PLACE

PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

ROMA
Centro Congressi
di Confindustria
Auditorium
della Tecnica

9ª Edizione

30 Settembre
1 Ottobre
2022

Echocardiographic Workshop

The assessment of left ventricular volumes and function.

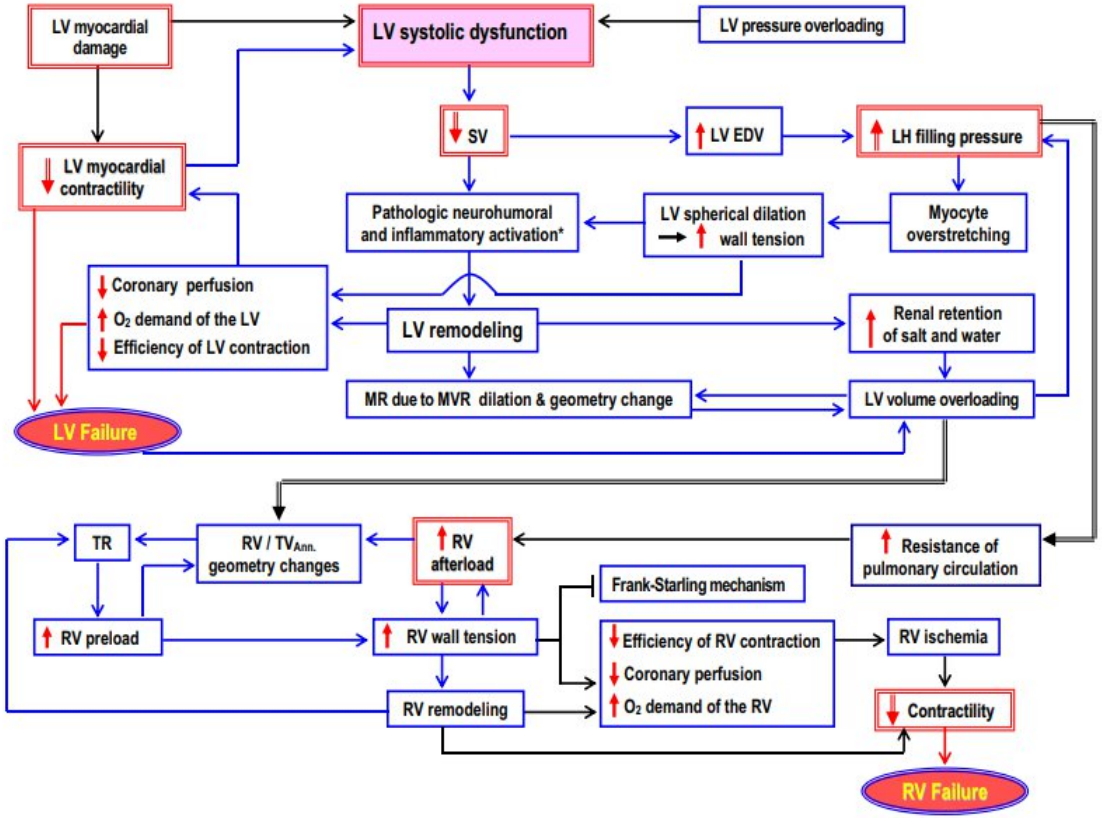
Perspectives from new echocardiographic tools.

Pellegrino Ciampi, MD

Policlinico Casilino

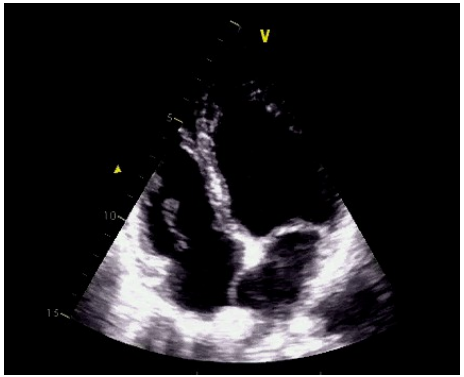
Rome, Italy

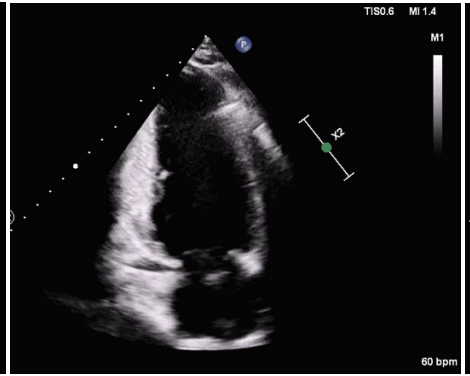
- Ischemic heart disease
- Valvular heart diseases
- Cardiomyopathies
- Heart failure
- Congenital heart disease

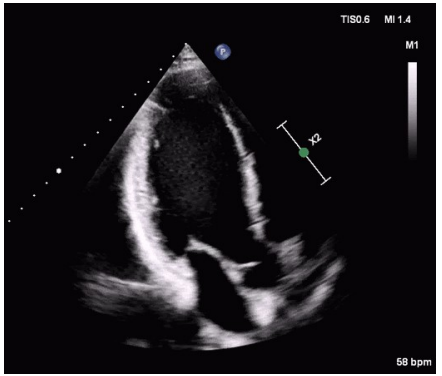


M. Dandel et al, International J of Cardiology 2021

How we do assess LV function?



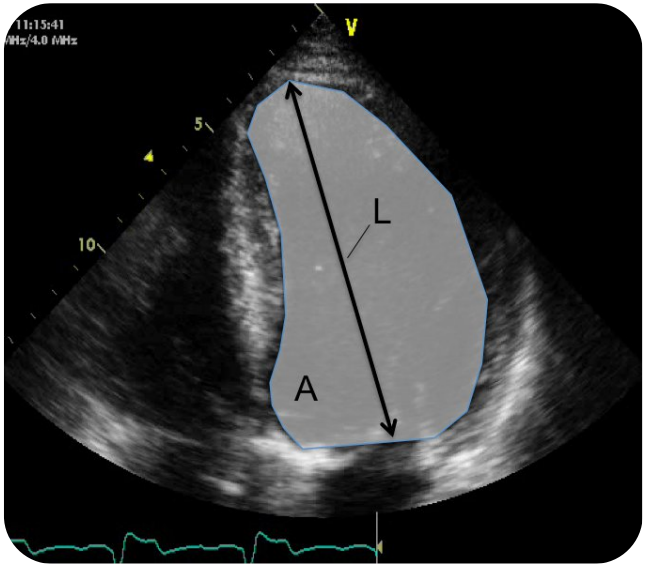


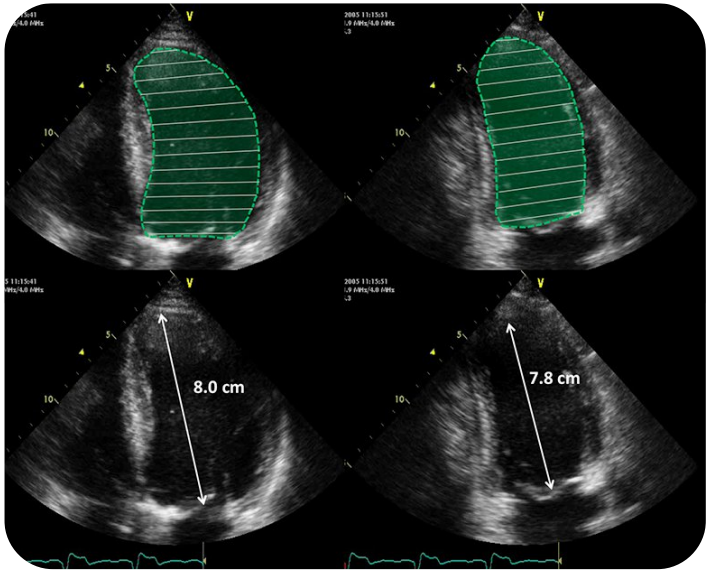


LIMITATIONS

- Subjective
- Experience dependent
- Lack of standardization
- Large inter- and intra-observer variability

Foreshortening





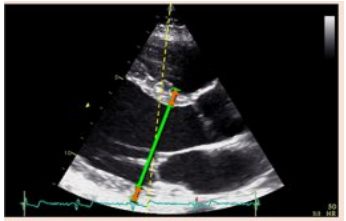
Geometry dependent

Tracing errors

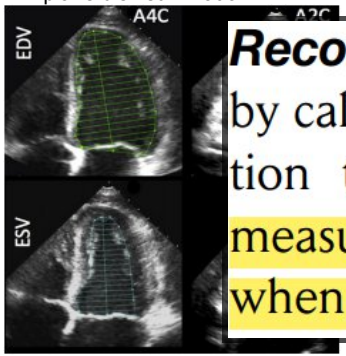
Lang RM. J Am Soc Echocardiography 2015:28:1-39

What is the accepted practice today

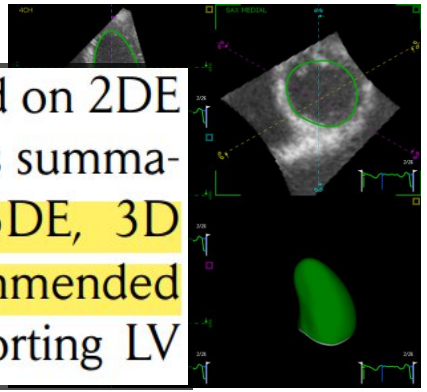
2DE linear measurements



Biplane disk summation



3DE data set



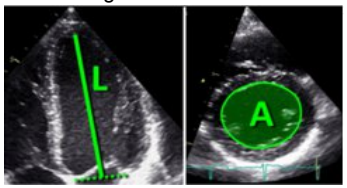
GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults:

Recommendation. LV size should be routinely assessed on 2DE by calculating volumes using the biplane method of disks summation technique. In laboratories with experience in 3DE, 3D measurement and reporting of LV volumes is recommended when feasible depending on image quality. When reporting LV

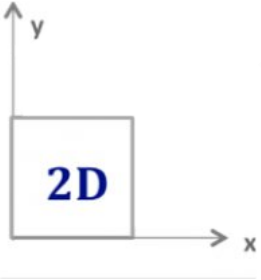
Washington, District of Columbia; Leuven, Liege, and Ghent, Belgium; Boston, Massachusetts

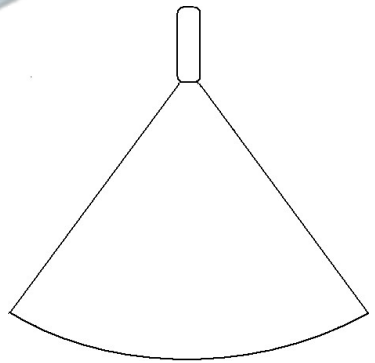
Area-lenght

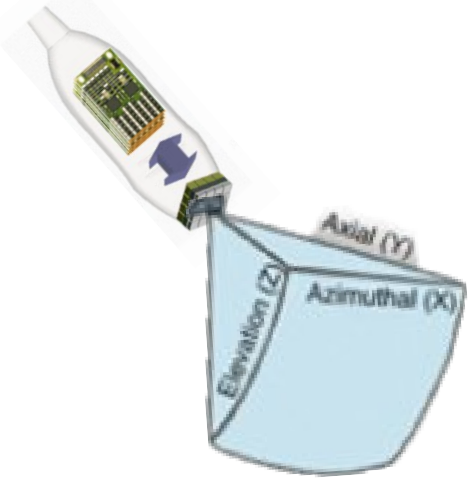


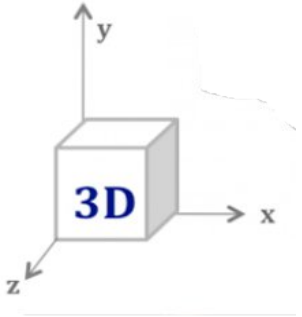
2D is the accepted practice for volume analysis and EF evaluation today with the acknowledgement that 3D is superior

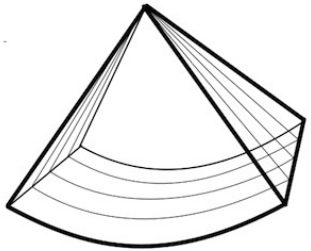
2D vs 3D Echocardiography











Different Modes of Acquisition

- **Simultaneous Multiplane mode**
- **Real-Time 3D Mode—Narrow Sector**
- **Focused Wide Sector—"ZOOM"**
- **Full Volume—Gated Acquisition**

Different Modes of Acquisition

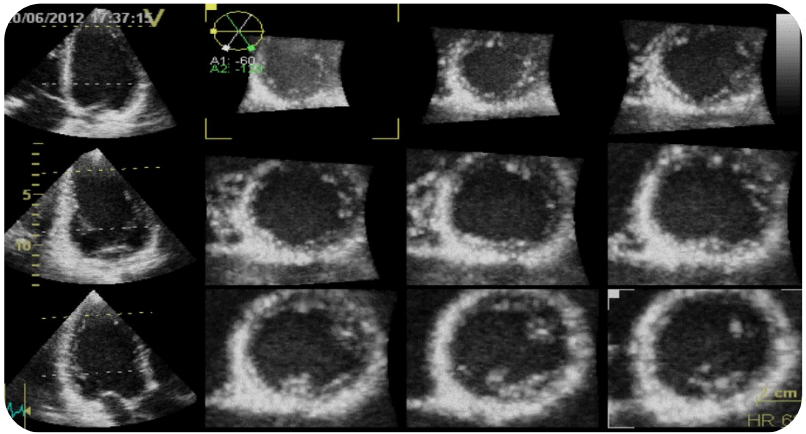
Real-Time 3D Mode

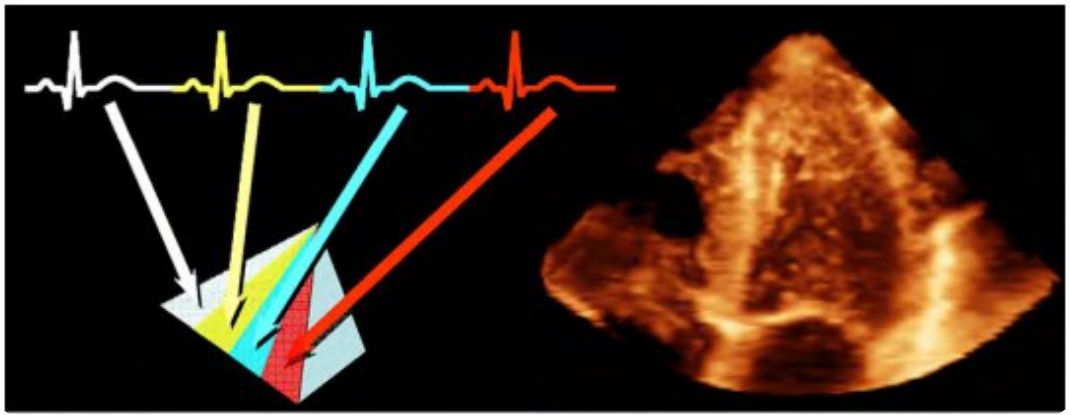
3D "ZOOM" Mode

3D Full Volume Mode

3DE acquisition of left ventricle

- The LV is generally acquired as a **Full-Volume dataset** over 4-6 heartbeats (**multi-beat acquisition**) during a **single breath-hold** by stitching together dynamic sub-volumes scanned during consecutive cardiac cycle





Lang Roberto M. et al, J Am Soc Echocardiogr 2012;25:3-46

3DE acquisition of left ventricle

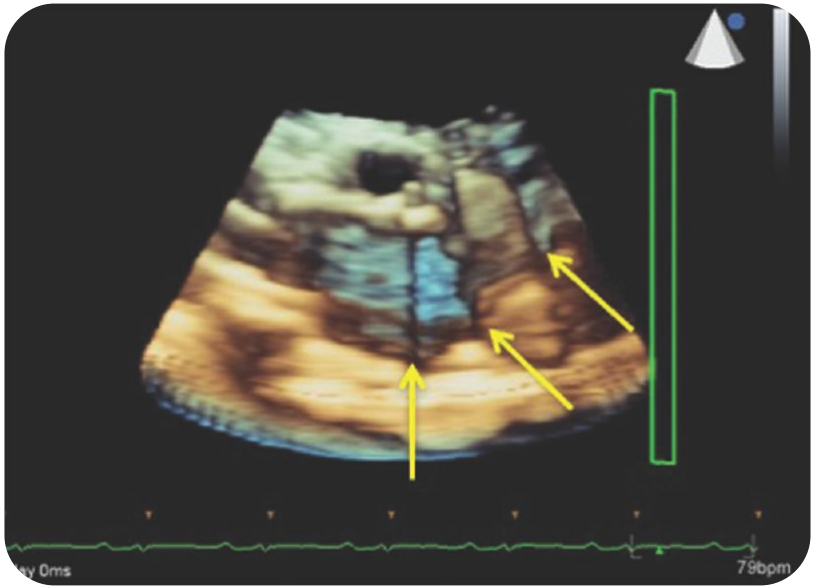
Multi-beat acquisition of LV

Advantage

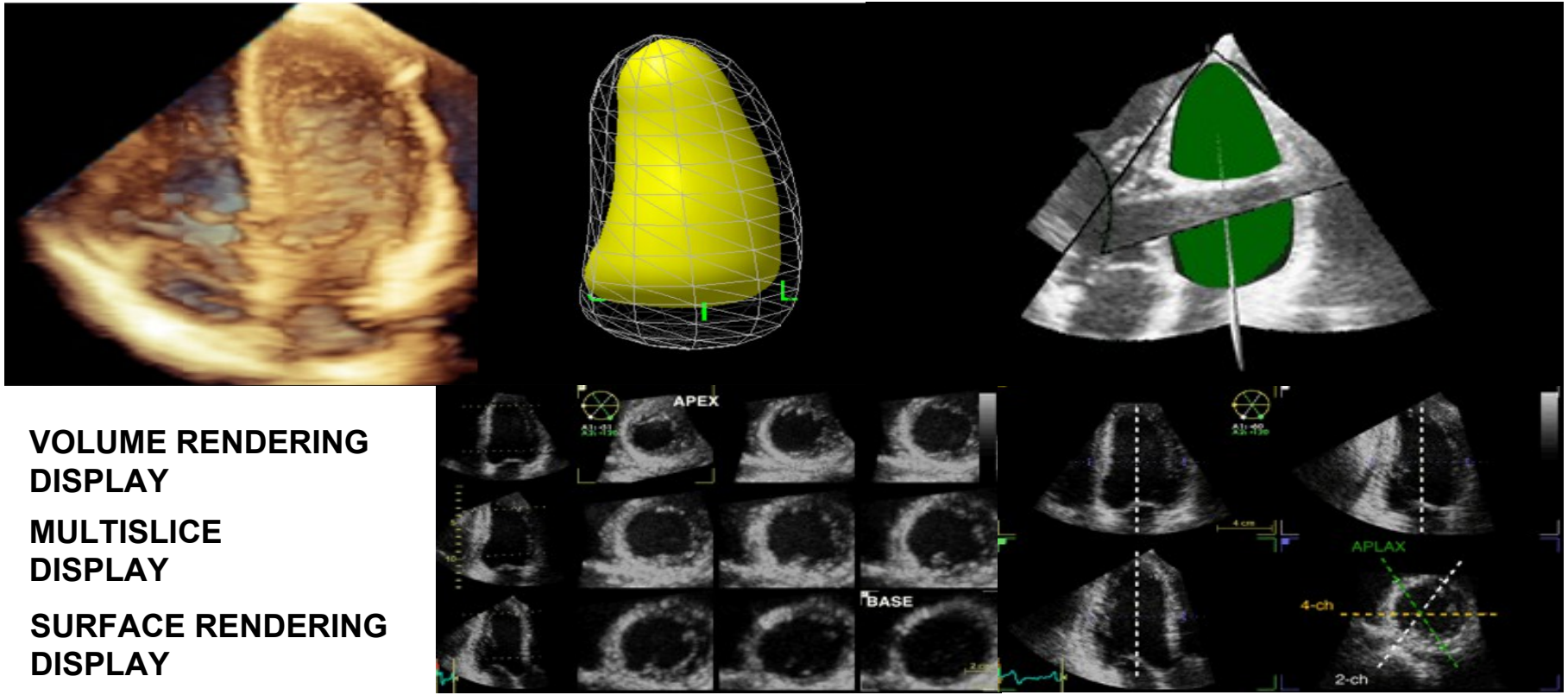
- Images with higher temporal and spatial resolution

Disadvantage

- Gated images are susceptible to artifacts from respiratory motion or cardiac arrhytmias (stitching artifacts)



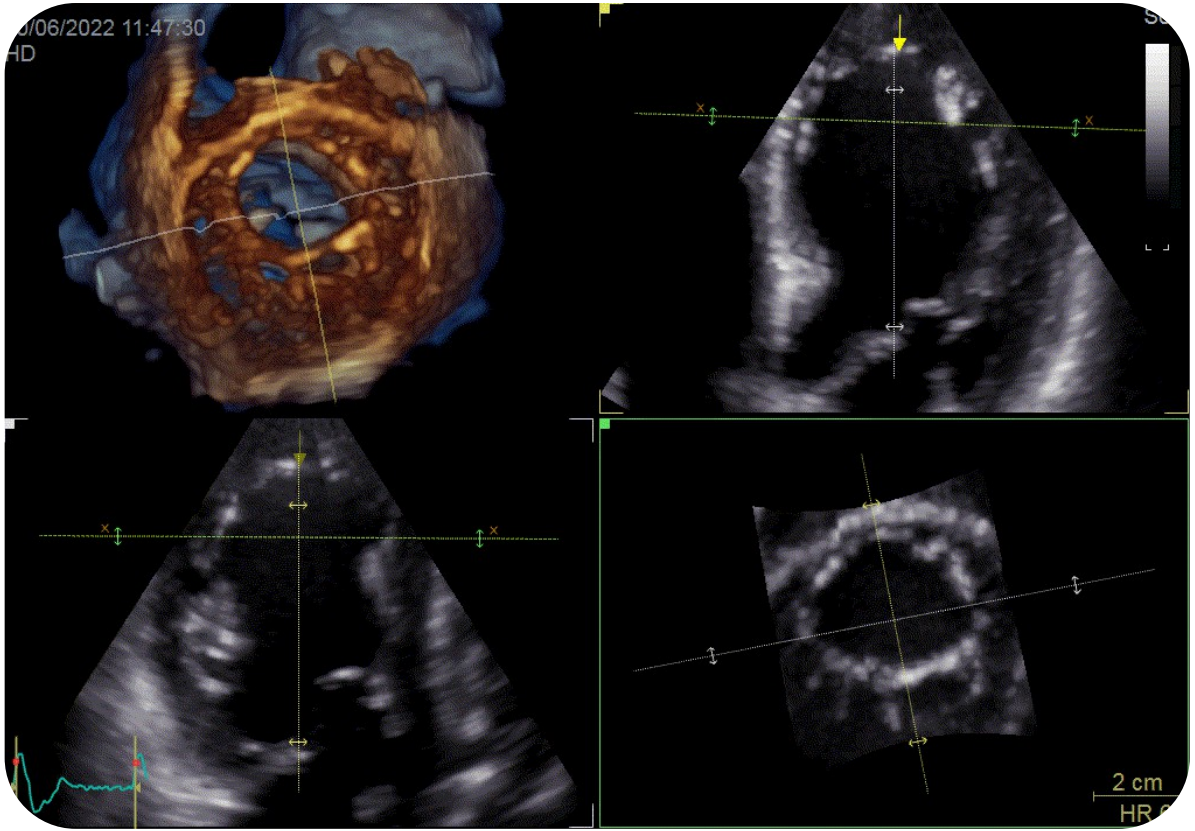
3DE dataset display of left ventricle



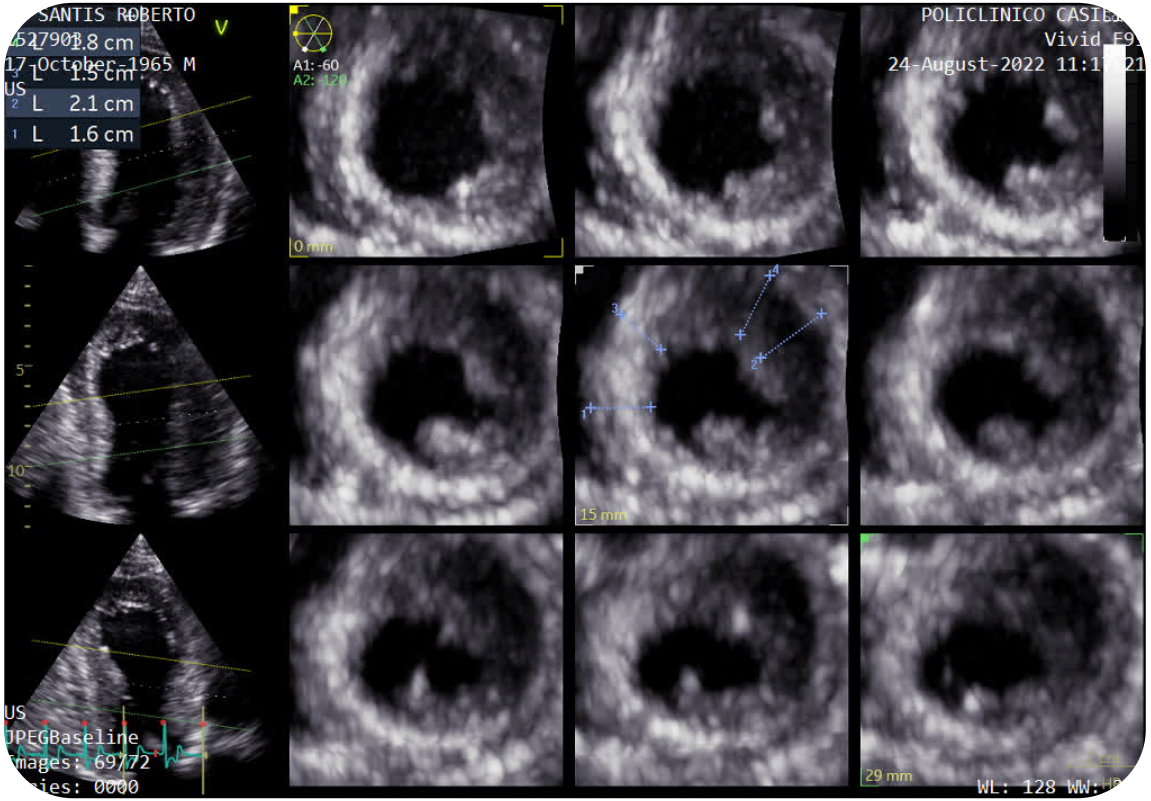
- **VOLUME RENDERING DISPLAY**
- **MULTISLICE DISPLAY**
- **SURFACE RENDERING DISPLAY**

Andrada C. Guta et al, Expert review of Cardiovascular Therapy2019

3DE dataset display of LV: volume rendering display



3DE dataset display of LV: multislice display



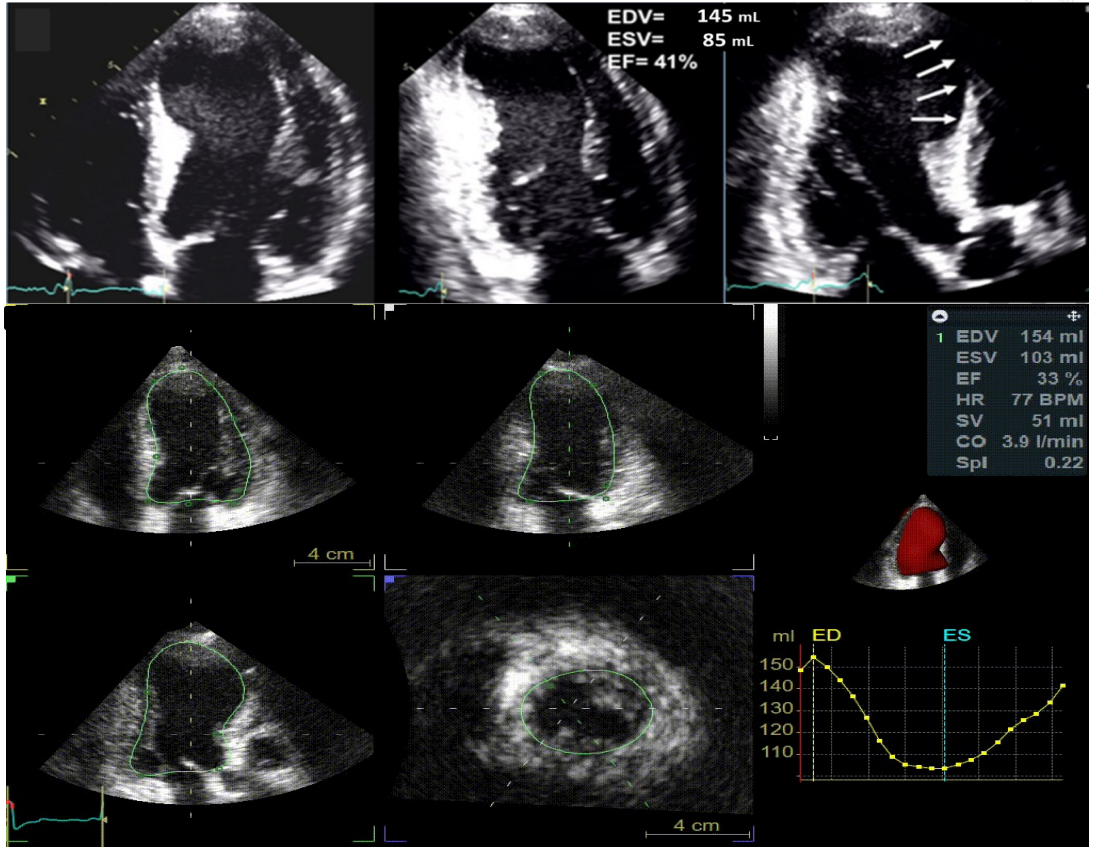
3DE assessment of LV size and systolic function: full-volume 3DE quantification

Advantages

- no geometric assumptions;
- more accurate than 2DE even in very dilated and aneurysmal ventricles;
- more reproducible than 2DE

Disadvantages

- time-consuming;
- requires training in 3DE analysis;
- accuracy varies with expertise;
- reproducibility varies among individuals



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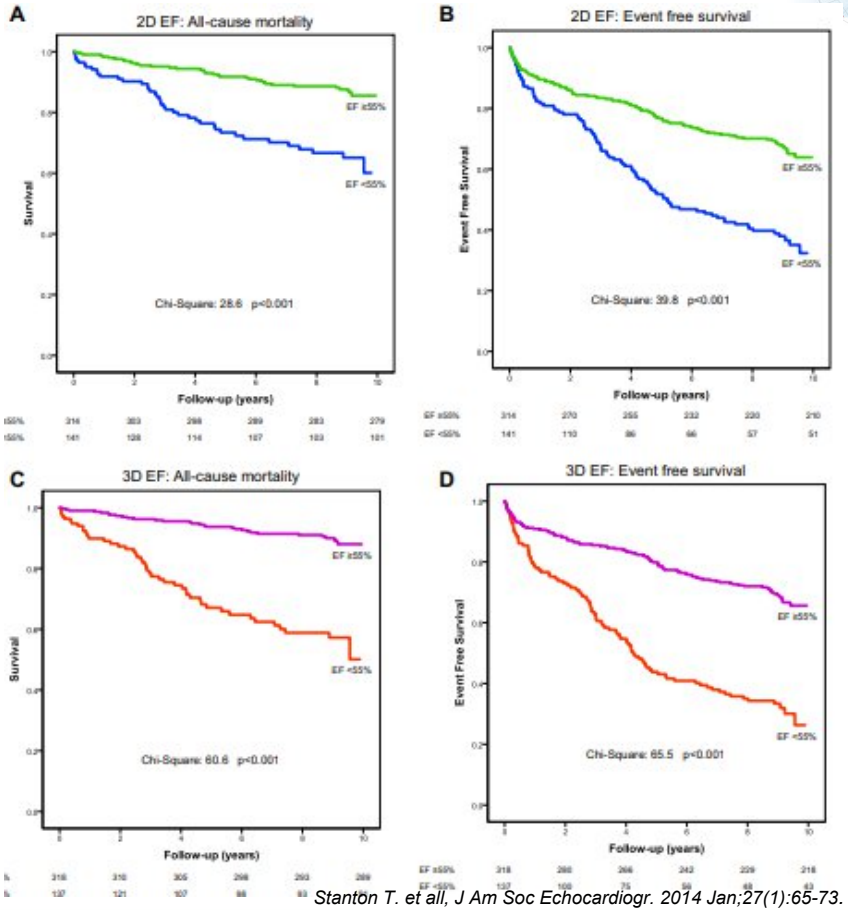
3DE assessment of LV size and systolic function: from theory to clinical practice

- 529 patients, with high frequency of cardiovascular risk factors, underwent LV assessment with 2DE and 3DE
- median follow up of 6,6 years
- 3DE EF and volumes showed stronger associations with outcomes than those derived from 2DE imaging



Stanton T. et all, J Am Soc Echocardiogr. 2014 Jan;27(1):65-73.

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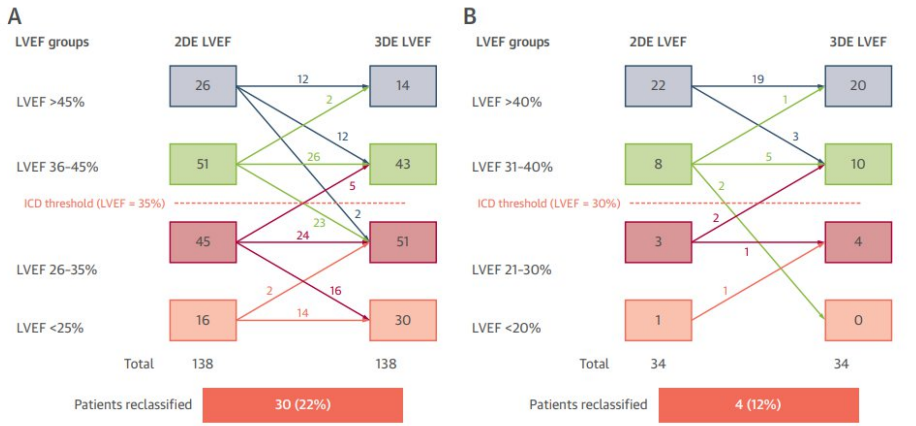
3DE assessment of LV size and systolic function: from theory to clinical practice

JACC Cardiovascular Imaging

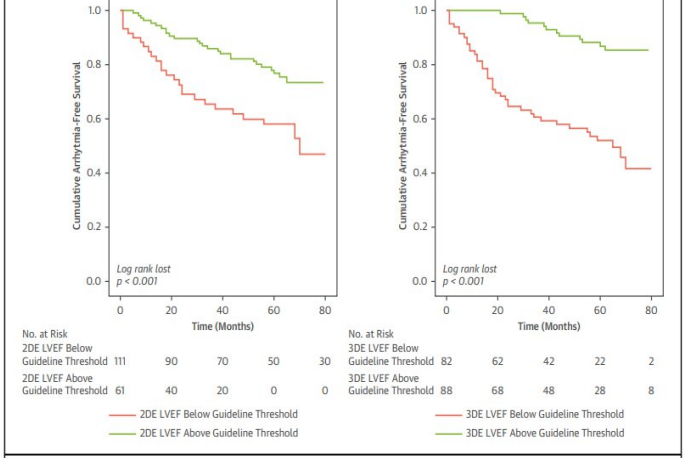
Added Value of 3- Versus 2-Dimensional Echocardiography Left Ventricular Ejection Fraction to Predict Arrhythmic Risk in Patients With Left Ventricular Dysfunction

FIGURE 2 Reclassification of Patients According to LVEF Using the American College of Cardiology/American Heart Association Guidelines Threshold Values Obtained by 2DE and 3DE



(A) Symptomatic patients and reclassification using an LVEF threshold ≤35%. **(B)** Asymptomatic patients with ischemic heart disease and reclassification using a LVEF threshold ≤30%. See Online Videos 1, 2, 3, and 4. ICD = implantable cardioverter-defibrillator; other abbreviations as in Figure 1.

FIGURE 4 Arrhythmia-Free Outcomes in Patients Meeting ACC/AHA Guideline Criteria for an ICD Using LVEF Measured by 2DE and 3DE



Using Kaplan Meier curves we show both patients with both **(A)** 2DE and **(B)** 3DE LVEF above guideline implant threshold have higher free outcome survival. ACC = American College of Cardiology; AHA = American Heart Association; other abbreviations as in Figures 1 and 2.

Rodríguez-Zanella H, Muraru D. et all, JACC Cardiovasc Imaging. 2019 Oct;12(10):1917-1926.

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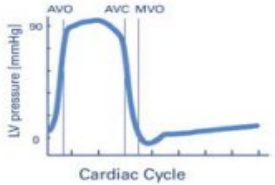
Myocardial Work: a new window on Myocardial Function using speckle tracking value

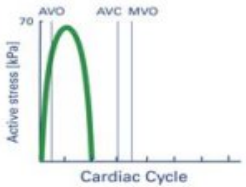
Segment interaction
Passive loading
proportional to local deformation of neigbouring segment

LV Pressure
Passive loading



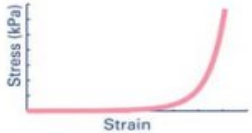
Load Dependancy!

Active contraction
Intrinsic contractility



Be careful: Strain is not Contractility

Elastic recoil
non-linear passive stress/strain relation
proportional to local deformation



R. Bijnens BH et all., Eur J Echocardiogr.

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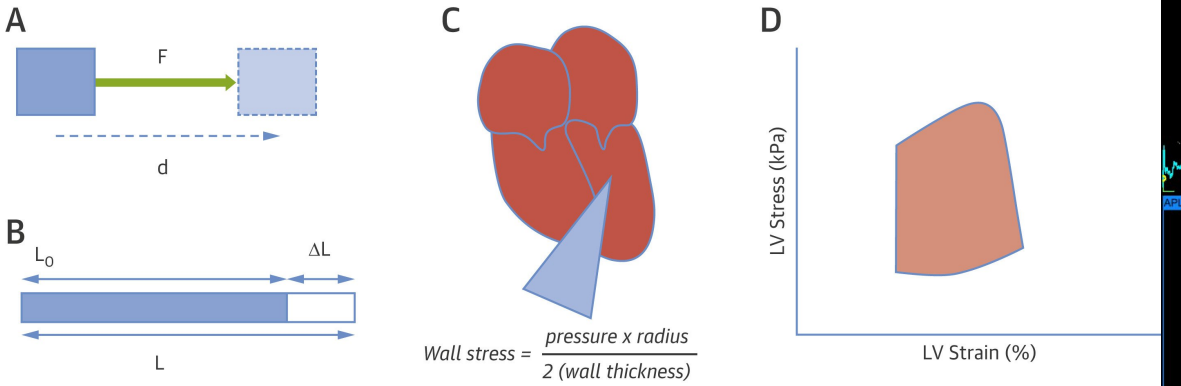
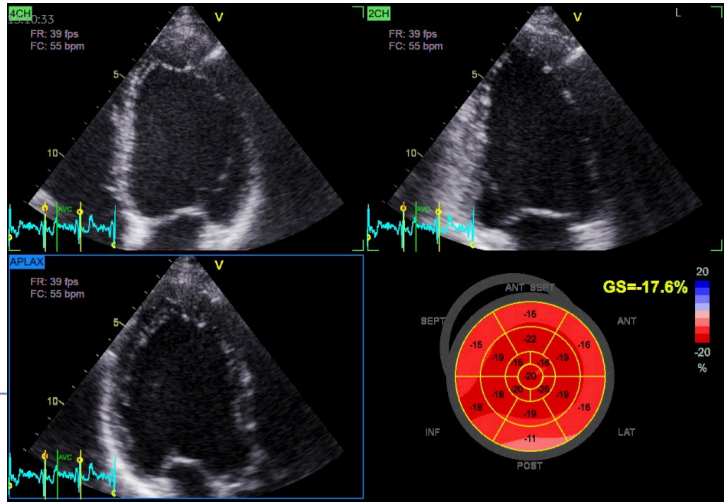
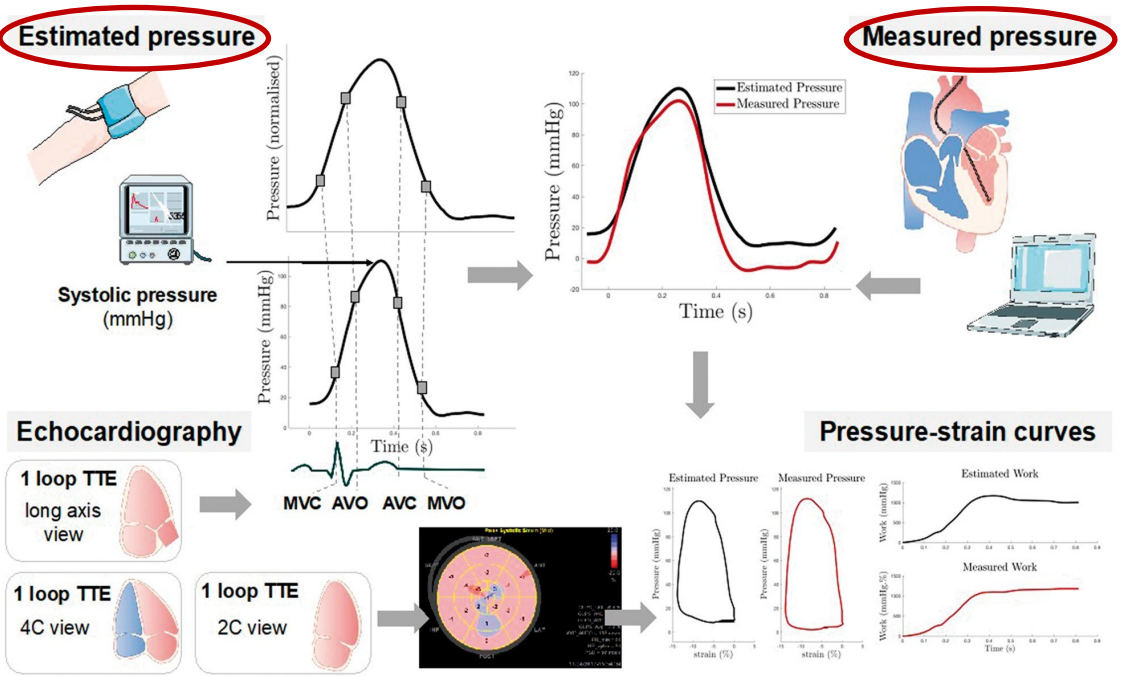
Myocardial Work is an index of LV performance incorporating afterload

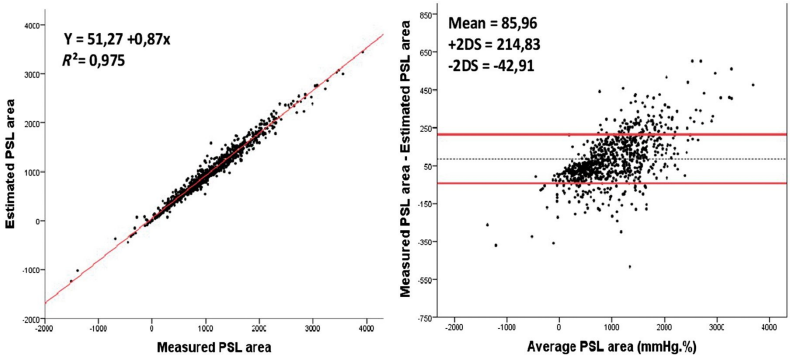


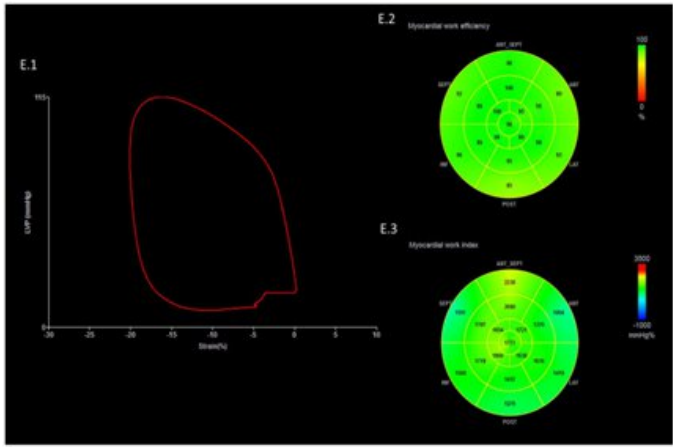


JACCi 2019.

Multiplying myocardial stress (Laplace law) and wall strain (longitudinal strain) provides a value for myocardial work







Arnaud Hubert et all., European Heart Journal Cardiovascular Imaging, 2019

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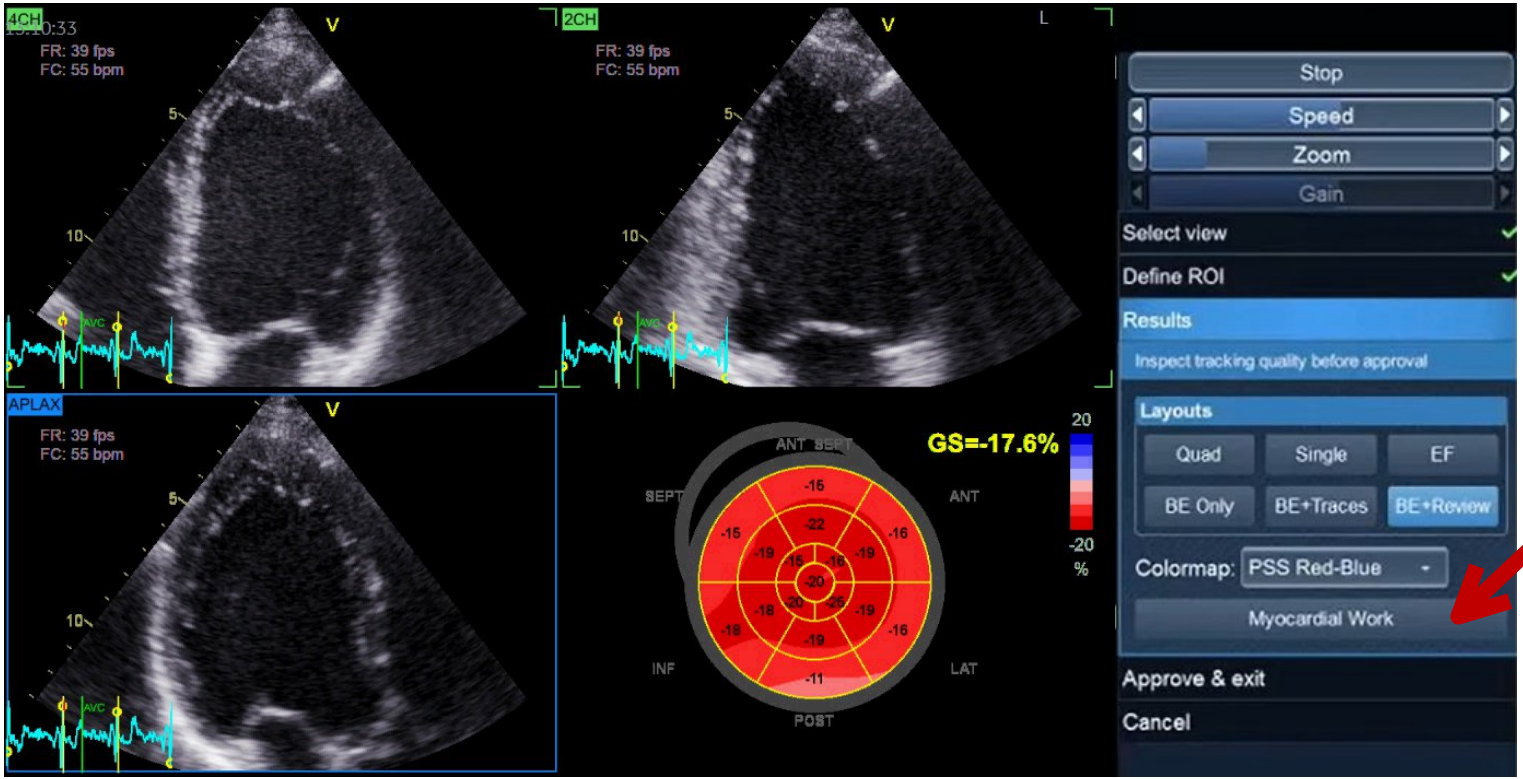
How to assess myocardial work in clinical practice



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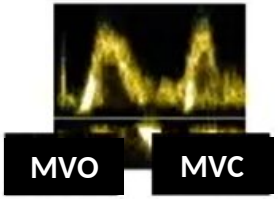
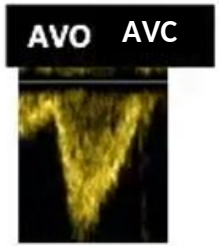
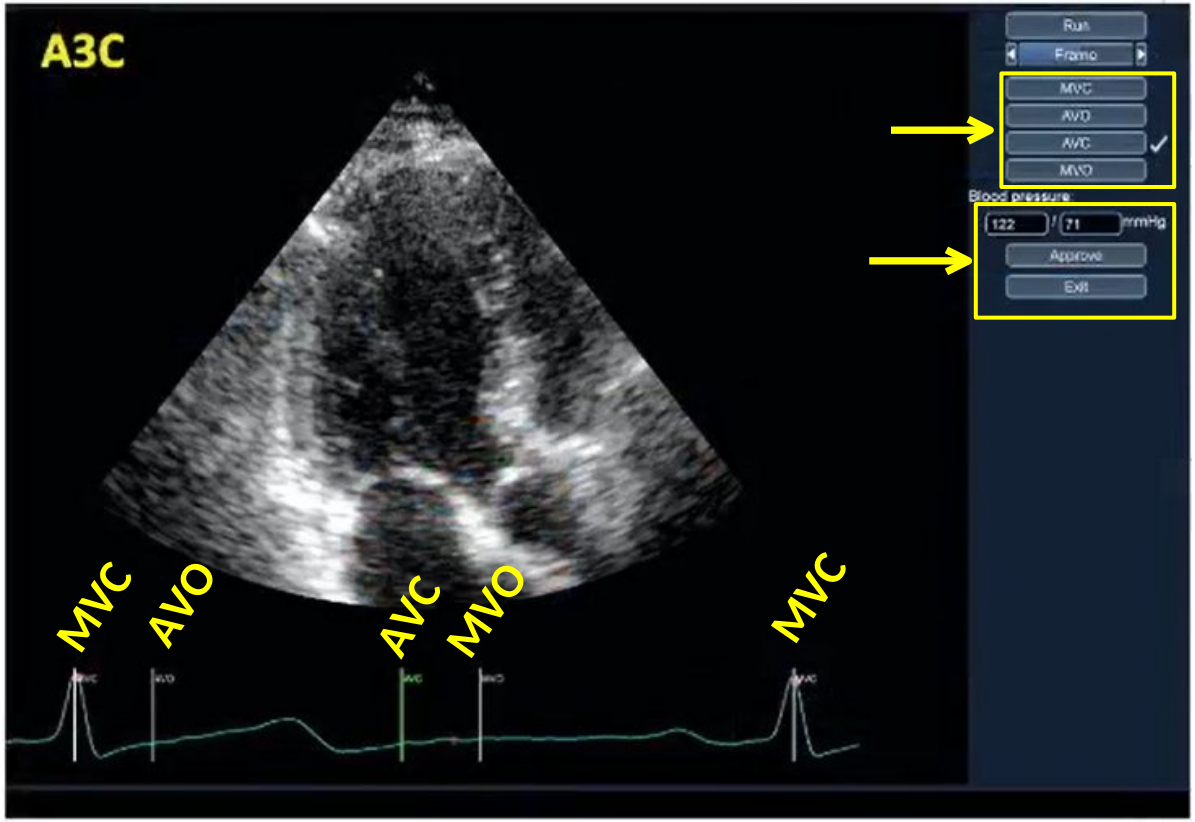
How to assess myocardial work in clinical practice

PW Doppler MV level

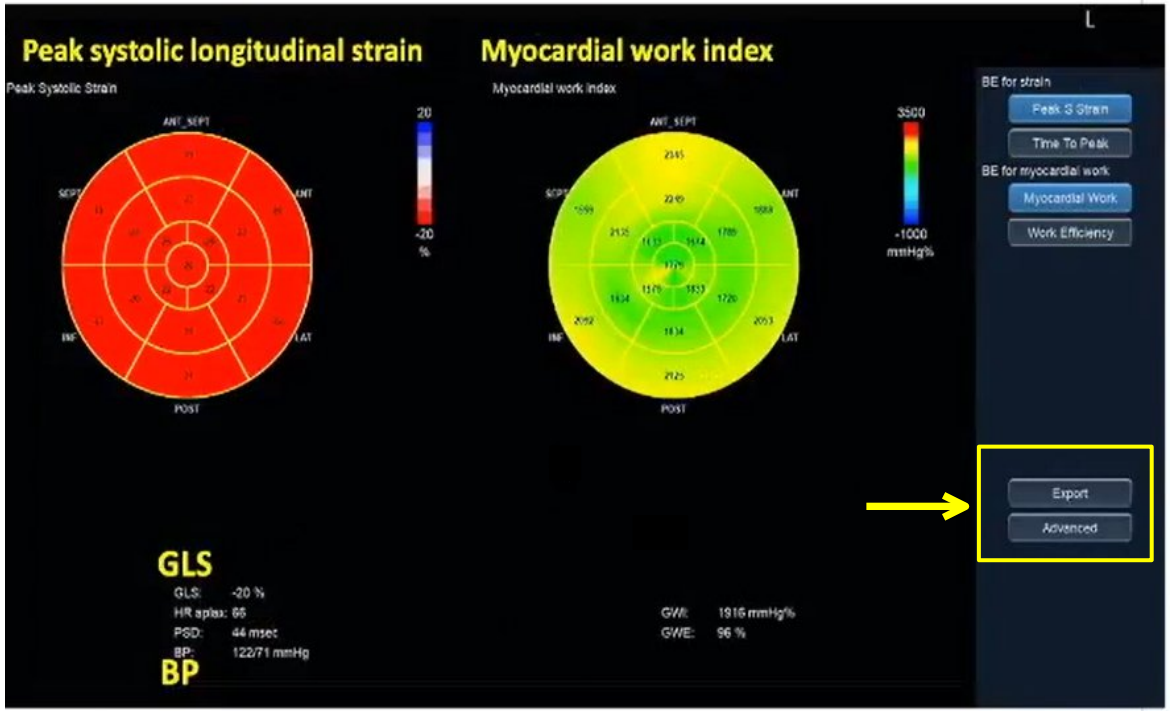




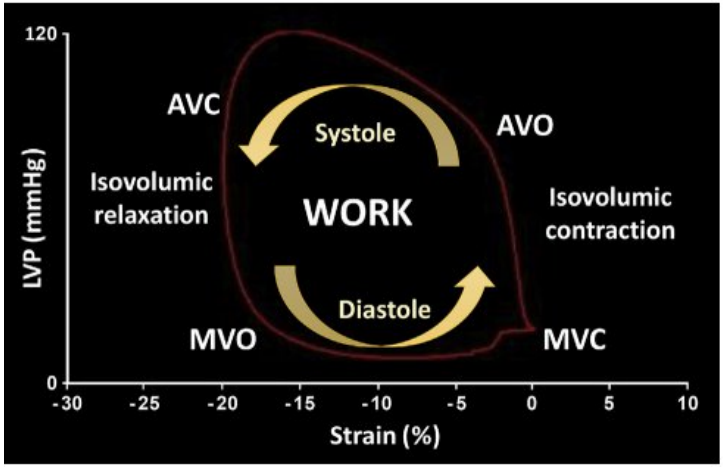
PW Doppler AV level



How to assess myocardial work in clinical practice

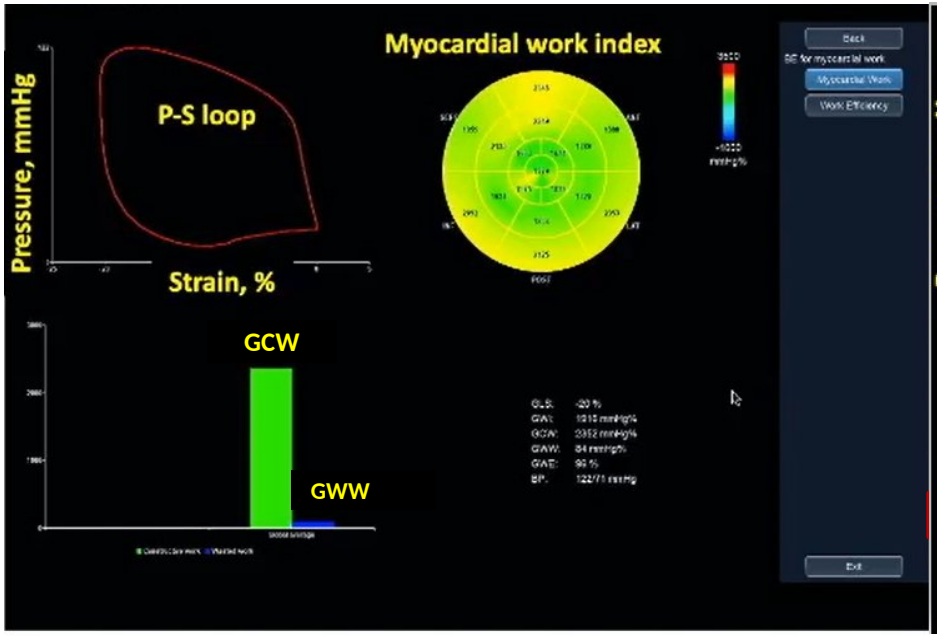


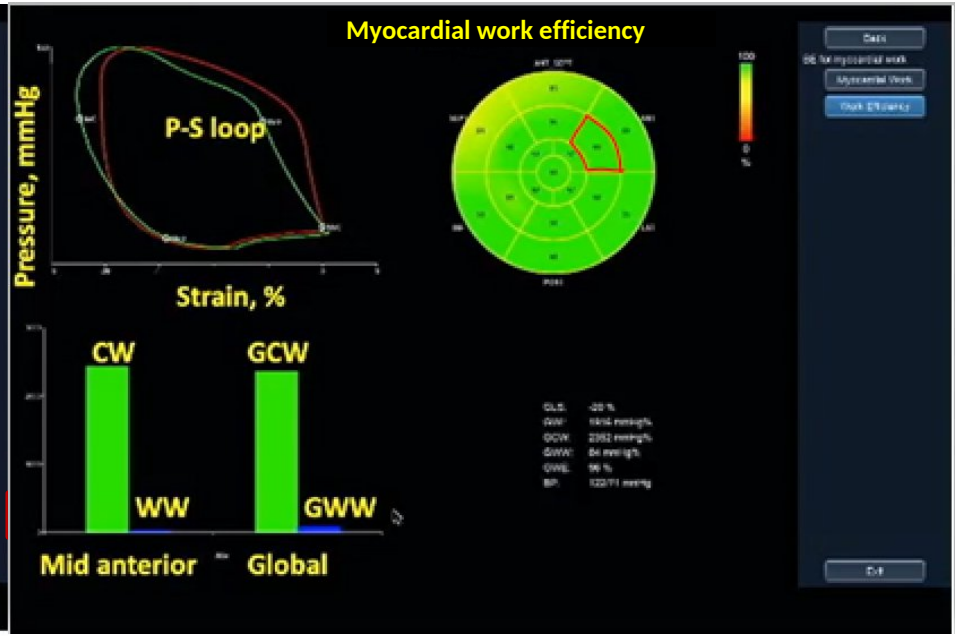
- **GWI**: total work performed by the LV during mechanical systole (MVC- MVO) plus IVC and IVR, reflected by the area within the PSL (normal values **1896 ± 308 mmHg%** [1292-2505]



Roemer S. et all., JASE 2021

How to assess myocardial work in clinical practice





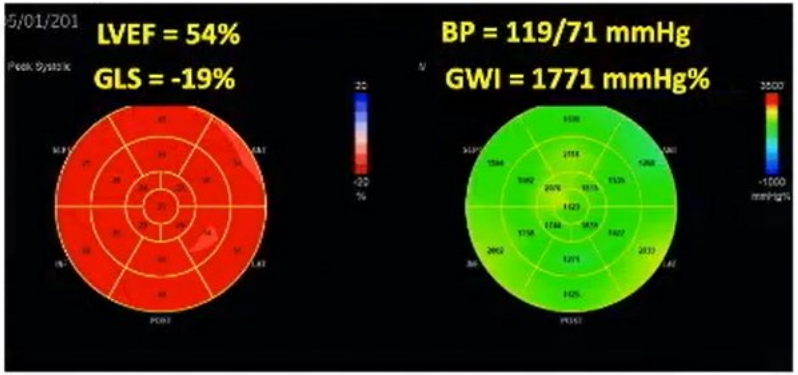
- **GCW**: (+)W systole + (-)W IVR **2232 ± 331 mmHg%**
- **GWW**: (-)W systole + (+)W IVR **79 (53-122) mmHg%**
- **GWE**: **GCW** / (**GCW** + **GWW**) **94-97%** (> **90%**)

The Utility of Myocardial Work in Clinical Practice

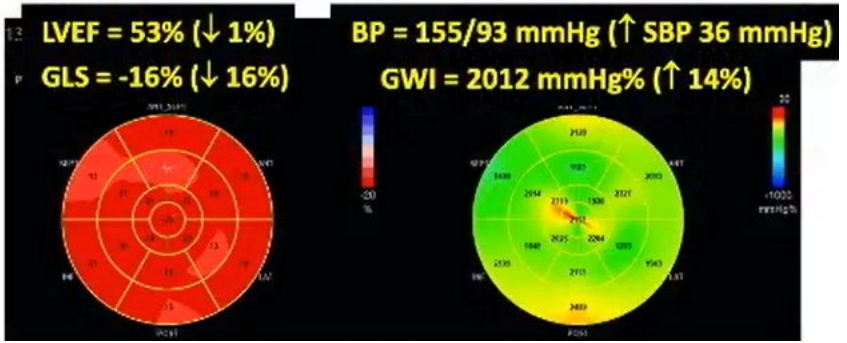
CARDIO-ONCOLOGY

55y W, Her2+ BC, E-C, trastuzumab

Baseline



Follow-up



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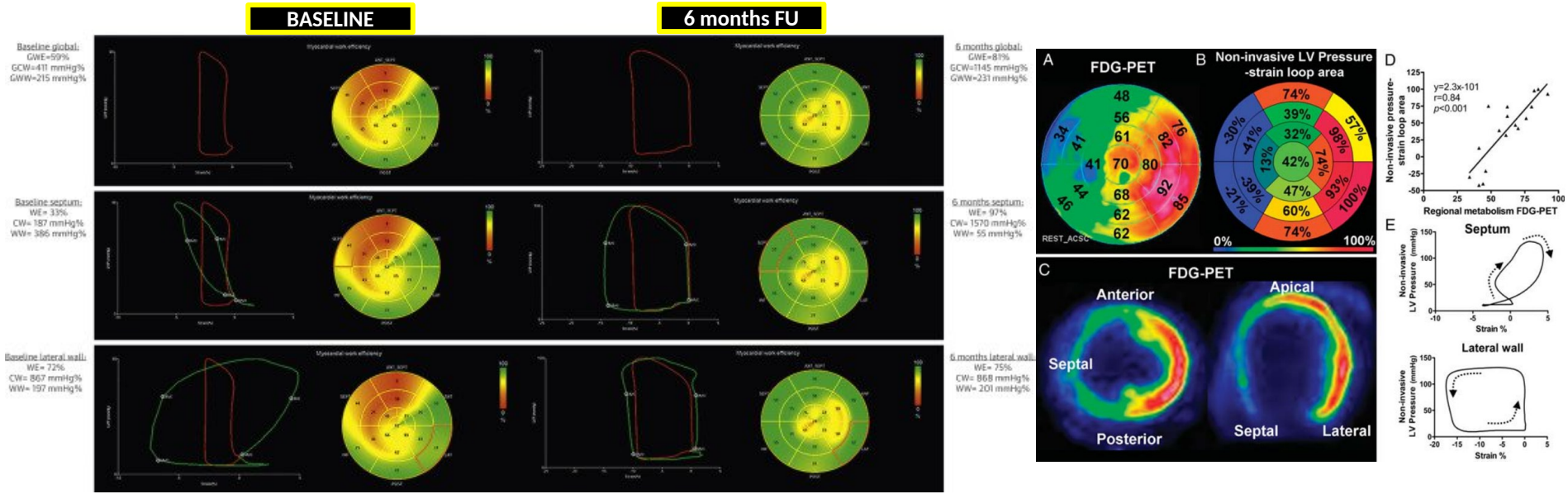
The Utility of Myocardial Work in Clinical Practice

IDENTIFICATION OF RESPONDERS TO CRT

65y M, non-ischemic DCM, LBBB, (QRS = 170 ms) and LVEF = 24%



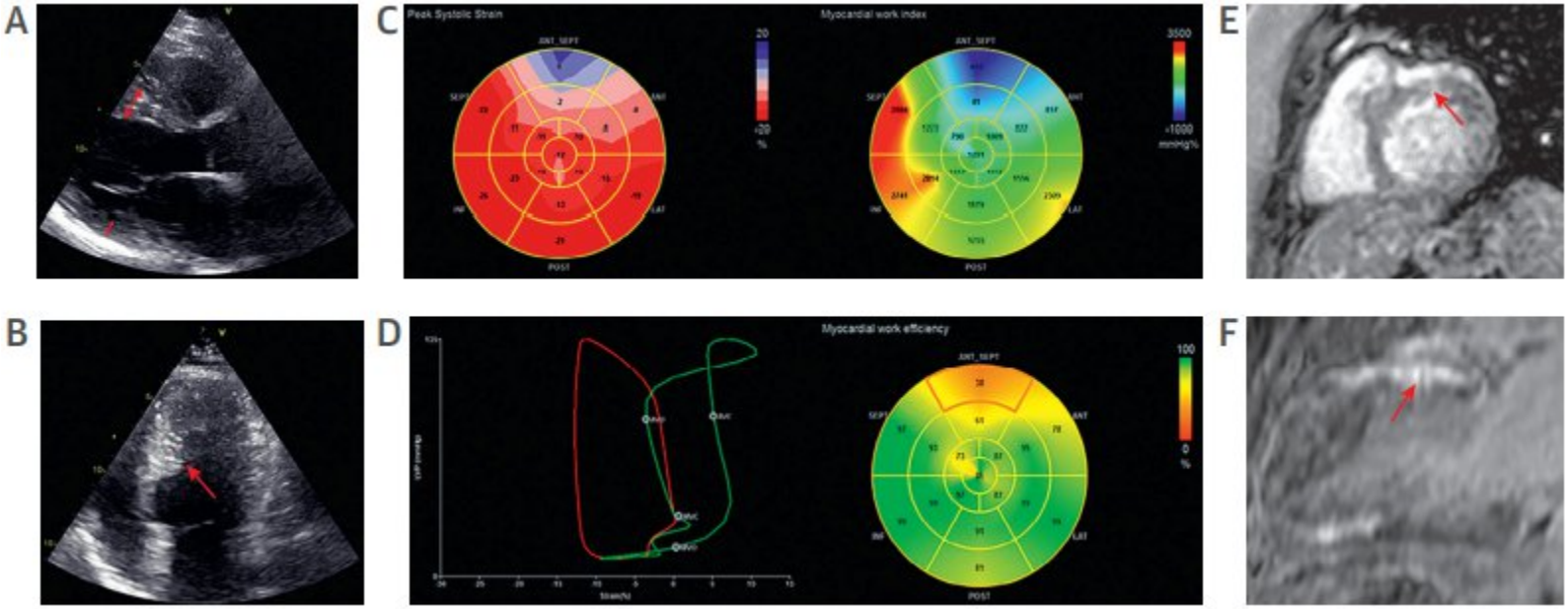
Van der Bijl P et all.. JACC Cardiovasc Imaging. 2019

B Russell K. et all., Eur Heart J. 2012

The Utility of Myocardial Work in Clinical Practice

HCM

41y F, HCM (LVEF = 61%)



Van der Bijl P et all.. JACC Cardiovasc Imaging. 2019

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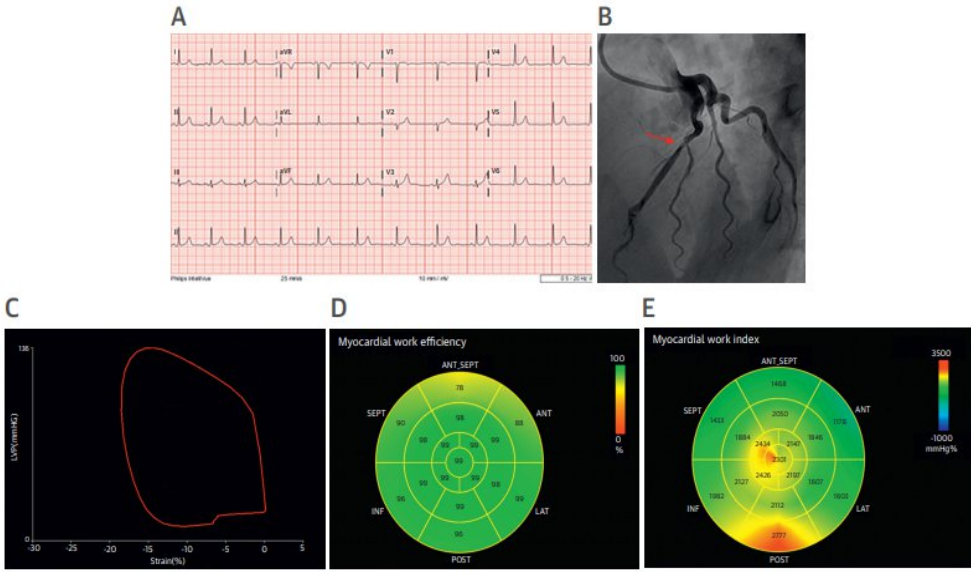
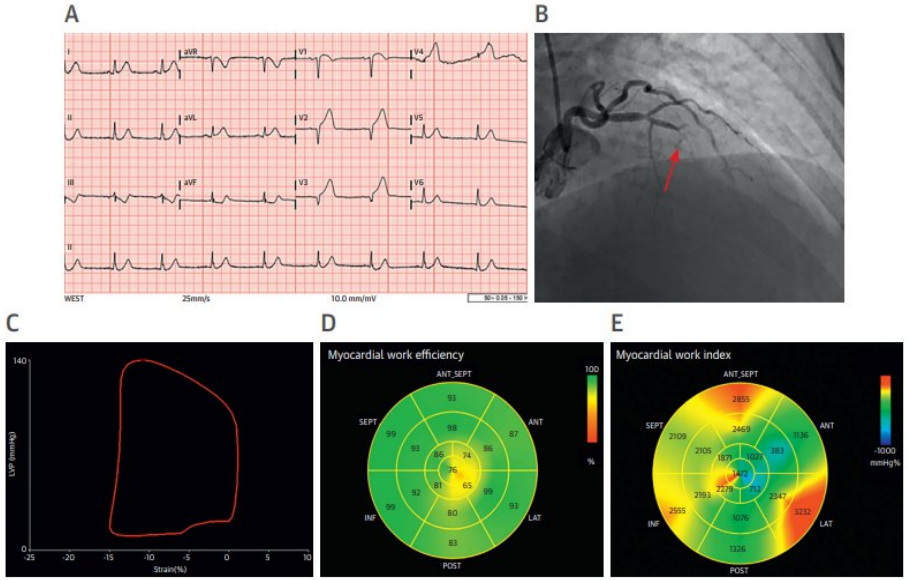
The Utility of Myocardial Work in Clinical Practice

ACS

52y F, DM, NSTEMI



49y F, STEMI

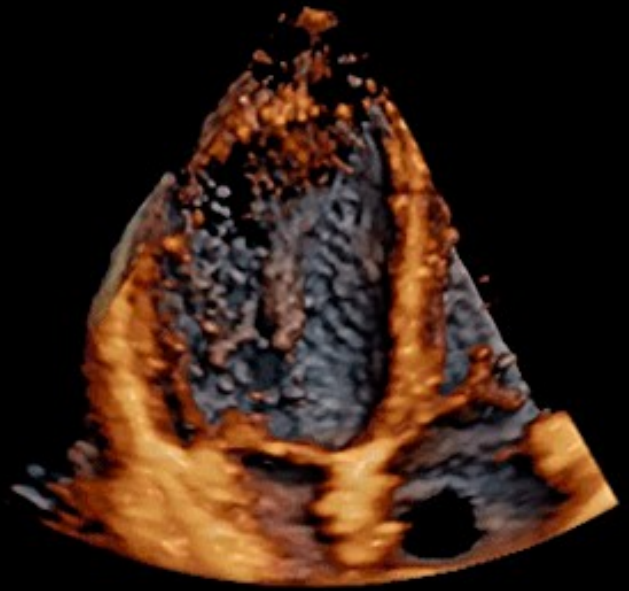


Van der Bijl P et all.. JACC Cardiovasc Imaging. 2019

Take-Home Messages

- 3DE allows the assessment of the anatomy of LV non being limited to a number of thin tomographic views as conventional 2DE
- LV volumes are more accurate, reproducible and repeatable when measured with 3DE
- LV volumes and EF measured by 3DE have added prognostic power compared with 2DE measurements
- MW is advanced analysis of LV function by including BP and afterload
- MW is more sensitive than GLS and LVEF as it overcomes load-dependent limitations
- MW shows high correlation with myocardial contractility than GLS
- Clinical applications can be applied across a multitude of diseases

THANKS FOR YOUR ATTENTION



PLACE

PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE