

Italy Air Force Health Service





Aerospace Medicine Institute “Angelo Mosso” Milan, Italy

- Department of Cardiology



Bicuspid Aortic Valve Disease in pilots: single pilot, multi-crew or surgery?

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fabriziopalumbo@libero.it

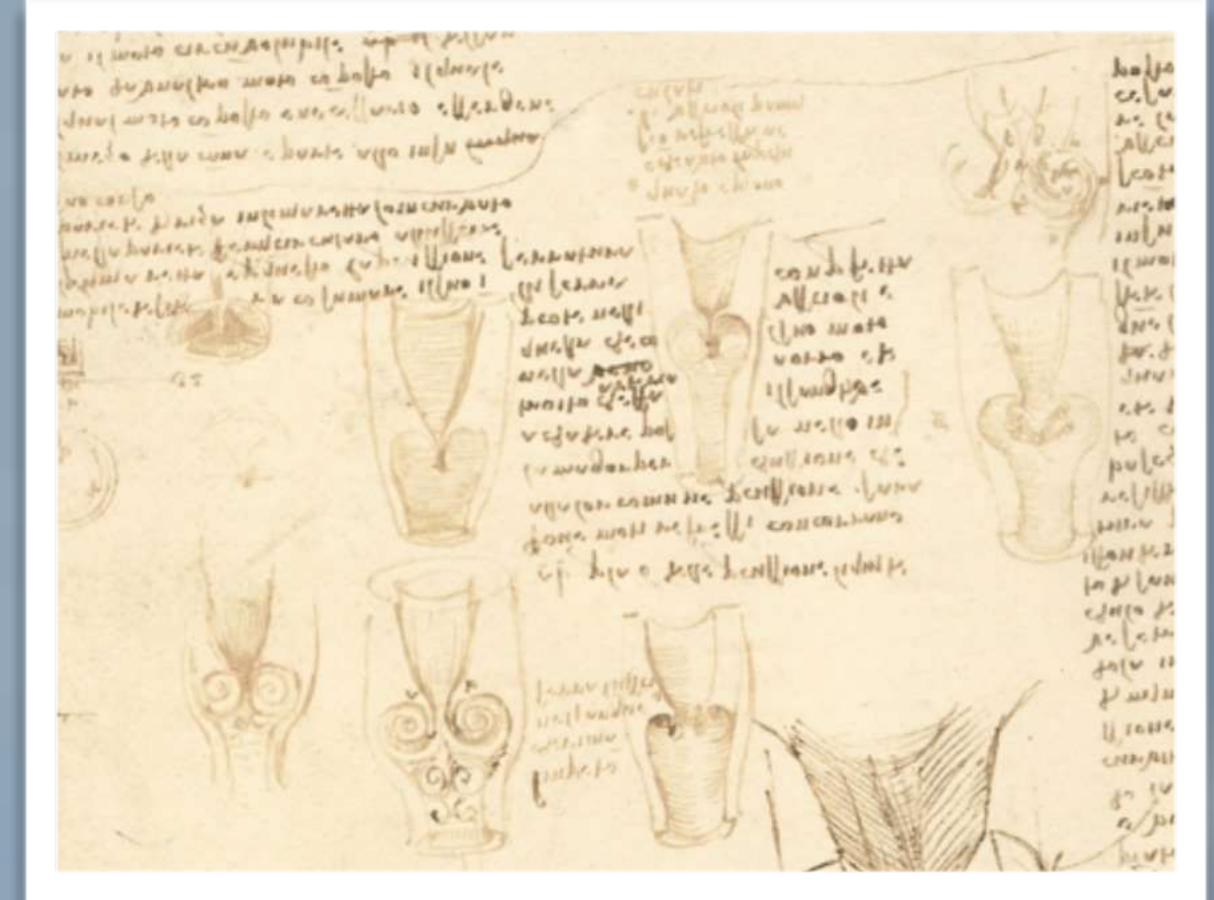
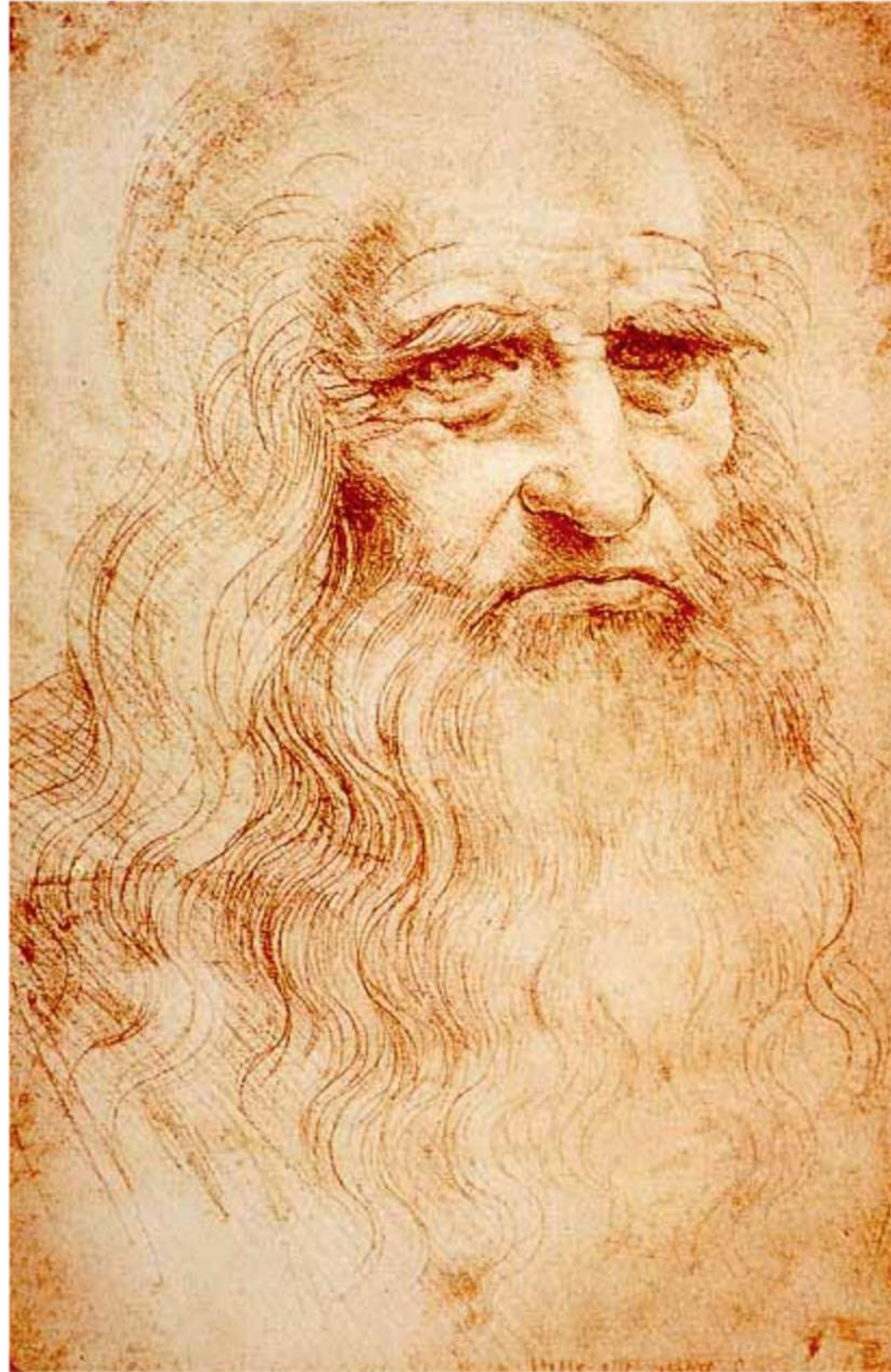


All good things are three.

Italian Proverb



Leonardo Da Vinci (1452-1519)



Stenosis (37%)

Regurgitation (20%)

Infection (2%)

Dilatation (74-91%)

Dissection (0,03-1%)

Coartation (50% COA has BAV)

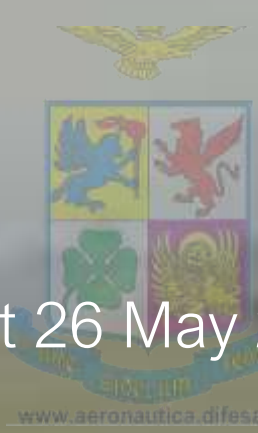
FIT

**MULTI
PILOT**

NOT FIT



Surgery (21% for valve,
7% for aneurysm)



- Bicuspid Aortic Valve Disease: New Insights. Arnold CT et al, Journal Structural Heart 26 May 2017

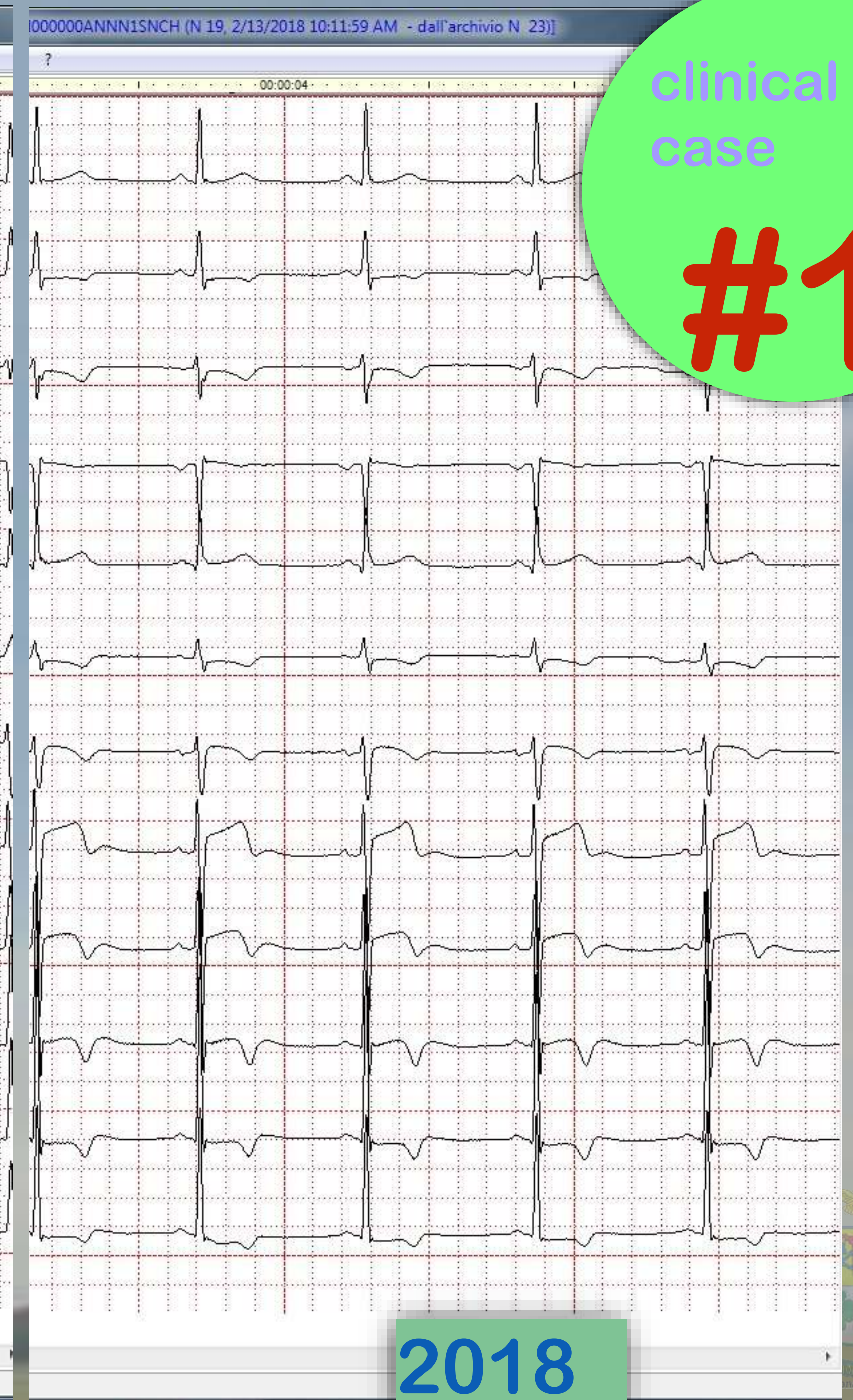
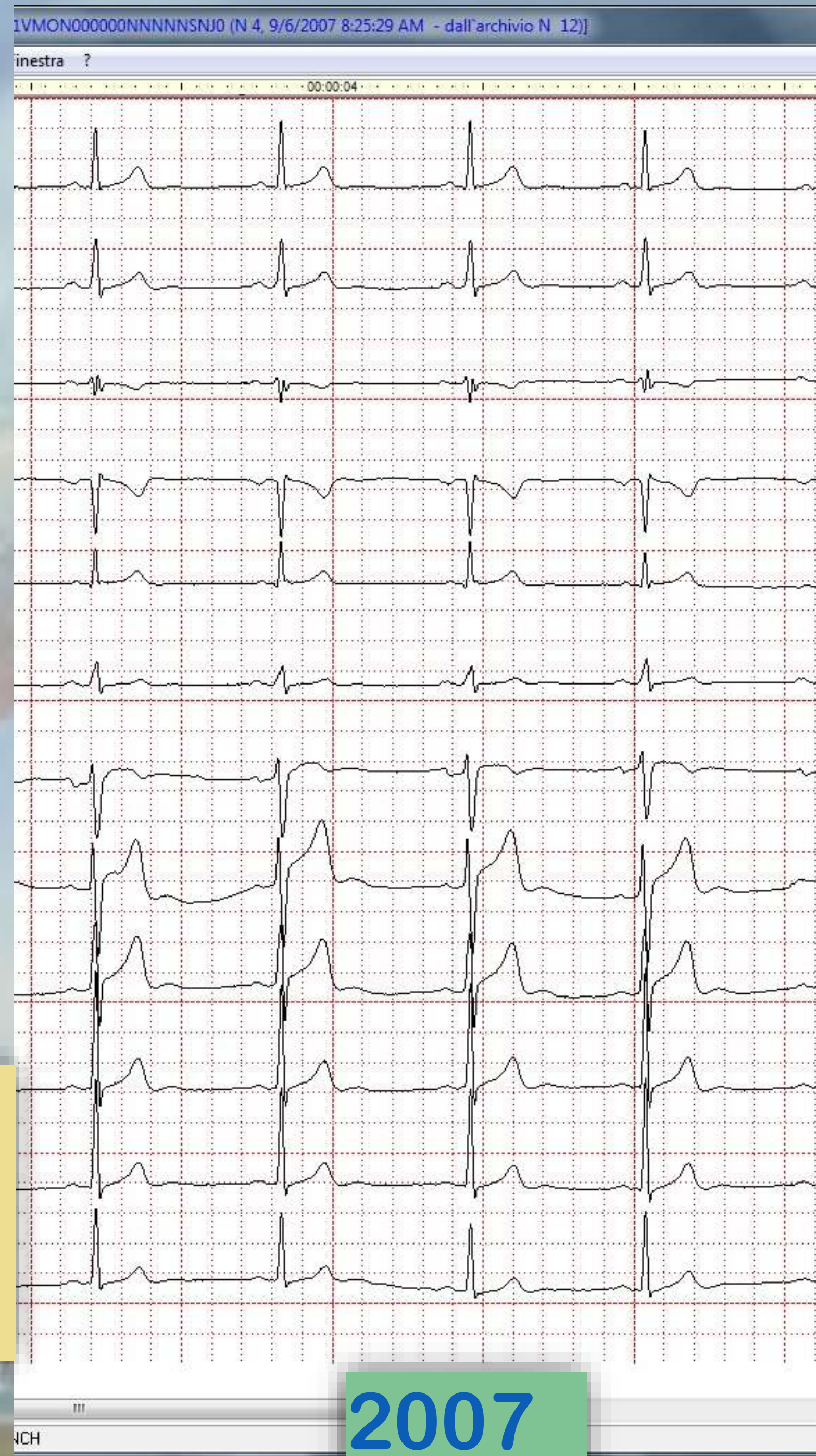
Civilian Pilot 1st cl.

- symptomless
- silent anamnesis
- male sex
- born 1965
- no therapy

- BP=130/70
- HR=55/min
- BMI=25,3

- dislipidemia

- right systolic murmur 2/6 2001
- diastolic murmur 1/6 Erb 2001
- echo Aortic regurgitation
- aortic velocity 1.1 m/sec



clinical
case

#1

Civilian Pilot 1st cl.

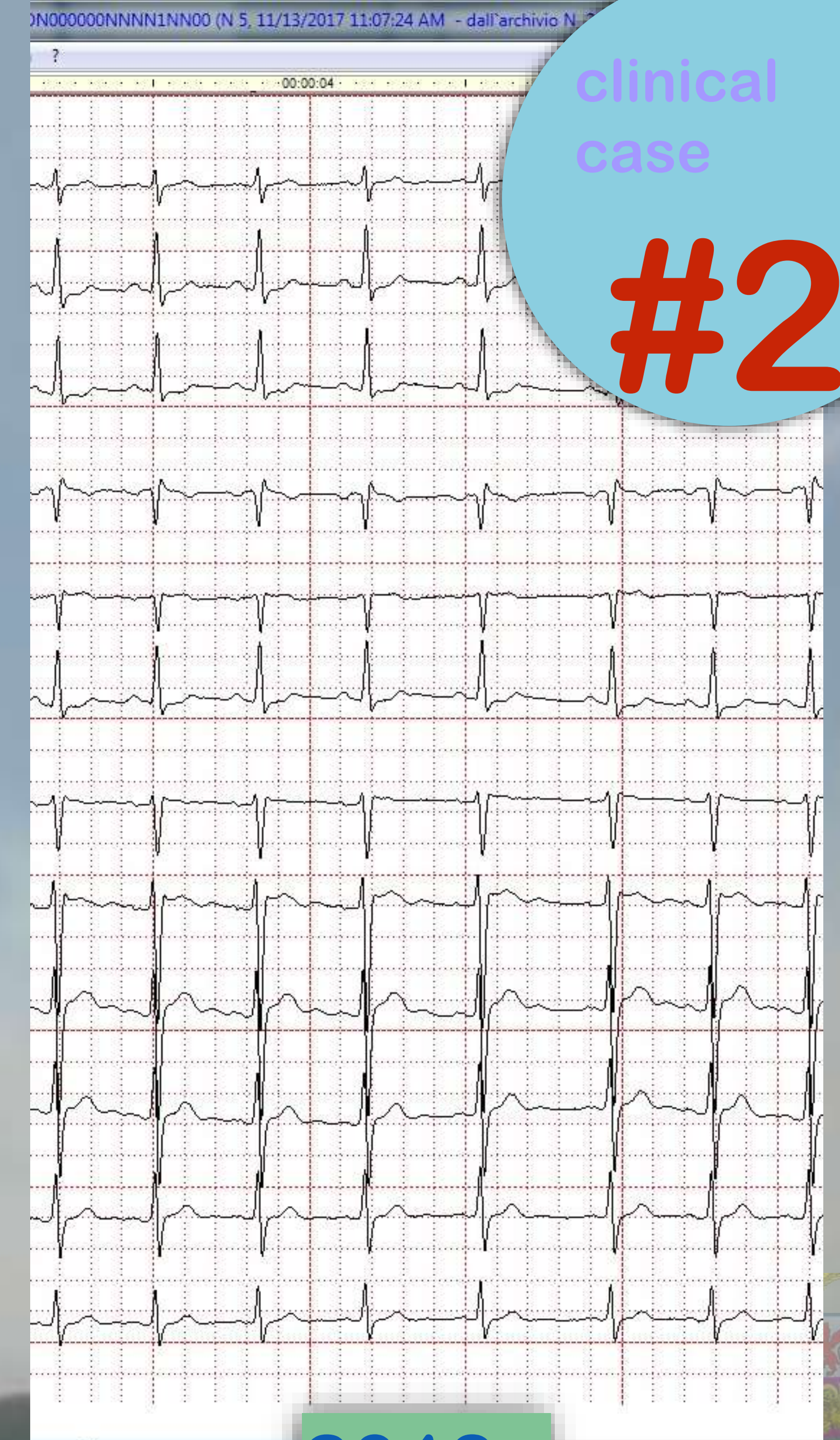
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- BP=130/85
- HR=85/min
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- right systolic murmur 2/6 2018
- aortic velocity 1.2 m/sec



2008



2018

clinical
case

#2

Military Pilot (Conventional)

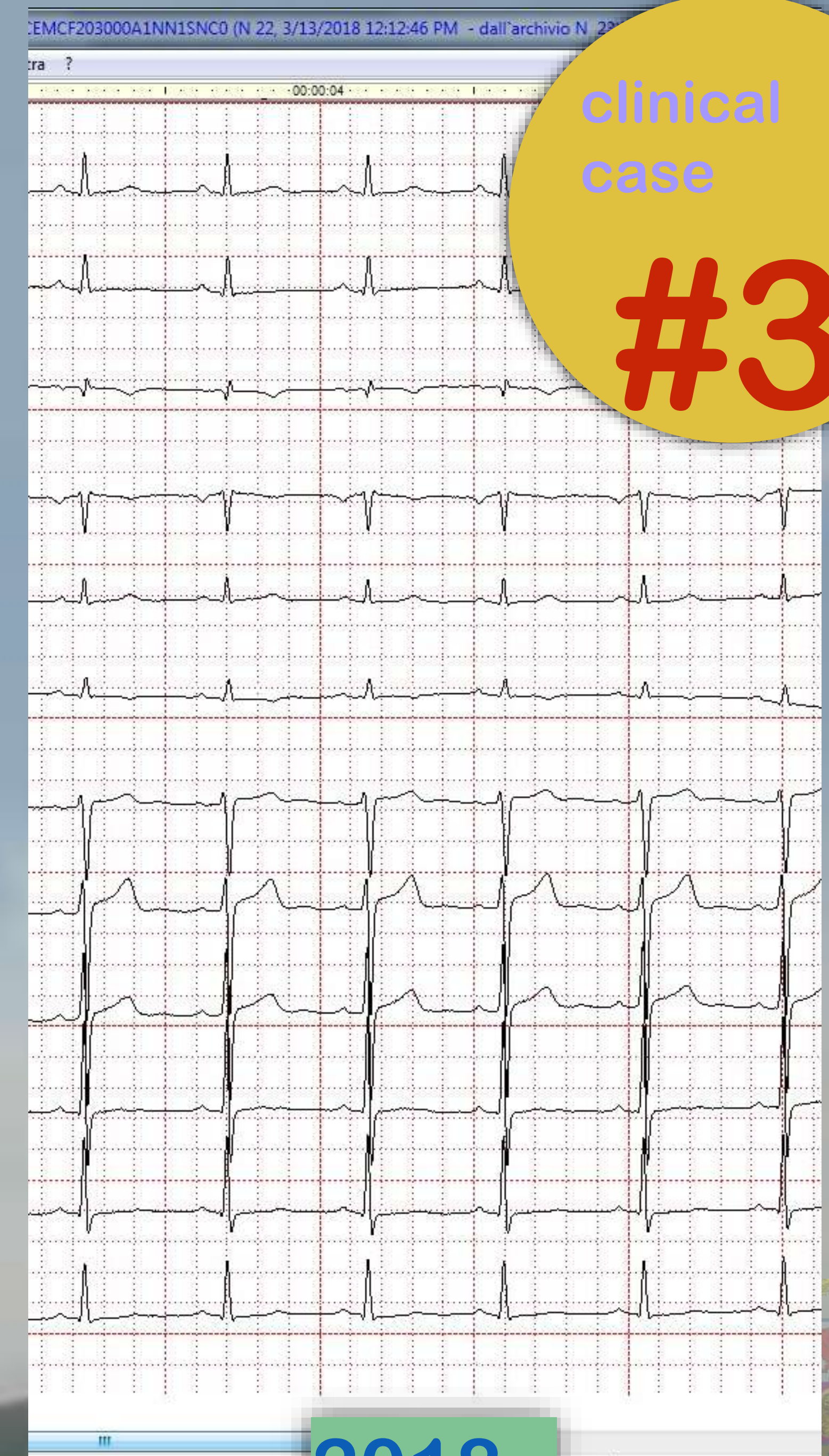
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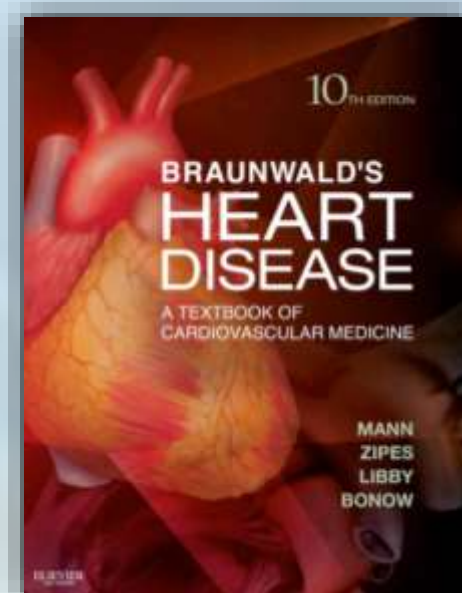
2007



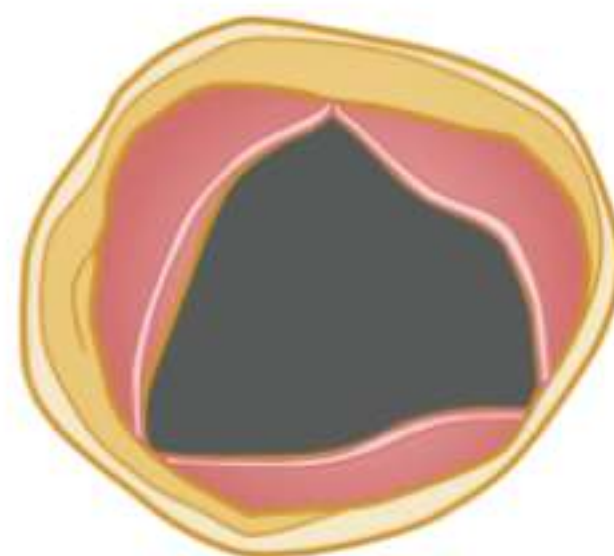
2018

clinical
case

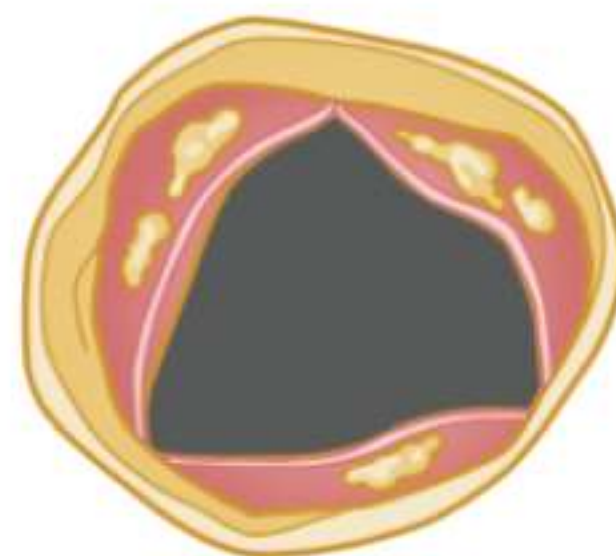
#3



AORTIC VALVE ANATOMY



Normal



Aortic sclerosis



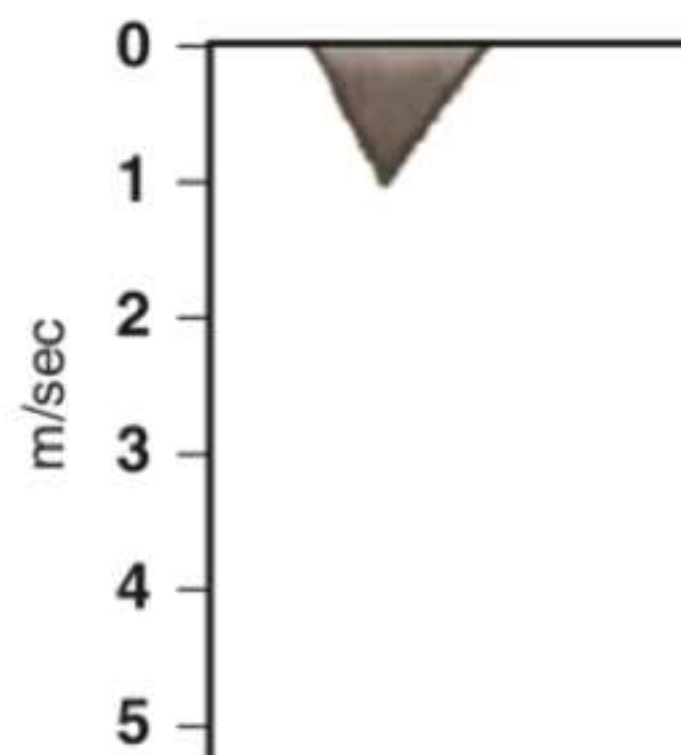
Mild to moderate aortic stenosis



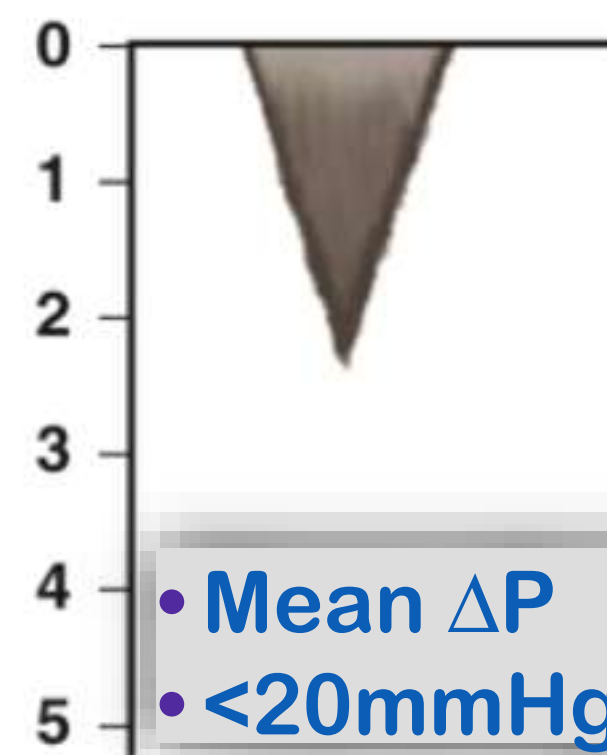
Severe aortic stenosis



DOPPLER AORTIC JET VELOCITY

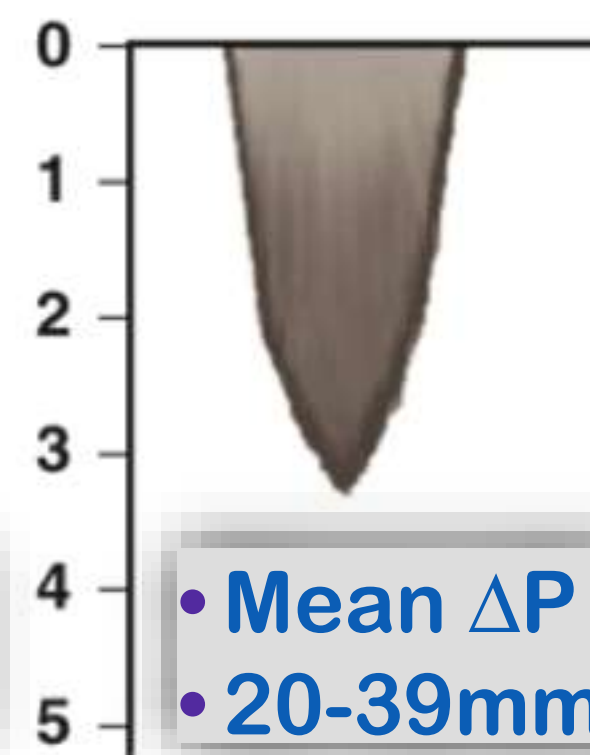


NORMAL



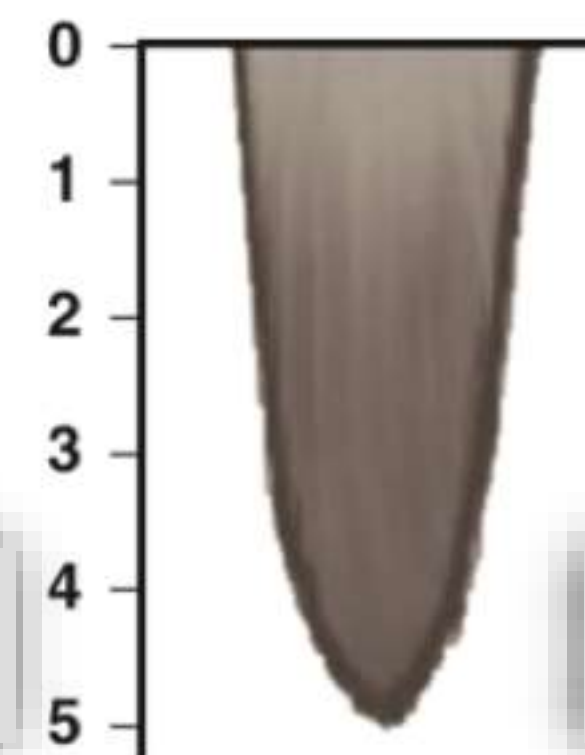
AORTIC SCLEROSIS
<2.5 m/sec

- Mean ΔP
• <20mmHg



MILD TO MODERATE
AORTIC STENOSIS
2.5-4.0 m/sec

- Mean ΔP
• 20-39mmHg



SEVERE AORTIC
STENOSIS
>4 m/sec

- Mean ΔP
• ≥ 40 mmHg

FIT

FIT

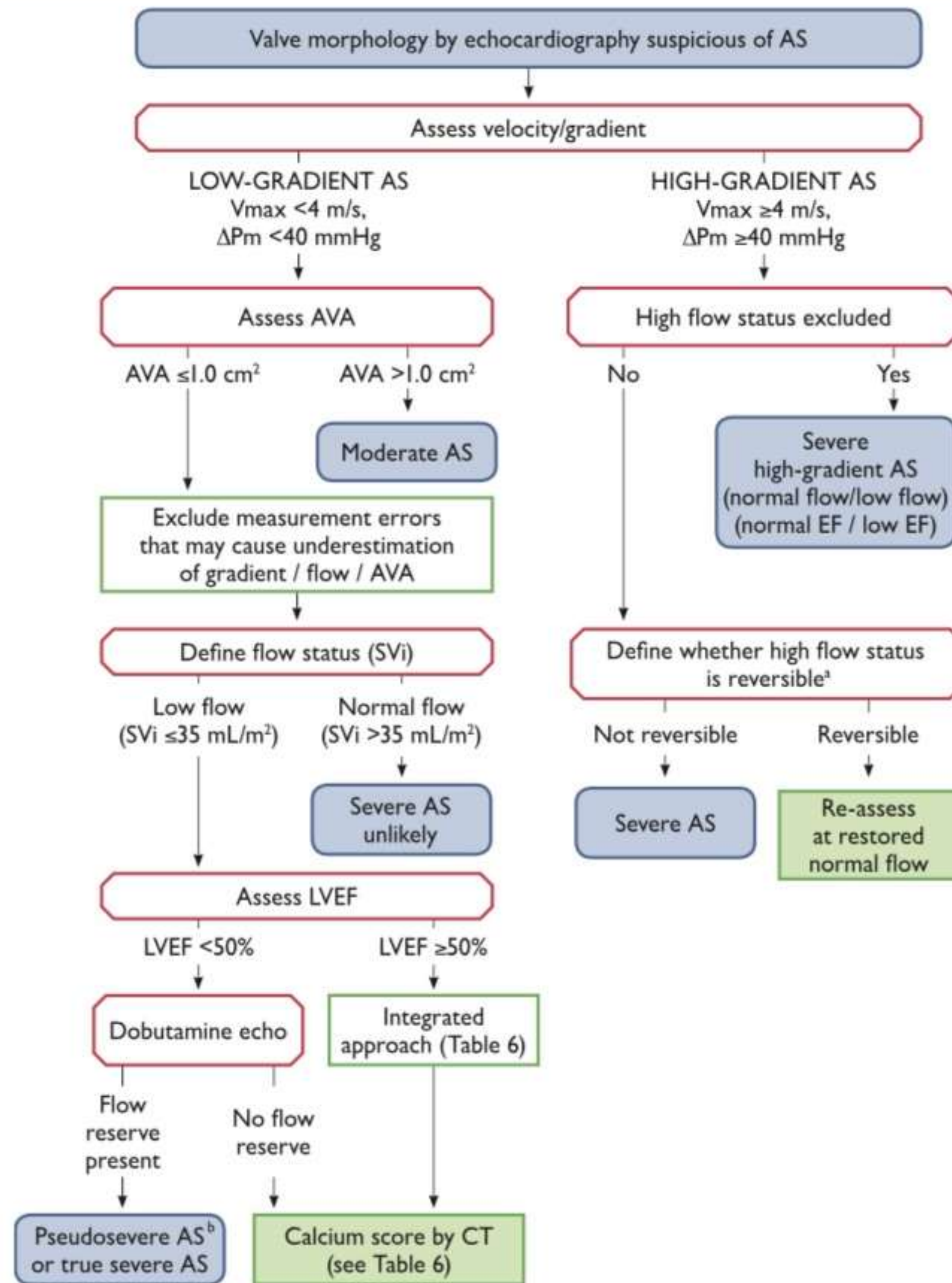
**MULTI
PILOT**

NOT FIT

Acceptable Means of Compliance
and
Guidance Material to Part-MED¹

Initial issue
15 December 2011

• >3m/sec? Possible stenosis



ESC

European Society
of Cardiology

European Heart Journal (2017) 38, 2739–2786
doi:10.1093/eurheartj/ehx391

ESC/EACTS GUIDELINES

2017 ESC/EACTS Guidelines for the management of valvular heart disease

The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Aortic Stenosis

• MILD

• Mean ΔP
• $< 20 \text{ mmHg}$

FIT

• MODERATE

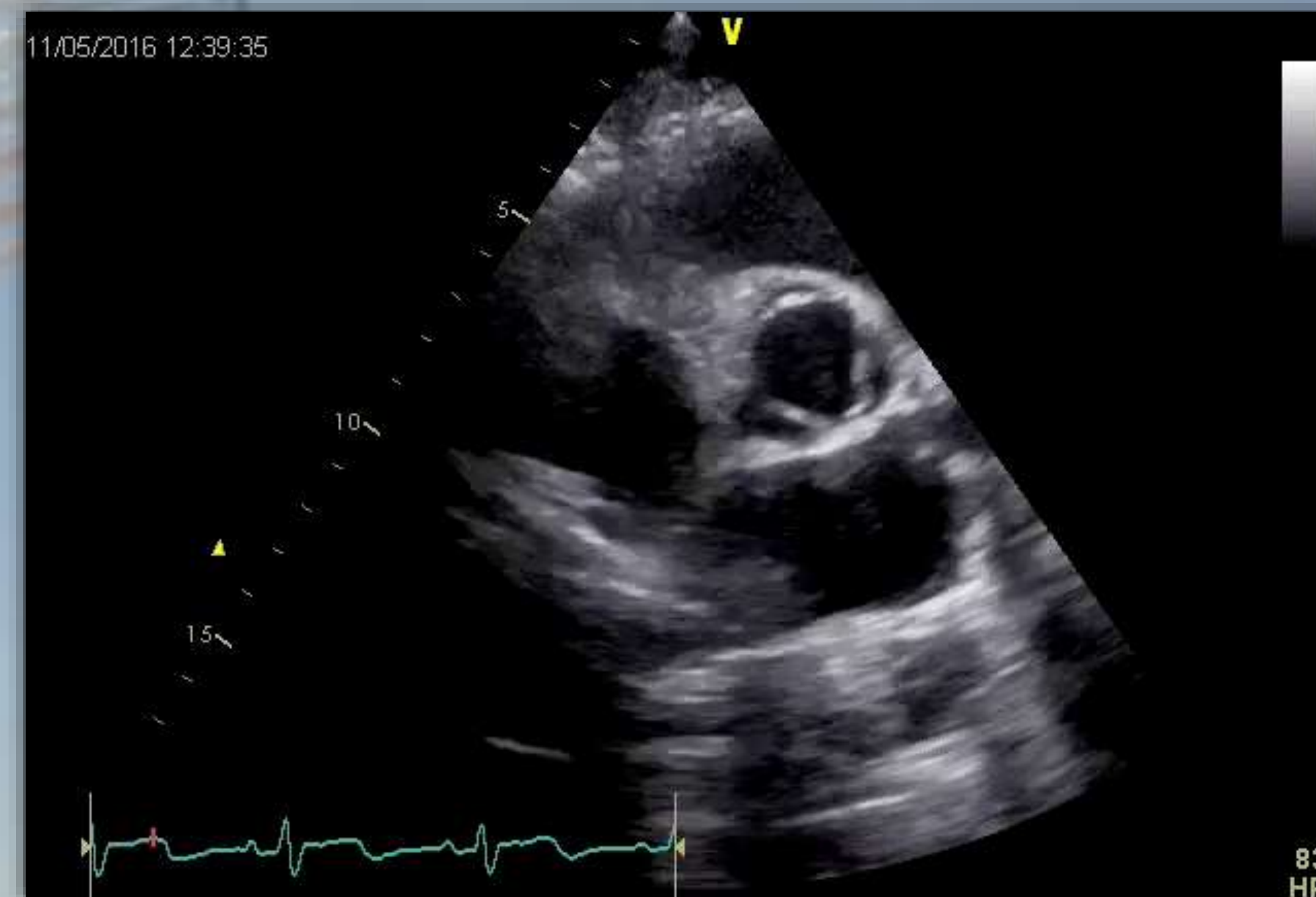
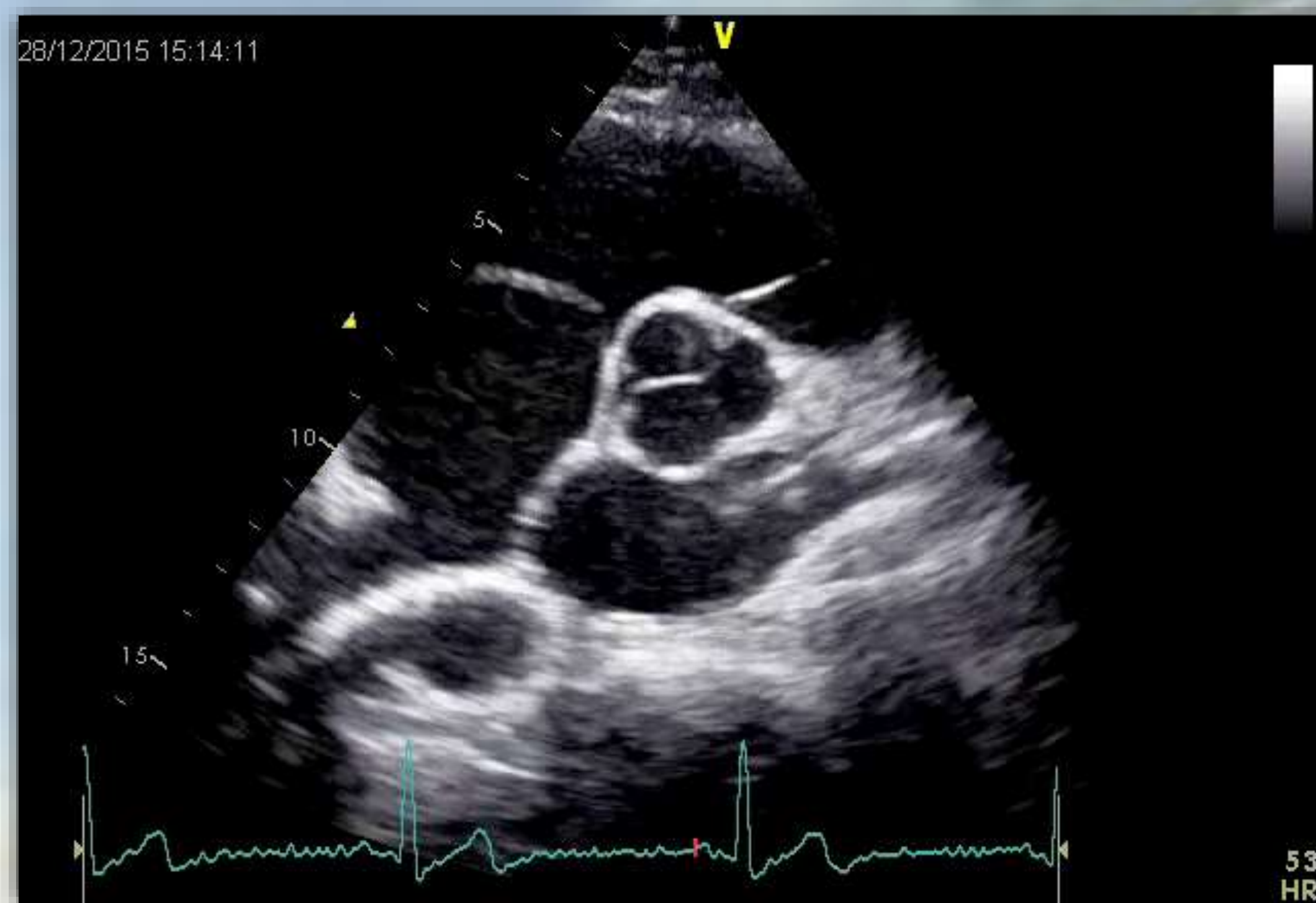
• Mean ΔP
• $20\text{--}39 \text{ mmHg}$

**MULTI
PILOT**

• SEVERE

• Mean ΔP
• $\geq 40 \text{ mmHg}$

NOT FIT







Current clinical approach?

- Screening for familiarity and coartation
- Endocarditis prevention/HTtreatment
- Ascending Aorta >40mm echo 6 months
- If no stenosis or regurgitation echo 3/5 yrs
- After ascending aorta surgery CT scan 3/5 yrs

(Circulation. 2014;129:2691-2704.)

Surgery?

Bicuspid Aortic Valve **Identifying Knowledge Gaps and Rising to the Challenge** **From the International Bicuspid Aortic Valve Consortium (BAVCon)**

BAV patients.²⁵ The underlying mechanisms responsible for such varied BAV-associated valvuloaortic phenotypes remain unknown, and, despite the aforementioned valvular pathophysiologic insights, why a BAV becomes stenotic, another regurgitant, another is associated with aortic dilatation, and yet another remains functional throughout a lifetime, remains fundamentally unknown and unpredictable, a critical knowledge gap that remains unresolved since its first description by Roberts >40 years ago.²⁸ More concerning is the fact that there is only scarce insight as to why a few unfortunate BAV patients will incur aortic dissection in their lifetime but many will not.¹⁰ Indeed, available clinical tools attempting to risk

- Severe Valvular Stenosis/Regurgitation
- Aortic Root Dilatation

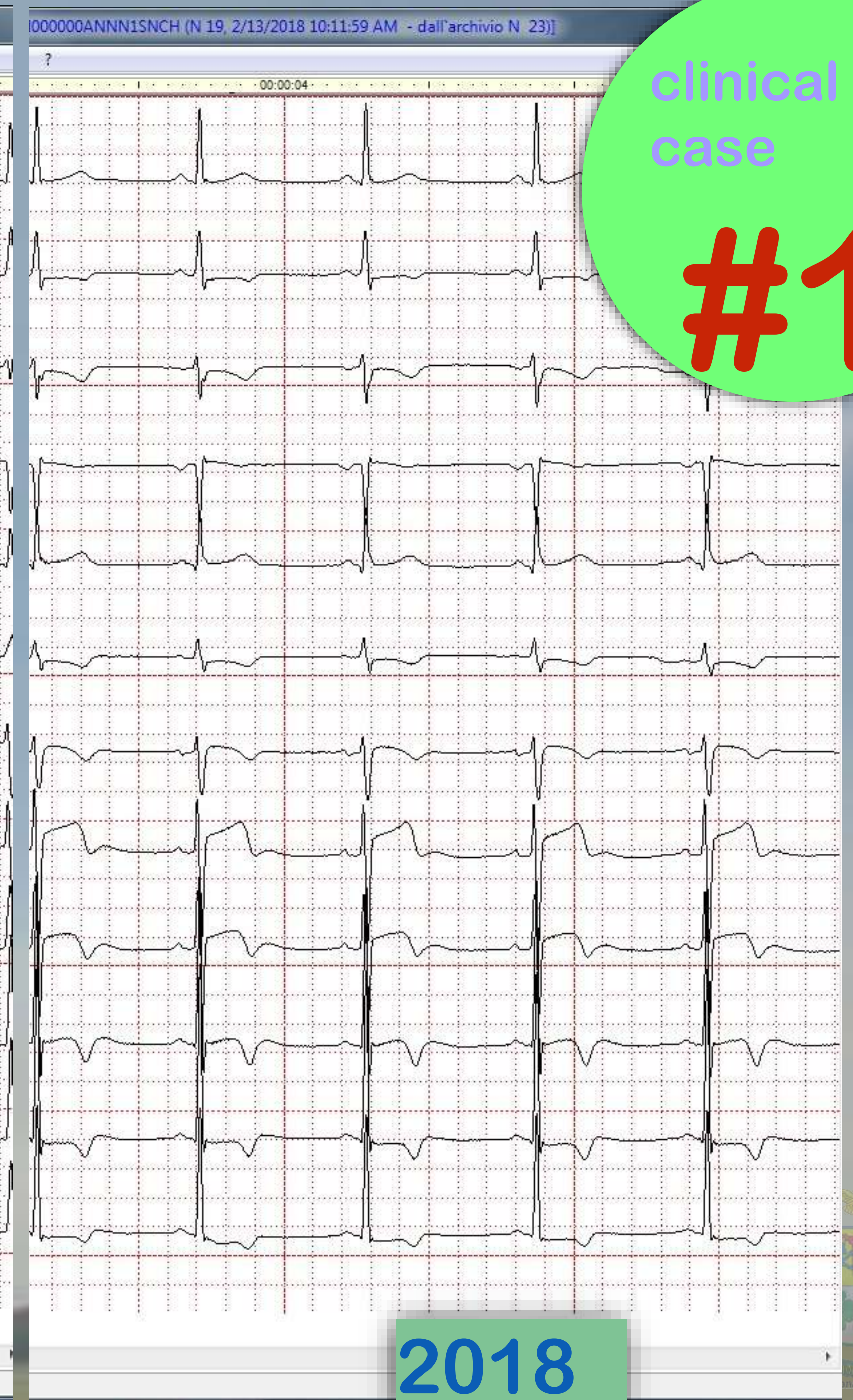
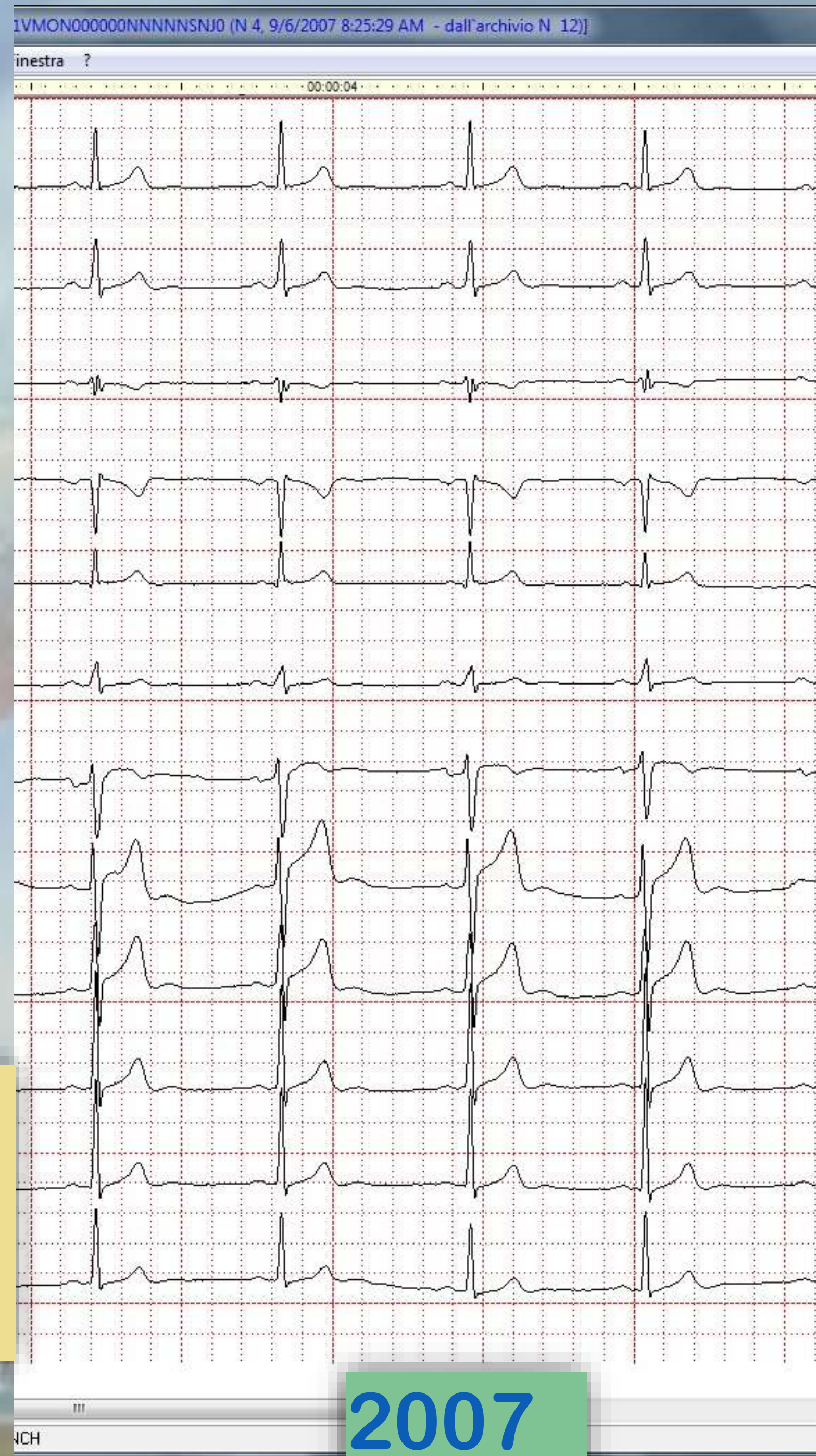
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clinical
case

#1

Civilian Pilot 1st cl.

clinical
case

#1

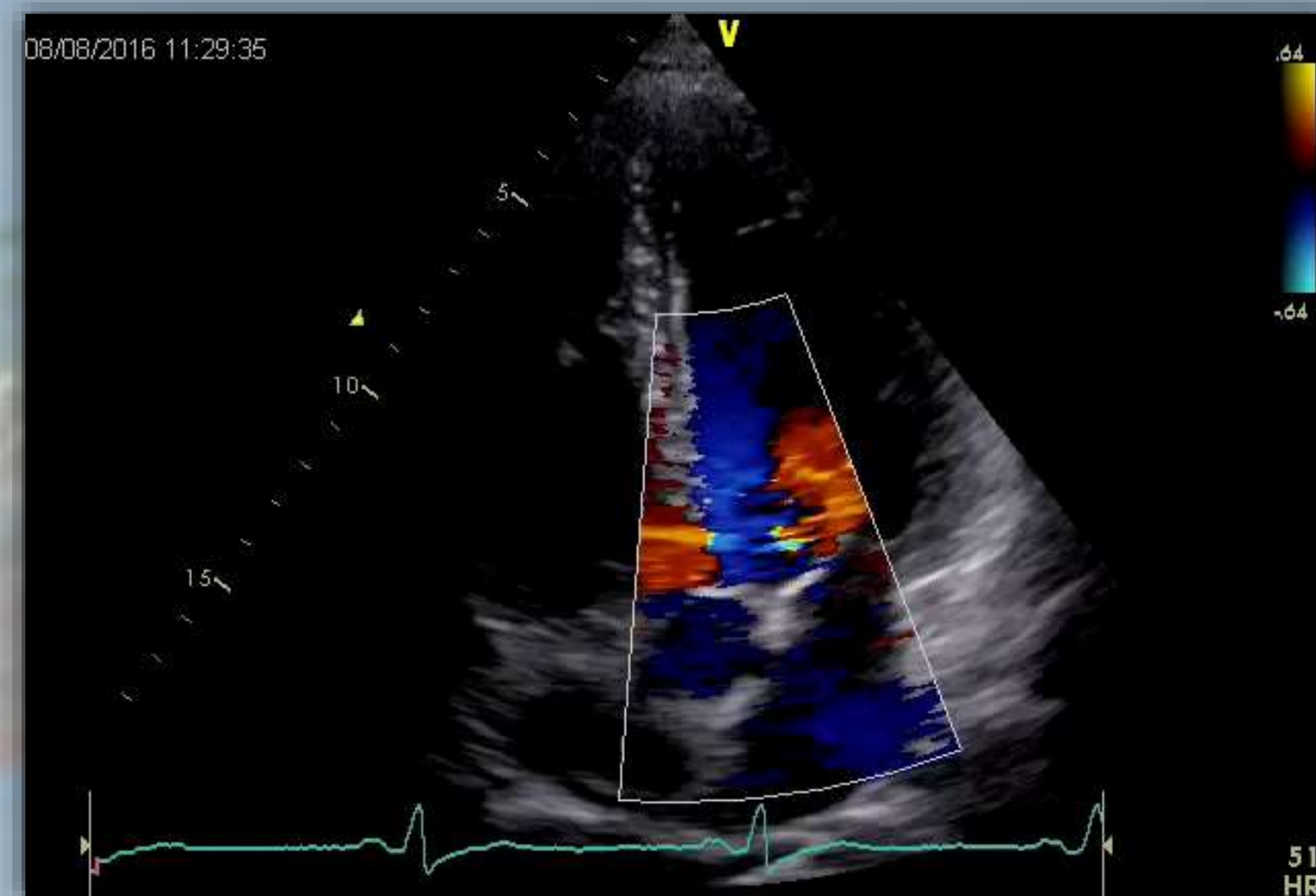
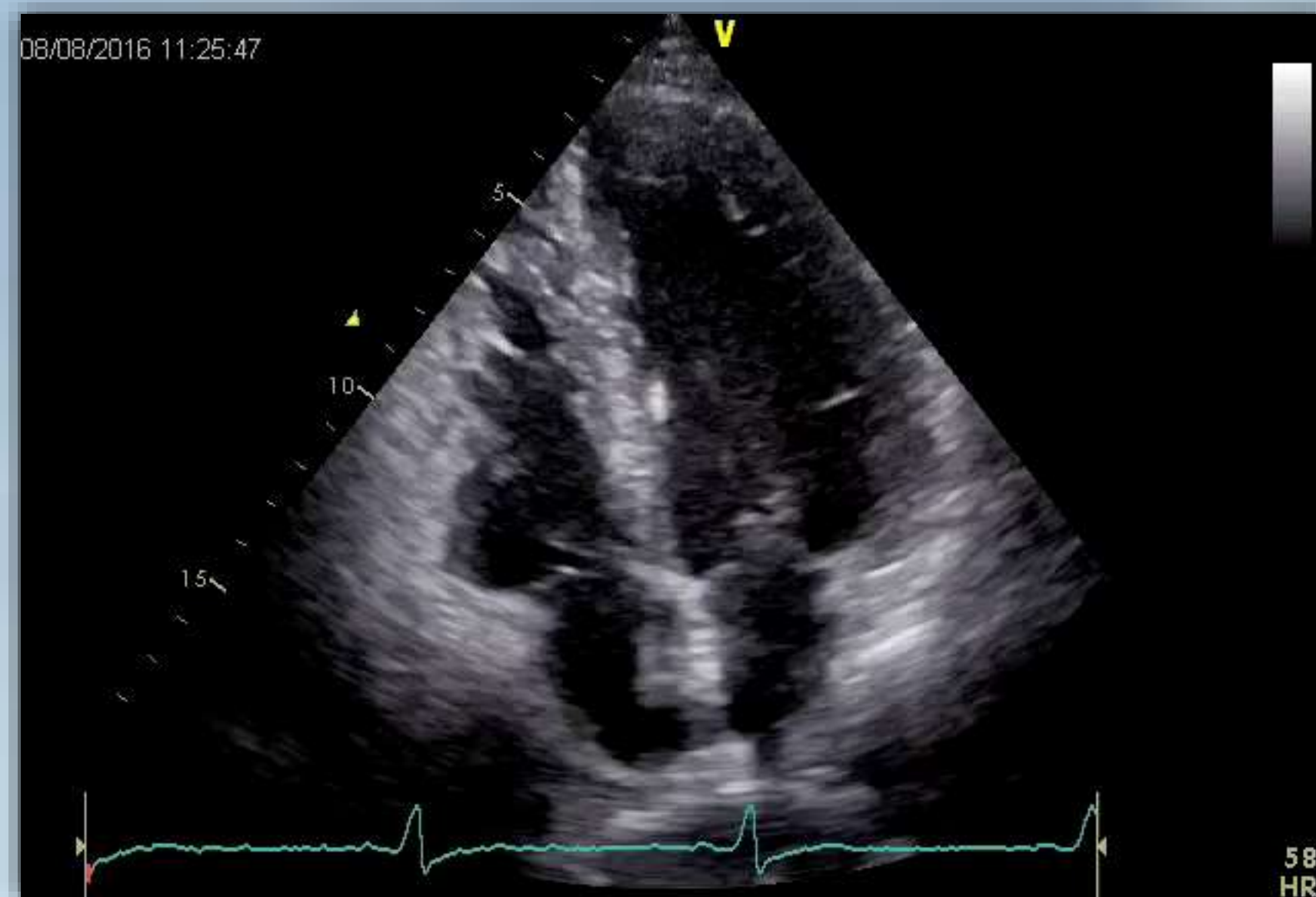
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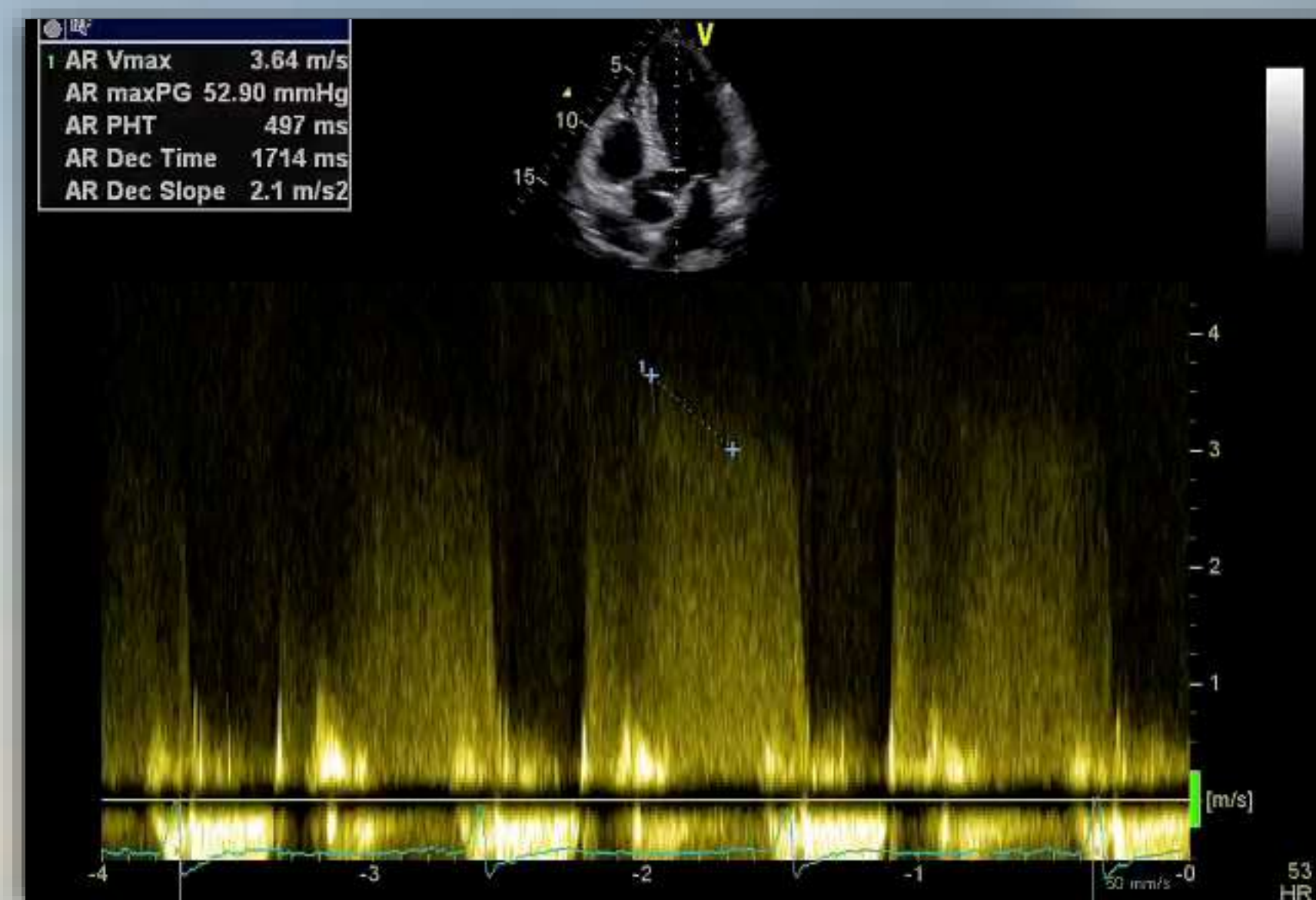
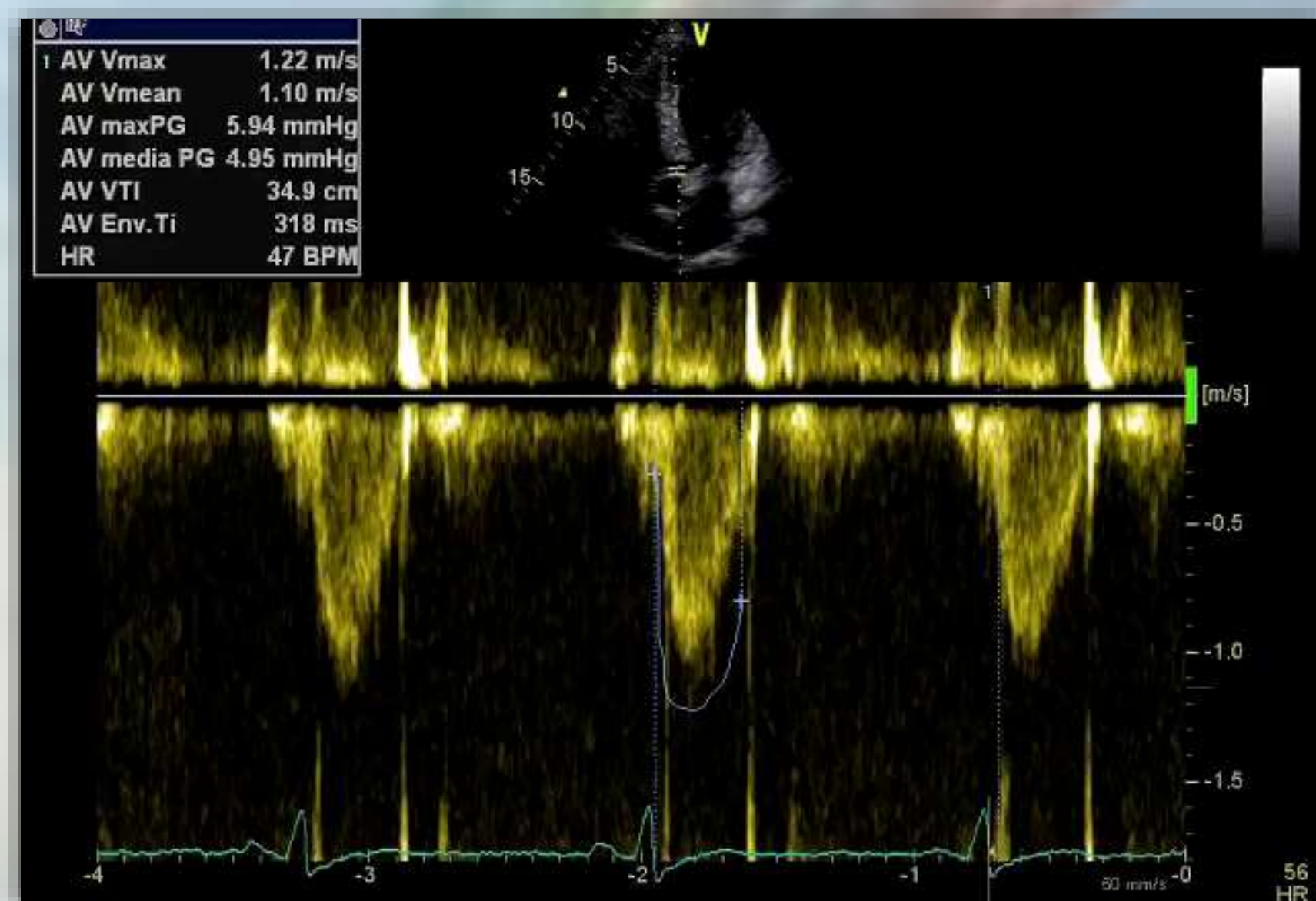
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- 2001 exercise test 87% MHR neg
- 2016 stress echo 87% MHR neg



clinical
case

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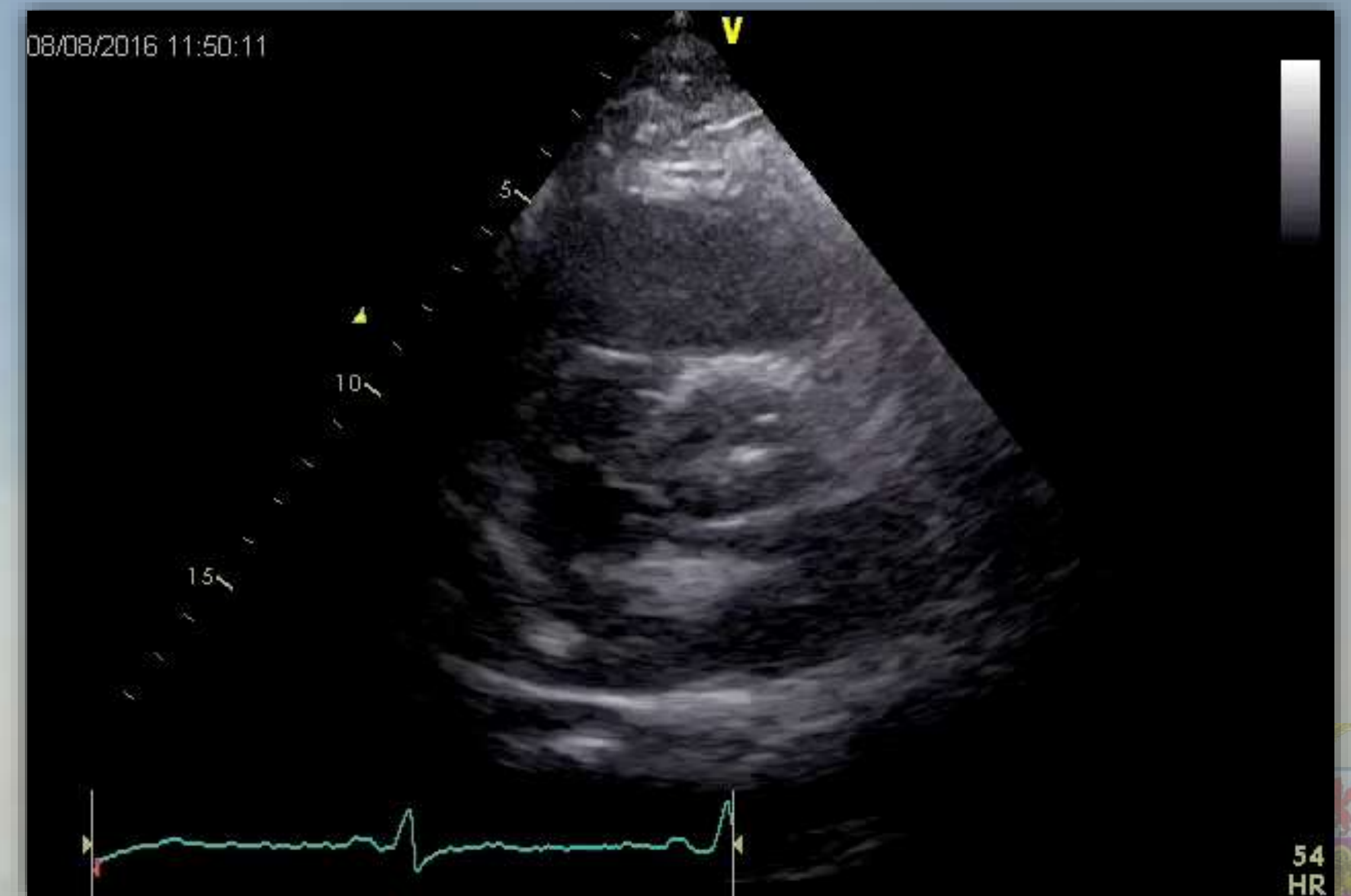
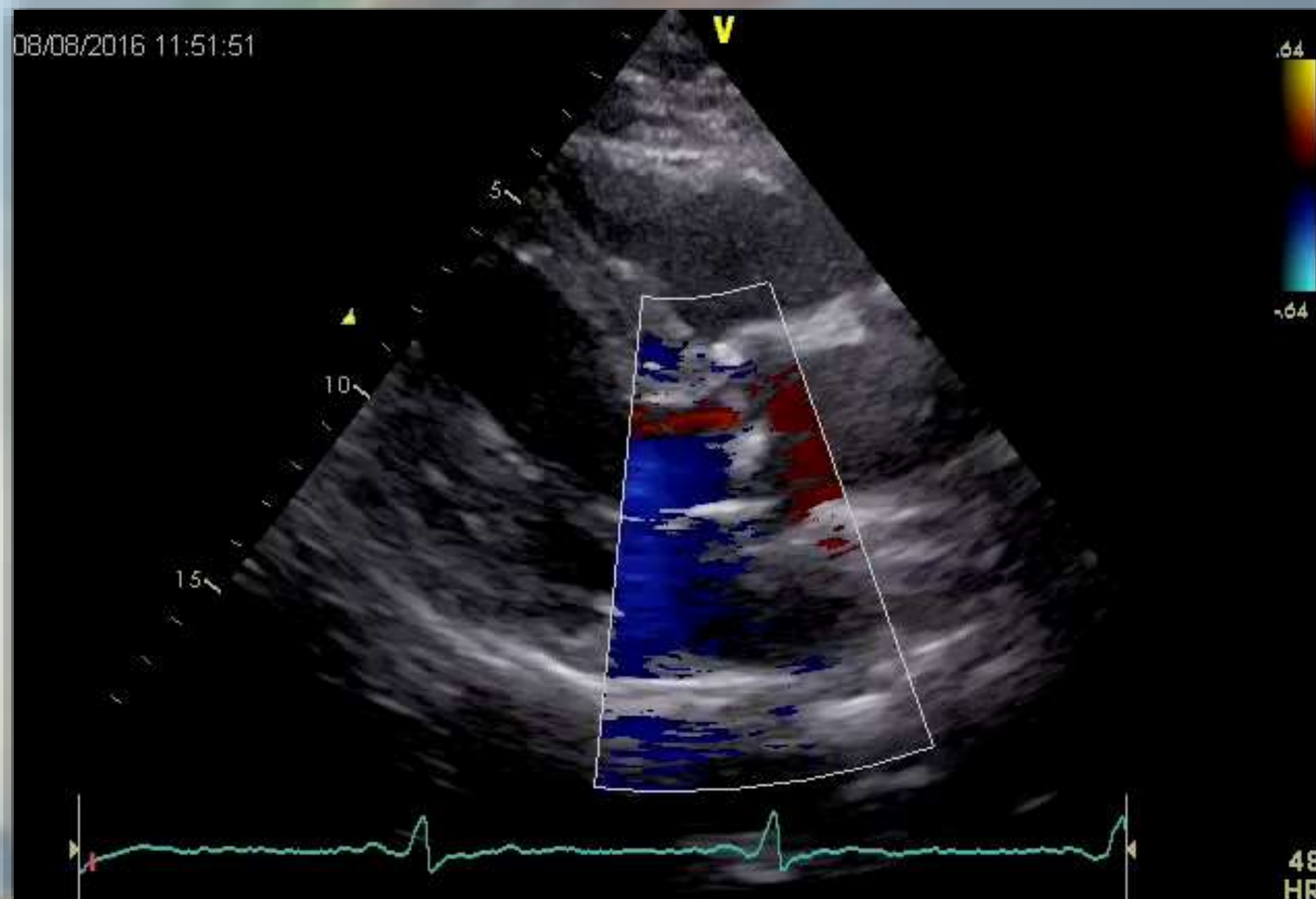
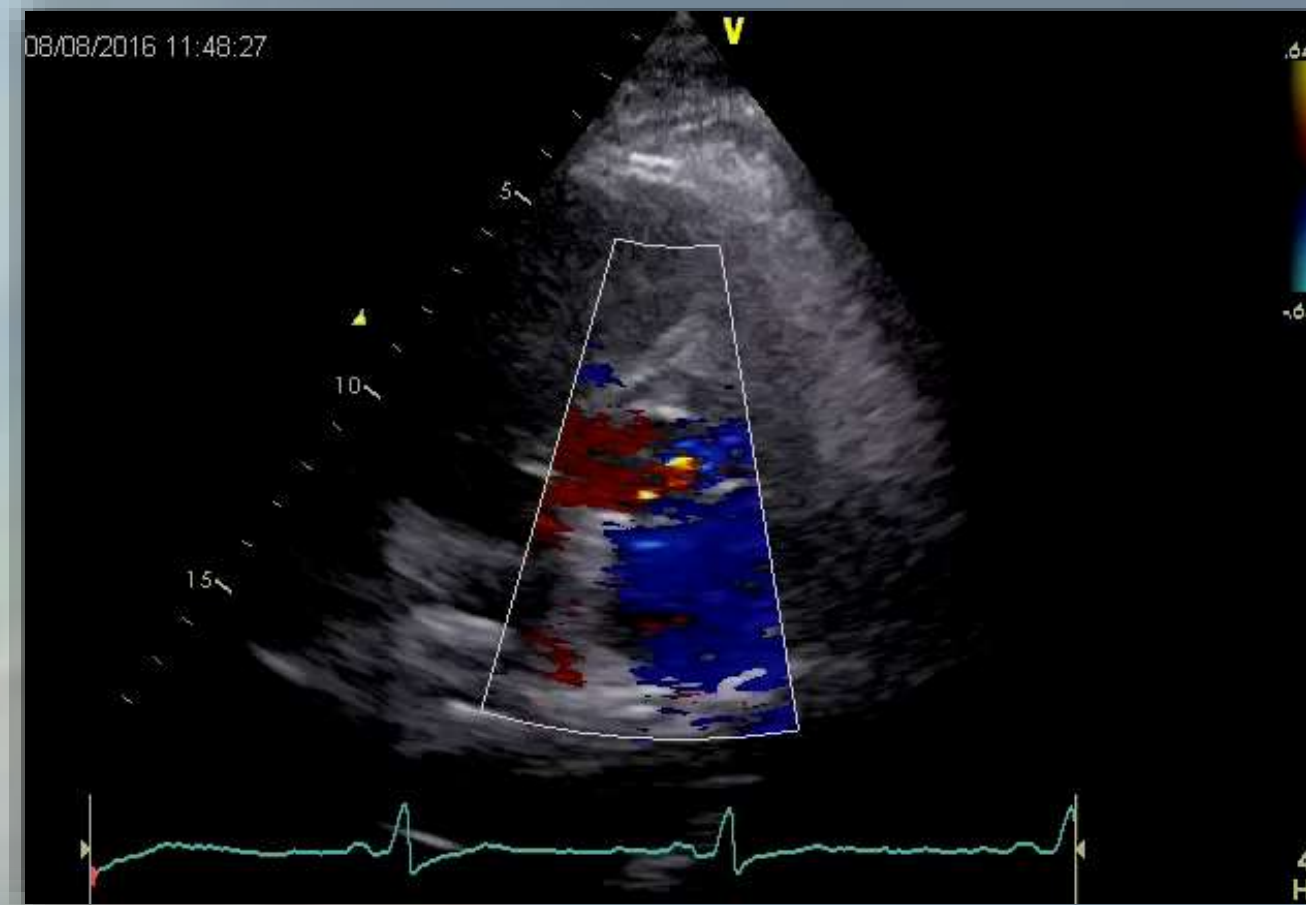


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clinical
case

#1



Section 2

Specific requirements for class 1 medical certificates

AMC1 MED.B.010 Cardiovascular system

(e) Cardiac valvular abnormalities

(3) Aortic valve disease

- Applicants with a bicuspid aortic valve may be assessed as fit if no other cardiac or aortic abnormality is demonstrated. Follow-up with echocardiography, as necessary, should be determined by the licensing authority.



clinical
case

#1

European Aviation Safety Agency

Accetable Means of Compliance
and
Guidance Material to Part-MED¹

Initial issue
15 December 2011



(e) Cardiac valvular abnormalities

- (1) Applicants with previously unrecognised cardiac murmurs should undergo evaluation by a cardiologist and assessment by the licensing authority. If considered significant, further investigation should include at least 2D Doppler echocardiography or equivalent imaging.
- (2) Applicants with minor cardiac valvular abnormalities may be assessed as fit by the licensing authority. Applicants with significant abnormality of any of the heart valves should be assessed as unfit.
- (3) Aortic valve disease
 - (i) Applicants with a bicuspid aortic valve may be assessed as fit if no other cardiac or aortic abnormality is demonstrated. Follow-up with echocardiography, as necessary, should be determined by the licensing authority.
 - (ii) Applicants with aortic stenosis require licensing authority review. Left ventricular function should be intact. A history of systemic embolism or significant dilatation of the thoracic aorta is disqualifying. Those with a mean pressure gradient of up to 20 mmHg may be assessed as fit. Those with mean pressure gradient above 20 mmHg but not greater than 40 mmHg may be assessed as fit with a multi-pilot limitation. A mean pressure gradient up to 50 mmHg may be acceptable. Follow-up with 2D Doppler echocardiography, as necessary, should be determined by the licensing authority. Alternative measurement techniques with equivalent ranges may be used.
 - (iii) Applicants with trivial aortic regurgitation may be assessed as fit. A greater degree of aortic regurgitation should require a multi-pilot limitation. There should be no demonstrable abnormality of the ascending aorta on 2D Doppler echocardiography. Follow-up, as necessary, should be determined by the licensing authority.

Civilian Pilot 1st cl.

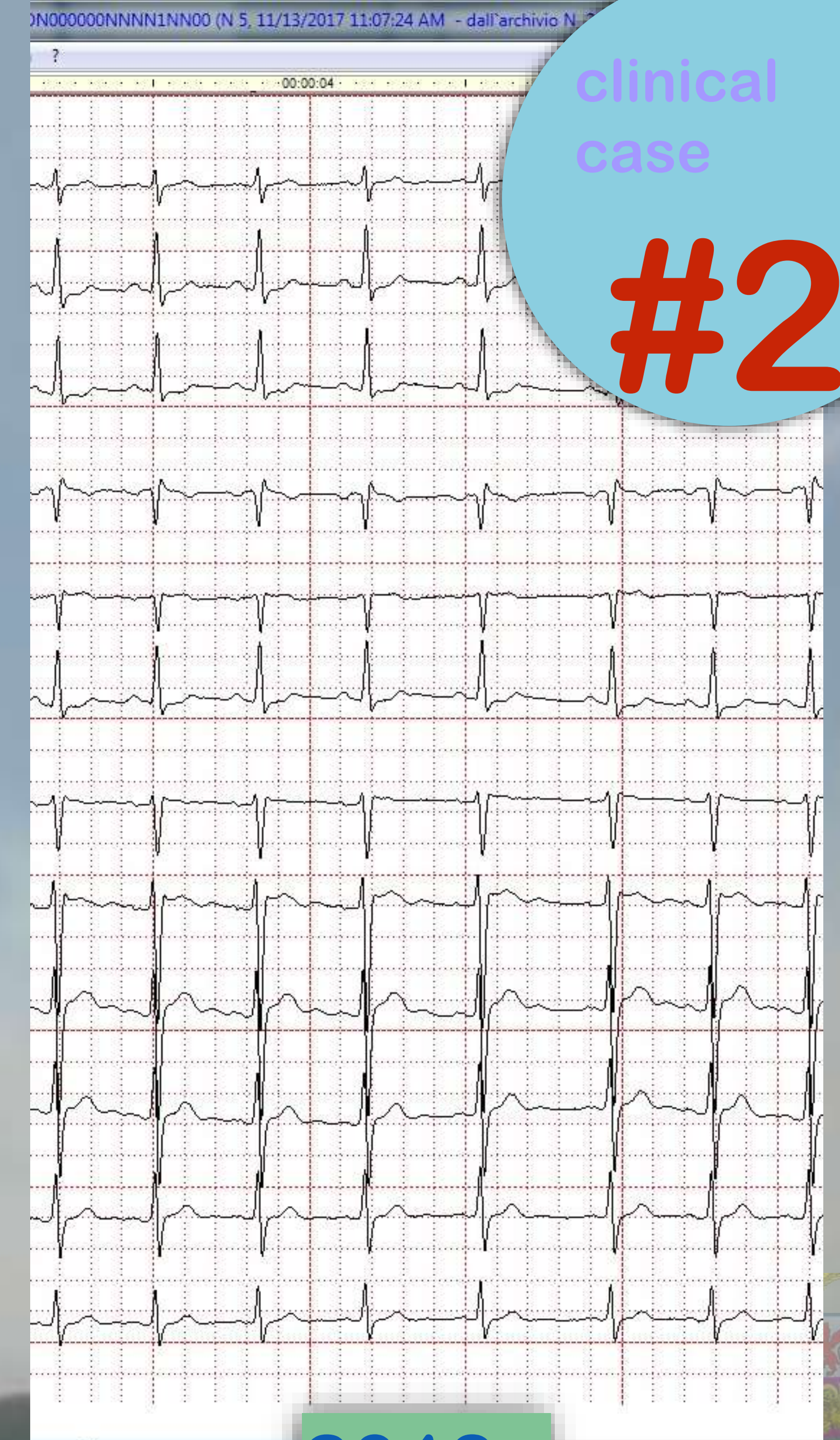
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- aortic velocity 1.2 m/sec



2008



2018

clinical
case

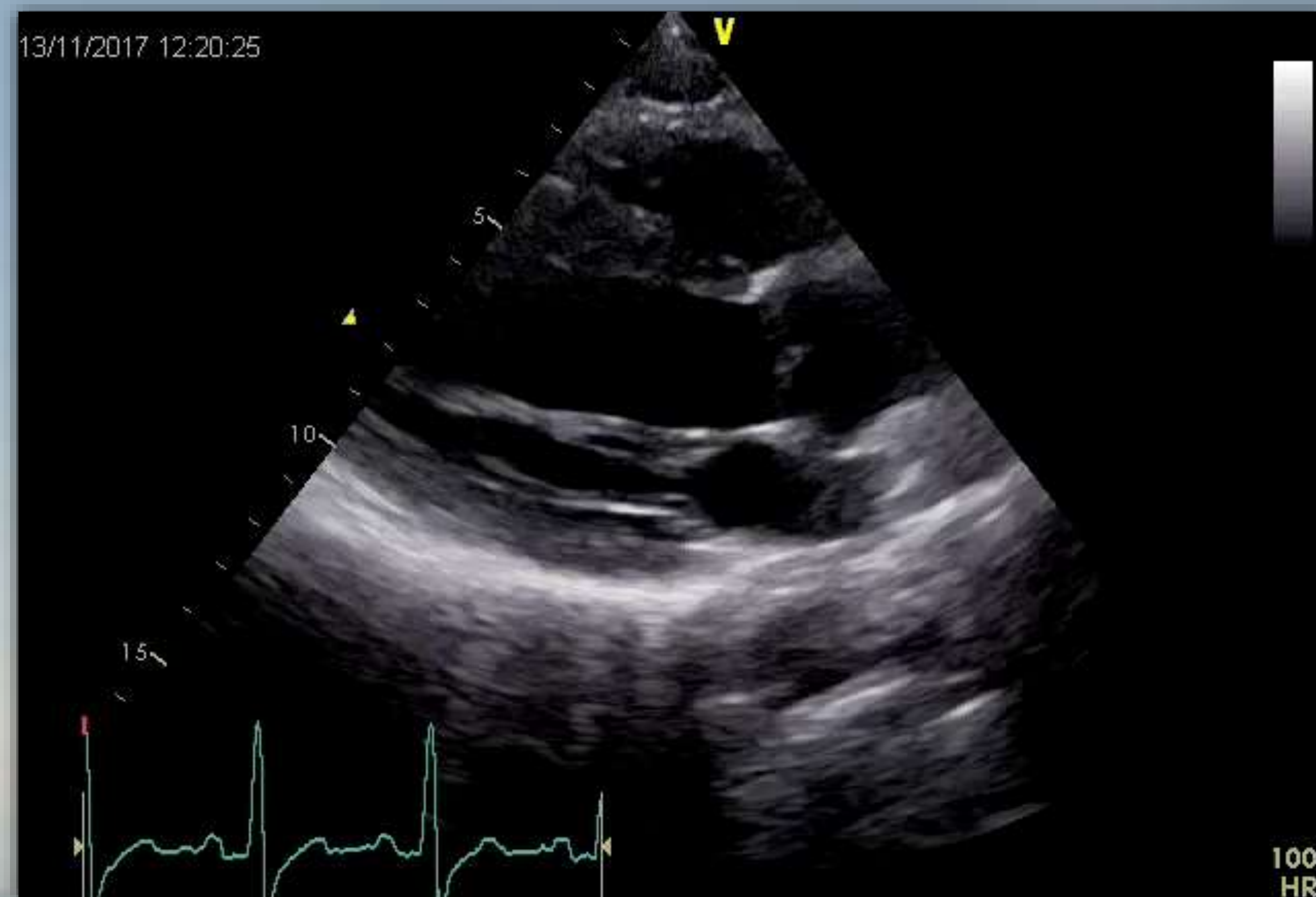
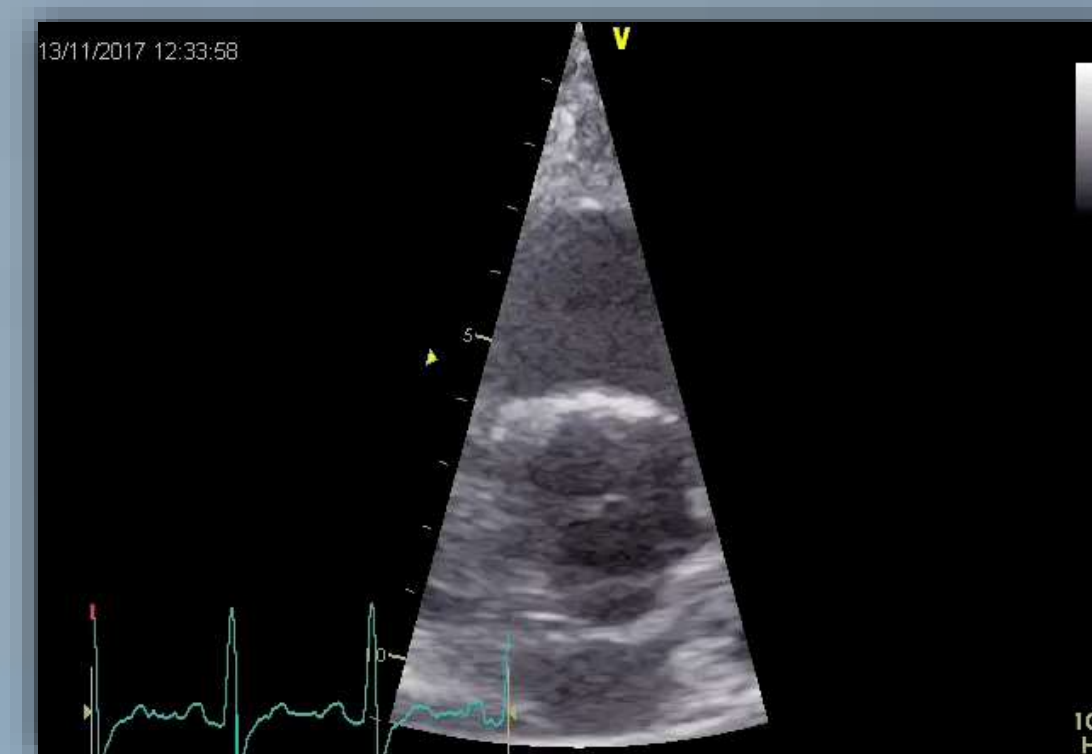
#2

Civilian Pilot 1st cl.

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- male sex
- born 1992
- no therapy

clinical
case

#2



- right systolic murmur 2/6 2018
- aortic velocity 1.2 m/sec

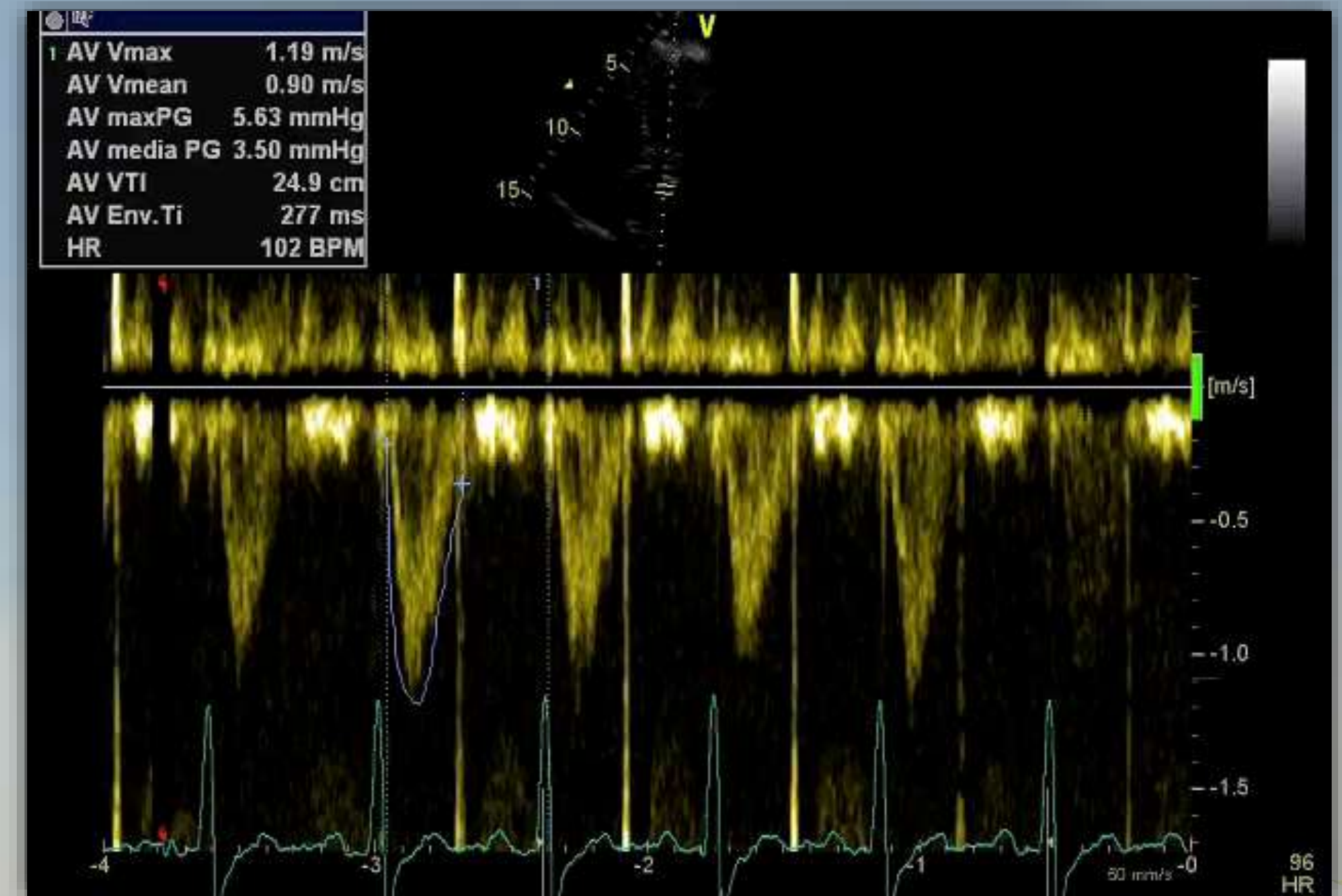
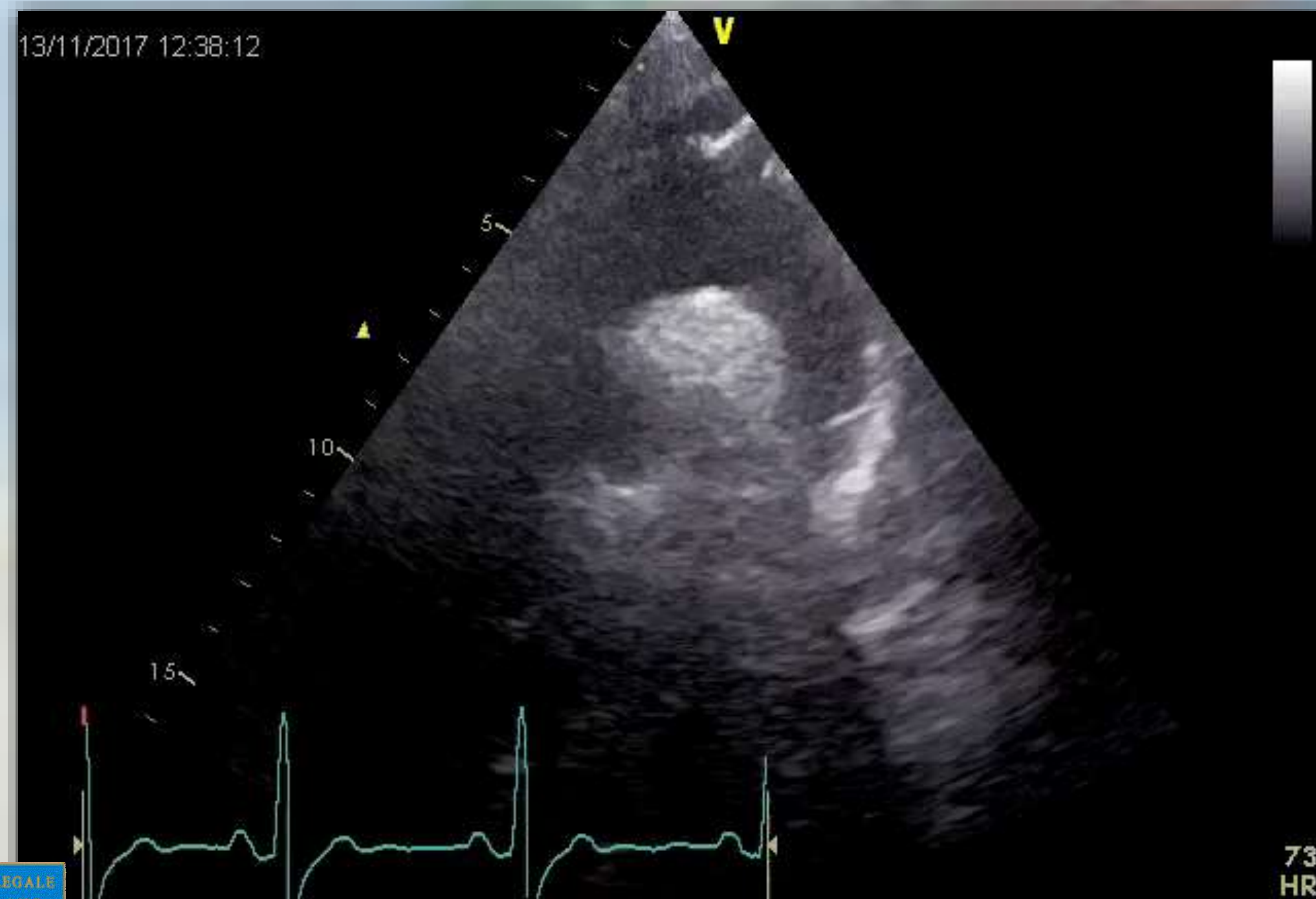
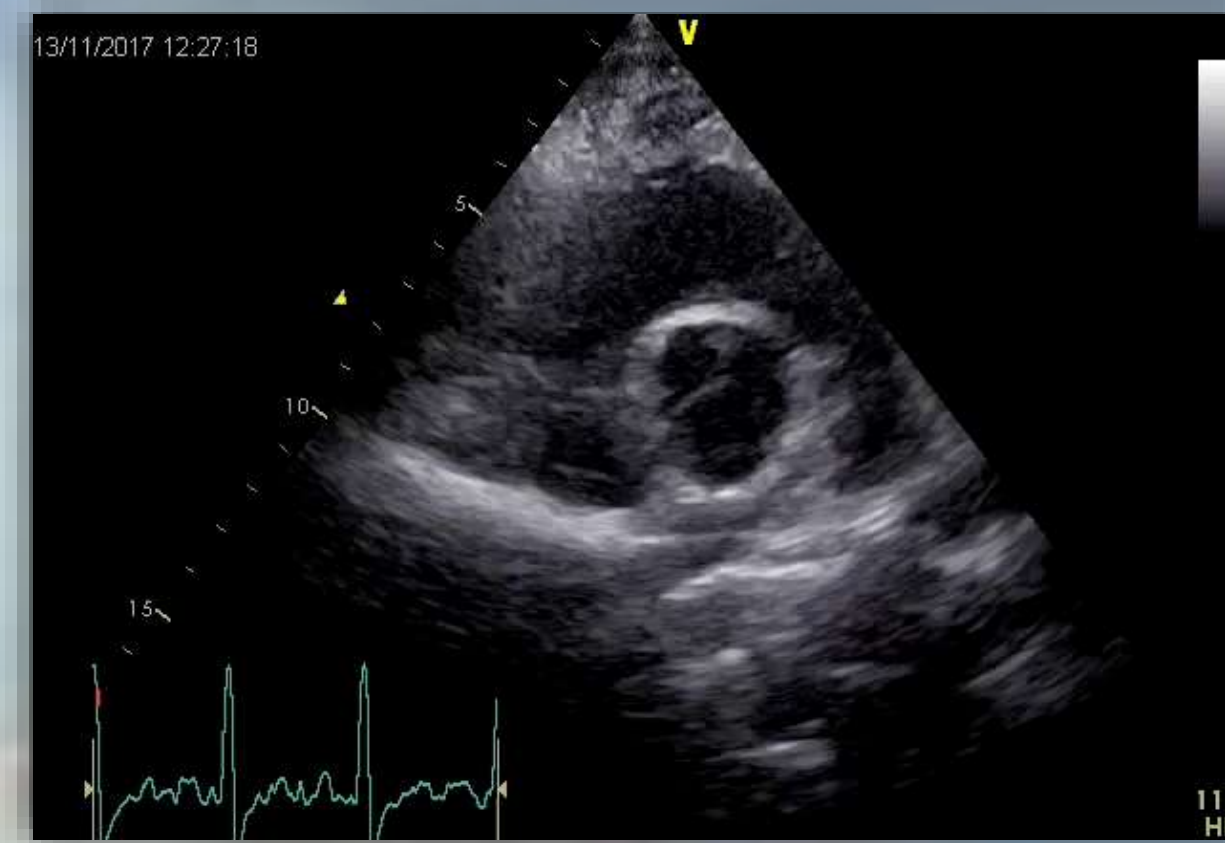
- symptomless
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- male sex
- born 1992
- no therapy

Civilian Pilot 1st cl.

clinical
case

#2

- right systolic murmur 2/6 2018
- aortic velocity 1.2 m/sec



Section 2

Specific requirements for class 1 medical certificates

AMC1 MED.B.010 Cardiovascular system

clinical
case

#2

(e) Cardiac valvular abnormalities

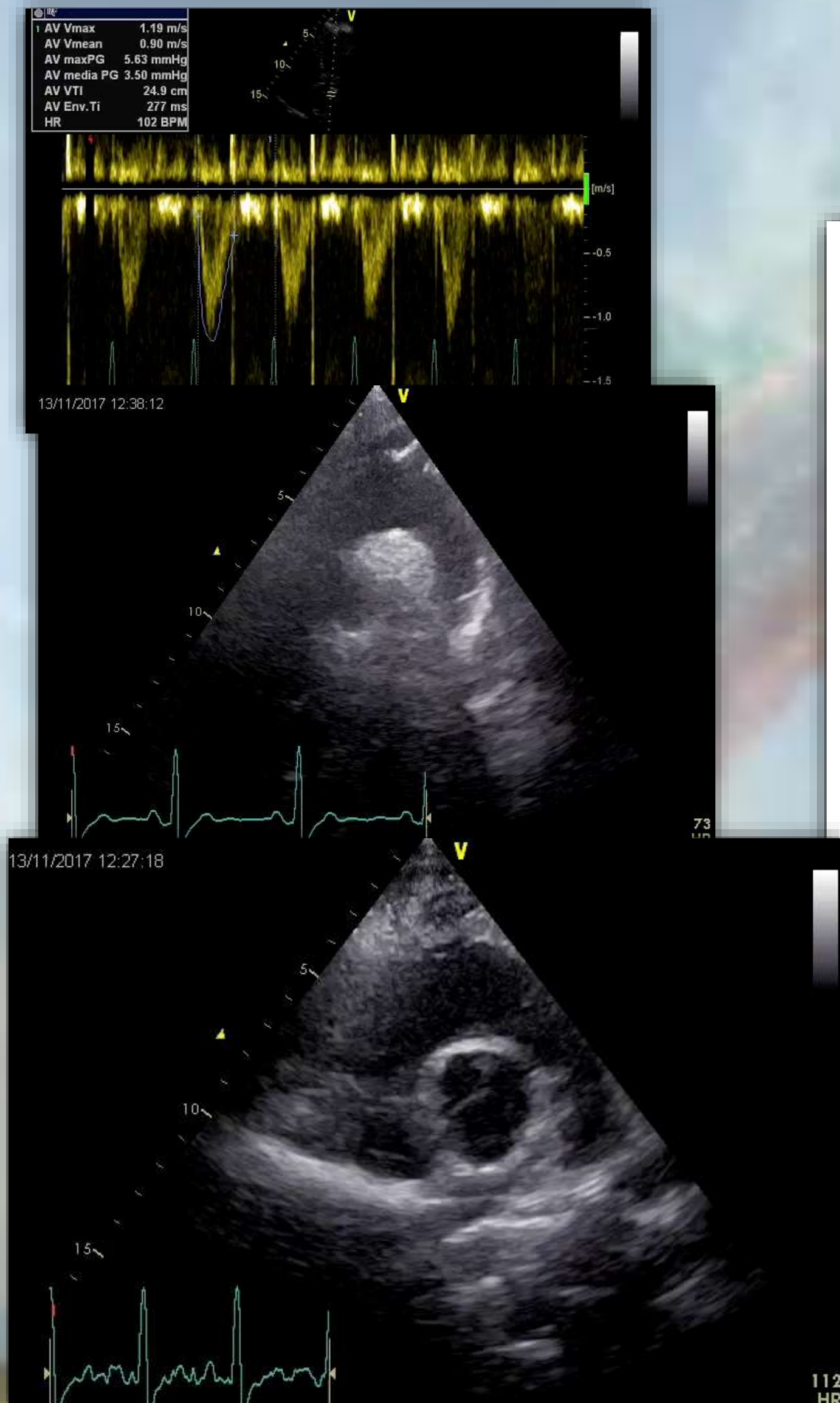
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Acceptable Means of Compliance
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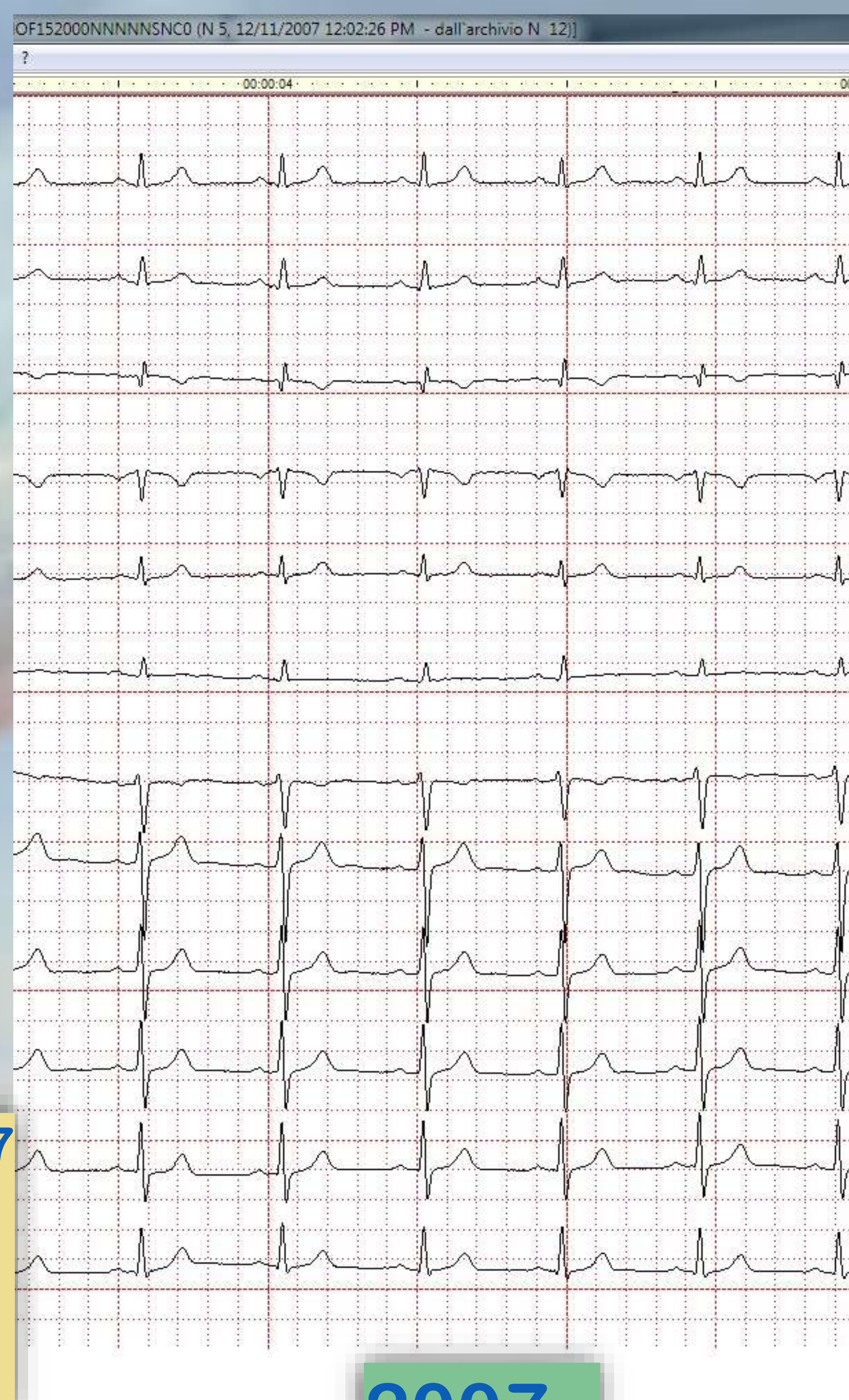


Military Pilot (Conventional)

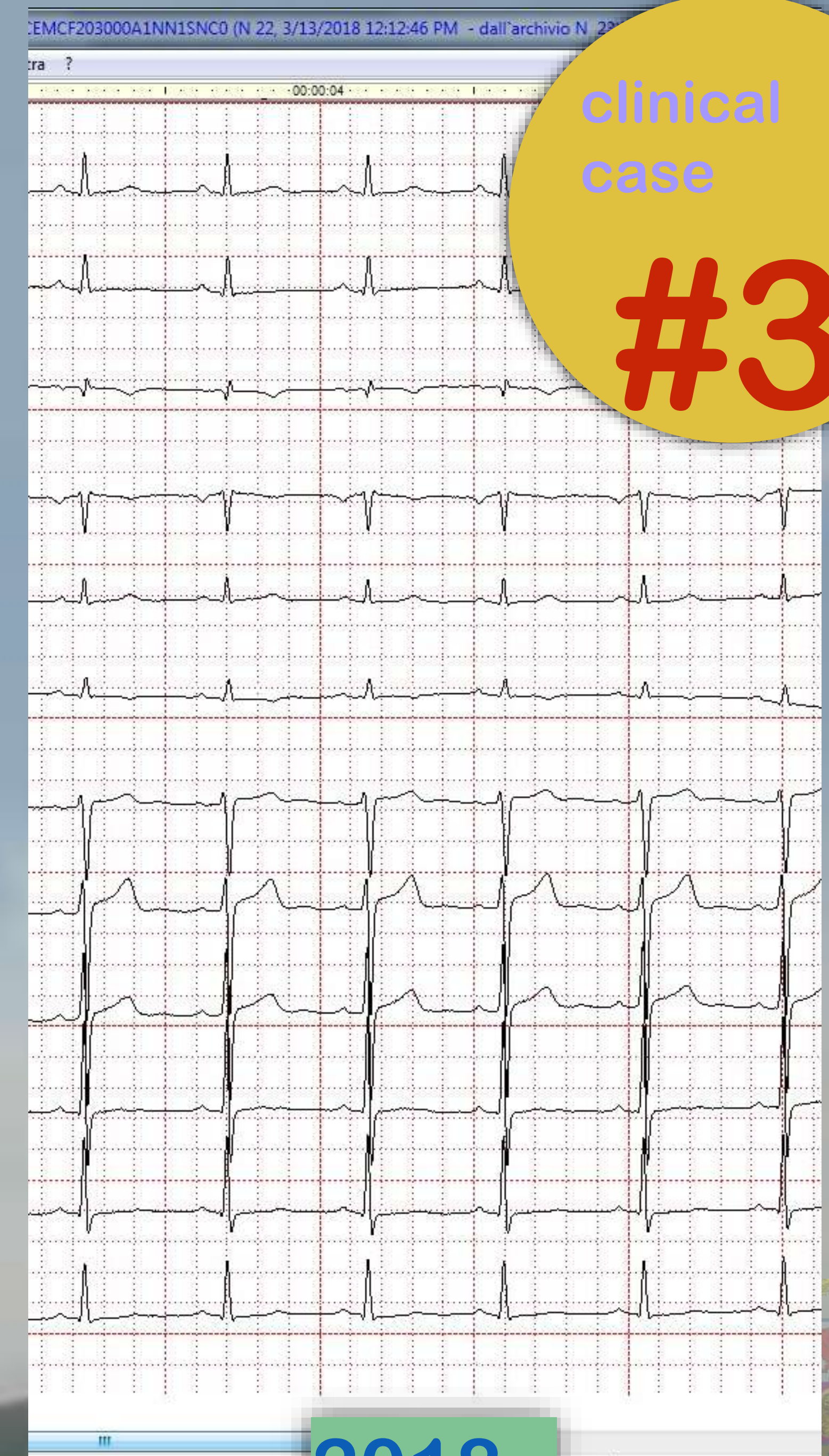
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- HR=85/min
- BMI=29,5

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- diastolic murmur 2/6 Erb
- echo Aortic Regurgitation ++
- Aortic Velocity 3.0 m/sec



2007



2018

clinical
case

#3

Military Pilot (Conventional)

clinical
case

#3

- No symptoms until 2018
- 2018 dizziness, pre-syncope
- previous AF 2009, hypertension 2009
- male sex
- born 1968
- ACE2, Amlodipine

- BP=130/85
- HR=85/min
- BMI=29,5

- right systolic murmur 2/6 2017
- diastolic murmur 2/6 Erb
- echo Aortic Regurgitation ++
- Aortic Velocity 3.0 m/sec

- 2009/2018 Exercise Test neg
- 2009/2018 holter ECG/MBP neg
- 2009 Aortic Vel<2m/sec
- Fit with double command 2009
- Mean Ao Δ g 18mmHg2015
- Mean Ao Δ g 39mmHg2018

• MILD

- Mean Δ P
- <20mmHg

FIT

• MODERATE

- Mean Δ P
- 20-39mmHg

MULTI
PILOT

• SEVERE

- Mean Δ P
- \geq 40mmHg

NOT FIT

Military Pilot (Conventional)

surgical images provided by
Prof.G.Polvani (Cardiac Surgery 2)
Prof. M Agrifoglio (Cardiac Surgery 2)
CC Monzino, IRCCS, Milan, Italy.



clinical
case

#3



UNIVERSITÀ
DEGLI STUDI
DI MILANO



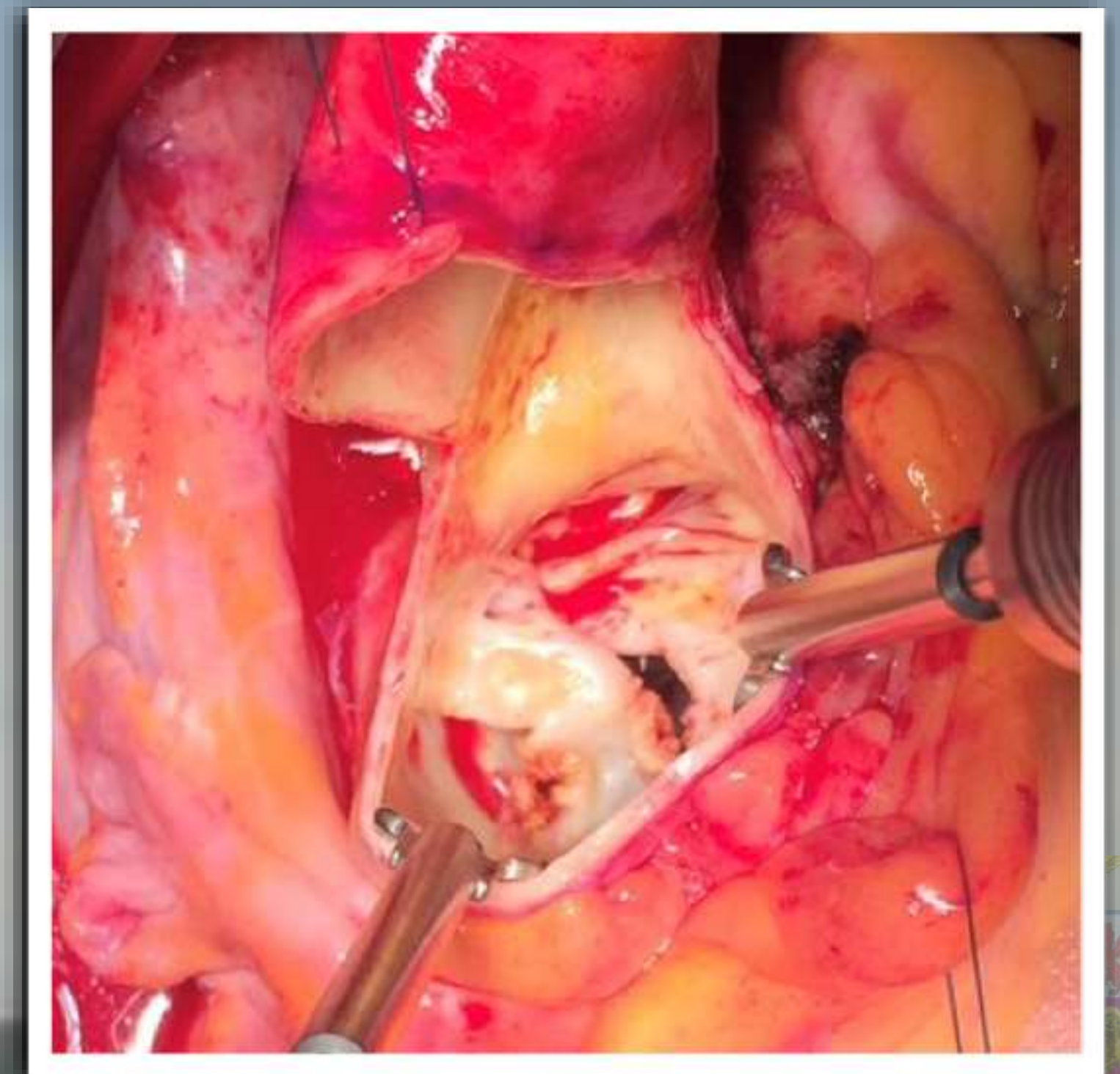
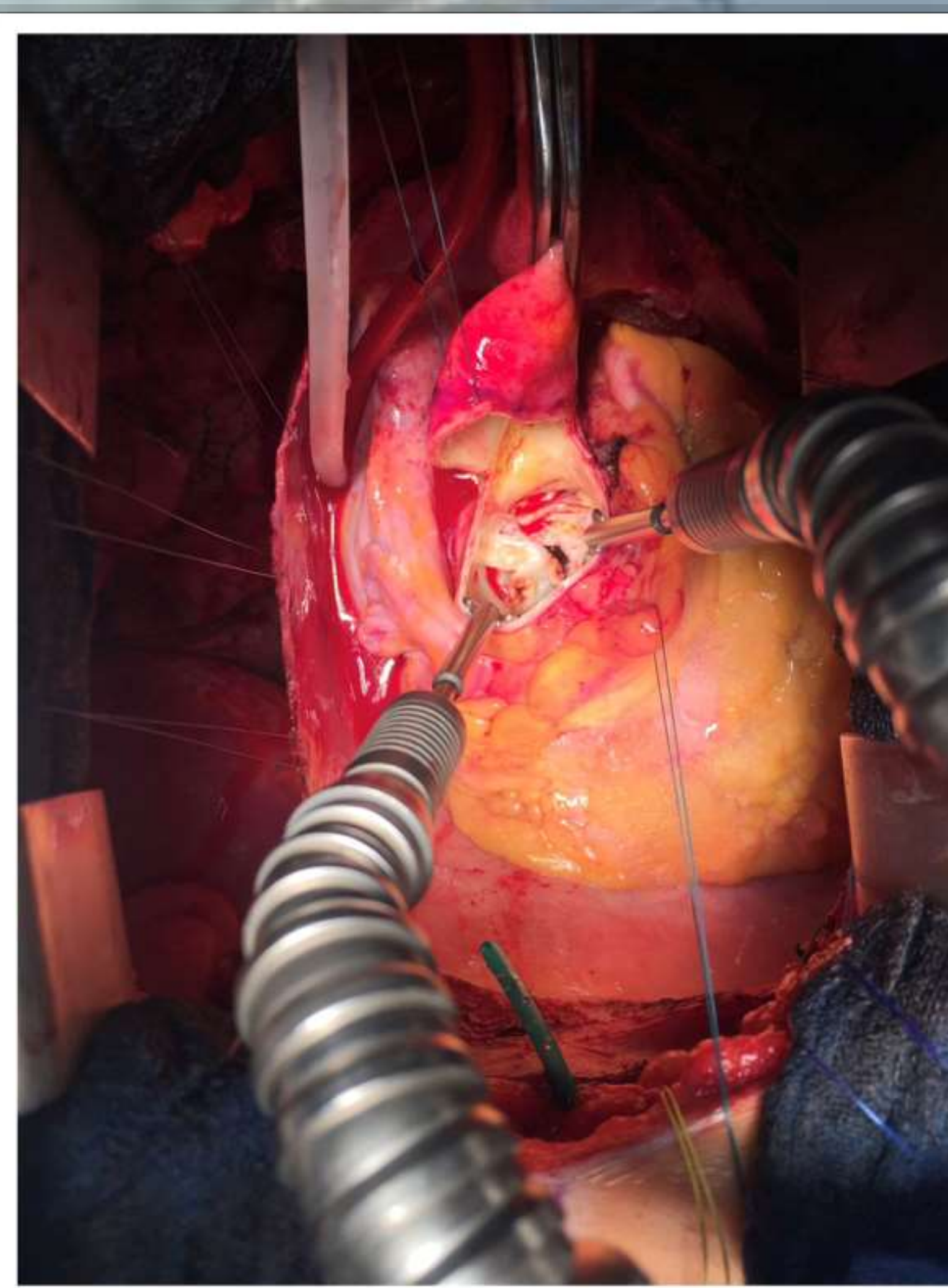
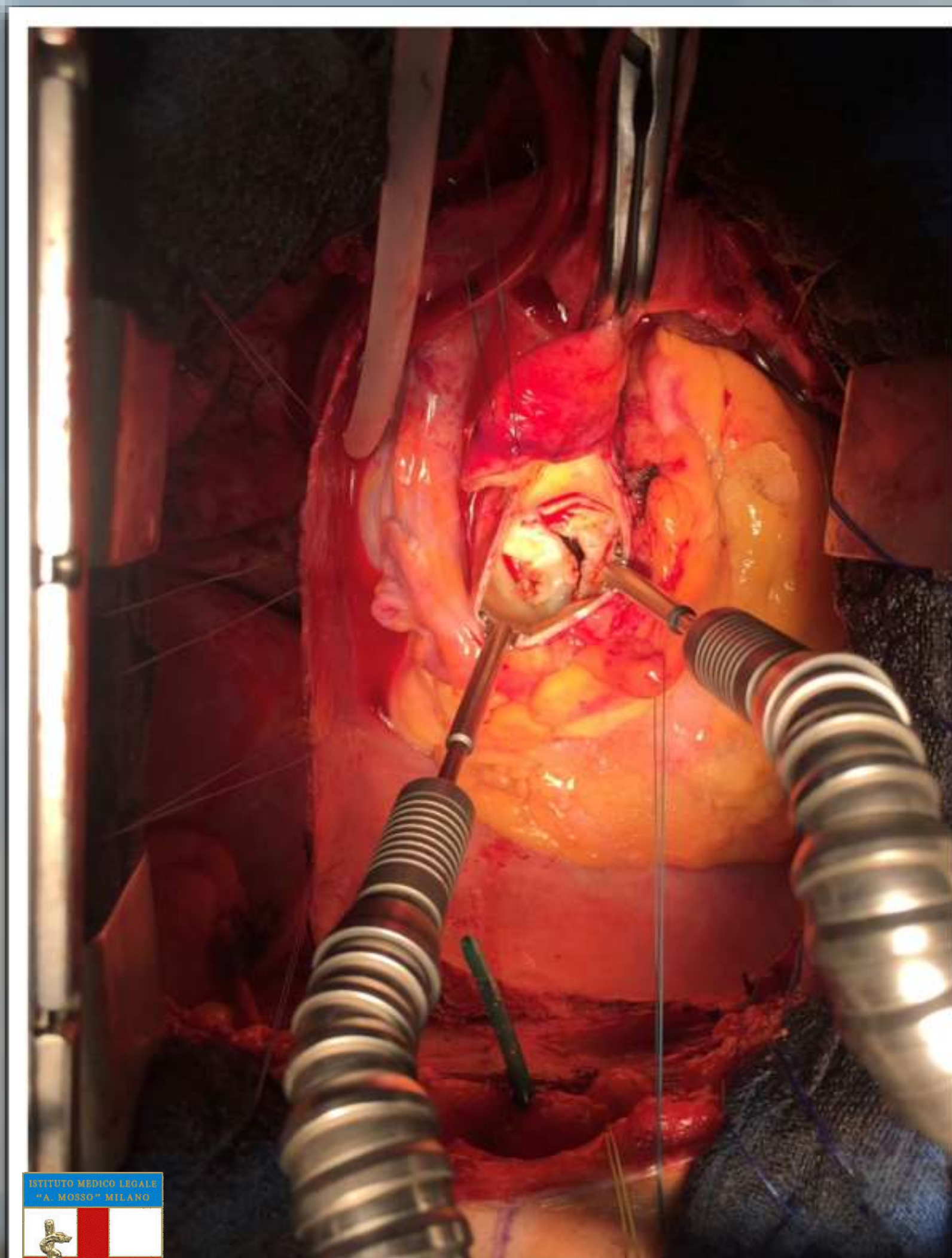
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clinical
case

#3



Military Pilot (Conventional)

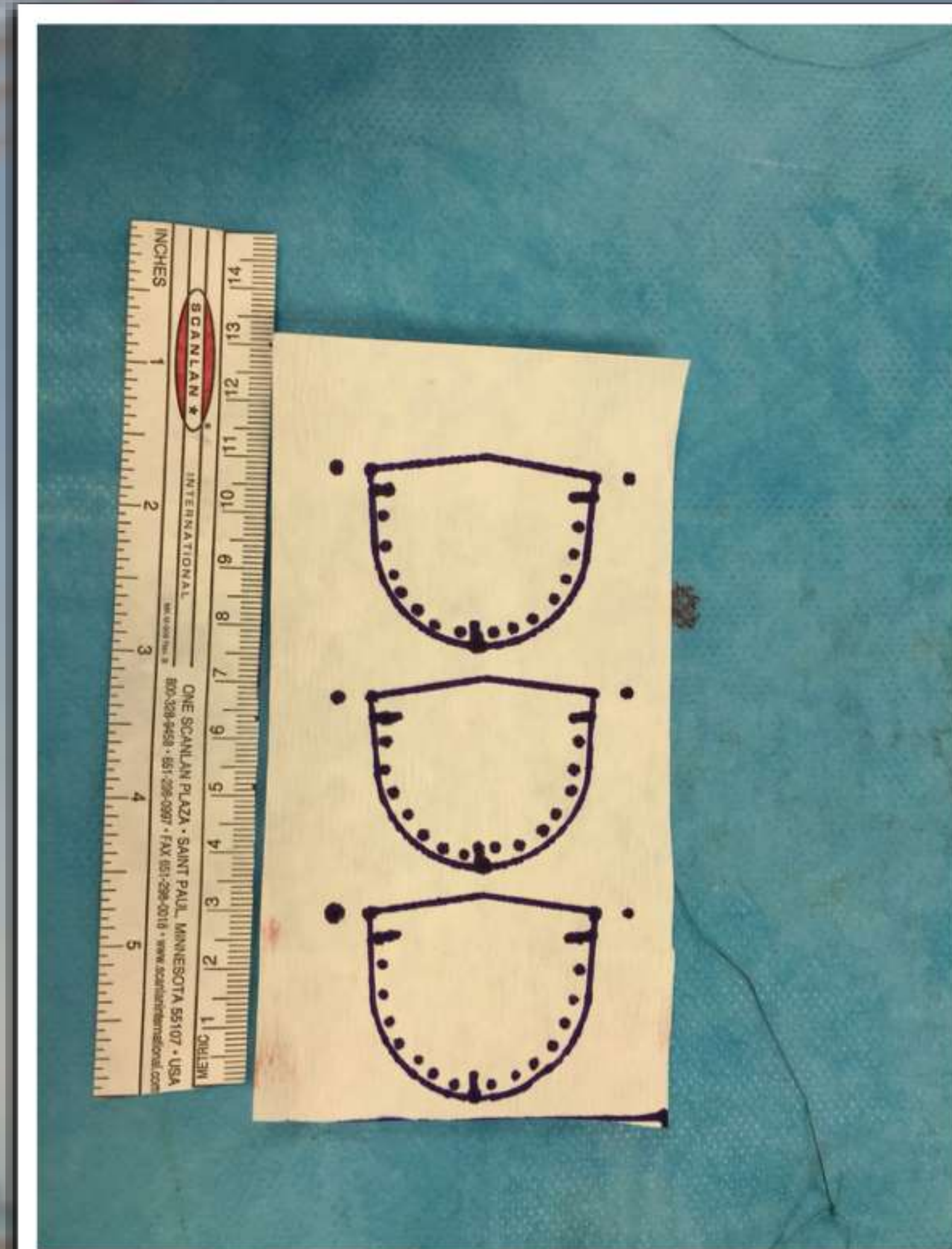
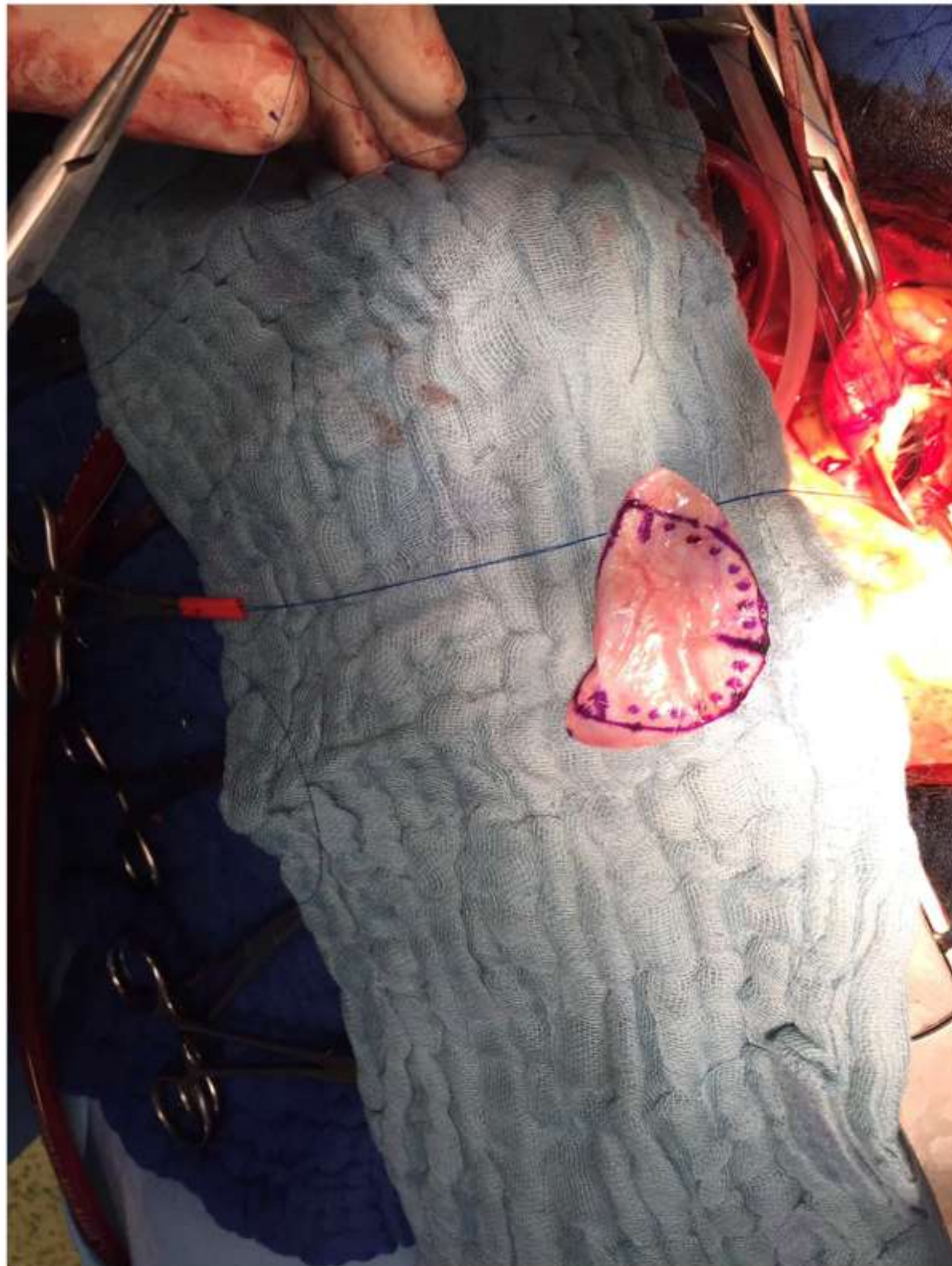
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 Centro Cardiologico
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 UNIVERSITÀ
DEGLI STUDI
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clinical
case

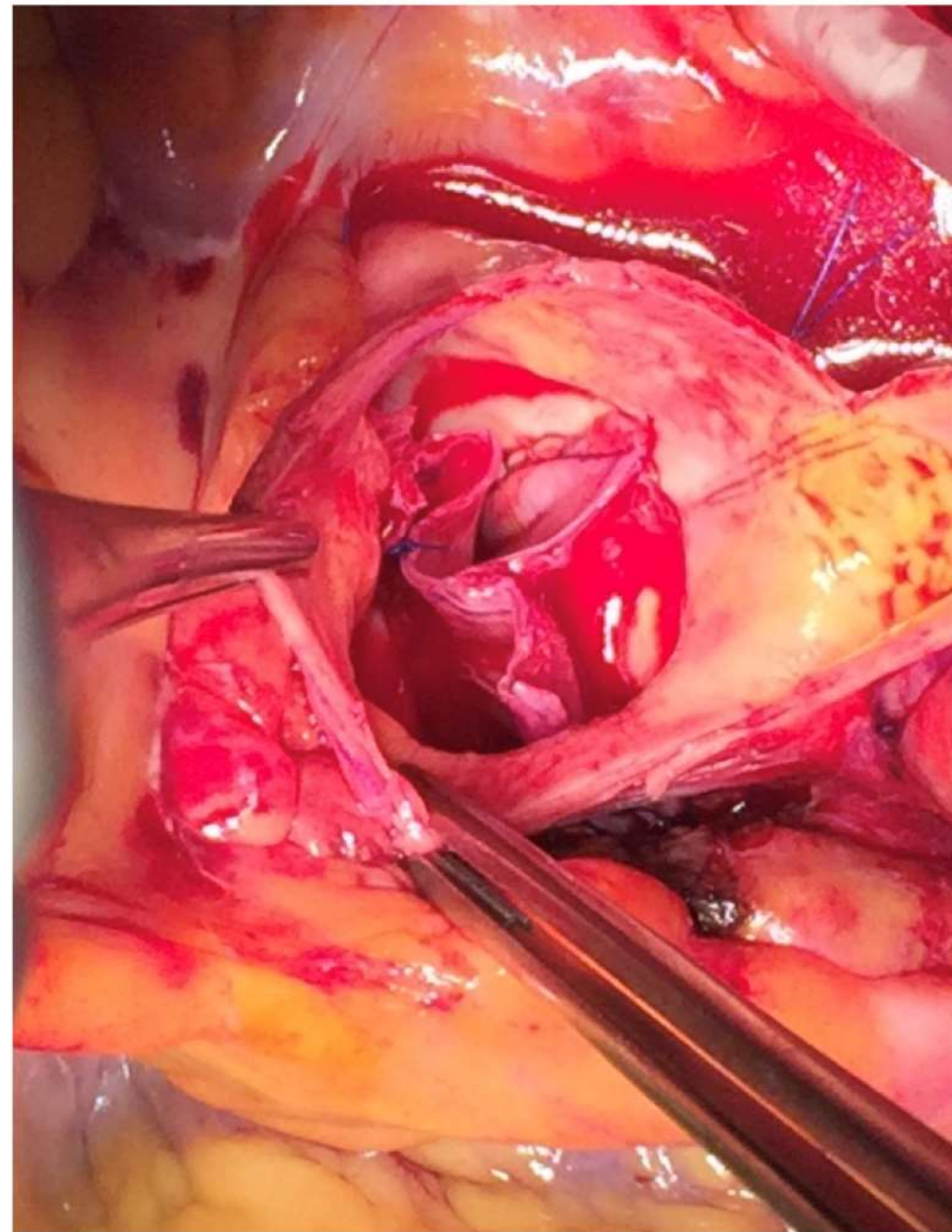
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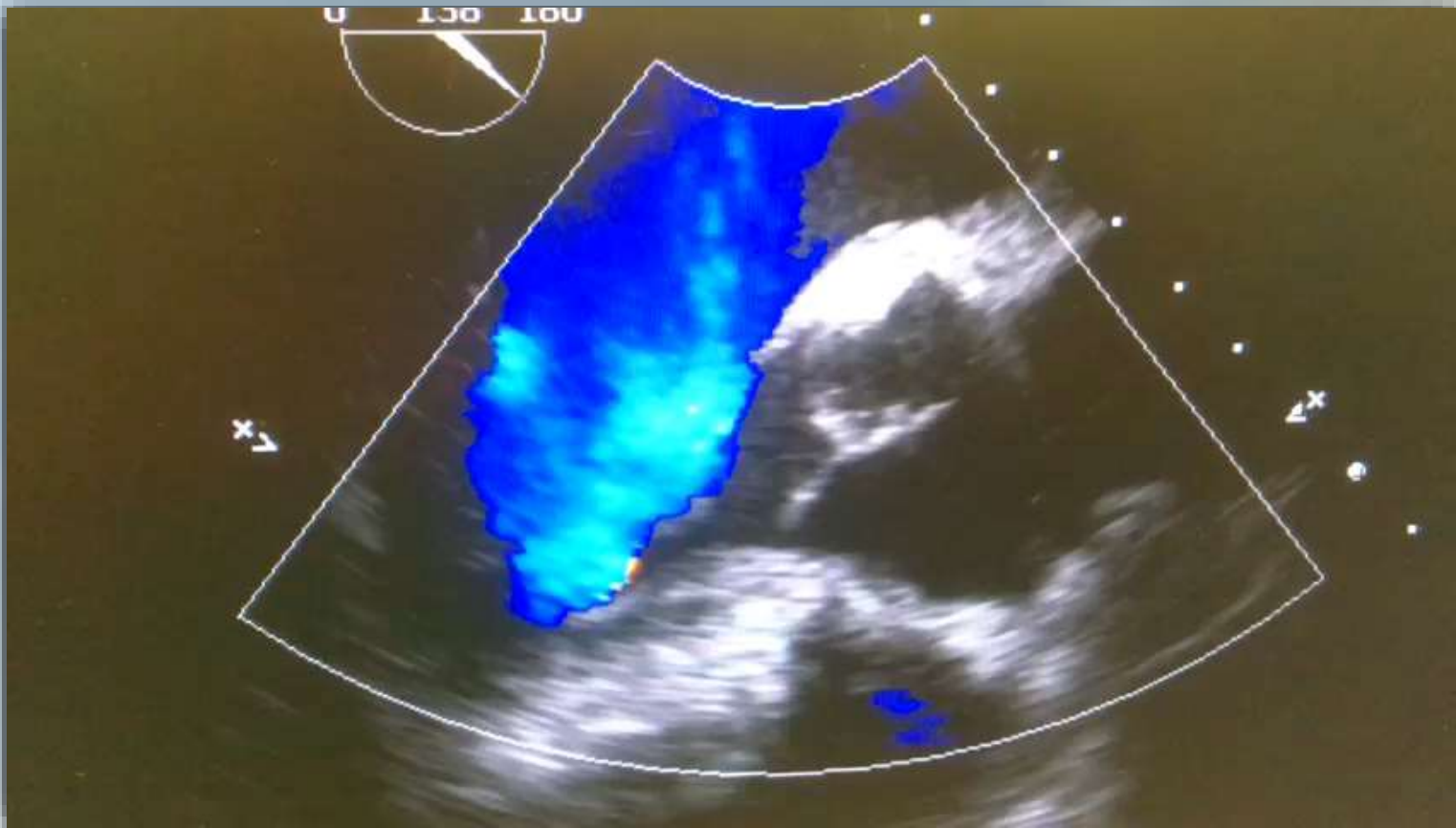
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clinical
case

#3





In conclusion, Bicuspid Aortic Valve Disease:

- is the most common congenital heart disease
- it can be hereditary
- should be suspected in the presence of an aortic systolic murmur
- due to the high incidence of complications a follow-up is recommended especially in flight crews
- when valvular surgery is the choice a good option is represented by autologous pericardium.




Thank you.

Lt.Col. Fabrizio Palumbo

fabrizio.palumbo@aeronautica.difesa.it

fabriziopalumbo@libero.it





Remember that the best
doctor is nature: it heals two-
thirds of the diseases and
does not talk bad of the
colleagues.

Galen, 200 AC

fabriziopalumbo@aeronautica.difesa.it



