Lee, Y. Fan, K.W. Kwok, et al, *"3D Printing for Planning Occlusion Procedure for A Double-lobed Left Atrial Appendage,"* **Circulation: Cardiovascular Interventions**

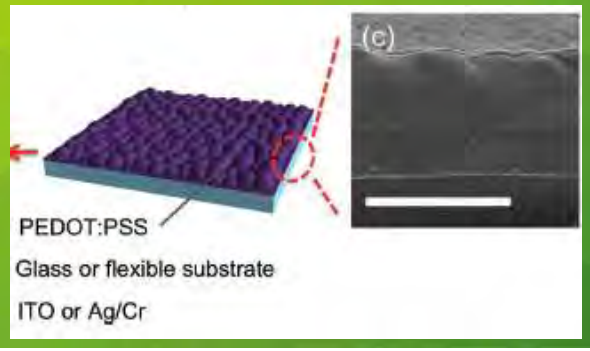
Integration with Force Sensor for Validation

- Advanced biomimetic materials (e.g. PVA cryogel) will be used to fabricate the LAA phantom
- Providing more similar mechanical property with the actual LAA tissue
- PDMS-based pressure sensor (high sensitivity: 851 k/Pa; board range up to 20kPa, low-power consumption: 100nW) will be integrated with the LAA model to validate the fitness of occluder in LAA









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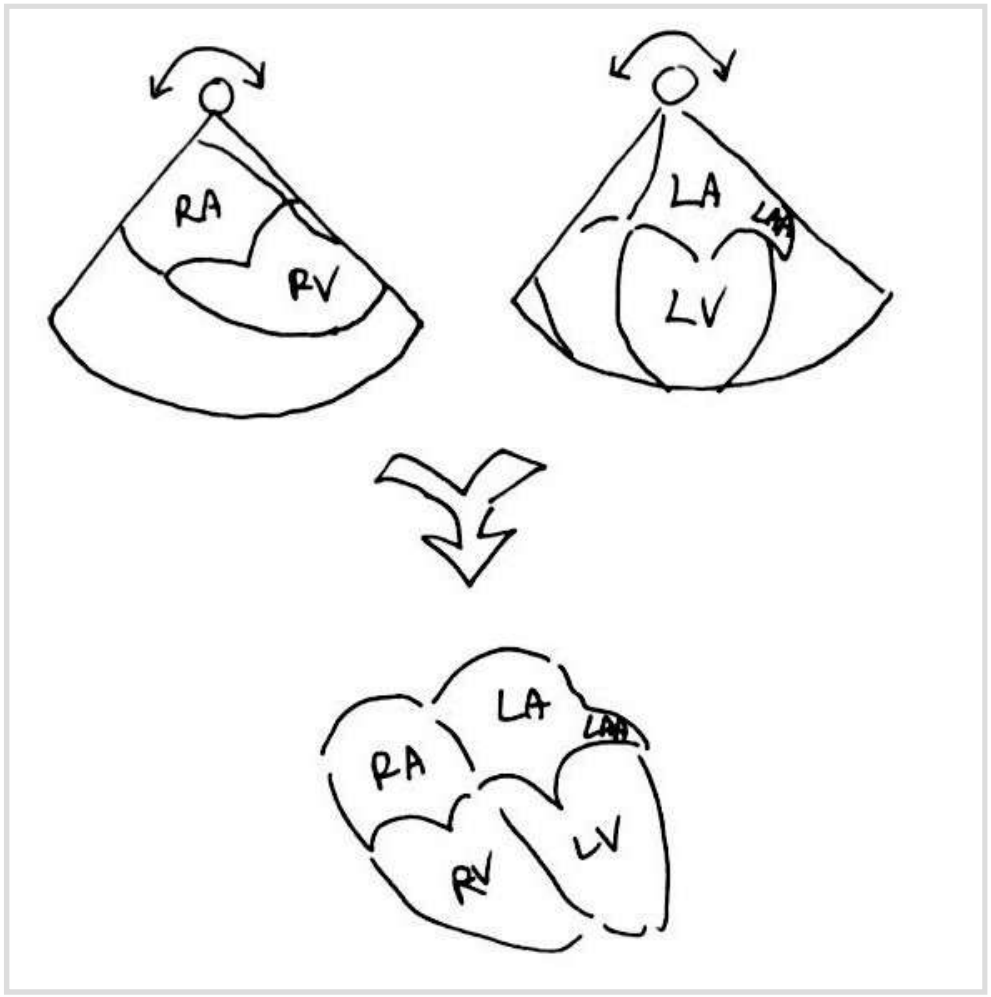
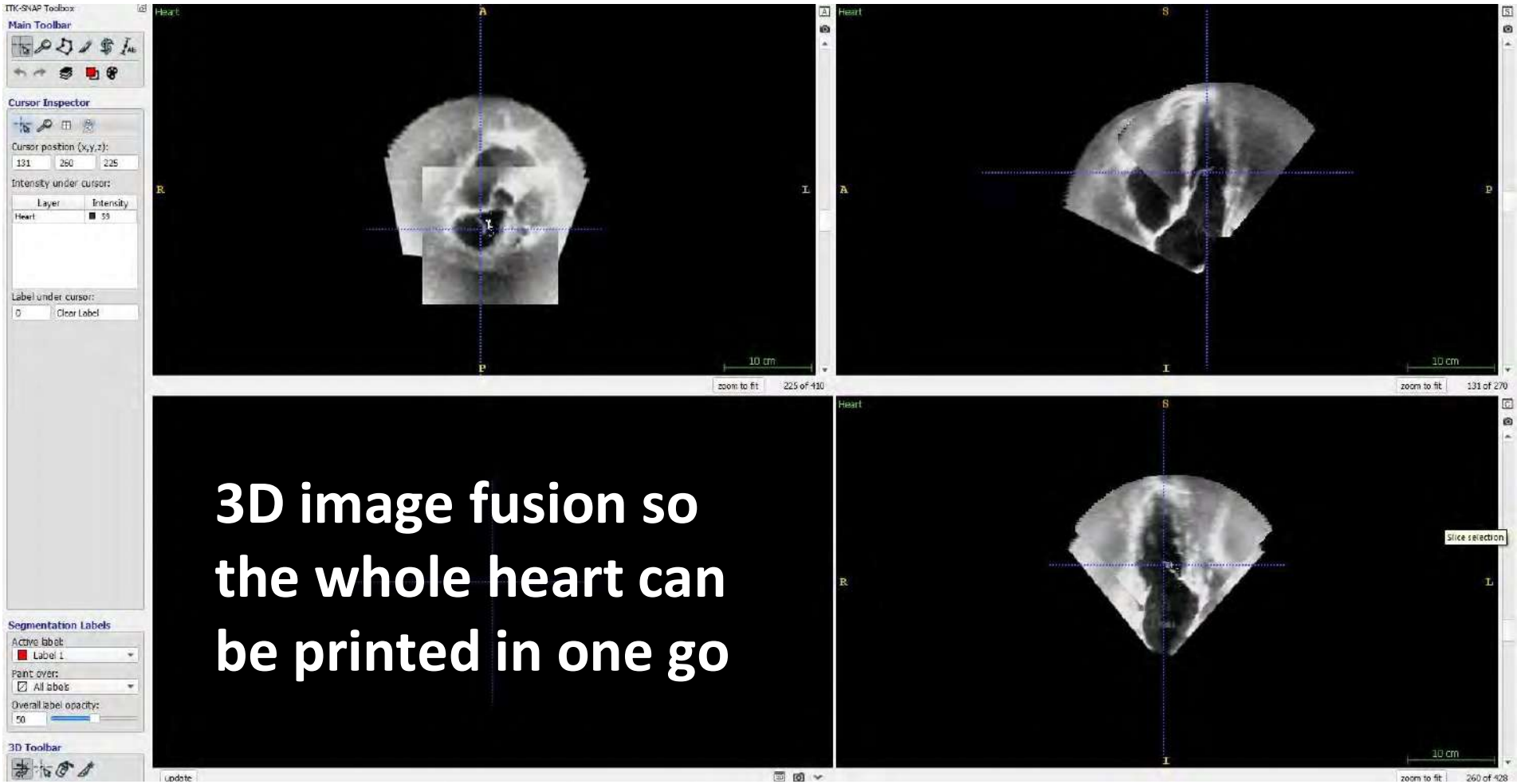
- Wang Z, Chan PK, et al., "*High Sensitivity, Wearable, Piezoresistive Pressure Sensors Based on Irregular Microhump Structures and Its Applications in Body Motion Sensing*," **Small, 2016**

香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong

Echo has limited field of view





Courtesy of Dr Liang Zhao, University of Technology, Sydney

Potential benefits of 3D printing for personalised CV procedural planning

- Facilitate planning for complex cases
- Simulation training
- Patient education
- Reduce procedural time (hence save money)
- Increase safety (hence save money)

明報周刊

透視健康 | FEATURE

3D醫學打印

Tailor made治療新趨勢

可應用於複雜心臟手術

假體左心耳　作術前預習

MIMS DOCTOR

NEWS & INSIGHTS

HONG KONG • JULY 2016

HONG KONG FOCUS 07

3D printing optimizes complex cardiac operations

HEPATITIS FOCUS 10

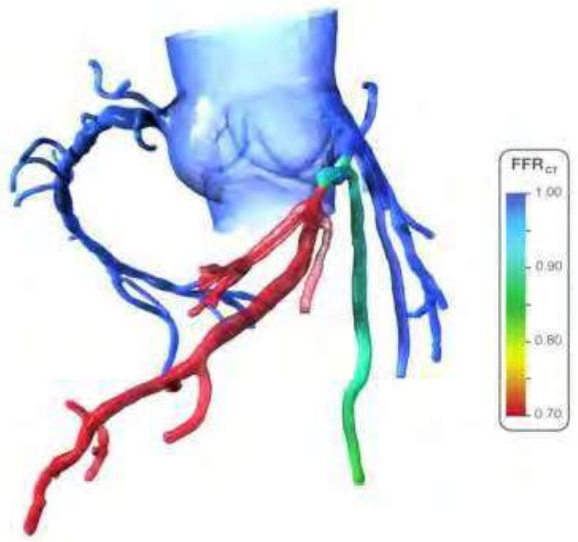
Excessive alcohol intake tied to hep C infection

CONFERENCE COVERAGE 16

Tofacitinib may be a promising therapeutic option for AS

Fractional flow reserve-computed tomography (FFR-CT)

- 60% of patients sent to cath lab for elective coronary angiography have non-obstructive CAD
- CT angiography: excellent sensitivity, modest specificity
- The Achilles heel of CT angiography has been intermediate lesions
- FFR-CT provides functional information of lesions and improves specificity
- Limitation: Turn-around time at remote sites (3-6h)



Advances in Cardiac MRI

Simplification and Reducing Time for Scans

- Despite excellent soft tissue imaging with zero radiation:
  - 1% of all MRI exam
  - Time consuming (>1h per 3D scan)

Simplification and Reducing Time for Scans

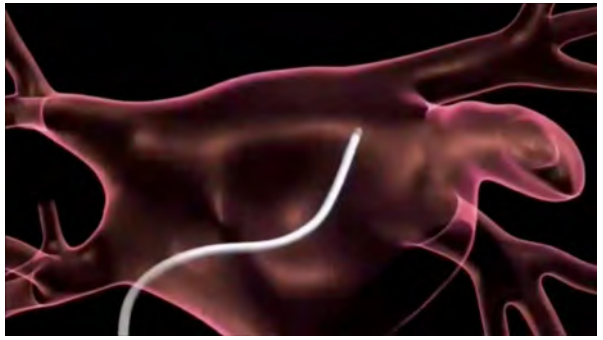
- Imaging time reduced from 70min to **8min**
- A single, free breathing exam
- Cloud-computing and deep learning technology

Courtesy of Dr. KW Kwok, HKU Mechanical Engineering

Why MRI-Guided Intervention?

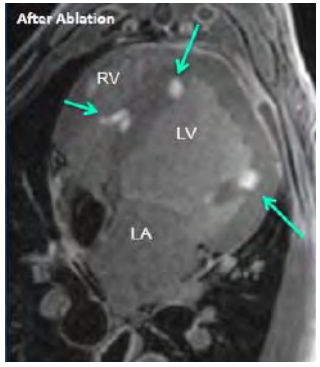
- Pros
  - High contrast soft tissue images
  - No radiation
  - Detect instant pathological and physiological change
- Example: Cardiac EP Catheterization
  - Monitor post-ablation progress (Edema)
  - Prevent tissue perforation
  - Improved surgical outcome
- Challenges
  - Long and flexible catheter
  - Safety – Strong Magnetic Field (1.5 - 3T)

VISIUS® Intra-operative MRI system

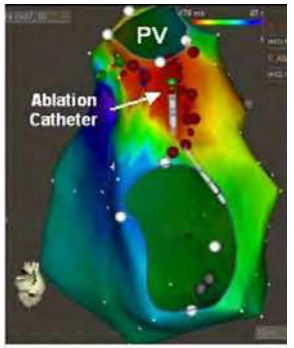


Isolation of Pulmonary vein

Ablation Catheter (~1.5m long)



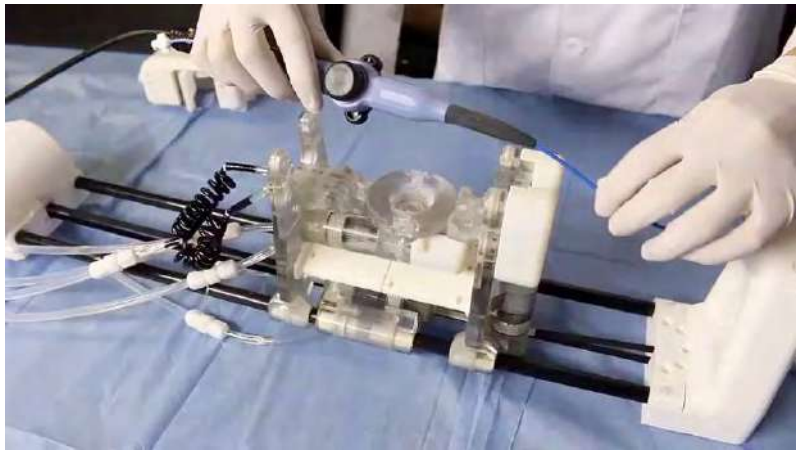
V.S.

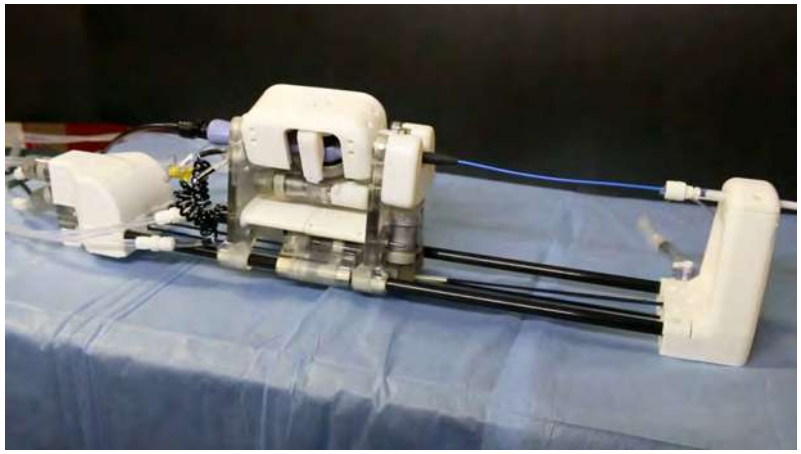


Post-ablation Edema (MRI)

SJM Velocity® EAM interface (Roadmap)

MR-conditional robotic control of cardiac catheter





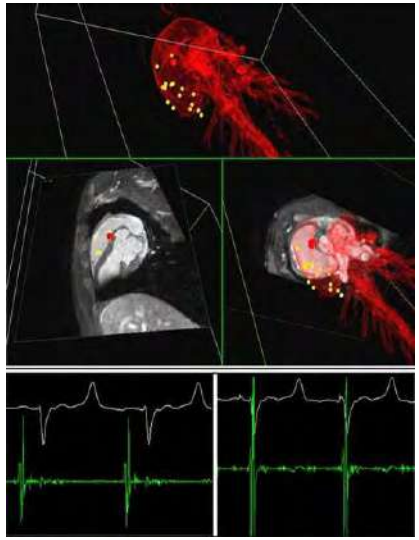
Courtesy of Dr. KW Kwok, HKU Mechanical Engineering

Courtesy of Dr. KW Kwok, HKU Mechanical Engineering

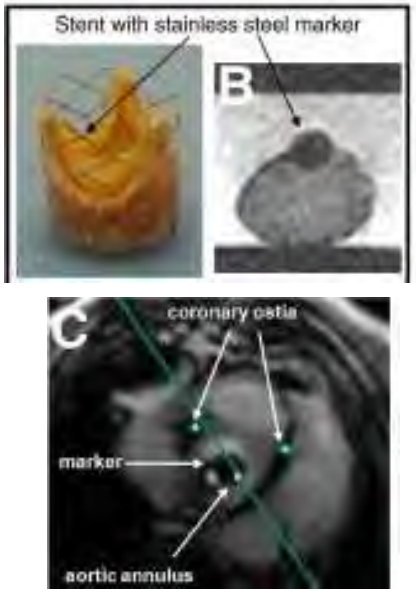
Potential Clinical Impact

✦Interventional Cardiovascular MRI is the future

Interventional CMR suite



Real-time CMR Electrophysiologic Mapping



Transcatheter aortic valve replacement

Real-time CMR-guided myocardial biopsy

MRI-guided Intervention
- Excellent tissue contrast, free from radiation

Robotic catheter control
- Catheter stability and precision, reduce procedural time and complication, increase success rate

MR-based Robotic Intervention

Questions?

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