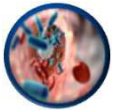
DIU TUSAR

Bordeaux – Lundi 15 décembre 2025



Fonction systolique du ventricule gauche

Philippe Vignon

Réanimation Polyvalente
Inserm CIC 1435
CHU Limoges

Généralités

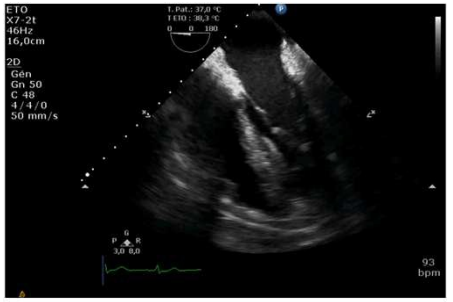
- Motif le plus fréquent pour réaliser une échocardiographie
- Doit être évaluée systématiquement au cours d'une échocardiographie (quelle que soit l'indication)
- Niveau basique : évaluation semi-quantitative (visuelle)
- Niveau avancé : évaluation quantitative (mesure)
- Aucun paramètre n'évalue directement la contractilité, mais la fonction systolique qui dépend des conditions de charge du VG
- Requiert un entraînement spécifique (courbe d'apprentissage)
- Peut varier rapidement dans le temps : évaluations répétées.

1- Fraction d'éjection (FEVG)

FE (%) = VTD – VTS / VTD (mL)

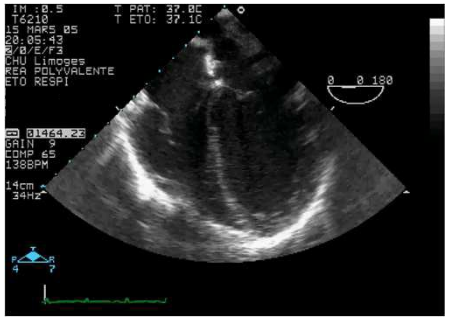
- Paramètre de fonction systolique VG le plus utilisé
- Intègre la contractilité myocardique et les conditions de charge du VG (précharge & postcharge)
- Indice de fonction systolique du VG "normalisé" par la géométrie du VG et la précharge (volume télédiastolique)
- Valeur normale : couplage ventriculo-artériel efficient.

80%



60%

10%



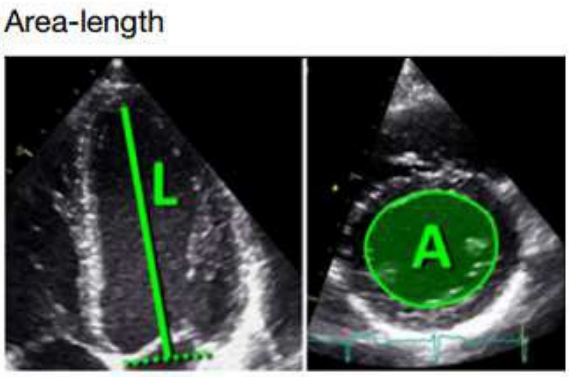
Fraction d'éjection = Volume d'éjection systolique / Précharge VG

FEVG : mesure dans le grand axe du coeur

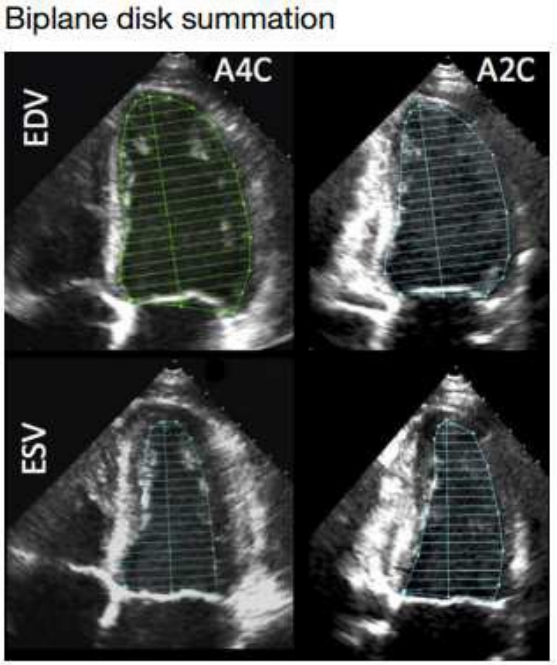
GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Roberto M. Lang, MD, FASE, FESC, Luigi P. Badano, MD, PhD, FESC, Victor Mor-Avi, PhD, FASE, Jonathan Afilalo, MD, MSc, Anderson Armstrong, MD, MSc, Laura Ernande, MD, PhD, Frank A. Flachskampf, MD, FESC, Elyse Foster, MD, FASE, Steven A. Goldstein, MD, Tatiana Kuznetsova, MD, PhD, Patrizio Lancellotti, MD, PhD, FESC, Denisa Muraru, MD, PhD, Michael H. Picard, MD, FASE, Ernst R. Rietzschel, MD, PhD, Lawrence Rudski, MD, FASE, Kirk T. Spencer, MD, FASE, Wendy Tsang, MD, and Jens-Uwe Voigt, MD, PhD, FESC, *Chicago, Illinois; Padua, Italy; Montreal, Quebec and Toronto, Ontario, Canada; Baltimore, Maryland; Créteil, France; Uppsala, Sweden; San Francisco, California; Washington, District of Columbia; Leuven, Liège, and Ghent, Belgium; Boston, Massachusetts*



Fondée sur des assomptions géométriques

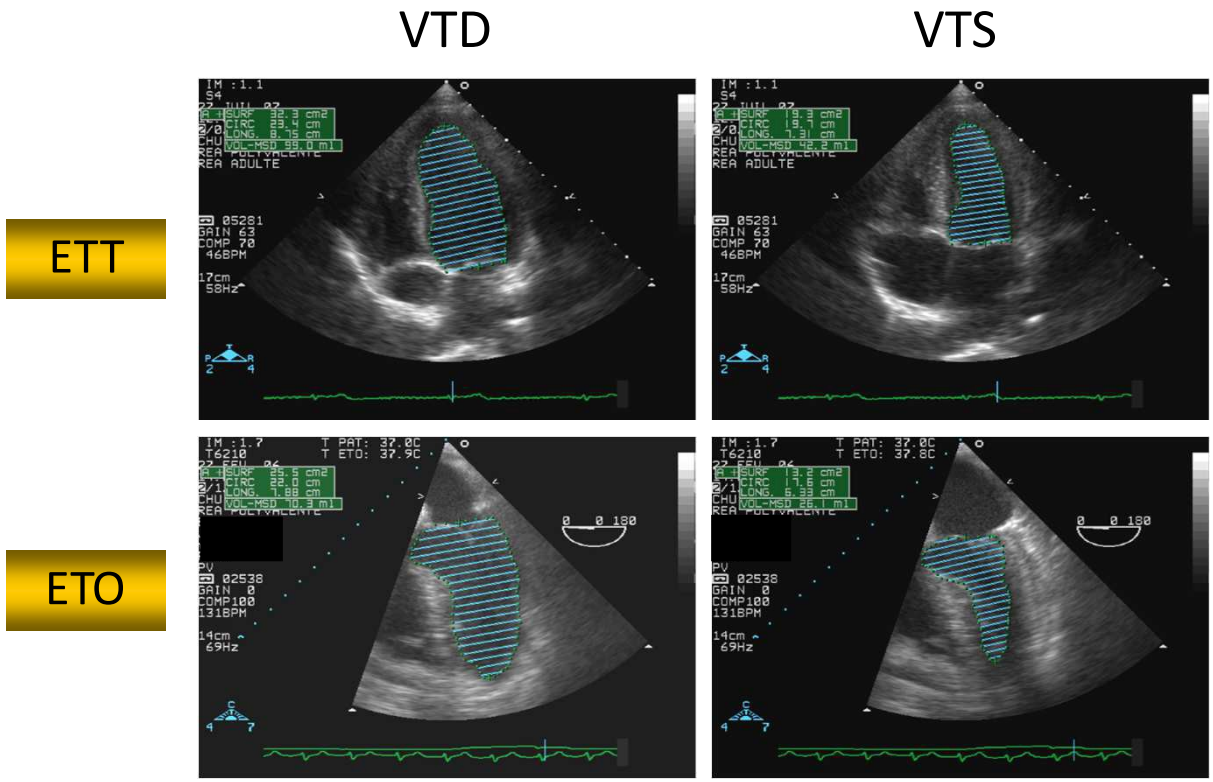


Corrige les distorsions anatomiques (moins d'assomptions)

Lang RM et al. JASE 2015; 28:1-39

FEVG : mesure en vue des 4 cavités

- Ne pas tronquer la vue 4 cavités
- Identifier précisément l'anneau mitral septal et latéral, puis la pointe du VG
- Inclure les muscles papillaires et les trabéculations dans la cavité VG
- Ajuster le traçage de l'endocarde manuellement avant validation
- Répéter en télédiastole et télésystole (± en 2 cavités) et moyenner.



FEVG : les paramètres qui l'influencent (1)

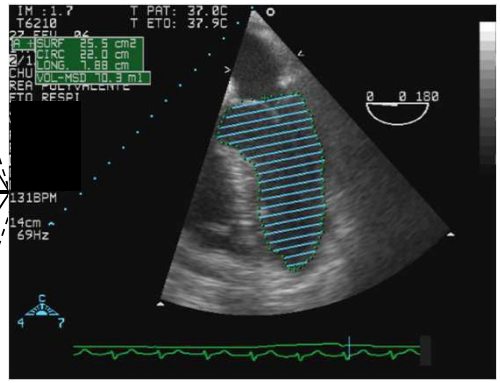
LV-RV interactions*

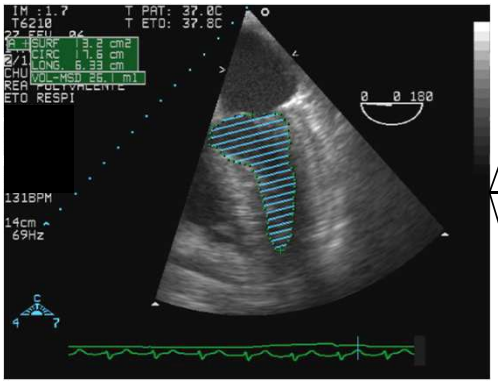
Heart rate

LV compliance

LV preload

LV remodeling*





Volume télédiastolique

Volume télésystolique

LV contractility

LV afterload

LV remodeling*

: physiological factors

: pathological factors

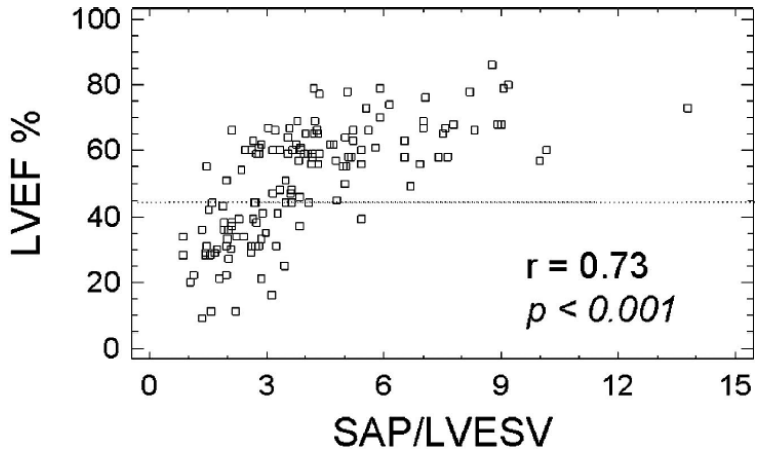
P. Vignon. Assessment of critically-ill patients with acute heart failure syndromes using echocardiography Doppler. In: Acute heart failure syndromes, Mebazaa A. Ed, Springer 2008

FEVG : les paramètres qui l'influencent (2)

Early Preload Adaptation in Septic Shock?

A Transesophageal Echocardiographic Study

Antoine Vieillard-Baron, M.D., Jean-Marie Schmitt, M.D.,† Alain Beauchet, M.D.,‡ Roch Augarde, M.D.,† Sebastien Prin, M.D.,† Bernard Page, M.D.,§ François Jardin, M.D.‖*



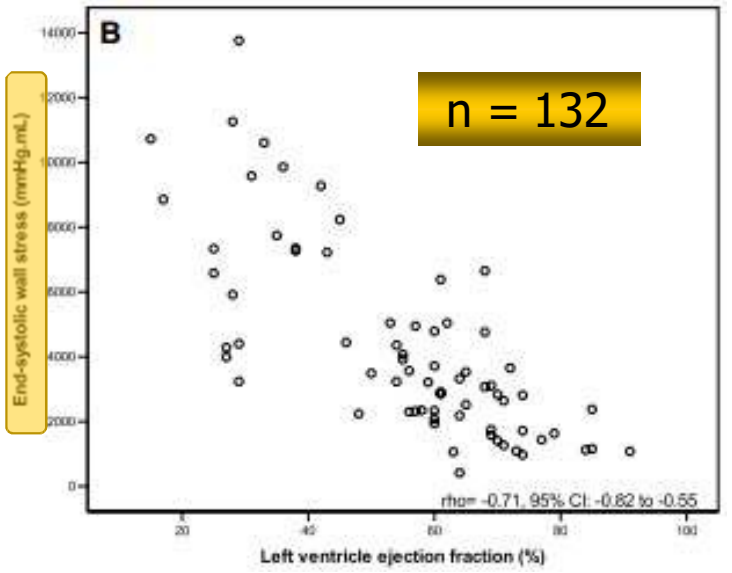
(Succédané de Emax : contractilité VG)

Vieillard-Baron A et al. Anesthesiology 2001; 94: 400-6

ORIGINAL

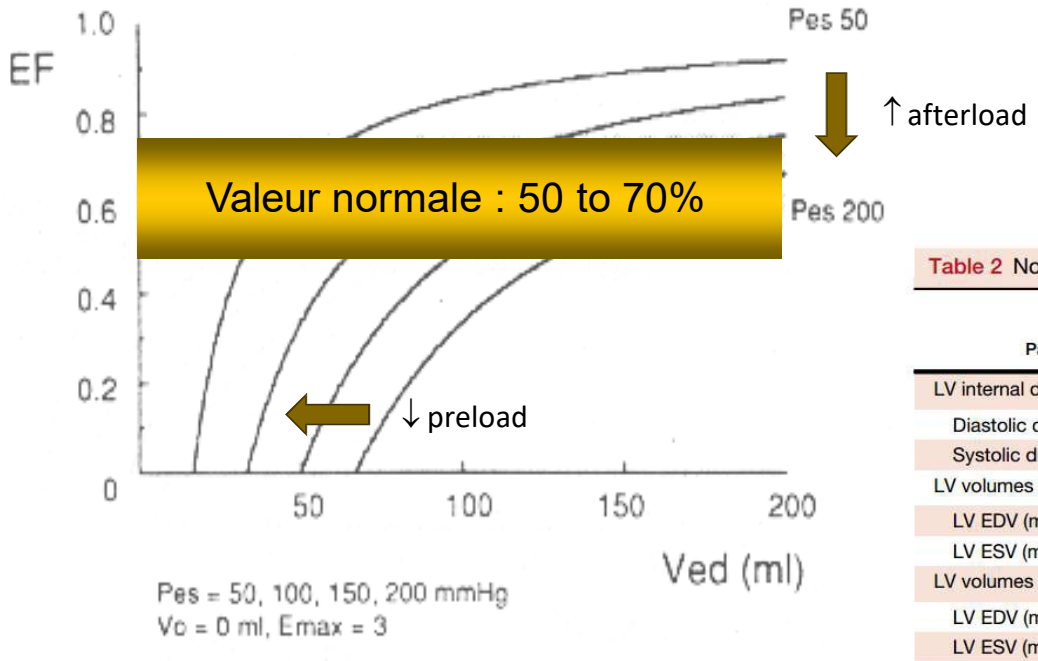
Left ventricular systolic dysfunction during septic shock: the role of loading conditions

Florence Boissier[1,2,4,5], Keyvan Razazi[1,2], Aurélien Seemann[1,3], Alexandre Bedet[1,2], Arnaud W. Thille[1,4,5], Nicolas de Prost[1,2], Pascal Lim[3], Christian Brun-Buisson[1,2] and Armand Mekontso Dessap[1,2,6*]



Intensive Care Med 2017 43: 633-42

FEVG : valeurs normales



Robotham JL et al. Anesthesiology 1991 ; 74 : 172-83.

GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Roberto M. Lang, MD, FASE, FESC, Luigi P. Badano, MD, PhD, FESC, Victor Mor-Avi, PhD, FASE, Jonathan Afilalo, MD, MSc, Anderson Armstrong, MD, MSc, Laura Ernande, MD, PhD, Frank A. Flachskampf, MD, FESC, Elyse Foster, MD, FASE, Steven A. Goldstein, MD, Tatiana Kuznetsova, MD, PhD, Patrizio Lancellotti, MD, PhD, FESC, Denisa Muraru, MD, PhD, Michael H. Picard, MD, FASE, Ernst R. Rietzschel, MD, PhD, Lawrence Rudski, MD, FASE, Kirk T. Spencer, MD FASE, Wendy Tsang, MD, and Jens-Uwe Voigt, MD, PhD, FESC, *Chicago, Illinois; Padua, Italy; Montreal, Quebec and Toronto, Ontario, Canada; Baltimore, Maryland; Créteil, France; Uppsala, Sweden; San Francisco, California; Washington, District of Columbia; Leuven, Liège, and Ghent, Belgium; Boston, Massachusetts*

Table 2 Normal values for 2D echocardiographic parameters of LV size and function according to gender

Parameter	Male		Female	
	Mean ± SD	2-SD range	Mean ± SD	2-SD range
LV internal dimension				
Diastolic dimension (mm)	50.2 ± 4.1	42.0–58.4	45.0 ± 3.6	37.8–52.2
Systolic dimension (mm)	32.4 ± 3.7	25.0–39.8	28.2 ± 3.3	21.6–34.8
LV volumes (biplane)				
LV EDV (mL)	106 ± 22	62–150	76 ± 15	46–106
LV ESV (mL)	41 ± 10	21–61	28 ± 7	14–42
LV volumes normalized by BSA				
LV EDV (mL/m^2)	54 ± 10	34–74	45 ± 8	29–61
LV ESV (mL/m^2)	21 ± 5	11–31	16 ± 4	8–24
LV EF (biplane)	62 ± 5	52–72	64 ± 5	54–74

BSA, body surface area; *EDV*, end-diastolic volume; *EF*, ejection fraction; *ESV*, end-stystolic volume; *LV*, left ventricular; *SD*, standard deviation.

FEVG : évaluation semi-quantitative visuelle : Jr vs Sr

Basic critical care echocardiography: Validation of a curriculum dedicated to noncardiologist residents*

Philippe Vignon, MD, PhD; Frédérique Mücke, MD; Frédéric Bellec, MD; Benoît Marin, MD; Jérôme Croce, MD; Tania Brouqui, MD; Cédric Palobart, MD; Patrick Senges, MD; Christophe Truffy, MD; Alexandra Wachmann, MD; Anthony Dugard, MD; Jean-Bernard Amiel, MD

(Crit Care Med 2011; 39:636–642)

- 201 patients de réanimation évalués par 6 internes en ETT
- Formation de 12 h et 33 ETT / interne en moyenne.

Table 4. Assessment of global left ventricular systolic function (n = 193)[a]

	Assessment by Residents		
Assessment by Experienced Intensivist	Normal	Moderately Depressed	Severely Depressed
Normal	111	7	1
Moderately depressed	7	30	3
Severely depressed	0	9	25

FEVG : expert ETT portable vs ETO Simpson biplan

Amiel et al. Critical Care 2012, 16:R29
http://ccforum.com/content/16/1/R29

CRITICAL CARE

RESEARCH Open Access

Assessment of left ventricular ejection fraction using an ultrasonic stethoscope in critically ill patients

Jean-Bernard Amiel[1,2], Ana Grümann[1], Gwenaëlle Lhéritier[1], Marc Clavel[1,2], Bruno François[1,2], Nicolas Pichon[1,2], Anthony Dugard[1,2], Benoît Marin[3] and Philippe Vignon[1,2,4*]

		Visual assessment of LVEF with the full-feature system			
Reference LVEF (biplane EF using Simpson's rule)	**94 patients Kappa = 0.75**	Increased LVEF > 75%	Normal LVEF: 50-75%	Moderately depressed LVEF: 30-49%	Severely depressed LVEF<30%
	Increased	3	5	0	0
	Normal	6	43	2	0
	Moderately depressed	0	2	11	1
	Severely depressed	0	0	4	7

FEVG : interprétation (Cardiologie)

ESC European Society of Cardiology

European Heart Journal (2021) 42, 3599–3726
doi:10.1093/eurheartj/ehab368

ESC GUIDELINES

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

Developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

With the special contribution of the Heart Failure Association (HFA) of the ESC

Table 3 Definition of heart failure with reduced ejection fraction, mildly reduced ejection fraction and preserved ejection fraction

Type of HF		HFrEF	HFmrEF	HFpEF
CRITERIA	1	Symptoms ± Signs[a]	Symptoms ± Signs[a]	Symptoms ± Signs[a]
	2	LVEF ≤40%	LVEF 41–49%[b]	LVEF ≥50%
	3	–	–	Objective evidence of cardiac structural and/or functional abnormalities consistent with the presence of LV diastolic dysfunction/raised LV filling pressures, including raised natriuretic peptides[c]

FEVG : interpretation (Réanimation)

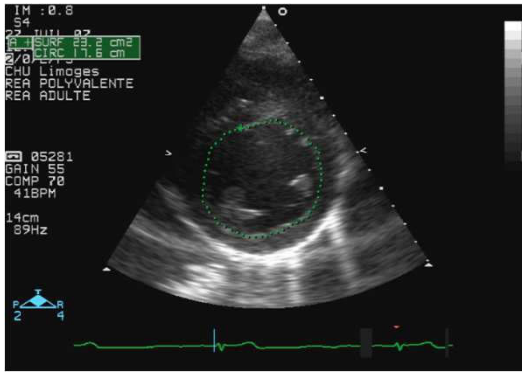
- FEVG > 65 % : VG “hyperkinétique” (vasoplégie fréquente)
- 50 % < FEVG < 65 % : fonction systolique VG normale
- 30 % < FEVG < 50 % : dysfonction systolique modérée
- FEVG < 30 % : dysfonction systolique sévère.

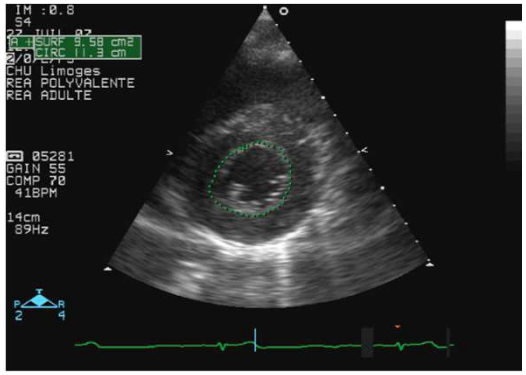
Facteurs confondants

- ✓ Anomalie de contraction segmentaire (étendue ou non / même plan ou non) ?
- ✓ Fréquence cardiaque, dysrythmie ?
- ✓ Valvulopathie (surcharge en volume / pression; aiguë / chronique) ?
- ✓ Traitement en cours (inotropes, vasopresseurs; doses) ?
- ✓ Contexte clinique (cause de dysfonction aiguë réversible) ?
- ✓ Température corporelle ?

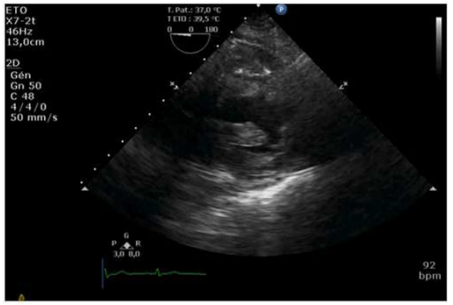
2- Fraction de reduction de surface (FRS)

- Mesure dans le petit axe du VG (raccourcissement maximal)
- Coupe reproductible : parasternale passant par les muscles papillaires (repères anatomiques)
- Inclure les muscles papillaires et trabéculations dans la cavité VG
- Les territoires de perfusion des trois principales coronaires sont représentés
- Valeur normale : 35 à 65 %.

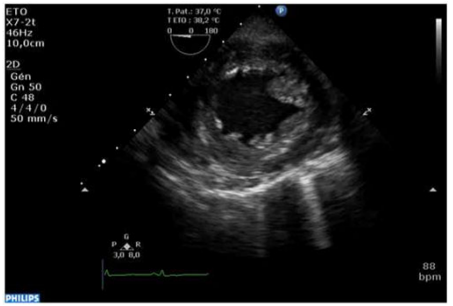




70%



40%



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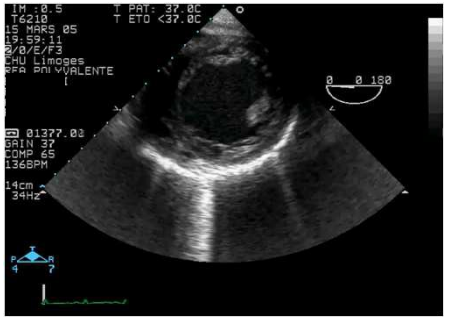

FRSVG et FEVG

Anesthesiology 2001; 94:400–6

Early Preload Adaptation in Septic Shock?

A Transesophageal Echocardiographic Study

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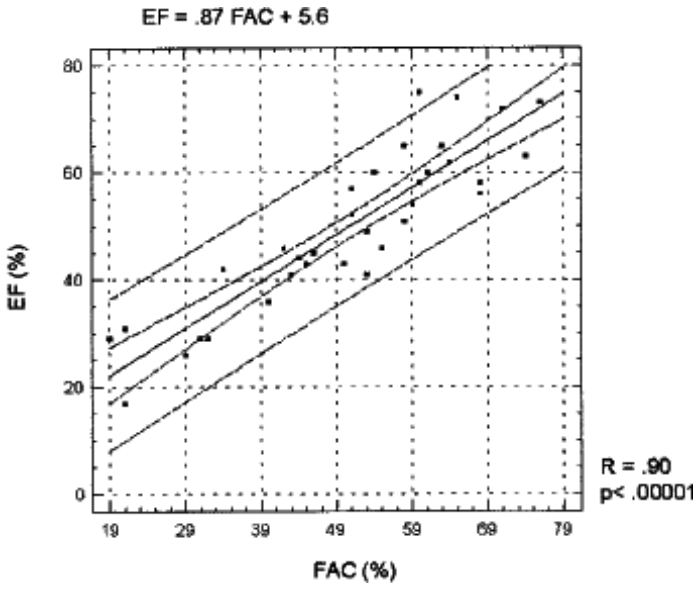
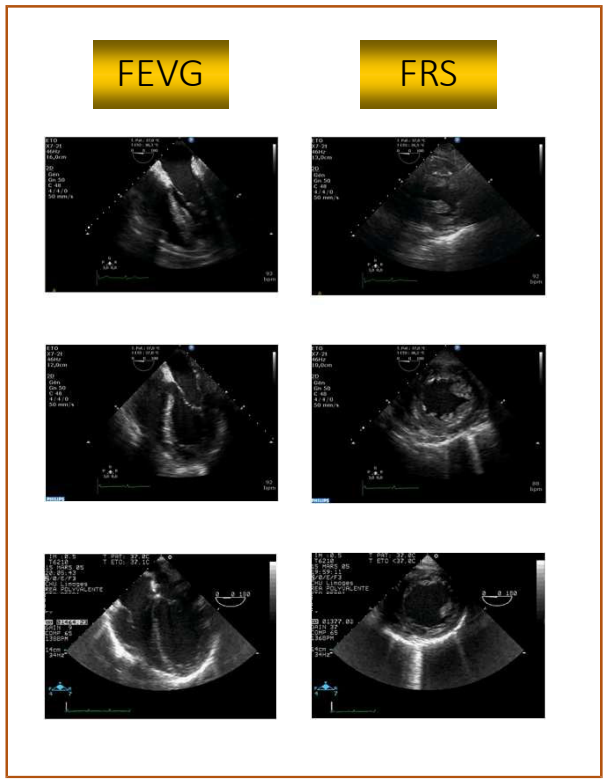
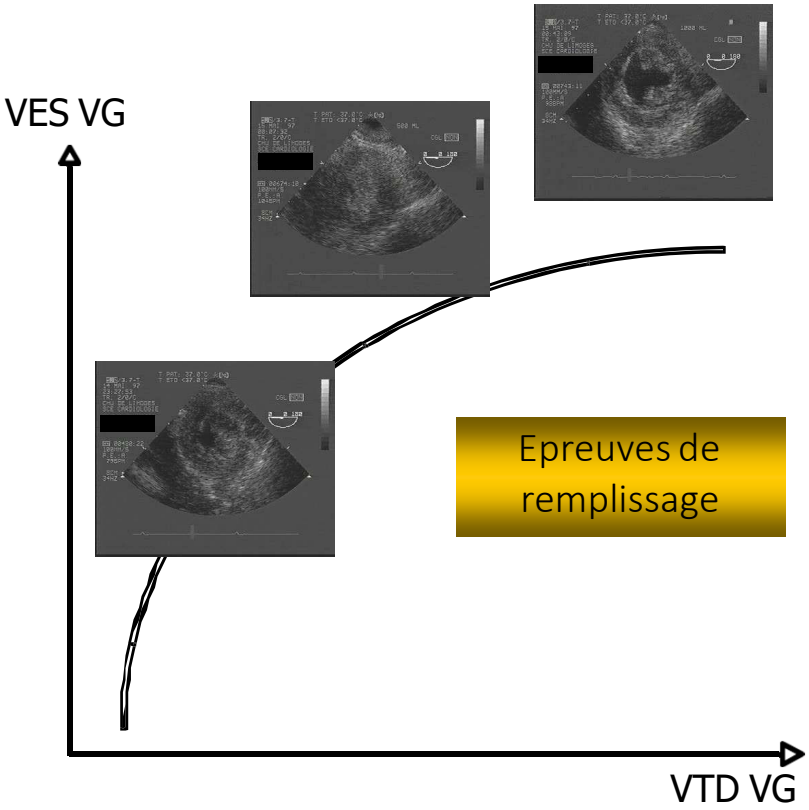


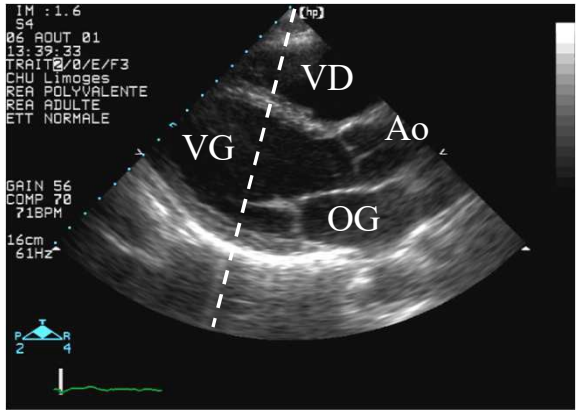
Corrélation FEVG et FRSVG

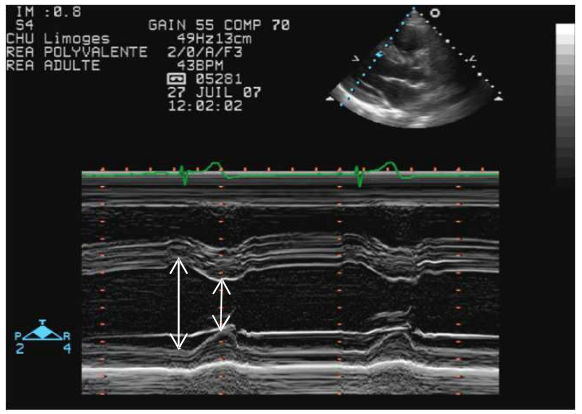


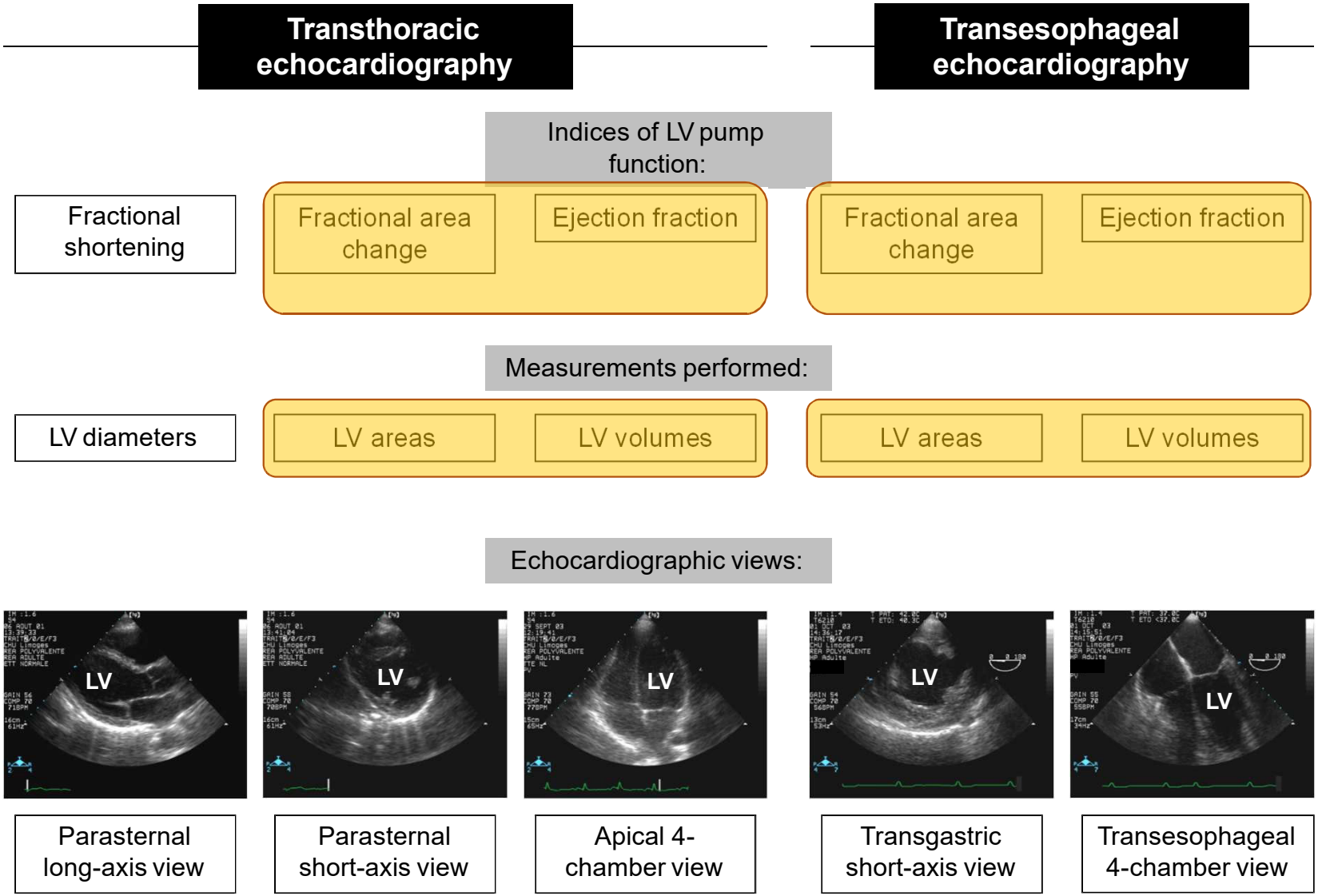


Fraction de raccourcissement de diamètre

- Mode Temps-Mouvement (TM)
- Haute résolution temporelle mais évaluation limitée à une ligne
- Strictement perpendiculaire aux parois VG, au sommet de la valve mitrale
- Risque de sur- / sous-estimation de la fonction systolique globale du VG si anomalie de contraction segmentaire (étendue)
- Valeur normale : 25-45%.



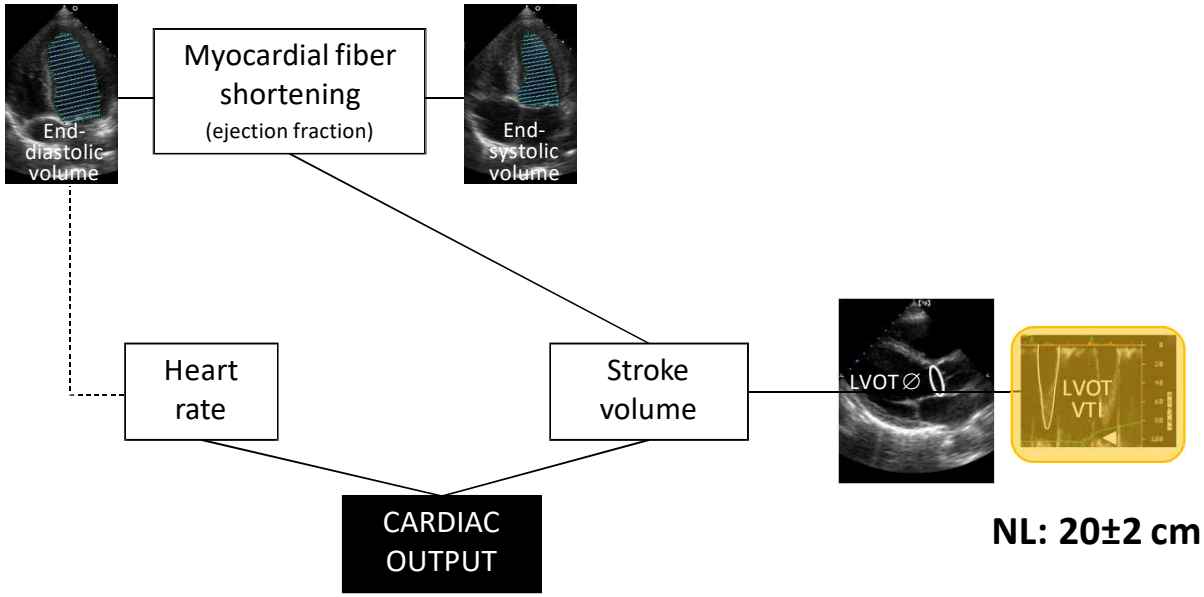




P. Vignon. Assessment of critically-ill patients with acute heart failure syndromes using echocardiography Doppler.
In: Acute heart failure syndromes, Mebazaa A. Ed, Springer 2008

FEVG vs. débit cardiaque (VES)

VES = VTDVG – VTSVG (mL)
FEVG (%) = VES/VTDVG (mL)



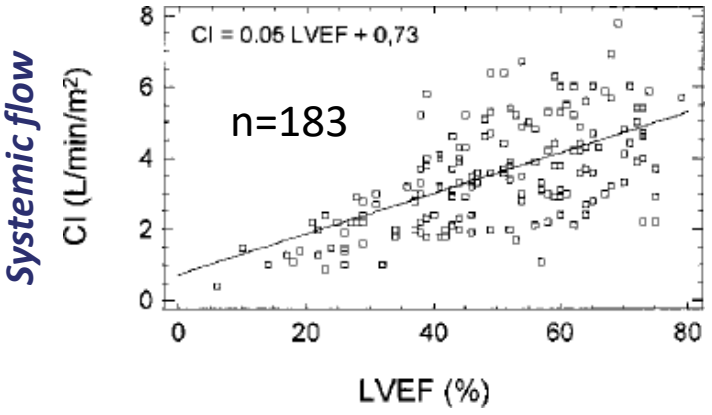
NL: 20±2 cm

Clinical Commentary

Hemodynamic Instability in Sepsis
Bedside Assessment by Doppler Echocardiography

Antoine Vieillard-Baron, Sebastien Prin, Karim Chergui, Olivier Dubourg, and François Jardin

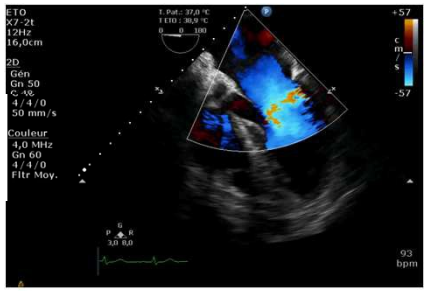
AJRCCM 2003 ; 168: 1270-6



Systemic flow

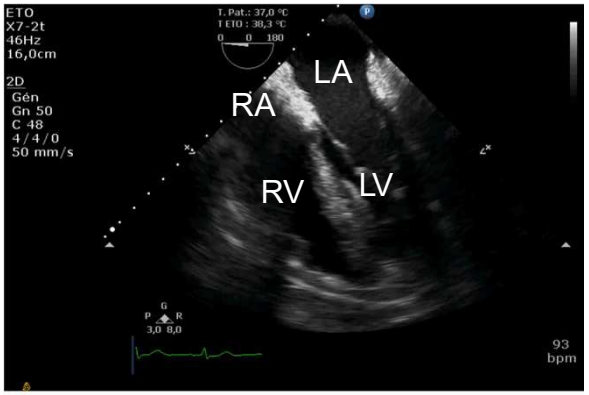
LV systolic function

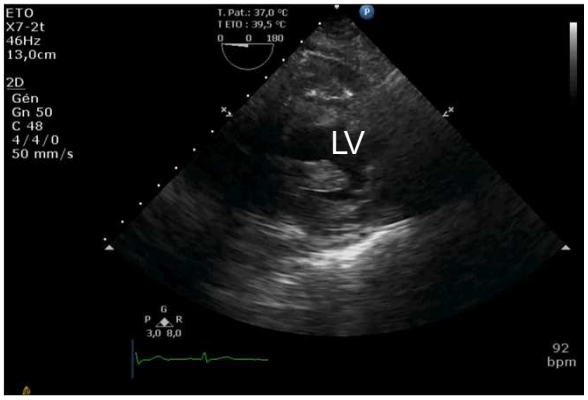
3- Intégrer le VES dans l'interprétation de la FEVG

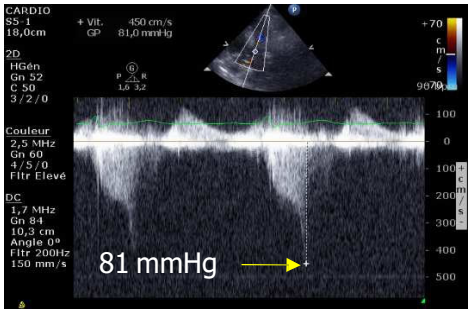


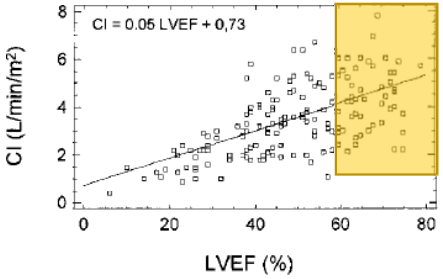
LVEF: 75%

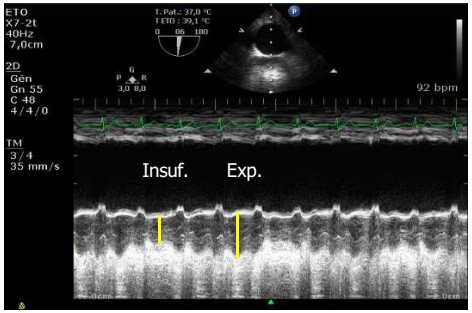
High flow & high LV systolic function









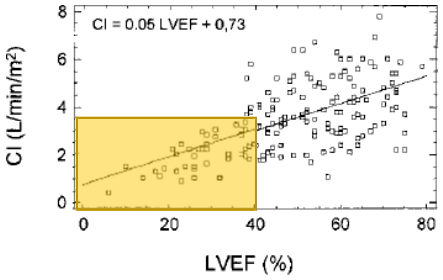


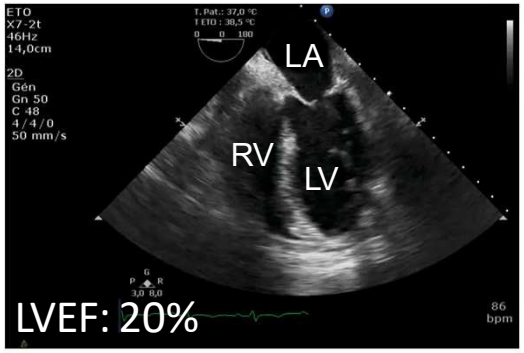
ΔSVC: 50%

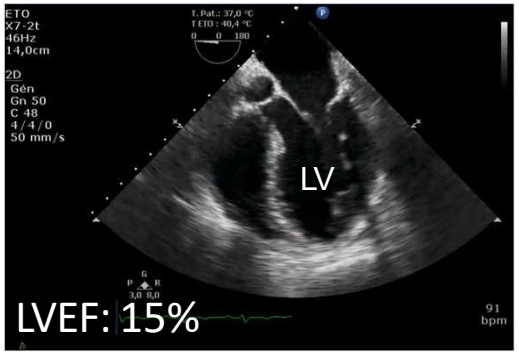
3- Intégrer le VES dans l'interprétation de la FEVG (2)

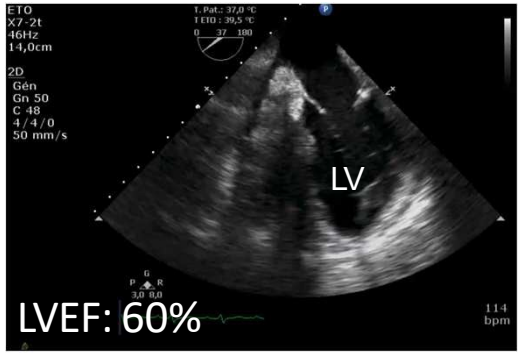
Low flow & low LV systolic function

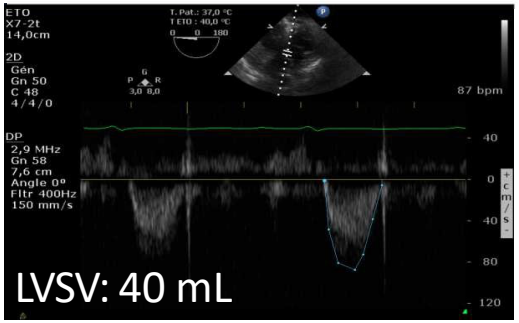
	H0	H2	H4
	BSL 8:41	NE 10:35	NE + DOBUTAMINE 5µ 13:01

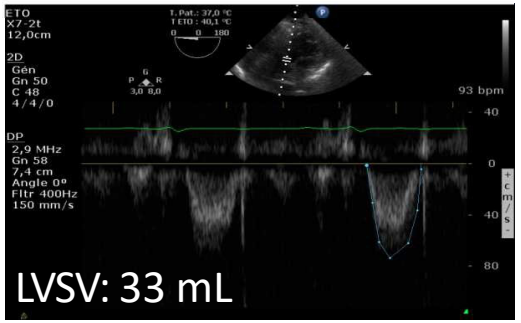


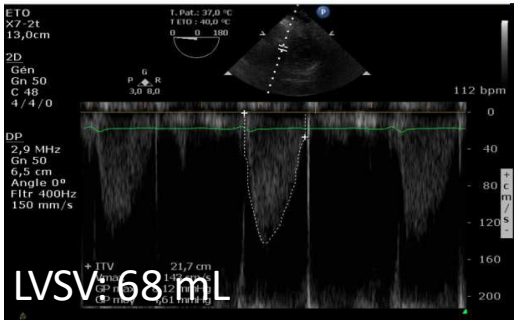








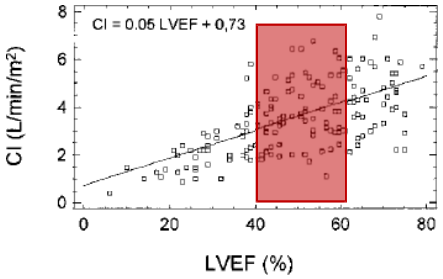


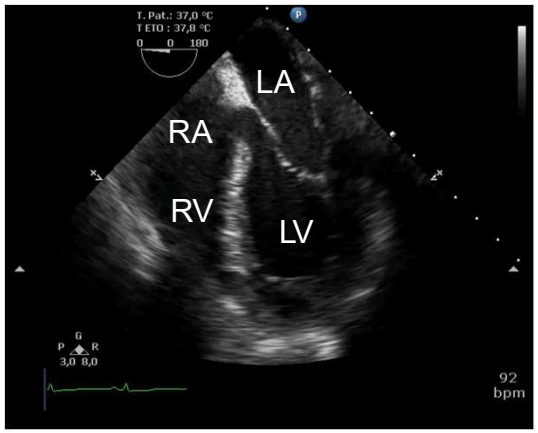


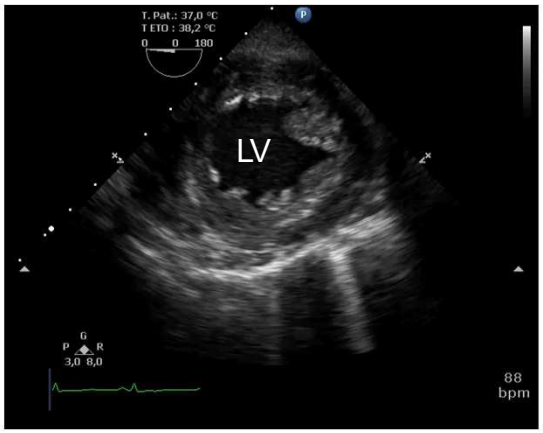
3- Intégrer le VES dans l'interprétation de la FEVG (3)

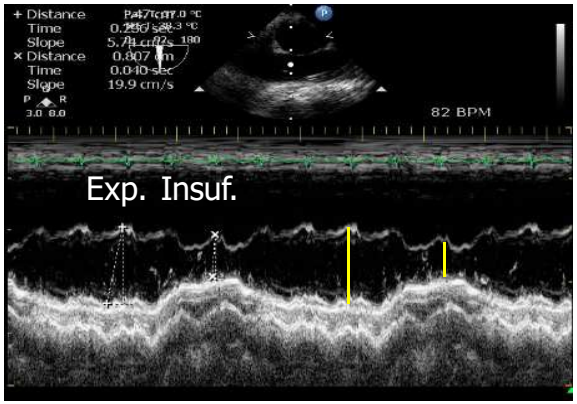
LVEF: 50%

Normal LV systolic function: is flow optimized?



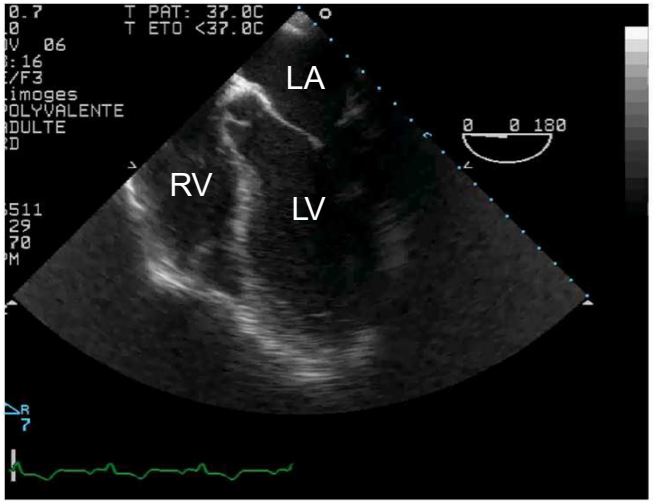


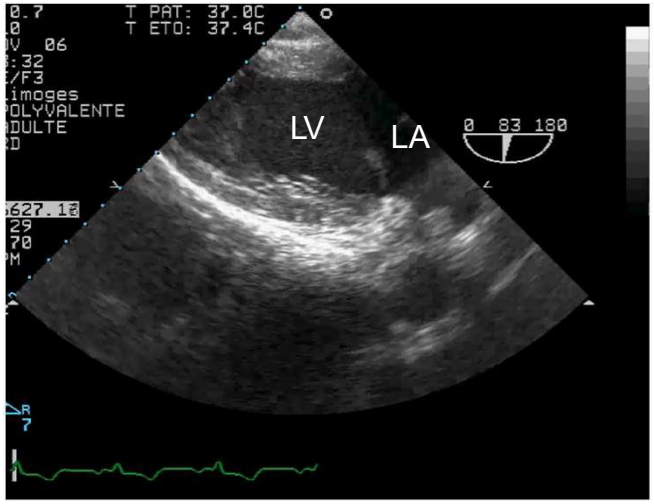




ΔSVC: 50%

4- Chercher une anomalie de contraction segmentaire du VG

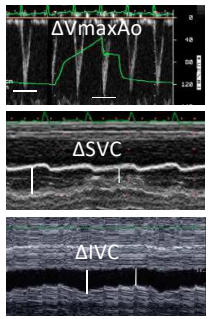


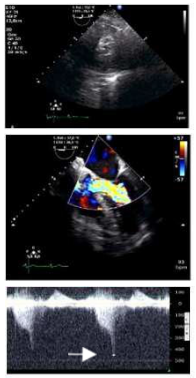


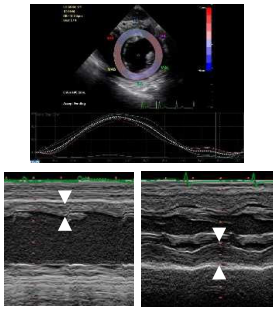
Large RWMA can be partially compensated by the hyperkinesia or other LV segments.

Preload / fluid responsiveness

Afterload / LVOT obstruction

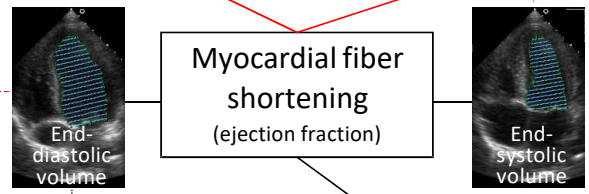






Loading conditions

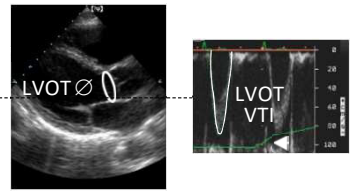
Myocardial contractility



Myocardial fiber shortening
(ejection fraction)

Heart rate

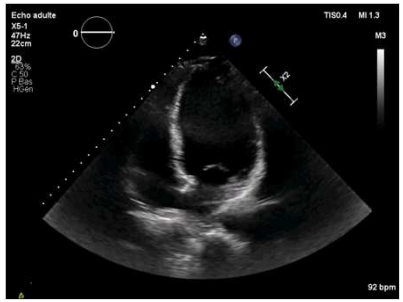
Stroke volume

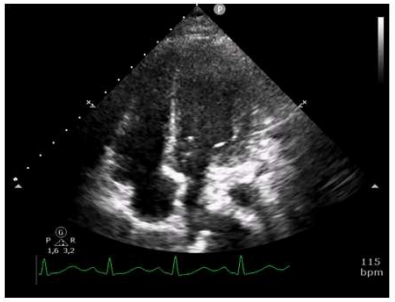


CARDIAC OUTPUT

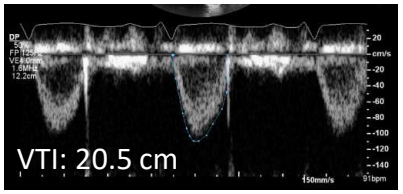
5- Chercher un remodelage du VG

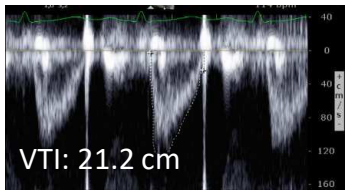
Increased LV cavity size





Increased LV wall thickening



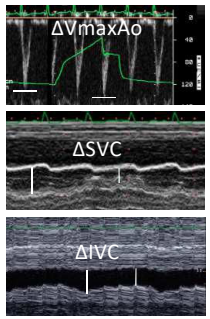


CO:	5.9 L/min	6.1 L/min
HR:	91 bpm	114 bpm
LVOT VTI:	20.5cm	21.2cm
LVOT surf.:	3.14 cm²	2.54 cm²
LVEDV:	320mL	80 mL
LVEF:	25%	60%

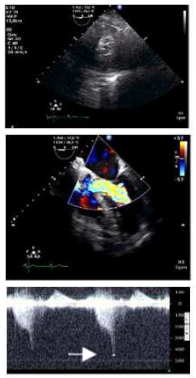
How LV stroke volume is generated?

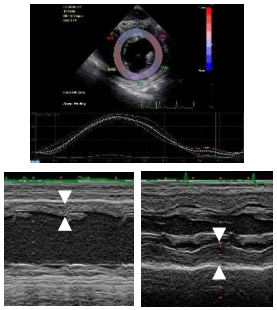
	LVSV (mL)	LVEF (%)	LVEDD (mm)
Normal	80	65	50
Dilated cardiomyopathy	70	20	75
Hypertrophic cardiomyopathy	70	75	45

Preload / fluid responsiveness



Afterload / LVOT obstruction

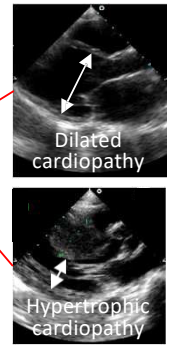


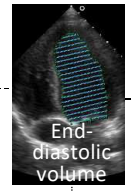


Loading conditions

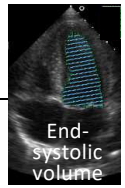
Myocardial contractility

Left ventricular remodeling
(end-diastolic dimension)



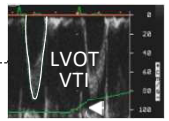


Myocardial fiber shortening
(ejection fraction)



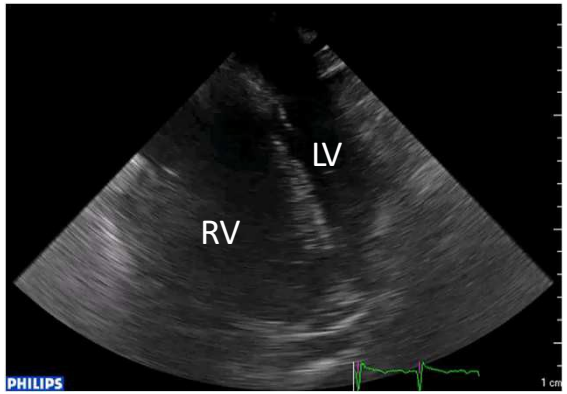
Heart rate

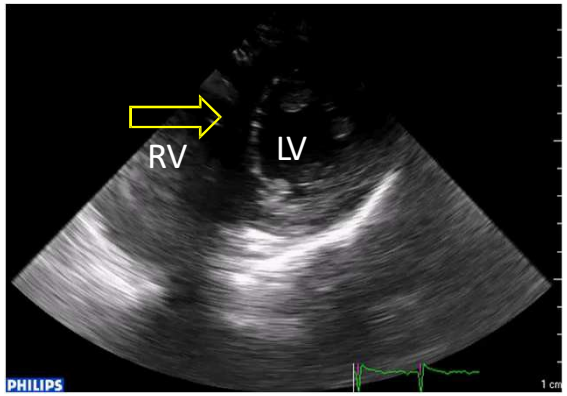
Stroke volume



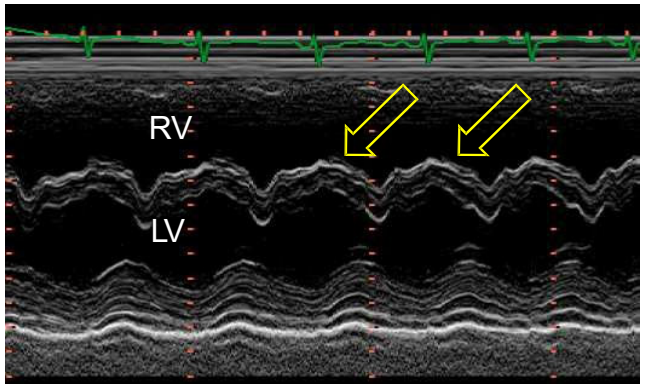
CARDIAC OUTPUT

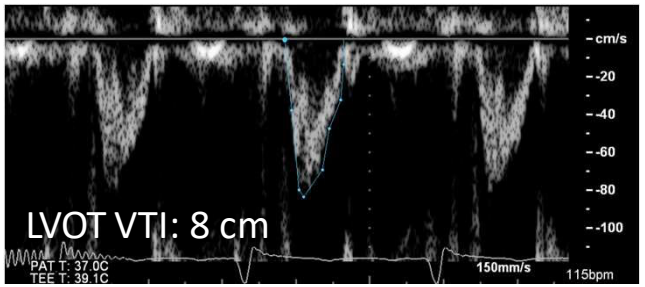
6- Chercher une interdépendance ventriculaire excessive

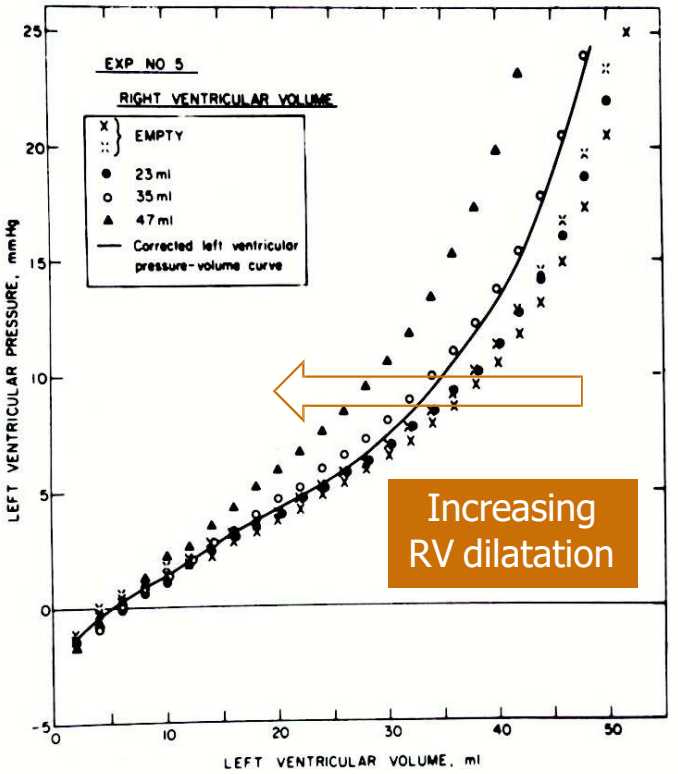




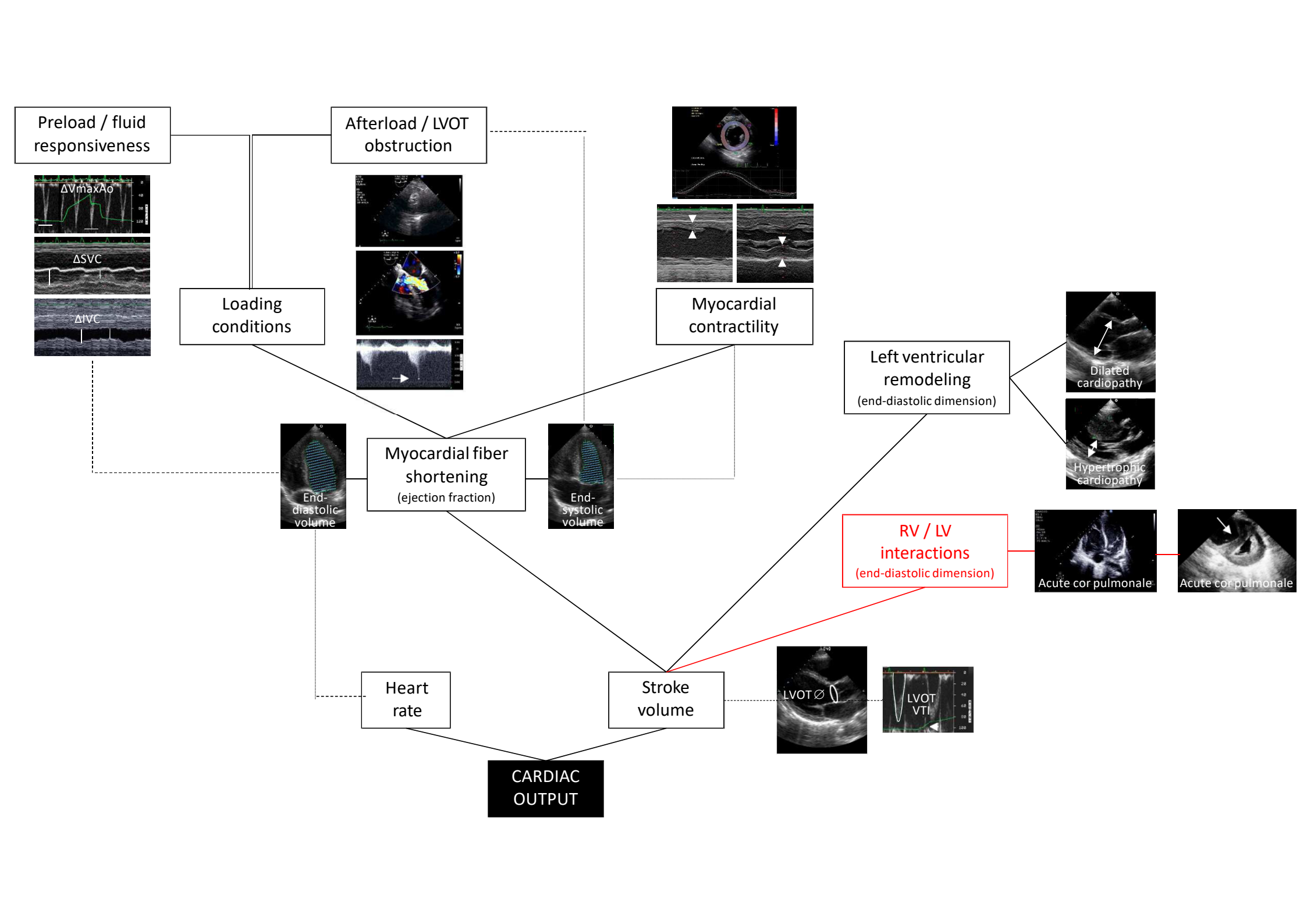
Severe acute cor pulmonale







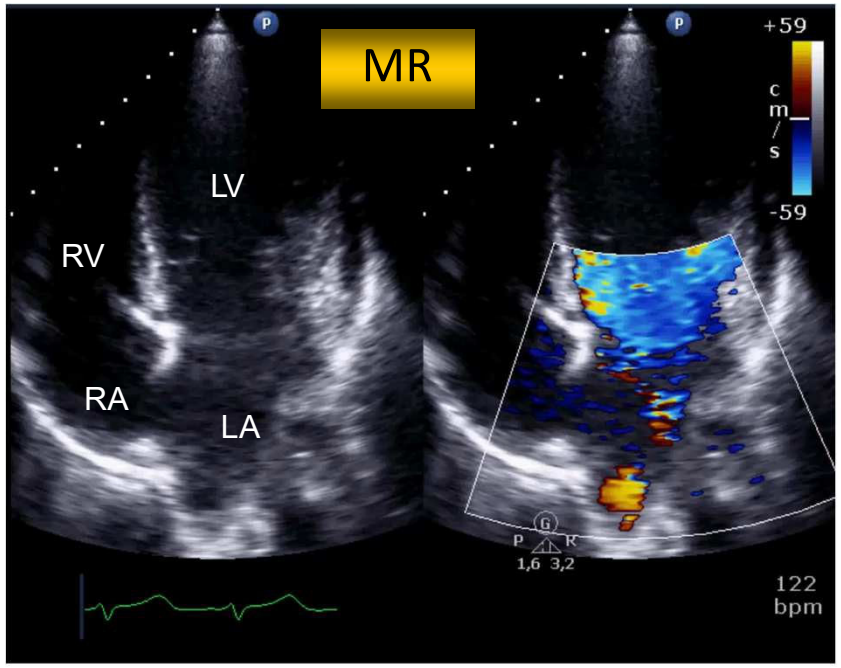
Taylor AJP 1967

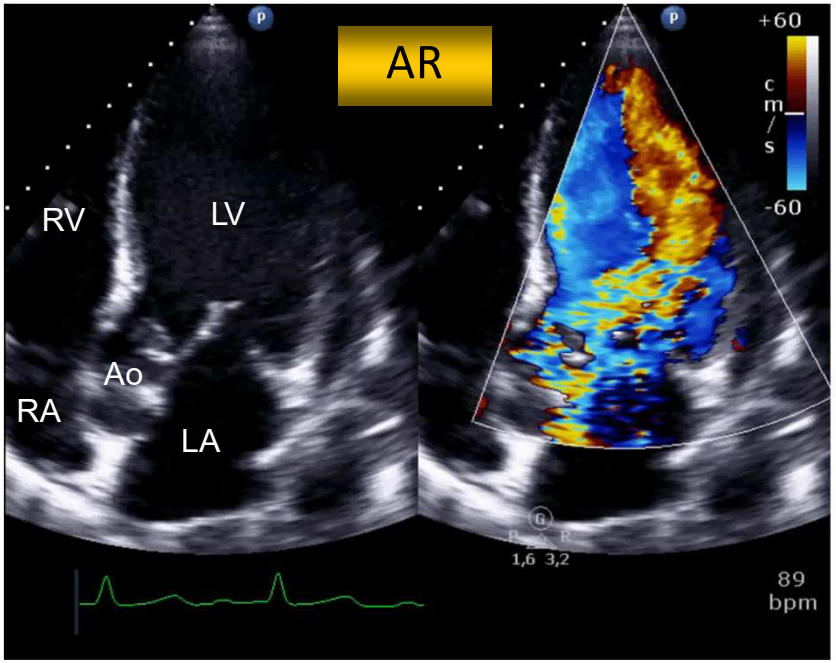

Preload / fluid responsiveness
ΔVmaxAo
ΔSVC
ΔIVC
Afterload / LVOT obstruction
Loading conditions
Myocardial contractility
Left ventricular remodeling
(end-diastolic dimension)
Dilated cardiopathy
Hypertrophic cardiopathy
End-diastolic volume
Myocardial fiber shortening
(ejection fraction)
End-systolic volume
RV / LV interactions
(end-diastolic dimension)
Acute cor pulmonale
Acute cor pulmonale
Heart rate
Stroke volume
LVOT ∅
LVOT VTI
CARDIAC OUTPUT

7- Chercher une surcharge en volume/pression du VG (1)

Severe left-sided regurgitation with **LOW** forward flow

Acute LV volume overload

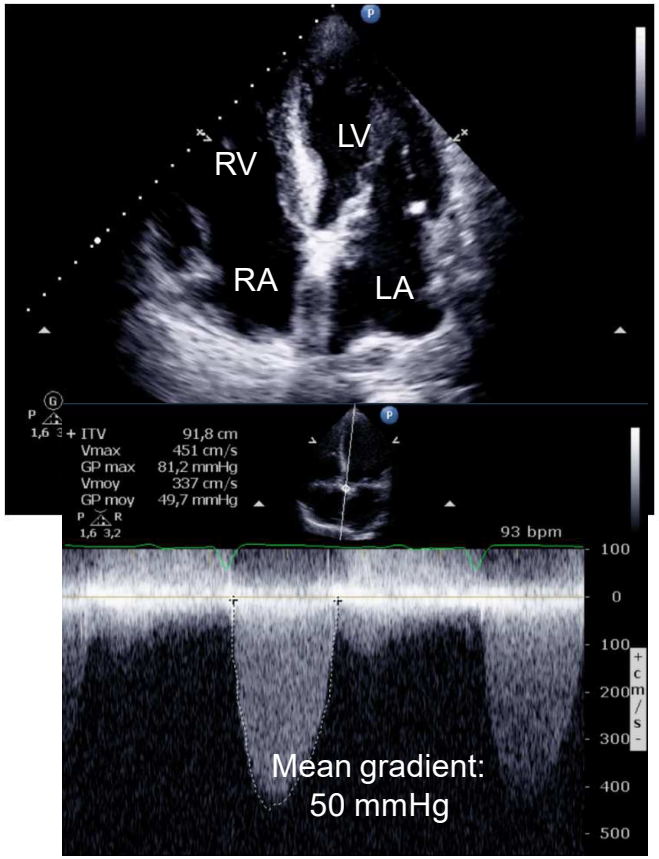




7- Chercher une surcharge en volume/pression du VG (2)

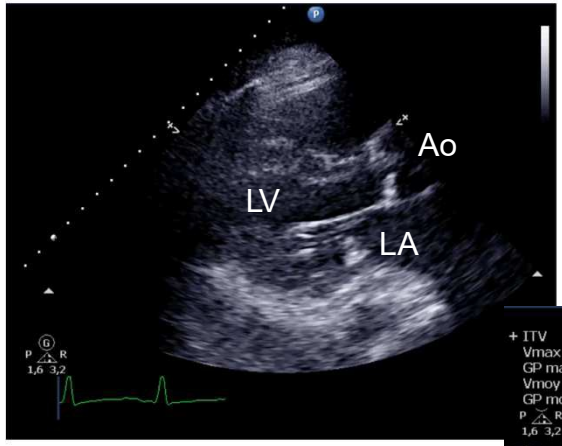
Chronic LV pressure overload

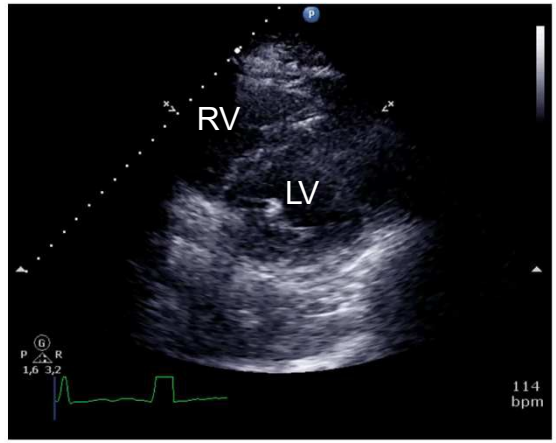
LVEF: 60%

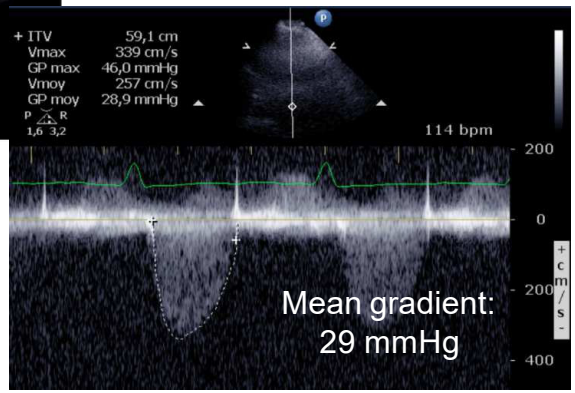


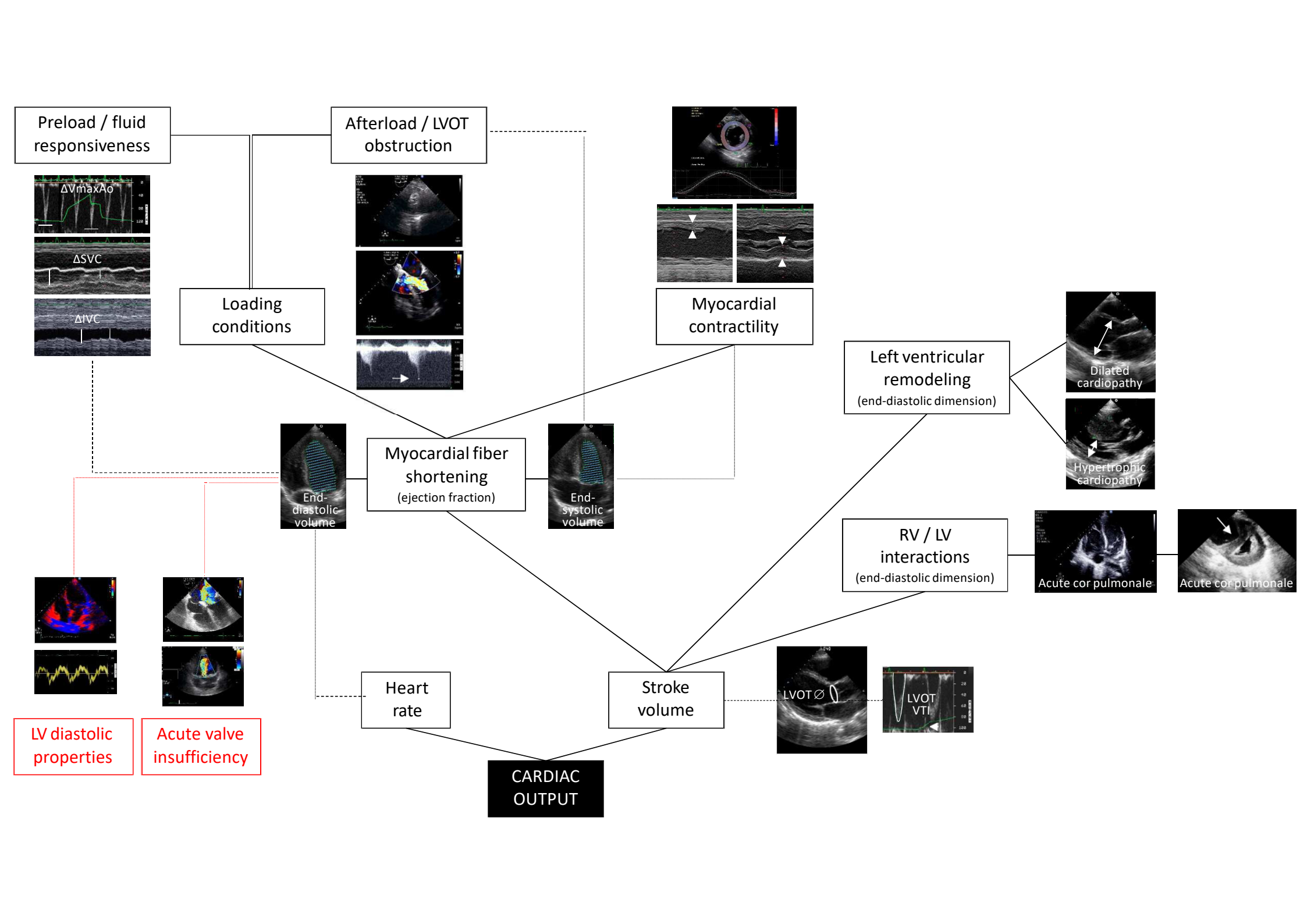
Low flow, low gradient

LVEF: 15%



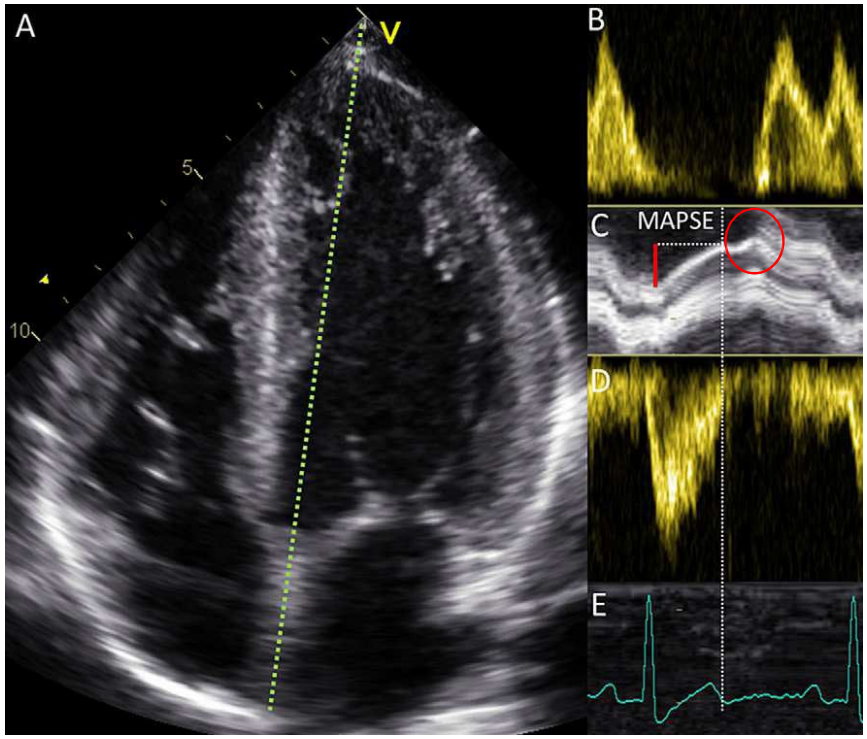


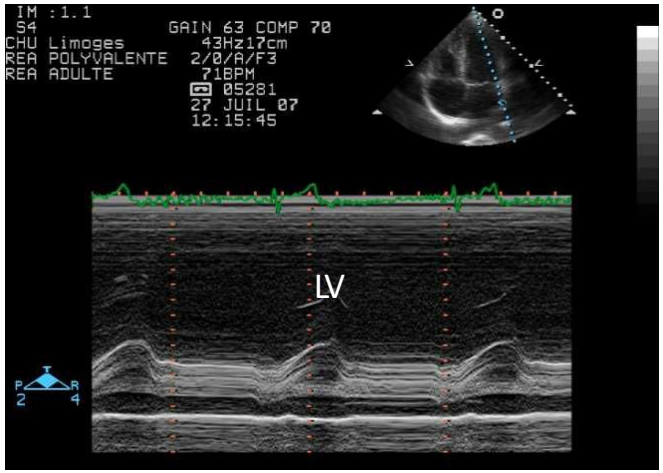



Preload / fluid responsiveness
Afterload / LVOT obstruction
ΔVmaxAo
ΔSVC
ΔIVC
Loading conditions
Myocardial contractility
Left ventricular remodeling
(end-diastolic dimension)
Dilated cardiopathy
Hypertrophic cardiopathy
End-diastolic volume
Myocardial fiber shortening
(ejection fraction)
End-systolic volume
RV / LV interactions
(end-diastolic dimension)
Acute cor pulmonale
Acute cor pulmonale
LV diastolic properties
Acute valve insufficiency
Heart rate
Stroke volume
LVOT ∅
LVOT VTI
CARDIAC OUTPUT

8- Evaluer la fonction des fibres longitudinales du VG (1)

Mitral Annulus Plane Systolic Excursion (MAPSE)





- ✓ M-mode: lateral and septal mitral ring
- ✓ High feasibility (irrespective of 2D quality)
- ✓ Not valid if RWMA of basal segments.

Généralités | FEVG | Succédanés de la FEVG | Fonction & débit | **Fonction longitudinale**

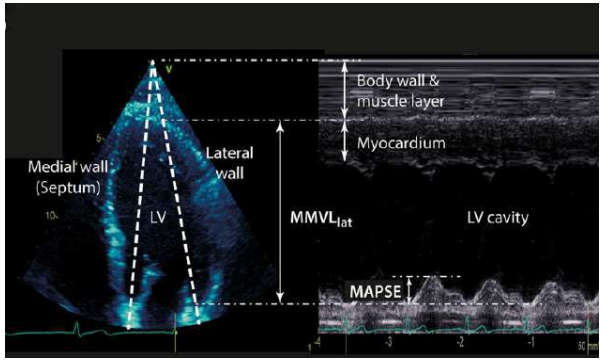
Huang et al. Critical Care (2017) 21:292
DOI 10.1186/s13054-017-1876-x

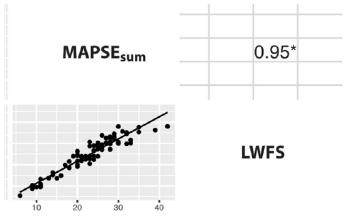
Critical Care

RESEARCH Open Access

Longitudinal wall fractional shortening: an M-mode index based on mitral annular plane systolic excursion (MAPSE) that correlates and predicts left ventricular longitudinal strain (LVLS) in intensive care patients

Stephen J. Huang[1*], Iris Ting[2], Andrea M. Huang[3], Michel Slama[1,4] and Anthony S. McLean[1]





Bergenzaun et al. Cardiovascular Ultrasound 2013, 11:16
http://www.cardiovascularultrasound.com/content/11/1/16

CARDIOVASCULAR ULTRASOUND

RESEARCH Open Access

Mitral annular plane systolic excursion (MAPSE) in shock: a valuable echocardiographic parameter in intensive care patients

Lill Bergenzaun[1*], Hans Öhlin[2], Petri Gudmundsson[3], Ronnie Willenheimer[4] and Michelle S Chew[5]

- ✓ Median MAPSE: 11 mm [10-12.8] if preserved LVEF
- ✓ Median MAPSE: 9 mm [7.3-12.3] if reduced LVEF < 50%.

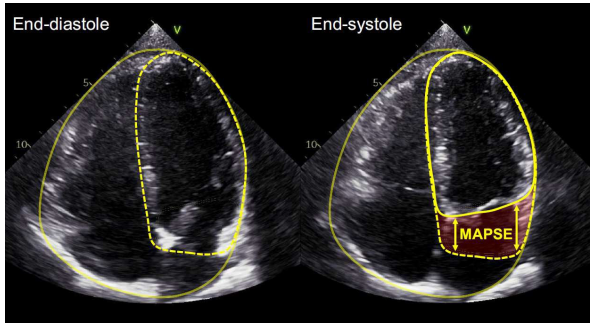
- ✓ MAPSE > 10 mm: preserved LVEF
- ✓ MAPSE < 8 mm: LVEF < 50%.

Intensive Care Med (2025) 51:1176–1178
https://doi.org/10.1007/s00134-025-07928-8

WHAT'S NEW IN INTENSIVE CARE

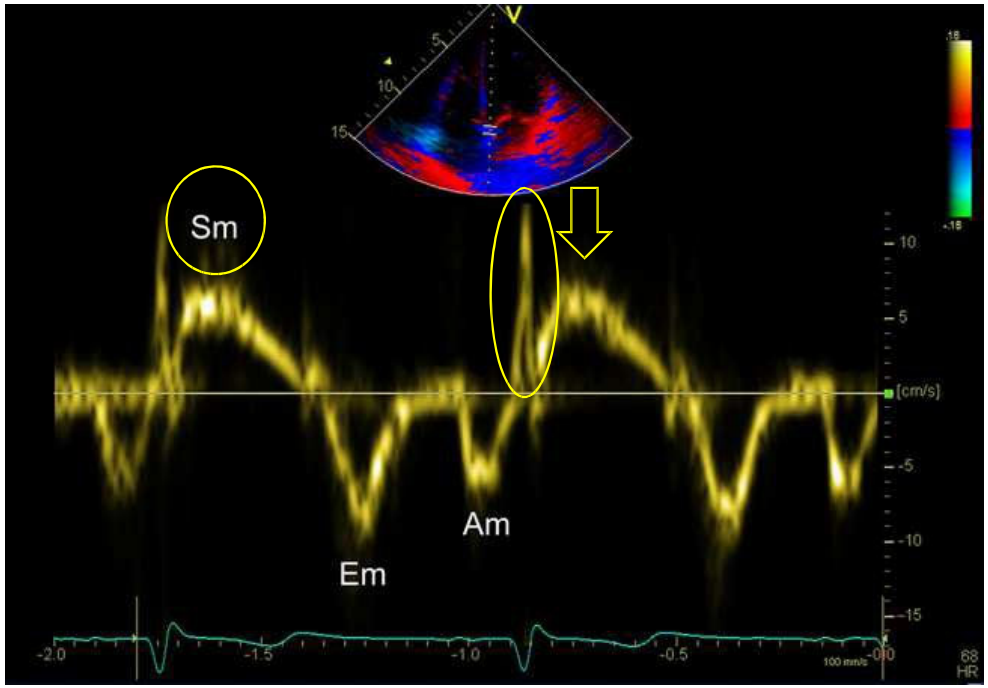
Monitoring left ventricular function with MAPSE and critical care echocardiography

Jinyang Yu[1,2,3*], Svend Aakhus[1,3] and Michelle S. Chew[4]



8- Evaluer la fonction des fibres longitudinales du VG (2)

Mitral Annulus S' or Sm peak velocity



- ✓ Normal Sm lateral: 9.9±2.4cm/s
- ✓ Normal Sm septal: 8.3±1.7cm/s

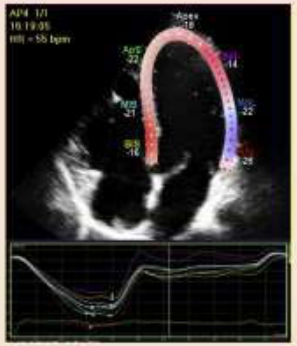
Alam M et al. Clin Physiol 1992 ; 4 : 443-5
Alam M et al. JASE 1999 ; 12 : 618-28

9- Strain longitudinal VG : un indice sensible prometteur ?

GUIDELINES AND STANDARDS

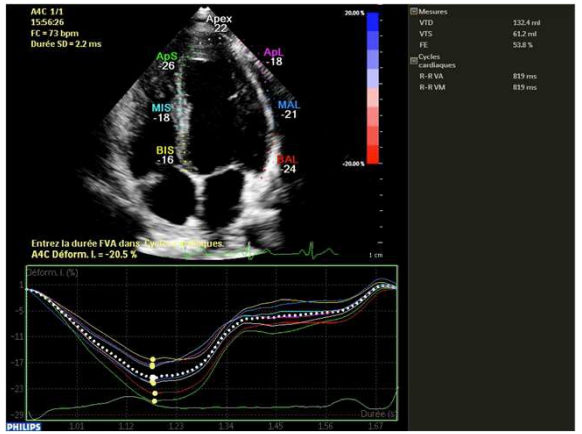
Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Table 1 (*Continued*)

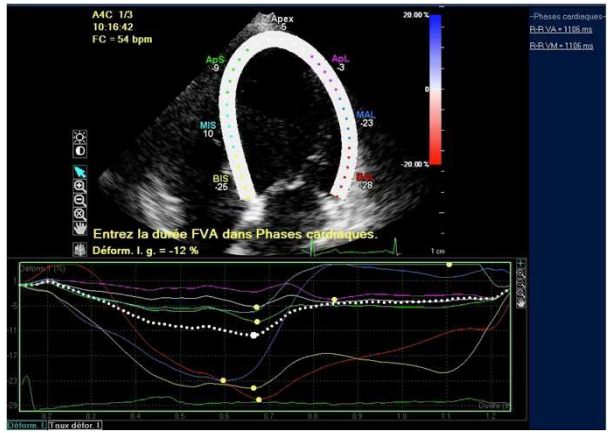
Parameter and method	Technique	Advantages	Limitations
Global Longitudinal Strain. Peak value of 2D longitudinal speckle tracking derived strain (%).		• Angle independent • Established prognostic value	• Vendor dependent

“Normal value” < -20%

-20 % (normal)



-12 % (low)



ORIGINAL

Left ventricular systolic dysfunction during septic shock: the role of loading conditions

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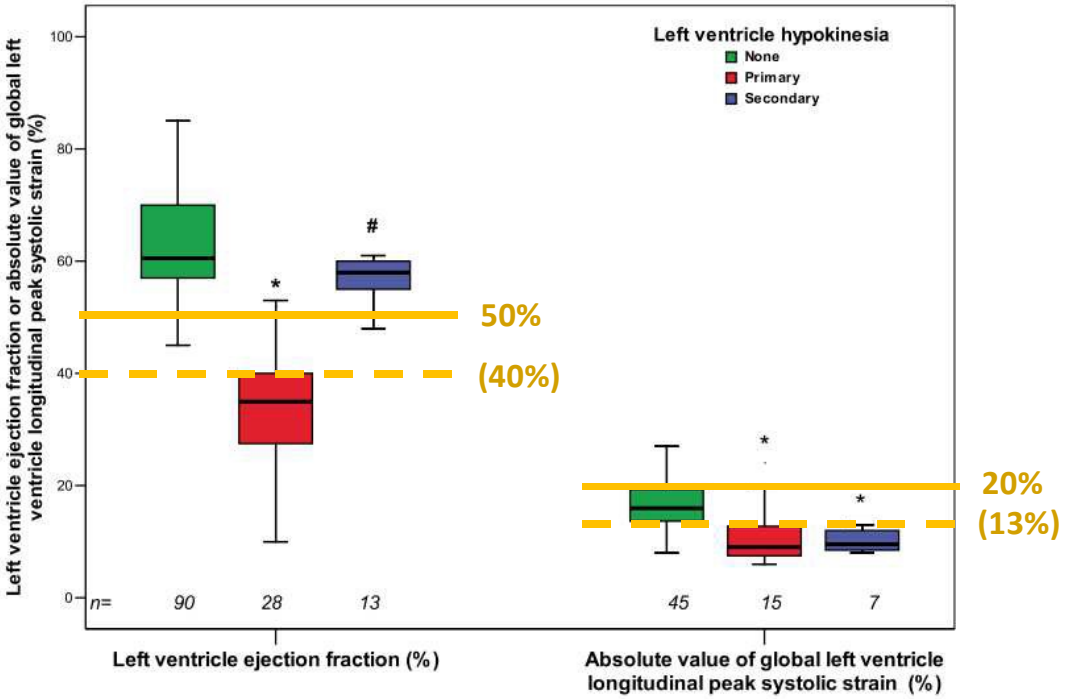
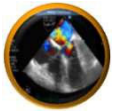


Fonction systolique du VG



1. La FEVG est le paramètre de fonction systolique du VG le plus utilisée
2. Elle ne reflète pas la contractilité VG (conditions de charge) car elle est très influencée par les conditions de charge
3. L'évaluation semi-quantitative visuelle de la FEVG doit être confirmée par sa mesure (méthode de Simpson)
4. L'interprétation de la FEVG doit intégrer le VES, un remodelage du VG, une dilatation VD, le traitement en cours…
5. Les paramètres de fonction longitudinale (MAPSE, S') sont corrélés avec la FEVG
6. Le strain longitudinal du VG est probablement plus sensible que la FEVG
7. Evaluation répétée de la fonction VG nécessaire.