Innovative treatment of mitral valve diseases: What is the role of echocardiography?

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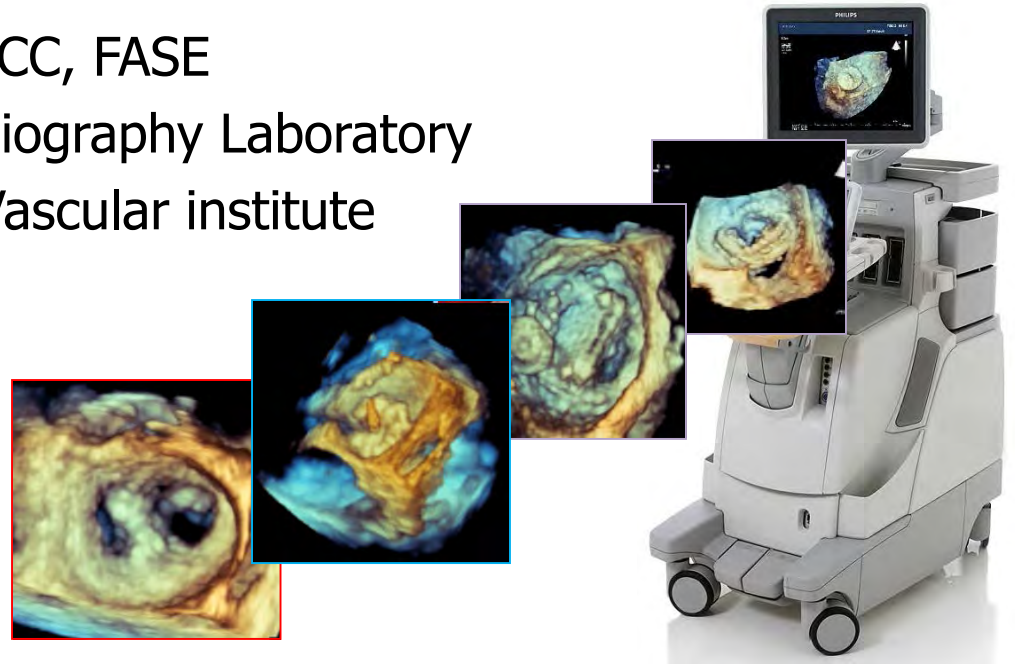
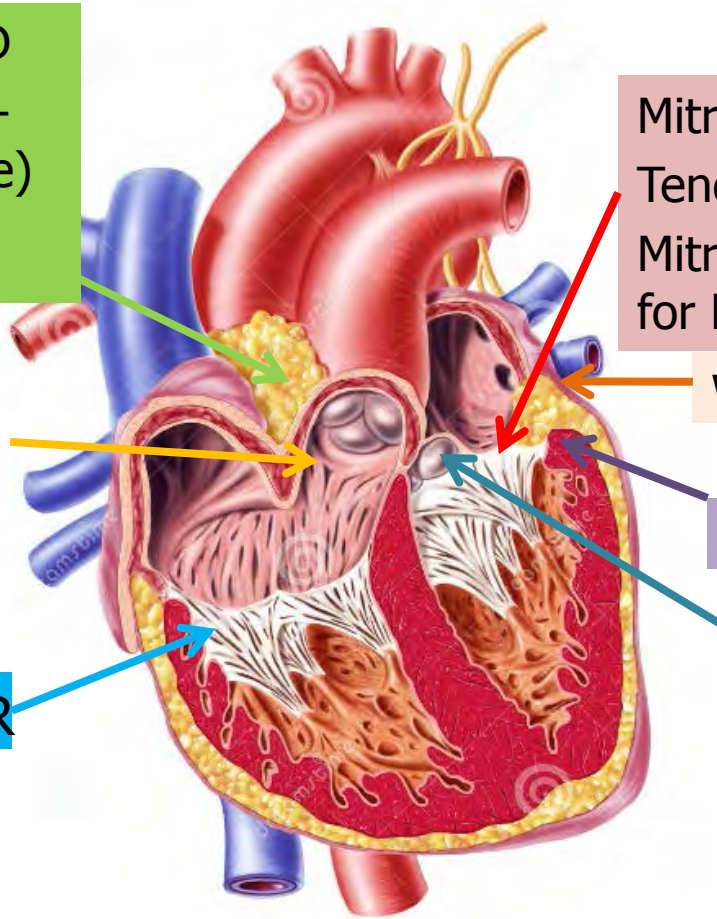


Besides the surgery……

Amplatzer for ASD
Amplatzer for PFO- (cryptogenic stroke)



MitraClip
Tendyne valve
Mitral trial-Sapien for MAC, VIV, VIR

Watchman LAA occluder

Sapien for PV conduit

Paravalvular leak repair

Trialign for TR

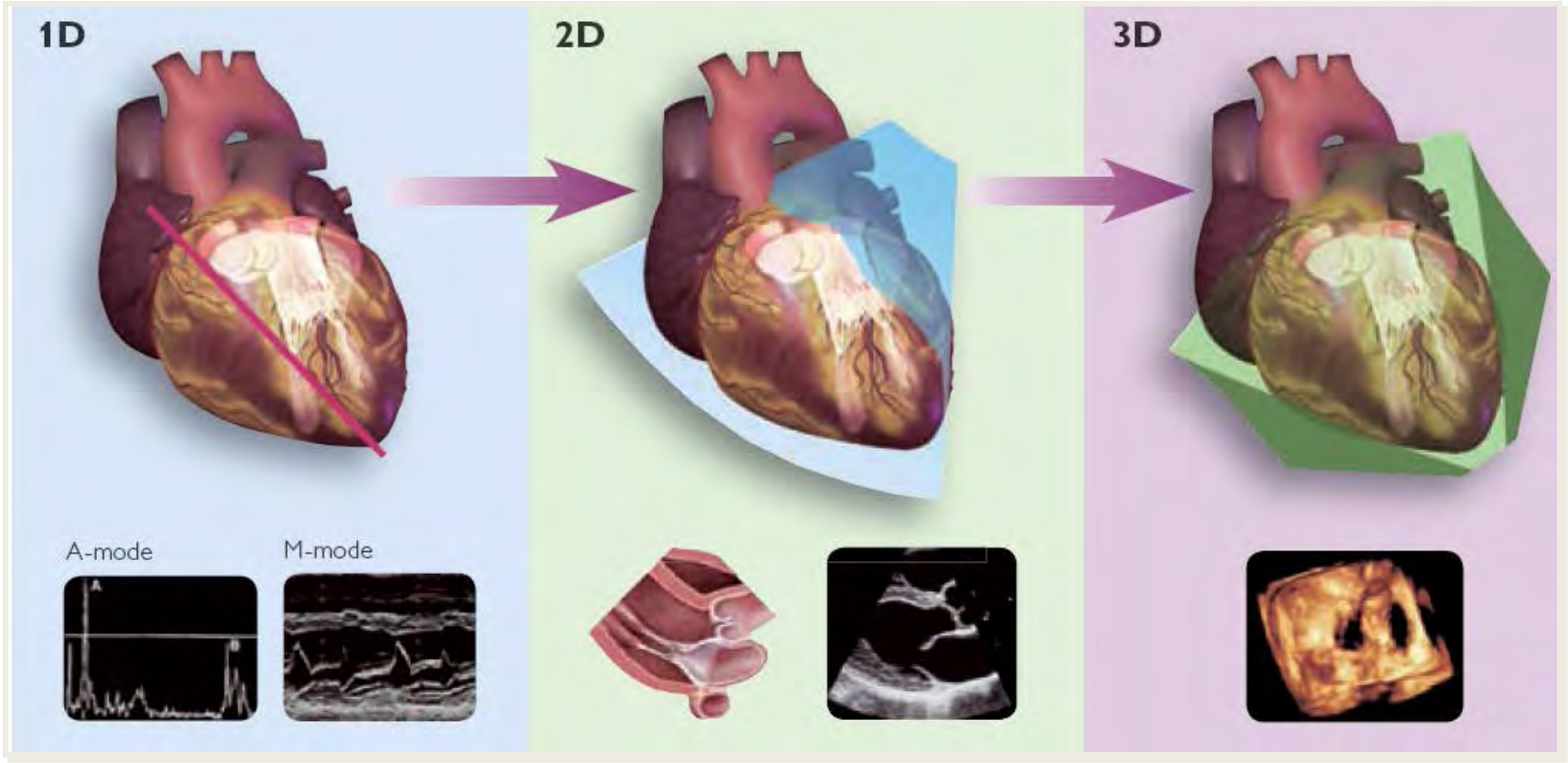
Sapien3
Core valve –Evolut
Direct flow
Portico
Lotus

We provide broad spectrum of innovative treatment for structural heart diseases

Surgery → **Percutaneous**

Healthy → Older, and sicker

Evolution of Echocardiography



Single line

Single slice

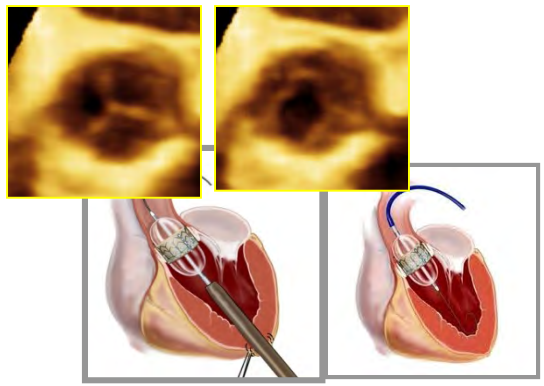
Full heart beat

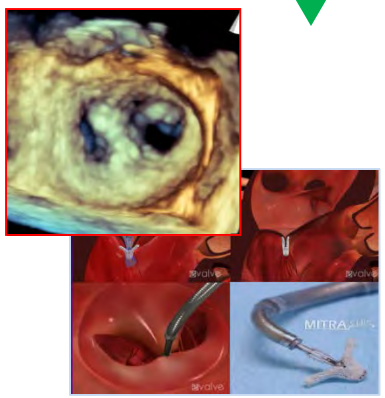
3D Echo is a “Must Have”
for Structure Heart Disease

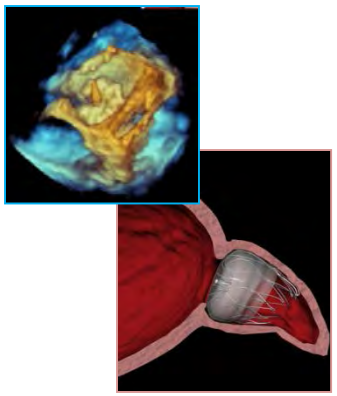
Screening, planning and risk assessment

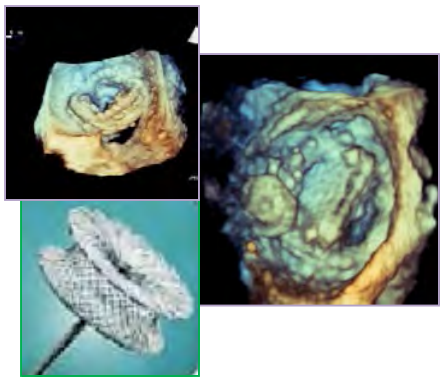
Intra-procedural monitoring and guidance

Post deployment assessment and management





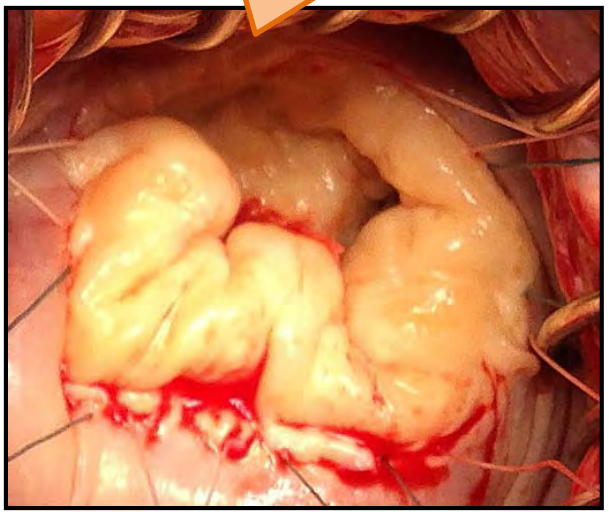




Where are the valves?

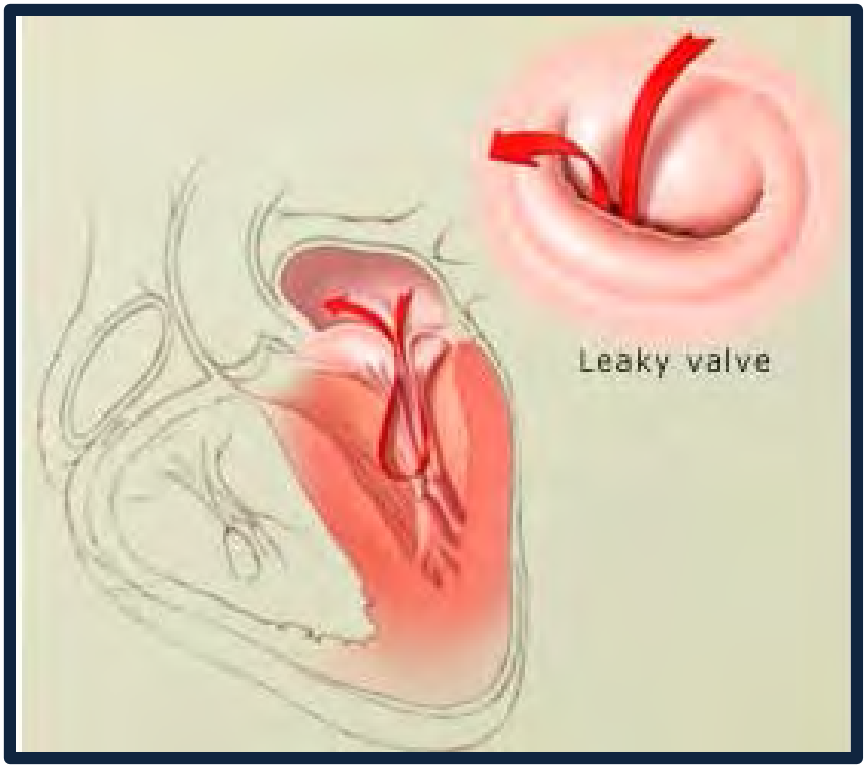
In the cath lab

Where is the leak?

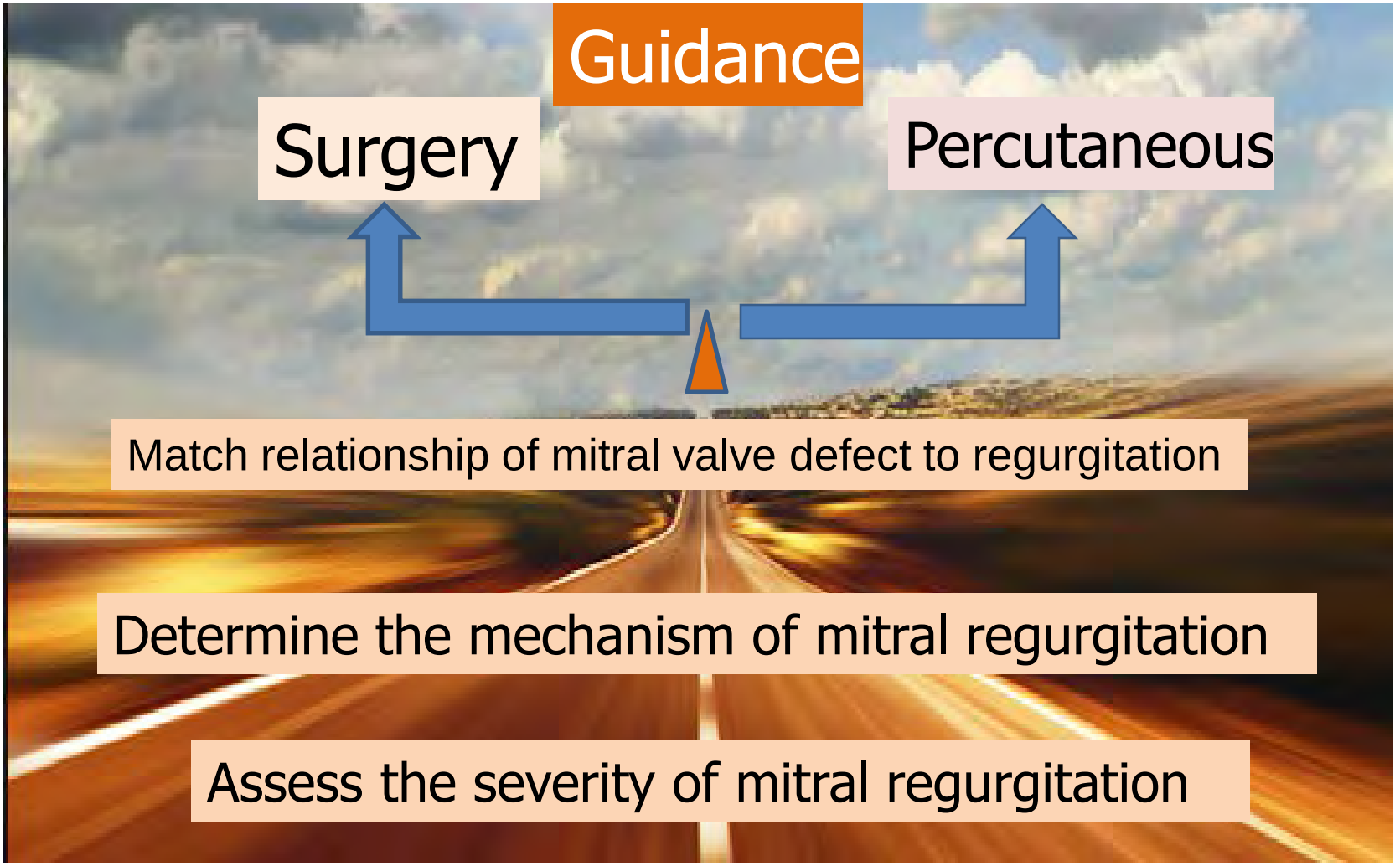


In the OR

Mitral Regurgitation



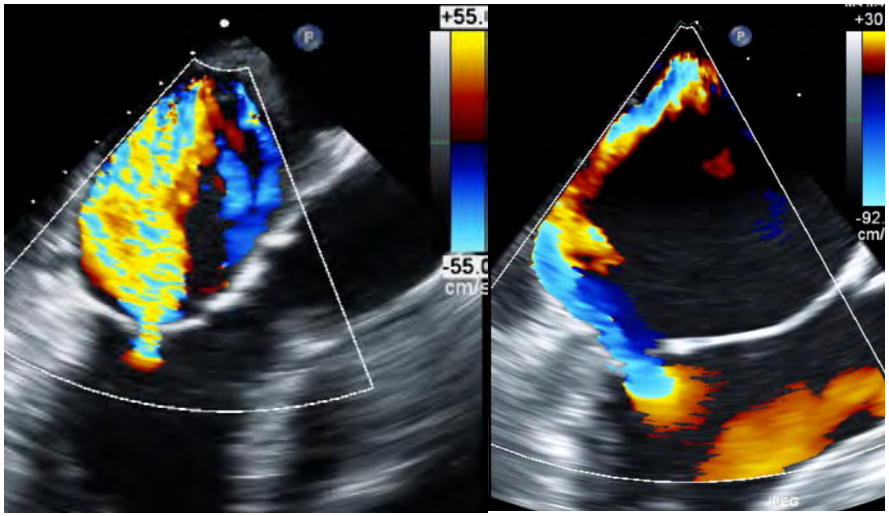
Echo = Roadmap



How much?

Severity ---3+ or 4+/4 mitral regurgitation

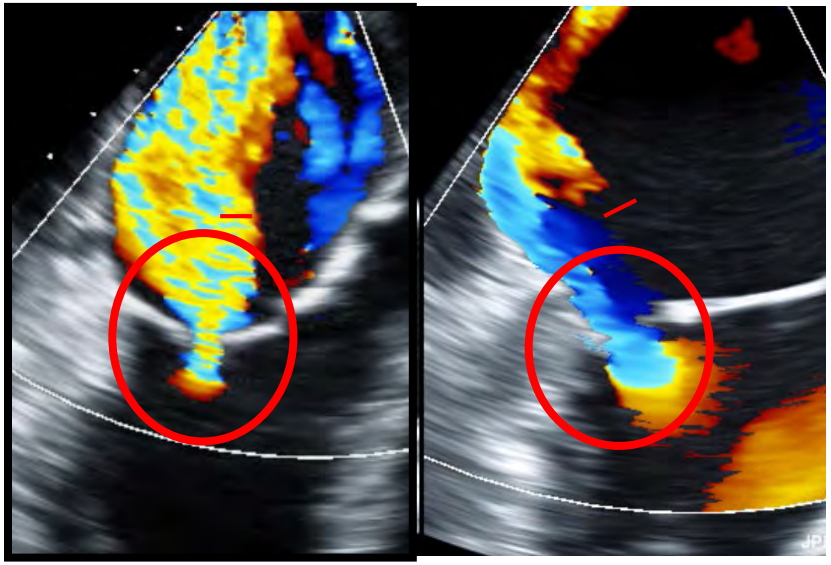
Jet area /LA area>40%



Central Jet

Eccentric Jet

Vena Contracta>0.7cm



Central Jet

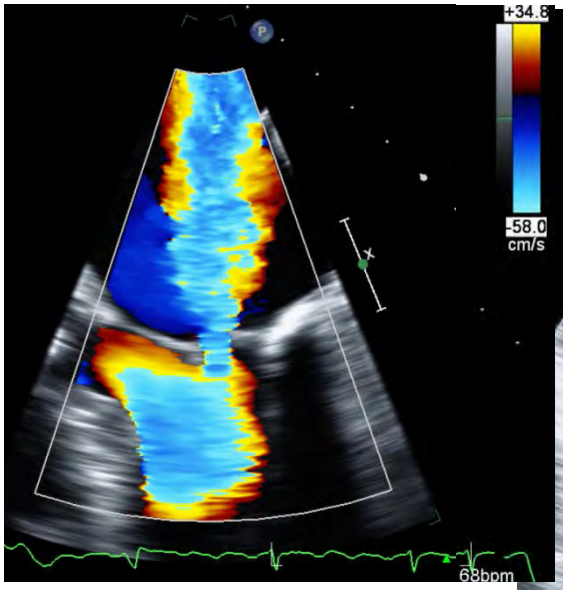
Eccentric Jet

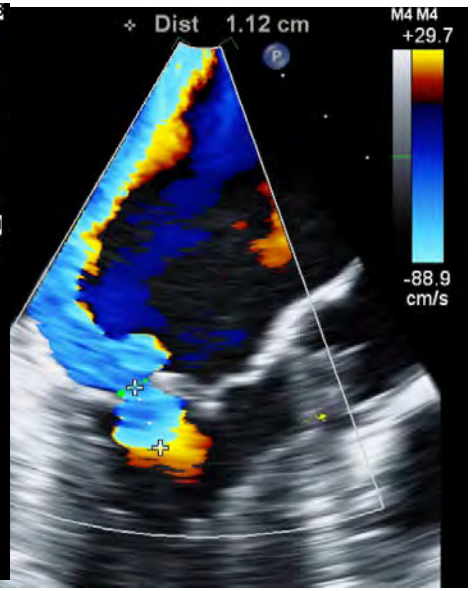
Severity ---3-4+ or 4+/4 mitral regurgitation

2D PISA

Primary MR ERO>0.4cm2

Secondary MR ERO>0.2cm2

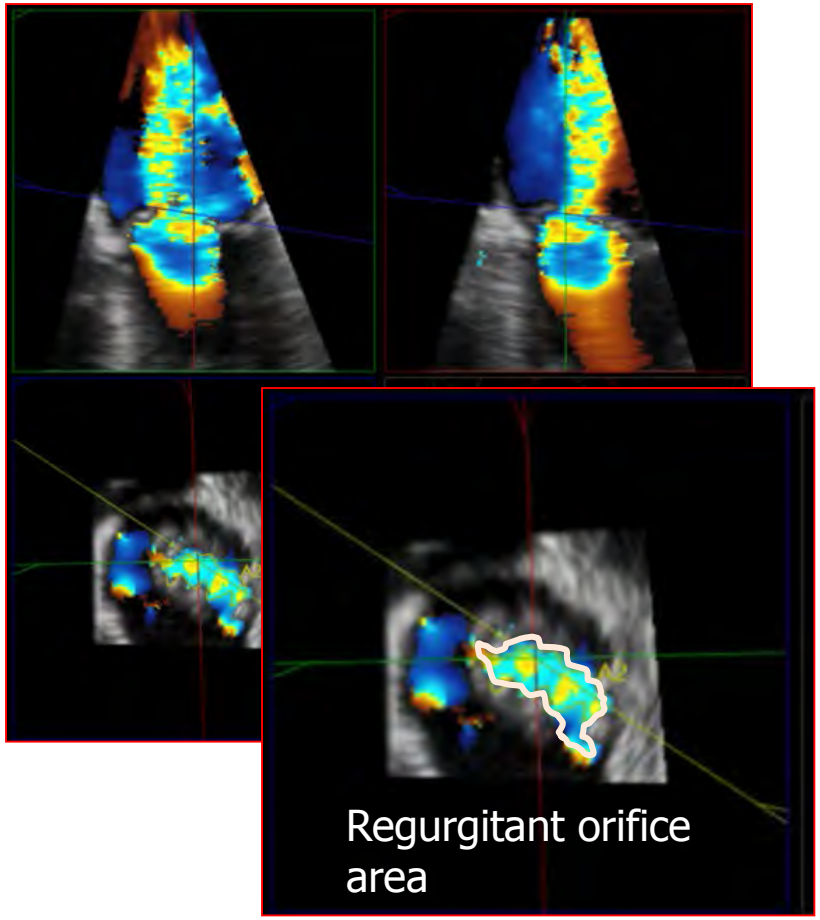




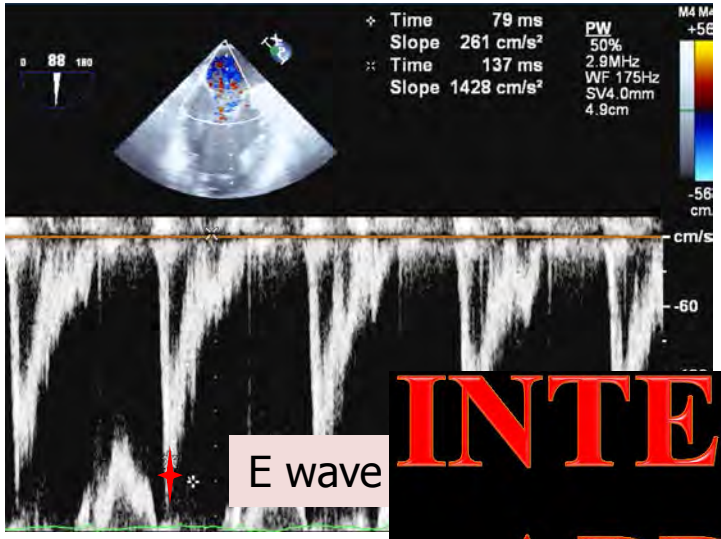
Central Jet

Eccentric jet

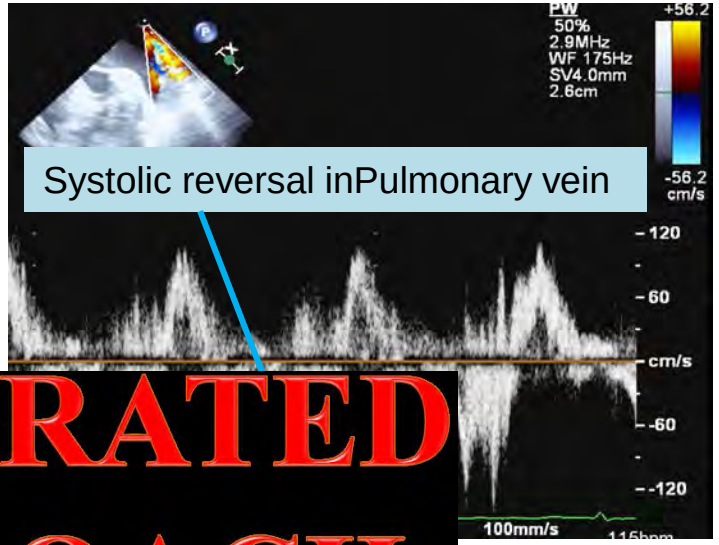
3D PISA



Don’t forget the “simple” parameters

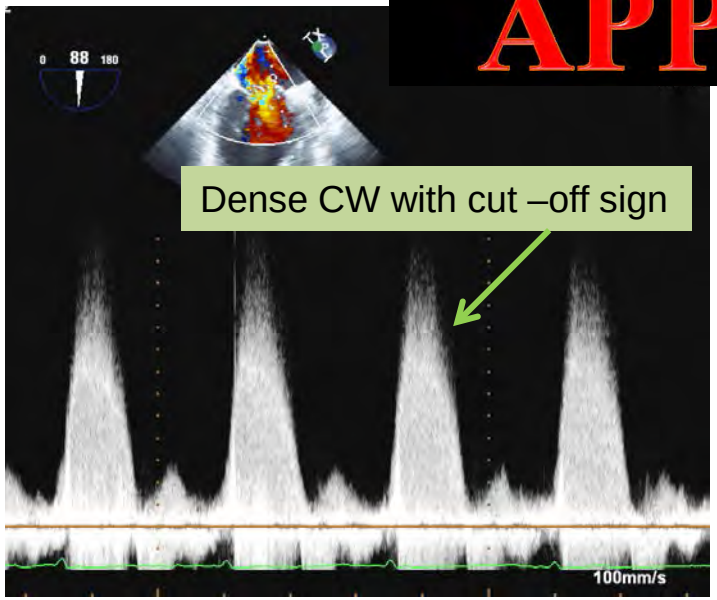


E wave



Systolic reversal inPulmonary vein

INTEGRATED APPROACH

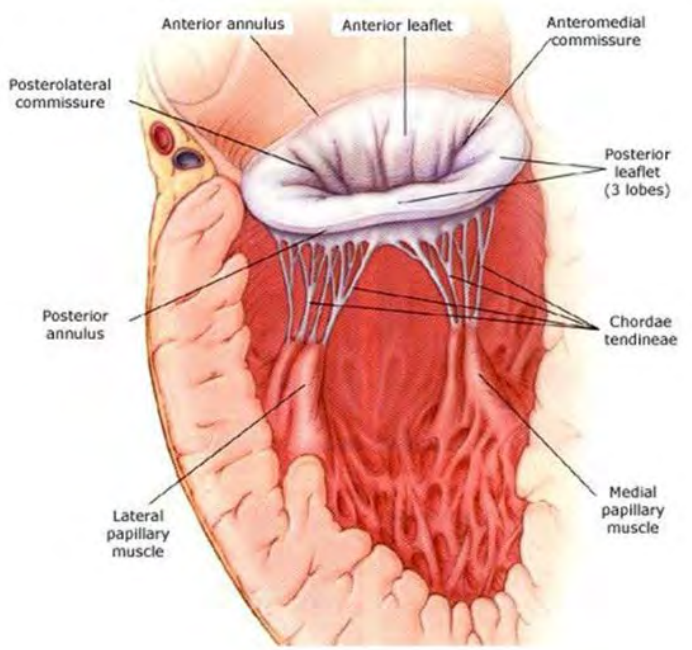


Dense CW with cut –off sign

Why?

Mechanism of Mitral Regurgitation

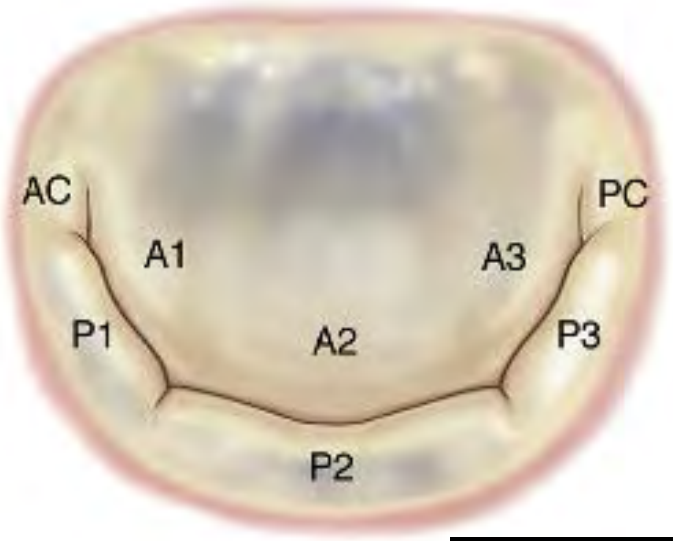
Mitral Valve Anatomy

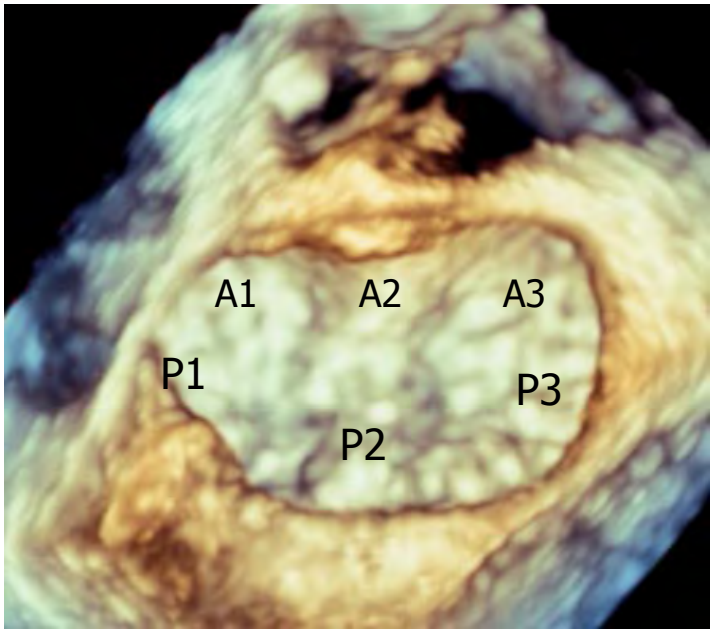


The mitral apparatus is composed of

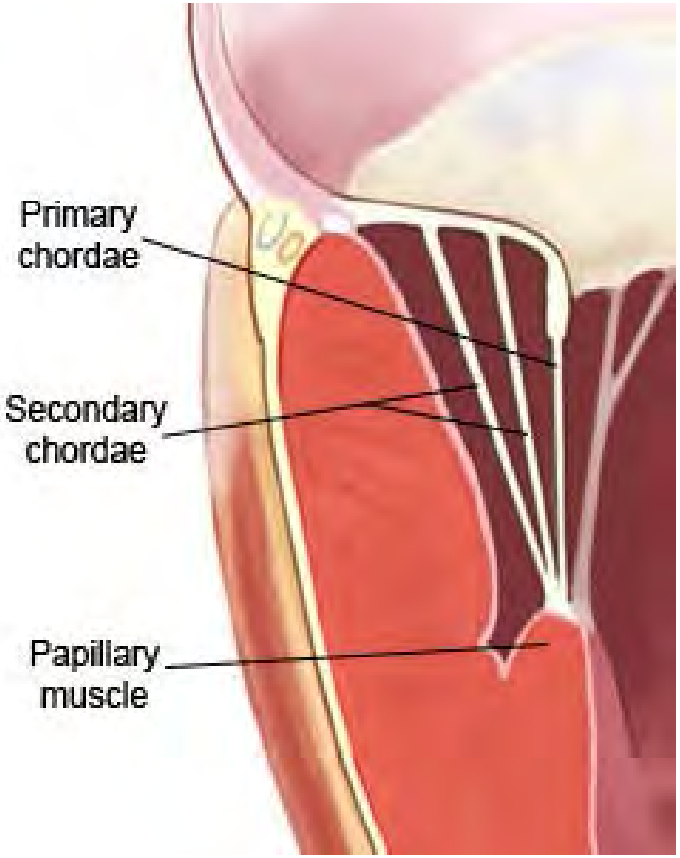
- Left atrial wall
- Annulus
- Leaflets
- Chordae tendineae
- Papillary muscles
- Left ventricular wall

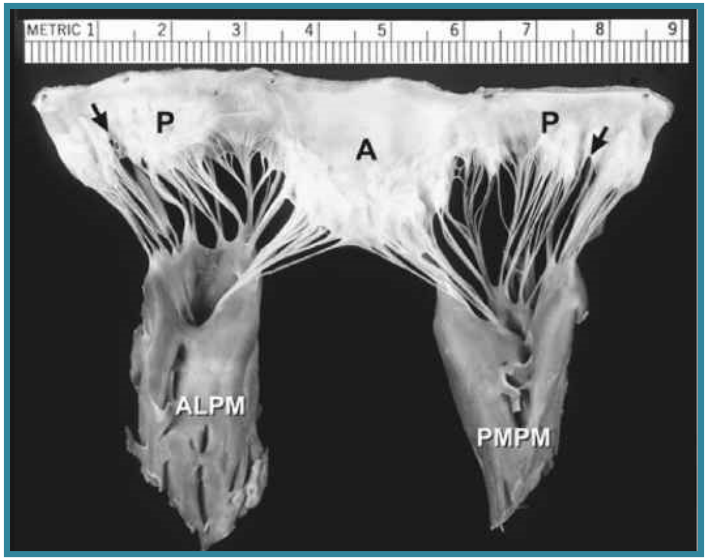
Surgeon's view

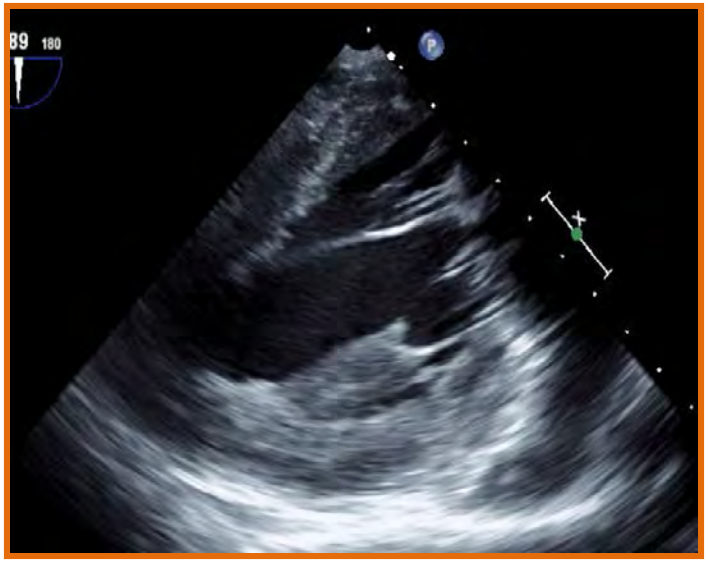




Components of Mitral Valve Leaflets







Mechanism of Mitral Regurgitation

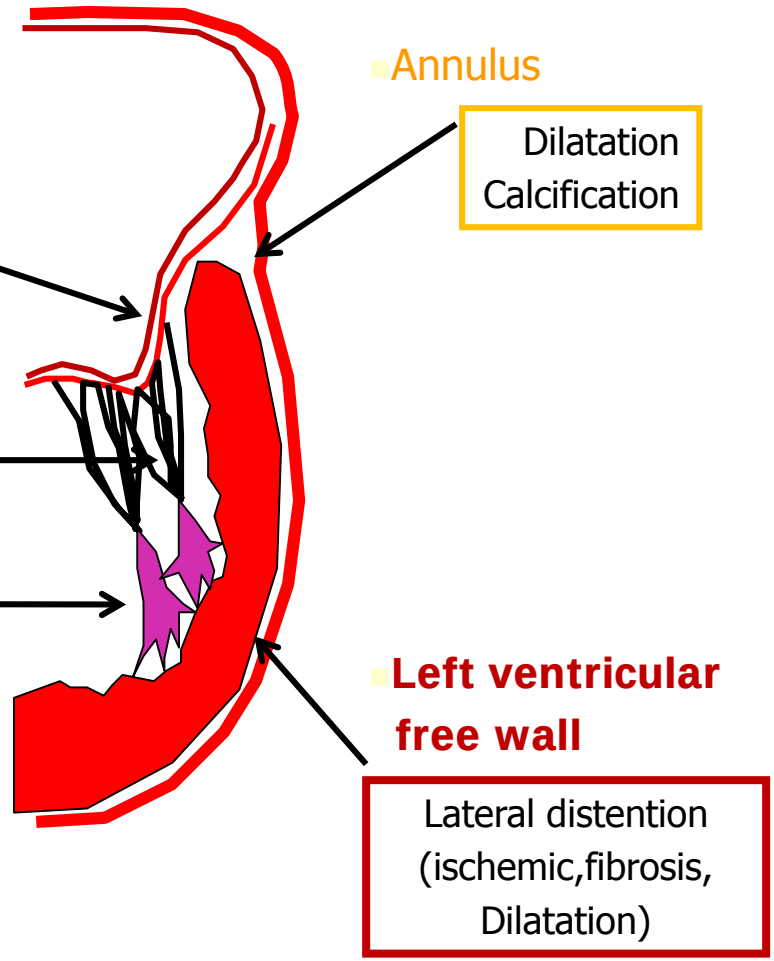
Primary MR

Perforation
Cleft
Prolapse
Thickening
Commissure fussion

Abnormal insertion
Elongation/rupture
Thickening/fussion

Ischemia
Fibrosis
Rupture

Secondary MR



Carpentier's Classification System of MR Mechanisms

Type 1- Normal Leaflet Motion

Annulus dilatation
Leaflet perforation

Type II-Increased Leaflet Motion

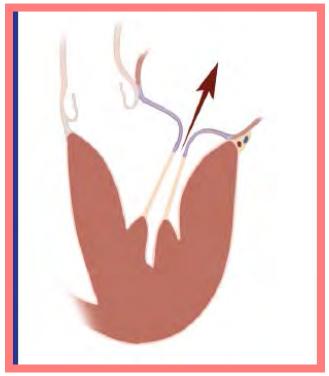
Ruptured Chordae
Elongated chordae and/or papillary muscle
Ruptued PM

Type IIIa-Restricted leaflet motion (Systolic and diastolic)

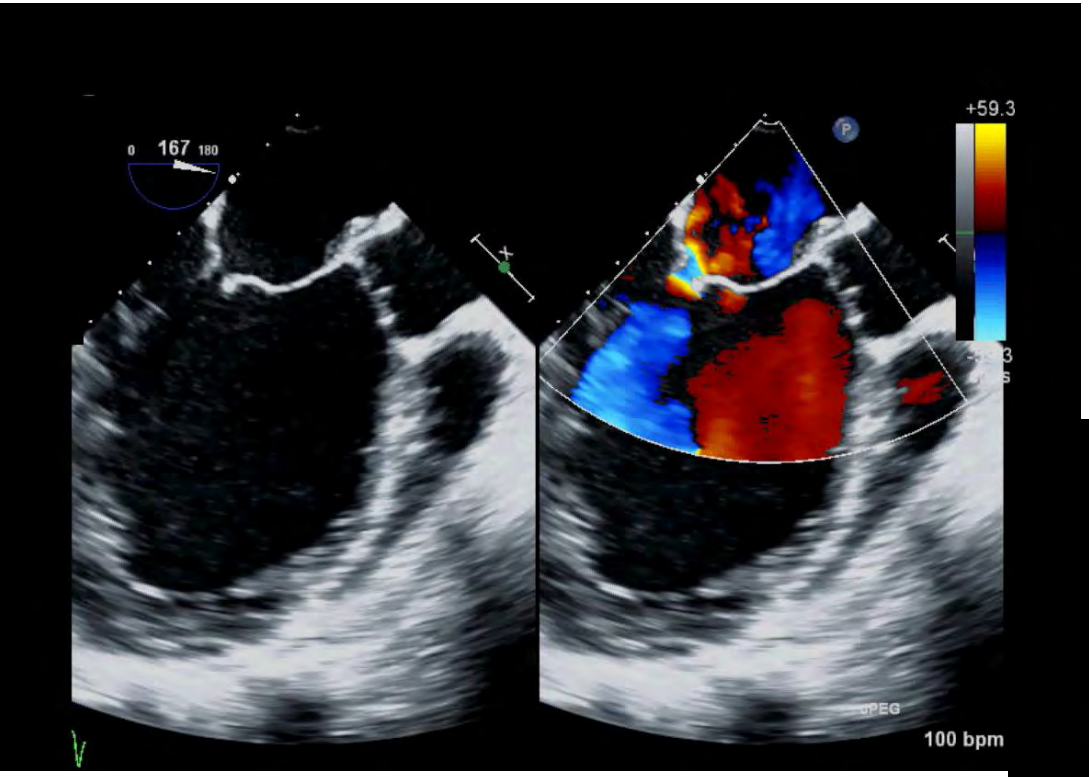
Commissure fusion
Leaflet thickening
Chordae fusion

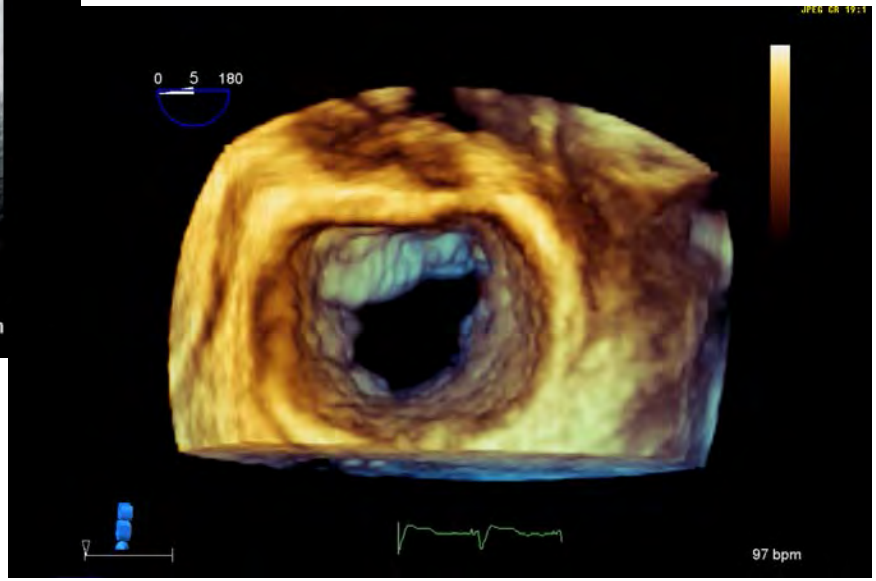
Type IIIb-Restricted leaflet motion (Systolic)

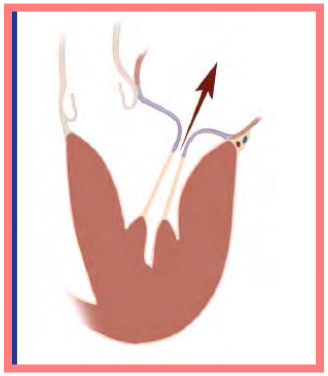
Ventricular Dilatation
Ventricular dyskinesia



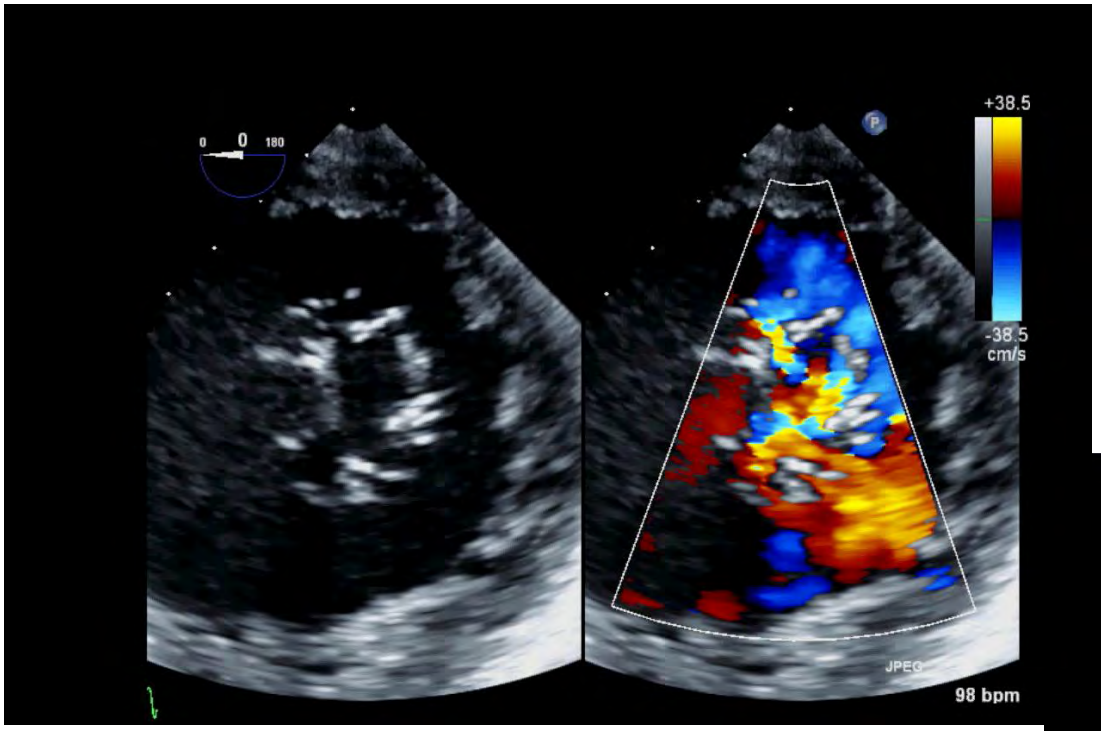
Type 1 (Normal Leaflet Motion)
Annulus dilatation

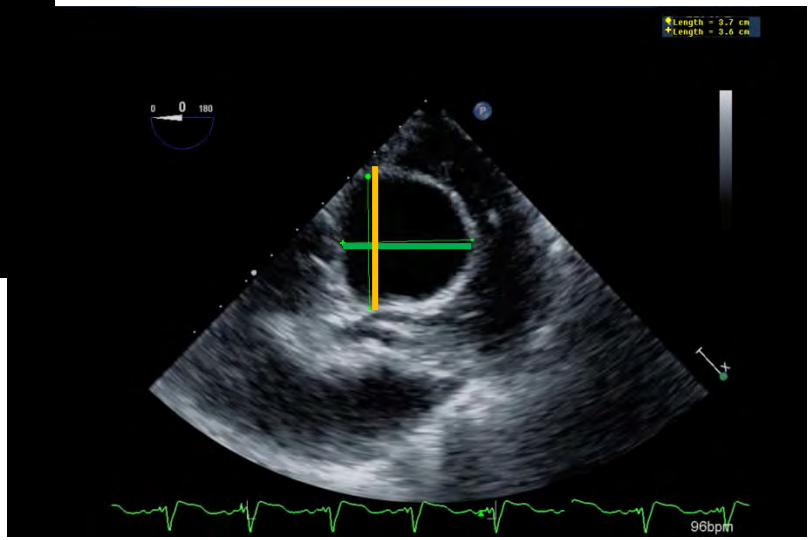


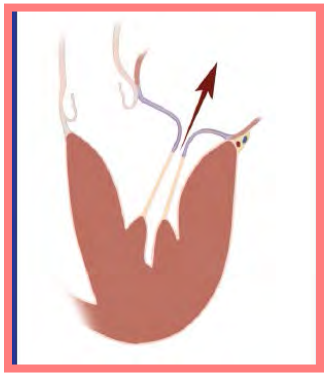




Type 1 (Normal Leaflet Motion)
Annulus dilatation

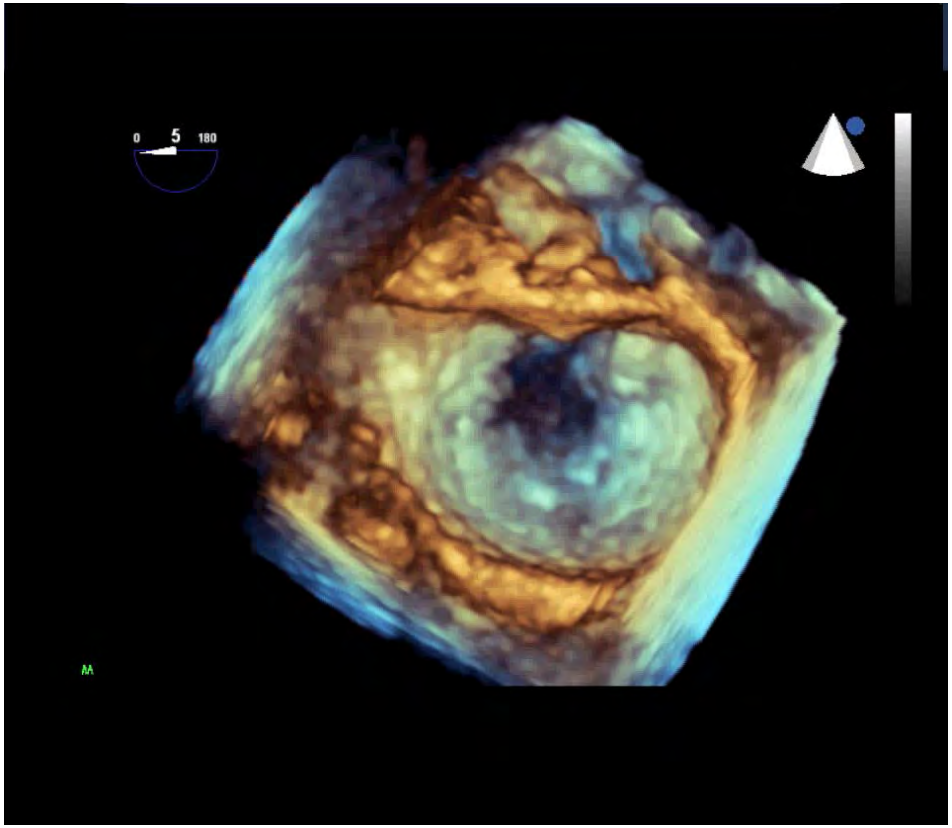


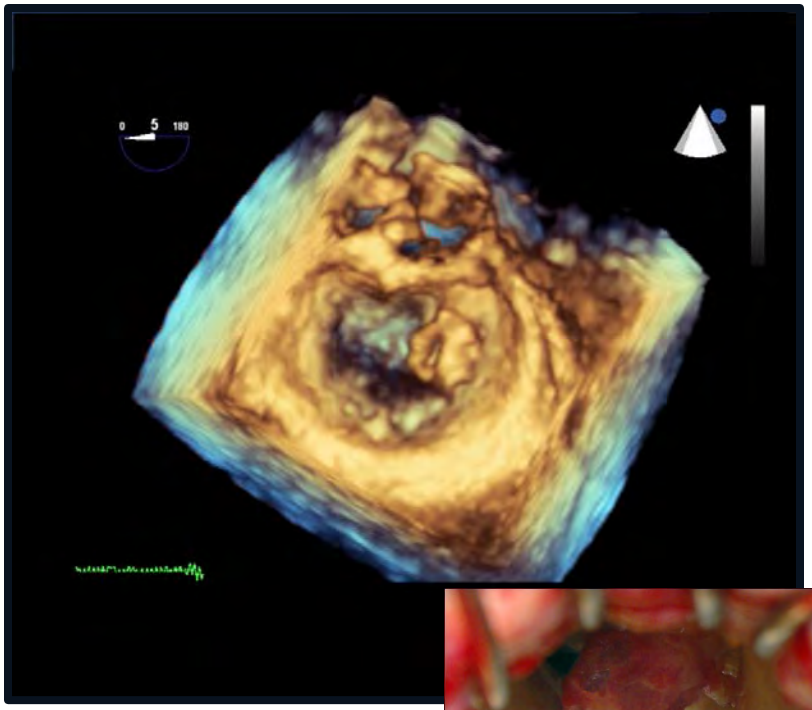


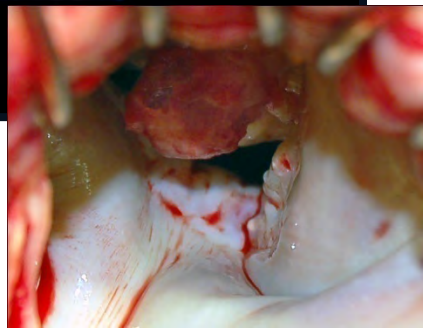


Type 1 (Normal Leaflet Motion)

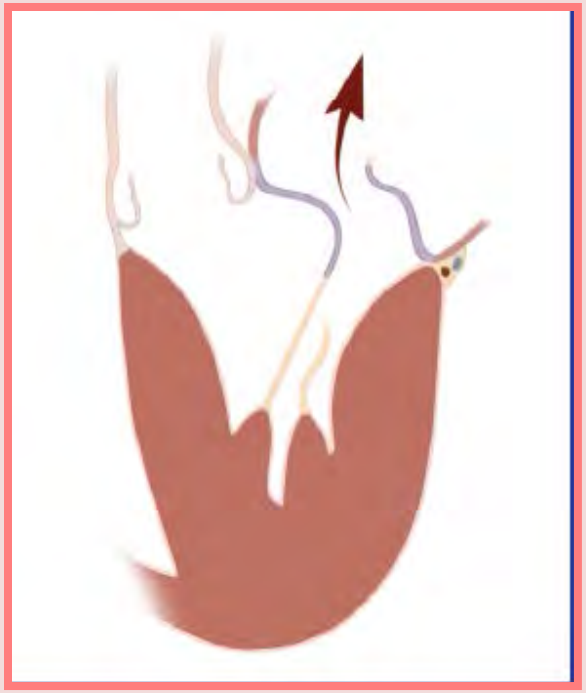
Leaflet Perforation





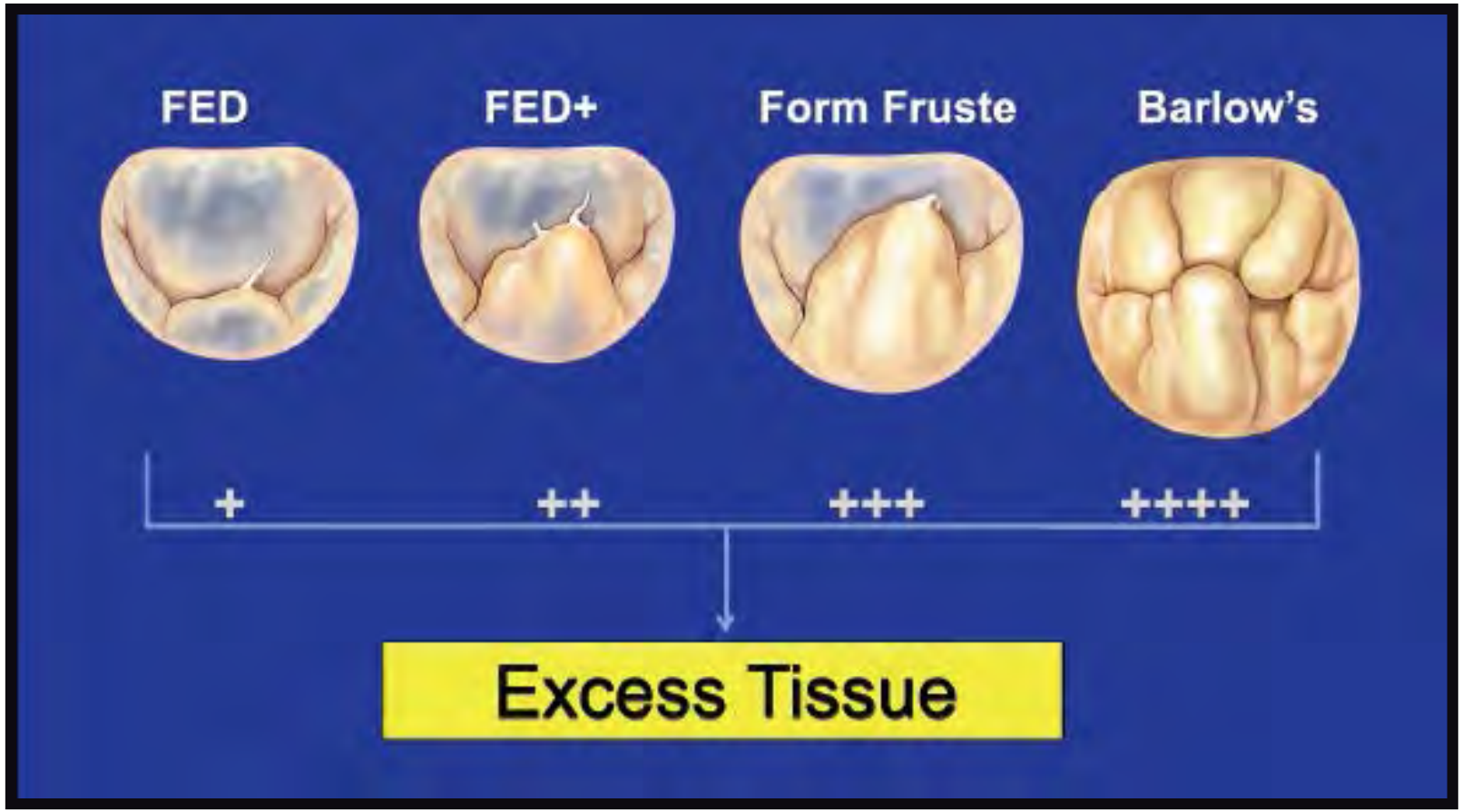


Type II-Increased Leaflet Motion



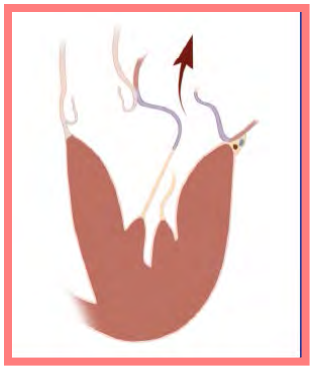
Ruptured Chordae
Elongated chordae and/or papillary muscle
Ruptued PM

Spectrum of Degenerative Mitral Valve Disease



Fibroelastic Deficiency (FED)

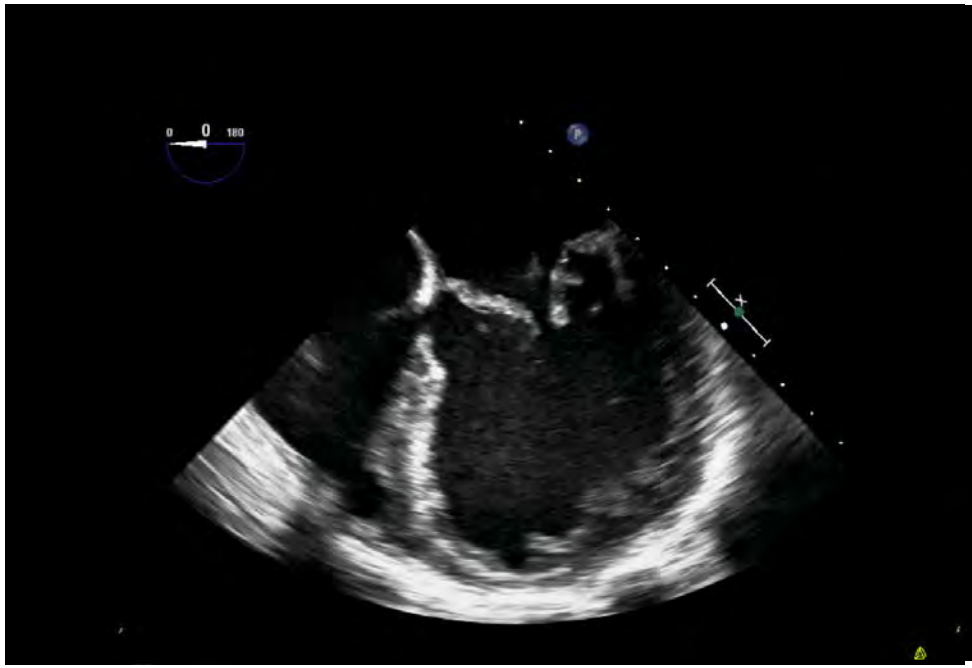
- Older individuals
- Short hx of MR
- Ruptured or elongated of a single chord
- Remaining segments are normal
- Posterior annulus may be dilated

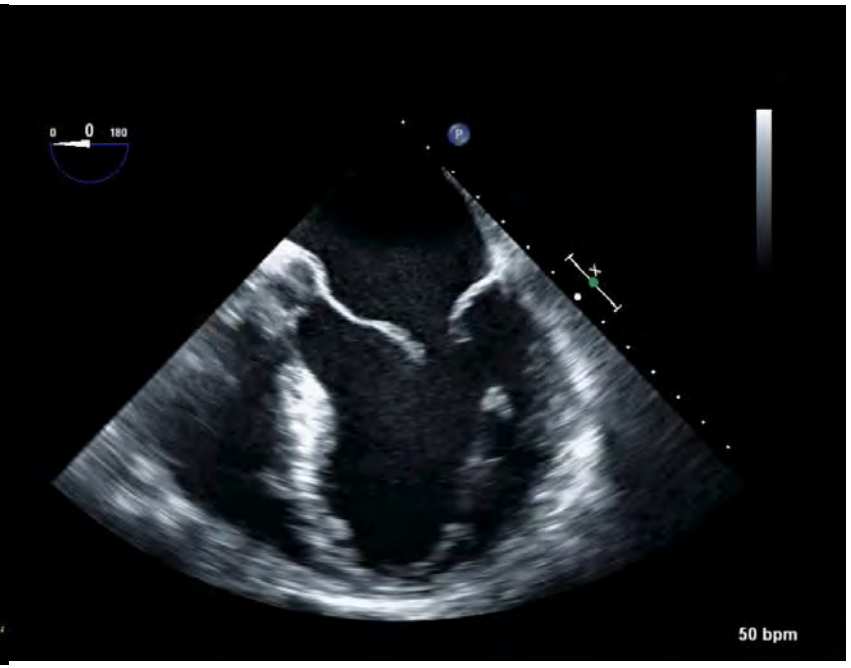


Fibroelastic Deficiency

Elongated Chordae

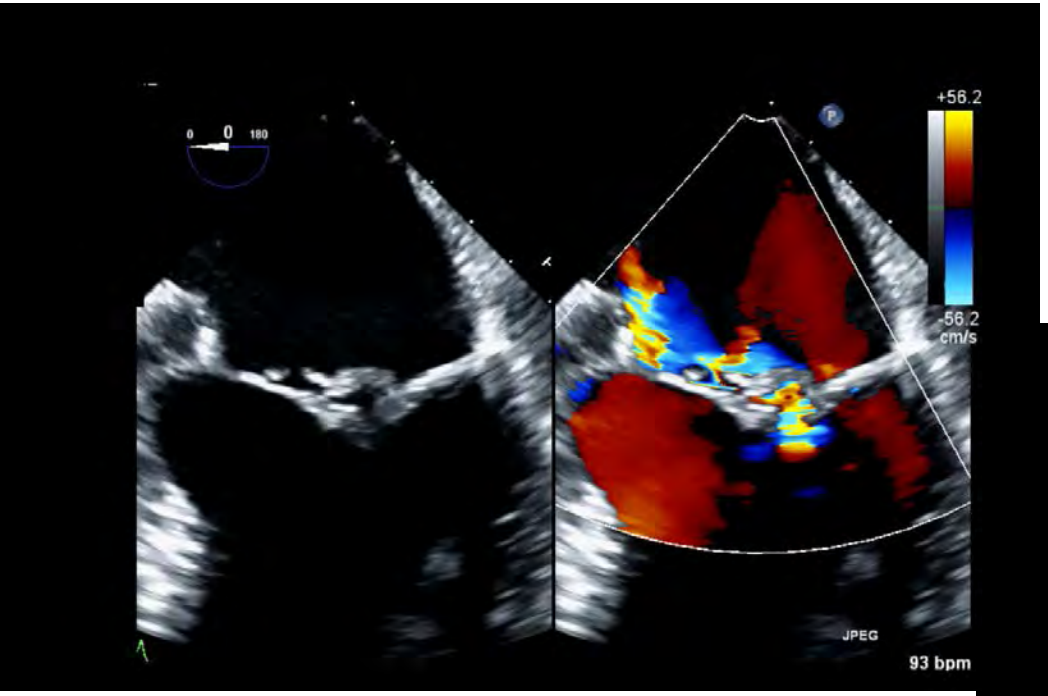
Ruptured Chordae

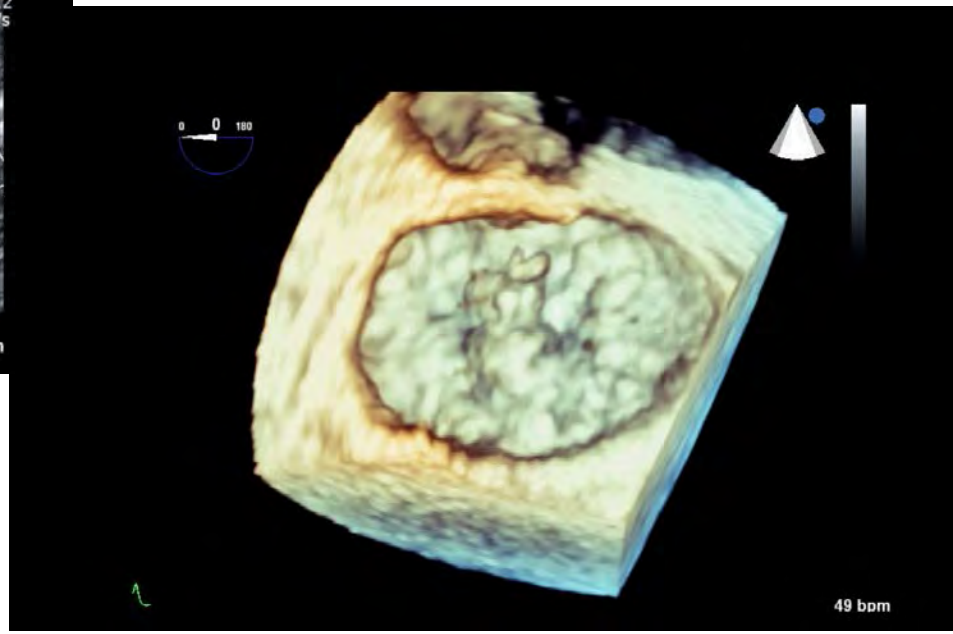




Fibroelastic Deficiency

Ruptured chordae off P2

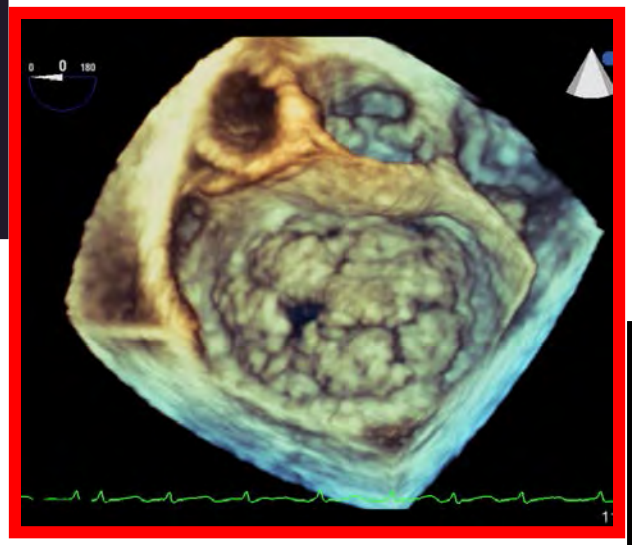


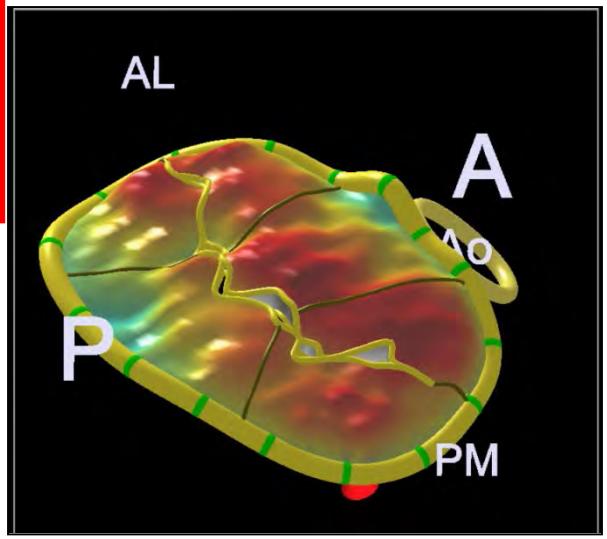


Barlow's Prolapse

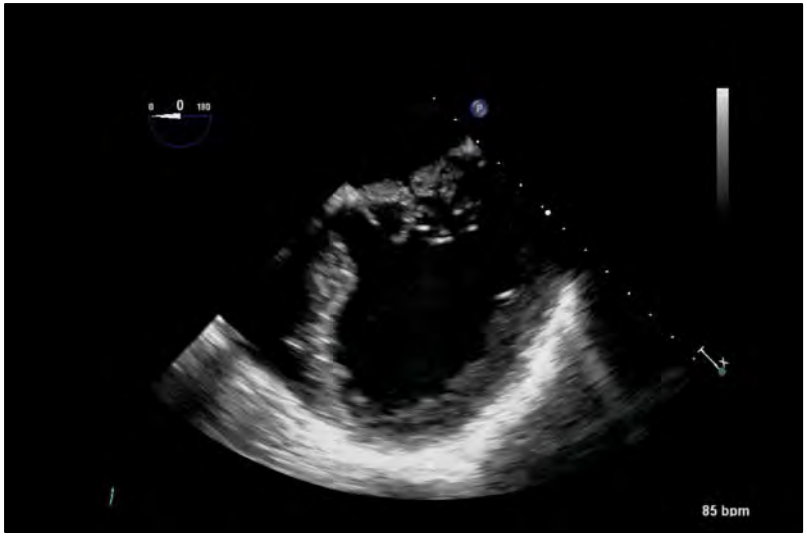
Excess leaflet tissue with billowing, thickened leaflets and chordae, large annulus

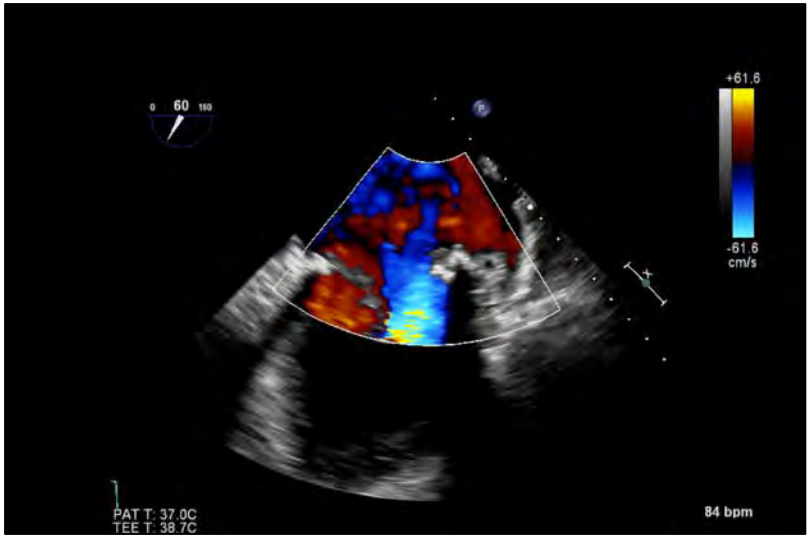
Barlow’s Disease

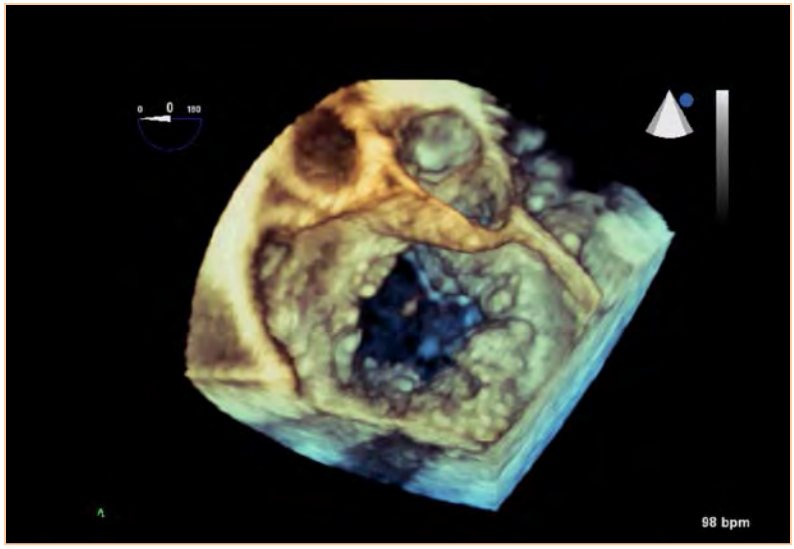




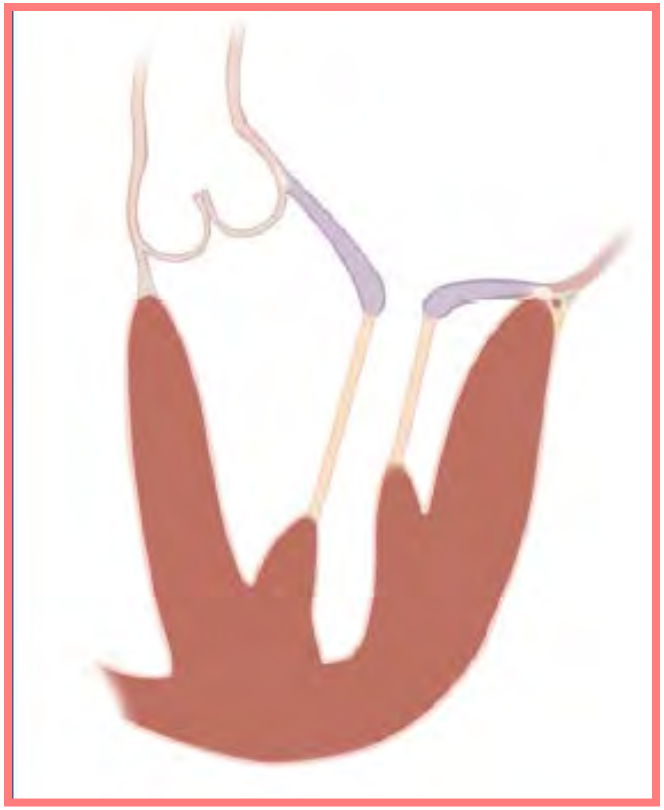
Barlow's Disease





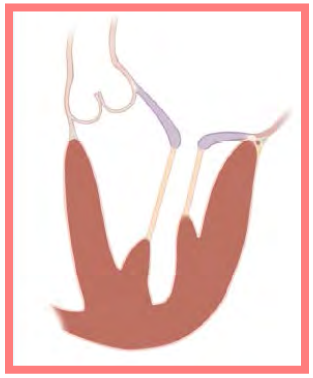


Type IIIa-Restricted leaflet motion (Systolic and diastolic)



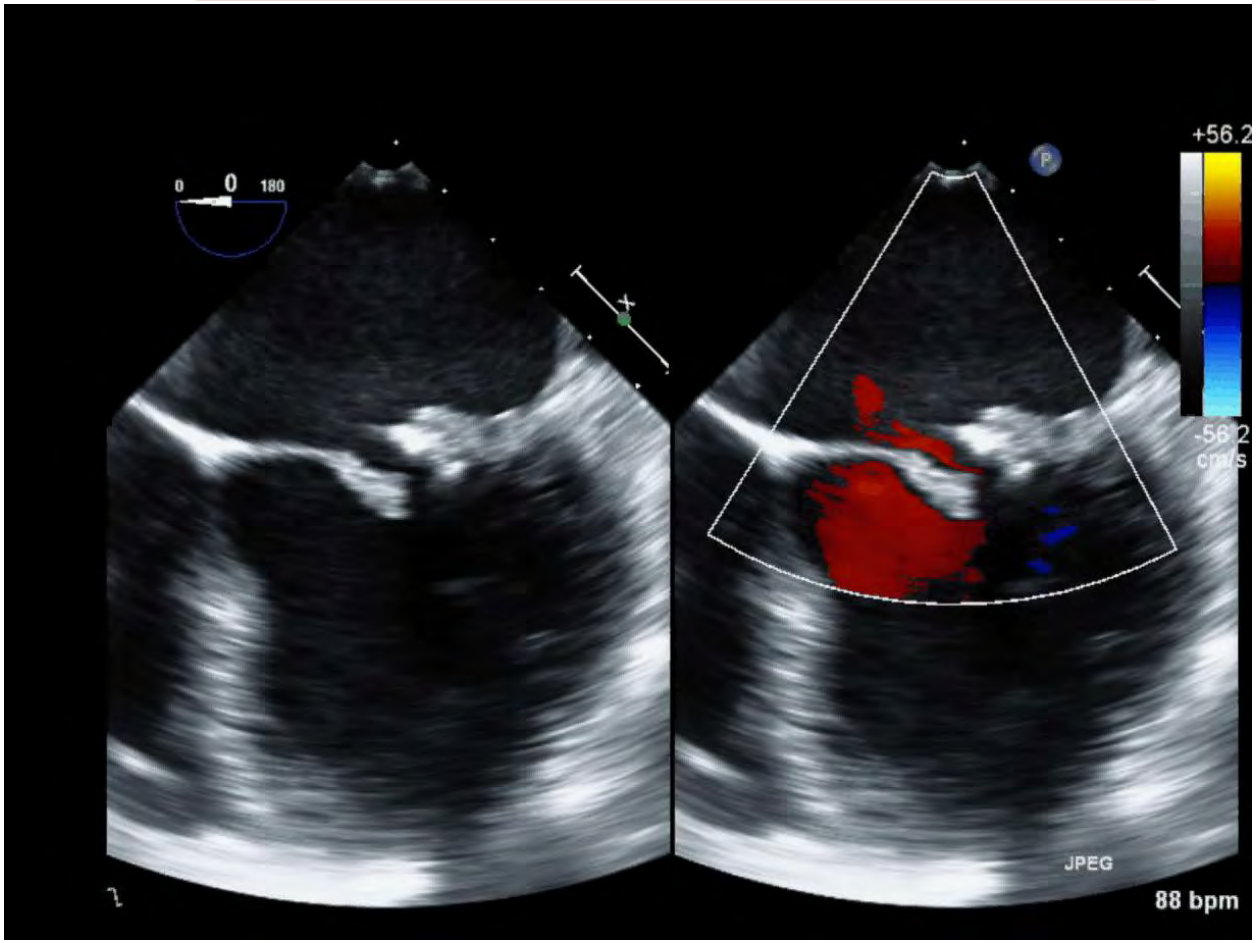
Commissure fusion
Leaflet thickening
Chordae fusion

Rheumatic valvular disease

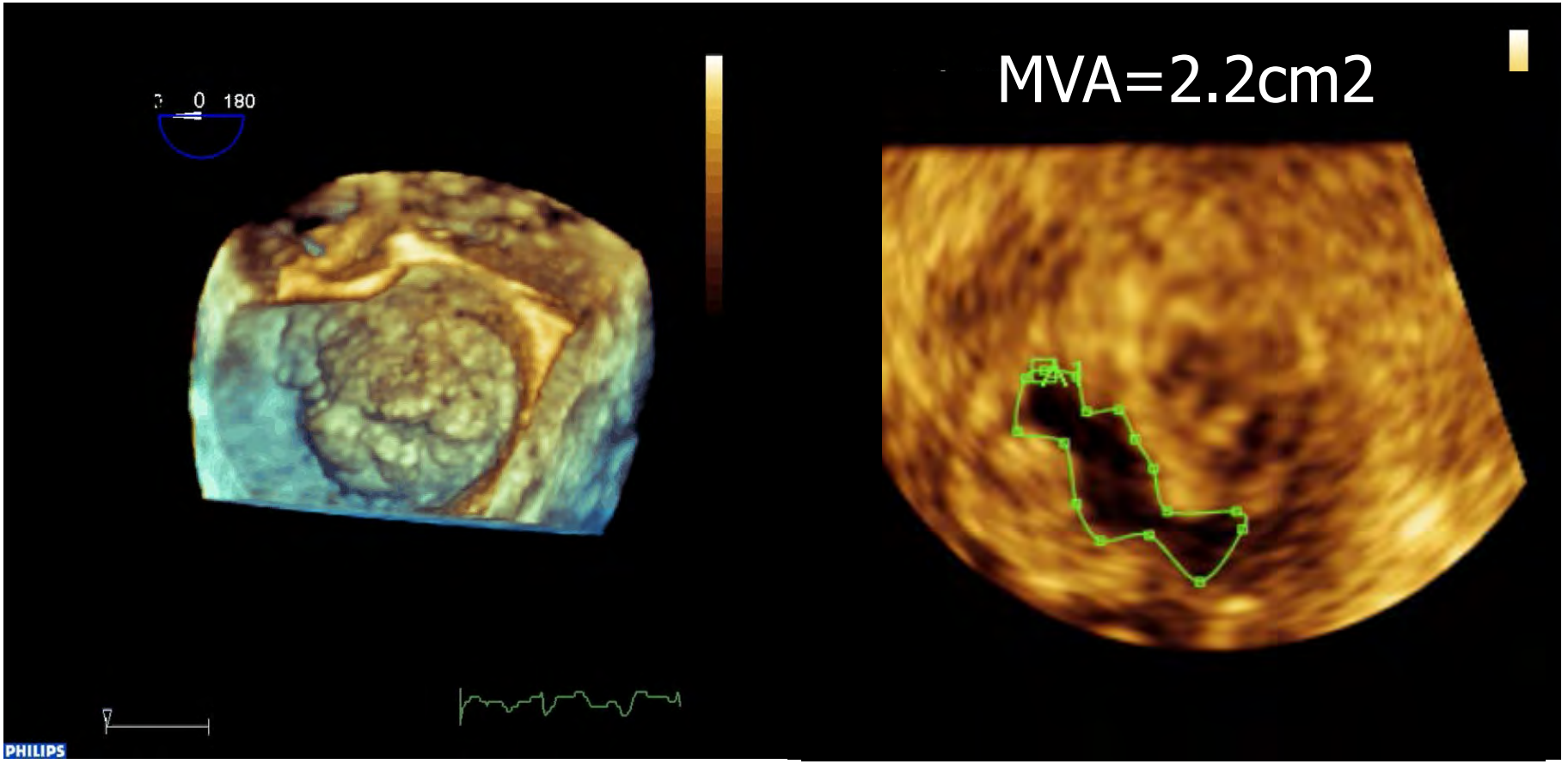


Type IIIa
(Systolic and diastolic Leaflet Restriction)

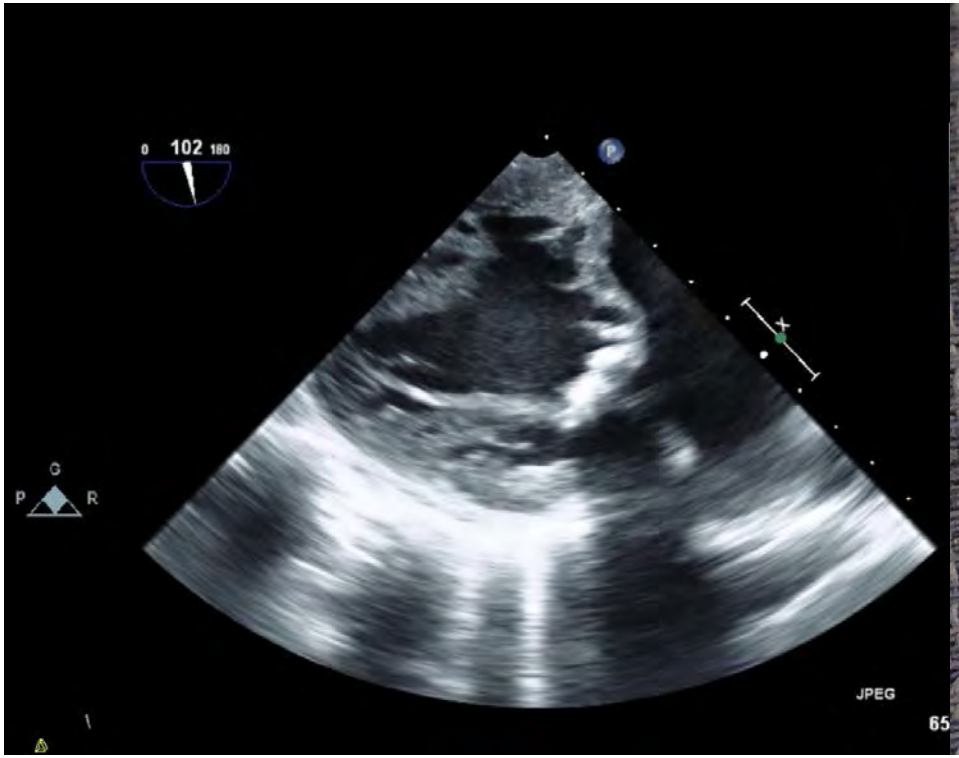
Commissure fusion
Leaflet thickening
Chordae fusion



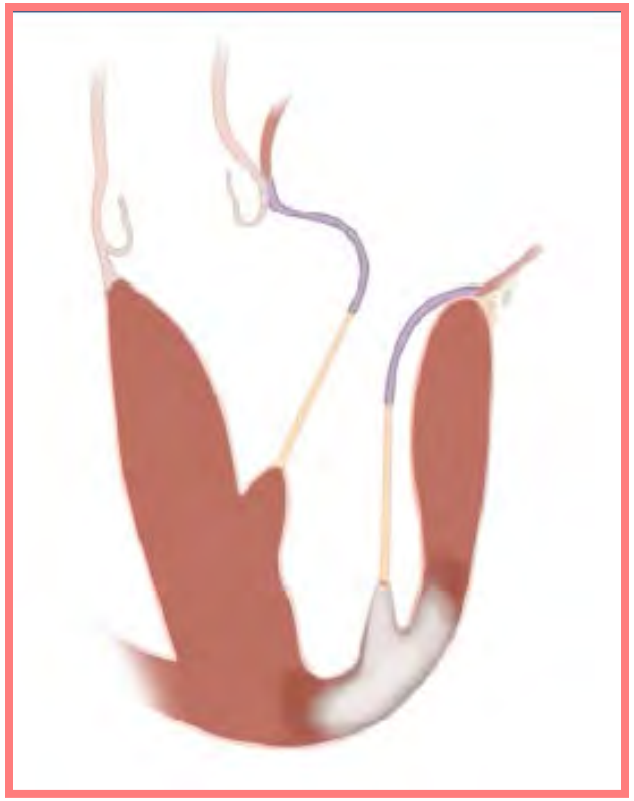
Type IIIa
(Systolic and diastolic Leaflet Restriction)



Myxomatous Mitral Valve Disease +Rheumatic Valve Disease



Type IIIb-Restricted leaflet motion (Systolic)



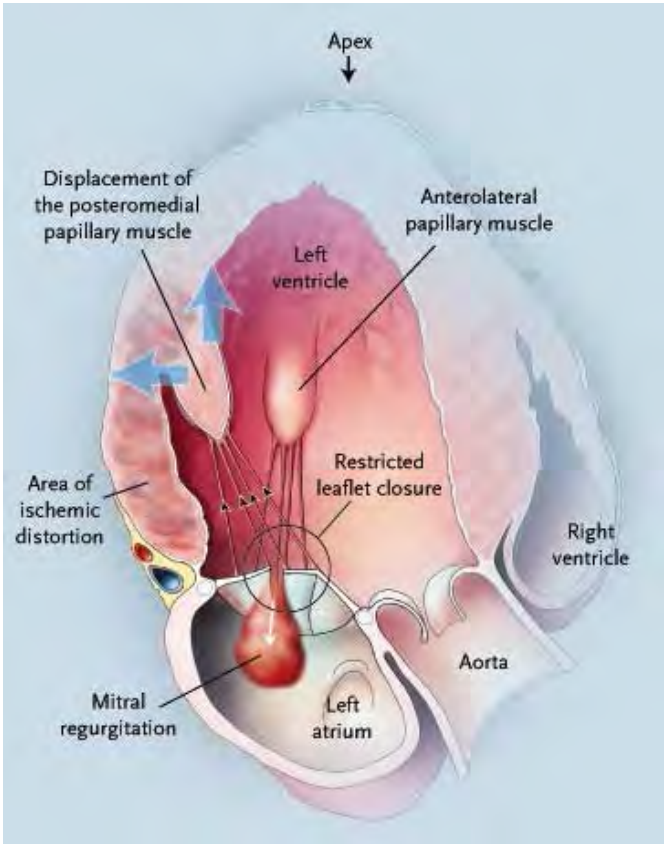
Ventricular dilatation
Ventricular dyskinesia

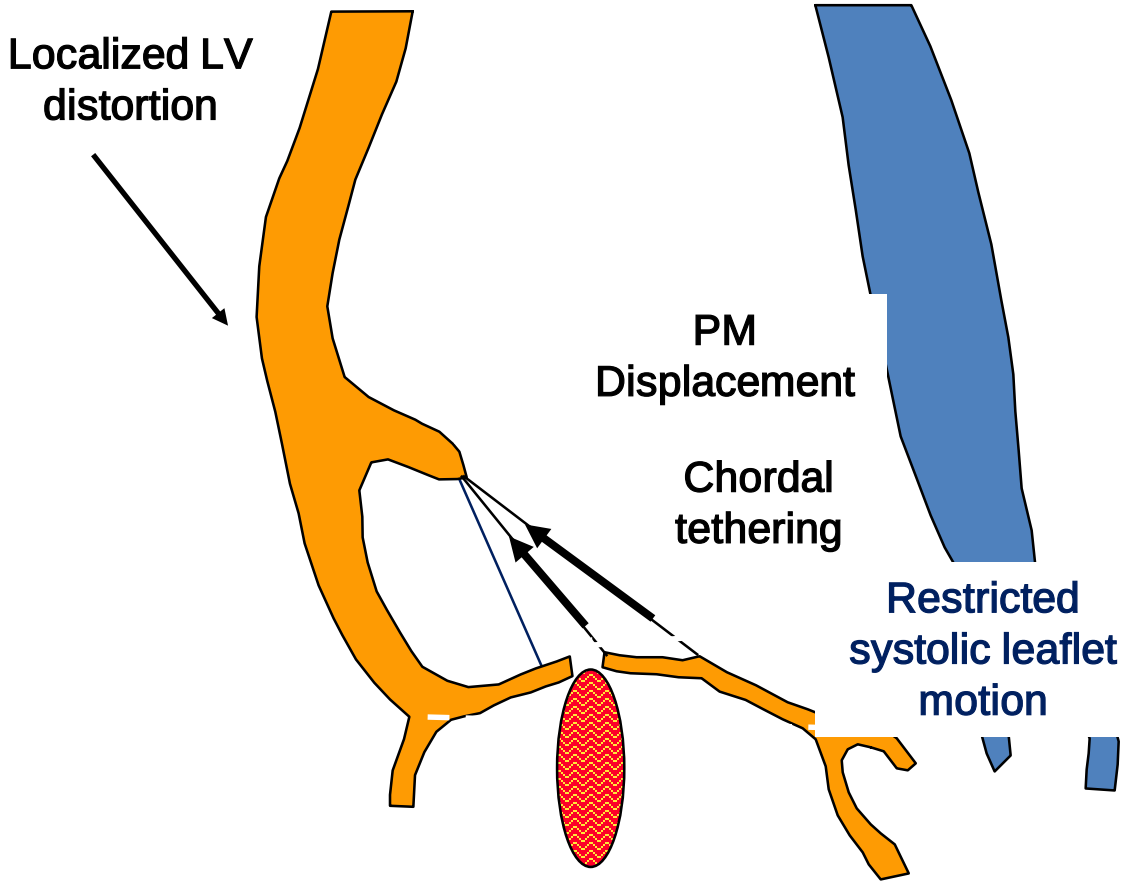
Ischemic mitral valve disease

Ischemic Mitral Regurgitation:
"Definition"

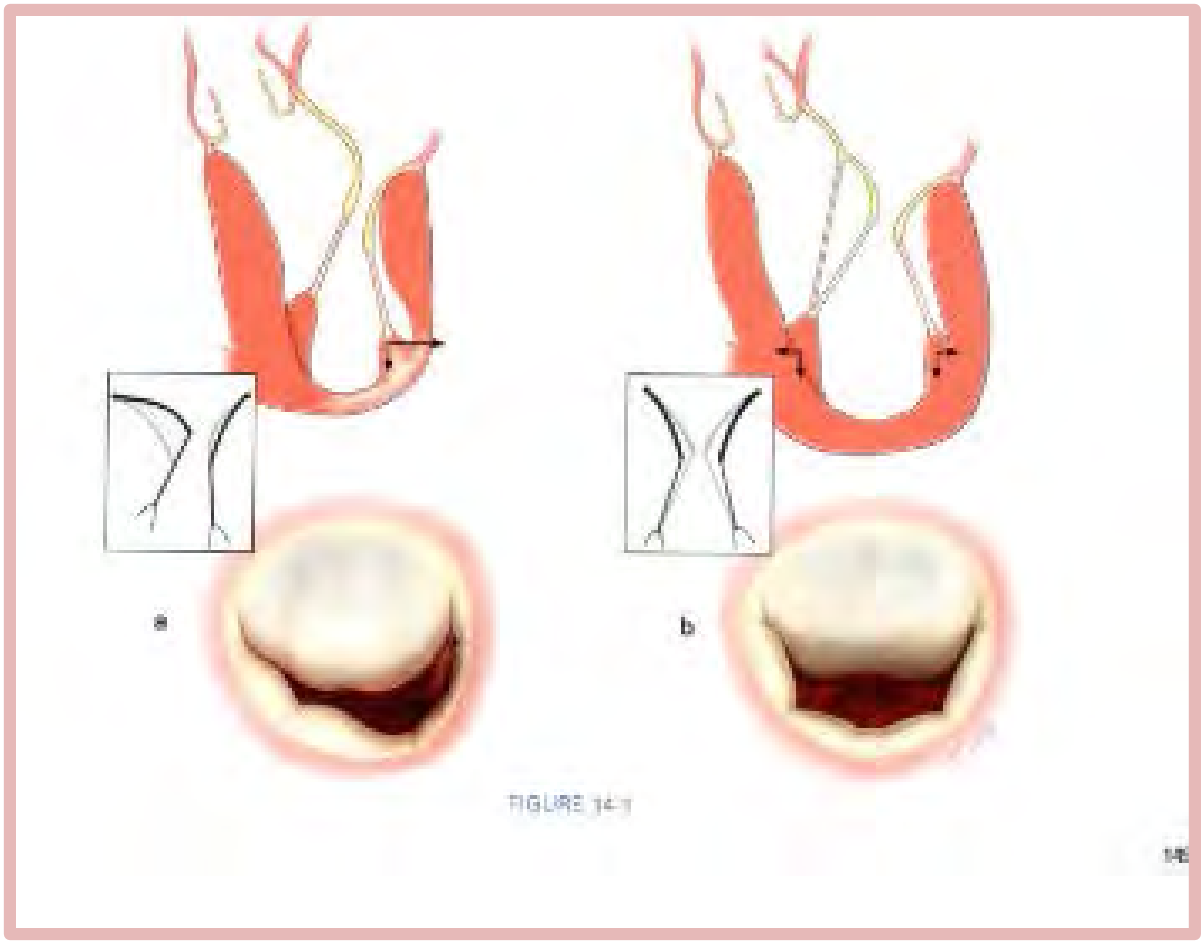
Mitral insufficiency that occurs as a result of coronary artery disease, in absence of intrinsic structure abnormalities of the leaflets and subvalvular apparatus(Functional)

Ischemic Mitral Regurgitation

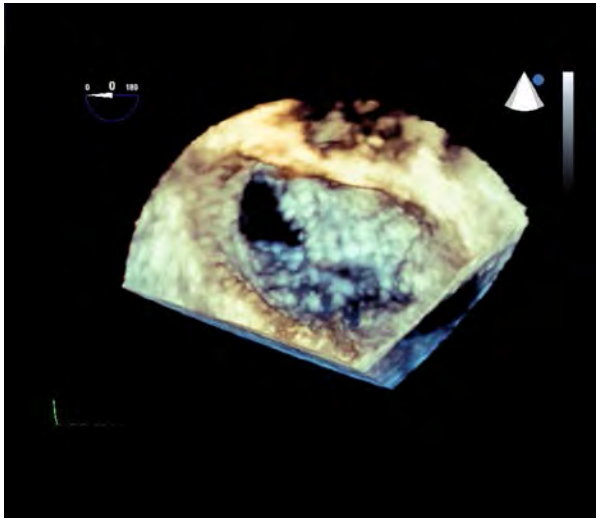


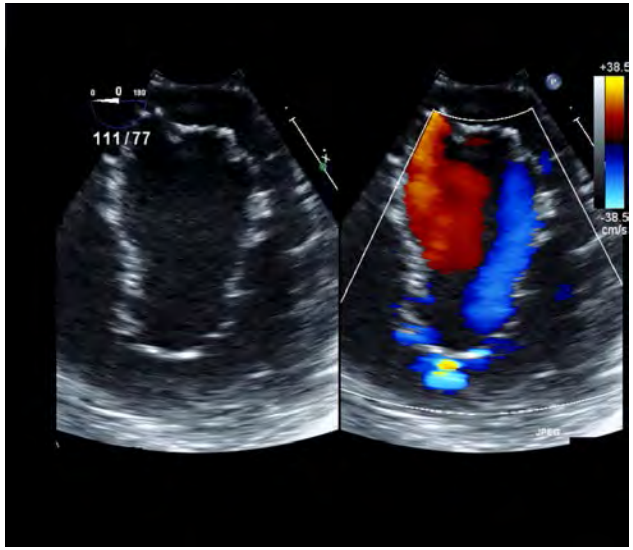


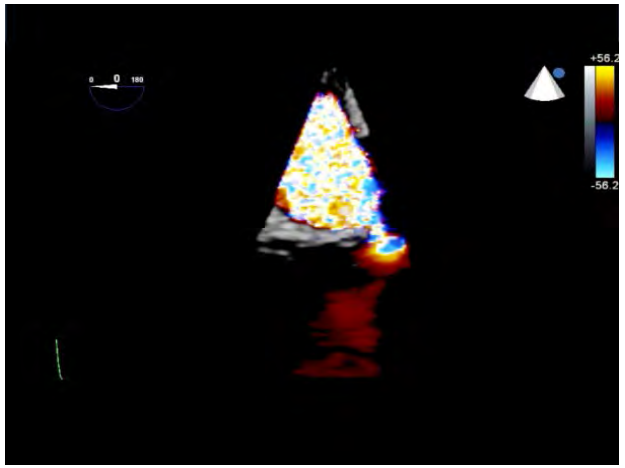
Ischemic Mitral Regurgitation



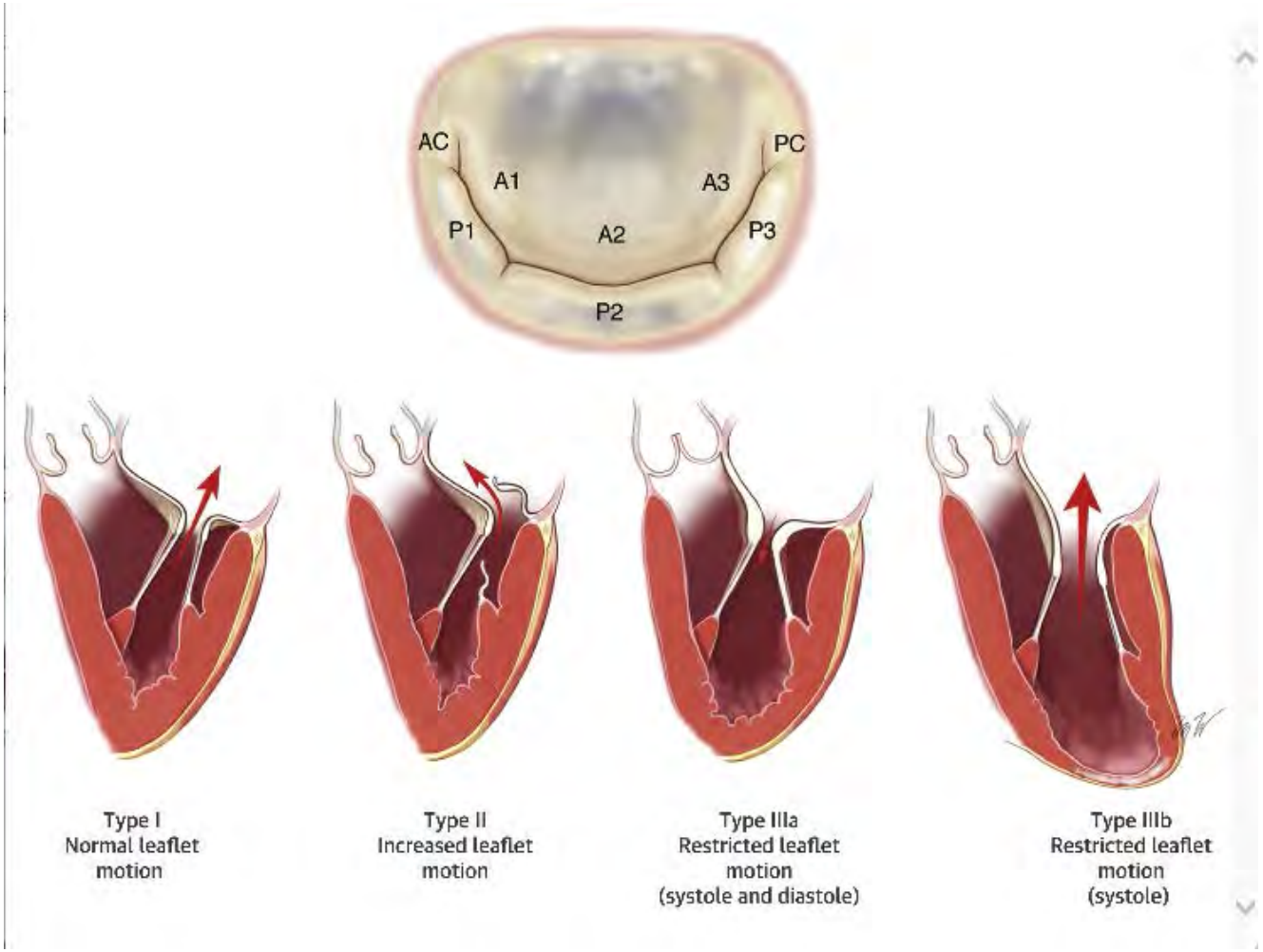
Ischemic Mitral Regurgitation



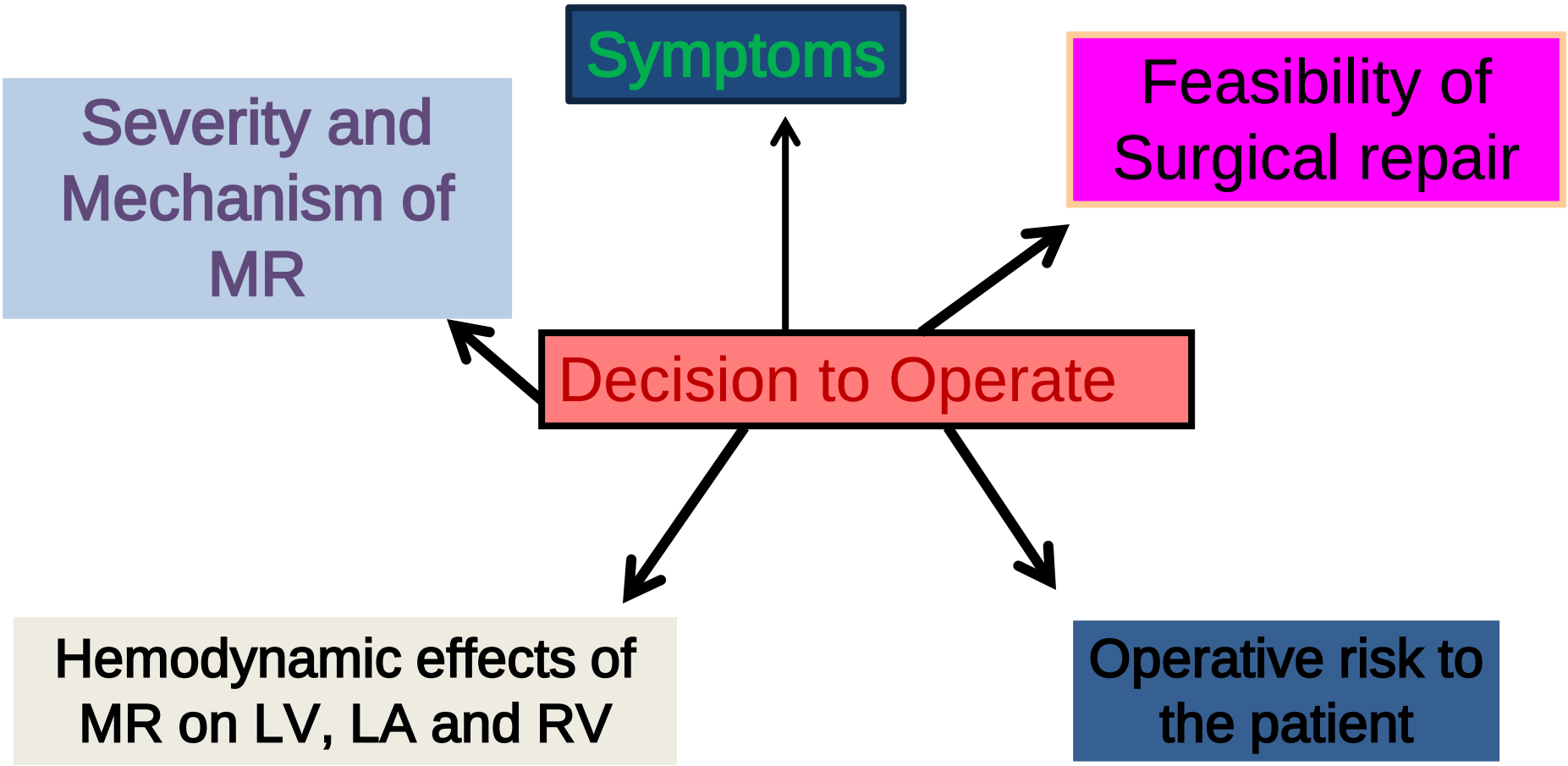




Carpentier's Classification System of MR Mechanisms



Factors Affecting Decision on the Patient with MR



When?

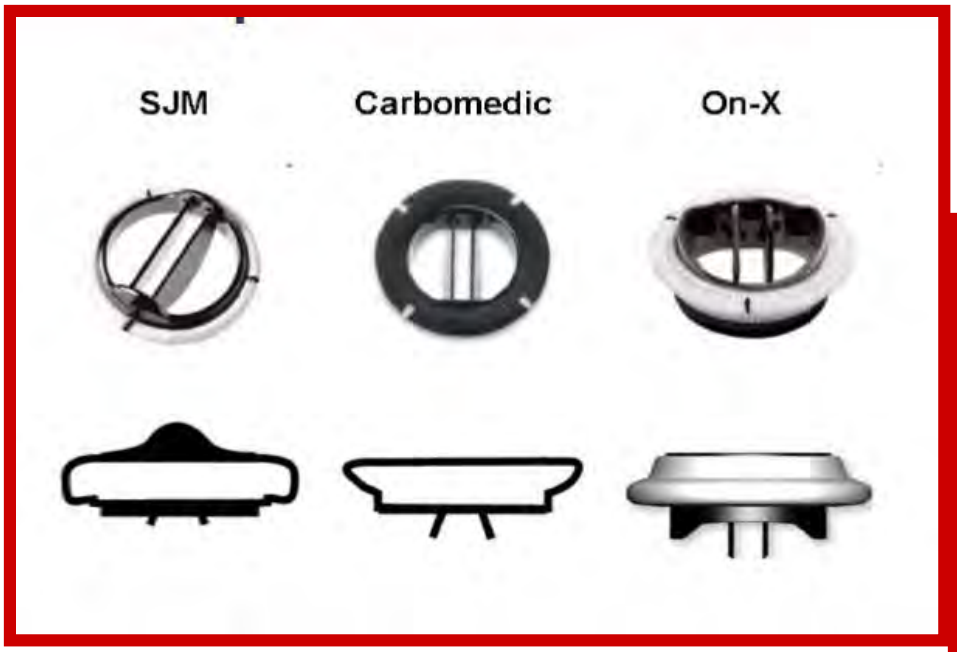
- The goal is to operate asymptomatic chronic MR:
  - Late enough in the natural history to justify the risk of intervention, but
  - Early enough to prevent irreversible ventricular dysfunction, pulmonary hypertension, and /or chronic arrhythmia….and sudden death

How?

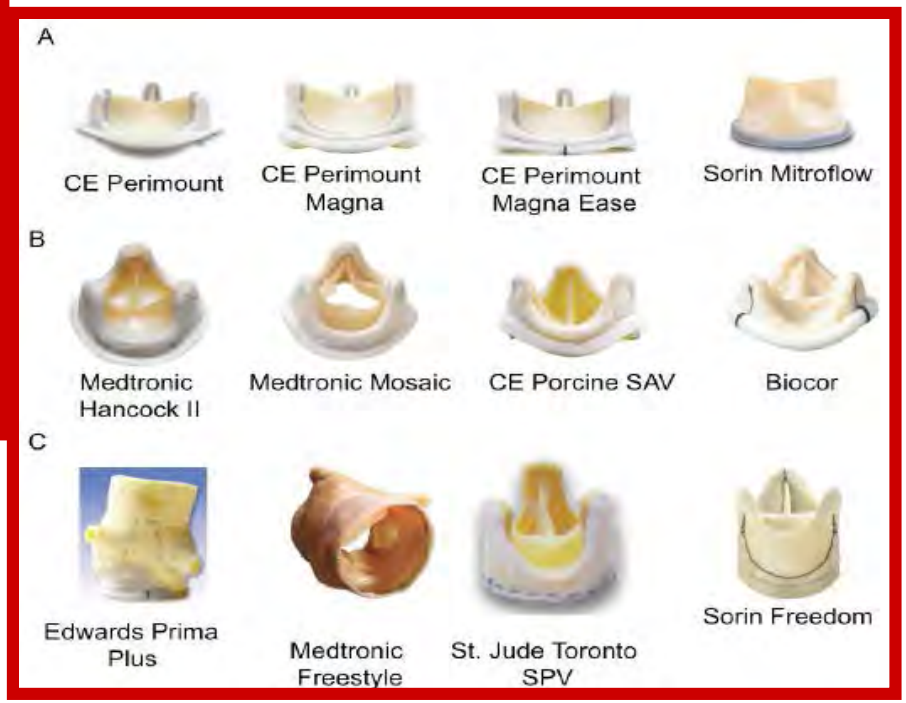
- Mitral valve replacement (Surgical vs percutaneous)
- Mitral valve repair (Surgical vs percutaneous)
- Medical treatment none

Surgical Mitral valve replacement

Mechanical prosthesis



Bovine stented,porcine stented & stentless valves



Percutaneous Mitral Valve Replacement

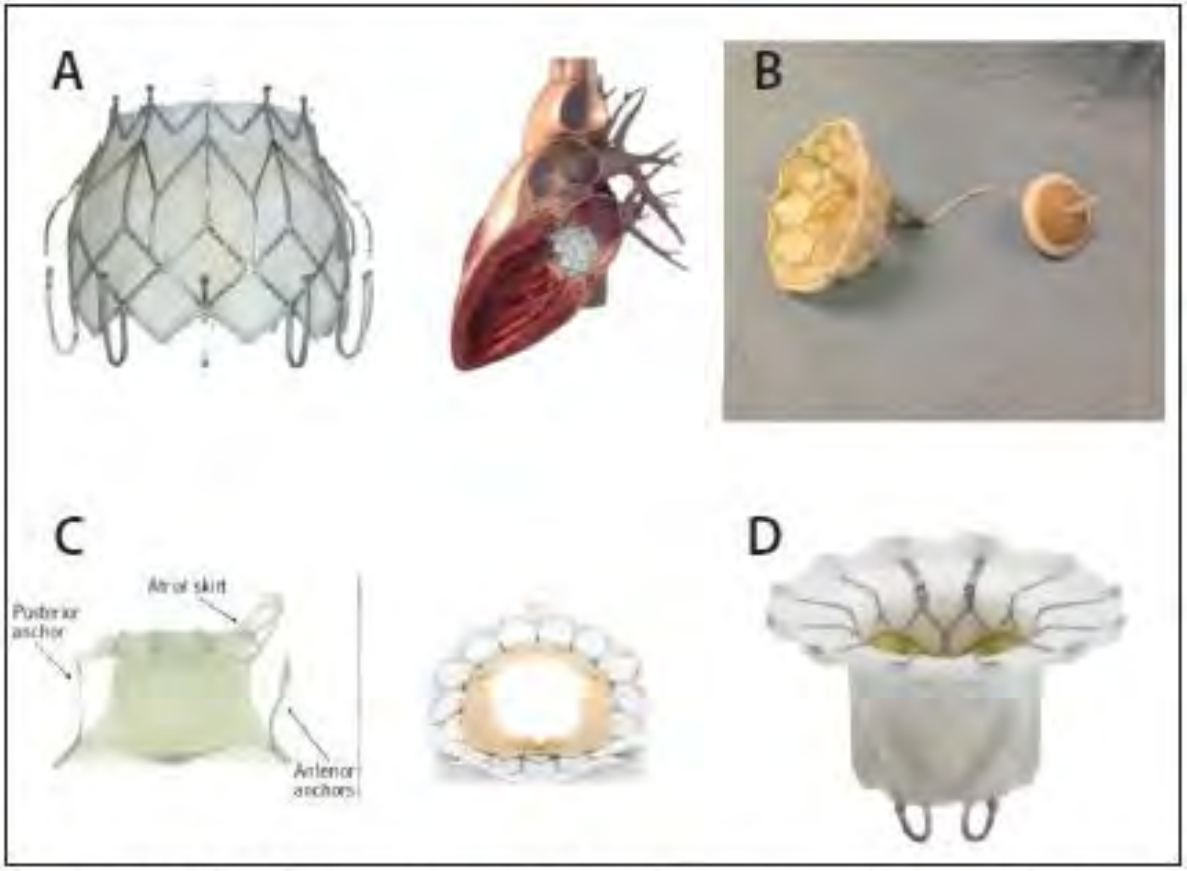


Figure 2. The first-generation CardiAQ valve (A), Tendyne valve (B), Tiara valve (C), Fortis valve (D).

Clinical History

Relevant history:

57 y/o male

Severe MR - flail segment in the region between P2 and P3 d/t ruptured chordae.

Ht=182cm, Wt=93kg, BMI=30, BSA=2.2, Cr=0.6

PMHx:

SBE

Hemorgic CVA frontal temporal parietal decompressive craniotomy - 2014

LT plegia, wheel chair bound, SZ

Heart Stab wound 1989

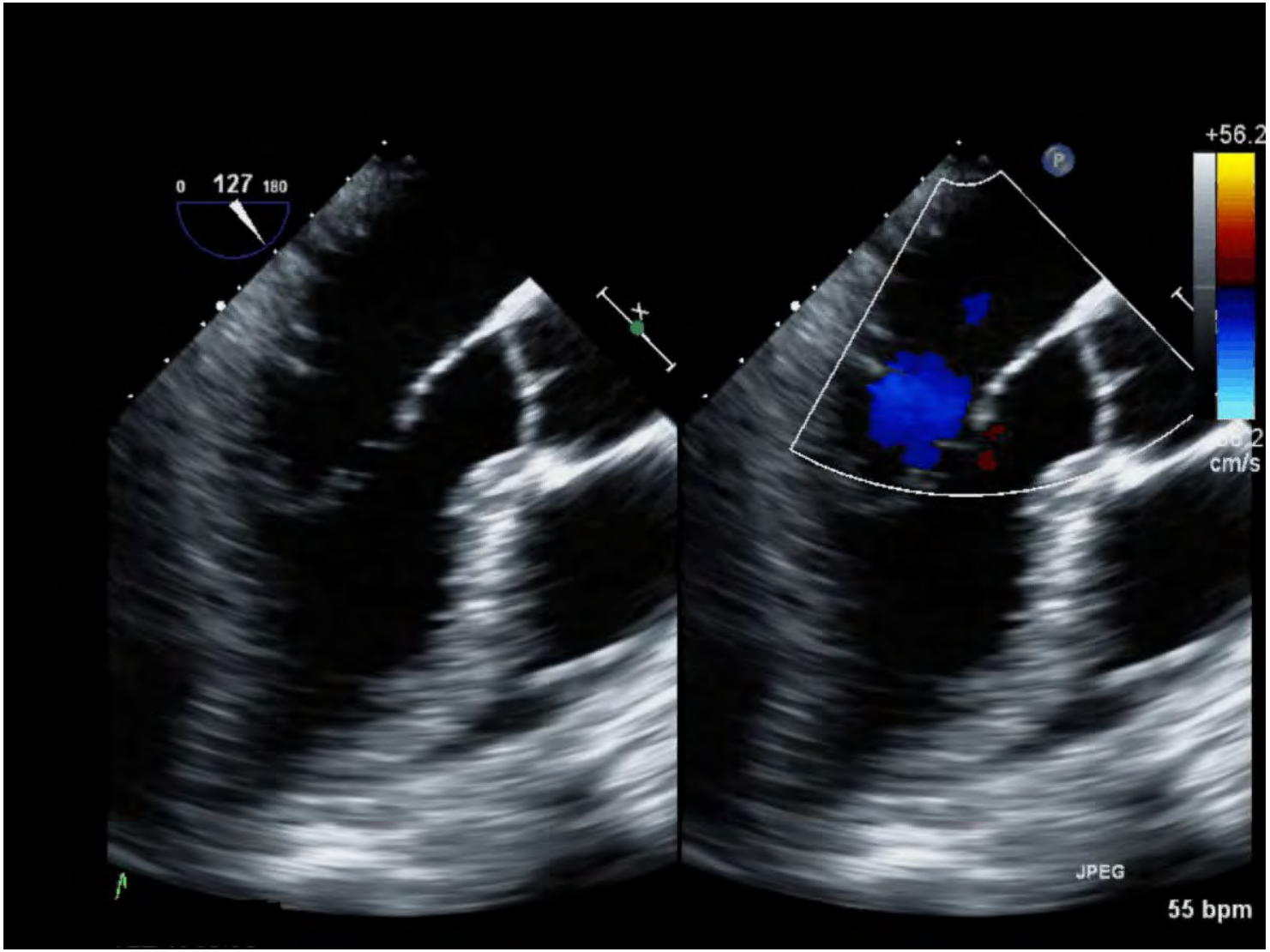
Low PLT-unclear cause BMB neg.

Non signficant CAD

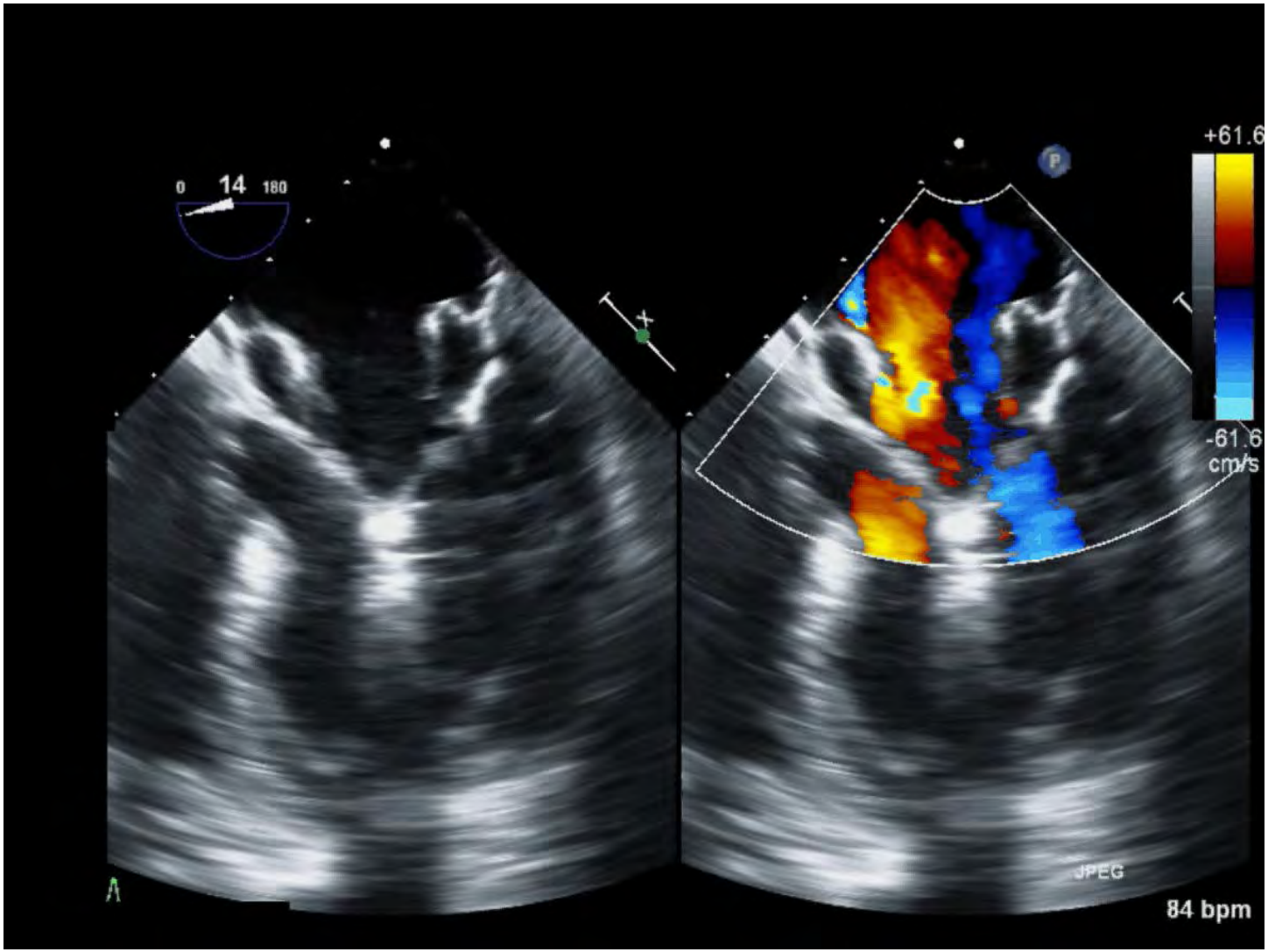
HTN, GERD

FEV1= 22% with Sev. restriction

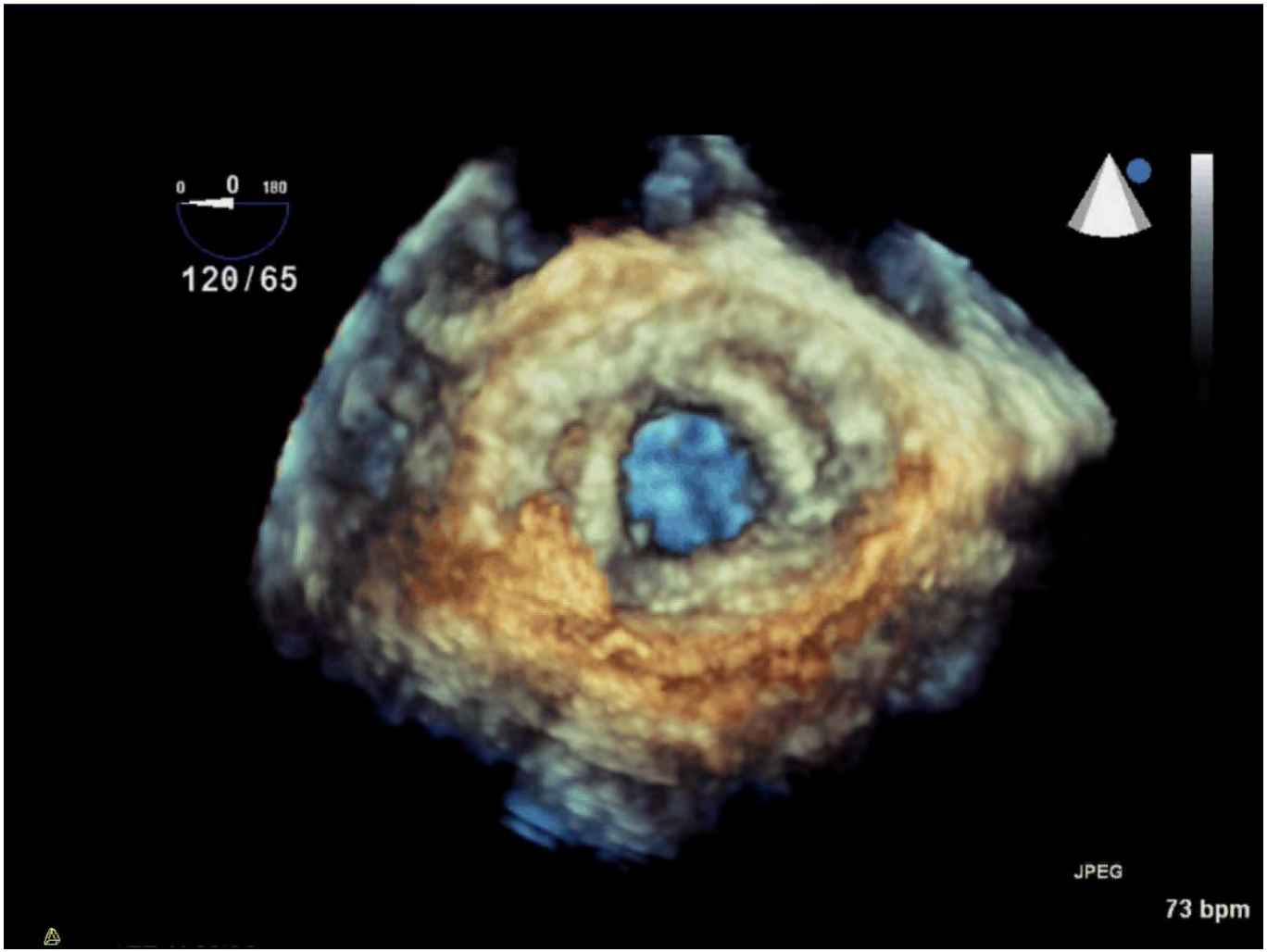
Pre Tendyne mitral valve replacement



Post Tendyne mitral valve replacement



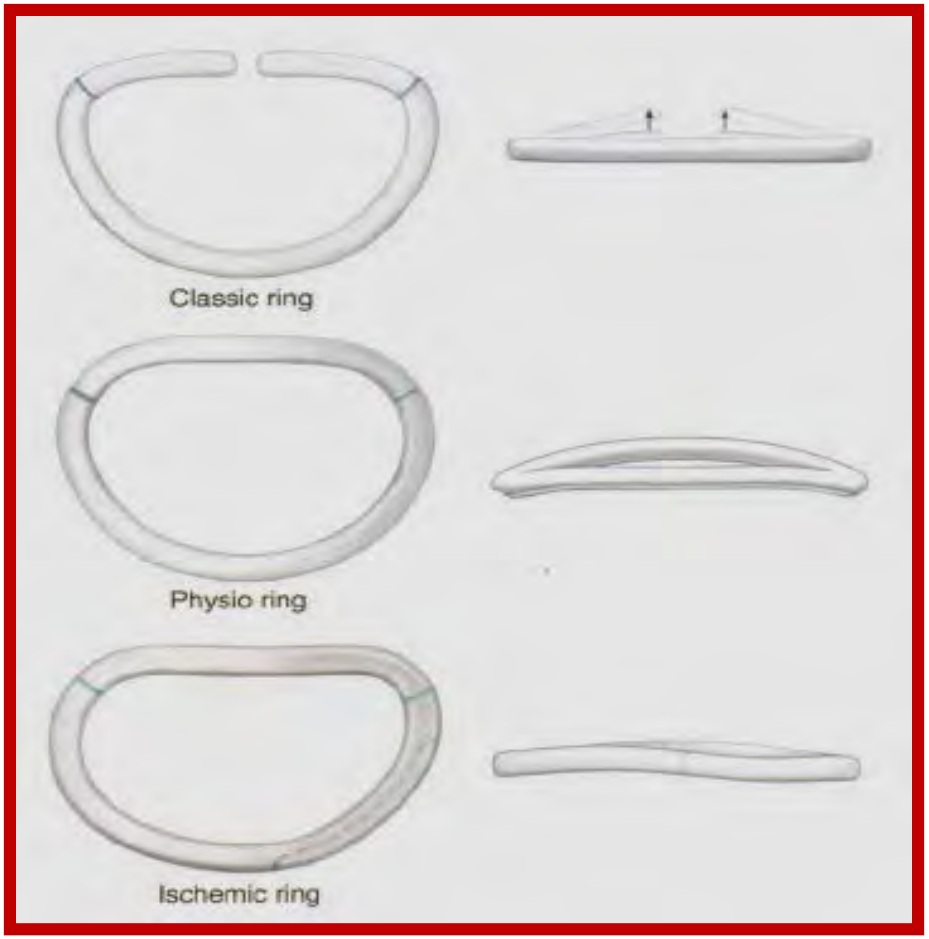
Post Tendyne mitral valve replacement

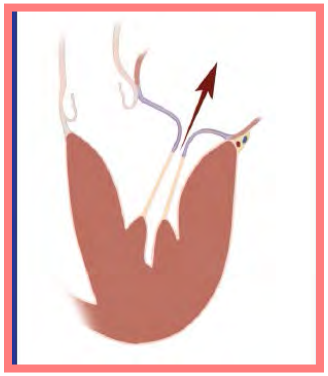


Mitral Valve Repair

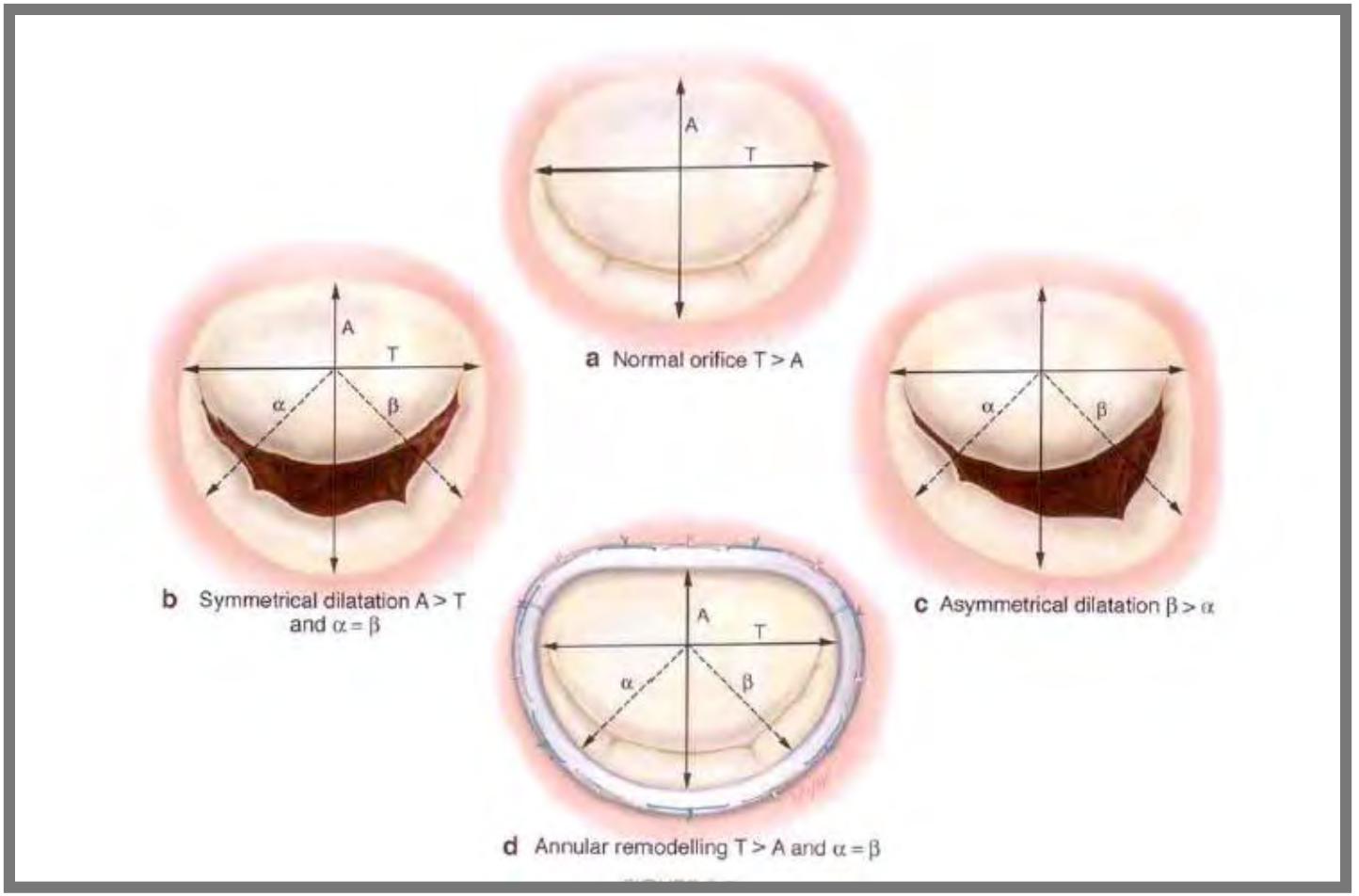
Simple surgical repair

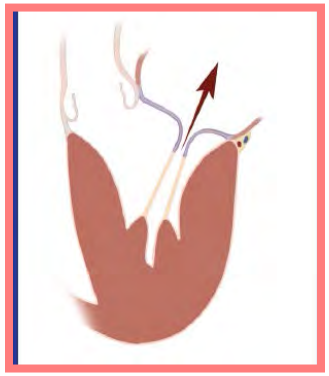
Annuloplasty Ring





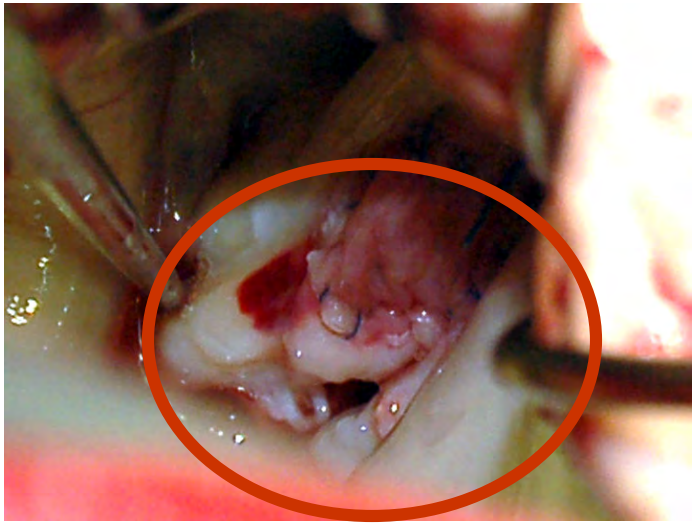
Type 1 (Normal Leaflet Motion)
Annulus dilatation

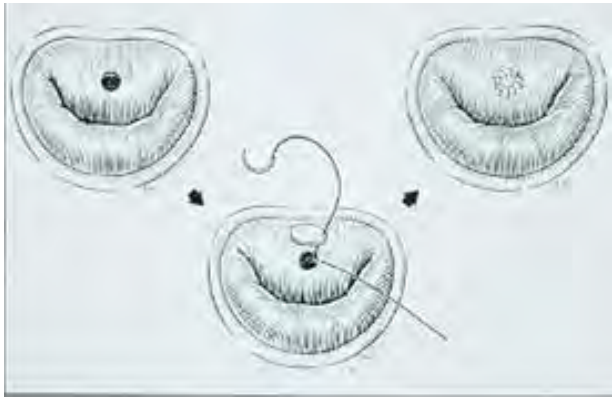


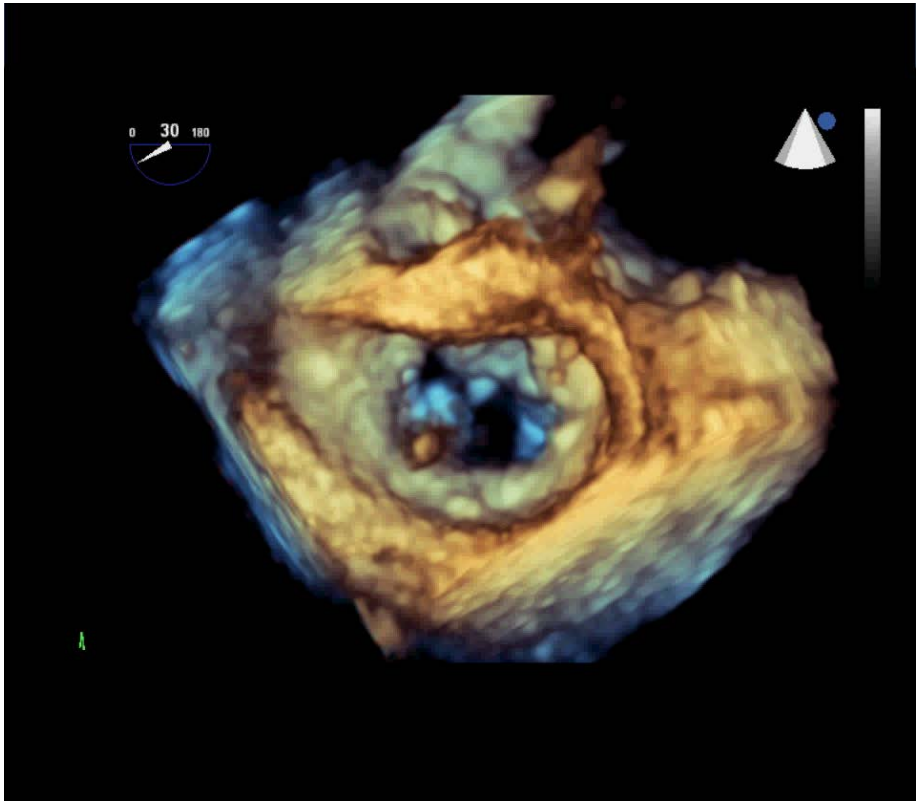


Type 1 (Normal Leaflet Motion)

Leaflet Perforation-Patch repair or replacement



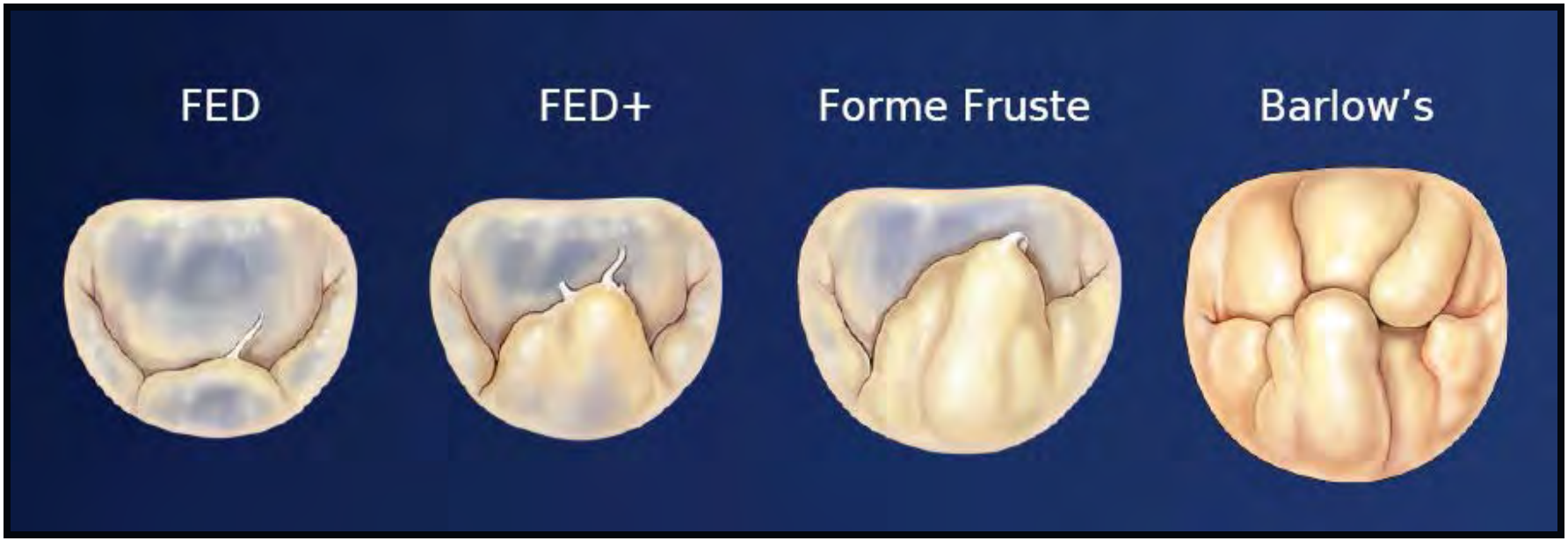




Fibroelastic Deficiency (FED)

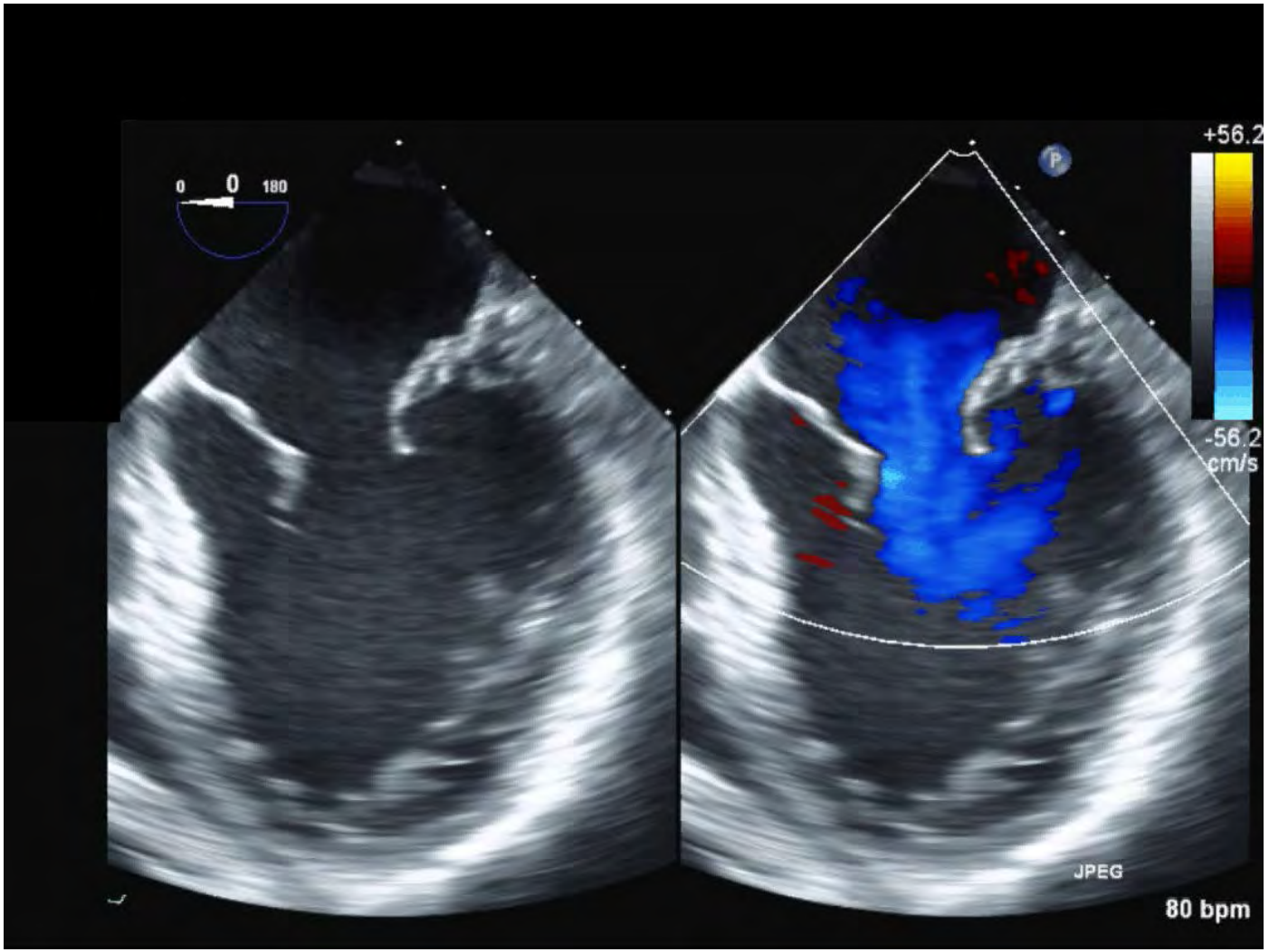
- Older individuals
- Short hx of MR
- Ruptured or elongated of a single chord
- Remaining segments are normal
- Posterior annulus may be dilated

Spectrum of Degenerative Mitral Valve Disease

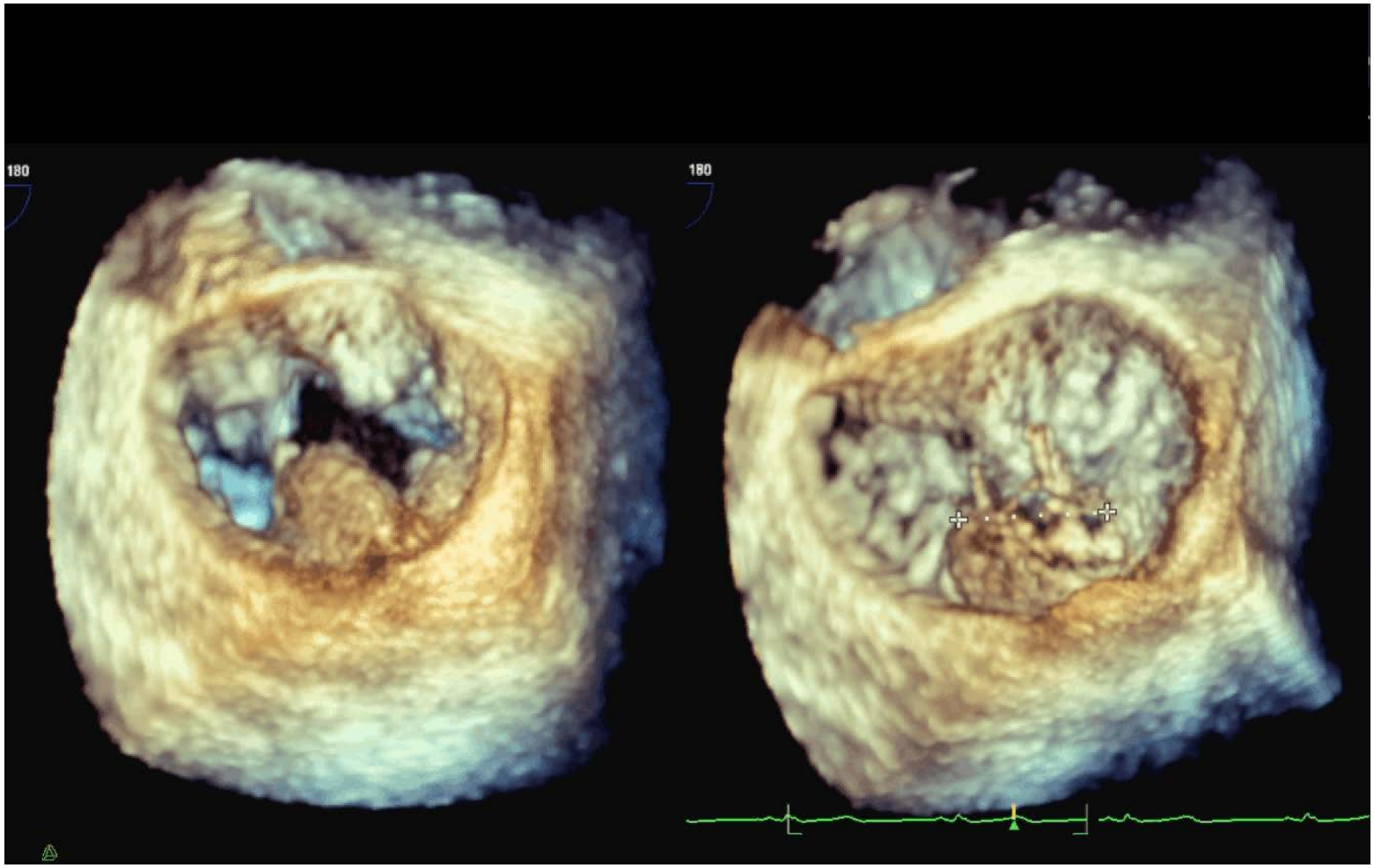


Increase repair difficulty

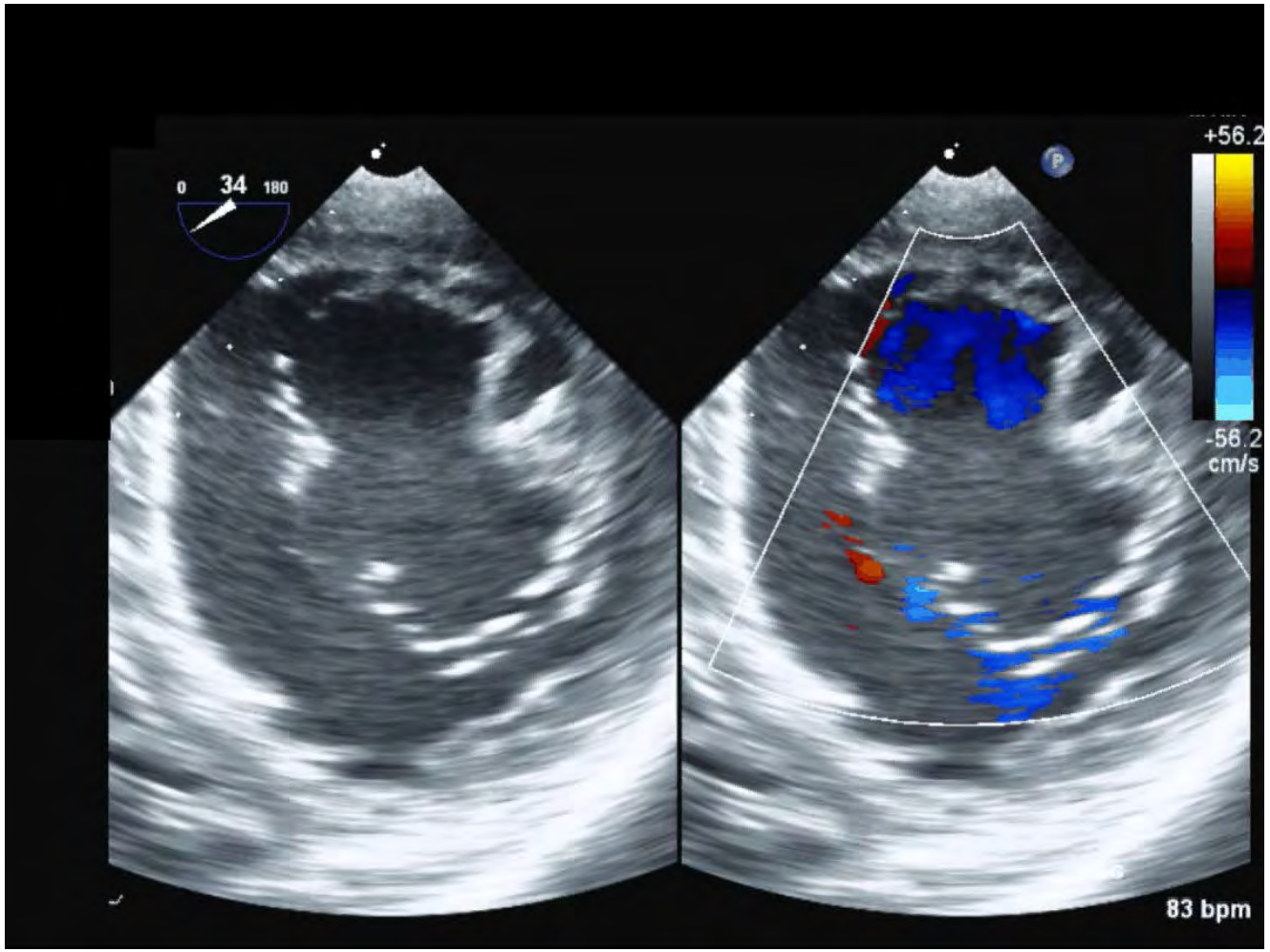
Flail P2 due to ruptured chordae

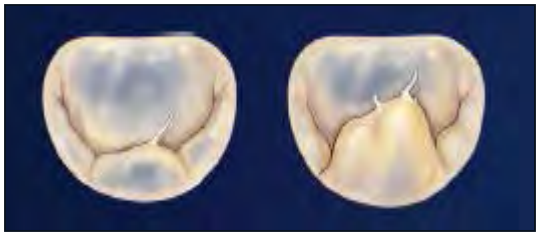


Flail P2 due to ruptured chordae



Flail P2 due to ruptured chordae

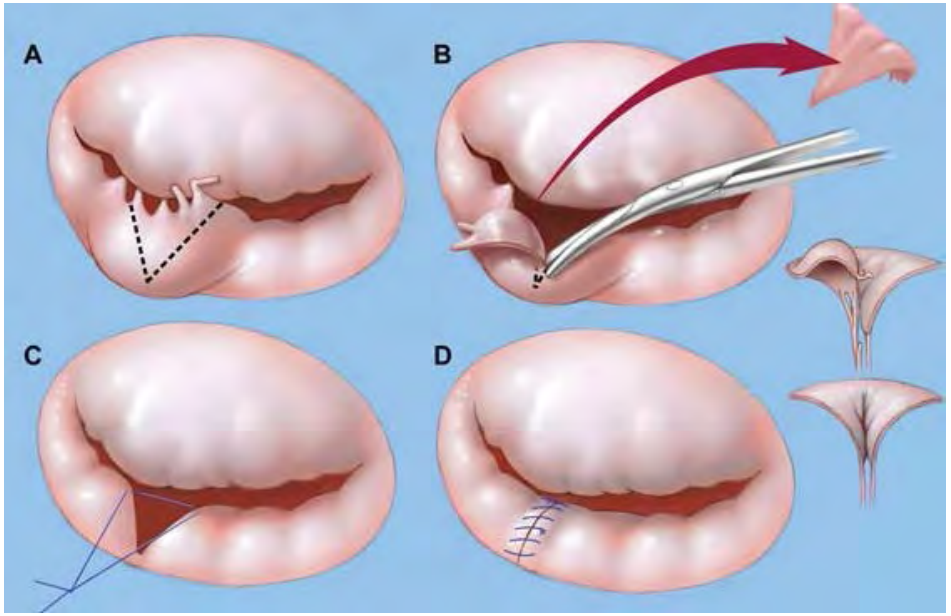


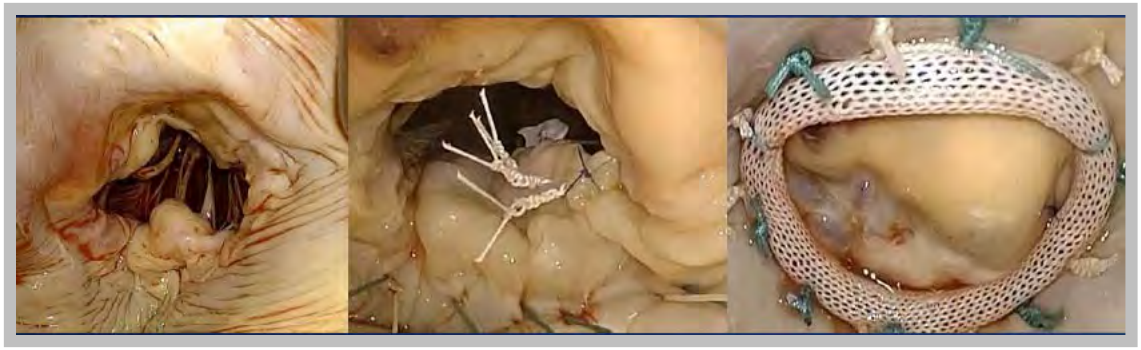


FED-Preserve Tissue

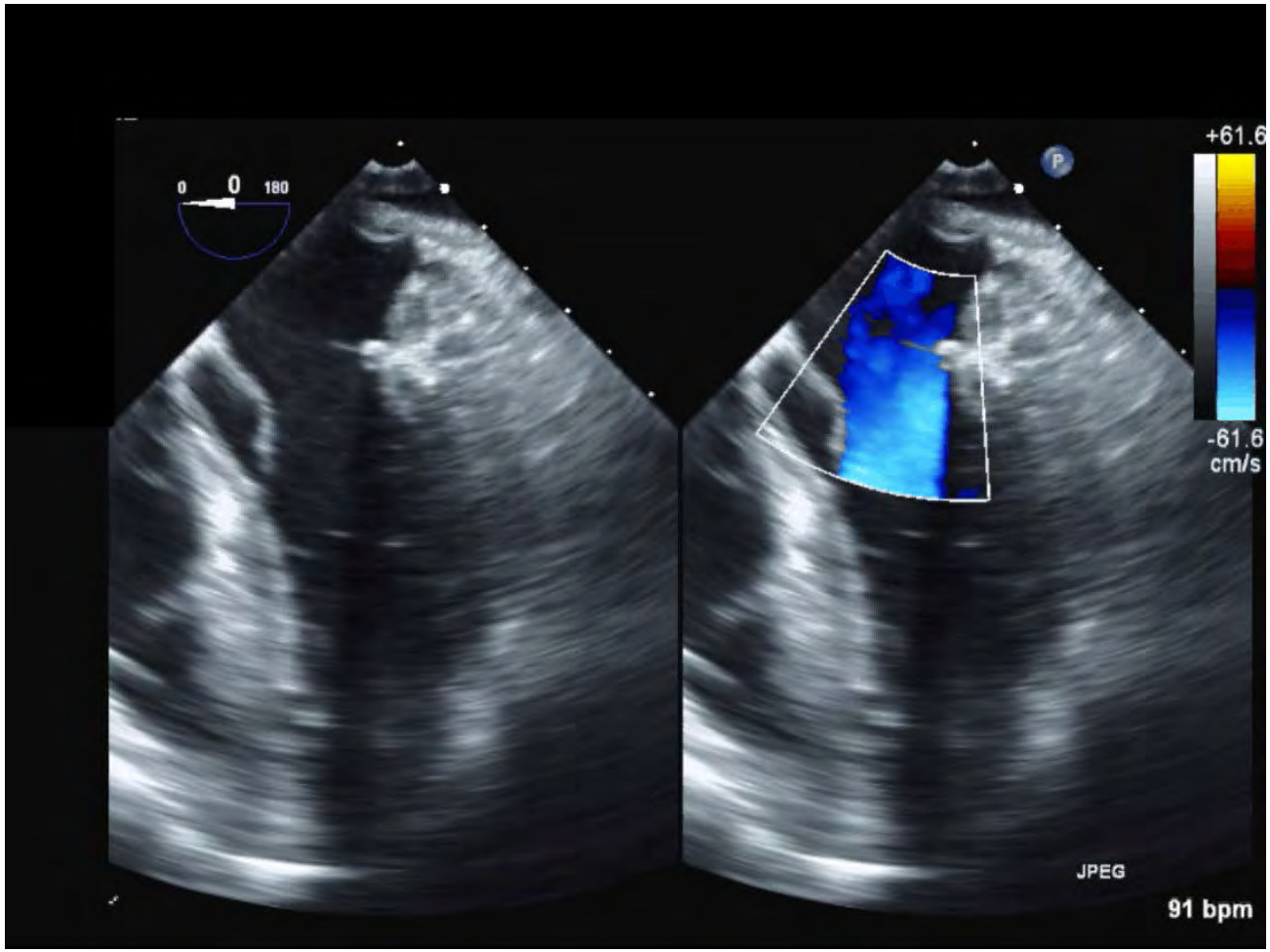
No Resection, or Limited Resection

Mitral Valve Repair –P2

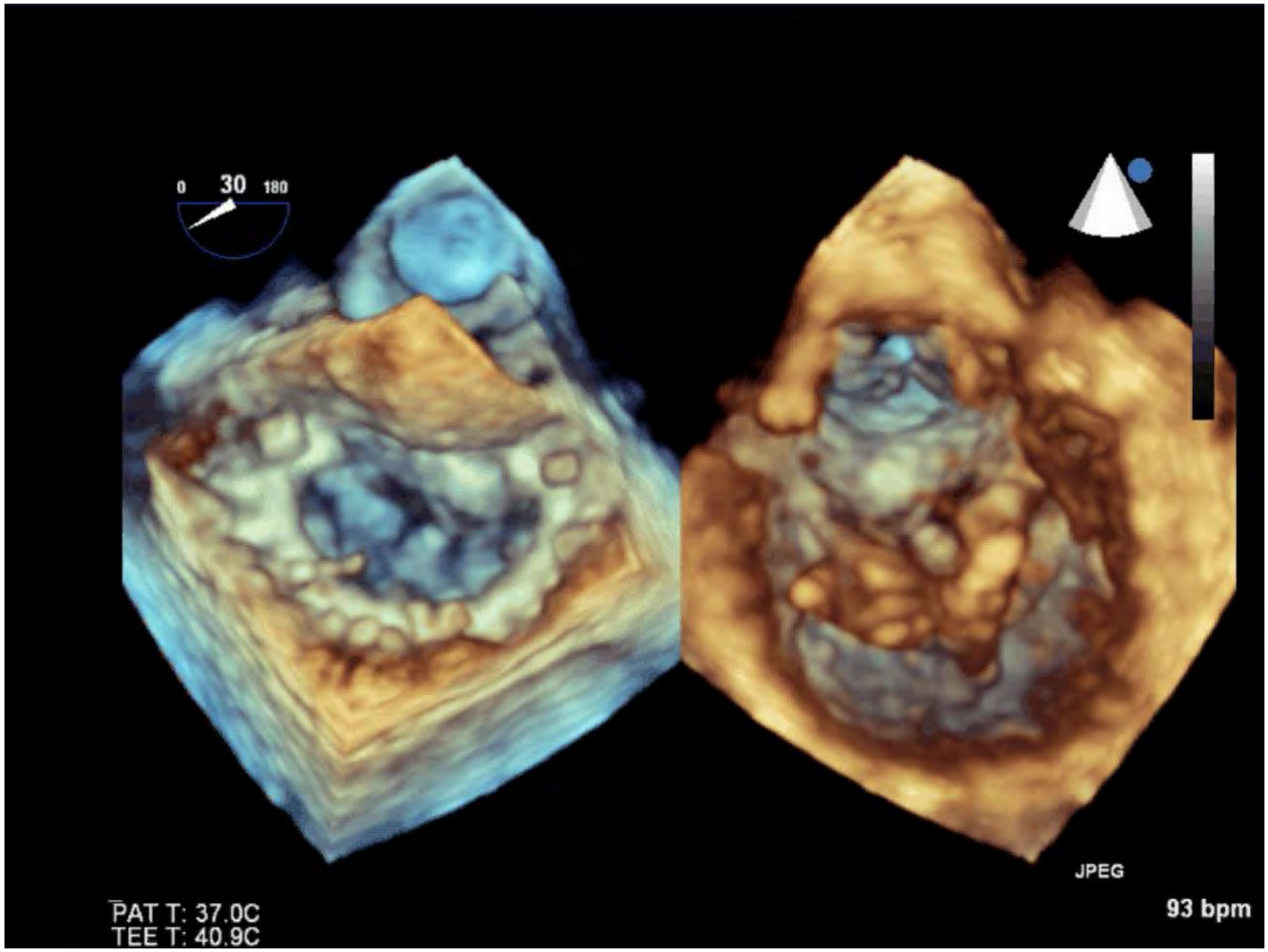




Post triangular resecton of P2 and annuloplasty with ring



Post triangular resecton of P2 and annuloplasty with ring

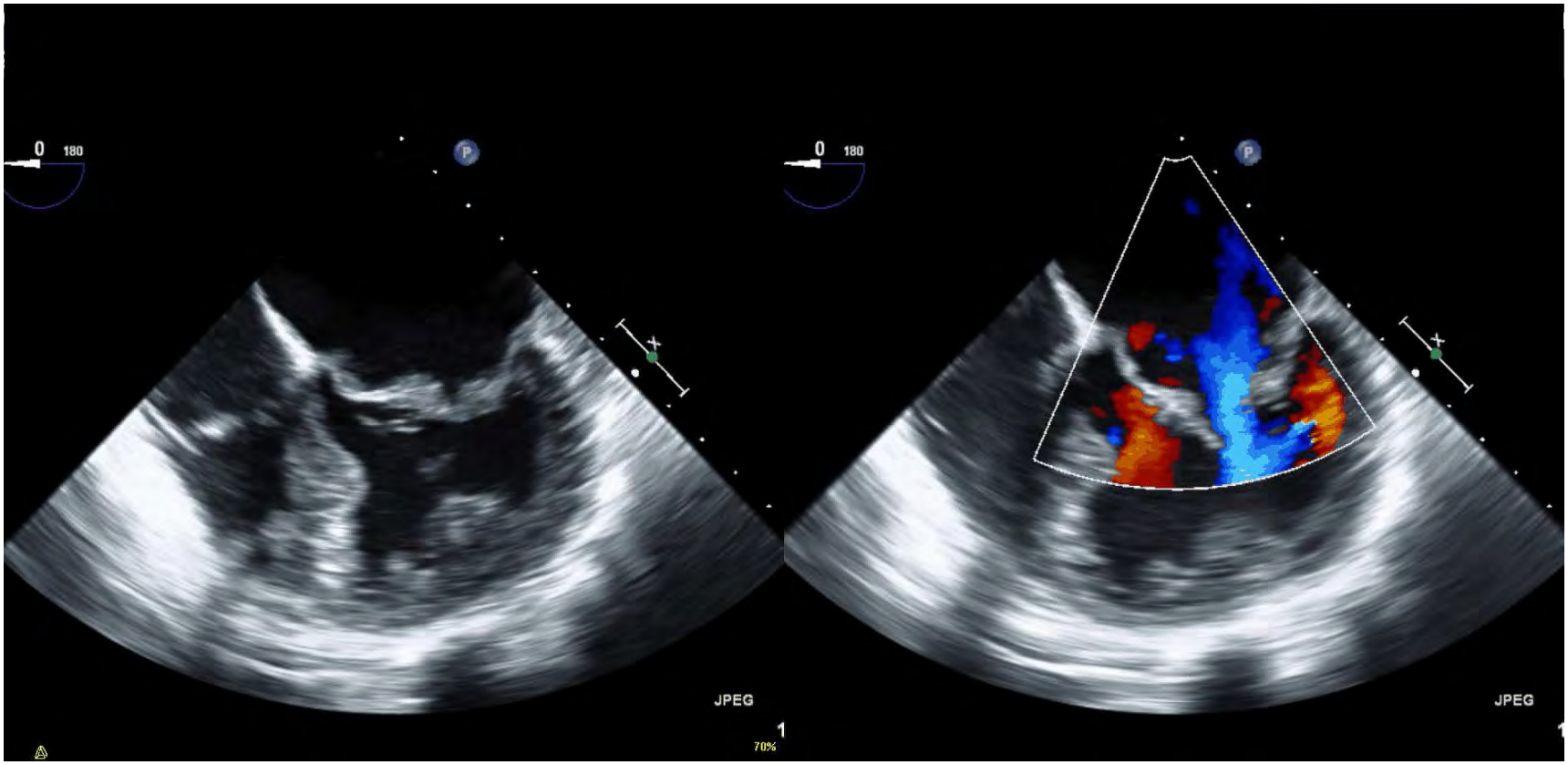


Mitral Valve Repair

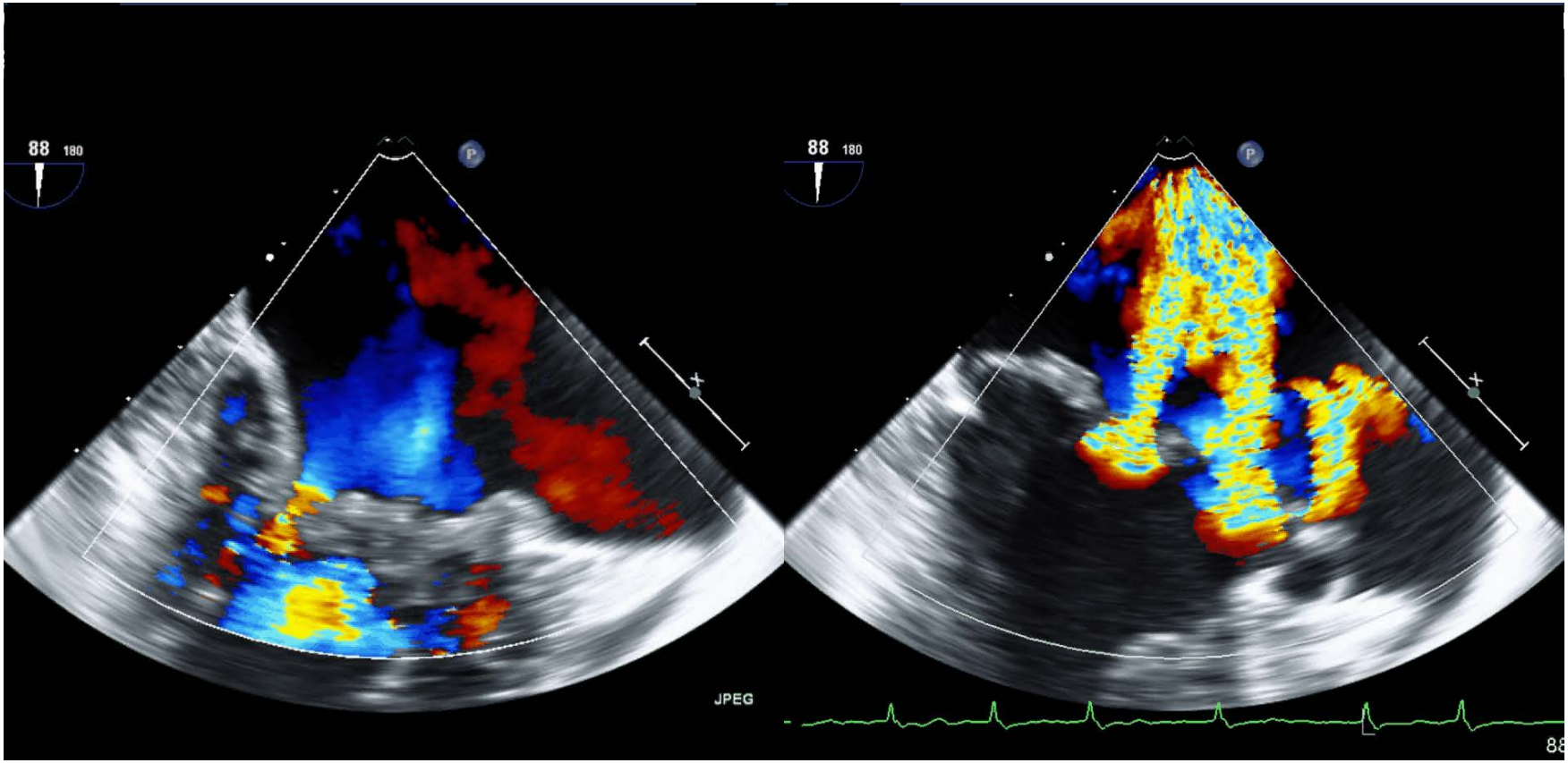
Complex surgical repair

Barlow's disease

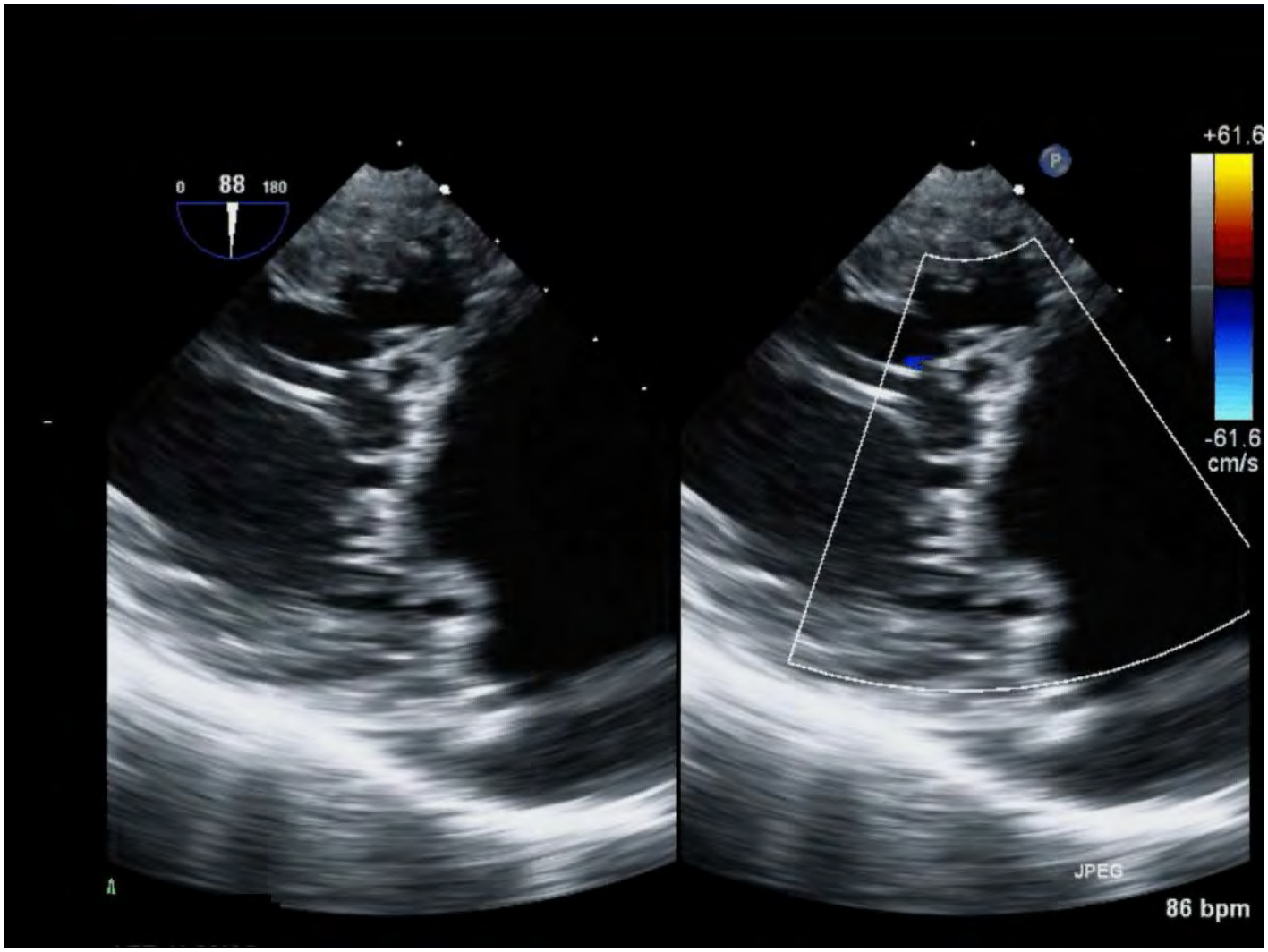
Balows's Prolapse---4 chamber



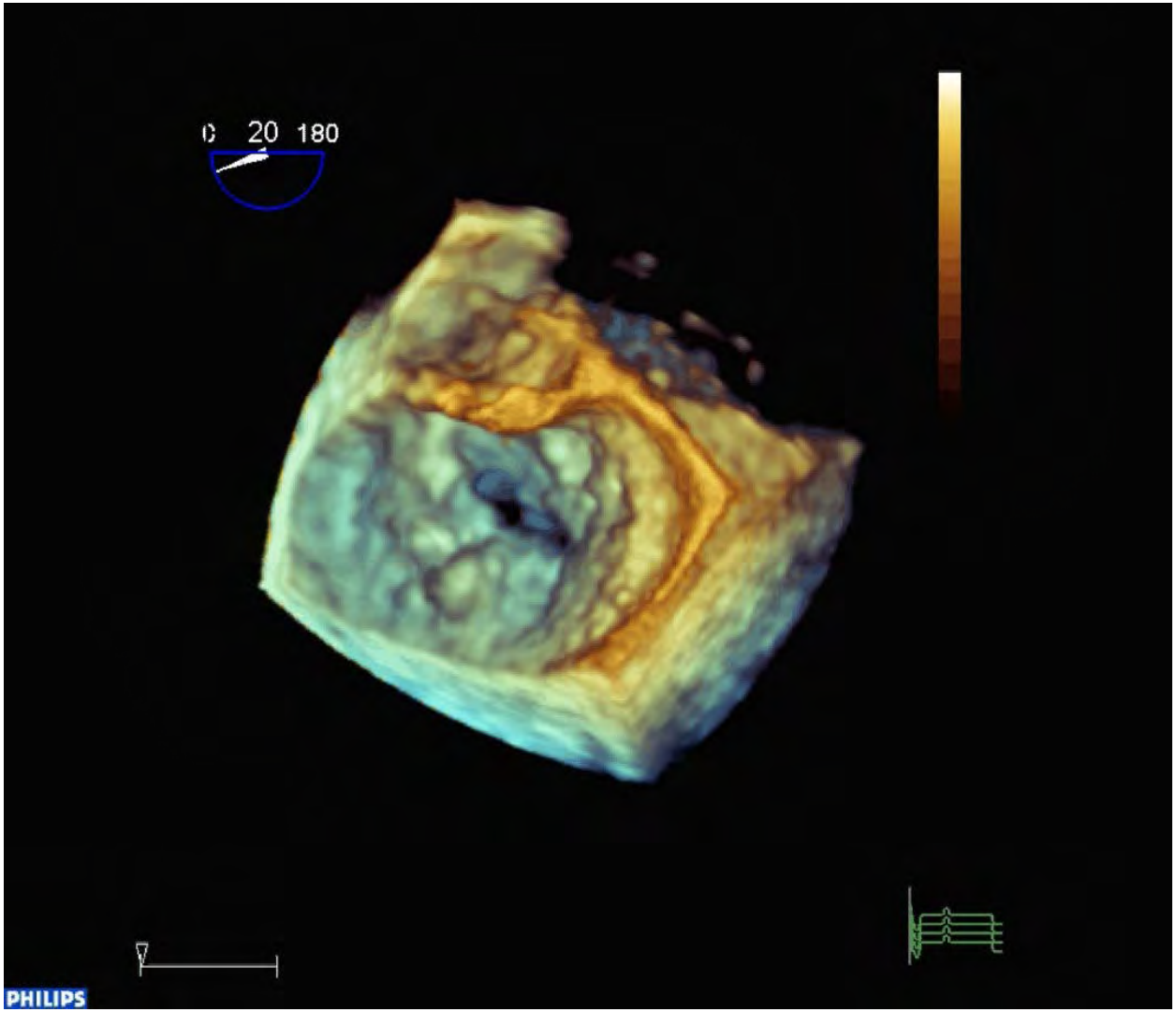
Pre mitral valve repair-Intercommissural view



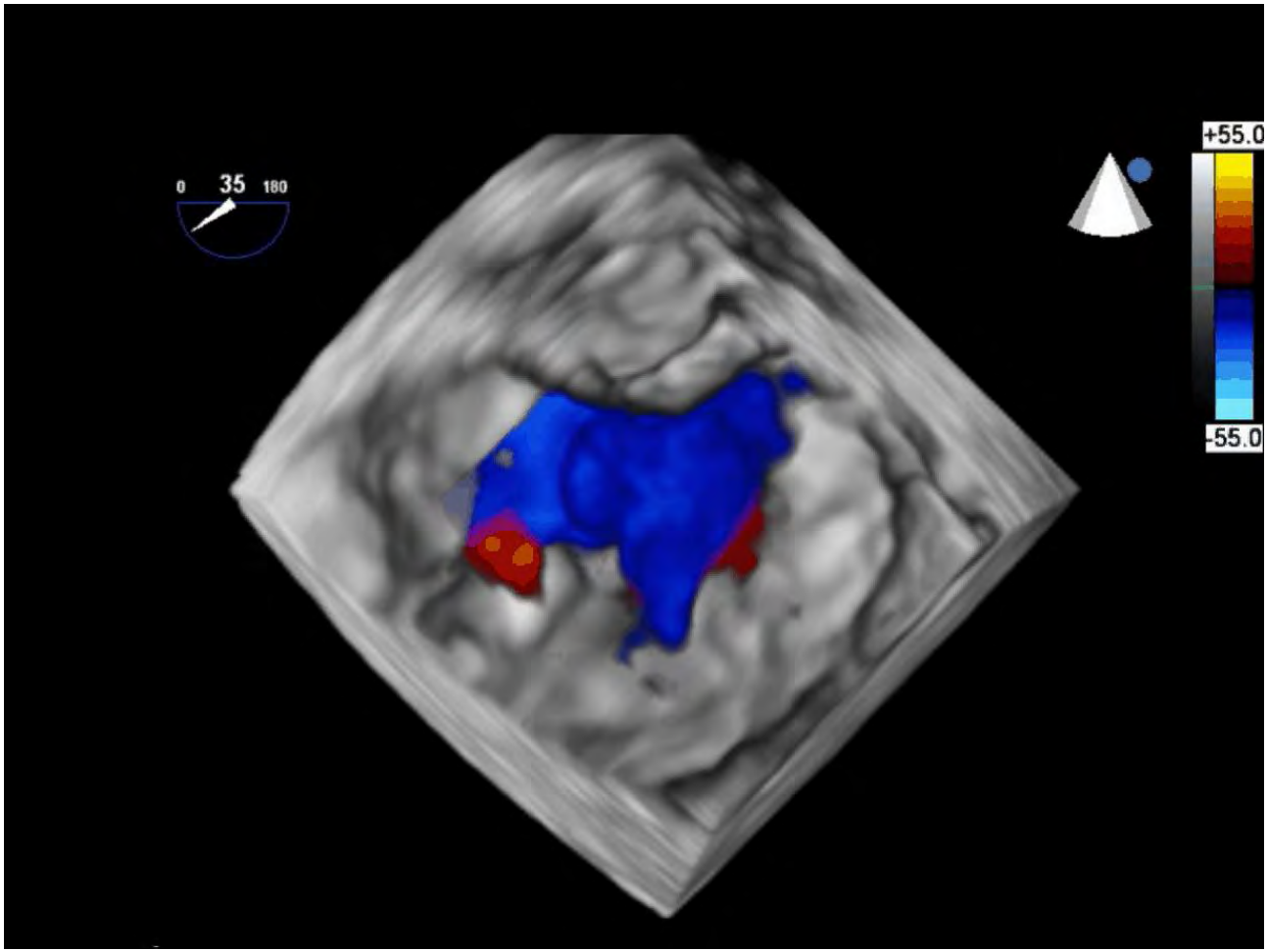
Pre mitral valve repair-Gastric view



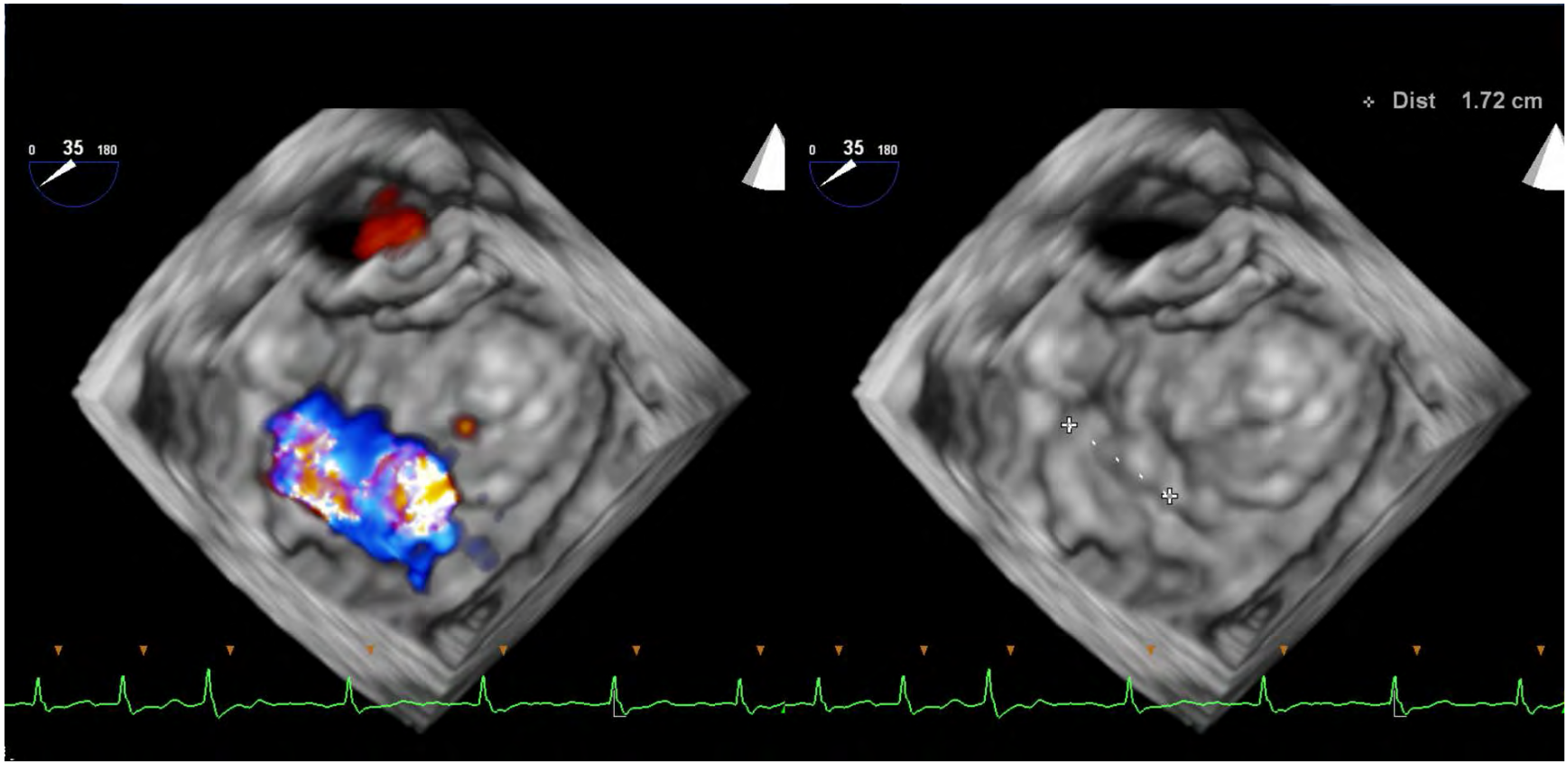
Pre mitral valve repair—mitral valve surgeon's view

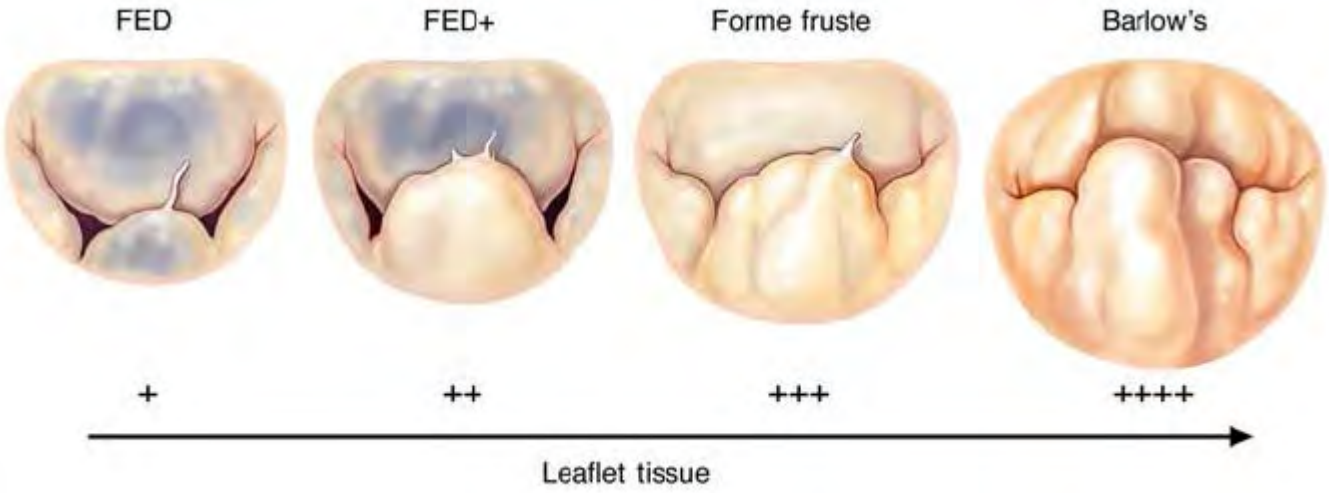


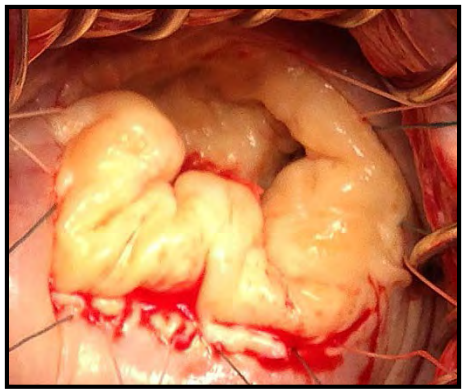
Pre mitral valve repair—mitral valve 3D color Doppler



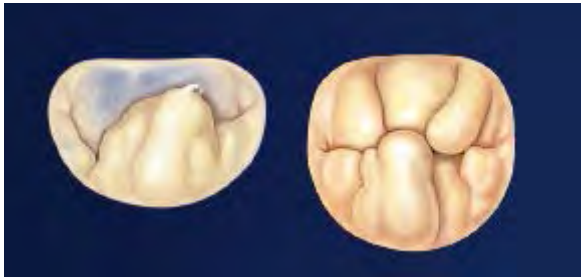
Pre mitral valve repair—mitral valve 3D color Doppler



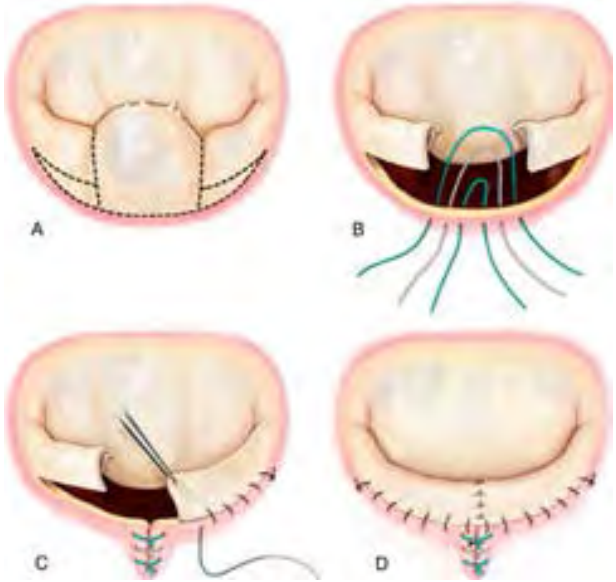


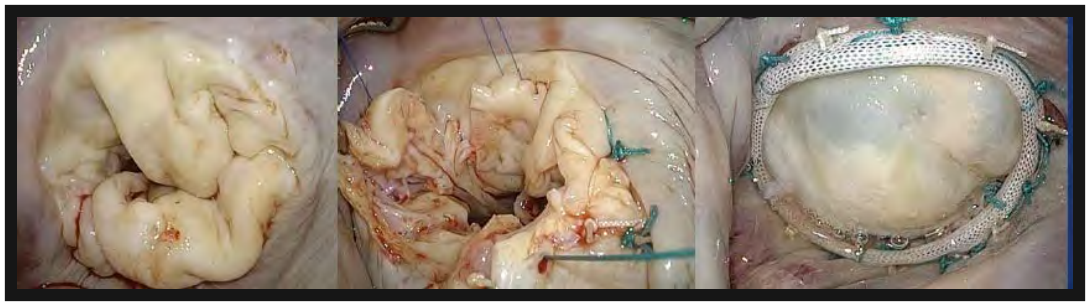


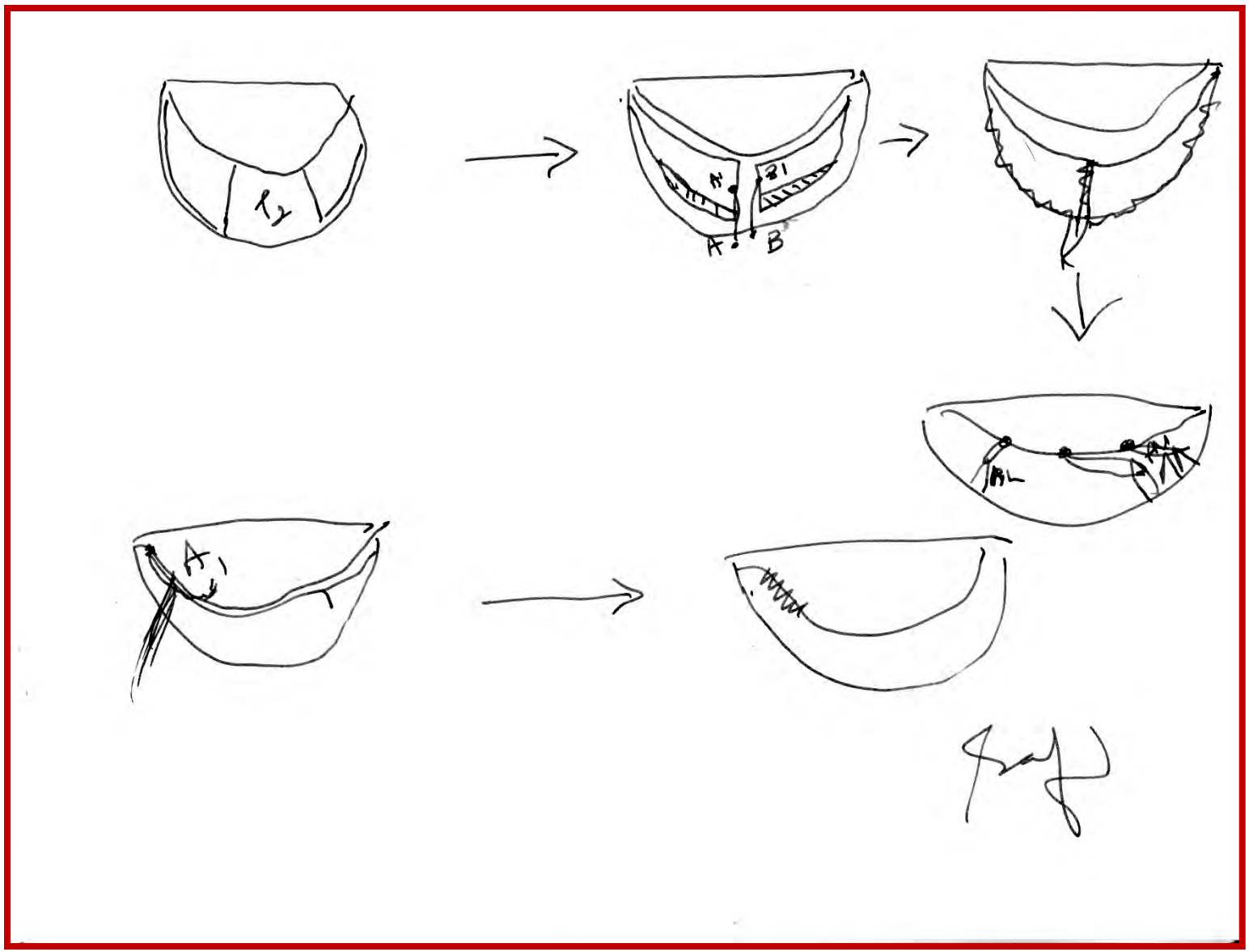
Hallmarks of Barlow's disease---Large valve size, with diffuse myxomatous changes and excess leaflet tissue, with thickened, elongated chordae

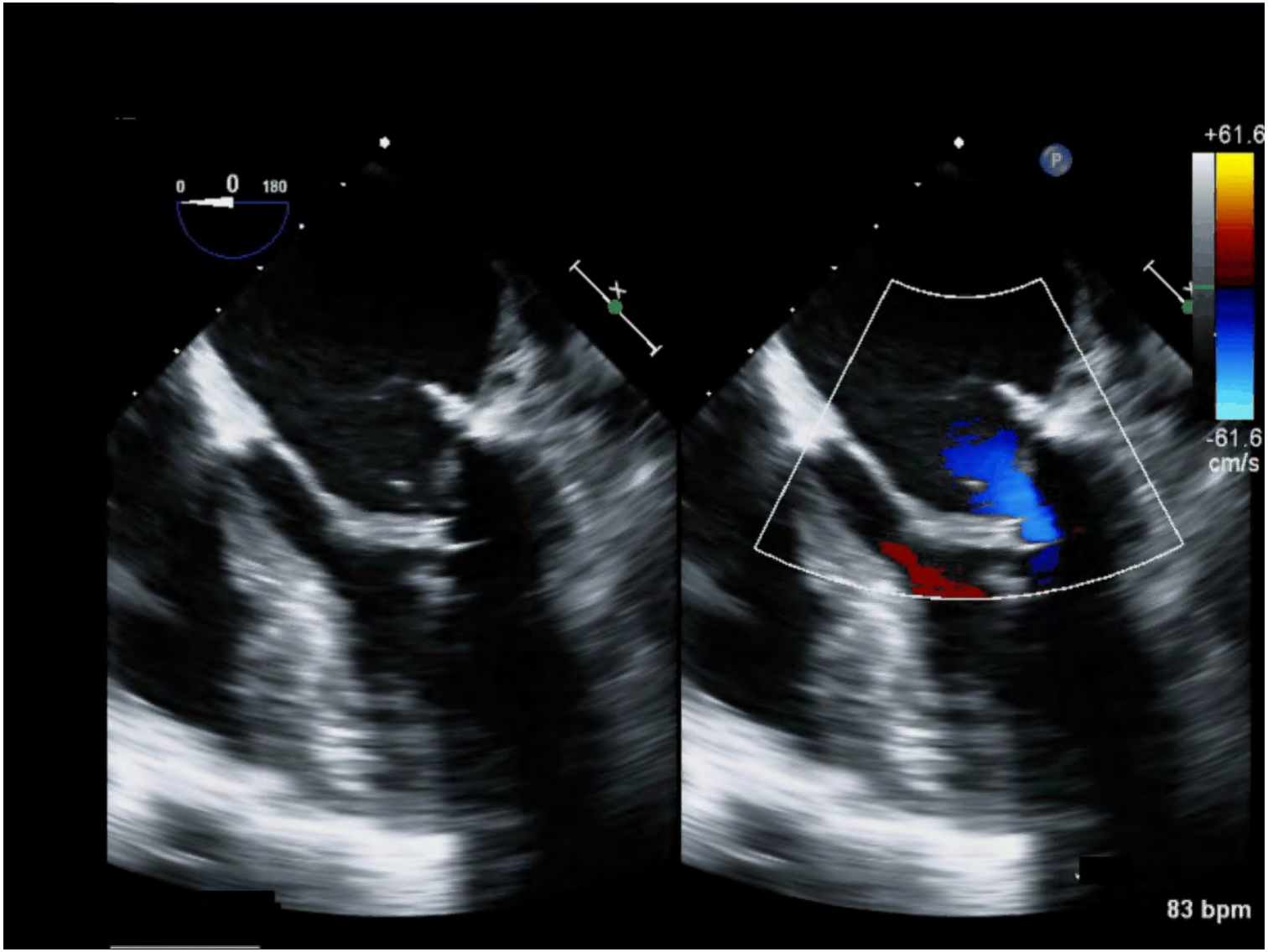


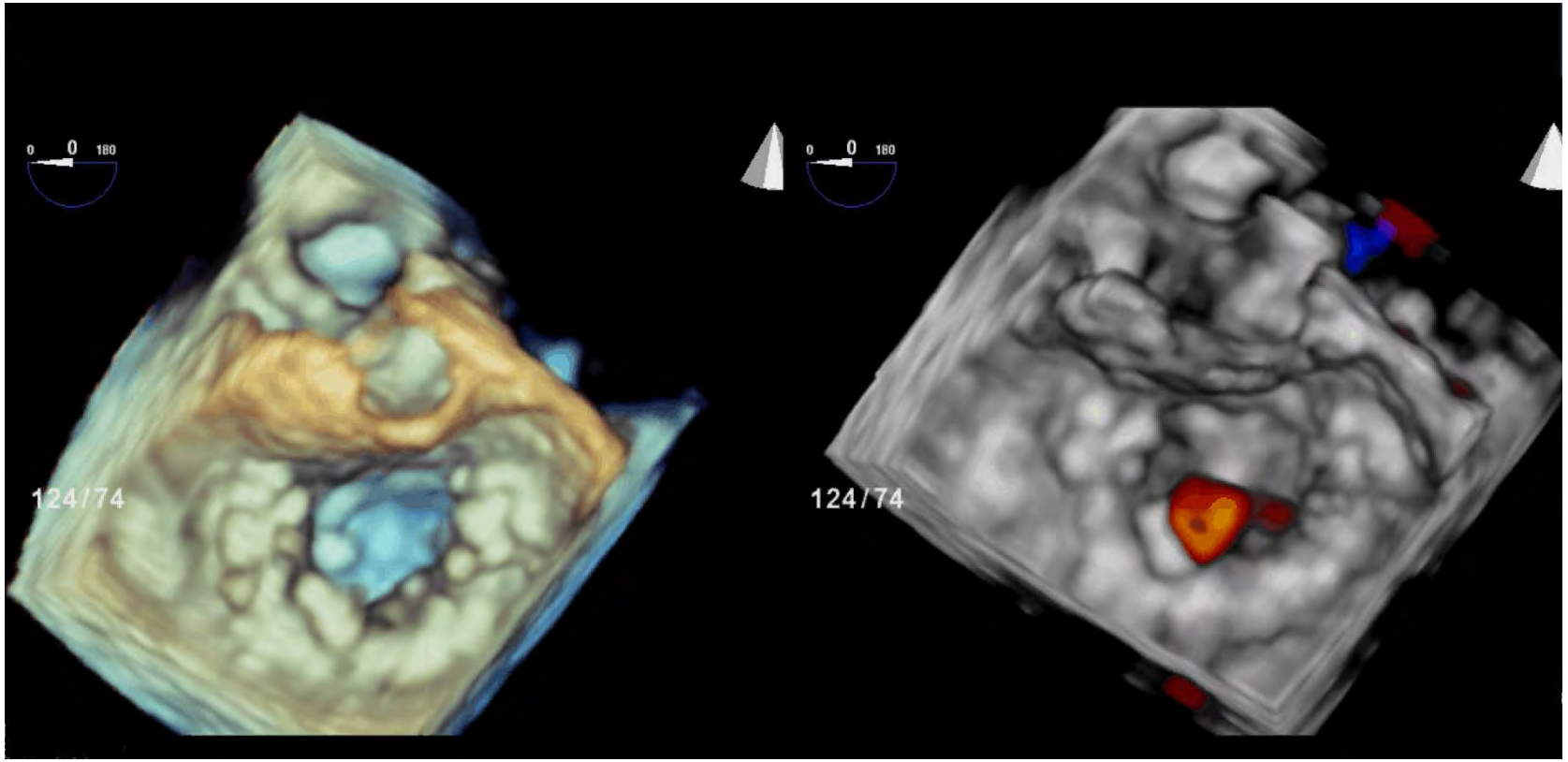
Barlow's-"Remove" Tissue, Targeted Resection, Leaflet Displacement






A
B

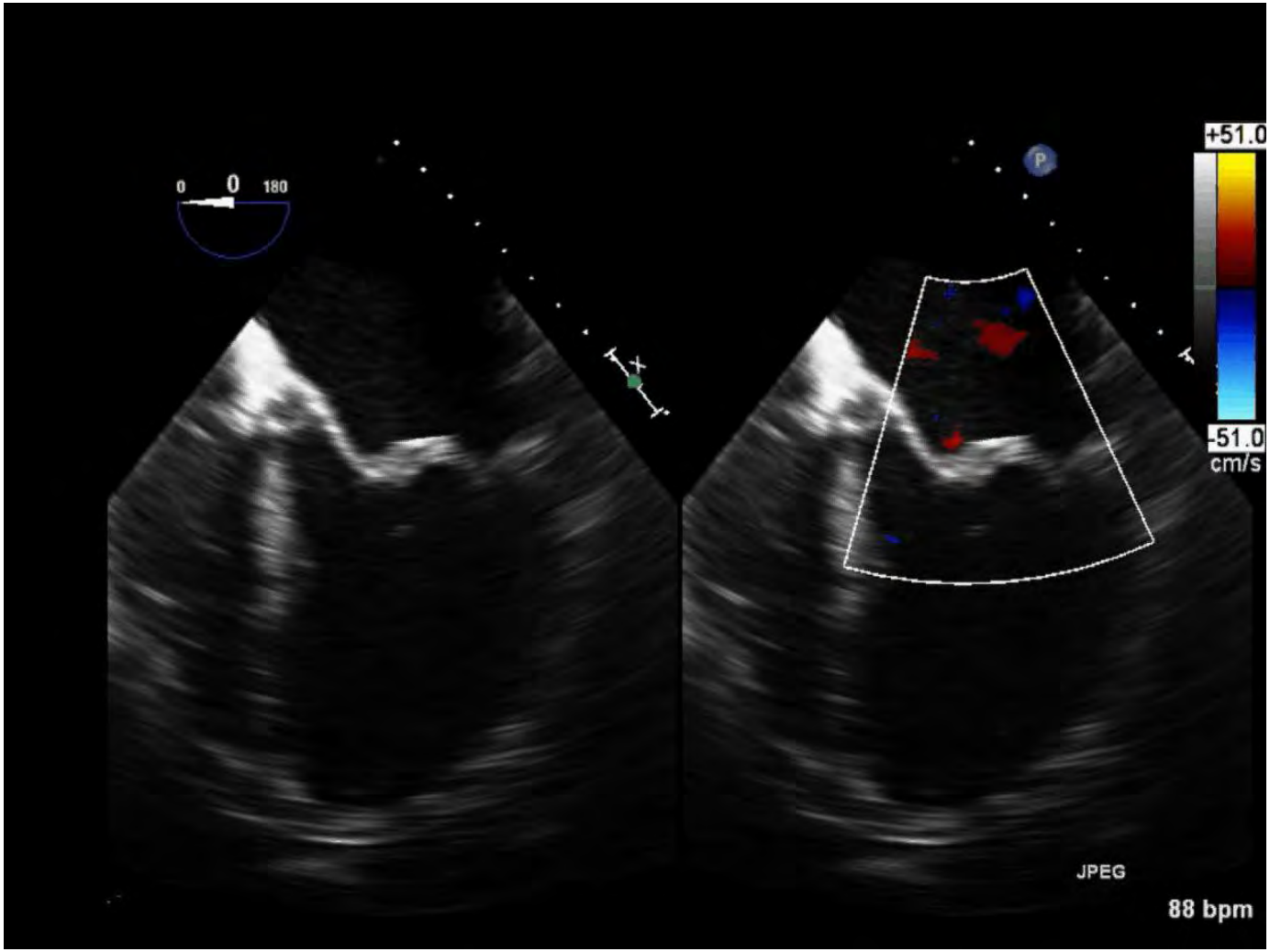

0
0
180
+61.6
-61.6
cm/s
83 bpm

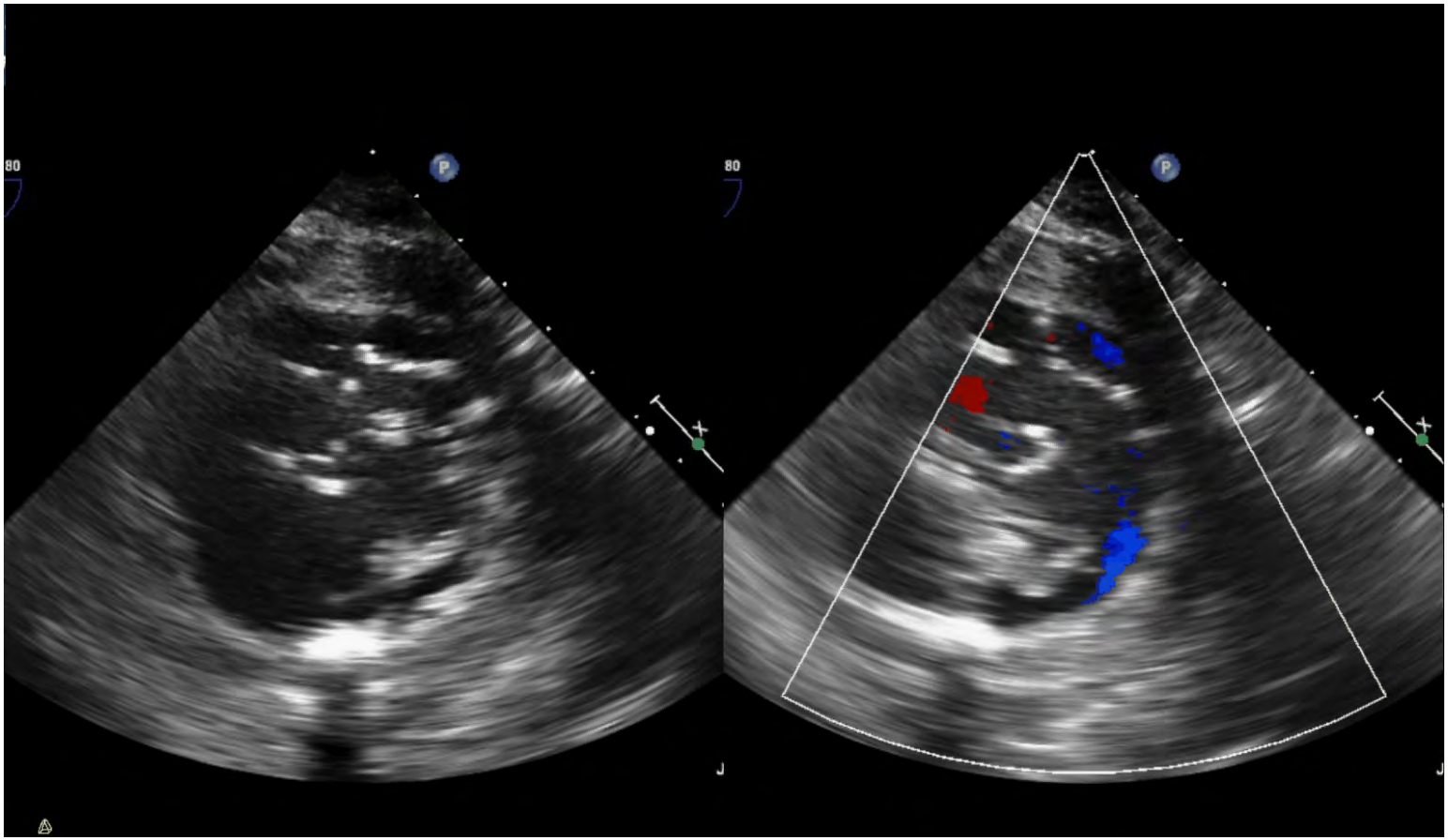

0 0 180
124/74
0 0 180
124/74

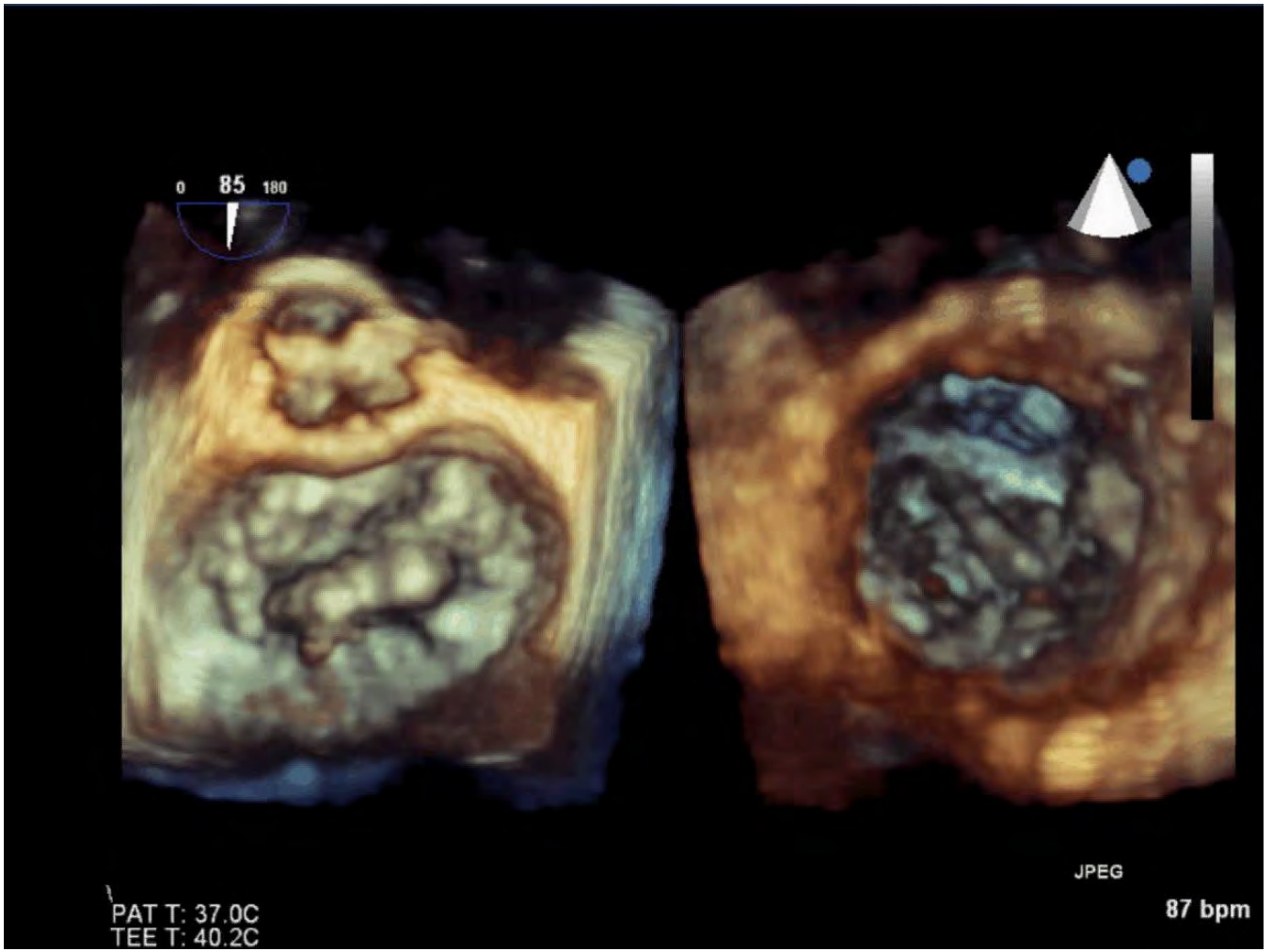
Mitral Valve Repair

Complex surgical repair

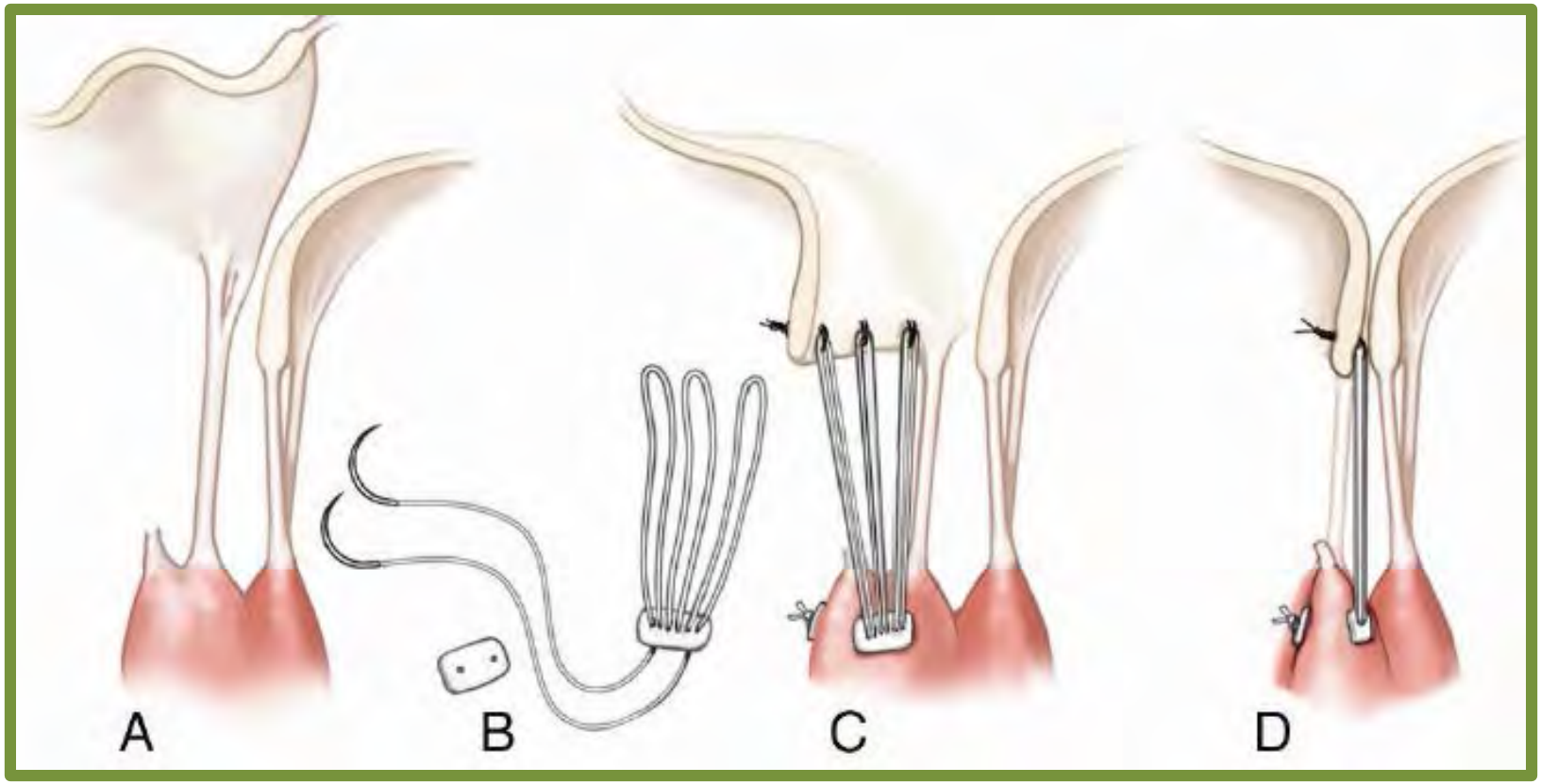
Ruptured chordae off A2

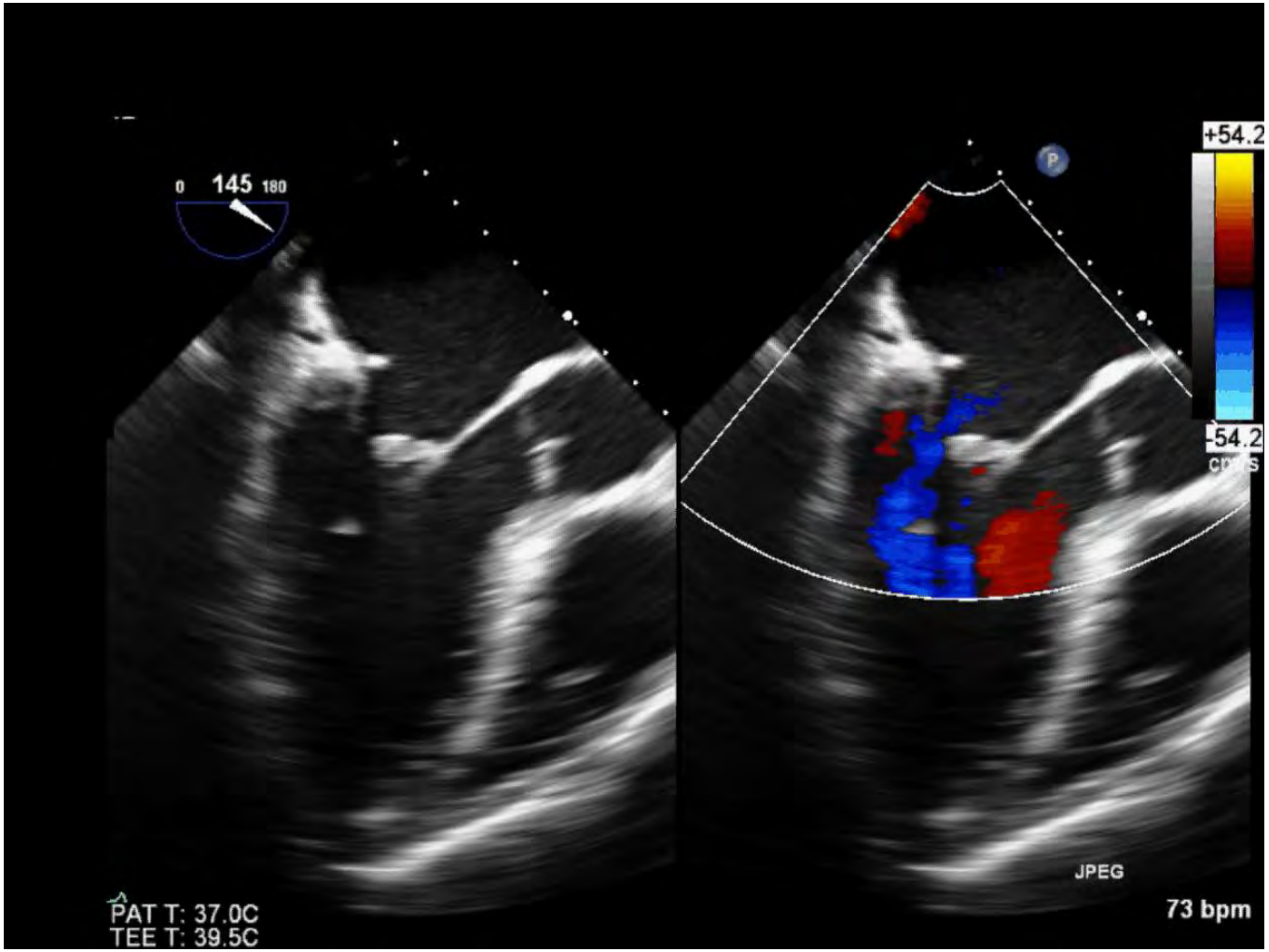

0
0
180
+51.0
-51.0
cm/s
JPEG
88 bpm

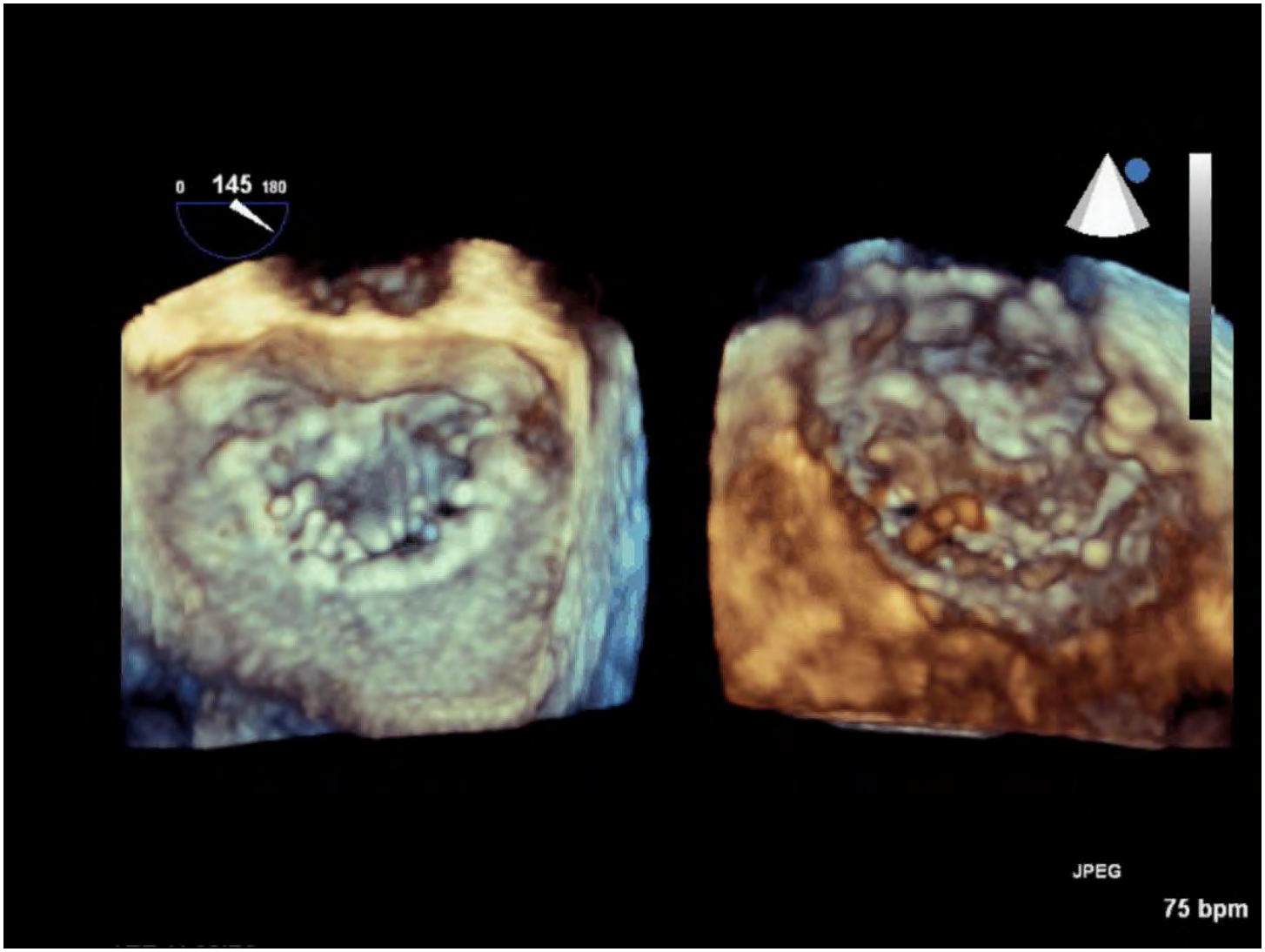

80
P
80
P


0
85
180
JPEG
87 bpm
PAT T: 37.0C
TEE T: 40.2C

Mitral Valve Repair
Anterior leaflet




0
145
180
+54.2
-54.2
JPEG
PAT T: 37.0C
TEE T: 39.5C
73 bpm


0
145
180
JPEG
75 bpm

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EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

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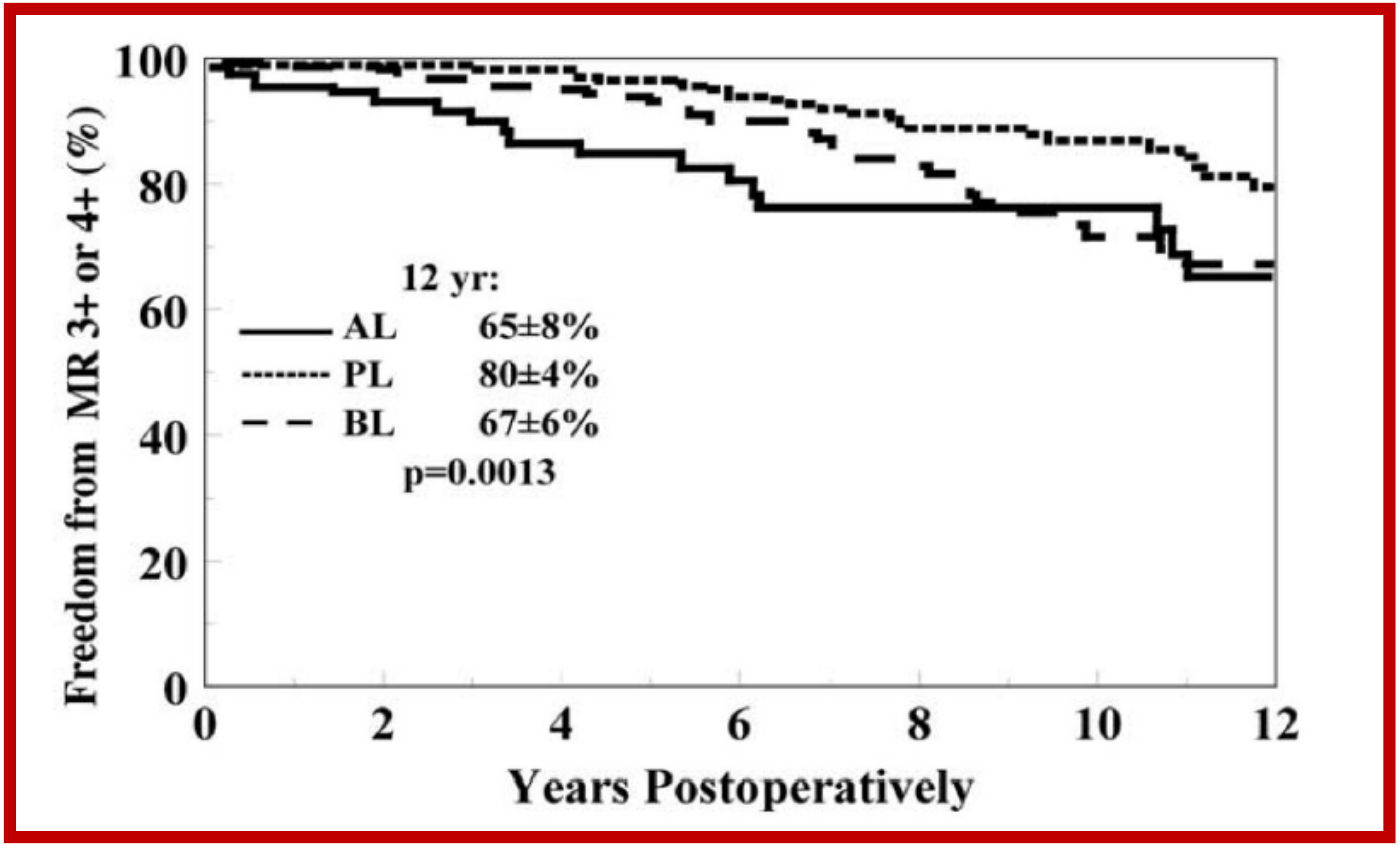
Comparison of outcomes of minimally invasive mitral valve surgery for posterior, anterior and bileaflet prolapse☆

Joerg Seeburger*, Michael A. Borger, Nicolas Doll, Thomas Walther, Jurgen Passage, Volkmar Falk, Friedrich W. Mohr

Overall Repair Rate	94% (1156/1230)
Posterior Leaflet Repair	97% (651/672)
Anterior Leaflet Repair	91% (142/156)
Bileaflet Repair	90% (363/402)

Durability of Mitral Valve Repair



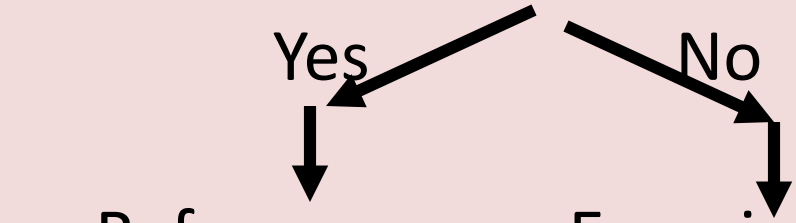
David et al. J Thorac Cardiovasc Surg. 2005 Nov;130(5):1242

Tageted Surgeon Referral: degenerative mitral valve disease

Younger patients

Early surgery-asymptomatic patients

Anterior leaflet or bileaflet prolapse



Adams et al. Eur Heart J 2010;31:1958-

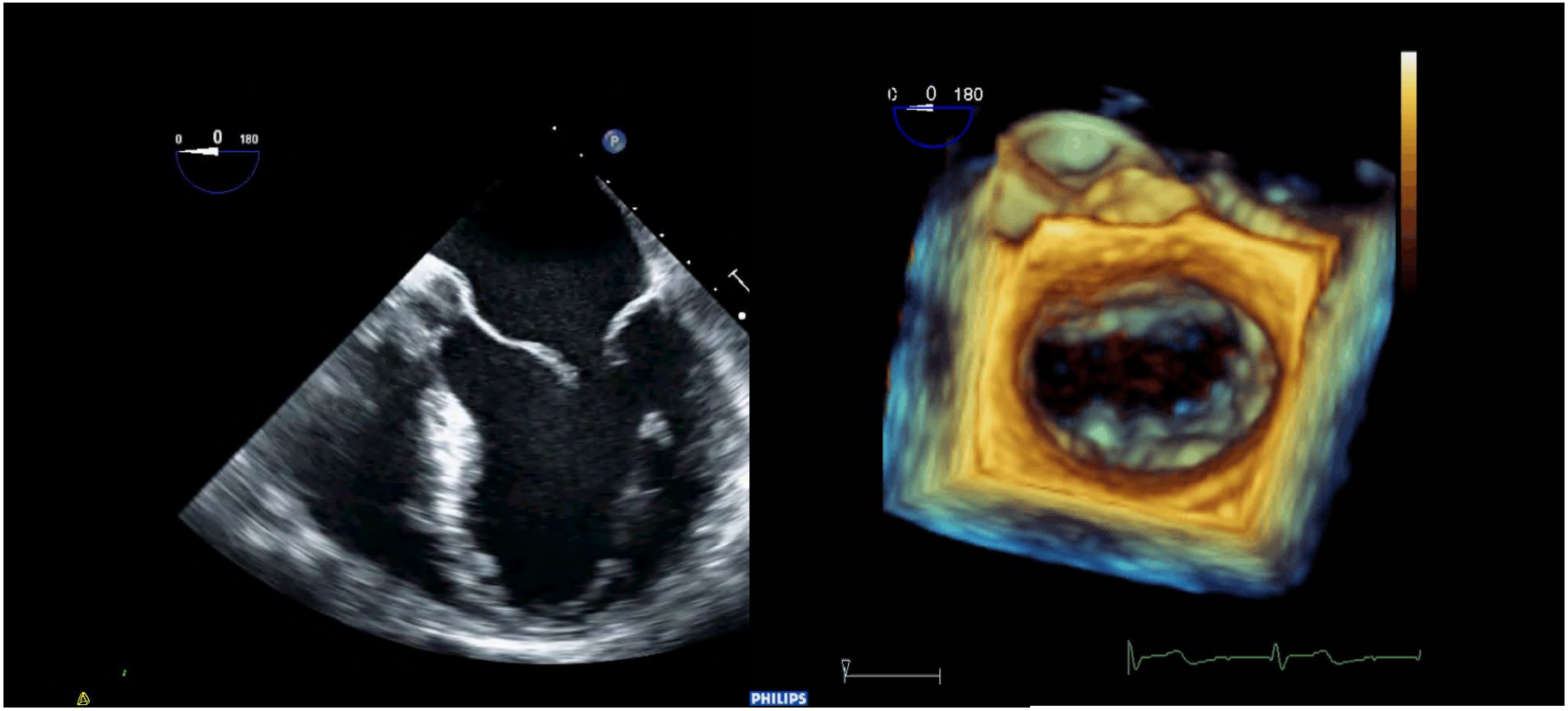
Transcatheter mitral repair

Simple mitral lesion with one MR jet

Significant, symptomatic, degenerative mitral regurgitation, high risk for surgery patients

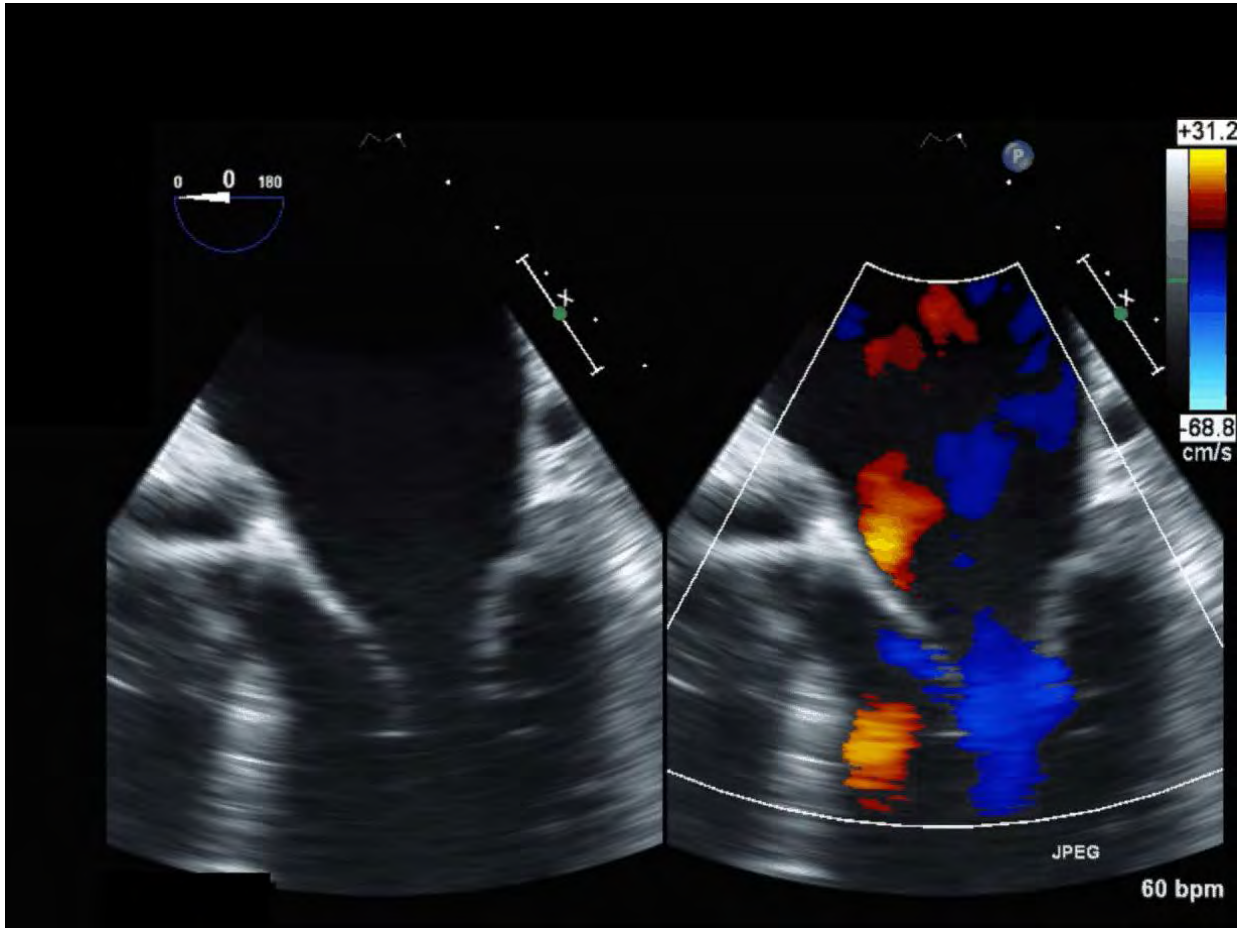
Percutaneous Mitral Repair
Pre-procedure

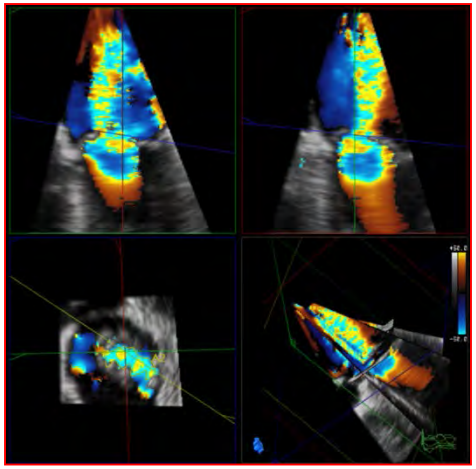
Degenerative



Percutaneous Mitral Repair

Quantitate the severity and location of MR

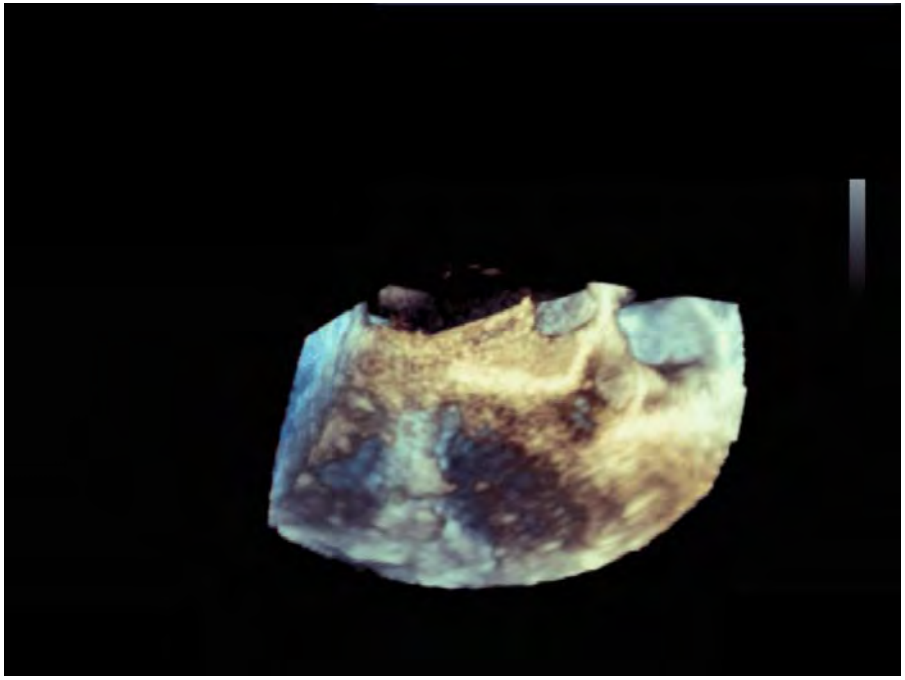


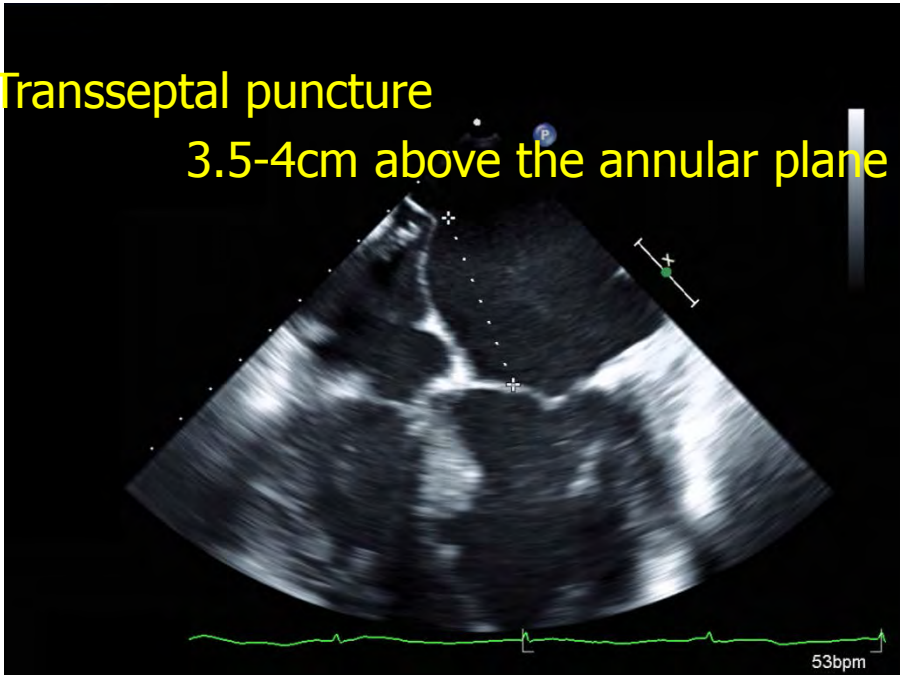


ROA=1.4cm2

Percutaneous Mitral Repair
Intraprocedure

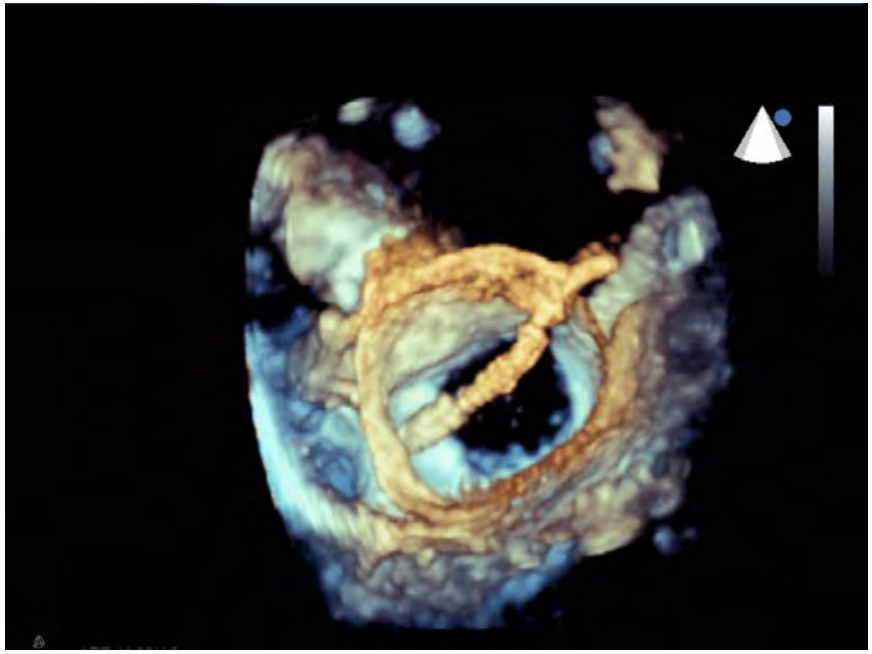
Guide transseptal puncture and assess the site of puncture



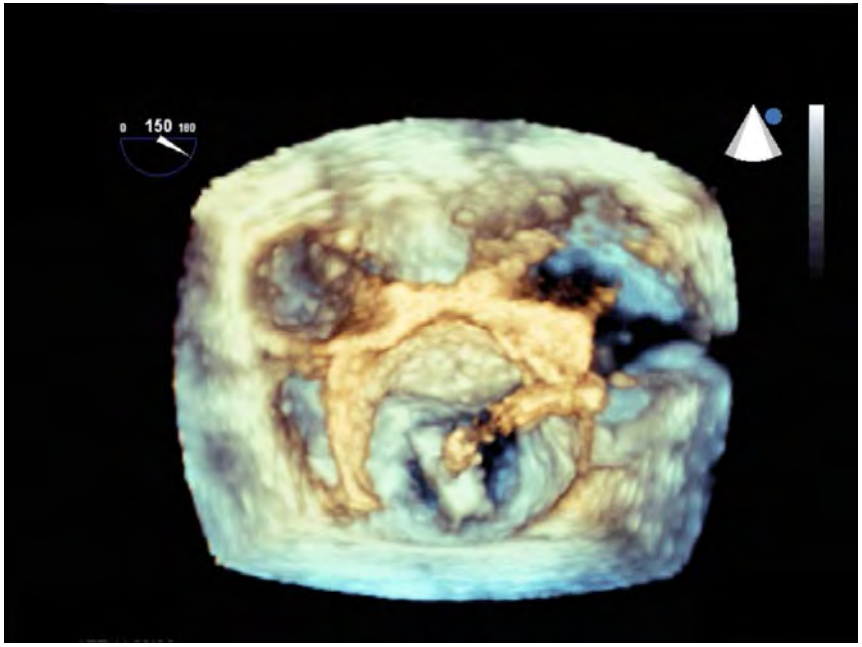


Percutaneous Mitral Repair Intraprocedure

Guiding catheter steering in LA towards mitral valve

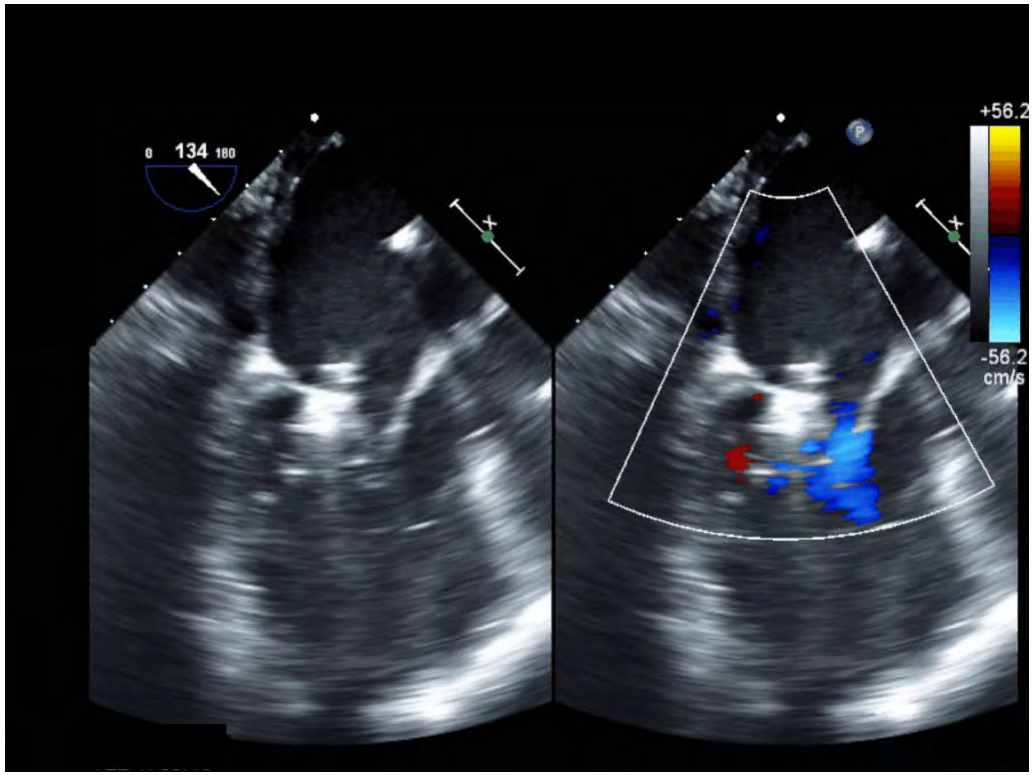


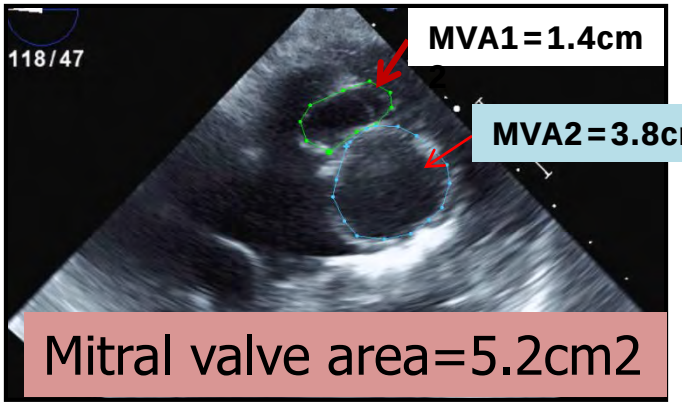
Position clip perpendicular to leaflets and opposite A2/P2



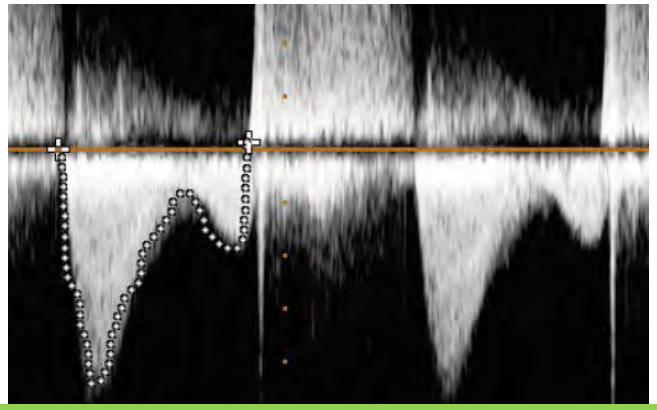
Percutaneous Mitral Repair Intraprocedure

Assess residual MR before releasing the clip





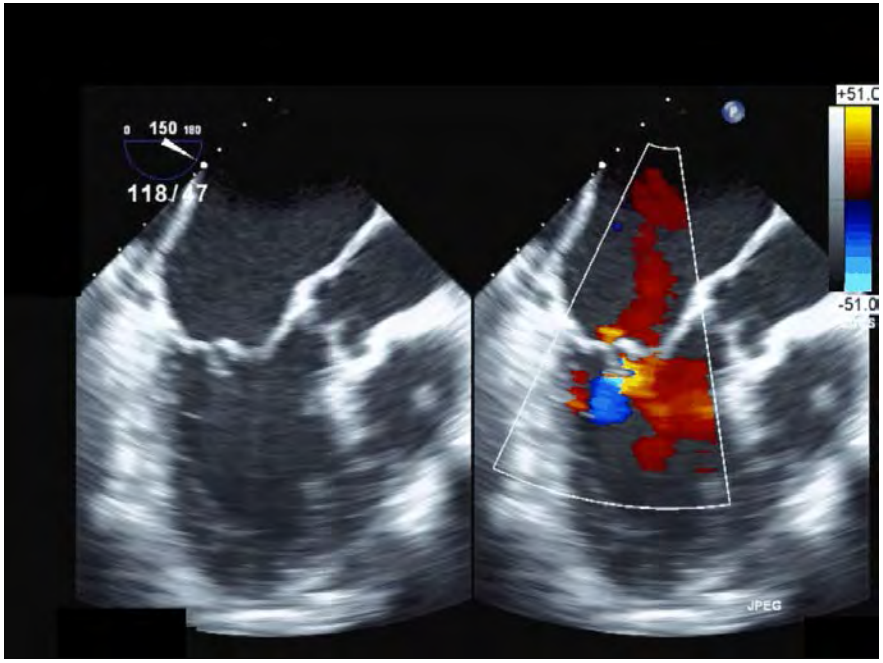
Mitral valve area=5.2cm2

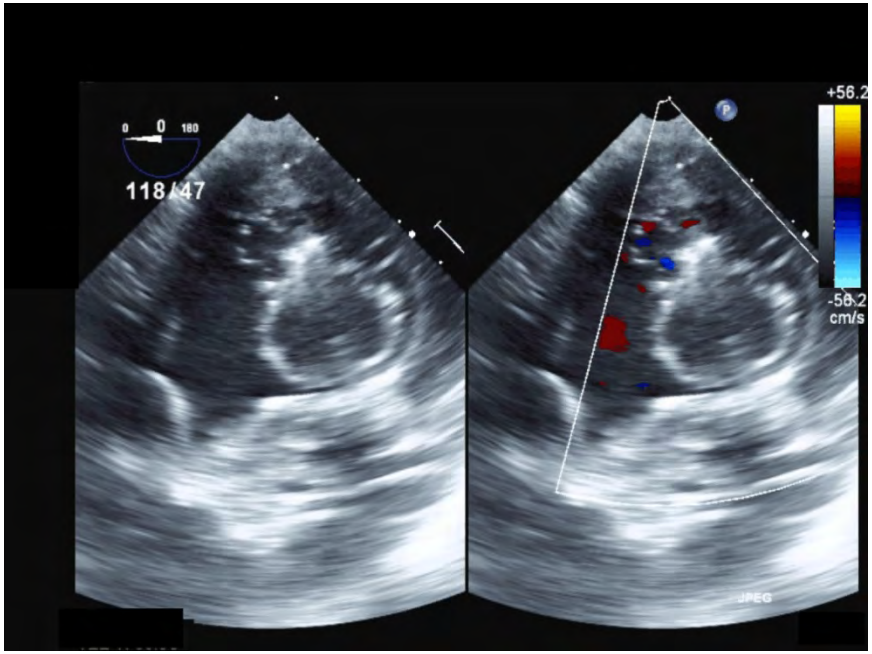


Mean gradient=2mmHg

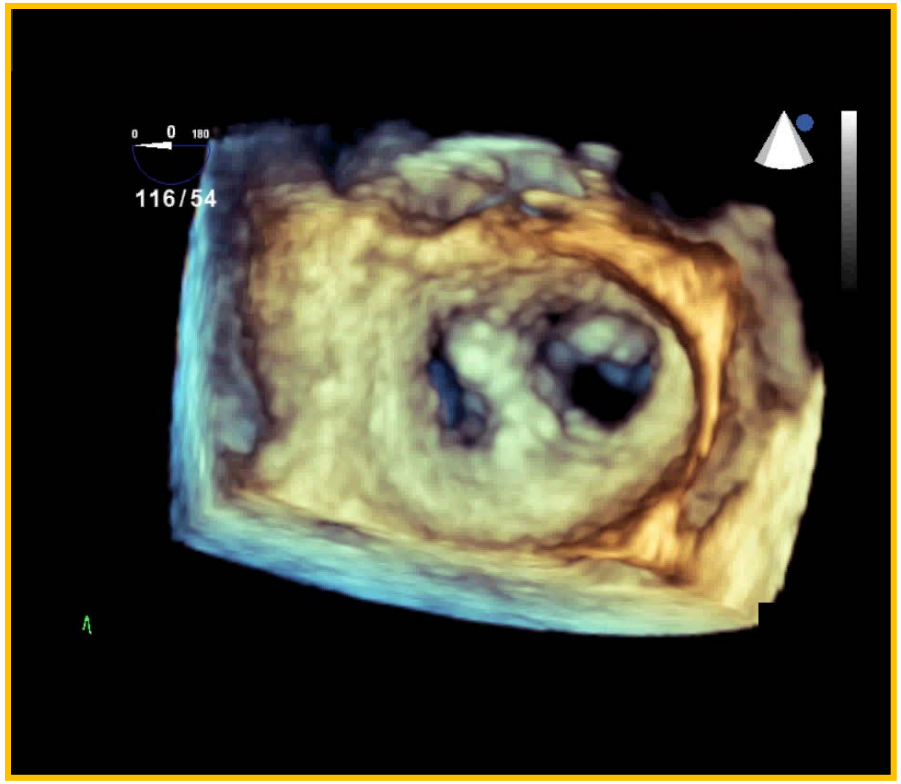
Percutaneous Mitral Repair Intraprocedure

Assess residual mitral regurgitation

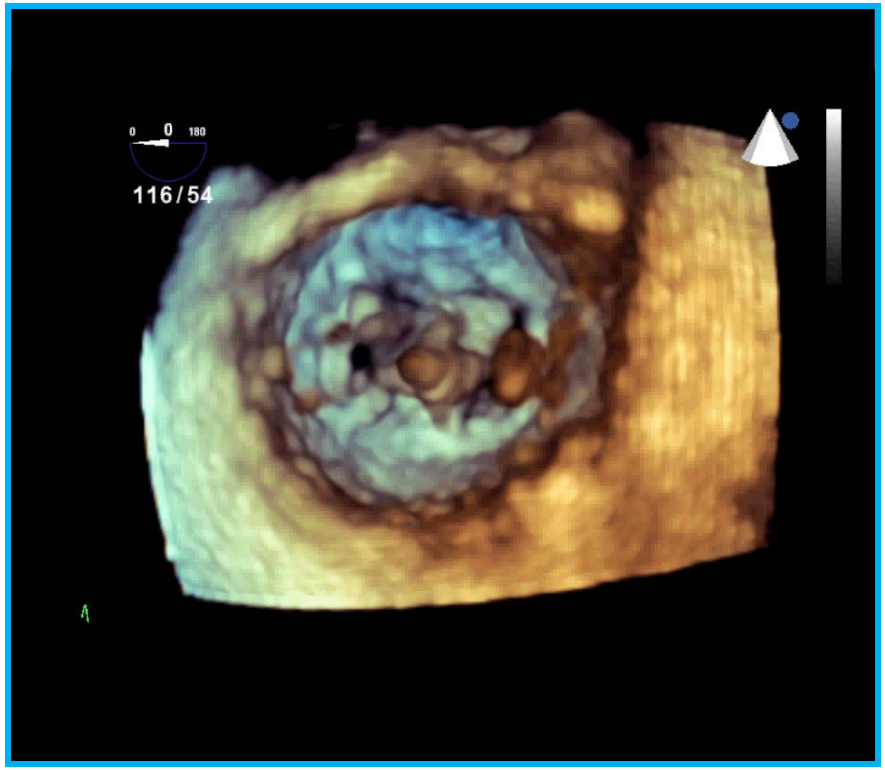




3D Live TEE E-valve assessment Intraprocedure



View from left atrium



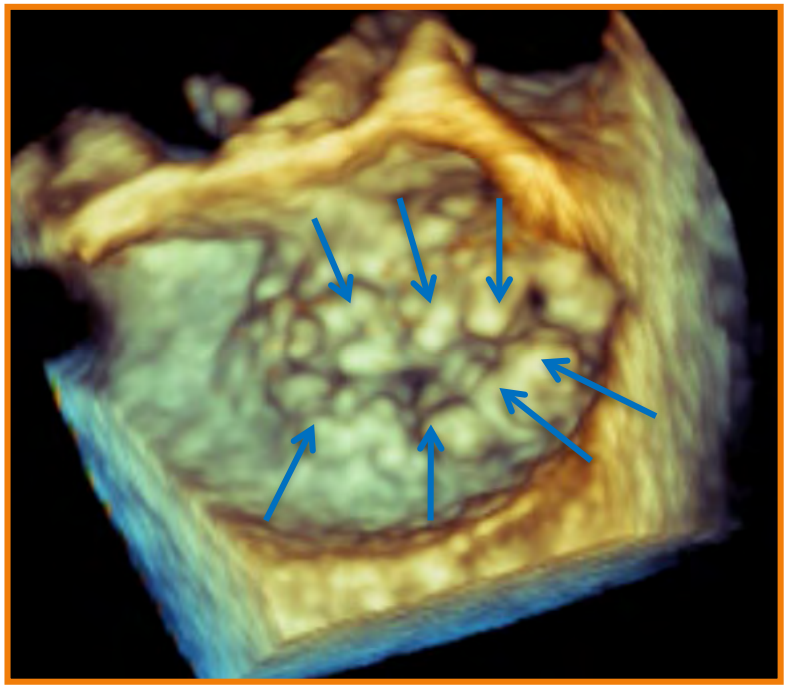
View from left ventricle

Transcatheter mitral repair

Complex mitral valve prolapse with multiple MR jets

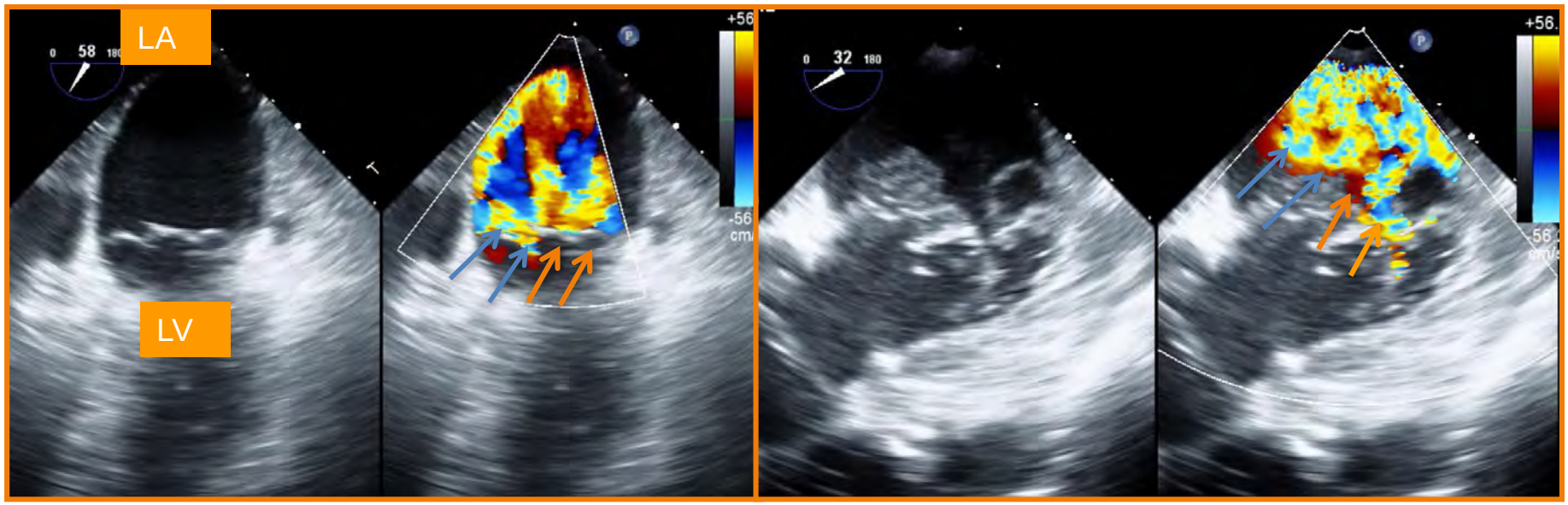
Case

92 year-old woman with multiple comorbidities presented with shortness of breath. He was found to have severe mitral regurgitation due to diffuse mitral valve prolapse.

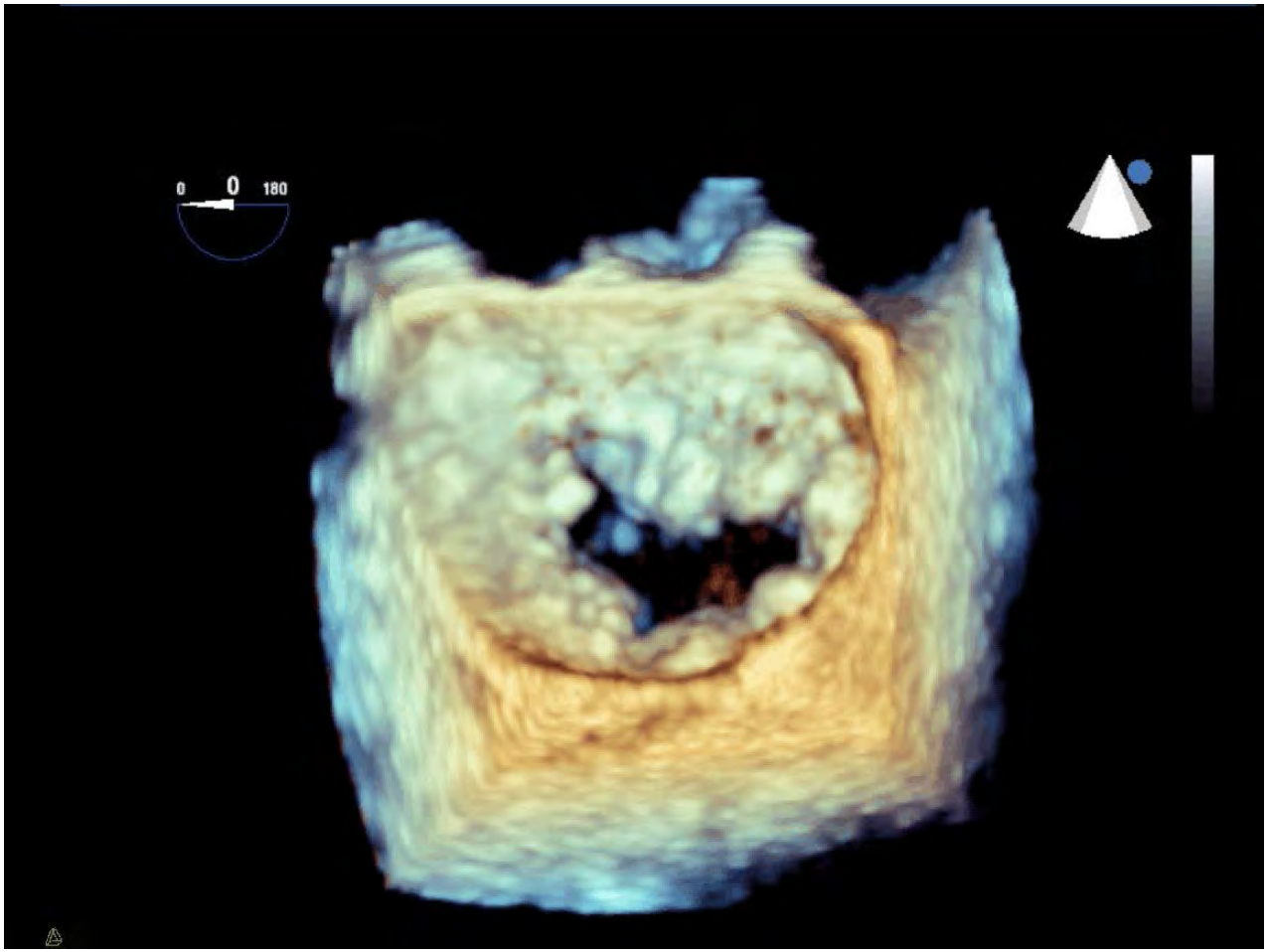


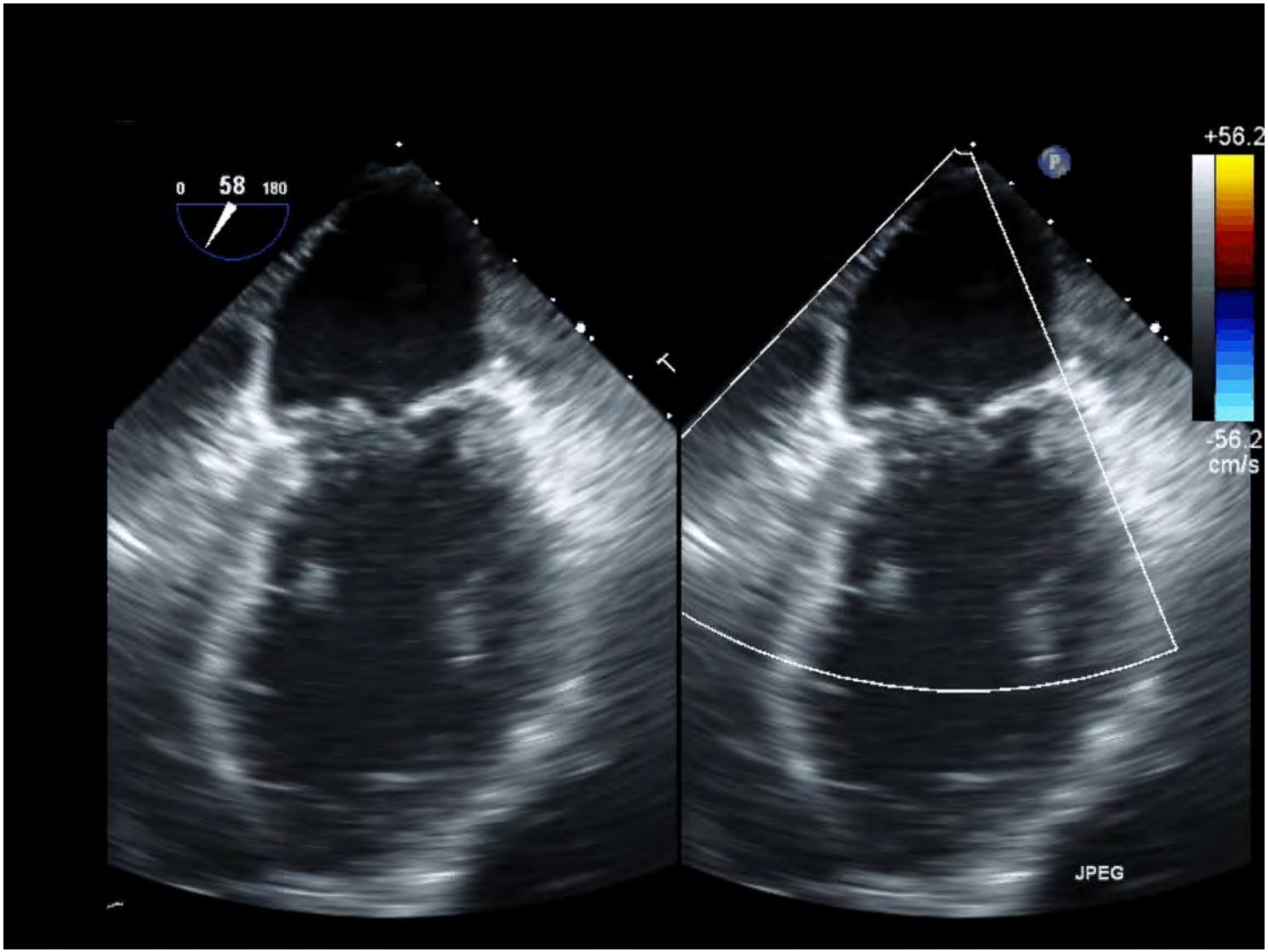
Pre-MitraClip therapy assessment --TEE

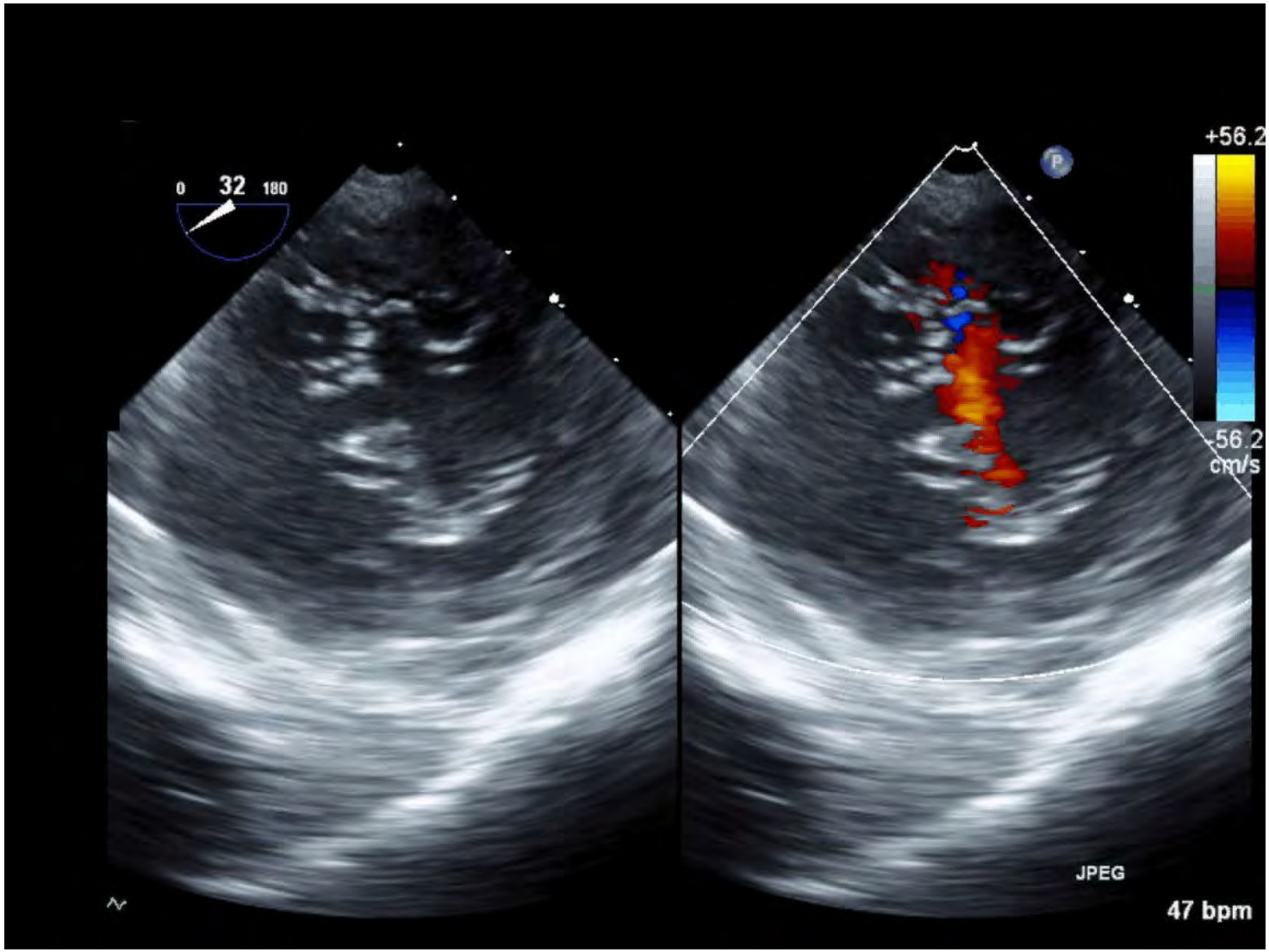
Intercommissural view Deep gastric short axis view



Multiple mitral regurgitation jets along the mitral leaflets with the most mitral regurgitation emanating from the mid to medial segment of mitral valve.

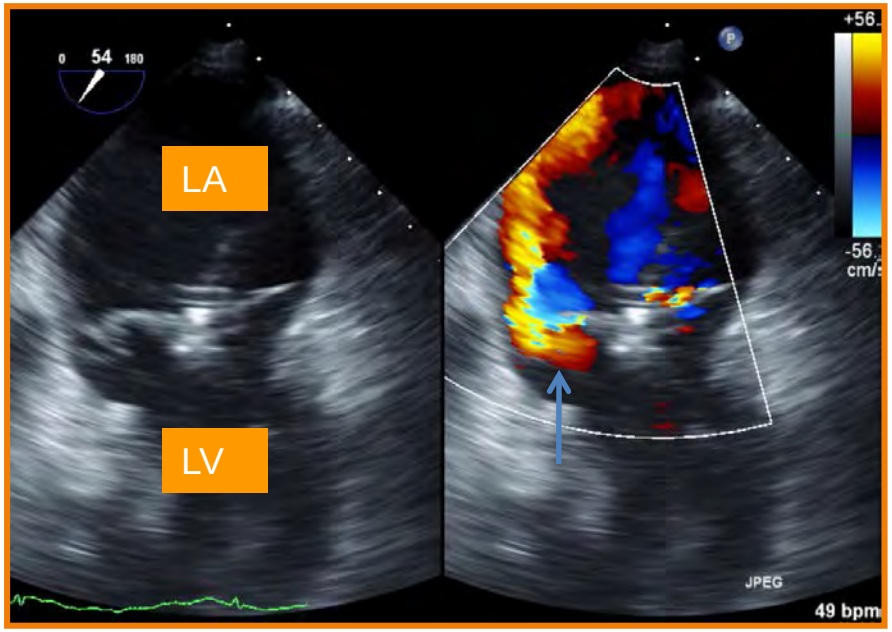

0
0
180


0
58
180
+56.2
-56.2
cm/s
JPEG

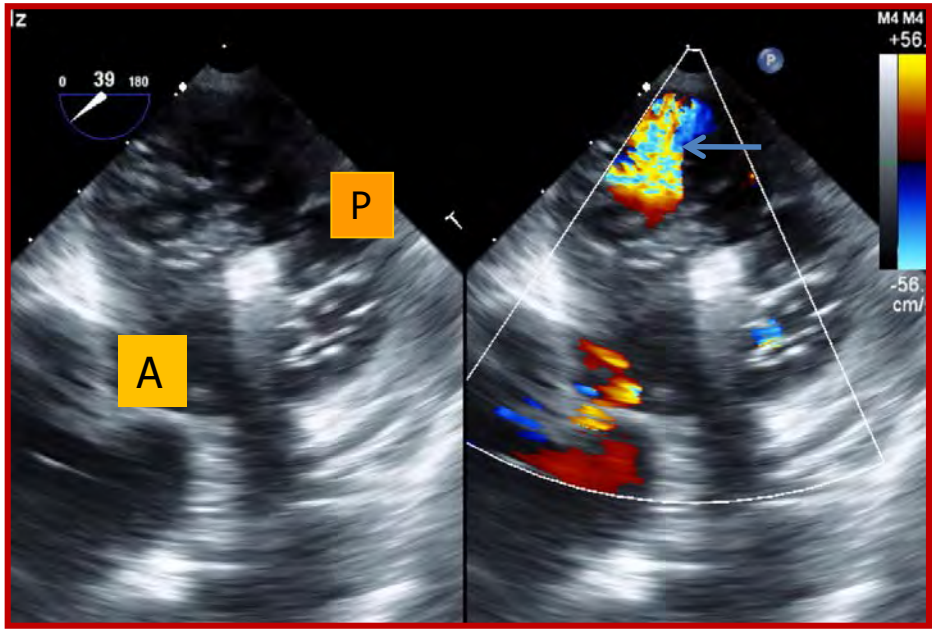

0
32
180
+56.2
-56.2
cm/s
JPEG
47 bpm

Intraprocedural MitraClip therapy assessment

Intercommissural view

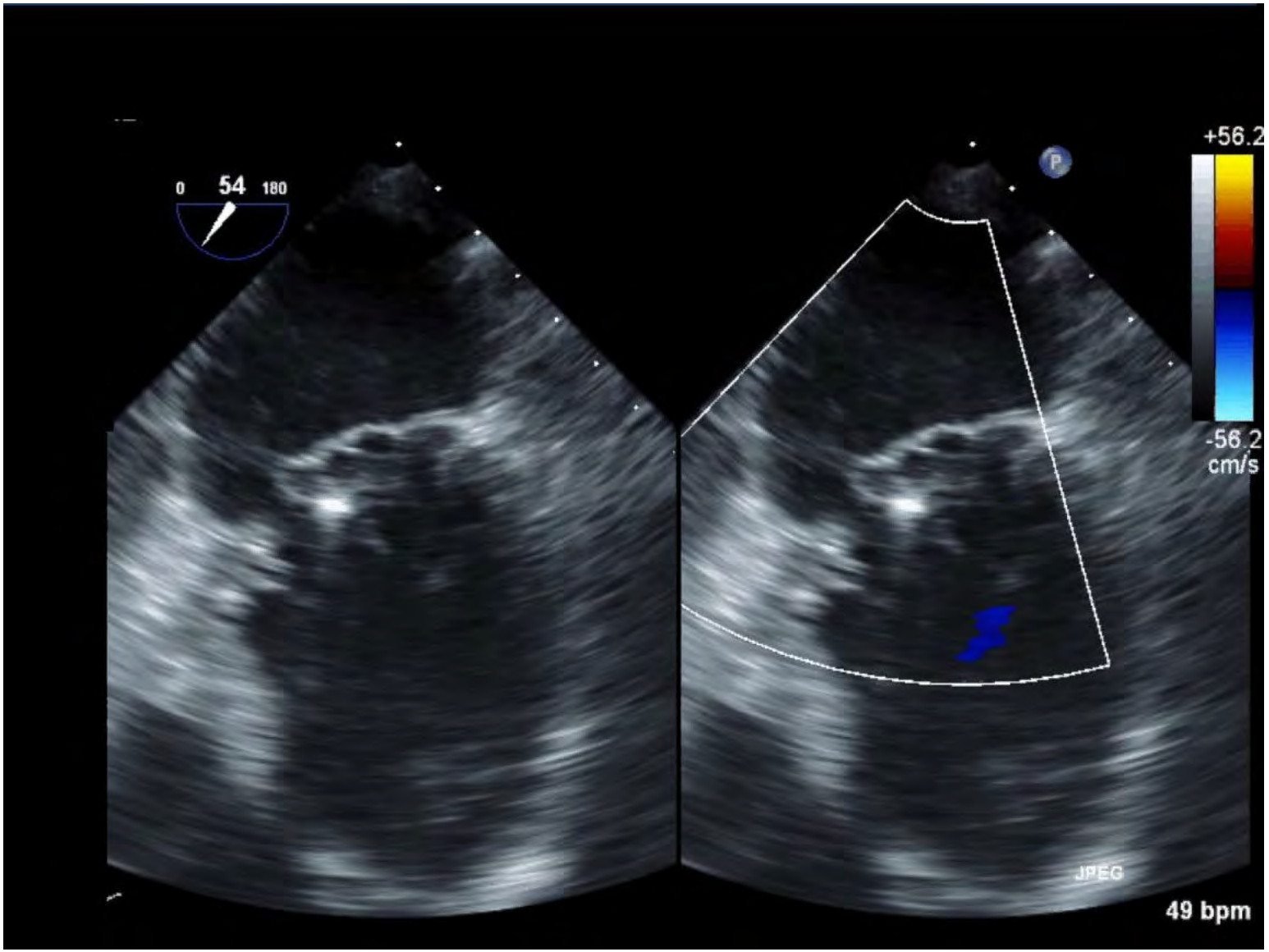


Deep gastric short axis view



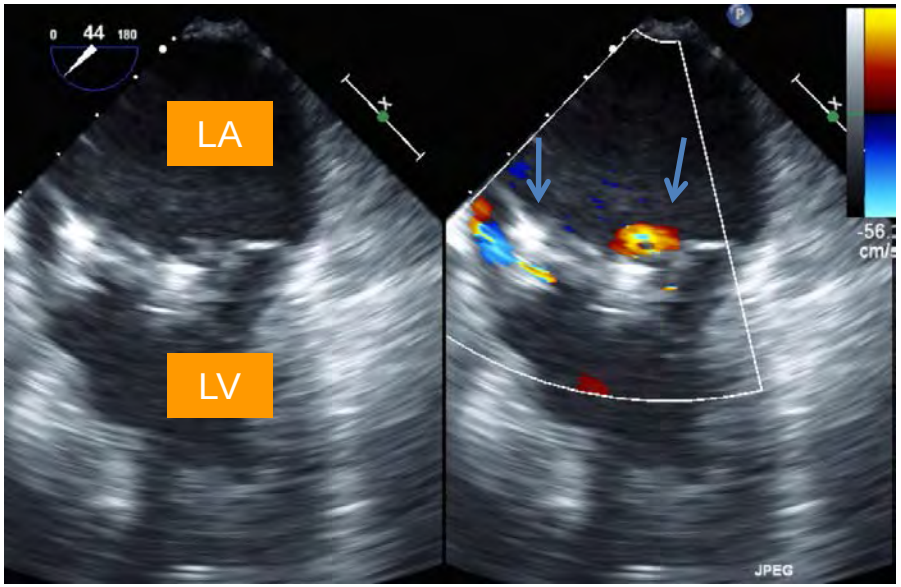
After implantation of first clip in the mid segment, there is significant reduction of mitral regurgitation

Systolic blood pressure increased from 120mm Hg to 140mmHg

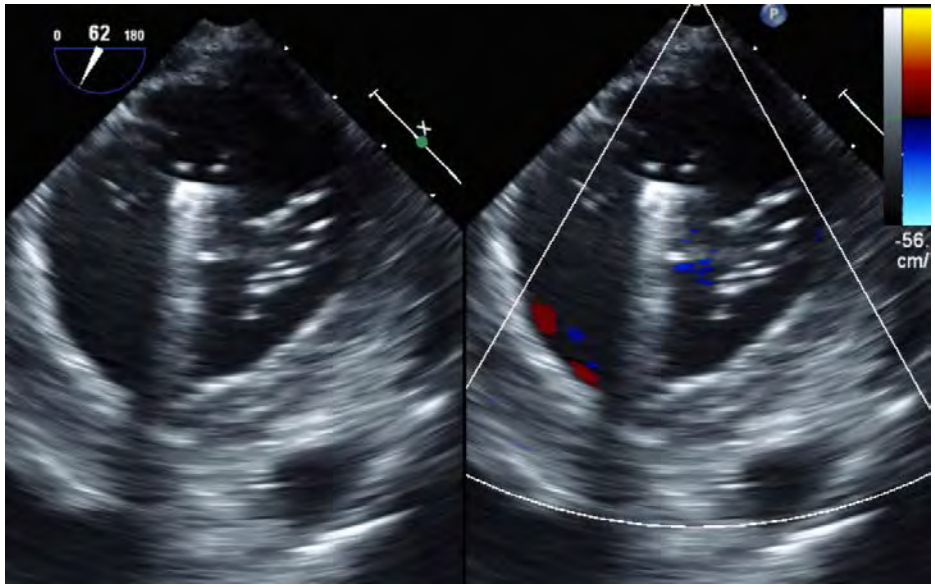

0
54
180
+56.2
-56.2
cm/s
JPEG
49 bpm

Post MitraClip therapy assessment --TEE

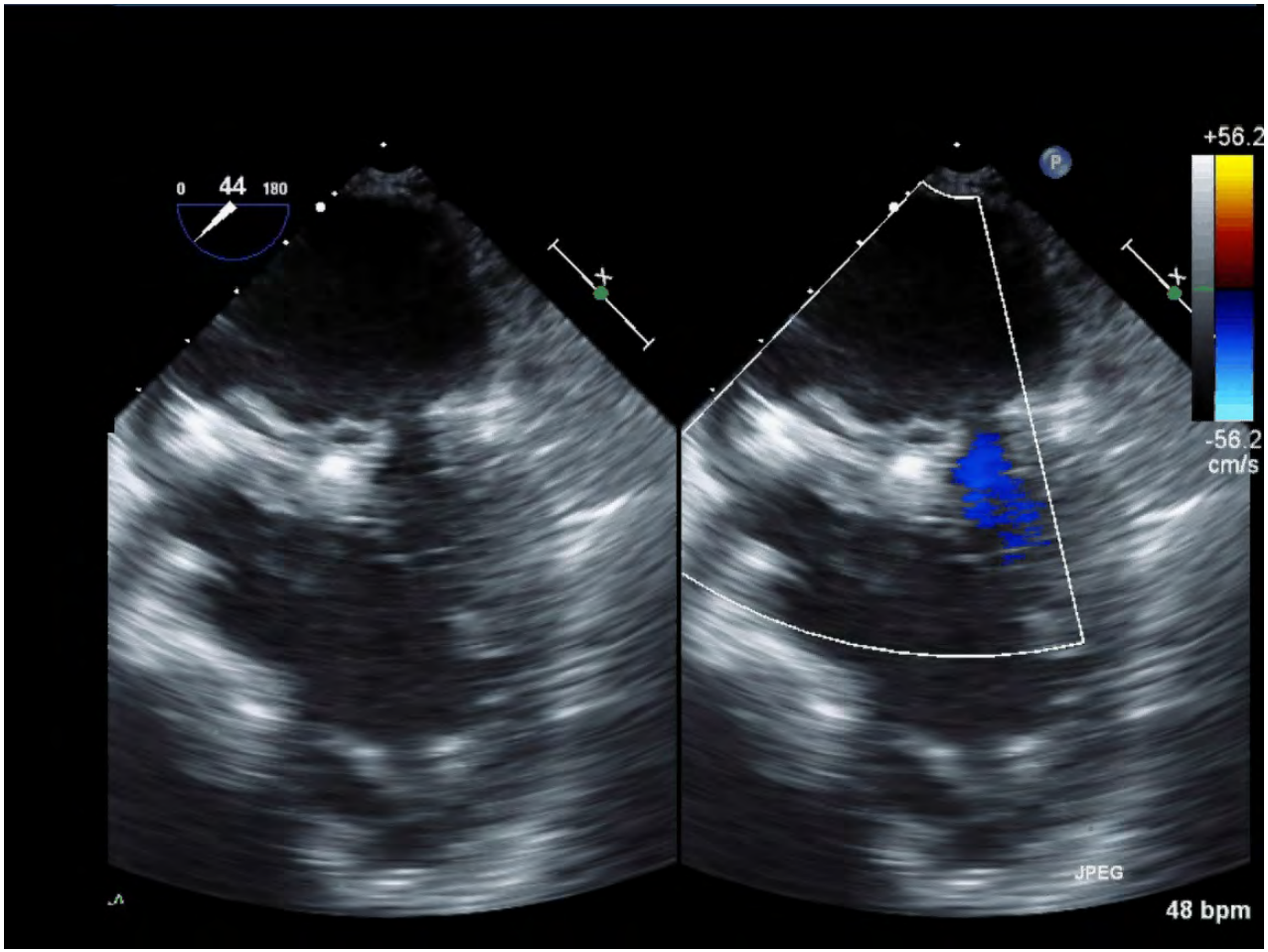
Intercommissural view



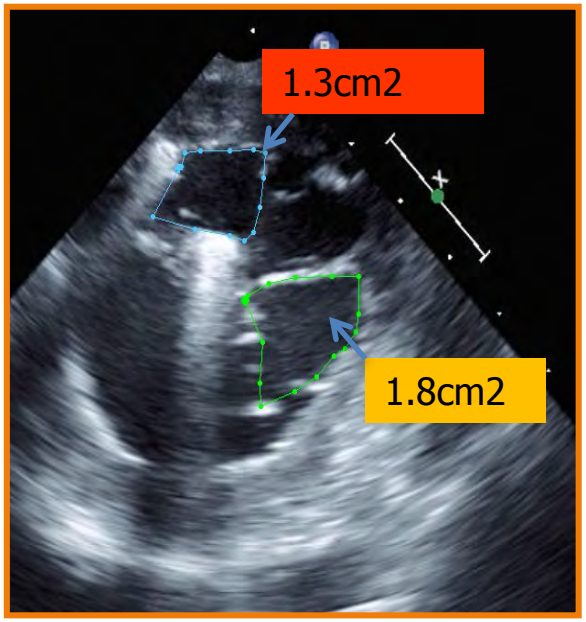
Deep gastric short axis view

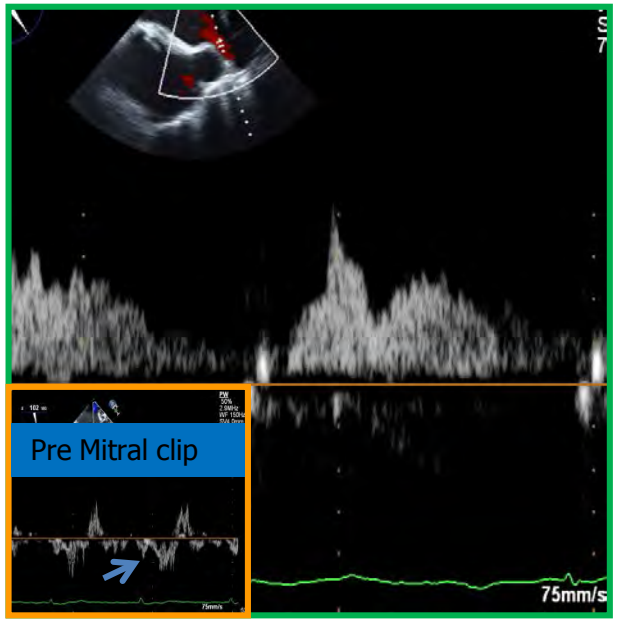


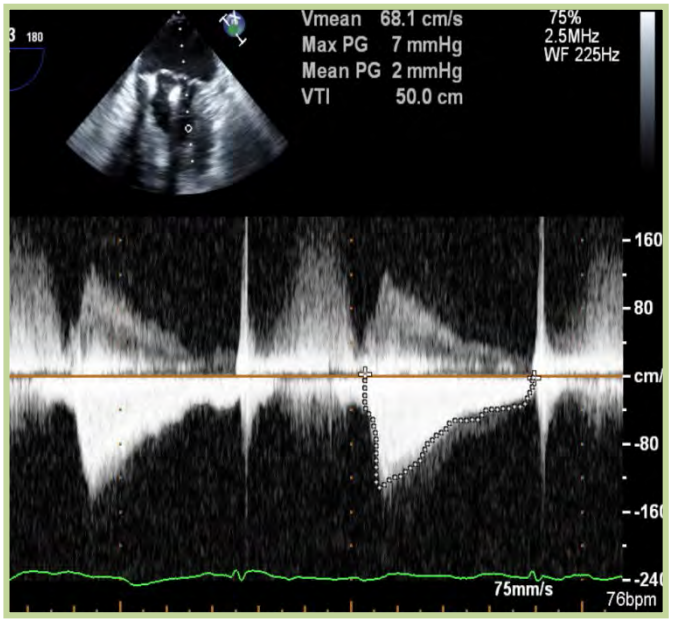
After the second mitral clip implantation, mitral regurgitation reduced to mild


0
44
180
+56.2
-56.2
cm/s
JPEG
48 bpm

Post MitraClip therapy assessment







Total mitral valve area 3.1cm2

Normal pulmonary vein inflow pattern

Mean gradient 2mmHg

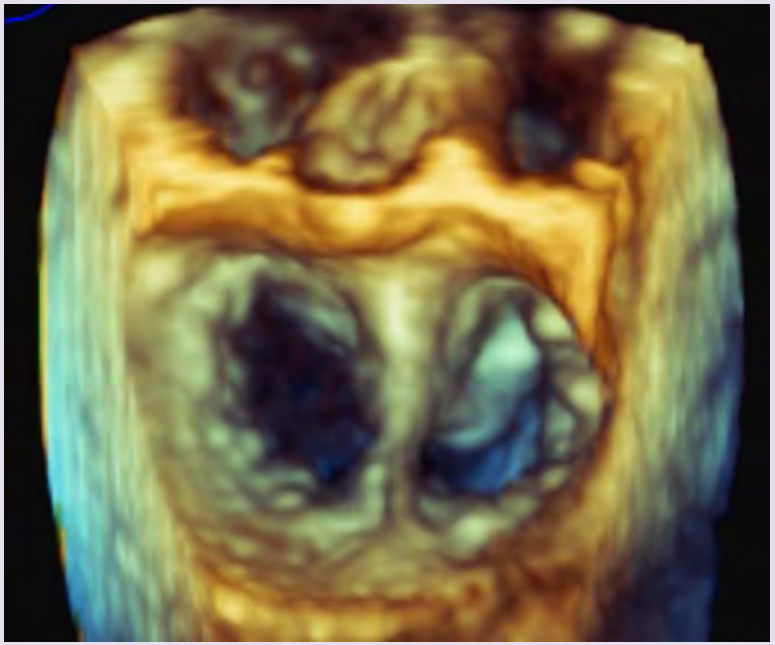
Introduction

- A double orifice mitral valve (DOMV) is a rare congenital malformation.
- The hemodynamic impact of DOMV varies from a normally functioning valve to significant mitral regurgitation or stenosis.
- Surgical mitral valve repair has been reported for ruptured chordae associated with DOMV.
- We present a case of successful mitral valve repair using MitraClip for flail mitral leaflet in patient with isolated DOMV assessed by real-time 3D TEE.

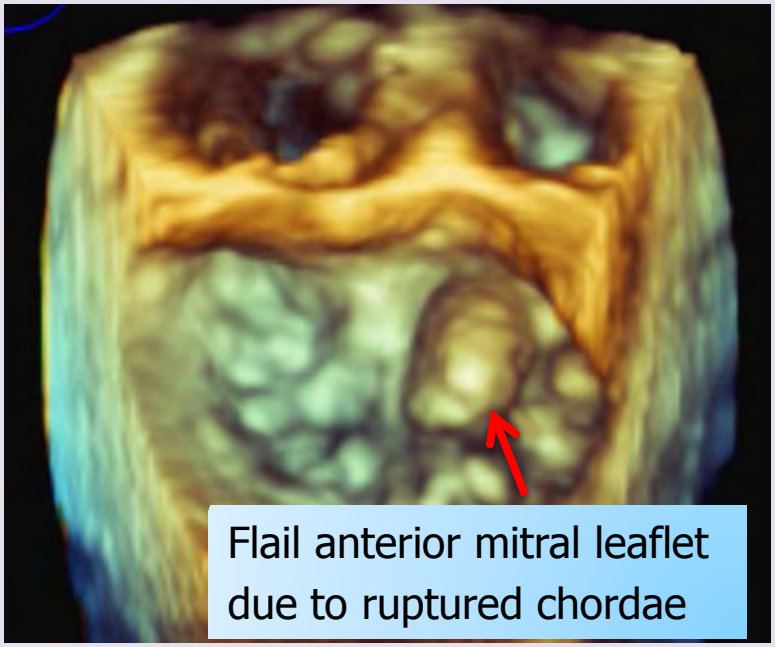
Case

86 year old man presented with exertional dyspnea.

Congenital double orifice mitral valve



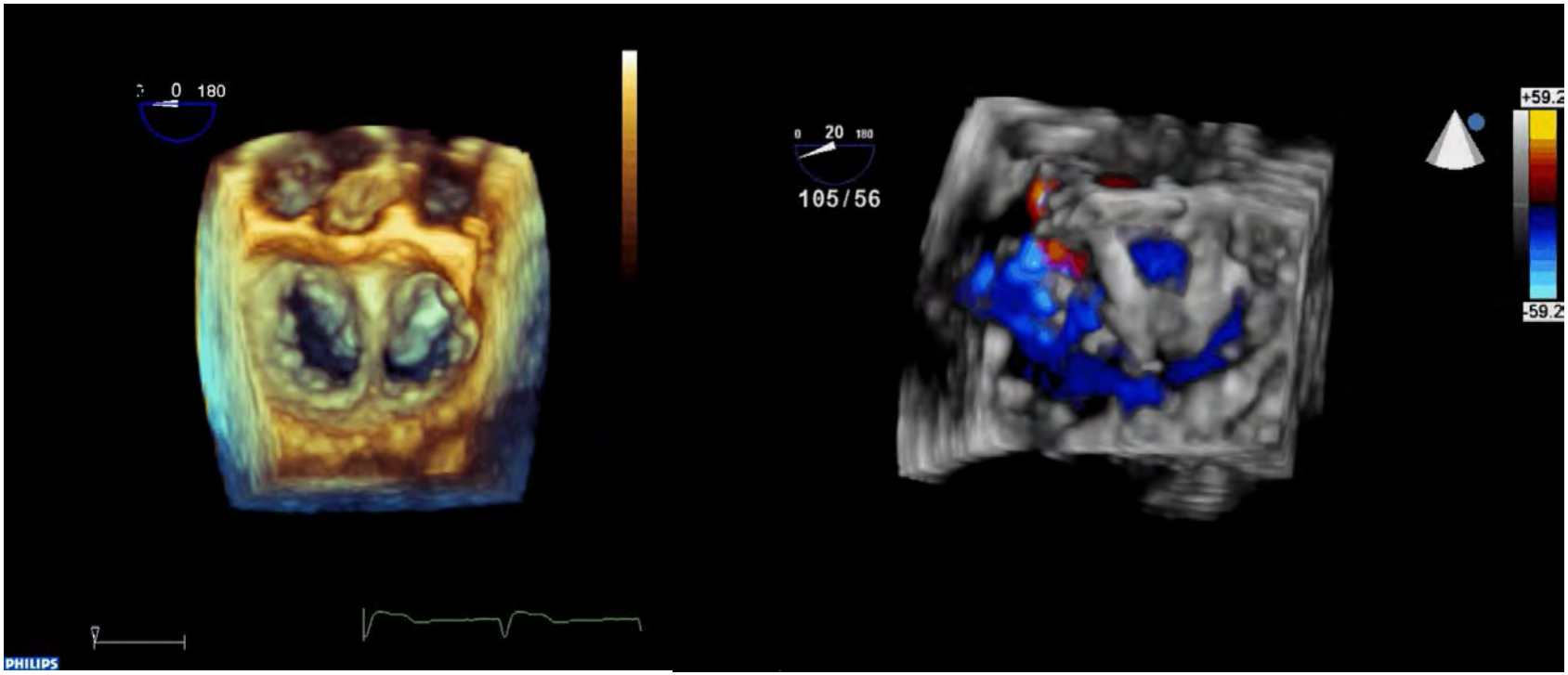
Diastole



Systole

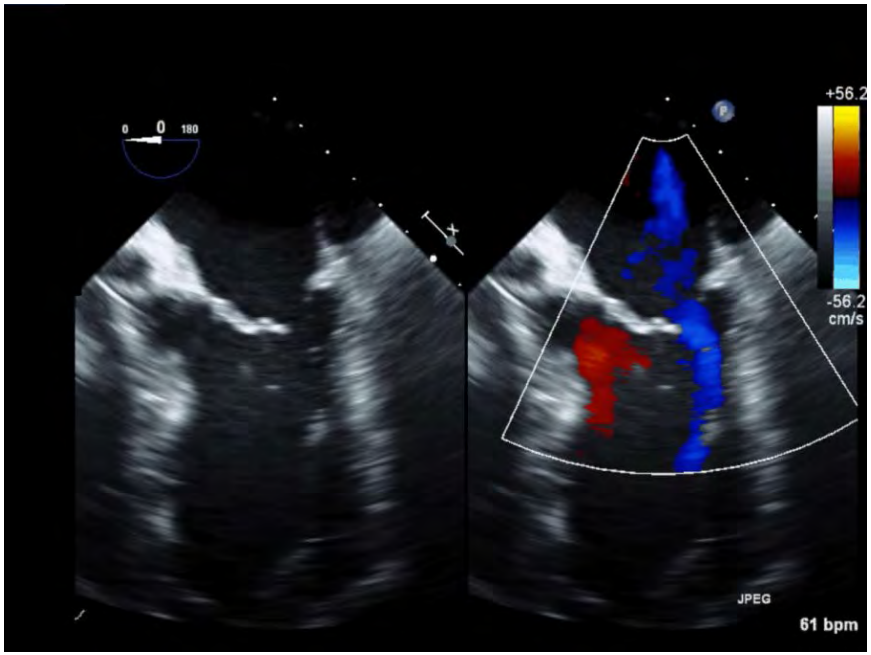
Noncentral Mitral Regurgitation

Congenital Double Orifice Mitral Valve

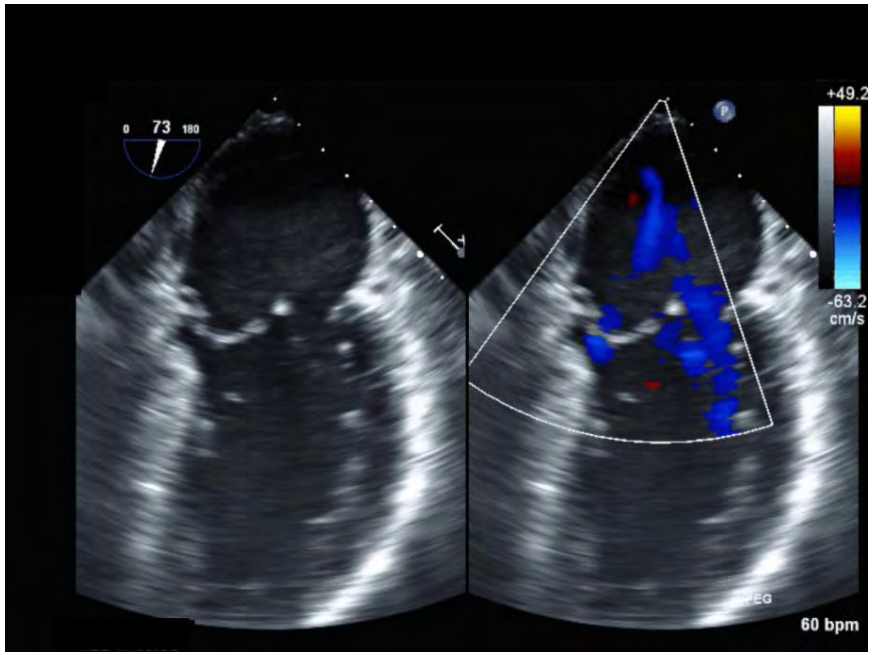


Pre-MitraClip assessment --TEE

4C Chamber



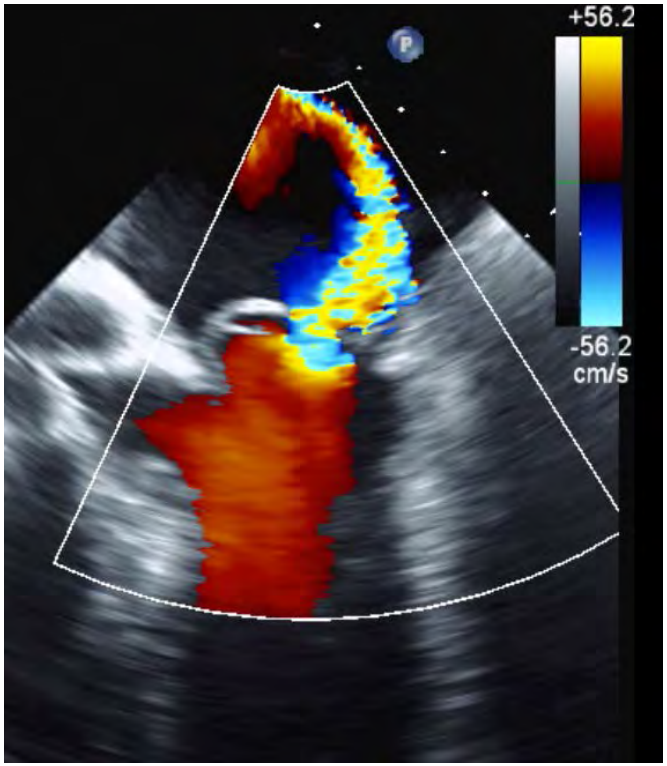
Intercommissural view



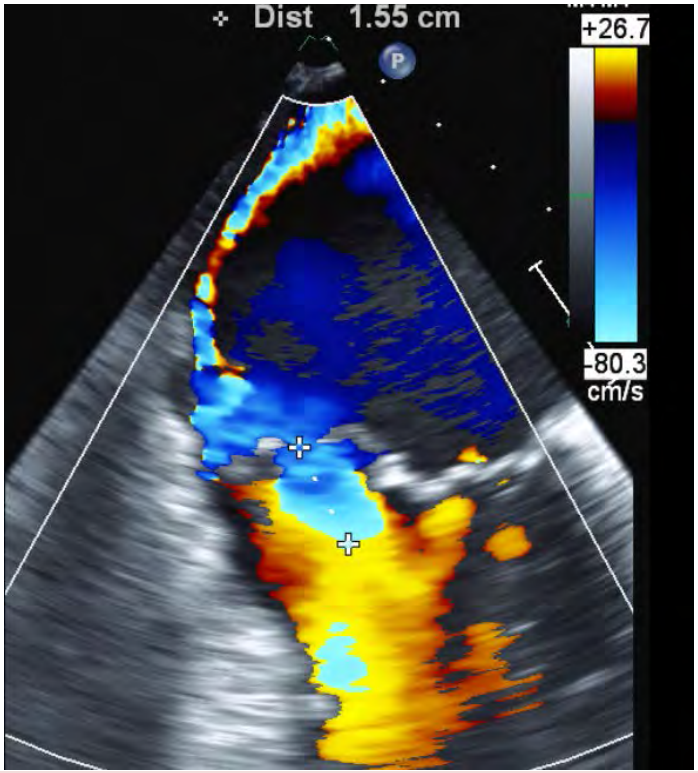
Mitral regurgitation jets emanating from the medial orifice of mitral valve.

Pre-MitraClip assessment --TEE

4 chamber view



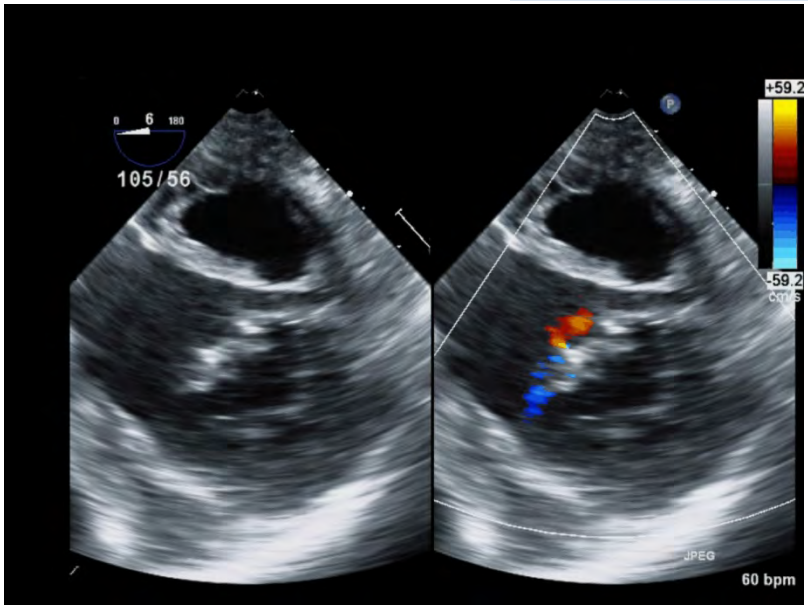
Intercommissural view

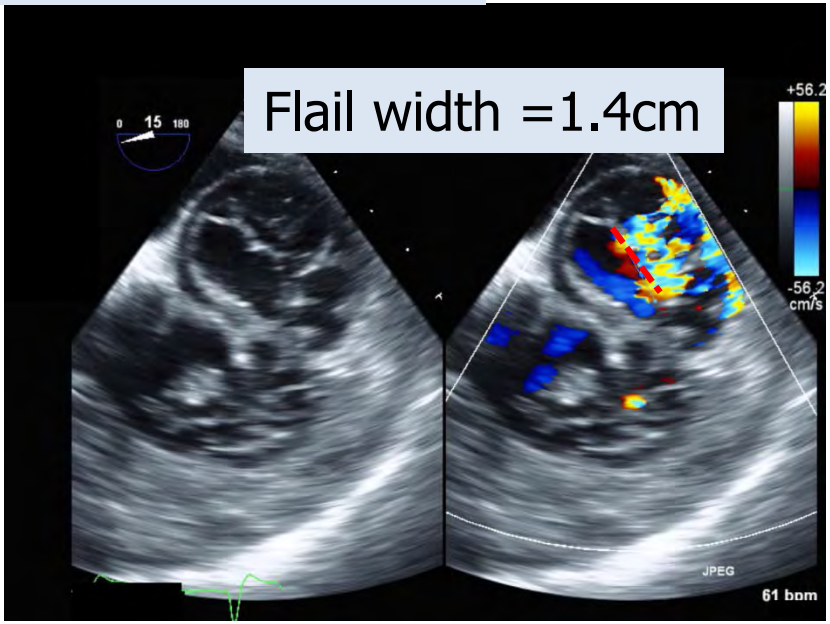


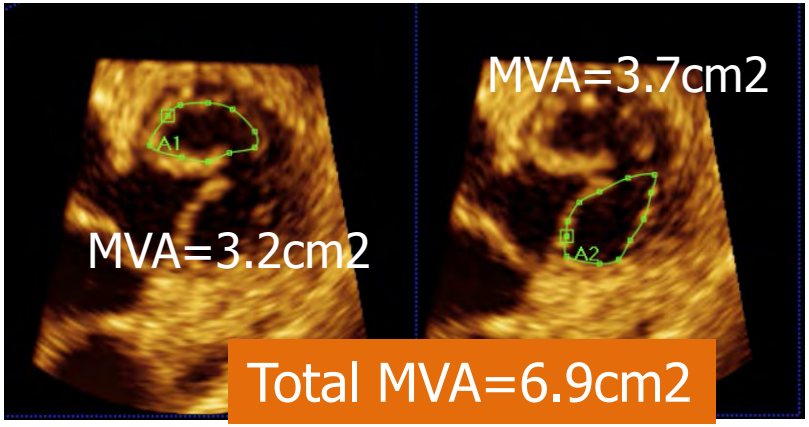
Mitral regurgitation PISA radius=1.6cm

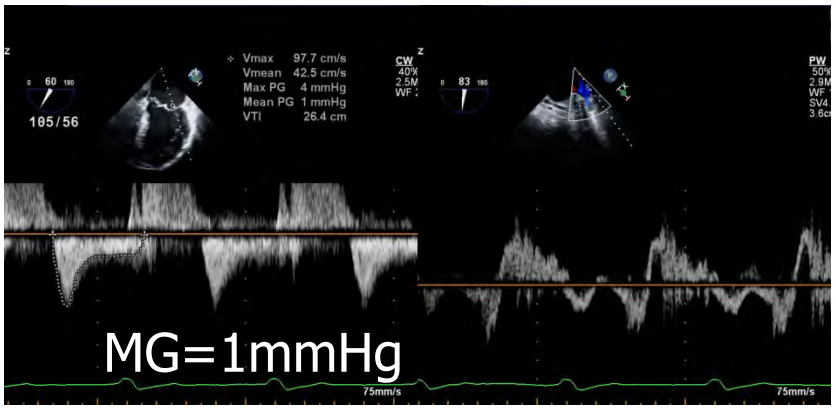
Pre-MitraClip assessment --TEE

Deep gastric short axis view

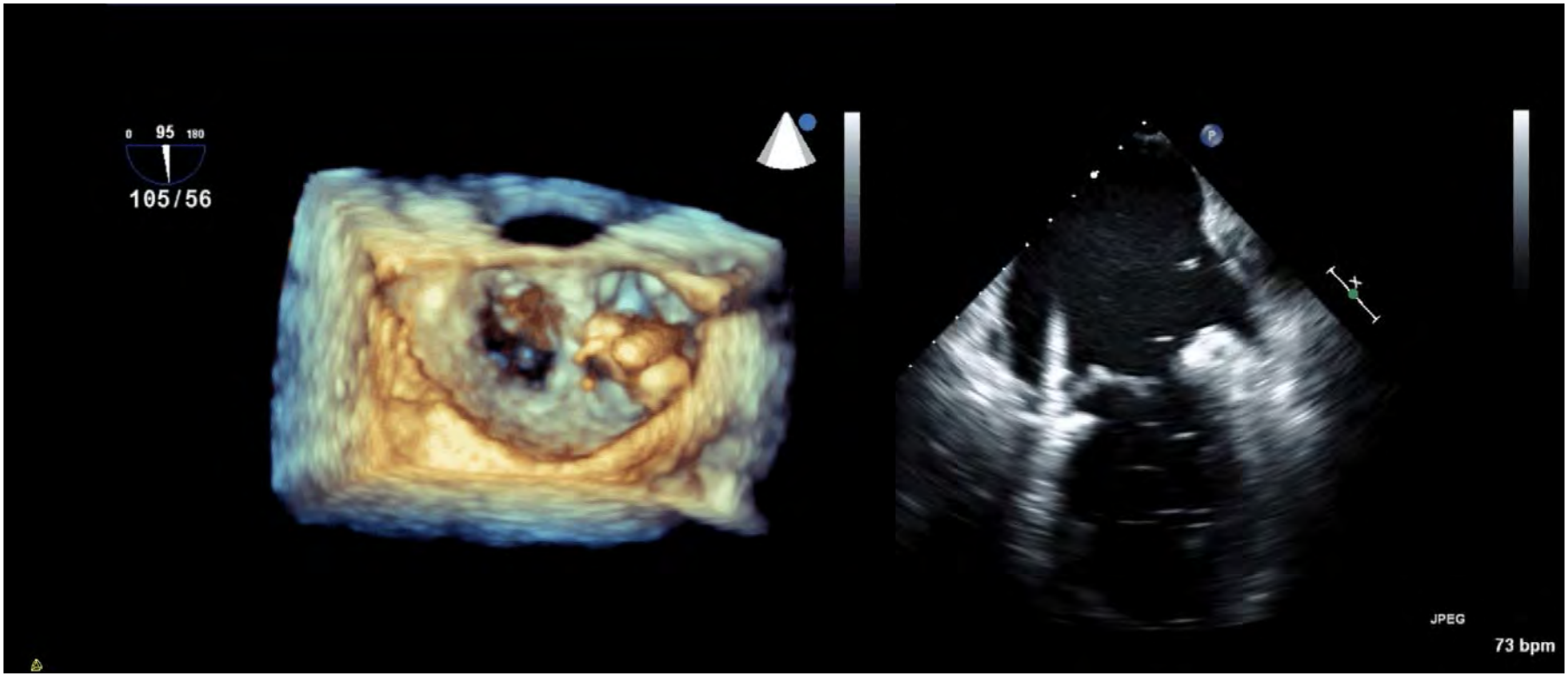




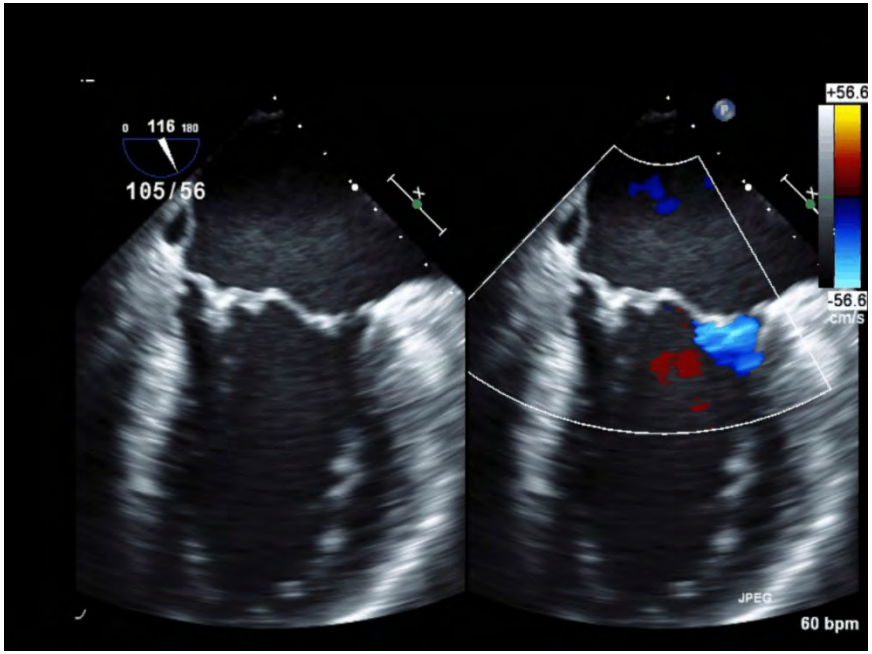


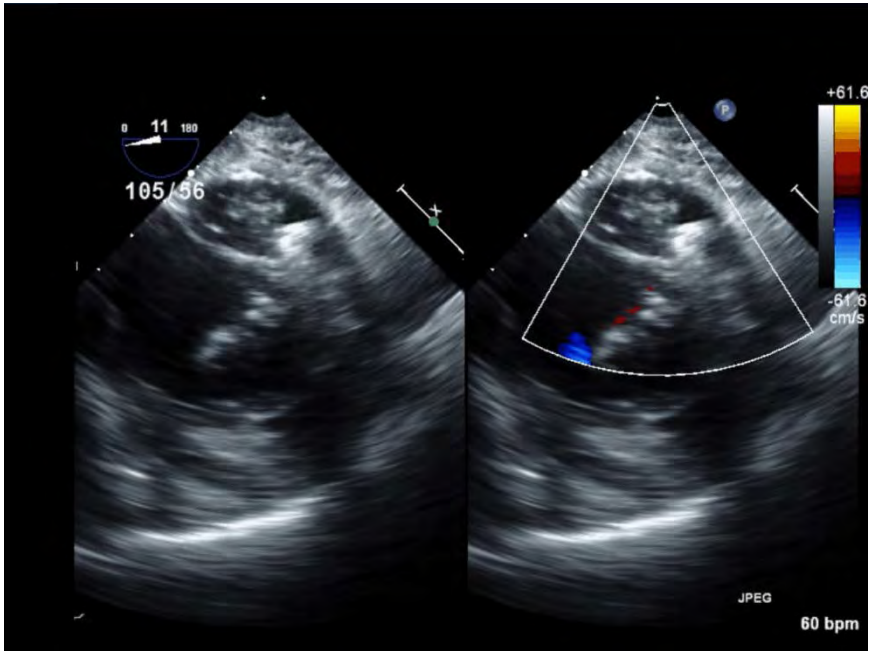


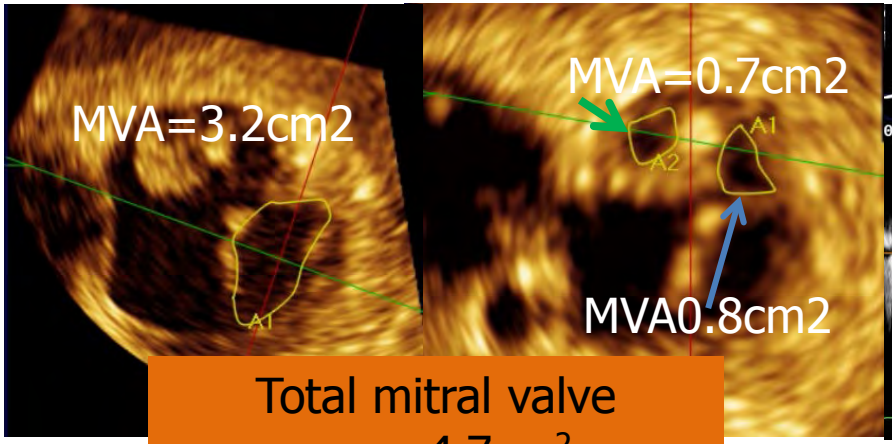
Intraprocendure MitraClip assessment --TEE



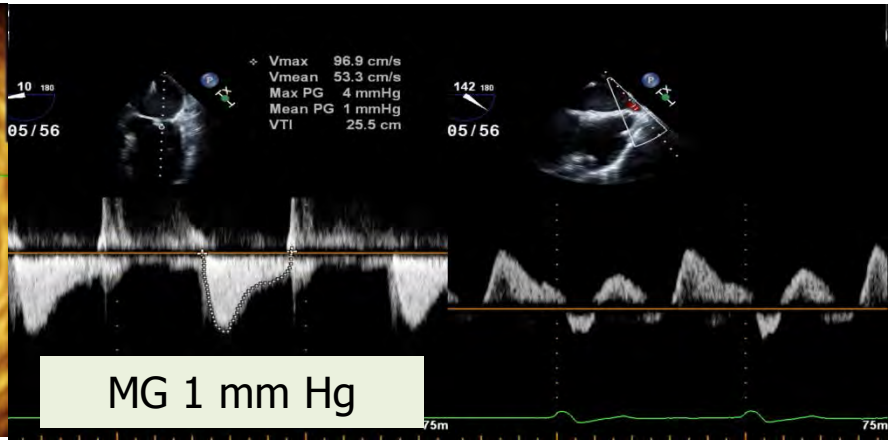
Post MitraClip therapy assessment-TEE





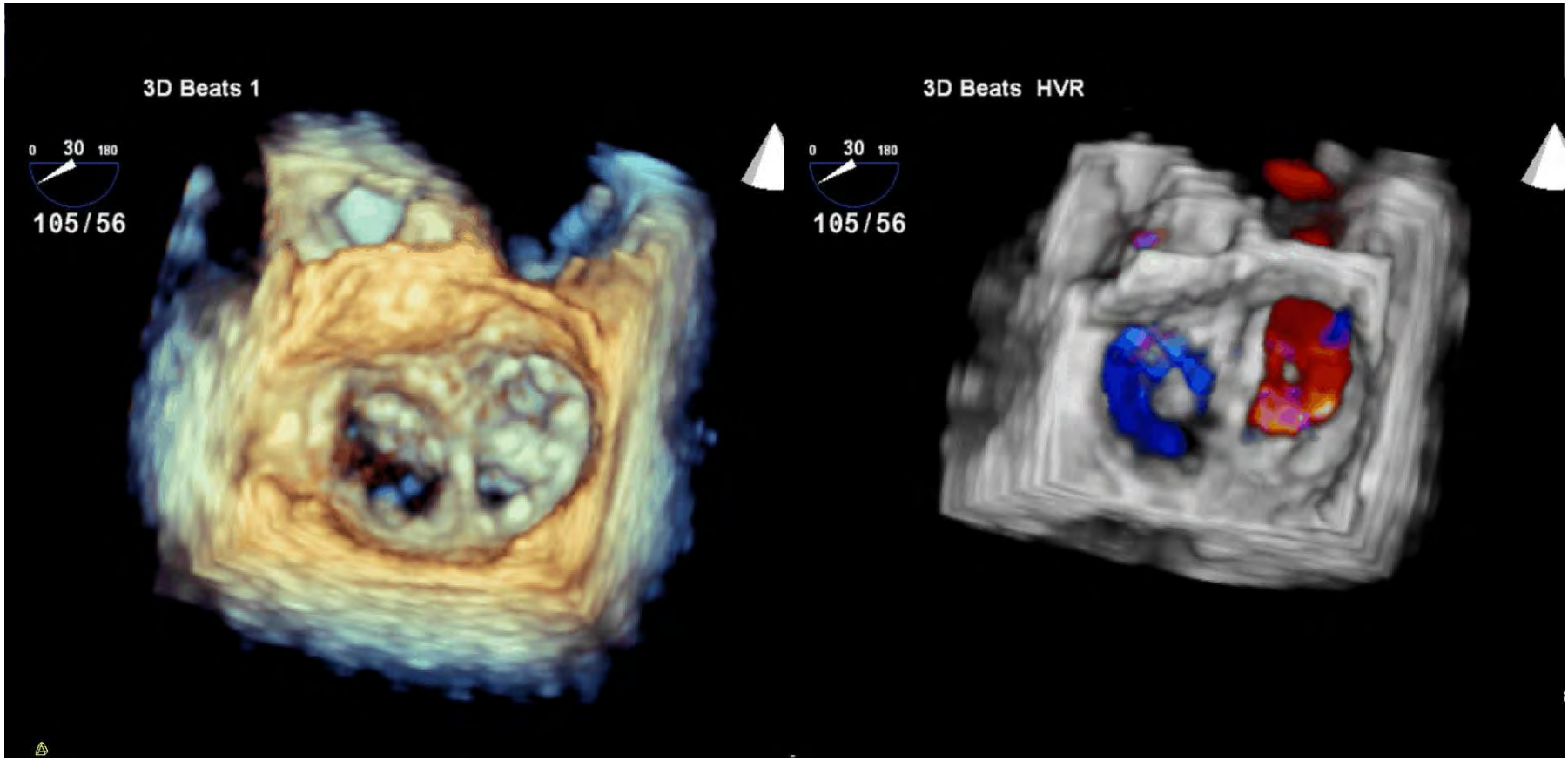


Total mitral valve area=4.7cm^2



MG 1 mm Hg

Post MitraClip therapy assessment-TEE

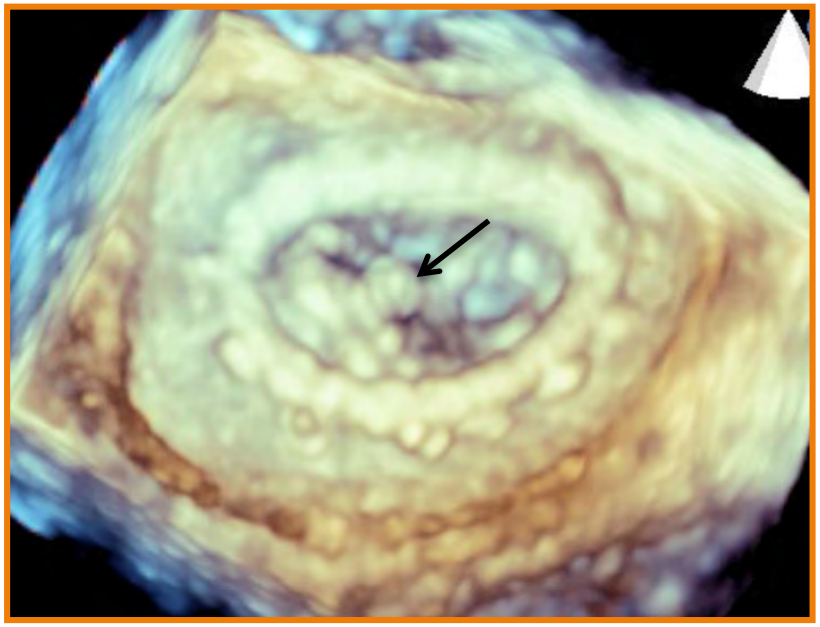


Transcatheter mitral repair

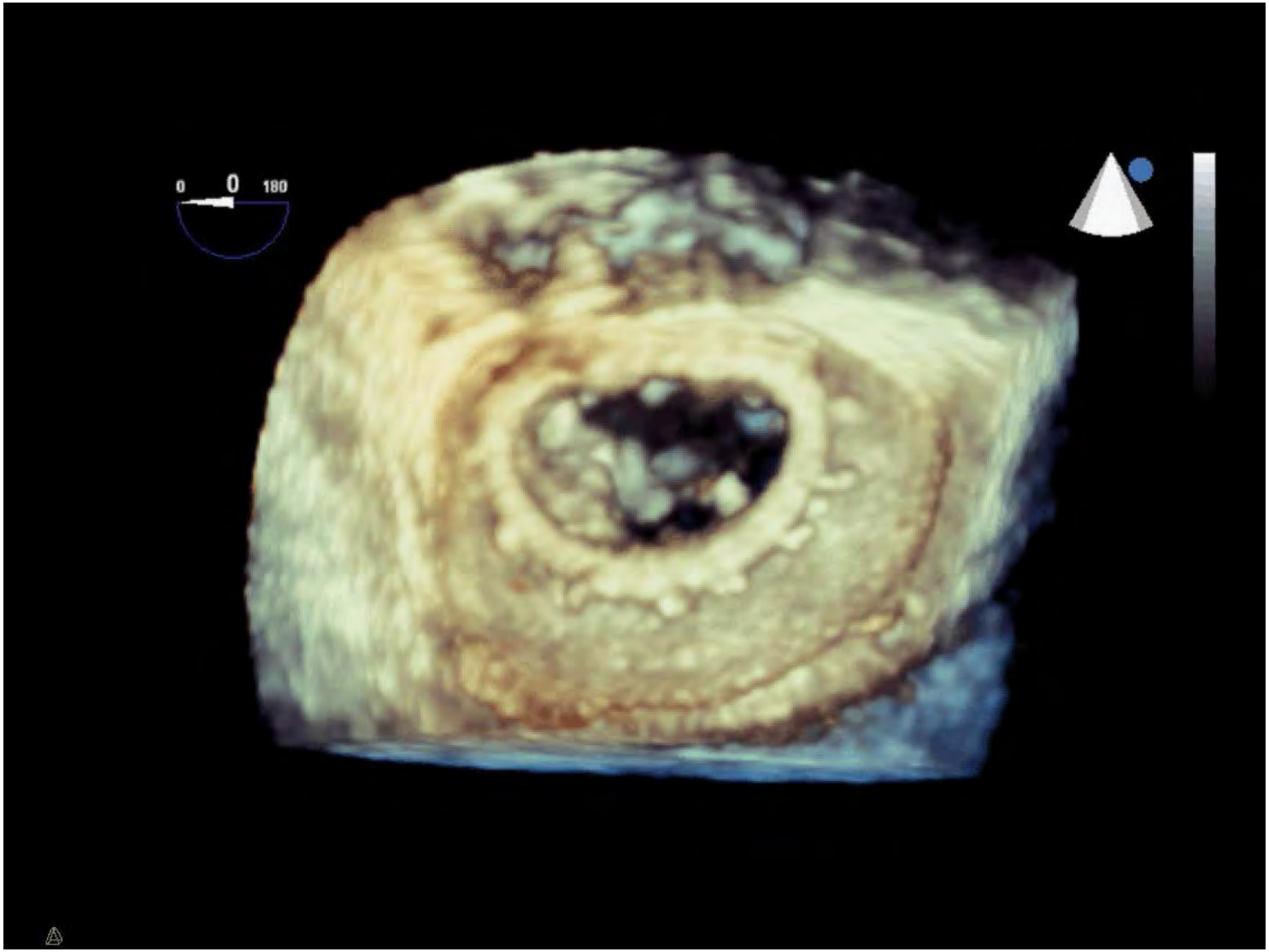
Failed mitral valve repair

Case

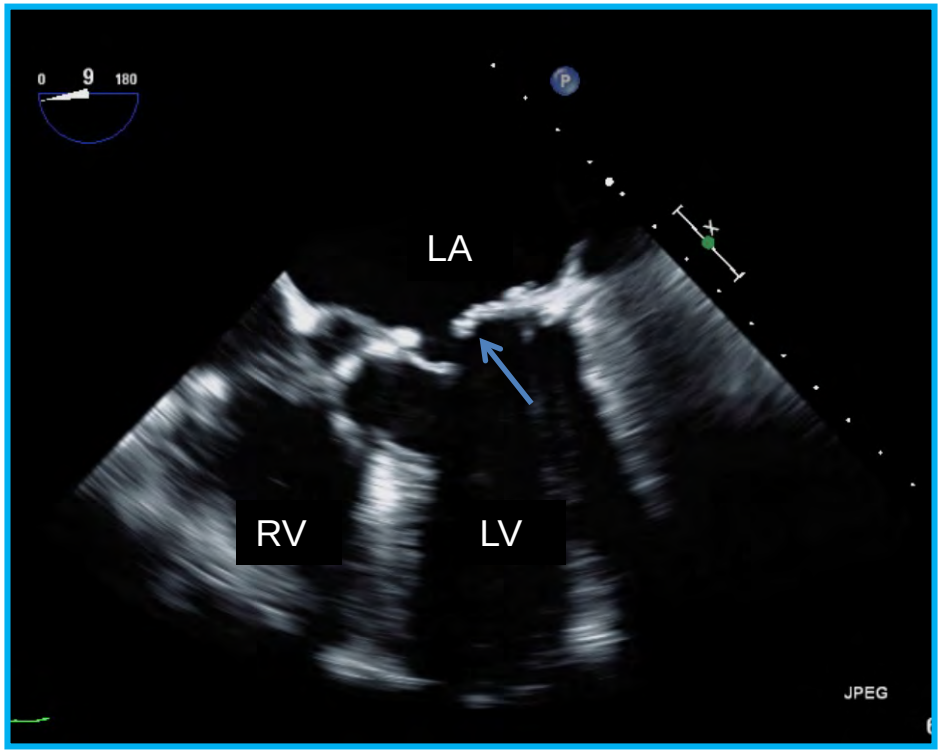
85 year-old woman with multiple comorbidities and previous surgical mitral annuloplasty presented with shortness of breath. She was found to have severe mitral regurgitation and referred for redo surgical mitral valve repair.

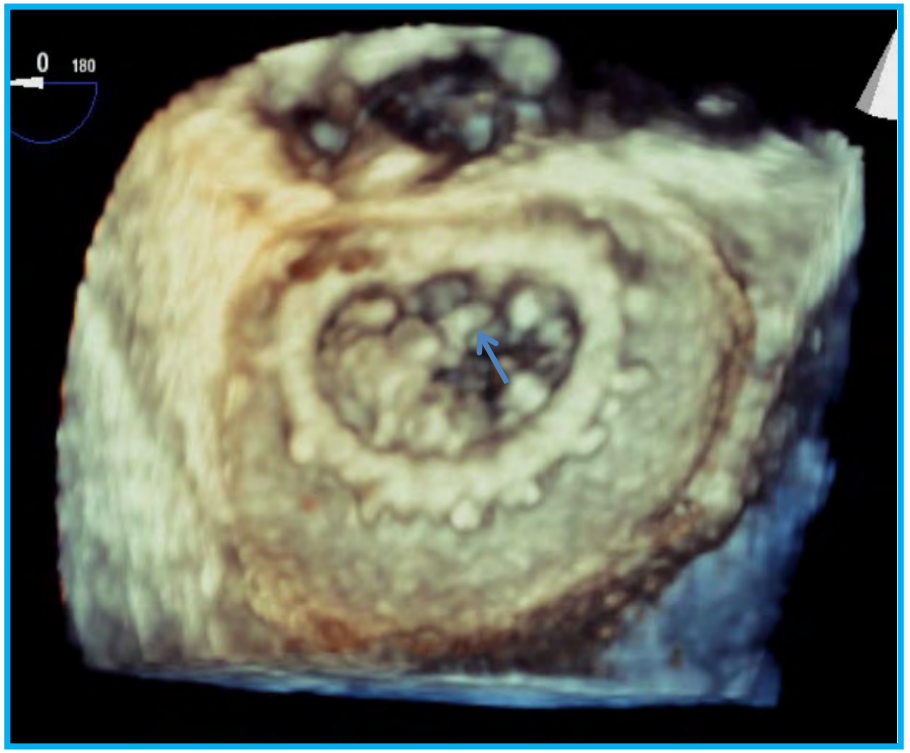


Flail posterior leaflet


0
0
180

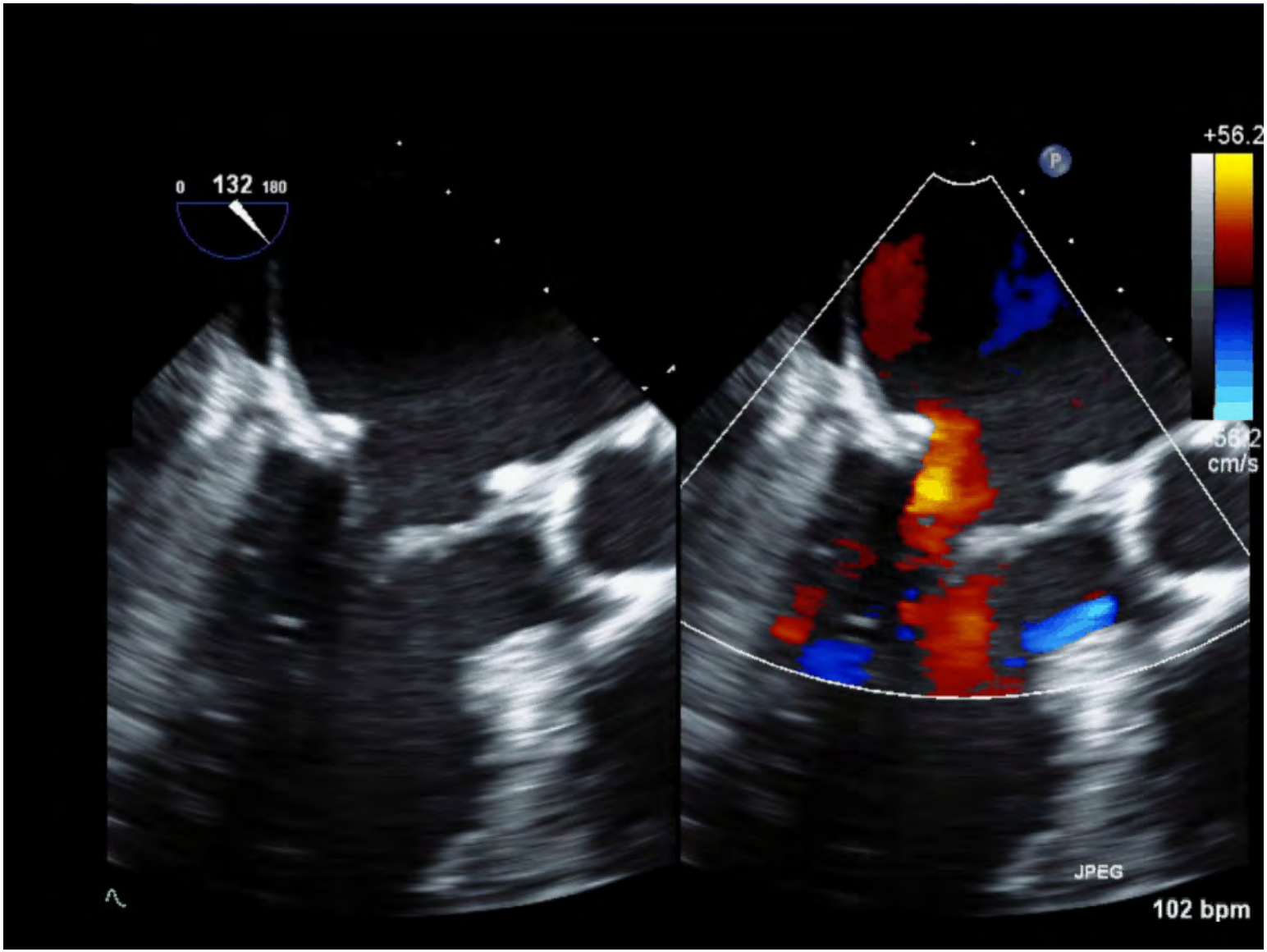
Pre-percutaneous mitral valve repair



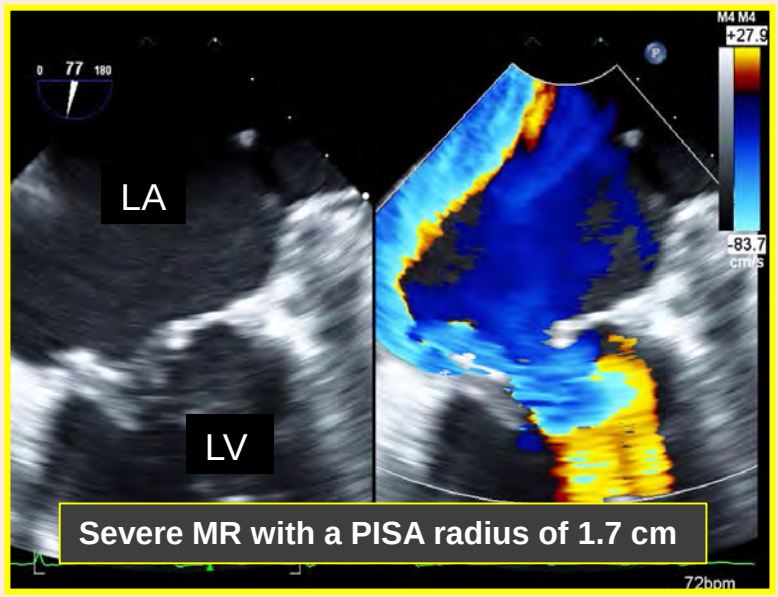


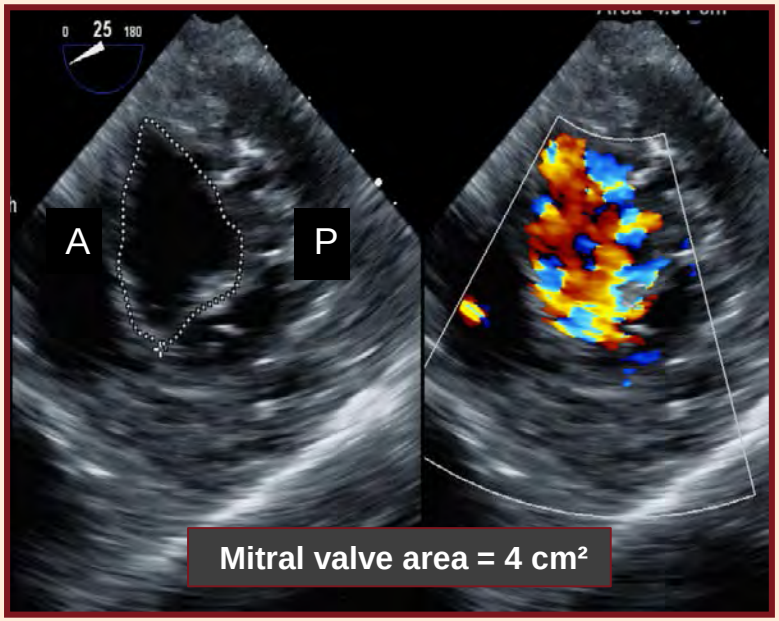
A mid (P2 towards P1) portion of the posterior mitral leaflet is flail due to ruptured chordae.

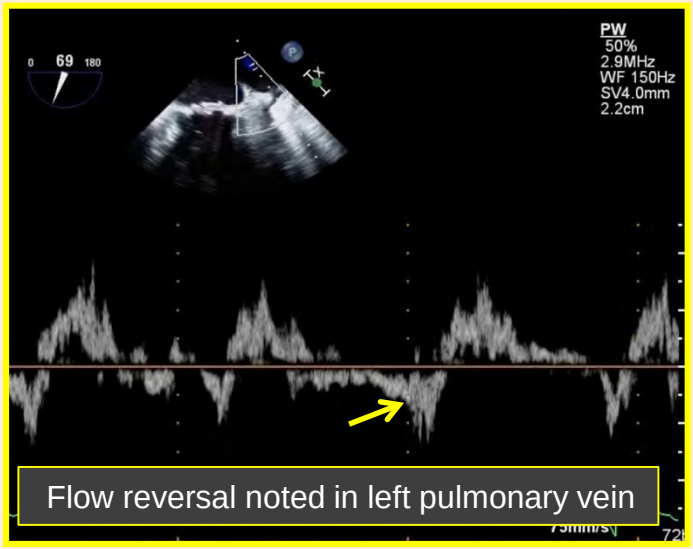
The flail gap measures 6 mm.

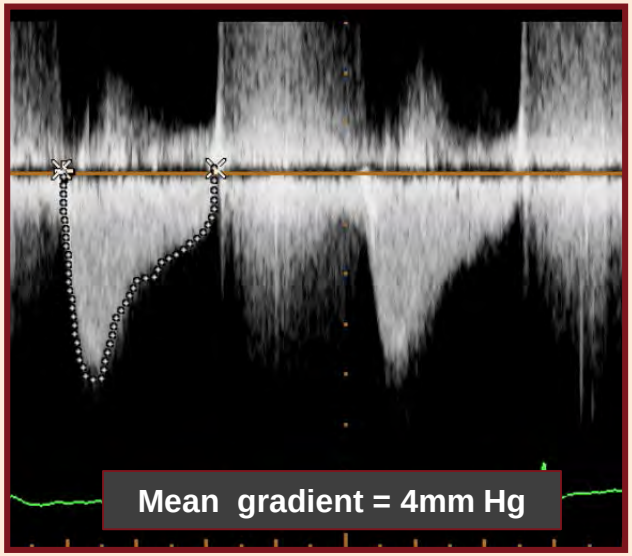

0
132
180
+56.2
cm/s
JPEG
102 bpm

Pre-percutaneous mitral valve repair

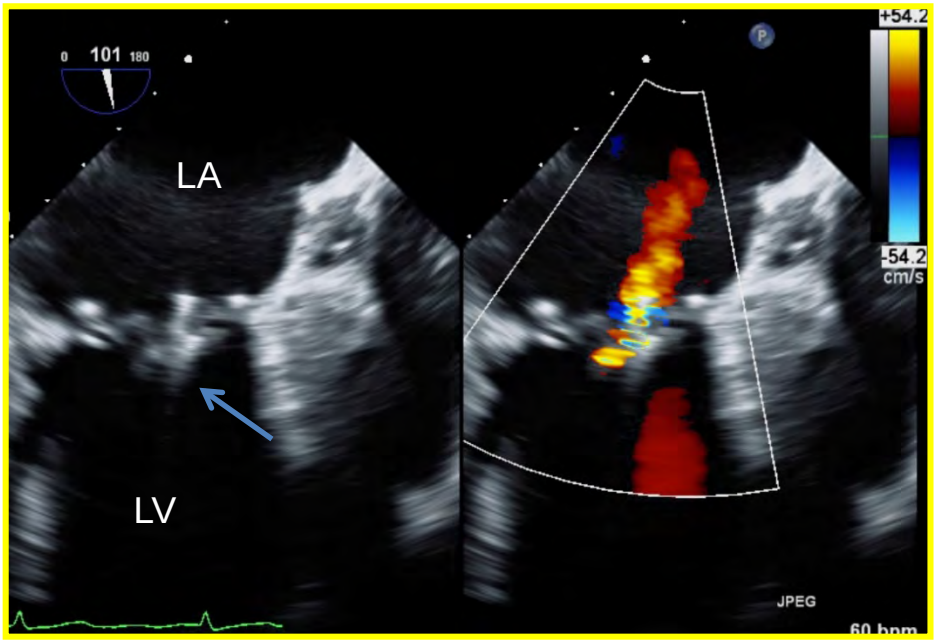


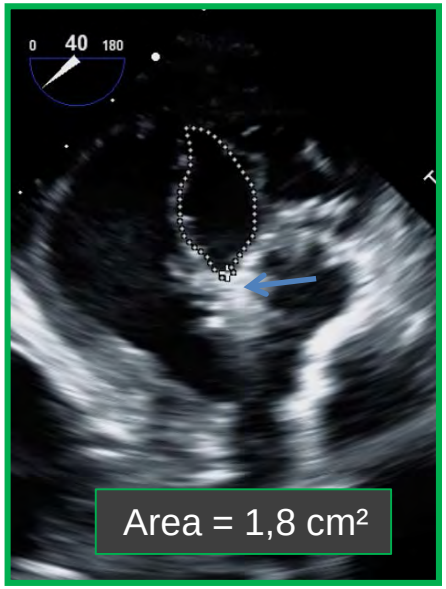


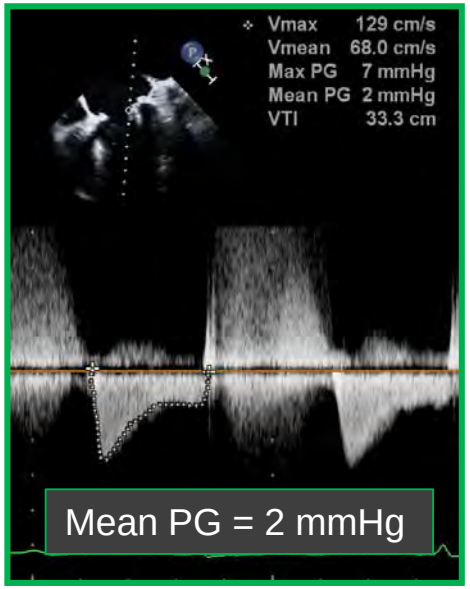




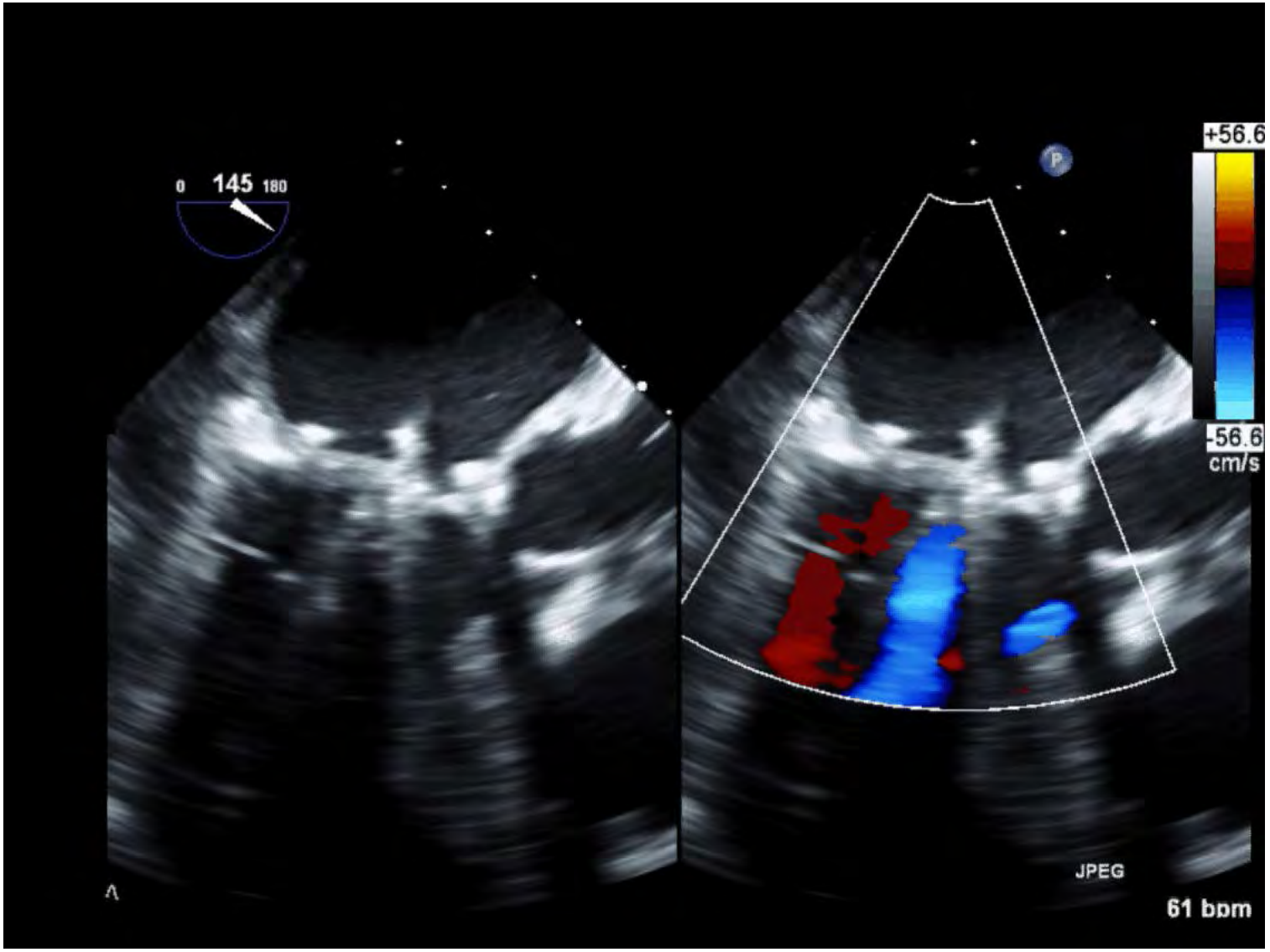
Post percutaneous mitral valve repair

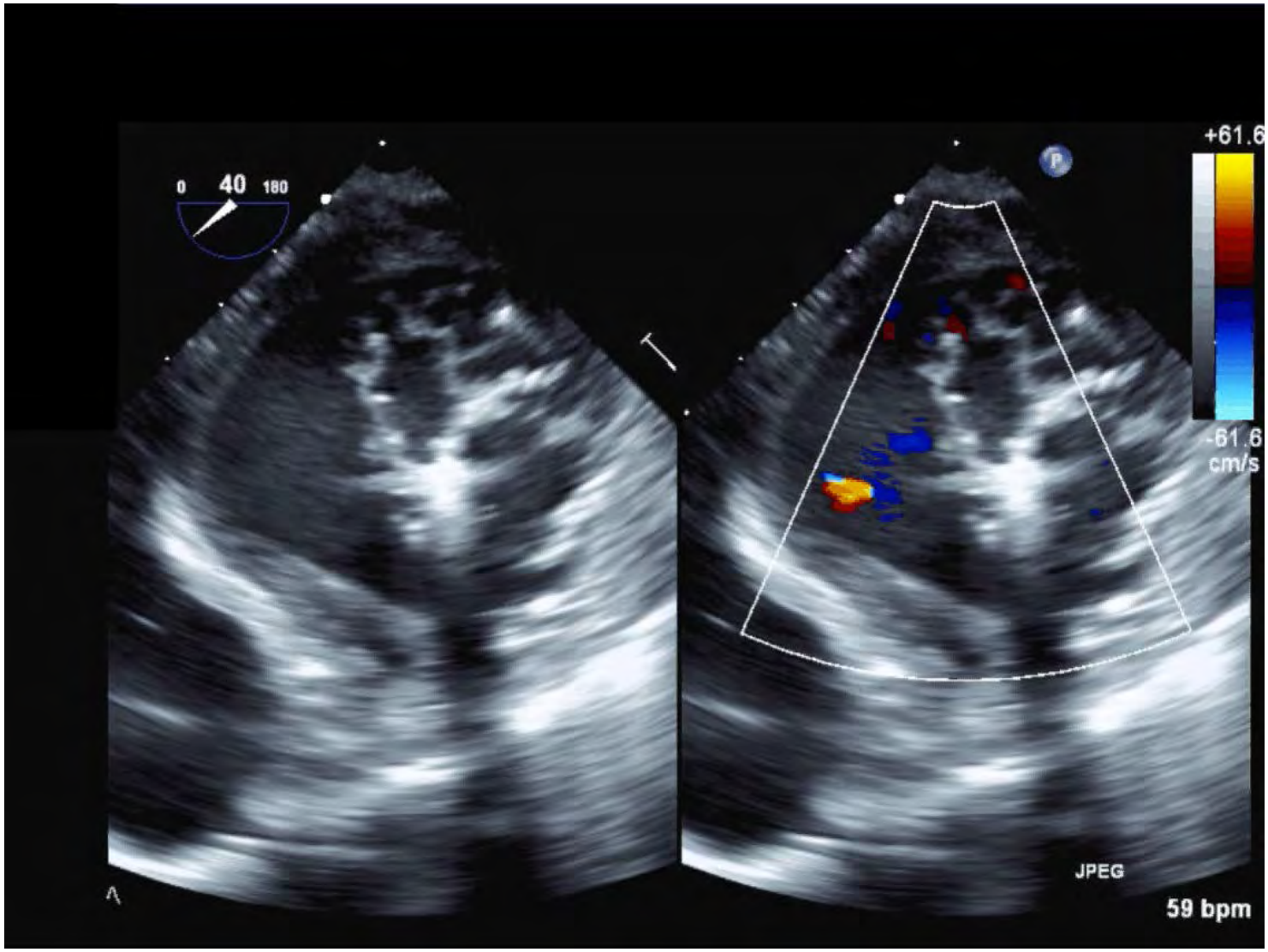






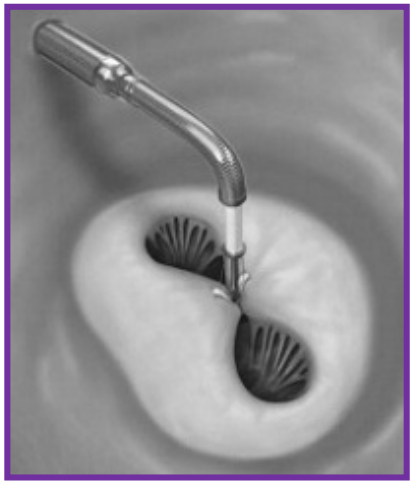
After the mitral clip implantation, mitral regurgitation reduced to mild


0
145
180
+56.6
-56.6
cm/s
JPEG
61 bpm


0
40
180
+61.6
-61.6
cm/s
JPEG
59 bpm

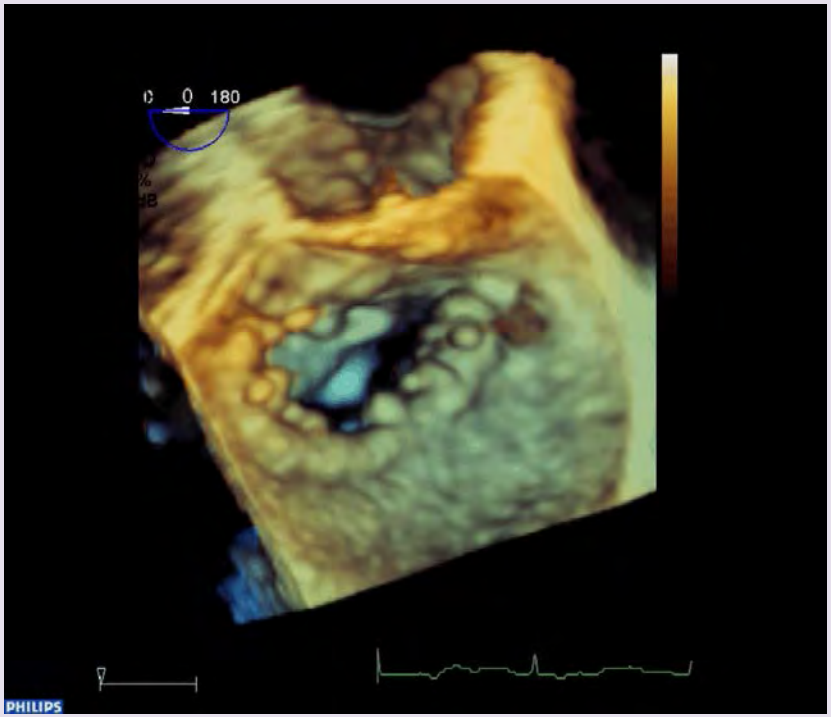
Introduction

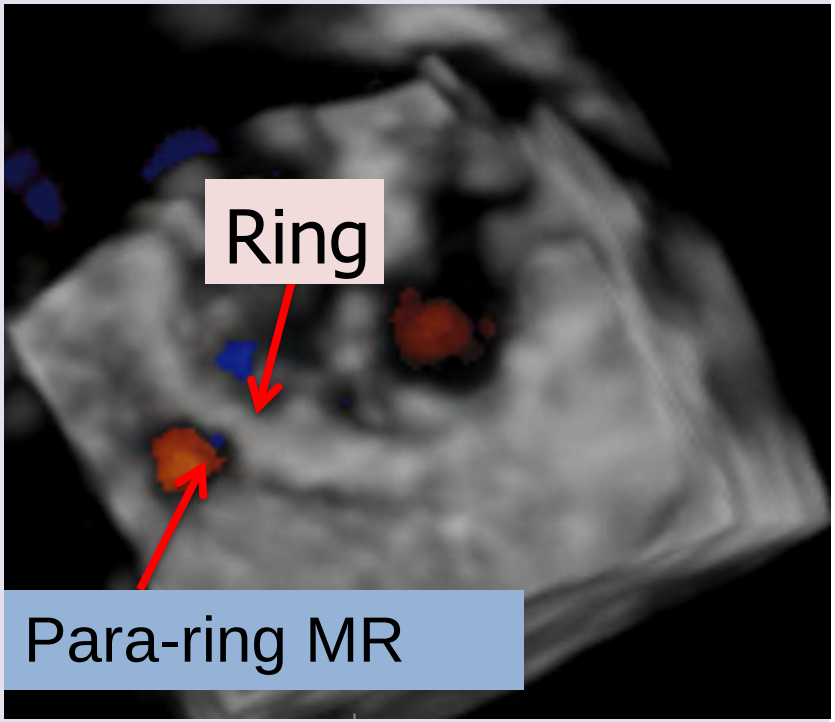
- Hemolytic anemia is one of the rare complications of mitral valve replacement or repair, mostly due to regurgitation around the prosthesis or annuloplasty ring.
- Reoperation is associated with an increased likelihood of a recurrent leak, morbidity, and mortality
- Percutaneous transcatheter closure procedures have been applied to the treatment of paraprosthetic valve leak using a variety of techniques
- We report a case using MitraClip therapy in a patient with hemolytic anemia induced by mitral para-annuloplasty ring leak



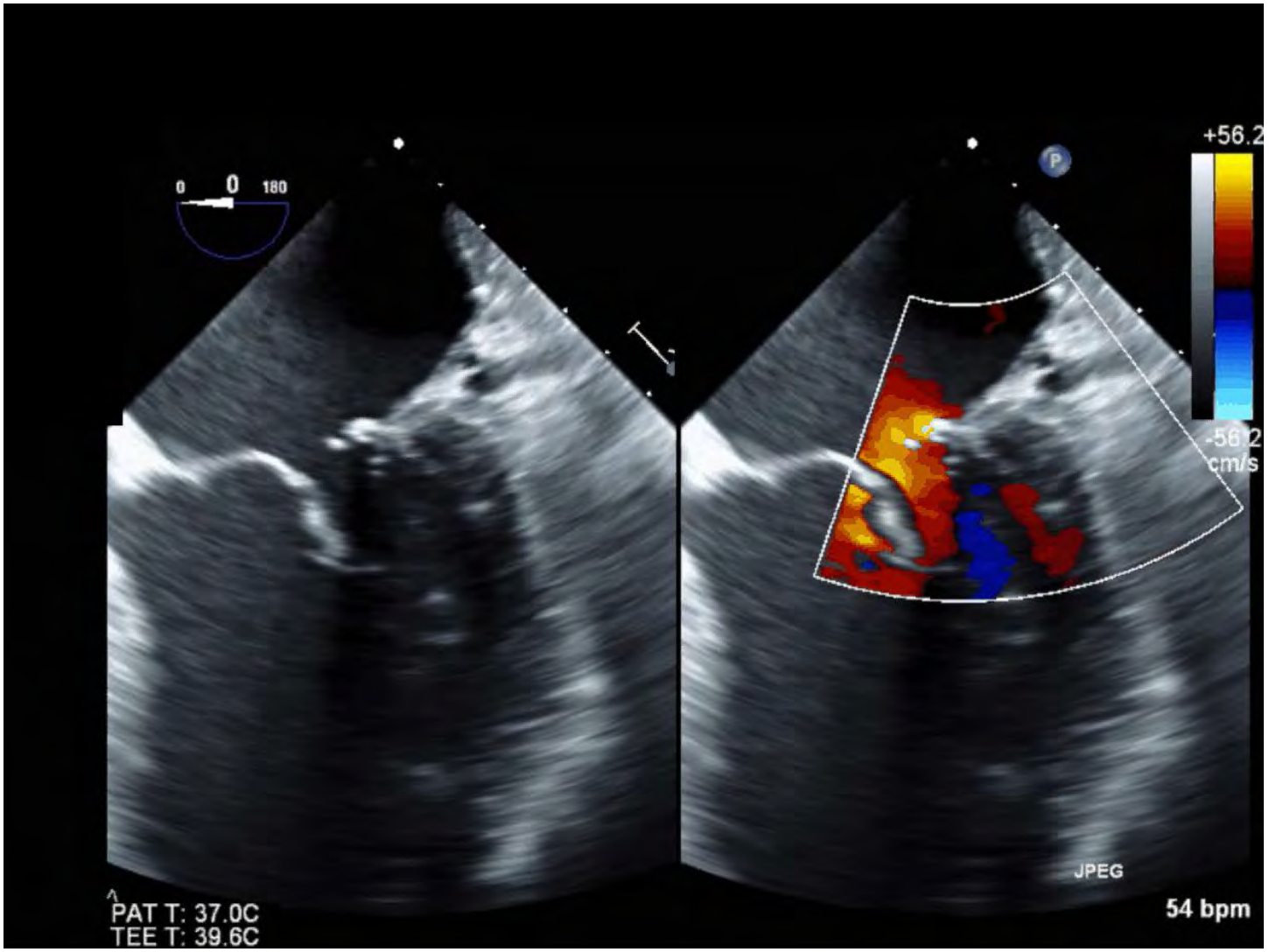
Case

A 76 years old man presented with shortness of breath and hemolytic anemia requiring frequent blood transfusion two months after mitral valve repair.

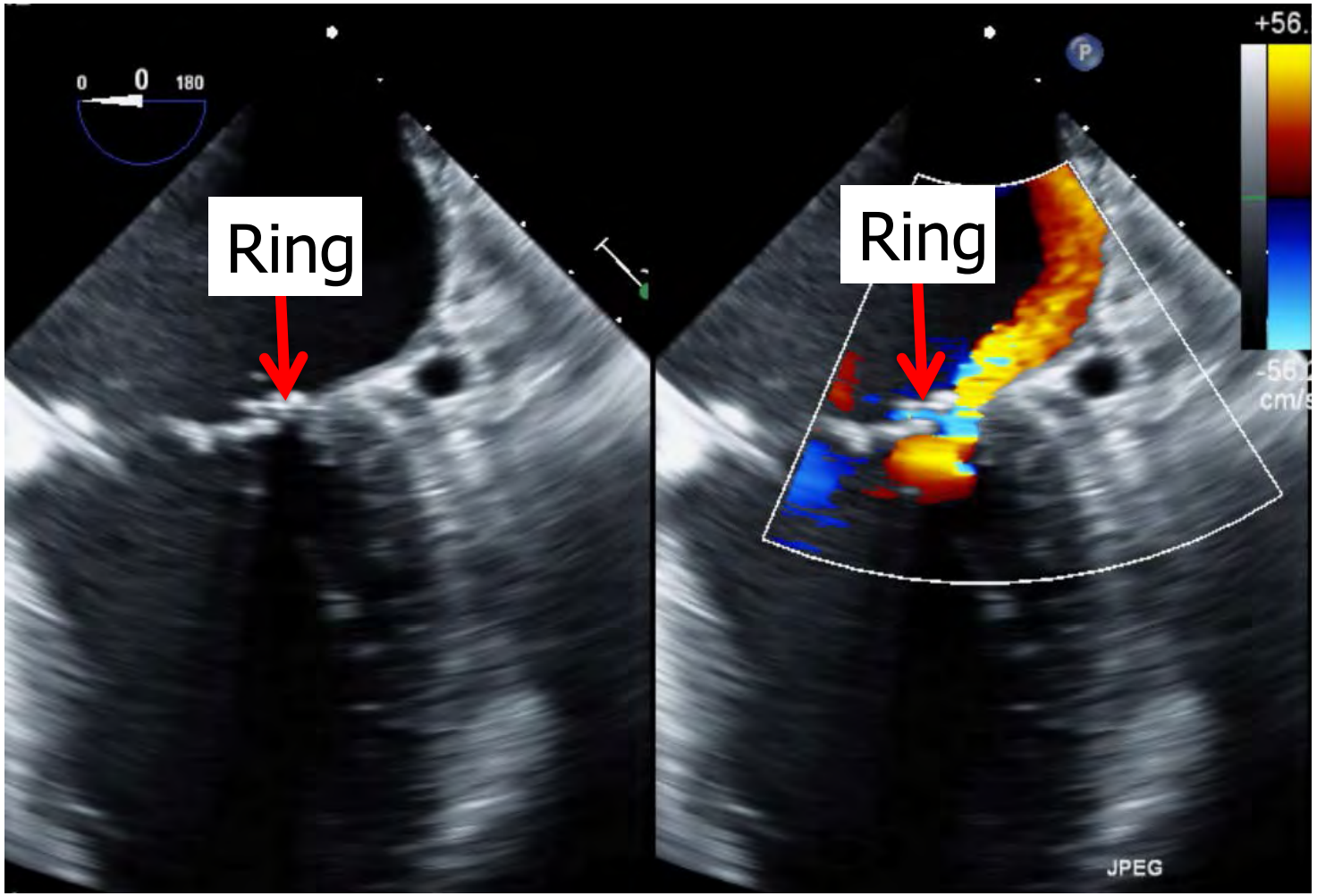




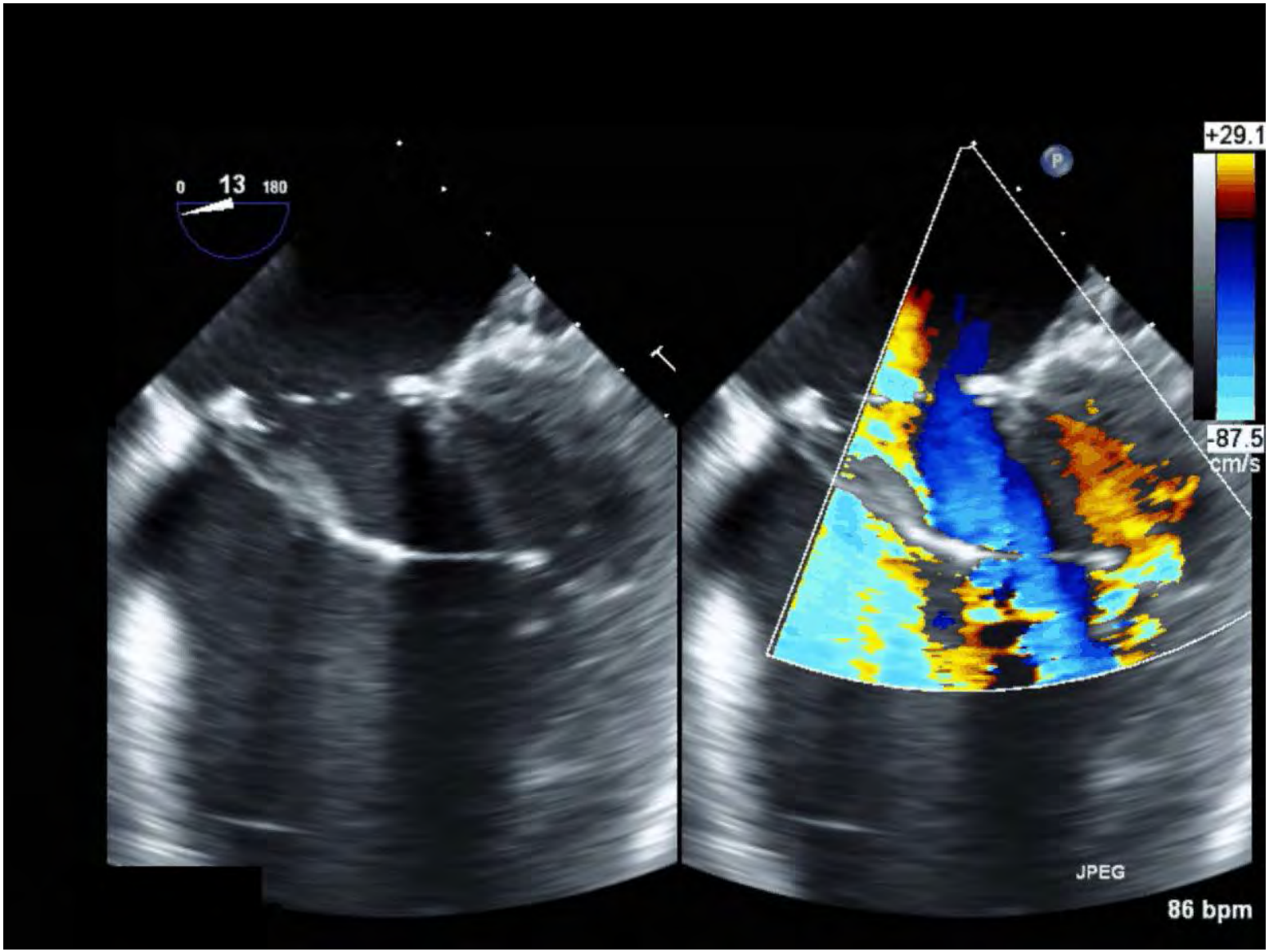
Para-ring mitral regurgitation



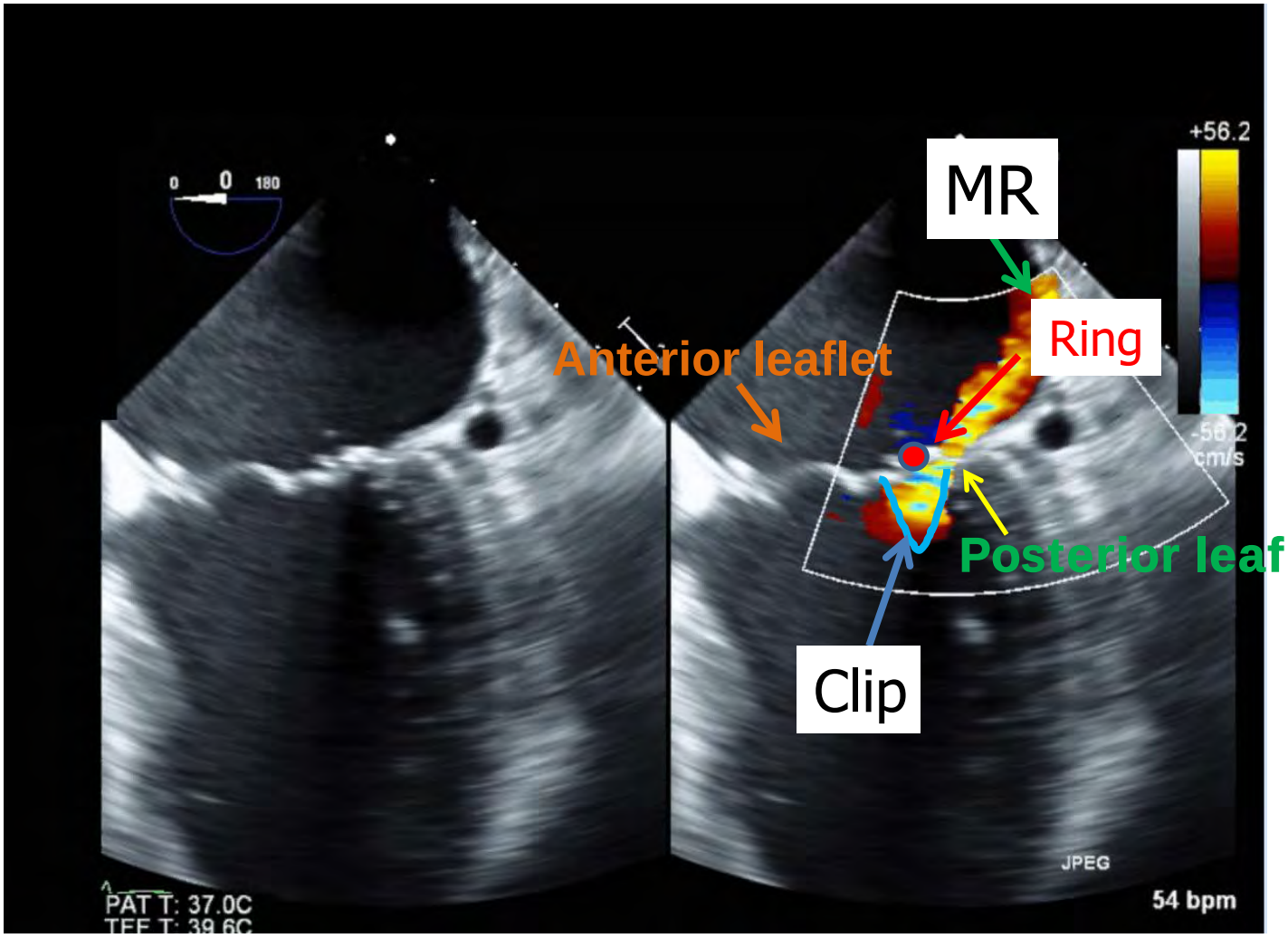
TEE: Para-ring mitral regurgitation



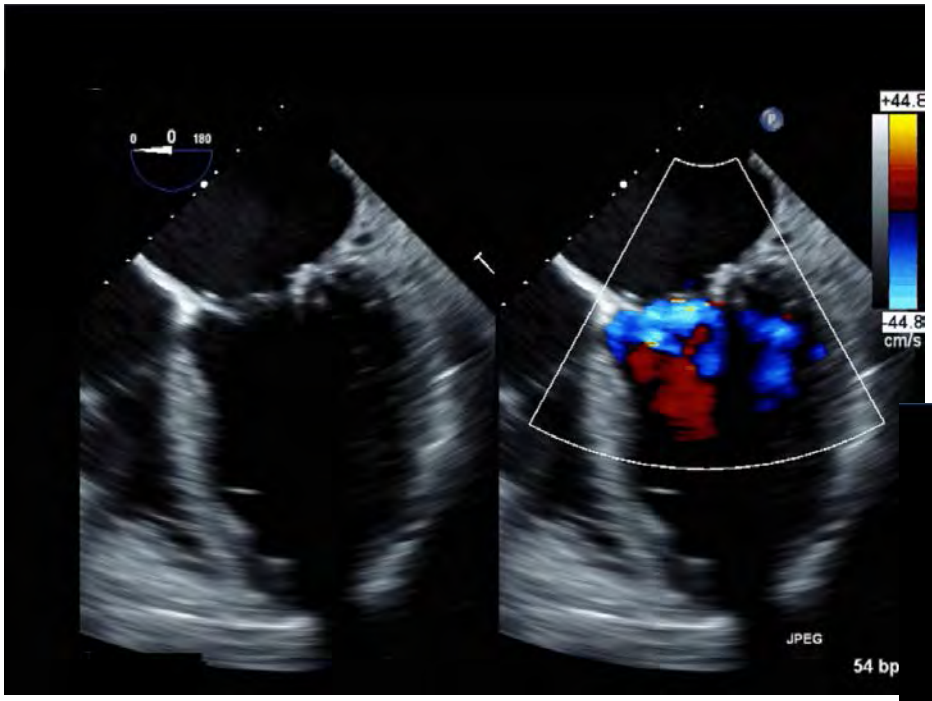
TEE: Para-ring mitral regurgitation

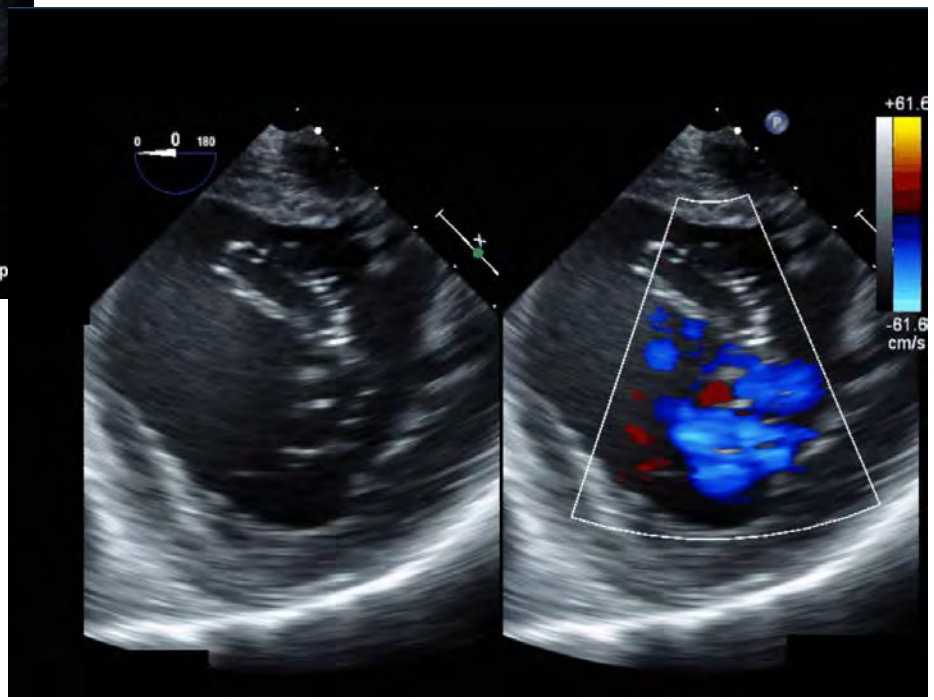


TEE: Para-ring mitral regurgitation



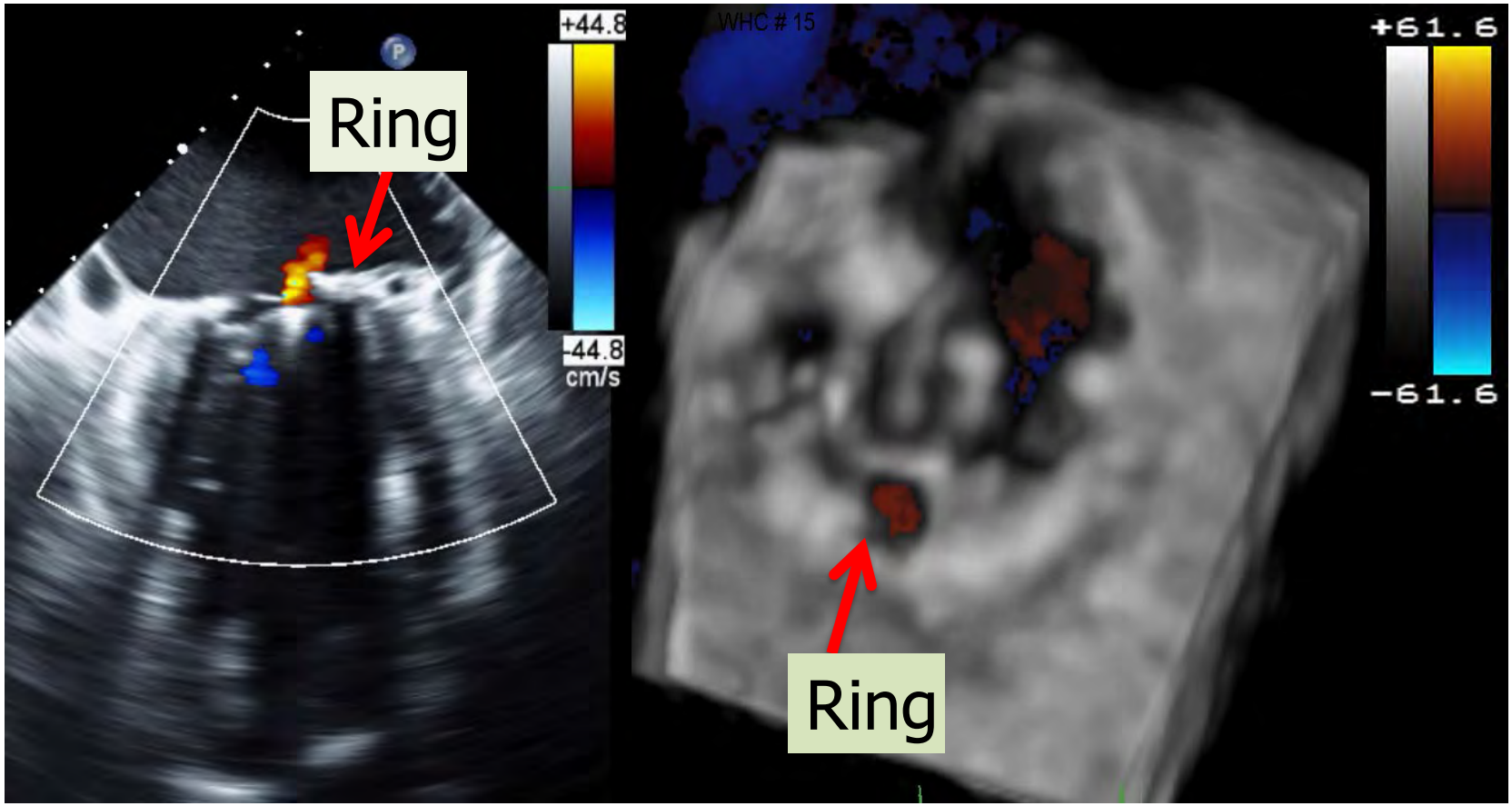
Post MitraClip





Post MitraClip

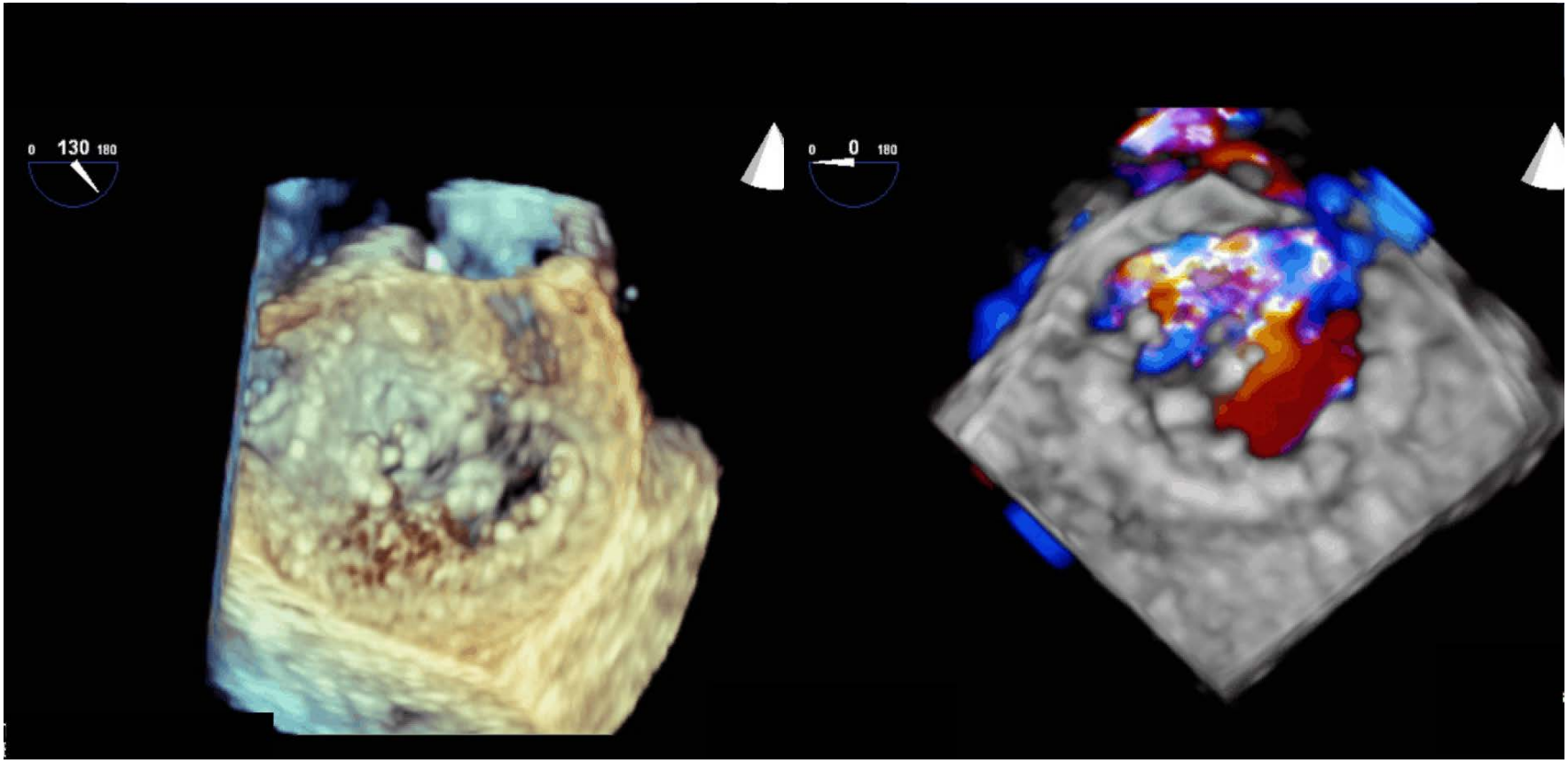
Trace intravalvular mitral regurgitation



Post MitraClip

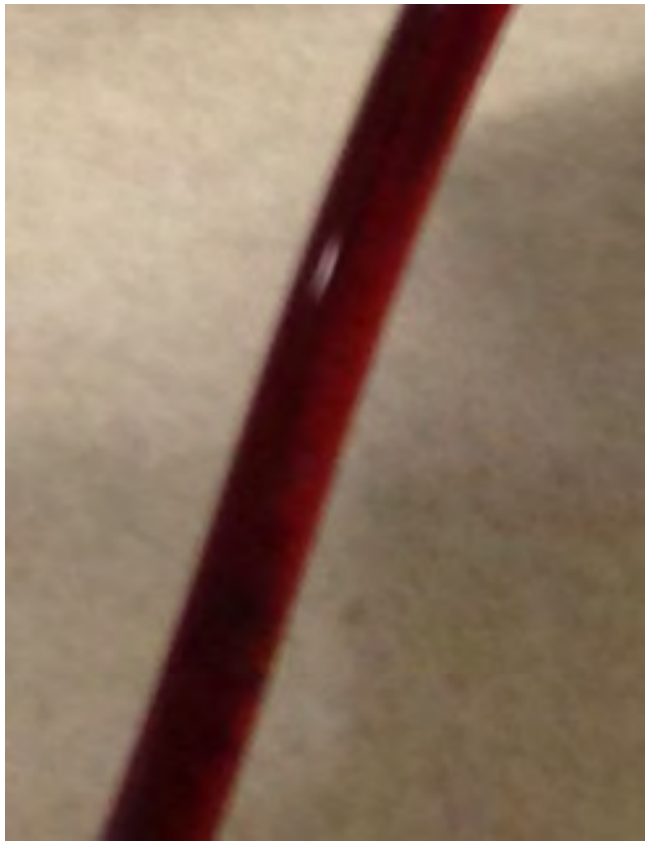
Pulmonary vein inflow Transmitral valvular gra

Post MitraClip



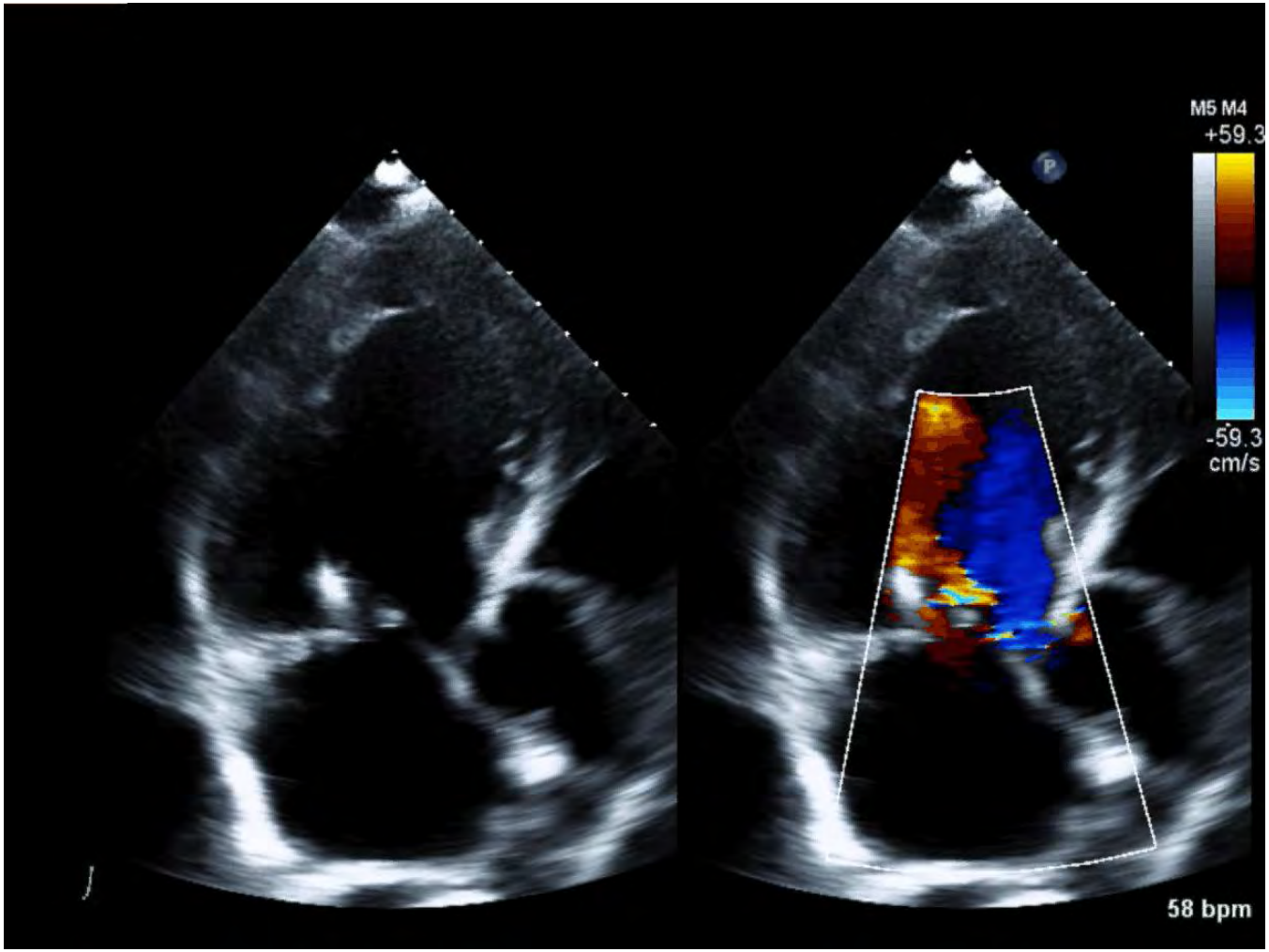
Urine color

Pre MitraClip



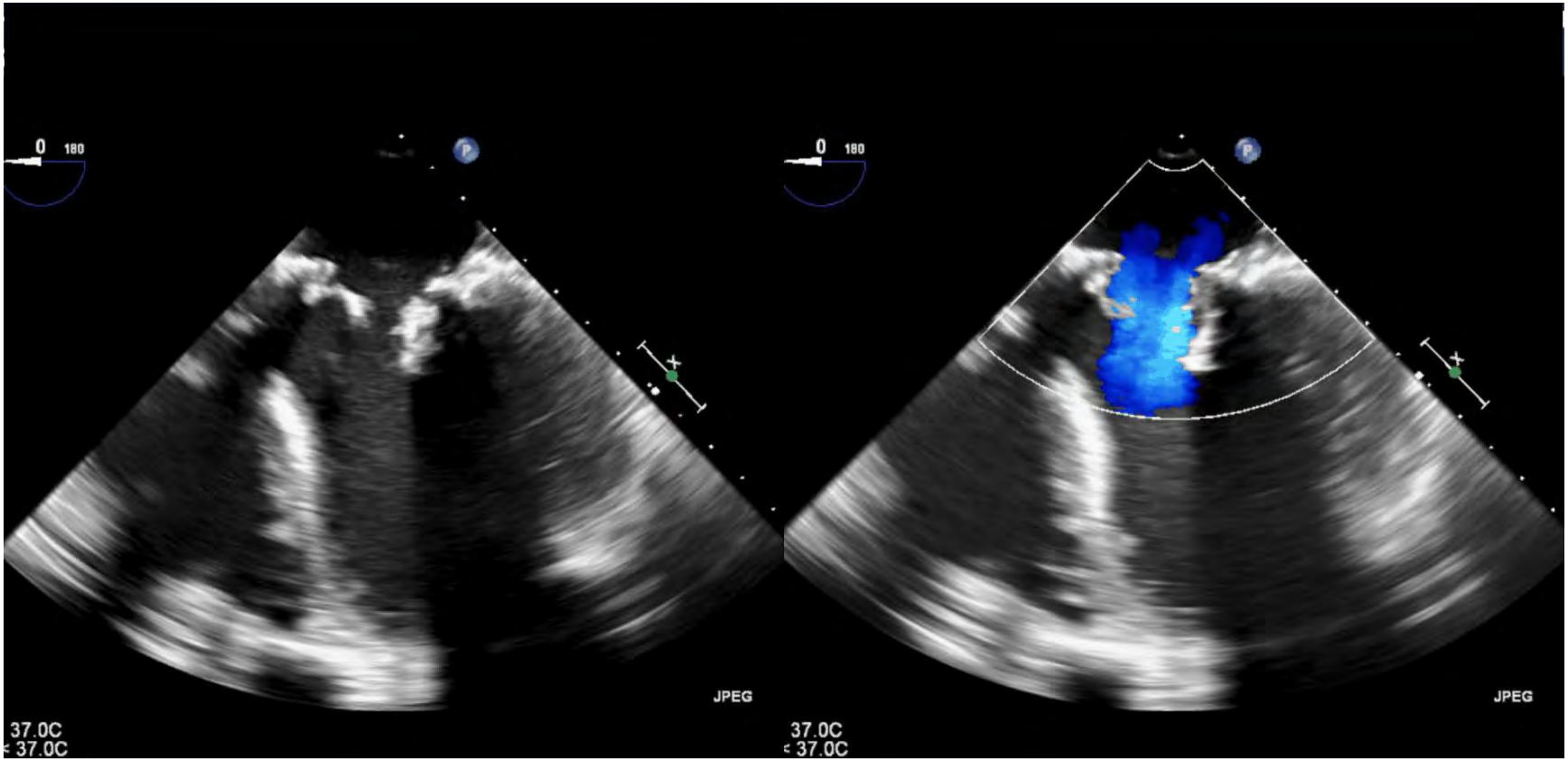
8 hour post MitraClip

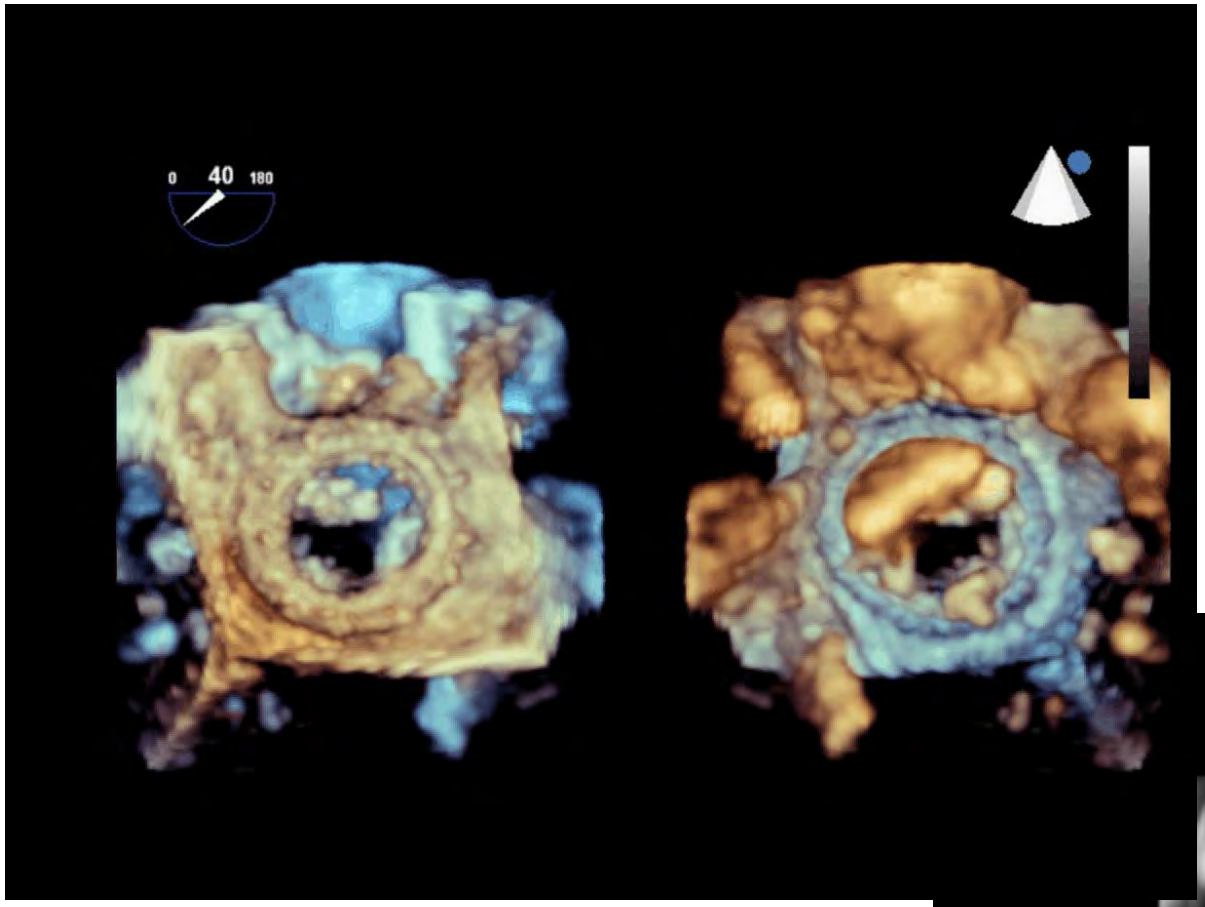
5 month post MitraClip therapy
Complete resolution of mitral regurgitation and hemolytic anemia

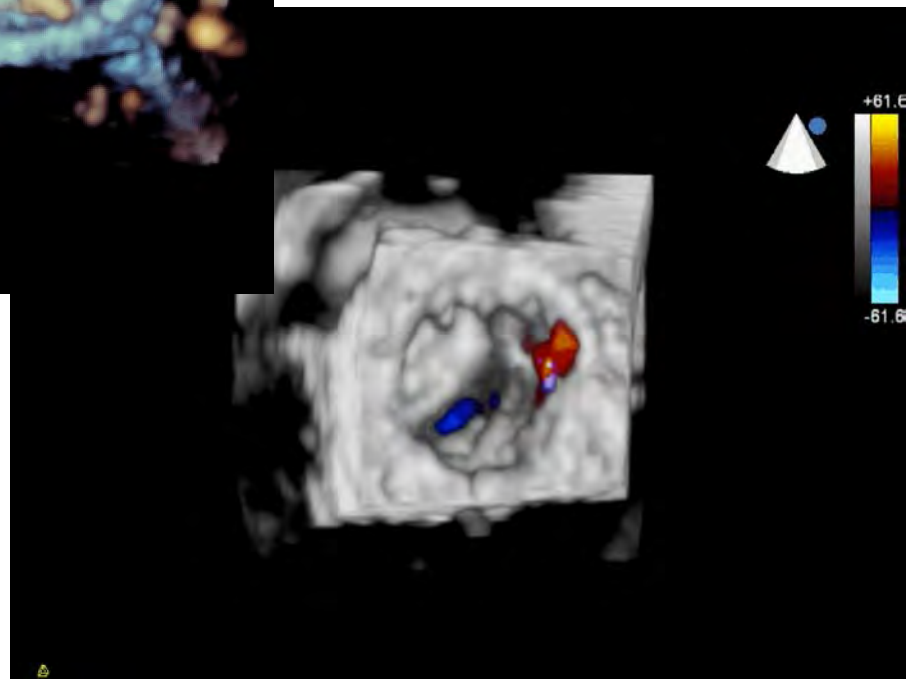


Transcatheter mitral repair

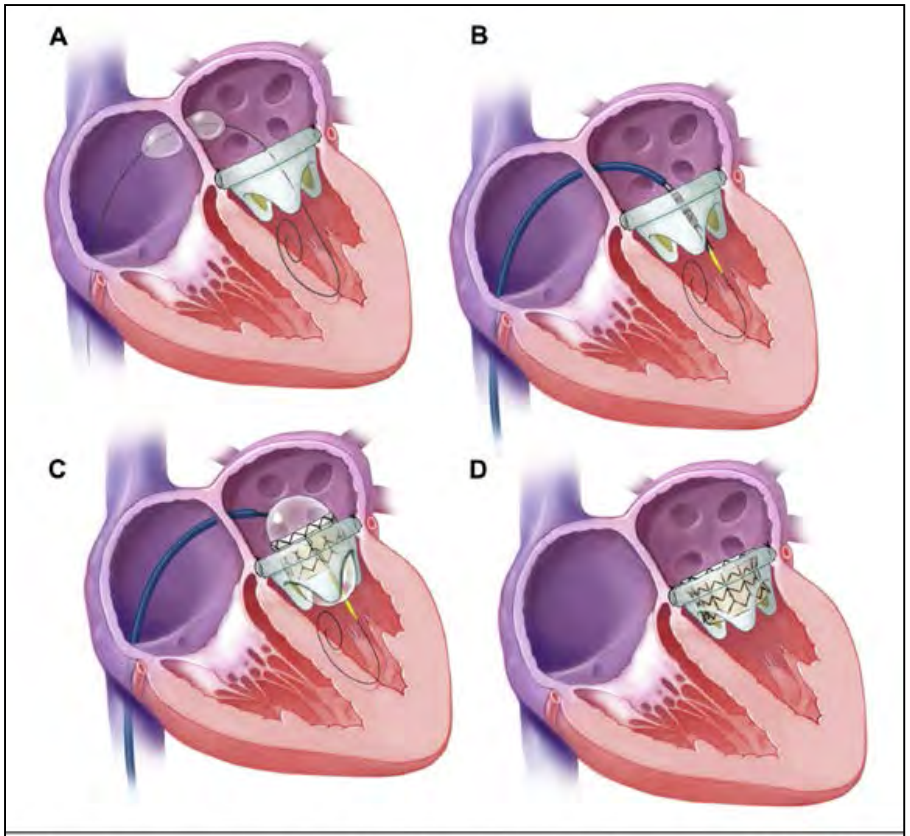
Degenerative mitral bioprosthetic valve


0
180
JPEG
37.0C
37.0C
0
180
JPEG
37.0C
37.0C


0
40
180

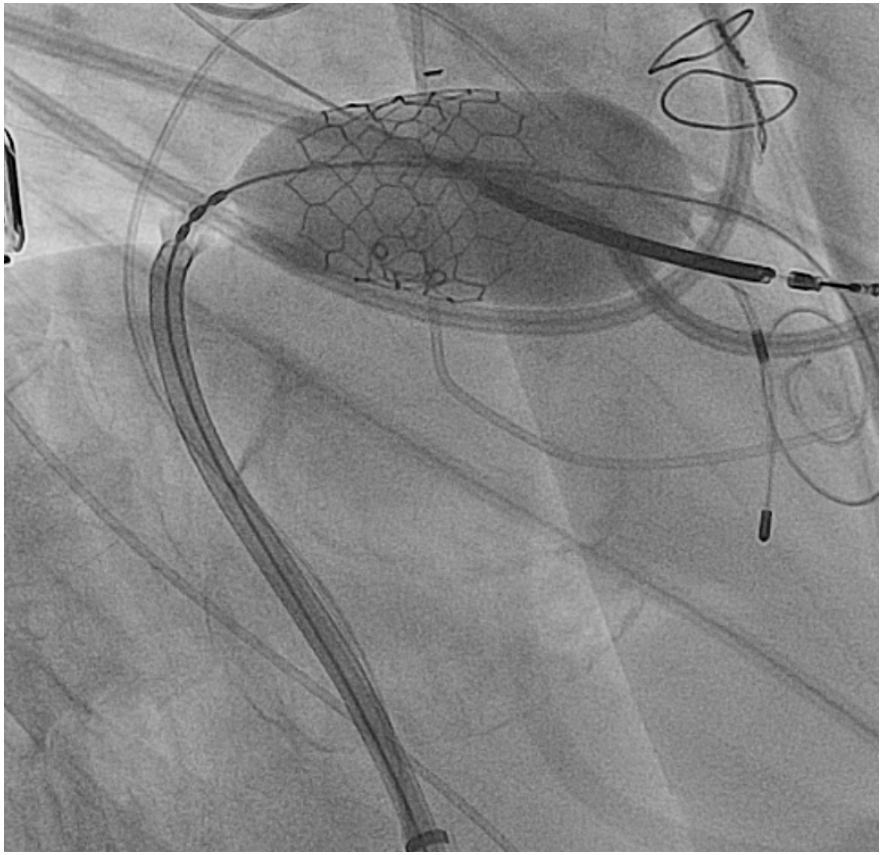

+61.6
-61.6

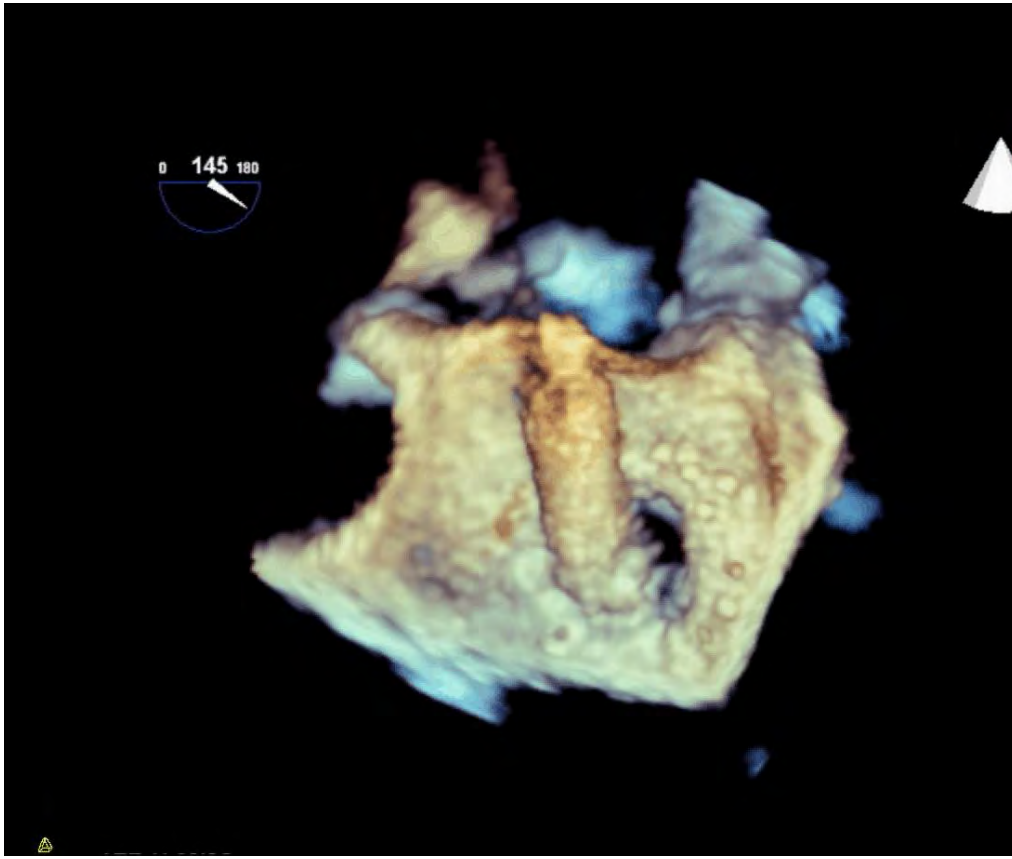
Transvenous Transseptal Mitral Valve-in- Valve Procedure

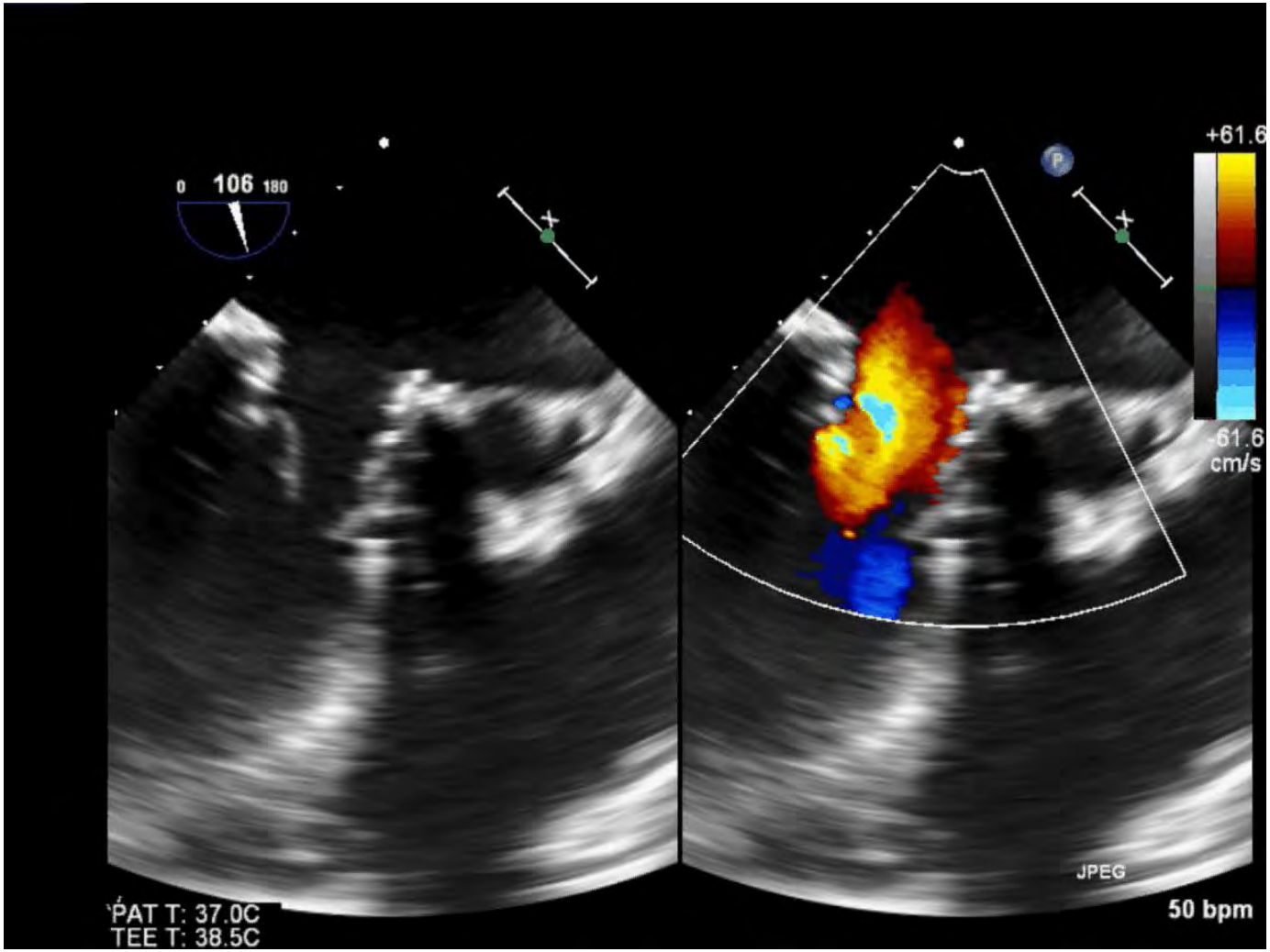


(A) Balloon atrial septostomy is performed to allow SAPIEN valve (Edwards Lifesciences, Irvine, California) delivery. **(B)** SAPIEN valve is carefully positioned within prosthesis over a left ventricular anchor wire. **(C)** Balloon expandable SAPIEN valve is deployed within the surgical valve, and **(D)** equipment is removed.

Sapien S3 in the 31mm Mosaic bioprosthesis






0
106
180
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
TEE T: 38.5C
50 bpm

In case you don’t know……

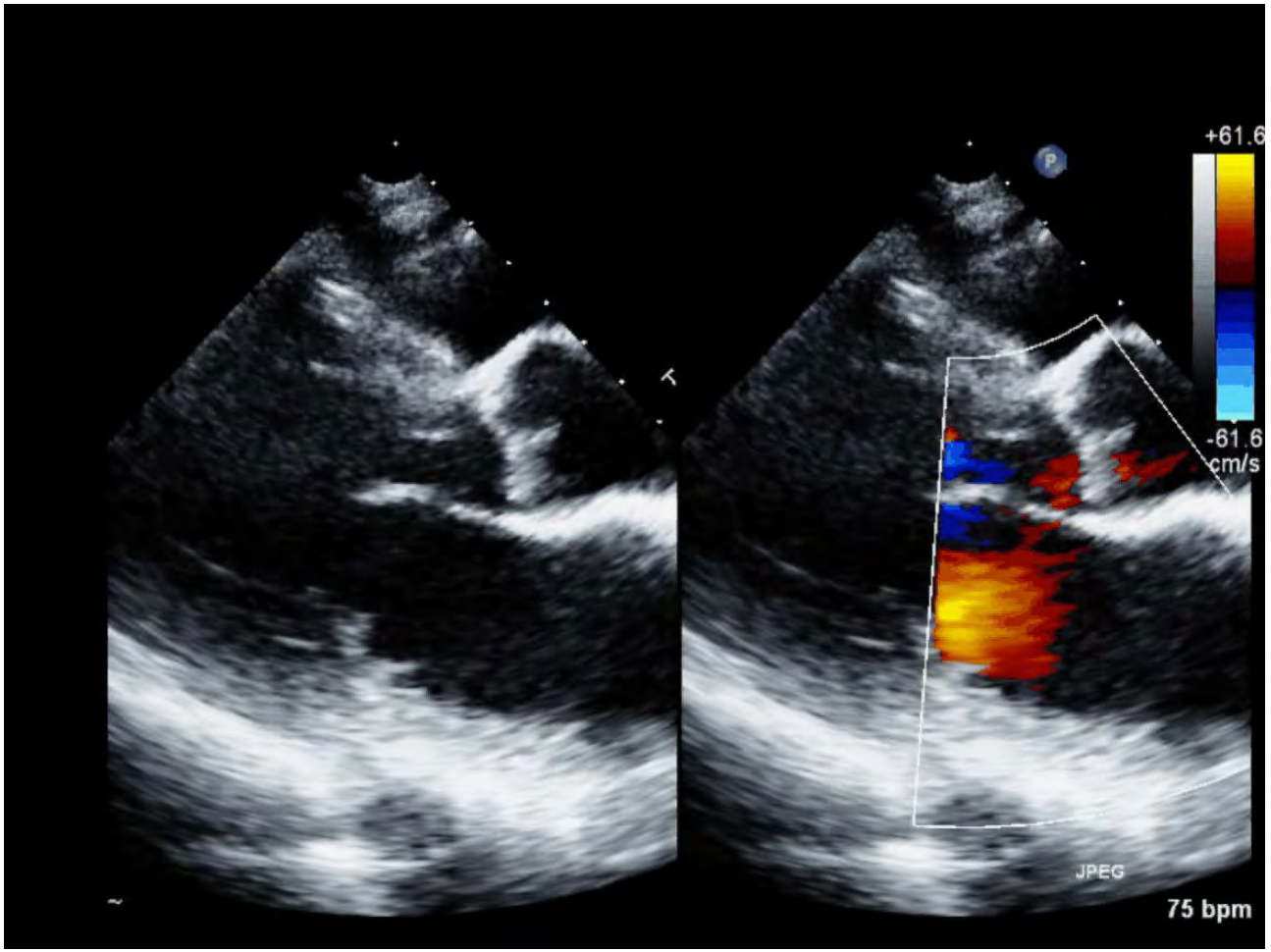
Mitre

The word *mitral* (/ˈmaɪtrəl/) comes from Latin, meaning "shaped like a mitre" (bishop's hat).

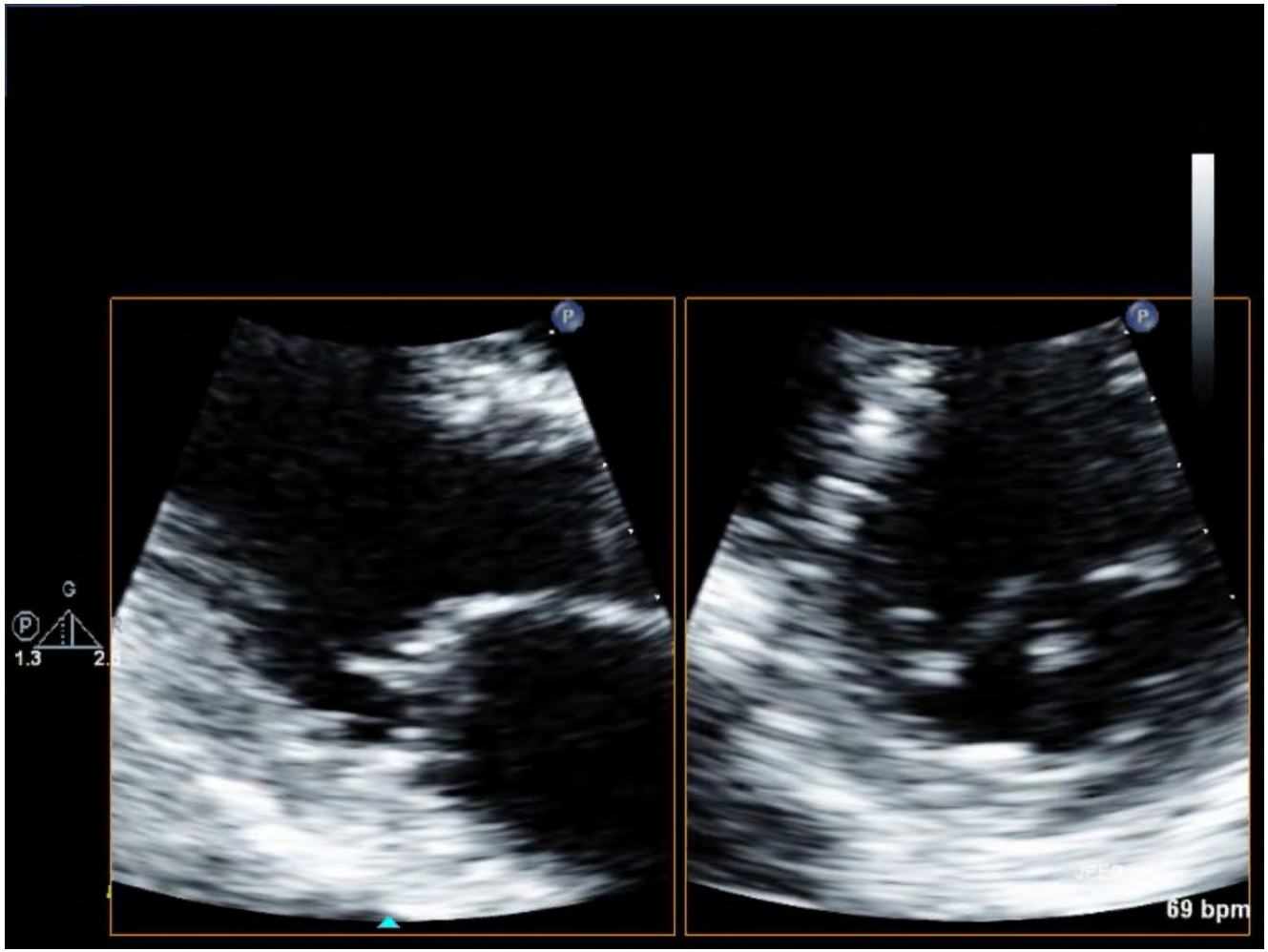
The word *bicuspid* uses combining forms of *bi-*, from Latin, meaning "double", and *cusp*, meaning "point", reflecting the dual-flap shape of the valve.

Thank You!!!

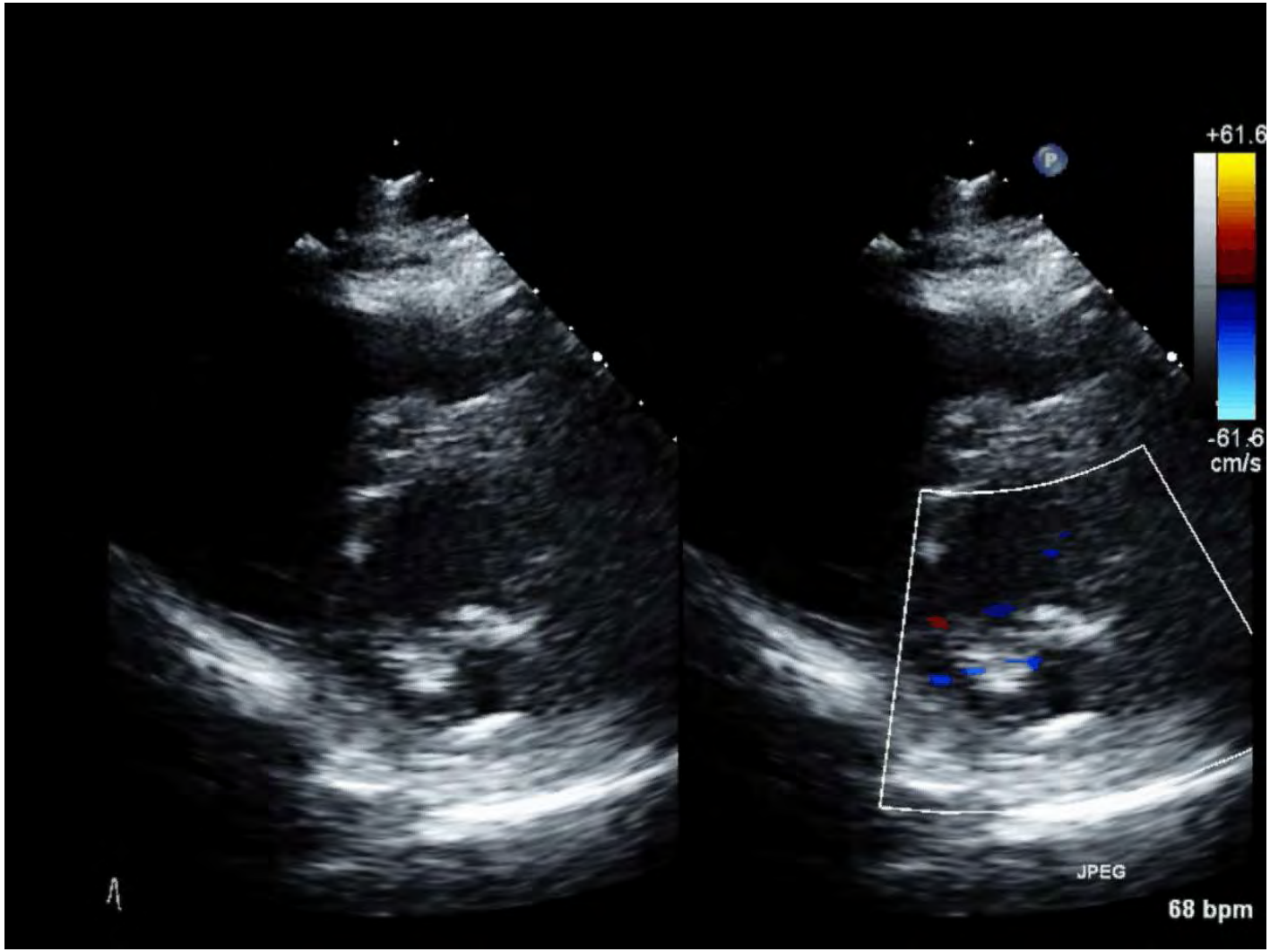
Case 1



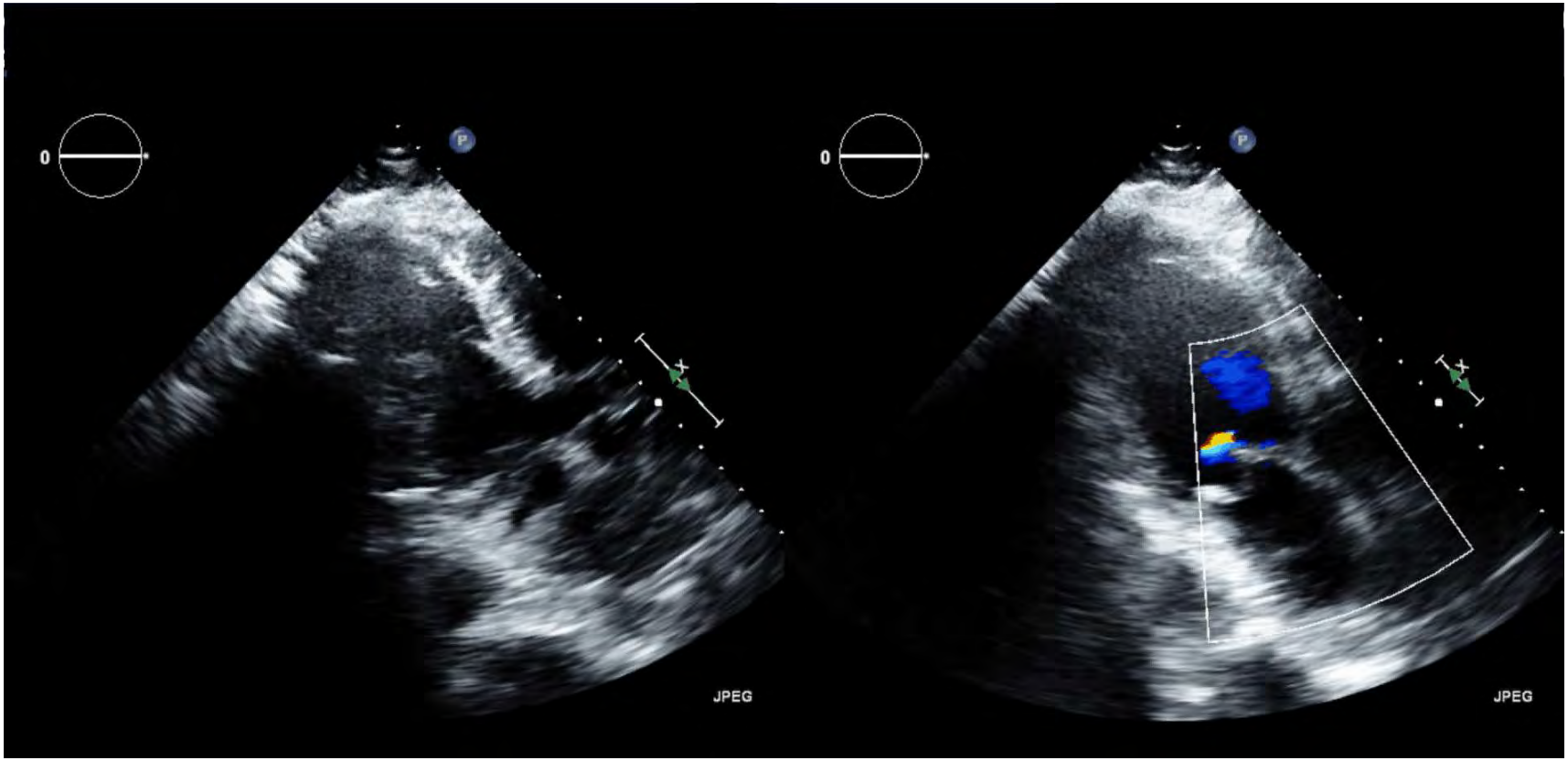
Case 1



Case 1



Case 1



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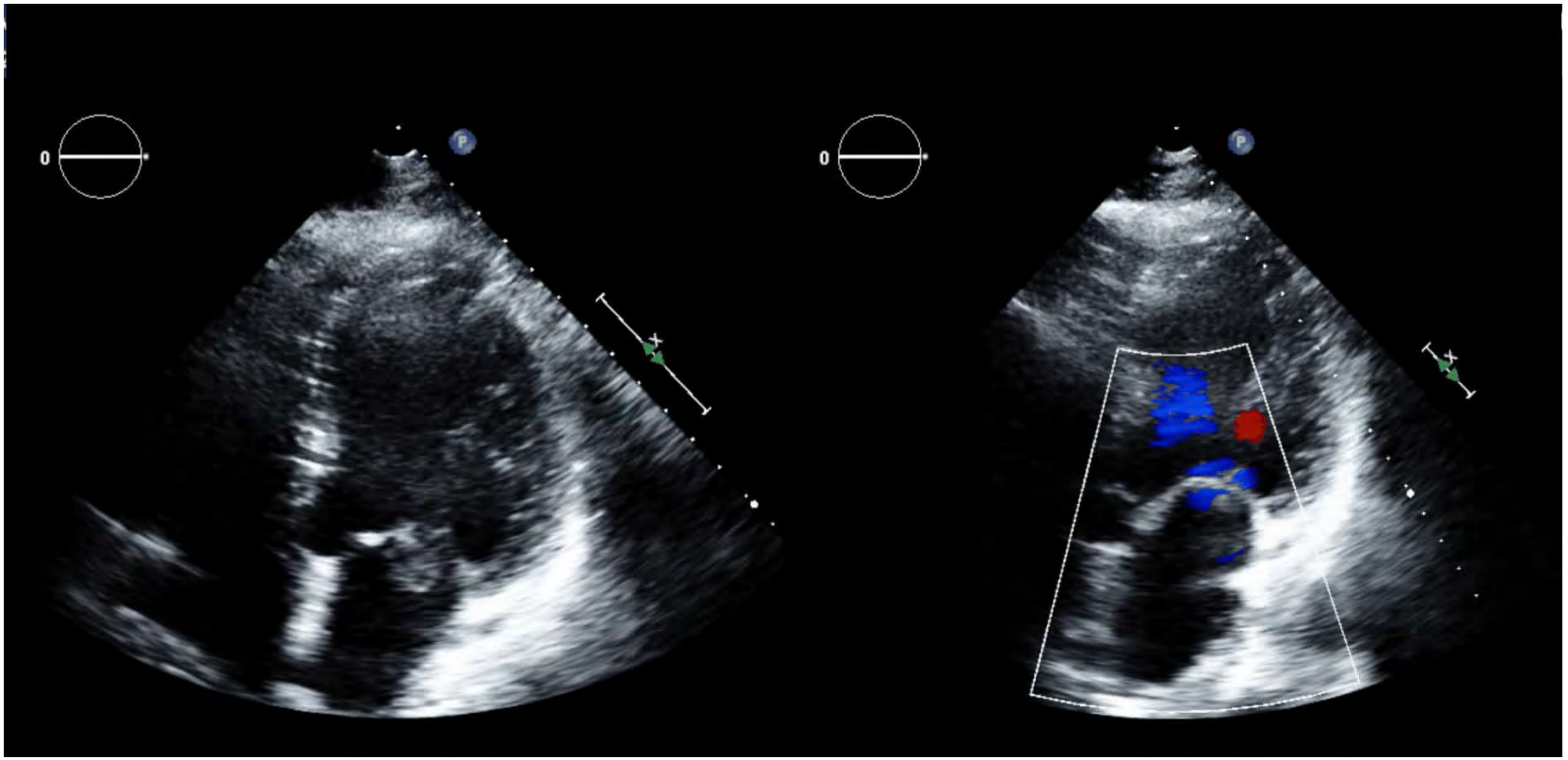
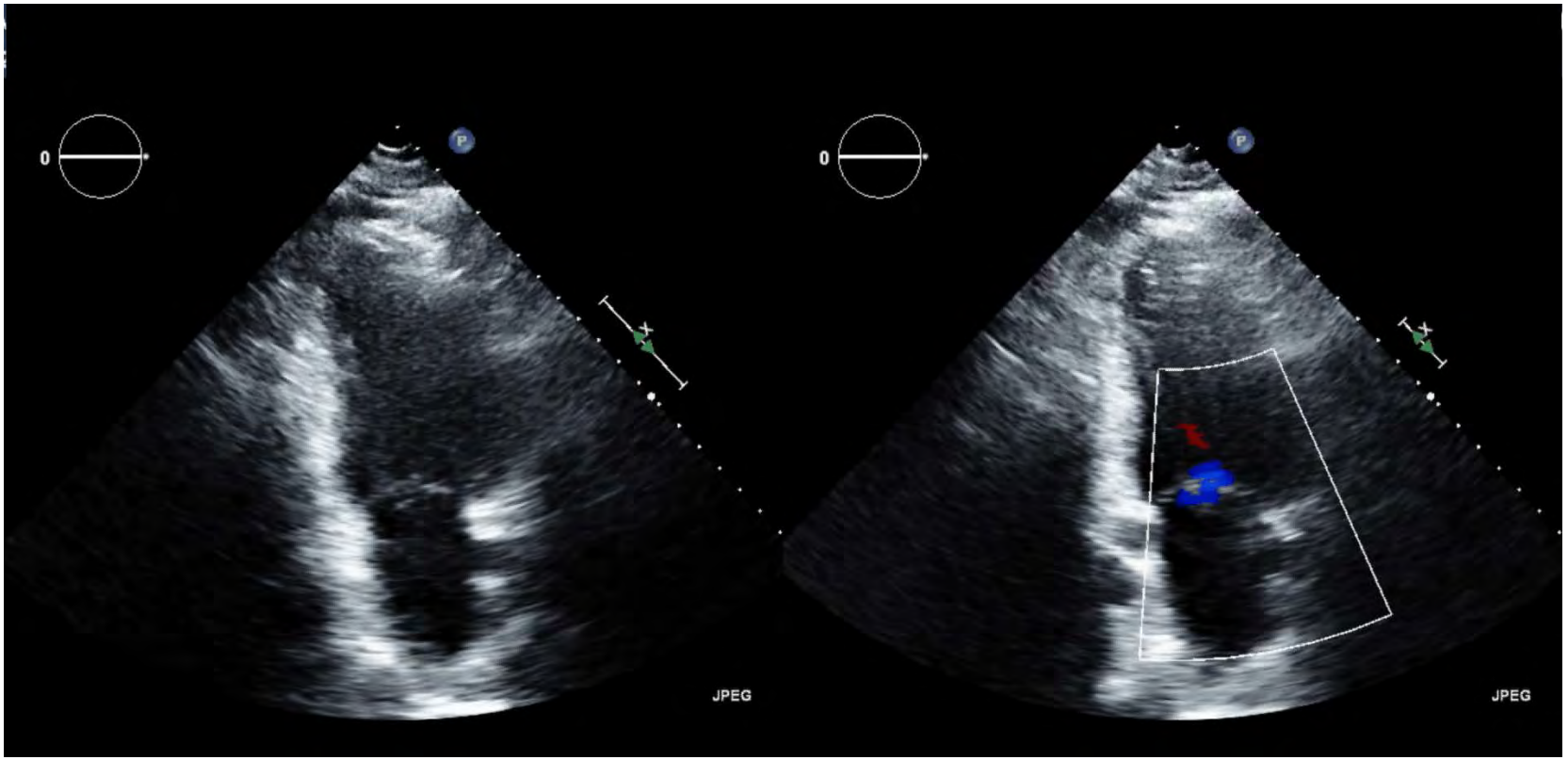
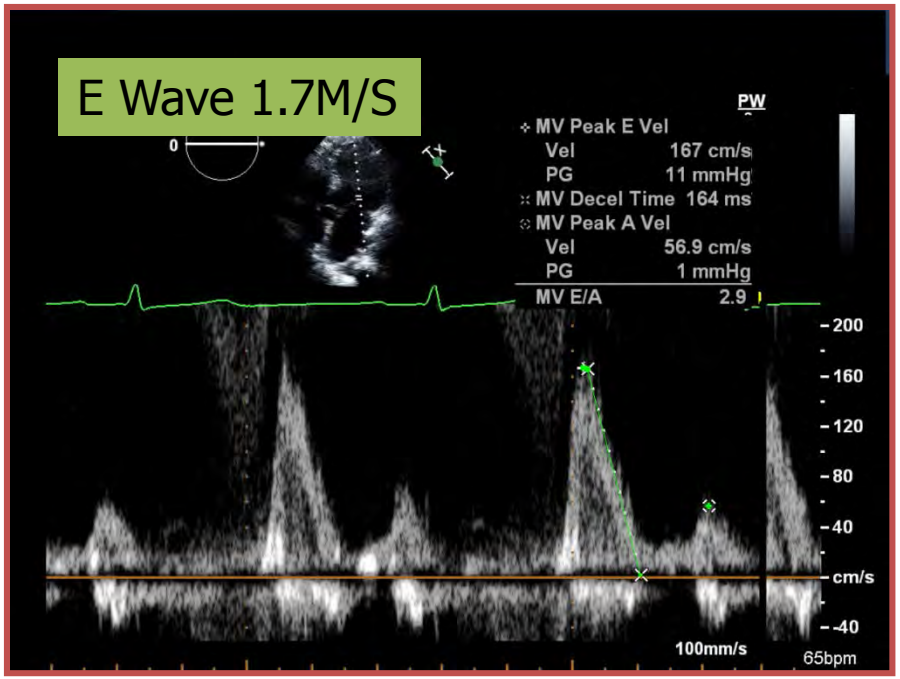
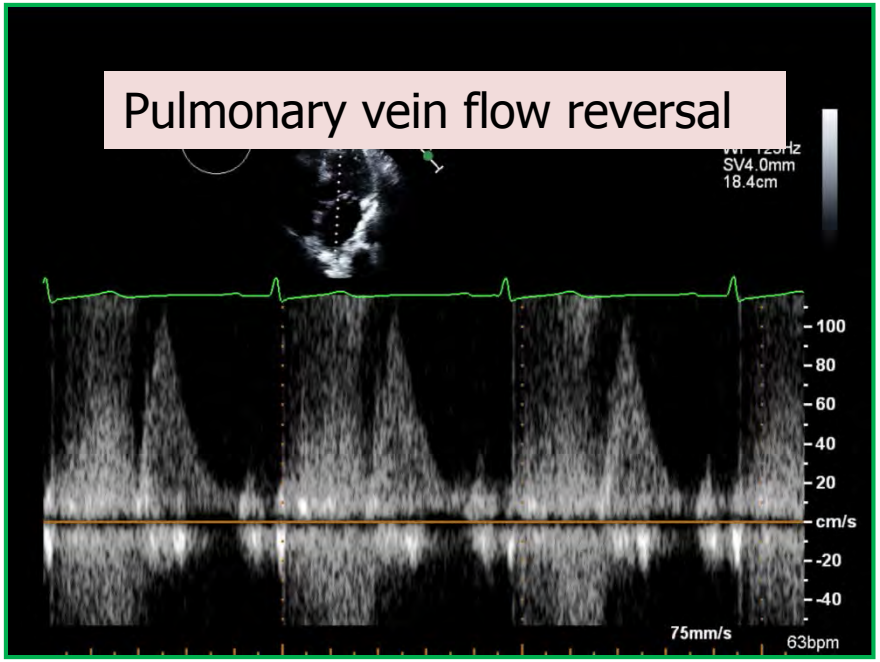
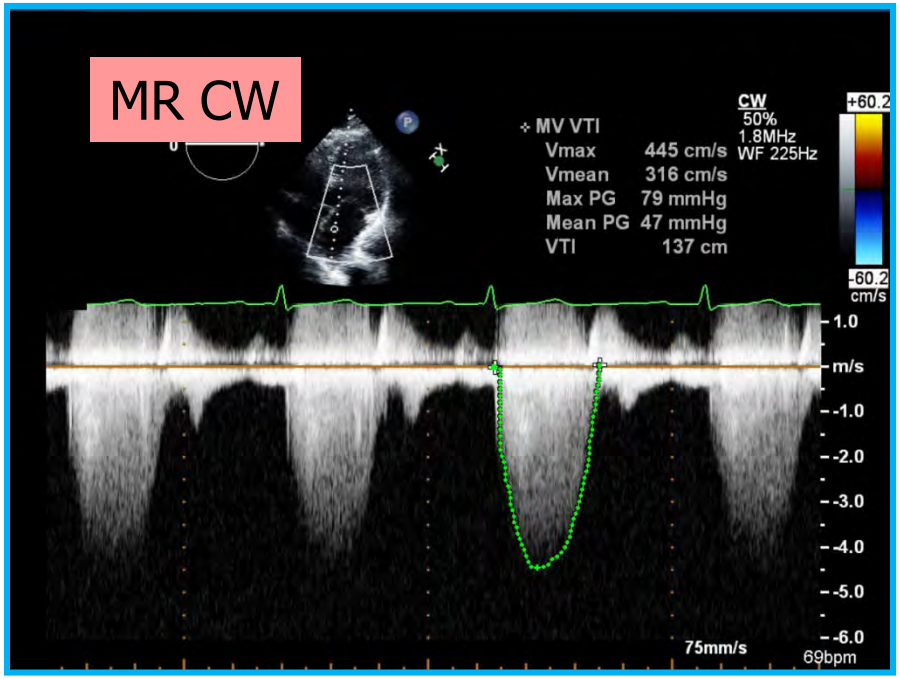


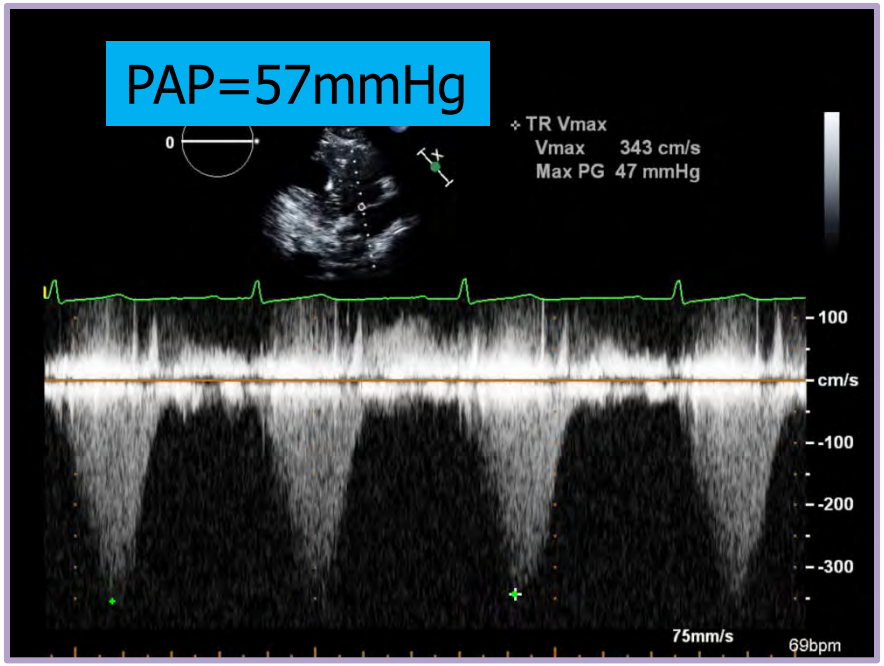
Case 1



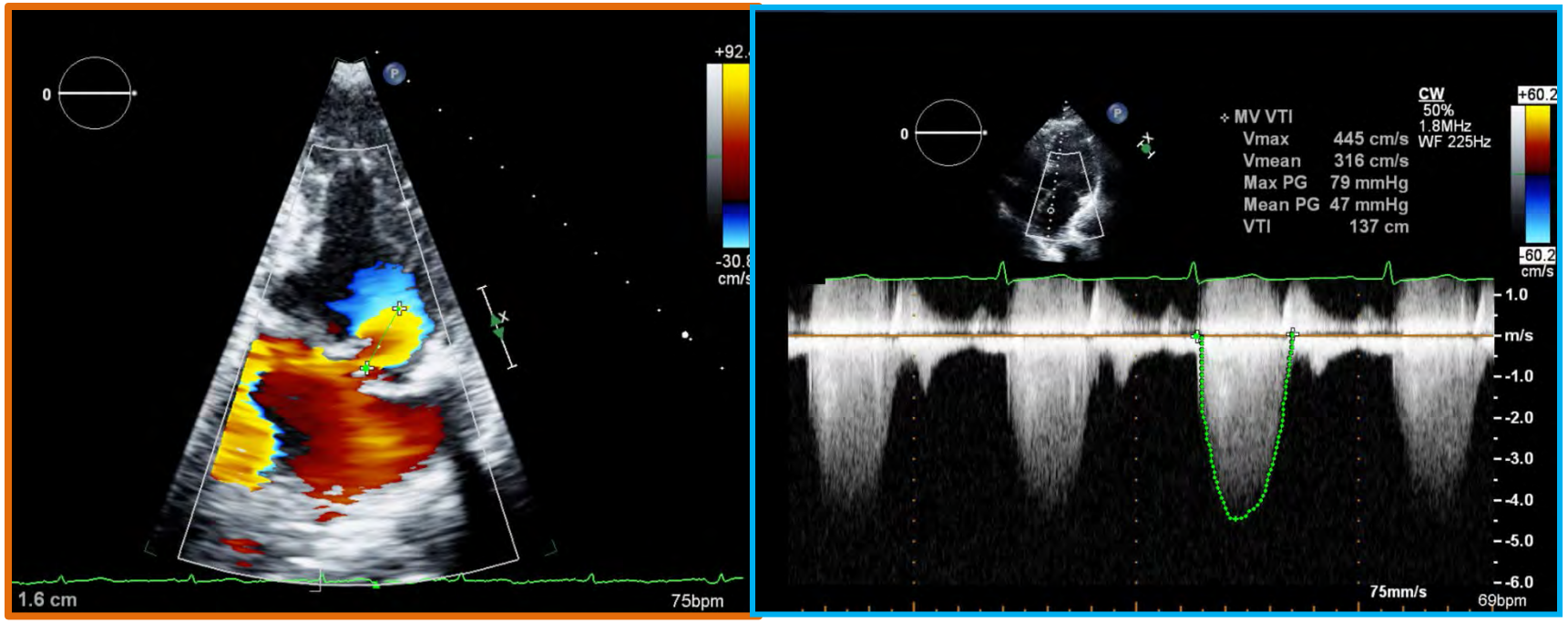

E Wave 1.7M/S
PW
MV Peak E Vel
Vel 167 cm/s
PG 11 mmHg
MV Decel Time 164 ms
MV Peak A Vel
Vel 56.9 cm/s
PG 1 mmHg
MV E/A 2.9
200
160
120
80
40
cm/s
-40
100mm/s
65bpm


Pulmonary vein flow reversal
SV4.0mm
18.4cm
100
80
60
40
20
cm/s
-20
-40
75mm/s
63bpm


MR CW
CW
50%
1.8MHz
WF 225Hz
MV VTI
Vmax 445 cm/s
Vmean 316 cm/s
Max PG 79 mmHg
Mean PG 47 mmHg
VTI 137 cm
+60.2
-60.2
cm/s
1.0
m/s
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
75mm/s
69bpm

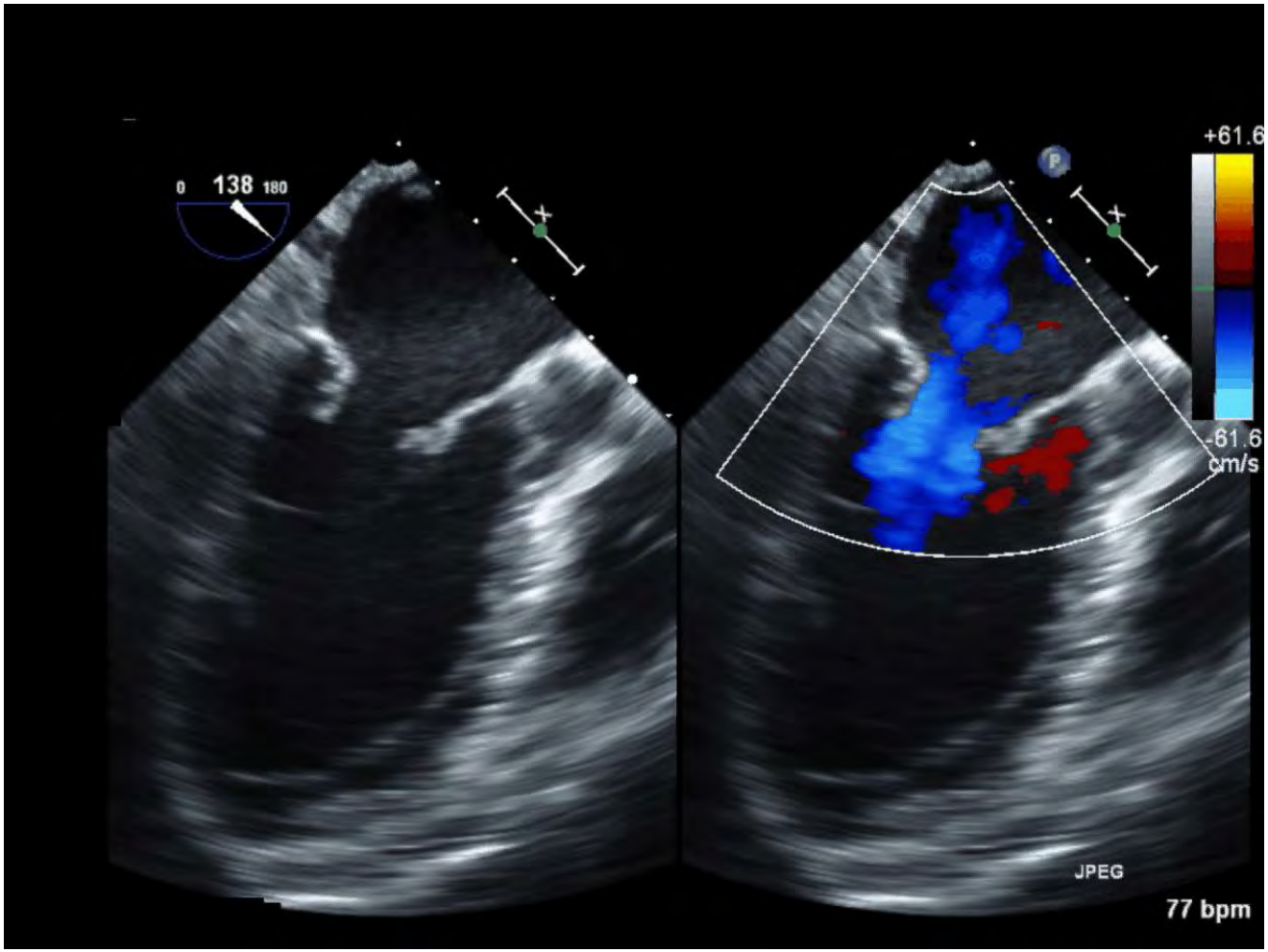

PAP=57mmHg
TR Vmax
Vmax 343 cm/s
Max PG 47 mmHg
100
cm/s
-100
-200
-300
75mm/s
69bpm

Case 1

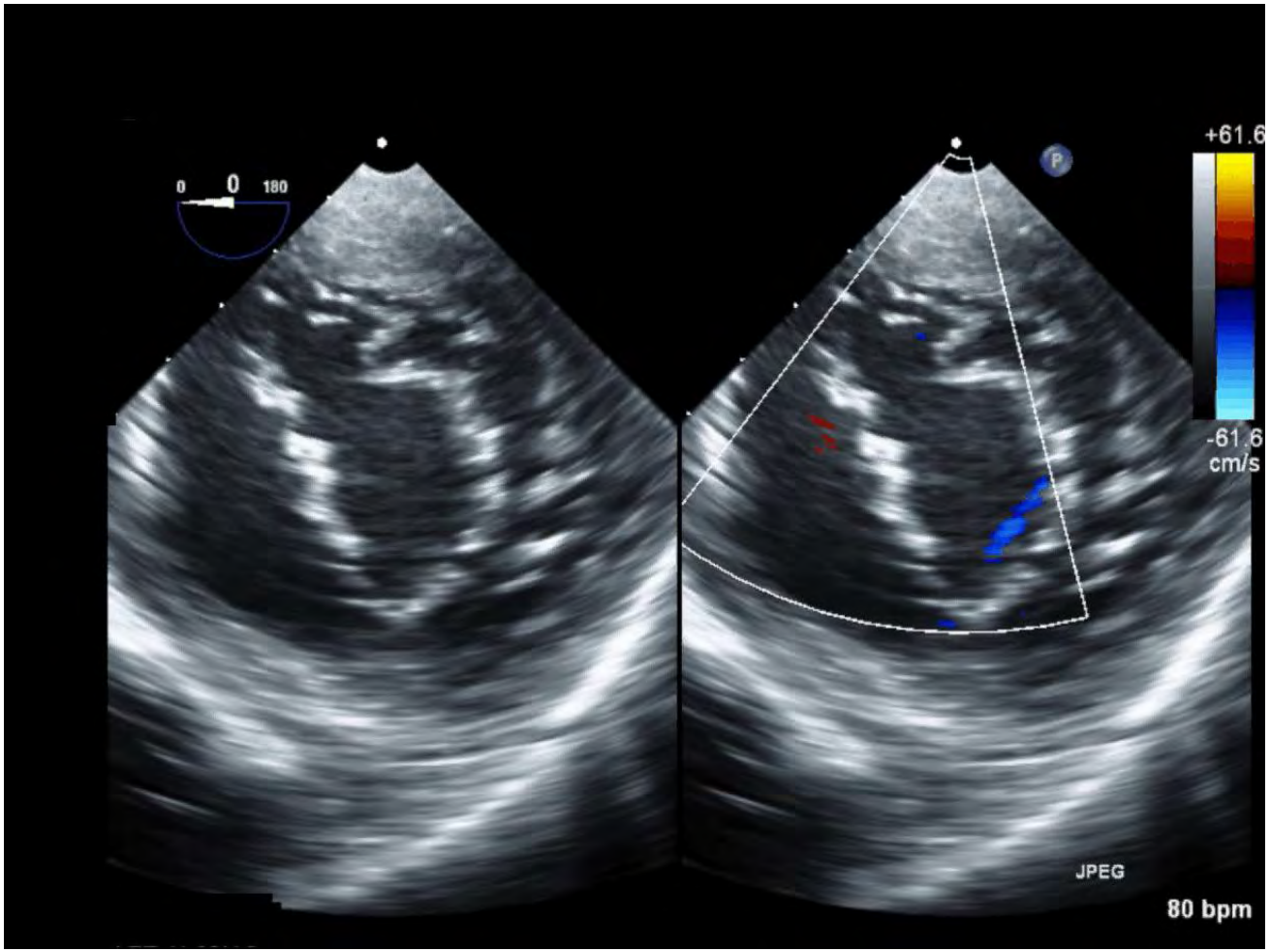


PISA radius=1.6cm

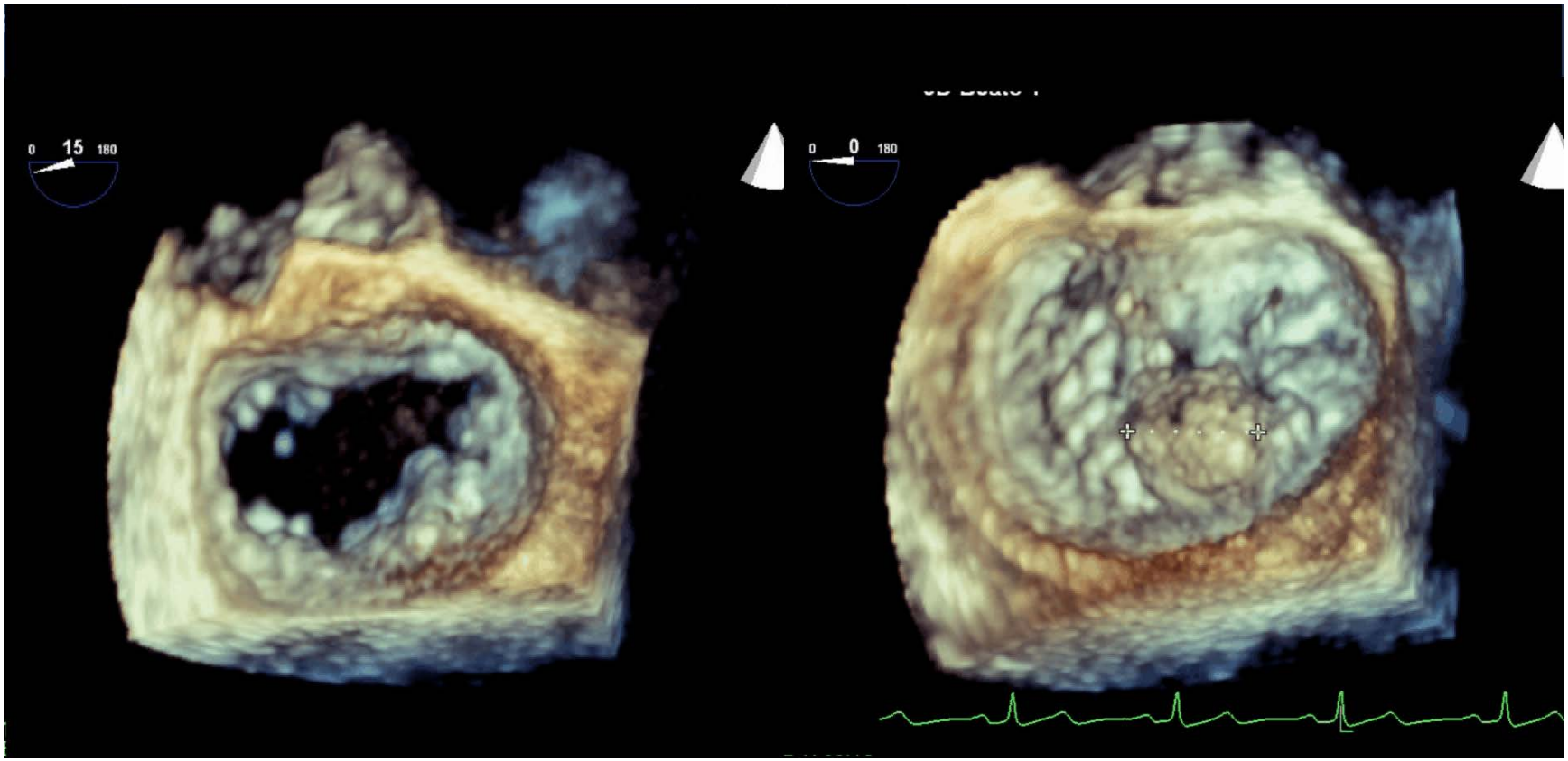
Case 1---TEE



Case 1---TEE

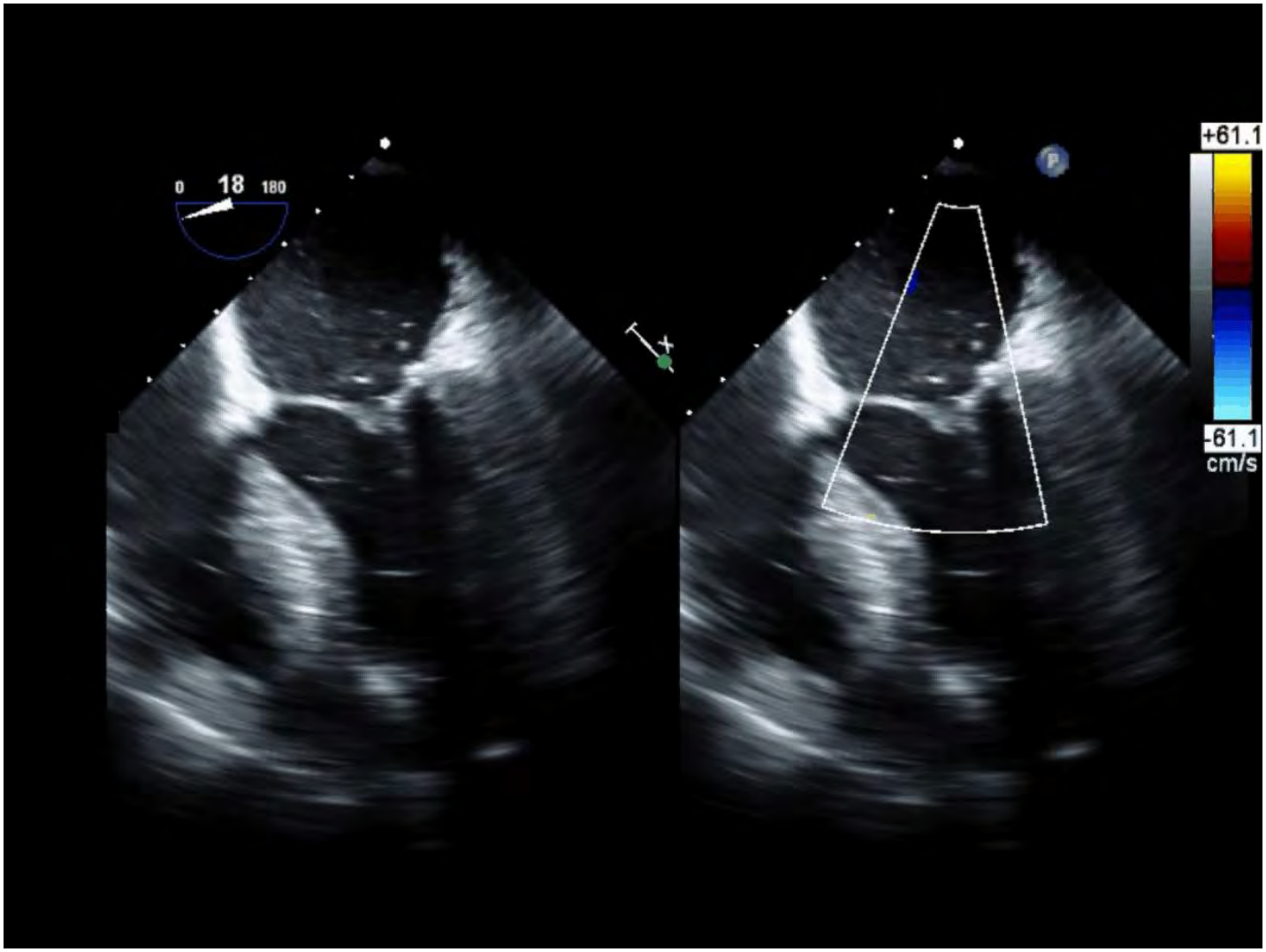


Case 1---TEE

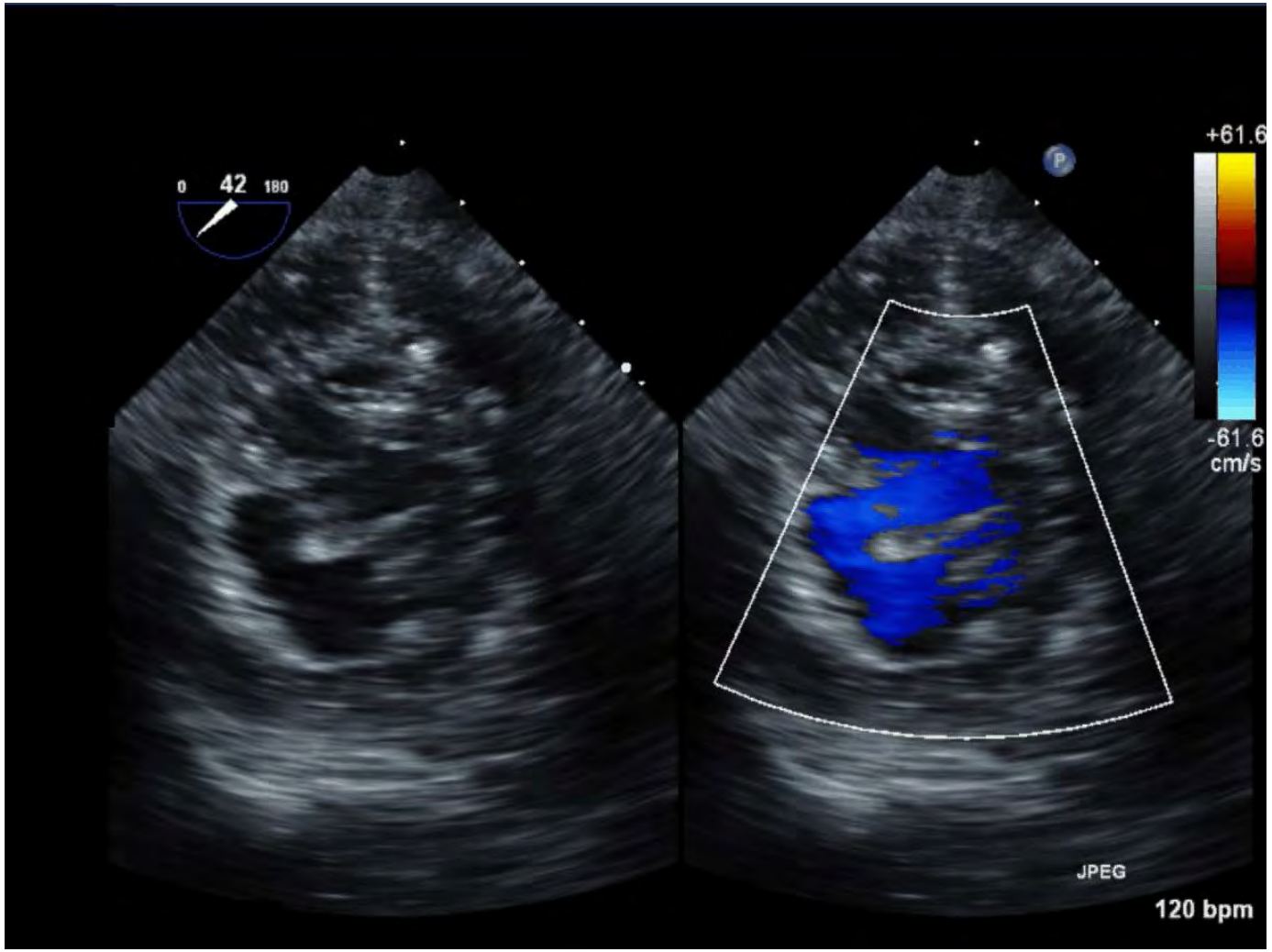


Flail segment =2.2cm

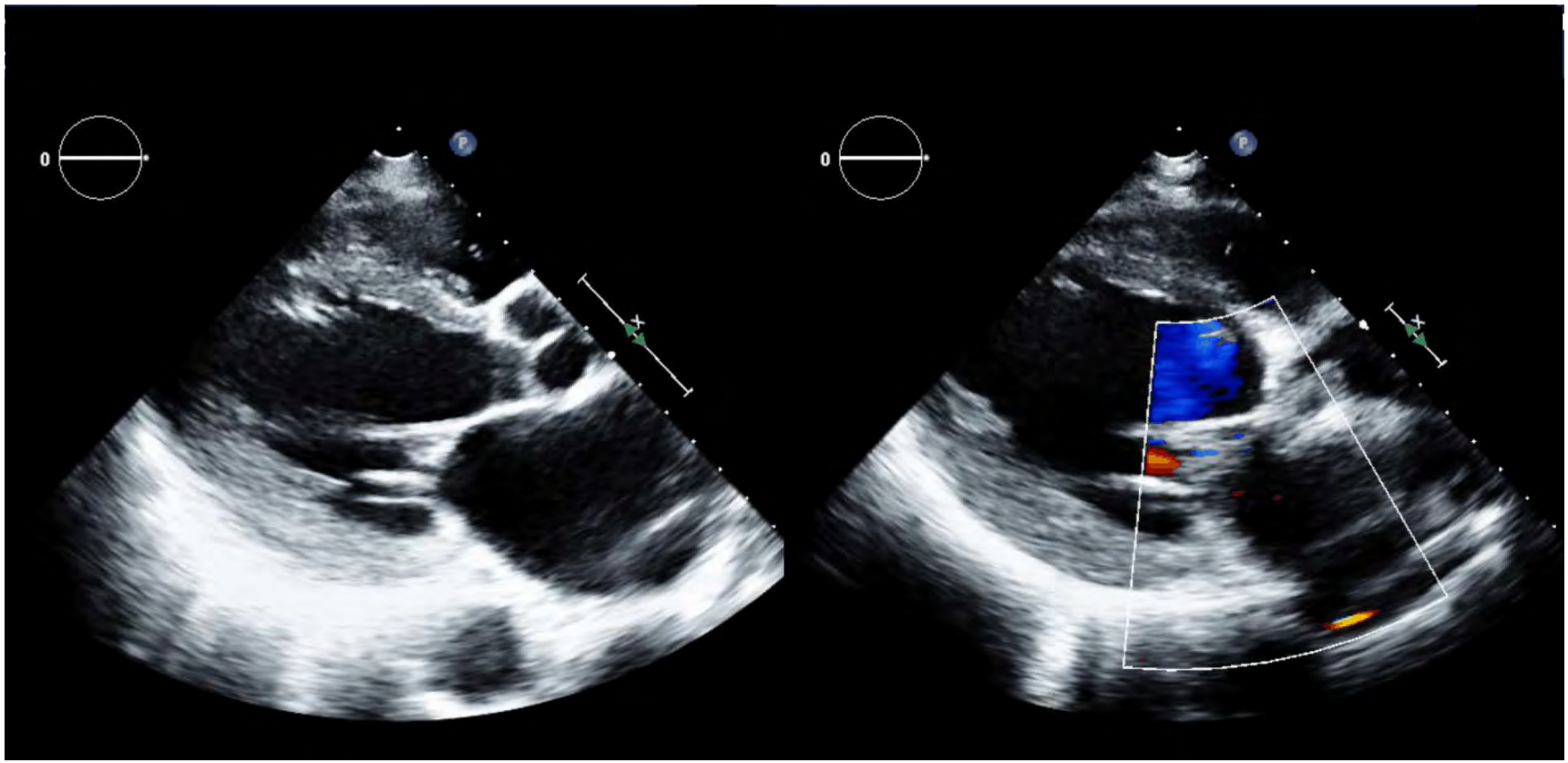
Case 1---Post Mitral Valve Repair TEE



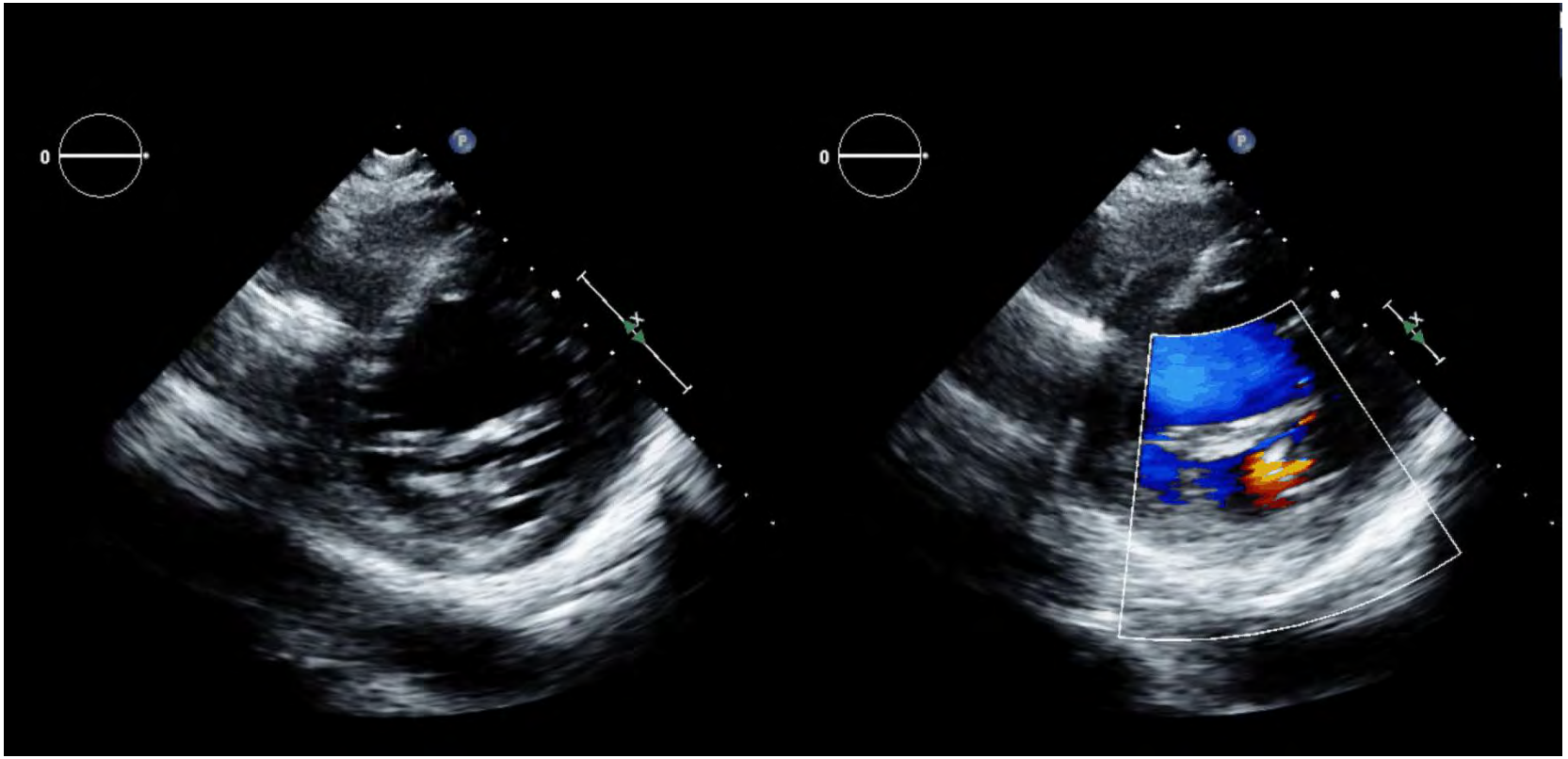
Case 1--- Post Mitral Valve Repair TEE



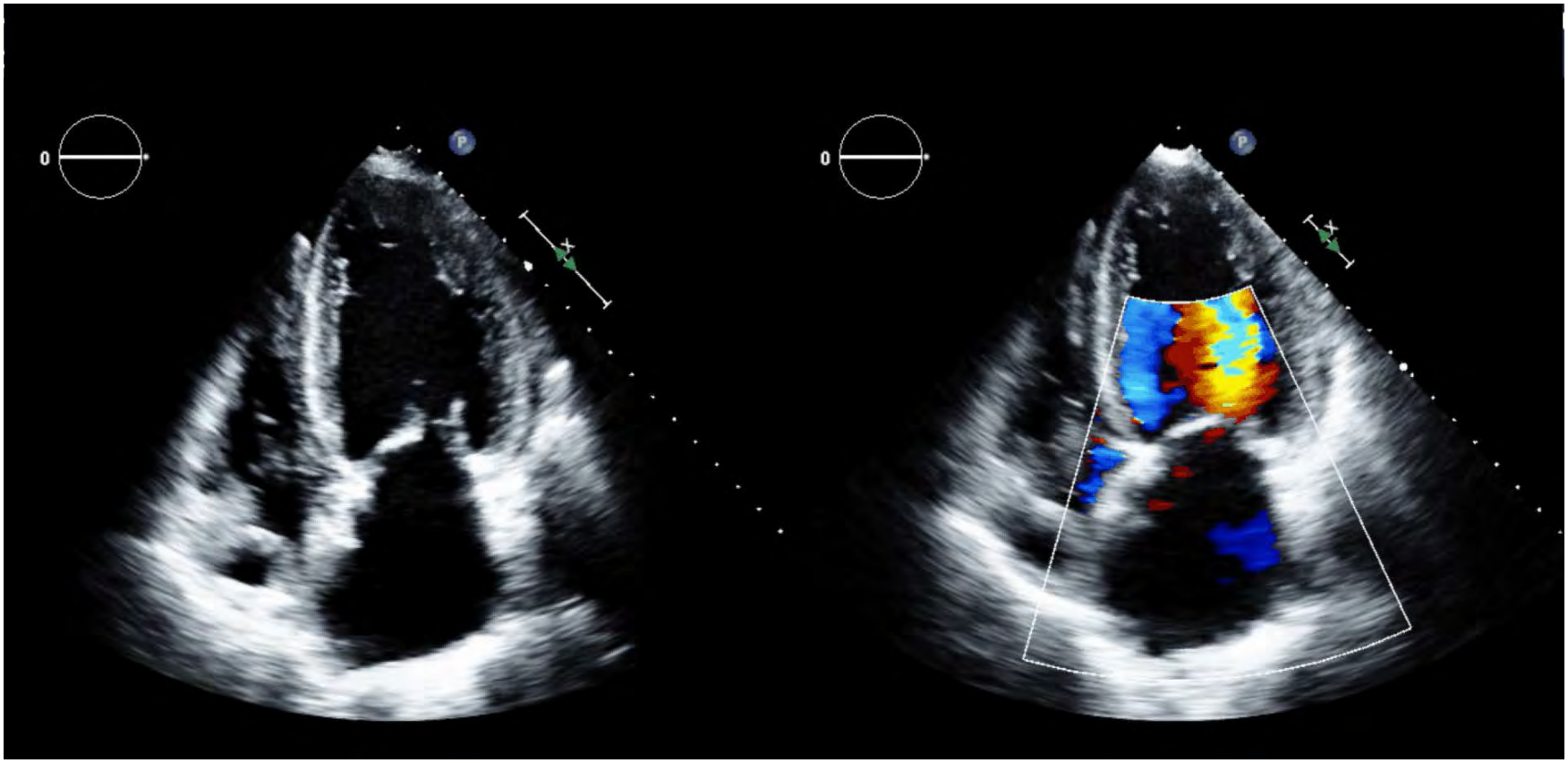
Case 2



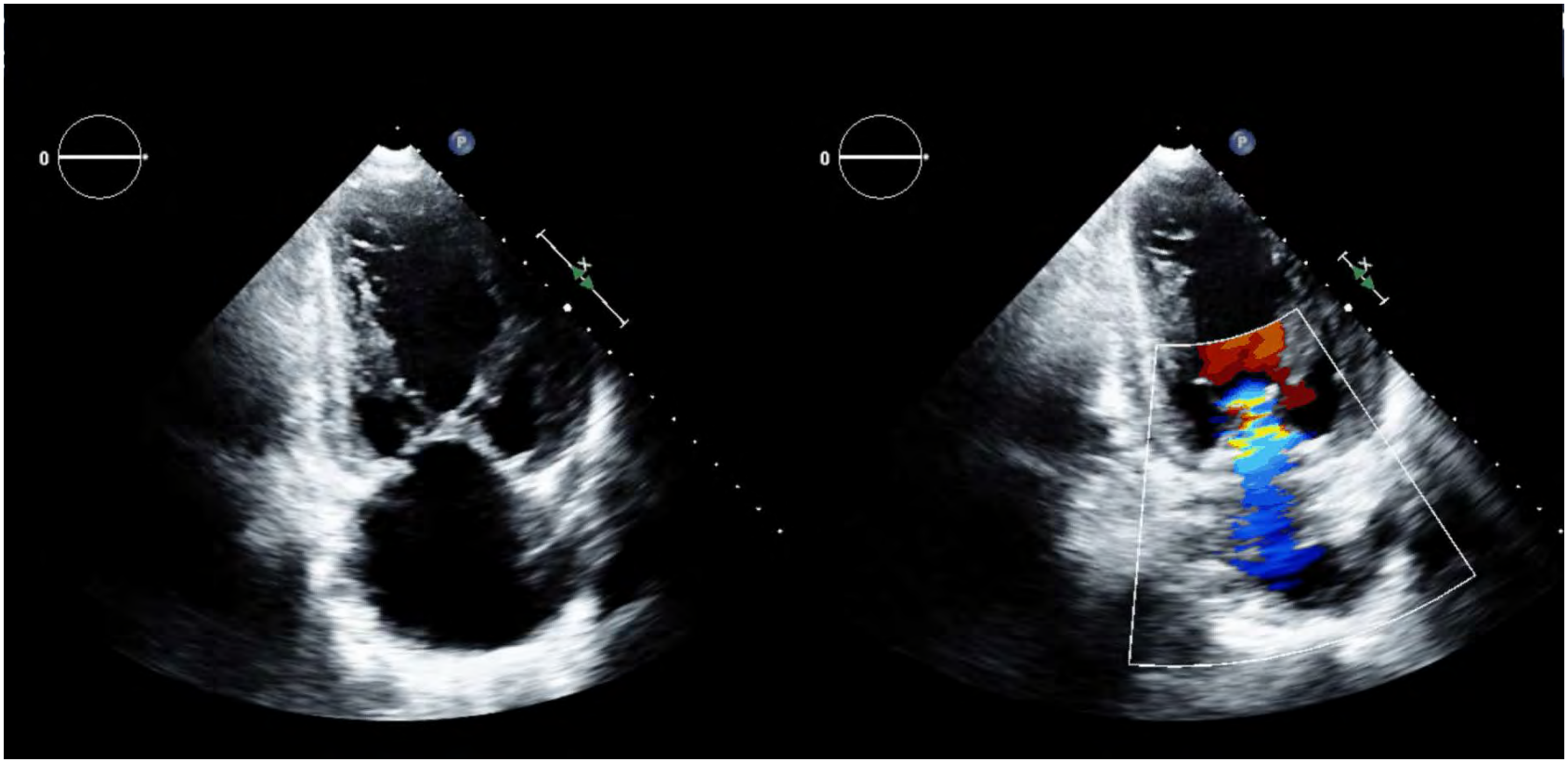
Case 2



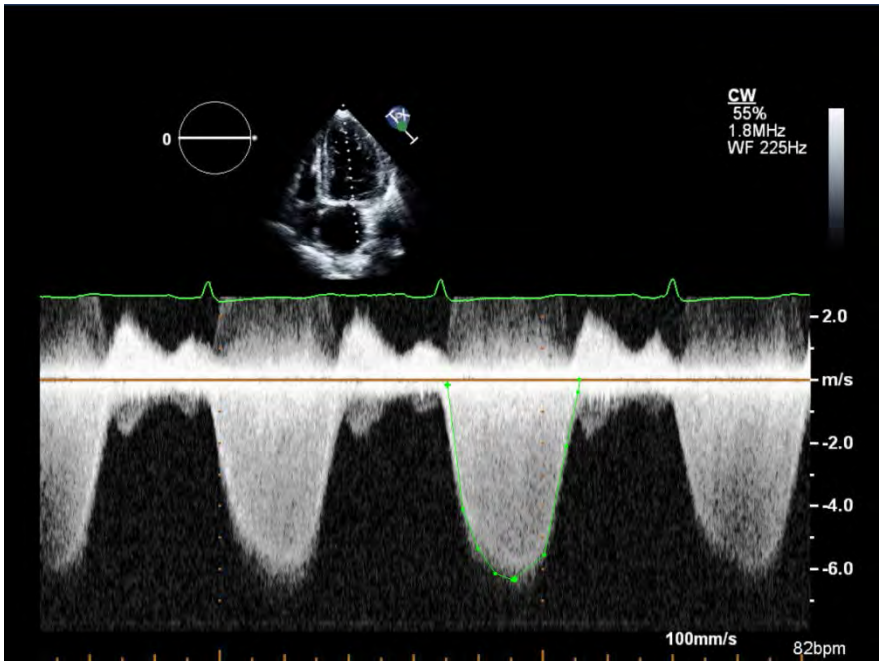
Case 1---TEE

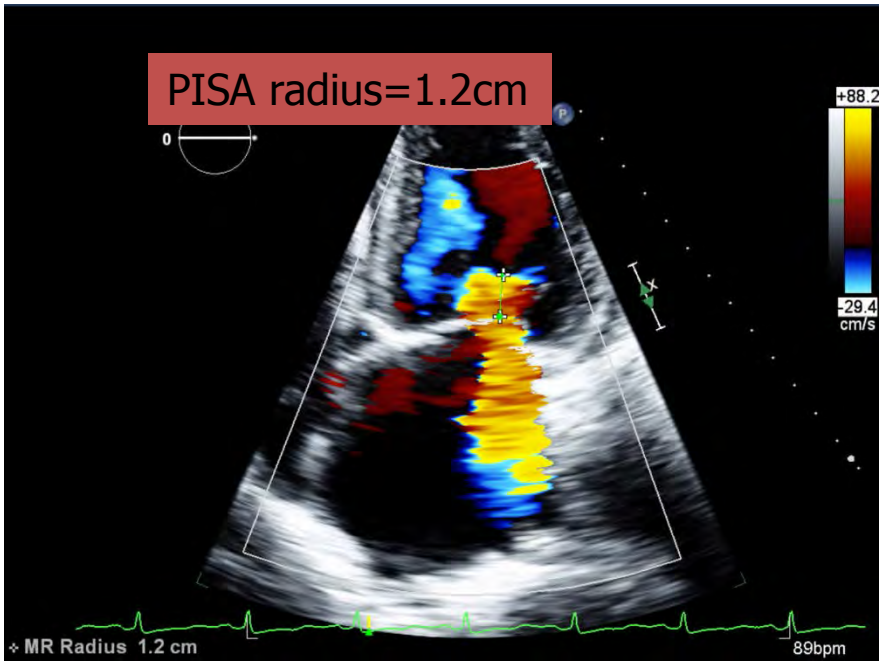


Case 1---TEE



Case 1---TEE





ERO=0.3cm2 R volume=60ml