

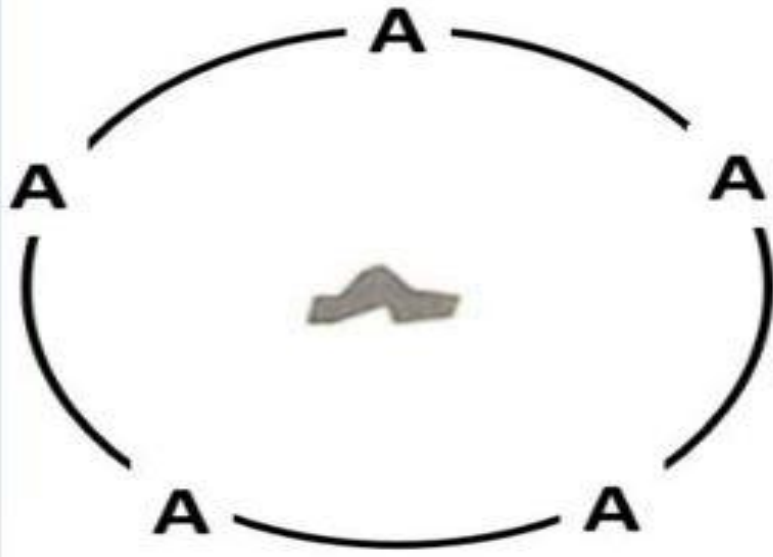
SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA
Azienda Unità Sanitaria Locale di Parma

ECOSTRESS: INDICAZIONI E PROTOCOLLI

Dott. Fabrizio De Rosa
Cardiologia-UTIC
Ospedale di Vaio

RAZIONALE

Stress echo 1980-2010



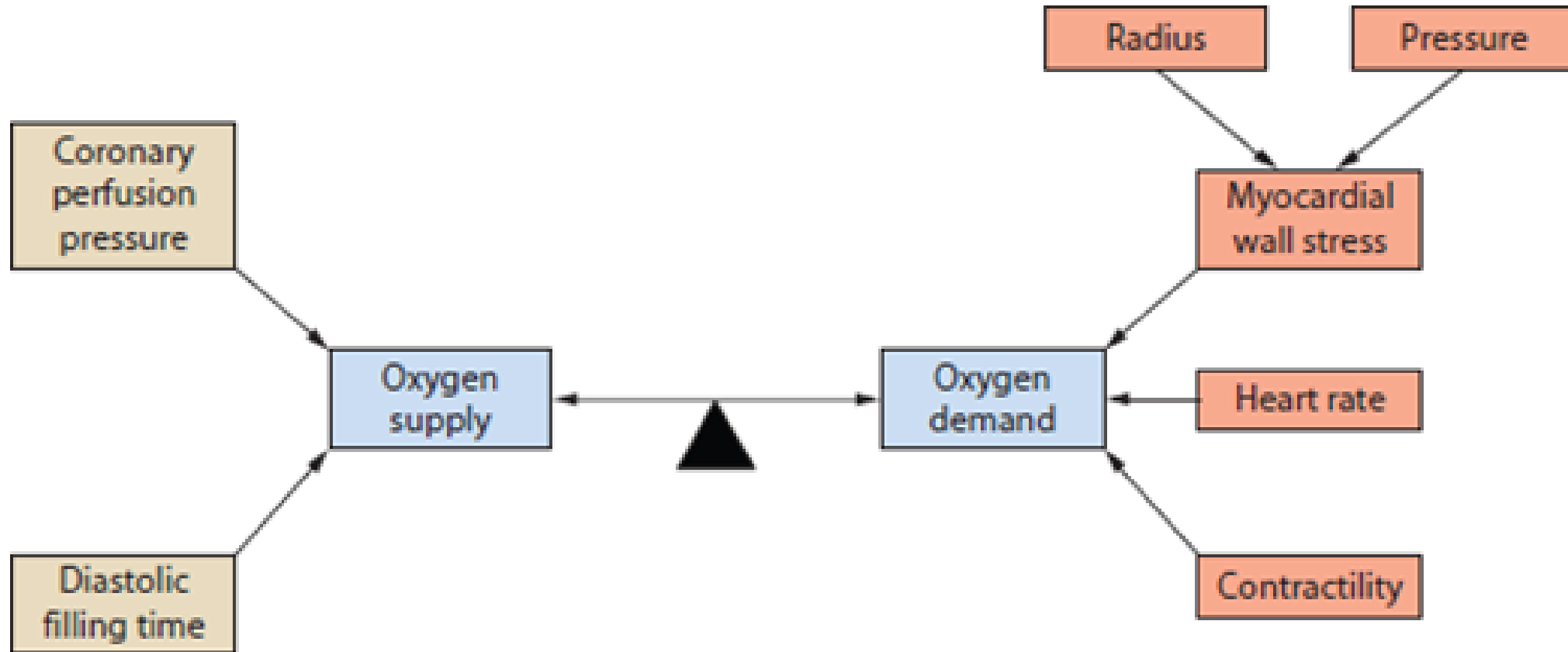
One patient (CAD)

One method (2D)

One sign (RWMA)

RAZIONALE

L'ISCHEMIA MIOCARDICA È IL RISULTATO DELLO SQUILIBRIO TRA DOMANDA DI O₂ DA PARTE DEL TESSUTO MIOCARDICO E L'OFFERTA DI O₂ ATTRAVERSO IL CIRCOLO CORONARICO



Source: Jesse B. Hall, Gregory A. Schmidt, John P. Kress: *Principles of Critical Care*, 4th Edition: www.accessmedicine.com

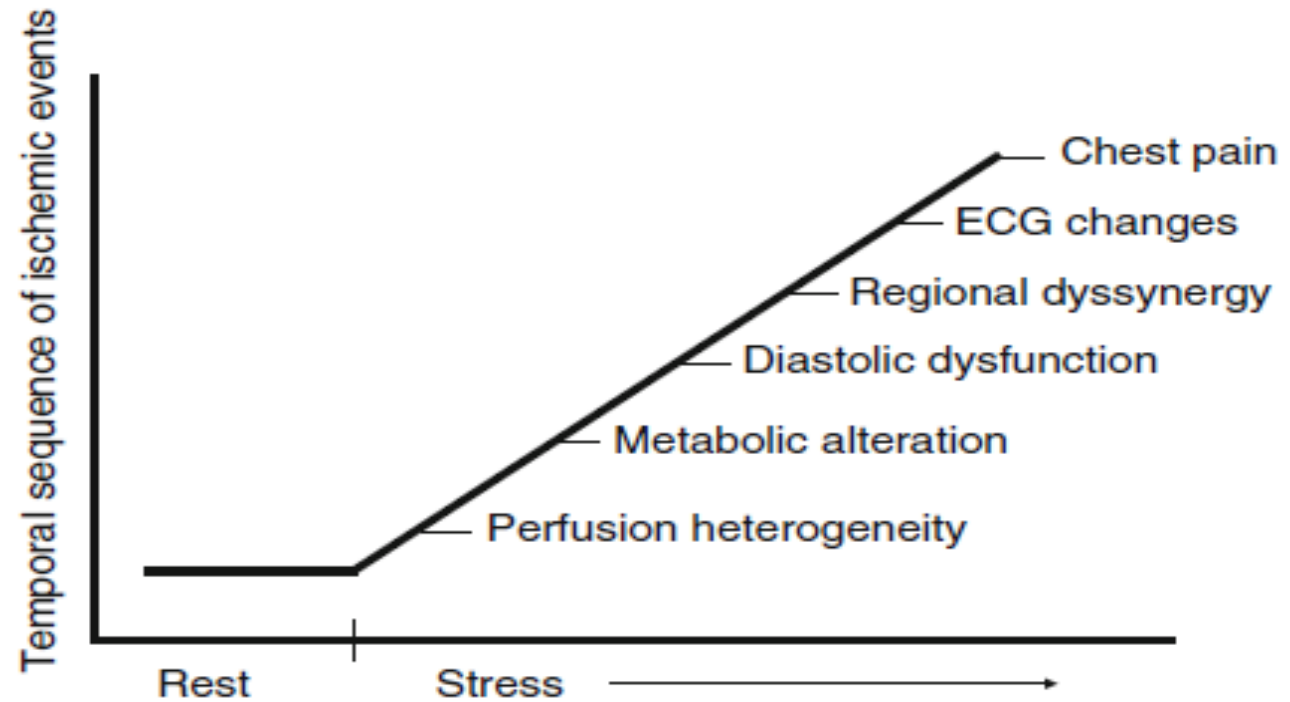
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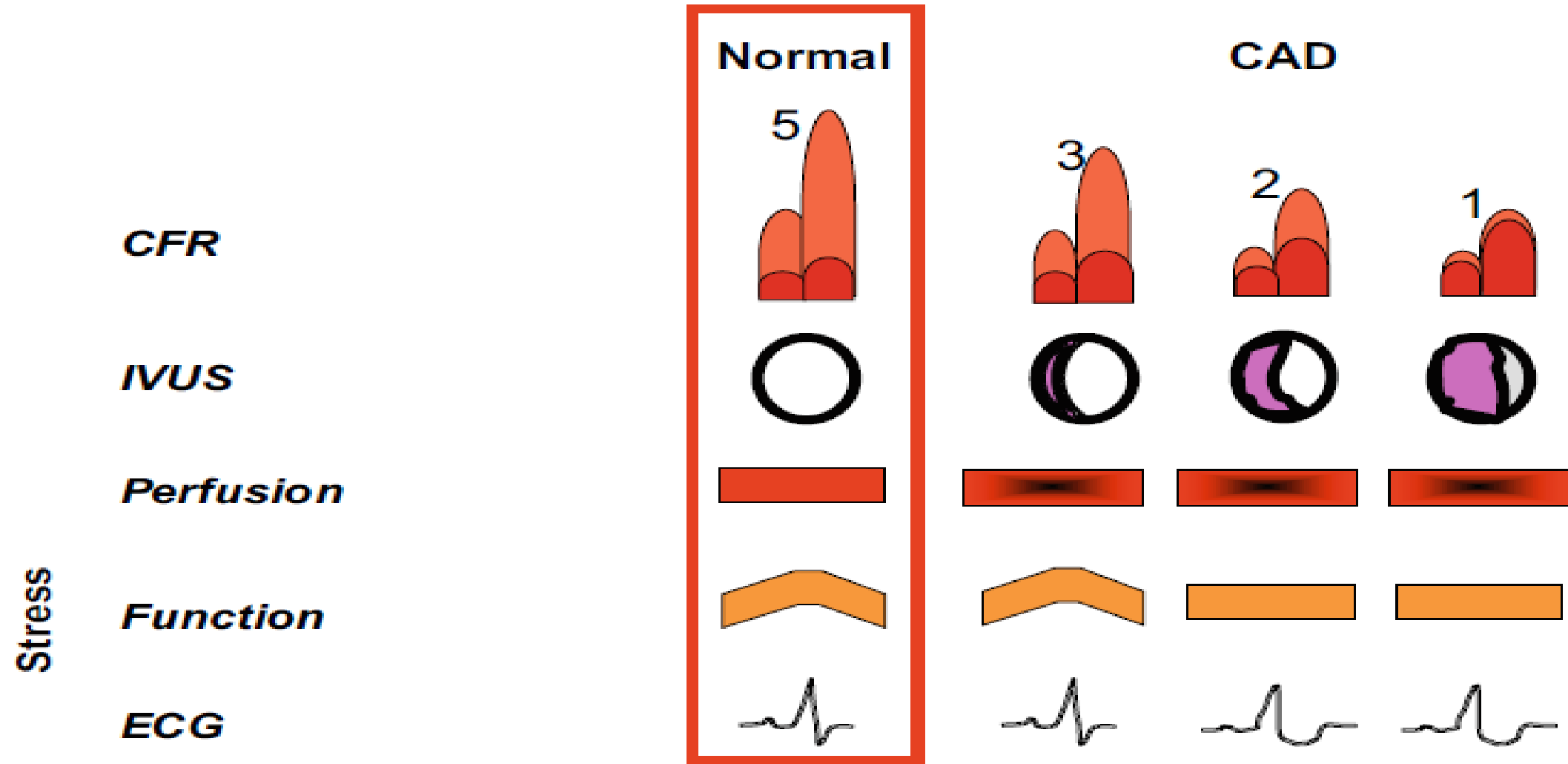
RAZIONALE

STRESS

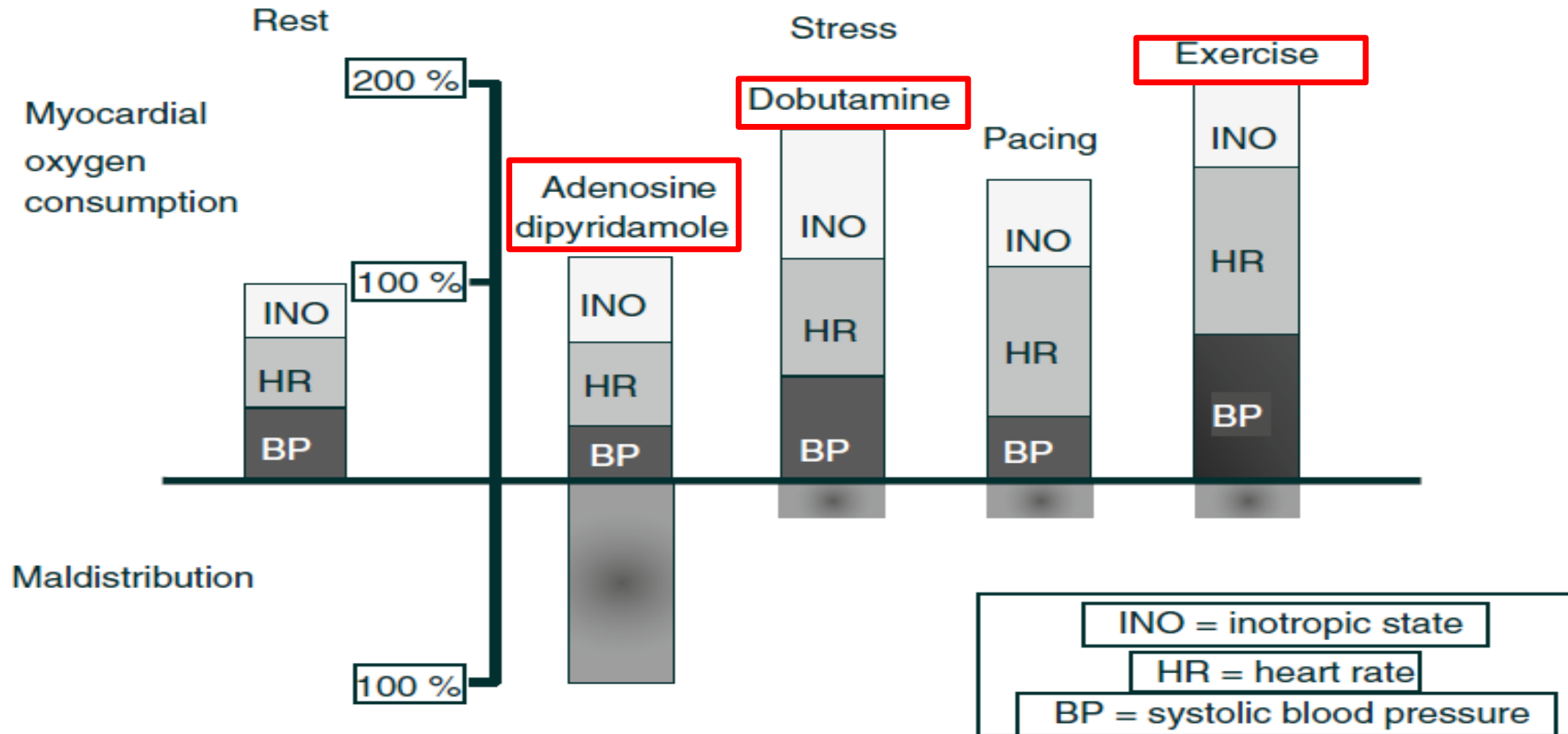
Fig. 3.1 The classic ischemic cascade, triggered by coronary vasospasm and/or epicardial stenosis. The various markers are usually ranked according to a well-defined time sequence



RAZIONALE

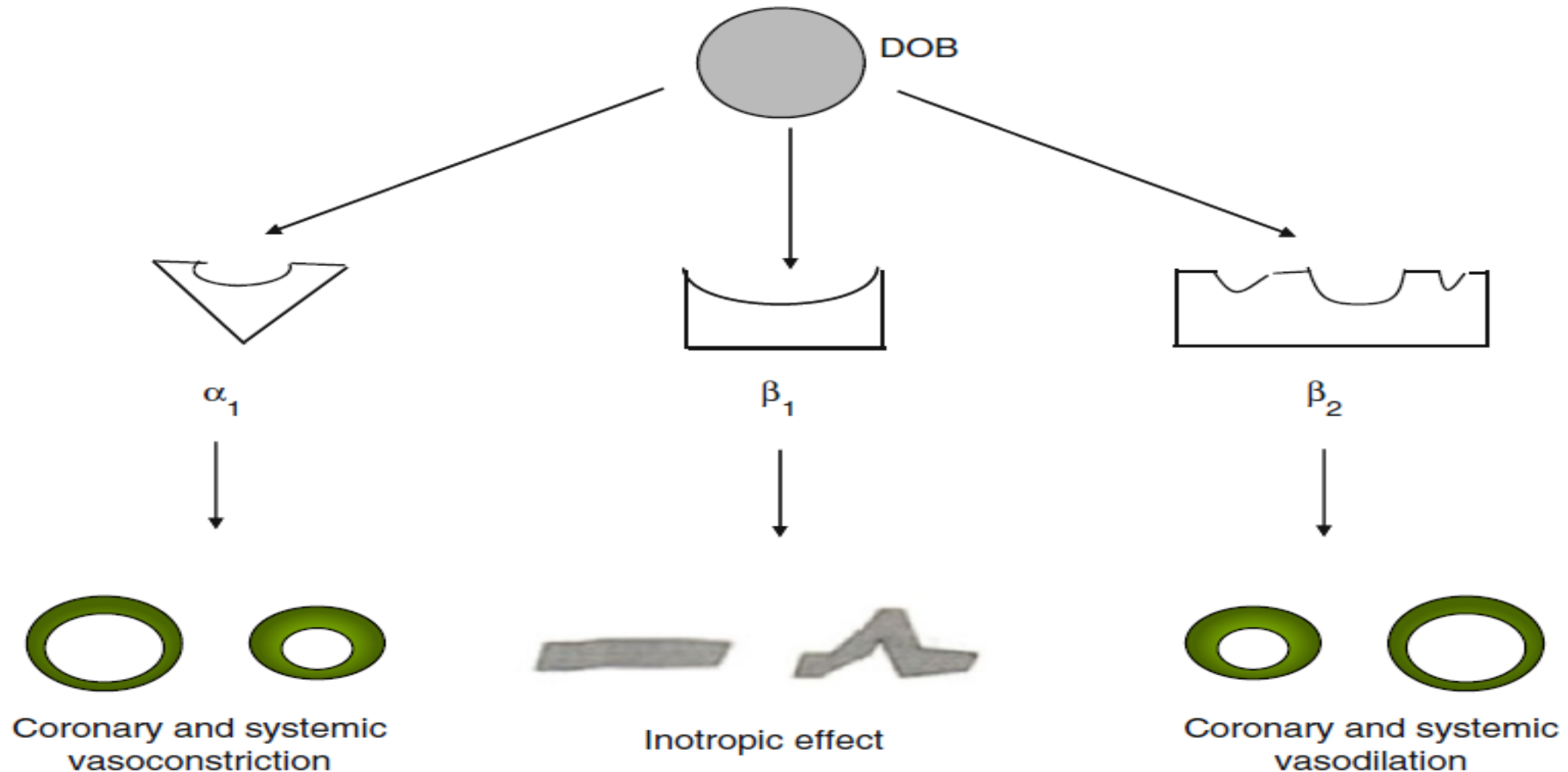


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DOBUTAMINA



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DOBUTAMINA → AUMENTO DELLA RICHIESTA DI OSSIGENO



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DOBUTAMINA: PROTOCOLLO

Dobutamine–atropine test

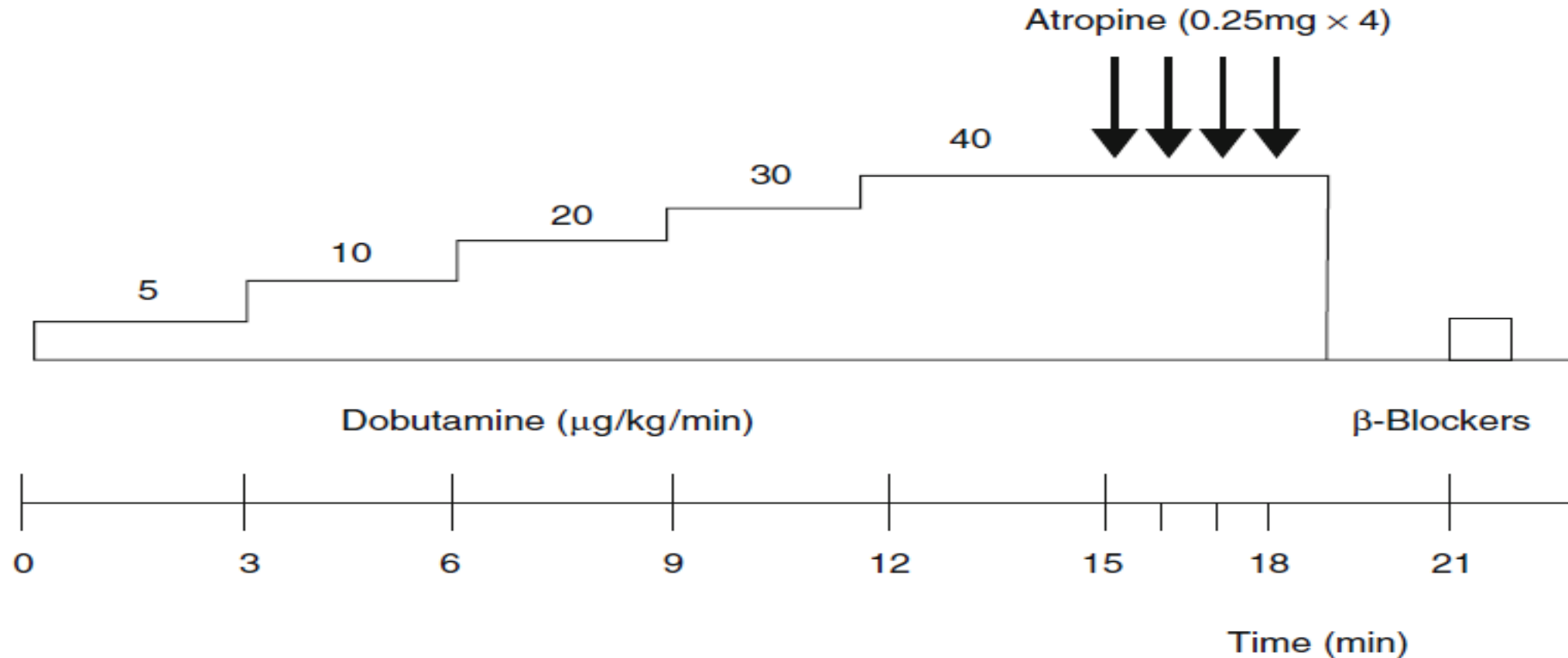
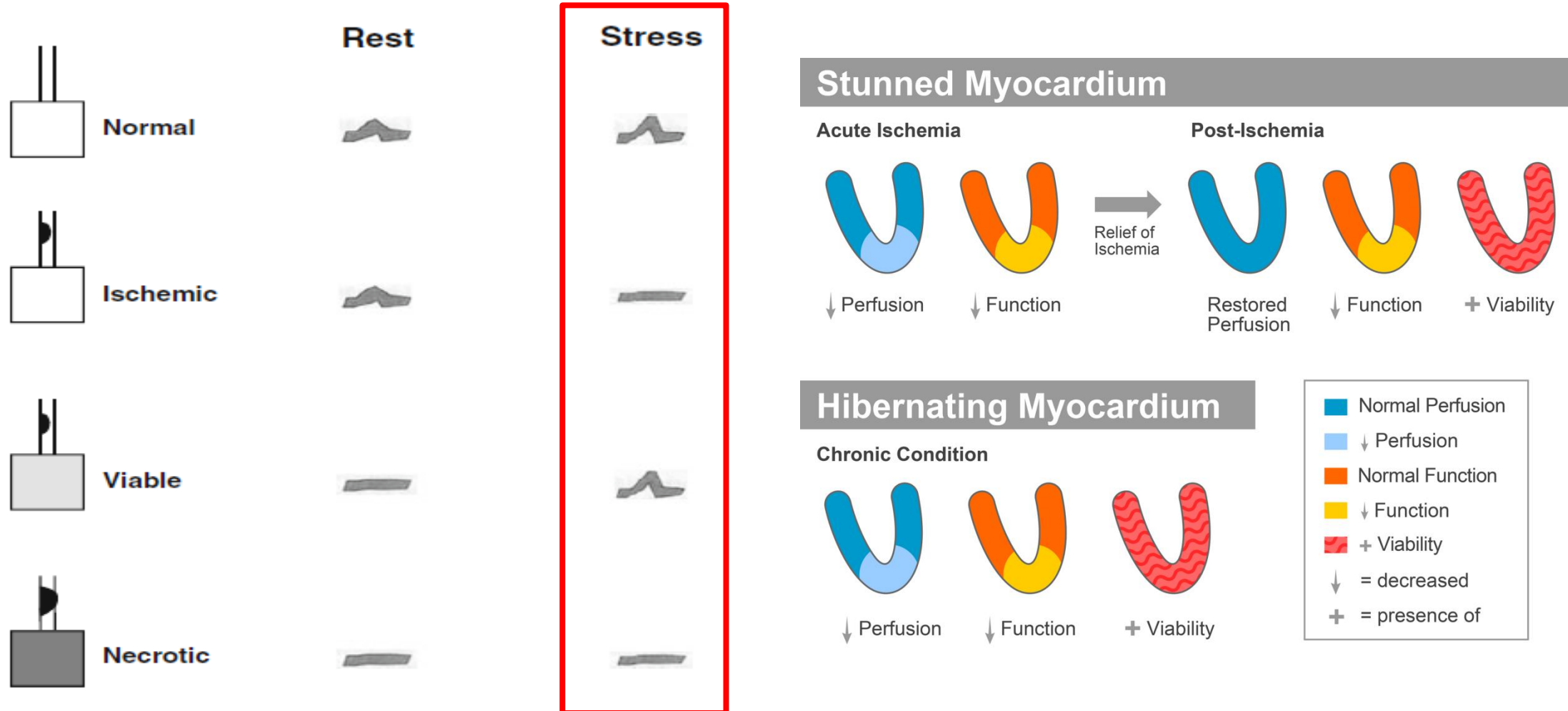


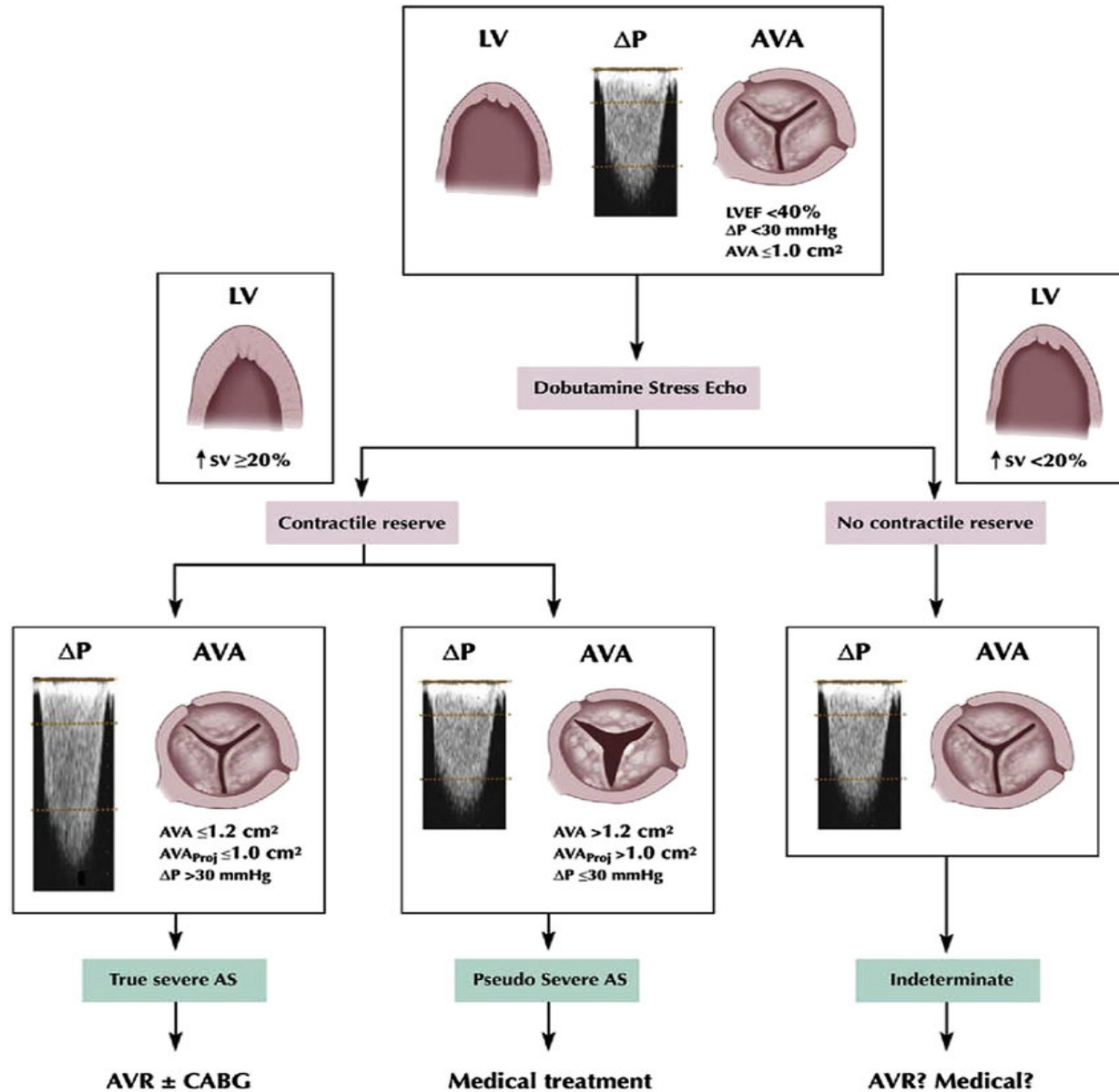
Fig. 12.2 Protocol of the dobutamine–atropine stress test. For viability detection in patients off beta-blockers, a 5-min step from 5 to 10 mcg is suggested

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DOBUTAMINA ISCHEMIA, VITALITÀ



ECOSTRESS FARMACOLOGICO STENOSI AORTICA



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DOBUTAMINA: **INDICAZIONI**

1. RICERCA ISCHEMIA INDUCIBILE
2. VALUTAZIONE DEI GRADIENTI TRANSVALVOLARI AORTICI (SOSPETTA STENOSI LF-LG)
3. STUDIO DI VITALITÀ

CONTROINDICAZIONI

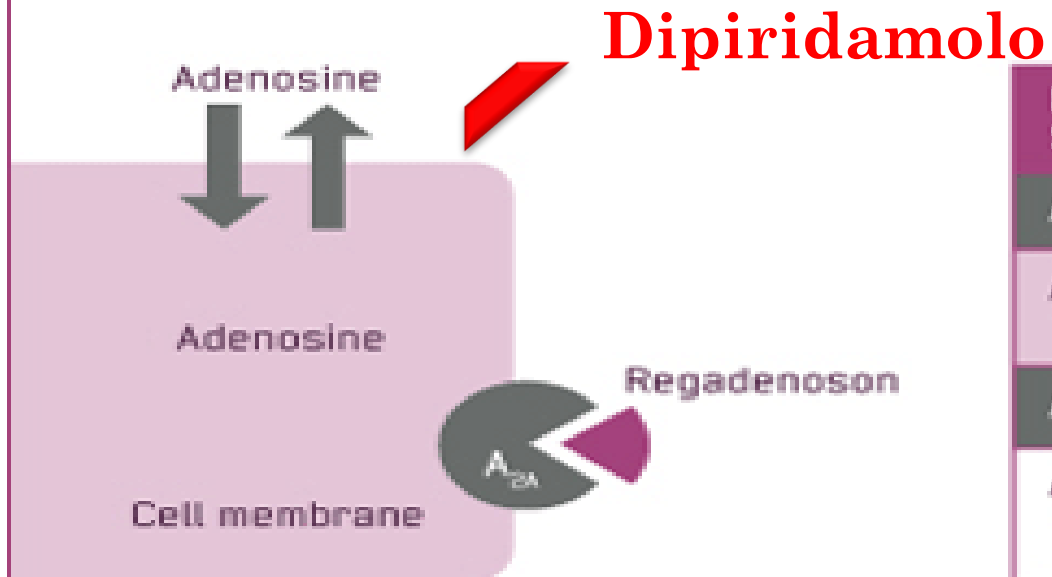
1. RECENTE IMA (<72 ORE)
2. IPERTENSIONE NON CONTROLLATA (PA 180/100 mmHg)
3. STENOSI AORTICA SEVERA
4. ARITMIE COMPLESSE
5. GRADIENTE LVOT>30 mmHg



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DIPIRIDAMOLO

Adenosine receptor pharmacology



Receptor Subtype	Response to an Agonist
A_1	Slows AV/SA Nodal Conduction
A_{2A}	Coronary Vasodilation Sympathetic Stimulation
A_{2B}	Mast Cell Degranulation
A_3	Bronchocontriction ? Preconditioning ?

Methylxanthines (caffeine, aminophylline)
block adenosine receptors

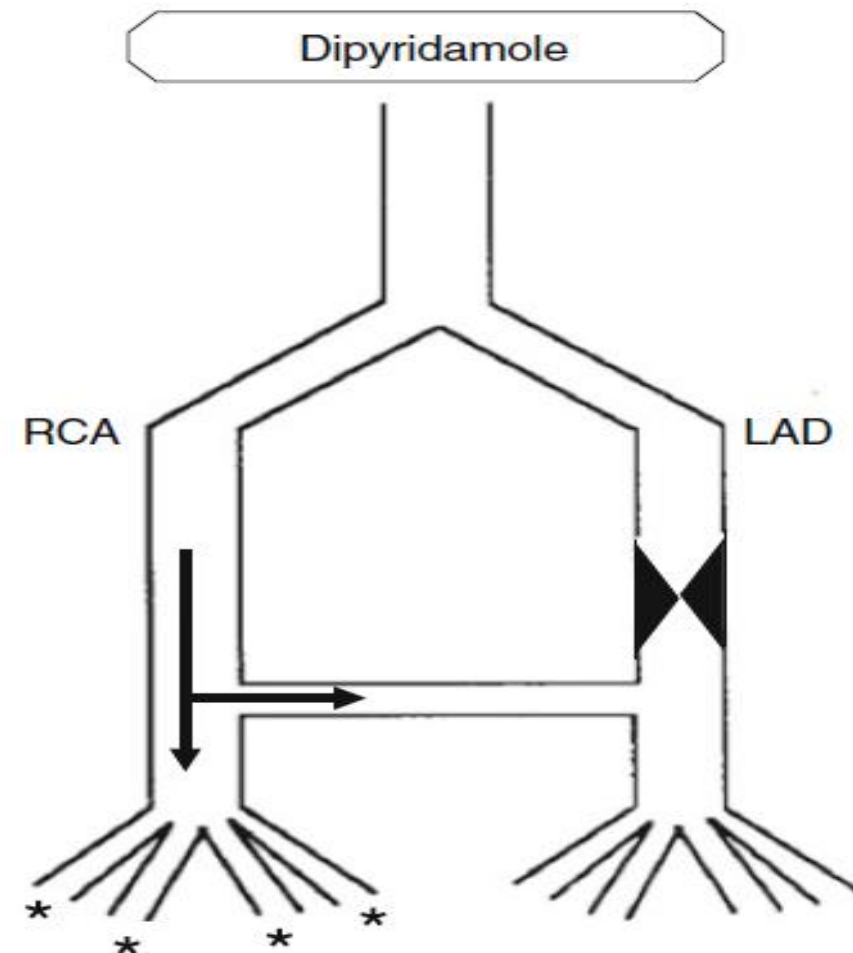
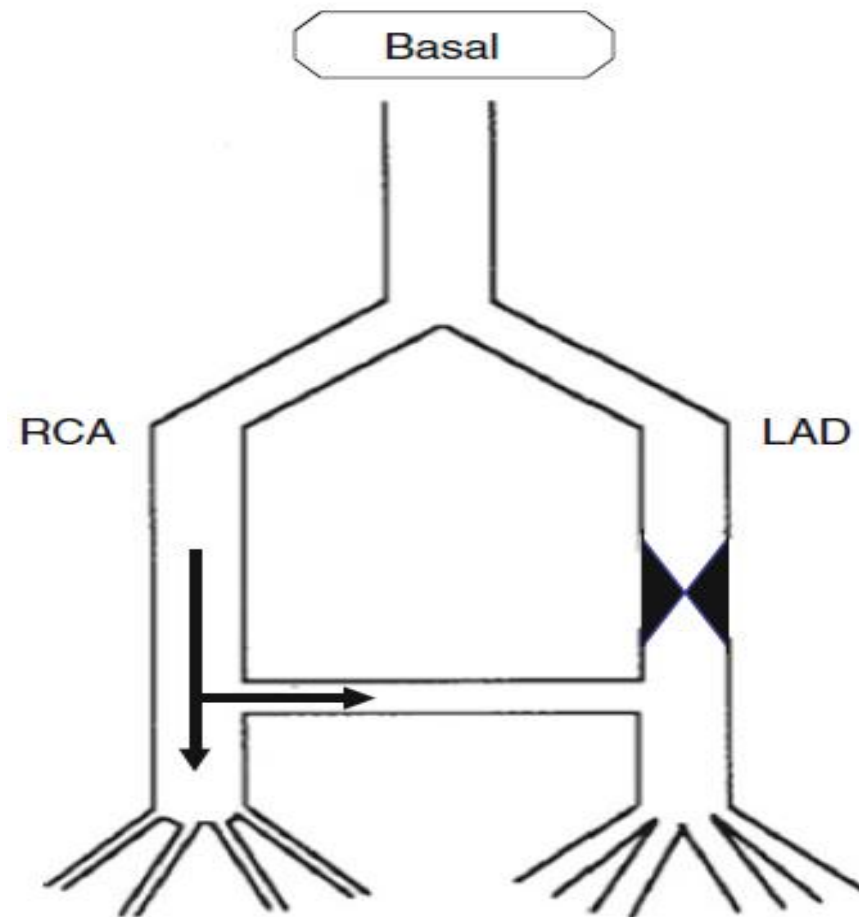
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DIPIRIDAMOLO → FURTO



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DIPIRIDAMOLO → FURTO



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DIPIRIDAMOLO: PROTOCOLLO

Fast high dose dipyridamole stress echo

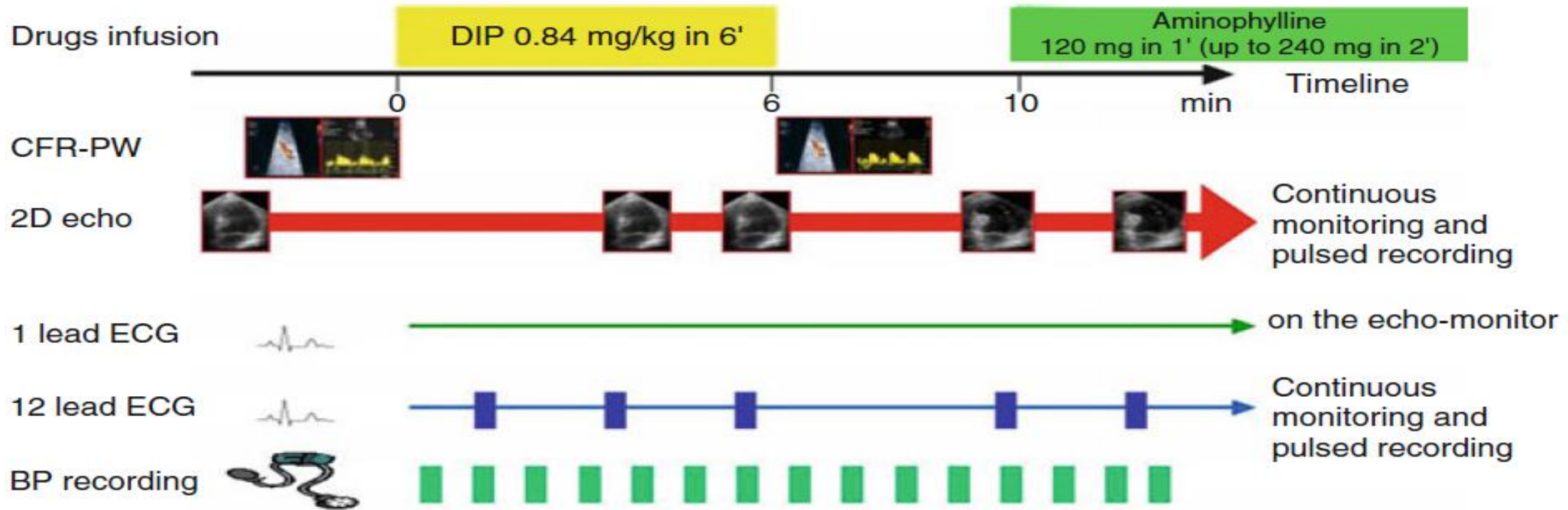


Fig. 13.4 The state-of-the-art protocol of high-dose, fast dipyridamole echocardiography test with dual imaging (wall motion and coronary flow reserve on the LAD coronary artery)

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DIPIRIDAMOLO

INDICAZIONI

1. Ricerca ischemia inducibile
2. Studio del microcircolo (CFR-LAD)

CONTROINDICAZIONI

1. Asma
2. BAV II e III grado
3. Pazienti in terapia con teofillina
4. Stenosi carotidea significativa



Ecotress nella patologia del microcircolo, esperienza clinica

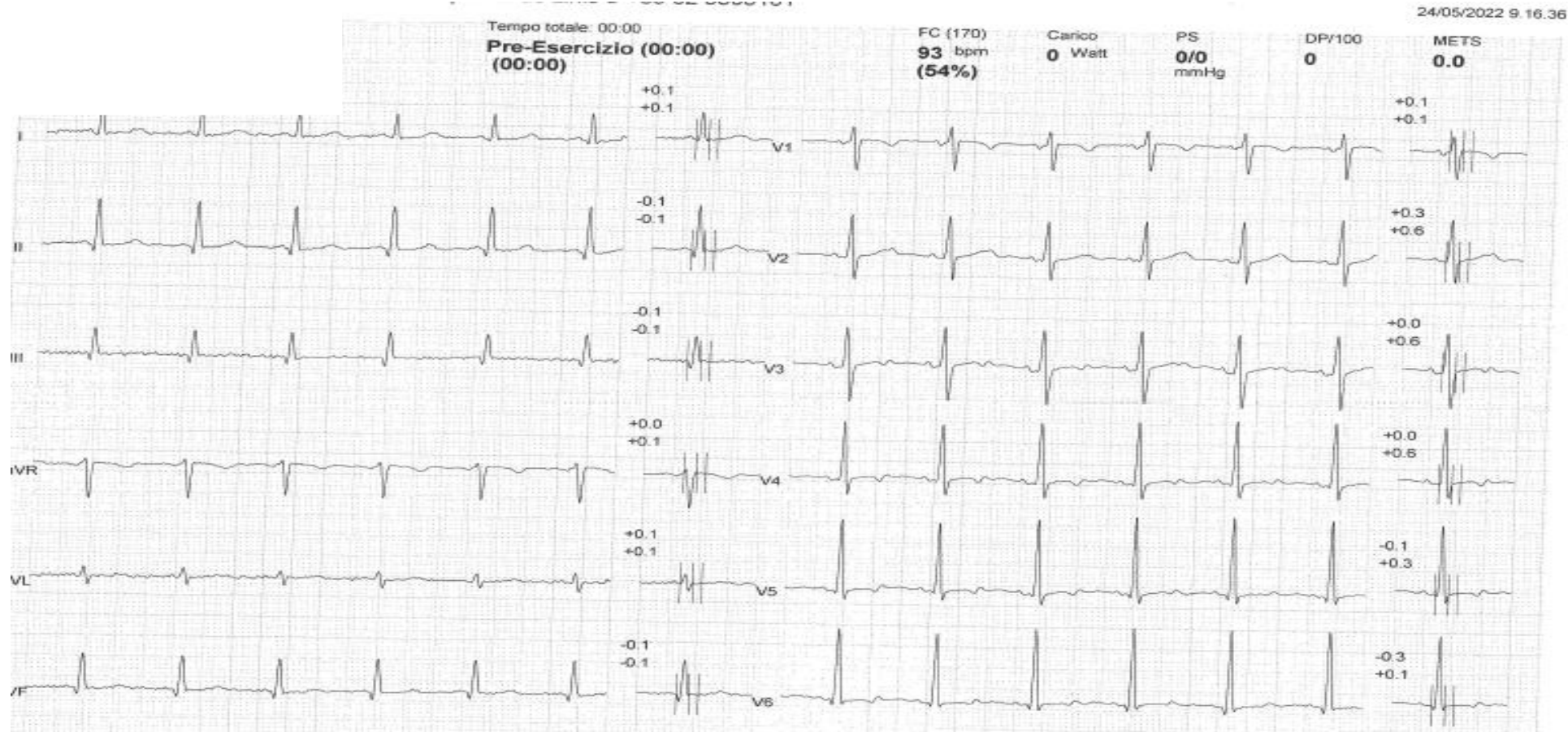
X. M.

- Donna di anni 49, non ancora in menopausa
- In anamnesi ipertensione arteriosa di nuova diagnosi
- Non ulteriori fattori di rischio cardiovascolare noti
- Maggio 2022 accesso in PS per episodio di dolore a riposo seguito da presincope
- Osservazione cardiologica negativa (due determinazioni di TnI <LOD)
- ECG RS normofrequente, non alterazioni della ripolarizzazione
- Riferito dolore toracico oppressivo da sforzo con risoluzione a riposo, presente da circa due mesi



Seguita visita cardiologica con indicazione ad esecuzione di ECO TT e PDS. ECO TT nei limiti (a meno di lieve ipertrofia del SIV/12 mm).

PDS



Tempo totale: 03:41
Esercizio (03:27)
Picco (01:27)

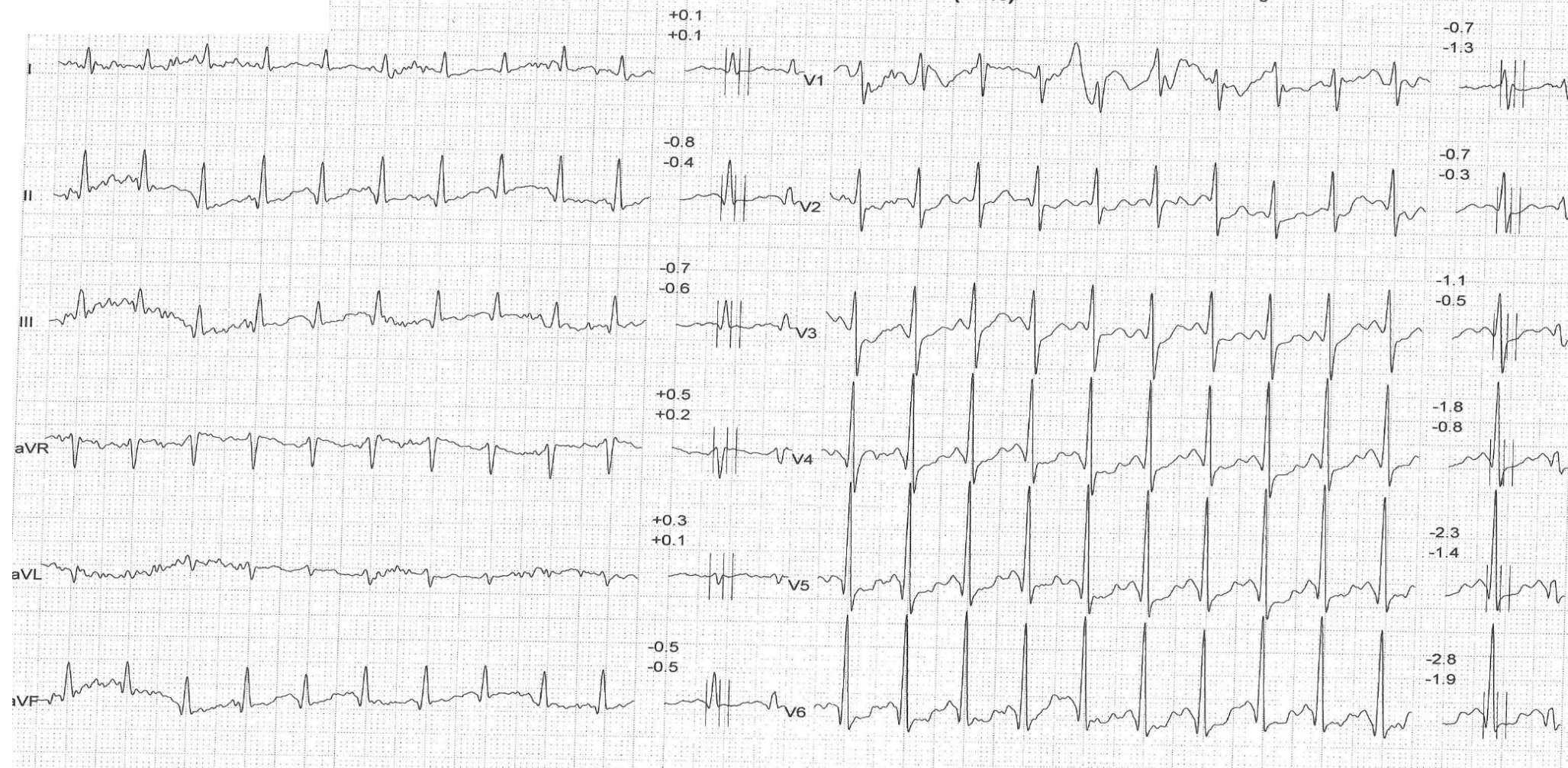
FC (170)
150 bpm
(88%)

Carico
60 Watt

PS
200/100
 mmHg

DP/100
300

METS
4.3



ARMANDO 15.10.20

Tempo totale: 03:48

Recupero (00:07)
1 (00:07)

FC (170)

151 bpm
(88%)

Carico

30 Watt

PS

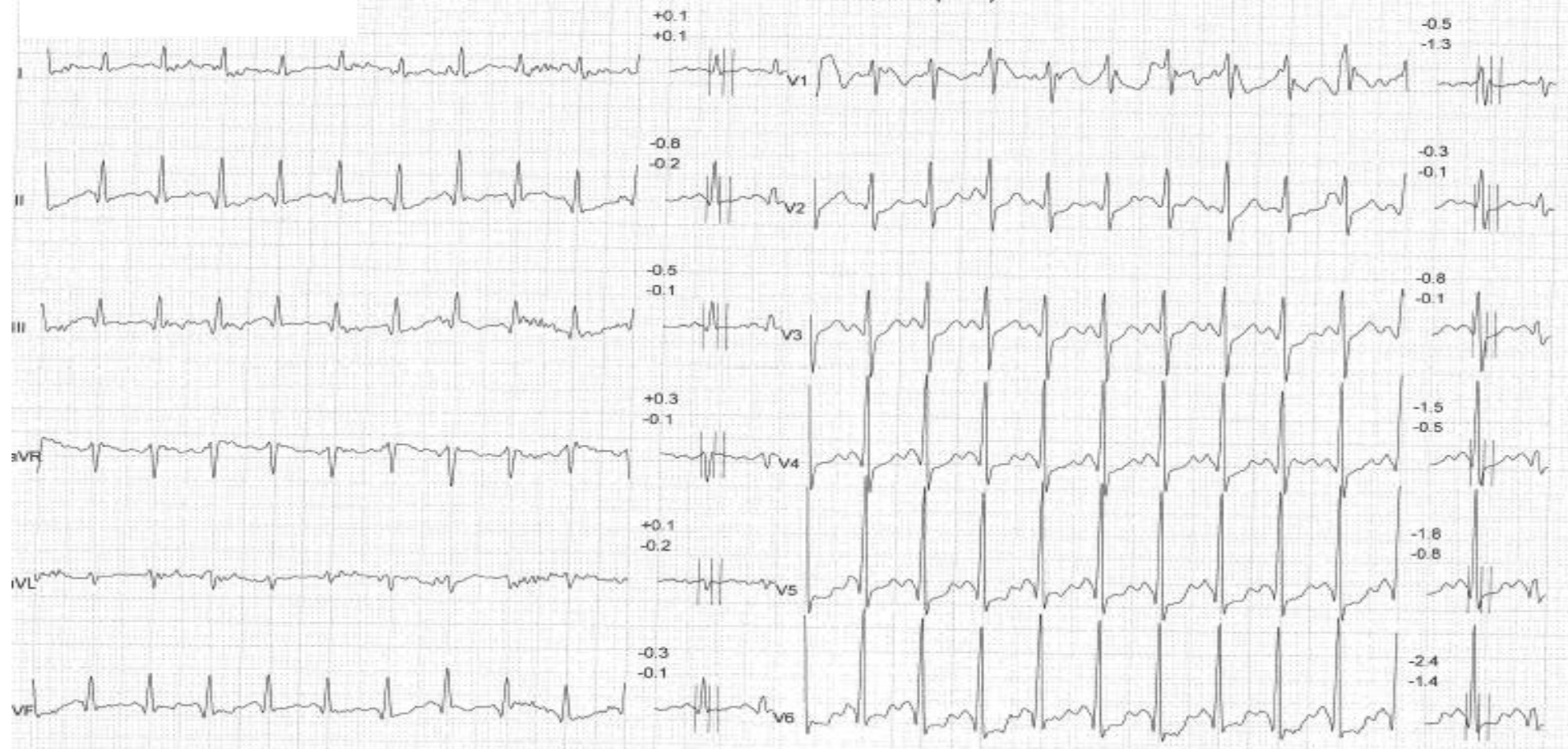
200/100
mmHg

DP/100

302

METS

2.8



24/05/2022 9.16.36

Tempo totale: 07:12
Recupero (03:31)
3 (00:31)

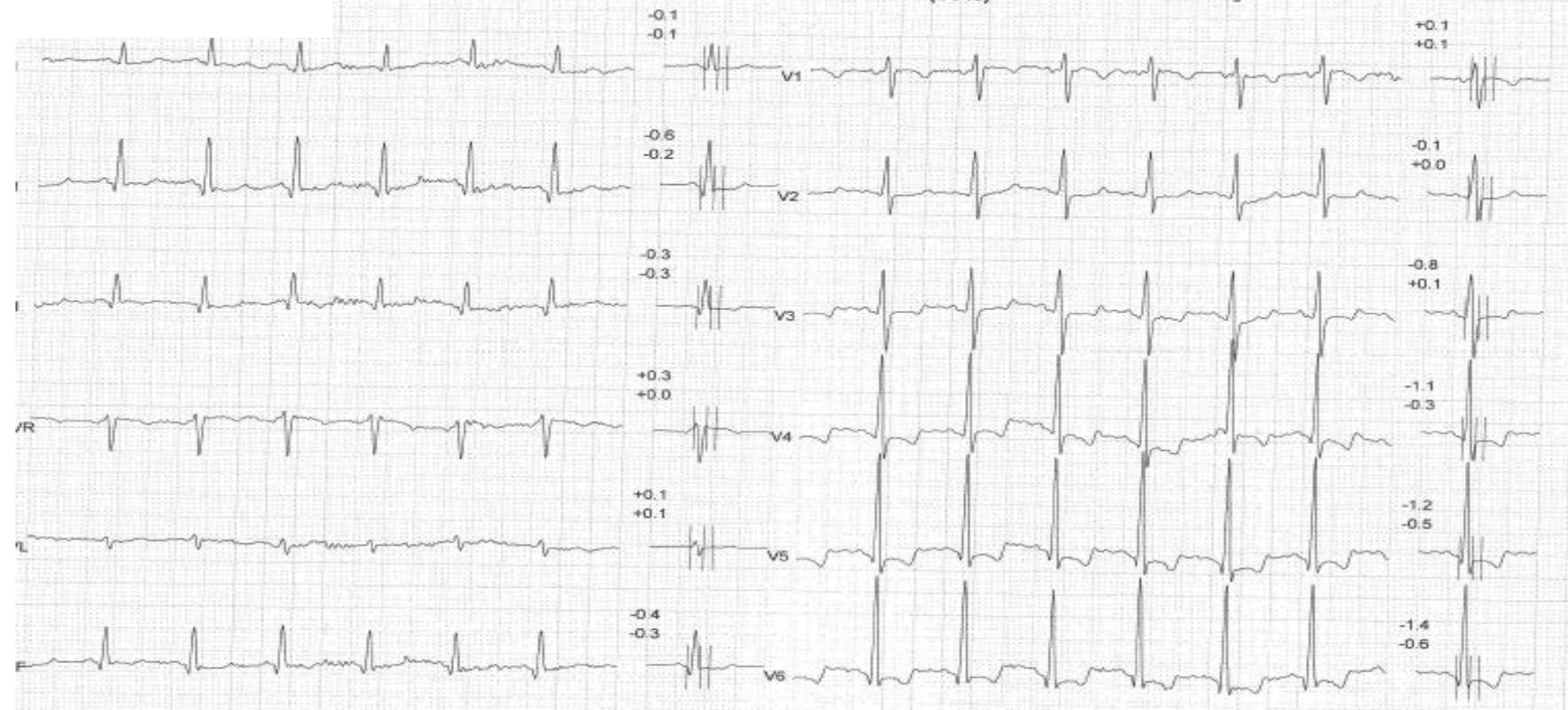
FC (170)
102 bpm
(60%)

Carico
0 Watt

PS
160/95
mmHg

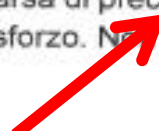
DP/100
163

METS
1.4



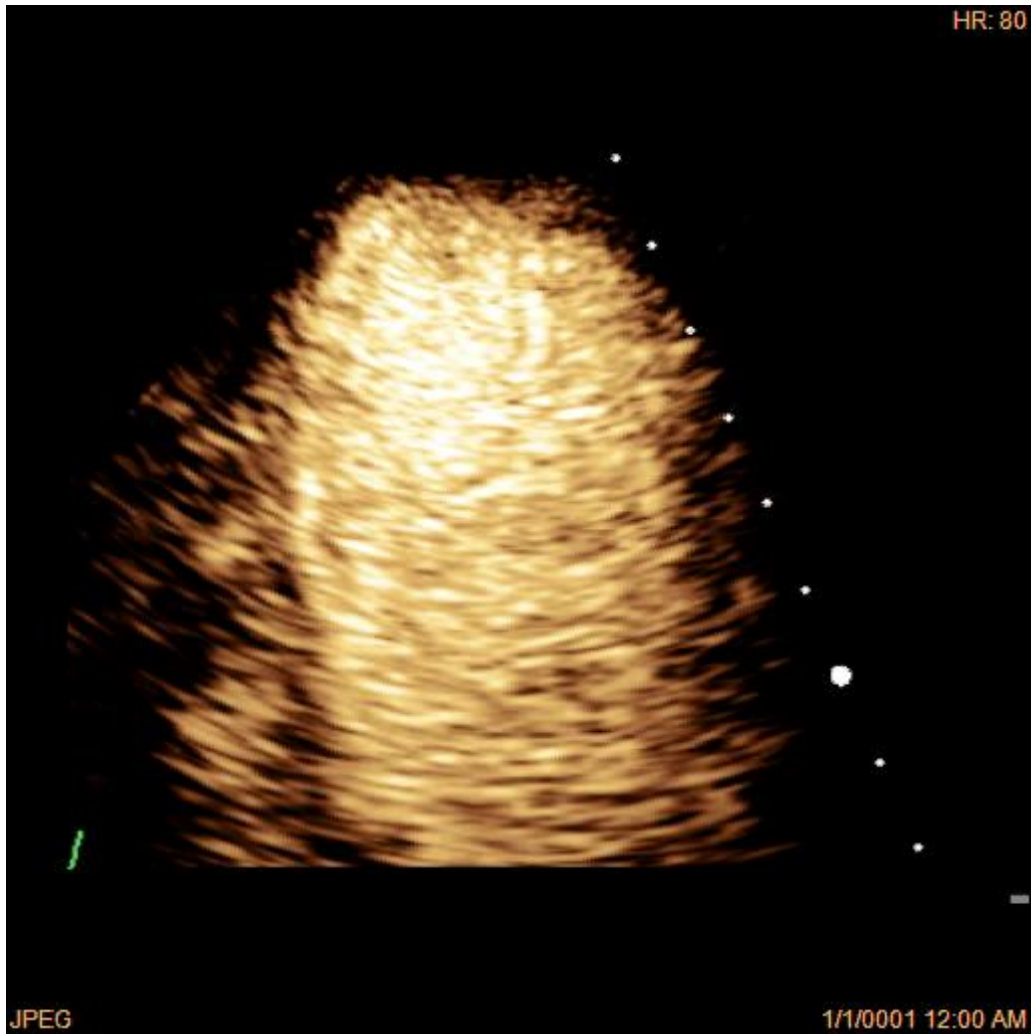
Paziente		Esame						
Cognome		Data/Ora	24/05/2022 9.16.36	FC max	151 (03:44)			
Nome		Tipo Test	Cicloergometro	% su FC teorica	88% (170)			
Sec. Nome		Protocollo	30 W x 2 min	PS Max	200/100 (03:36)			
Nato/a il		Pre-Esercizio	00:14	DP Max	302 (03:44)			
Sesso	Femmina	Esercizio	03:27					
ID	TEST ERGOMETRICO	Recupero	09:07					
Indicazioni								
Terapia	ramipril							
Fase	Tempo mm:ss	FC bpm	PS mmHg	DP/100	METS	Carico Watt	J+X ms	V5 mm
Pre-Esercizio	00:14	88	130/80	114	1.4	0	60	0.60
Picco	03:41	150	200/100	300	4.3	60	60	-1.55
Fine Prova	12:48	86	130/80	111	1.4	0	60	0.40
Interrotto per		dolore toracico						

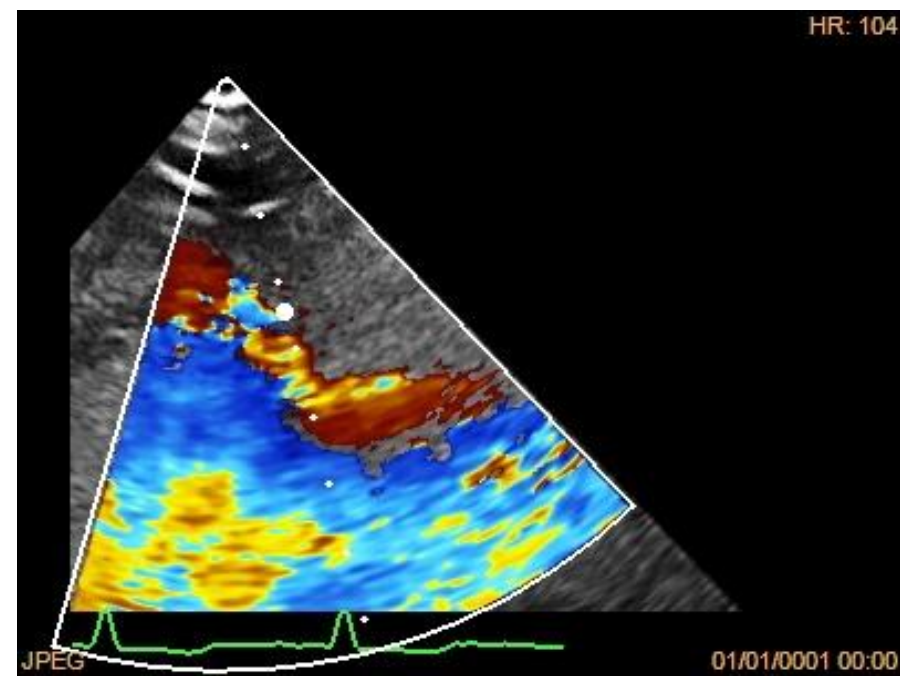
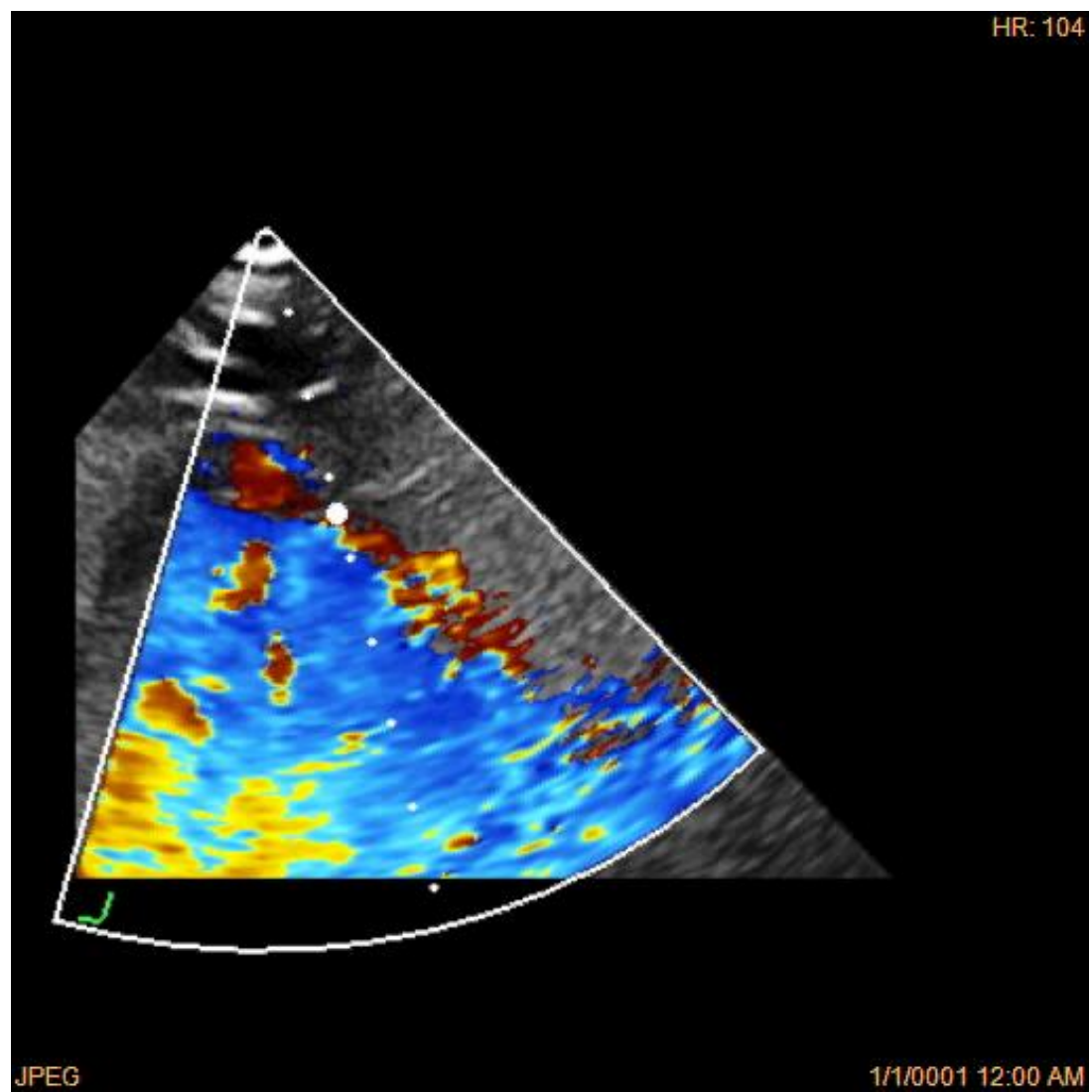
Conclusioni

Test massimale. Al II stadio comparsa di precordialgia costrittiva e sottoslivellamento del tratto ST in V3-V6, più evidente in fase di recupero. Risposta ipertensiva da sforzo.  eventi aritmici. Competenza cronotropa. Test clinicamente e strumentalmente positivo a carico intermedio-basso.



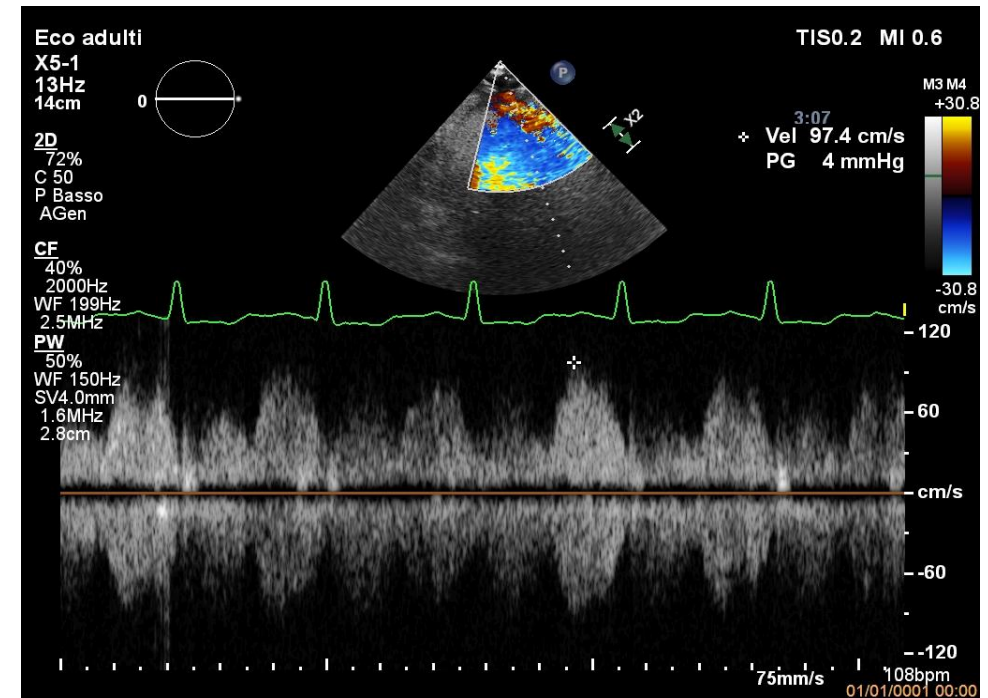
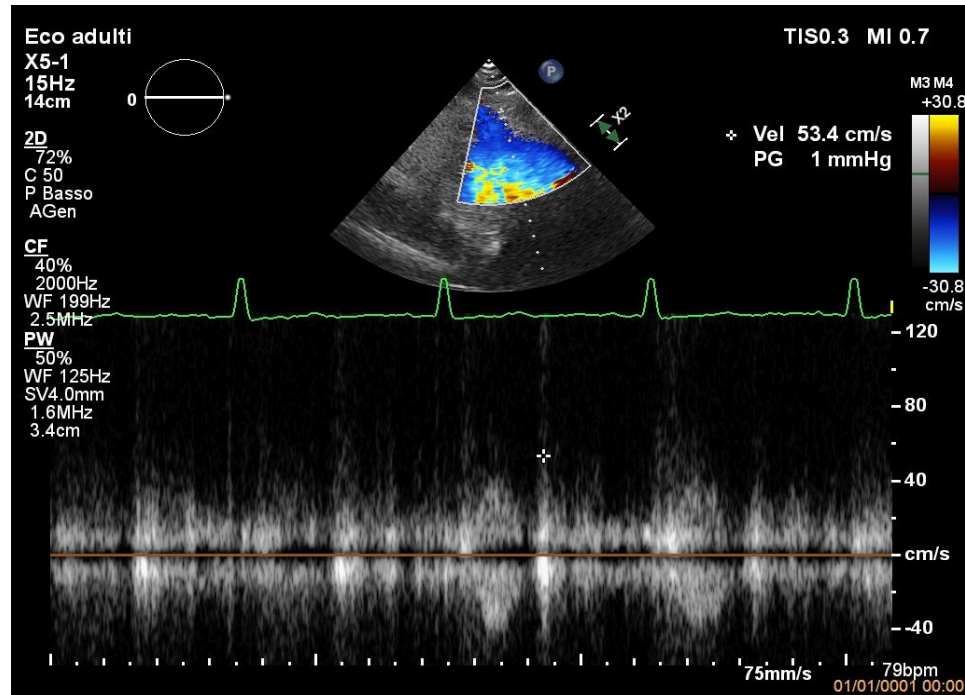






Al picco dello stress comparsa di sottoslivellamento del tratto ST con negativizzazione dell'onda T

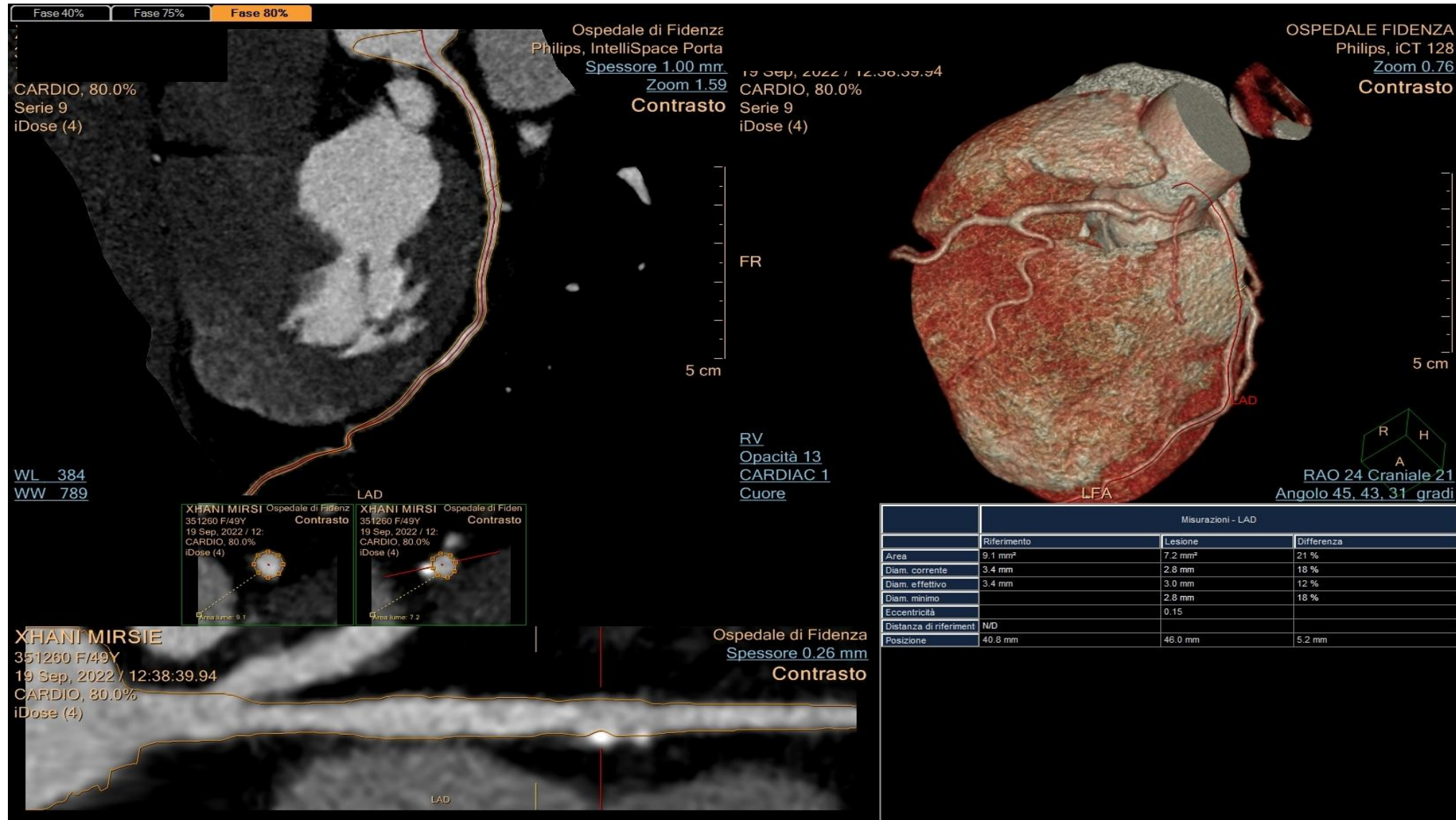
Non alterazioni significative della cinesi regionale e globale del VSn



CFR LAD = 1,8

TC coronarica

Ateromasia 20% IVA prossimale



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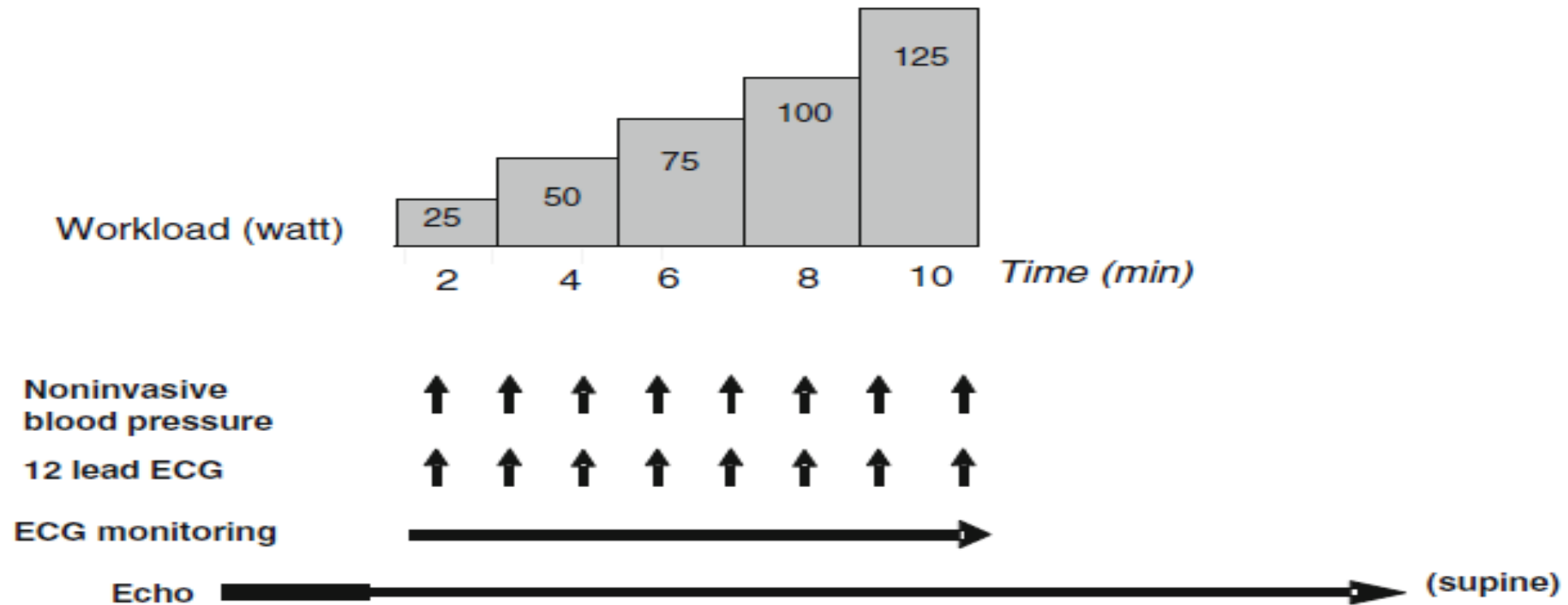
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Table 11.1 Exercise versus pharmacological stress

Parameter	Exercise	Pharmacological
Intravenous line required	No	Yes
Diagnostic utility of heart rate and blood pressure response	Yes	No
Use in deconditioned patients	No	Yes
Use in physically limited patients	No	Yes
Level of echocardiography imaging difficulty	High	Low
Safety profile	High	Moderate
Clinical role in valvular disease	Yes	No
Clinical role in pulmonary hypertension	Yes	No
Fatigue and dyspnea evaluation	Yes	No



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25W OGNI 2' FINO AL RAGGIUNGIMENTO DELL'85% DELLA FCMT



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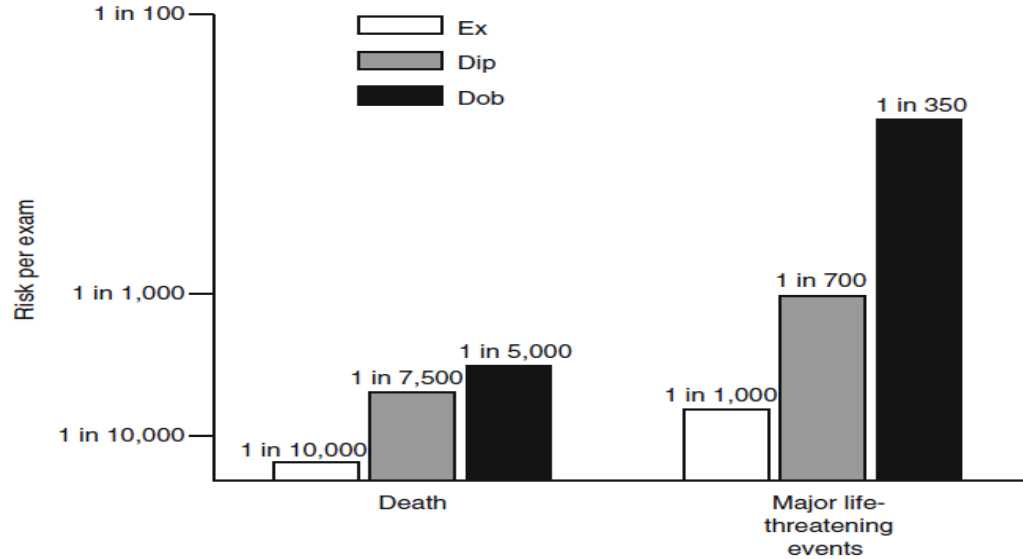
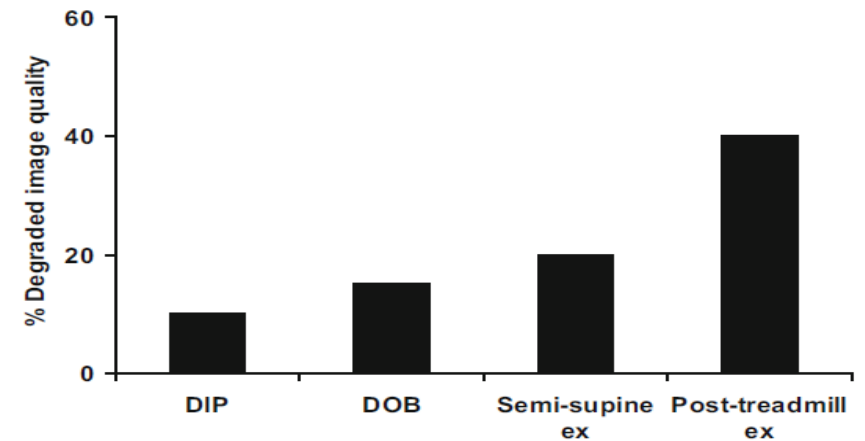


Fig. 11.3 Safety of stress echocardiography: highest for exercise, intermediate for dipyridamole, lowest for dobutamine stress (Original data from [29–32], summarized in [15])

MA TECNICAMENTE PIÙ
COMPLESSO

ESAME PIÙ SICURO



Contrast needed →

Technical difficulty →

Fig. 11.4 The technical echocardiographic difficulties of different stresses. Factors polluting image quality are more frequent with post-treadmill and least frequent with pharmacological stresses

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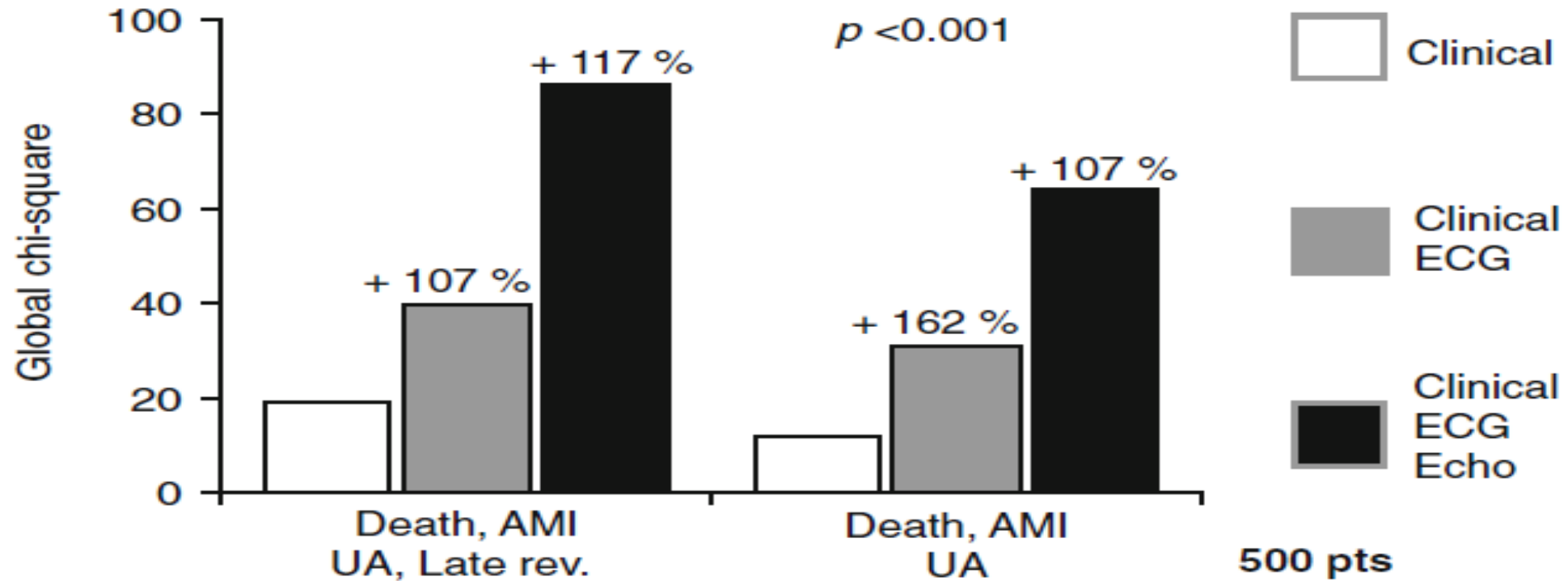


Fig. 11.6 The prognostic value of exercise echocardiography (Modified from Marwick et al. [42])

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STRESS FISIOLOGICO IN ASSENZA DI FARMACI →
MIGLIORE INQUADRAMENTO DEI SINTOMI IN PARTICOLARE DELLA
DISPNEA DA SFORZO



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UN MONDO SOMMERSO OLTRE LA CARDIOPATIA ISCHEMICA



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Indicazioni

1. Valutazione ischemia inducibile
2. Valutazione ostruzione LVOT
3. IM dinamica
4. Stenosi mitralica con discrepanza sintomi/gradiente-MVA
5. Ipertensione polmonare da sforzo
6. Disfunzione destra in IM primitiva
7. Disfunzione di protesi
8. Inquadramento dispnea



The Clinical Use of Stress Echocardiography in
Non-Ischaemic Heart Disease: Recommendations
from the European Association of Cardiovascular
Imaging and the American Society of
Echocardiography



Patrizio Lancellotti, MD, PhD, FESC (Chair), Patricia A. Pellikka, MD, FASE (Co-Chair),
Werner Budts, MD, PhD, Furoq A. Chaudhry, MD, FASE, Erwan Donal, MD, PhD, FESC,
Raluca Dulgheru, MD, Thor Edvardsen, MD, PhD, FESC, Madalina Garbi, MD, MA,
Jong Won Ha, MD, PhD, FESC, Garvan C. Kane, MD, PhD, FASE, Joe Kreeger, ACS, RCCS, RDCS, FASE,
Luc Mertens, MD, PhD, FASE, Philippe Pibarot, DVM, PhD, FASE, FESC, Eugenio Picano, MD, PhD,
Thomas Ryan, MD, FASE, Jeanne M. Tsutsui, MD, PhD, and Albert Varga, MD, PhD, FESC, *Liege, Belgium; Bari
and Pisa, Italy; Rochester, Minnesota; Leuven, Belgium; New York, New York; Rennes, France; Oslo, Norway; London,
UK; Seoul, South Korea; Atlanta, Georgia; Toronto and Quebec, Canada; Columbus, Ohio; São Paulo, Brazil; and
Szeged, Hungary*

ECOSTRESS FISICO

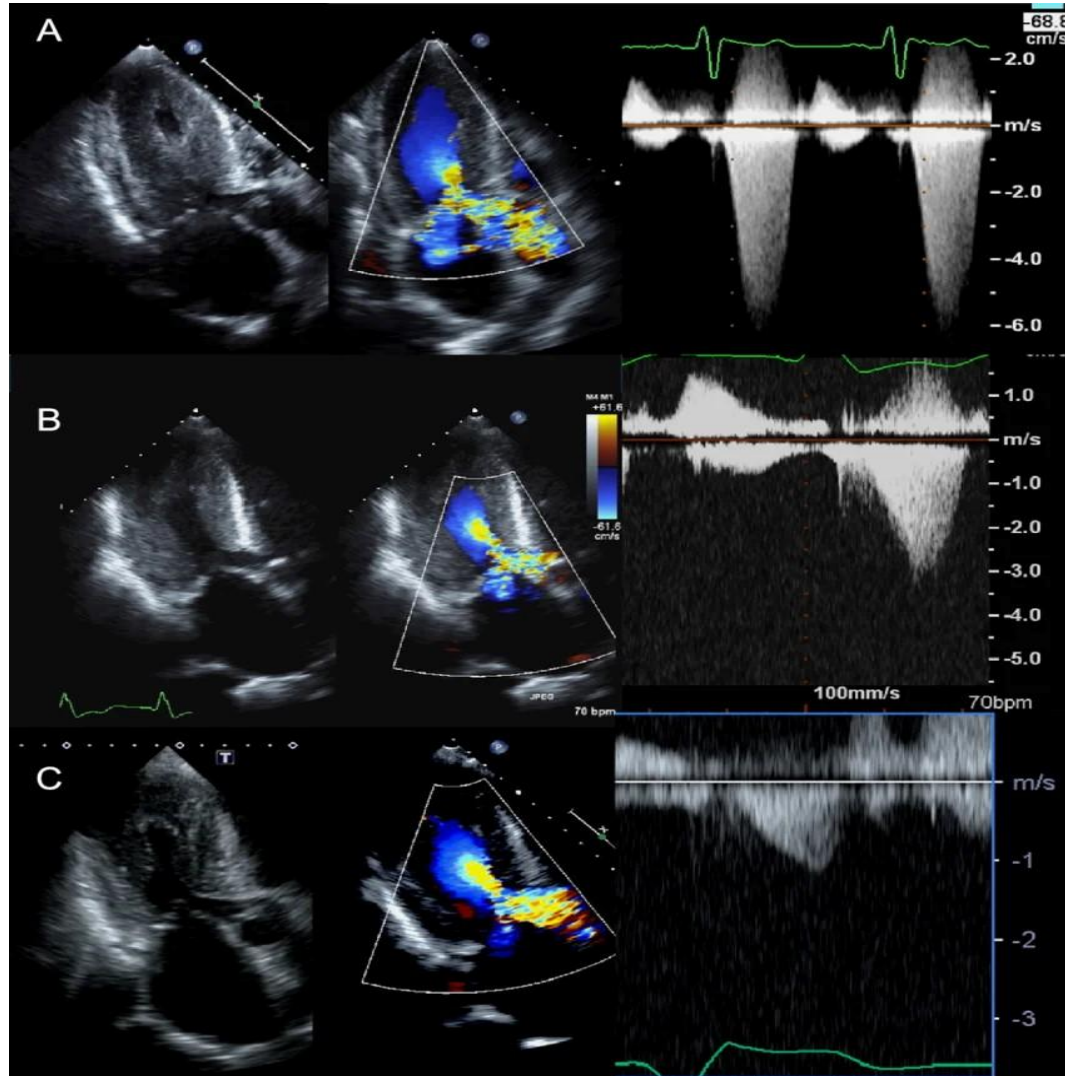
Table 2 SE cut-off values associated with clinical significance, outcome or limited response to therapy

Parameters	Cut-off values
Intraventricular obstruction	• LVOT gradient >50 mmHg
Inadequate contractile reserve	• Δ WMSI <0.25 in dilated cardiomyopathy (ESE, DSE) • Δ LVEF <7.5% in patients with biventricular pacing and heart failure (ESE, DSE) • Δ LVEF <4–5% in Primary MR, AR (ESE) • Δ global longitudinal strain <2% in Primary MR (ESE)
Inadequate flow reserve	• Δ stroke volume <20% (DSE)
Dynamic mitral regurgitation	• Δ EROA $\geq$ 10–13 mm ² in MR patients (ESE)
Systolic pulmonary hypertension	• SPAP $\geq$ 60 mmHg (ESE)
Limited valve compliance/fixed stenosis	• Mean transmitral gradient in MS ○ >15 mmHg (ESE) ○ >18 mmHg (DSE) • Mean transaortic gradient in AS ○ Δ MPG >18–20 mmHg (ESE)
Prosthesis dysfunction or PPM	• Mean transmitral gradient in MV Prosthesis ○ >10 mmHg (ESE or DSE) • Mean transaortic gradient in AV Prosthesis ○ >20 mmHg (ESE or DSE)
Functional MS after mitral valve repair	• Δ mean transmitral gradient >7 mmHg
RV dysfunction	• TAPSE <19 mm in Primary MR (ESE)
Increase in B-lines	• >5 (28-region chest scan) (ESE)
Reduced coronary flow reserve (CFR)	• CFR <2.0 (VSE)

Δ , changes from rest to peak stress; AS, aortic stenosis; CFR, coronary flow reserve; DSE, dobutamine stress echocardiography; EROA, effective regurgitant orifice area; ESE, exercise stress echocardiography; LVOT, left ventricular outflow tract; MS, mitral stenosis; MR, mitral regurgitation; RV, right ventricle; SPAP, systolic pulmonary artery pressure; TAPSE, tricuspid annulus plane systolic excursion; VSE, vasodilator stress echocardiography.

ECOSTRESS FISICO

1. Valutazione ostruzione LVOT



MAVACAMTEN

Graphic by Dr. Kate Wilcox @KateAltaWilcox, reviewed by Dr. Ahmed Ghoneem @a_h_ghoneem



- Novel therapeutic agent under FDA review for use in obstructive hypertrophic cardiomyopathy (HCM)
- MOA: elective allosteric inhibitor of cardiac myosin ATPase targeting underlying sarcomere hypercontractility in HCM

PATHOPHYSIOLOGY OF HCM

Increased actin-myosin interactions (cross bridges) → **hypercontractility**

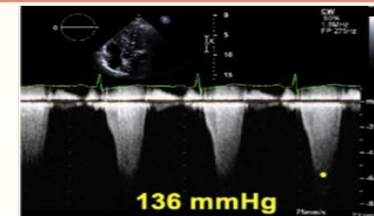
VS TREATMENT W/ MAVACAMTEN

Reduced actin-myosin cross-bridge interaction → **attenuated contractility**

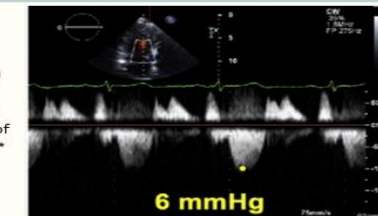


Altered myocardial dynamics & **LVOT obstruction**

Improved energetics & less LVOT obstruction

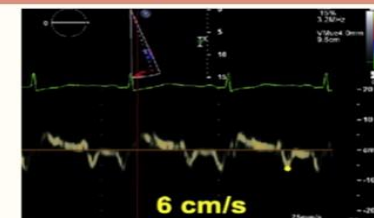


LVOT resting gradient at screening (L) and week 30 of treatment (R)*

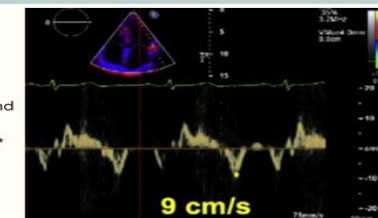


Impaired **lusitropy** (rate of relaxation) of the sarcomere

More effective myocardial relaxation & increased LV compliance



Lateral e' at screening (L) and week 30 of treatment (R)*



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2. Stenosi mitralica con discordanza sintomi/gradiente-MVA

Paziente M di anni 70

In anamnesi: ipertensione arteriosa, dislipidemia, diabete mellito in terapia con ipoglicemizzanti orali.

2019 ecocardiogramma di controllo: VSn non dilatato, spessori parietali ai limiti superiori di norma, cinesi regionale e globale conservata (FE 60%), lembi mitralici ispessiti con stenosi di grado lieve/moderato (Gmedio 5 mmHg) e lieve insufficienza, non valvulopatia aortica, sezioni destre e PAPs nei limiti.

4/2020 ricovero per **ictus ischemico**.

All'ECG RS normofrequente, BAV I grado, BBDx.

ECO-TT invariato: nota steno-insufficienza mitralica di grado lieve/moderato.



8/2020 visita cardiologica: paziente sintomatico per dispnea da sforzo

- **Test ergometrico → negativo per criteri ECG ma positivo per sintomi.**
- **SPECT miocardica con Dipiridamolo: negativa per deficit perfusivi.**
Durante infusione del farmaco paziente sintomatico per dispnea e oppressione toracica, non alterazioni ST/T.

2021 visita cardiologica: paziente persistentemente sintomatico per dispnea da sforzo

- **TC coronarica:** coronarie epicardiche esenti da patologia ateromasica di rilievo e normo opacizzate.
 - **ECO TT:** invariato.
 - **Holter ECG:** RS normofrequente alla Fc media di 77/min, Fc min 63 bpm, Fc max 112 bpm, rari BEV e BESV.
 - **Valutazione pneumologica:** spirometria con DLCO negativa.
- 

10/2022 ricovero in ortopedia per PTA sinistra elettiva

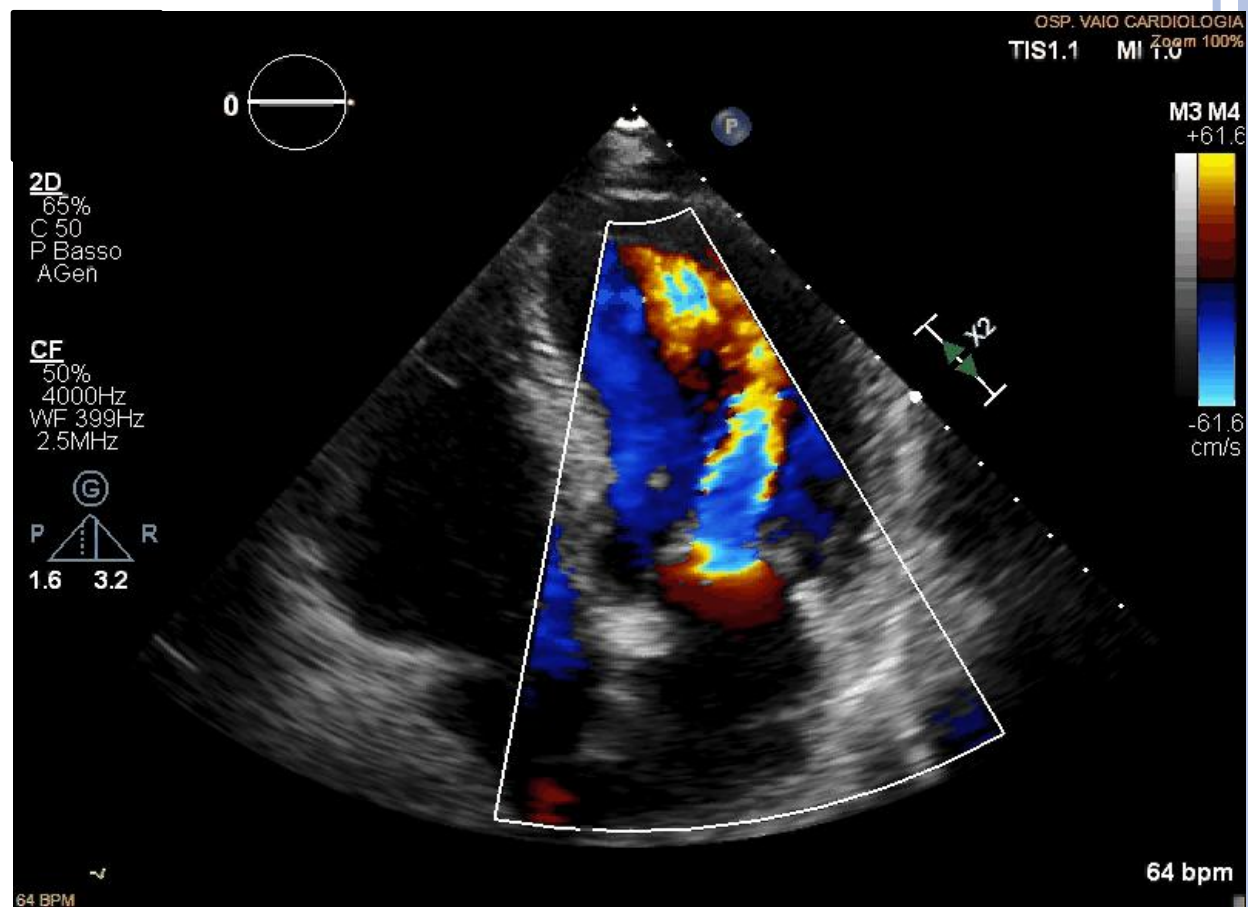
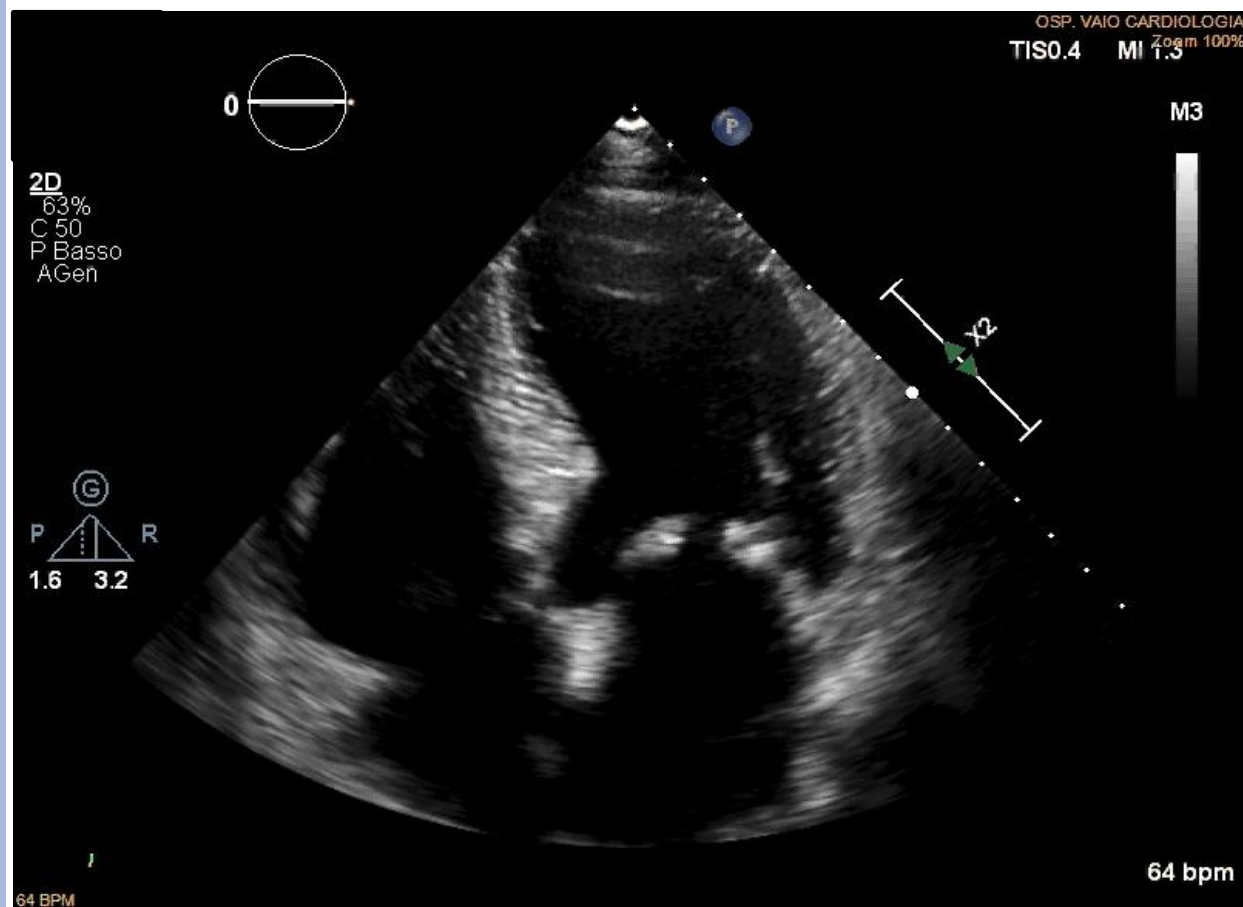
Durante l'intervento comparsa di grave ipotensione non responsiva all'infusione di liquidi e comparsa di FA ad elevata risposta ventricolare. Inefficaci 3 CVE, seguiva cardioversione farmacologica con Amiodarone.

2/2024 ECO TT: VSn non dilatato, lieve ipertrofia del SIV (12 mm), FE 60%. Stenosi mitralica di grado lieve/moderato (Gmedio 5 mmHg) con lieve insufficienza. Non valvulopatia aortica, IT lieve con PAPs 33 mmHg. VCI non dilatata e collassabile.

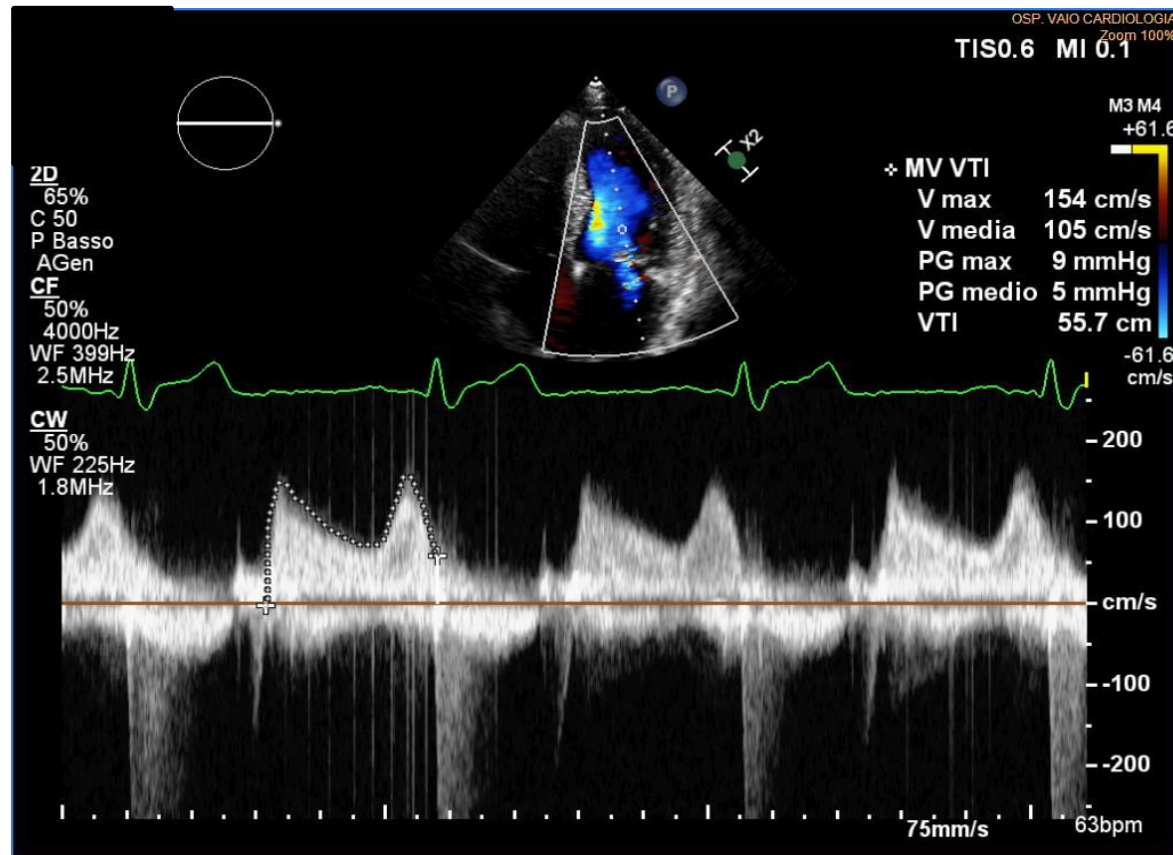
→ Successiva visita cardiologica con indicazione a studio approfondito della valvulopatia mitralica



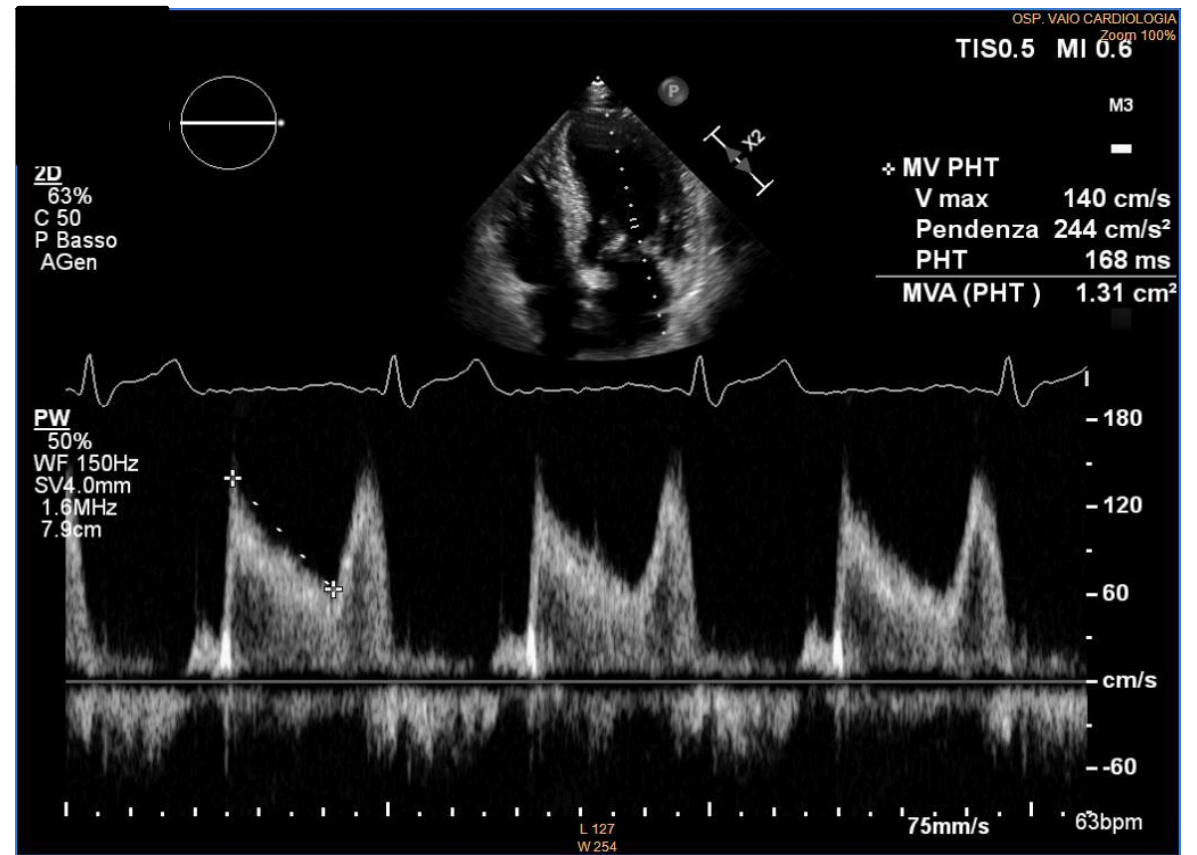
ECO TT



ECO TT



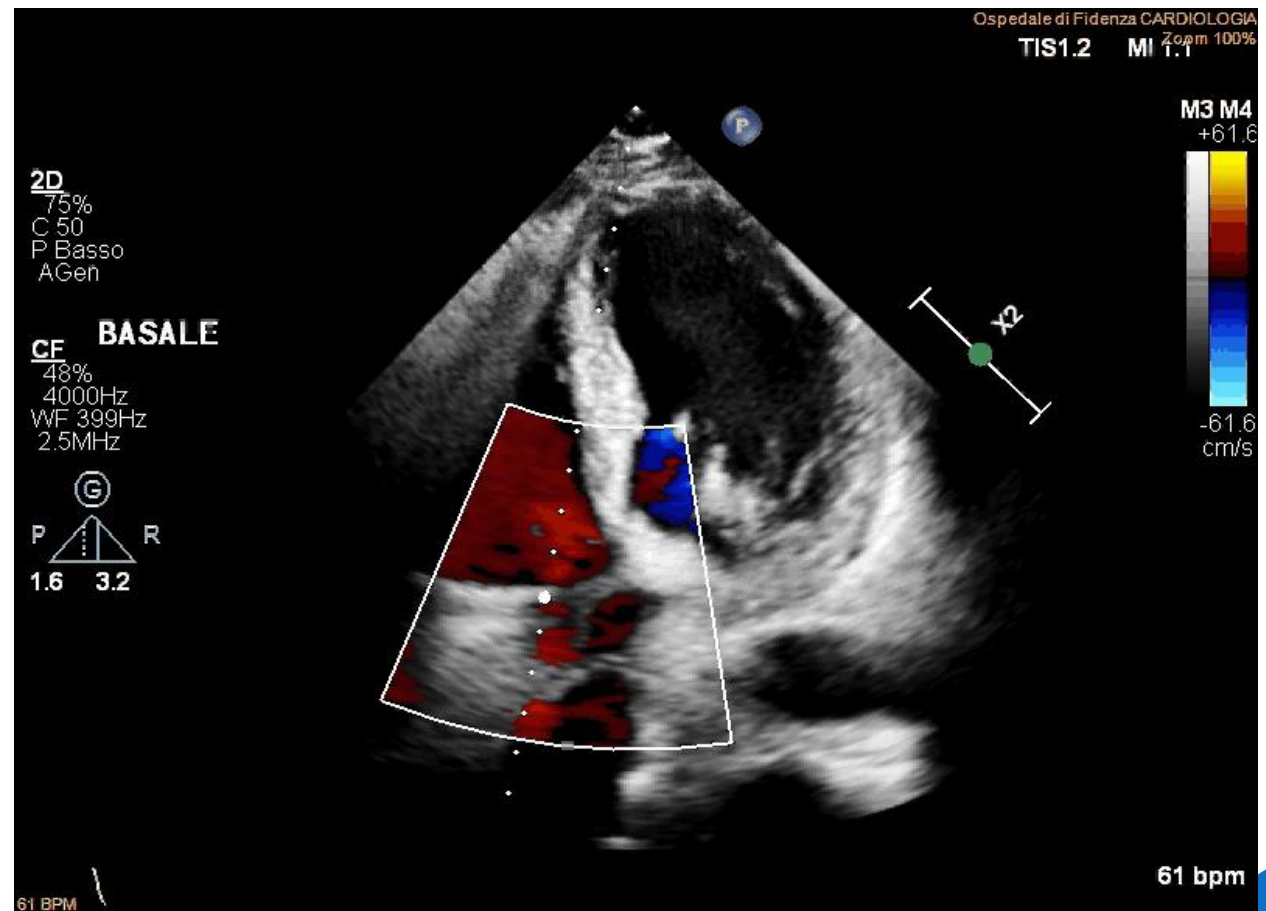
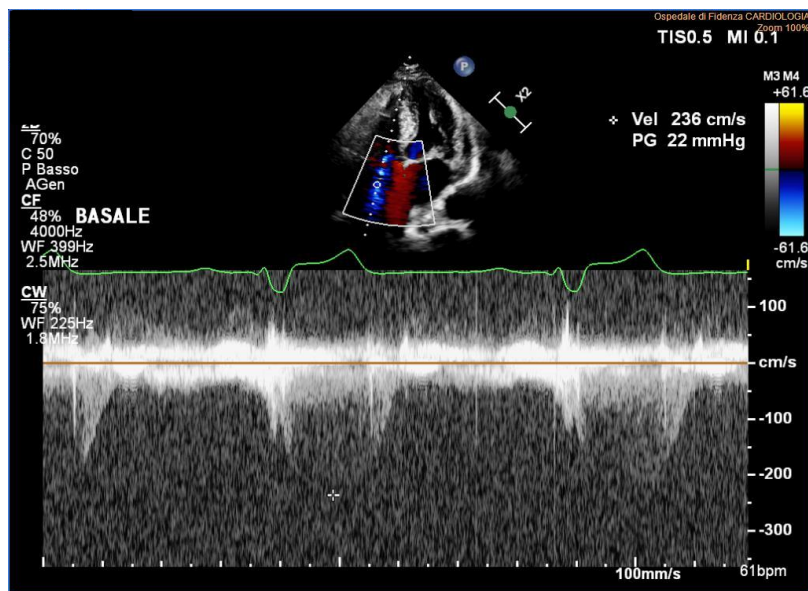
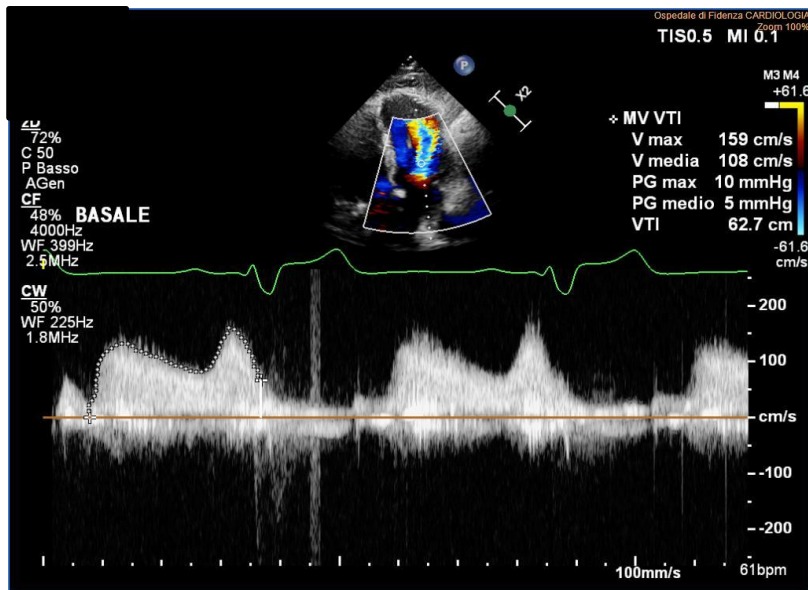
Noto gradiente medio di 5 mmHg



MVA PHT 1,31 cm²

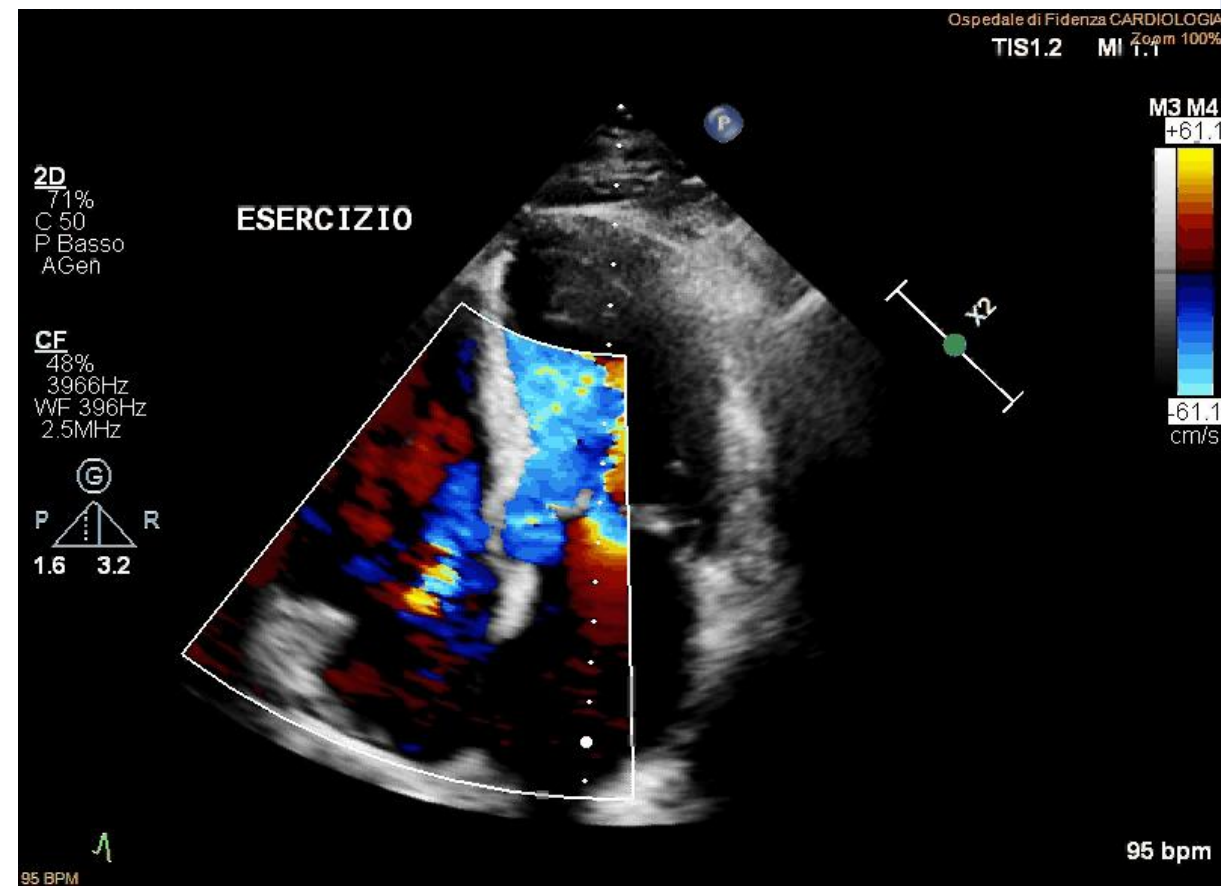
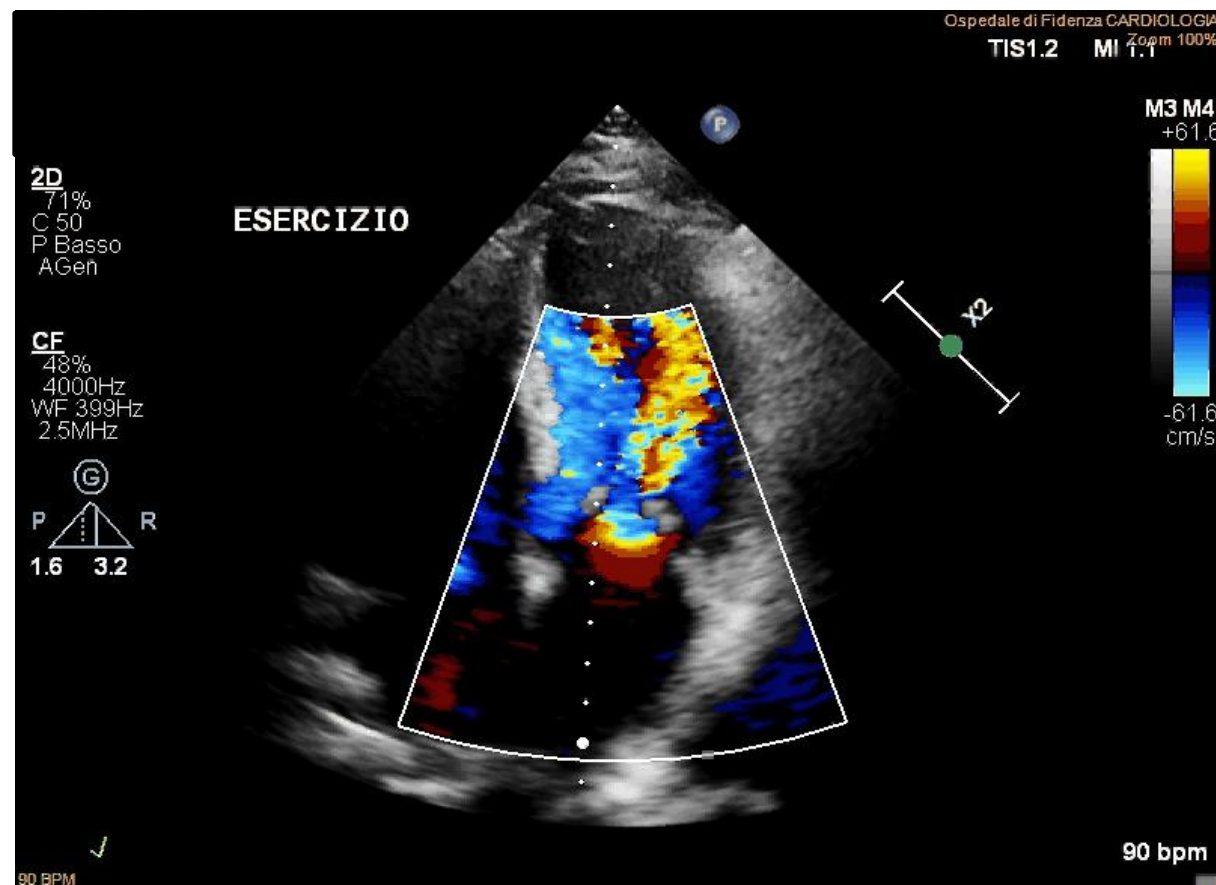
ECOSTRESS AL LETTOERGOMETRO

BASALE



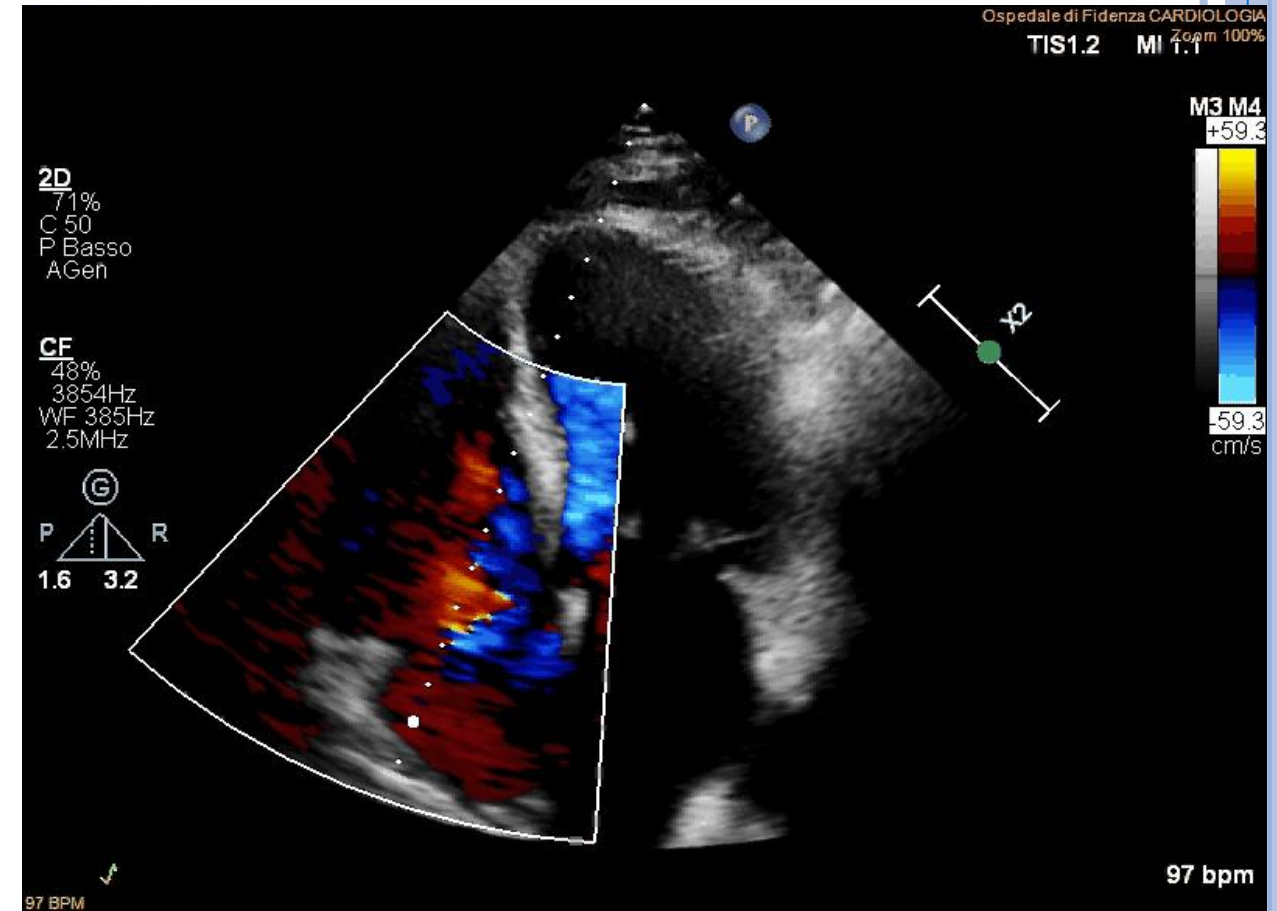
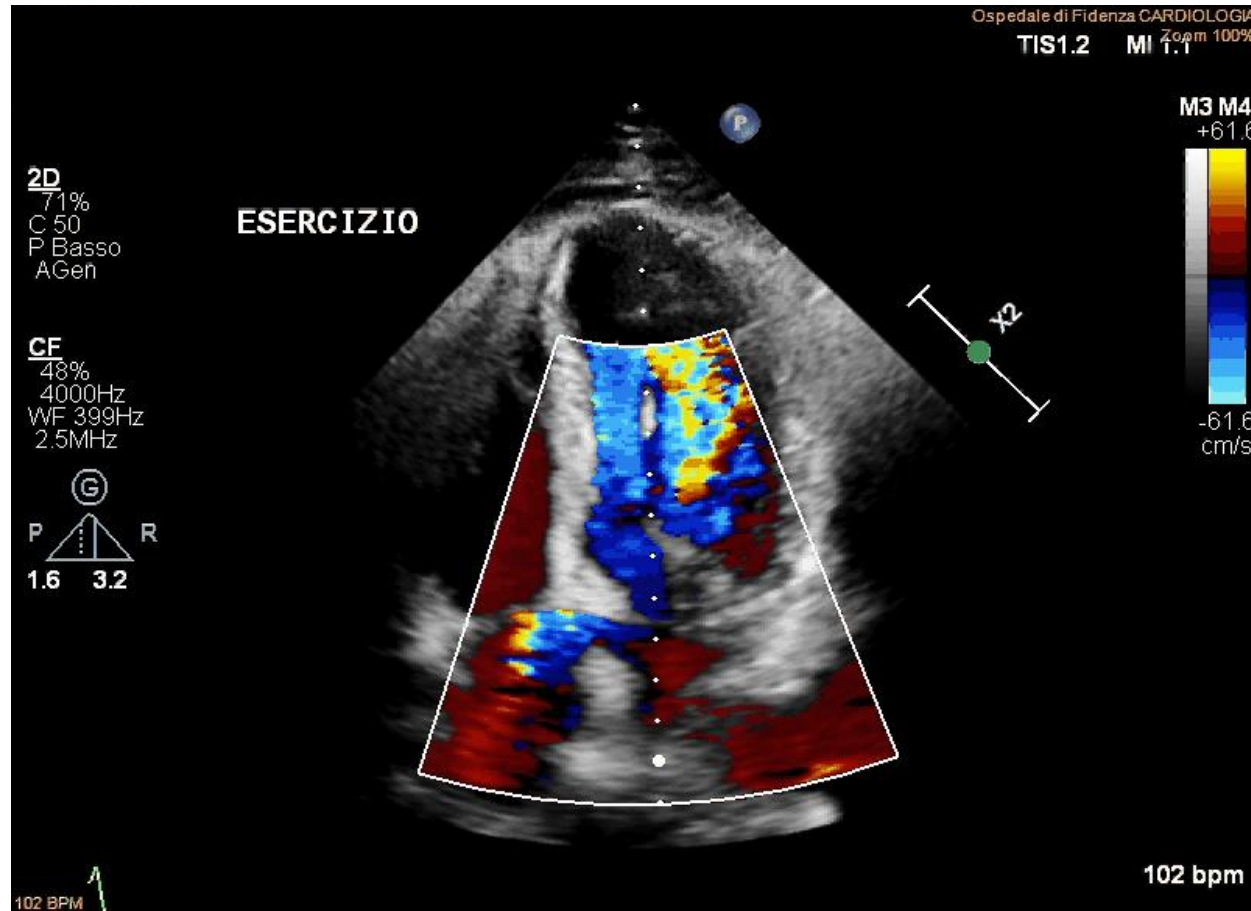
ECOSTRESS AL LETTOERGOMETRO

50 Watt



ECOSTRESS AL LETTOERGOMETRO

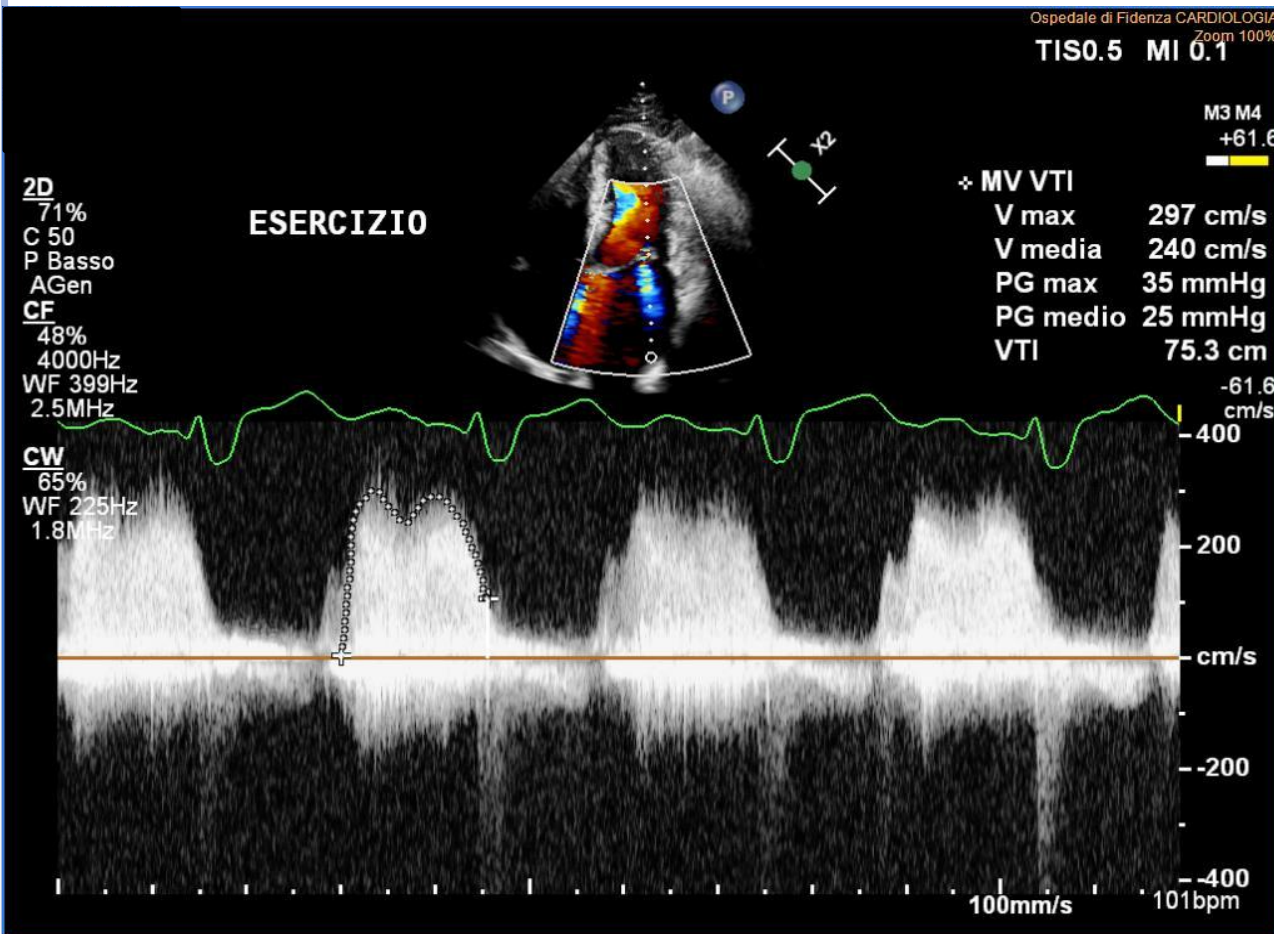
75 Watt



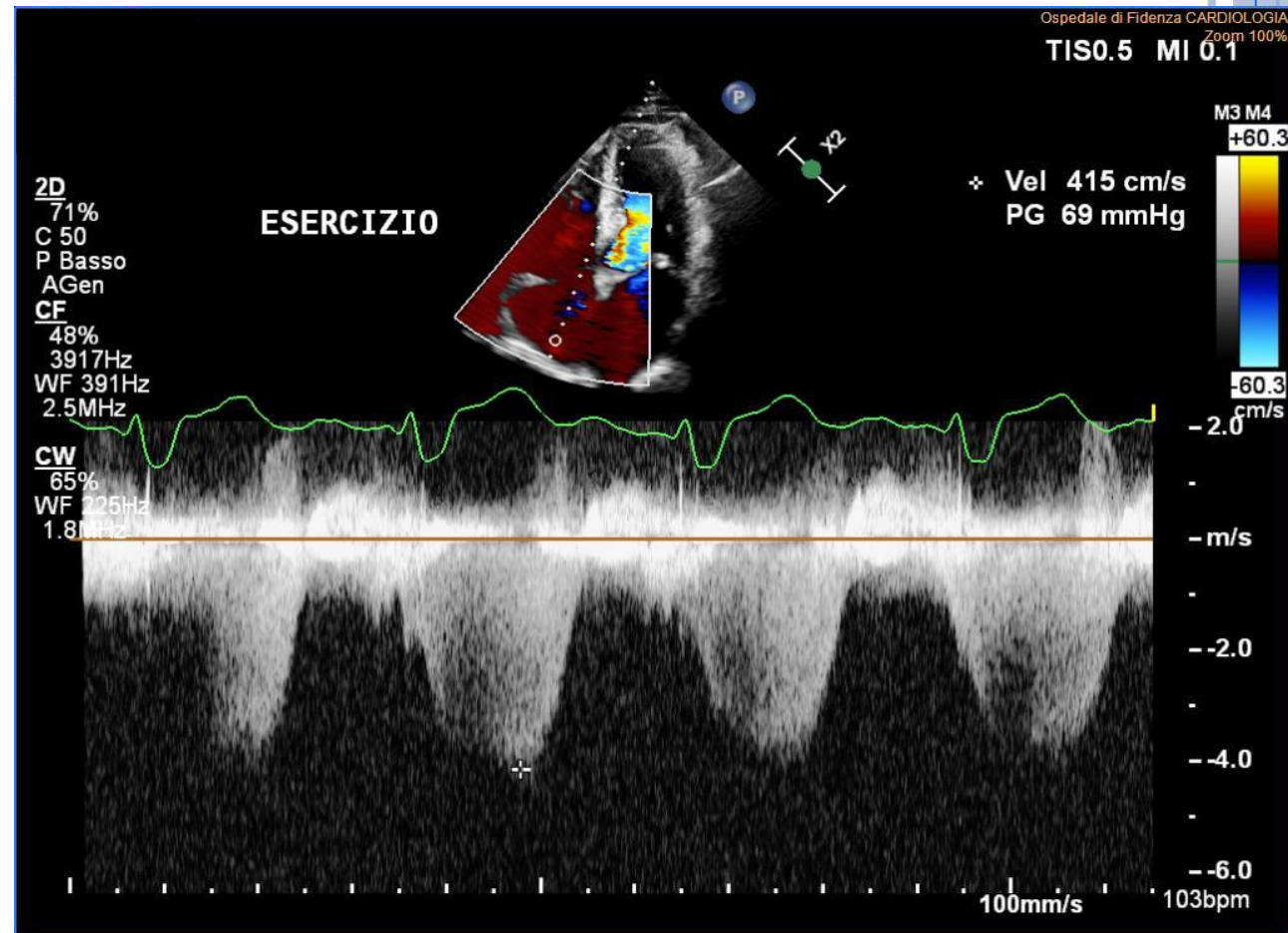
Comparsa di significativa dispnea

ECOSTRESS AL LETTOERGOMETRO

75 Watt



Gradiente medio al picco
dello sforzo 25 mmHg



Gradiente Vd-Ad al picco
dello sforzo 69 mmHg

The Clinical Use of Stress Echocardiography in
Non-Ischaemic Heart Disease: Recommendations
from the European Association of Cardiovascular
Imaging and the American Society of
Echocardiography



Patrizio Lancellotti, MD, PhD, FESC (Chair), Patricia A. Pellikka, MD, FASE (Co-Chair),
Werner Budts, MD, PhD, Farooq A. Chaudhry, MD, FASE, Erwan Donal, MD, PhD, FESC,
Raluca Dulgheru, MD, Thor Edvardsen, MD, PhD, FESC, Madalina Garbi, MD, MA,
Jong Won Ha, MD, PhD, FESC, Garvan C. Kane, MD, PhD, FASE, Joe Kreeger, ACS, RCCS, RDCS, FASE,
Luc Mertens, MD, PhD, FASE, Philippe Pibarot, DVM, PhD, FASE, FESC, Eugenio Picano, MD, PhD,
Thomas Ryan, MD, FASE, Jeane M. Tsutsui, MD, PhD, and Albert Varga, MD, PhD, FESC, *Liège, Belgium; Bari
and Pisa, Italy; Rochester, Minnesota; Leuven, Belgium; New York, New York; Rennes, France; Oslo, Norway; London,
UK; Seoul, South Korea; Atlanta, Georgia; Toronto and Québec, Canada; Columbus, Ohio; São Paulo, Brazil; and
Szeged, Hungary*

SE is indicated to assess the haemodynamic significance of MS, which if severe, may account for symptoms.

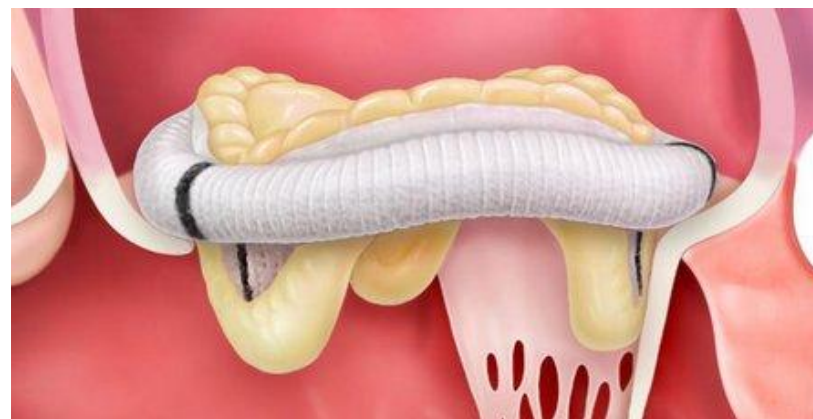
MS is diagnosed as severe if the **mean gradient is >15 mmHg on exertion** or >18 mmHg during dobutamine infusion. An **SPAP is >60 mmHg** on exertion is another marker of haemodynamically significant MS.

Posta indicazione a correzione chirurgica

**12/2024 eseguita sostituzione
valvolare mitralica**

ECO TT di controllo del 1/2025: VSn non dilatato, FE 55%, bioprotesi mitralica normofunzionante (Gmedio 3 mmHg), non leak. IT lieve con PAPs stimata 28 mmHg.

Completa remissione dei sintomi



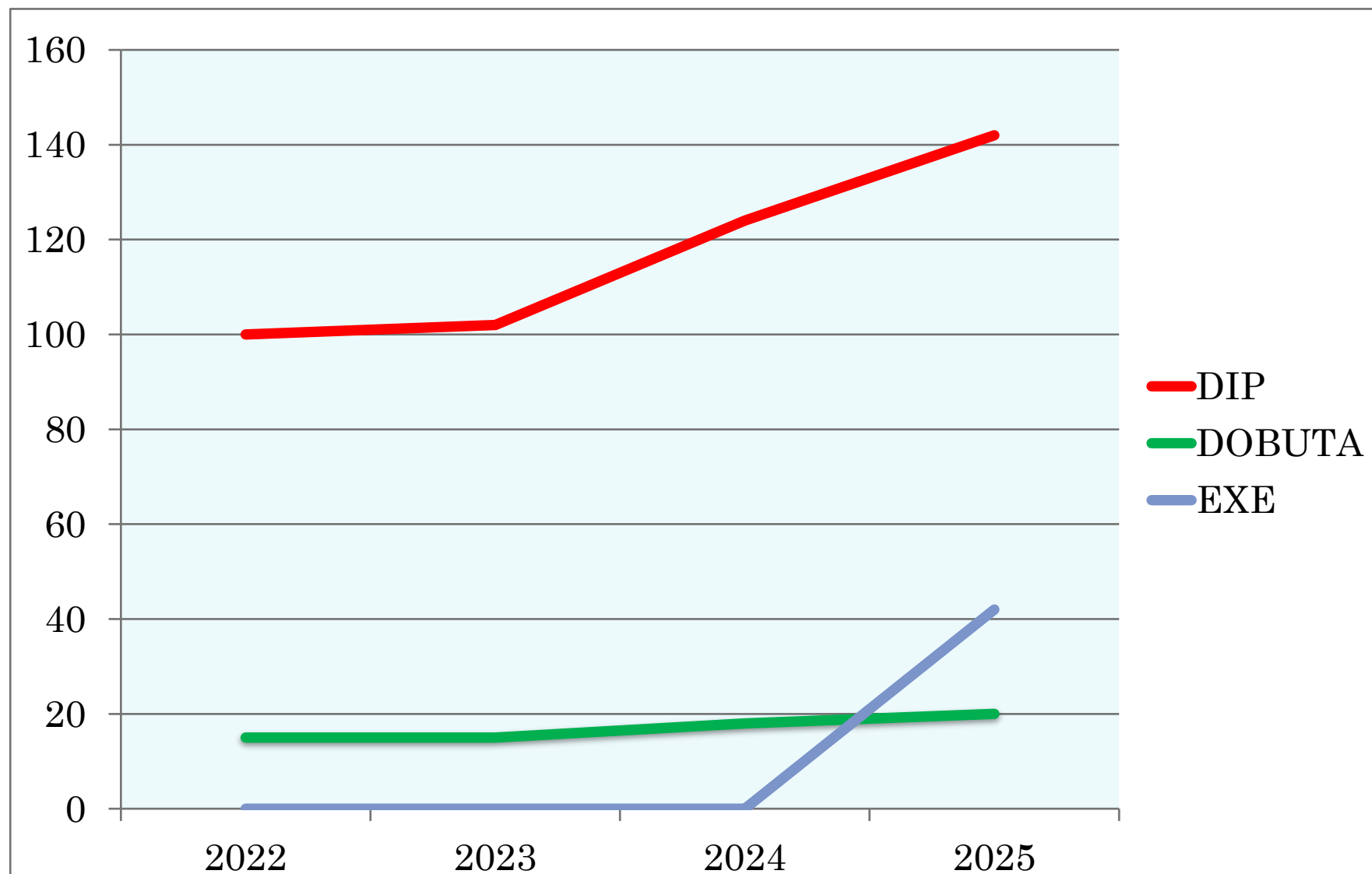
ECOSTRESS FISICO

NON CONTROINDICAZIONI SPECIFICHE MA RISULTA FONDAMENTALE LA SELEZIONE DEL PAZIENTE:

- 1. CAPACITÀ DI ESERCIZIO FISICO**
- 2. FINESTRE ACUSTICHE OTTIMALI/SI POTRÀ VALUTARE UNA FINESTRA SUBOTTIMALE CON UTILIZZO DI MDC SE INDICAZIONE È L'ISCHEMIA INDUCIBILE**

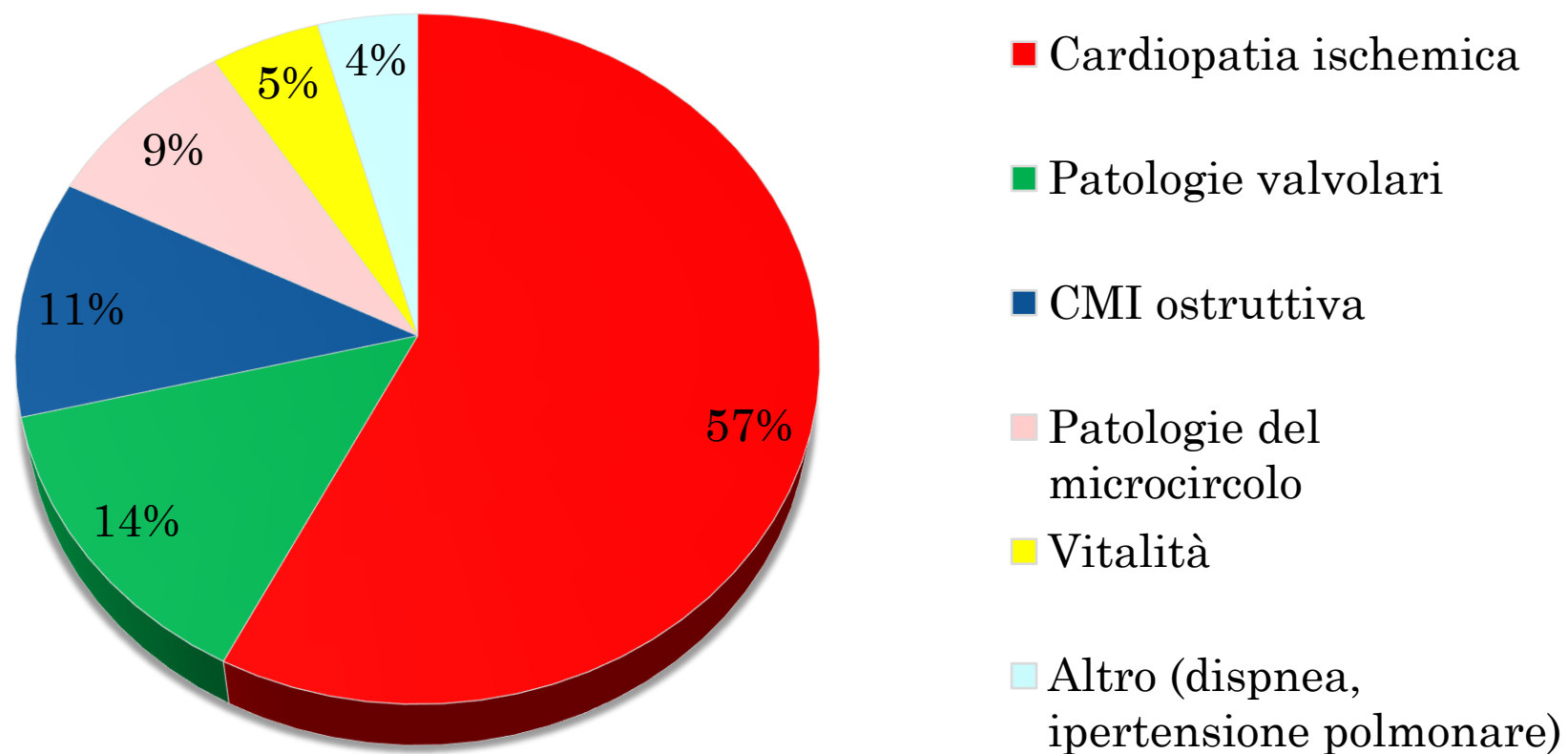


ECOSTRESS, ESPERIENZA LABORATORIO DI ECOCARDIOGRAFIA OSPEDALE DI VAIO



ECOSTRESS, ESPERIENZA LABORATORIO ECOCARDIOGRAFICO OSPEDALE DI VAIO

Indicazioni



CONCLUSIONI

Diverse tipologie di ecostress

Diverse indicazioni/controindicazioni



Grazie per l'attenzione

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