Aortic Regurgitation

Assessment of severity *Indications for surgery*

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Aortic regurgitation *results from the improper or inadequate coaptation of the aortic valve leaflets during diastole*

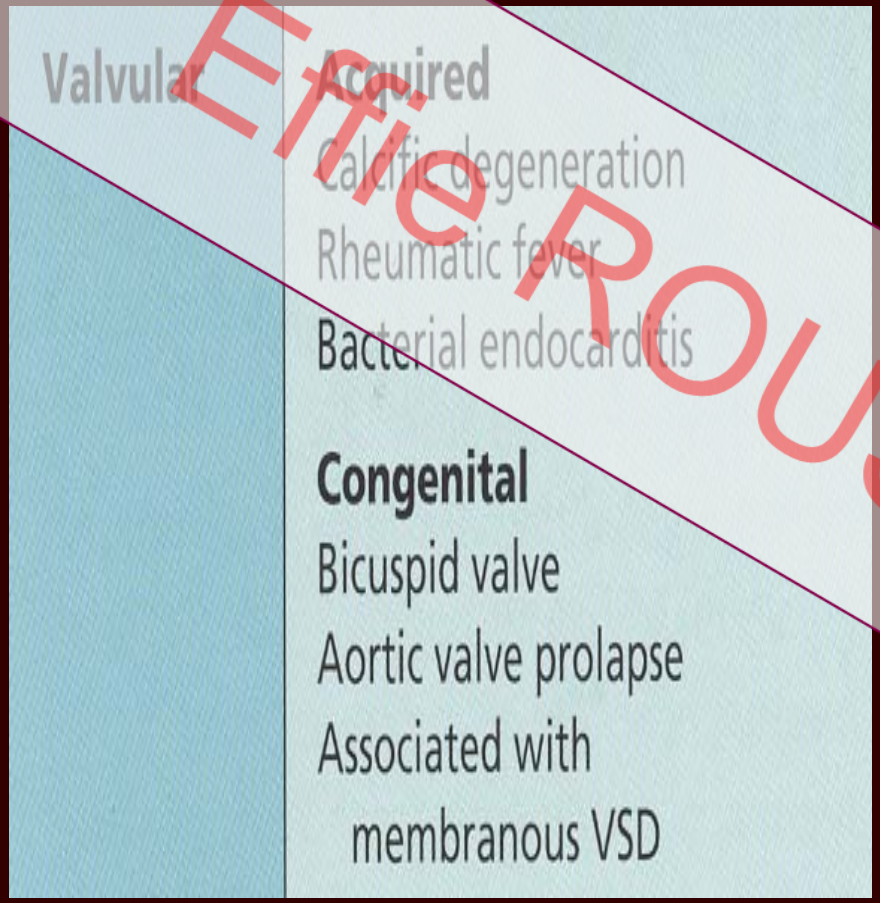
ACUTE

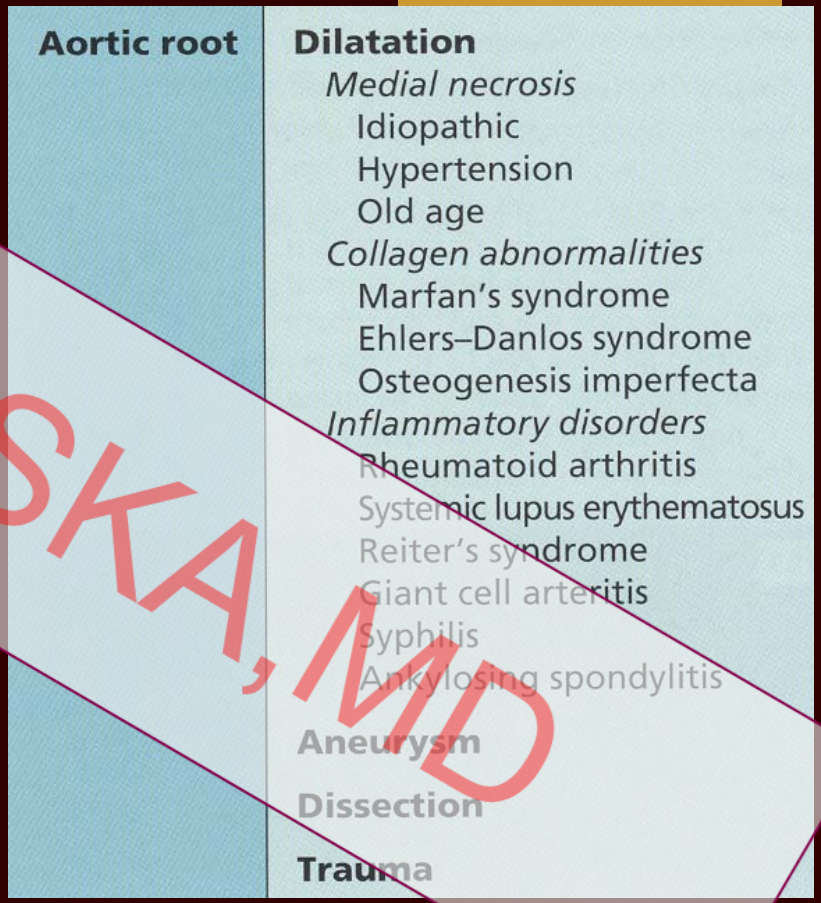
- Endocarditis
- Trauma
- Aortic dissection

CHRONIC

Causes of AR

? Recently Anorexic Drugs





In Developing Countries: *Rheumatic Disease*

In Western Countries: *Congenital or Degenerative Disease*

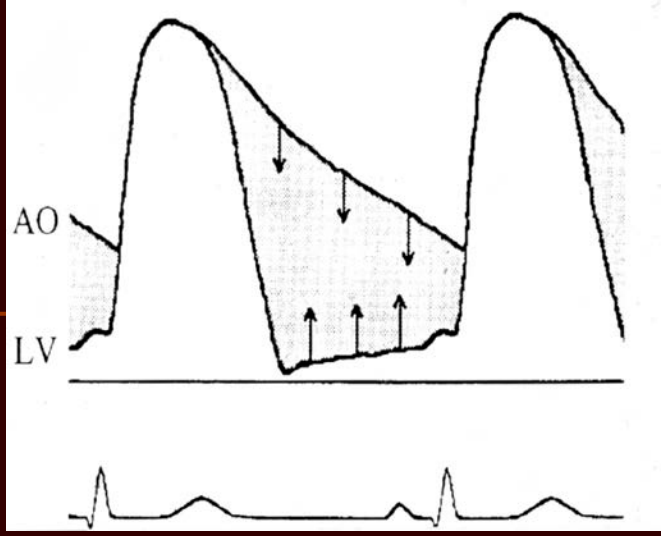
Prevalence

- Framingham Heart Study *(whites)*
  - Overall: 4.9%
  - Moderate/severe: 0.5%
- Strong Heart Study *(native Americans)*
  - Overall: 10%
  - Moderate/severe: 2.7%

-Prevalence increases with age

-Severe AR more often observed in men

Acute vs Chronic AR



- Causes
- Response of LV – Forward CO
  Different clinical presentations and physical examination findings
- Evidence for rapid pressure equilibration of aortic and LV diastolic pressures – Pulmonary edema
- Premature closure of the MV
- Coronary flow reserve – subendocardial ischaemia

Acute AR is a surgical emergency!!

Diagnostic Evaluation

- Clinical symptoms
- Physical symptoms
- Electrocardiography
- Exercise testing
- Echocardiography
- Magnetic Resonance Imaging
- Cardiac catheterization

Echocardiography is indicated

- To confirm the diagnosis of AR
  if there is an equivocal diagnosis based on physical examination *(Class I)*
- To assess the cause of AR
  and to assess valve morphology *(Class I)*
- To provide a semiquantitative/quantitative estimate of the severity of AR *(Class I)*
- To assess LV dimension,mass and
  systolic function *(Class I)*
- To assess Ao Root size *(Class I)*

M-Mode Echocardiography

- Premature MV closure (severe, usually acute AR)
- Diastolic opening of AV (severe, usually acute AR)
- Fluttering motion of the AMVL (significant AR)
- LV volume overload pattern
- LA dilatation (late in course)
- Exaggerated early diastolic dip of the IVS

Colour M-Mode

- Timing and thickness of the AR jet
- Presence, timing and duration of diastolic flow reversal in the descending thoracic Ao

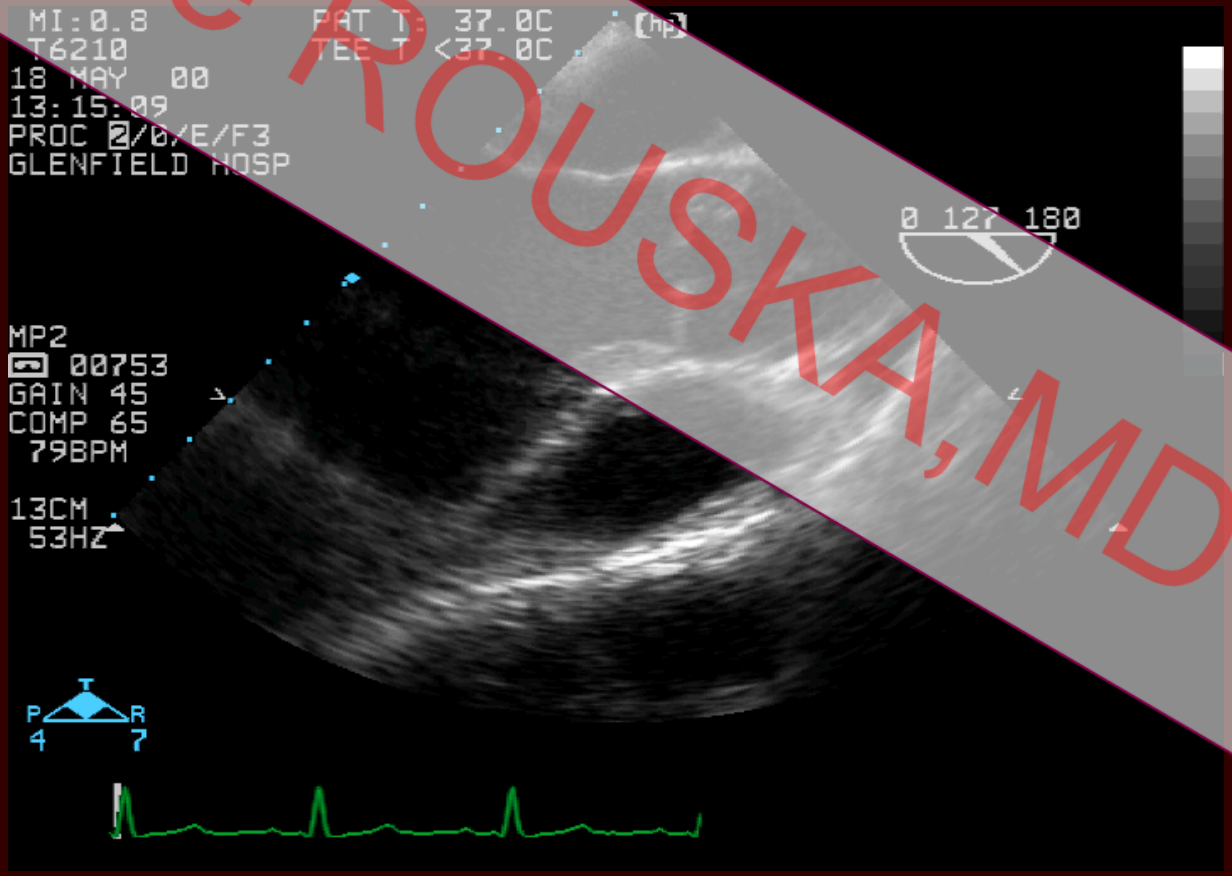
2-D, Doppler and Color-Flow Imaging

- 2D
- colour flow mapping
- Perry index or jet height
- Vena Contracta
- jet distance into LV
- continuous wave Doppler
- pressure half time / velocity slope
- flow reversal in descending aorta
- pre-systolic closure of MV, ?diastolic MR
- regurgitant volume / fraction / orifice area

Aortic regurgitation - 2D

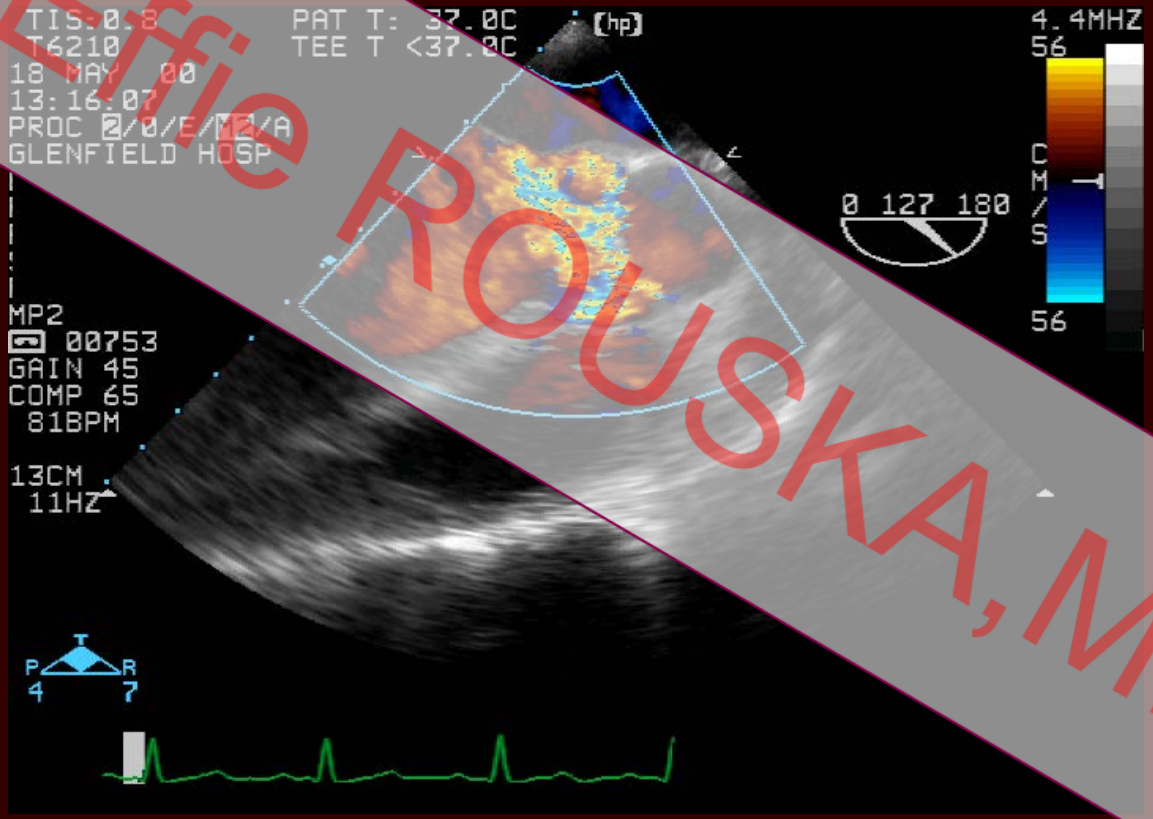
chamber enlargement/remodelling

interpret within clinical context
at time of examination
?intra-op, BP, medication?



Aortic regurgitation - 2D + CFD

- Flow convergence
- Vena contracta
- Jet direction and size



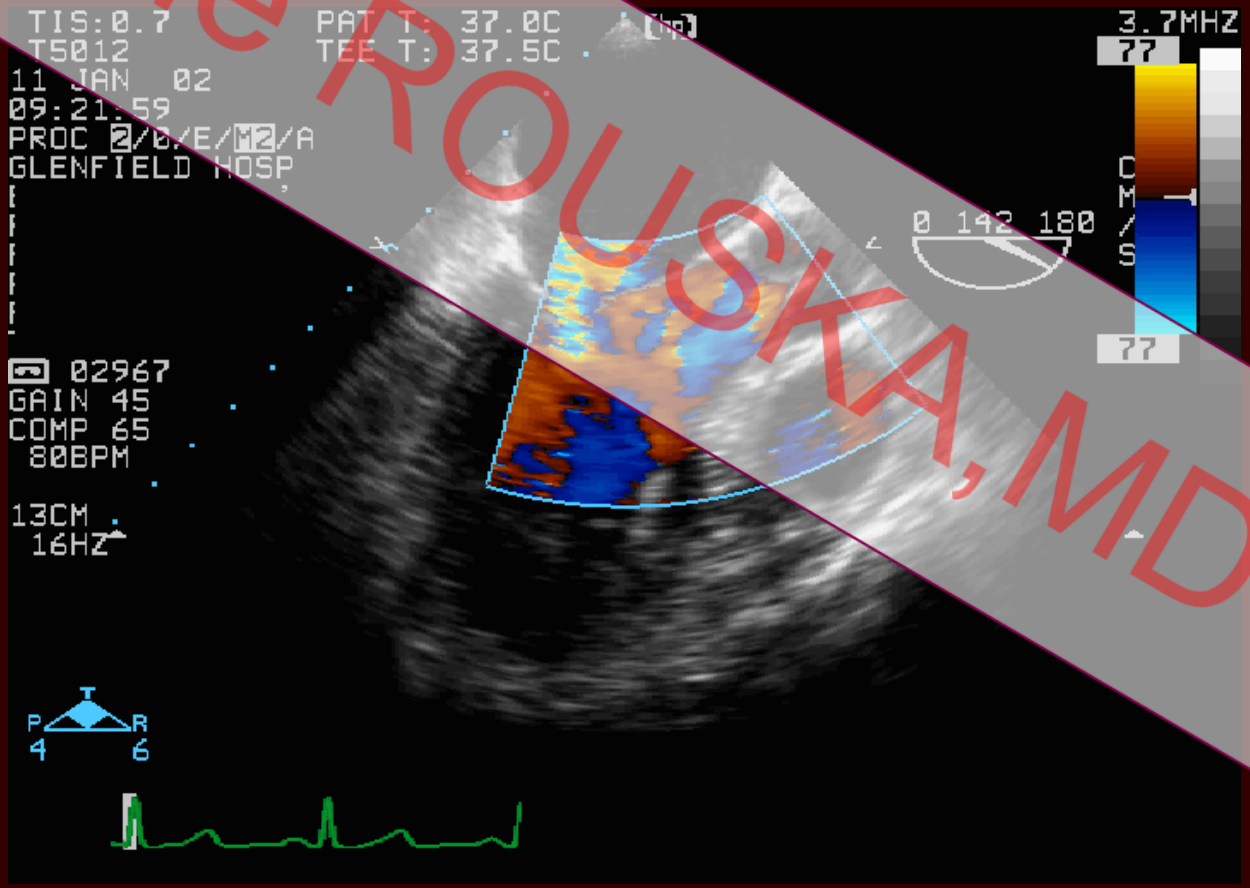
Use with caution!

Zoghbi WA, et al. Recommendations for evaluation of the severity of native valvular regurgitation with two-dimensional and Doppler echocardiography: a report from the ASE nomenclature and standards committee and task force on valvular regurgitation. J Am Soc Echocardiogr 2003;16:777-802

Aortic regurgitation - Perry Index

Perry GJ, et al. Evaluation of aortic insufficiency by Doppler color flow mapping. J Am Coll Cardiol 1987:952-959

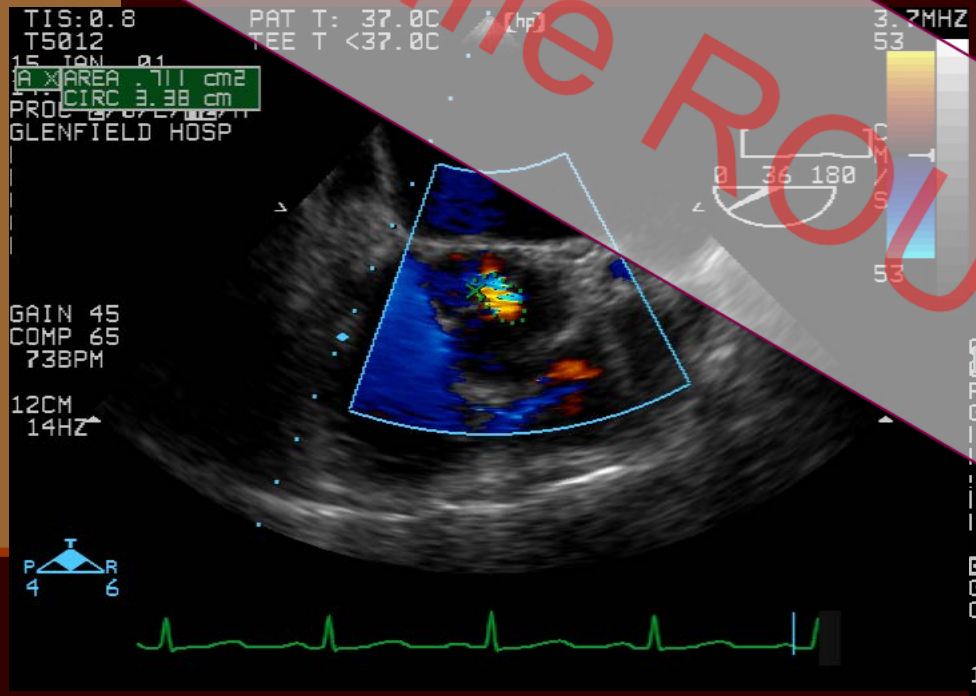
Jet height / LVOT height ratio		
	Grade I	< 25%
	Grade II	25 - 46%
	Grade III	46 - 65%
	Grade IV	> 65%

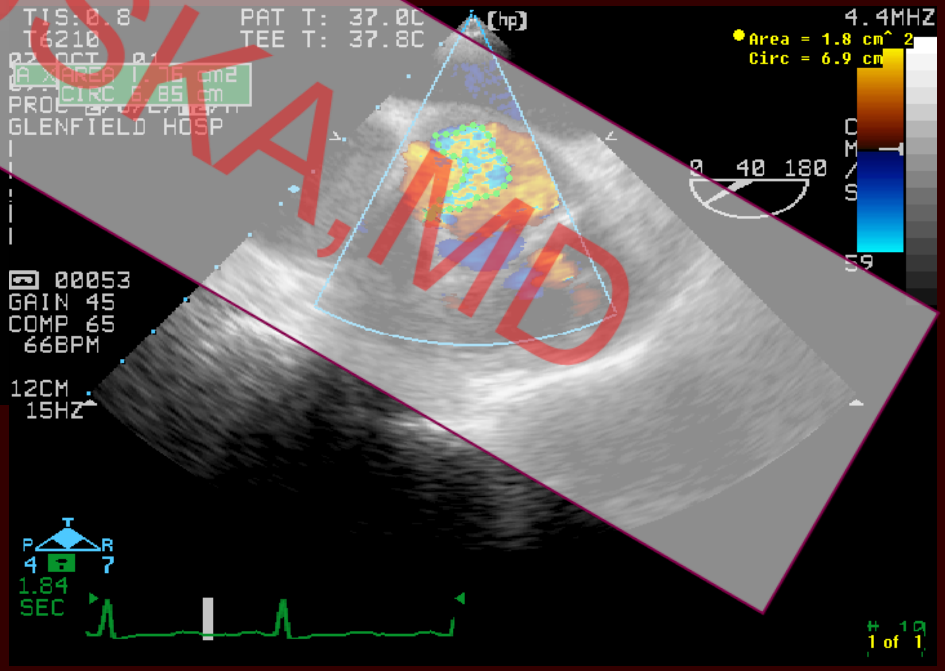


Aortic regurgitation - Regurgitant Jet Area

Willett DL, et al. Assessment of aortic regurgitation by transesophageal color Doppler Imaging of the Vena Contracta: validation against an intraoperative aortic flow probe. J Am Coll Cardiol 2001;37:1450-5

Severe > 0.75 cm^2





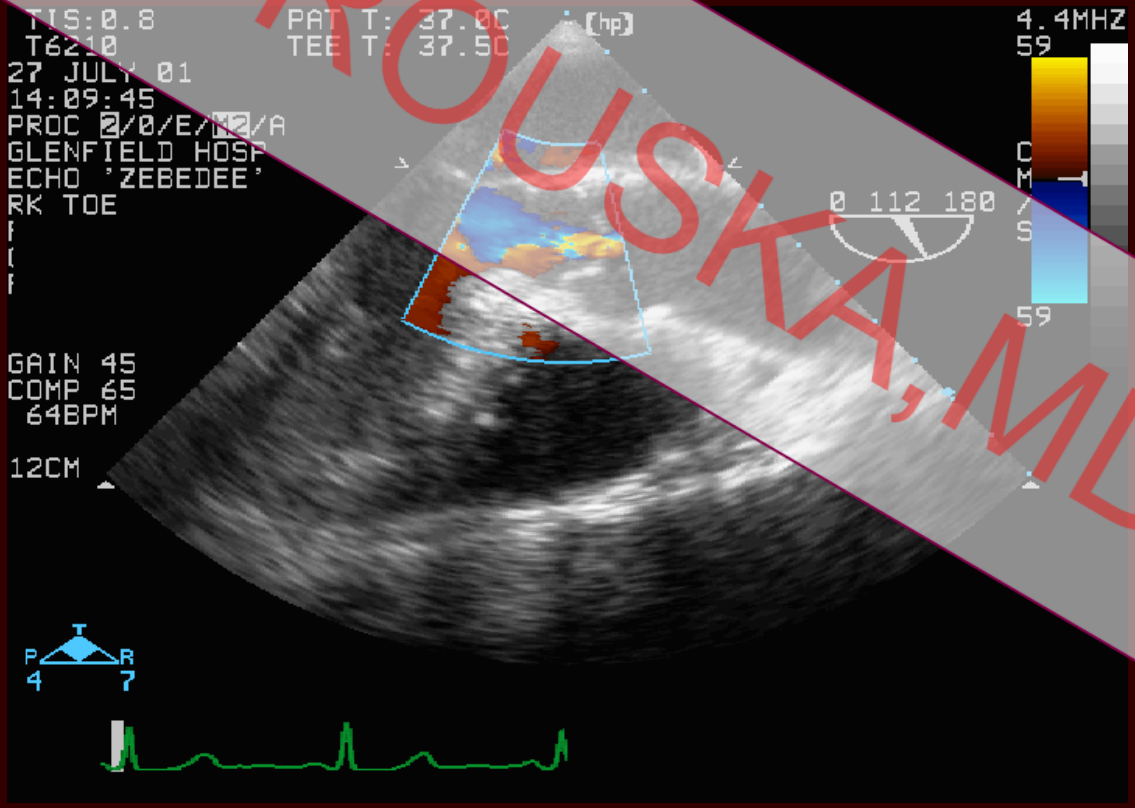
Vena Contracta

Willett DL, et al. Assessment of aortic regurgitation by transesophageal color Doppler Imaging of the Vena Contracta: validation against an intraoperative aortic flow probe. J Am Coll Cardiol 2001;37:1450-5

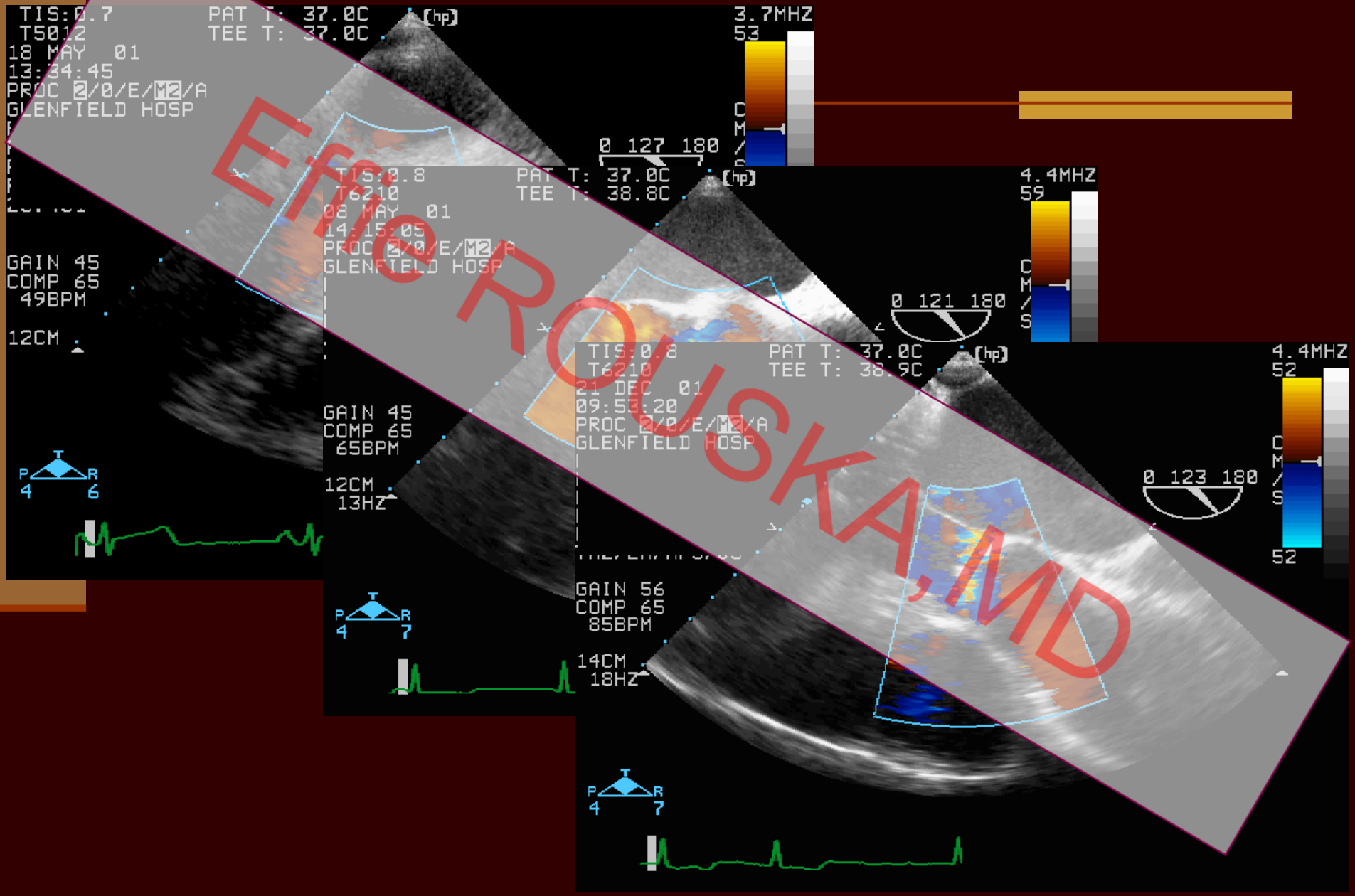
Tribouilloy CM et al. Assessment of severity of aortic regurgitation using the width of the vena contracta: a clinical color Doppler imaging study. Circulation 2000;102:558-64

severe **> 6 mm**

nonsevere **< 5 mm**

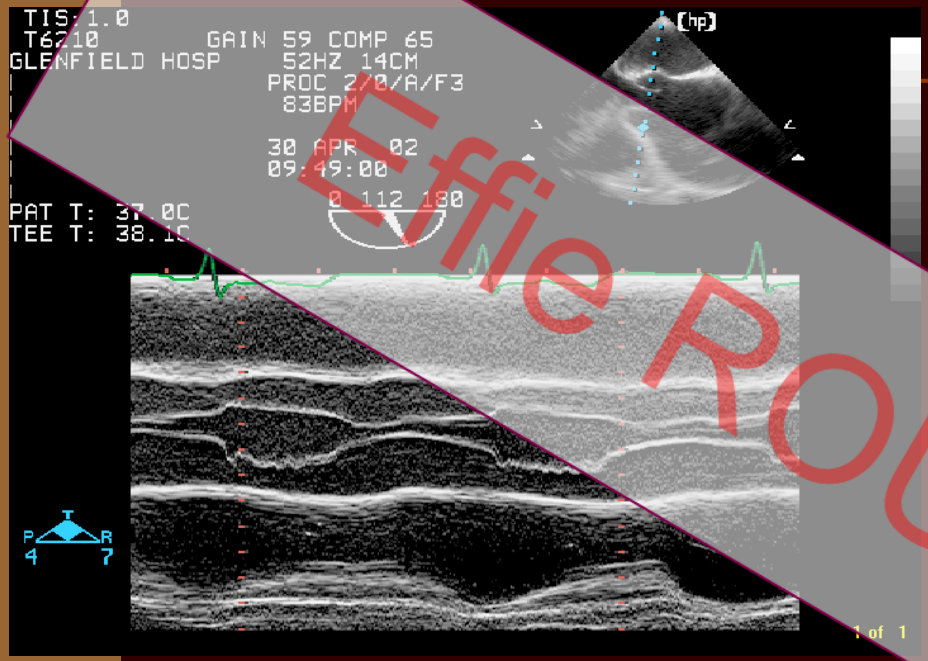


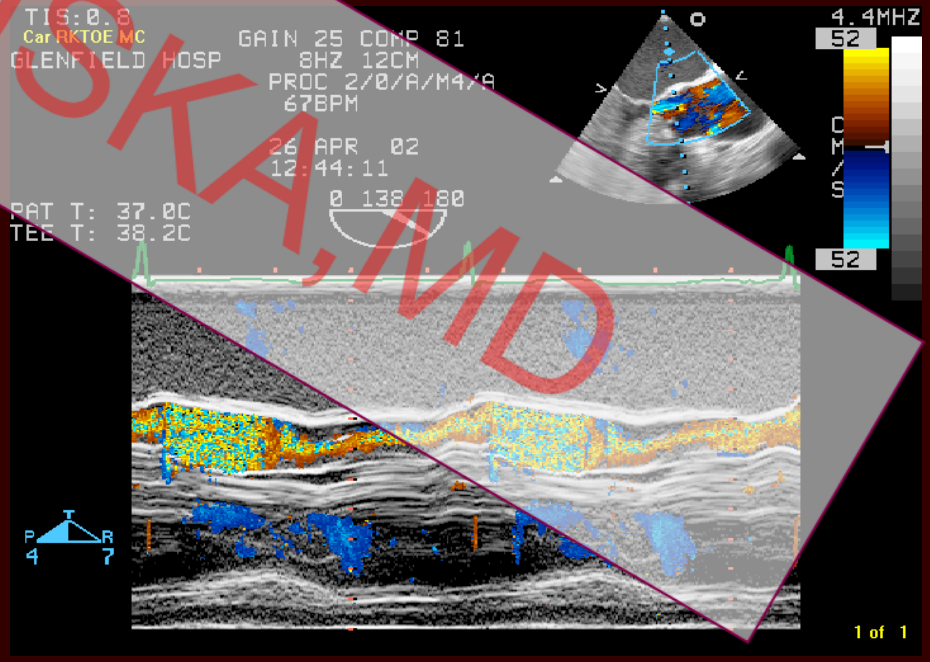
Vena Contracta - direction

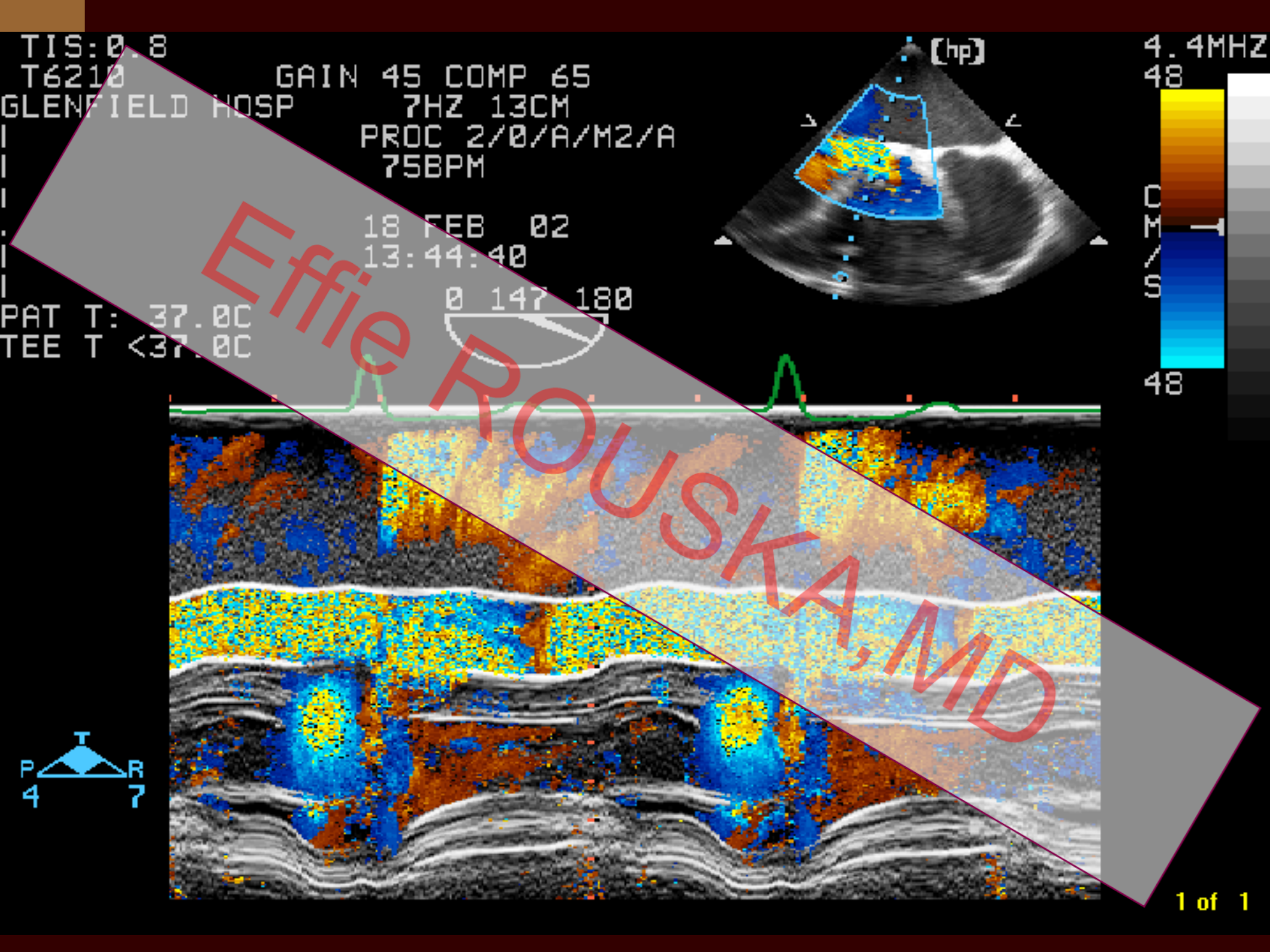


Vena Contracta – leaflet prolapse

Aortic regurgitation - colour M-Mode





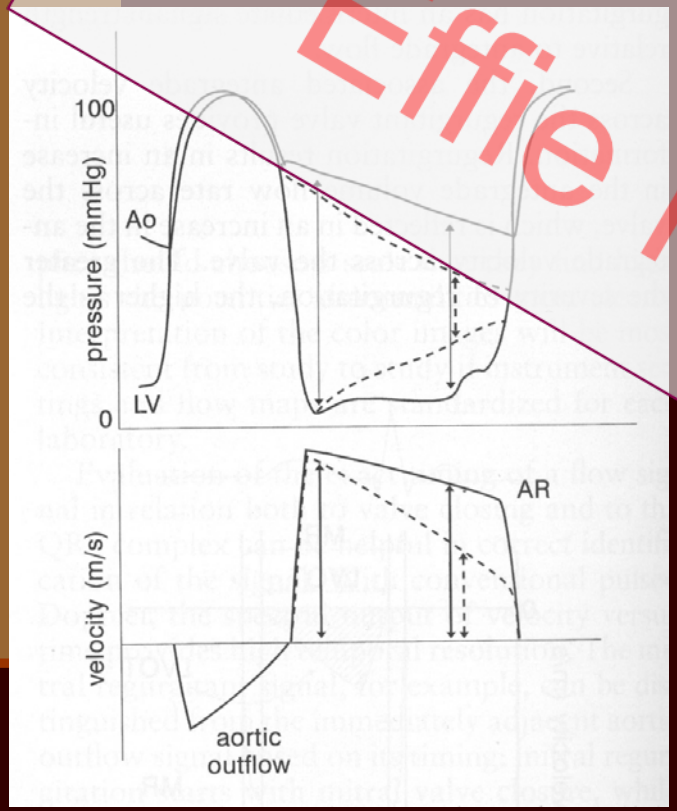


AR - pressure halftime

early peak velocity - 3-5m/s

mild AR - more than 400 millisec

severe AR - less than 200 millisec



Samstad SO, et al. Half-time of the diastolic aortoventricular pressure difference by continuous wave Doppler ultrasound: a measure of severity of aortic regurgitation? Br Heart J 1989;61:336-343

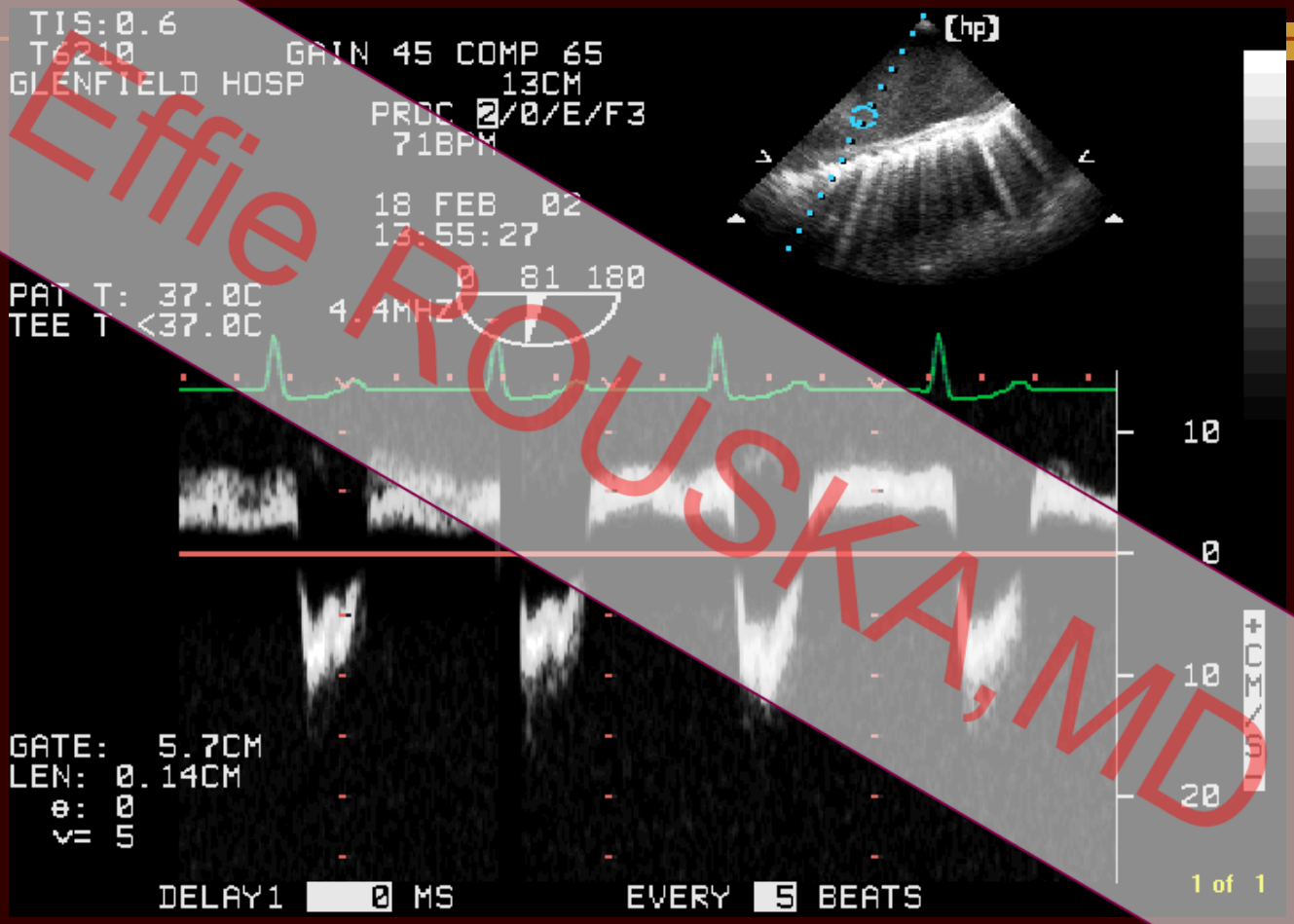
AR - deceleration slope

severe > 3 m / sec^2

Grayburn PA, et al. Quantitative assessment of the hemodynamic consequences of aortic regurgitation by means of continuous wave Doppler recordings.

J Am Coll Cardiol 1987;10:135-41

AR - holodiastolic flow reversal in descending aorta



Takenaka K, et al. Pulsed Doppler echocardiographic detection of regurgitant blood flow in the ascending, descending and abdominal aorta of patients with aortic regurgitation. J Cardiol 1987;17:301-309

Regurgitant volume =

$$\frac{FLOW_{AoV} - FLOW_{MV}}{VTI_{AoV} \times CSA_{AoV} - VTI_{MV} \times CSA_{MV}}$$

no mitral regurgitation or VSD

Severe > 60 ml

Regurgitant fraction =

$$\frac{VTI_{AoV} \times CSA_{AoV} - VTI_{MV} \times CSA_{MV}}{VTI_{AoV} \times CSA_{AoV}}$$

Severe > 50%

Effective regurgitant orifice =

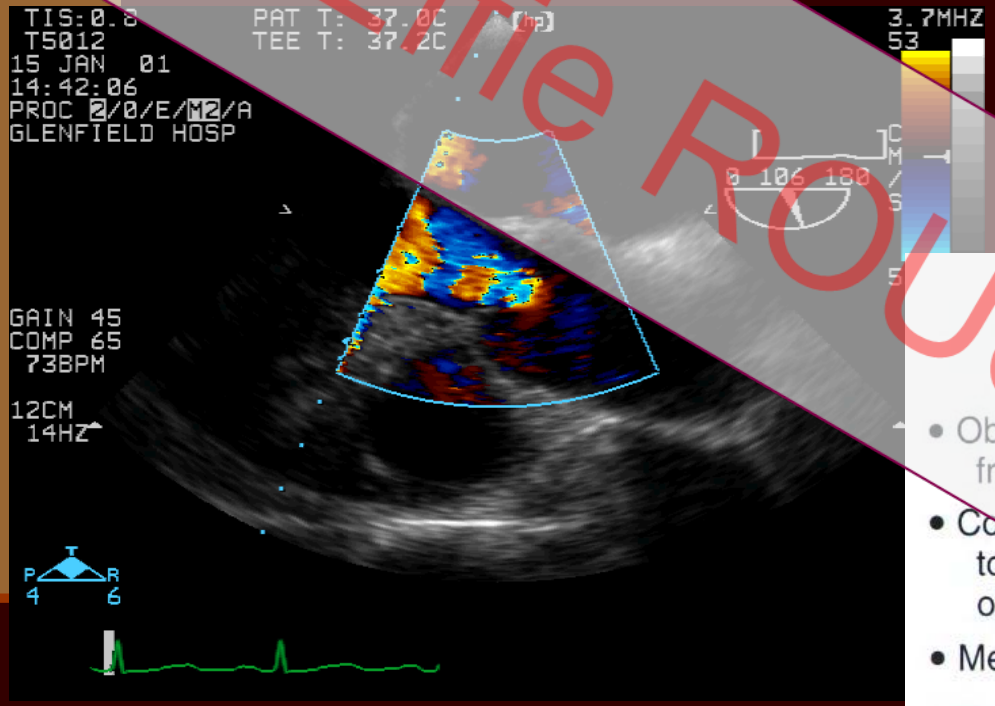
$$\frac{\text{Regurgitant volume}_{AV}}{\text{Regurgitant VTI}}$$

Severe > 0.3 cm^2

Flow convergence or PISA principle

Tribouilloy CM et al. Application of the proximal flow convergence method to calculate the effective orifice area in aortic regurgitation. J Am Coll Cardiol 1998;32:1032-9

- Optimise 2-D colour flow
- Zoom
- Freeze in cine loop



Assume hemisphere

?Eccentric jet?

Assessment of Severity of AR by Echo

Severe AR

- Regurgitant jet width/LVOT d ratio>60%
- Regurgitant jet area/LVOT area ratio>60%
- AR PHT<250ms
- Restrictive MV flow pattern
- Holodiastolic flow reversal in the desc Ao
- Dense C/W Doppler signal
- Reg. Fraction>55%
- Reg. volume>60%
- LVDD>7.5cm
- ERO>0.30cm^2

Mild AR

- Regurgitant jet width/LVOT d ratio<30%
- Regurgitant jet area/LVOT area ratio<30%
- AR PHT>400ms
- Mild diastolic flow reversal in the desc Ao
- Faint C/W Doppler signal
- Reg. Fraction<30%
- Reg. volume<20%
- LVDD<6cm
- ERO<0.10cm^2

Mechanisms of AR

Movsowitz HD, Levine RA, Hilgenberg AD, et al. Transesophageal Echocardiography Description of the mechanisms of AR in Acute Type A Aortic Dissection: Implications for AV Repair. J Am Coll Cardiol 2000;36:884-90

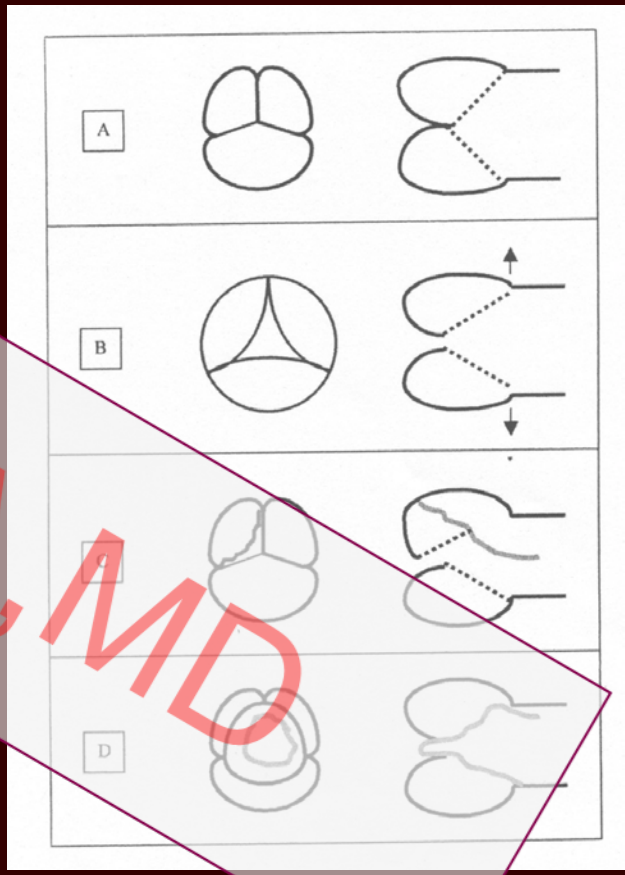
normal AV anatomy
- incomplete closure, leaflet tethering, dilated STJ

leaflet prolapse
- disruption of leaflet attachments, dissection flap below STJ into root

leaflet prolapse
- dissection flap through normal leaflets, disrupts coaptation

bicuspid AV
- associated leaflet prolapse, unrelated to dissection

degenerative leaflet thickening
- abnormal coaptation



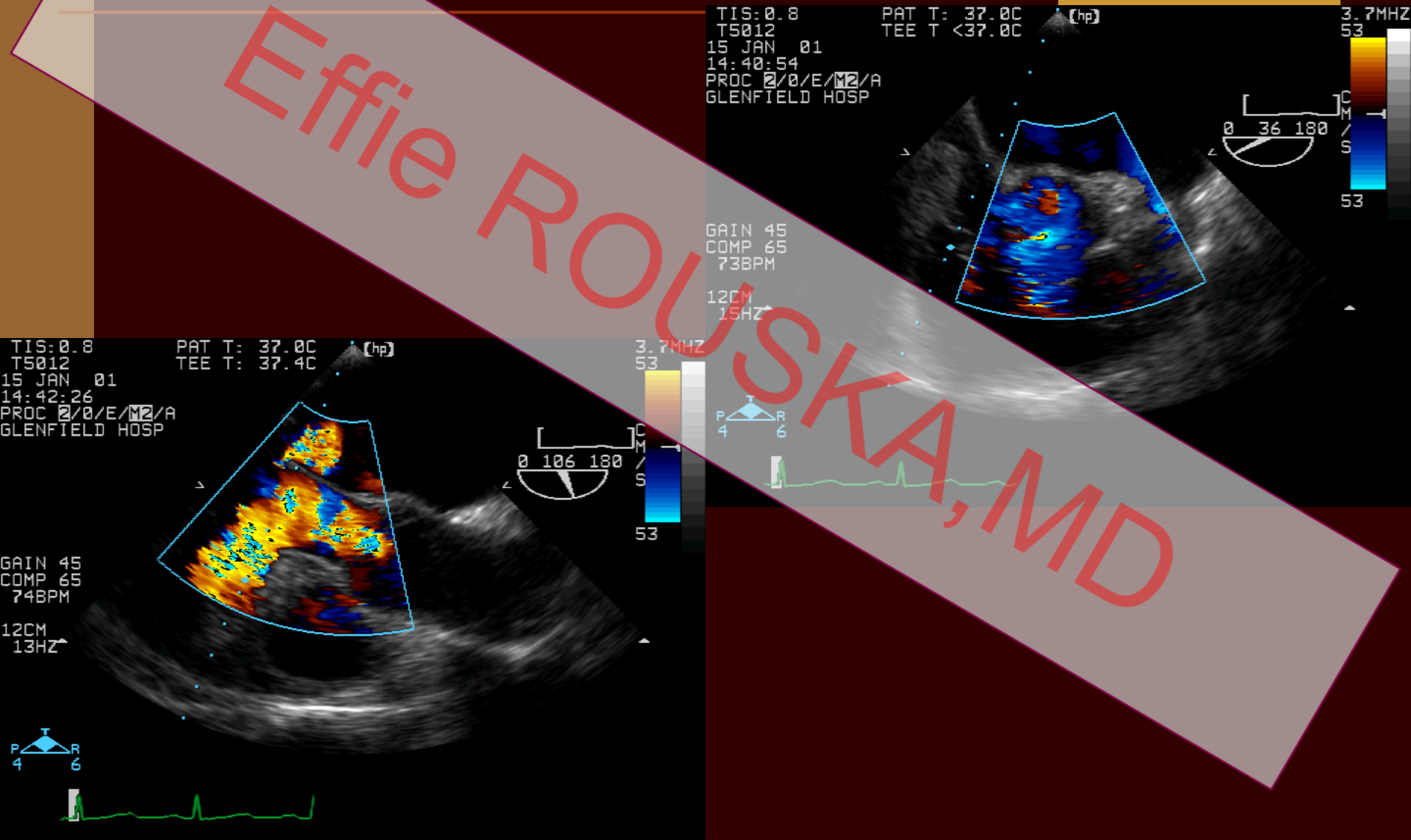
MORE THAN ONE MECHANISM?

Functional classification for AR

El Khoury, Rubay, Noirhomme, d'Udekem, et al
University Hospital of Louvain, Brussels, Belgium

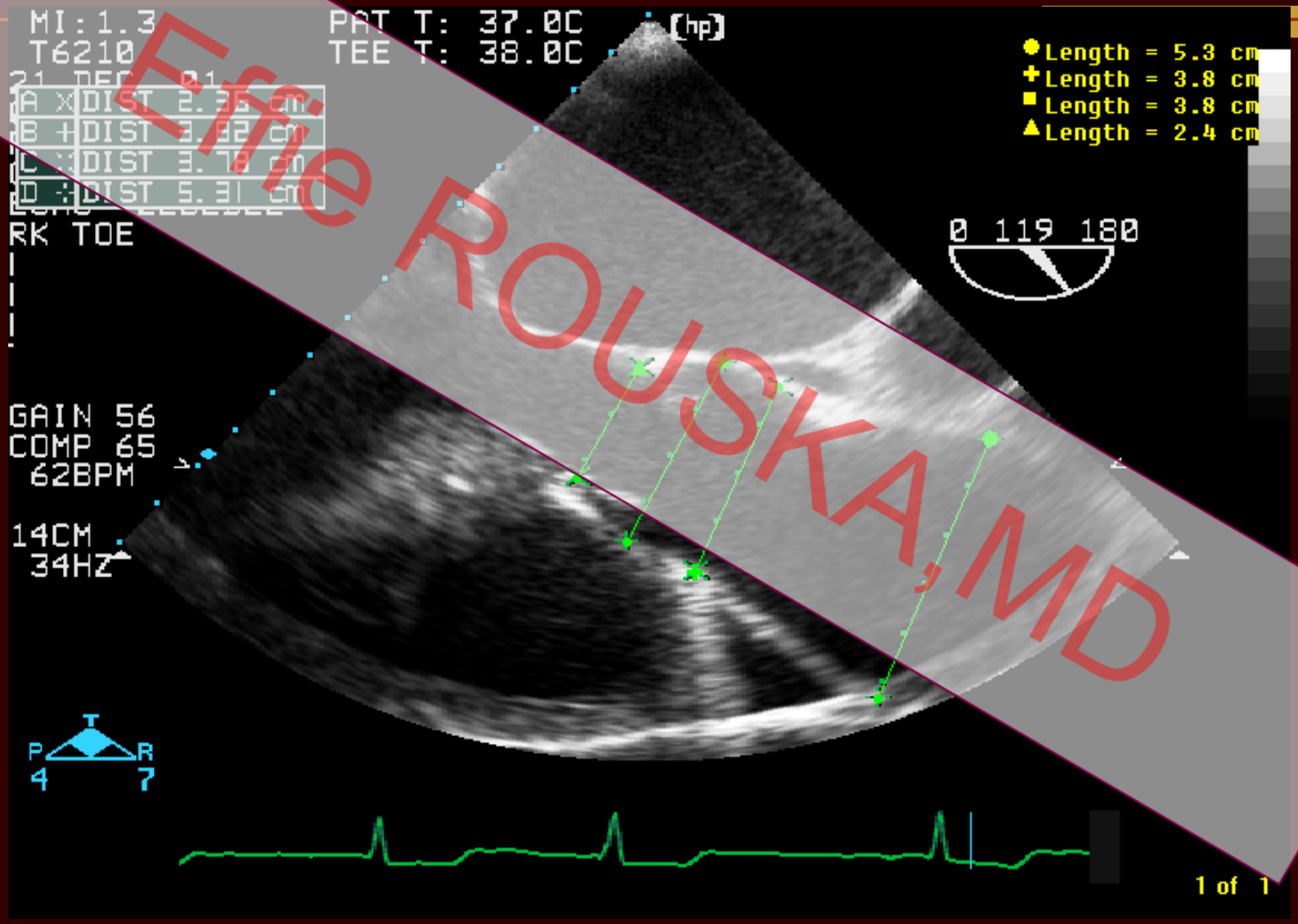
- Type I — normal cusp motion (central jet)
  - Type I a — STJ dilatation
  - Type I b — STJ + sinuses of Valsalva dilatation
    ?aneurysm, ?Marfan
  - Type I c — annular dilatation
    poor coaptation and apposition, ?aortic dissection
  - Type I d — leaflet defect / perforation
    ?endocarditis
- Type II — cusp prolapse (eccentric jet)
  excessive cusp tissue, commissural disruption + malpositioning, poor coaptation and apposition
  ?endocarditis
- Type III — restricted cusp motion (central jet)
  ?bicuspid valve, ?calcification

AR - Type I : normal cusp motion



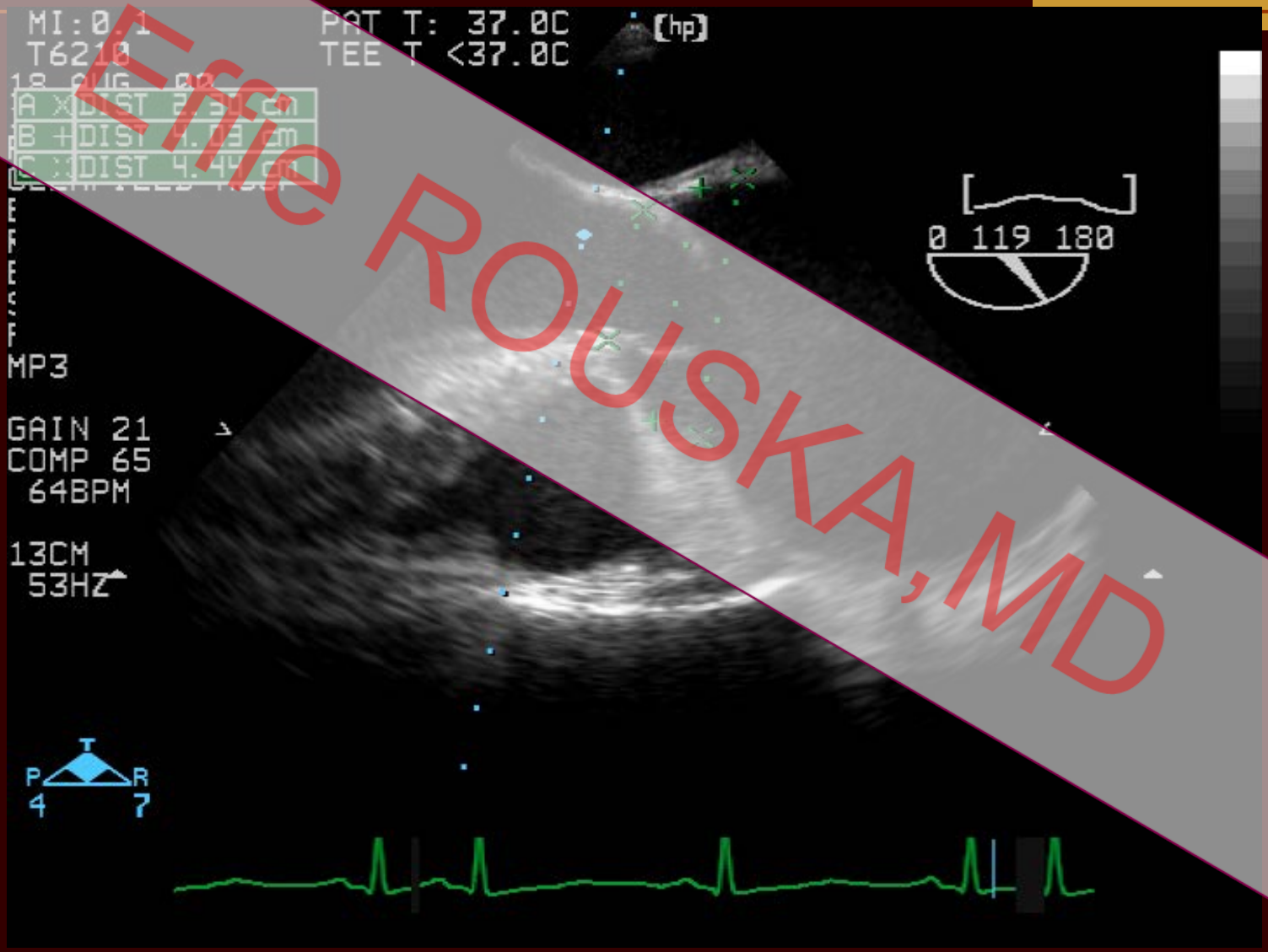
AR - Type I : normal cusp motion

I a : STJ dilated



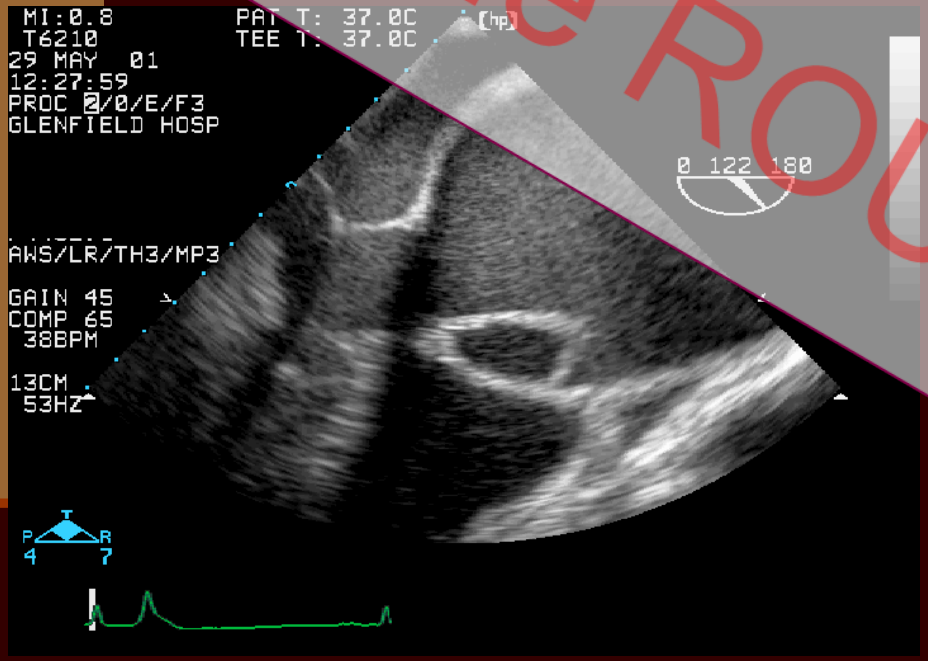
AR - Type I : normal cusp motion

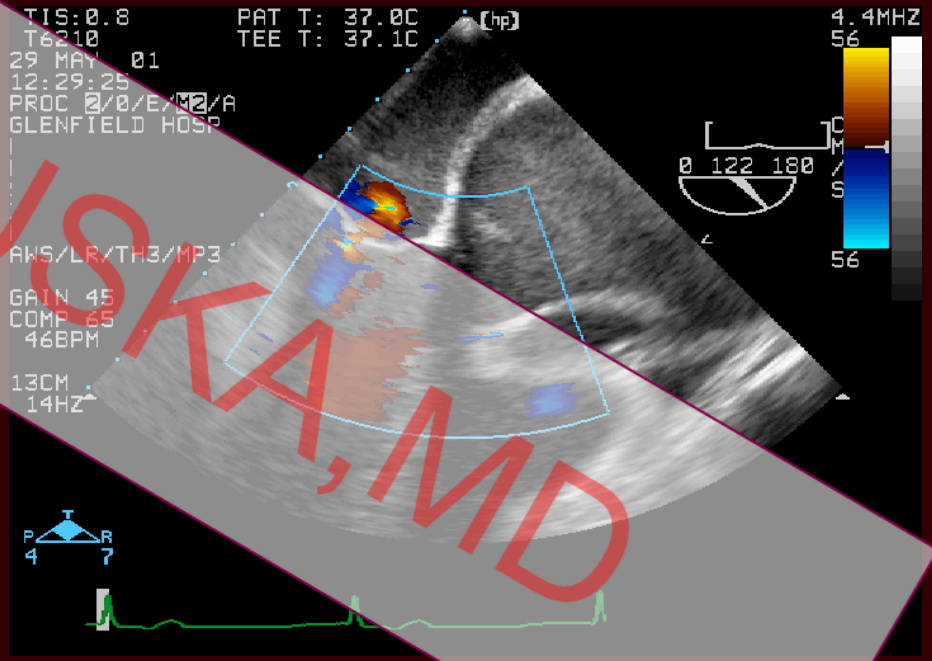
Ib : STJ and sinuses of Valsalva dilated

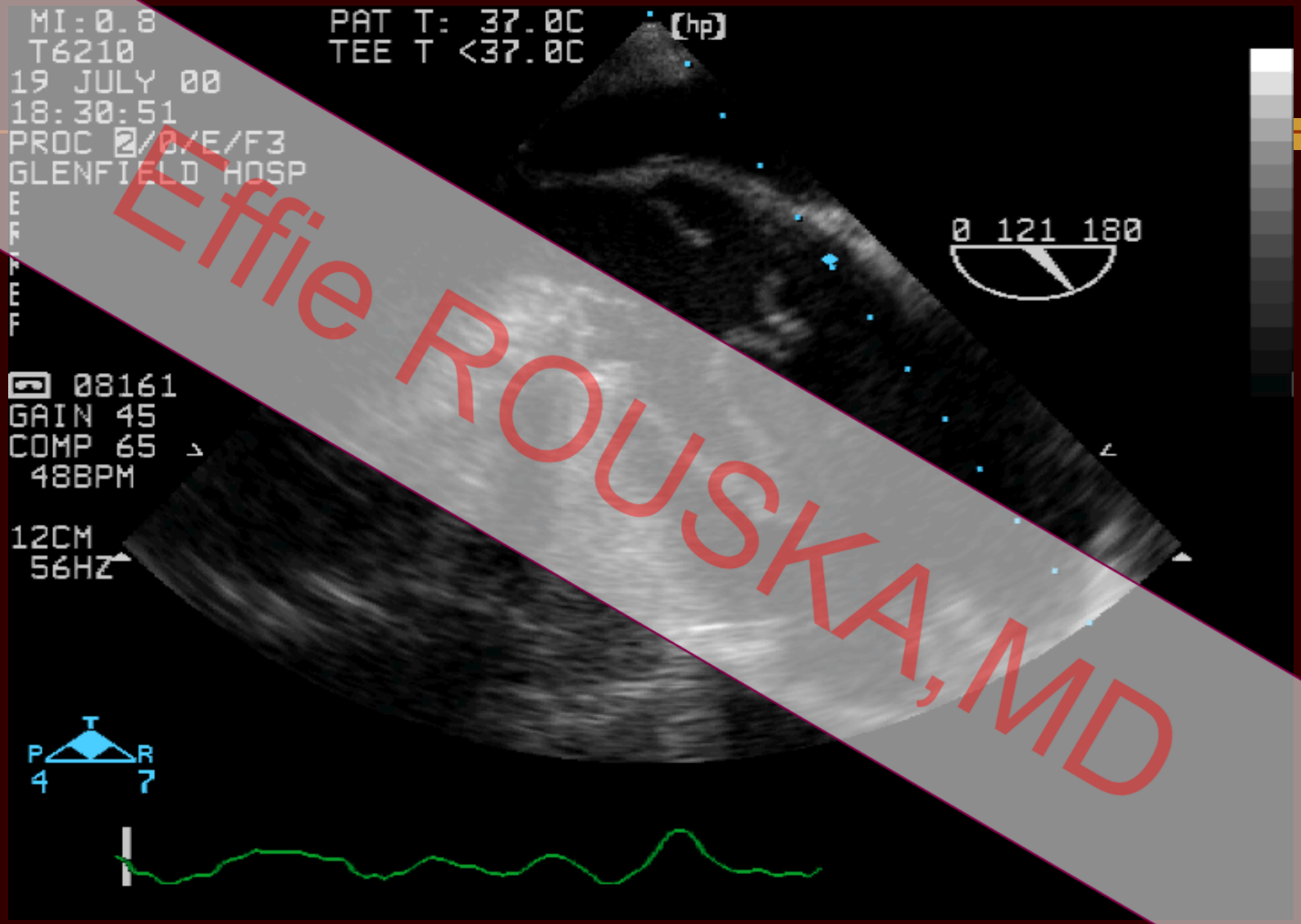


AR - ? Type I : normal cusp motion

I c : annular dilatation - dissection



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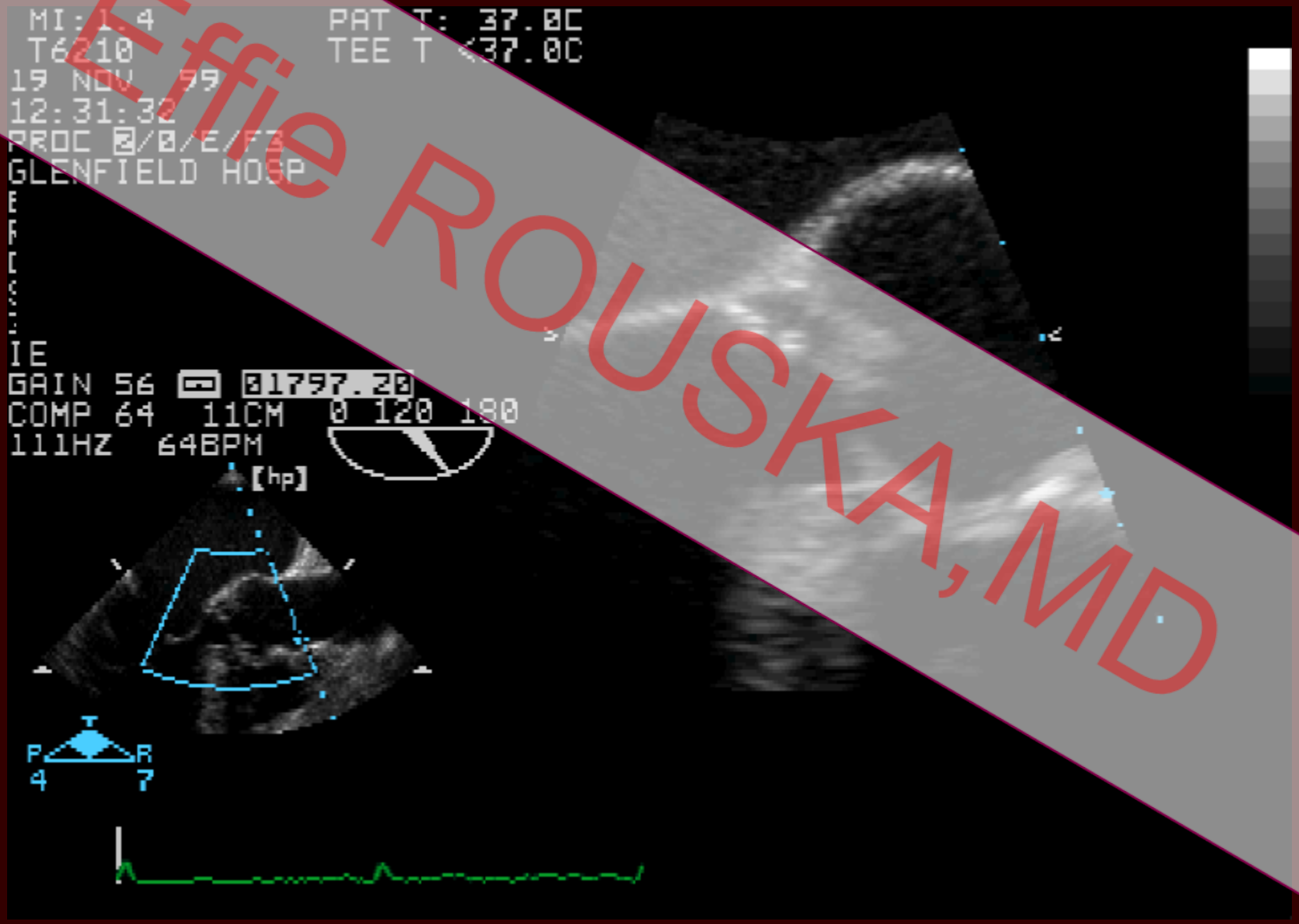
Effie ROUSKA,MD

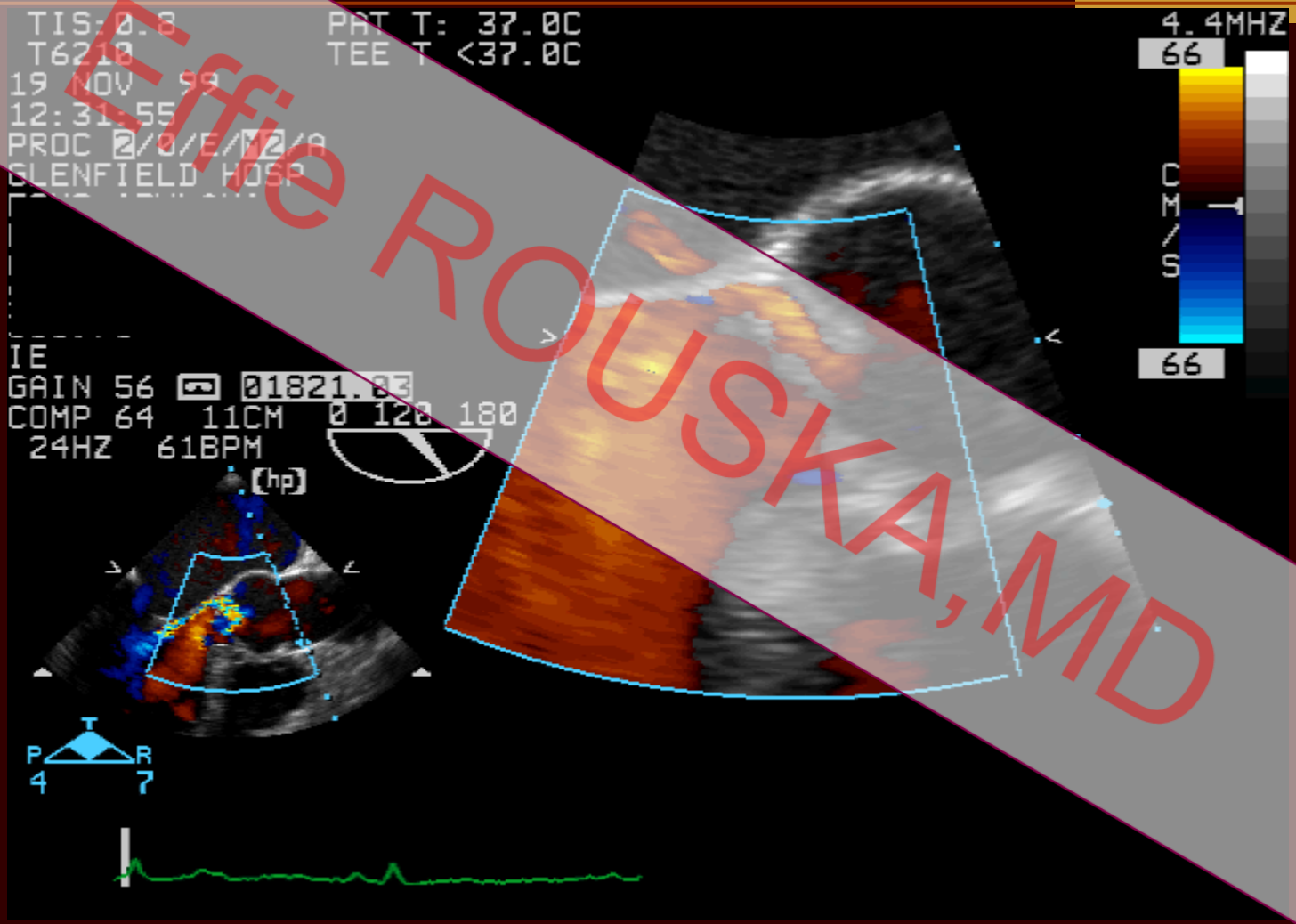
AR - Type II : cusp prolapse

? endocarditis

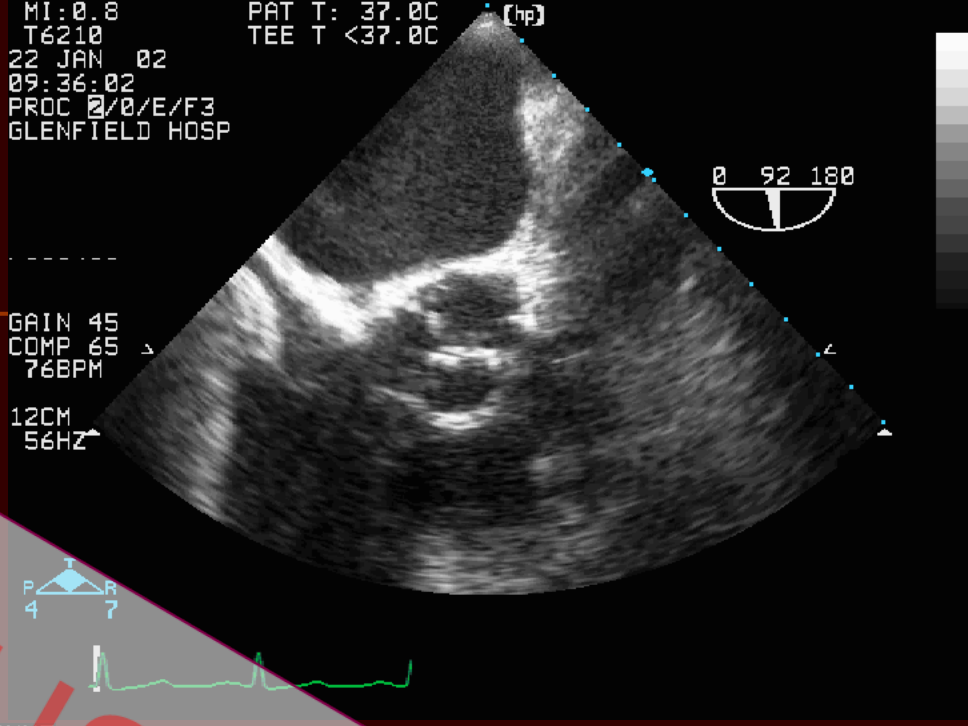


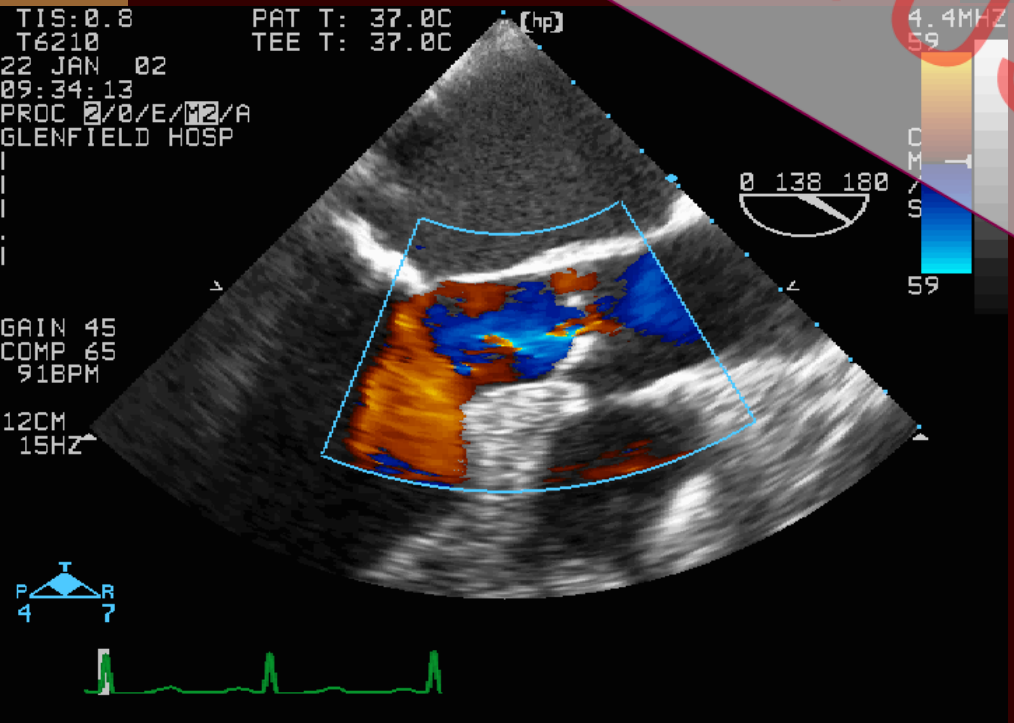
AR - Type II : cusp prolapse

? endocarditis

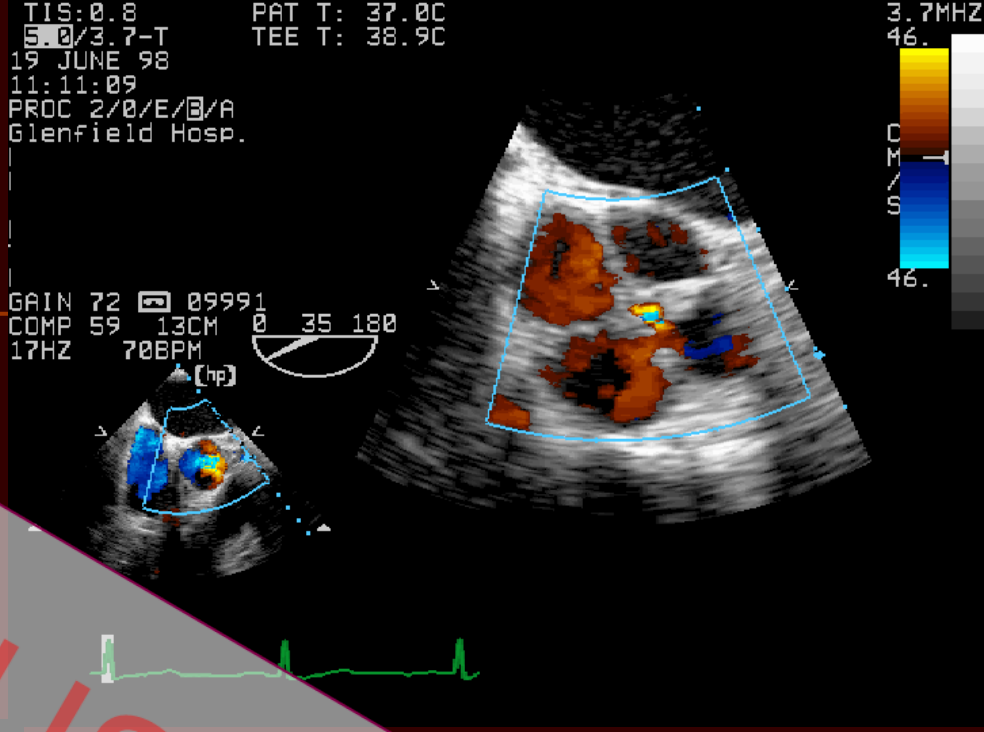


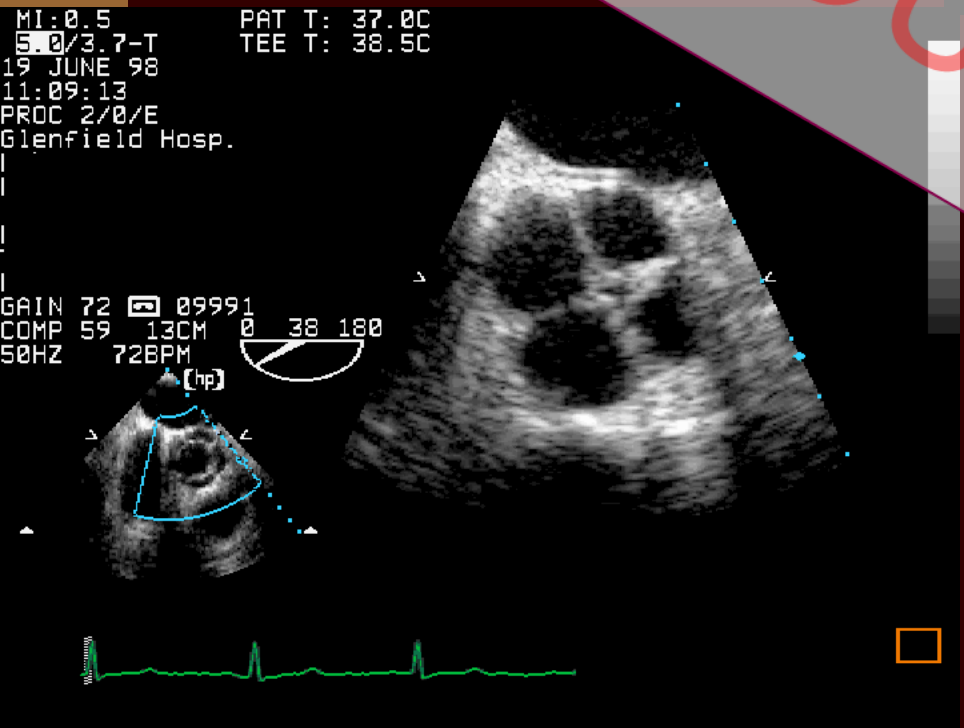
AR - Type III : restricted cusp motion





AR - Type III : restricted cusp motion quadricuspid

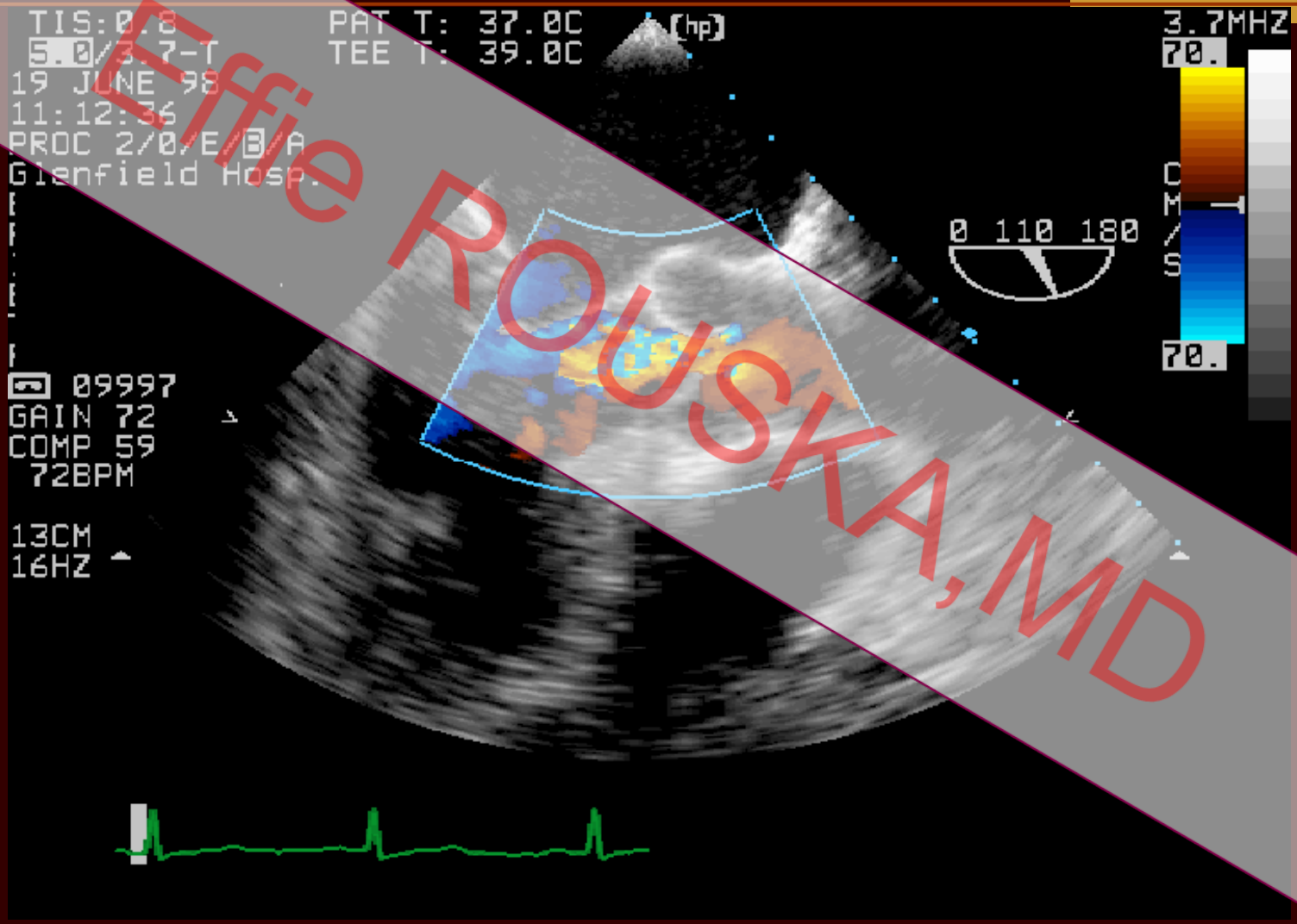




Rare – 0.008%

Cusp malcoaptation

AR - Type III : restricted cusp motion quadricuspid



AR - Type III : restricted cusp motion unicuspid

Natural History

- *Asymptomatic patients with normal LV systolic function*

Progression to symptoms and/or LV dysfunction: Less than 6%per y
Progresssion to asymptomatic LV dysfunction: Less than 3.5%per y
Sudden Death: Less than 0.2% per y

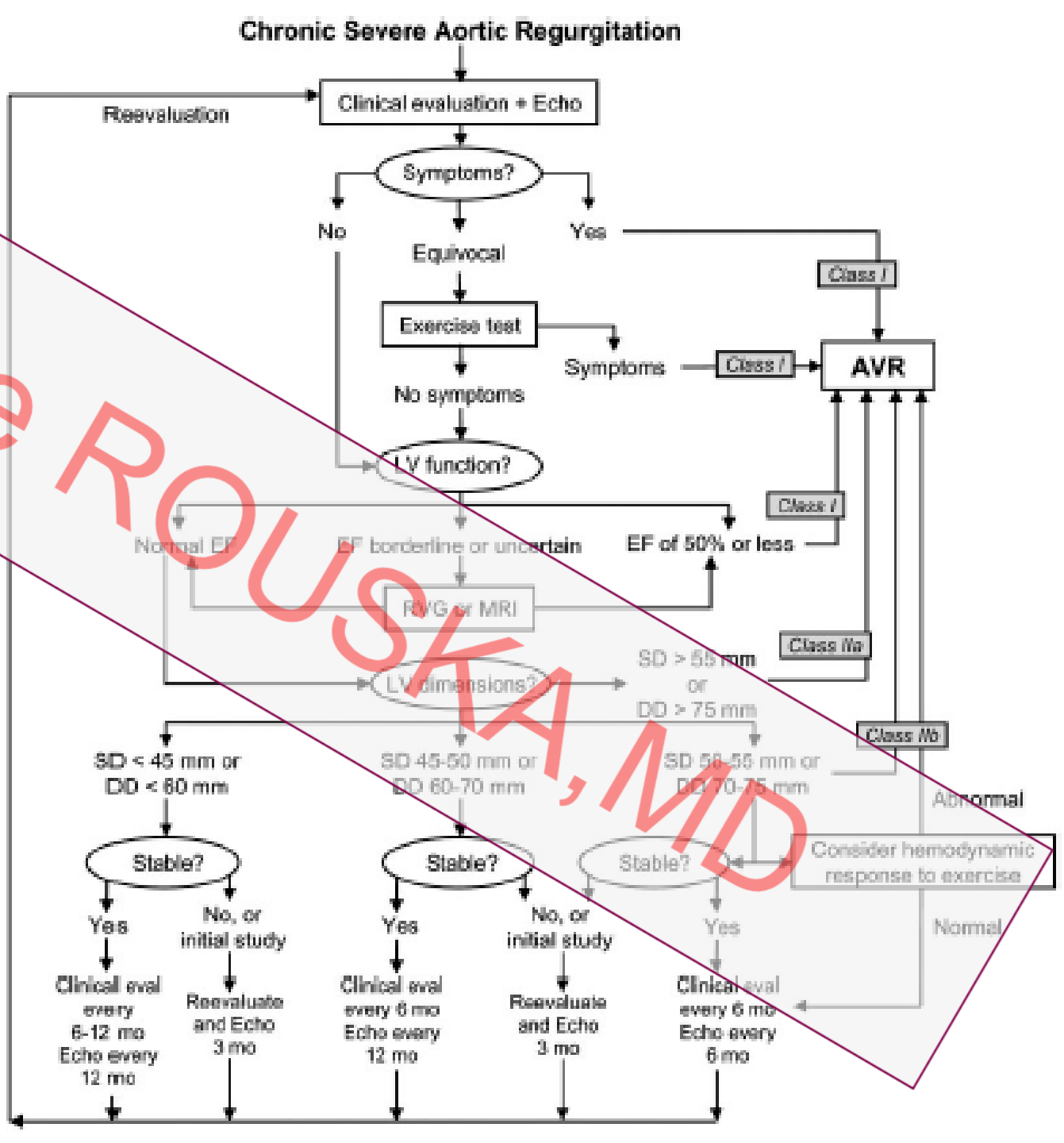
- *Asymptomatic patients with LV dysfunction*

Progression to cardiac symptoms: Greater than 25%per y

- *Symptomatic patients*

Mortality rate: Greater than 10% per y

Management Strategy



Medical Therapy

Class I

Vasodilator therapy is indicated for chronic therapy in patients with severe AR who have symptoms or LV dysfunction when surgery is not recommended because of additional cardiac or noncardiac factors. *(Level of Evidence: B)*

Class IIa

Vasodilator therapy is reasonable for short-term therapy to improve the hemodynamic profile of patients with severe heart failure symptoms and severe LV dysfunction before proceeding with AVR. *(Level of Evidence: C)*

Class IIb

Vasodilator therapy may be considered for long-term therapy in asymptomatic patients with severe AR who have LV dilatation but normal systolic function. *(Level of Evidence: B)*

Class III

1. Vasodilator therapy is not indicated for long-term therapy in asymptomatic patients with mild to moderate AR and normal LV systolic function. *(Level of Evidence: B)*
2. Vasodilator therapy is not indicated for long-term therapy in asymptomatic patients with LV systolic dysfunction who are otherwise candidates for AVR. *(Level of Evidence: C)*
3. Vasodilator therapy is not indicated for long-term therapy in symptomatic patients with either normal LV function or mild to moderate LV systolic dysfunction who are otherwise candidates for AVR. *(Level of Evidence: C)*

Indications for AV Replacement or Repair
Timing of Surgery

ACC/AHA Practice Guidelines
Circulation 2006;114:84-231

Class I

1. AVR is indicated for symptomatic patients with severe AR irrespective of LV systolic function. *(Level of Evidence: B)*
2. AVR is indicated for asymptomatic patients with chronic severe AR and LV systolic dysfunction (ejection fraction 0.50 or less) at rest. *(Level of Evidence: B)*
3. AVR is indicated for patients with chronic severe AR while undergoing CABG or surgery on the aorta or other heart valves. *(Level of Evidence: C)*

Class IIa

AVR is reasonable for asymptomatic patients with severe AR with normal LV systolic function (ejection fraction greater than 0.50) but with severe LV dilatation (end-diastolic dimension greater than 75 mm or end-systolic dimension greater than 55 mm).* *(Level of Evidence: B)*

Class IIb

1. AVR may be considered in patients with moderate AR while undergoing surgery on the ascending aorta. *(Level of Evidence: C)*
2. AVR may be considered in patients with moderate AR while undergoing CABG. *(Level of Evidence: C)*
3. AVR may be considered for asymptomatic patients with severe AR and normal LV systolic function at rest (ejection fraction greater than 0.50) when the degree of LV dilatation exceeds an end-diastolic dimension of 70 mm or end-systolic dimension of 50 mm, when there is evidence of progressive LV dilatation, declining exercise tolerance, or abnormal hemodynamic responses to exercise.* *(Level of Evidence: C)*

Class III

AVR is not indicated for asymptomatic patients with mild, moderate, or severe AR and normal LV systolic function at rest (ejection fraction greater than 0.50) when degree of dilatation is not moderate or severe (end-diastolic dimension less than 70 mm, end-systolic dimension less than 50 mm).* *(Level of Evidence: B)*

**Consider lower threshold values for patients of small stature of either gender.*

Principles of Assessment

- Severity of lesion
- Symptoms
- Left ventricular function
- Associated lesions
- Individual risk-benefit ratio

Preoperative Predictors of Surgical Outcome in AR

Severity of preoperative symptoms or reduced exercise tolerance
Severity of depression of left ventricular ejection fraction
Duration of preoperative left ventricular systolic dysfunction

ACC/AHA Practice Guidelines
Circulation 2006; 114:84-231

Surgical Risks

Immediate Outcome of AVR

- Parsonnet score ≥ 20 ⇨ 31%mortality
  - Age70-74=7
  - Aortic valve surgery=5
  - AS gradient >120mmHg=7
  - CABG at valve surgery=2
  - LVEF 30-49%=2
- Euroscore ≥ 6 ⇨ 11% mortality
  - Age70-74=3
  - Other than isolated CABG=2
  - Active Endocarditis=3
  - Thoracic Aorta Surgery=3
  - LVEF 30-50%=1

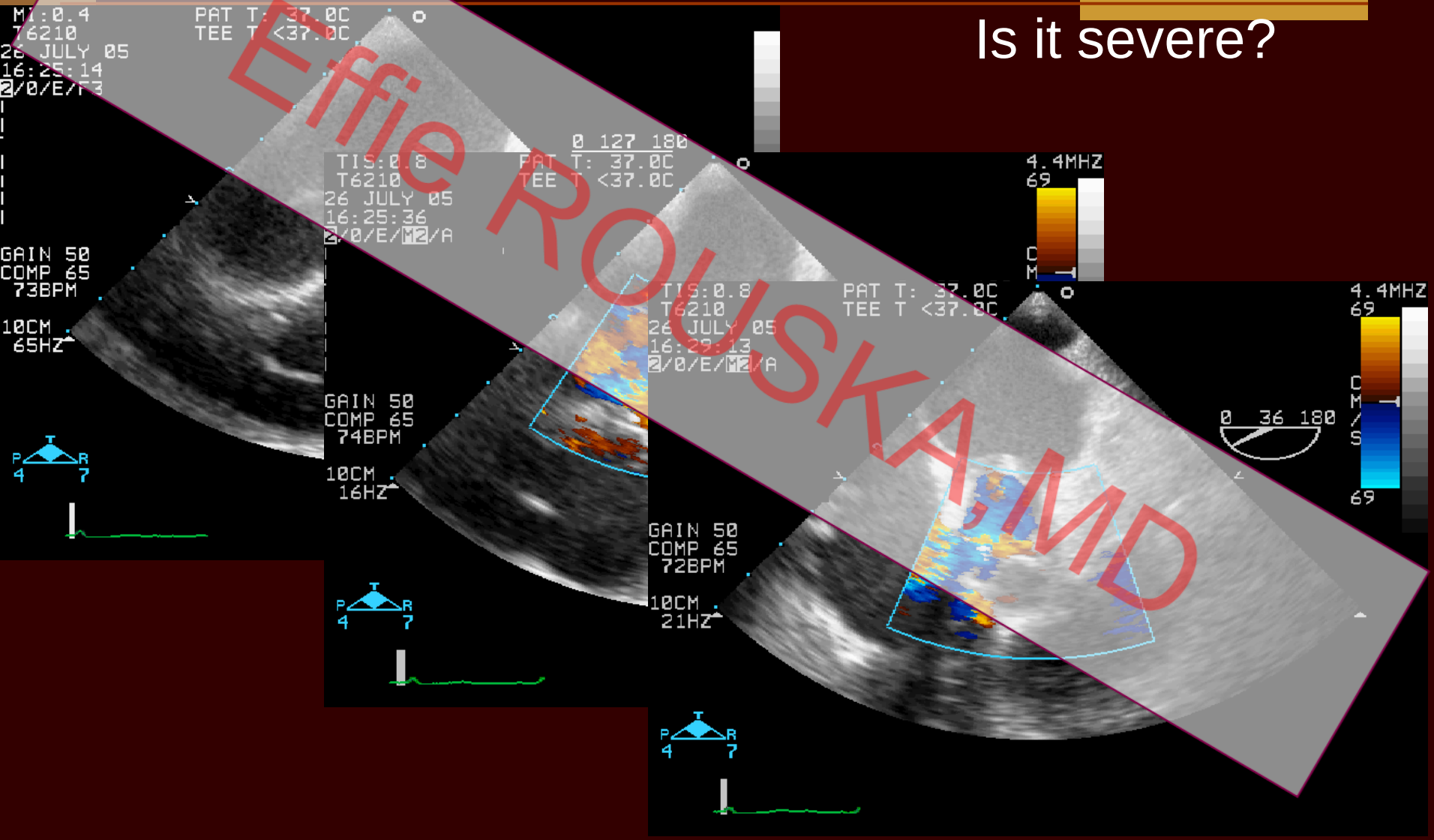
In Conclusion before Surgery

- Predict individual patient risk
- Avoid irreversible cardiomyopathy
- Consider concomitant dx
- Assess local surgical outcomes

60 yr old female

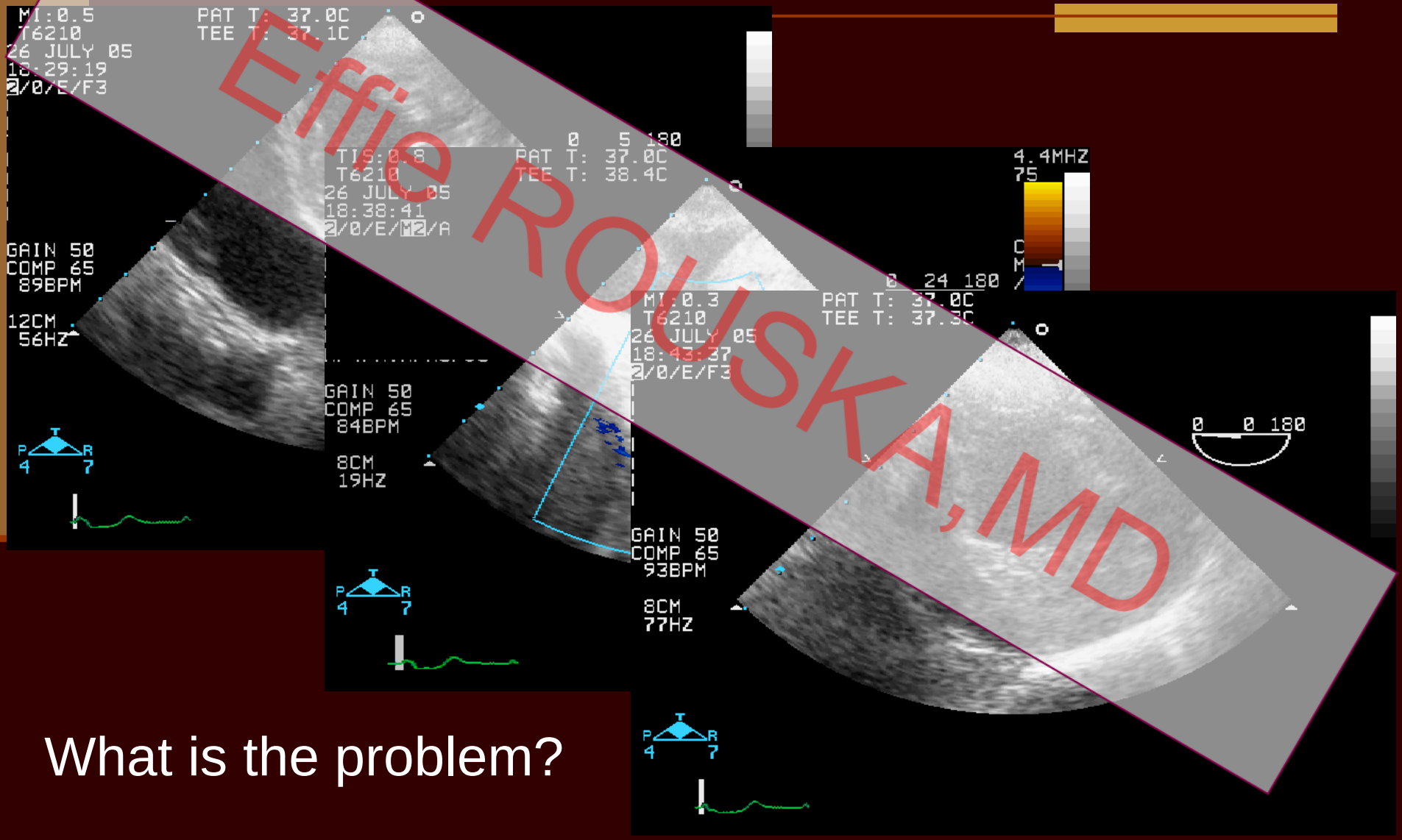
AVR - why?

Is it severe?



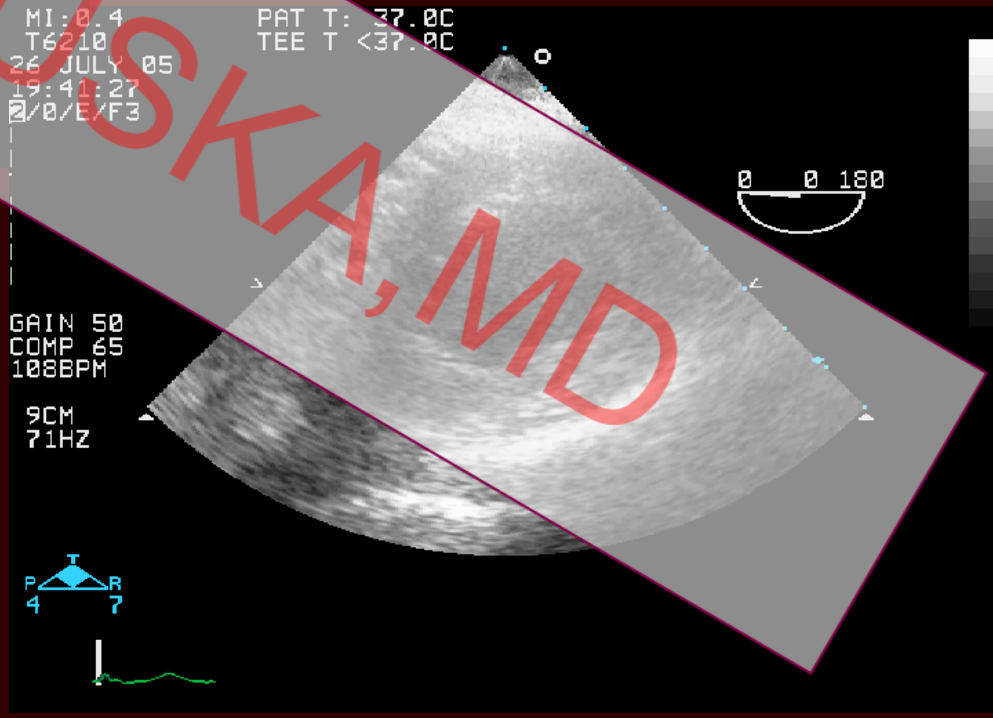
Stentless tissue valve

On separation from CPB



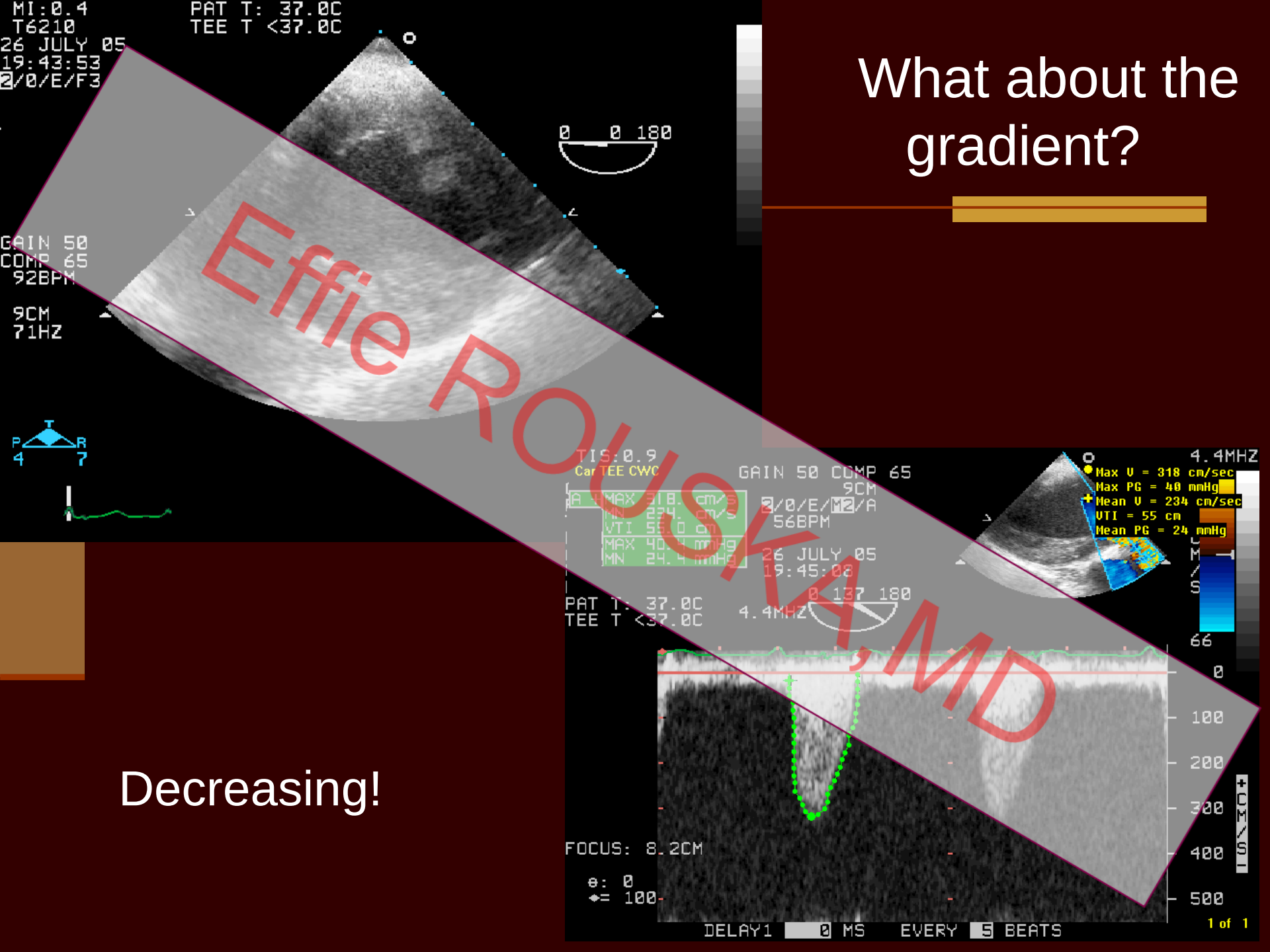
What is the problem?

What can we do? What have we done?



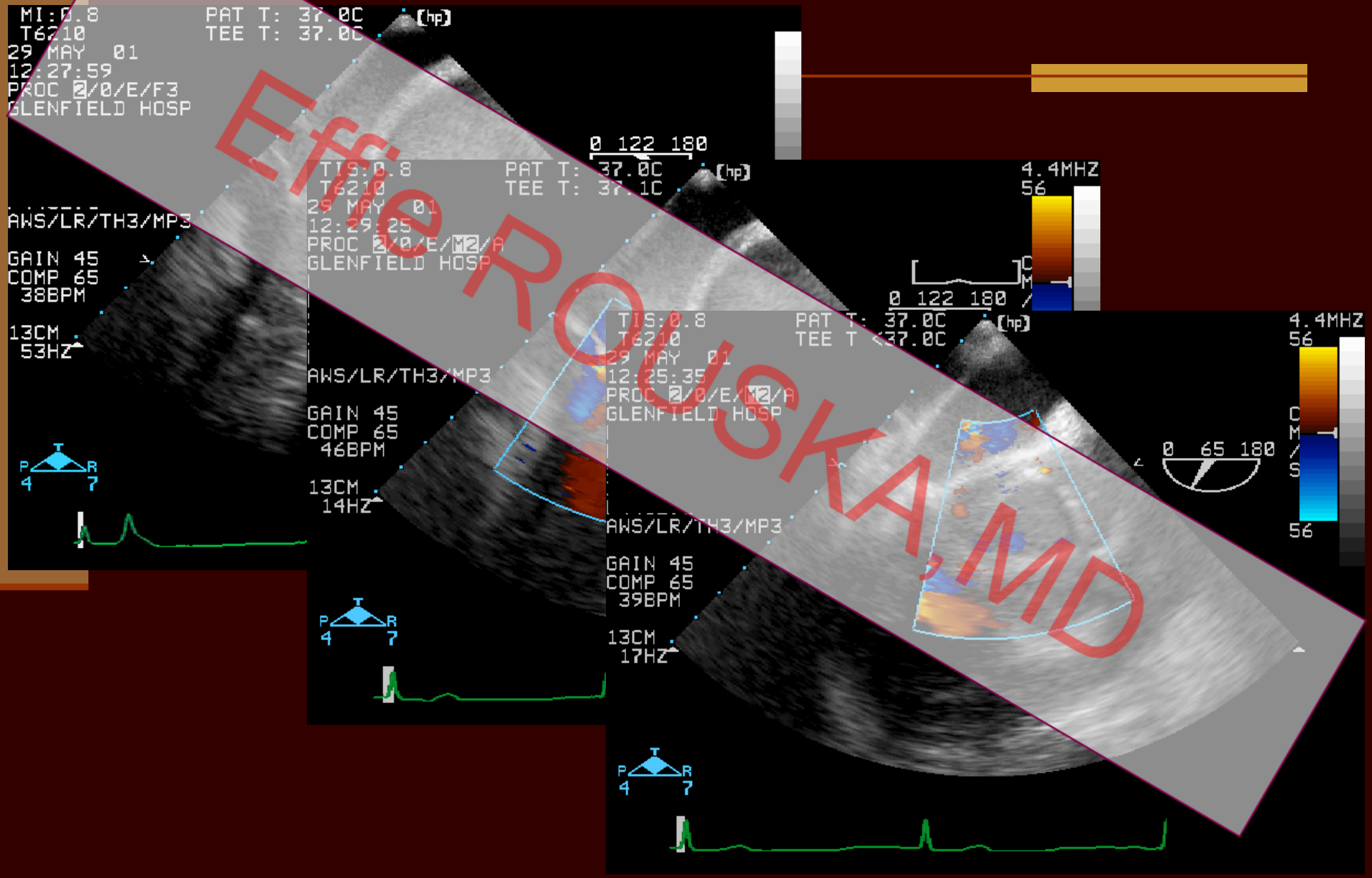
What about the gradient?

What about the gradient?

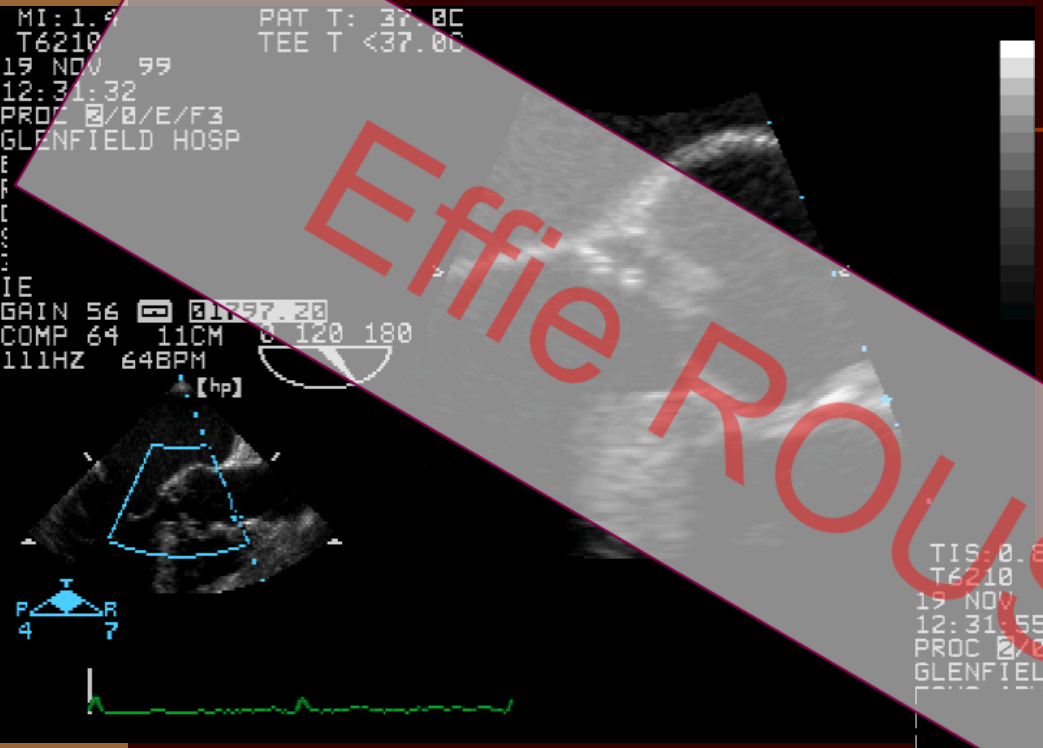


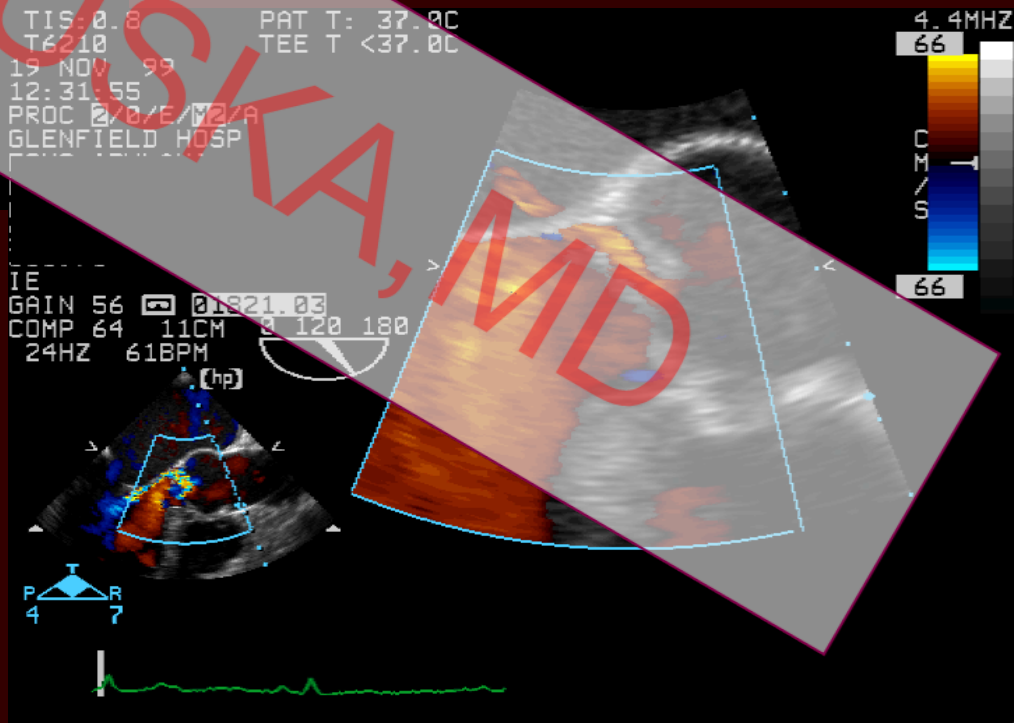
Decreasing!

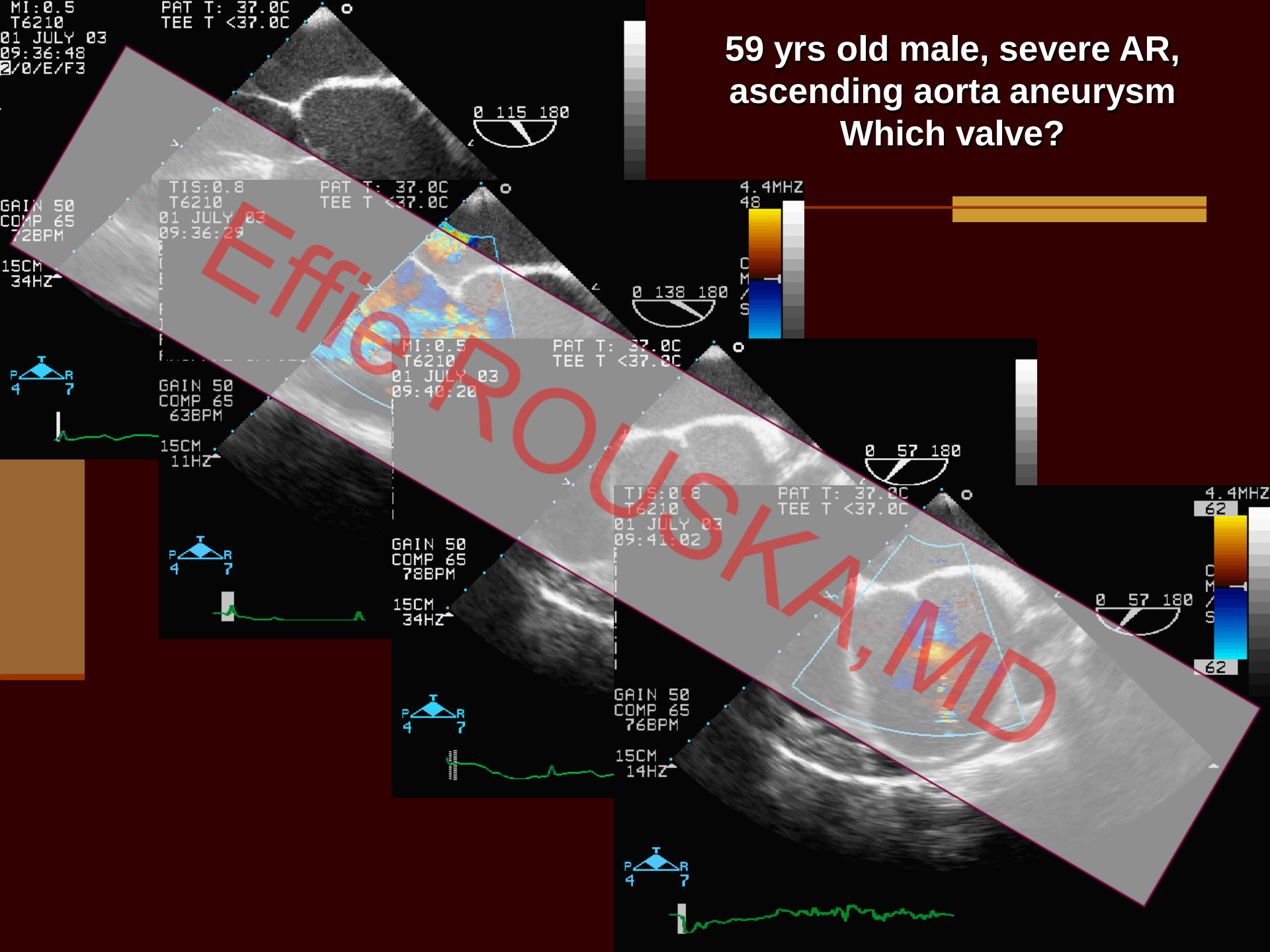
AR – Root dilatation, dissection



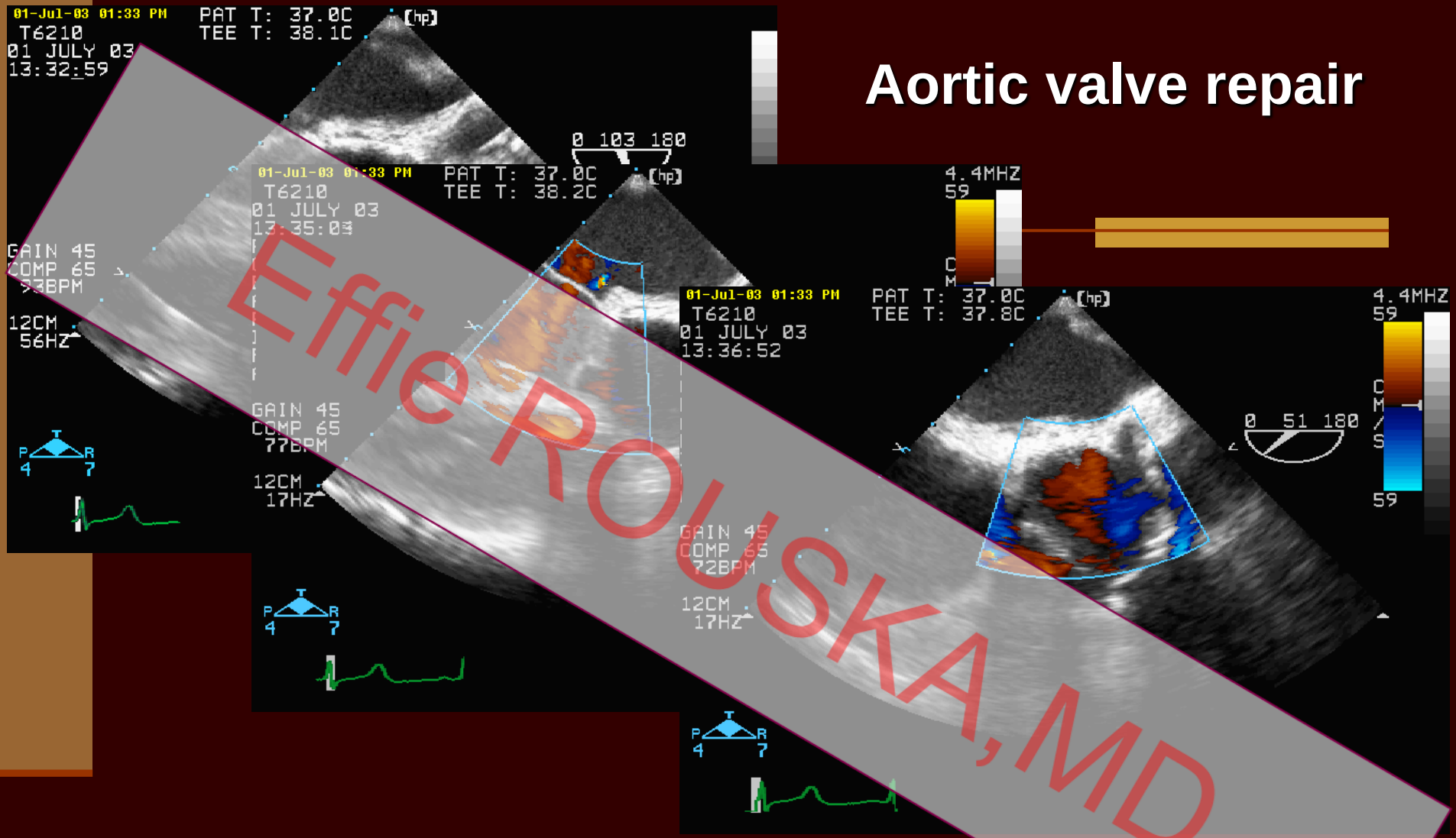
AR – endocarditis with cusp prolapse






59 yrs old male, severe AR, ascending aorta aneurysm
Which valve?
Effie ROUSKA,MD

Aortic valve repair



Residual AR – How much is too much?

Hopkins RA. Aortic valve leaflet sparing and salvage surgery: evolution of techniques for aortic root reconstruction. Eur J Cardiothorac Surg 2003;24:886-897


Thank you
Thank you
Effie ROUSKA,MD