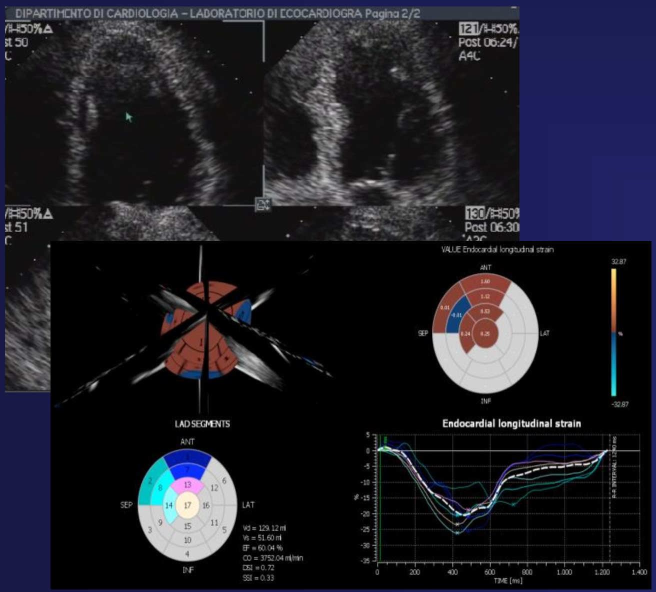
CAMPUS CUORE
14 APRILE 2023



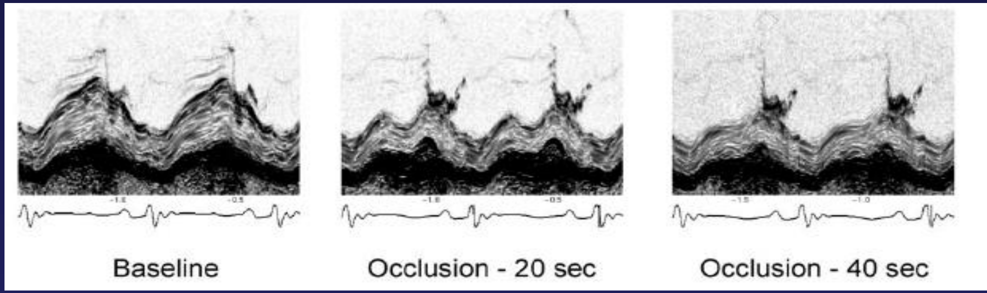
NUOVE TECNOLOGIE ECOCARDIOGRAFICHE NELLA VALUTAZIONE DELLA CARDIOPATIA ISCHEMICA ACUTA E CRONICA

ANTONELLO D'ANDREA

UOC Cardiologia ed UTIC – PO Umberto I° Nocera Inferiore (ASL Salerno)

“UNMET NEEDS” dell’Eco nella CAD

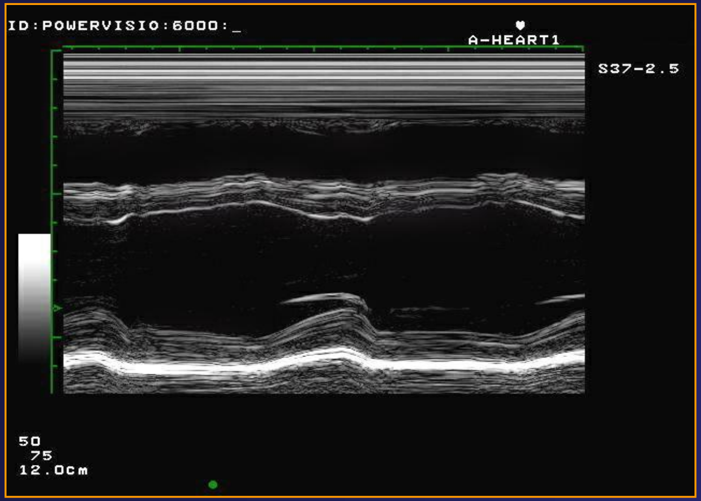
Quantify Myocardial Function

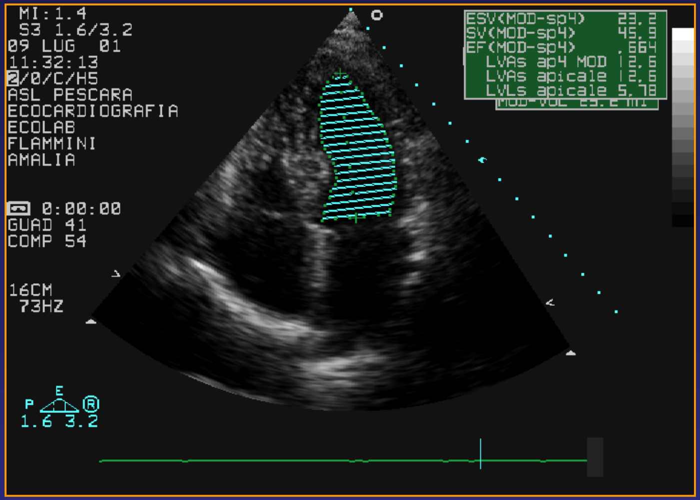


Visual evaluation of wall motion only assesses radial deformation of the myocardium and it is well known that myocardial contractility consists of thickening, shortening and twisting.

Need for more sensitive parameters of LV dysfunction <u>to detect early abnormalities</u>

Rilevanza clinica delle variazioni





Δ DTSVS >10%

Δ FEVS >0.10

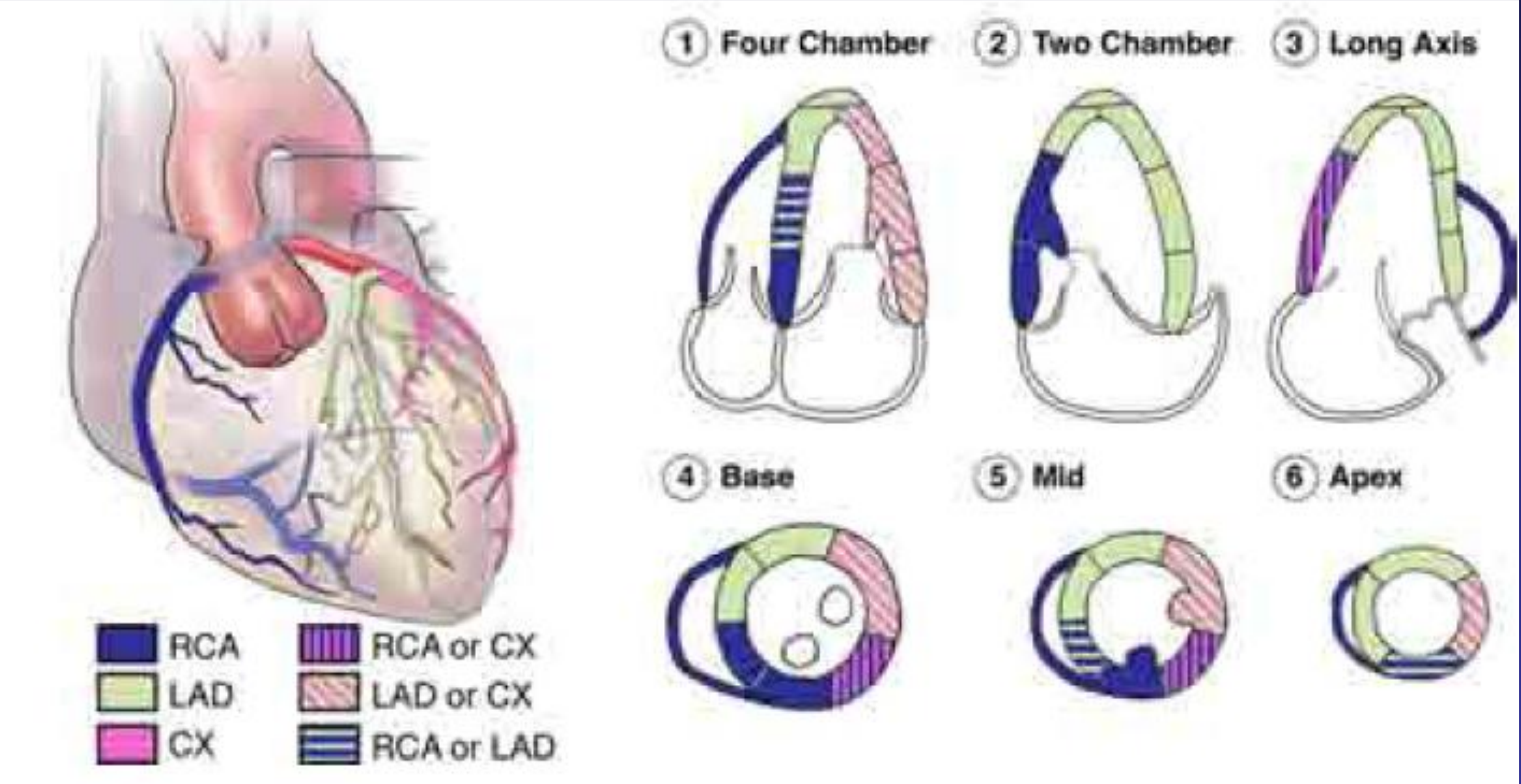
VOLUMI VENTRICOLARI

VARIABILTA' INTRAOSSERVATORE 4 a 6 %

VARIABILITA' INTEROSSERVATORE 8.5% VTD 16,5% VTS

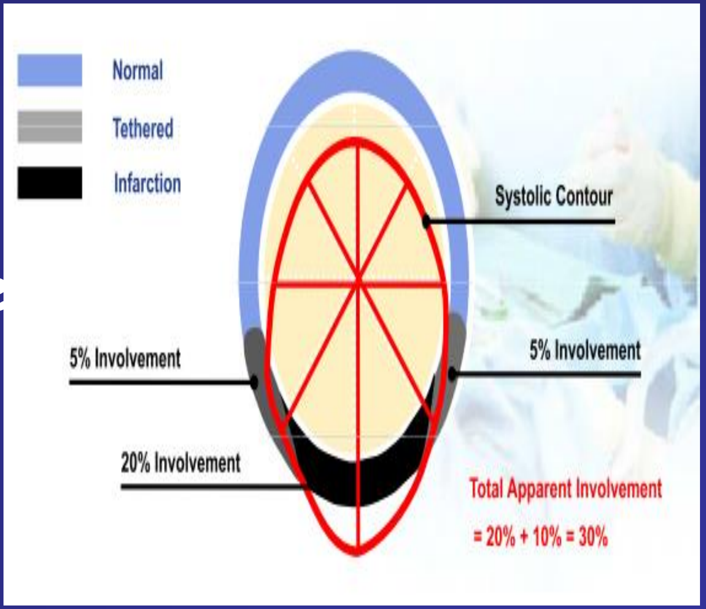
Una VARIAZIONE 15% per VTS
25%per VTD
è necessaria per considerare la variazione di rilevanza clinica
10 PUNT Iper FE

Funzione Regionale



Limiti nella Valutazione della RWMA

- Thetering o Dissinergie preesistenti → Se ipercinesia compensatoria nei territori normocontrattili e normale ecoriflettenza e spessore: evento acuto
- Ima non transmurali → Dissinergia assente
- Subottimale qualità delle immagini
- Cardiomiopatie anche in fase iniziale
- Rotazione e traslazione cardiaca
- Condizioni di precarico e postcarico



Eco: Operatore Dipendente!!

Cinesi Segmentaria del Ventricolo Sinistro

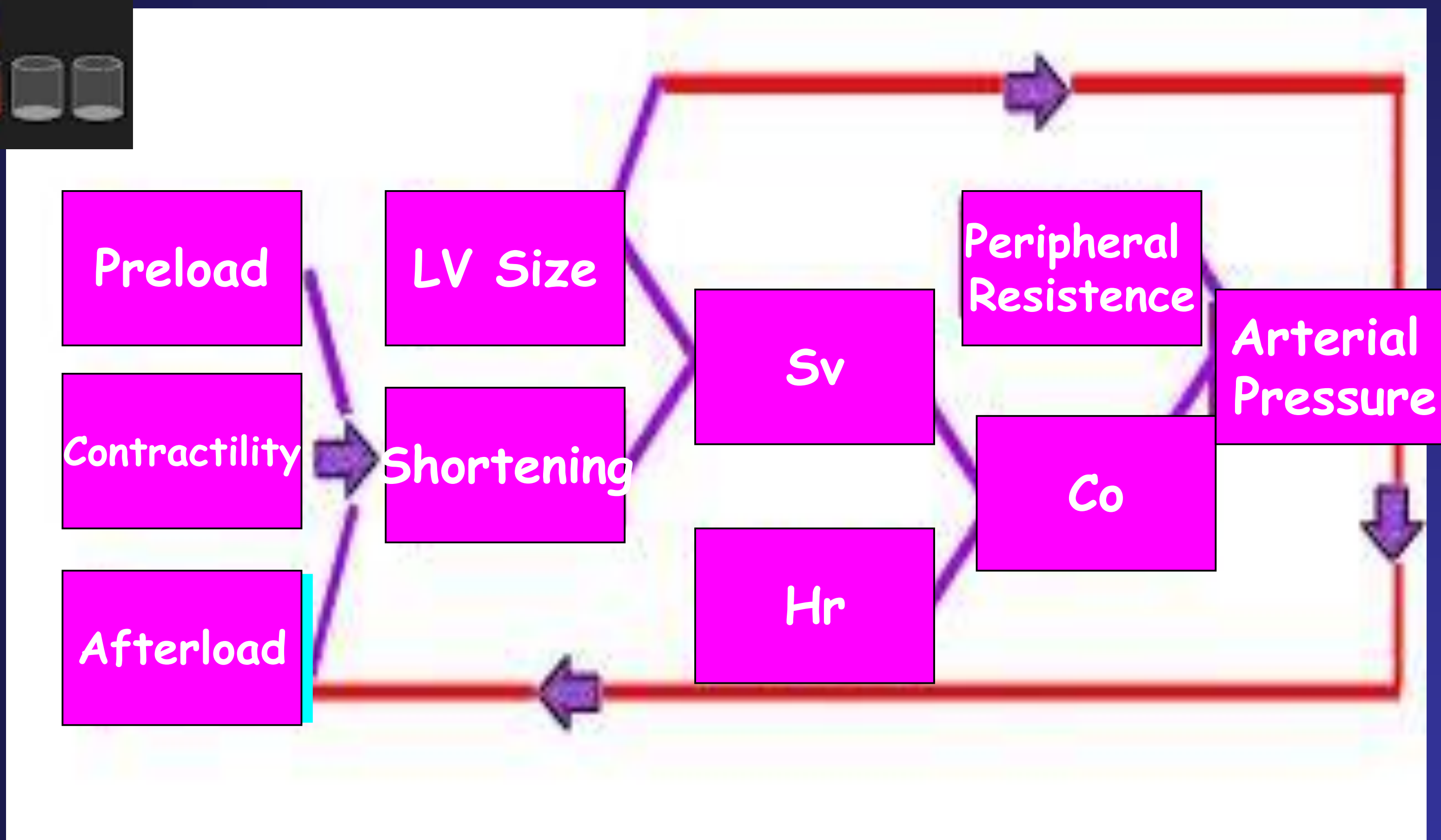
	Setto I-V		Pareti			
	Ant.	Post.	Inf.	P.lat.	Lat.	Ant.
Livello basale	1	1	1	1	1	1
Livello intermedio	1	1	1	1	1	1
Livello apicale	3		3		3	3

1 Normocinesia
2 Ipocinesia
3 Acinesia
4 Discinesia
5 Aneurisma
0 Non valutabile

Wall motion score index 1,5

Estensione % della acinesia 25

Determinants Of Cardiac Output

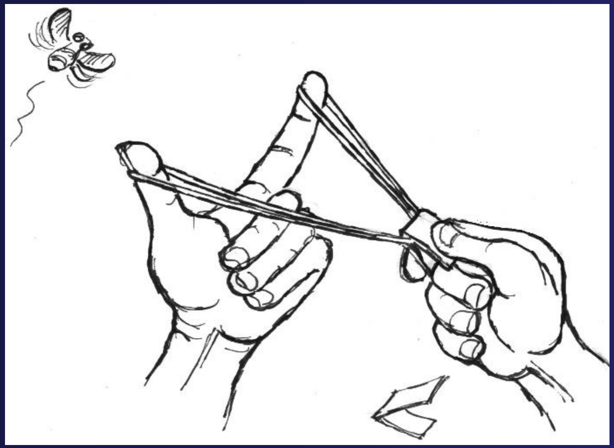


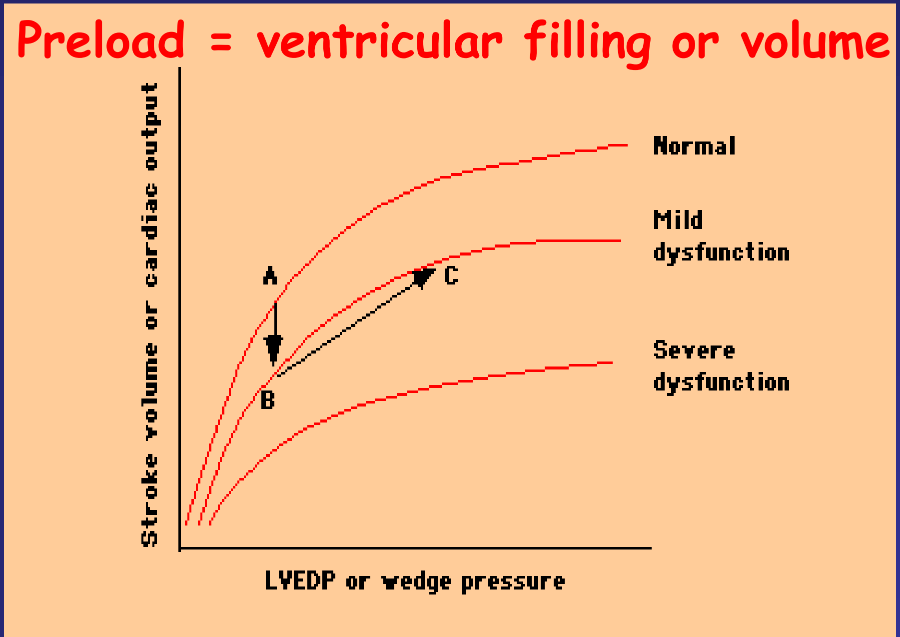
Determinants of Cardiac Output: PRELOAD

Amount of stretch of the ventricular myocardium prior to contraction

1. **Central venous pressure (CVP) = right atrial pressure.**

2. **Pulmonary capillary diastolic wedge pressure (PCWP) = LVEDP**





Determinants of Cardiac Output

AFTERLOAD

The load that a ventricle must overcome while it contracts during ejection

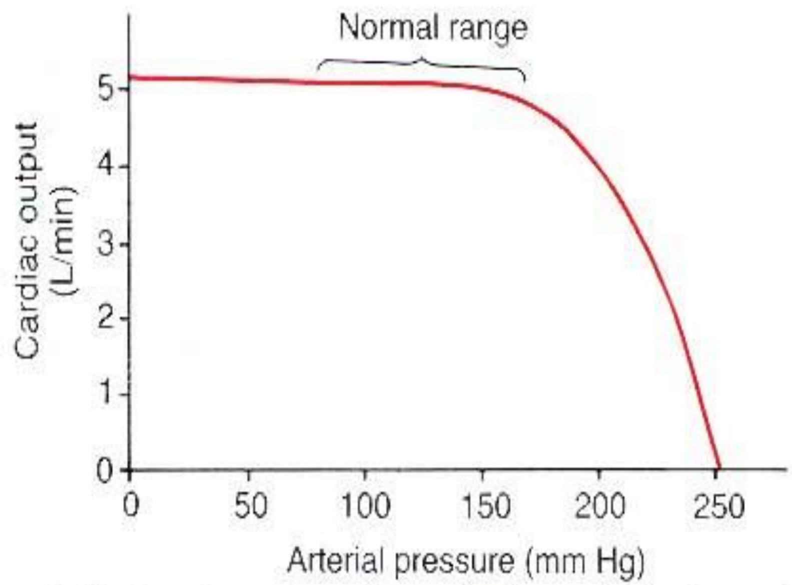
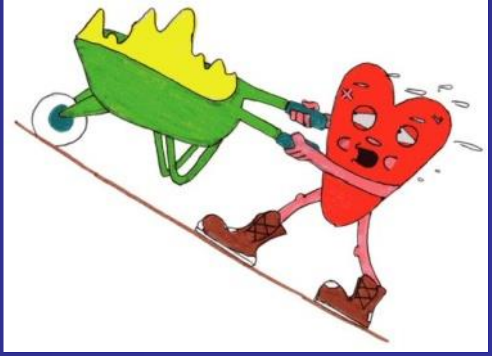


Figure 9–8. Constancy of cardiac output even in the face of wide changes in arterial pressure. Only when the arterial pressure rises above the normal operating pressure range does the pressure load cause the heart to begin to fail.



Ef in decision making

EF cutoff-values for therapeutic decision making in cardiology

- Surgery in mitral regurgitation → EF <60%
- Surgery in aortic regurgitation → EF <50%
- Medical Tx for heart failure → EF <40%
- Implantation of ICD → EF <35%
- Implantation of CRT → EF <35%

Prof. Dr. H. P. Kühl

www.escardio.org/EAE

EUROPEAN ASSOCIATION OF Echocardiography

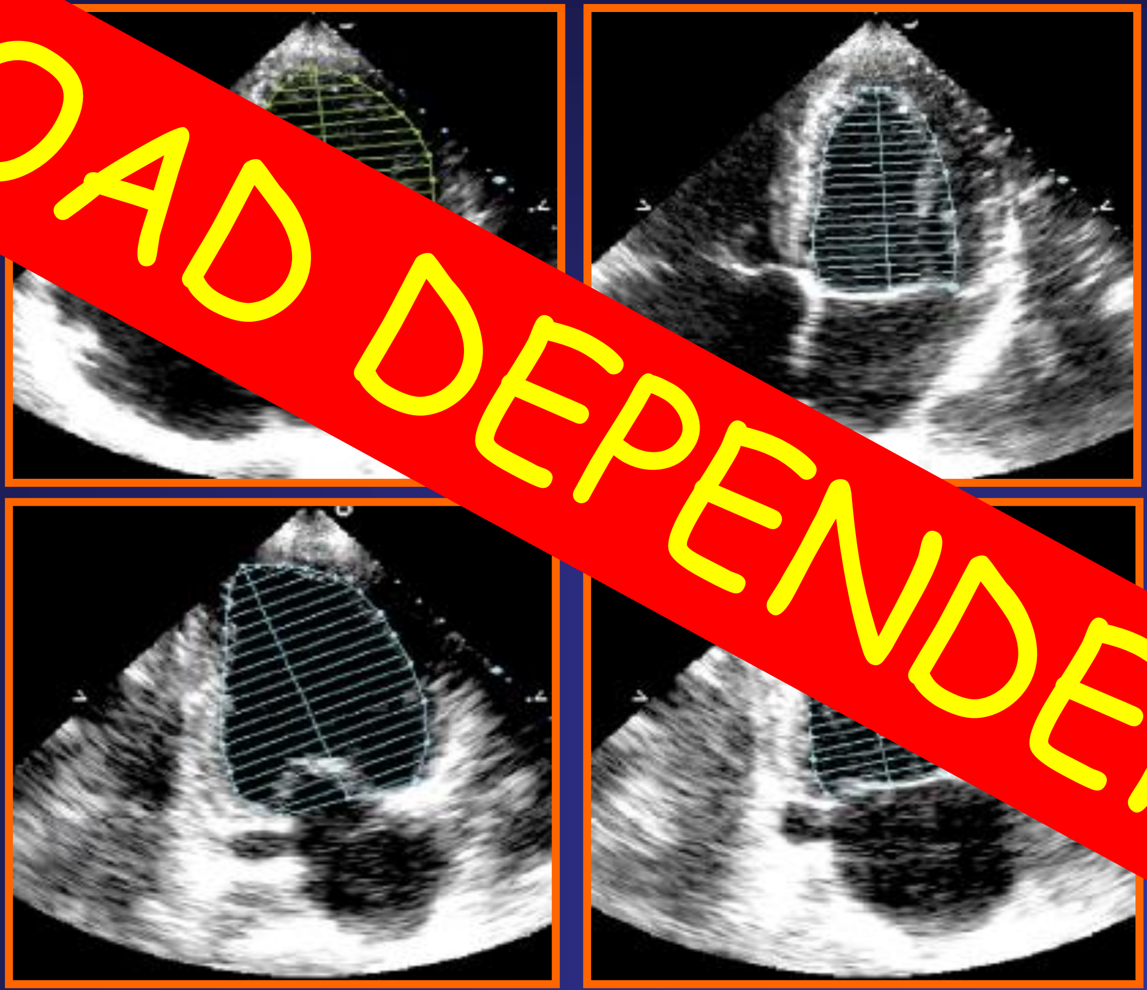
EUROPEAN SOCIETY OF CARDIOLOGY®

2D LV Ejection Fraction

LOAD DEPENDENT

4-ch

2-Ch

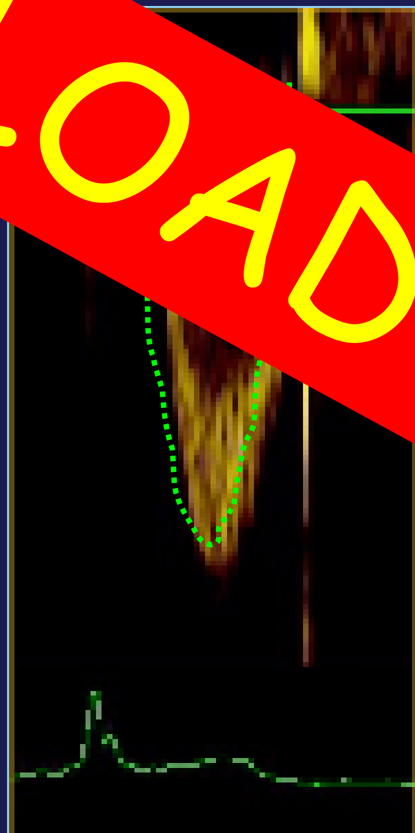


END-DIASTOLE

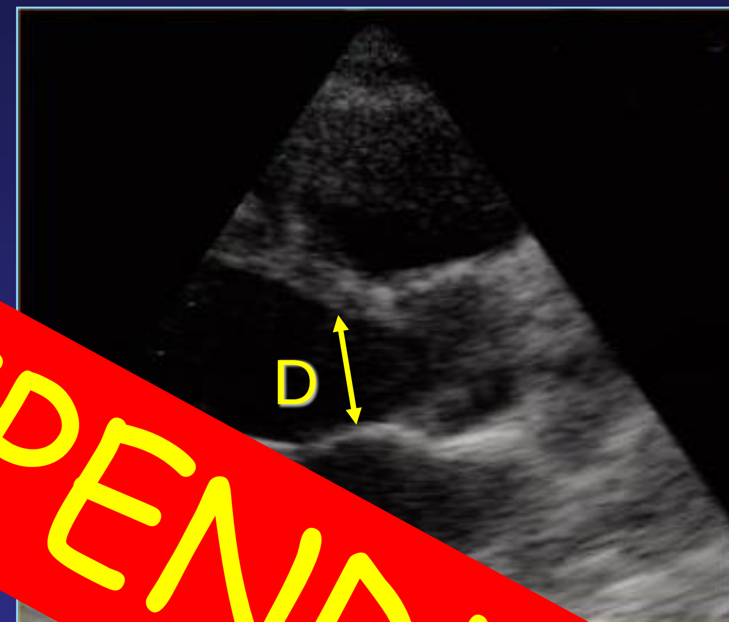
END-SYSTOLE

Doppler LV Stroke Volume

LOAD DEPENDENT

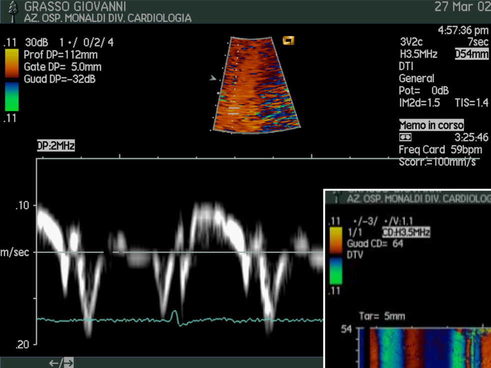


TVI



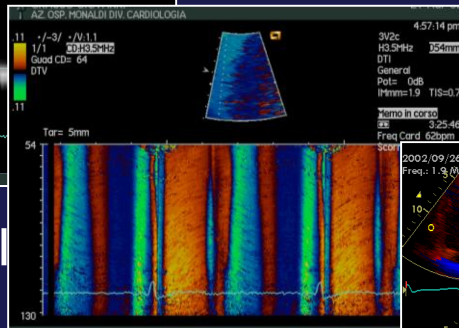
$SV\,(ml) = D^2 \times 0.7$...

Myocardial Function

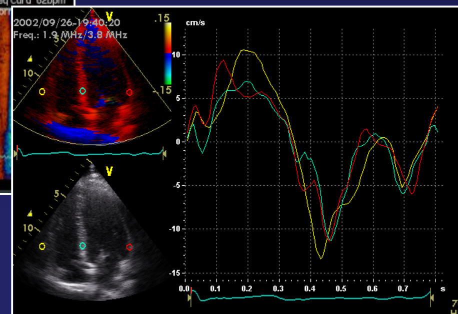


PW-DMI

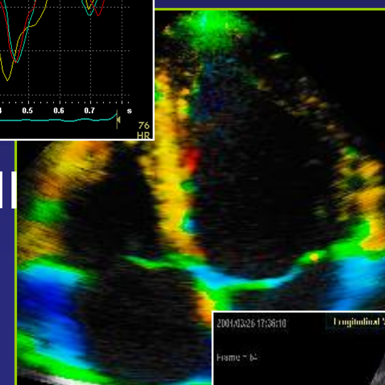
1989



Color M-Mode



2D-Color DMI

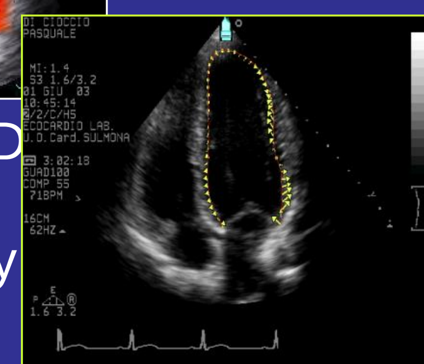


2003

Strain/S-Rate

Strain-2D

2005



Vector Velocity Imaging

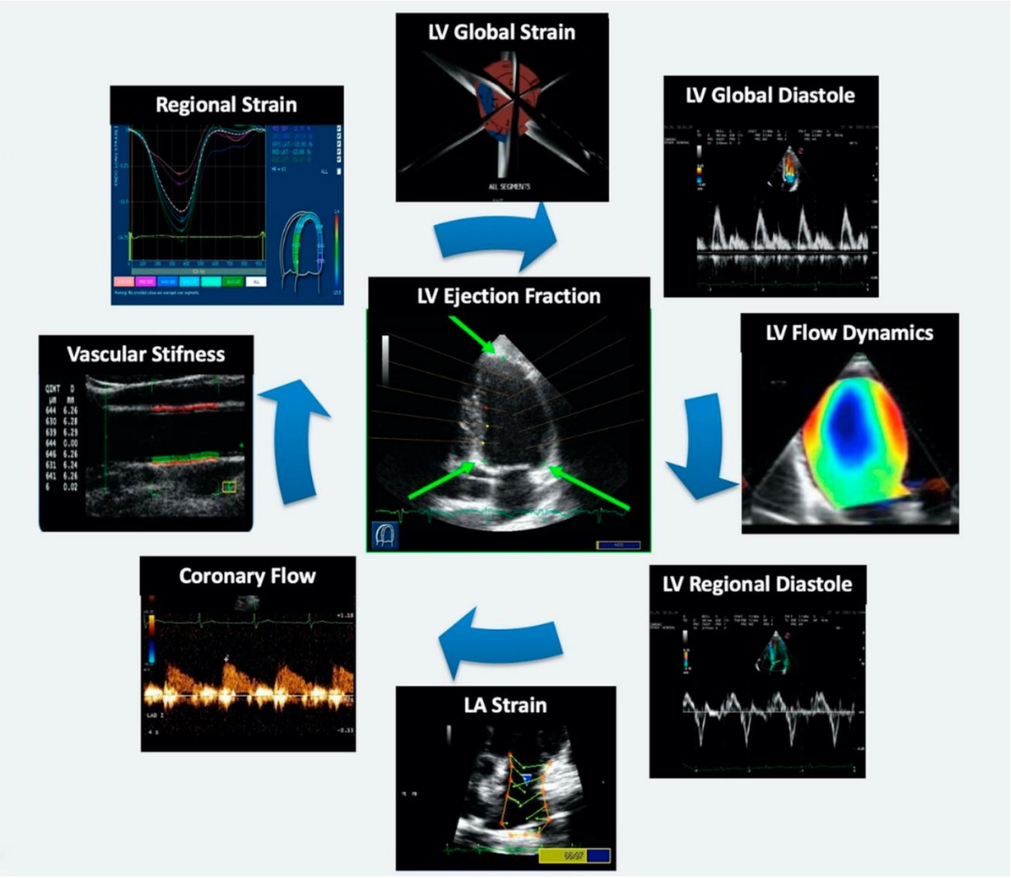
Journal of *Clinical Medicine*

MDPI

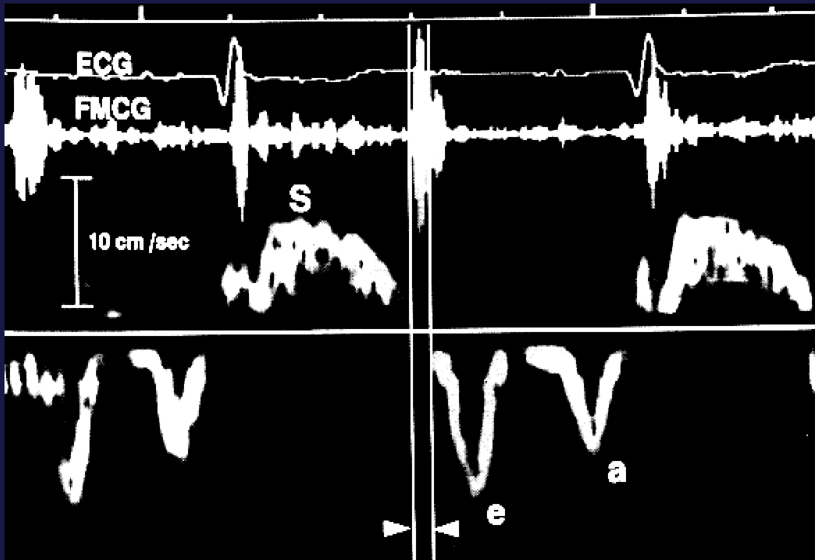
Review

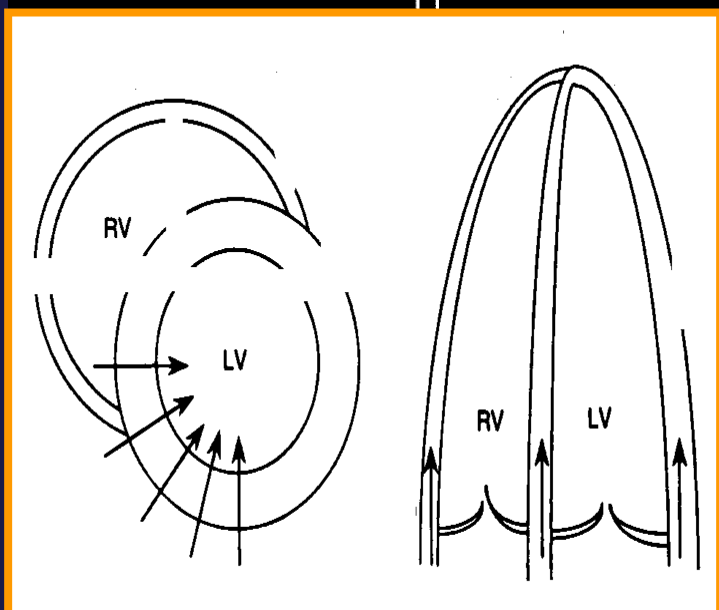
New Ultrasound Technologies for Ischemic Heart Disease Assessment and Monitoring in Cardiac Rehabilitation

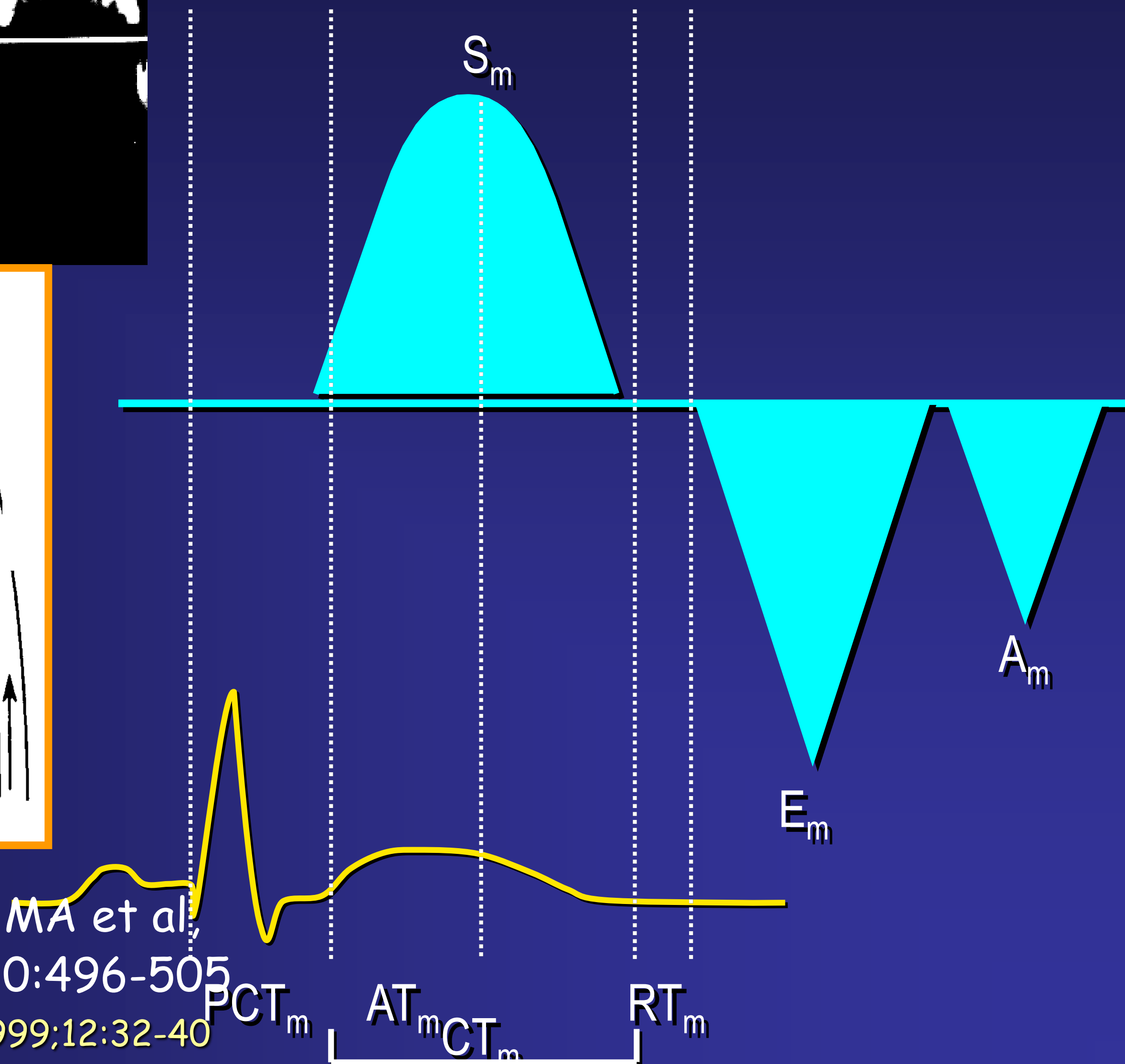
Antonello D'Andrea [1,2,*], Simona Sperlongano [1], Mario Pacileo [2], Elio Venturini [3], Gabriella Iannuzzo [4], Marco Gentile [4], Rossella Sperlongano [5], Giuseppe Vitale [6], Marco Maglione [7], Gennaro Cice [8], Filippo Maria Sarullo [6], Anna Di Lorenzo [9], Carlo Vigorito [9], Francesco Giallauria [9] and Eugenio Picano [10]



PW DMI QUANTIFICATION







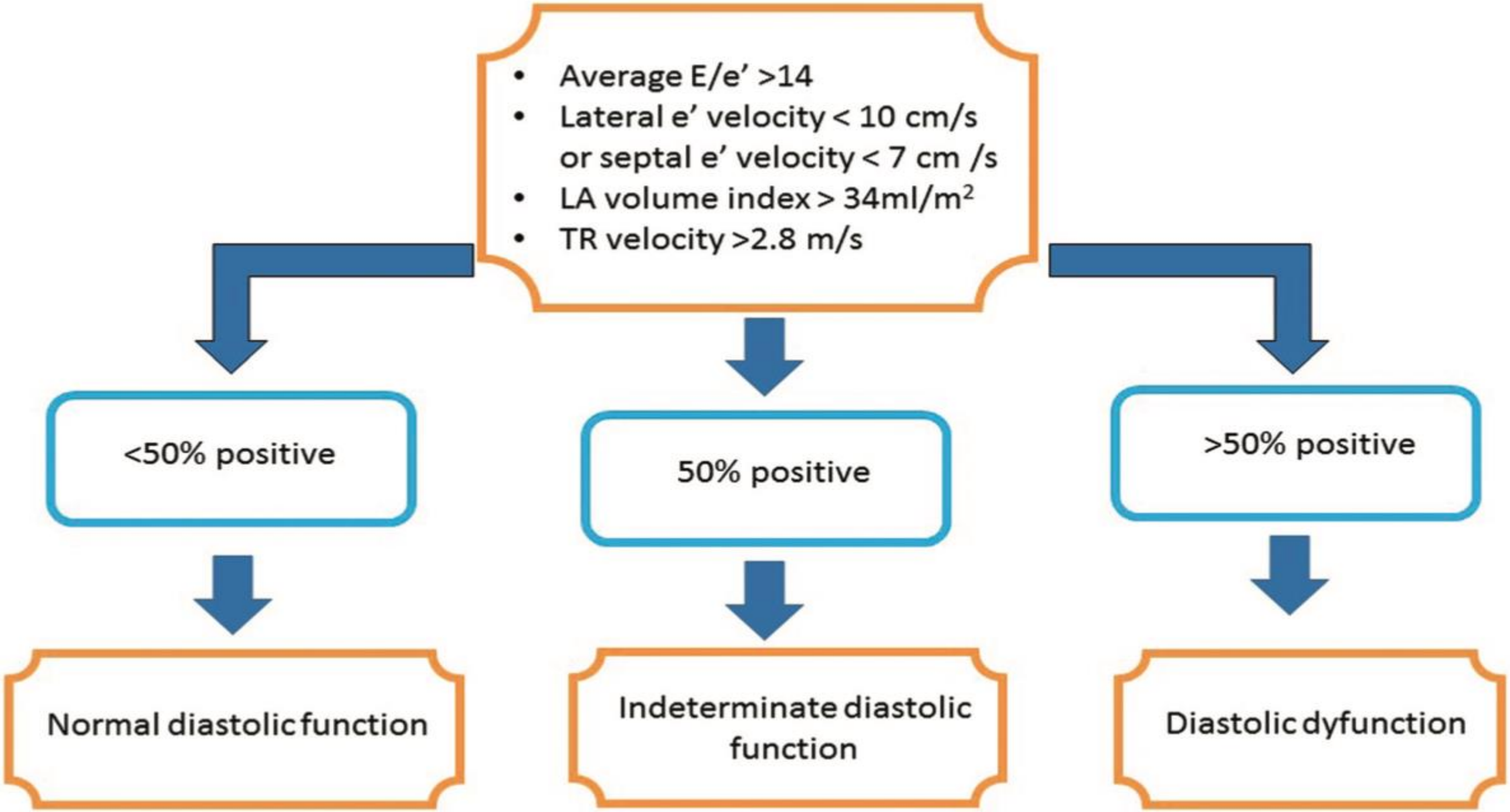
Garcia-Fernandez MA et al,
Eur Heart J 1999;20:496-505

Tuchnitz J. J Am Soc Echo 1999;12:32-40

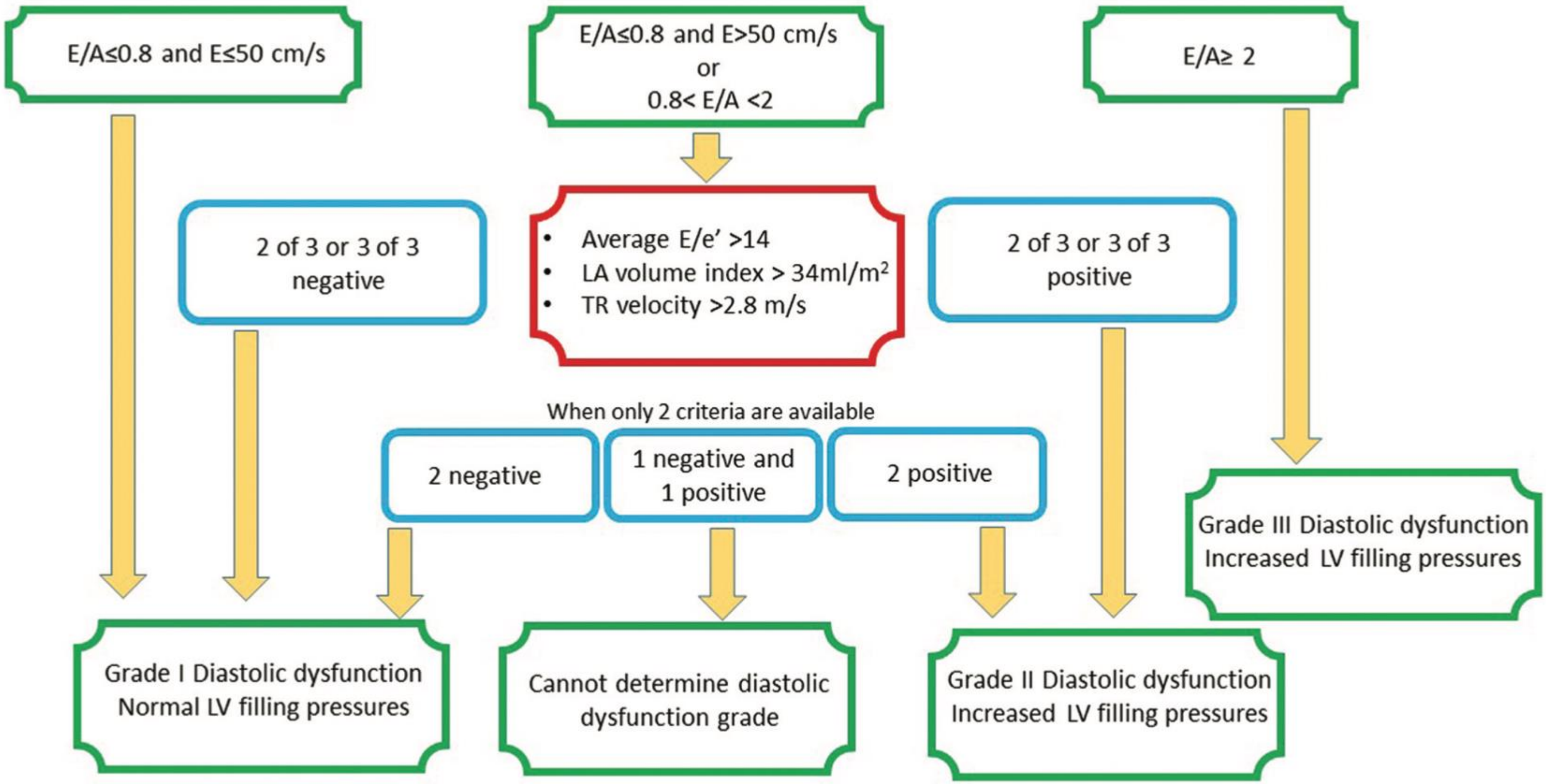
Identification of cardiac organ damage in arterial hypertension: insights by echocardiography for a comprehensive assessment

Matteo Cameli[a,*], Maria Lembo[b,*], Carlotta Sciaccaluga[a], Francesco Bandera[c], Marco M. Ciccone[d], Antonello D'Andrea[e], Flavio D'Ascenzi[a], Roberta Esposito[b], Vincenzo Evola[f], Riccardo Liga[g], Giulia E. Mandoli[a], Pasquale Palmiero[h], Ciro Santoro[b], Pietro Scicchitano[d], Regina Sorrentino[b], Annapaola Zito[d], Roberto Pedrinelli[g], Sergio Mondillo[a], Anna V. Mattioli[i], Maurizio Galderisi[b], on behalf of Working Groups of Echocardiography and Arterial Hypertension of Italian Society of Cardiology (SIC)

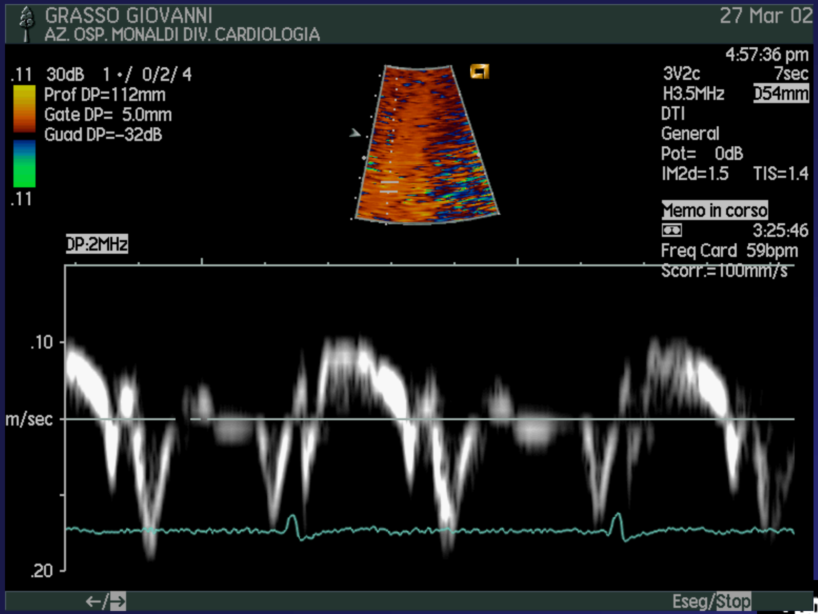
Diastolic function algorithm for hypertensive patients with normal LVEF (> 50%) and without myocardial disease (e.g., presence of LVH, ischaemic or significant valvular heart disease)



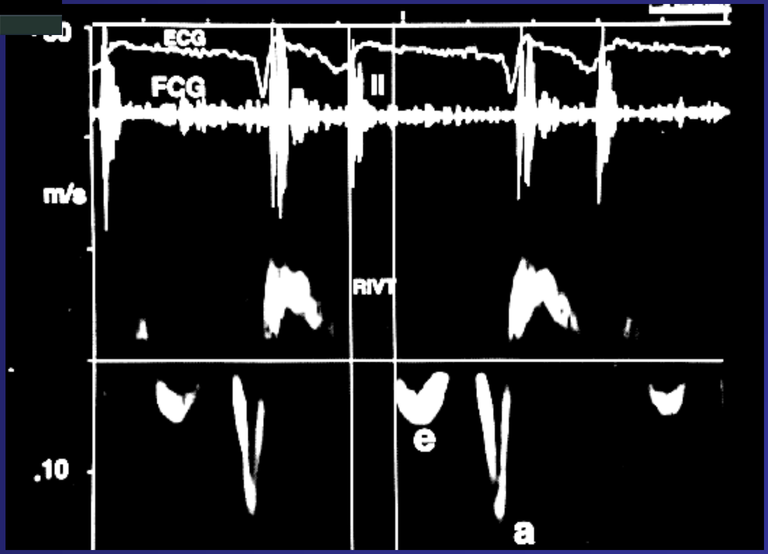
Diastolic dyfunction algorithm for hypertensive patients with abnormal LVEF (< 50%) or normal LVEF and concomitant myocardial disease (e.g., presence of LVH, ischaemic or significant valvular heart disease)



PW-DMI Dysfunctional Pattern



Normal



Dysfunctional

E velocity reduction

Hypertension

Ischaemia

HCM

Age

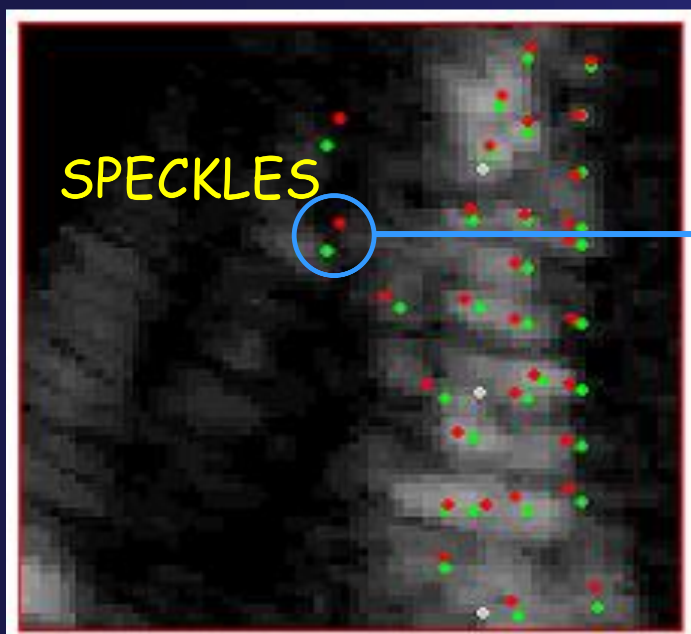
Transplant rejection

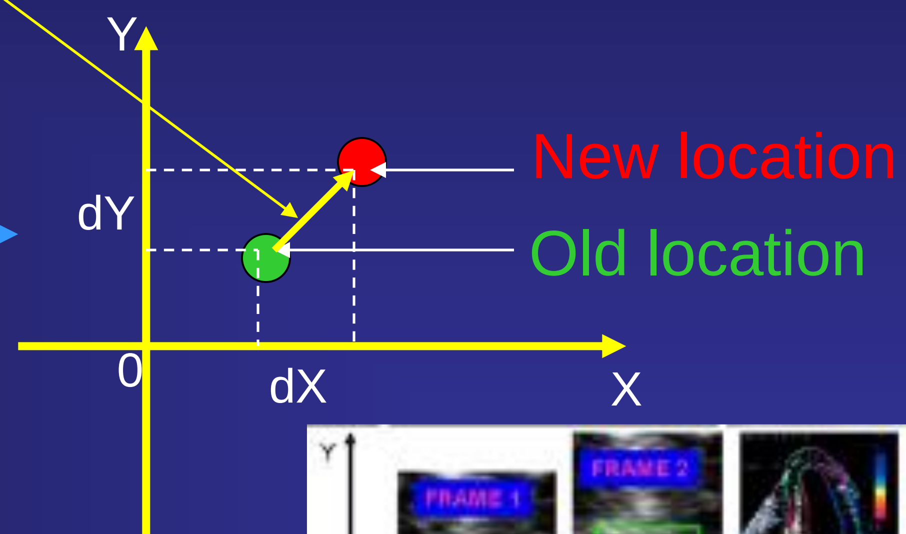
Garcia-Fernandez MA et al. Eur Heart J

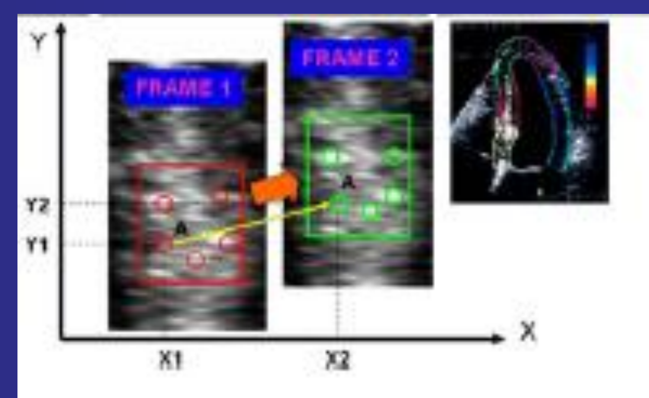
Gray Scale Velocity Estimation

Velocity is estimated as a shift of each object divided by time between successive frames (or multiplied by Frame Rate)-->

2D velocity vector: (Vx, Vy) = (dX, dY) * FR







REVIEW ARTICLE

Non-Doppler Two-dimensional Strain Imaging by Echocardiography–From Technical Considerations to Clinical Applications

Gila Perk, MD, Paul A. Tunick, MD, FACC, and Itzhak Kronzon, MD, FACC,
New York, New York

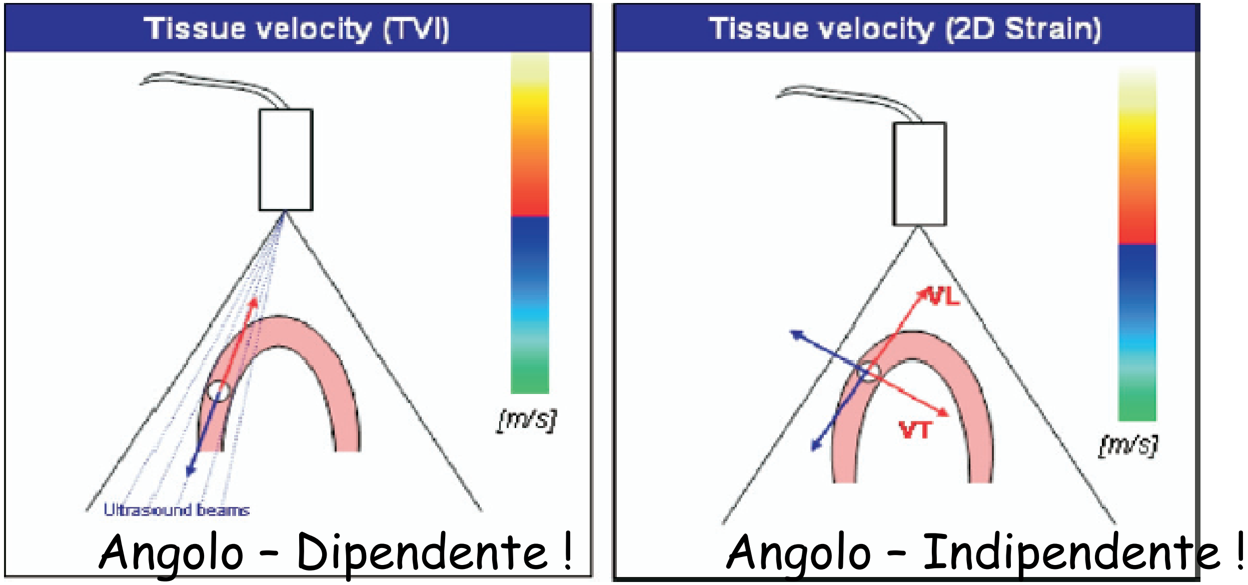
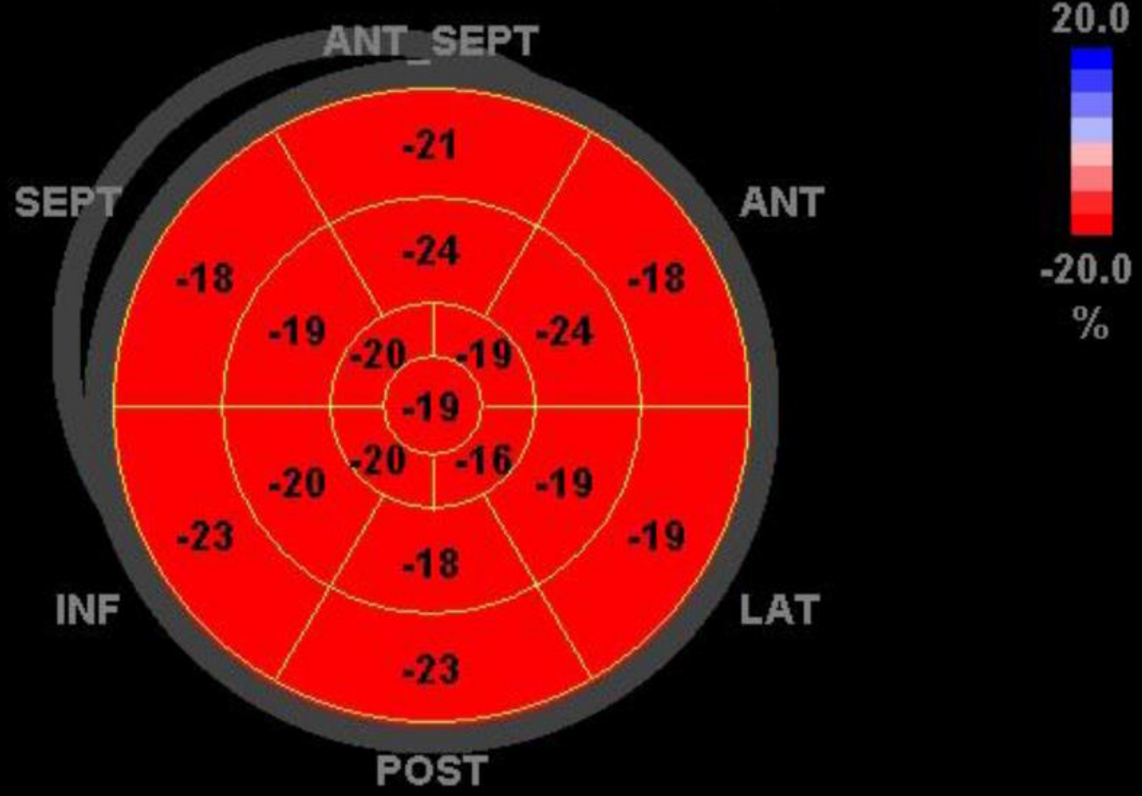


Figure 3 Angle independency of non-Doppler 2-dimensional (2D) strain imaging. Tissue Doppler measures longitudinal velocity (*VL*) components toward or away from transducer. Non-Doppler 2D strain measures vector velocities in plane of imaging relative to direction of muscle contraction. *VT*, Transverse velocity.

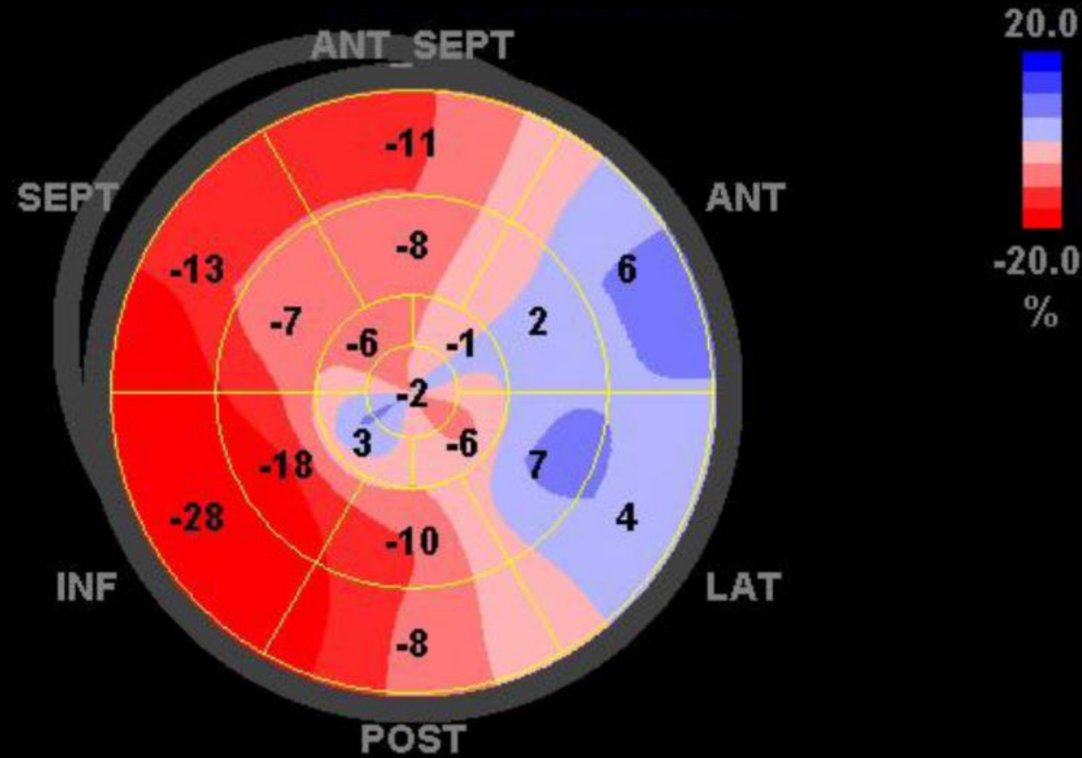
Global Strain in a Normal Heart



Global strain = average of all segmental strain values

Global strain= -20 %

Global Strain - LAD Infarct



Global strain = average of all segmental strain values

Global strain = -9 %

EACVI PAGES

European Heart Journal – Cardiovascular Imaging (2013) **14**, 1039–1040
doi:10.1093/ehjci/jet184

EACVI-ASE-industry initiative to standardize deformation imaging: a brief update from the co-chairs

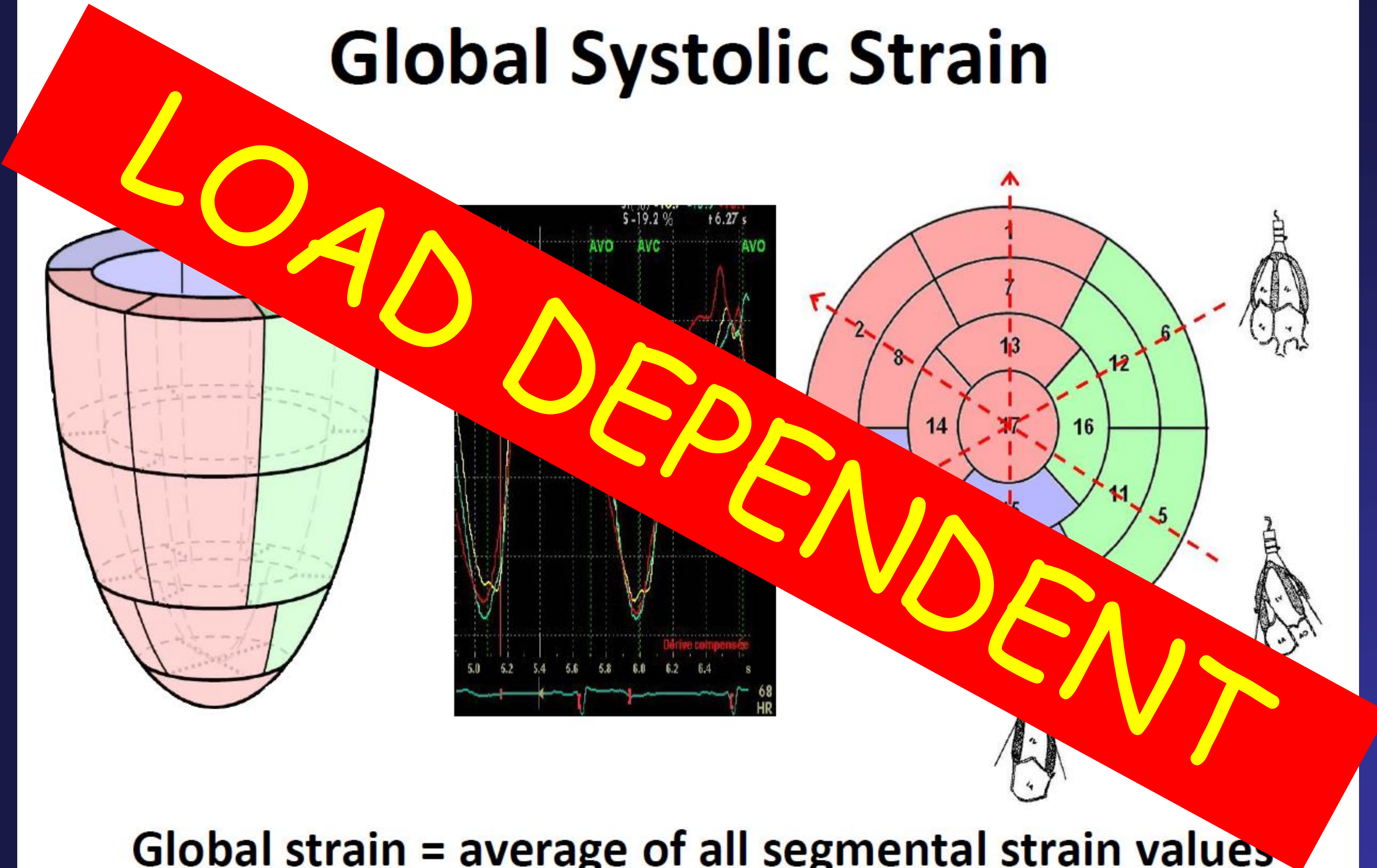
James D. Thomas and Luigi P. Badano*

Echocardiographic quantitation of myocardial deformation has been one of the most significant developments in our field over the last decade, with important applications in basic myocardial mechanics, ischaemic heart disease, cardiomyopathies, valvular heart disease, diastolic function, and in detecting pre-clinical myocardial dysfunction such as in cardiotoxicity in cancer chemotherapy and valvular regurgitation. Unfortunately, several investigators have documented a relatively poor reproducibility when strain is calculated using echo-

Table 1 EACVI-ASE-industry initiative to standardize deformation imaging

Founding societies
European Association of Cardiovascular Imaging—Luigi P. Badano, MD, co-chair
American Society of Echocardiography—James D. Thomas, MD, co-chair
Supporting societies
Japanese Society of Echocardiography
Korean Society of Echocardiography

Global Systolic Strain



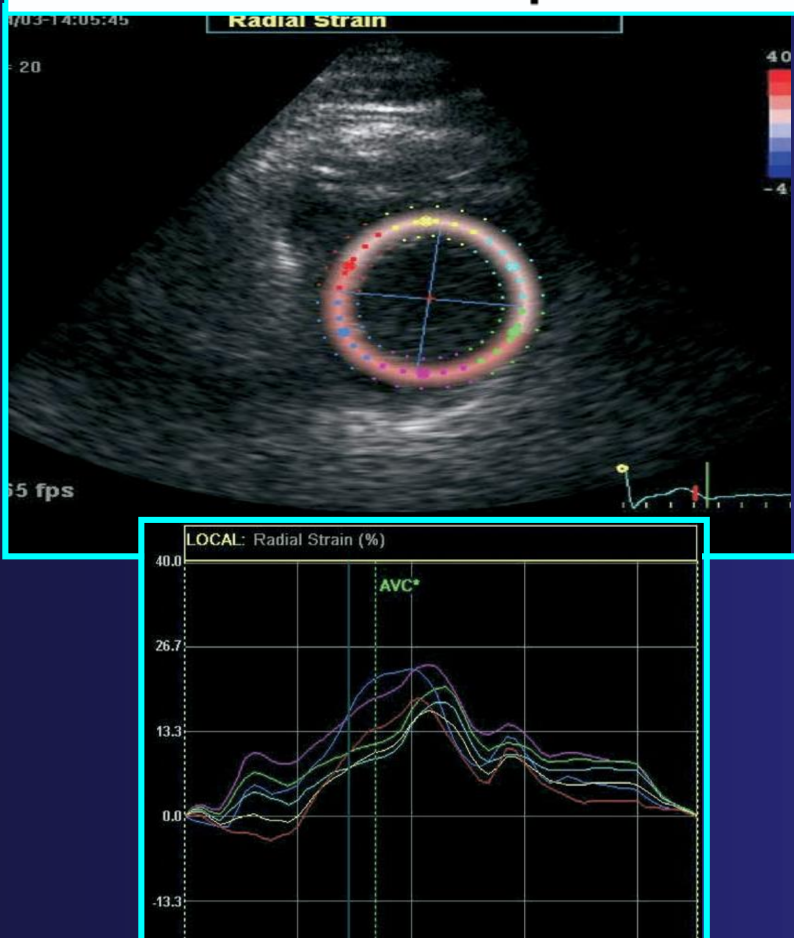
Global strain = average of all segmental strain values

Modified from Ola Gjesdal

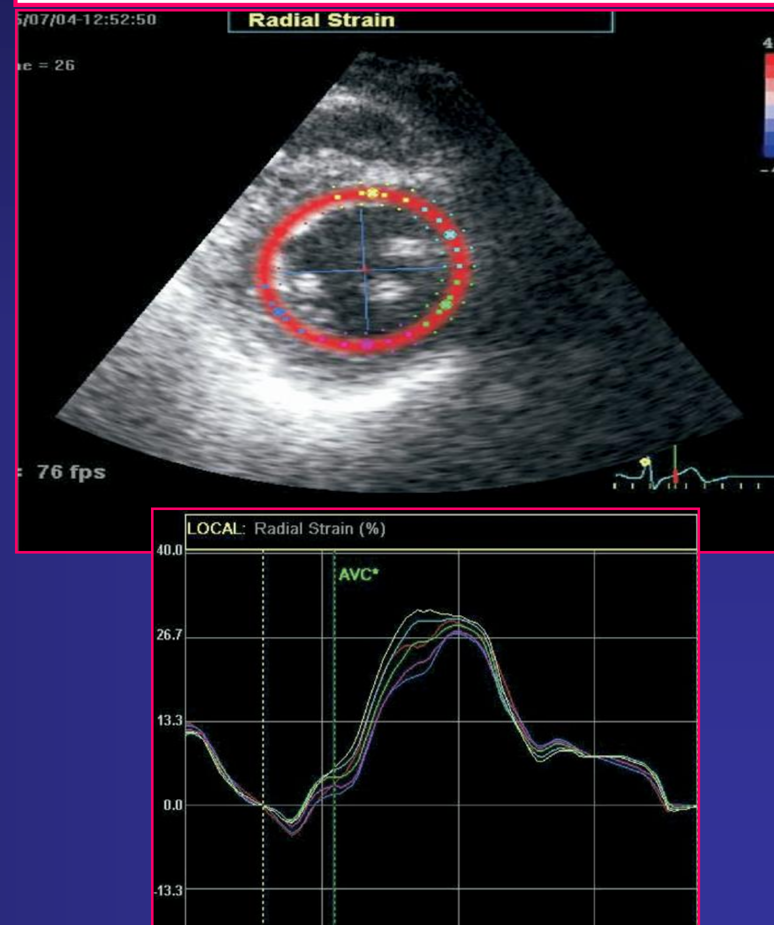
Impact of Left Ventricular Loading Conditions on Myocardial Deformation Parameters: Analysis of Early and Late Changes of Myocardial Deformation Parameters after Aortic Valve Replacement

Michael Becker, MD, Rafael Kramann, Guido Dohmen, MD, Andreas Lückhoff, MD, Rüdiger Autschbach, MD, Malte Kelm, MD, and Rainer Hoffmann, MD, FESC, *Aachen, Germany*

Before aortic valve replacement

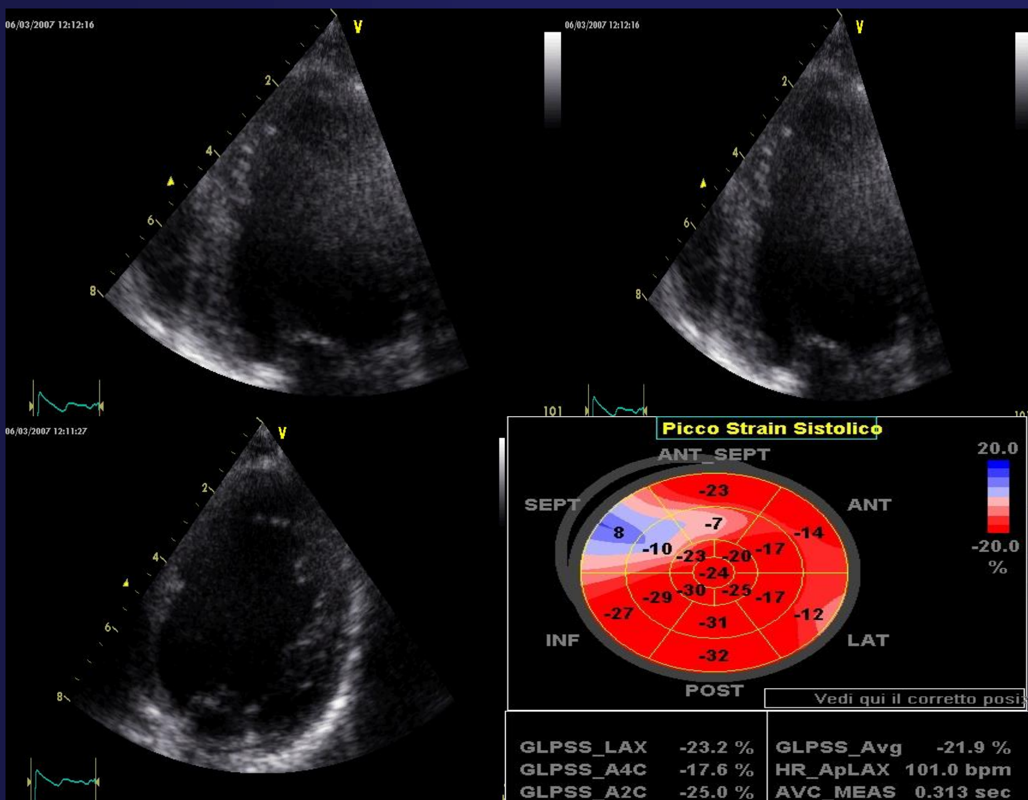


After aortic valve replacement

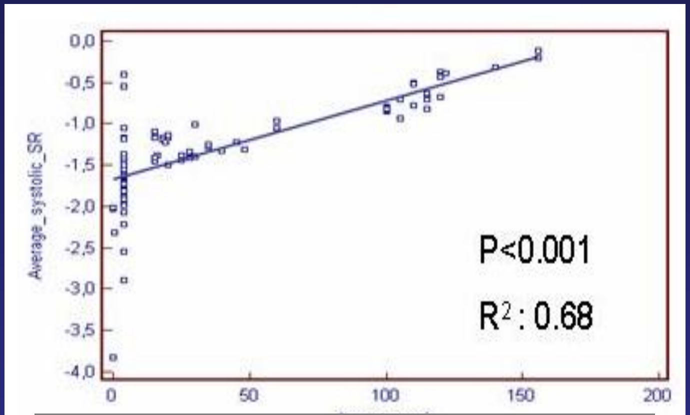


(JASE 2007;20:681-689.)

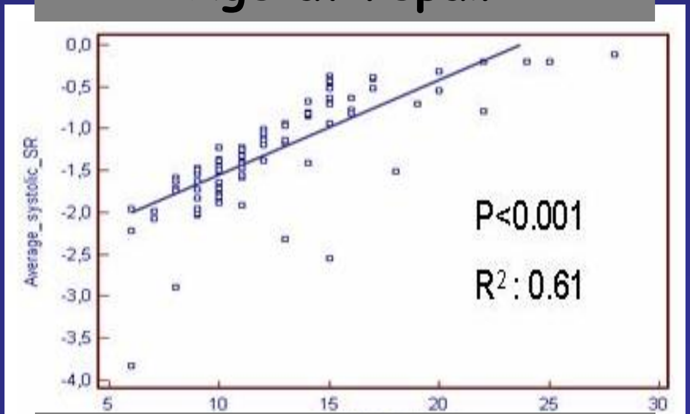
After “Successful” Correction



G. Di Salvo – A. D’Andrea - *Clinical Science 2007*



Age at repair



Aortic Stiffness

Received: 15 November 2020 | Revised: 15 March 2021 | Accepted: 6 April 2021
DOI: 10.1111/echo.15059

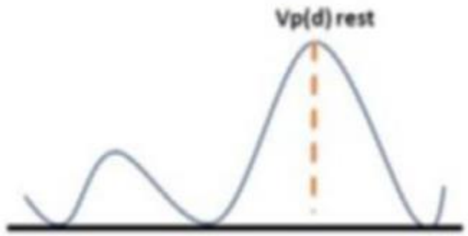
Echocardiography WILEY

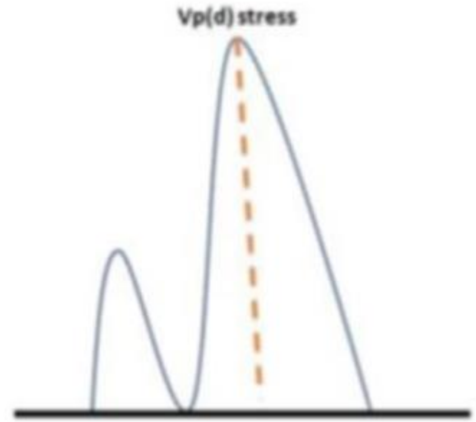
REVIEW

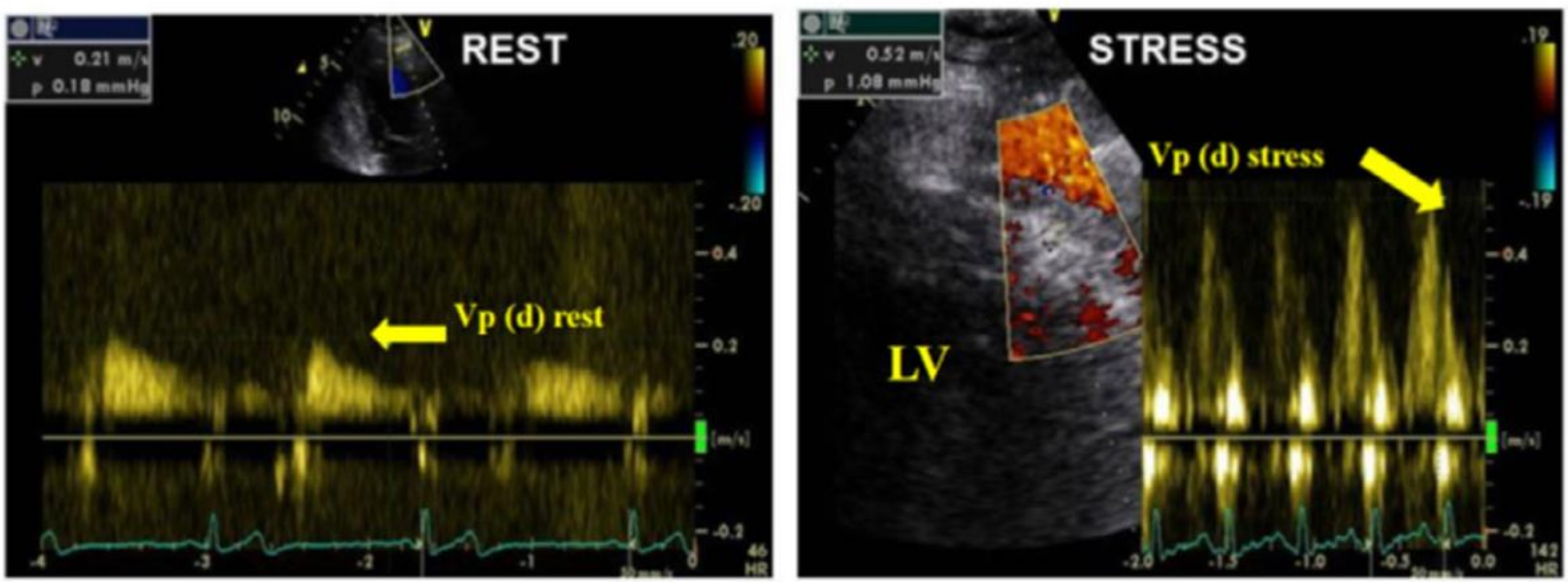
Echocardiographic assessment of coronary microvascular dysfunction: Basic concepts, technical aspects, and clinical settings

Andreina Carbone MD[1] | Antonello D'Andrea MD, PhD[2] | Simona Sperlongano MD[2] | Ercole Tagliamonte MD[2] | Giulia Elena Mandoli MD[3] | Ciro Santoro MD[4] | Vincenzo Evola MD[5] | Francesco Bandera MD[6,7] | Doralisa Morrone MD[8] | Alessandro Malagoli MD[9] | Flavio D'Ascenzi MD, PhD[3] | Eduardo Bossone MD[10] | Matteo Cameli MD, PhD[3] | Echocardiography study group of the Italian Society of Cardiology

$$CFVR = \frac{Vp(d)\ stress}{Vp(d)\ rest}$$

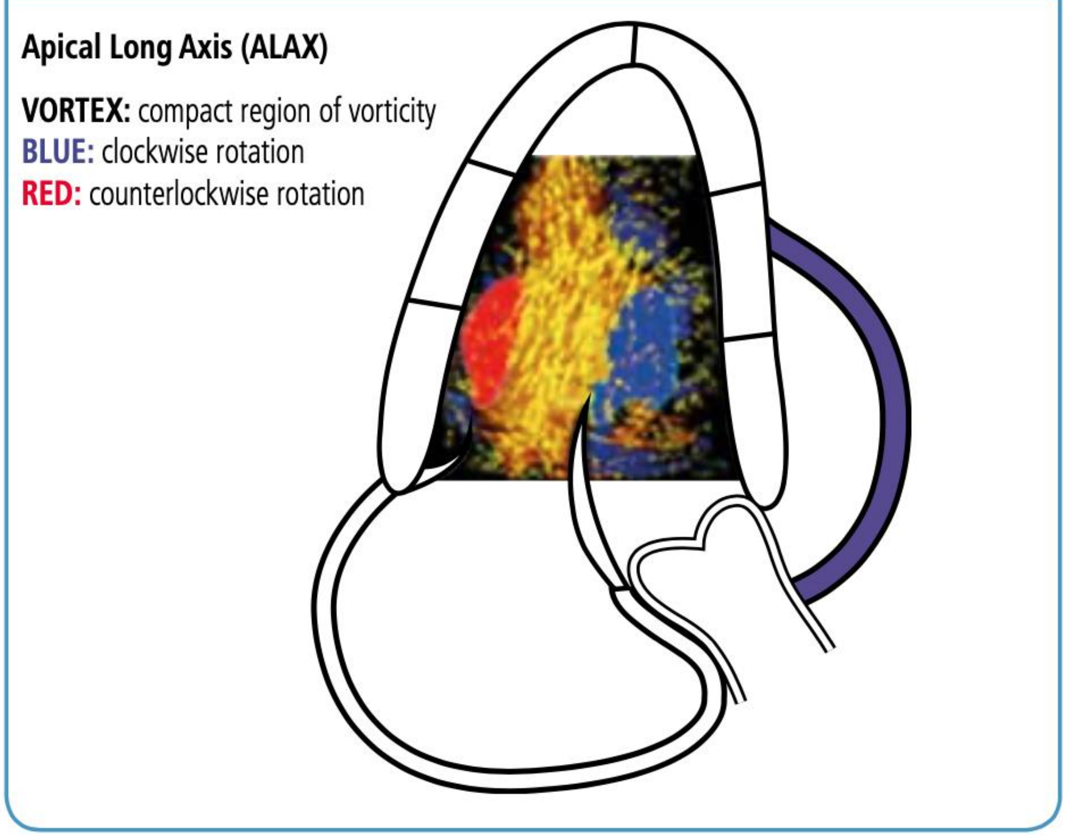






HYPERDOPPLER FLOW VELOCITIES

Figure 1 - Vortex formation at mitral in-flow. ALAX (A3CH) view illustrating the asymmetric vortex detaching from the distal tips of the mitral valve



Normally the main anterior vortex rotates clockwise, and the secondary posterior vortex rotates counterclockwise (Figure 2). During the cardiac cycle, the vortex flow changes. As vortices propagate towards the LV apex, their rings deform. This deformation is due both to the inhomogeneous pressure gradient within the LV and to the interaction with LV walls.

Figure 2 - HyperDoppler Flow Velocity Vector mapping, highlighting the different rotational behavior between the anterior and posterior vortex - Modified from Mele et al., JASE. 2019 Mar;32(3):319-332

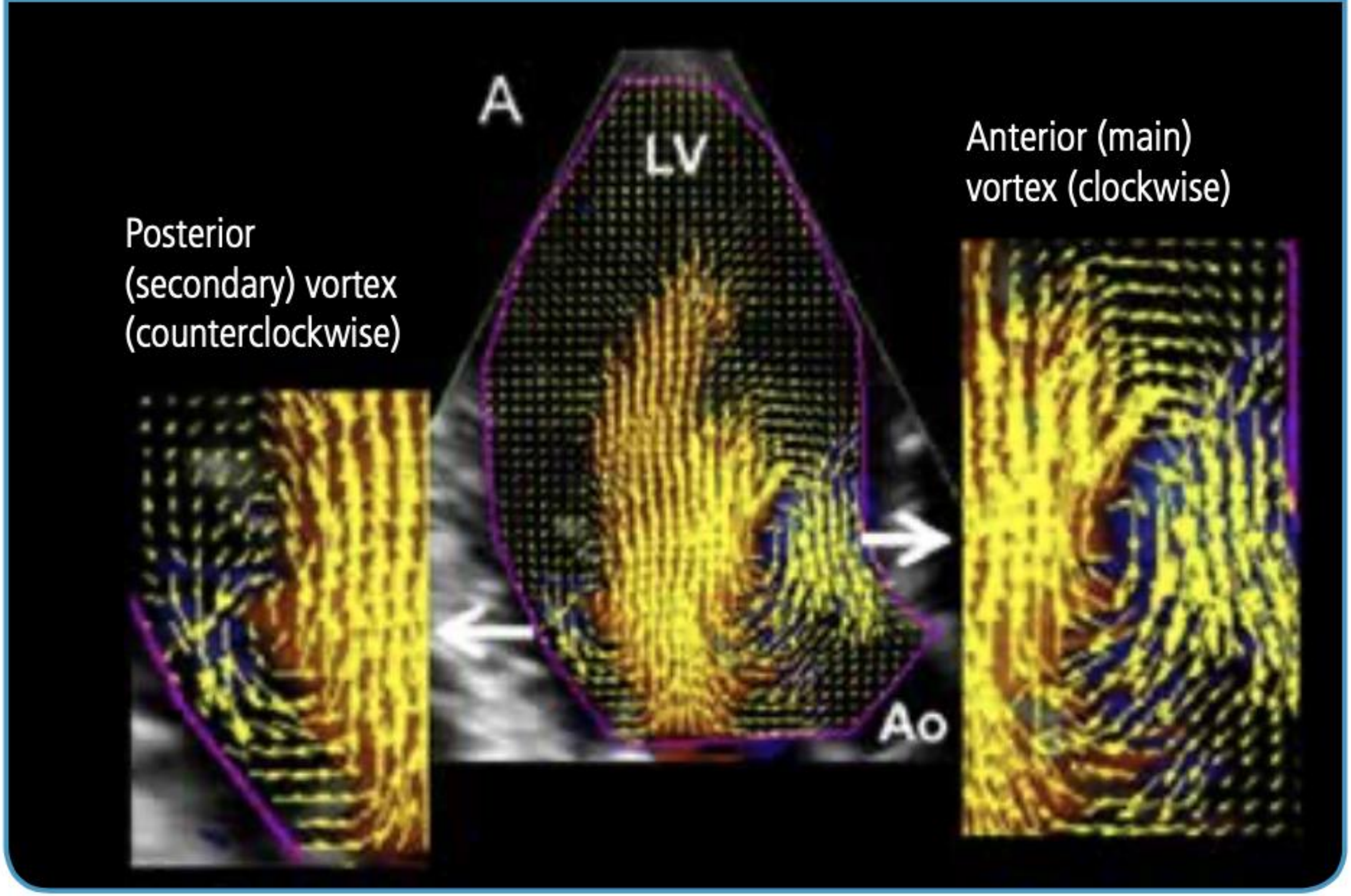
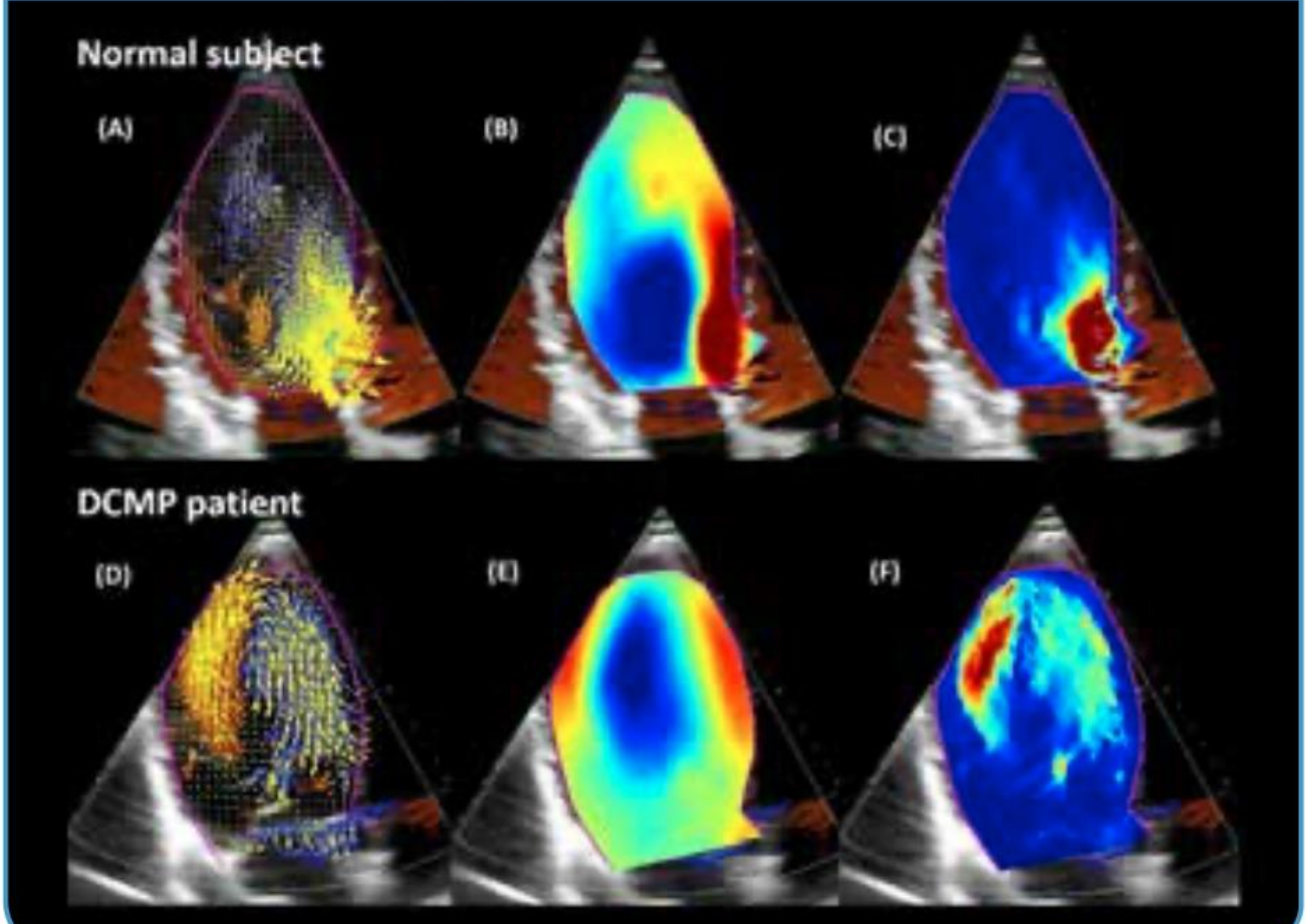
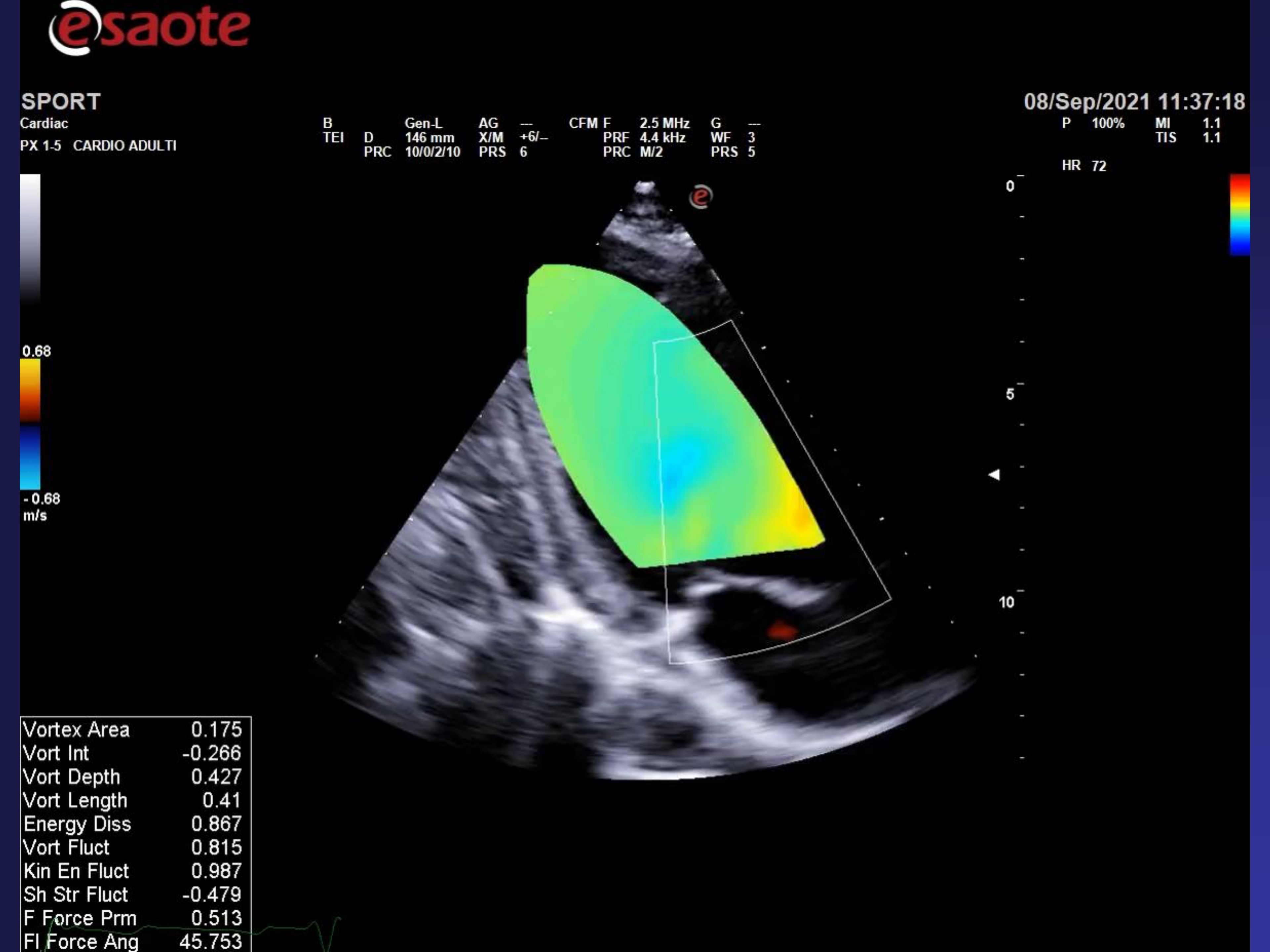
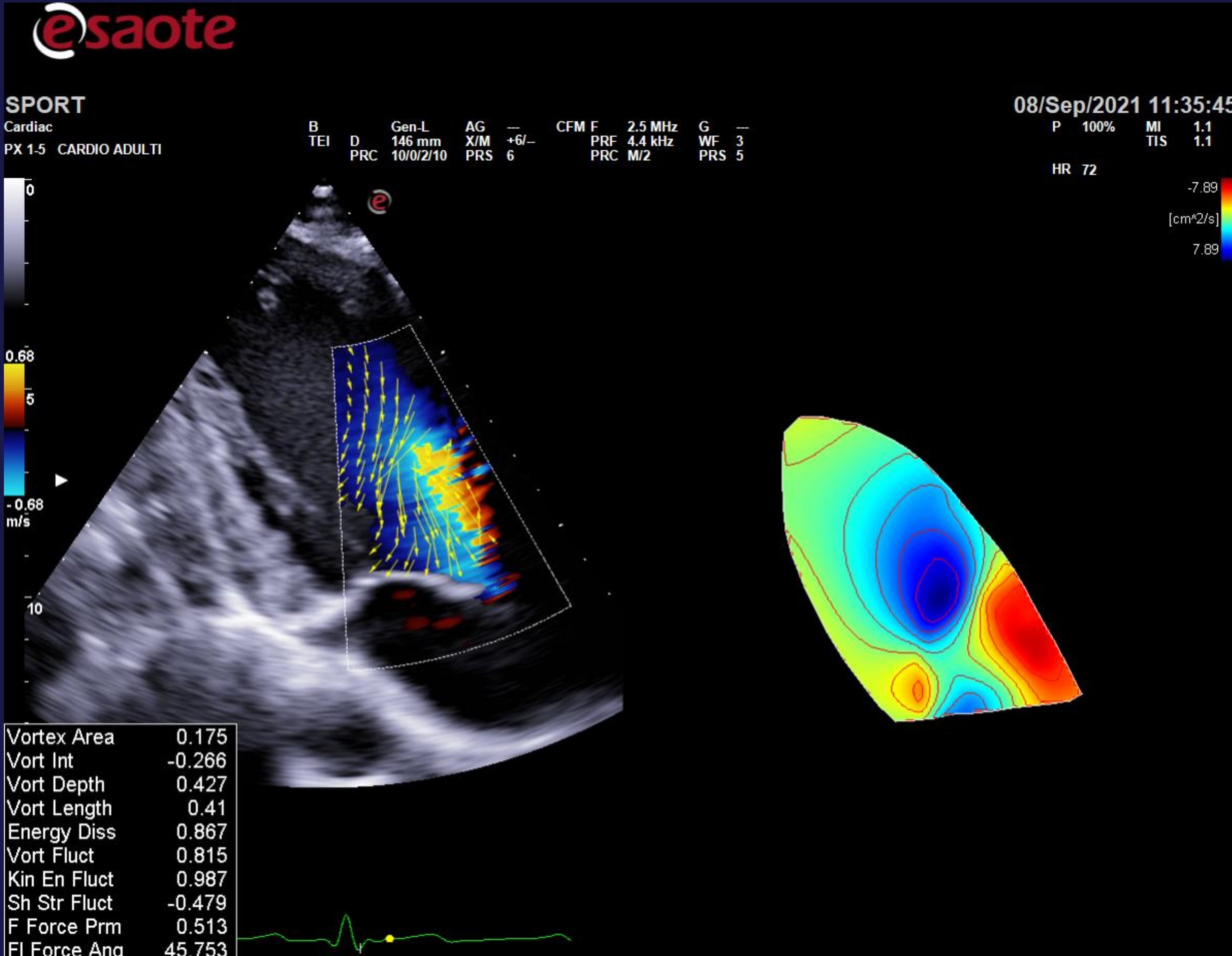


Figure 4 - Findings in Normal versus a DCMP patient - Picture courtesy of Dr. Donato Mele, Cardiology Unit and LTTA Center, University of Ferrara

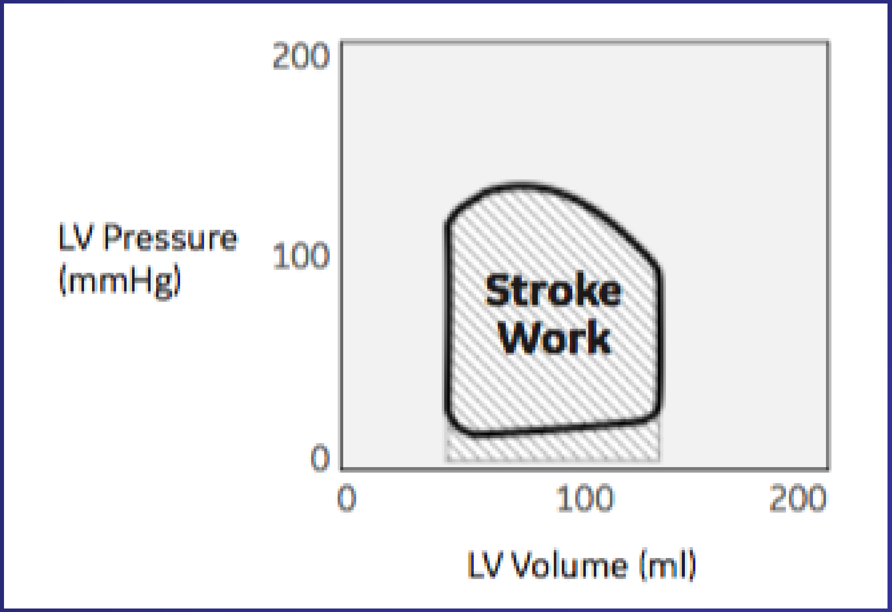



esaote
SPORT
Cardiac
PX 1-5 CARDIO ADULTI
B
TEI
D
PRC
Gen-L
146 mm
10/0/2/10
AG ---
X/M +6/--
PRS 6
CFM F 2.5 MHz
PRF 4.4 kHz
PRC M/2
G ---
WF 3
PRS 5
08/Sep/2021 11:37:18
P 100%
MI 1.1
TIS 1.1
HR 72
0.68
- 0.68
m/s
0
5
10
Vortex Area 0.175
Vort Int -0.266
Vort Depth 0.427
Vort Length 0.41
Energy Diss 0.867
Vort Fluct 0.815
Kin En Fluct 0.987
Sh Str Fluct -0.479
F Force Prm 0.513
Fl Force Ang 45.753

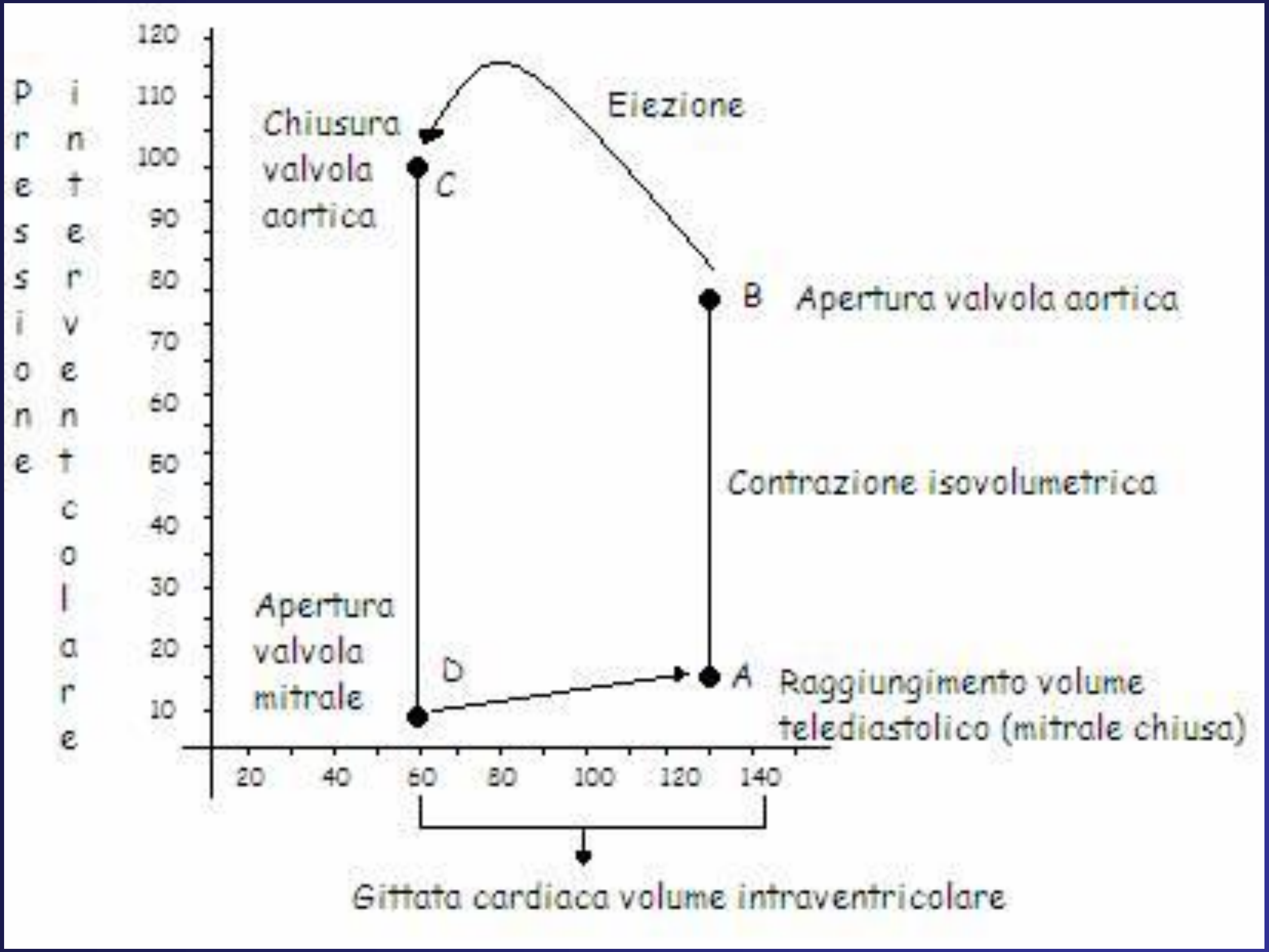

esaote
SPORT
Cardiac
PX 1-5 CARDIO ADULTI
B
TEI
D
PRC
Gen-L
146 mm
10/0/2/10
AG ---
X/M +6/--
PRS 6
CFM F 2.5 MHz
PRF 4.4 kHz
PRC M/2
G ---
WF 3
PRS 5
08/Sep/2021 11:35:45
P 100%
MI 1.1
TIS 1.1
HR 72
-7.89
[cm^2/s]
7.89
0.68
-0.68
m/s
Vortex Area 0.175
Vort Int -0.266
Vort Depth 0.427
Vort Length 0.41
Energy Diss 0.867
Vort Fluct 0.815
Kin En Fluct 0.987
Sh Str Fluct -0.479
F Force Prm 0.513
Fl Force Ang 45.753

Pressure-Volume Loop

- As the heart is pumping blood into the circulatory system it is performing work on the blood for every beat. This work is often denoted the stroke work. The stroke work can be explained as the **area of the pressure-volume loop**

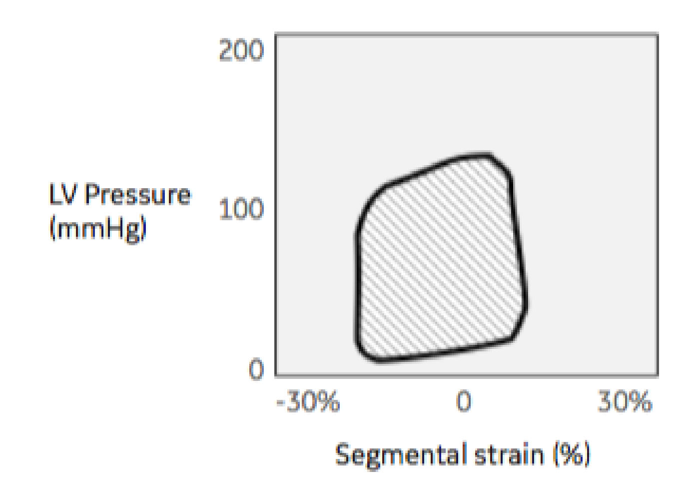


Pressure-Volume Loop



Strain – LV Pressure Area

- The segmental strain – LV pressure area provides a surrogate for the work performed by each segment, as LV pressure does not fully explain the force developed by each segment.



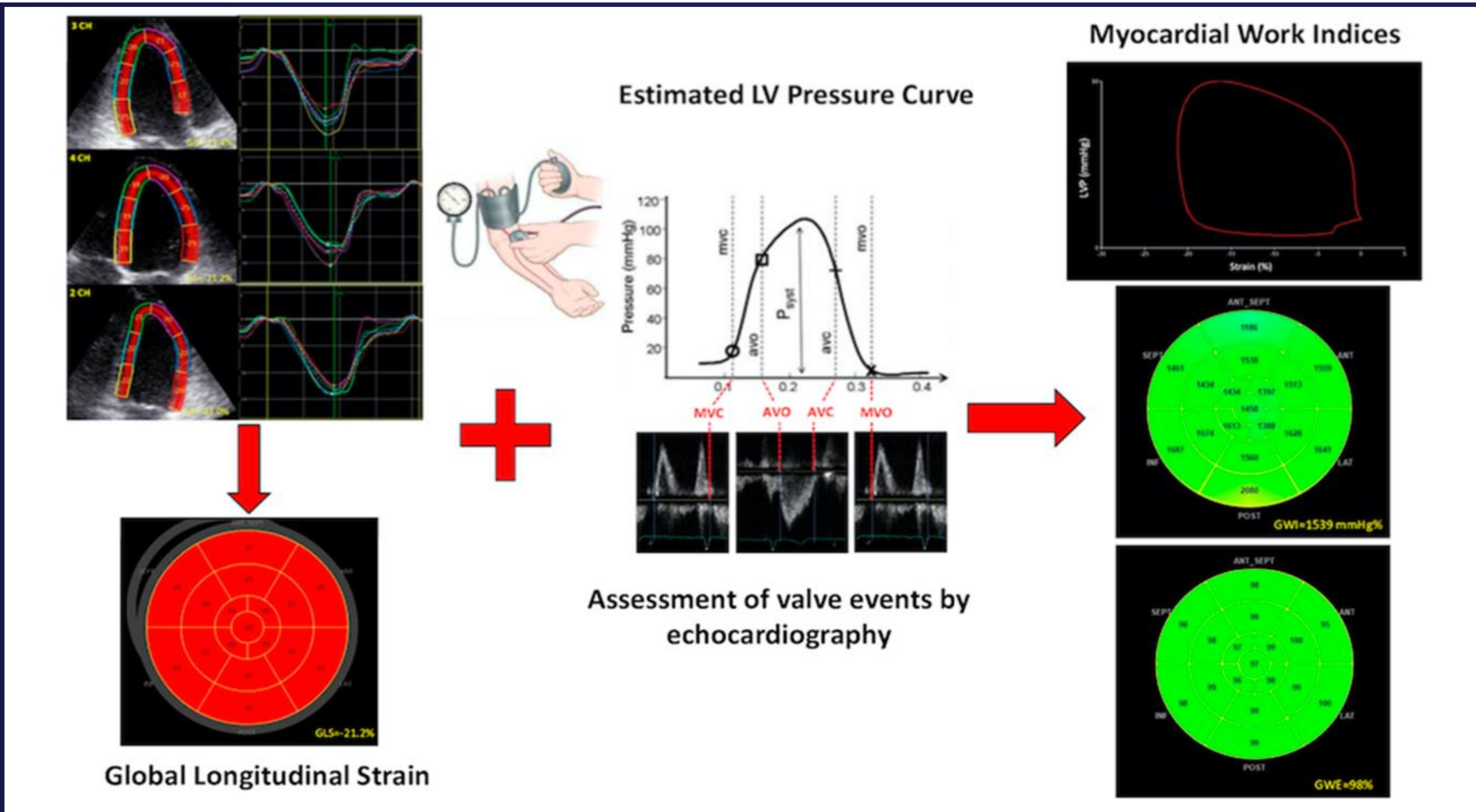
Journal of
Clinical Medicine

MDPI

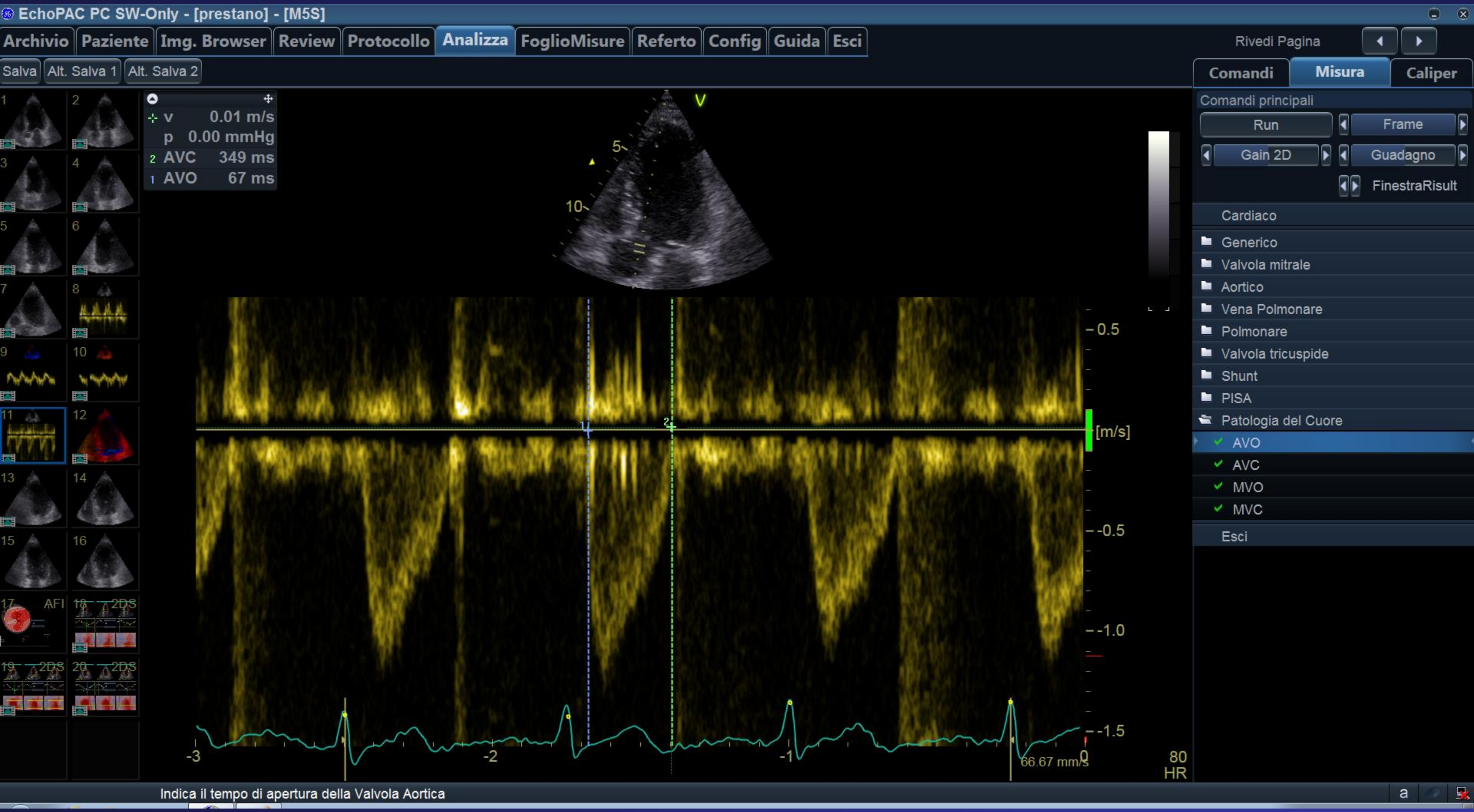
Review

Myocardial Work by Echocardiography: Principles and Applications in Clinical Practice

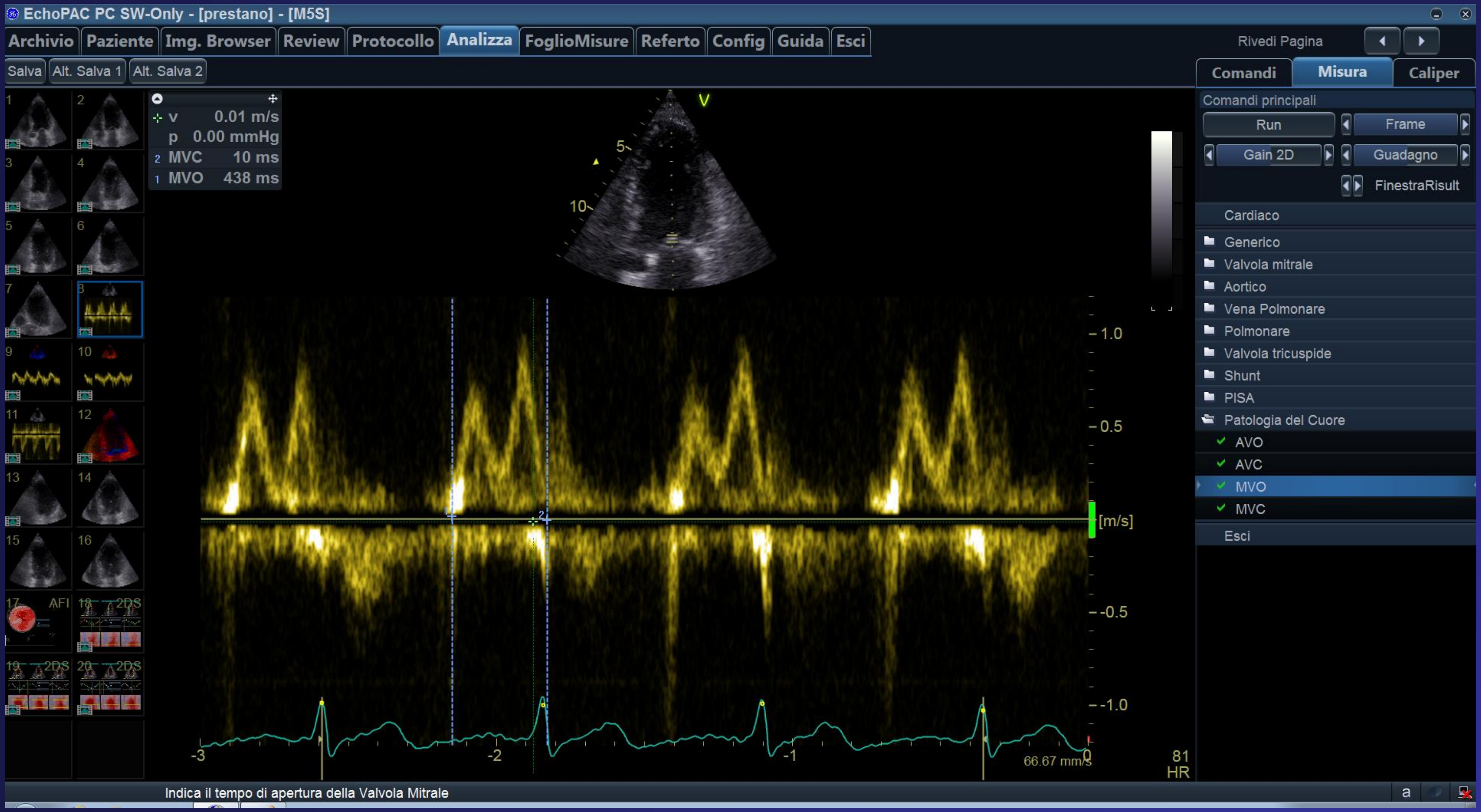
Federica Ilardi [1,2,*], Antonello D'Andrea [3,4], Flavio D'Ascenzi [5], Francesco Bandera [6], Giovanni Benfari [7], Roberta Esposito [1,2], Alessandro Malagoli [8], Giulia Elena Mandoli [5], Ciro Santoro [1], Vincenzo Russo [3], Mario Crisci [9], Giovanni Esposito [1], Matteo Cameli [5] and on behalf of the Working Group of Echocardiography of the Italian Society of Cardiology (SIC) [†]



Myocardial Work: Metodologia

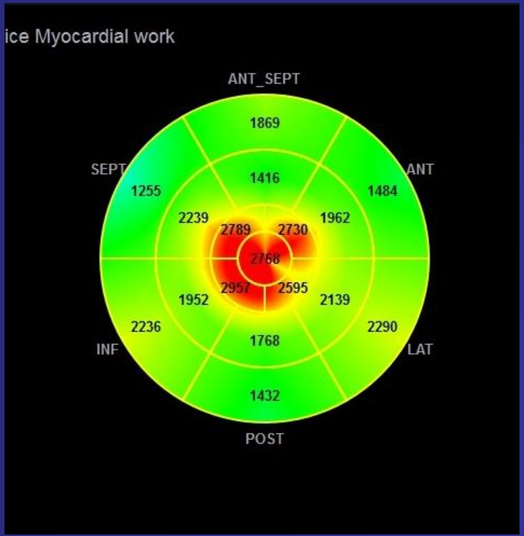


Myocardial Work: Metodologia



MYOCARDIAL WORK

- A bull’s eye with the segmental myocardial work values and global values are provided. Work is evaluated from Mitral Valve Closure (MVC) to Mitral Valve Opening (MVO), in other words: mechanical systole including isovolumetric relaxation (IVR).



Constructive work: work performed by a segment during shortening in systole adding negative work during lengthening in IVR

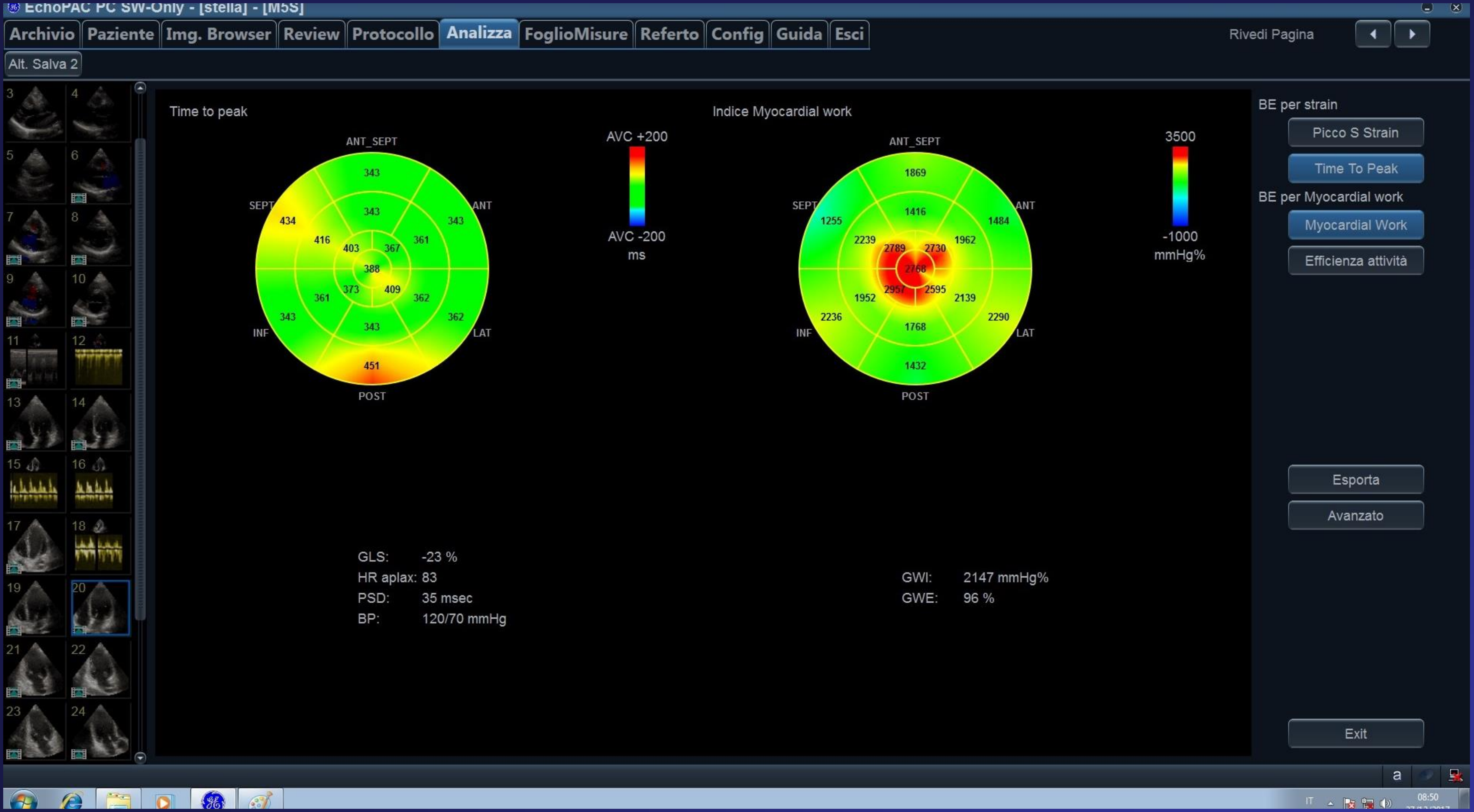
- **Wasted work:** negative work performed by a segment during lengthening in systole adding work performed during shortening in IVR

• **Myocardial work efficiency:** constructive work divided by the sum of constructive and wasted work (0-100%)

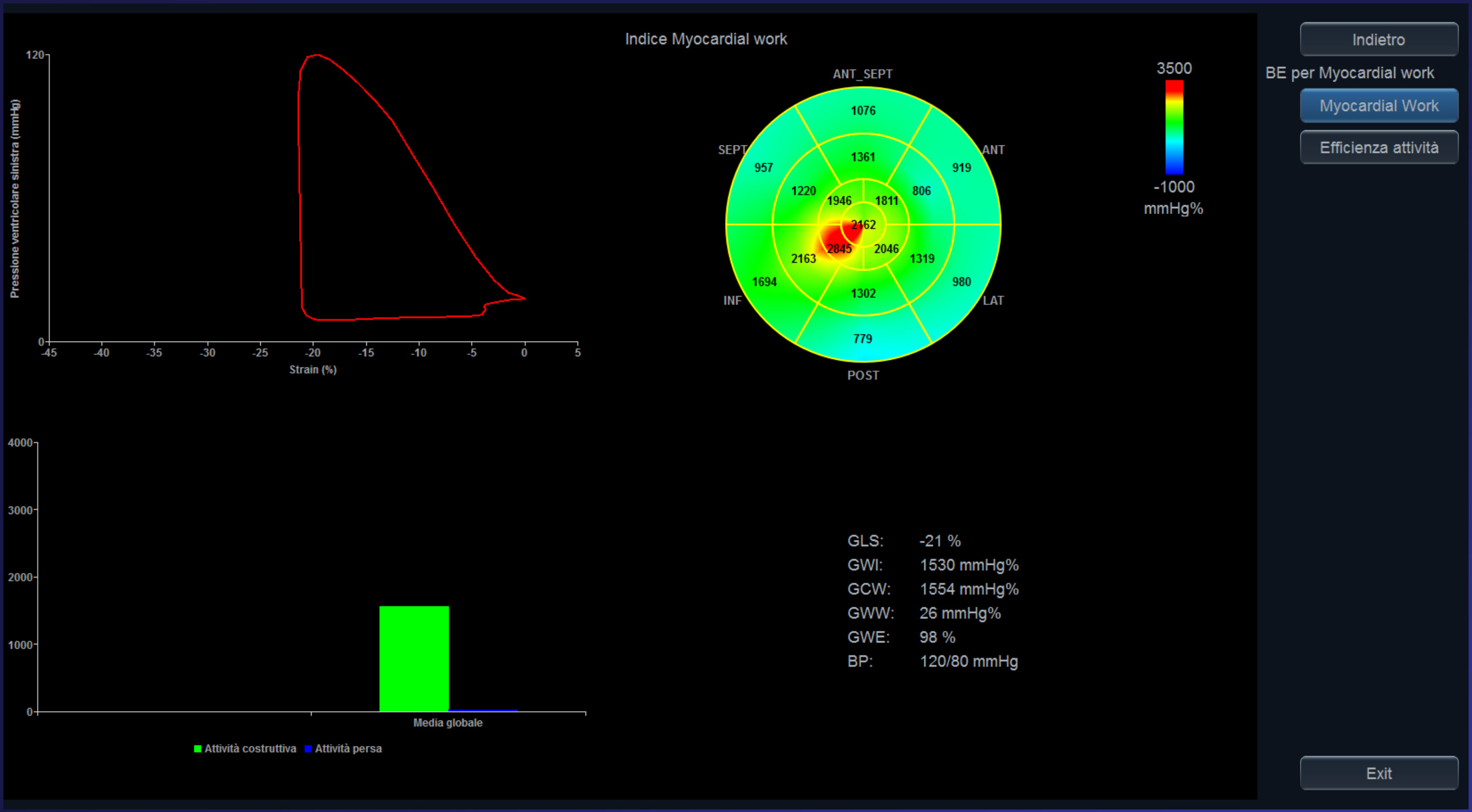
MYOCARDIAL WORK

- Myocardial Work values
- Assuming normal systolic pressure (120 mmHg) and normal global longitudinal strain (-20%) Myocardial Work will be approximately 2400 mmHg%.
- With all segments contracting during systole the Myocardial Work Efficiency will be 100%.

SANO SEDENTARIO



SANO SEDENTARIO

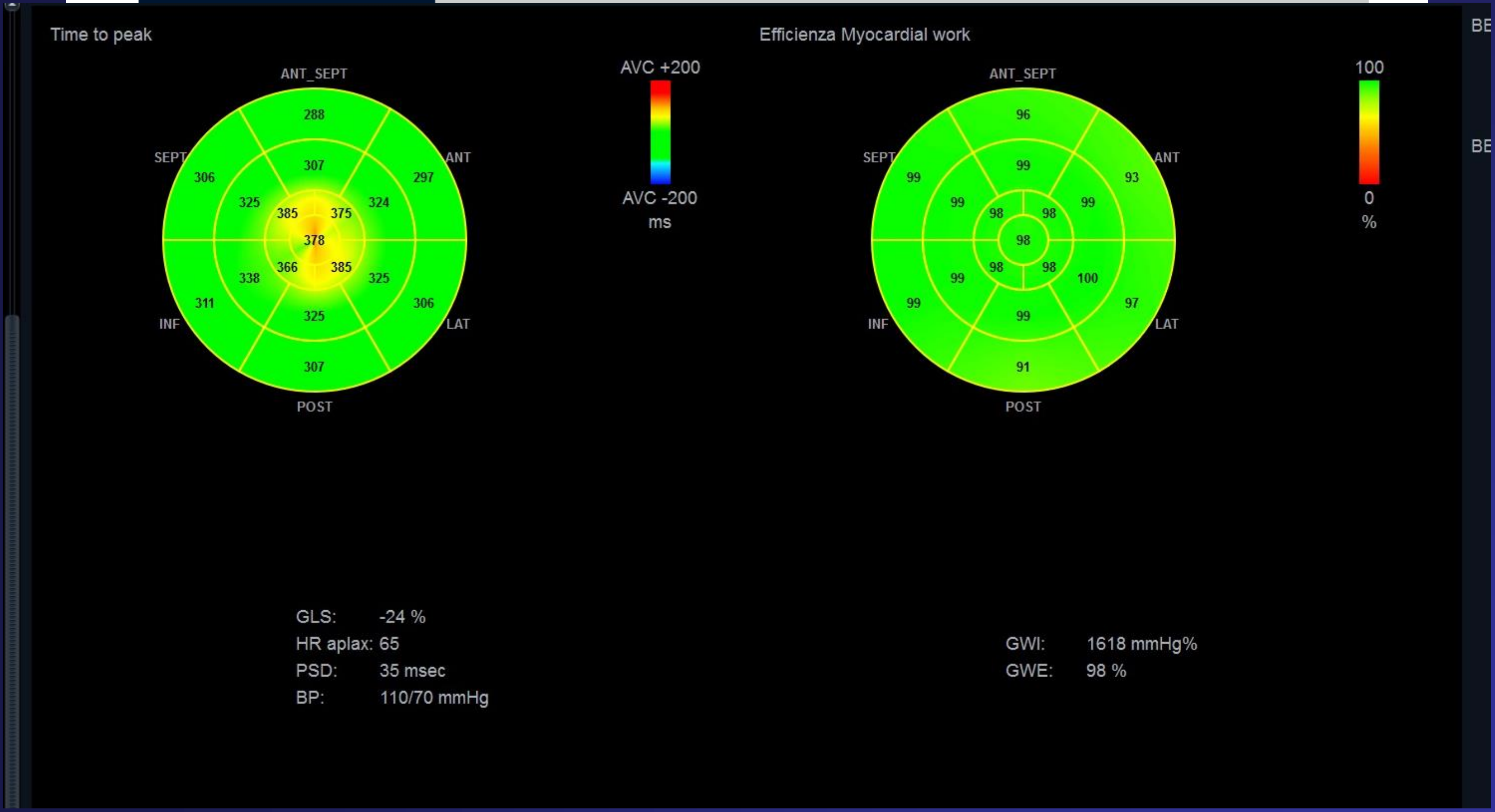


Original Article

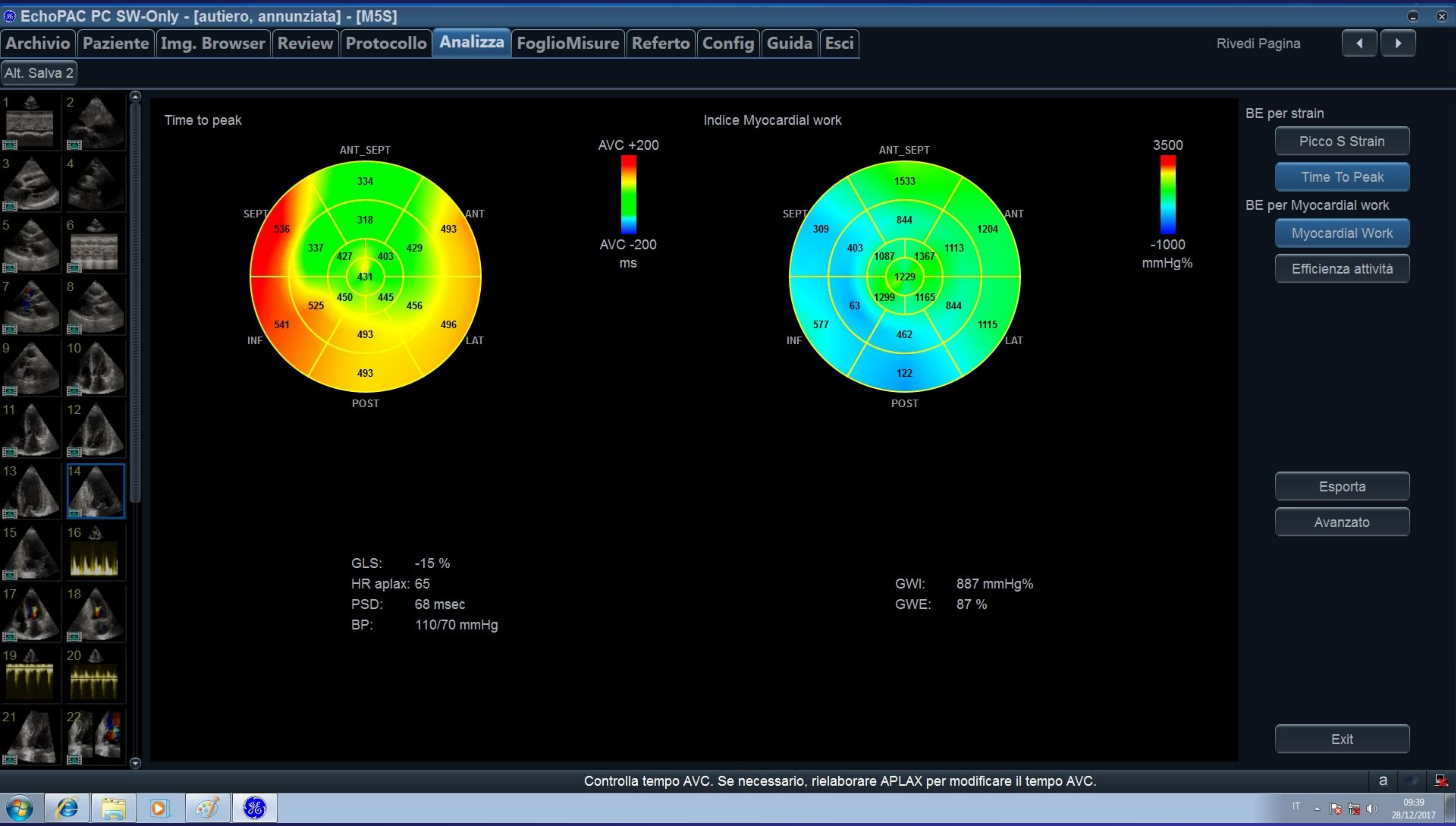
Myocardial Work Efficiency in Physiologic Left Ventricular Hypertrophy of Power Athletes

Antonello D'Andrea[1,2], Andreina Carbone[2], Juri Radmilovic[1], Vincenzo Russo[2], Dario Fabiani[2], Marco Di Maio[3], Federica Ilardi[4], Francesco Giallauria[5], Adriano Caputo[2], Teresa Cirillo[1], Eduardo Bossone[6], Eugenio Picano[7]

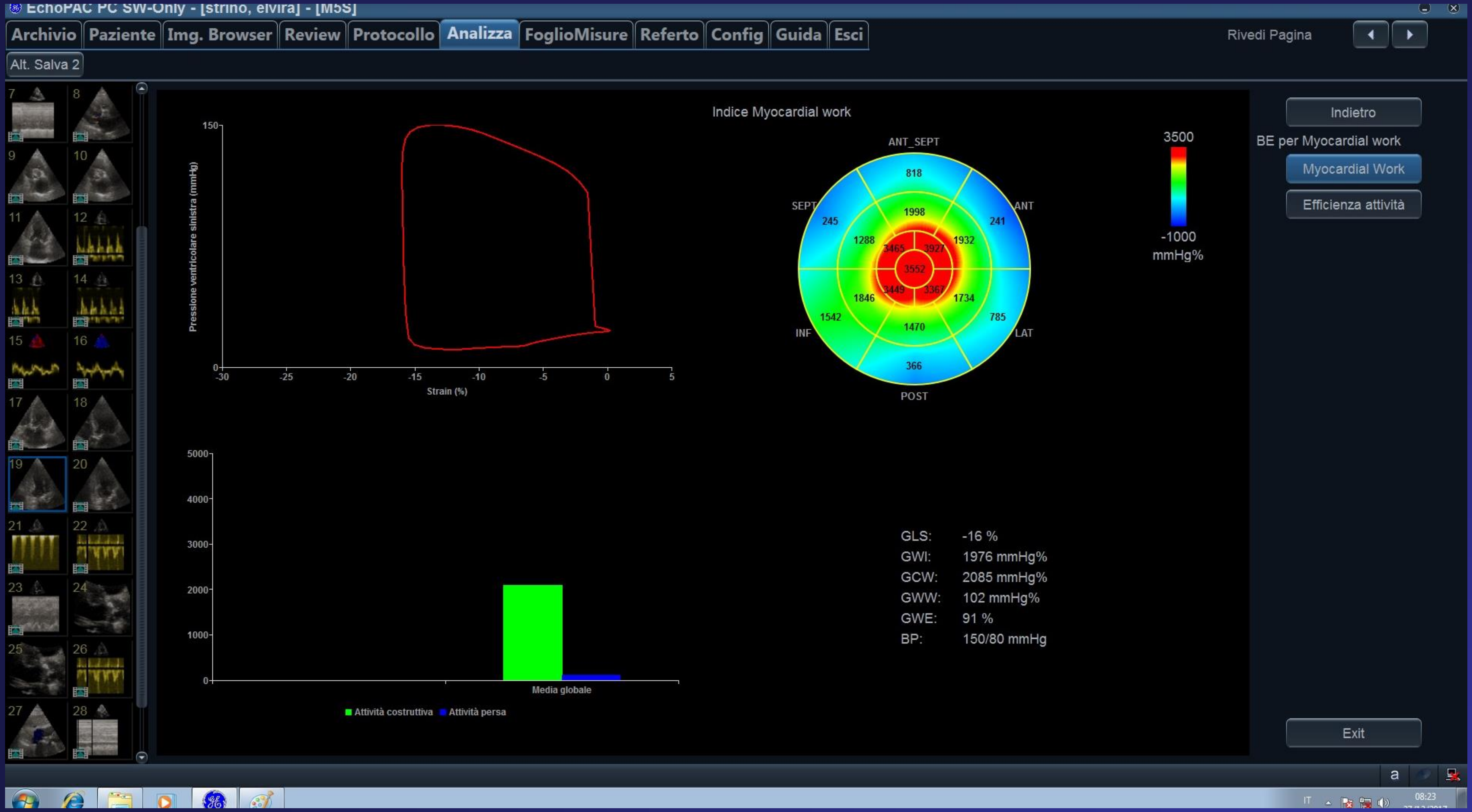
[1]Department of Cardiology, Unit of Cardiology and Intensive Coronary Care, "Umberto I" Hospital, Nocera Inferiore, [2]Department of Traslational Medical Sciences, Unit of Cardiology, University of Campania "Luigi Vanvitelli", Monaldi Hospital, Naples, Departments of [4]Cardiology and [5]Internal Medicine, University of Naples Federico II, [6]Department of Cardiology, UOC Cardiologia Riabilitativa, Cardarelli Hospital, Naples, [3]Department of Cardiology, Unit of Cardiology, "Hospital, Eboli (ASL Salerno), Salerno, [7]Department of Cardiology, Institute of Clinical Physiology, CNR, Pisa, Italy



HCM


EchoPAC PC SW-Only - [autiero, annunziata] - [M5S]
Archivio Paziente Img. Browser Review Protocollo Analizza FoglioMisure Referto Config Guida Esci
Rivedi Pagina
Alt. Salva 2
Time to peak
Indice Myocardial work
ANT_SEPT
SEPT
ANT
INF
LAT
POST
AVC +200
AVC -200
ms
3500
-1000
mmHg%
BE per strain
Picco S Strain
Time To Peak
BE per Myocardial work
Myocardial Work
Efficienza attività
Esporta
Avanzato
Exit
GLS: -15 %
HR aplax: 65
PSD: 68 msec
BP: 110/70 mmHg
GWI: 887 mmHg%
GWE: 87 %
Controlla tempo AVC. Se necessario, rielaborare APLAX per modificare il tempo AVC.

STENOSI AORTA CON BUONA FE



European Heart Journal (2012) **33**, 724–733
doi:10.1093/eurheartj/ehs016

FASTTRACK
CLINICAL RESEARCH

A novel clinical method for quantification of regional left ventricular pressure–strain loop area: a non-invasive index of myocardial work

Kristoffer Russell[1,2,3], Morten Eriksen[1,3], Lars Aaberge[2,3], Nils Wilhelmsen[2], Helge Skulstad[1,2], Espen W. Remme[1,3,4], Kristina H. Haugaa[1,2,3], Anders Opdahl[1,2], Jan Gunnar Fjeld[5], Ola Gjesdal[1,2], Thor Edvardsen[1,2,3], and Otto A. Smiseth[1,2,3]*

[1]Institute for Surgical Research, Oslo University Hospital, Rikshospitalet, University of Oslo, Oslo, Norway; [2]Department of Cardiology, Oslo University Hospital, Rikshospitalet, University of Oslo, N-0027 Oslo, Norway; [3]Center for Cardiological Innovation, Oslo University Hospital, University of Oslo, Oslo, Norway; [4]KG Jebsen Cardiac Research Centre, Oslo, Norway; and [5]Department of Radiology and Nuclear Medicine, Oslo University Hospital, University of Oslo, Oslo, Norway

Received 9 November 2011; revised 22 December 2011; accepted 16 January 2012; online publish-ahead-of-print 6 February 2012

VALIDAZIONE Press. INVASIVA - SONOMICROMETRIA

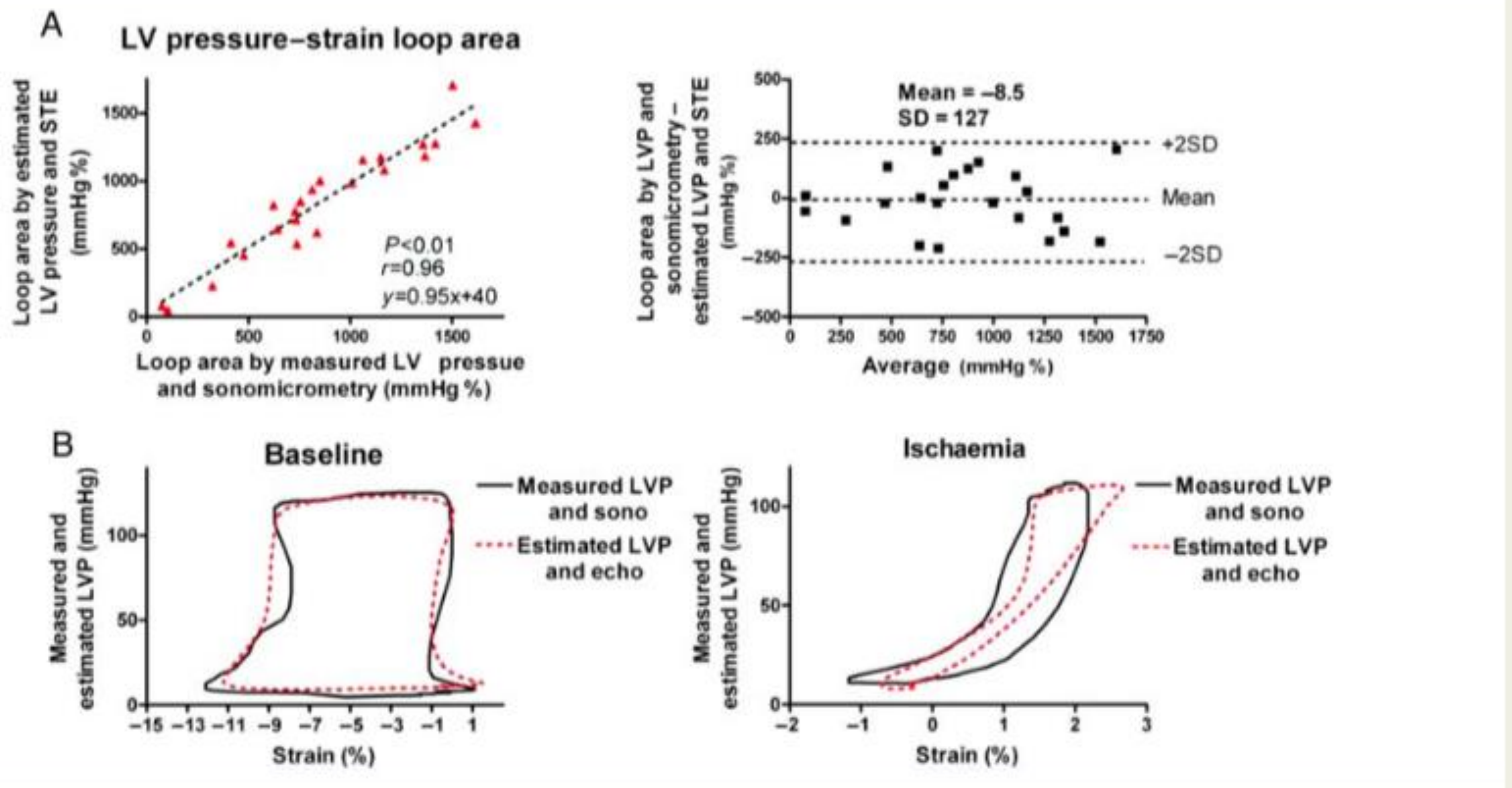
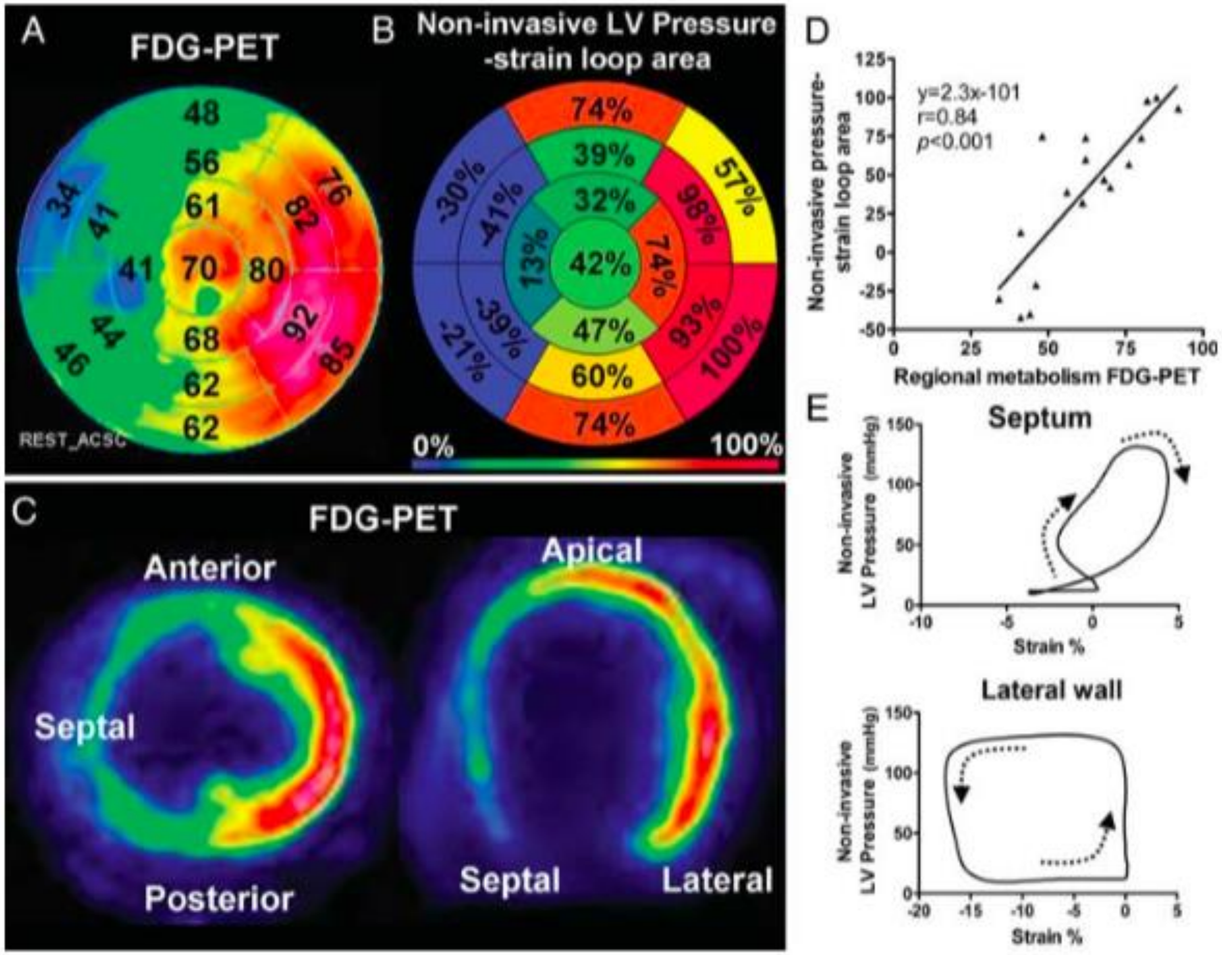


Figure 3 (*A*) Correlation and agreement between area of the pressure–strain loops by estimated left ventricular pressure and speckle tracking echocardiography vs. measured left ventricular pressure and sonomicrometry. (*B*) Representative traces showing pressure–strain loops by left ventricular pressure and sonomicrometry (black line) vs. estimated left ventricular pressure and echocardiography (red dotted line). Measurements during baseline (left panel) and ischaemia (right panel). Sono, sonomicrometry; echo, speckle tracking echocardiography.

CORRELAZIONE WORK – METABOLISMO PET FDG



Value of Myocardial Work Estimation in the Prediction of Response to Cardiac Resynchronization Therapy

Elena Galli, MD, PhD, Christophe Leclercq, MD, PhD, Maxime Fournet, MD, Arnaud Hubert, MD, Anne Bernard, MD, PhD, Otto A. Smiseth, MD, PhD, Philippe Mabo, MD, Eigil Samset, PhD, Alfredo Hernandez, PhD, and Erwan Donal, MD, PhD, *Rennes and Tours, France; and Oslo, Norway*

Background: Cardiac resynchronization therapy (CRT) in heart failure is plagued by too many nonresponders. The aim of the present study is to evaluate whether the estimation of myocardial performance by pressure-strain loops (PSLs) is useful for the selection of CRT candidates.

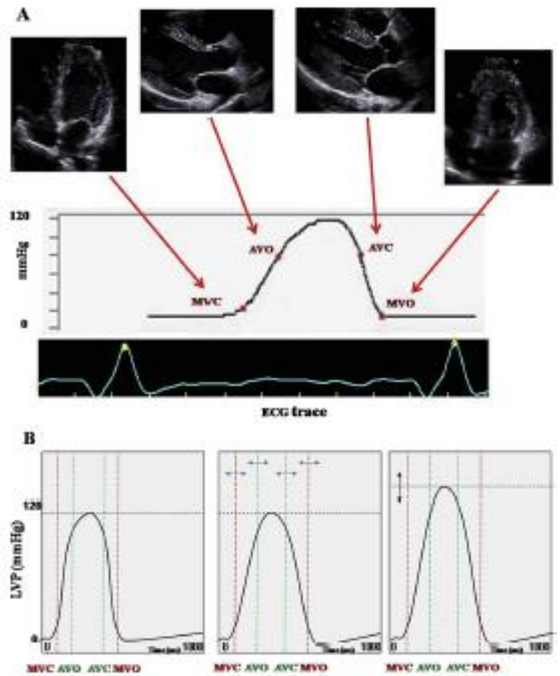


Figure 1 (A) Example of noninvasive estimation of the LV pressure (LVP) curve. The timing of mitral and aortic valve events is indicated. (B) Examples of variation of the LV pressure curve with measured durations of cardiac phases and with adjustment of peak pressure according to cuff pressure. *Left:* Basal pressure trace. *Middle:* Valvular event times are modified (*vertical lines*). *Right:* Pressure is increased. (C) Representative traces showing PSLs measured in the basal anteroseptal and basal inferoseptal segments in a CRT responder before (upper) and after CRT (lower). *AVC*, Aortic valve closure; *AVO*, aortic valve opening; *MVC*, mitral valve closure; *MVO*, mitral valve opening.

CRT OFF

CRT ON

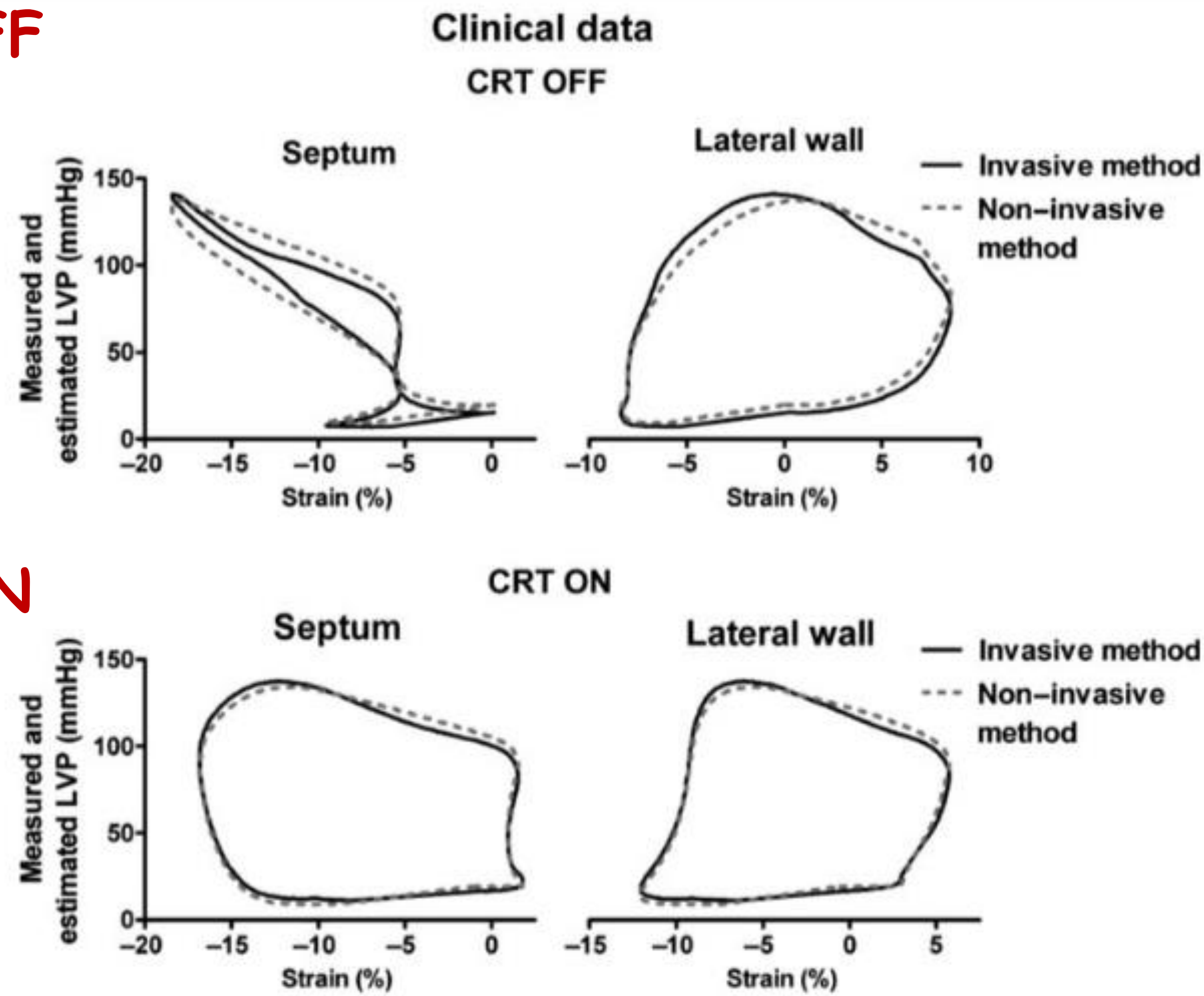


Figure 6 Loop areas by left ventricular pressure and speckle-tracking echocardiography (solid line) vs. the non-invasive method by estimated left ventricular pressure and speckle-tracking echocardiography (dashed line), for a septal and lateral wall segment in a patient with the cardiac resynchronization therapy device turned on and off.

The addition of CW > 1,057 mm Hg% and WW > 384 mm Hg% to a baseline model including clinical, echocardiographic, and conventional dyssynchrony parameters significantly increased the model power to predict CRT response

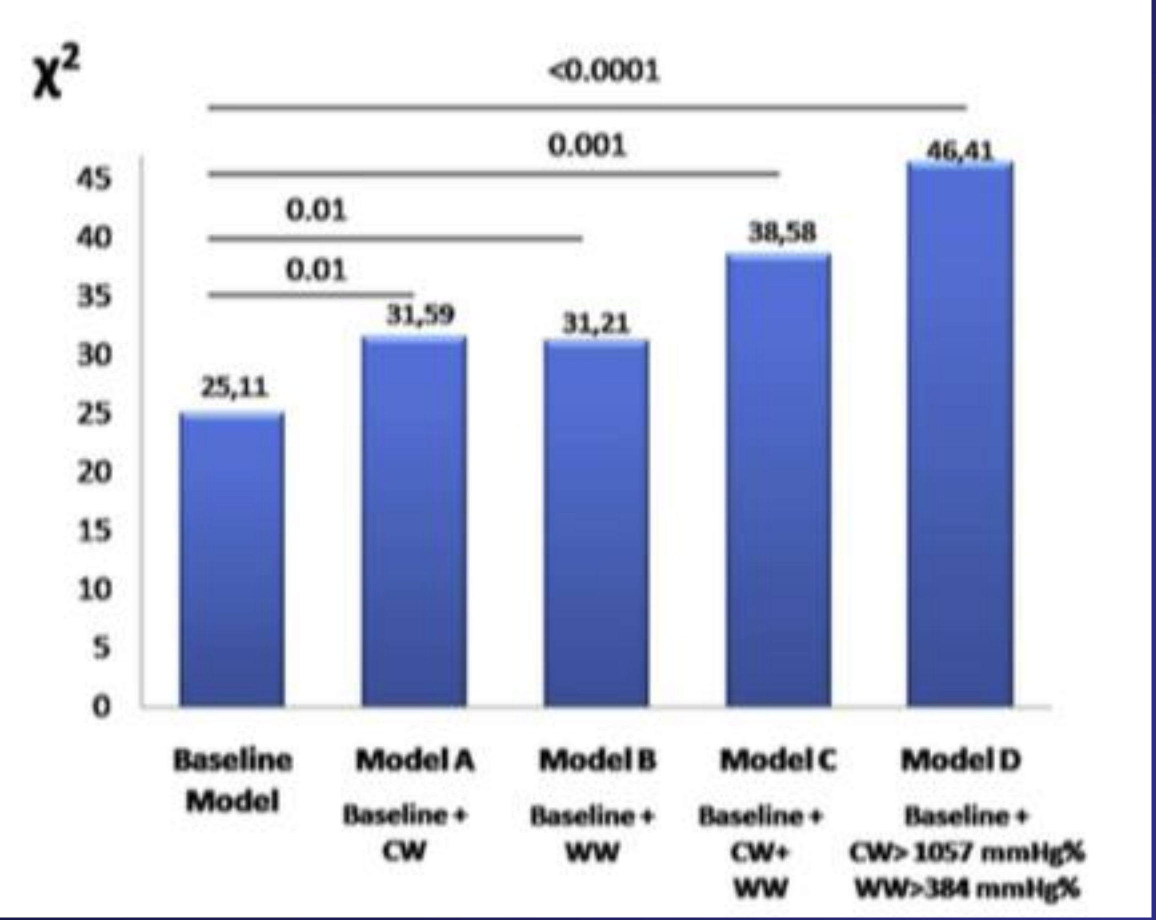
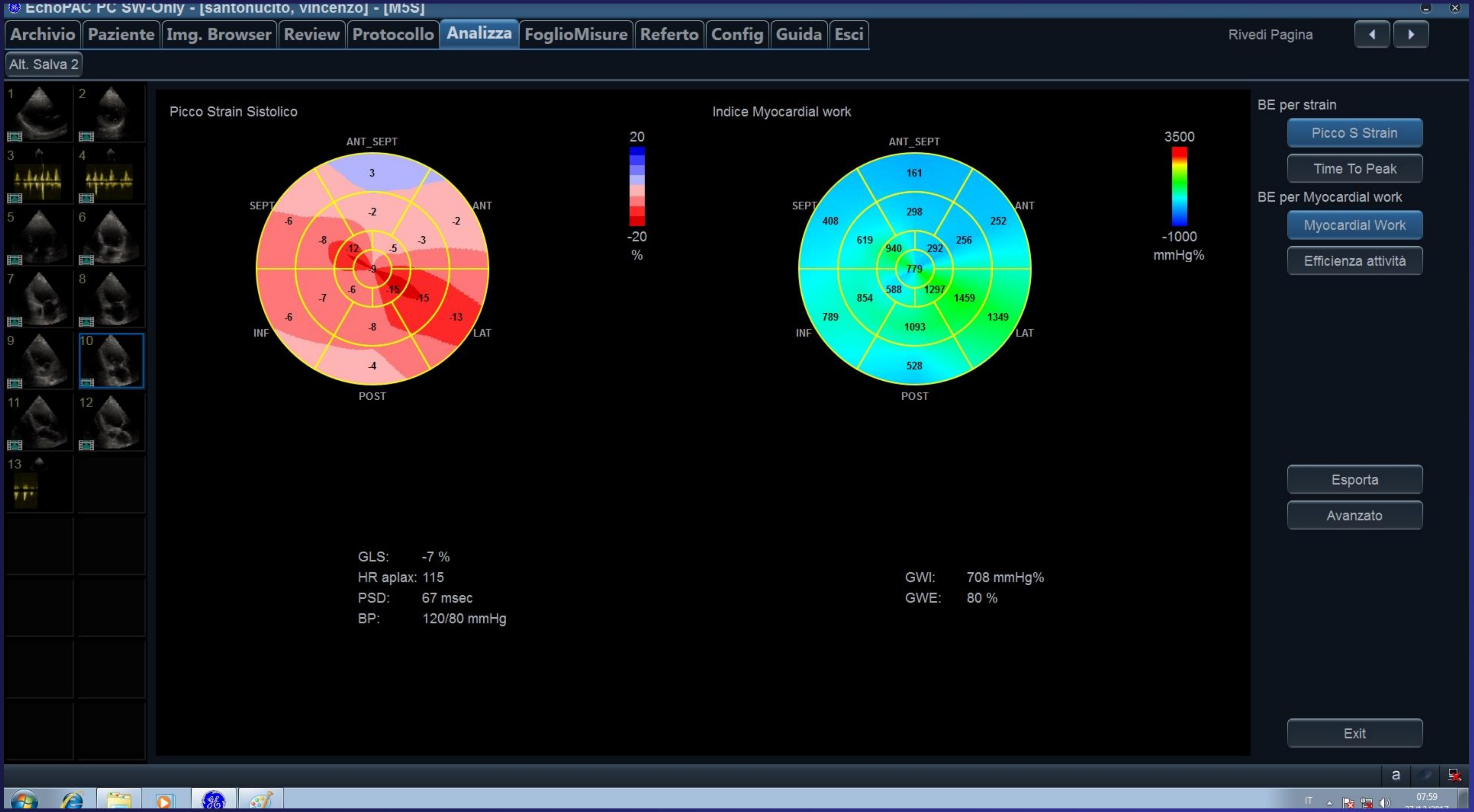


Table 4 Se, Sp, PPV, and NPV, in monoparametric and multiparametric approach to predict CRT positive response

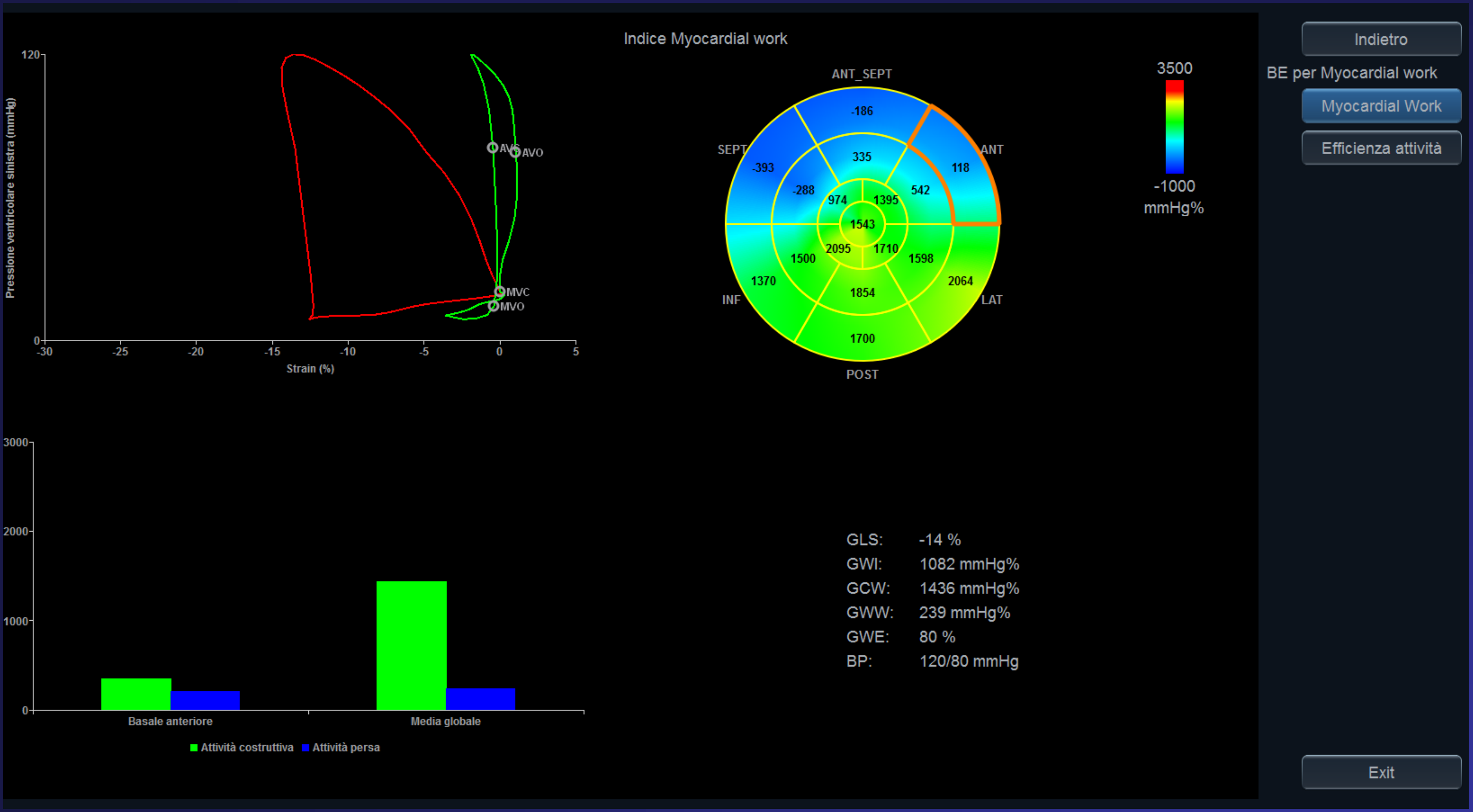
	Se	Sp	PPV	NPV	Accuracy
AVD	32	79	74	39	48
IVD	68	62	77	51	66
SF	81	62	81	63	75
CW > 1,057 mm Hg%	56	85	88	51	66
WW > 338 mm Hg%	40	94	93	46	59
AVD + IVD + SF + CW > 1,057 mm Hg% + WW > 384 mm Hg%	6	100	100	37	39
CW > 1,057 mm Hg% + WW > 384 mm Hg%	22	100	100	41	49

AVD, Atrioventricular dyssynchrony; IVD, interventricular dyssynchrony. Data are percentages.

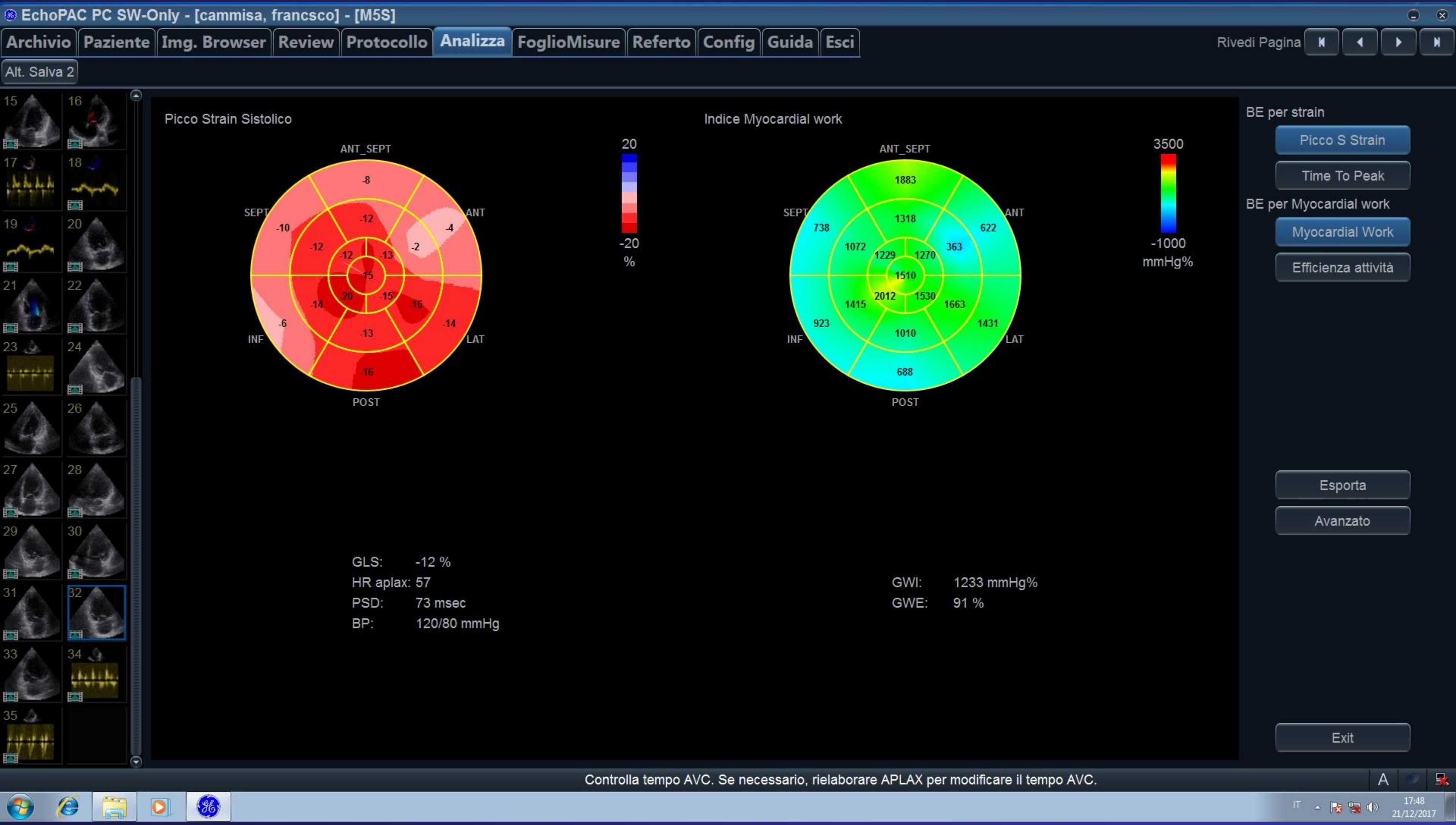
DILATATIVA CON BBS



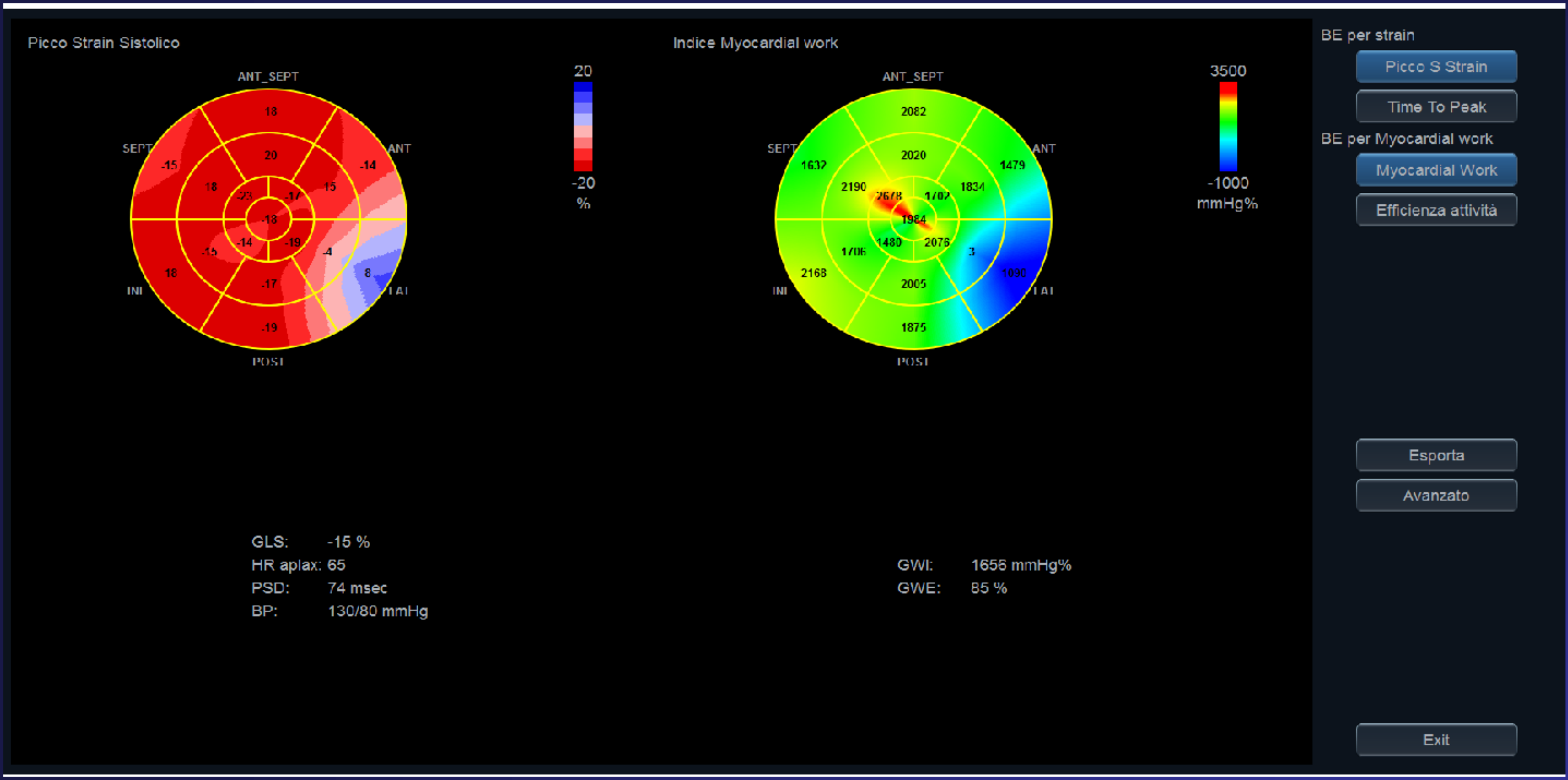
BBS


Indice Myocardial work
Pressione ventricolare sinistra (mmHg)
Strain (%)
AVC
AVO
MVC
MVO
ANT_SEPT
SEPT
ANT
INF
LAT
POST
-186
-393
335
118
-288
542
974
1395
1543
2095
1710
1500
1598
1370
2064
1854
1700
3500
-1000
mmHg%
Indietro
BE per Myocardial work
Myocardial Work
Efficienza attività
Basale anteriore
Media globale
Attività costruttiva
Attività persa
GLS: -14 %
GWI: 1082 mmHg%
GCW: 1436 mmHg%
GWW: 239 mmHg%
GWE: 80 %
BP: 120/80 mmHg
Exit

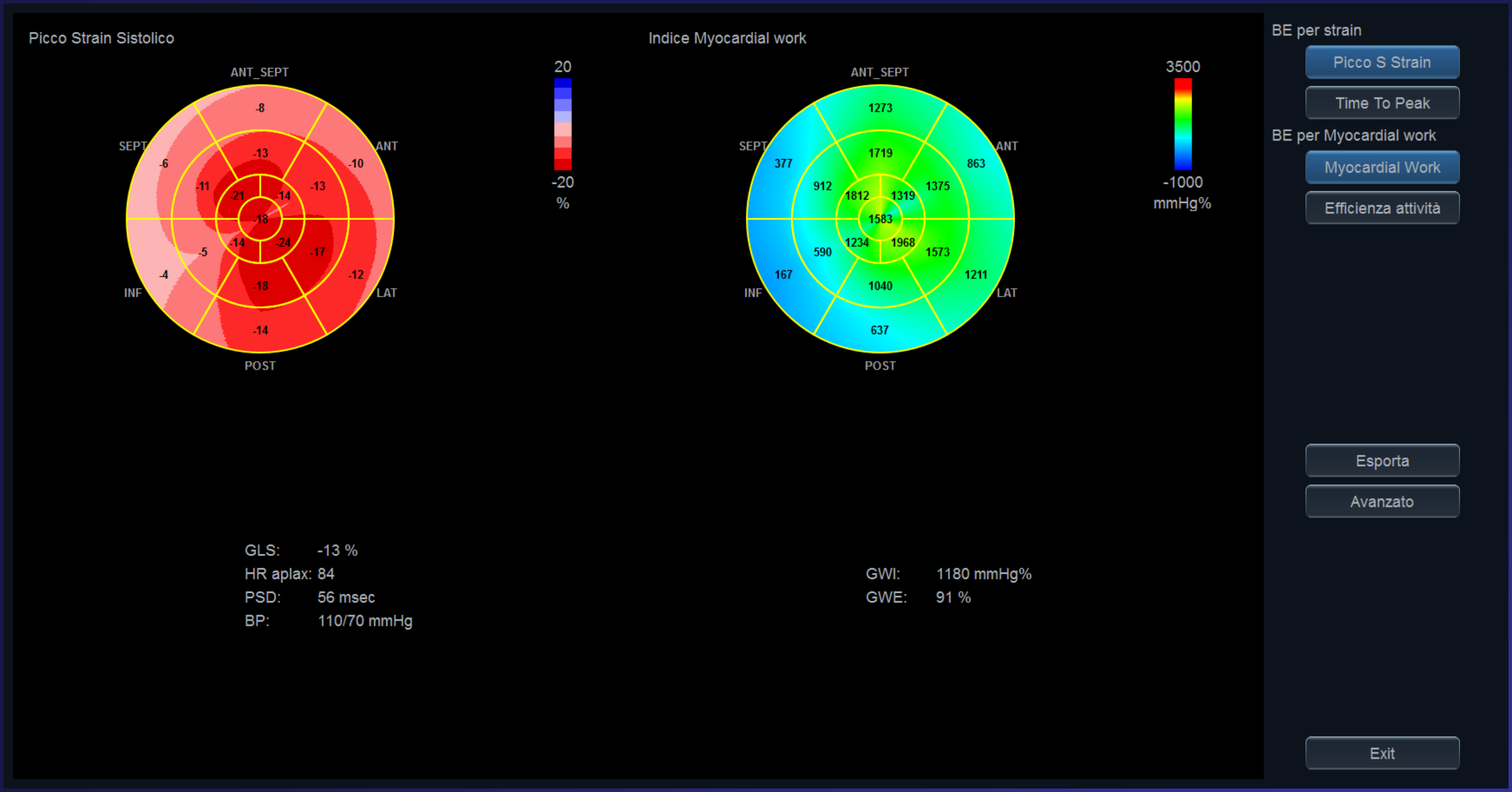
Ischemia Anteriore



Ischemia-necrosi laterale

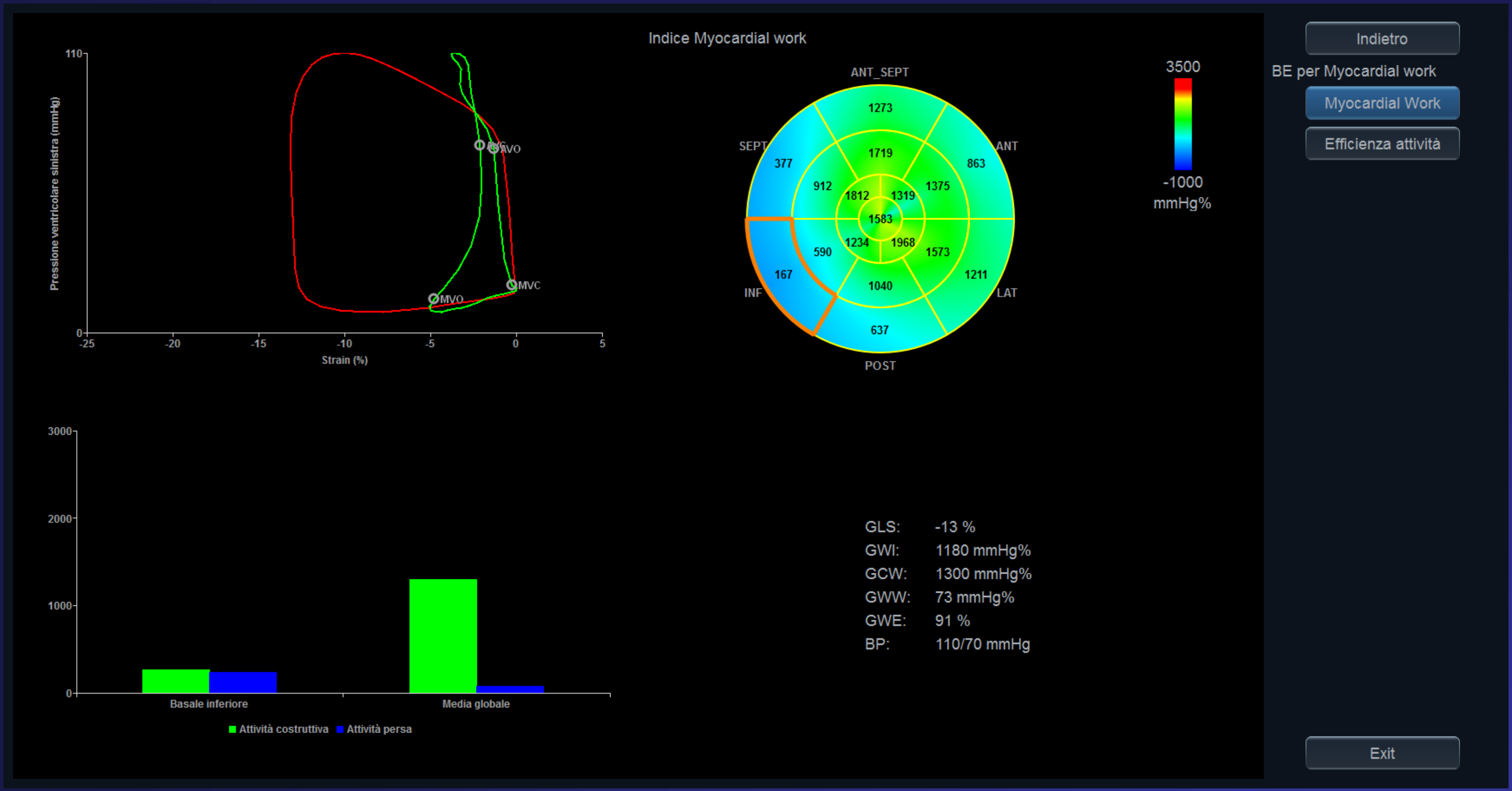


Myocardial Work: Metodologia



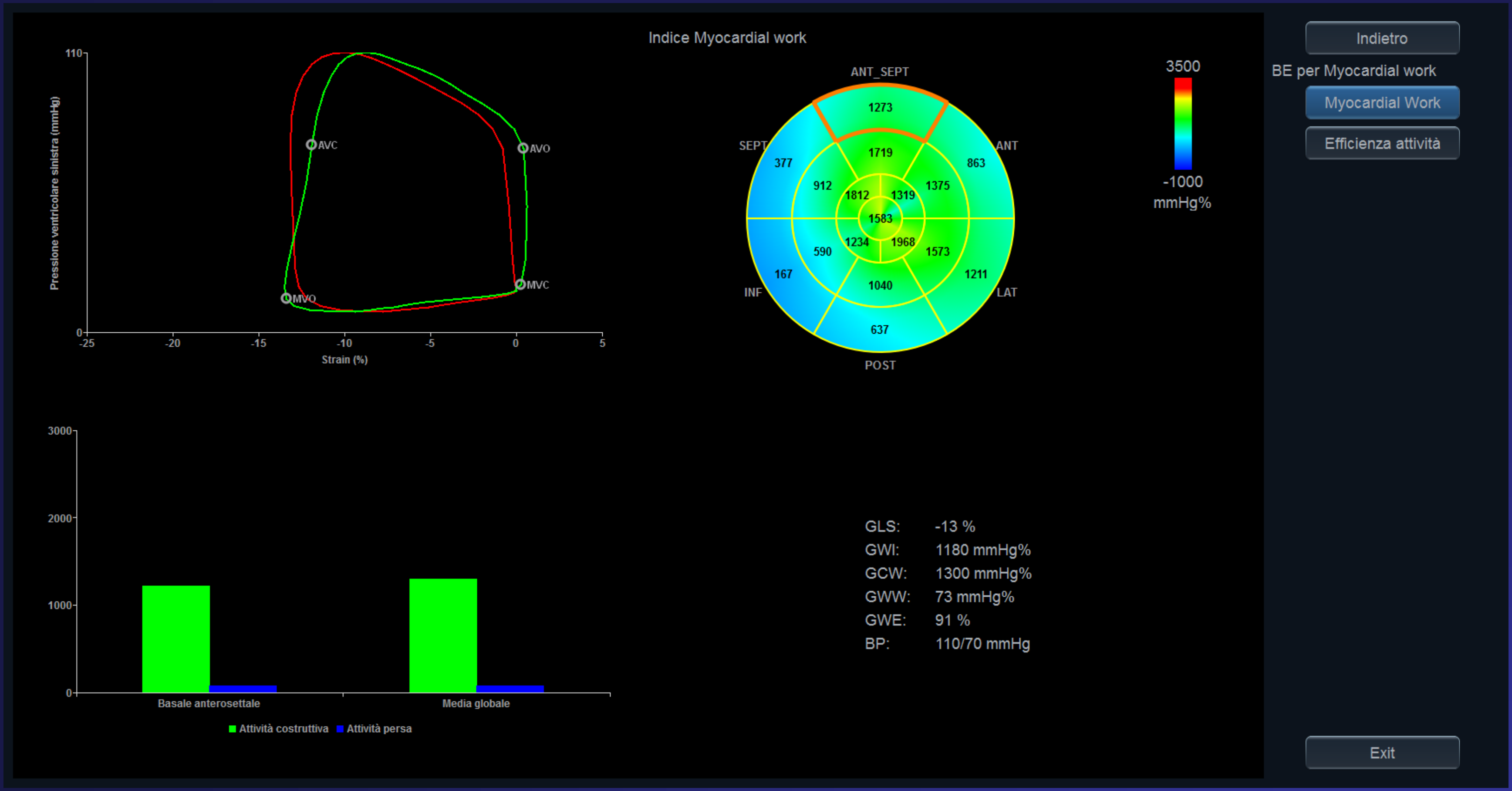
SCA Inferiore

Myocardial Work: Metodologia



SCA Inferiore: sede necrosi

Myocardial Work: Metodologia



SCA Inferiore: zona remota

European Heart Journal - Cardiovascular Imaging Advance Access published April 6, 2015

EUROPEAN SOCIETY OF CARDIOLOGY®

European Heart Journal – Cardiovascular Imaging
doi:10.1093/ehjci/jev078

Non-invasive myocardial work index identifies acute coronary occlusion in patients with non-ST-segment elevation-acute coronary syndrome

Espen Boe[1,2,3], Kristoffer Russell[1,2,3], Christian Eek[2,3], Morten Eriksen[1,3], Espen W. Remme[1,2,3,4], Otto A. Smiseth[1,2,3,4], and Helge Skulstad[1,2,3*]

Myocardial Work and NSTEMI

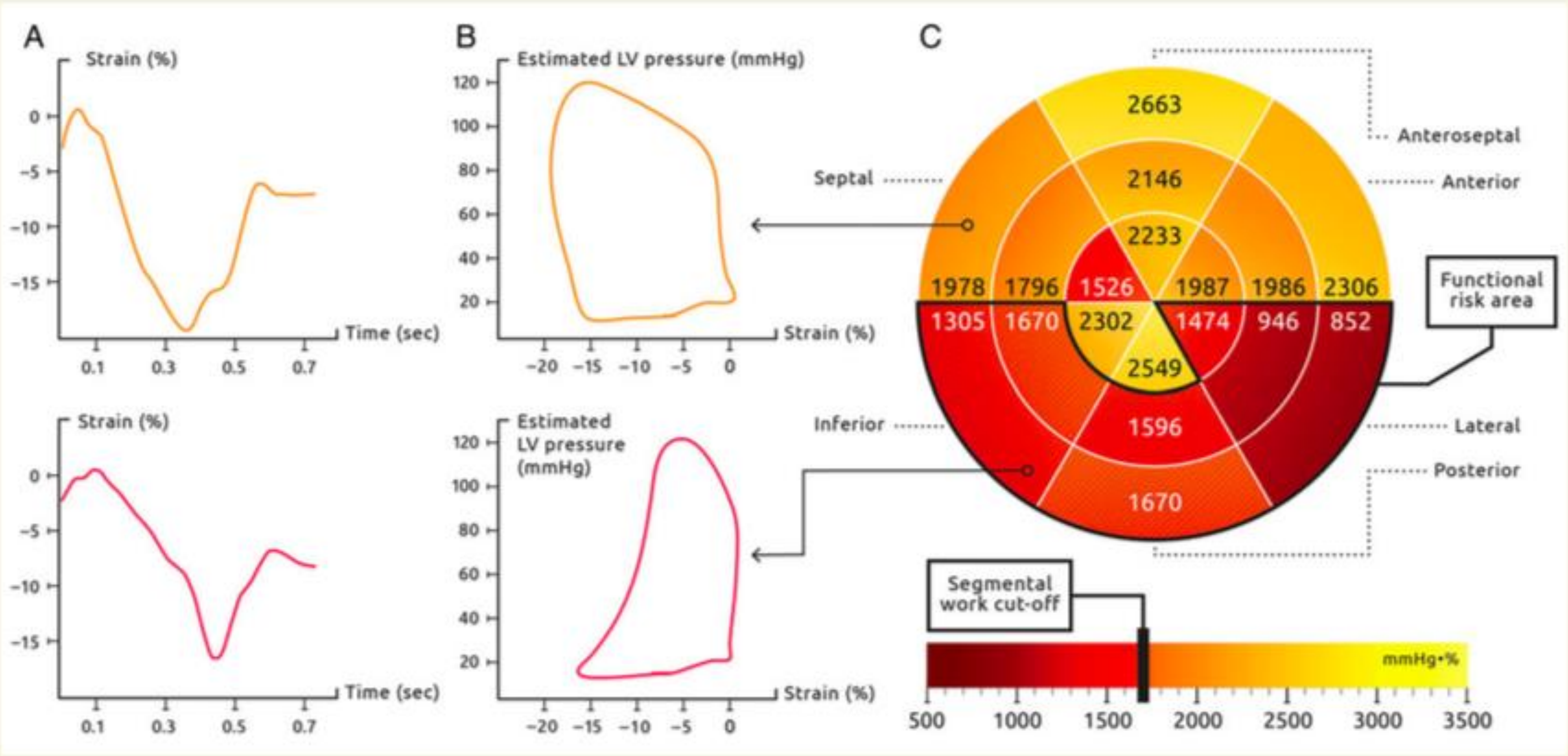


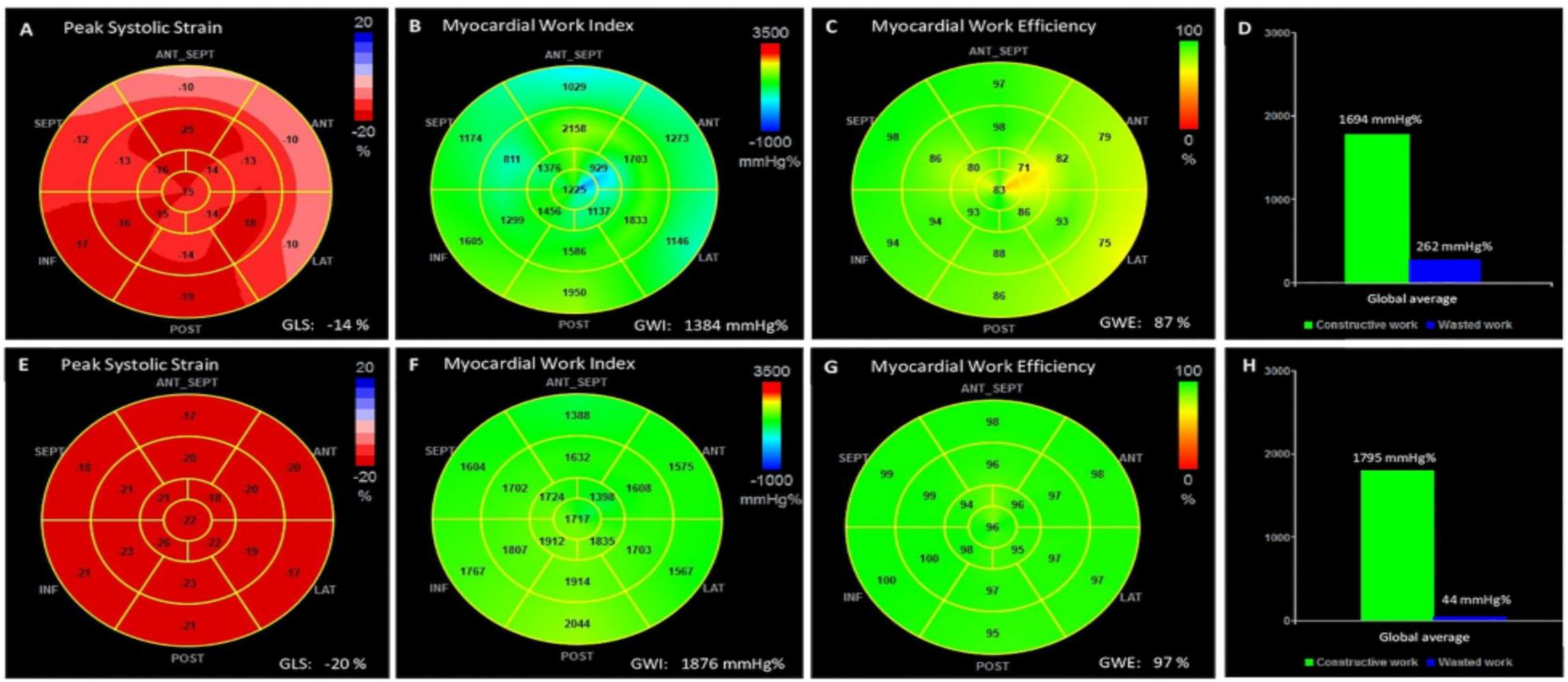
Figure 2 Data from a patient with an acute occlusion in the right coronary artery. (*A*) Two myocardial strain curves from one normal (yellow; top) and one dysfunctional (red; bottom) segment. (*B*) Two estimated LV pressure-strain loops from the same patient. The top left LV pressure-strain loop (yellow) shows a normal segment with a MWI of 1978 mmHg %. The bottom left LV pressure-strain loop (red) shows a dysfunctional segment, within the functional risk area, with a MWI of 1305 mmHg %. (*C*) A bull's eye plot showing segmental work in an 18-segment model. Eight of the segments had impaired systolic function with a MWI of <1700 mmHg % (segmental work cut-off). The functional risk area comprises these segments (shaded) and is marked by the black line. (*D*) Coronary angiogram revealed an occluded right coronary artery (black arrow, top) successfully treated with percutaneous coronary intervention (bottom).

ESC
European Society of Cardiology

European Heart Journal - Cardiovascular Imaging (2021) **22**, 1312–1320
doi:10.1093/ehjci/jeab153

Impaired myocardial work efficiency in heart failure with preserved ejection fraction

Antonello D'Andrea [1,2]*, Federica Ilardi[3], Flavio D'Ascenzi[4], Francesco Bandera[5], Giovanni Benfari[6], Roberta Esposito[3], Alessandro Malagoli[7], Giulia Elena Mandoli[4], Ciro Santoro[3], Vincenzo Russo[1], Michele D'Alto[1], and Matteo Cameli[4]; On Behalf of Working Group of Echocardiography of the Italian Society of Cardiology (SIC)



European Heart Journal - Cardiovascular Imaging (2021) **22**, 1312–1320
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Impaired myocardial work efficiency in heart failure with preserved ejection fraction

Antonello D'Andrea [1,2]*, Federica Ilardi[3], Flavio D'Ascenzi[4], Francesco Bandera[5], Giovanni Benfari[6], Roberta Esposito[3], Alessandro Malagoli[7], Giulia Elena Mandoli[4], Ciro Santoro[3], Vincenzo Russo[1], Michele D'Alto[1], and Matteo Cameli[4]; On Behalf of Working Group of Echocardiography of the Italian Society of Cardiology (SIC)

[1]Department of Traslational Medical Sciences, Unit of Cardiology, University of Campania "Luigi Vanvitelli", Monaldi Hospital, Naples, Italy; [2]Unit of Cardiology and Intensive Coronary Care, "Umberto I" Hospital, Nocera Inferiore, Italy; [3]Department of Advanced Biomedical Sciences, Federico II University Hospital, Naples, Italy; [4]Division of Cardiology, Department of Medical Biotechnologies, University of Siena, Siena, Italy; [5]Department of Biomedical Sciences for Health, University of Milan, Milan, Italy; [6]Department of Medicine, Section of Cardiology, University of Verona, Verona, Italy; and [7]Department of Cardiology, Guglielmo da Saliceto Hospital, Piacenza, Italy

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Table 5 **Clinical and echocardiographic data associated with oxygen uptake (peak VO_2) during physical effort in HFpEF patients**

Type of variables	Model R^2	*P*-value	Variables selected (beta coefficient; 95% CI; *P*-value)
Clinical	4.3	<0.01	NT-proBNP (-0.40; -0.22 to 0.55; <0.01)
Clinical + standard echo	13.8	<0.001	LV *E*/*e*′ during ESE (-0.41; -0.28 to 0.49; $P < 0.001$)
			B lines during ESE (-0.30; -0.22 to 0.40; <0.01)
Clinical + standard echo + strain and work	19.7	<0.0001	Resting MWE (0.46; -0.35 to 0.52; <0.001)

medicina

MDPI

Article

Effects of High Intensity Interval Training Rehabilitation Protocol after an Acute Coronary Syndrome on Myocardial Work and Atrial Strain

Antonello D'Andrea [1,2,*], Andreina Carbone [1], Federica Ilardi [3], Mario Pacileo [2], Cristina Savarese [2], Simona Sperlongano [1], Marco Di Maio [4], Francesco Giallauria [3], Vincenzo Russo [1], Eduardo Bossone [5] and Eugenio Picano [6]

Table 5. Univariable analysis: Correlations between resting LV and LA echo indexes and functional parameters during effort in CR patients.

Variable		R	*p* Value
LV EF	VO_2 Peak	0.21	NS
	LV E/e′ during ESE	−0.31	<0.05
	B lines during ESE	−0.2	NS
LV GLS	VO_2 Peak	−0.40	<0.01
	LV E/e′ during ESE	0.33	<0.05
	B lines during ESE	0.23	NS
LA Strain	VO_2 Peak	0.36	<0.01
	LV E/e′ during ESE	−0.36	<0.01
	B lines during ESE	−0.28	<0.05
LV MWE	VO_2 Peak	0.52	<0.001
	LV E/e′ during ESE	−0.49	<0.001
	B lines during ESE	−0.39	<0.01

LV FE: left ventricular ejection fraction; GLS = global longitudinal strain; MWE: myocardial work efficiency. ESE = exercise stress echocardiography.

MYOCARDIAL WORK

- An **increase in afterload** may lead to reduced strain while the myocardial work may be preserved or even increased.
- Myocardial Work can be seen as a **less load dependent** measure of LV function than mere strain.

Se il lavoro nobilita l’uomo..

...IL MYOCARDIAL WORK NOBILITA..LO STRAIN!