

La dysfonction diastolique et pressions de remplissage en pratique quotidienne

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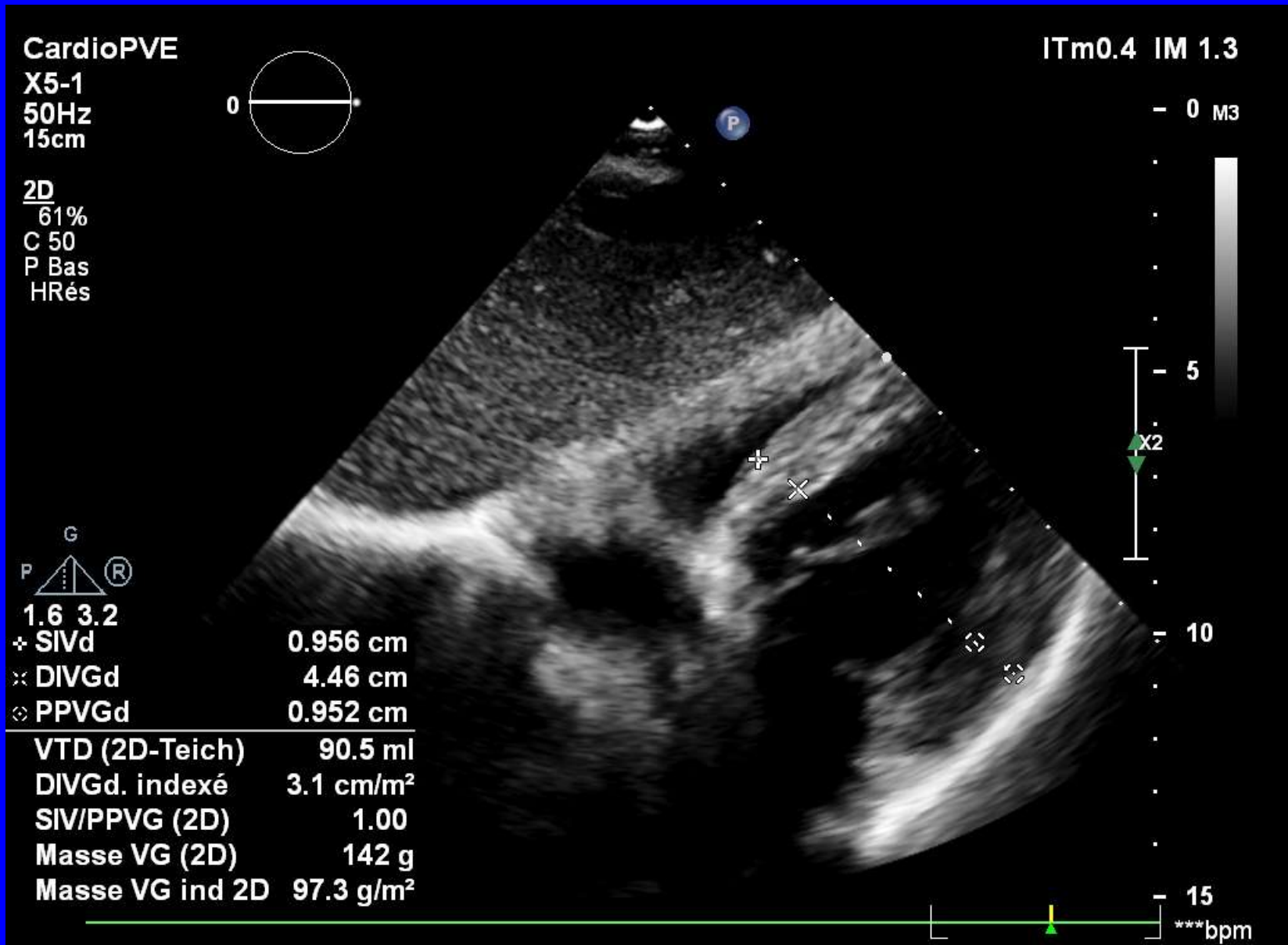
Conflits d'intérêt

“The solution isn't disclosure. If you're doing something that's wrong or unethical, don't disclose it, just don't do it. So if you don't do it, you don't have anything to disclose and there's no more conflict of interest.”

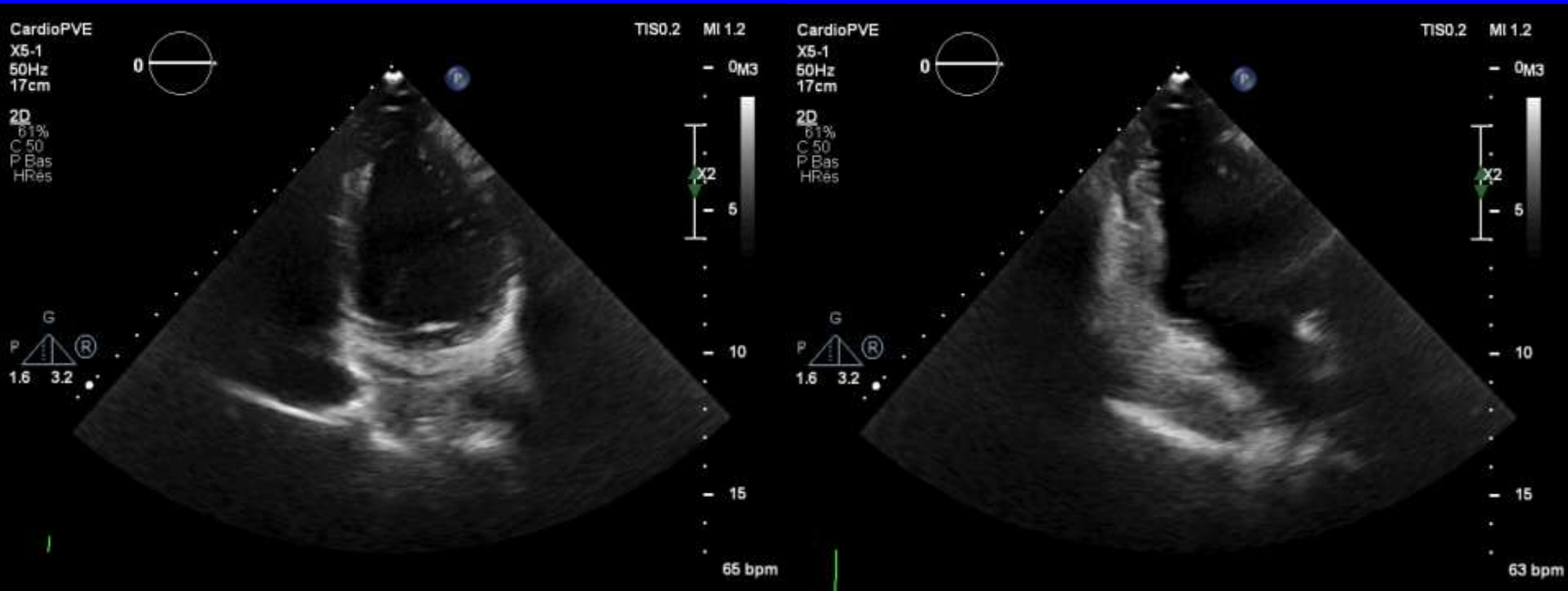
Dr Stein, Wisconsin



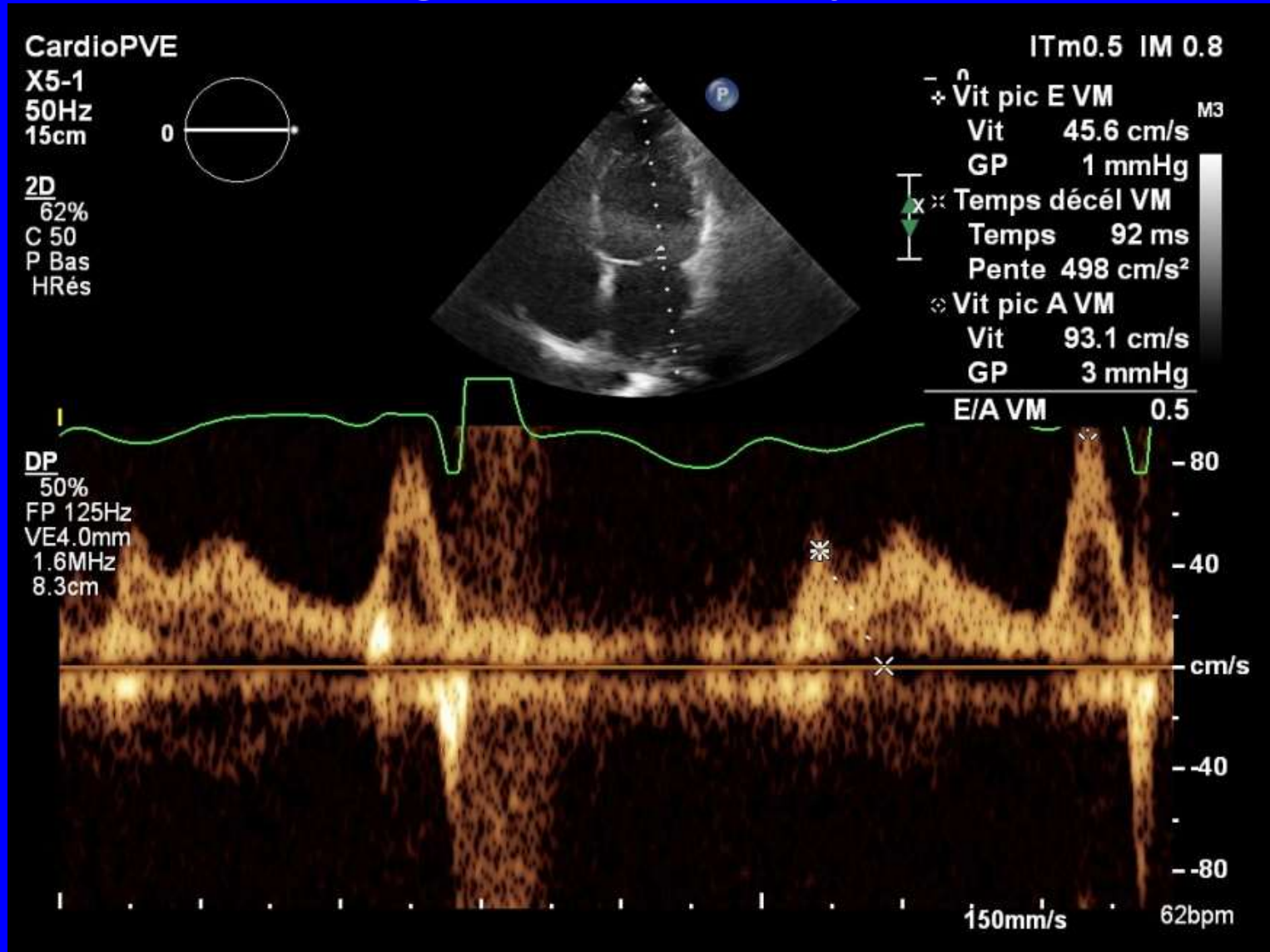
♀ 82 ans aux urgences pour dyspnée



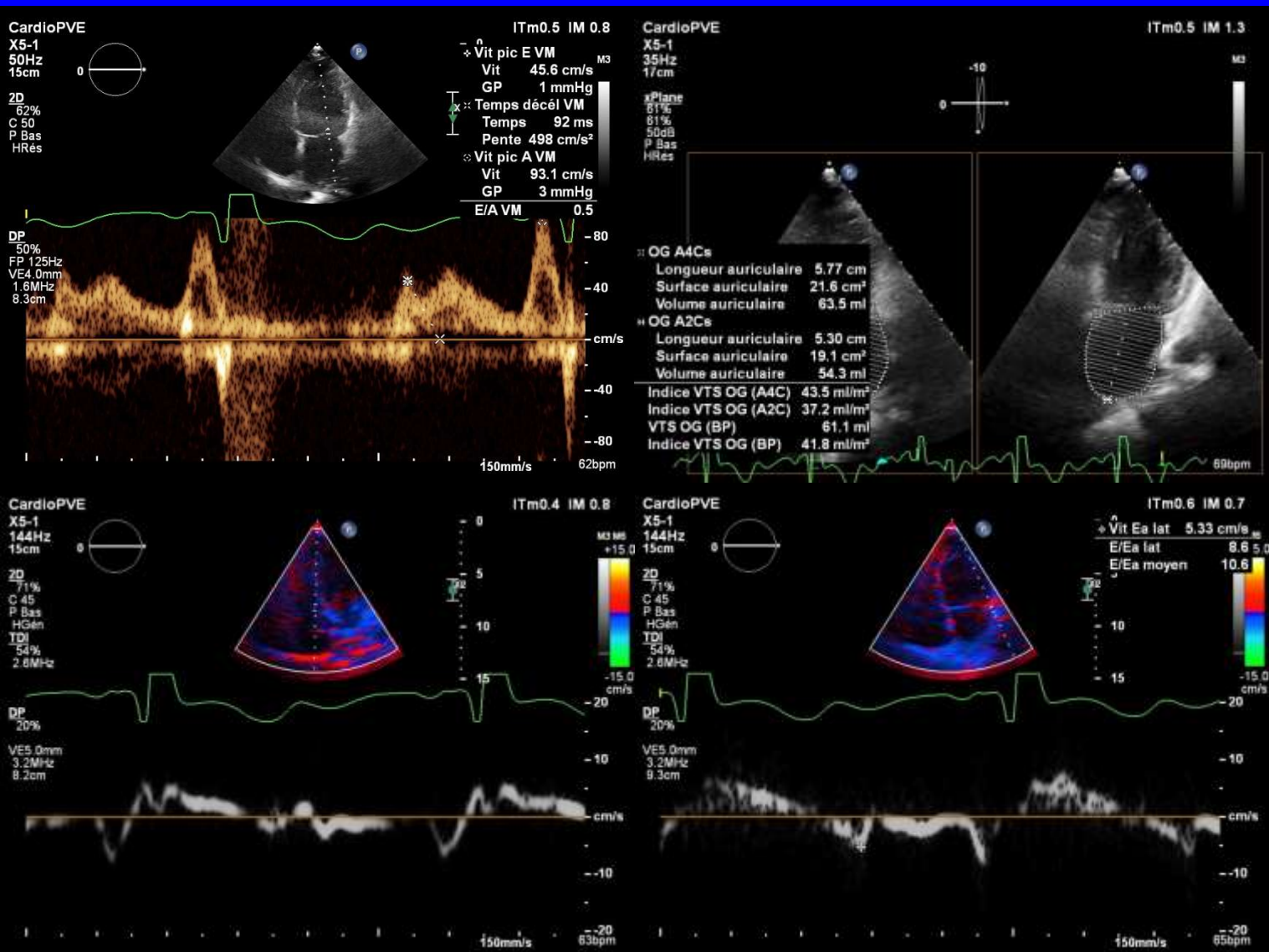
♀ 82 ans aux urgences pour dyspnée



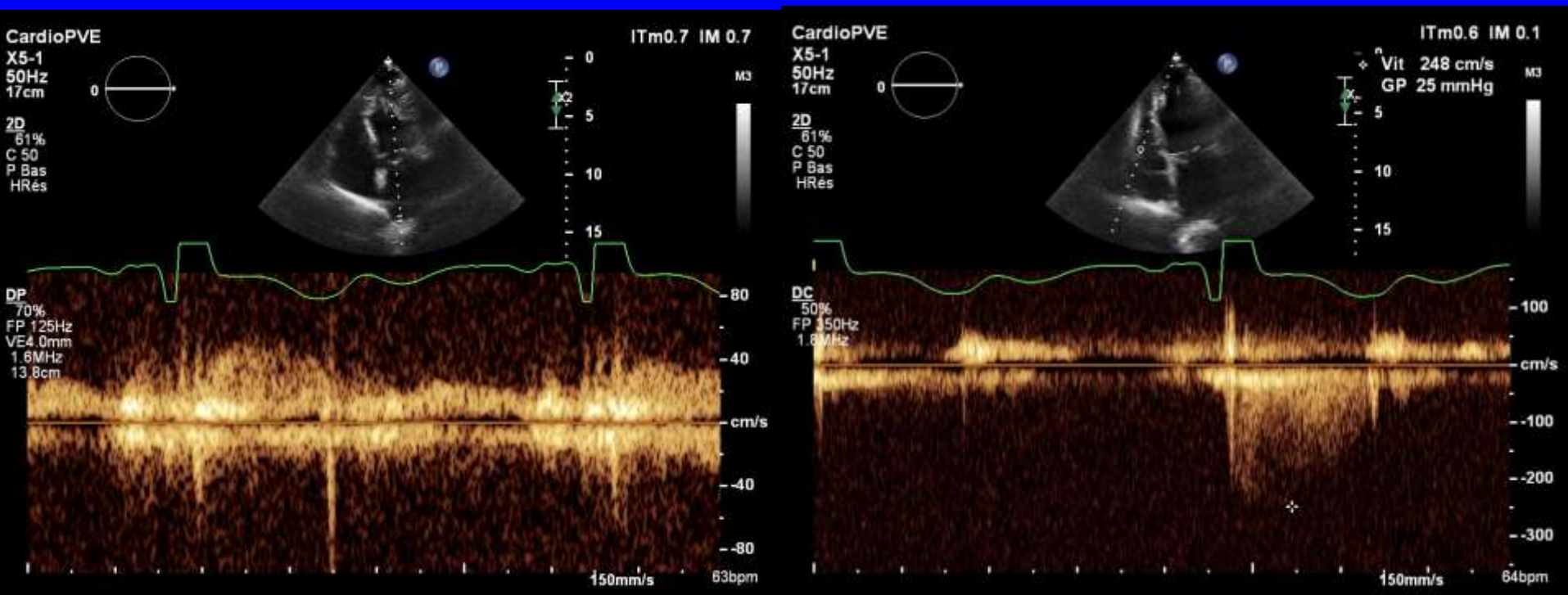
♀ 82 ans aux urgences pour dyspnée
Origine cardiaque?



♀ 82 ans aux urgences pour dyspnée



♀ 82 ans aux urgences pour dyspnée



La patiente s'améliore pourtant sous furosémide !

- Avec arrêt du Vérapamil....

Fonction cardiaque normale

- Maintenir et adapter un volume d'éjection associé à des pressions de remplissage normales
- Au repos et au cours de l'effort!
- Couplage étroit entre diastole et systole

Quels sont les déterminants des pressions de remplissage?

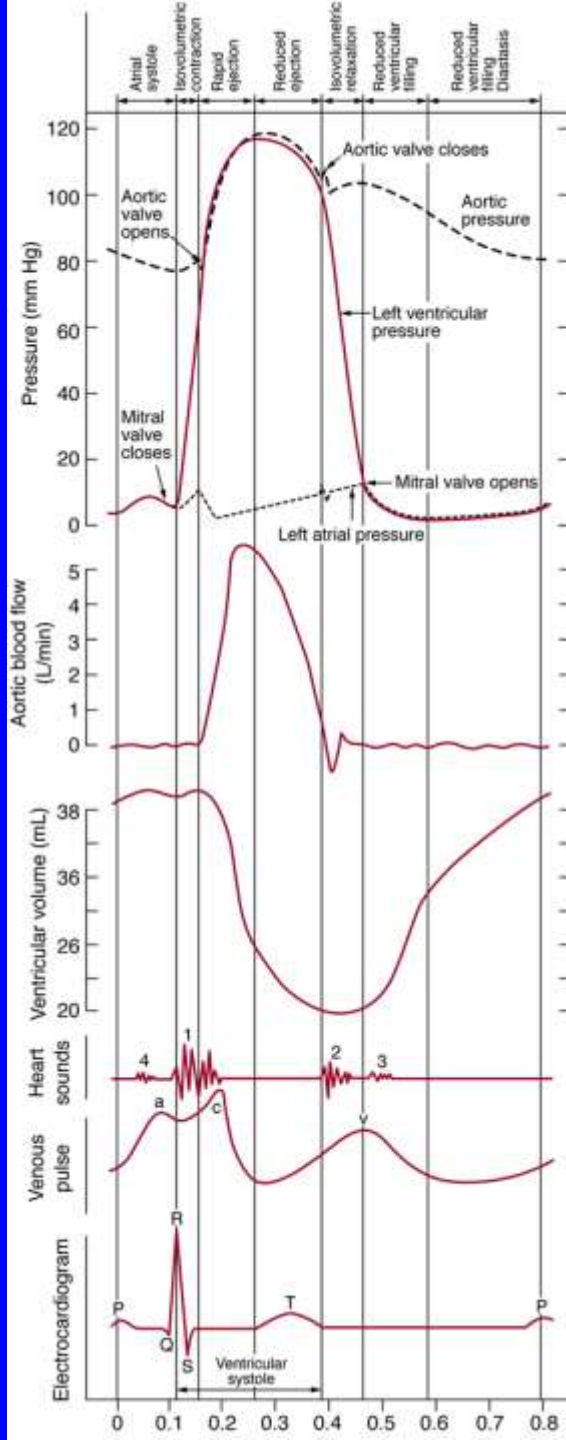
- Les propriétés passives de distension du VG
- La relaxation du VG
- La contraction de l'oreillette gauche
- La volémie
- Manque t'il des déterminants?

Quels sont les déterminants des pressions de remplissage?

- Les propriétés passives de distension du VG
- La relaxation du VG
- La contraction de l'oreillette gauche
- La volémie
- Le péricarde
- La fréquence cardiaque
- Les médicaments
- Les performances systoliques du ventricule

Questions clefs

- Les symptômes sont-ils reliés à une dysfonction cardiaque?
- Les symptômes sont-ils causés par une altération de la fonction de remplissage VG (à une dysfonction diastolique)?



Pressure (mm Hg)

120

Fermeture V.Aortique

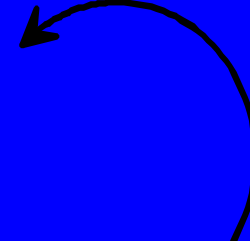
100

Ejection

Ouverture V.Aortique

80

Relaxation Isovolumétrique



Contraction Isovolumétrique

60

40

Ouverture V. Mitrale

Remplissage

Fermeture V. Mitrale

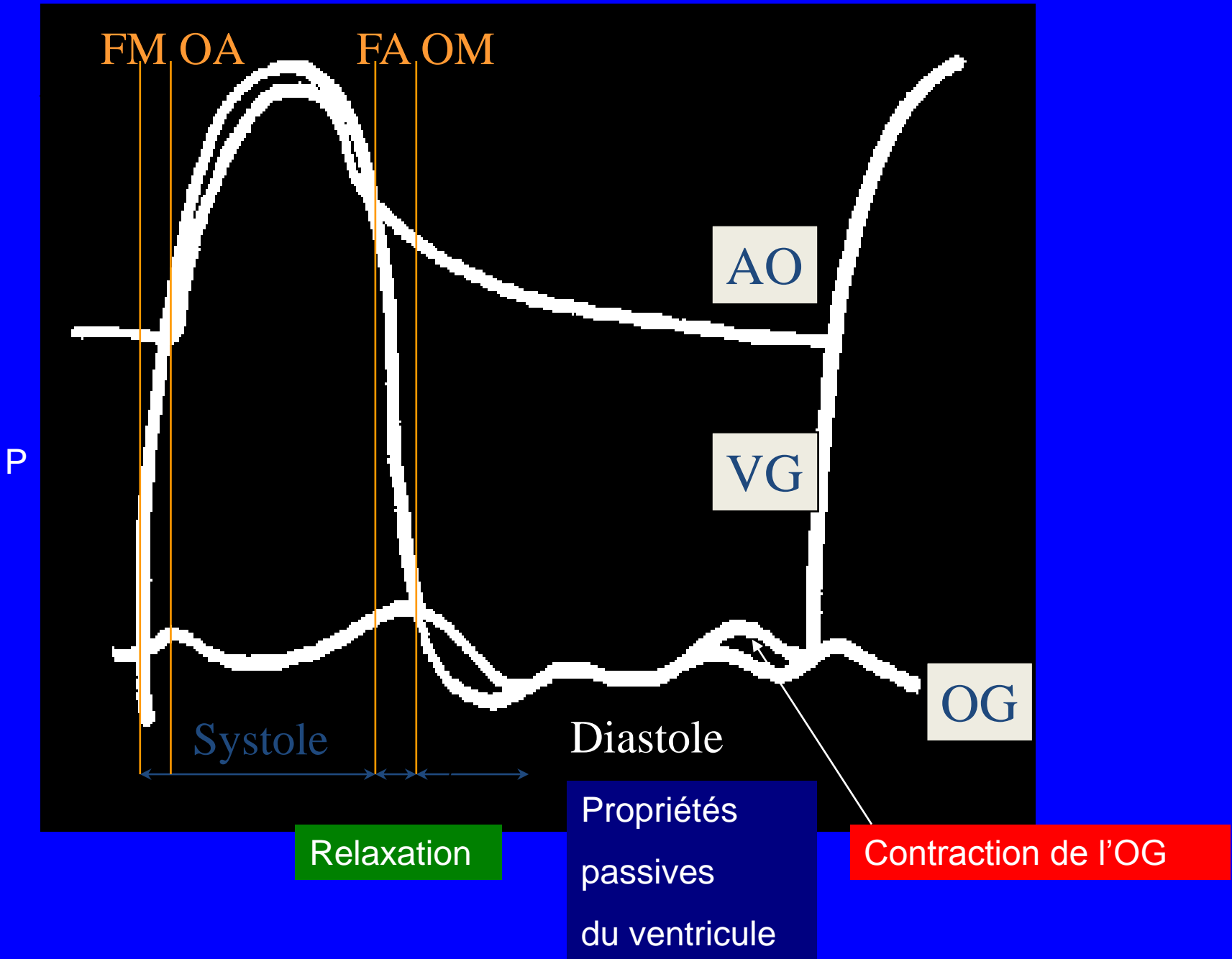
20

0

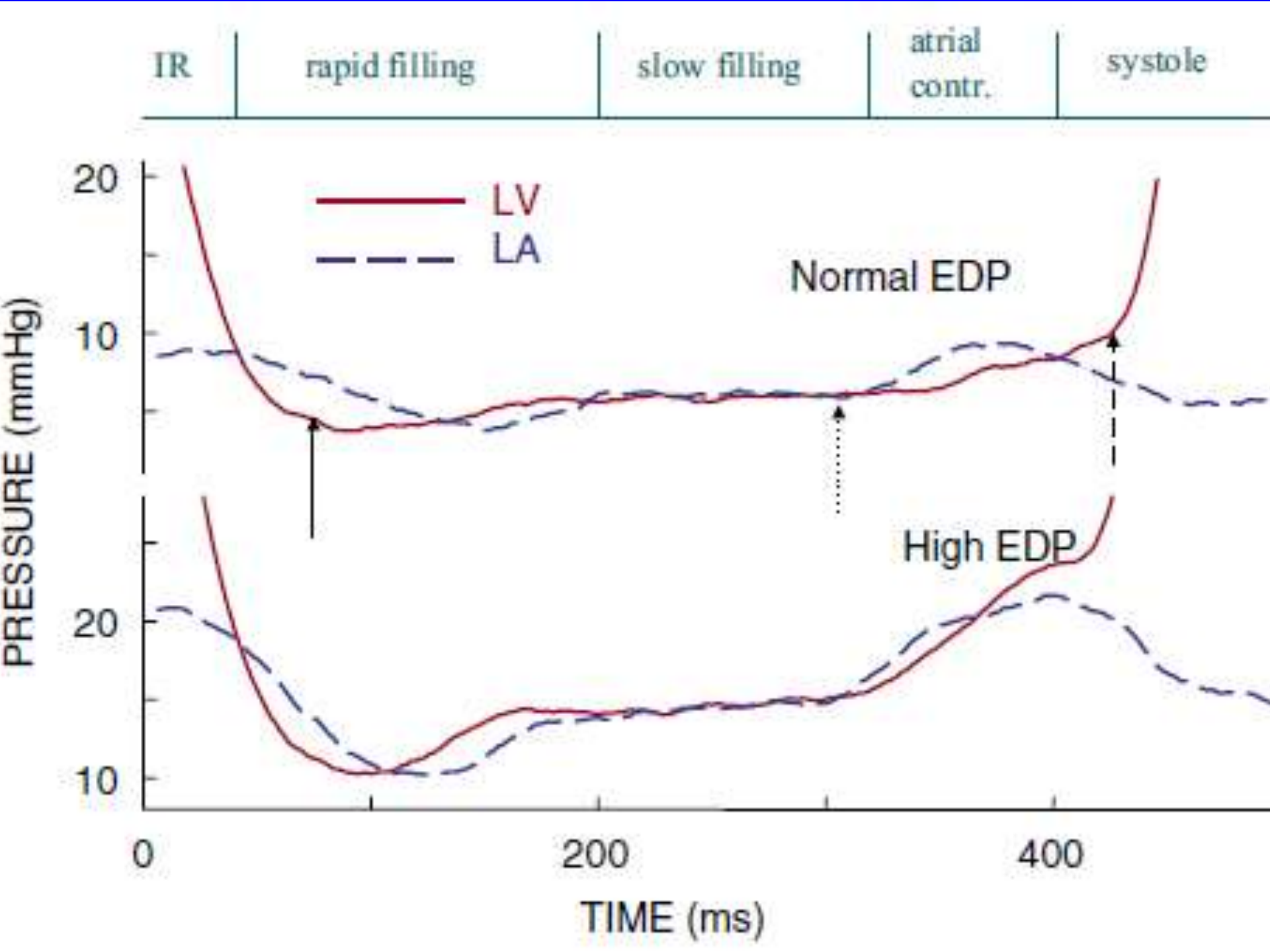
Volume (ml)

40

120



Déterminants du remplissage VG



**Lorsqu'il existe une cardiopathie
sous-jacente**

**l'objectif n'est pas de démontrer
qu'il y a une dysfonction diastolique mais
d'évaluer les pressions de remplissage**

DES DYSFONCTIONS DIASTOLIQUES; DES PRESSIONS DE REMPLISSAGE

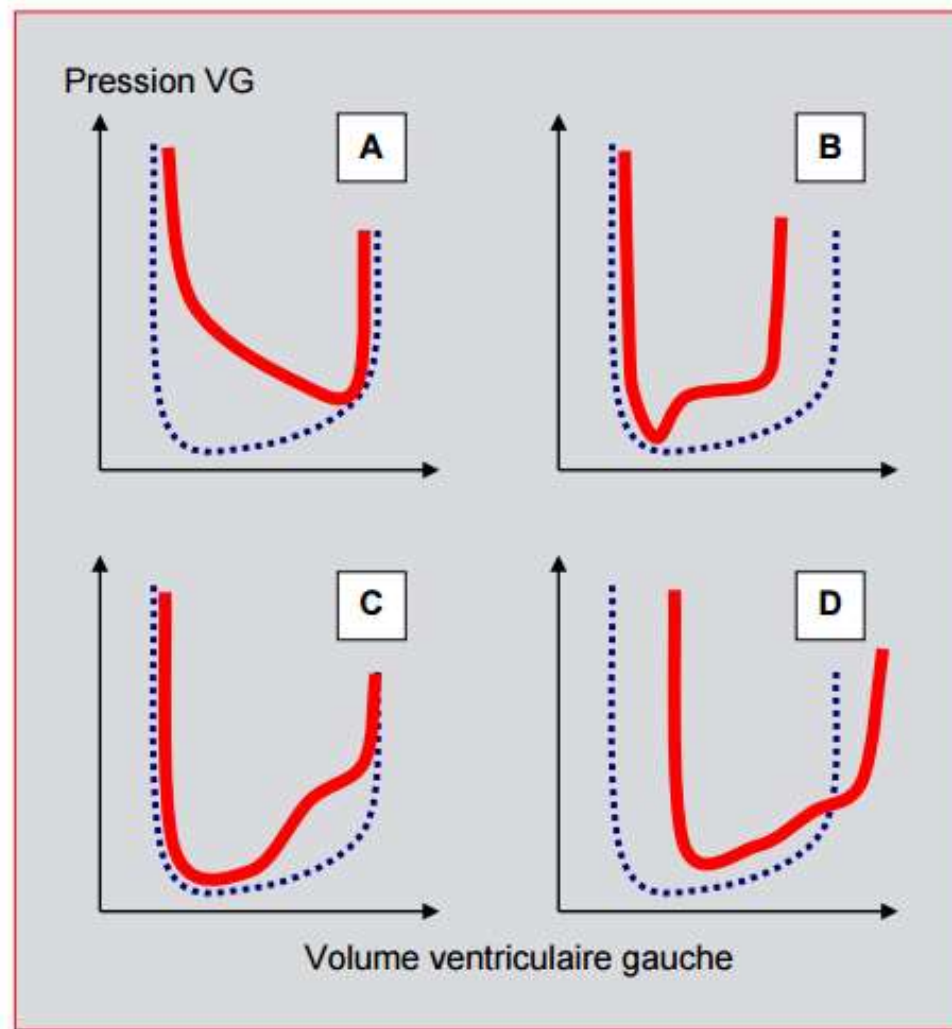


Figure 5.70 : Courbes Pression – Volume du ventricule gauche dans différentes situations de dysfonction diastolique. **A:** Défaut de relaxation (protodiastolique). **B:** Restriction péricardique. **C:** Défaut de distensibilité (télédiastolique). **D:** Dilatation ventriculaire. Traitillé bleu: courbe normale; trait rouge: courbe pathologique (d'après réf 434).

Le substrat de la dysfonction diastolique

- Vieillesissement
- HVG, remodelage VG etc...
- Anomalies de la cinétique segmentaire
- Ischémie myocardique
- Maladies du péricarde
- Dilatation VD

Le substrat de la dysfonction diastolique

- Vieillesissement
- HVG, remodelage VG etc...
- Anomalies de la cinétique segmentaire
- Ischémie myocardique
- Maladies du péricarde
- Dilatation VD
- Les médicaments potentiellement délétères...

Impact des traitements de certaines situations cliniques sur les paramètres échographiques

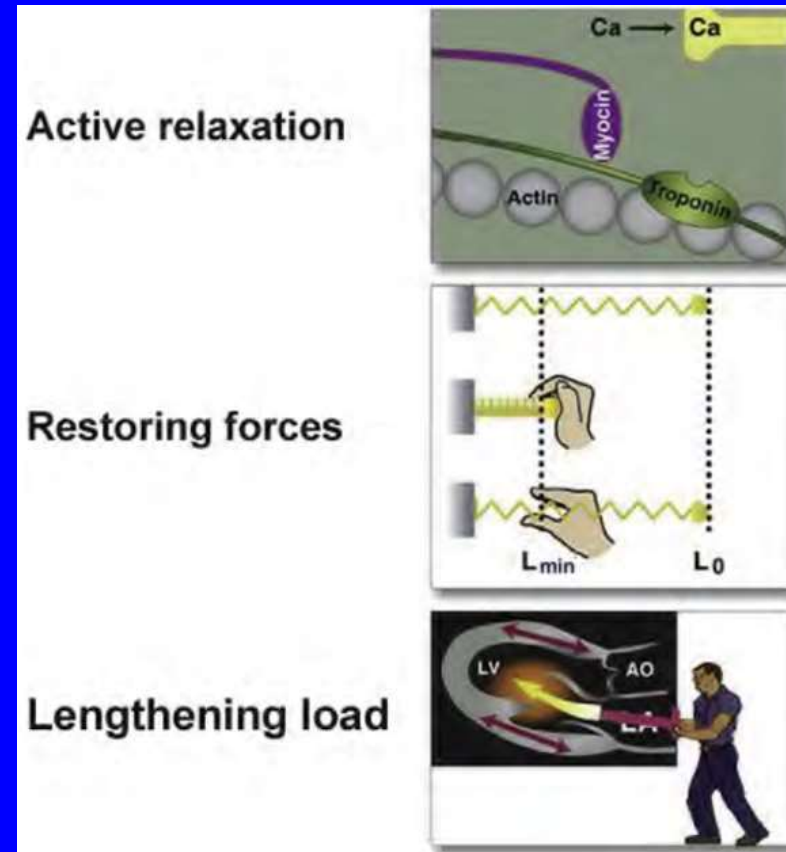
- Phase aiguë d'infarctus du myocarde
- Epanchements péricardiques
- Valvulopathies mitrales
- Hypertension artérielle
- Sepsis
- Fréquence cardiaque (tachycardie versus bradycardie, troubles conductifs, électrostimulation)
- Ventilation mécanique, VNI, vasodilatateurs....

Impact des traitements médicaux sur les paramètres échographiques est très peu évalué.....

- Béta-bloquants
- Calcium bloqueurs bradycardisants
- Ivabradine
- Inotropes positifs....

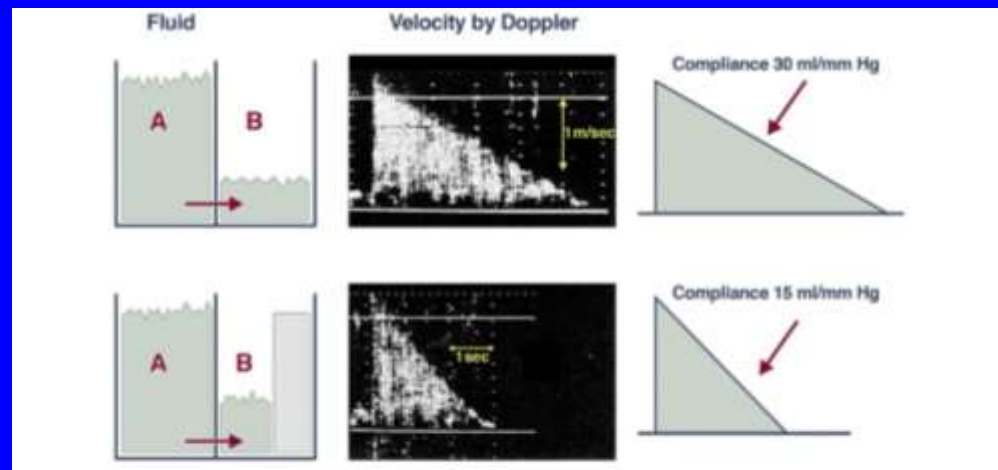
Que mesure-t'on?

- Dysfonction diastolique?
 - Relaxation altérée?
 - Forces de restauration altérées?
 - Rigidité VG accrue?



Physiopathologie complexe de la diastole

- Déterminants du temps de décélération de l'onde E
 - Compliance myocardique
 - Pressions OD et VD
 - Structures extraventriculaires (péricarde, plèvres et poumons...)
 - *Attention!*
TDE court chez le jeune



In a hydraulic model, the flow from chamber A to B (arrow) was measured by Doppler echocardiography, mimicking transmitral flow during passive left ventricular filling. A reduction in compliance in the receiving chamber (B) by placement of a solid object that reduced chamber compliance led to shorter Doppler deceleration time. Reproduced with permission from Flachskampf et al. (18).

On distingue plusieurs pressions diastoliques

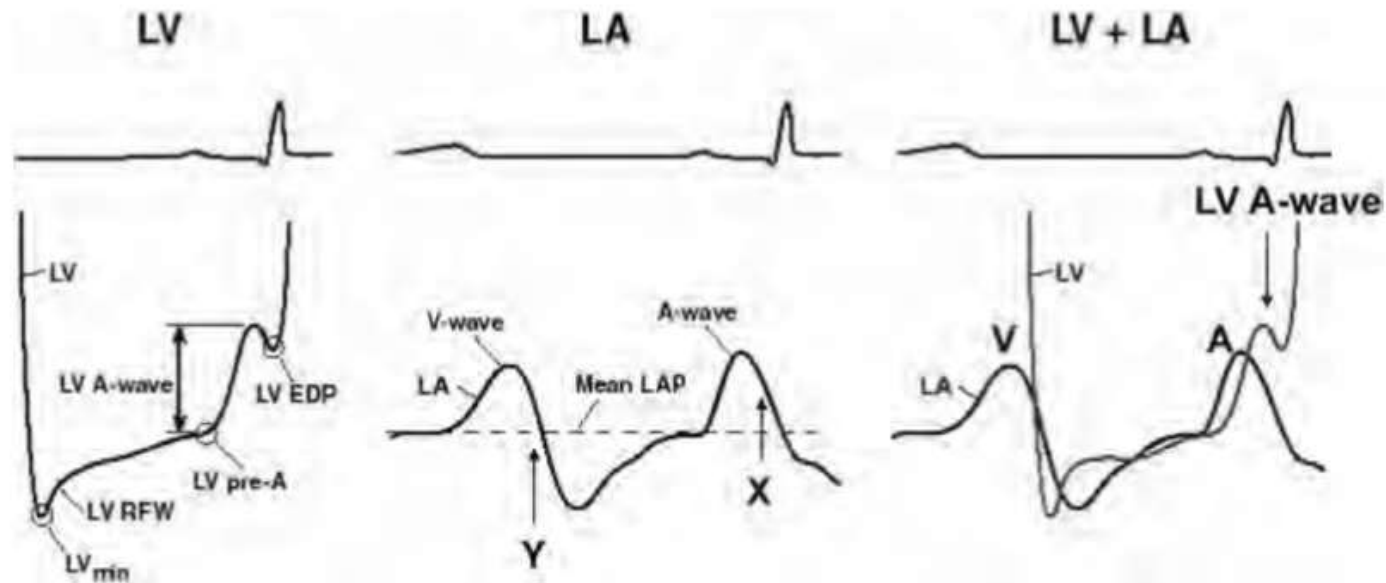
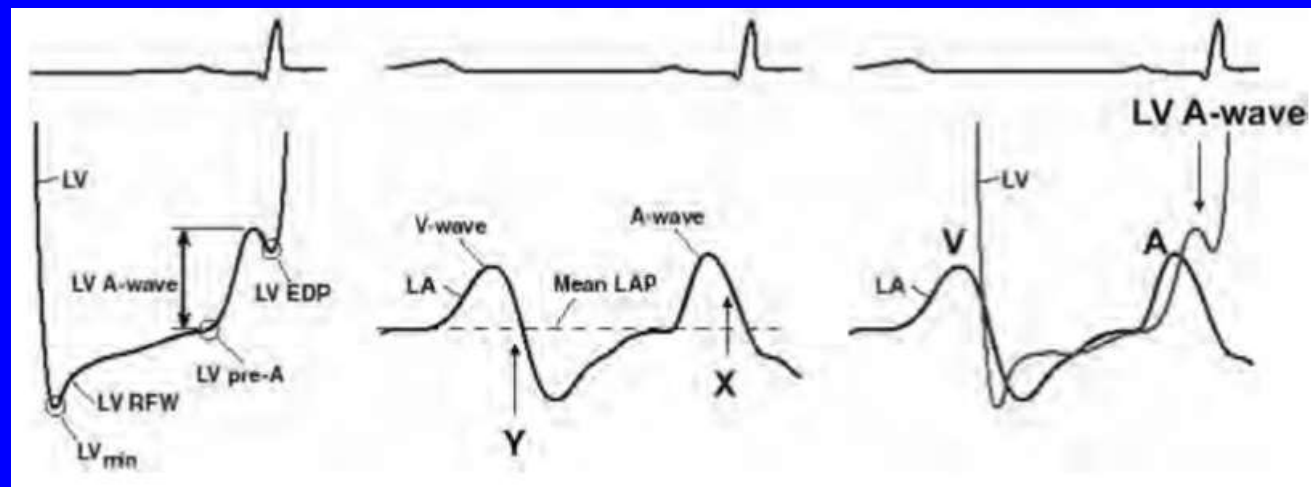


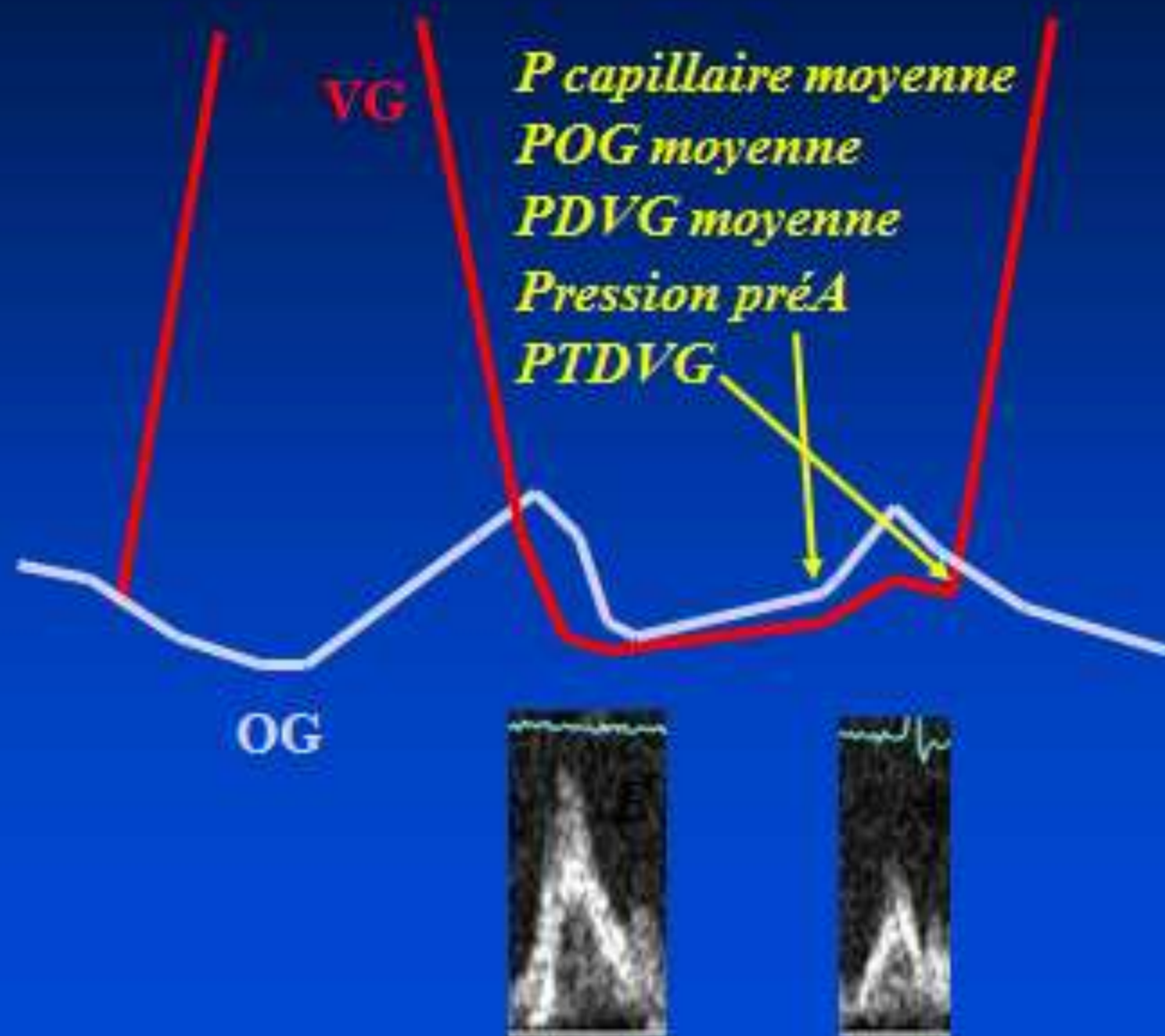
Figure 1 (Left) LV diastolic pressures recording. Arrows point to LV minimal pressure (min), LV rapid filling wave (RFW), LV pre-A pressure (pre-A), A wave rise with atrial contraction and end-diastolic pressure (EDP). (Middle) LAP recording showing “V” and “A” waves marked along with Y and X descent (Right) Simultaneous LV and LAP recording showing early and late transmitral pressure gradients. Notice that LA “A wave” pressure precedes the late diastolic rise (LV A wave) in LV pressure.

Que mesure-t'on?

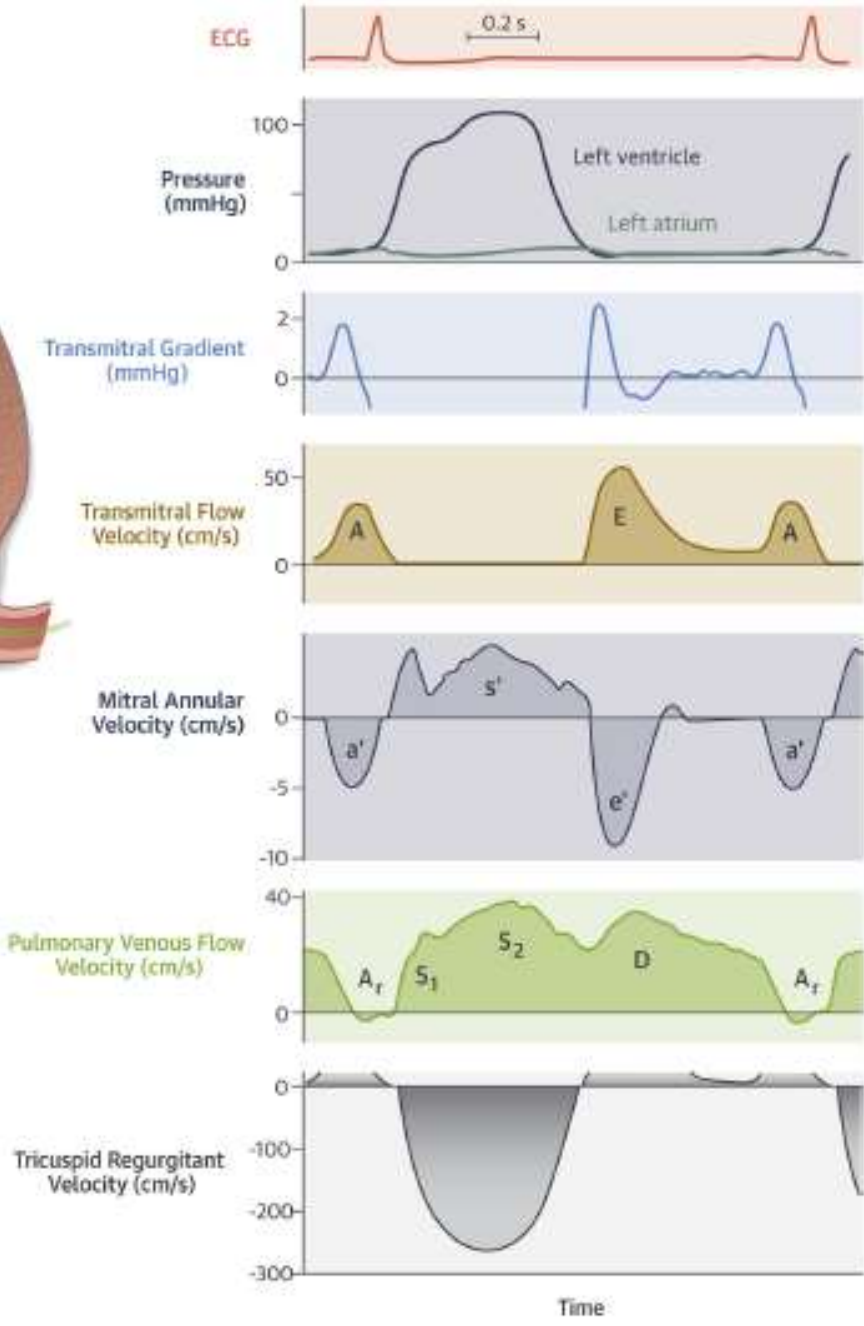
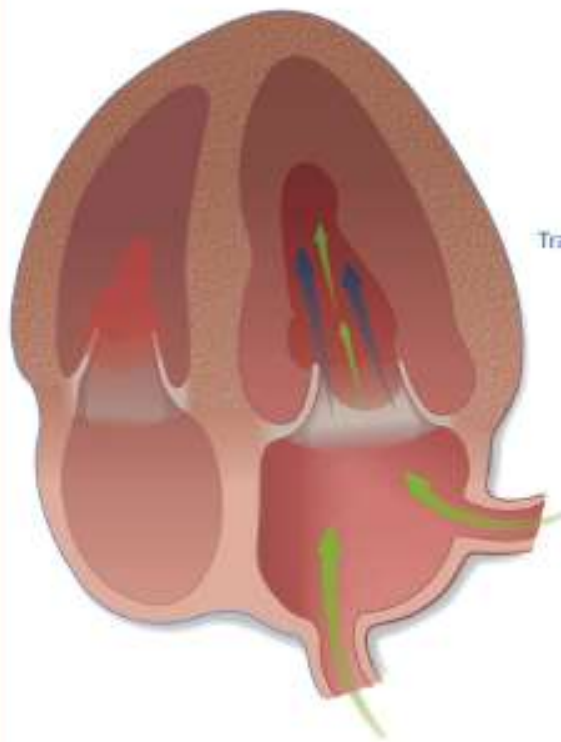
- Pressions de remplissage VG?
 - Pression diastolique VG moyenne (LVDP)
 - Pression capillaire pulmonaire moyenne (CPWP)
 - Pression atriale gauche moyenne (mean LAP)
 - Pression VG pré-A
 - Pression télédiastolique VG (LVEDP)

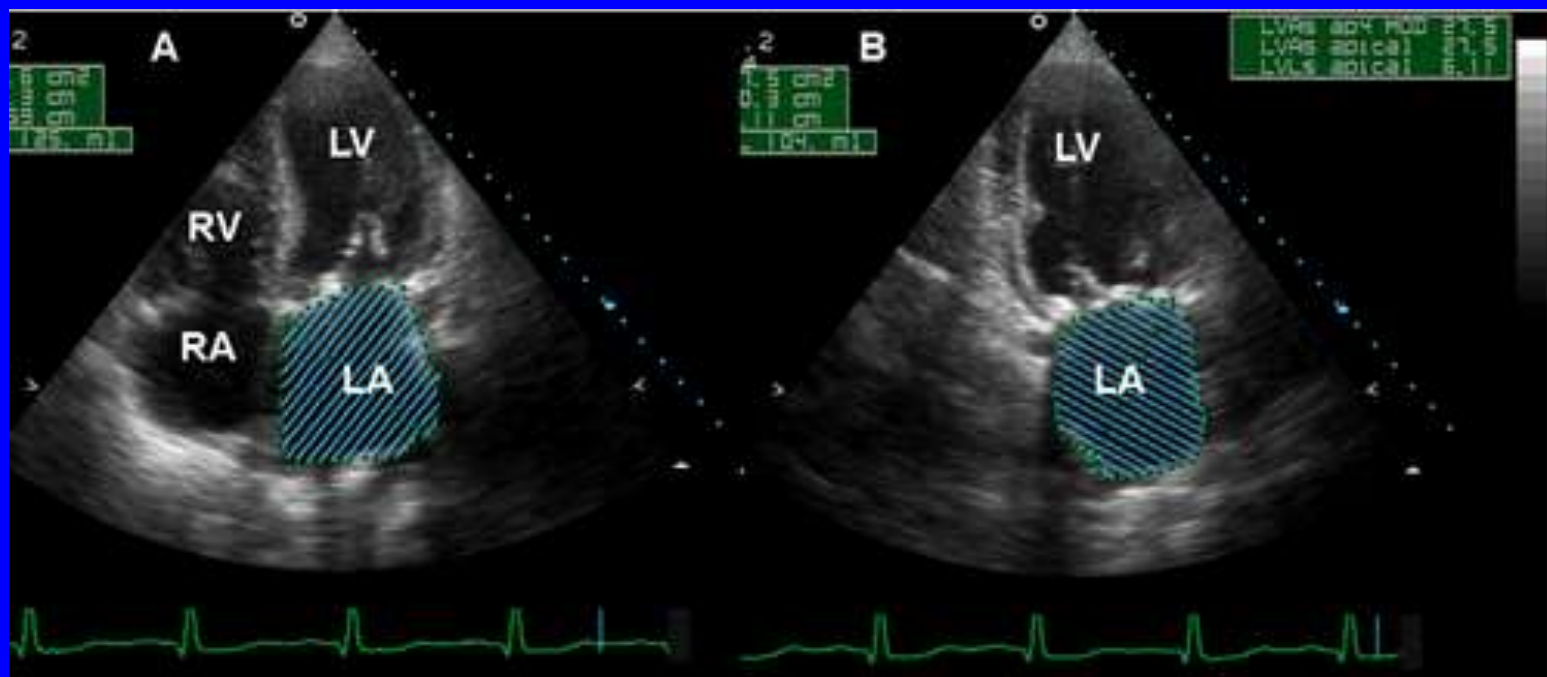


Quelle pression de remplissage mesurer ?



Quels sont les outils échographiques pour évaluer les pressions de remplissage?

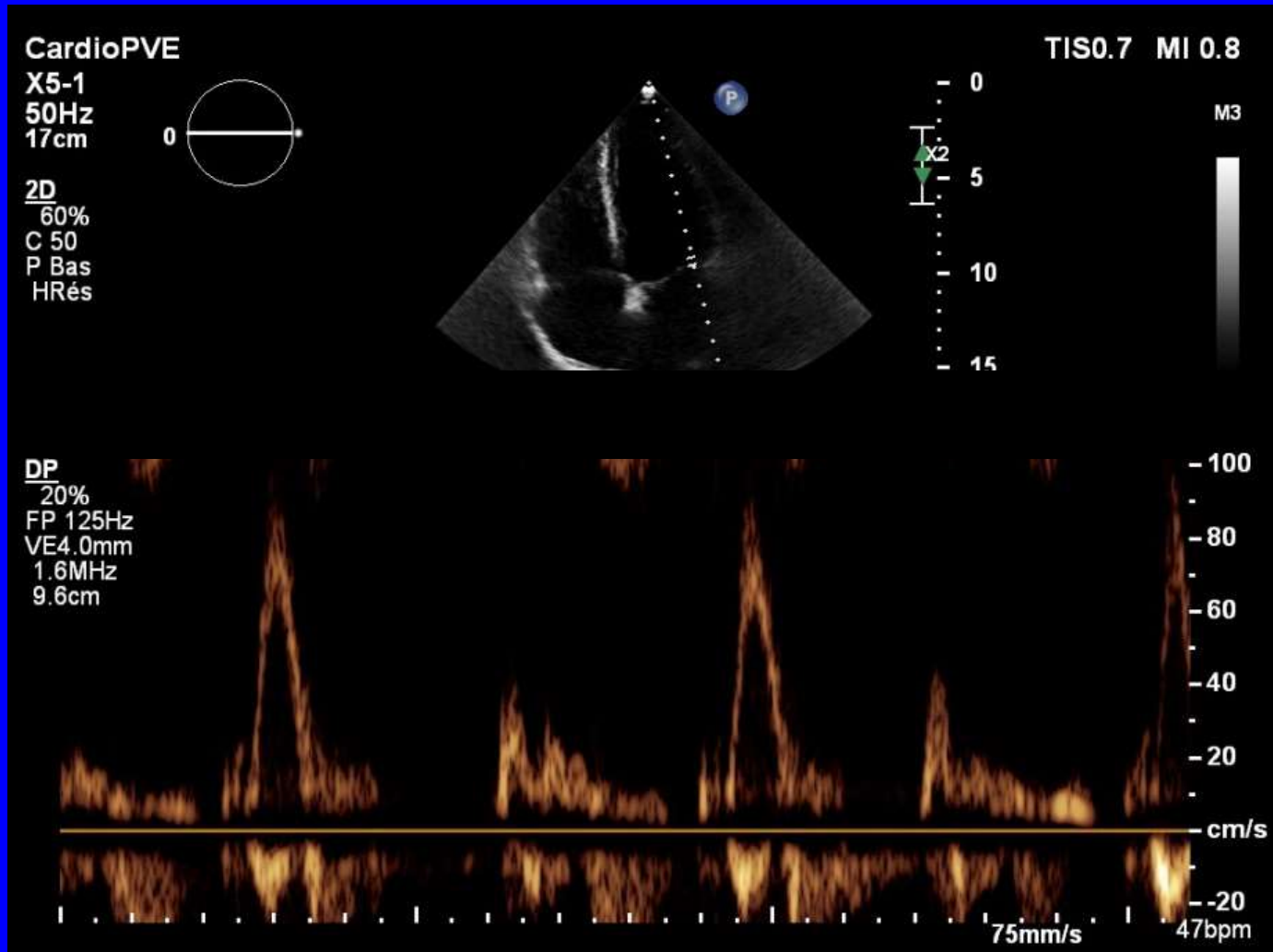




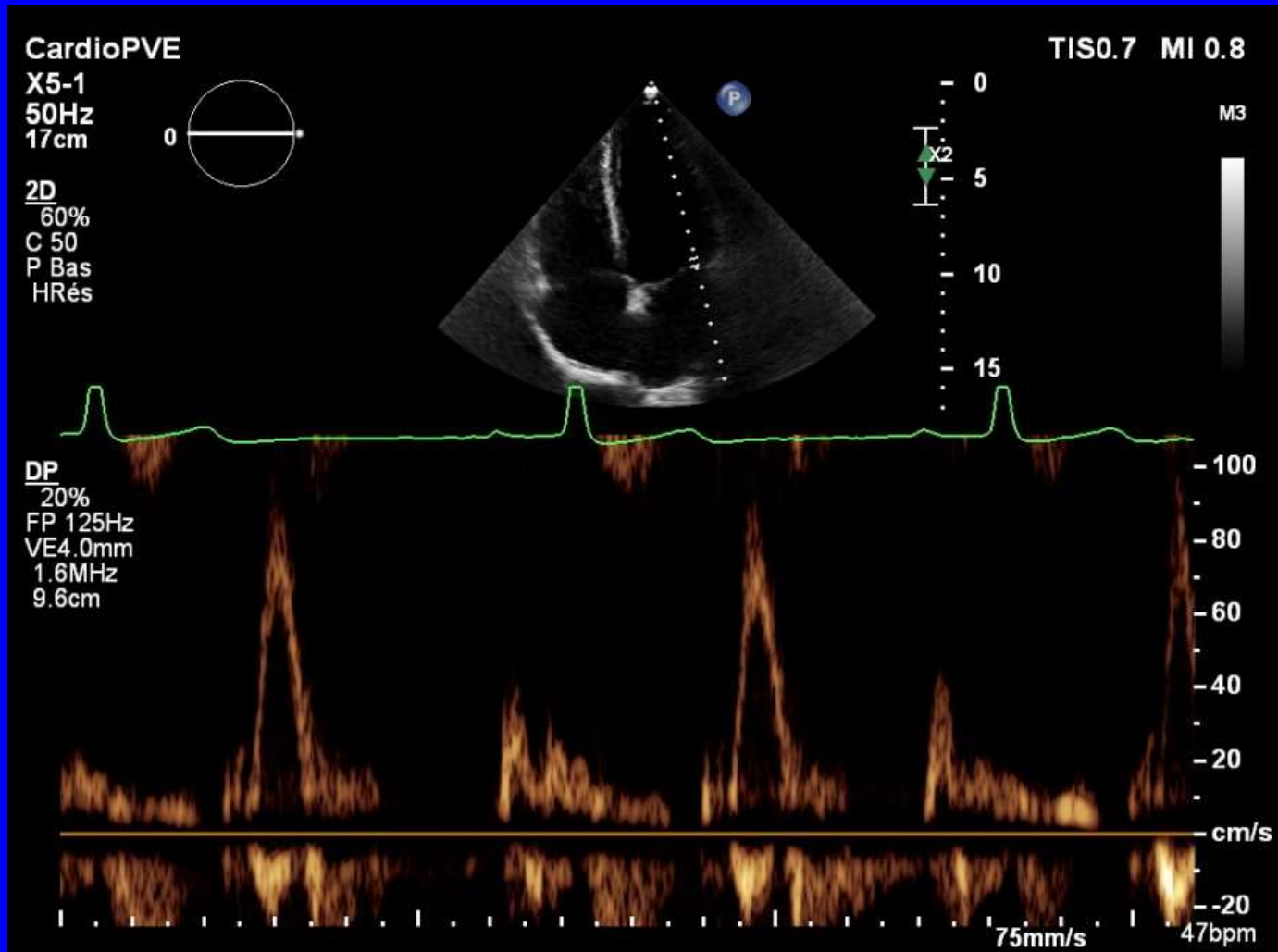
Le baromètre de la dysfonction diastolique et des pressions de remplissage

- L'augmentation de la POG produit une dilatation OG ($>34 \text{ ml/m}^2$)
 - En l'absence de RM, d'IM organique
 - En l'absence de calcification annulaire extensive
 - En l'absence de prothèse mitrale
 - En l'absence de FA
 - En l'absence de sport de haut niveau
 - Attention à l'indexation chez les sujets obèses+++

Quel de type de flux?

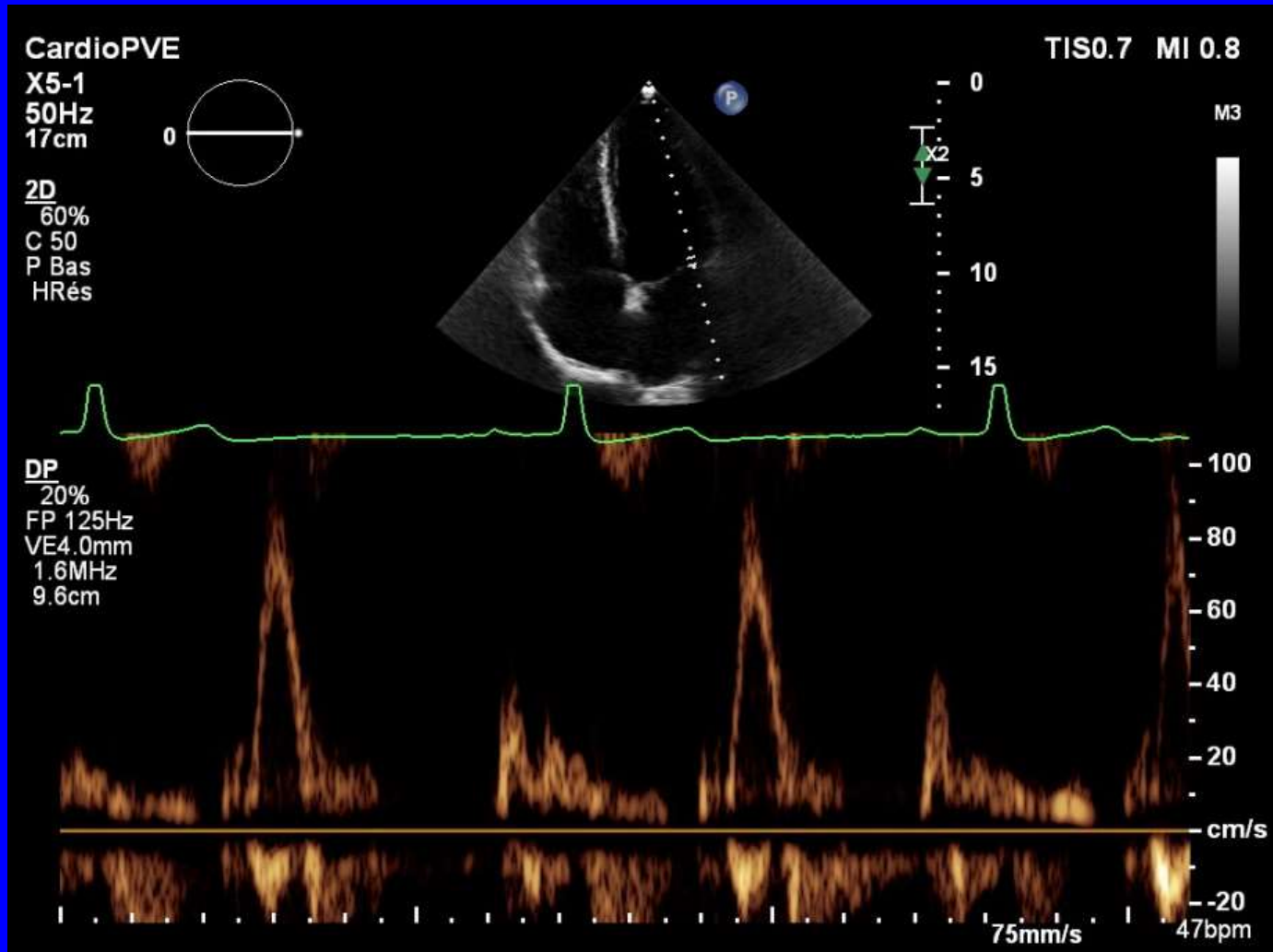


Quel de type de flux?



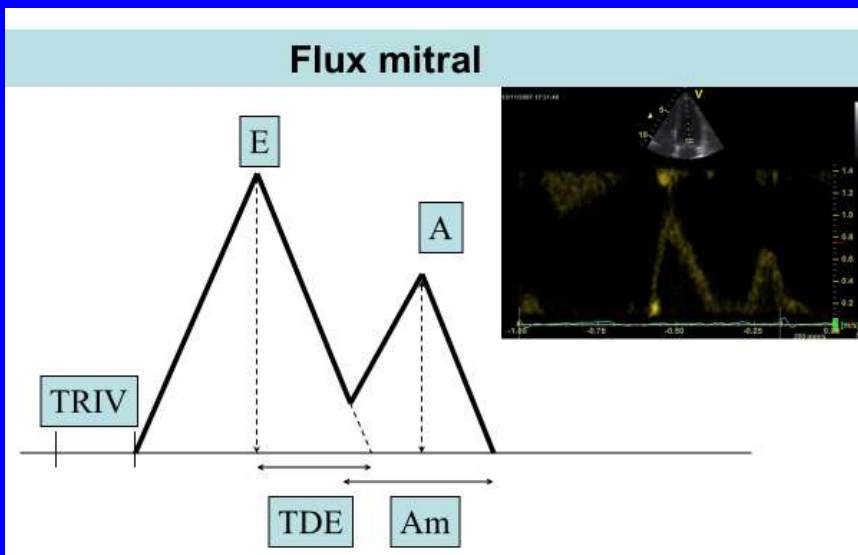
Flux normal ou restrictif?

E/A 2, TDE 110 ms



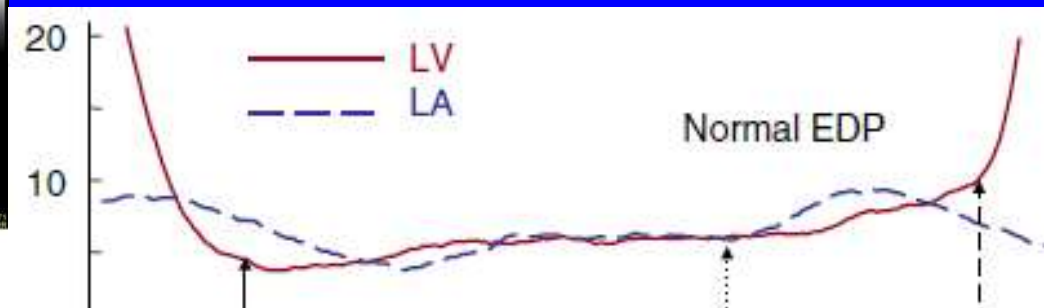
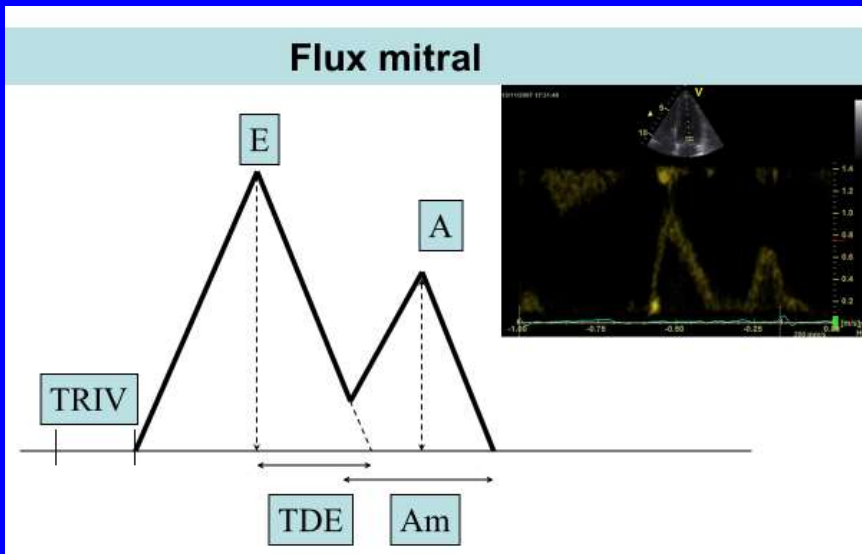
Quelle est la signification de chaque paramètre?

- La vélocité de l'onde E reflète le gradient de pression OG-VG durant la protodiastole:
 - vitesse de relaxation du VG et POG



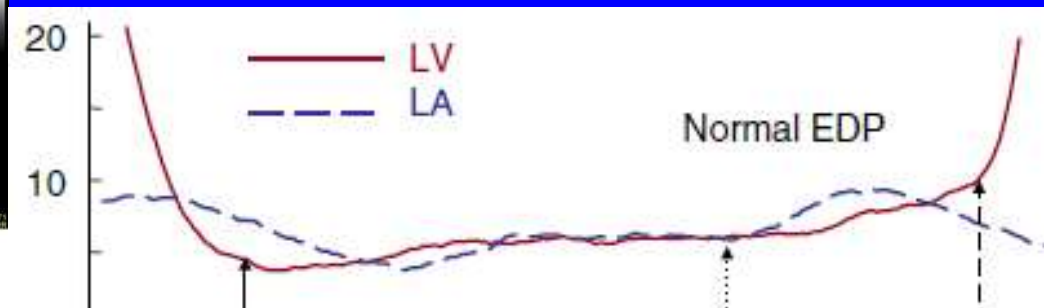
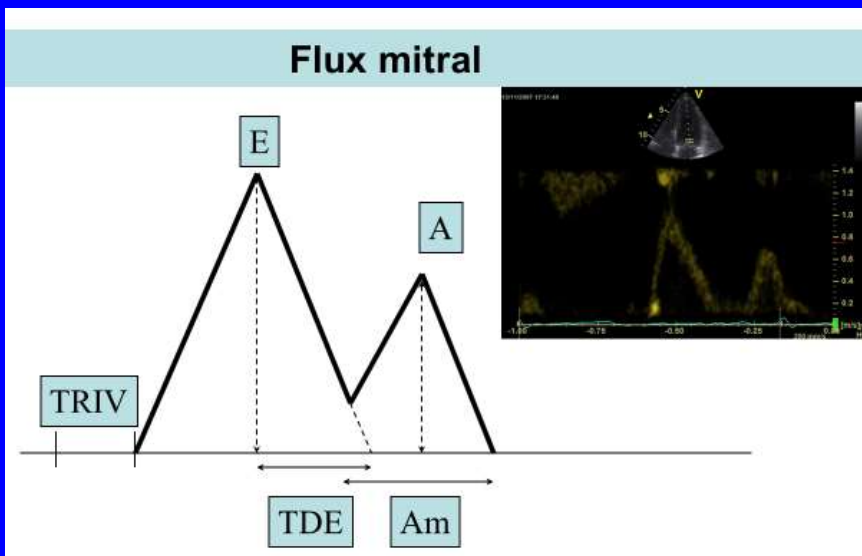
Quelle est la signification de chaque paramètre?

- Le temps de décélération de l'onde E dépend de la relaxation VG, de la pression VG et de la compliance VG



Quelle est la signification de chaque paramètre?

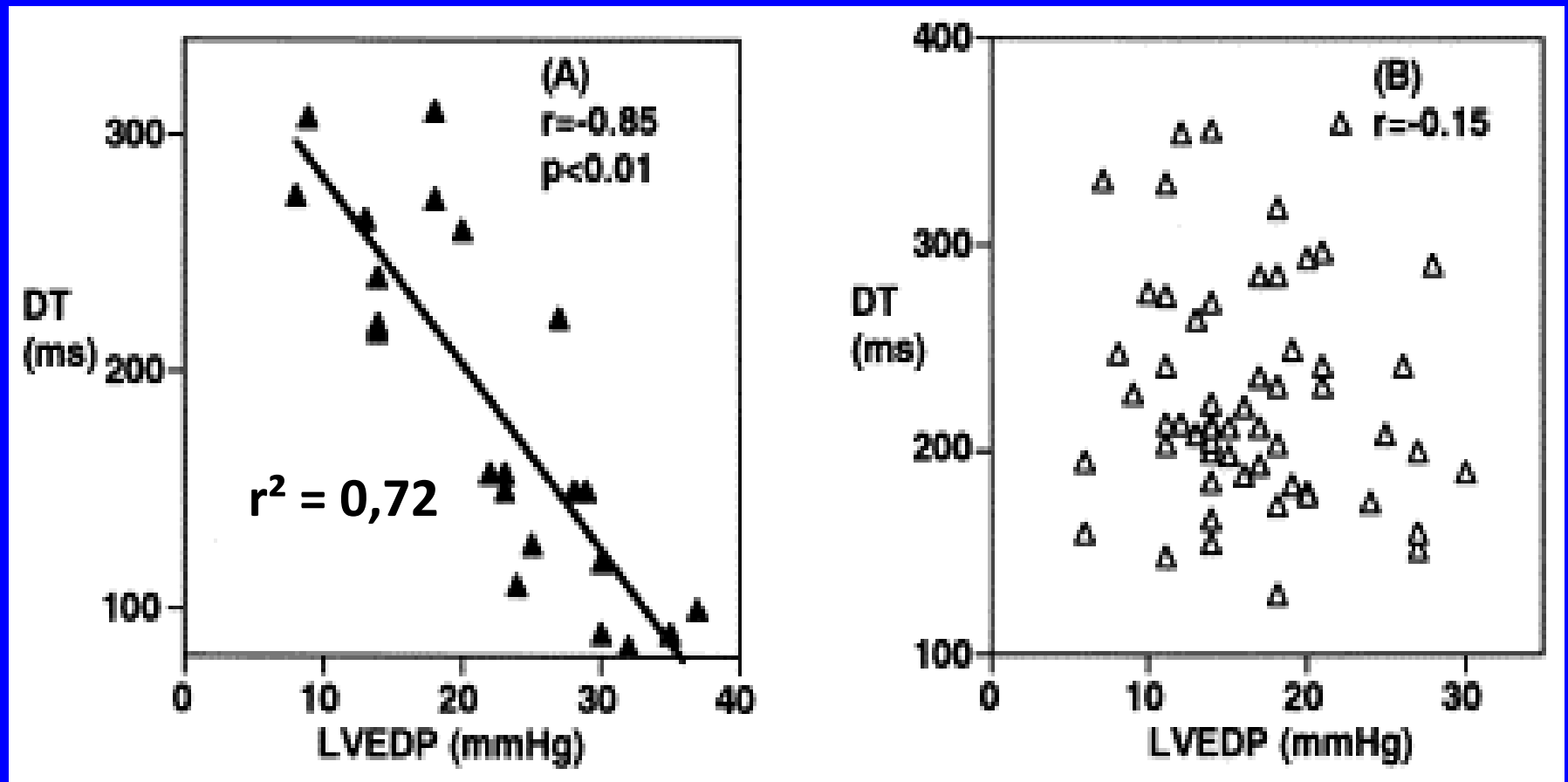
- La vitesse de l'onde A reflète le gradient de pression OG-VG durant la télédiastole:
 - Compliance du VG et fonction contractile de l'OG



Valeur du TDE et du flux mitral: comparaison entre patients avec FE VG < 50% et > 50%

- E/A vs PTDVG si FE<50%, $r = 0.66$
- E/A vs PTDVG si FE>50%, $r = 0.33$

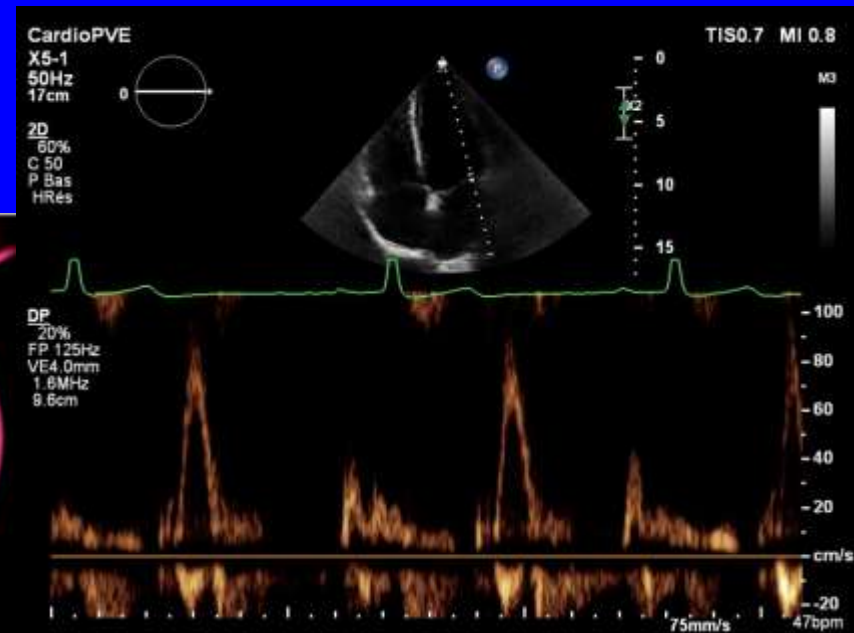
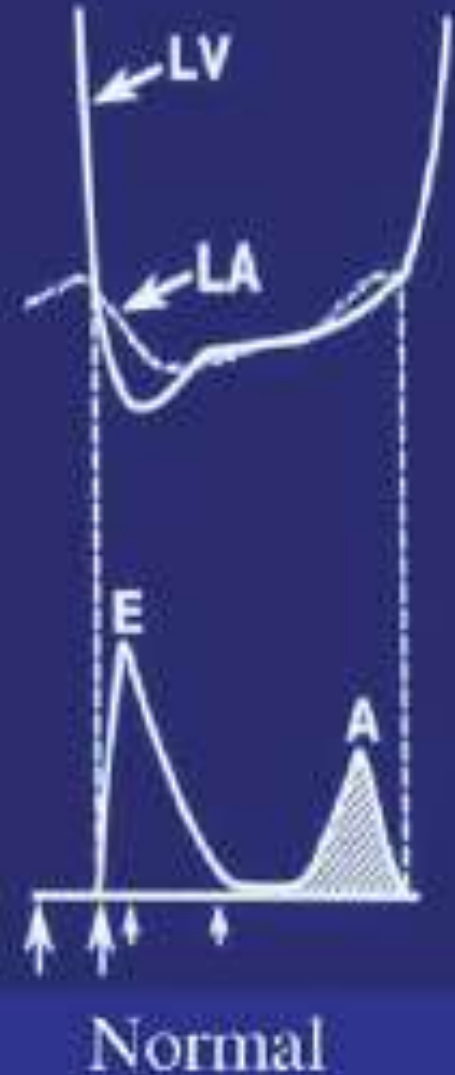
Valeur du TDE et du flux mitral: comparaison entre patients avec FE VG < 50% et > 50%



Yamamoto K et al, J Am Coll Cardiol, 1997

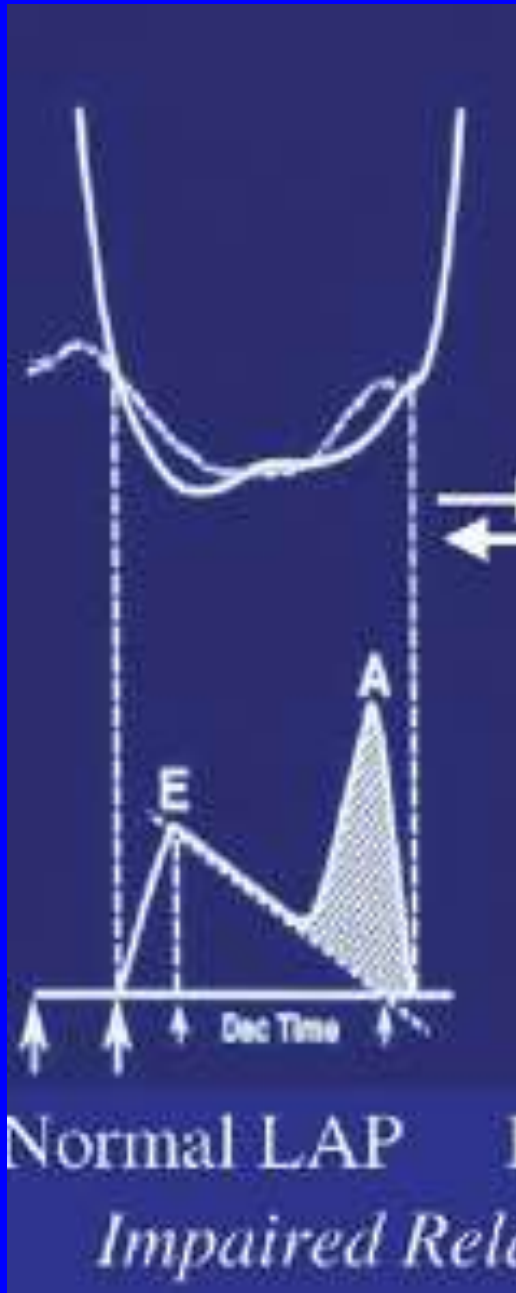
Chez le jeune aspiration du sang en protodiastole provoquant une vidange atriale rapide:

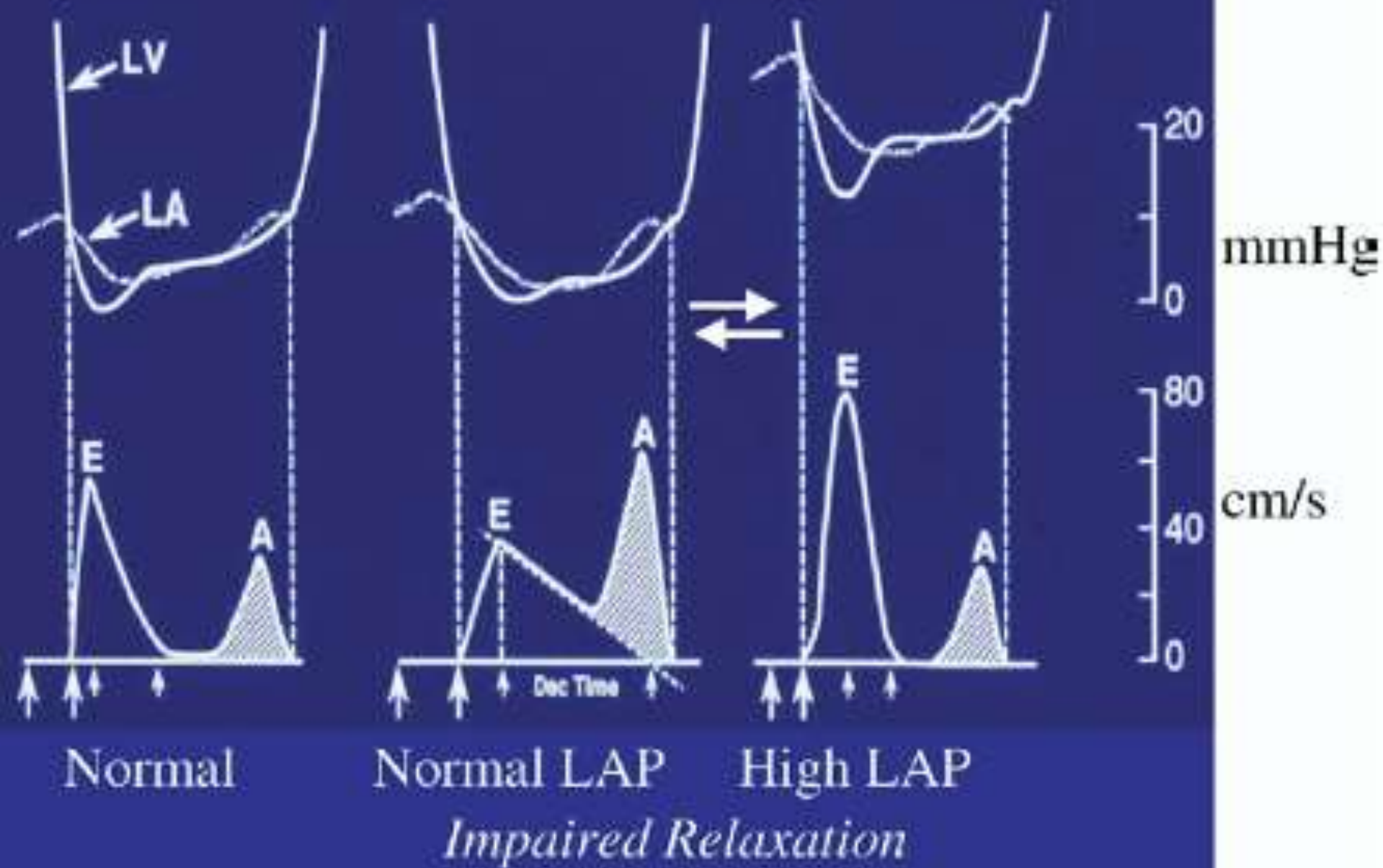
- Grande onde E et petite onde A

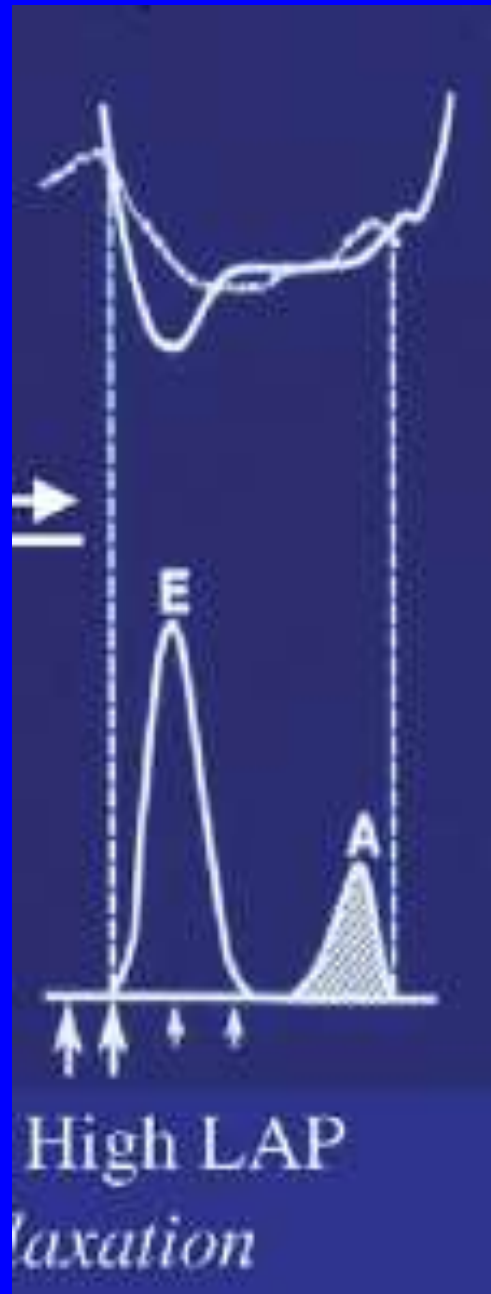


Altération de la relaxation VG avec pressions de remplissage normales contribuant à une vidange atriale graduelle:

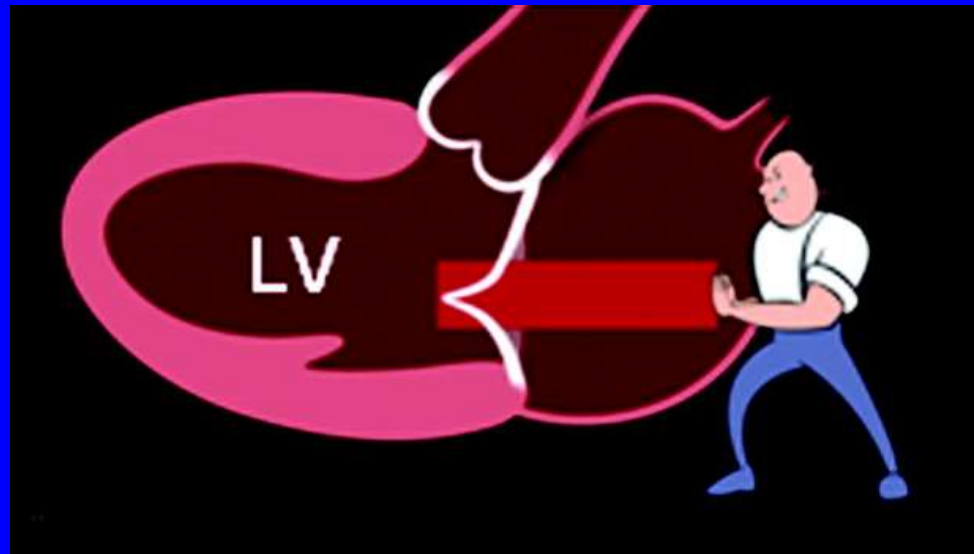
- Baisse de la vélocité de E et augmentation de la contribution atriale

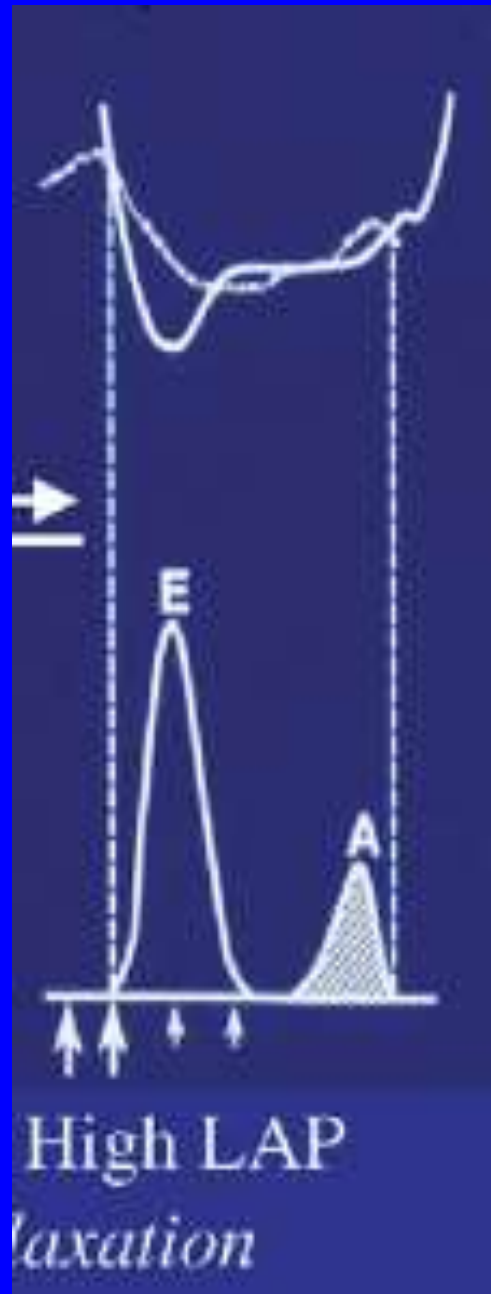




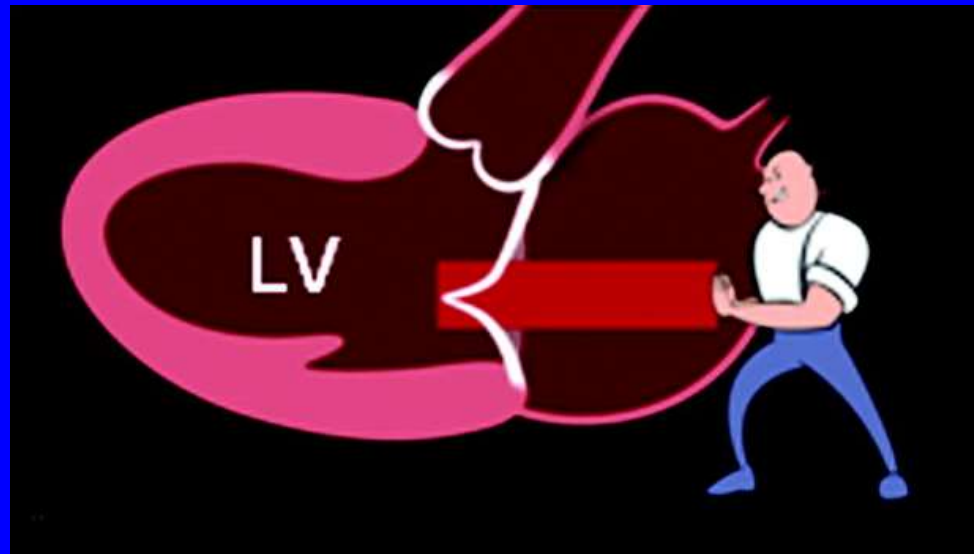


En présence d'une altération de la relaxation et d'une élévation de la POG, la POG produit une force de poussée sur les feuillets mitraux résultant en une grande onde E et une onde A réduite; c'est le pattern "pseudonormal".

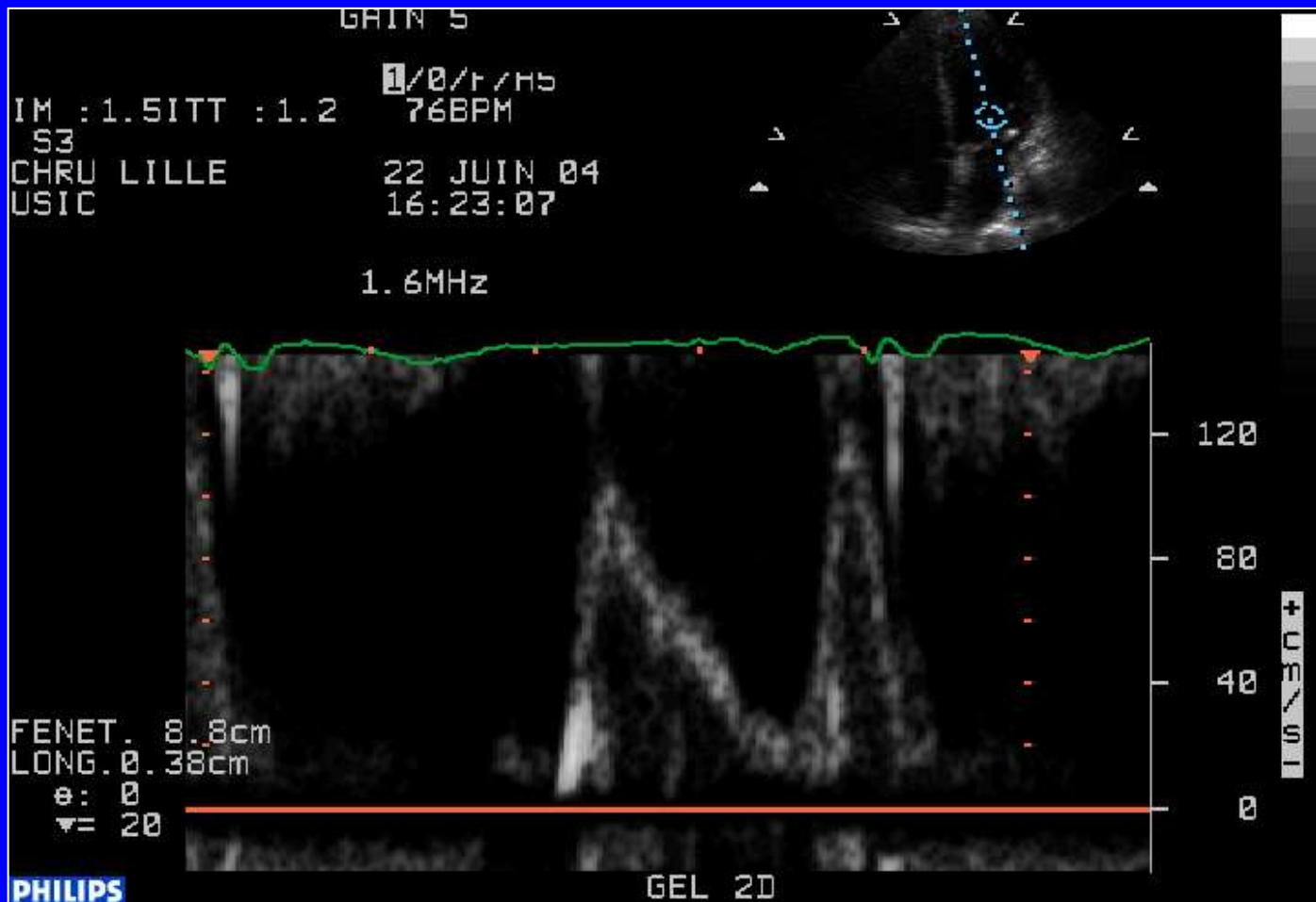




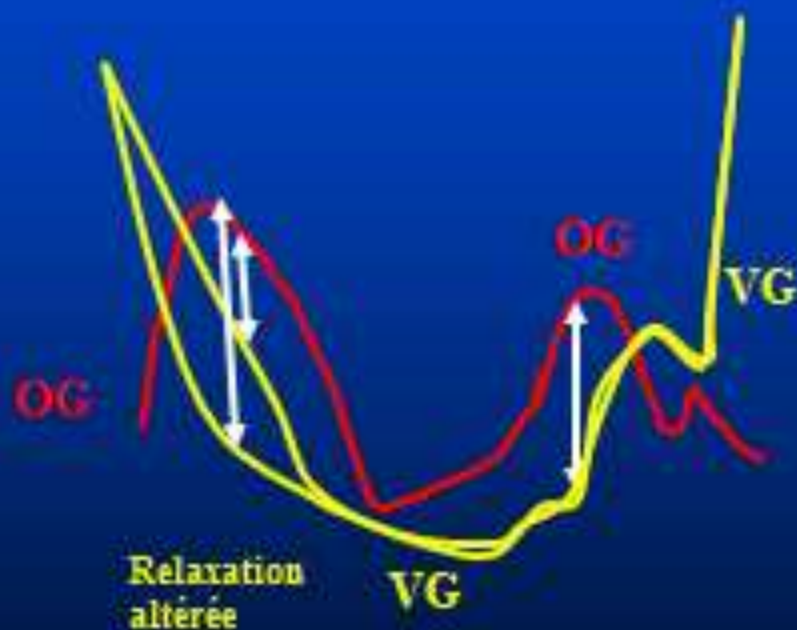
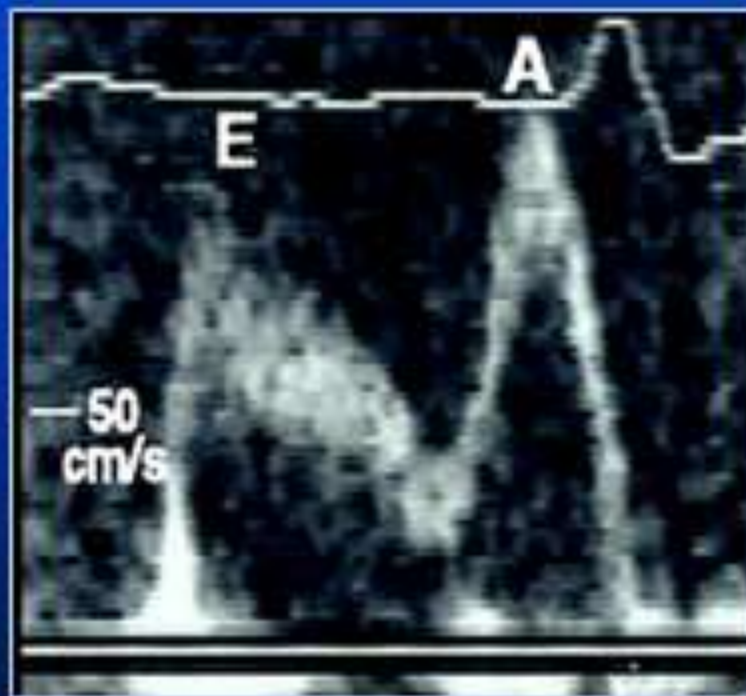
En cas d'élévation des pressions de remplissage avec rigidité ventriculaire, l'ouverture précoce de la valve mitrale liée à l'élévation de la POG est suivie d'une équilibration rapide des pressions produisant un raccourcissement du temps de décélération de E: c'est le remplissage restrictif



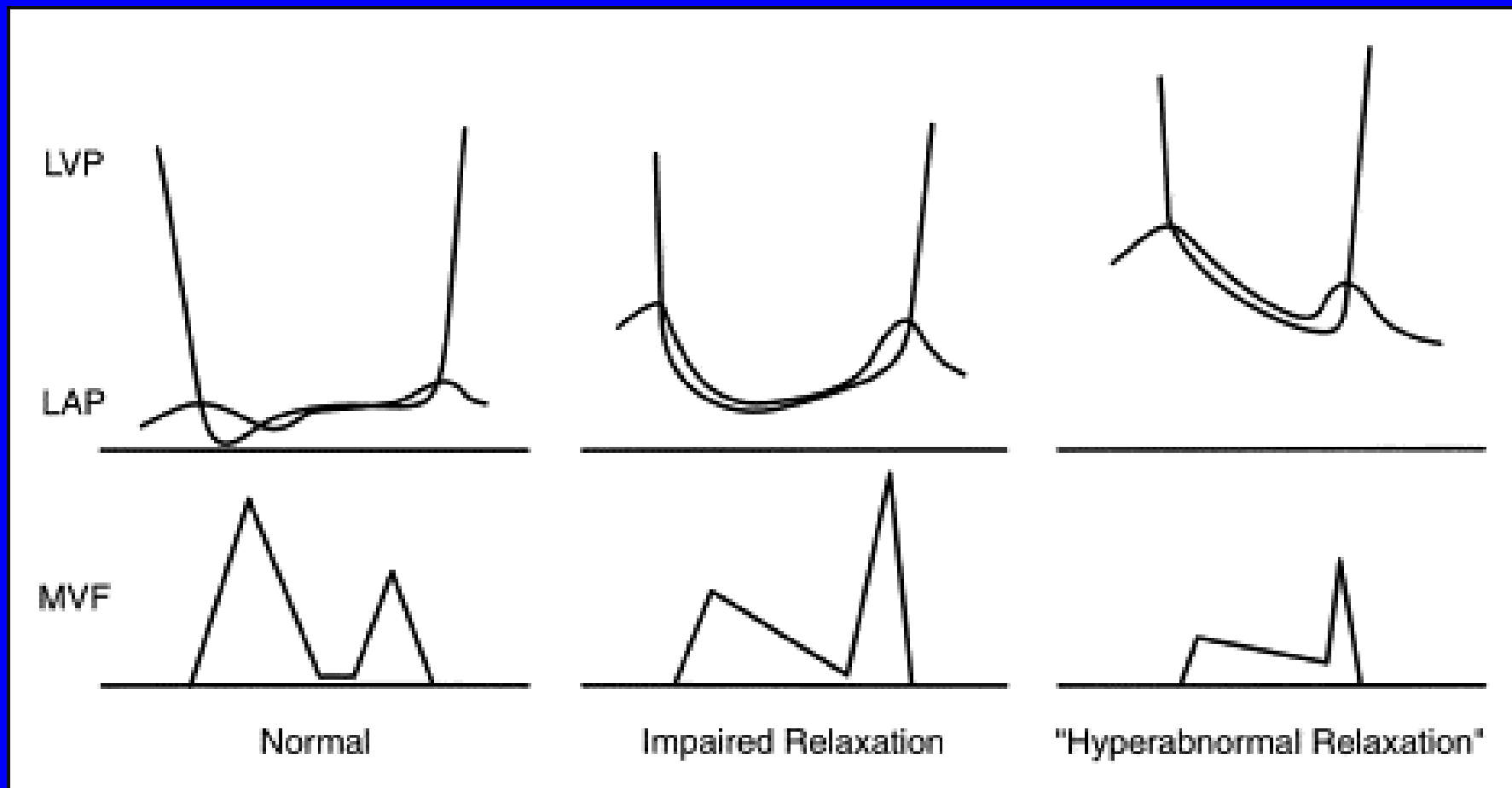
Pressions de remplissage normales ou élevées?



Une exception : $E < A$ et HVG
P rempl variables, parfois très augmentées



Nagueh. Circulation 1999;99:254.
Abergel E. Euroecho 7.



Peter Bogaty, Paola Muré, Jean G Dumesnil

New insights into diastolic dysfunction as the cause of acute left-sided heart failure associated with systemic hypertension and/or coronary artery disease

The American Journal of Cardiology, Volume 89, Issue 3, 2002, 341–345

Quelle est la signification de chaque paramètre?

- La manœuvre de Valsalva permet d'augmenter la pression intrathoracique et de diminuer le retour veineux et donc la précharge

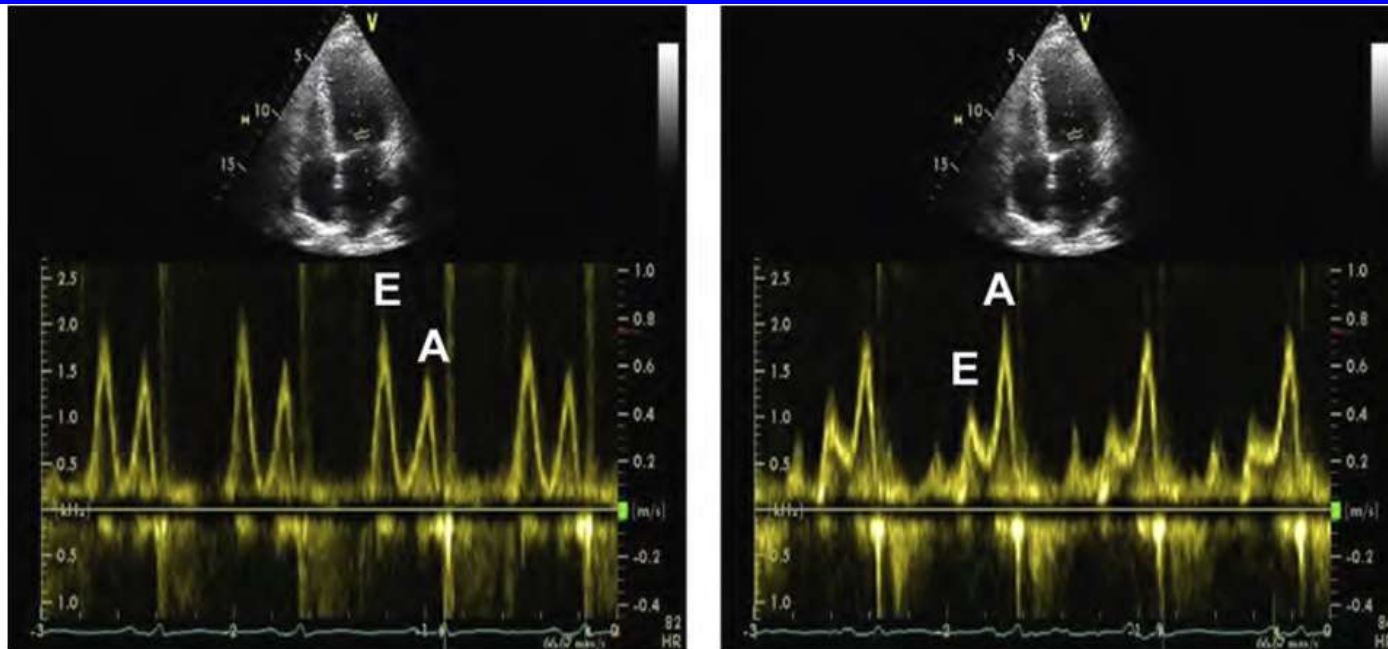


Figure 5 Valsalva maneuver in a patient with grade II diastolic dysfunction. At baseline, E/A ratio is 1.3 (left) and decreases to 0.6 (impaired relaxation pattern) with Valsalva.

Quelle est la signification de chaque paramètre?

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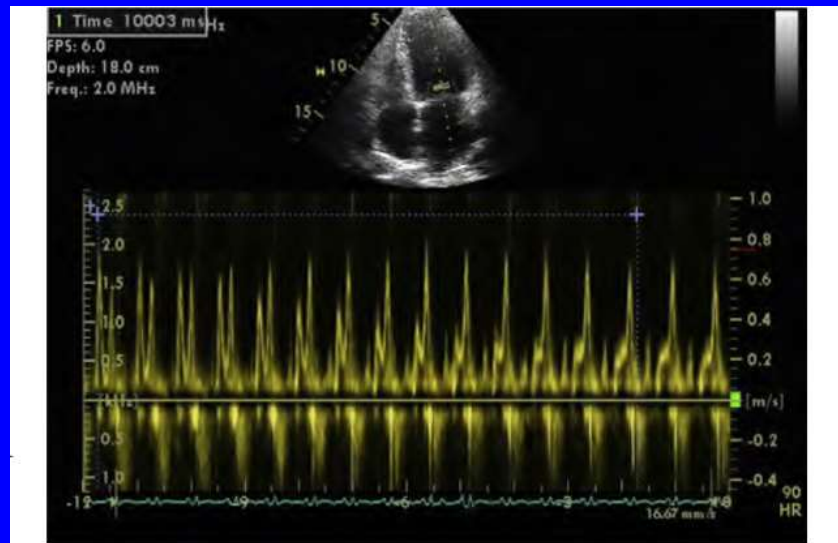
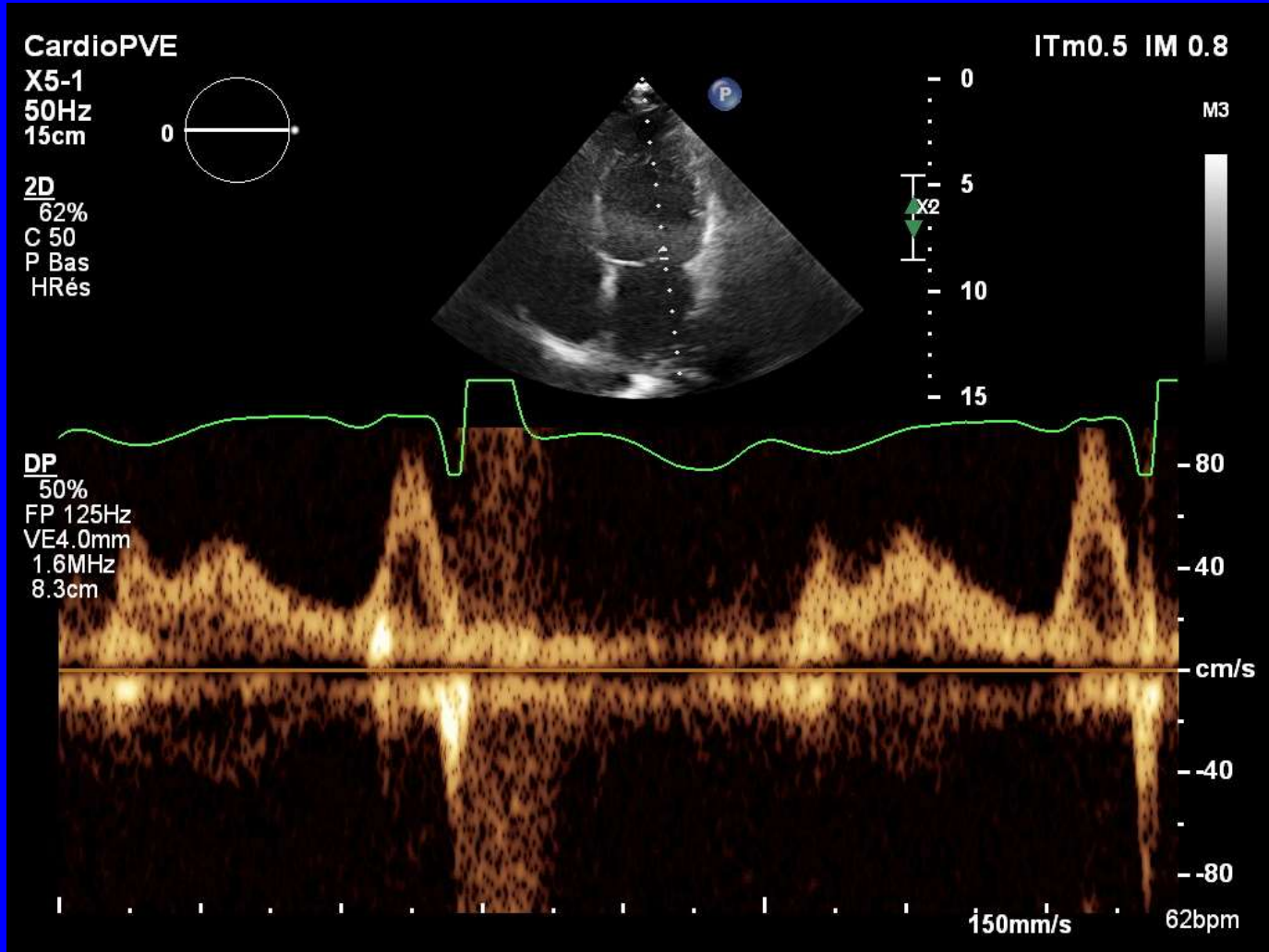


Figure 6 Continuous recording of mitral inflow during standardized Valsalva maneuver for 10 sec showing the decrease in E/A ratio with straining, which is consistent with elevated LV filling pressures.

?

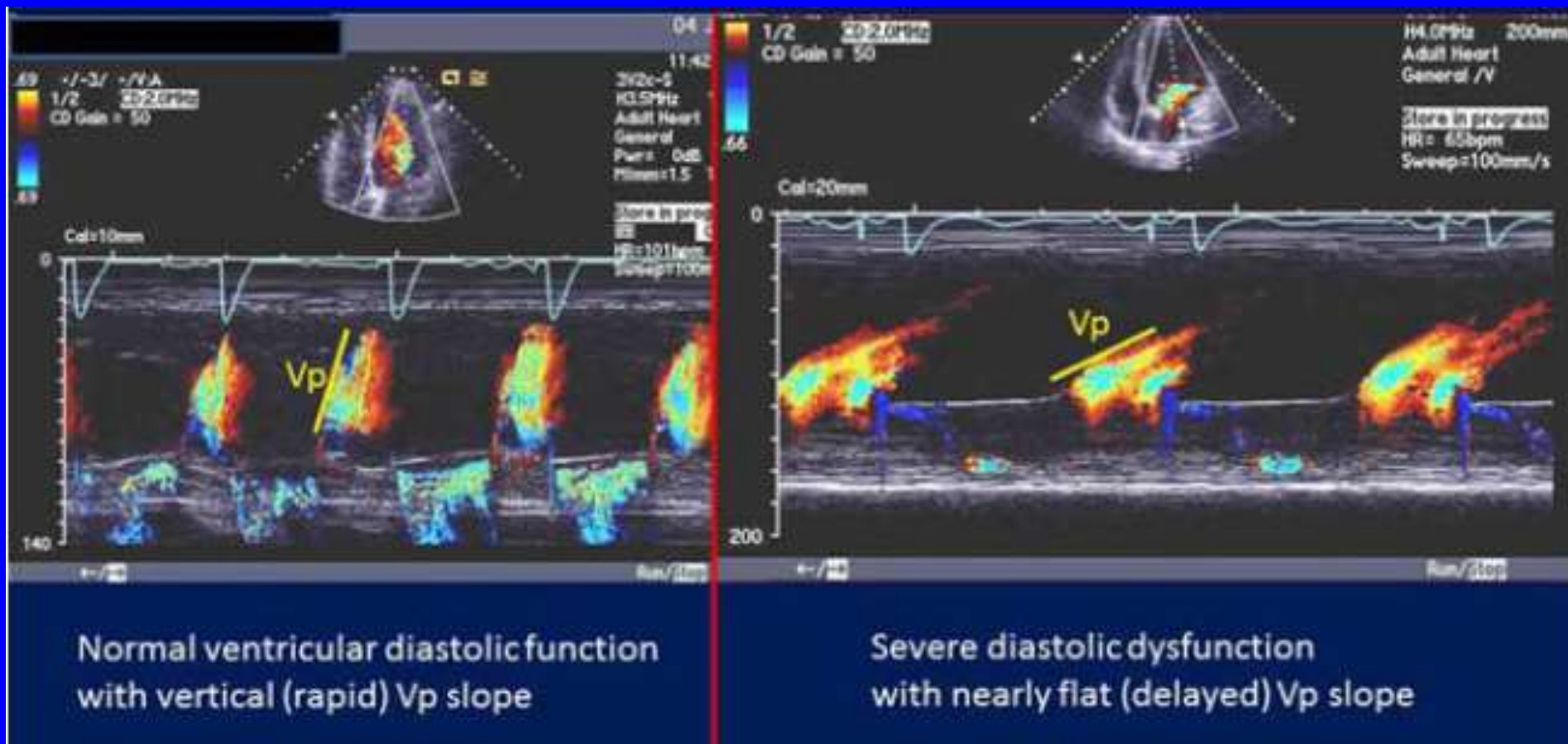


Quelle est la signification de chaque paramètre?

- La vélocité de l'onde L (« late ») dépend de la réduction de la vitesse de relaxation VG et d'une augmentation de la POG avec une fréquence cardiaque diminuée



Vélocité de propagation du Doppler couleur transmitral

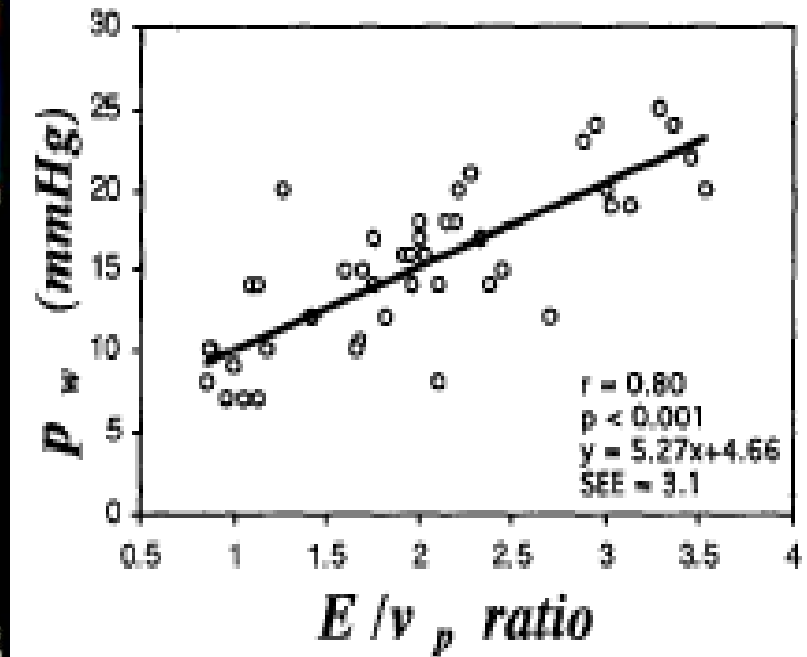
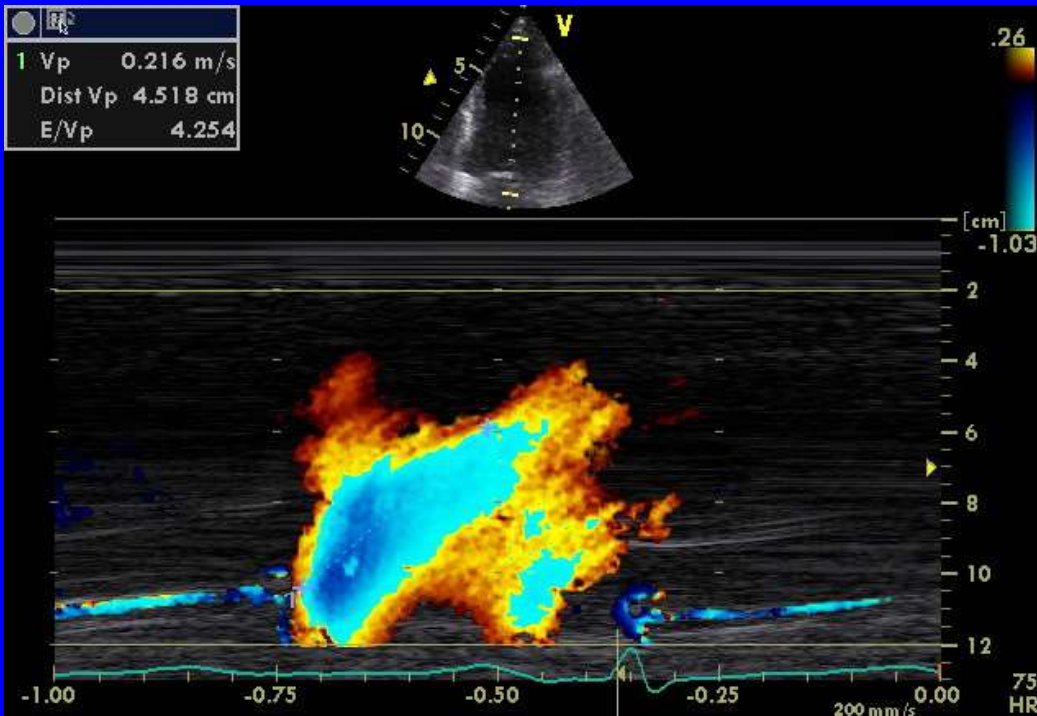


Normal ventricular diastolic function with vertical (rapid) Vp slope

Severe diastolic dysfunction with nearly flat (delayed) Vp slope

Reproducibility issue

Pression de remplissage VG et E/Vp



(Garcia et al. JACC 1997; 29: 448-54)

n = 45

- $E/V_p > 2.5$: \uparrow LVDP pre-A
- $E/V_p < 1.5$: Normal LVDP pre-A

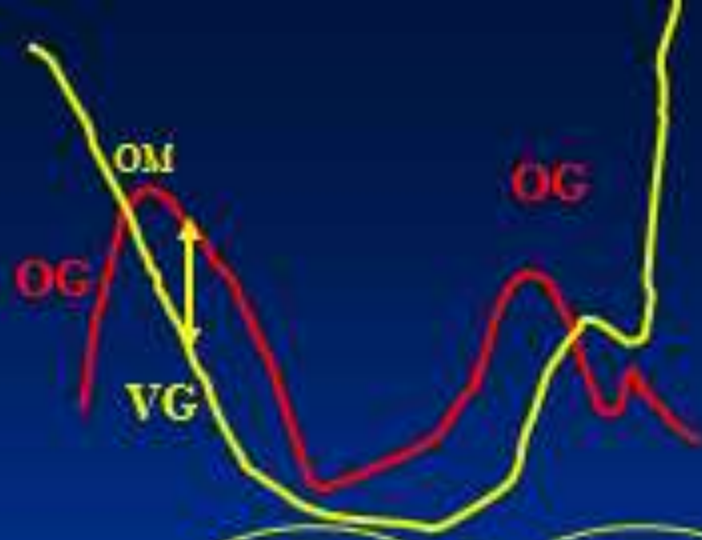
Doppler tissulaire

- e' : le meilleur indice non invasif de la relaxation
- Plus la relaxation VG est ralentie, plus basse est la vitesse de e'
- Le rapport E/e' a été validé comme indice de pression VG moyenne quelle que soit la FEVG
- A noter que plus e' est réduite plus l'onde S est réduite: couplage systole-diastole
- ***L'APPAREIL VALVULAIRE MITRAL DOIT ETRE NORMAL!***

TABLE 1 Normal Values for e' and E/e'

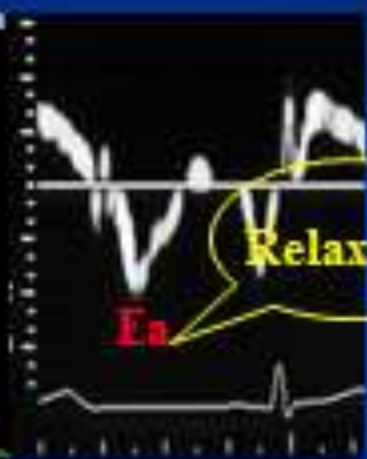
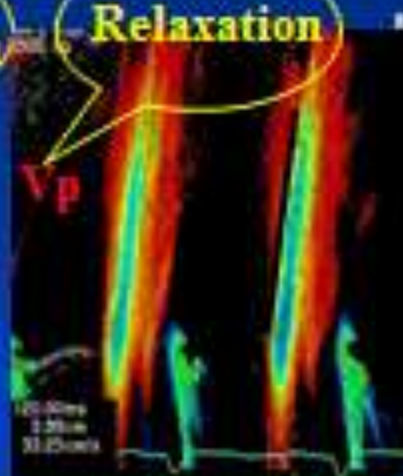
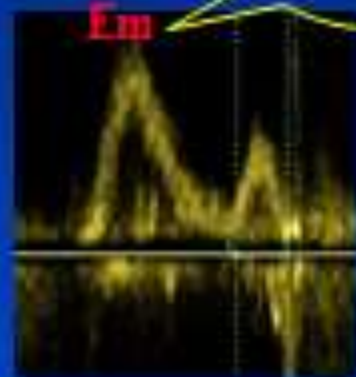
	e' , cm/s	E/e' Ratio
Women, <40 yrs	10.0-19.2	3.0-8.2
Women, 40-59 yrs	6.5-16.1	3.2-10.4
Women, \geq 60 yrs	1.8-14.6	3.1-14.3
Women, overall	5.4-18.2	2.5-10.9
Men, <40 yrs	8.7-19.5	2.5-8.5
Men, 40-59 yrs	6.1-15.3	3.0-9.4
Men, \geq 60 yrs	4.4-12.0	3.1-12.3
Men, overall	4.8-16.8	2.4-10.4

Normal reference ranges for left ventricular regional lengthening velocity (e' ; by pulse-wave Doppler) and E/e' ratio (mean \pm 2 SD) in 1,266 randomly selected healthy individuals. Average values from all 4 left ventricular walls. The findings were similar when e' was calculated as an average of septal and lateral e' . Modified from Dalen et al. (114).



POG
Relaxation

Relaxation



Relaxation

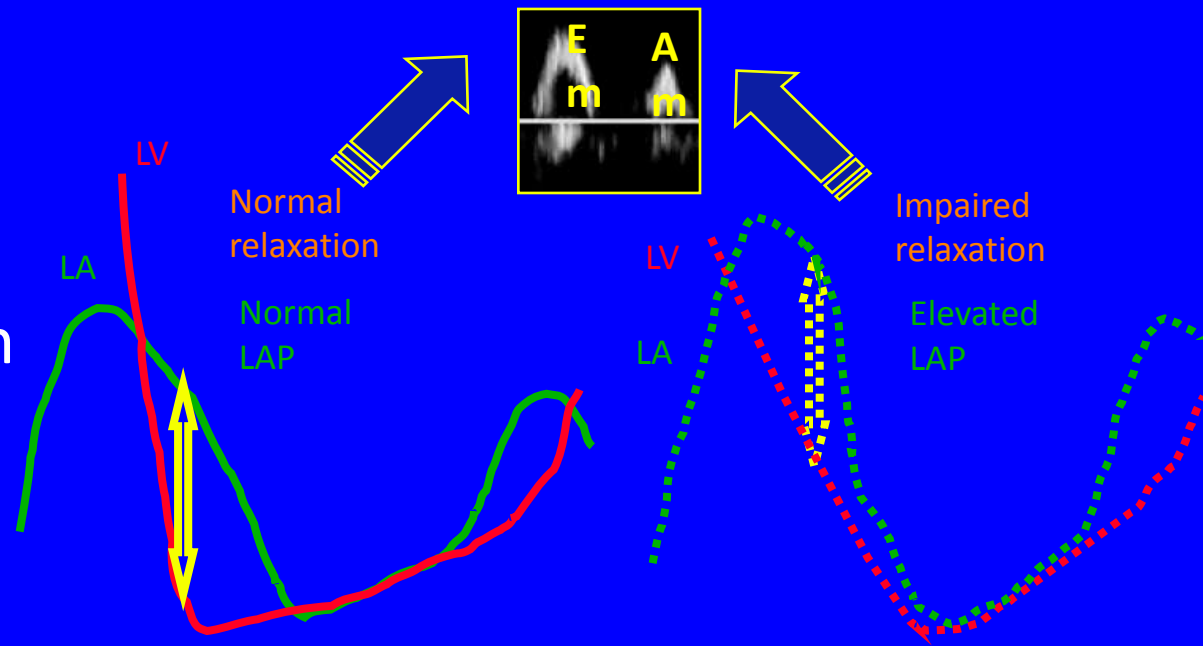
A quoi sert E/e': rappel "historique"

Distinguer flux mitral normal ou pseudonormalisation?

(≠ profil restrictif)

- Indice de relaxation

- $E_a < 8$ cm/s
- $V_p < 45$ cm/s



- Rapport pour avoir un seuil personnalisé par patient

- E/E_a ou E/V_p

Sohn JACC 1997;30:474

Nagueh Circulation 1998;98:1644

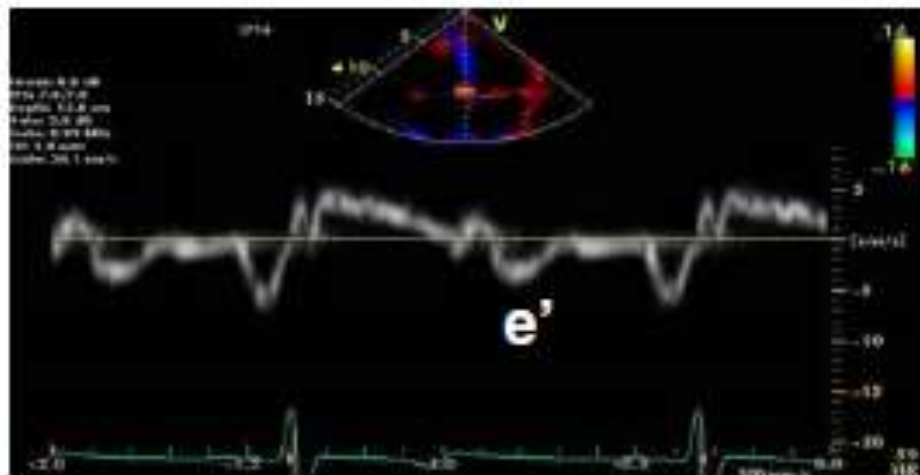
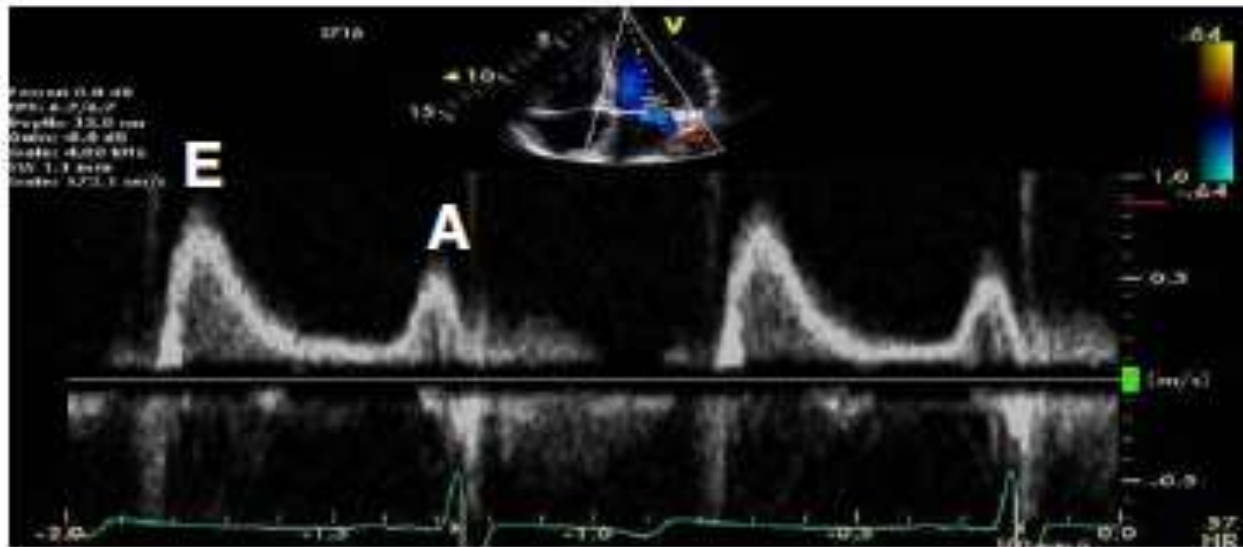
Stugaard Circulation 1993;88:2705

Physiopathologie complexe de la diastole

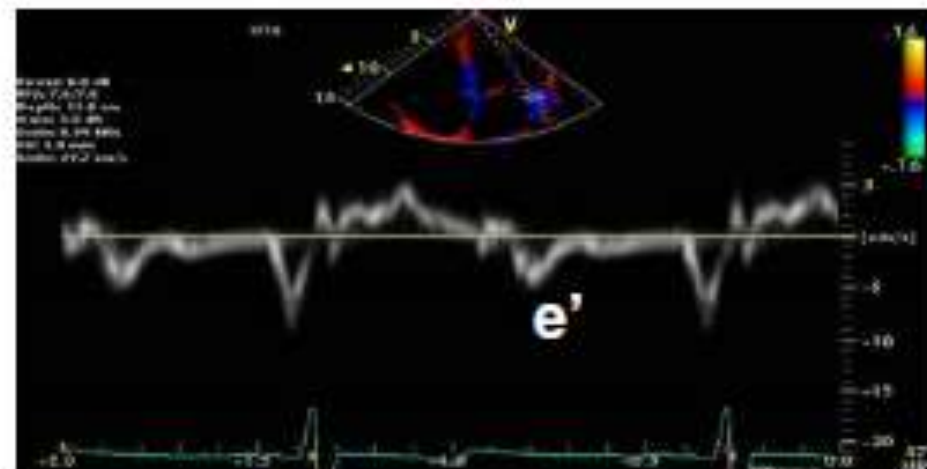
- Déterminants de e' et du pic de l'onde E
 - Relaxation (constante tau)
 - Forces de restauration
 - e' septale > 8 cm/s exclue (presque toujours...)
une relaxation VG altérée (attention constriction péricardique, IM significative, sujets jeunes...)
 - Réduction e' septale: BBG, pacing VD, infarctus septal, calcification...

A noter que plus e' est réduite plus l'onde S est réduite: couplage systole-diastole

LE MOYENNAGE DES VELOCITES SEPTALE ET LATERALE EST RECOMMANDE

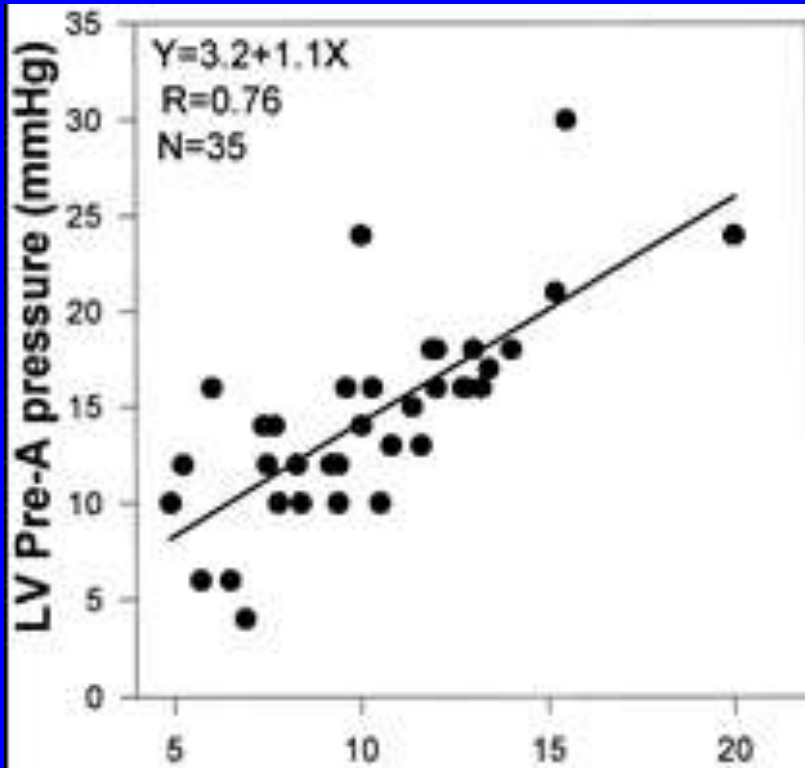


$$\text{Septal } E/e' = 80/4 = 20$$

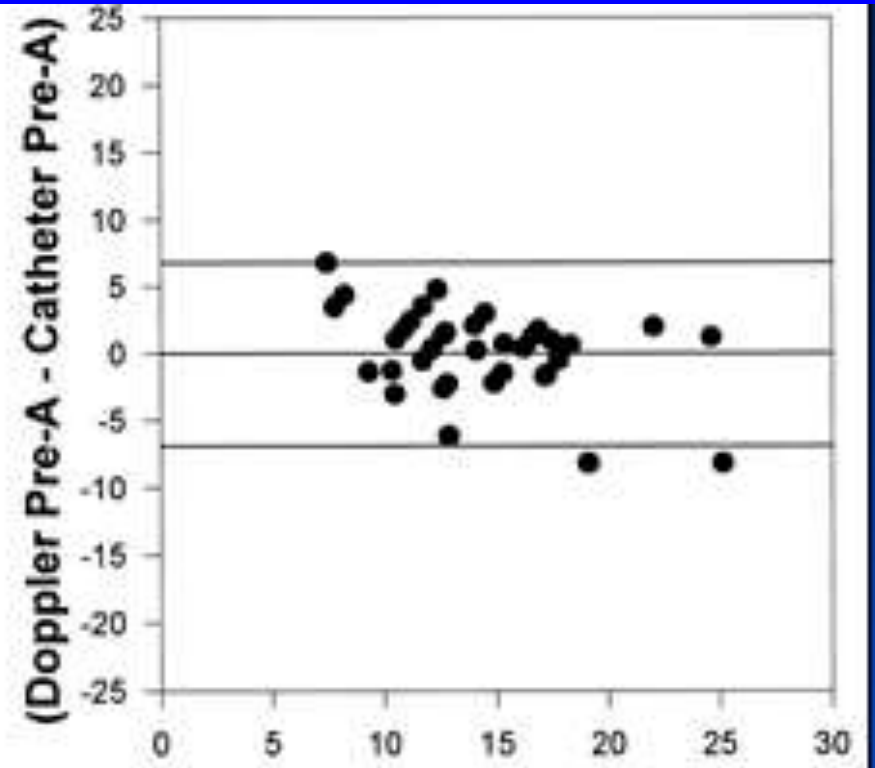


$$\text{Lateral } E/e' = 80/5 = 16$$

Validation du E/e'



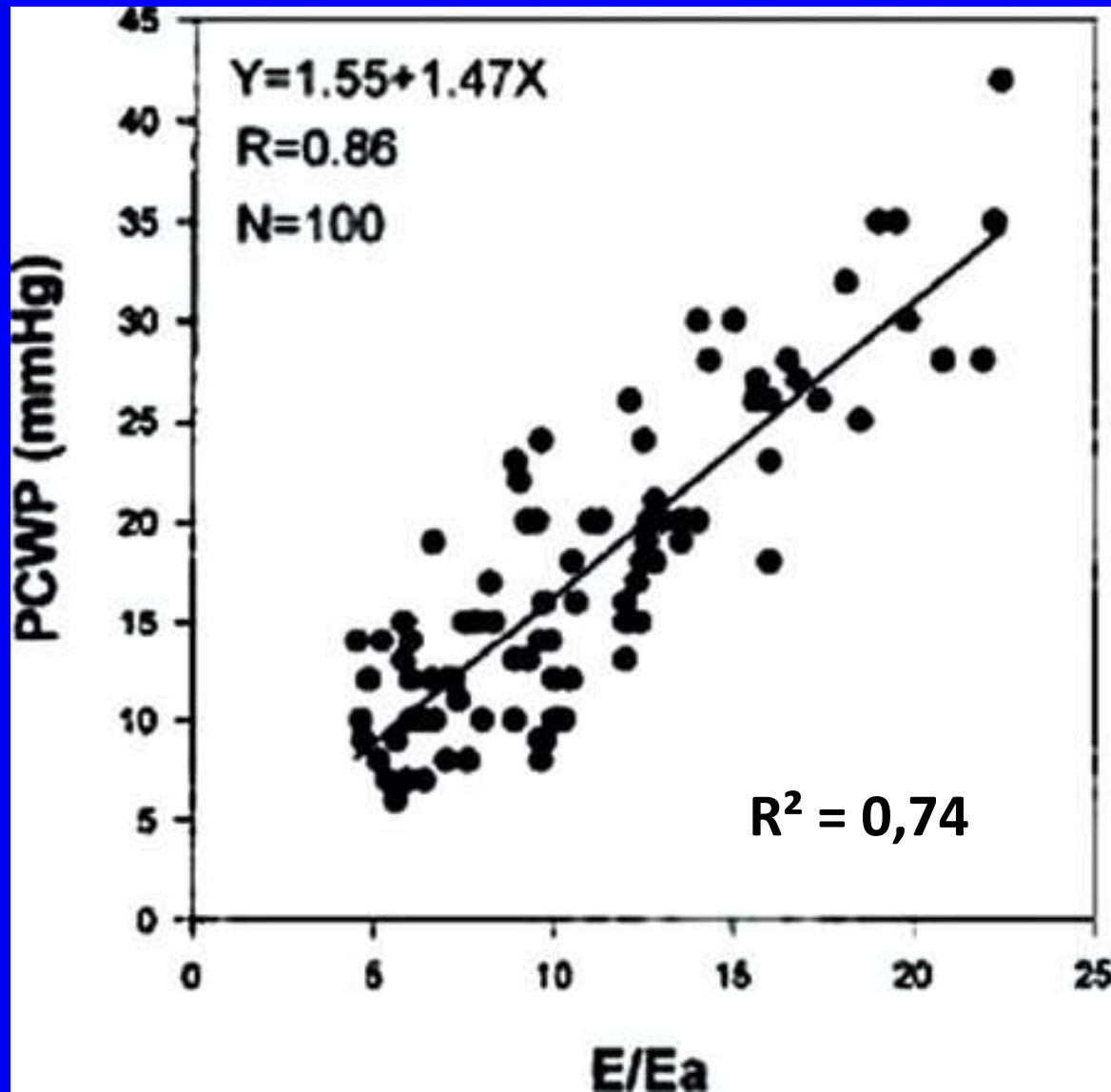
E/Ea



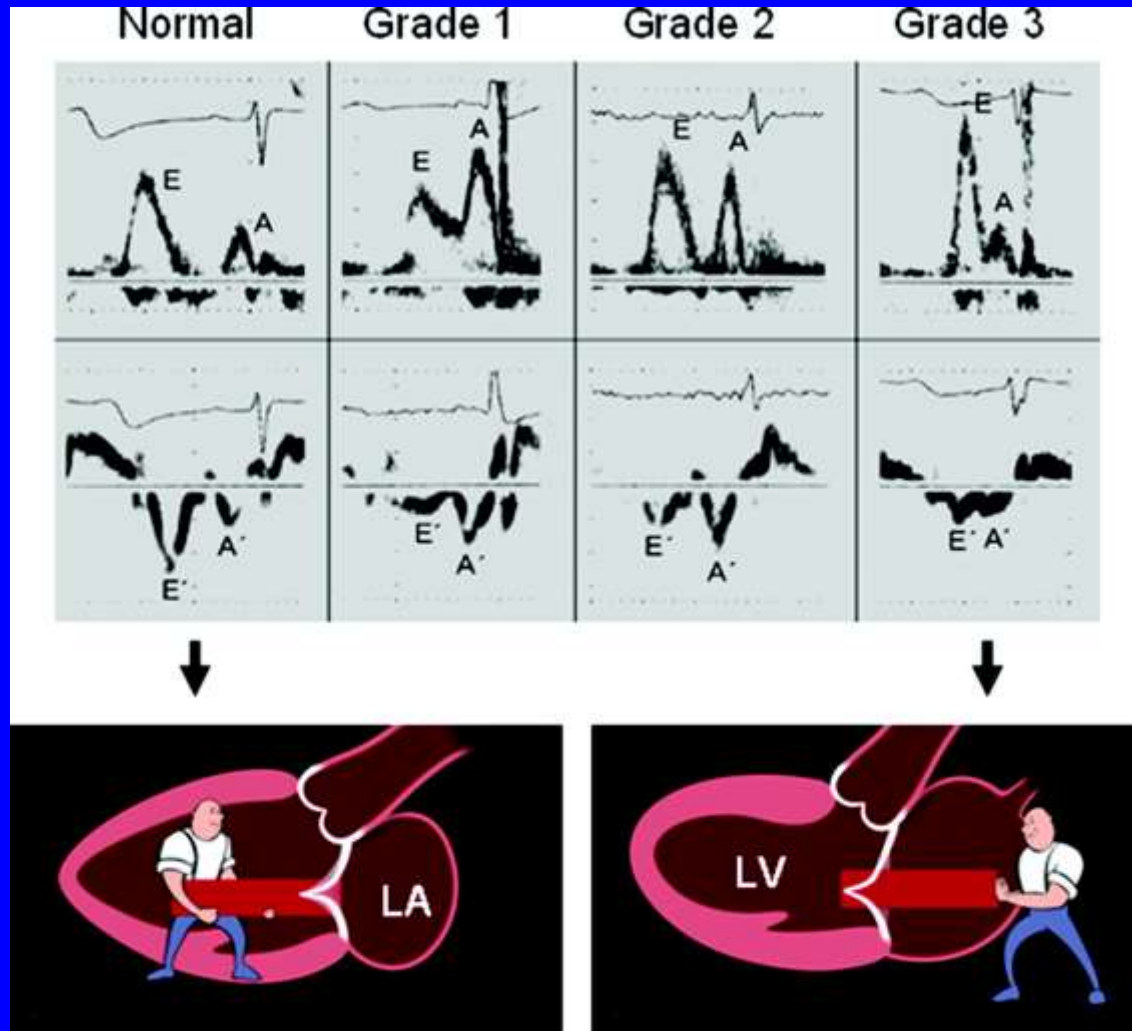
(Doppler Pre-A + Catheter Pre-A)/2

$R^2 = 0.58$

Nagueh S et al. Circulation 1999;99:254-261



Schematic diagram of mitral inflow and mitral medial annulus velocities from normal to progressive stages of diastolic dysfunction.

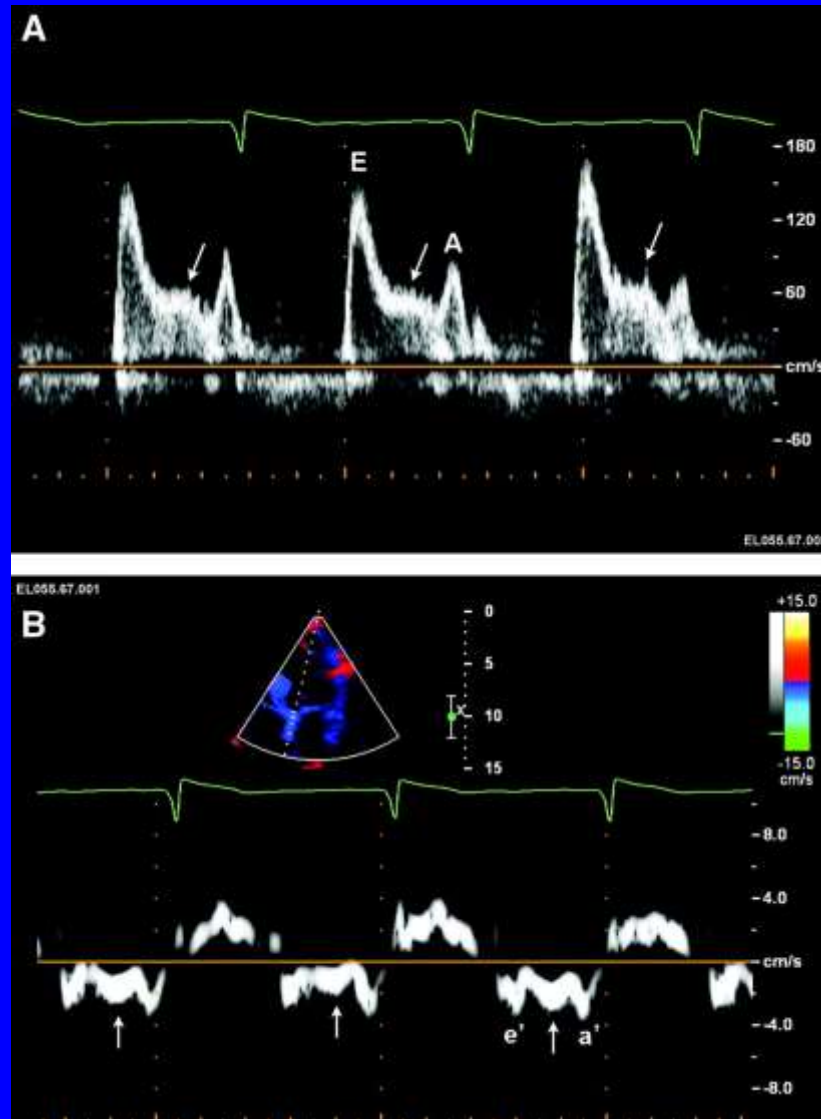


Jae K. Oh et al. Circ Cardiovasc Imaging. 2011;4:444-455

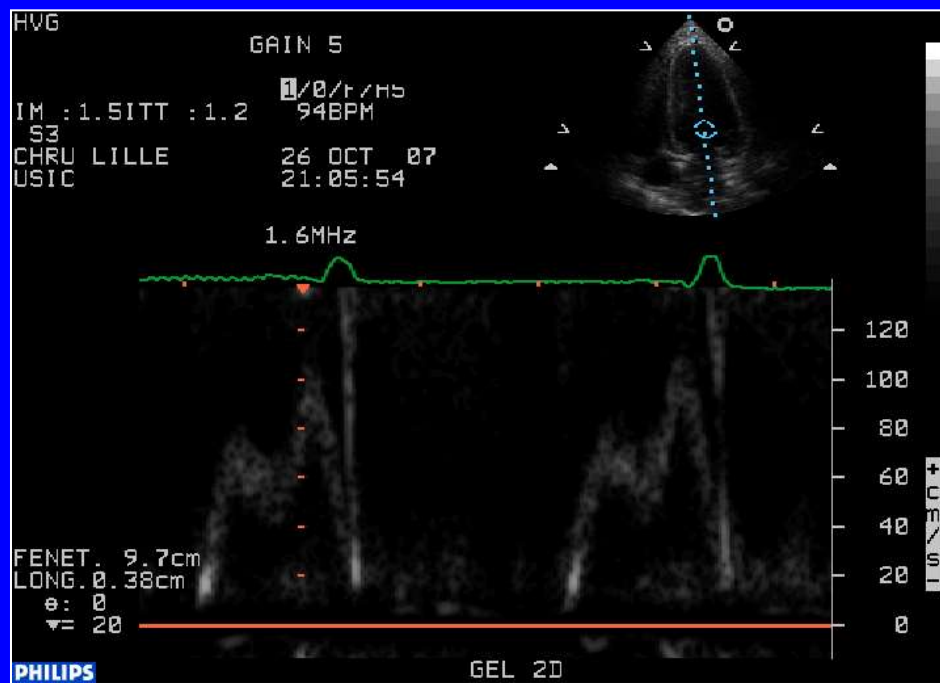
Des pressions de remplissage normales au repos n'excluent pas une dysfonction diastolique ou une ICFEP?

- Effet du traitement?
- élévation des pressions de remplissage induites par l'exercice?

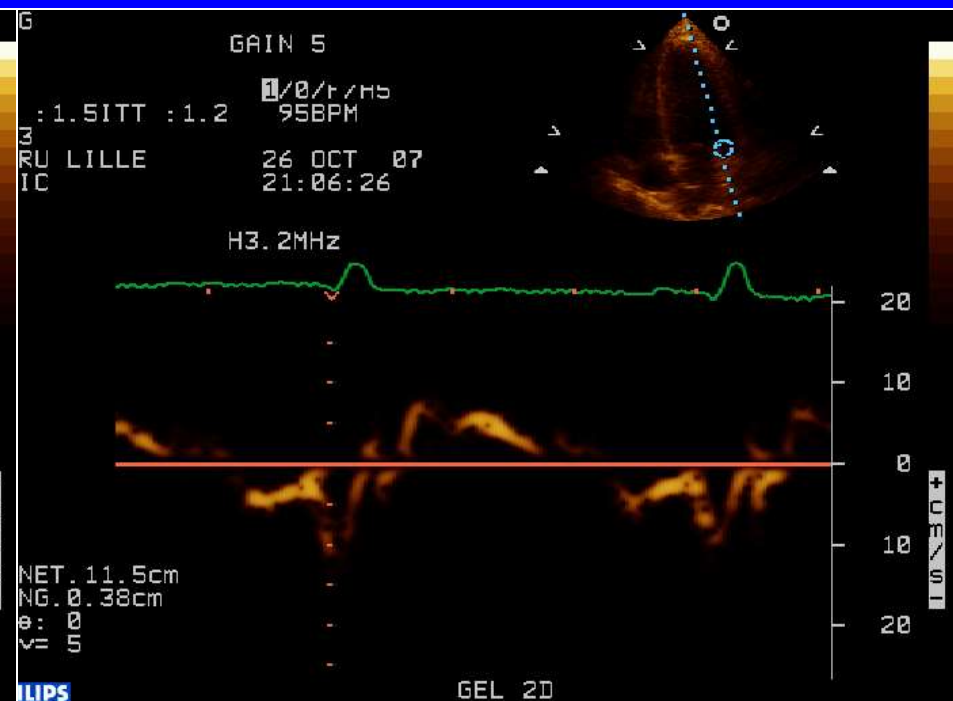
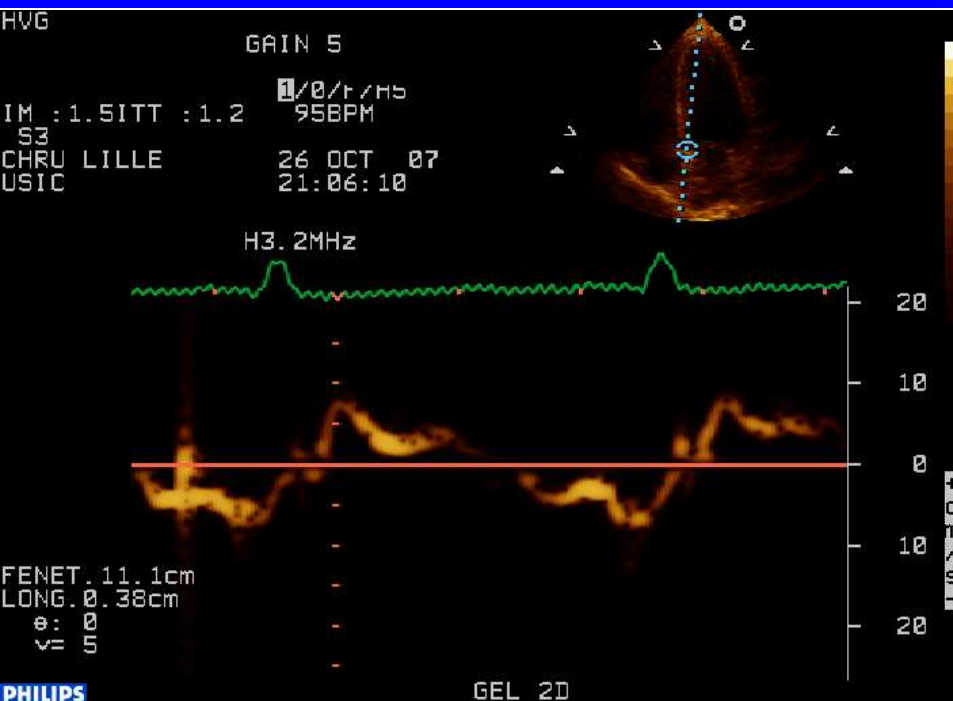
A, Pulsed Doppler echocardiographic recording of mitral inflow velocity showing a mid-diastolic flow, L wave (arrow), of 60 cm/s between the E and A



Jae K. Oh et al. *Circ Cardiovasc Imaging*. 2011;4:444-455

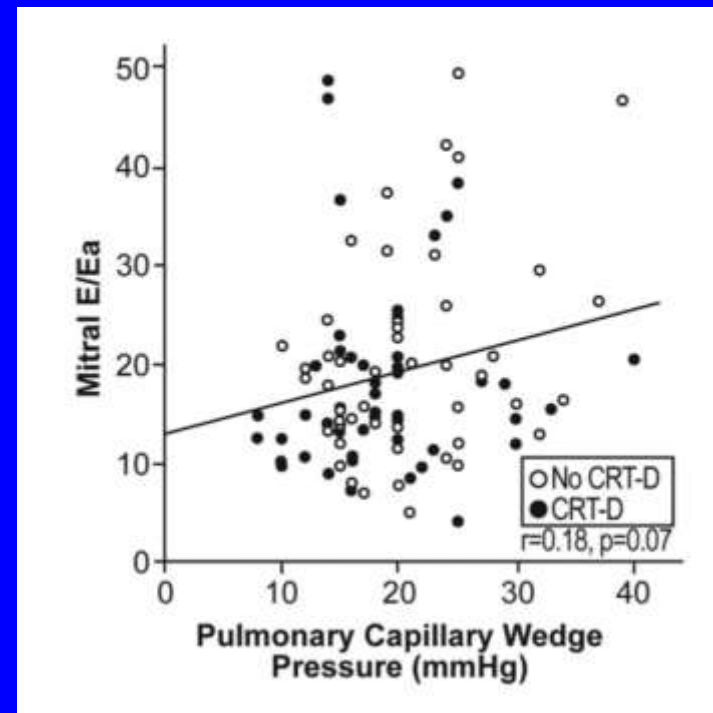


OAP HVG
 $E/e' = 17$



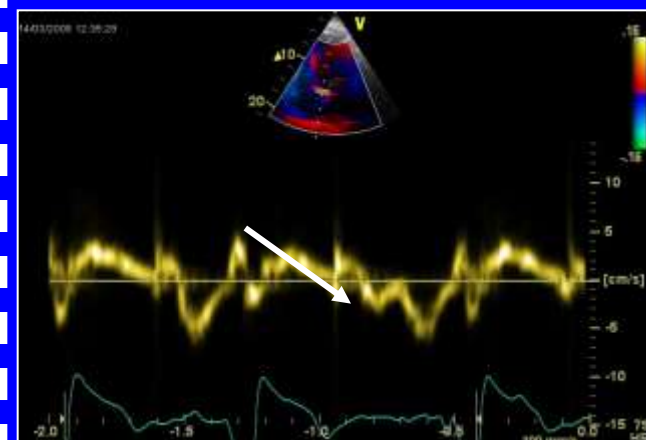
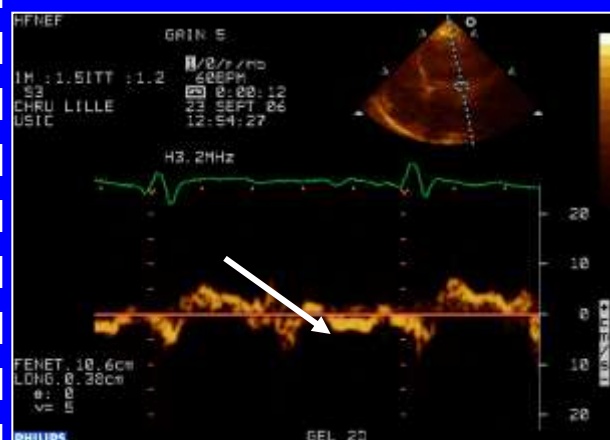
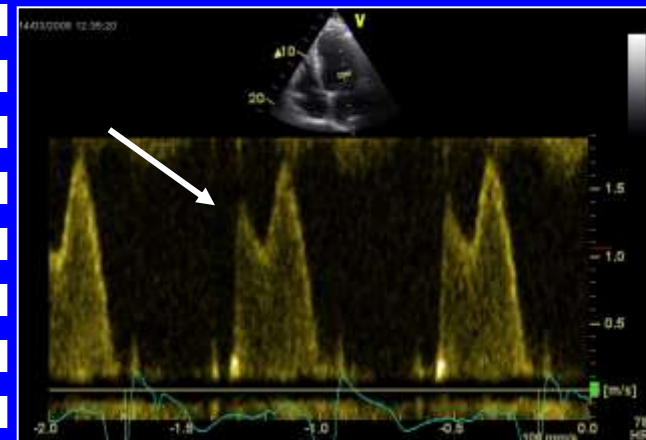
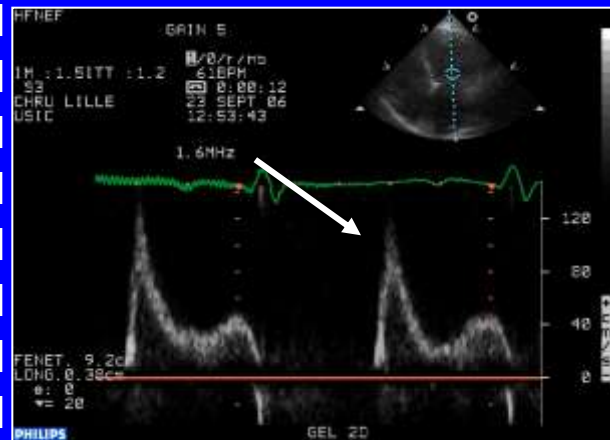
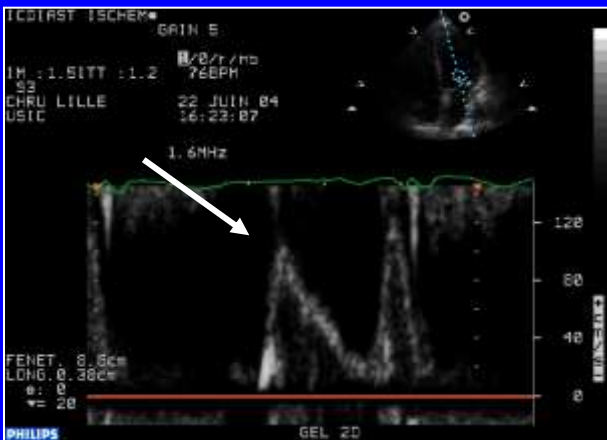
E/e' Dysfonction VG et FM restrictif

- Anneau mitral paradoxalement plus rapide en protodiastole (Doppler tissulaire mode TM)
 - patients avec dysfonction VG, IM et PRVG très hautes (Pcap = 20 mmHg)
Ohte. Eur J Echo 2002, 3 :52.
- E/Ea n'est pas corrélé à PAPO
 - 106 pts, echo/cath simultanés
 - NYHA 3-4
 - FEVG = 24%
 - PAPO 21 ± 7 mmHg
 - TD E Mitral 150 ± 45 ms
 - E/e' = 20 ± 12



High LV filling Pressure

$$E/e' > 15$$

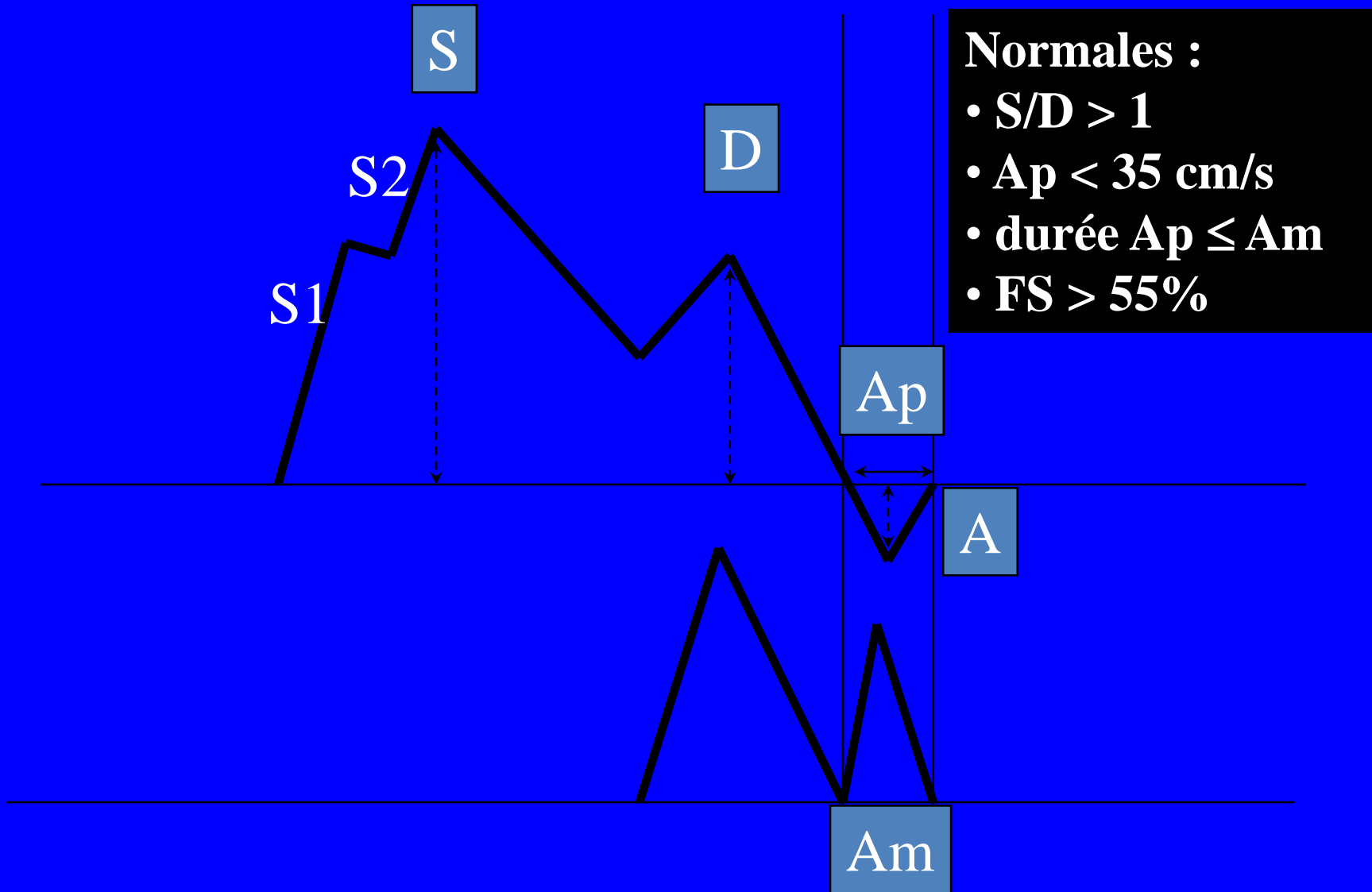


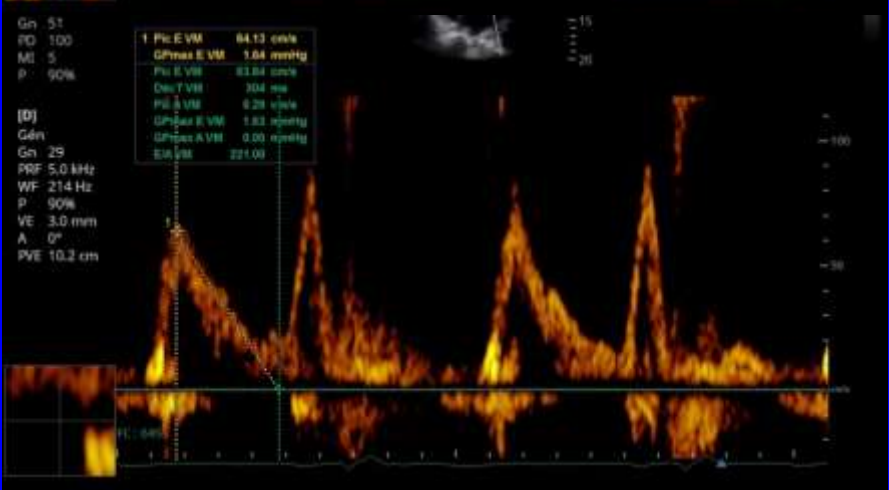
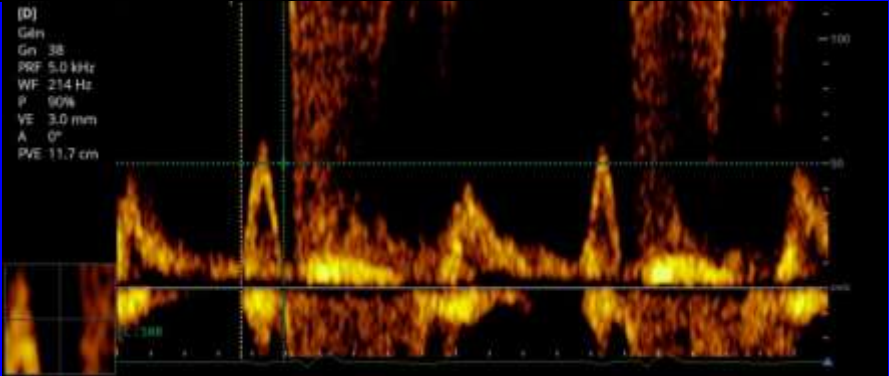
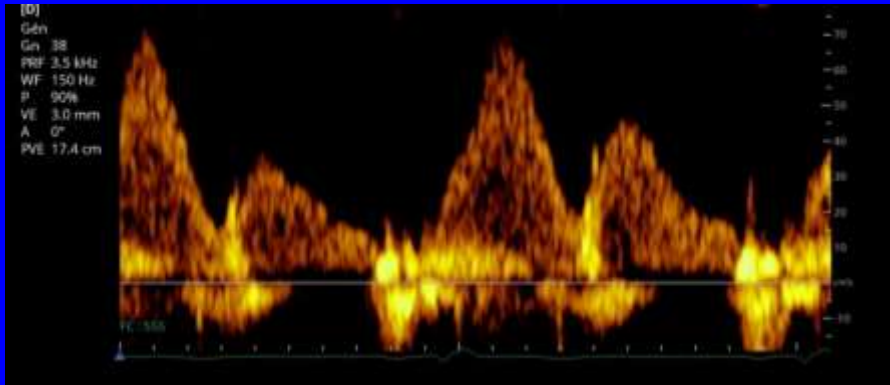
$E/e' = 18$

$E/e' = 27$

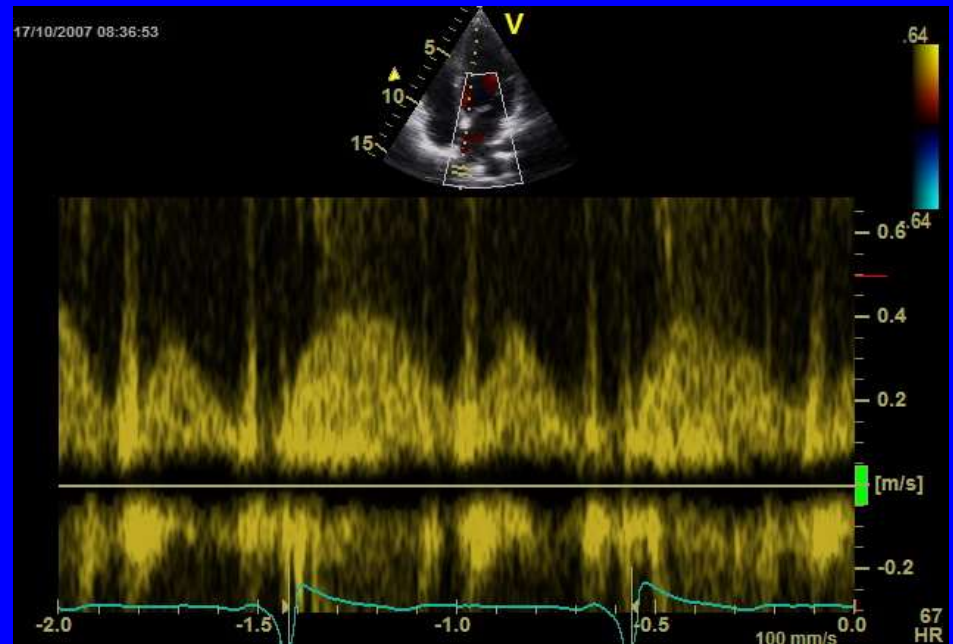
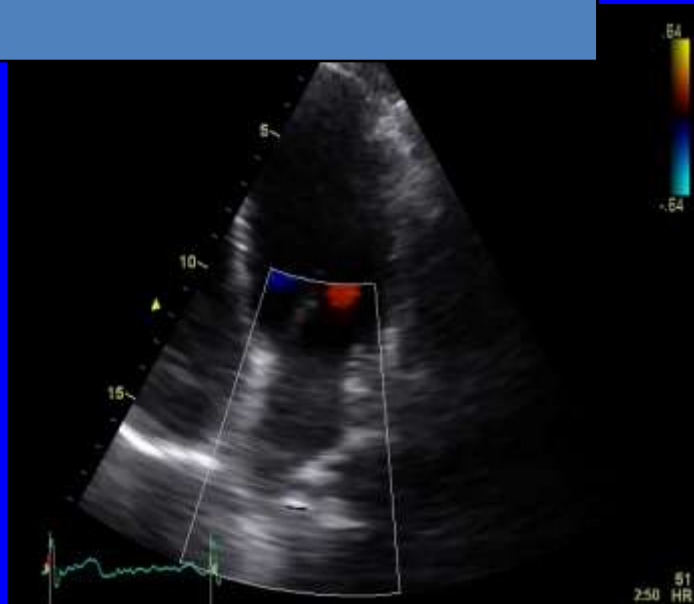
$E/e' = 42$

Flux veineux pulmonaire





- 1 à 2cm dans VP
- gains minimum
- filtres minimum
- faisabilité en ETT:
 - S et D : 70 à 95%
 - Ap : 40 à 90%



$S > D$

**Apicale, Zoom sur l'OG, baisser la PRF,
attention à la double porte!**

Flux veineux pulmonaire

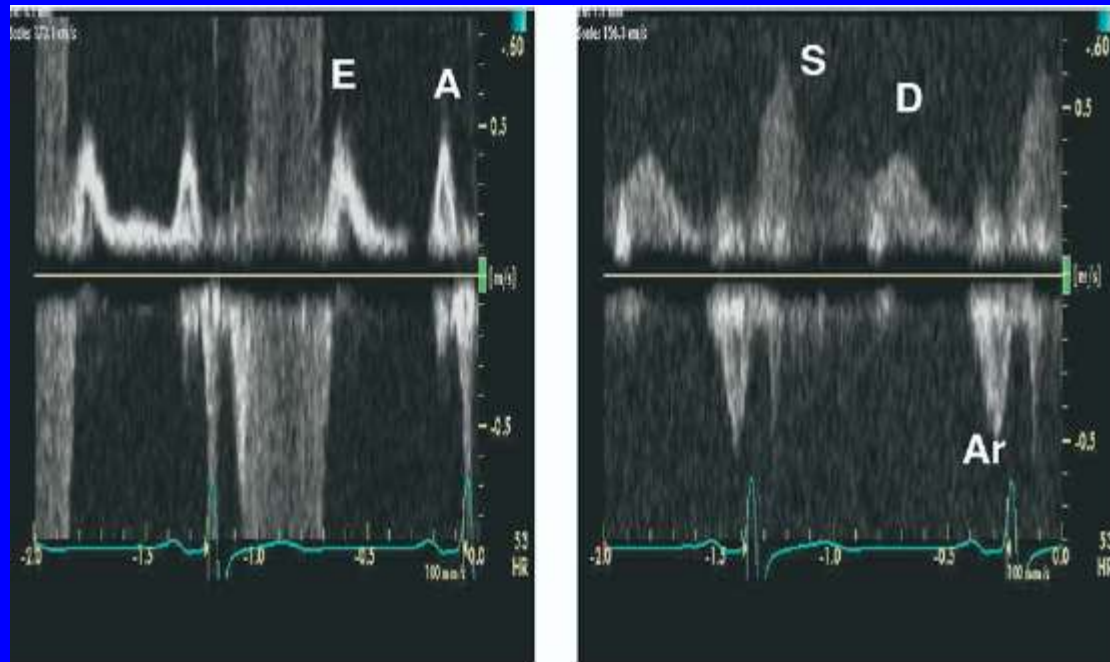
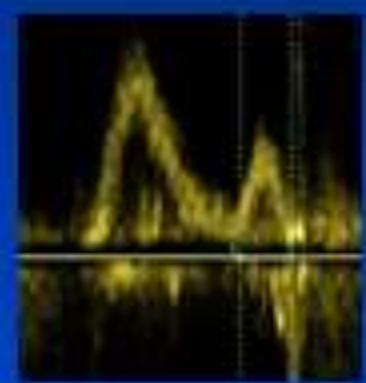
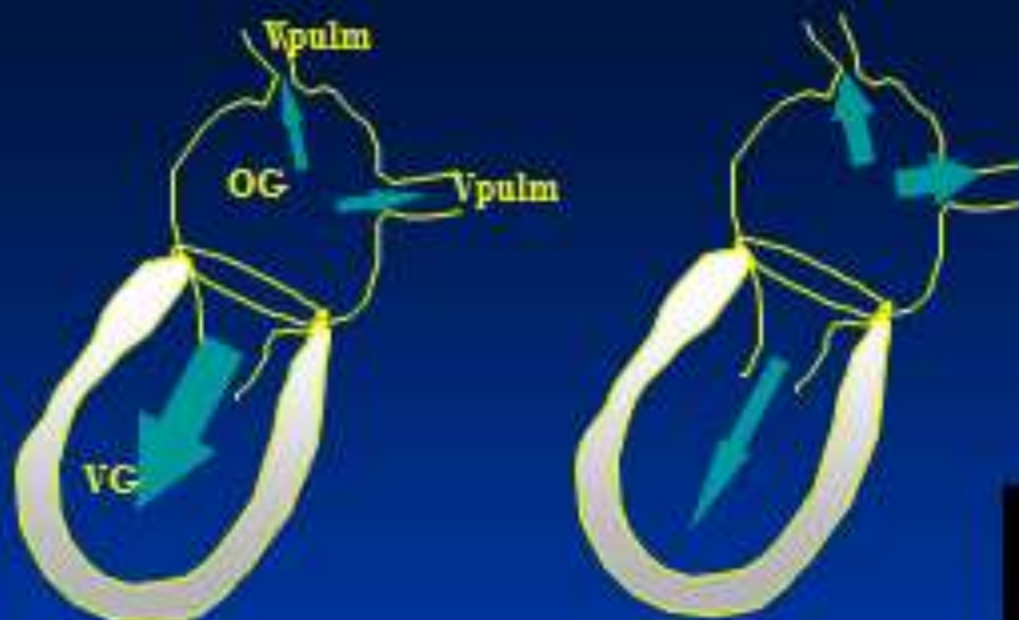
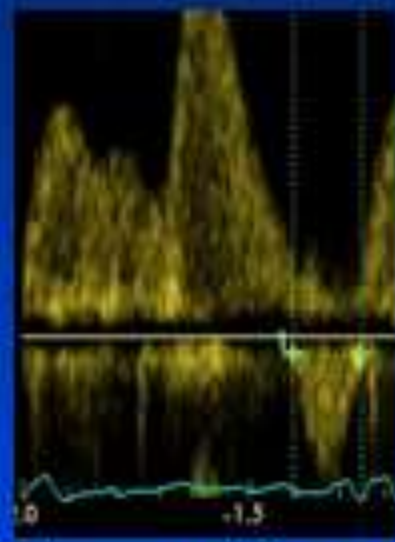


Figure 6 Recording of mitral inflow at the level of the annulus (*left*) and pulmonary venous flow (*right*) from a patient with increased LVEDP. Notice the markedly increased pulmonary venous Ar velocity at 50 cm/s and its prolonged duration at >200 ms in comparison with mitral A (late diastolic) velocity. Mitral A duration is best recorded at the level of the annulus.²²



PRVG normales

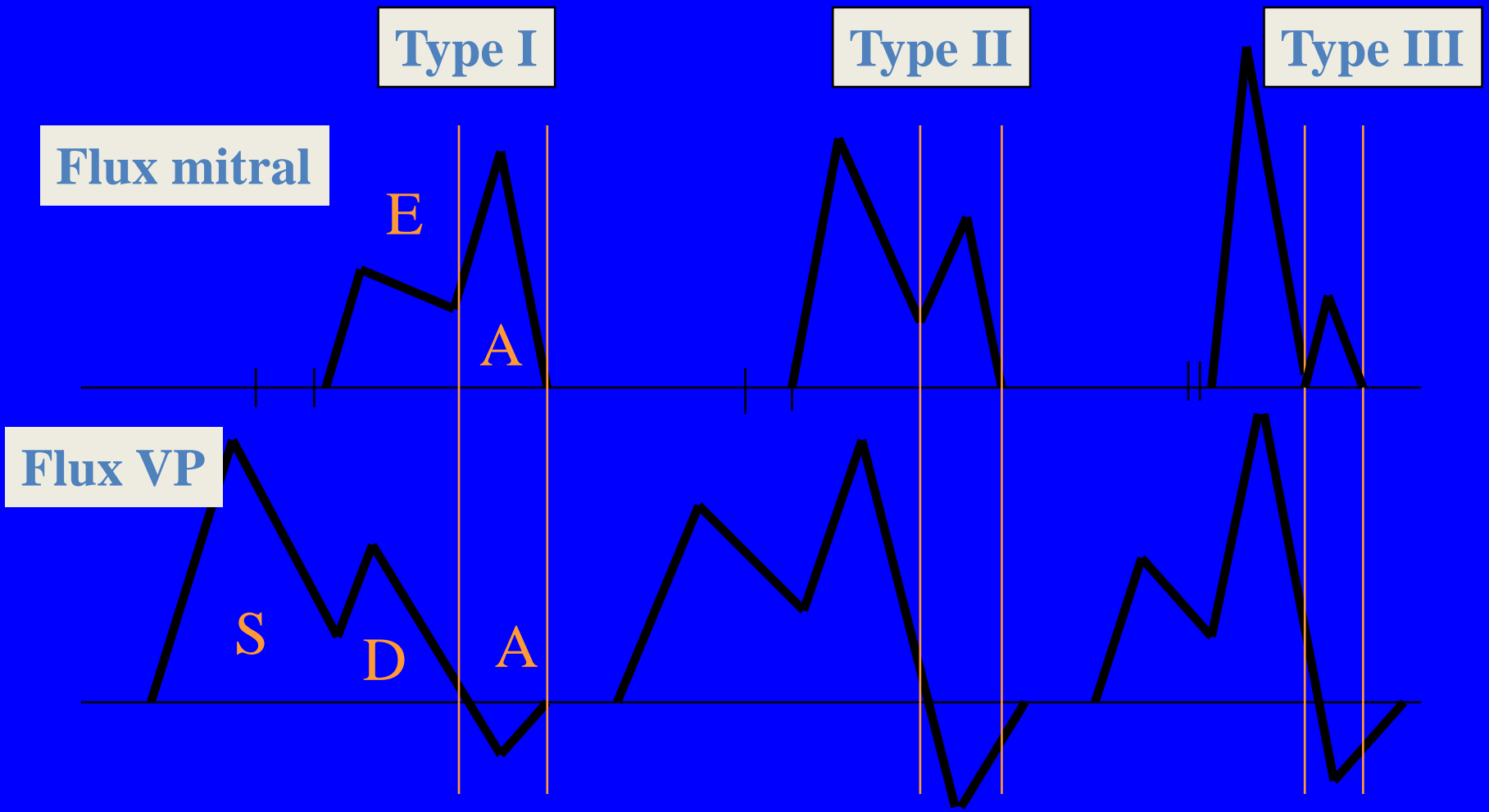


PRVG élevées

Durée Am



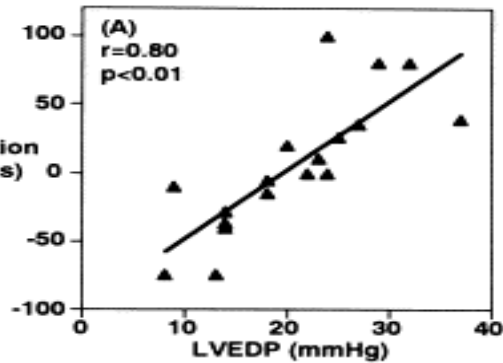
Durée Ap



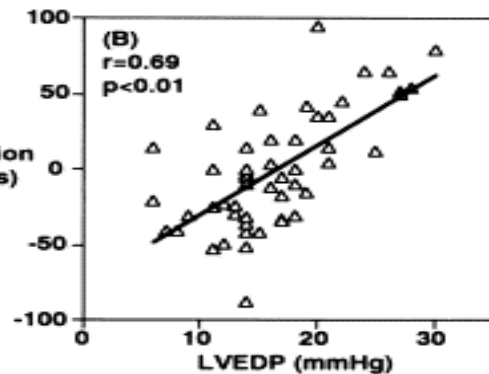
D'après Appleton et al

Flux veineux pulmonaire

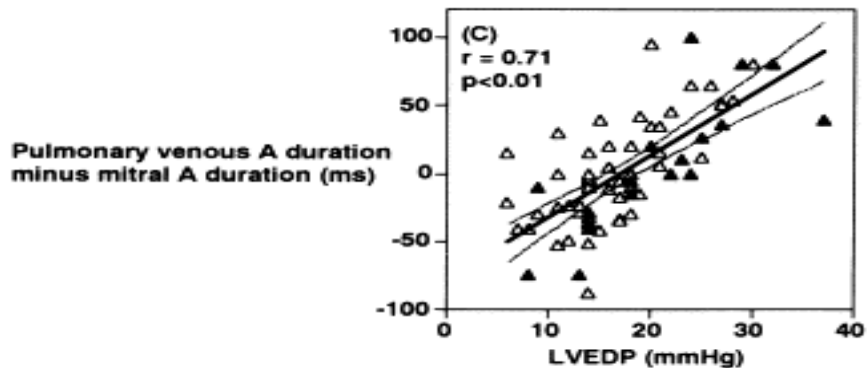
Flux veineux pulmonaire



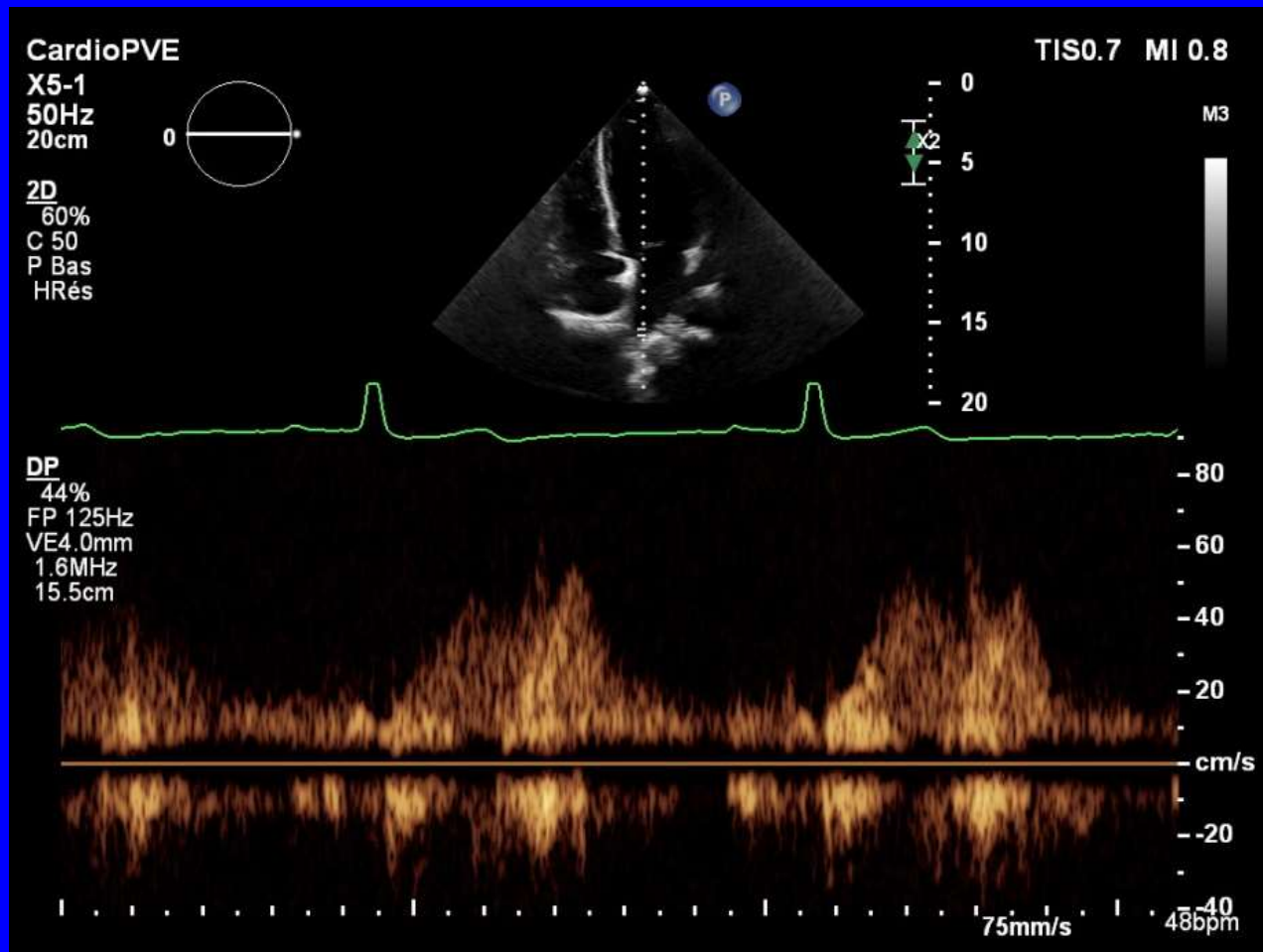
**Ap-Am > 20ms : PTDVG > 12mmHg
(Se : 74%, Sp: 95%)**



**FS < 40% PDG pré-A > 15mmHg
(Kuecherer, Circulation, 1990)**



Pressions de remplissage normales ou élevées?

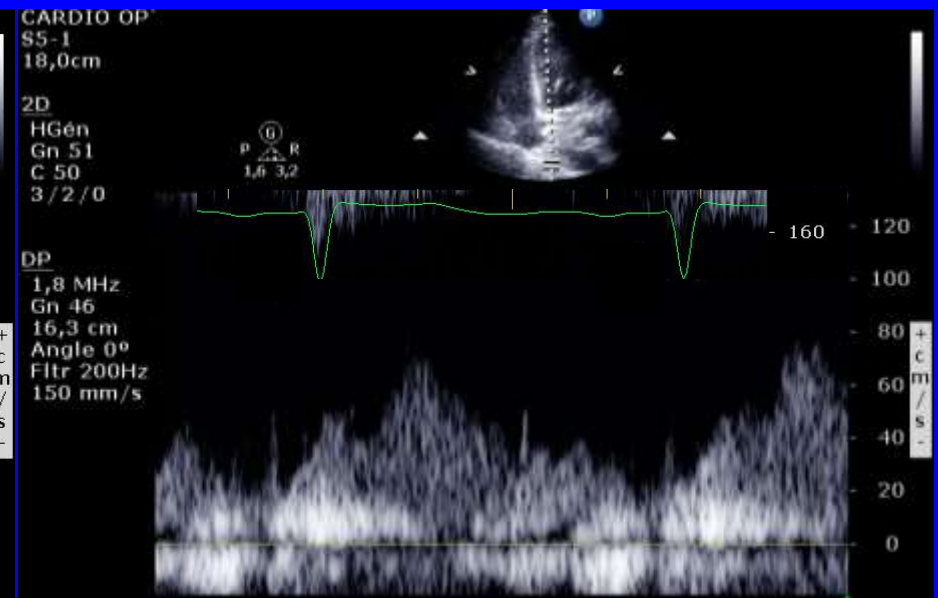
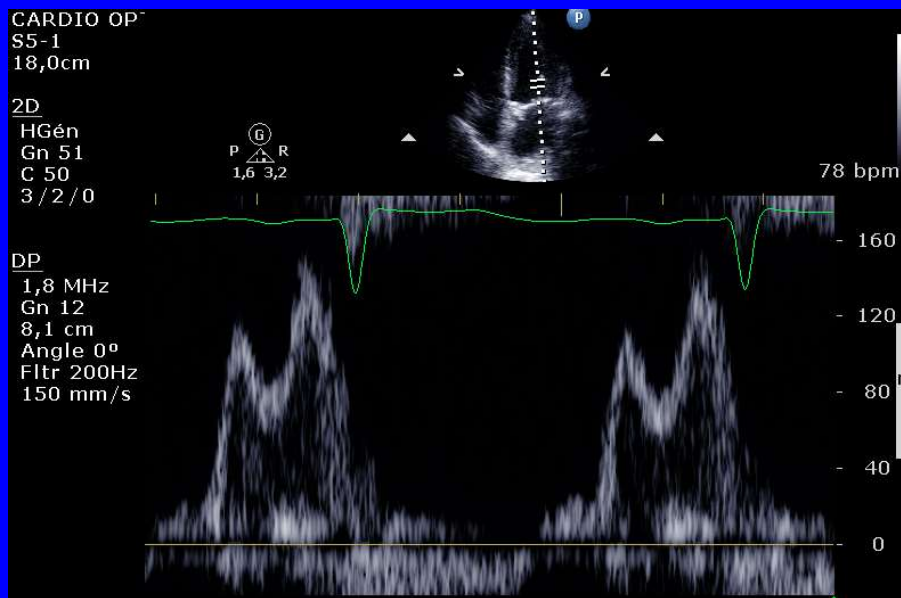
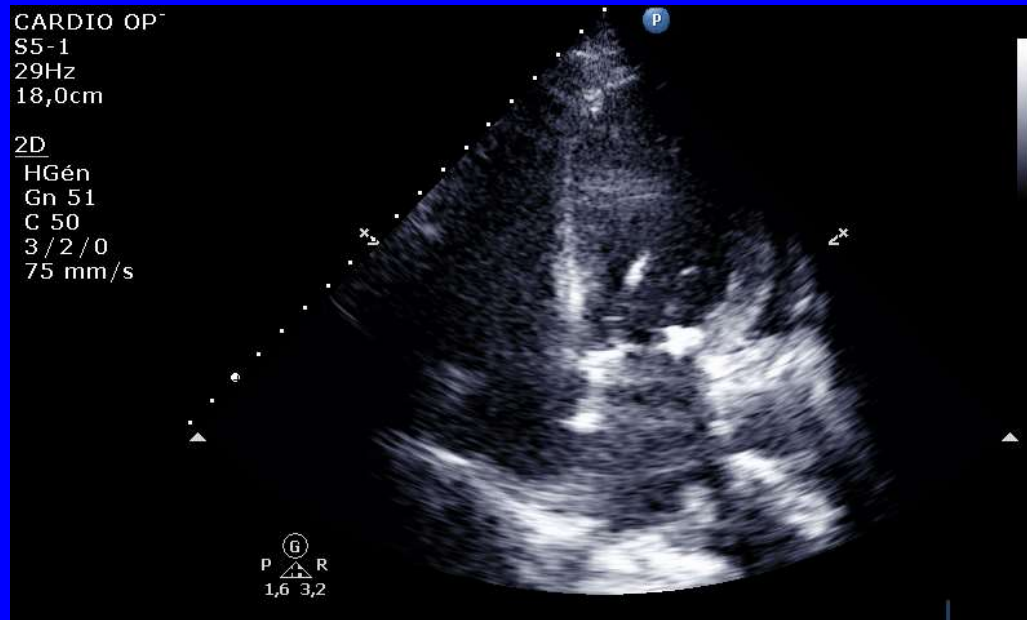


Flux veineux pulmonaire

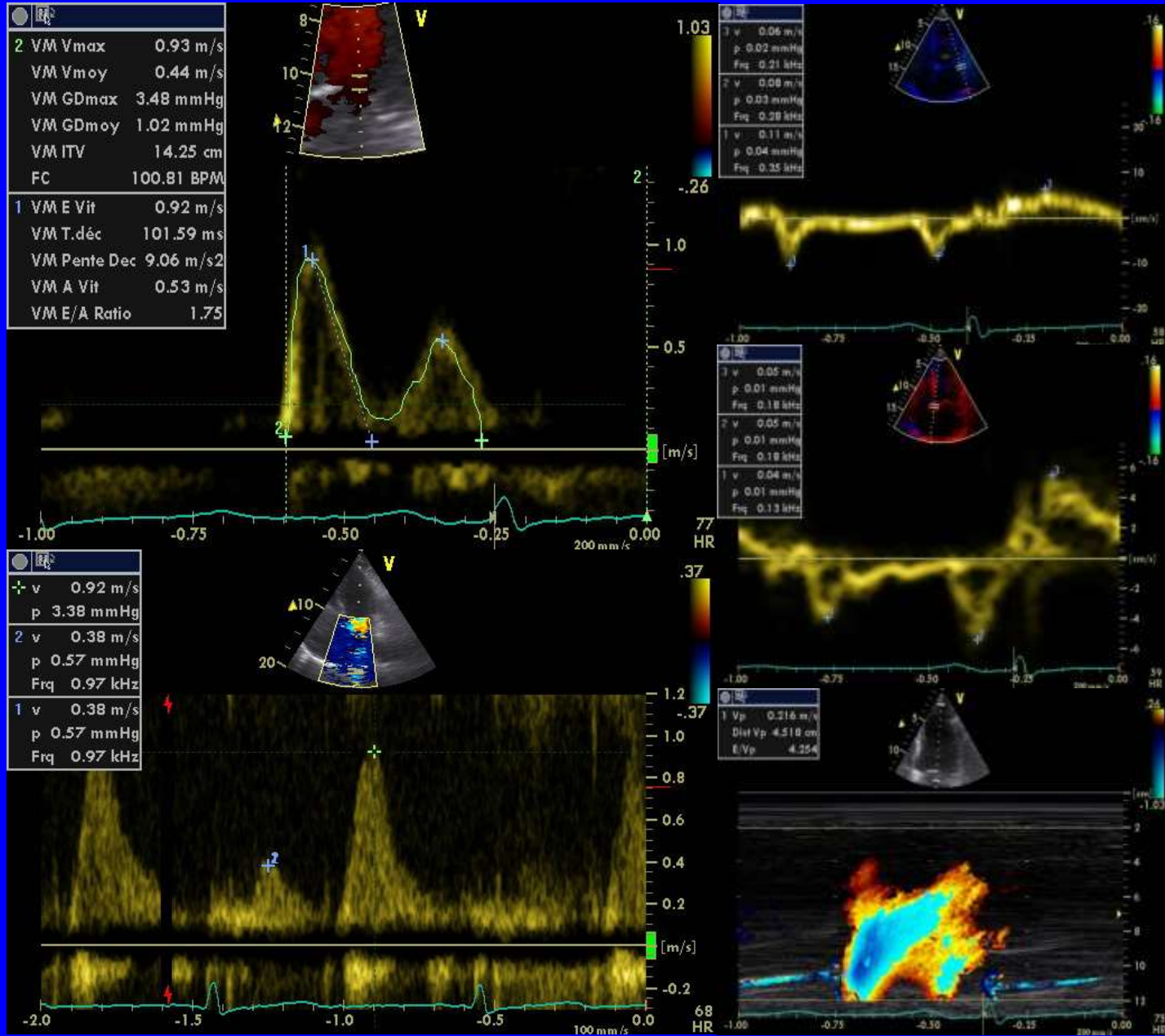
Dans le coeur normal on peut observer une onde D prédominante correspondant à l'onde E prédominante, la fonction lusitrope est complètement normale:

$$- S < D$$

Calcifications annulaires mitrales



Dyspnée, FEVG normale



Vélocité maximale de l'IT élevée?

- Pressions de remplissage élevées?
- Maladie vasculaire pulmonaire ou du parenchyme pulmonaire?

- *Attention: défaillance VD ($RAP \times DC = PAP_{moy} - PAPO$), IT sévère*

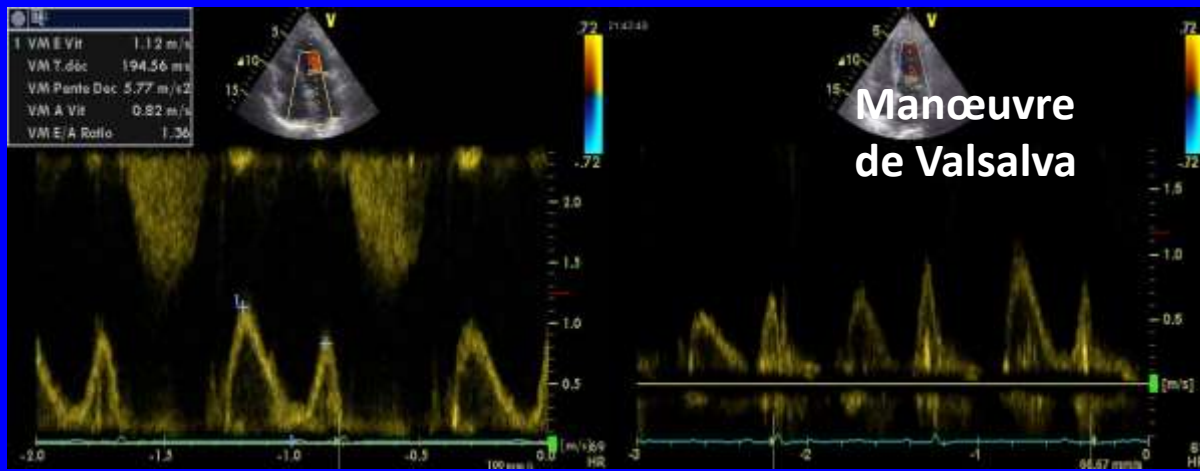
Volume OG (≥ 34 ml/m²): témoin d'une dysfonction diastolique chronique?

- Athlètes
- Fibrillation atriale
- Anémie
- Maladie mitrale, prothèses mitrales
- Bradycardie
- Haut débit cardiaque

- *Attention: l'indexation n'a pas de sens chez les sujets obèses*

$E/A > 1$ chez un sujet âgé?

- Pattern de type 2 (Pseudonormal)?



- Grenoble pattern: entraînement régulier à l'endurance?
 - $E/e' < 8$

In patients with normal LV EF

- 1-Average $E/e' > 14$
- 2-Septal e' velocity < 7 cm/s or Lateral e' velocity < 10 cm/s
- 3-TR velocity > 2.8 m/s
- 4-LA volume index > 34 ml/m²

**<50%
positive**

**Normal Diastolic
function**

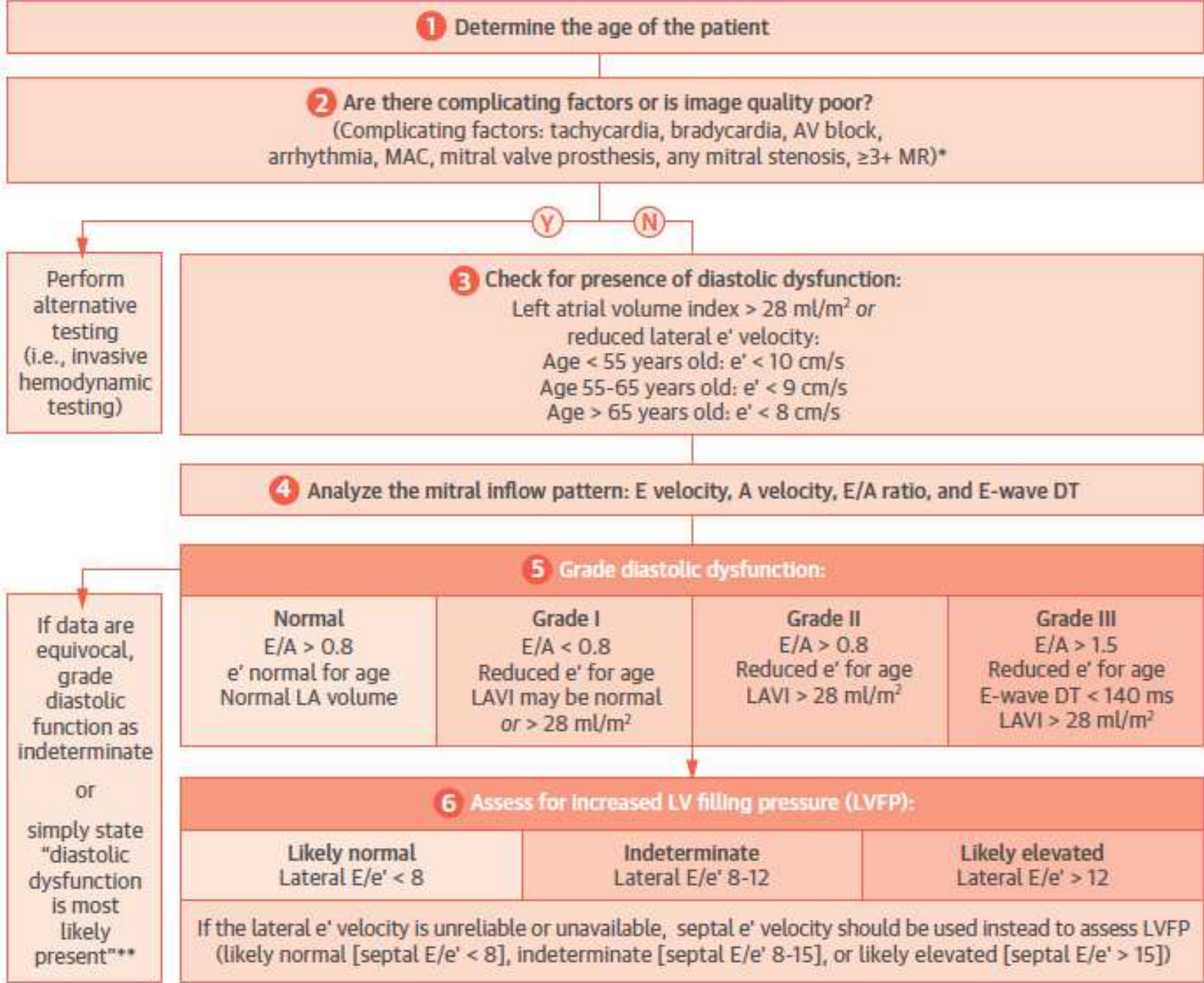
**50%
positive**

Indeterminate

**>50%
positive**

**Diastolic
Dysfunction**

	TRANSMITRAL PULSE WAVE DOPPLER	MITRAL ANNULUS TISSUE DOPPLER	PEARLS
L AND L' WAVES			<ul style="list-style-type: none"> The presence of L and L' waves in pulse wave and tissue Doppler signals in mid-diastole represent a combination of severely impaired relaxation and high left atrial pressure
ATRIAL FIBRILLATION			<ul style="list-style-type: none"> No definite A or a' due to lack of organized atrial activity Atrial fibrillation greatly complicates the grading of diastolic dysfunction, but $E/e' > 11$ (using septal e') may be useful for diagnosing LV filling pressure regardless of underlying ejection fraction*
PULMONARY ARTERIAL HYPERTENSION			<ul style="list-style-type: none"> In patients with pulmonary arterial hypertension, $E/A < 1$ because of underfilling of the LA due to pulmonary vascular disease Lateral e' velocity is preserved because LV function is normal Septal e' often reduced because the RV influences septal e'
CONSTRICTIVE PERICARDITIS			<ul style="list-style-type: none"> Increased respiratory variation is present in the mitral inflow tracing (variable E/A ratios) due to ventricular interdependence Septal e' is equal to or greater than lateral e' (opposite of the normal lateral $e' >$ septal e')
MITRAL ANNULAR CALCIFICATION			<ul style="list-style-type: none"> MAC can lead to small decreases in mitral orifice area, and small elevations of E (while mean gradient remains < 4 mmHg), and blunts e' measurements when in fact LV relaxation may be normal The combined effects result in a falsely elevated E/e'



Conclusions

- Guidelines très utiles
- Algorithmes simples but nécessairement faux!
- La dysfonction diastolique est un continuum
- Dépendance de l'âge, sédentarité, médicaments....

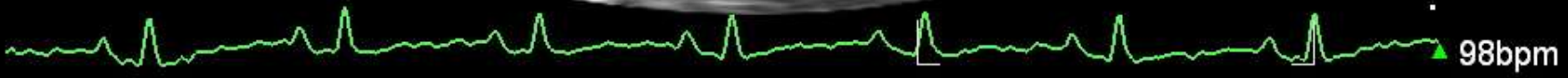
AVOIR UNE VISION GLOBALE
DE LA FONCTION CARDIAQUE

CardioPVE

ITm0.4 IM 1.4

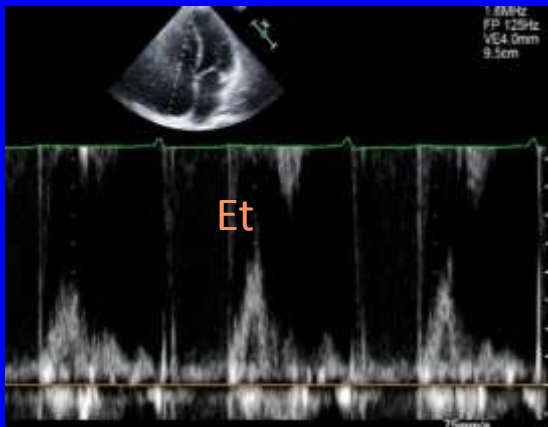
S5-1
35Hz
26cm

2D
83%
C 50
P Bas
HGén

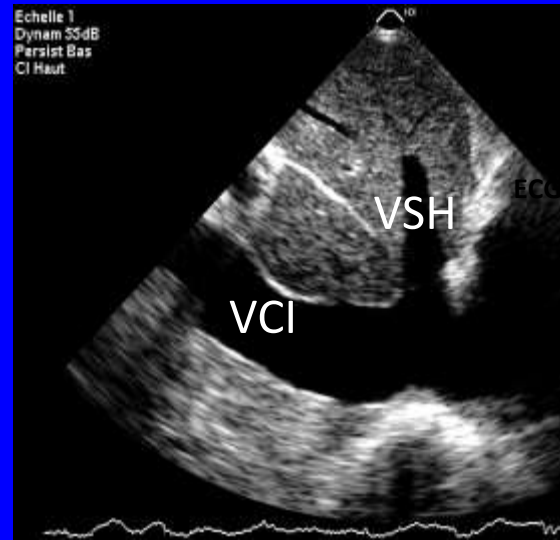


Elévation des Pressions de remplissage VD: non spécifique...

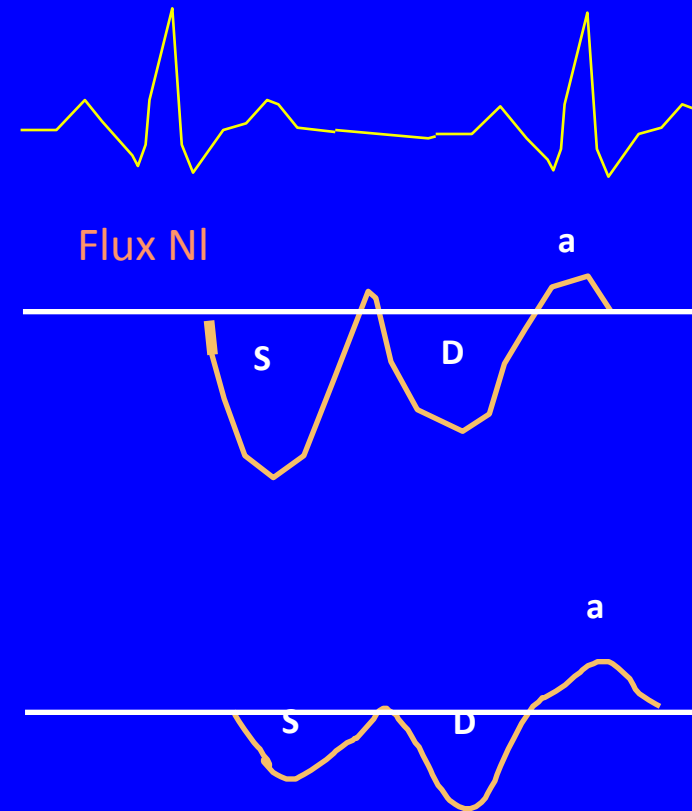
Flux transtricuspidé



Veine cave inférieure

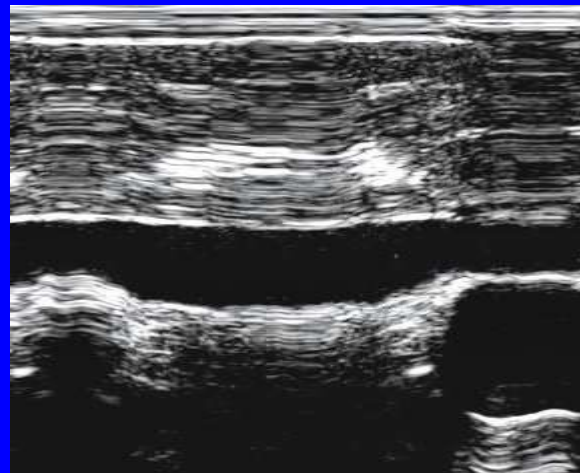


Flux veineux sus hépatique

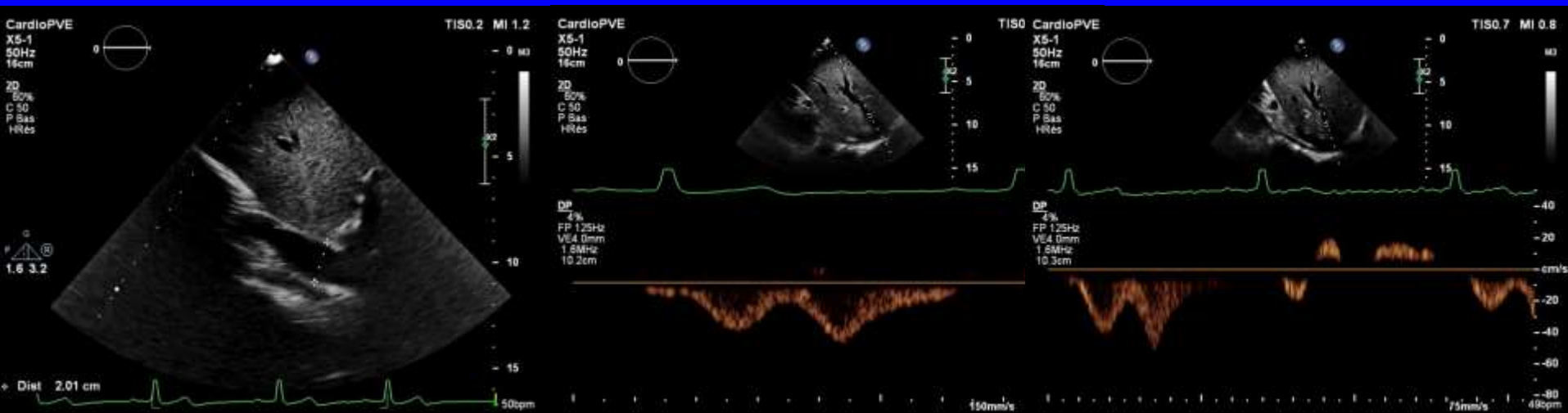


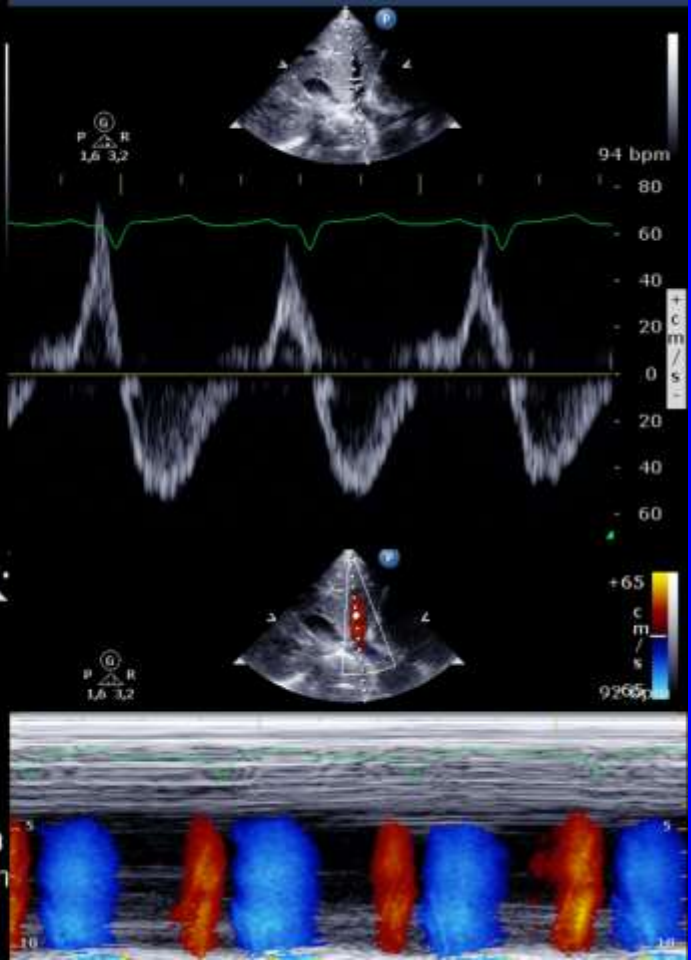
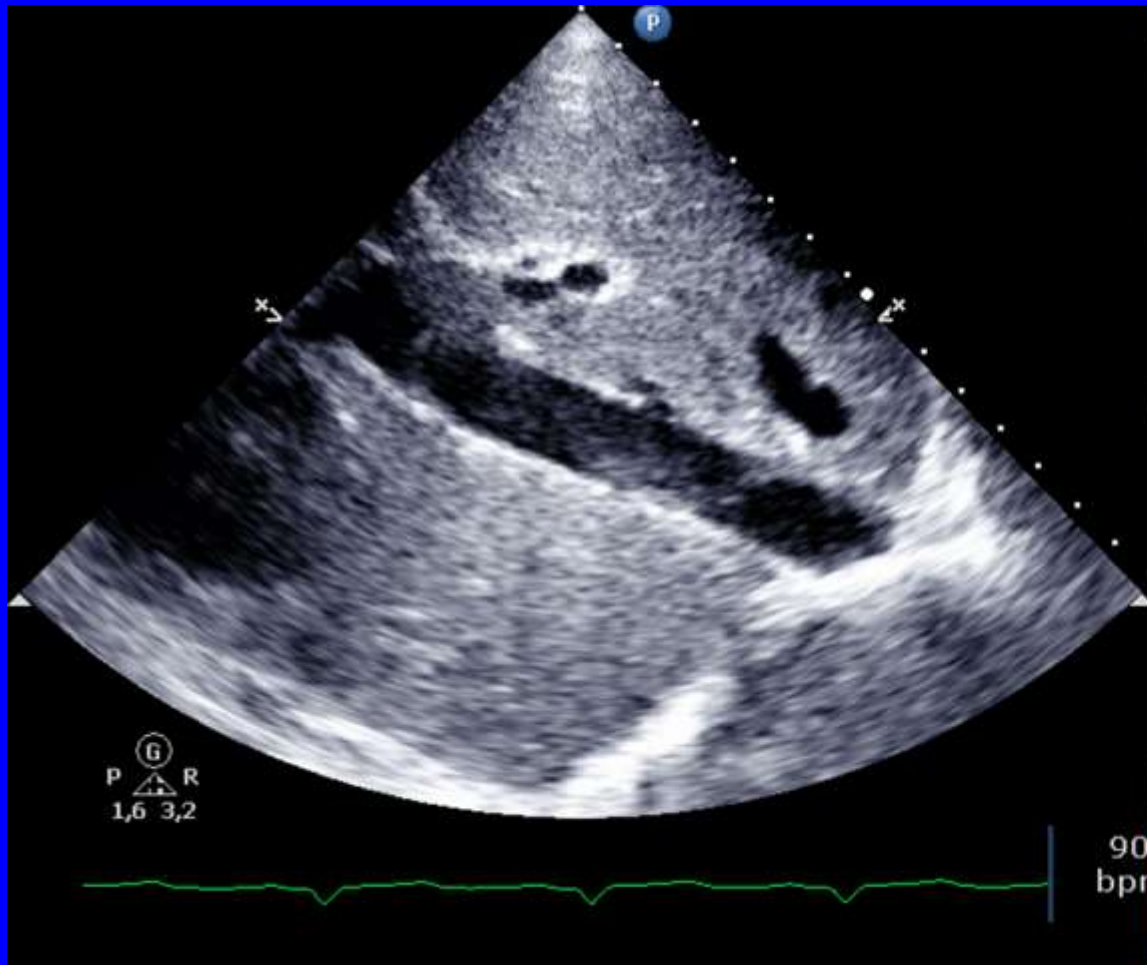
Mesures difficiles
Restrictif TDEtric < 150 ms

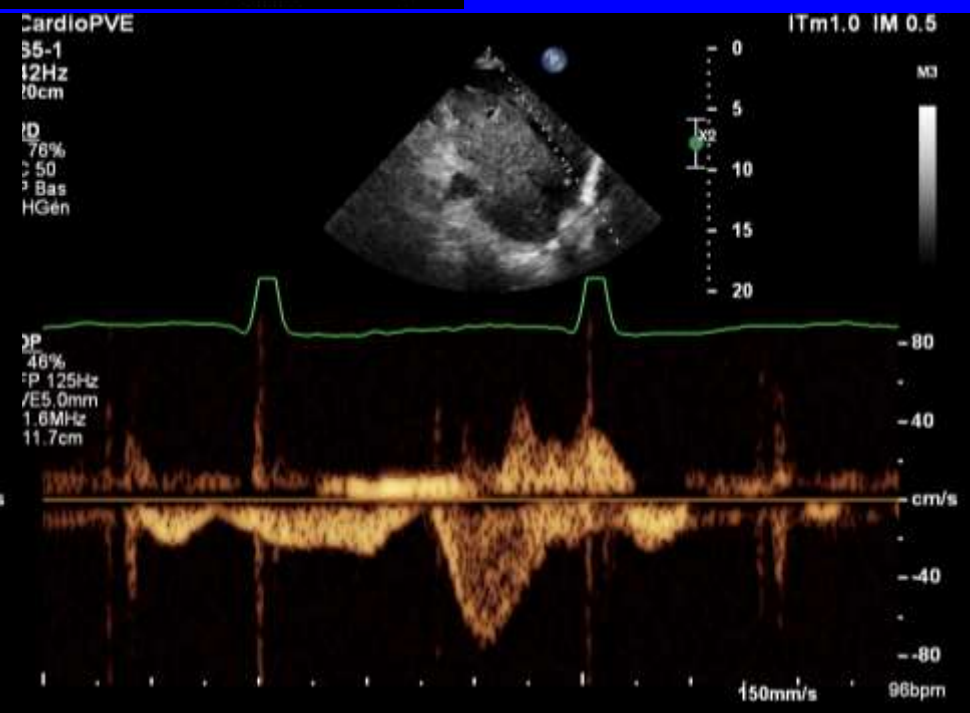
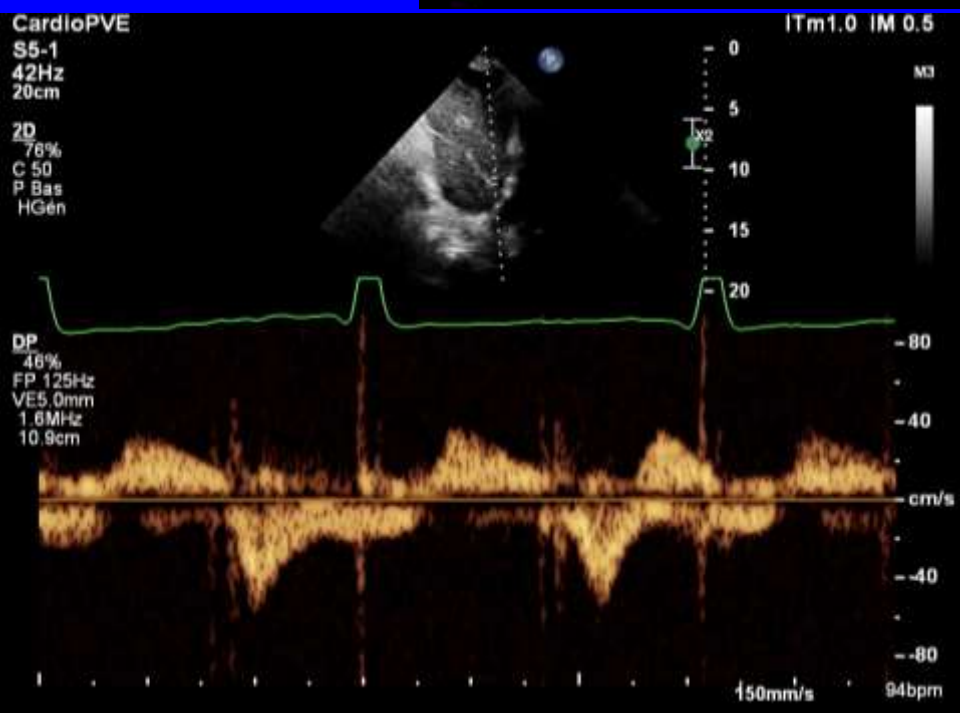
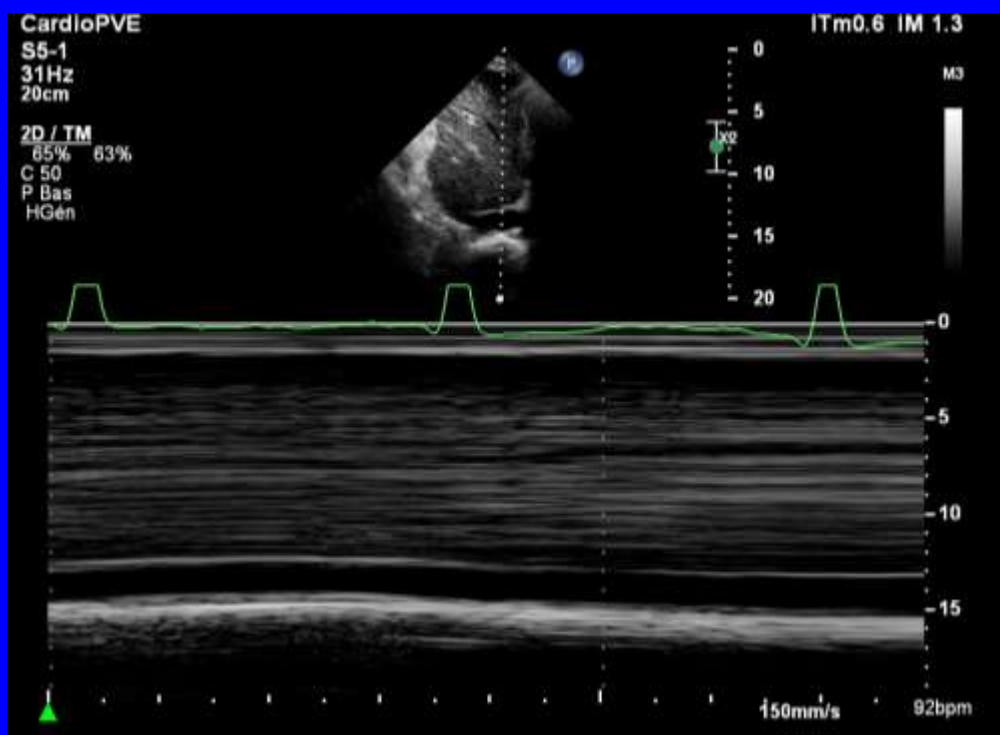
Klein. JACC
1990;15:99



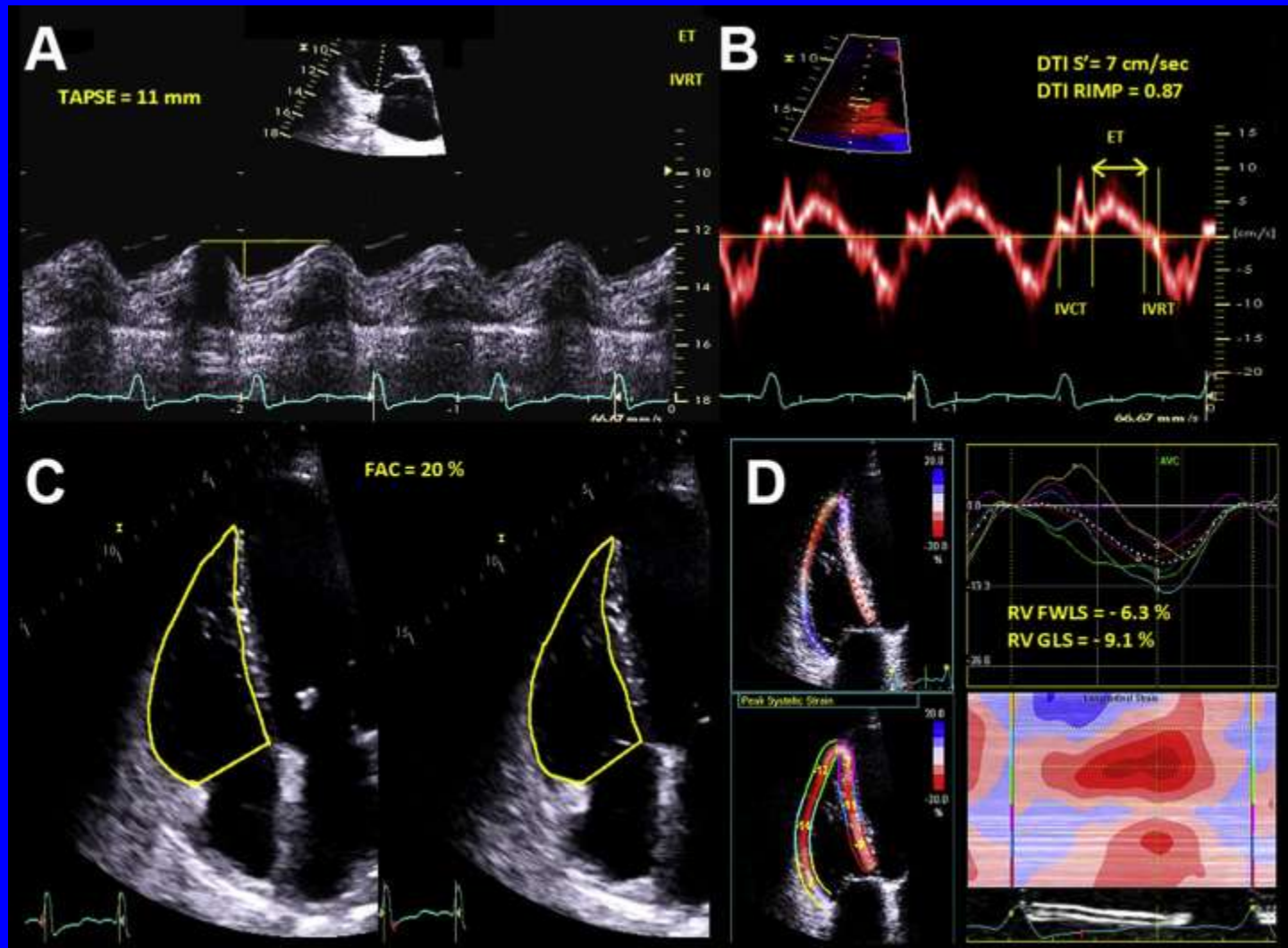
Healthy young male subject



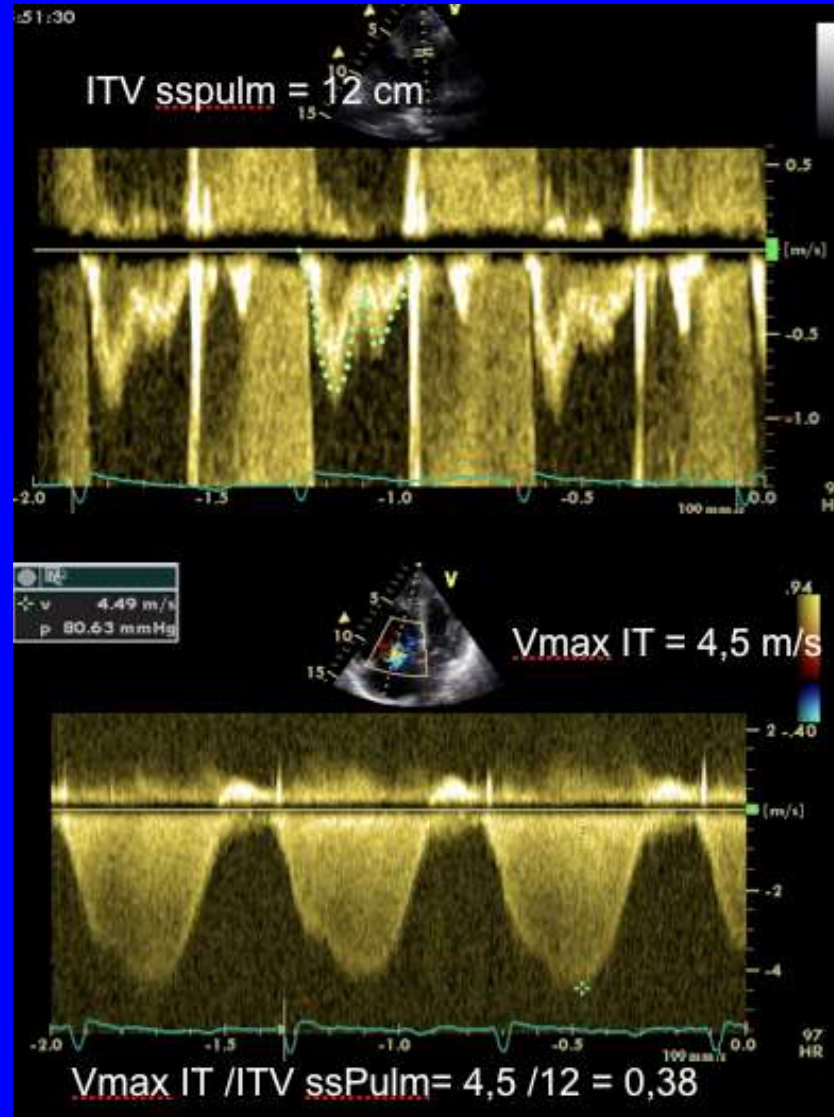




Fonction ventriculaire droite



Pressions pulmonaires et resistances vasculaires pulmonaires



Résistances vasculaires pulmonaires

V_{maxIT}/ITV_{sspulm} (normal < 0,15)

Abbas AE. JACC 2003 ; 41 : 1021-7

> 0.2: RVP > 2 U Wood Se 70% Sp 94%

Abbas AE. JACC 2003 ; 41 : 1021-7

> 0.38: RVP > 8 U Wood Se 75% Sp 100%

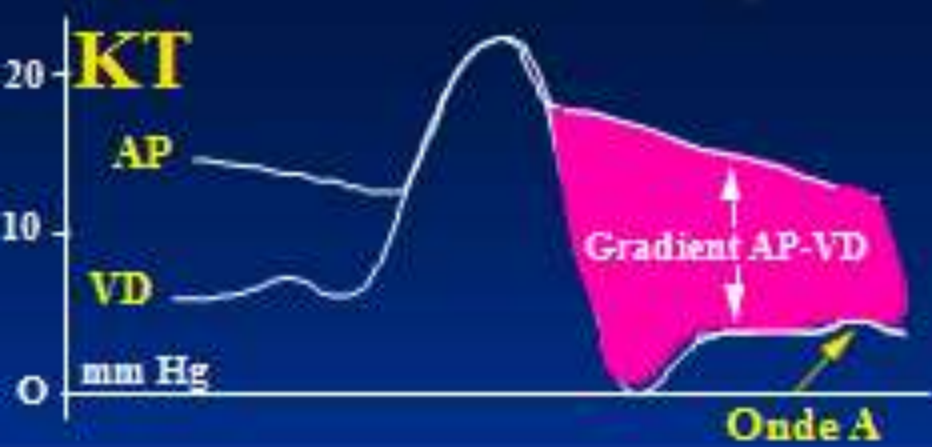
Vlahos AP. JASE 2008 ; 21 : 711

> 0.12: RVP > 1.5 U Wood Se 100% Sp 86%

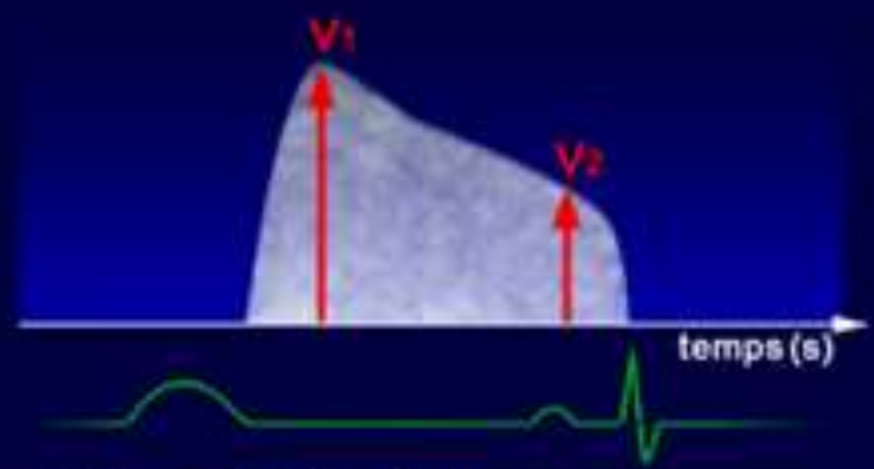
Farzaneh-Far R. AJC 2008 ; 101 : 259

RVP Normales < 1,5 U Wood

Mesure des pressions pulmonaires



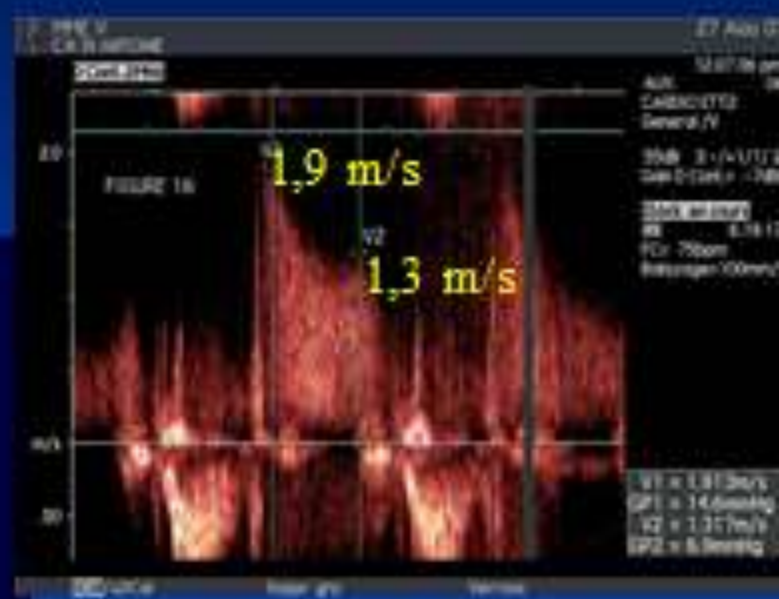
Insuffisance Pulmonaire



$$PAP_m = 4(V_1)^2 + POD$$

$$PAP_d = 4(V_2)^2 + POD$$

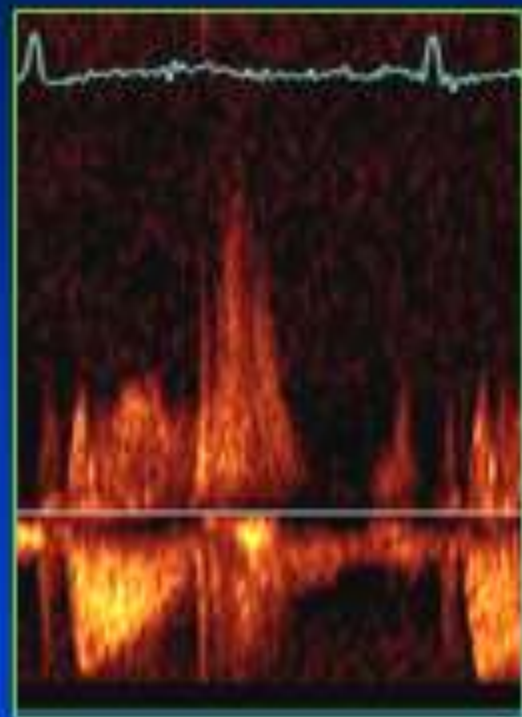
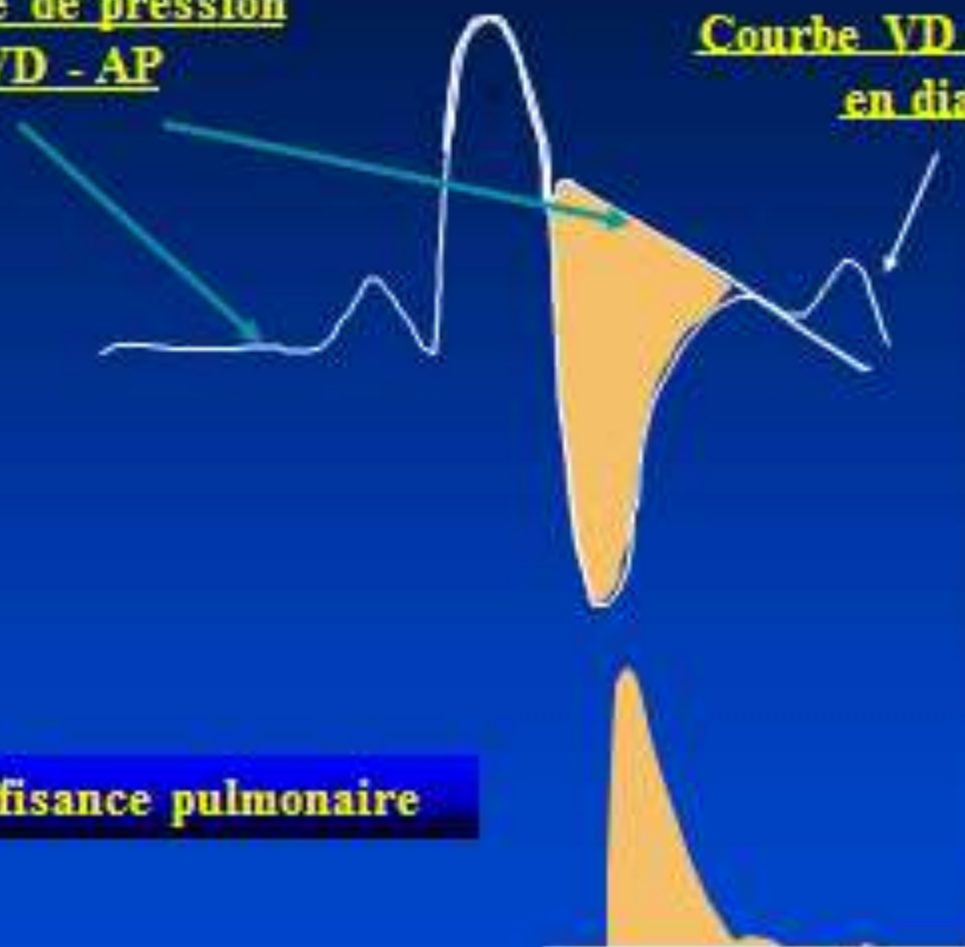
$$PAP_s = 3 PAP_m - 2 PAP_d$$



Adiastolie à droite

Courbe de pression
VD - AP

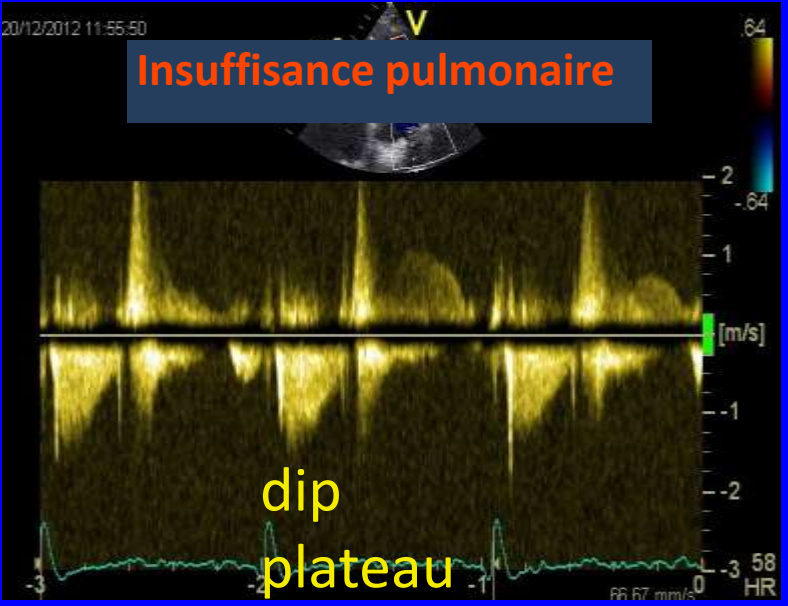
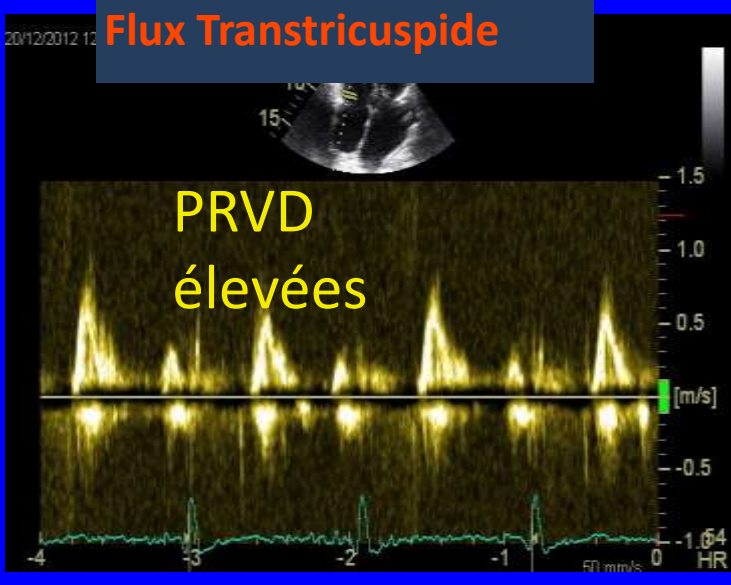
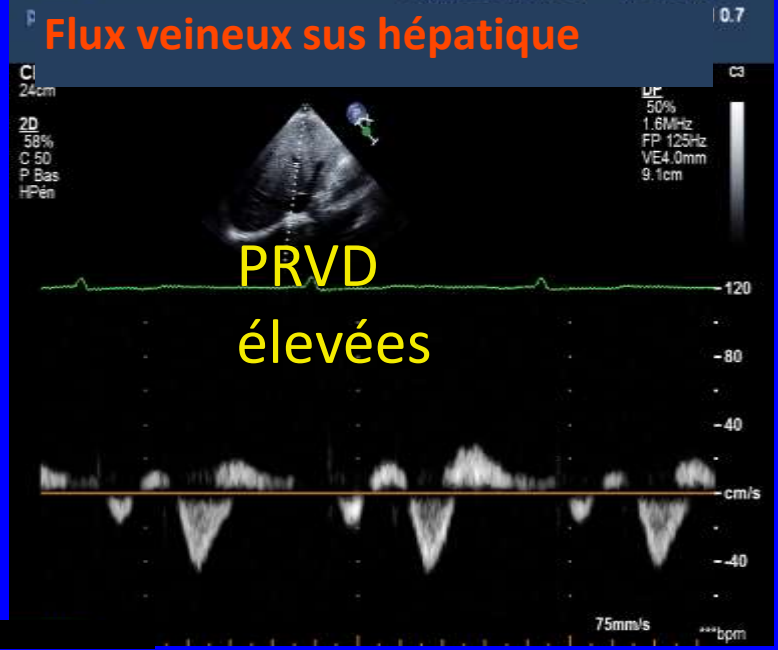
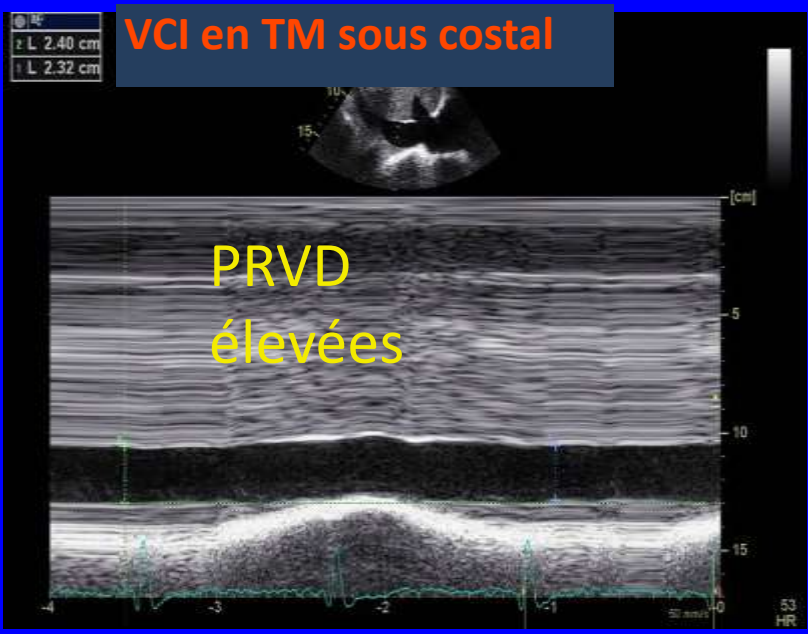
Courbe VD dépasse AP
en diastole



Insuffisance pulmonaire

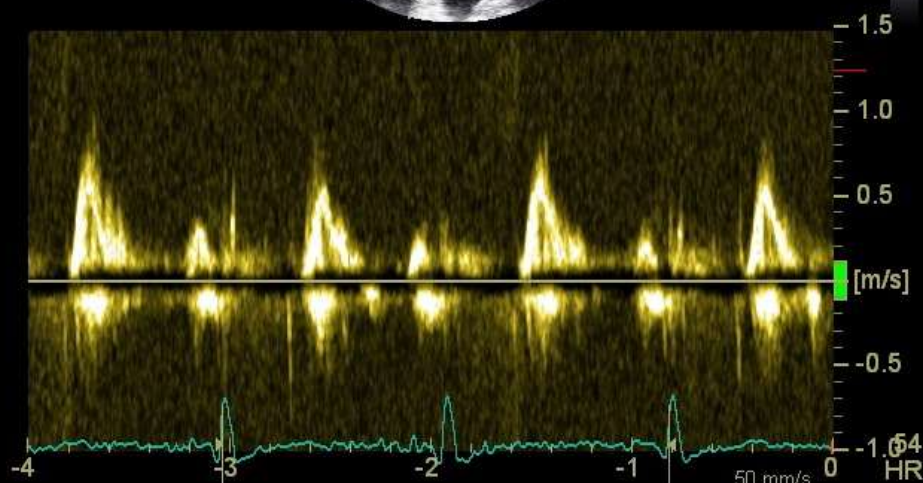
Ejection diastolique

Ejection systolique



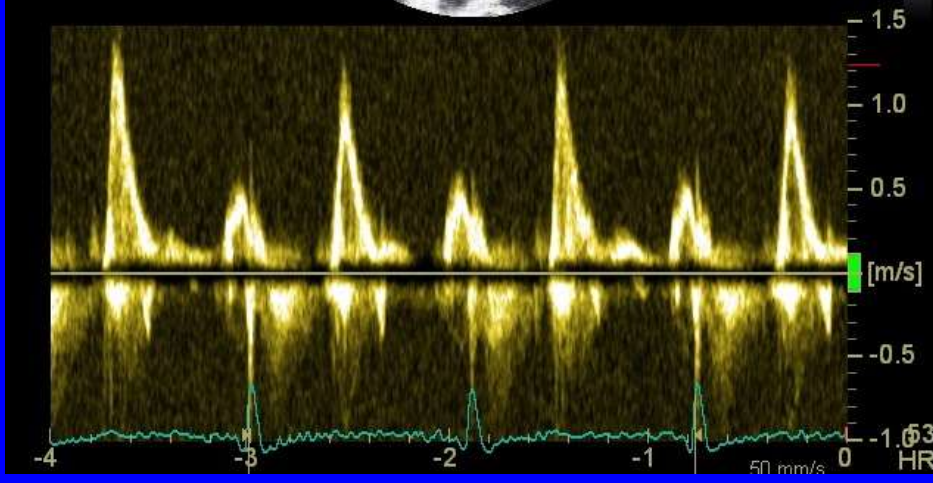
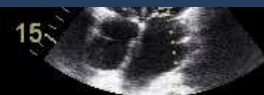
20/12/2012 12:00:44

Flux tricuspide



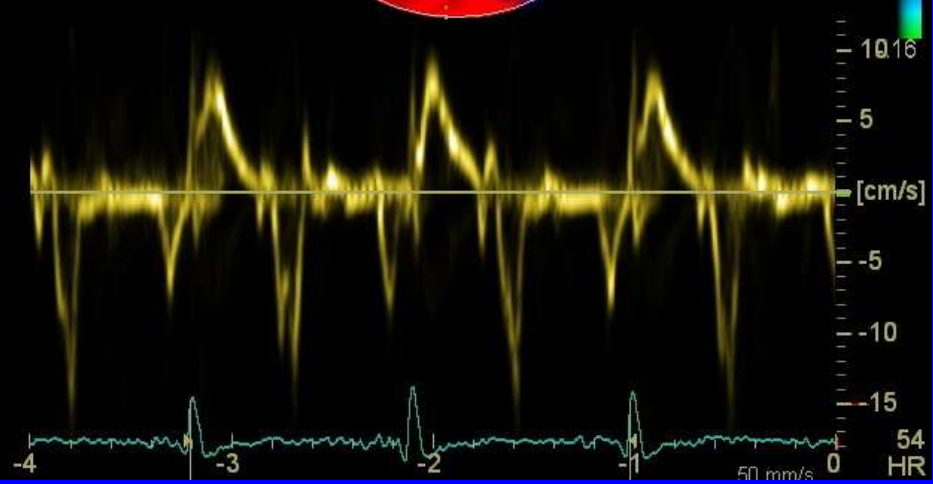
20/12/2012 12:00:26

Flux mitral



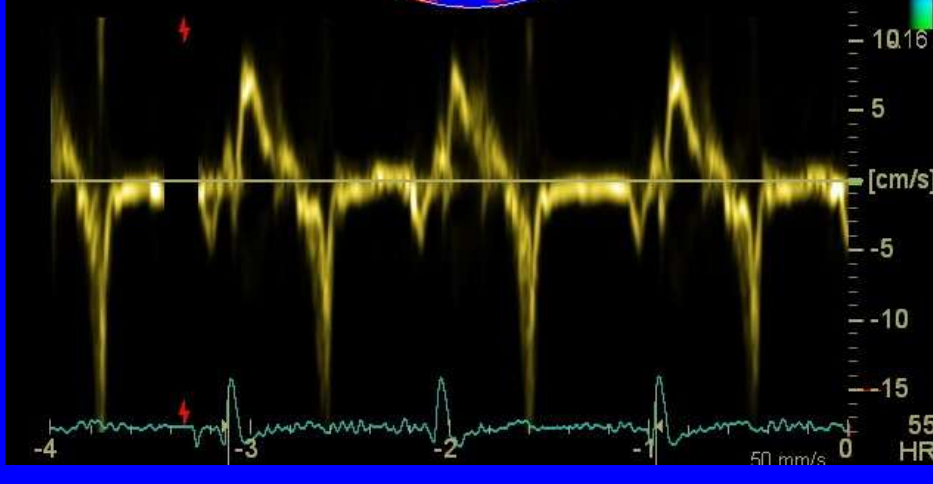
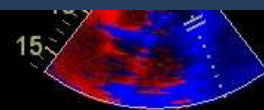
20/12/2012 12:01:21

DTI pulsé paroi inféroseptale

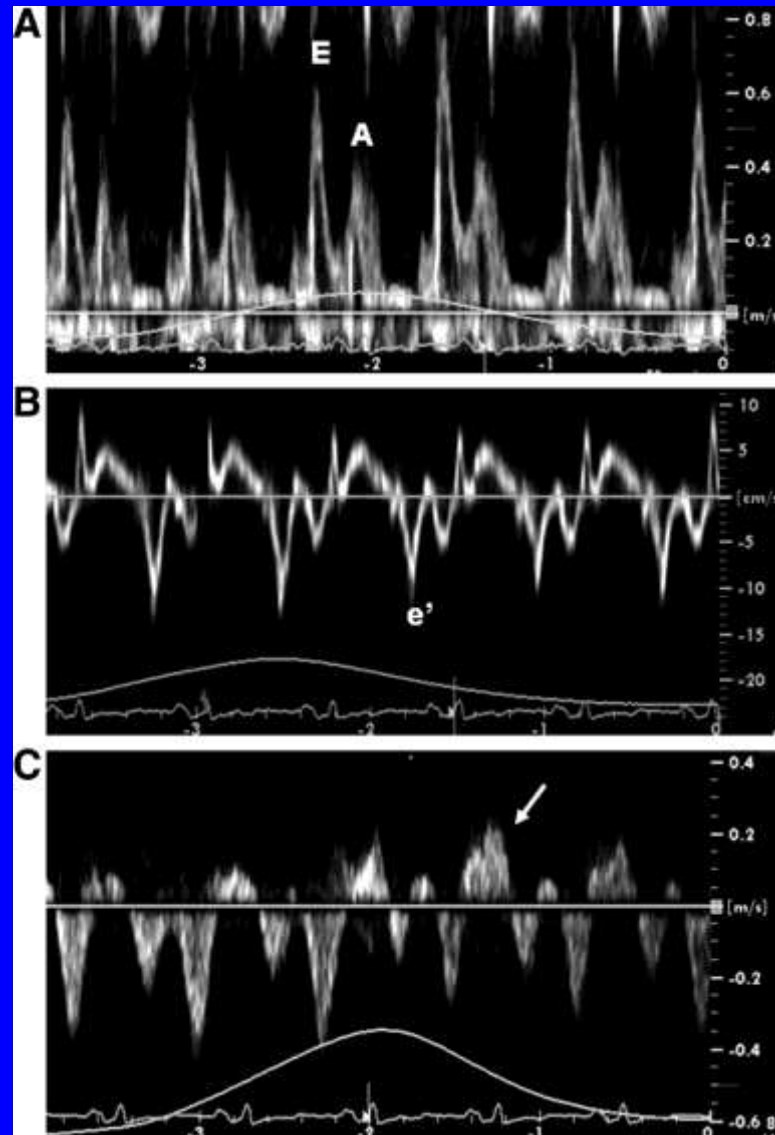


20/12/2012 12:01:

DTI pulsé paroi antérolatérale



Typical mitral inflow (A), mitral medial annulus (B), and hepatic vein (C) velocity recordings from a 72-year-old patient with constrictive pericarditis along with simultaneous respirometer recording at the bottom that indicates inspiration by upward curve and expiration by downward curve.

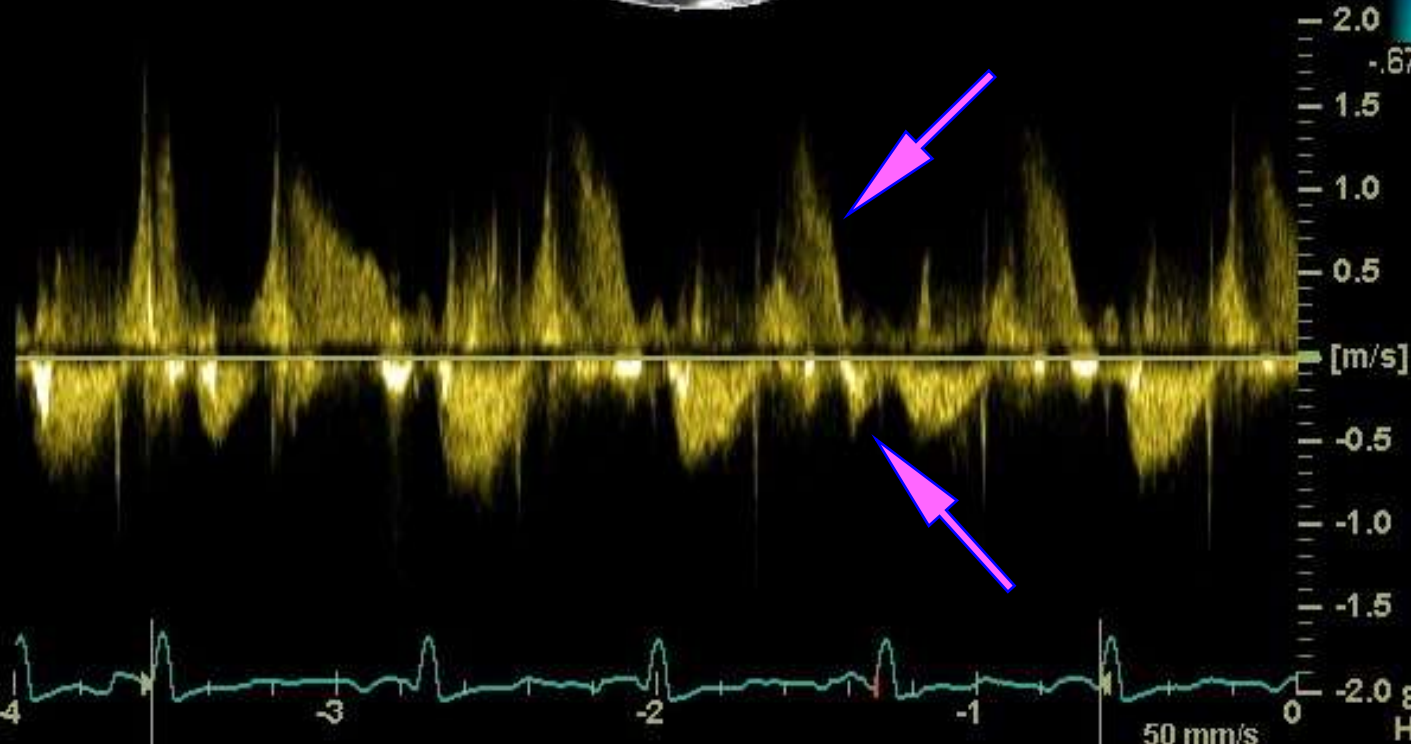


Jae K. Oh et al. *Circ Cardiovasc Imaging*. 2011;4:444-455

05:49:53



.67

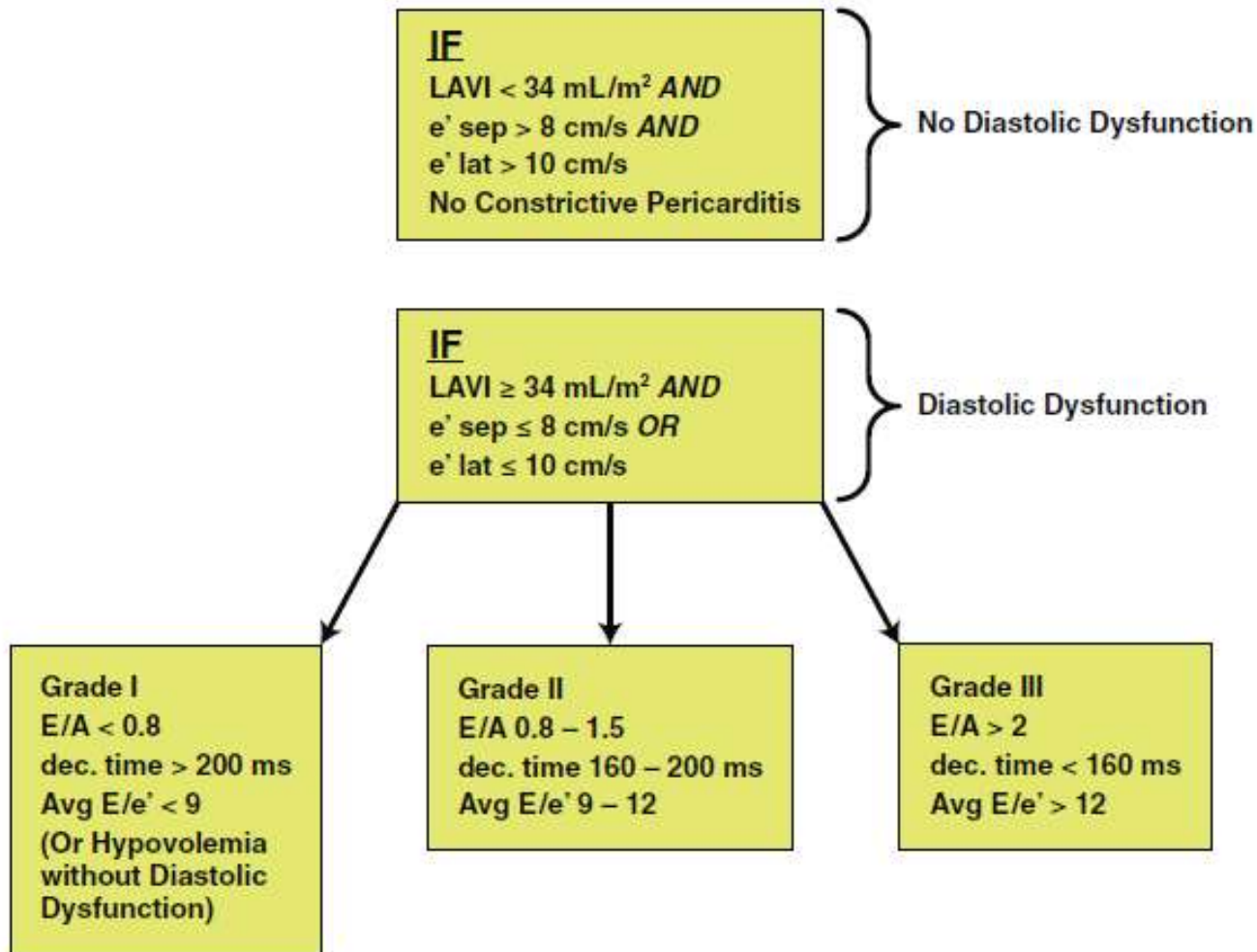


Variable	Restriction	Constriction
Mouvement septal	Normal	Déplacement (resp)
E/A mitral	>1,5	>1,5
TD mitral	<160	<160
Variations resp FM	Absentes (<15%)	Présentes (>25%)
Flux veineux sus hep	inversion diast insp	inversion diast exp
e' septal	en général < 7 cm/s	en général > 7 cm/s
e'latéral VG	> e' septal	< e' septal
strain VG	diminué	en général normal

modifié d'après Nagueh SF. JASE 2009 ;22:107.



FIGURE 5 Simplified Flow Chart for the Integrative Echocardiographic Evaluation of LV Diastolic Function



If inconclusive, consider:

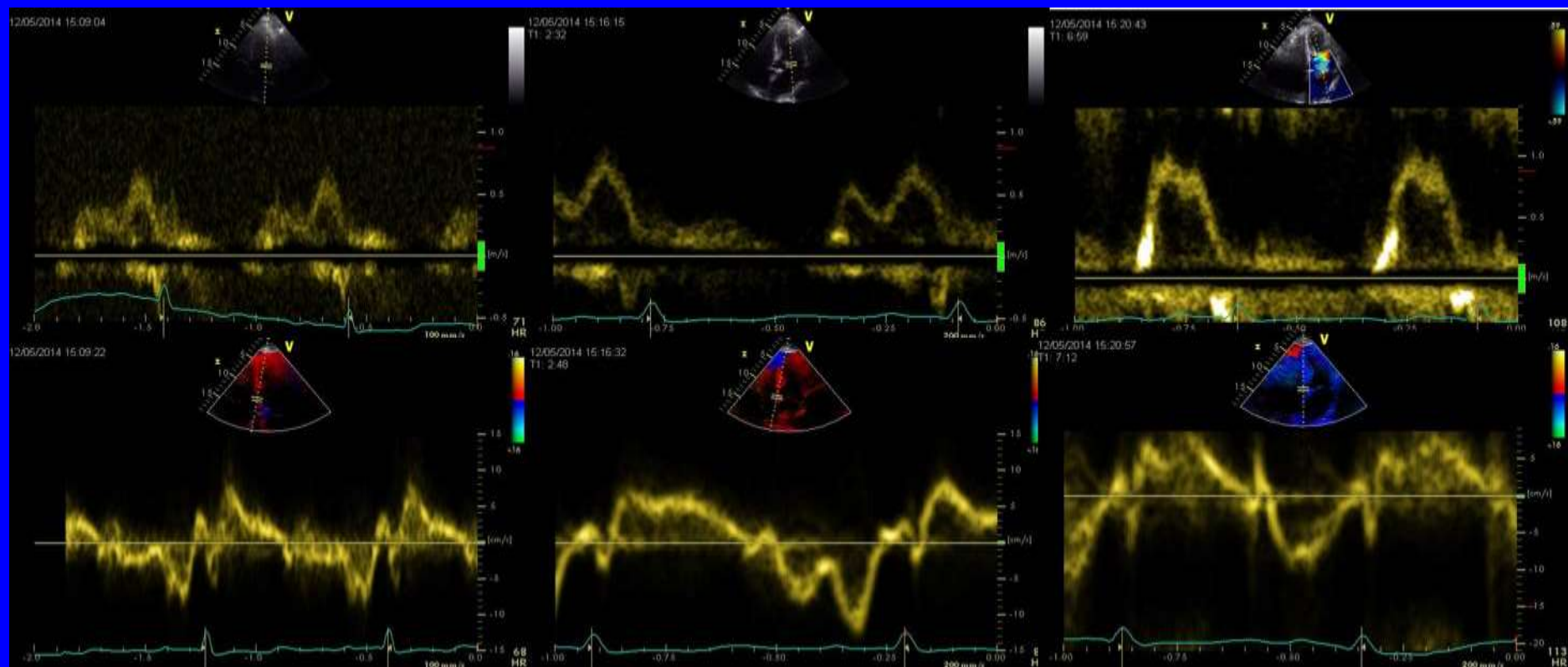
SPAP ↑, pulmonary venous S/D < 1, onset e' later than onset E, LV wall hypertrophy, and other signs

Réserve diastolique:

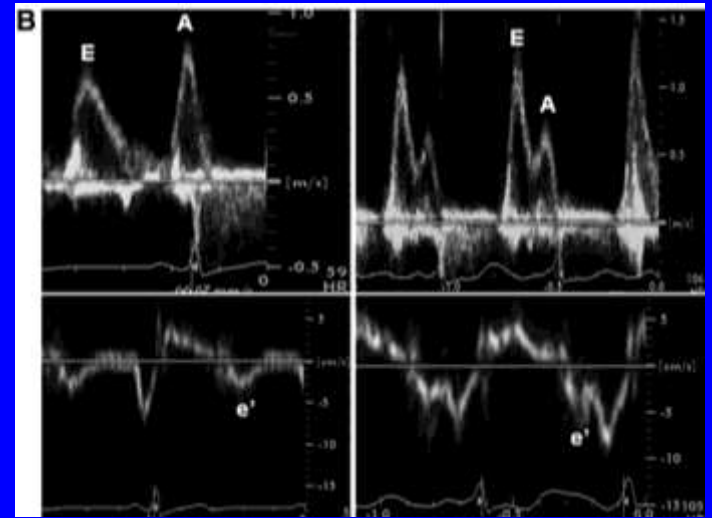
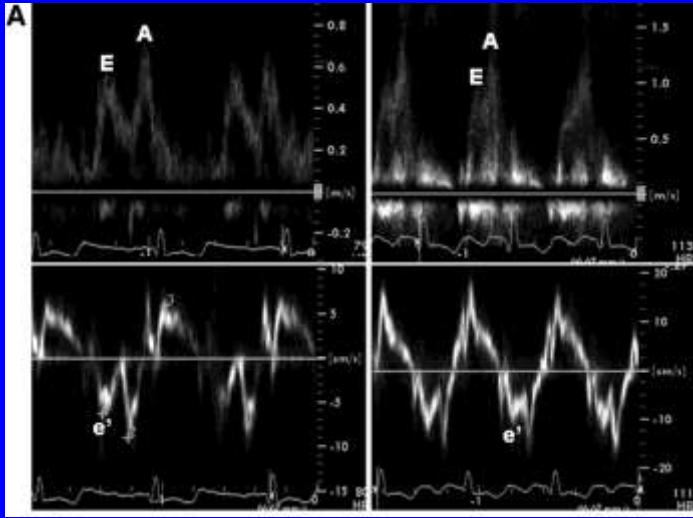
Toutes les mesures sont réalisées au repos pour évaluer des symptômes souvent provoqués par l'exercice!

- Chez l'individu normal (jusqu'à environ 50 ans), le remplissage ventriculaire protodiastolique est assuré par l'aspiration active du sang par le VG et non par le gradient de pression entre l'OG et le VG.
- Comme l'exercice physique a un effet lusitrope positif, la relaxation est améliorée, et la pression de l'OG ne monte pas à l'effort malgré l'augmentation du débit cardiaque.
- Avec l'âge et l'HVG, toutefois, la relaxation devient de moins en moins efficace et le remplissage dépend de plus en plus du gradient de pression OG – VG; dans ces conditions, la POG s'élève avec l'effort.

Réserve diastolique: effort
Toutes les mesures sont réalisées au repos pour évaluer des symptômes souvent provoqués par l'exercice!



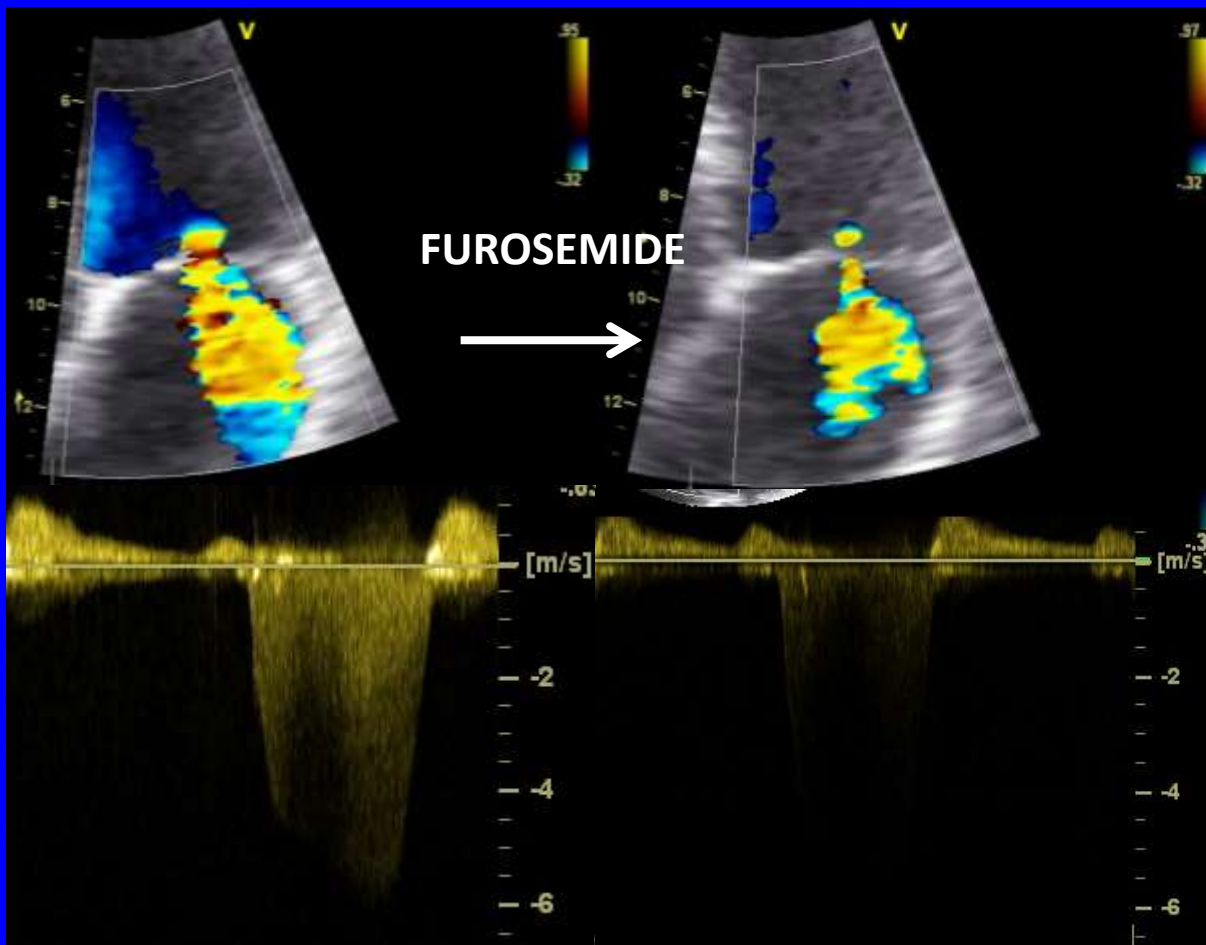
RESERVE DIASTOLIQUE



Mitral inflow and annulus velocity recordings at resting baseline and immediately after 5 minutes of exercise from 2 patients with exertional dyspnea.

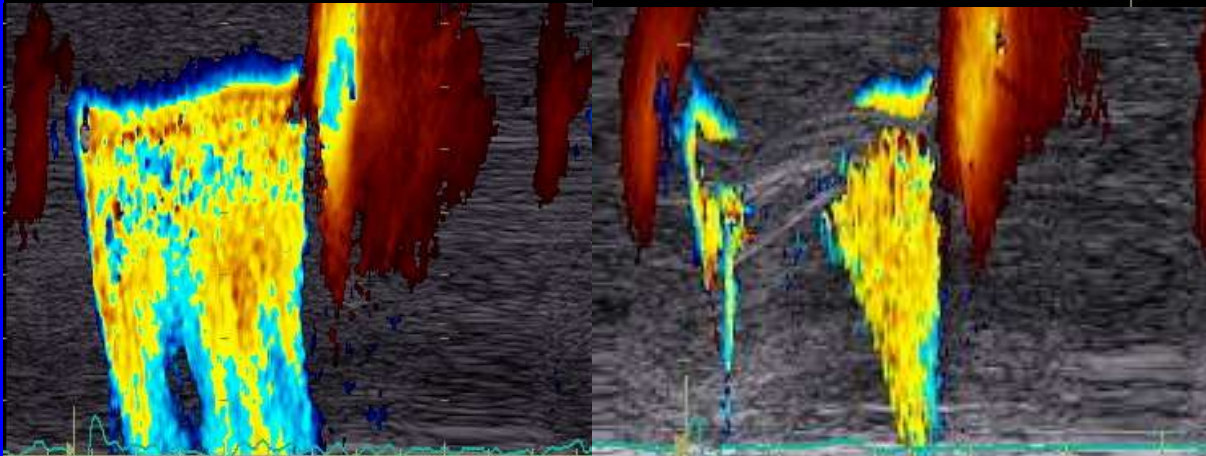
A, Recording from a 65-year-old patient with noncardiac dyspnea. From resting to exercise period, E increased from 60 to 100 cm/s and e' from 6 to 12 cm/s, with no major change in E/ e' ratio (from 10 to 9).

B, Recording from a 56-year-old patient with exertional dyspnea. From resting to exercise period, E increased from 60 to 120 cm/s and e' from 4 to 5 cm/s, with a major change in E/ e' ratio (from 15 to 24).

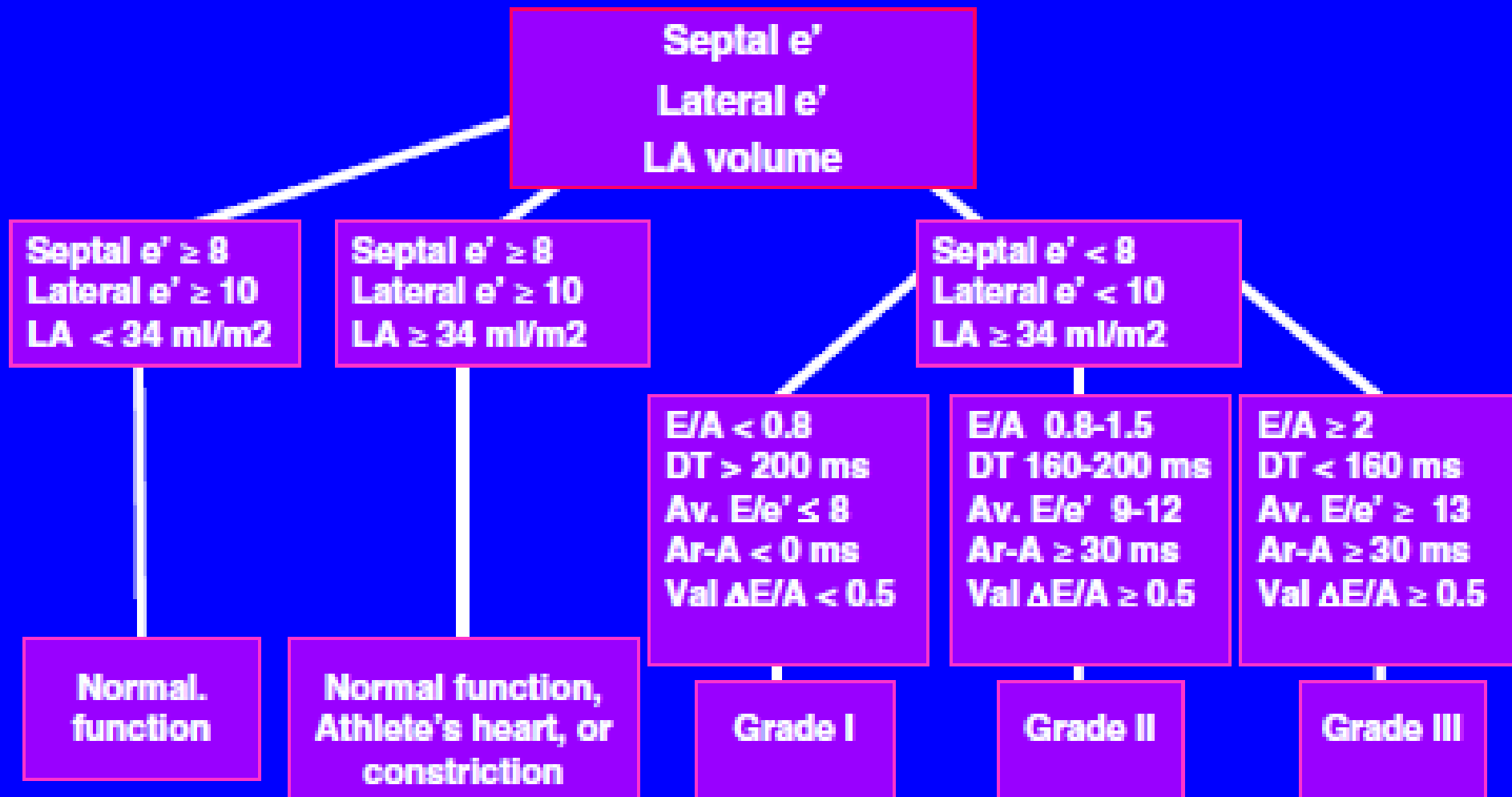


**IMPORTANCE DE L'IM
FONCTIONNELLE:**

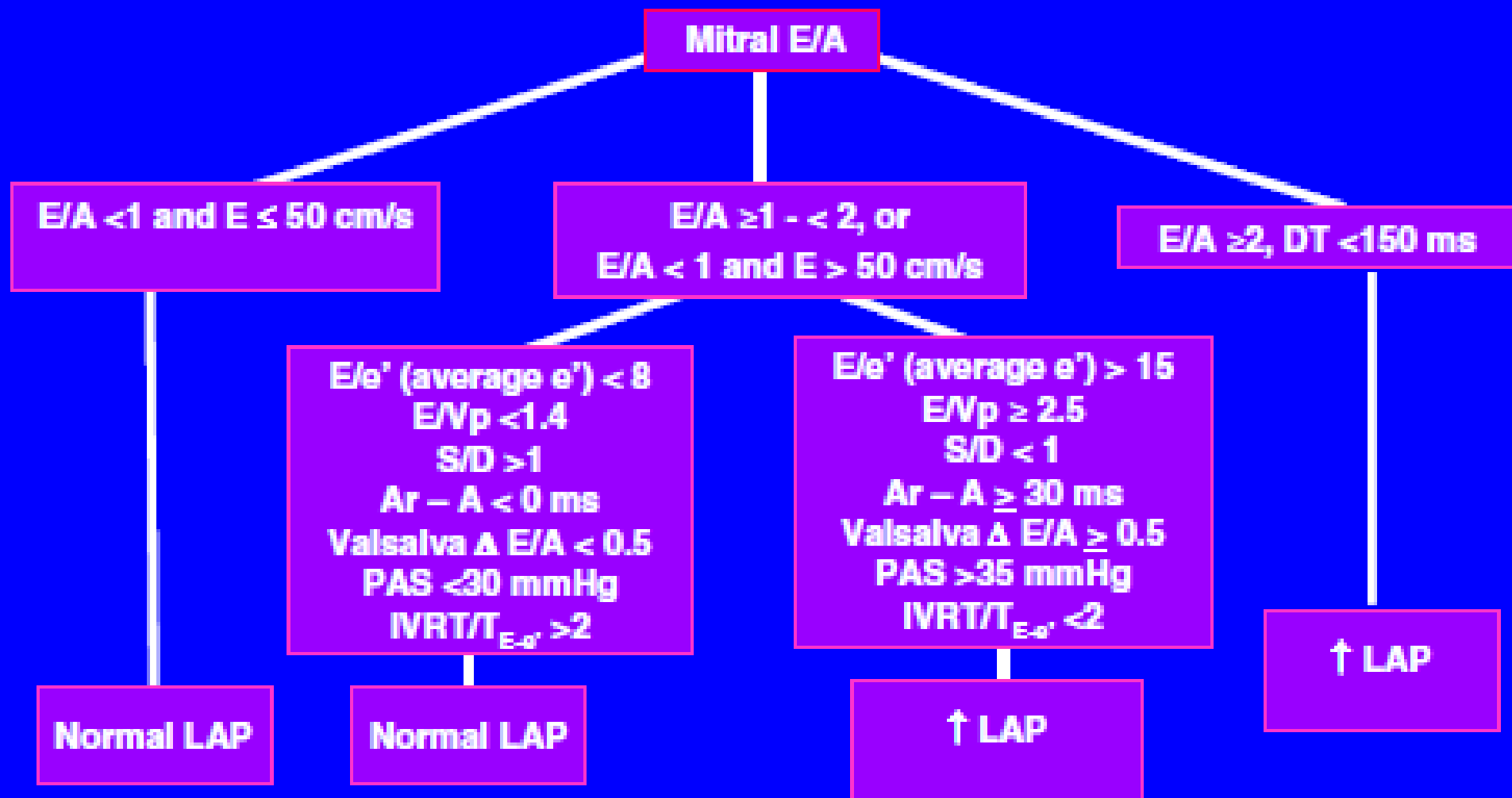
**MARQUEUR DES
PRESSIONS DE
REPLISSAGE**



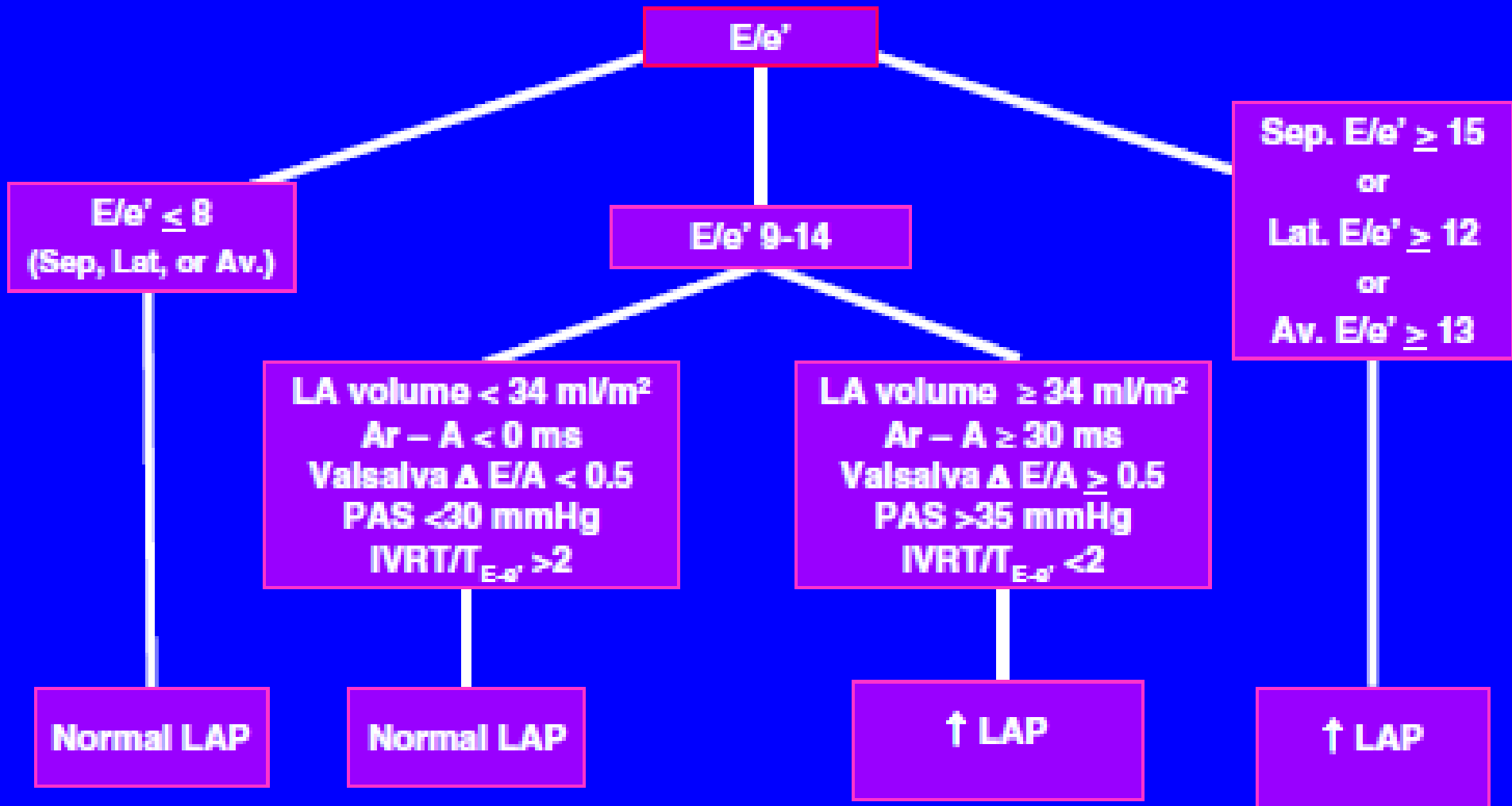
Practical Approach to Grade Diastolic Dysfunction

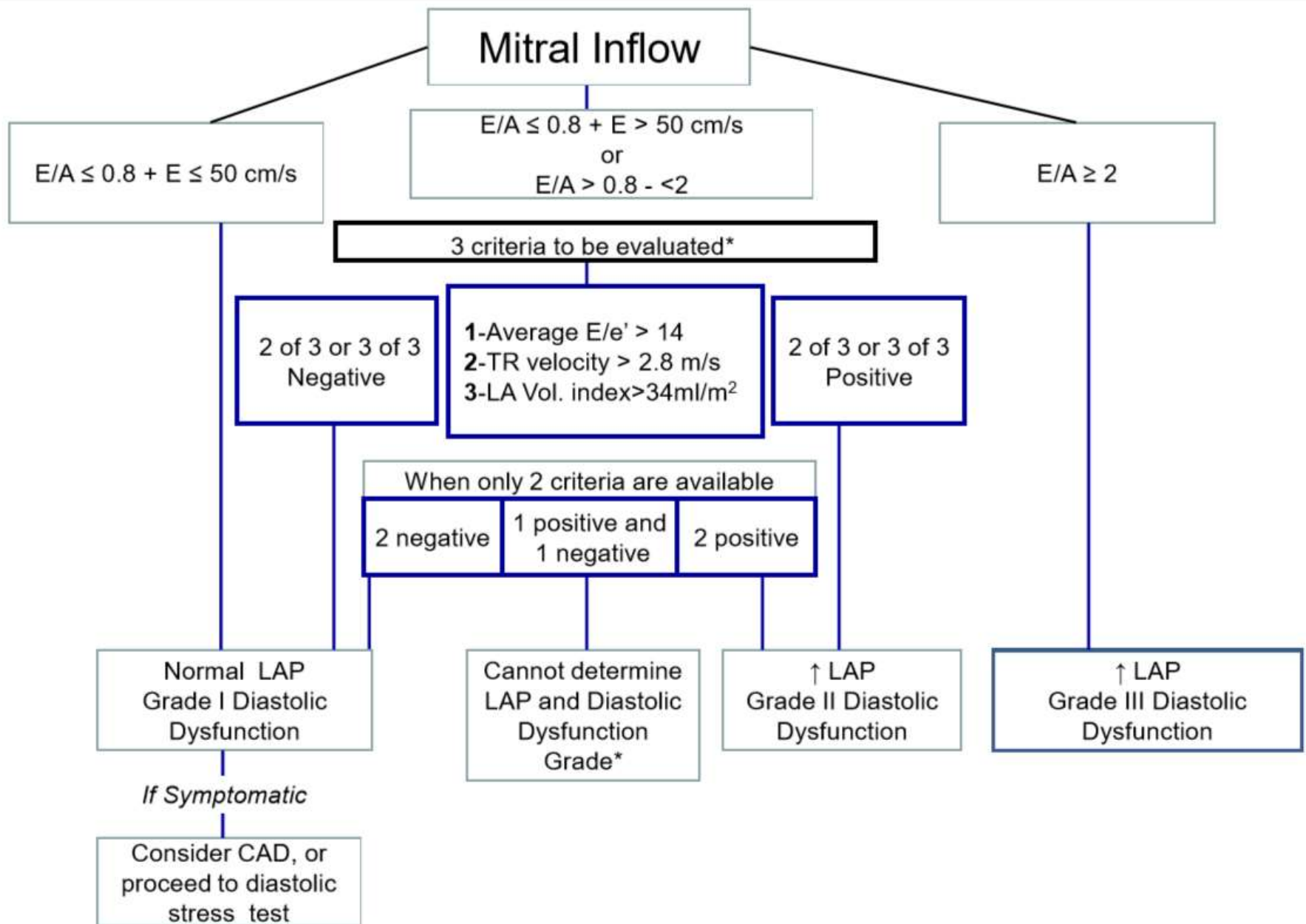


Estimation of Filling Pressures in Patients with Depressed EF



Estimation of Filling Pressures in Patients with Normal EF





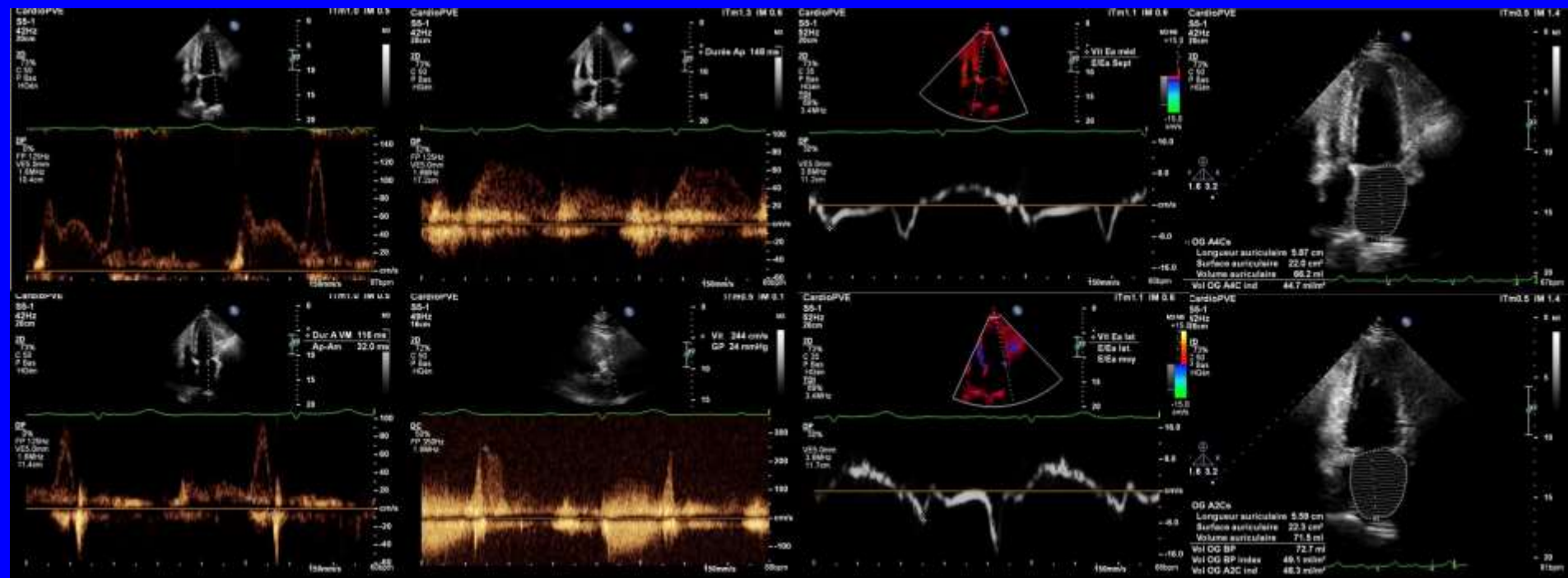
(* : LAP indeterminate if only 1 of 3 parameters available. Pulmonary vein S/D ratio <1 applicable to conclude elevated LAP in patients with depressed LV EF)

Take Home Messages

- Ne pas confondre dysfonction diastolique et pressions de remplissage
- Evaluation multiparamétrique
- Les propositions de l'ASE sont contestables

1. The four recommended variables for identifying diastolic dysfunction and their abnormal cutoff values are annular e' velocity: septal $e' < 7$ cm/sec, lateral $e' < 10$ cm/sec, average E/e' ratio > 14 , LA volume index > 34 mL/m², and peak TR velocity > 2.8 m/sec.
2. LV diastolic function is normal if more than half of the available variables do not meet the cutoff values for identifying abnormal function. LV diastolic dysfunction is present if more than half of the available parameters meet these cutoff values. The study is inconclusive if half of the parameters do not meet the cutoff values.

E/e' 13



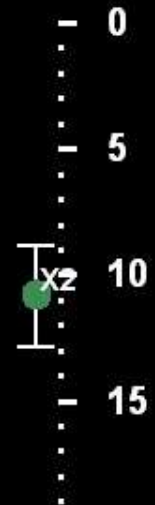
Healthy hypertensive 72 y.o. woman
but exertional dyspnea

CardioPVE

S5-1
43Hz
19cm

2D
82%
C 50
P Bas
HRés

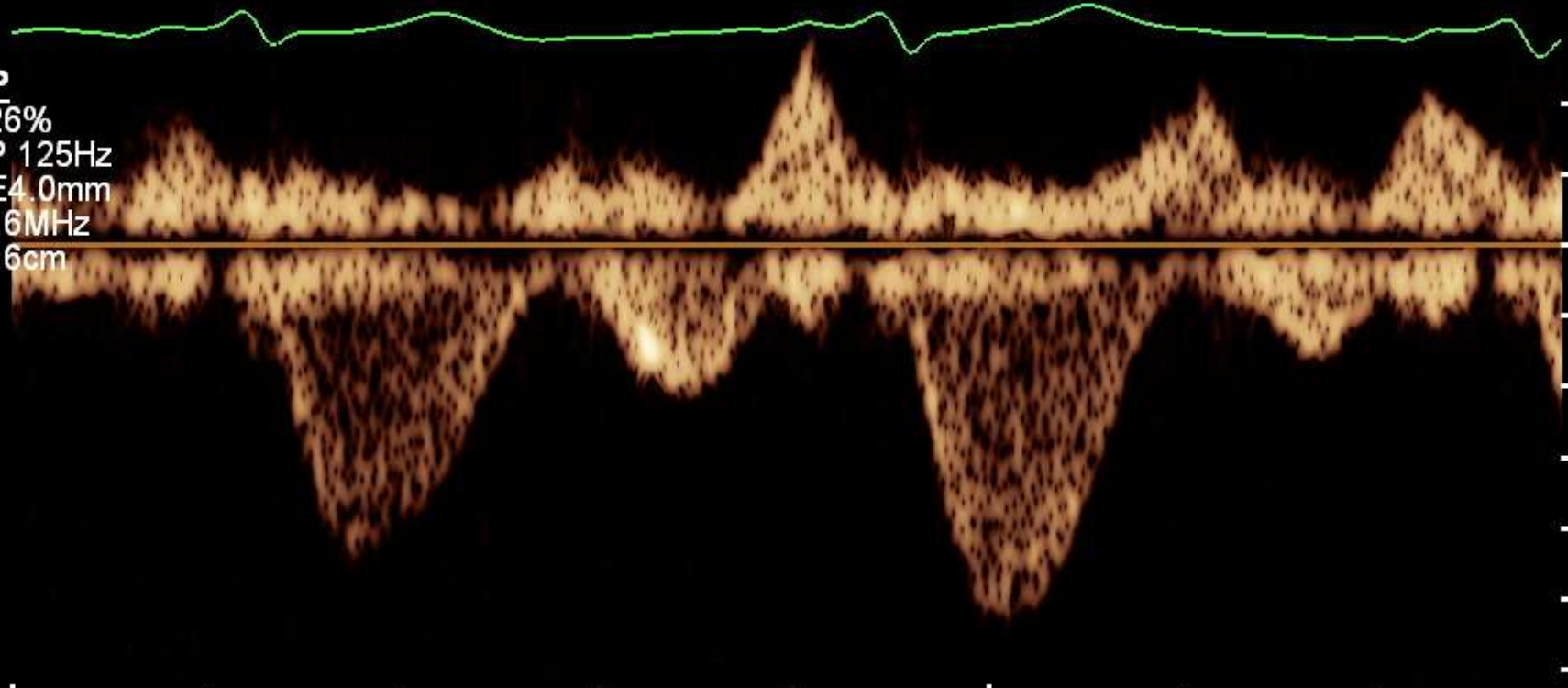
ITm0.9 IM 0.7



M1



DP
26%
FP 125Hz
VE4.0mm
1.6MHz
9.6cm



-40

cm/s

-40

-80

-120

150mm/s

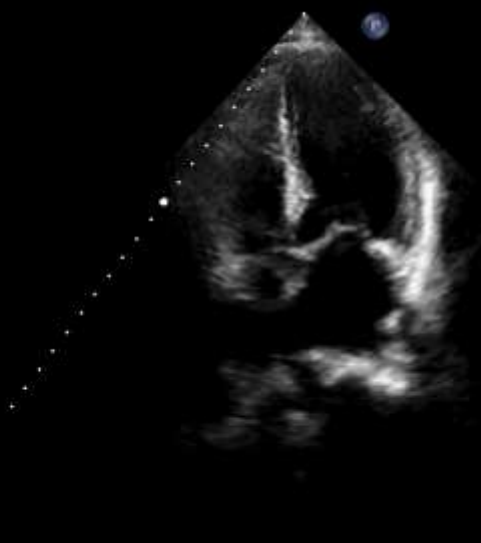
92bpm

CardioPVE

S5-1
39Hz
72cm

2D
72°
C 50
P Bas
HRes

G
P R
1.6 3.2

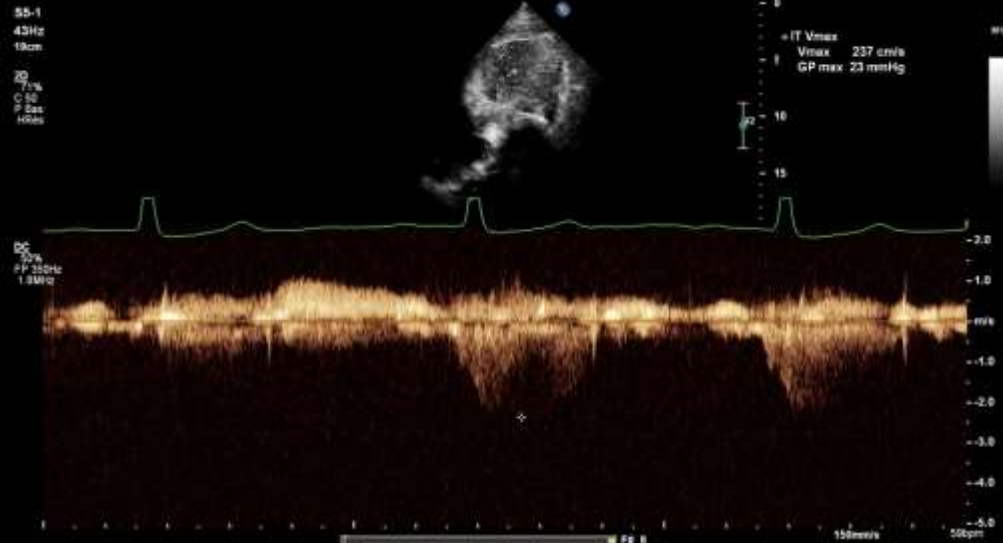


TIS CardioPVE

S5-1
43Hz
19cm

2D
71°
C 50
P Bas
HRes

DC
20%
PF 320Hz
1.8MHz



ITm0.5 IM 0.1
IT Vmax
Vmax 237 cm/s
GP max 23 mmHg

CardioPVE

S5-1
39Hz
72cm

2D
71°
C 50
P Bas
HRes

G
P R
1.6 3.2



OG A4Cs
Longueur auriculaire 5.94 cm
Surface auriculaire 23.3 cm²
Volume auriculaire 69.9 ml
Indice VTS OG (A4C) 44.5 ml/m²

ITr CardioPVE

S5-1
39Hz
72cm

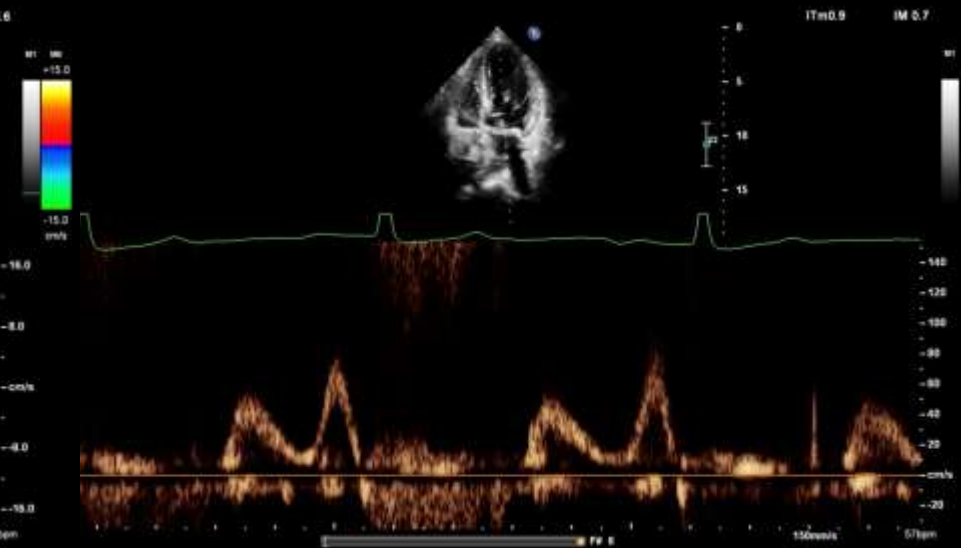
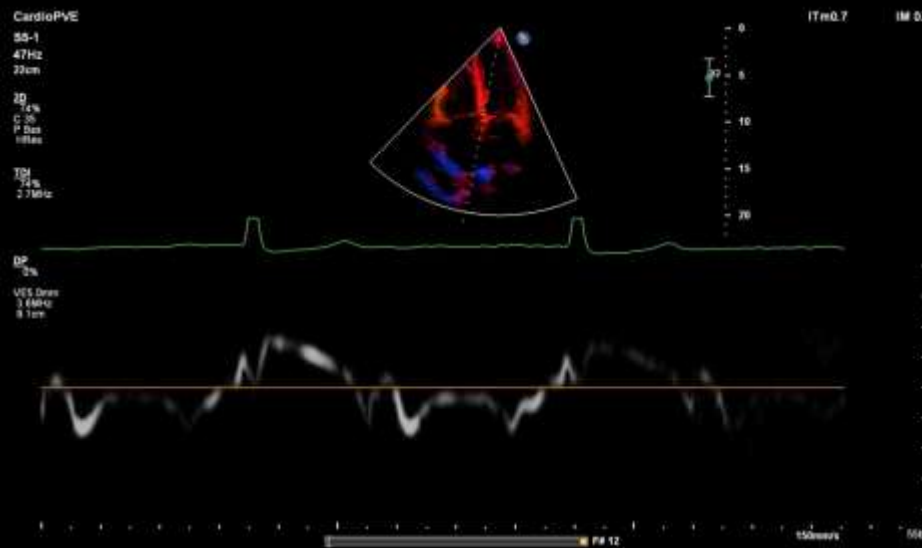
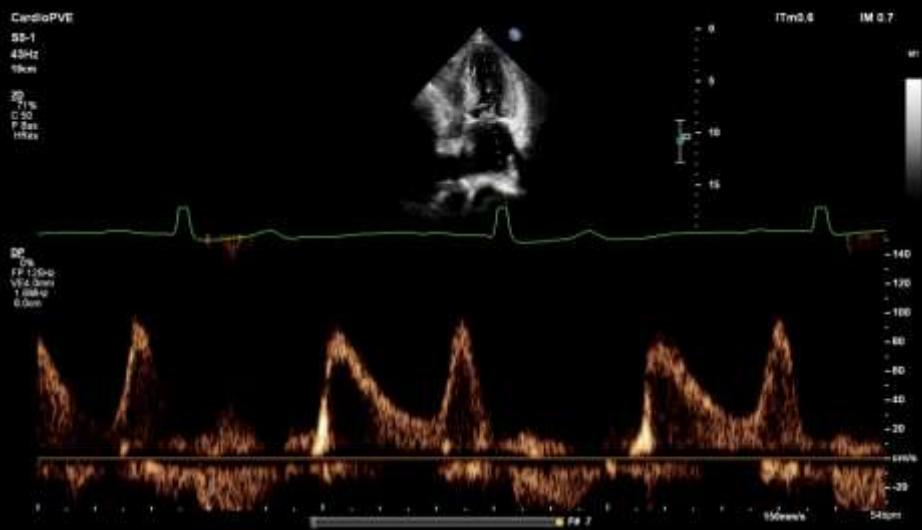
2D
71°
C 50
P Bas
HRes

G
P R
1.6 3.2



OG A2Cs
Longueur auriculaire 6.14 cm
Surface auriculaire 24.4 cm²
Volume auriculaire 78.9 ml
Indice VTS OG (A2C) 50.2 ml/m²
VTS OG (BP) 74.6 ml
Indice VTS OG (BP) 47.5 ml/m²

ITm0.5 IM 1.4



$E/e' 16$

$Ap-Am = 30 \text{ ms}$

CardioPVE

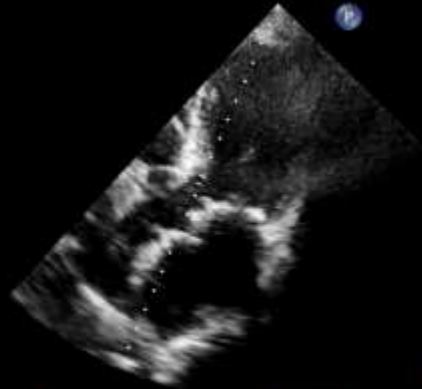
S5-1
43Hz
19cm

2D
71%
C 50
P Bas
HRés

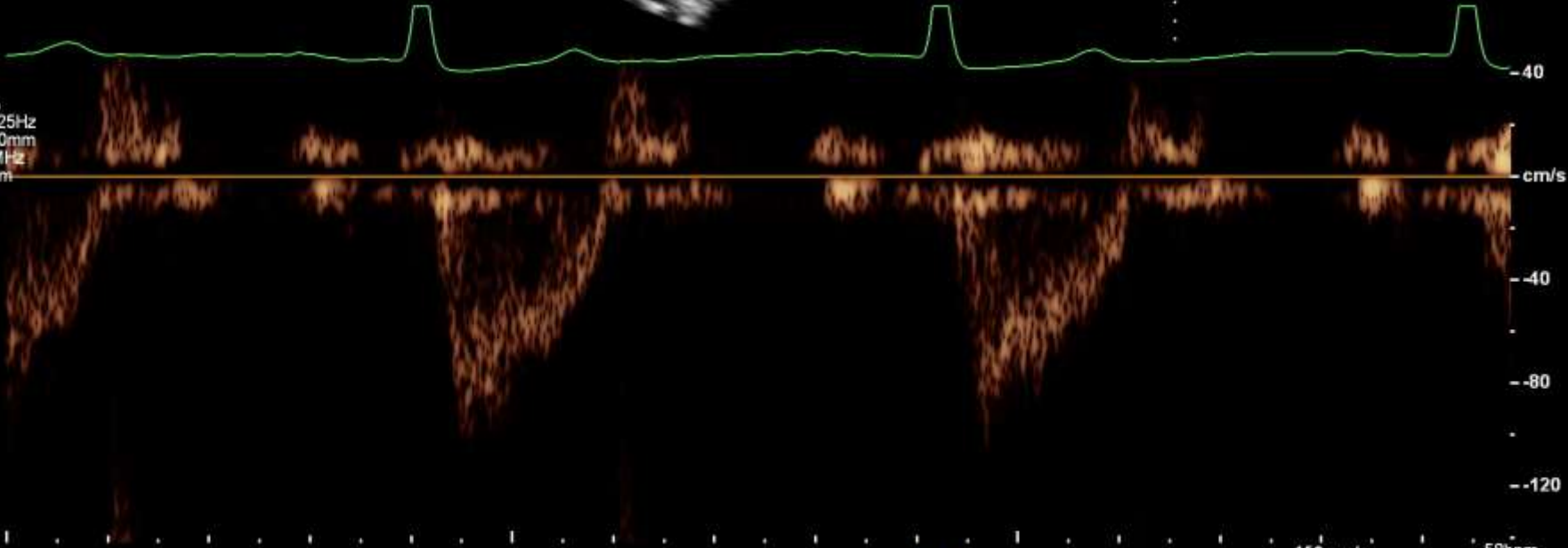
ITm0.9

IM 0.7

M1

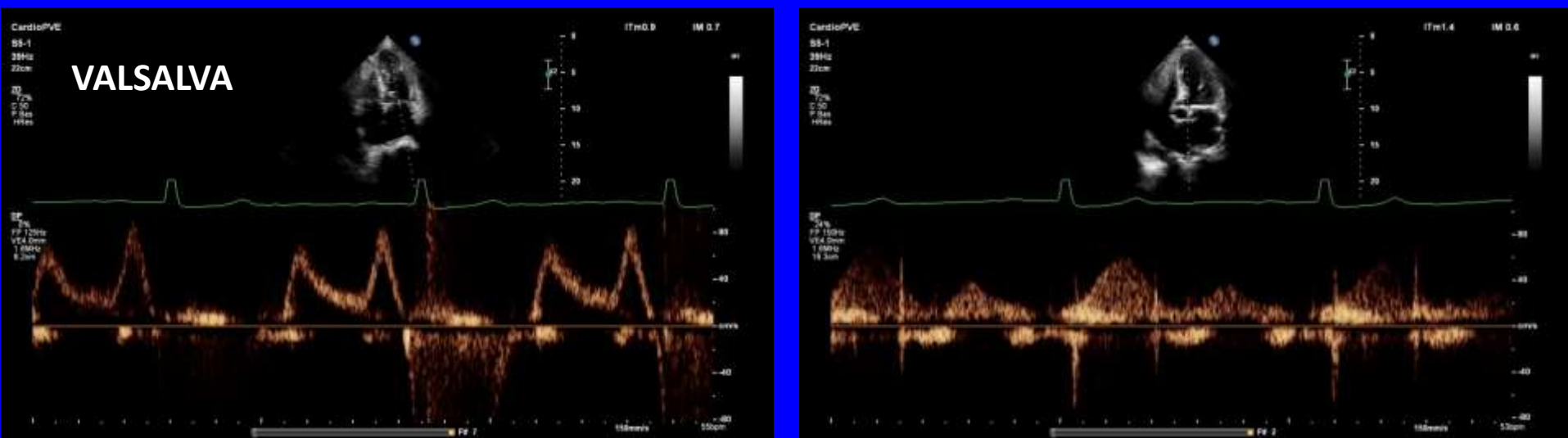
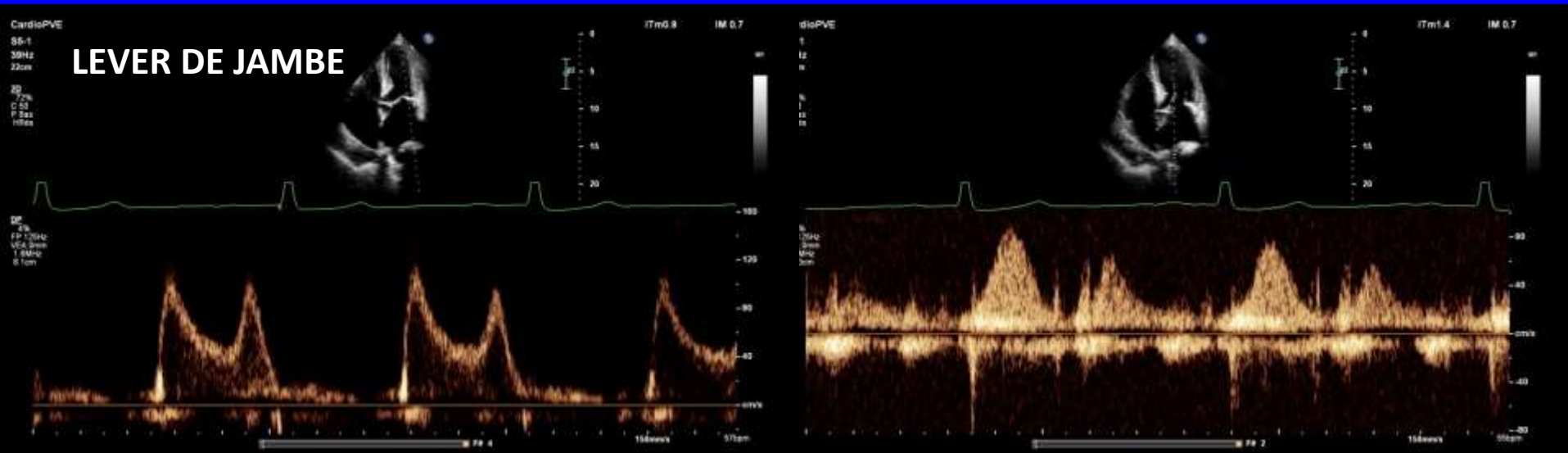


DP
0%
FP 125Hz
VE4.0mm
1.6MHz
9.2cm

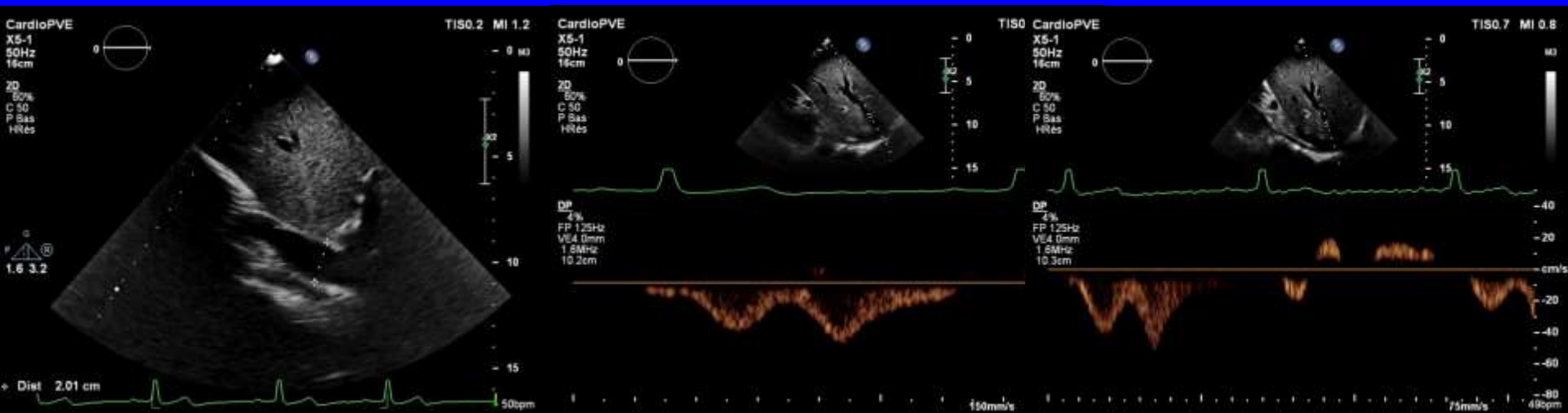


F# 2 150mm/s 58bpm

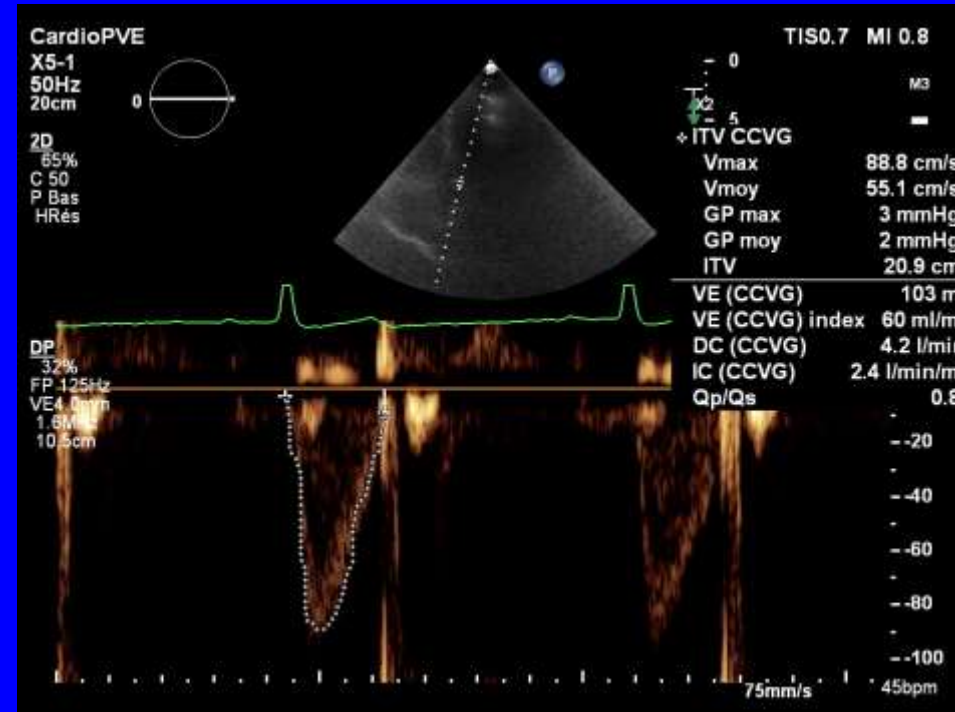
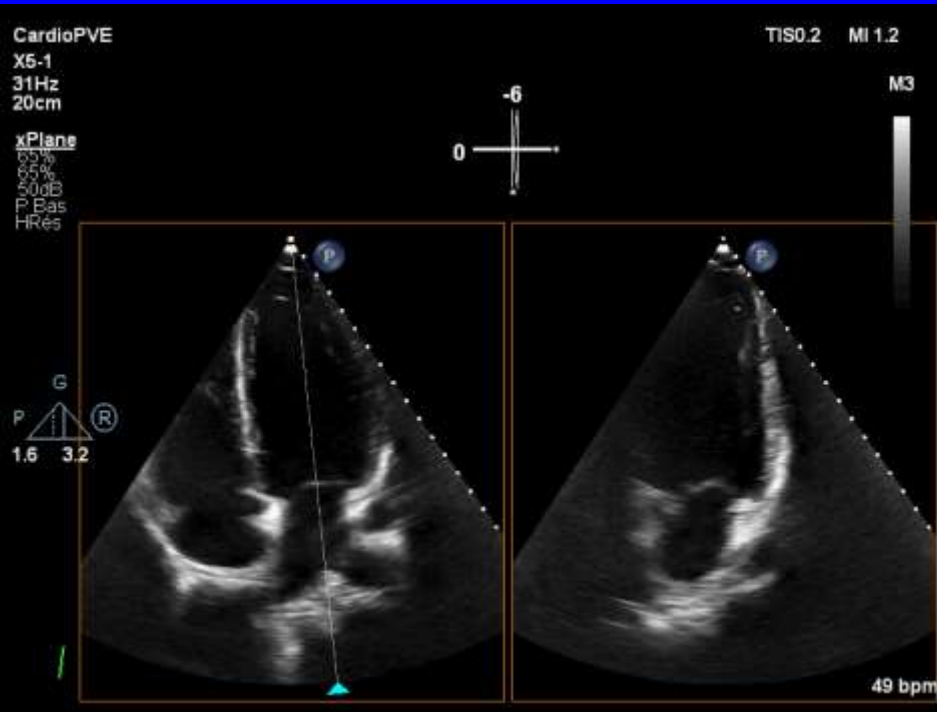
Lever de jambe versus Valsalva



Healthy young male subject

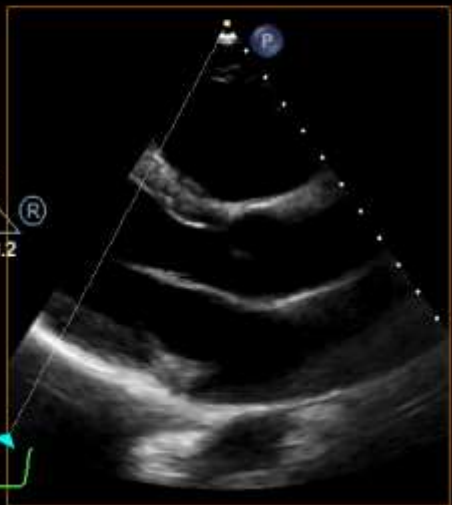


Healthy young male subject



CardioPVE
 X5-1
 42Hz
 14cm

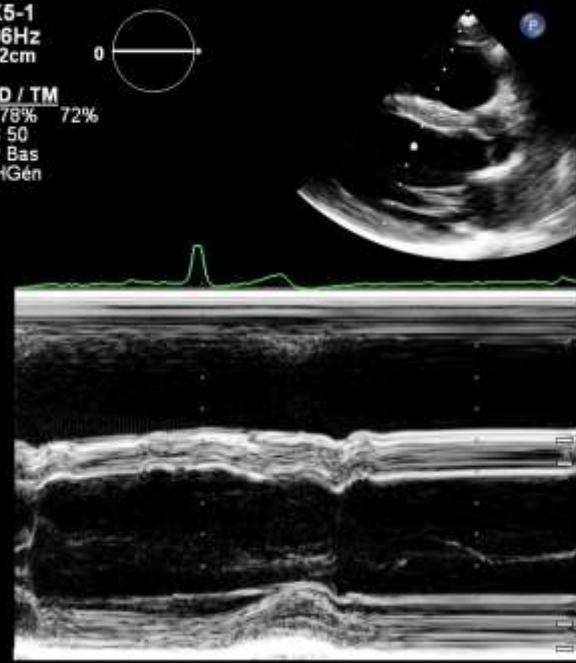
xPlane
 6.1%
 6.1%
 50dB
 P LOW
 HRes



48

TIS0.2 MI 1.2 Echo adulte
 X5-1
 66Hz
 12cm

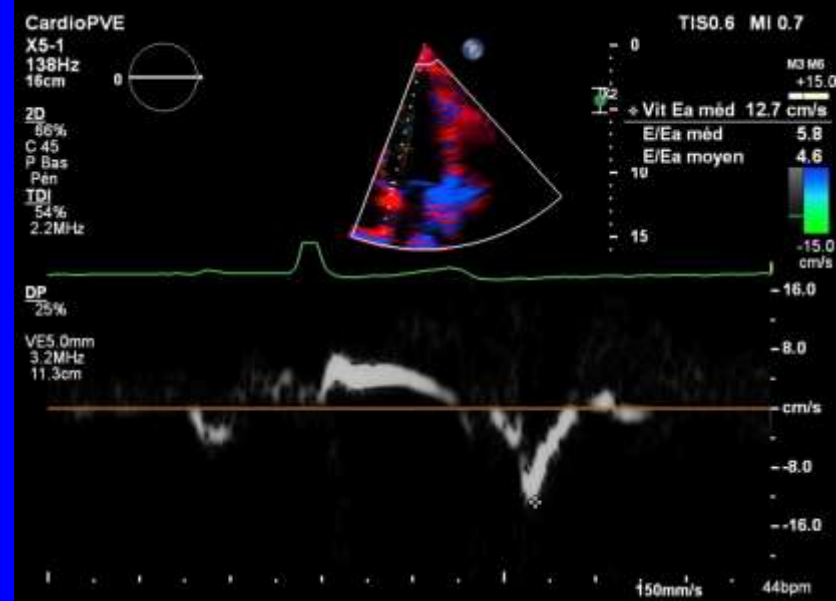
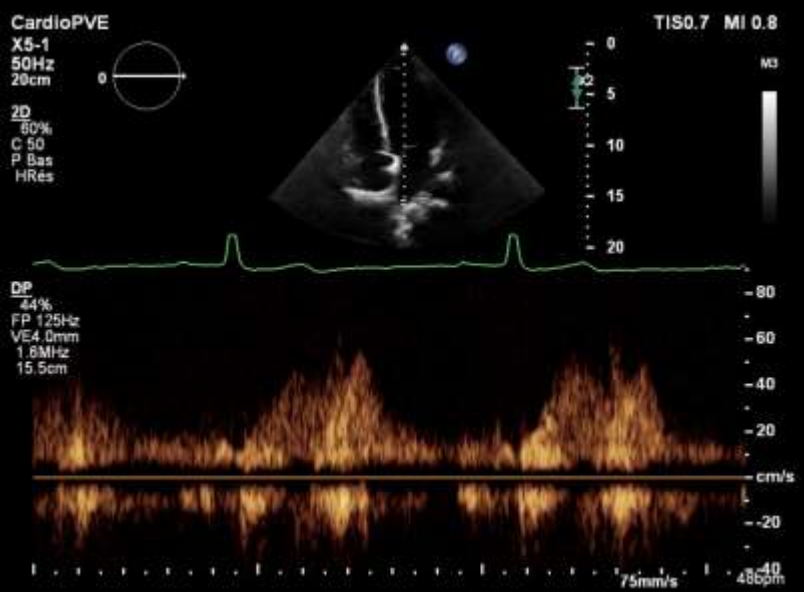
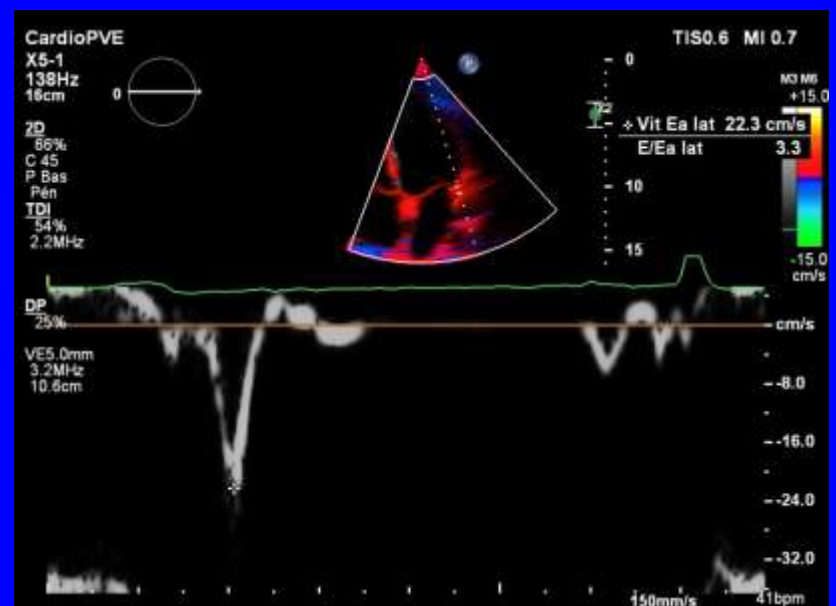
2D / TM
 78% 72%
 C 50
 P Bas
 HGén



- SIVd	0.737 cm
- DIVGd	5.10 cm
- PPVGd	0.799 cm
- SIVs	1.32 cm
- DIVGs	3.53 cm
- PPVGs	1.44 cm
DIVGd indexé	3.0 cm/m ²
VTD (TM-Teich)	124 ml
Masse VG (cube)	133 g
SIV/PPVG (TM)	0.922
Indice masse VG (cube)	77.3 g/m ²
% SIV (TM)	79.1 %
DIVGs indexé	2.1 cm/m ²
VTS (TM-Teich)	51.9 ml
FR (TM-Teich)	30.8 %
FE (TM-Teich)	58.1 %
% PPVG (TM)	80.2 %

TIS0.5 MI 1.3

75mm/s
 46bpm



CardioPVE

X5-1
25Hz
9.1cm

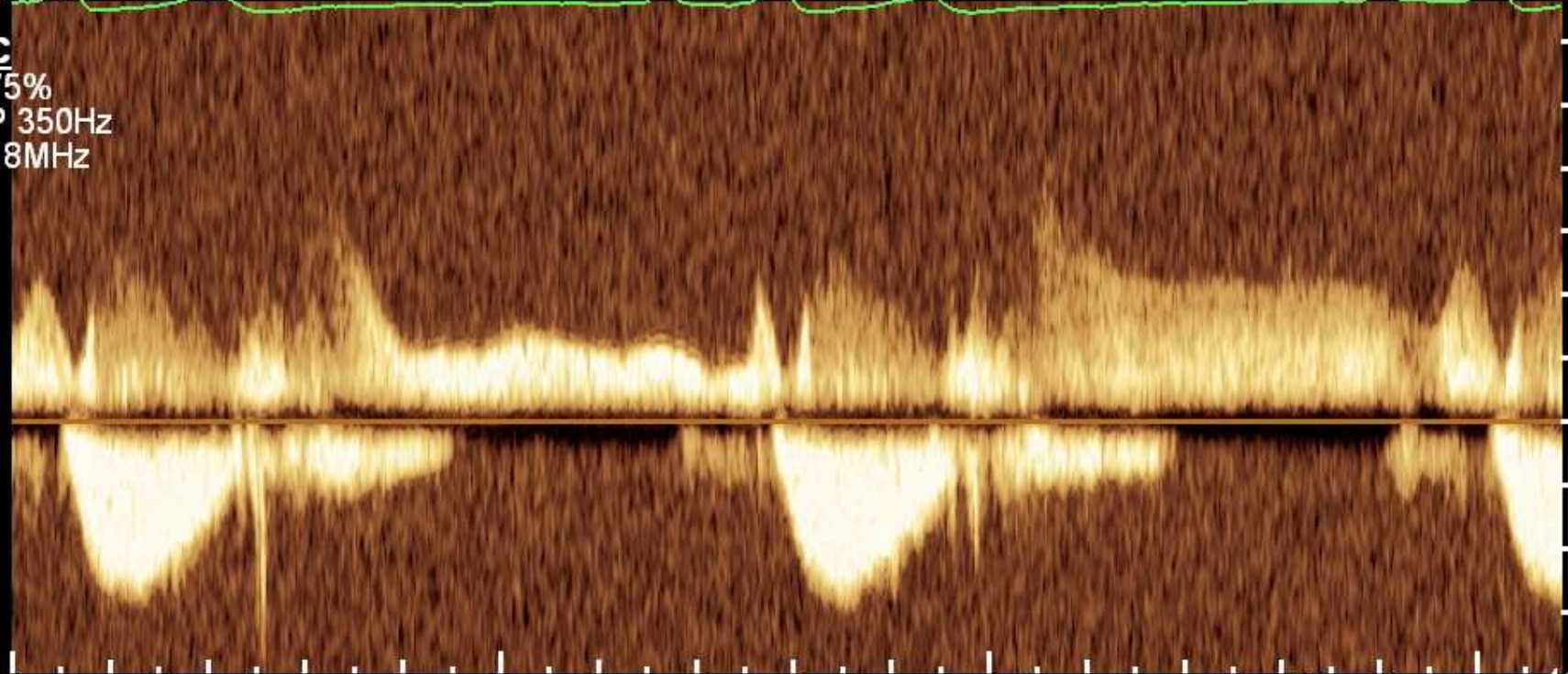
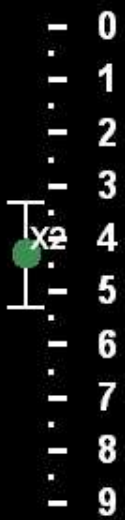
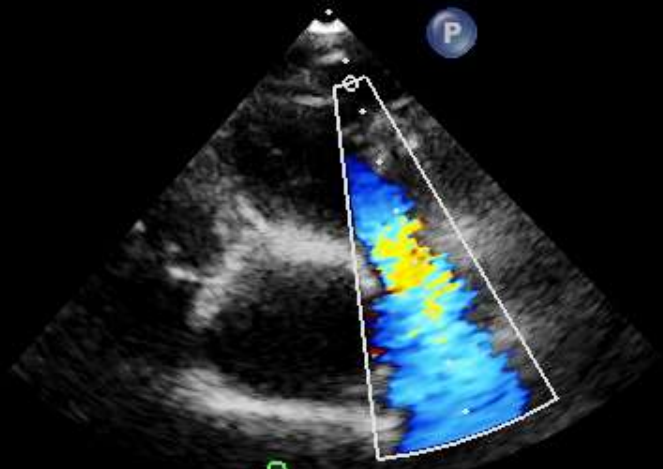


2D
50%
C 50
P Bas
HRés

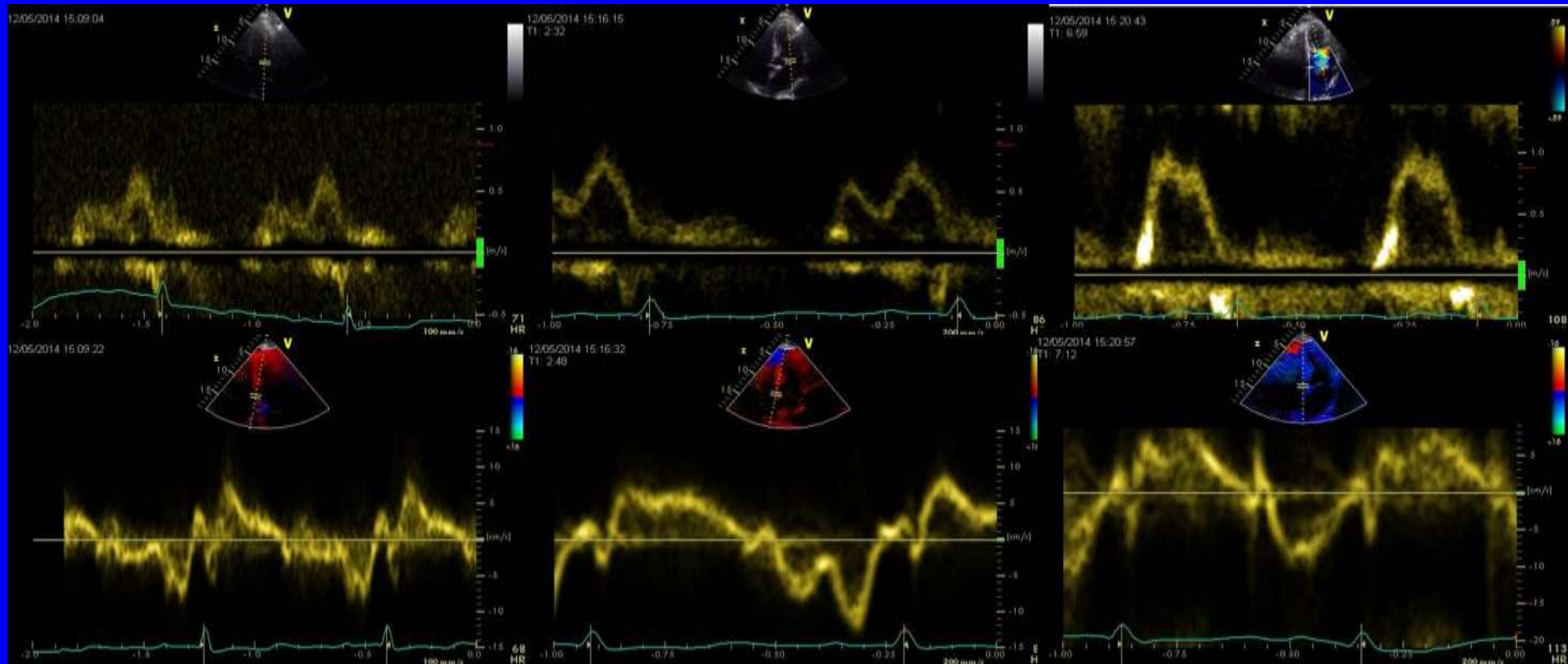
Coul
50%
4000Hz
FP 399Hz
2.5MHz

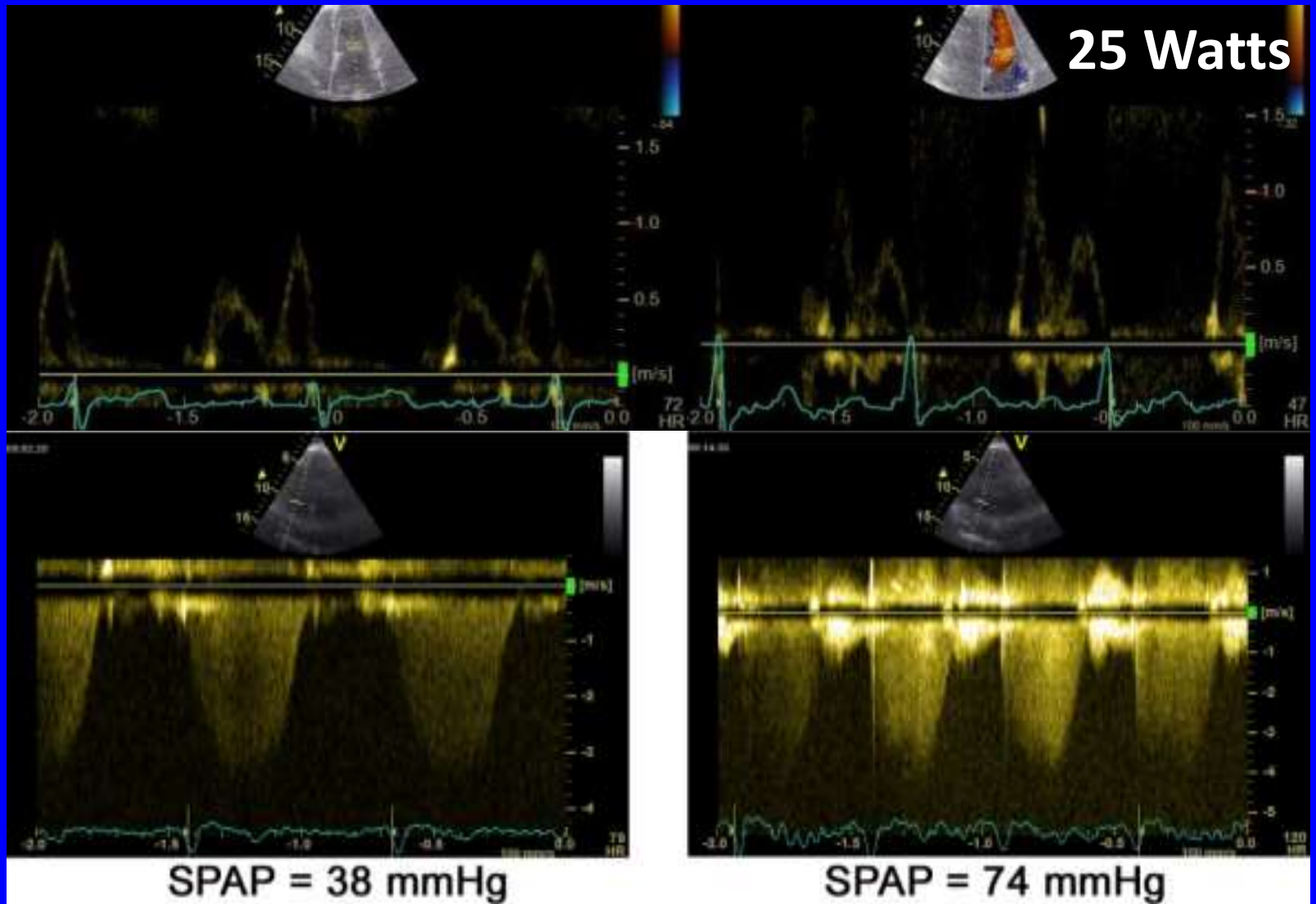
DC
75%
FP 350Hz
1.8MHz

TIS0.4 MI 0.1



Réserve diastolique: effort



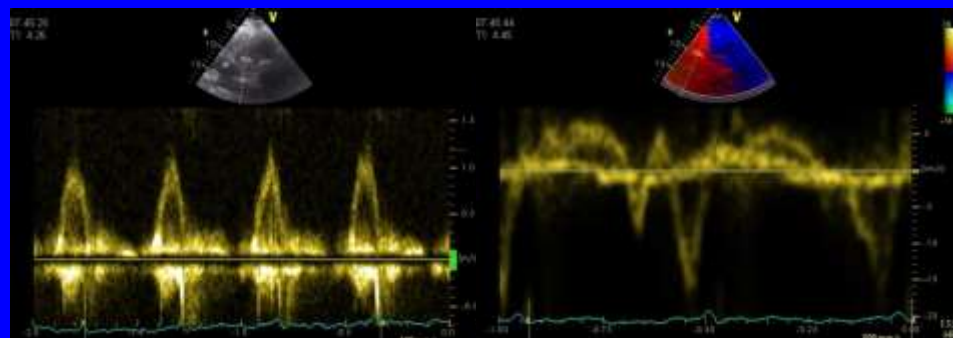
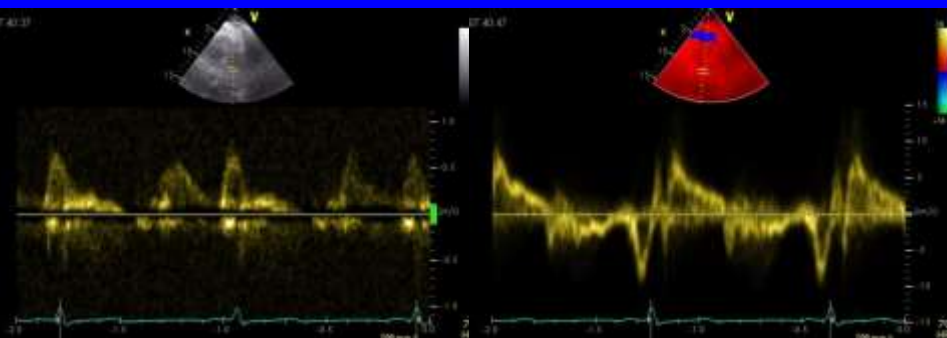
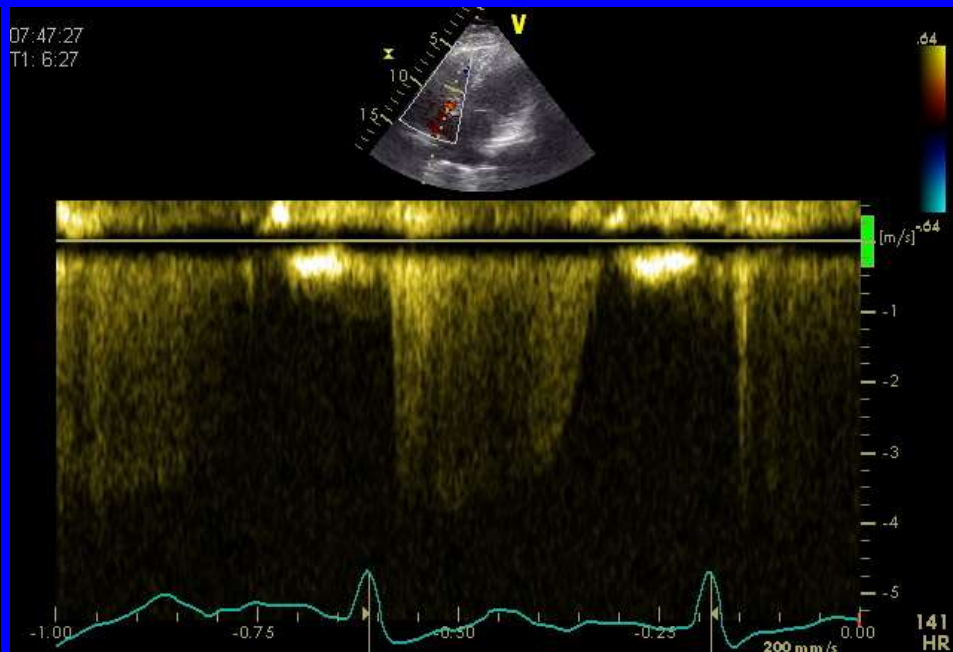
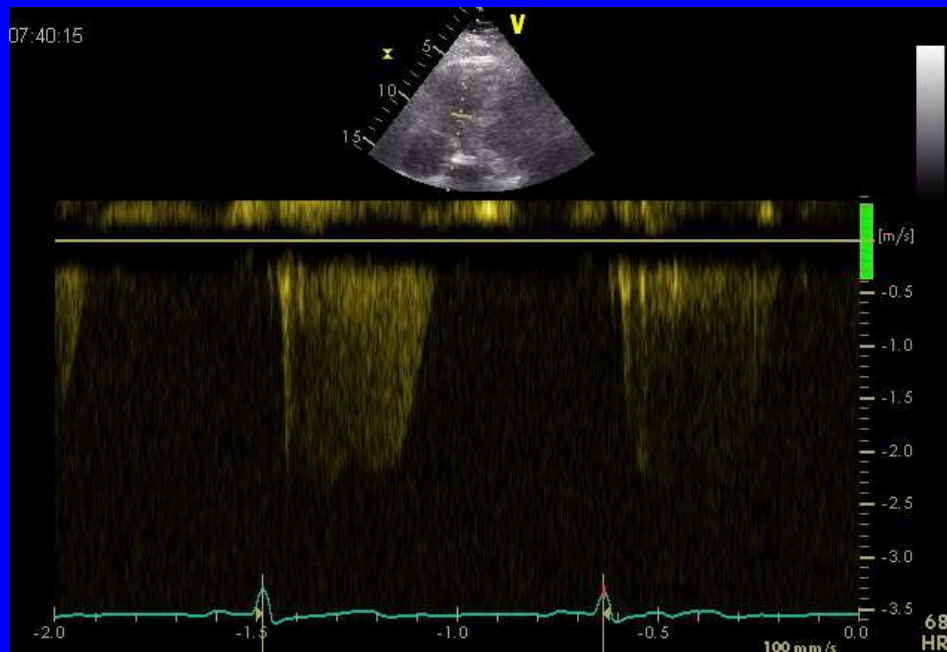


REPOS

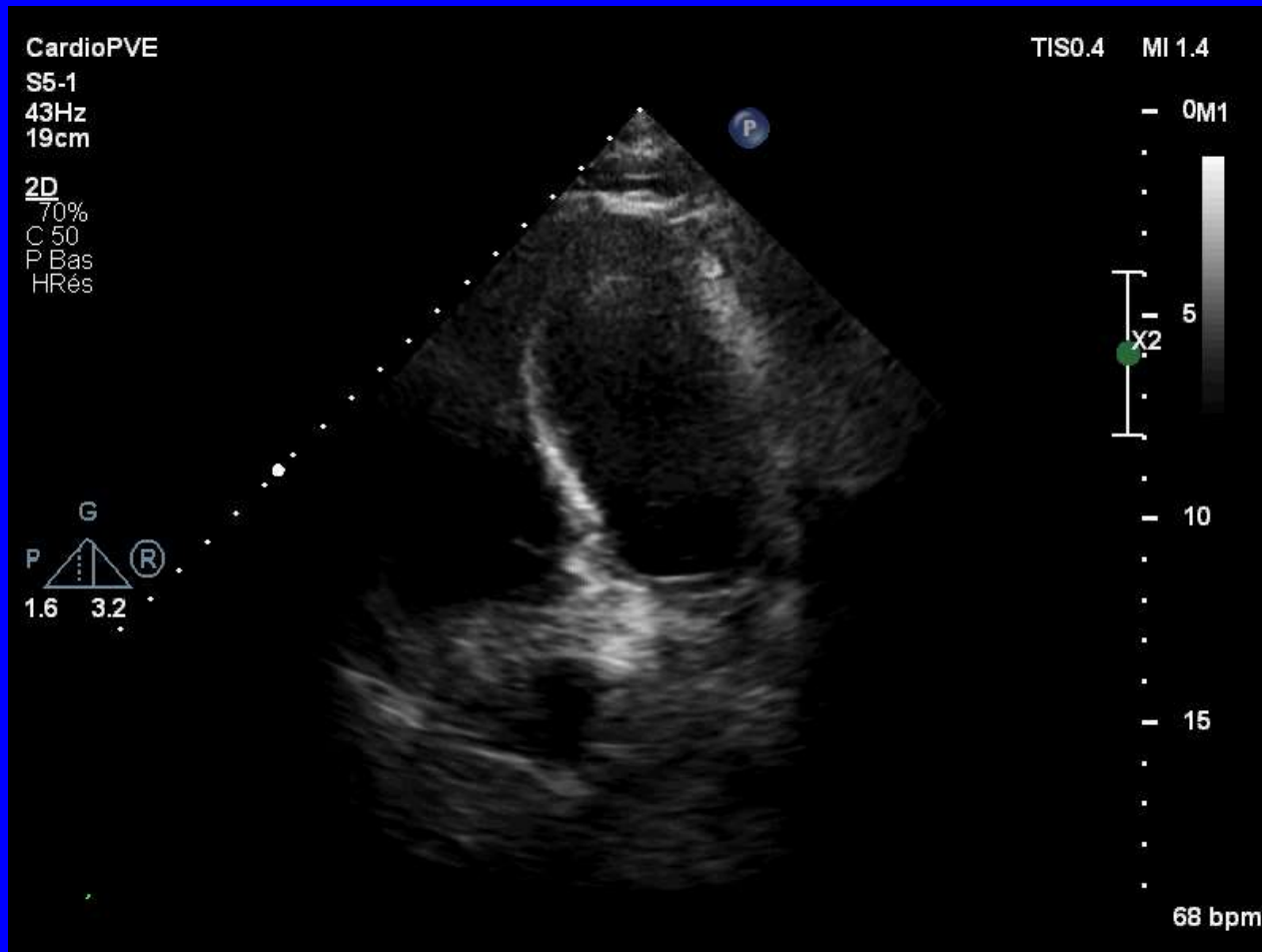
EXERCICE

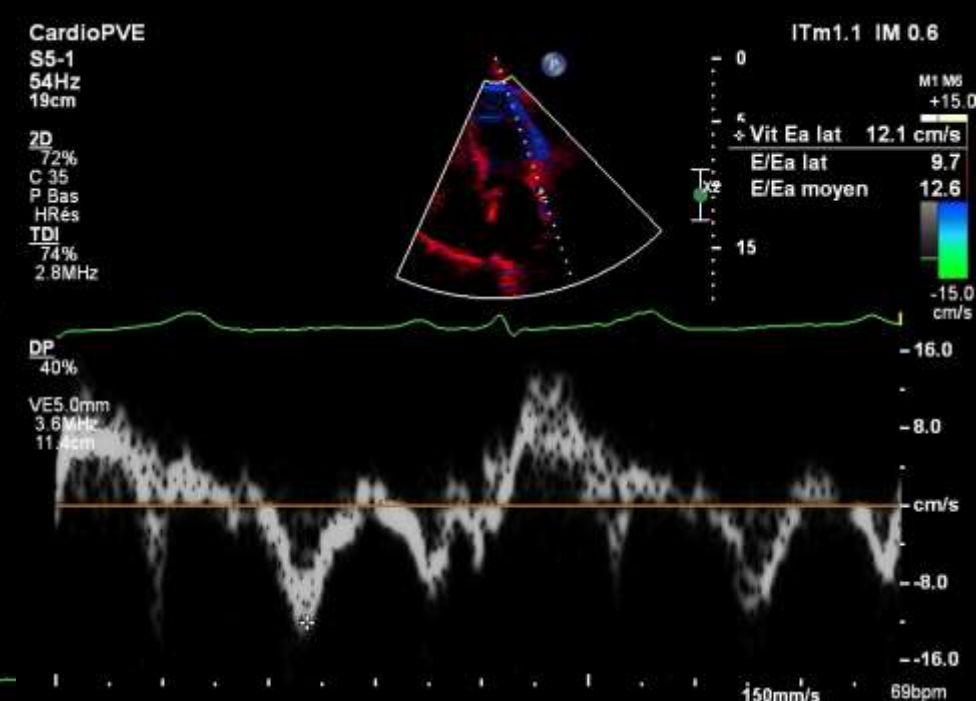
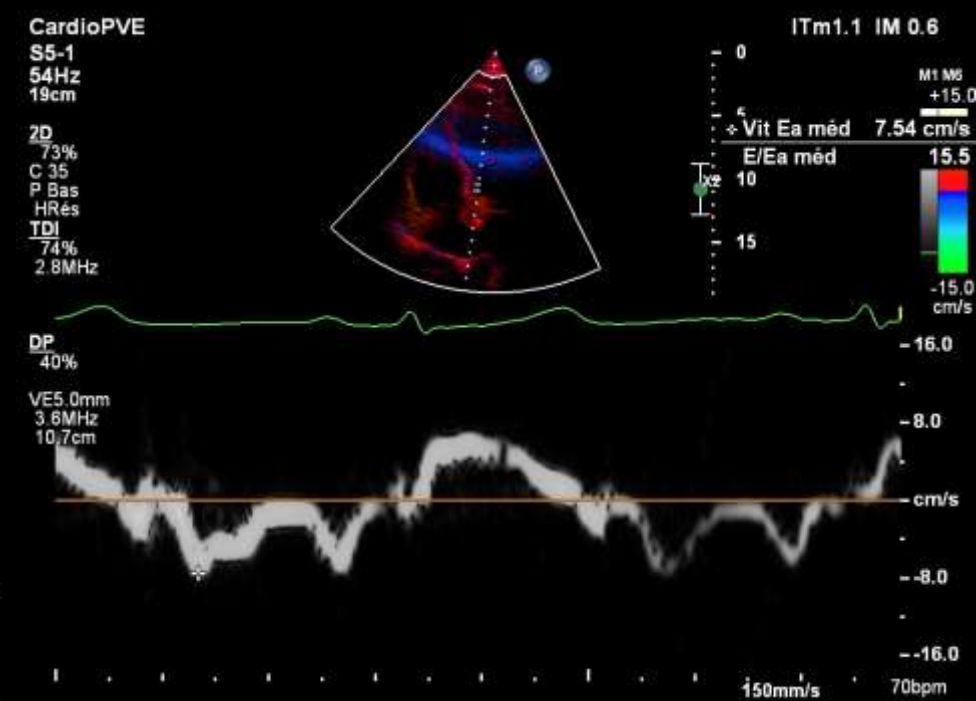
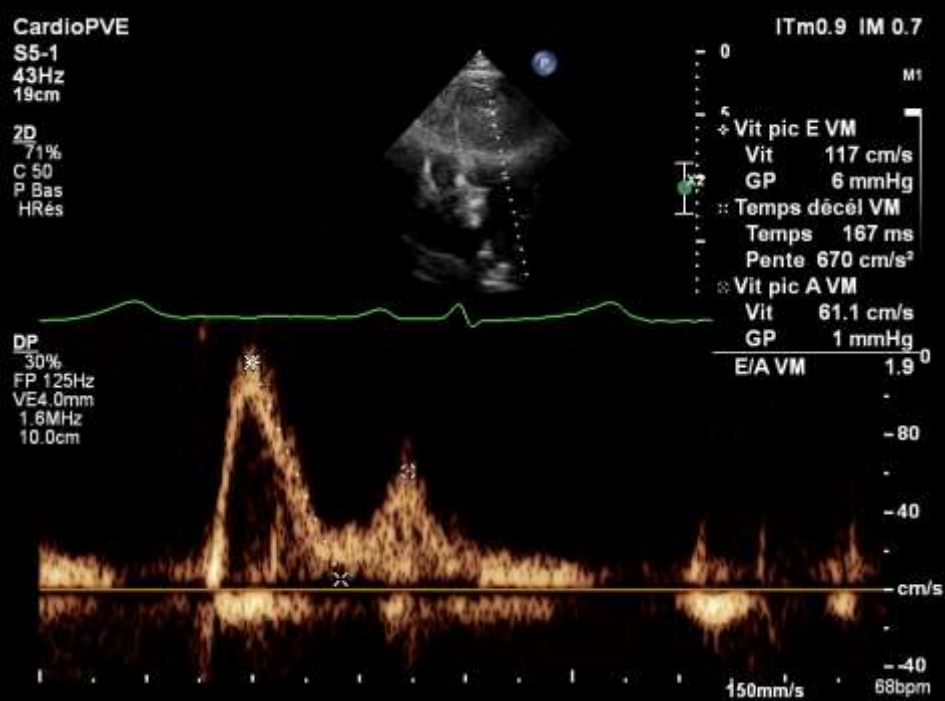
REST

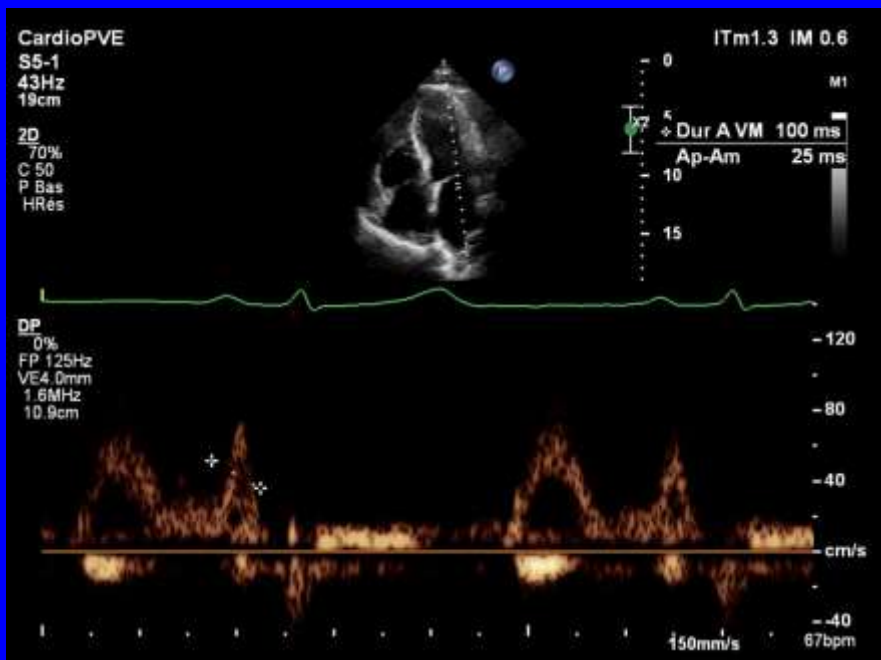
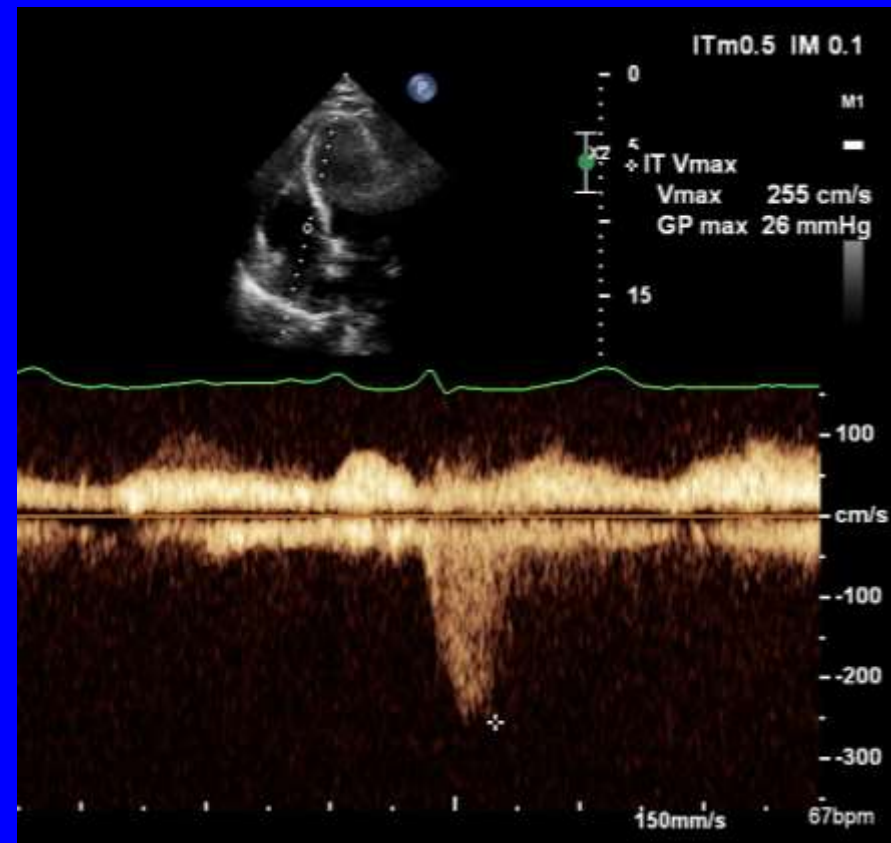
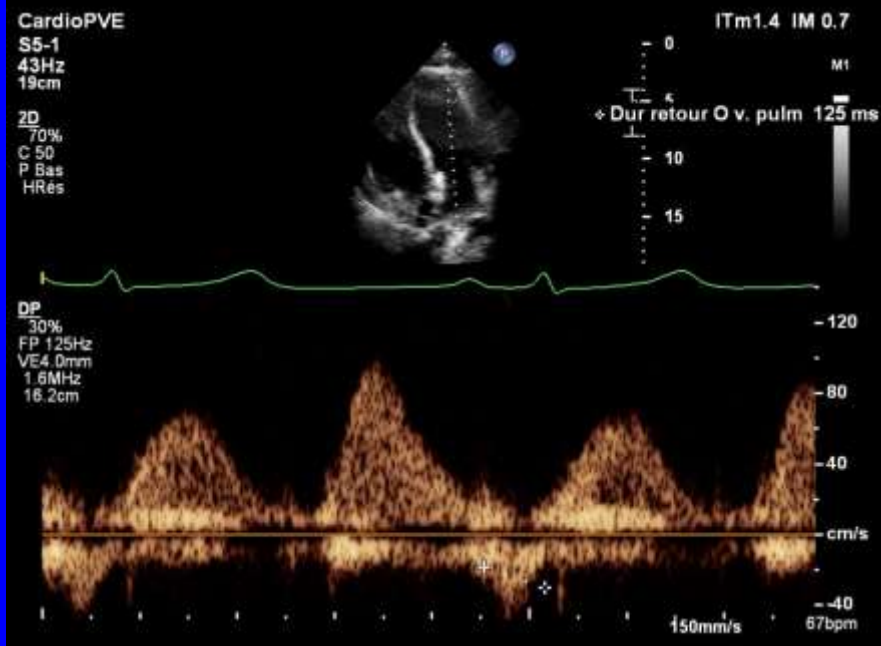
50 Watts



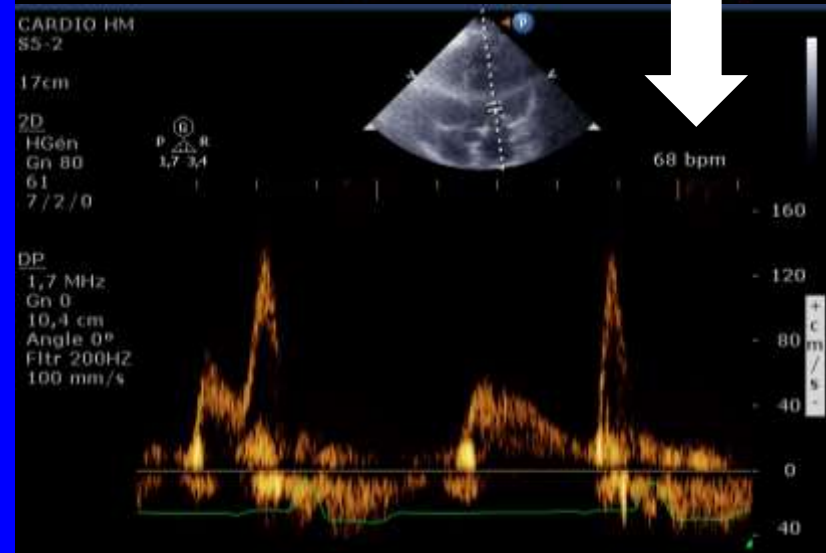
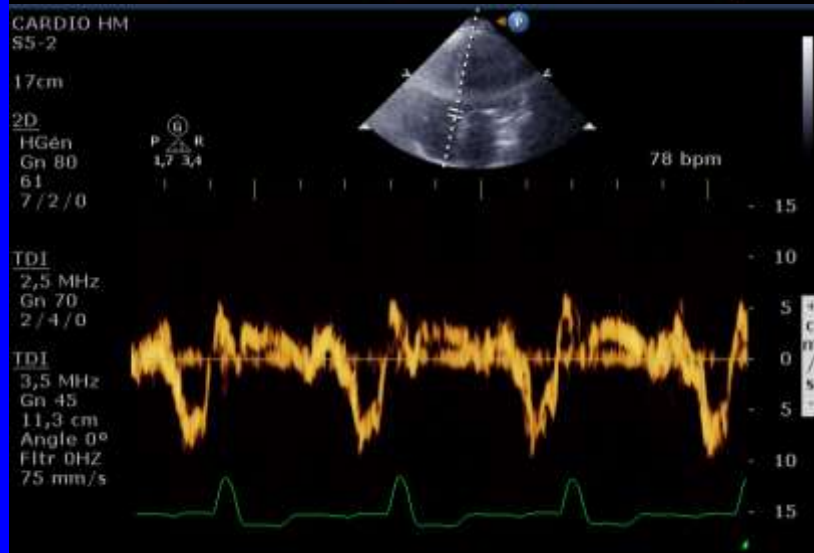
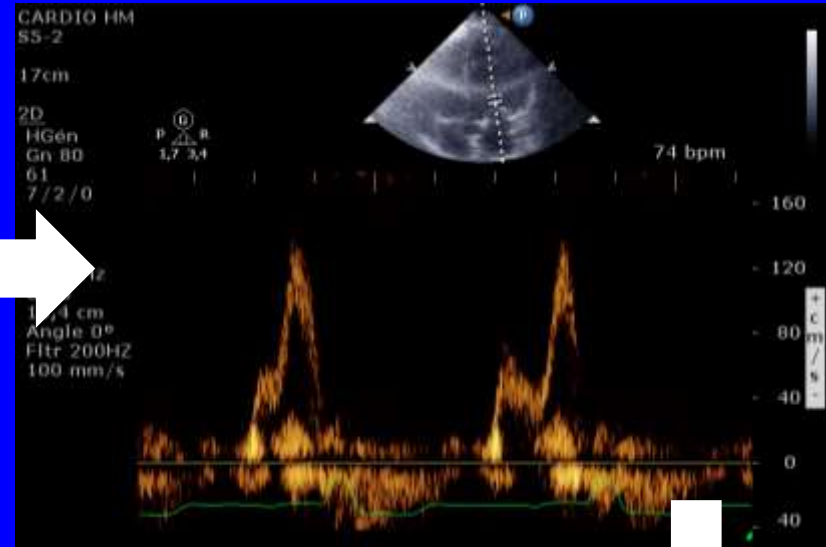
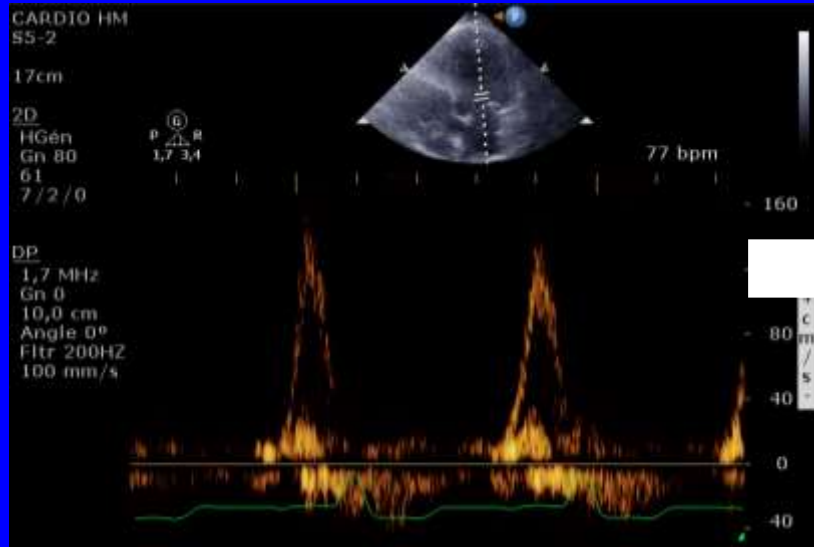
Femme 71 ans, HTA, dyspnée d'effort





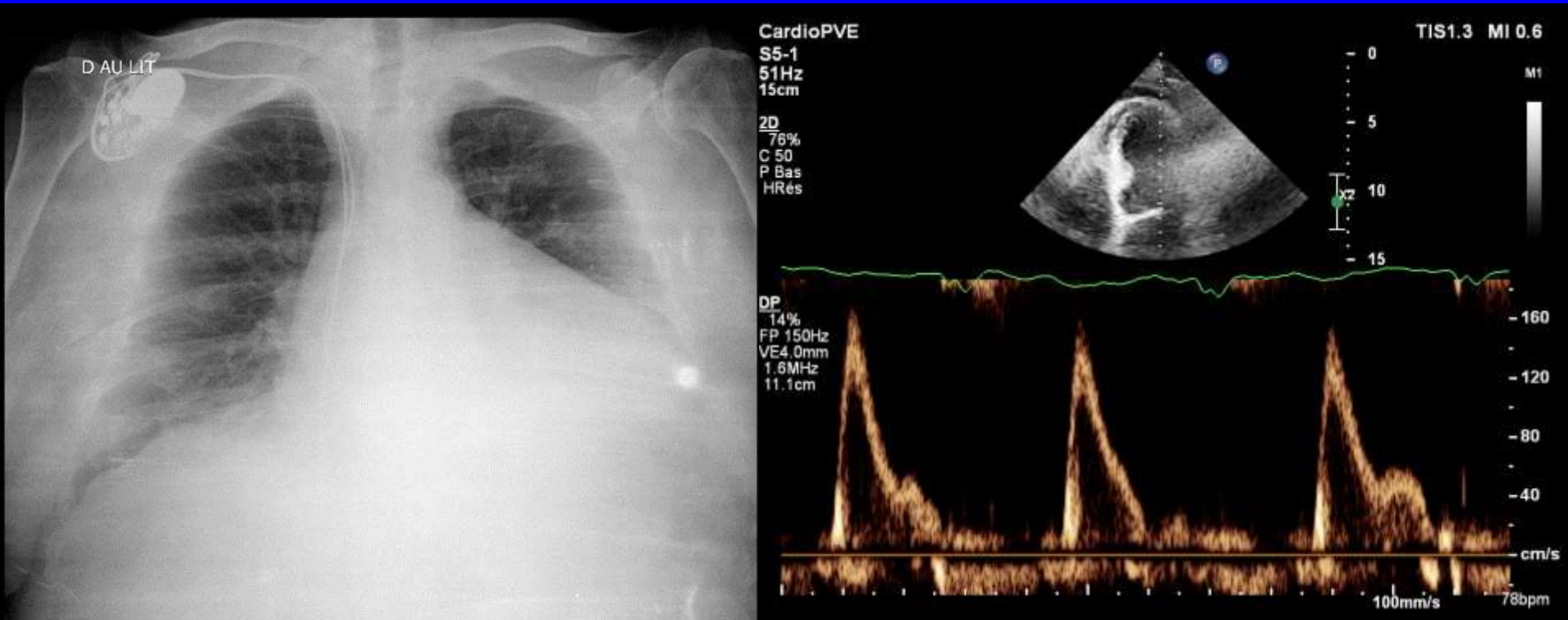


♀ 83 ans CMD FEVG 35% BBG



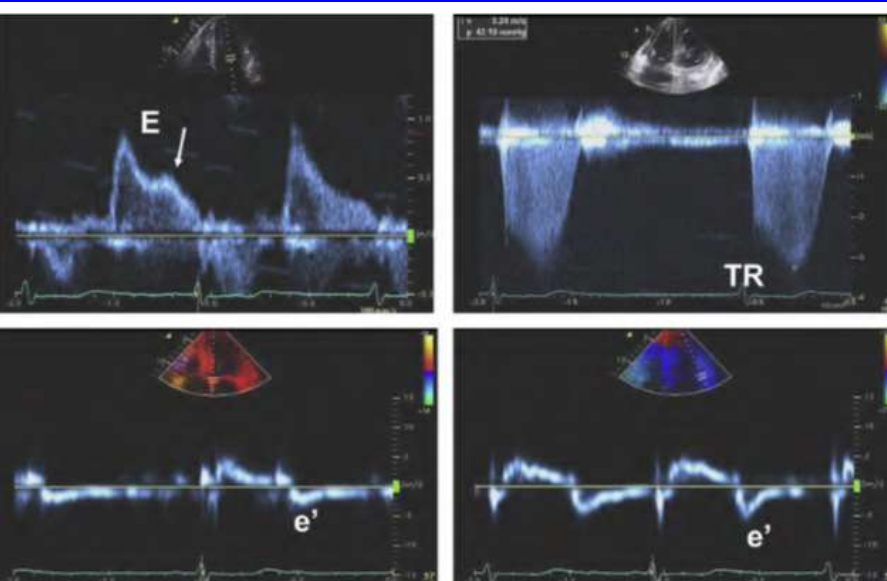
♂ 83 ans dyspnée TAVI FA BBG

- TDE 123 ms

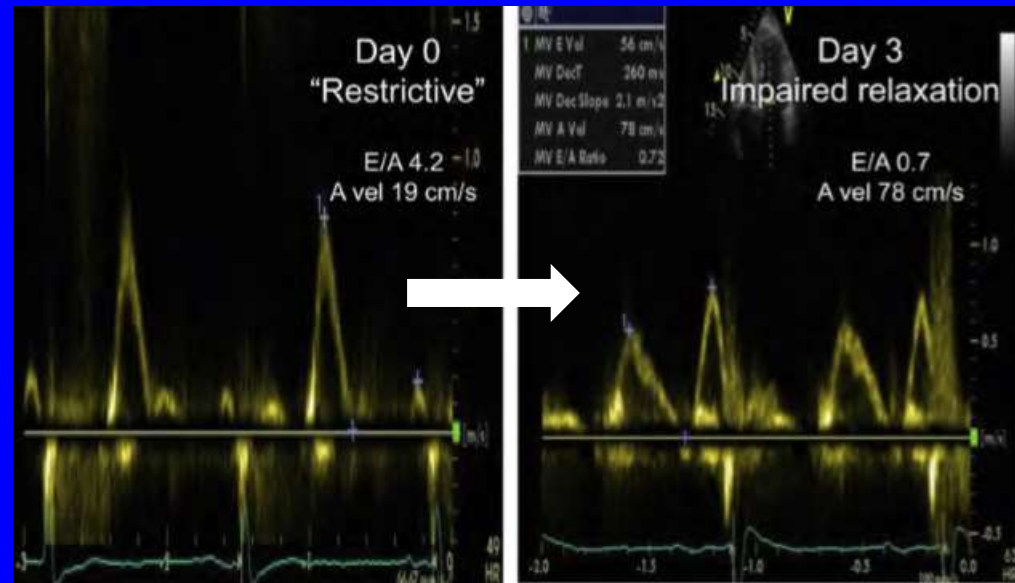


Evaluation des pressions de remplissage et FA

- Evaluation clinique+++
- TDE ≤ 160 ms en cas de FEVG altérée

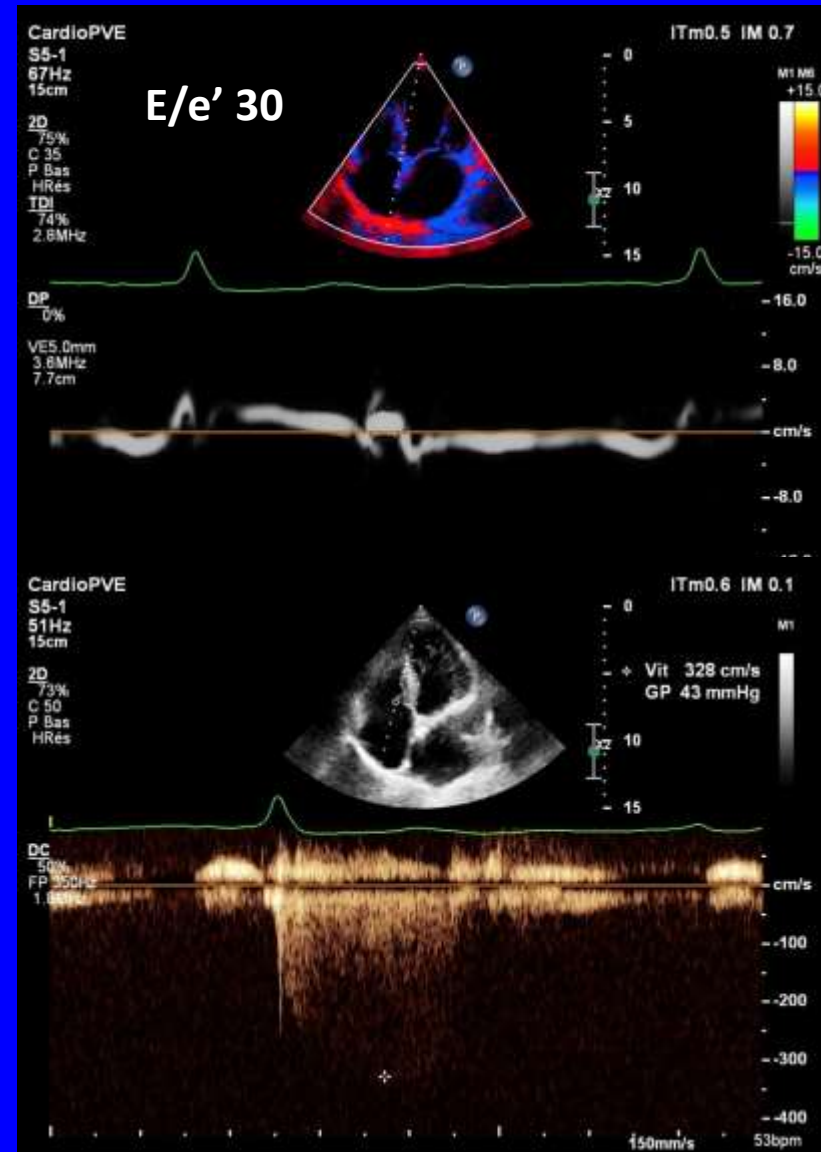
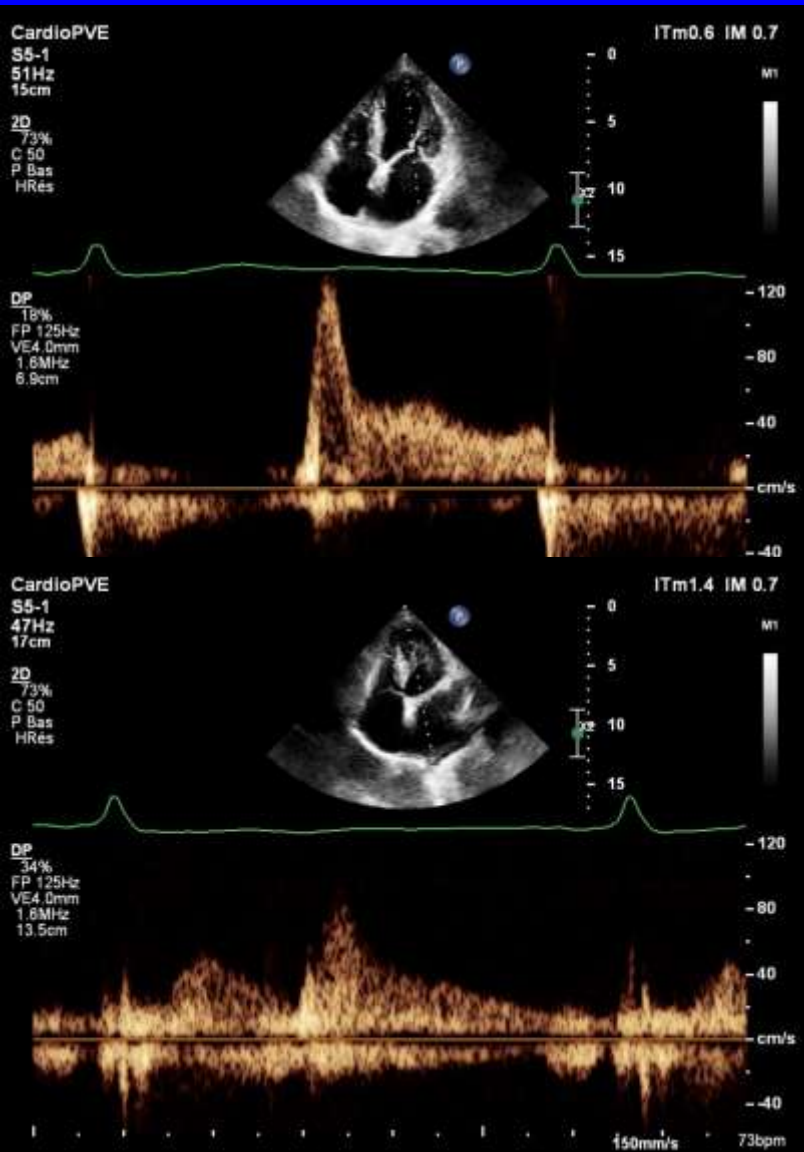


PASP 42+5 mm Hg, E/e' 30



Effect of cardioversion

♀ 84 ans FA paroxystique



CardioPVE
S5-1
47Hz
17cm

2D
73%
C 50
P Bas
HRés

G
P 1.6 3.2
R

TIS0.6 MI 1.4

0M1



G
P 1.6 3.2
R

57 bpm

CardioPVE
S5-1
24Hz
13cm

2D
76%
C 50
P Bas
HRés

Coul
43%
4000Hz
FP 399Hz
2.5MHz

G
P 1.6 3.2
R

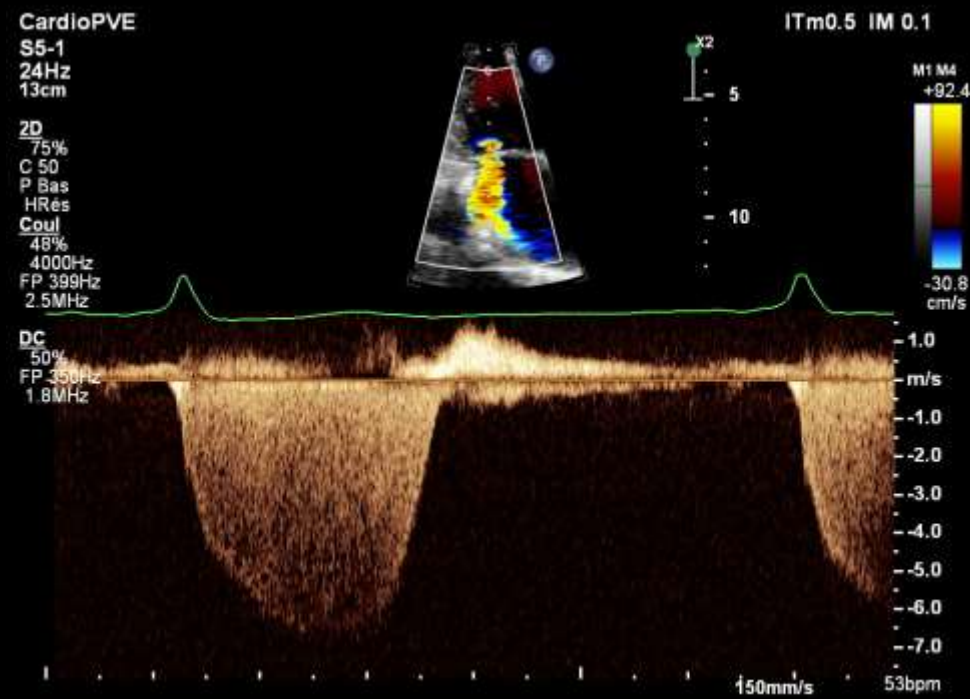
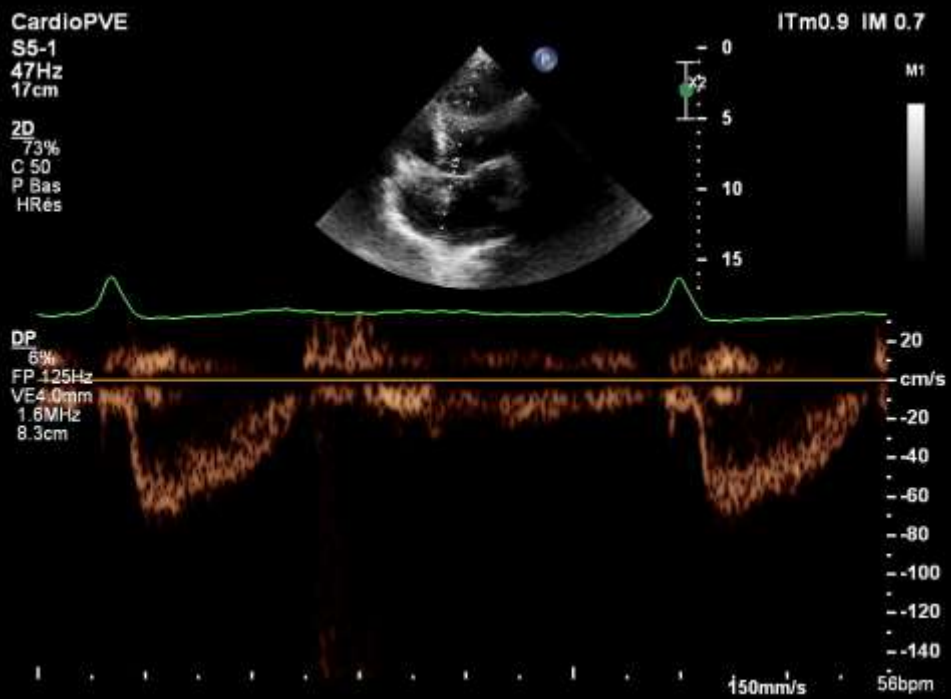
TIS1.0 MI 0.9

M1 M4
+92.4



G
P 1.6 3.2
R

51 bpm



Evaluation des pressions de remplissage et troubles de conduction

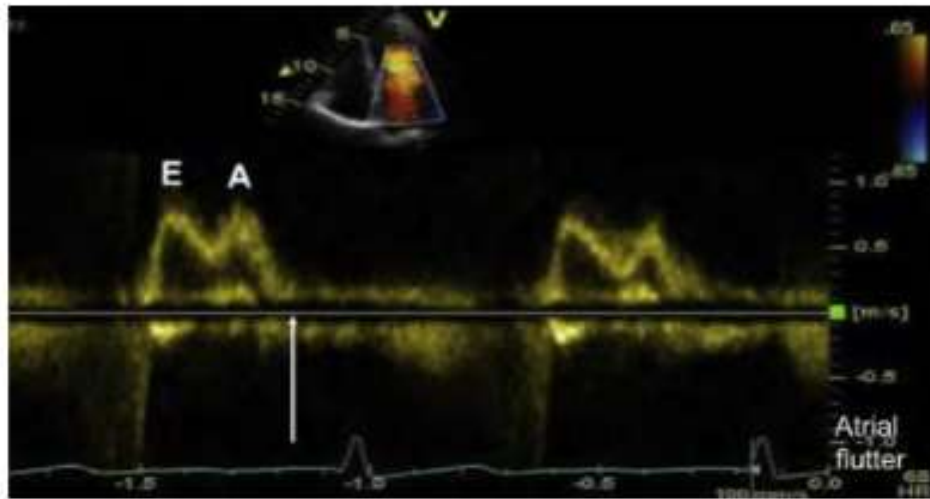
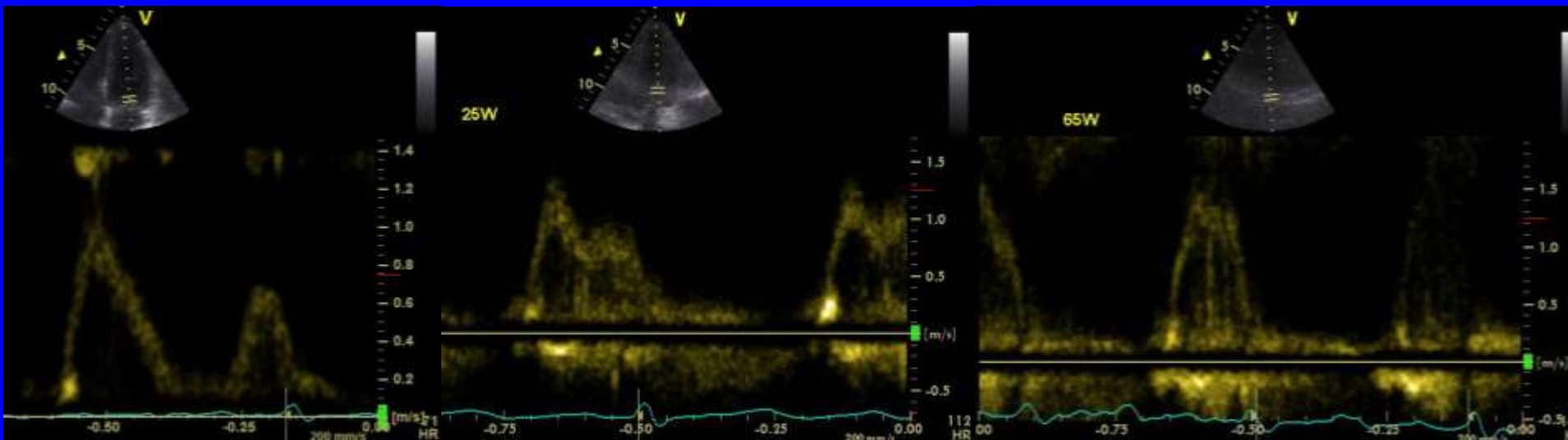
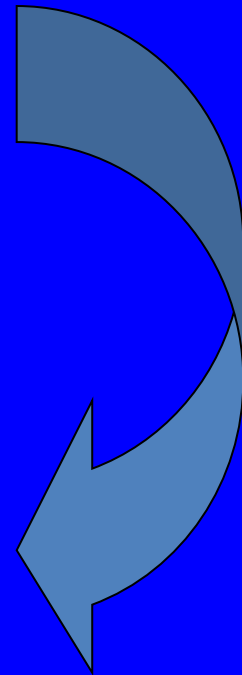


Figure 27 Mitral inflow in a patient with a first-degree AV block. Notice merging of mitral E and A velocities and the shortened diastolic filling period. Mitral A velocity ends before end-diastole (arrow) and leads to an abbreviated diastolic filling period.

Evaluation des pressions de remplissage et fréquence cardiaque





MSC

Evaluation des pressions de remplissage et fréquence cardiaque

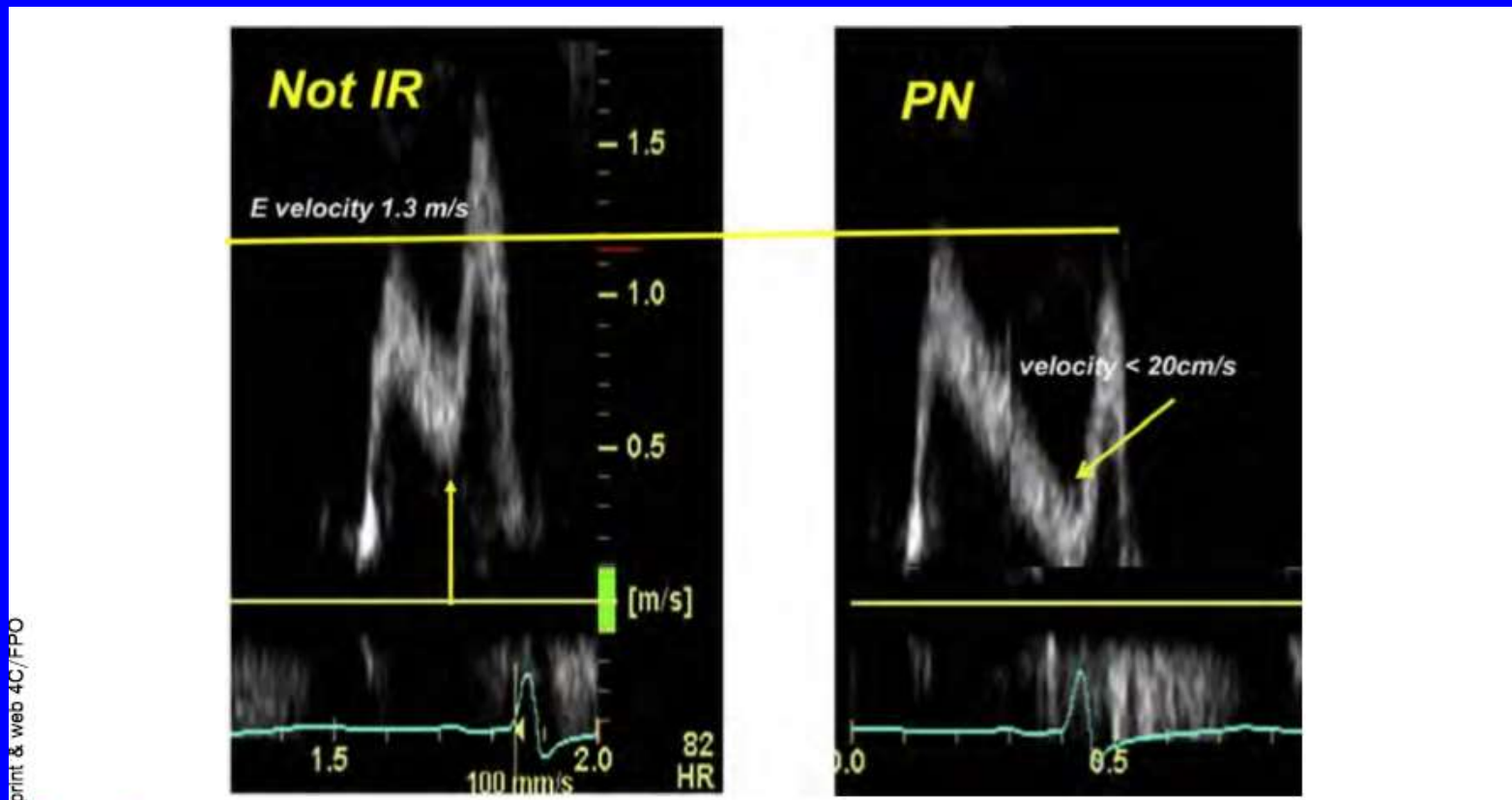
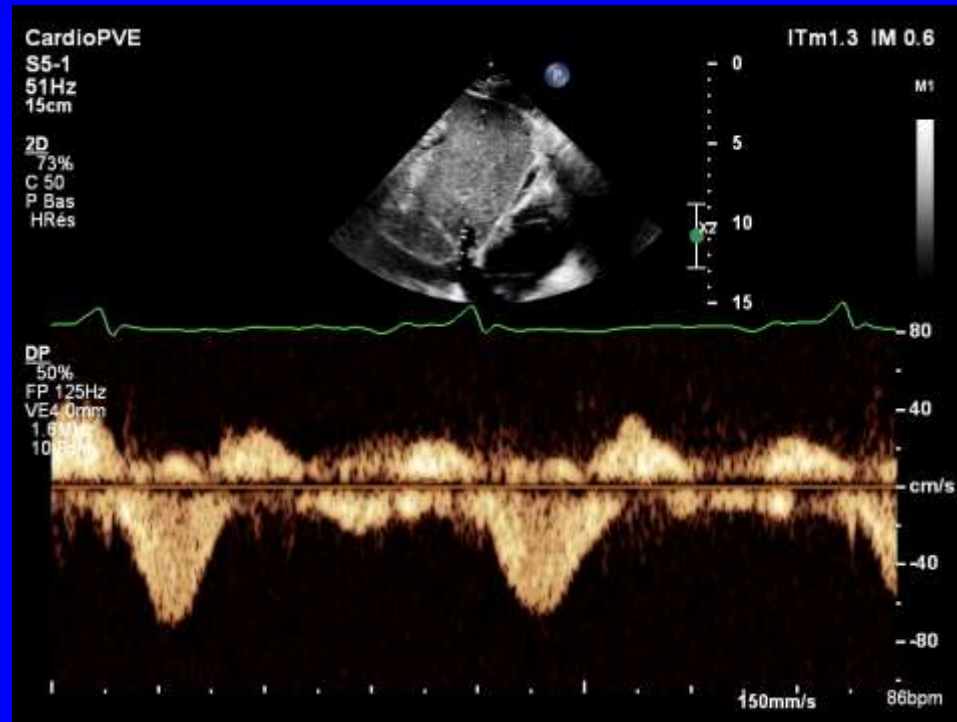
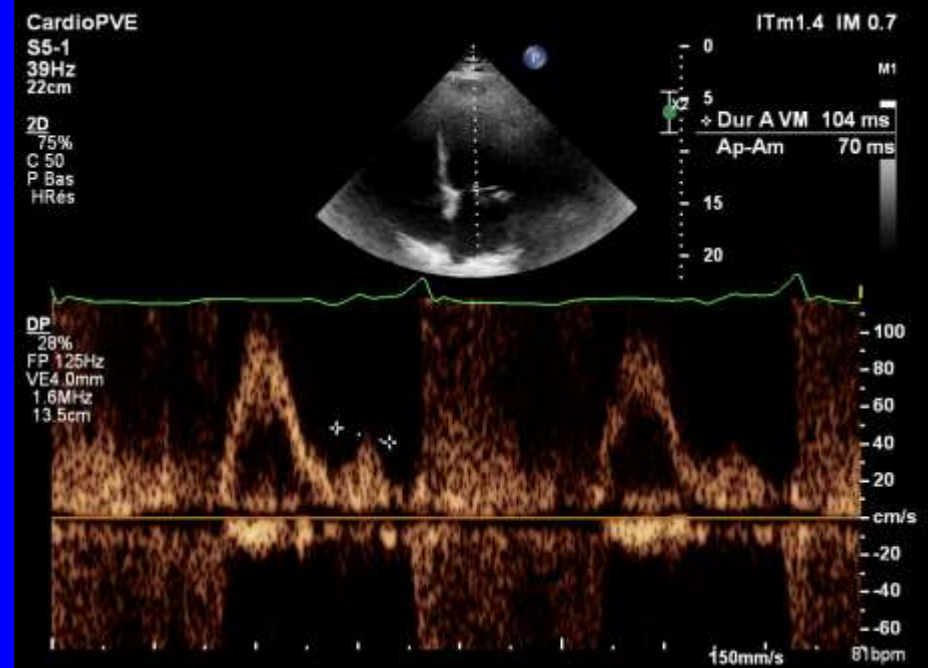
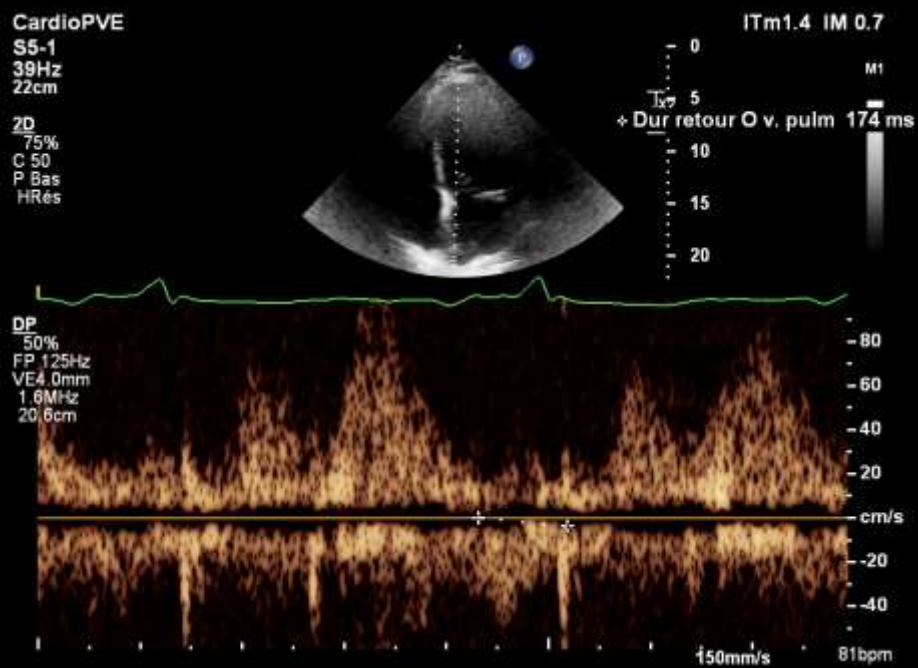
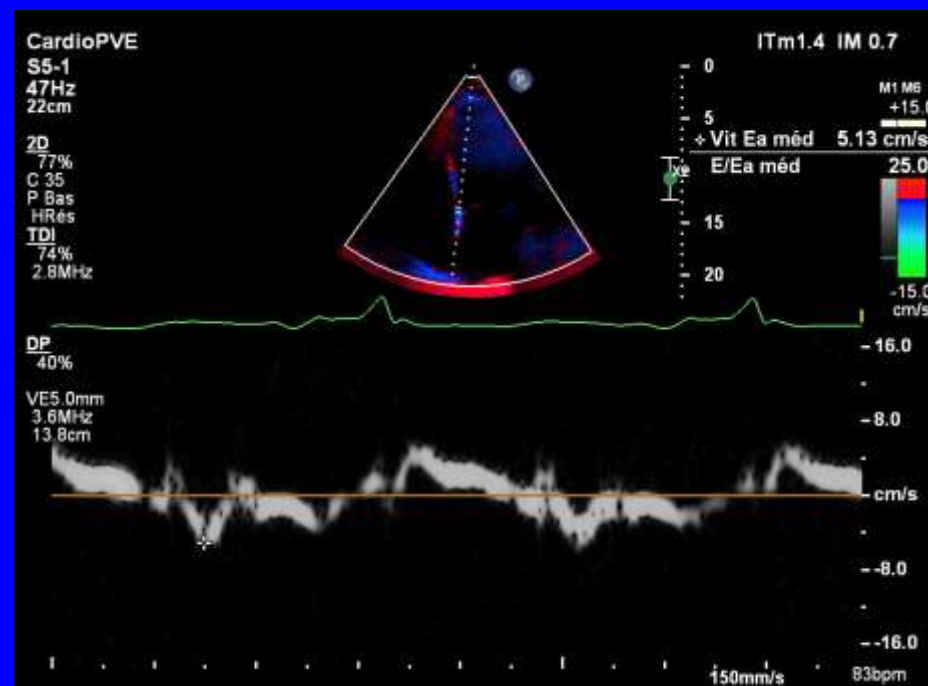
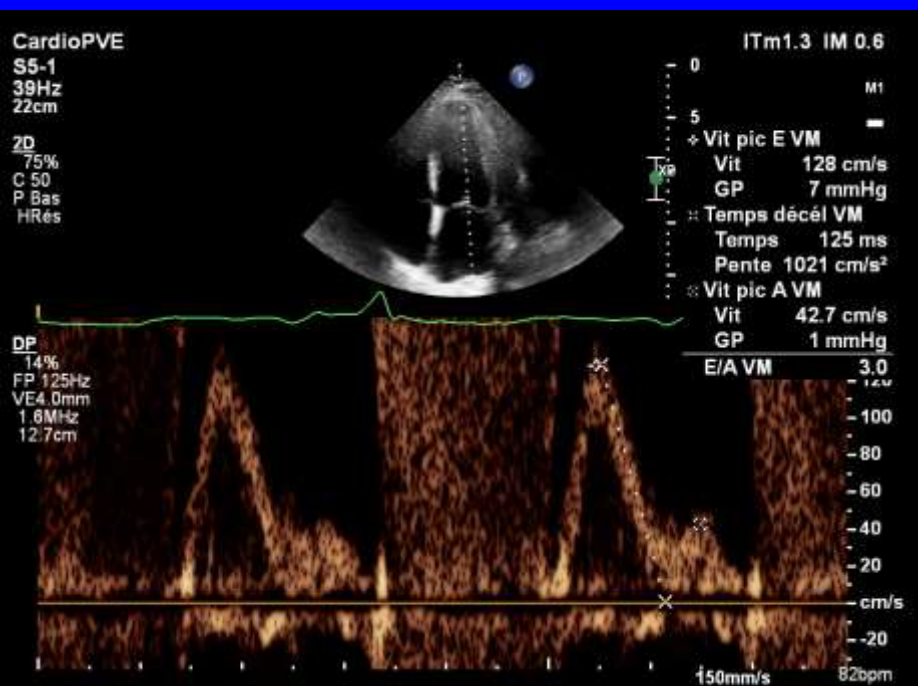
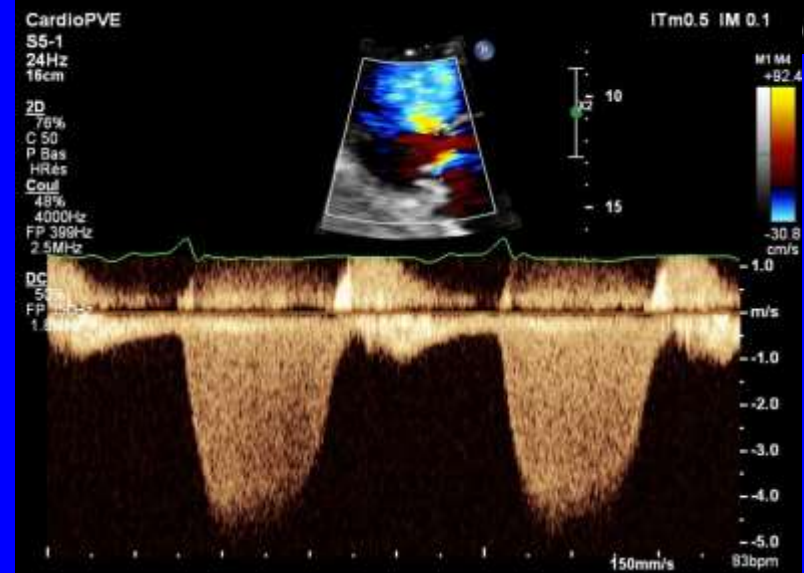
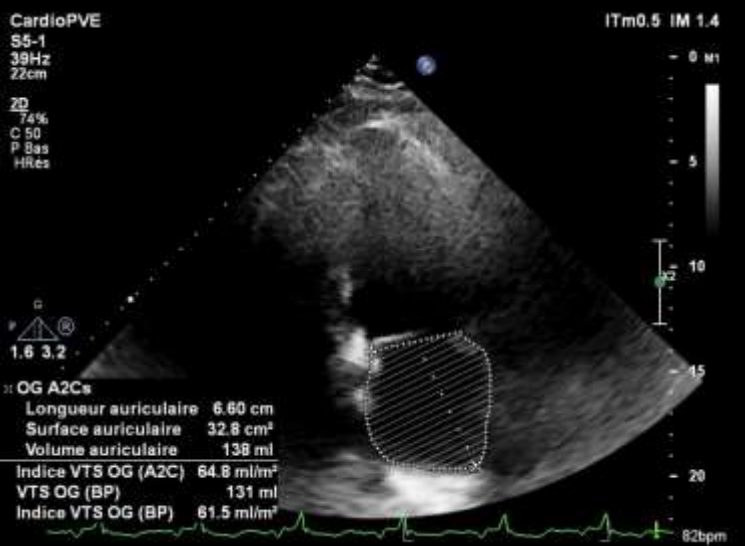
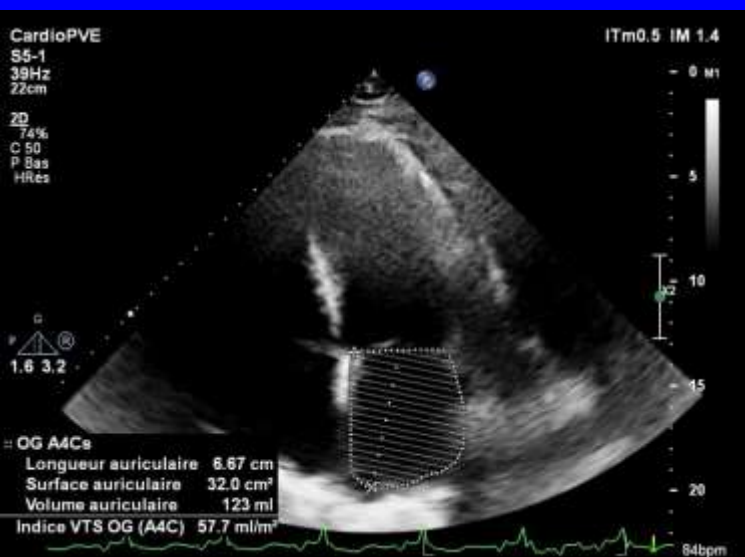


Figure 28 Effect of heart rate on merging of E and A velocities and need to consider mitral velocity at onset of A. *Left panel* recording was obtained at heart rate of 82/min with mitral velocity at onset of A exceeding 20 cm/sec (arrow), which if not considered (subtracted from peak A velocity) results in the erroneous conclusion of impaired relaxation pattern. *Right panel* was obtained from the same patient at heart rate of 65 beats/min in whom mitral velocity at onset of A is < 20 cm/sec. The *right panel* shows that the patient indeed has pseudonormal LV filling.

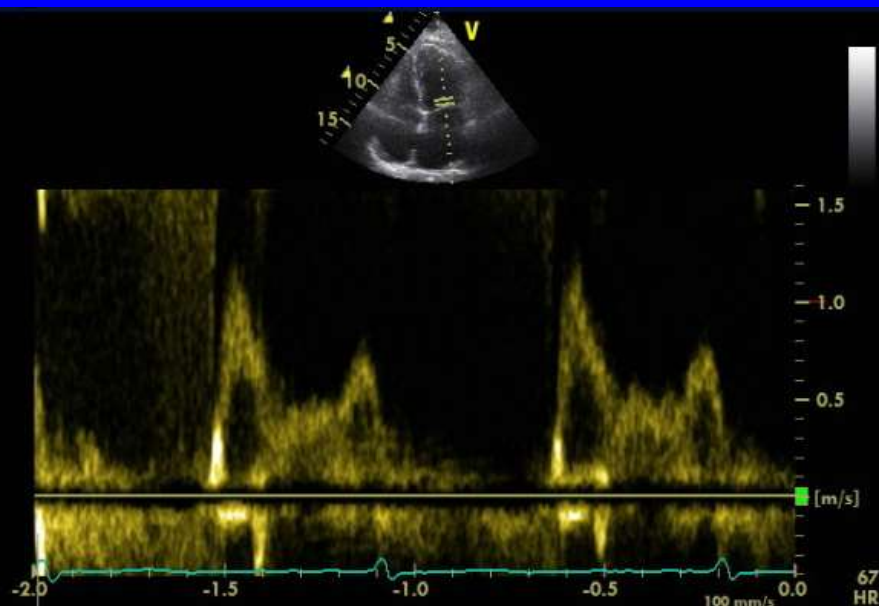
♂ 56 ans PACX3 Insuffisance cardiaque



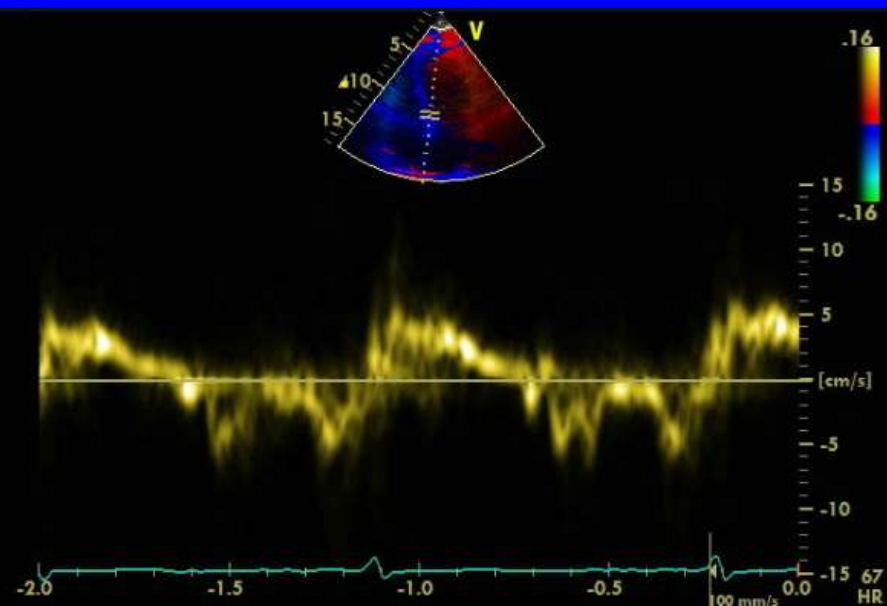




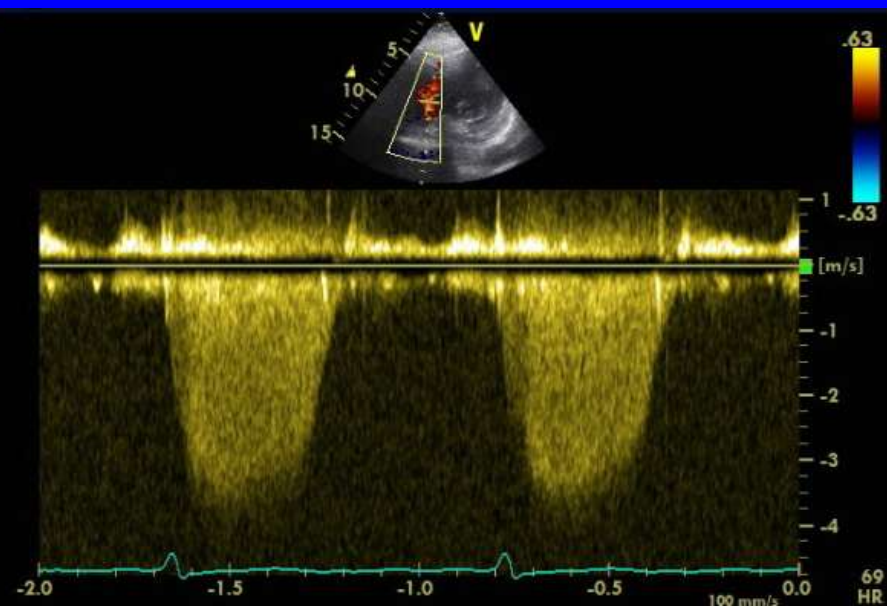
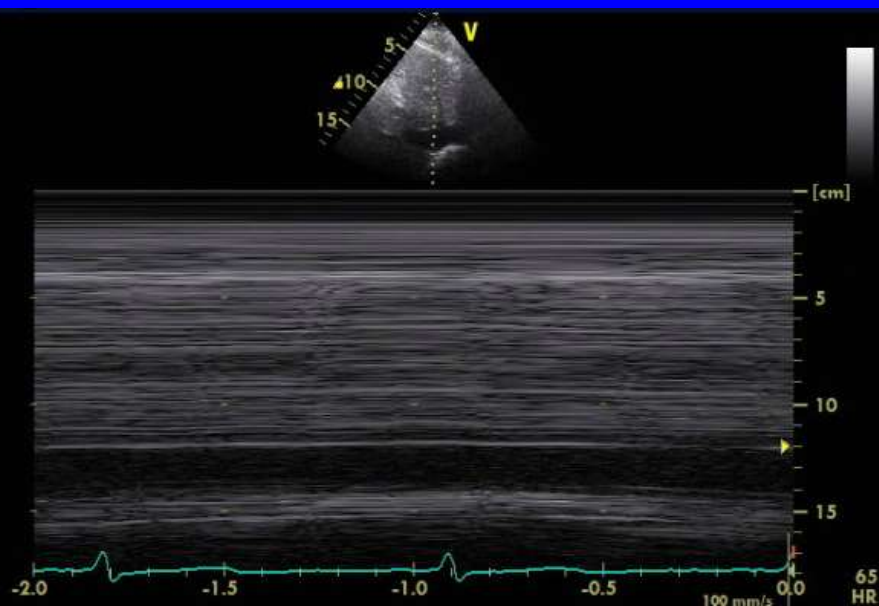
HFpEF



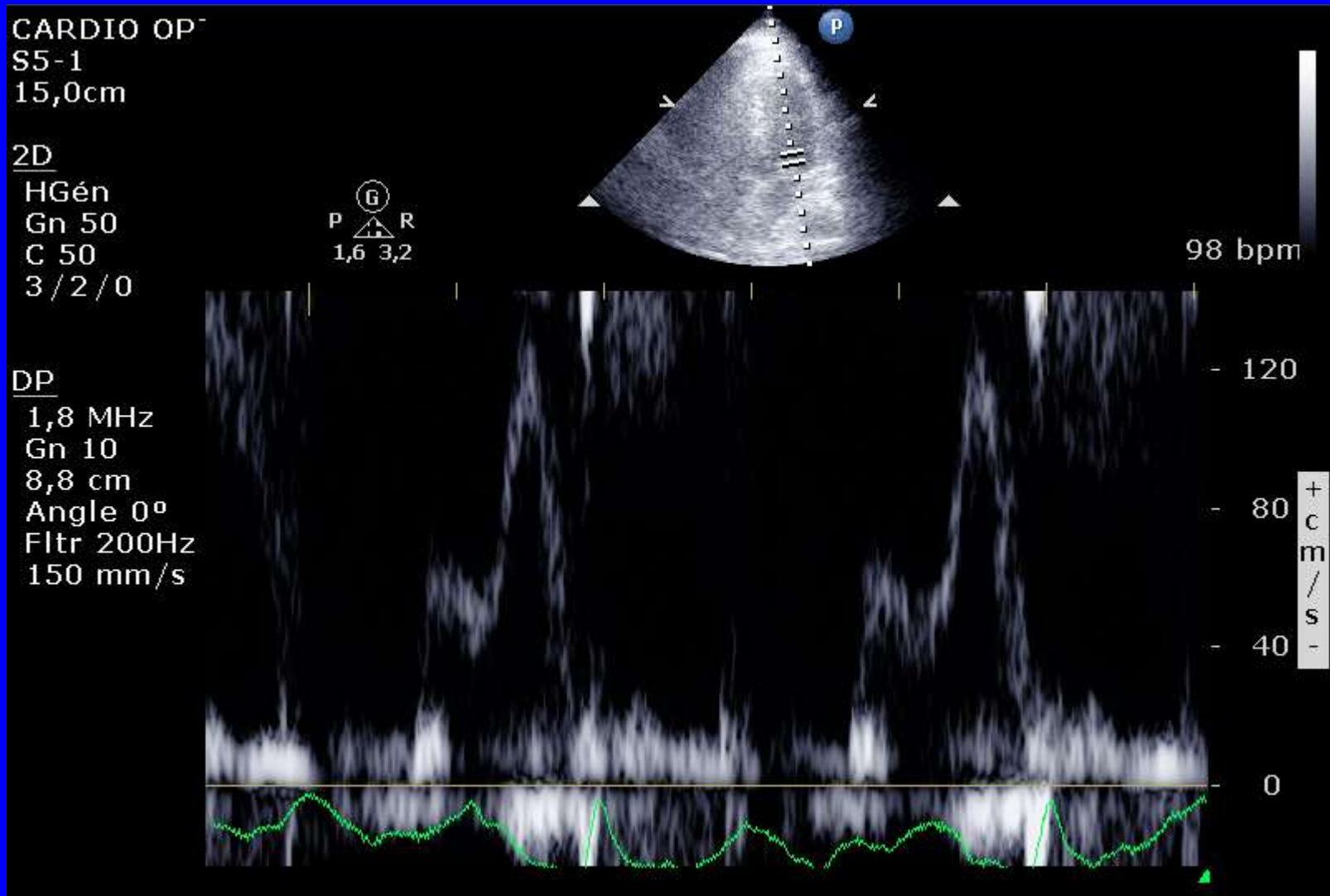
$E/e' = 20$



PASP = 50 + 20 mm Hg



QUIZZ: ♀ 75 ans HTA Malaise



PHILIPS

IM 0,1
ITm 0,5

CARDIO OP⁺
S5-1
15,0cm

2D

HGén
Gn 50
C 50
3/2/0

Ⓞ
P R
1,6 3,2

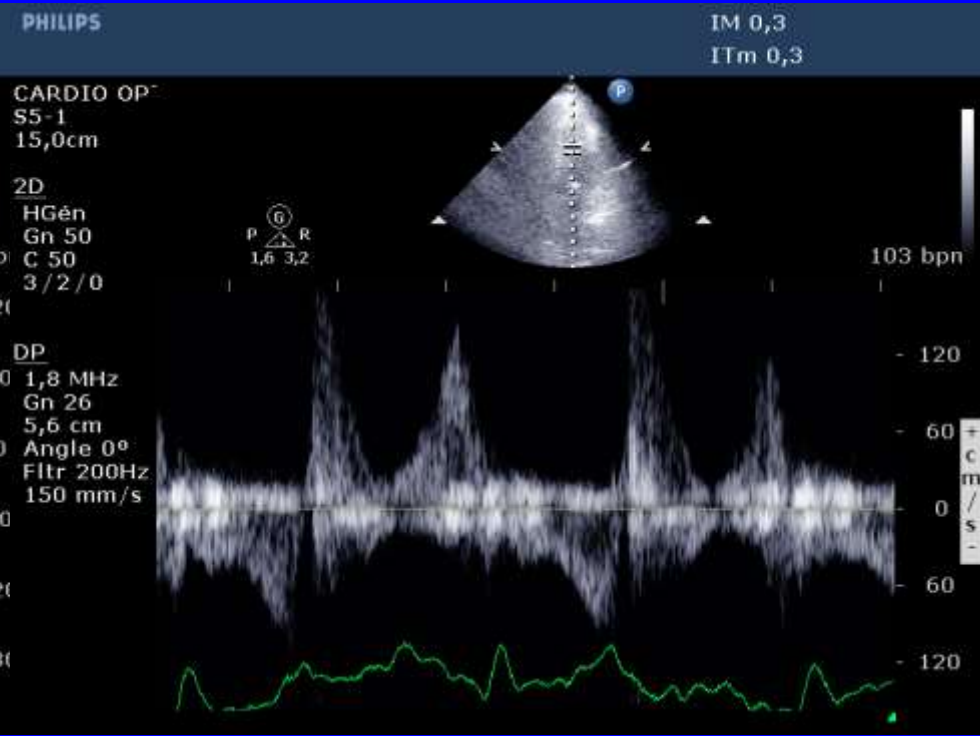
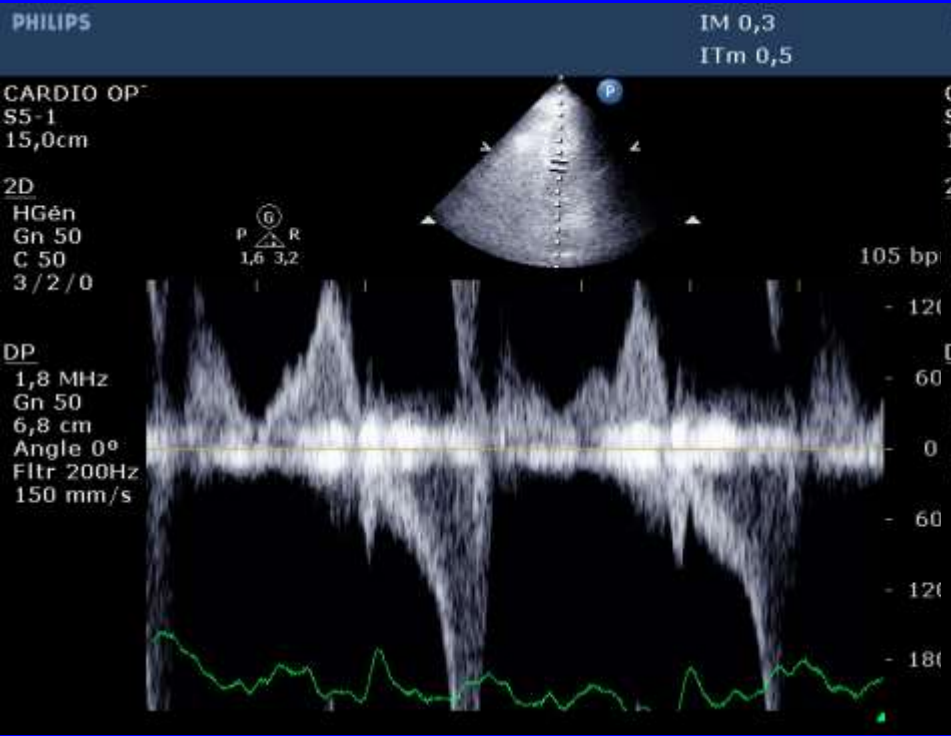


103 bpm

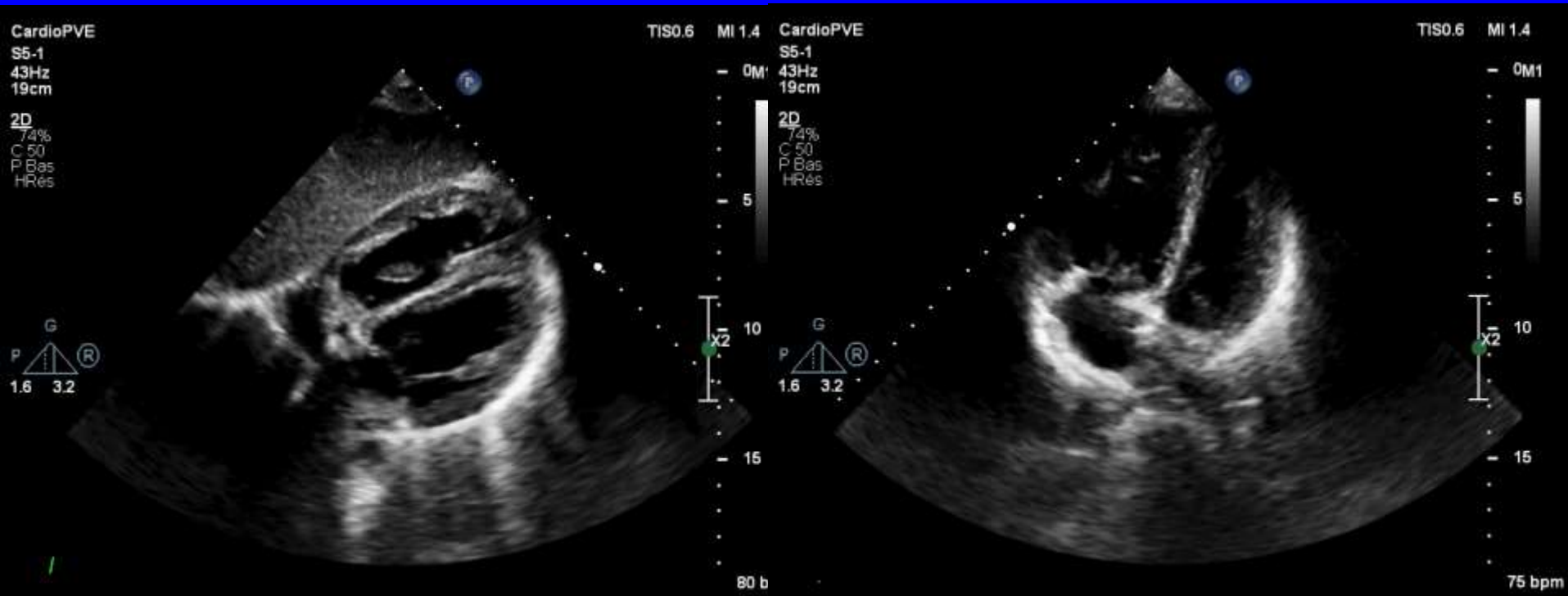
DC

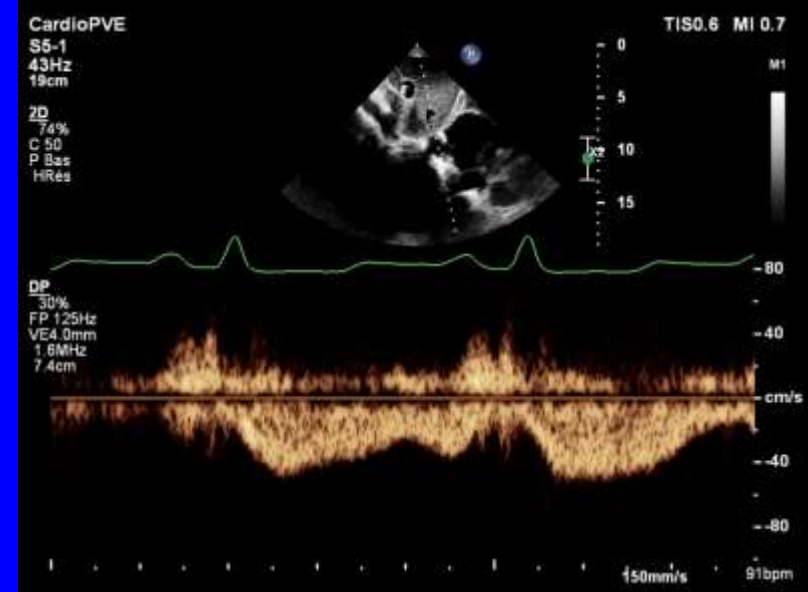
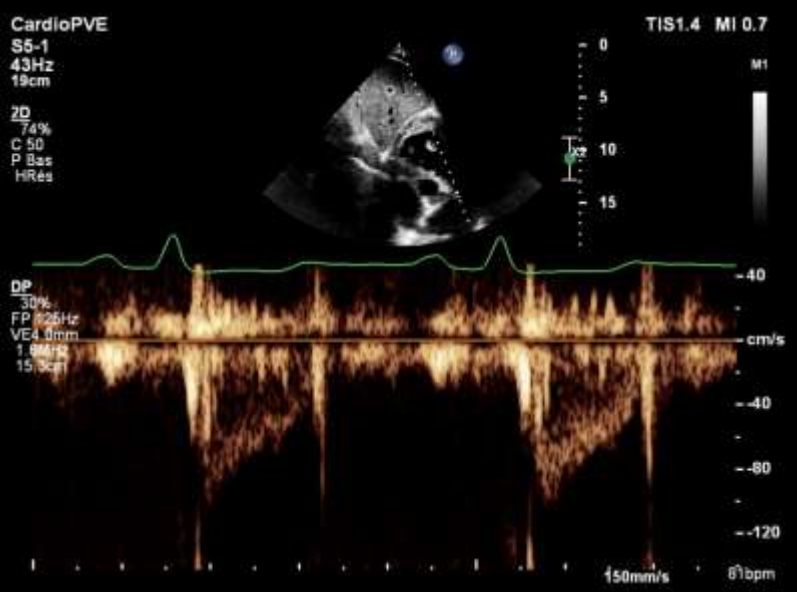
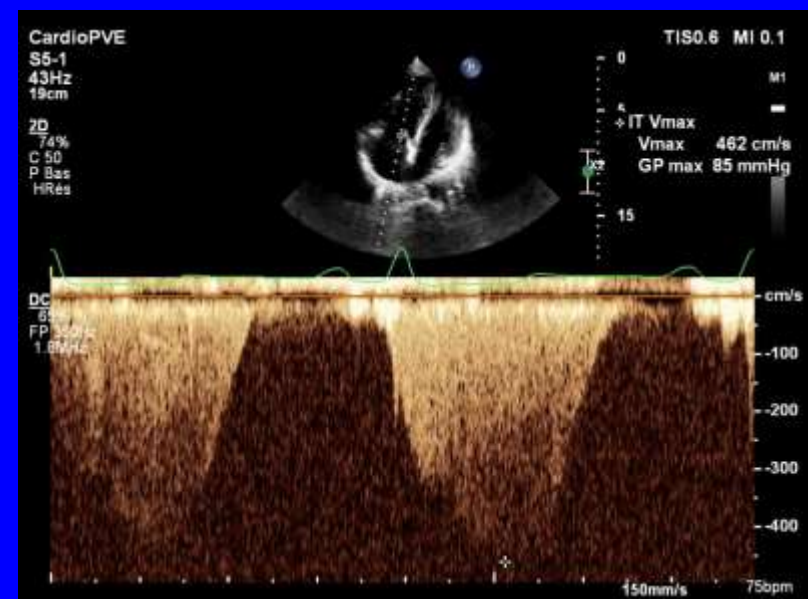
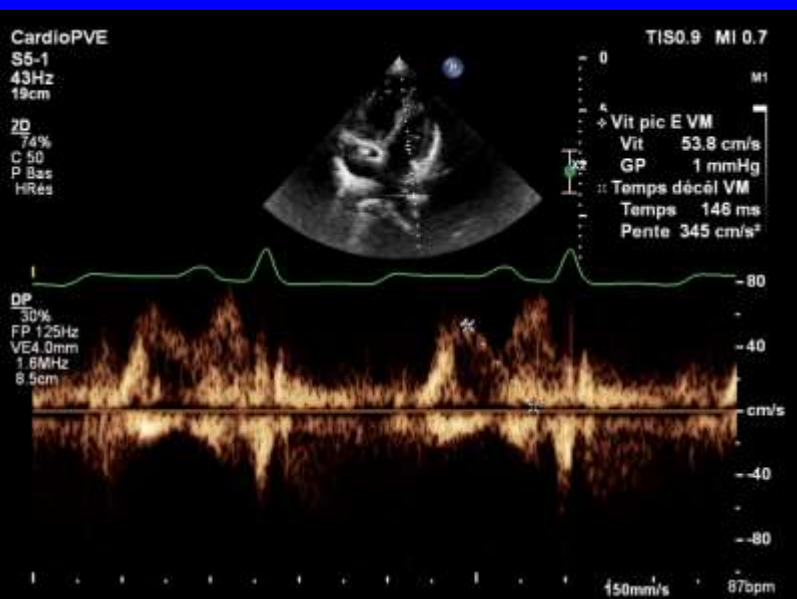
1,7 MHz
Gn 60
8,8 cm
Angle 0°
Filtr 400Hz
150 mm/s



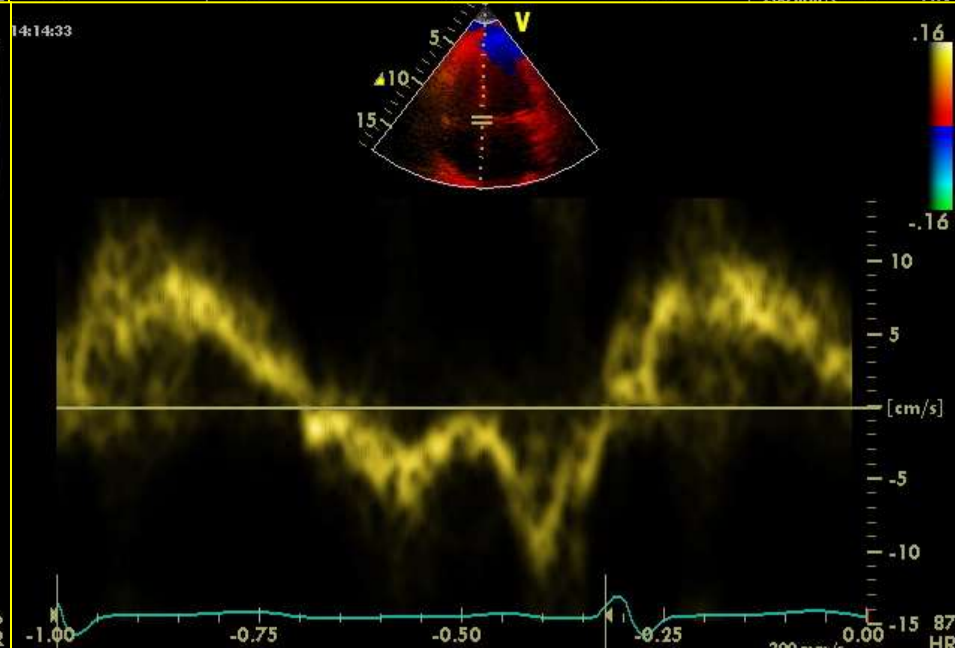
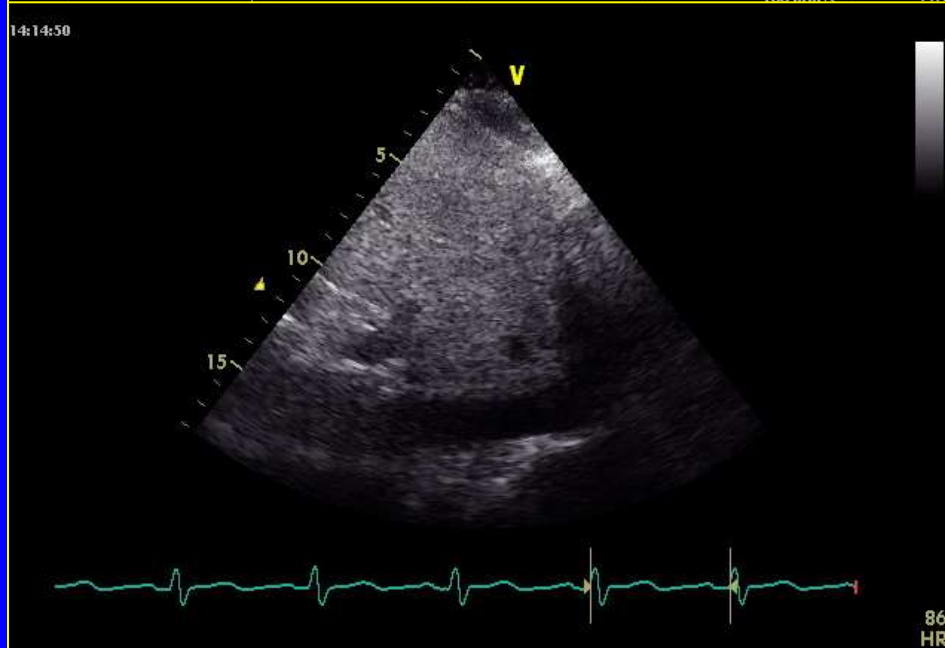
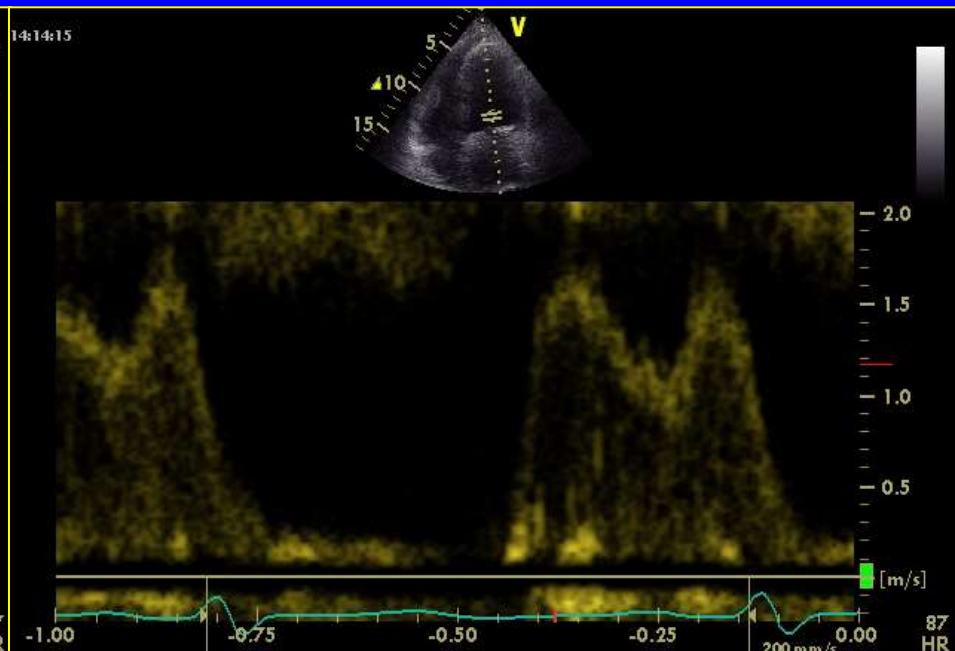
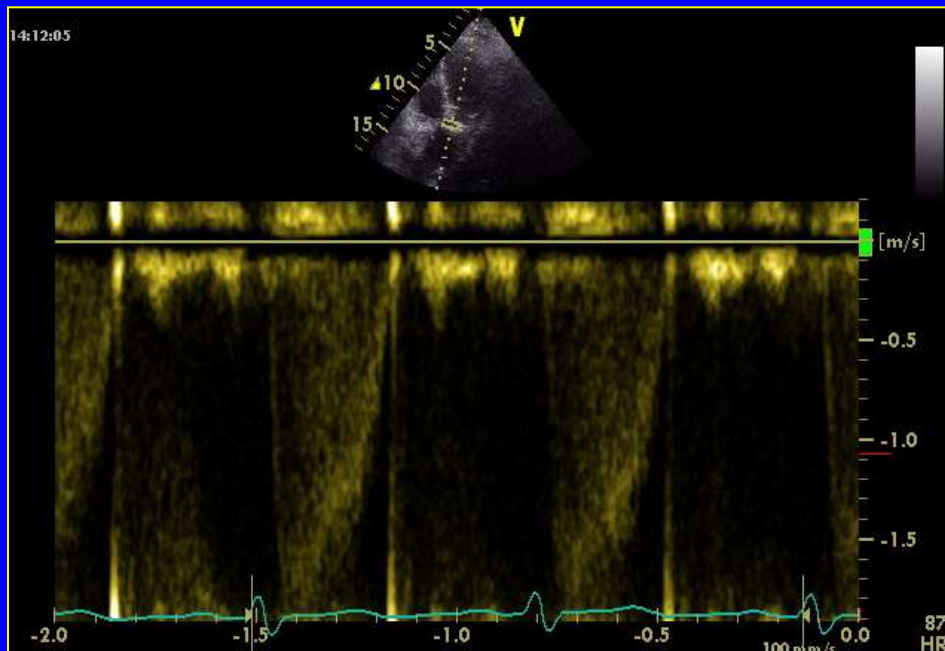


♀ 27 ans essoufflement





Cardiac output 9.2 L/min – E/Ea 24 – Engorged IVC



♀ 35 ans volumineux
épanchement pleural droit

CardioPVE

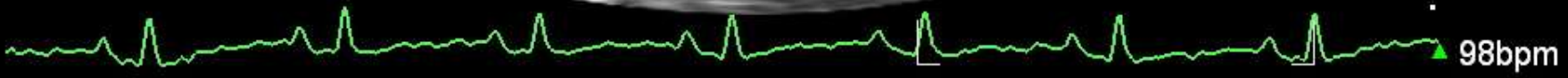
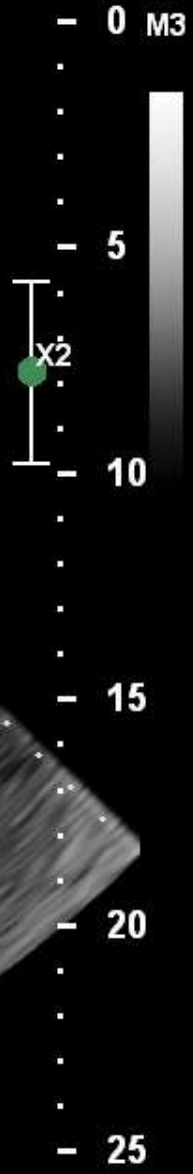
S5-1
35Hz
26cm

2D
83%
C 50
P Bas
HGén

ITm0.4 IM 1.4

♀ 35 ans volumineux

épanchement pleural droit

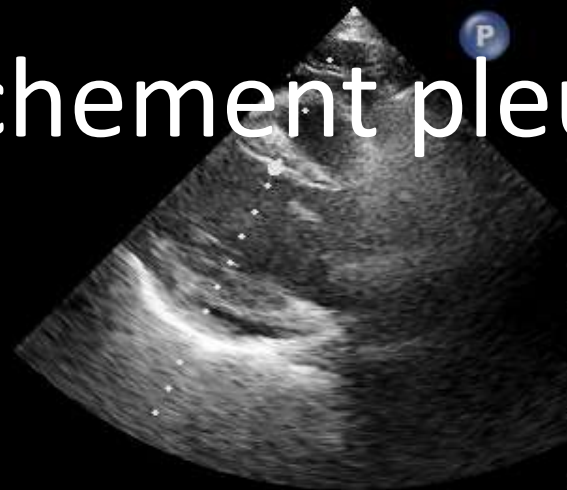


CardioPVE
S5-1
31Hz
17cm

♀ **35 ans volumineux**

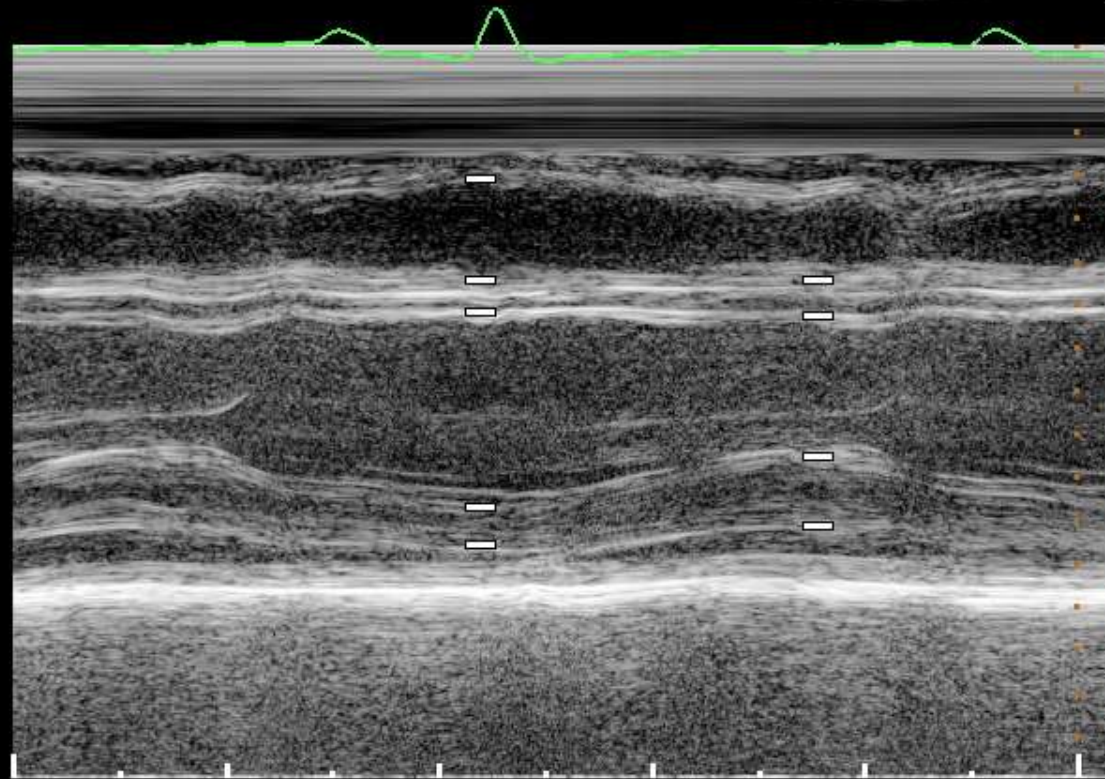
ITm0.6 IM 1.3

épanchement pleural droit



2D / TM
 70% 68%
 C 50
 P Bas
 HGén

- DIVDd	2.35 cm
- SIVd	0.739 cm
- DIVGd	4.52 cm
- PPVGd	0.870 cm
- SIVs	0.826 cm
- DIVGs	3.26 cm
- PPVGs	1.61 cm



VTD (TM-Teich)	93.4 ml
SIV/PPVG (TM)	0.849
Masse VG (cube)	115 g
h/R	0.4
Indice masse VG (cube)	62.8 g/m ²
% SIV (TM)	11.8 %
FR (TM-Teich)	27.9 %
VTS (TM-Teich)	42.8 ml
Indice DIVGs	1.8
FE (TM-Teich)	54.2 %
% PPVG (TM)	85.1 %

150mm/s

-15
 98bpm

CardioPVE

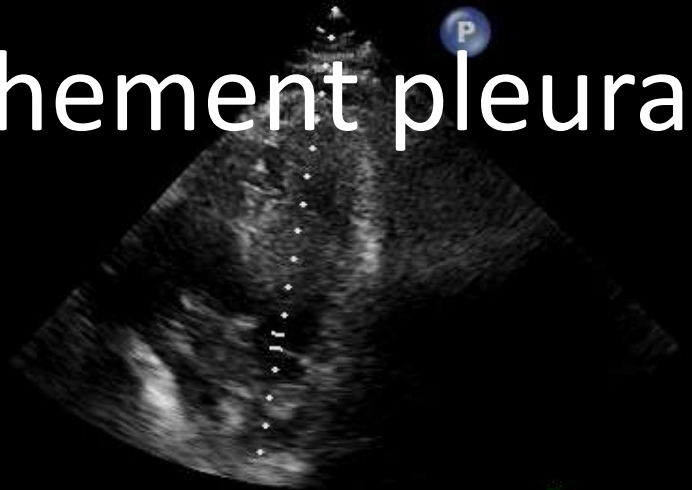
♀ 35 ans volumineux

ITm1.0 IM 0.5

S5-1
47Hz
17cm

épanchement pleural droit

2D
72%
C 50
P Bas
HGén

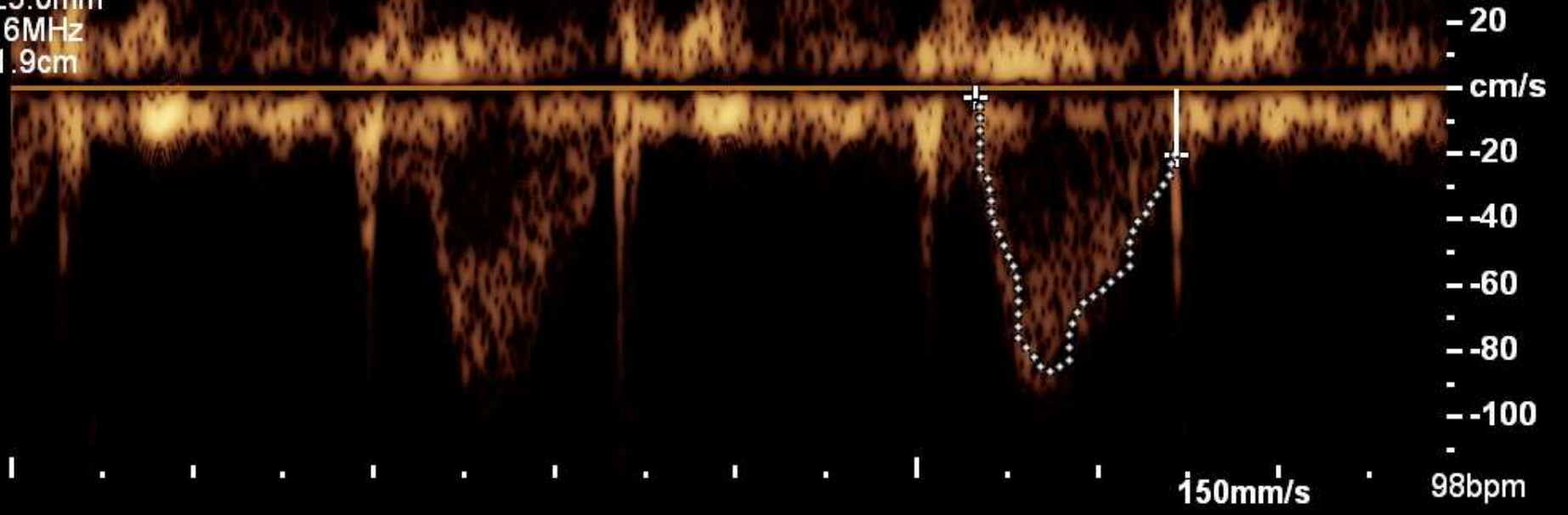


+ITV CCVG	
Vmax	85.7 cm/s
Vmoy	54.9 cm/s
GP max	3 mmHg
GP moy	1 mmHg
ITV	12.2 cm
FC - VA	98 bpm

DP
10%
FP 125Hz
VE5.0mm
1.6MHz
11.9cm



VE (CCVG)	46 ml
VE (CCVG) index	25 ml/m ²
DC (CCVG)	4.5 l/min
IC (CCVG)	2.5 l/min/m ²



98bpm

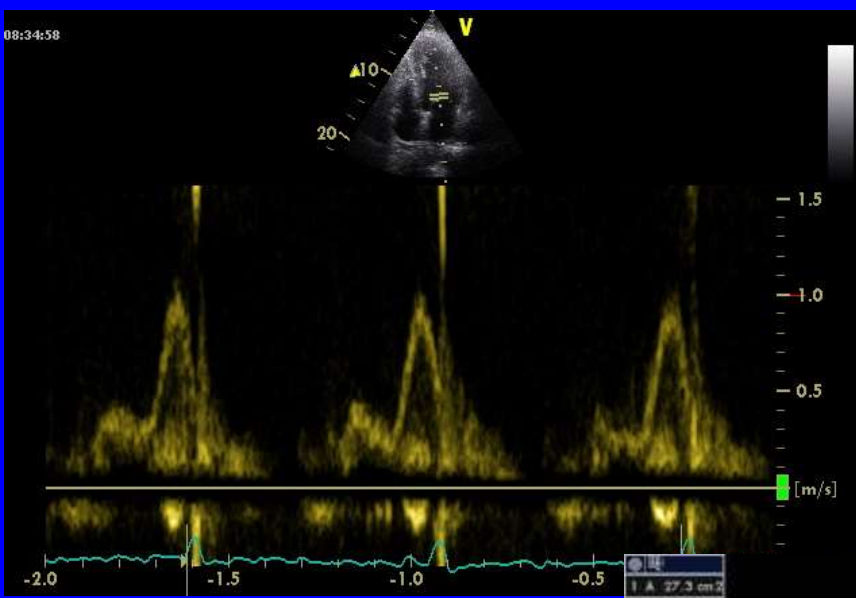
♀ 35 ans volumineux épanchement pleural droit



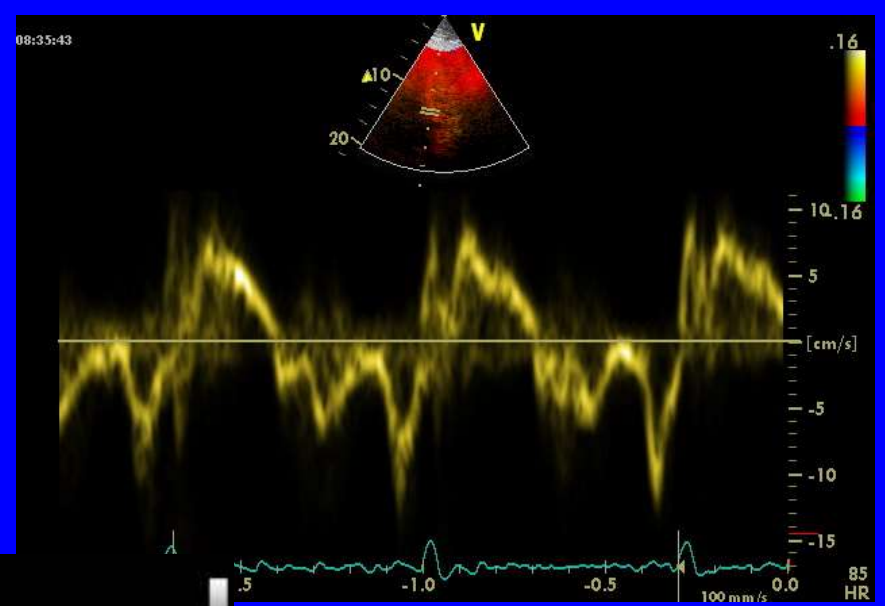
♀ 35 ans volumineux épanchement pleural droit



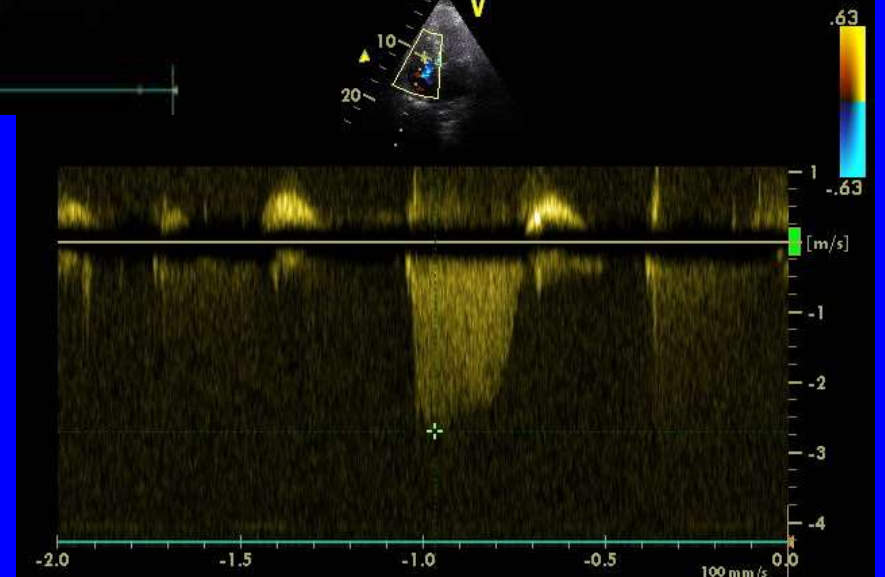
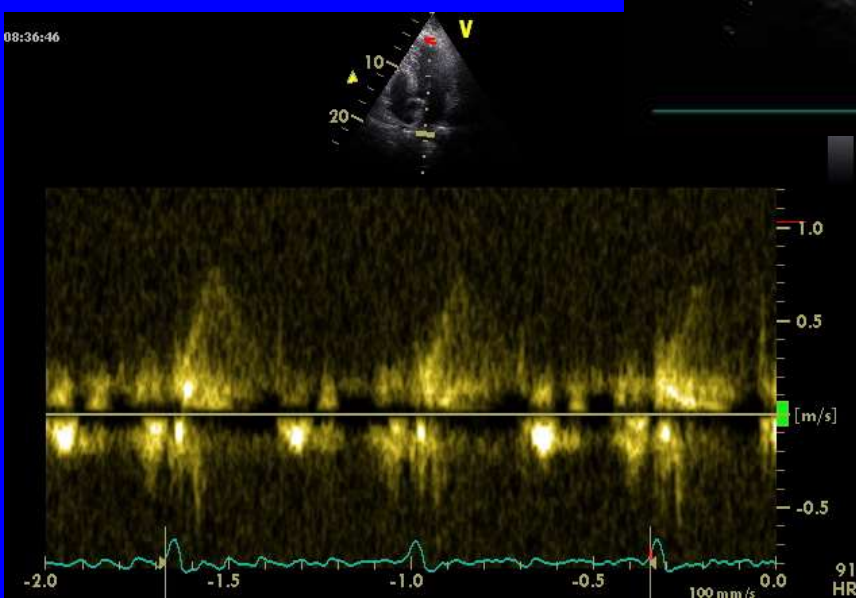
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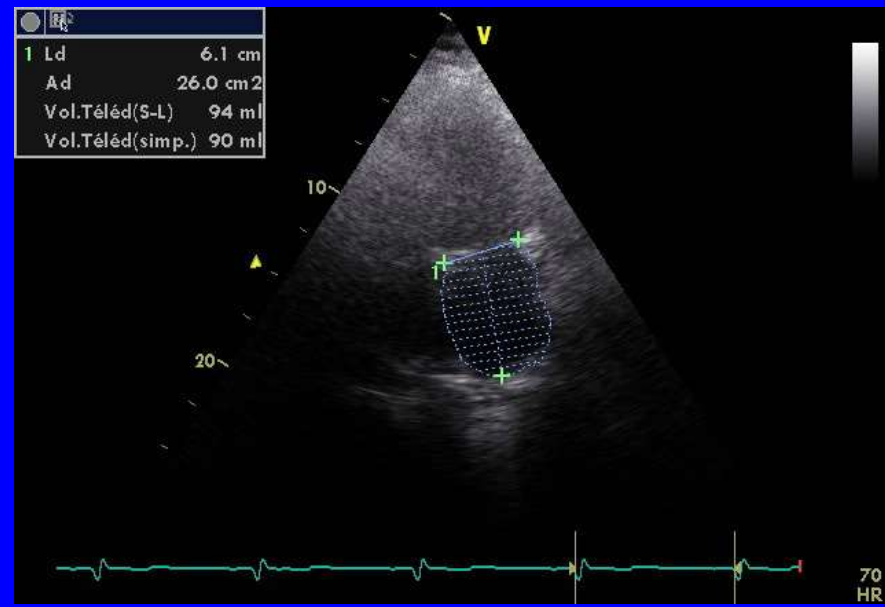
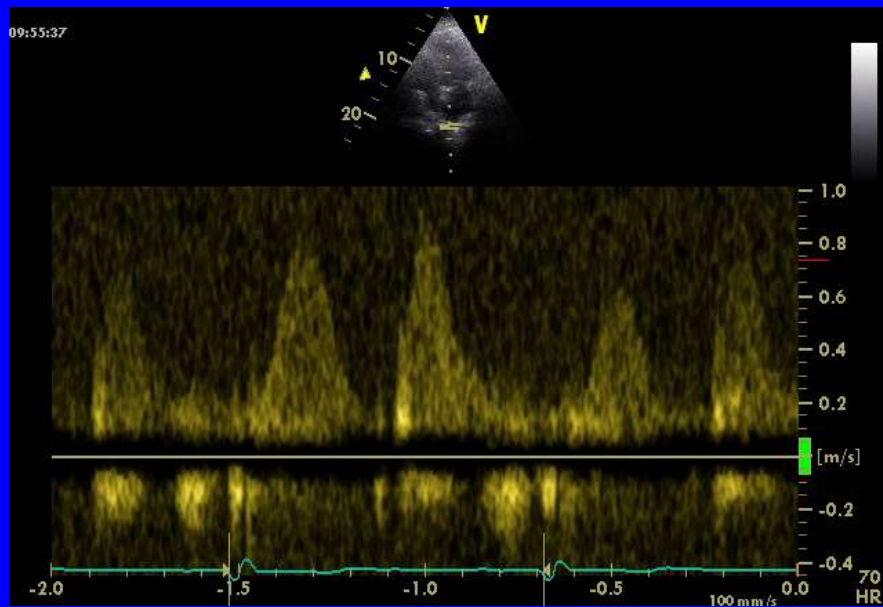
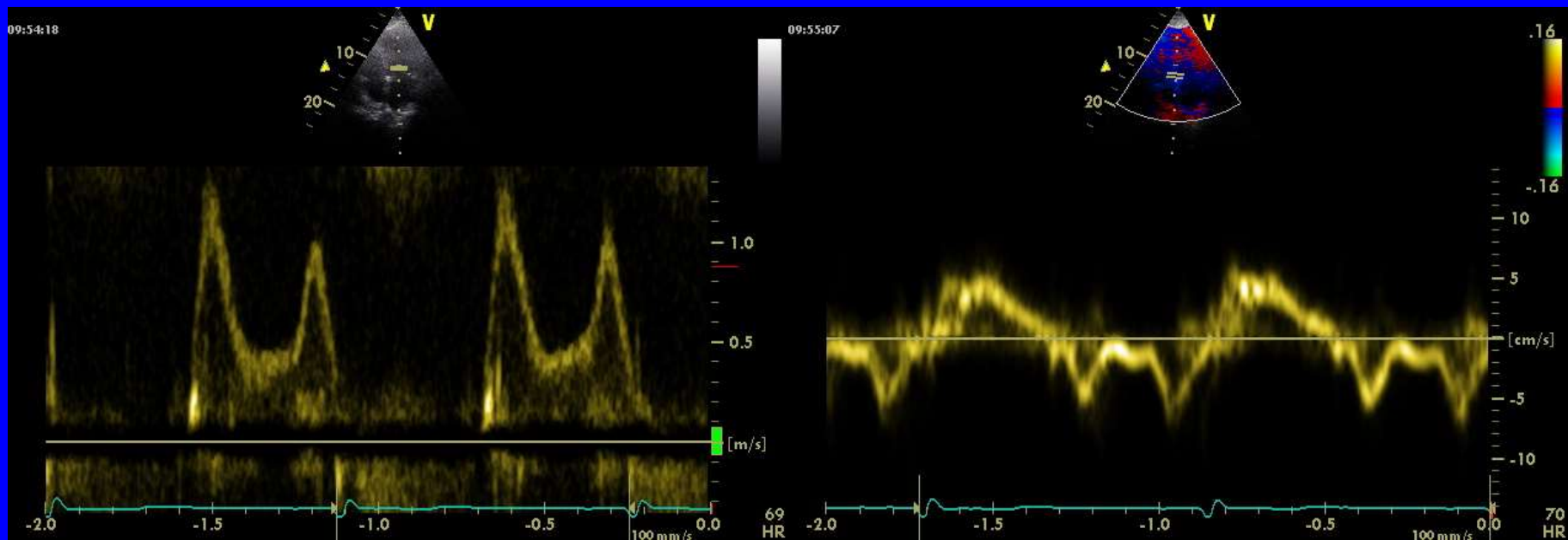


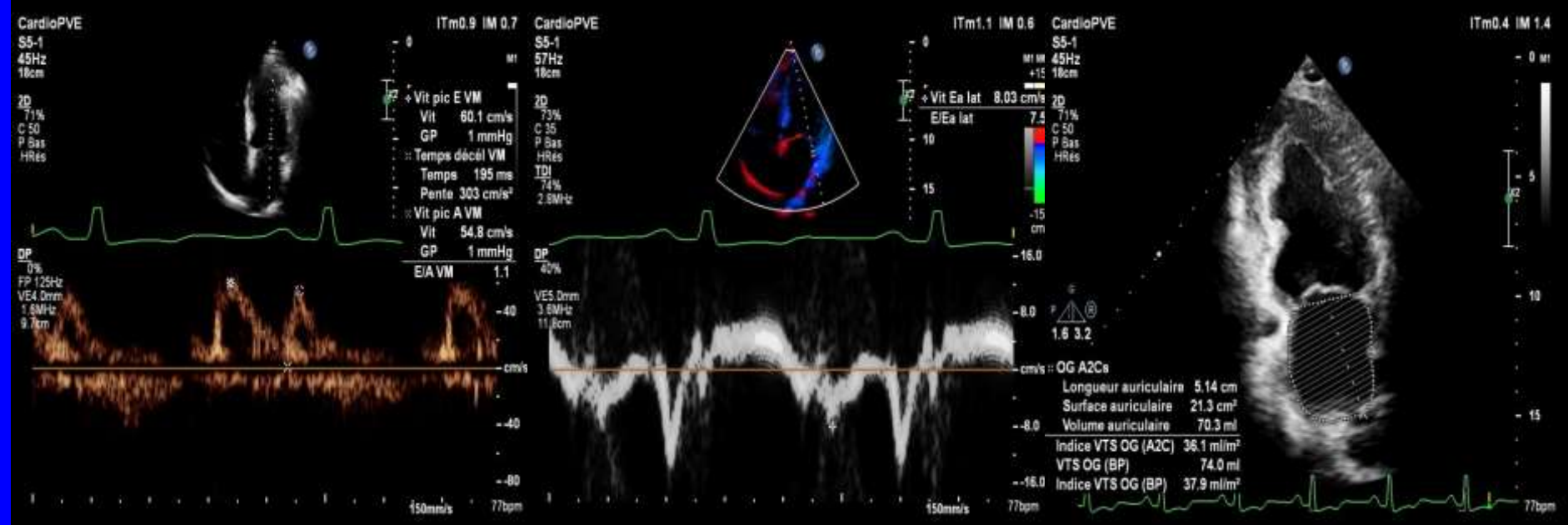
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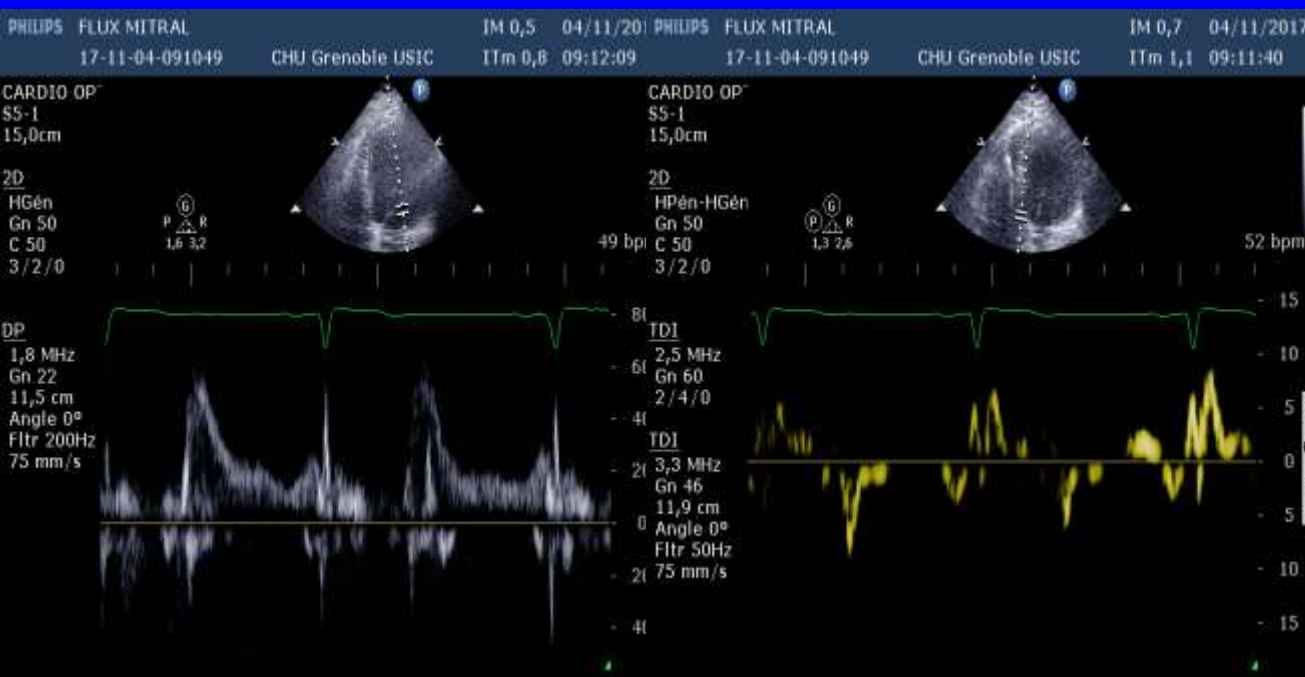


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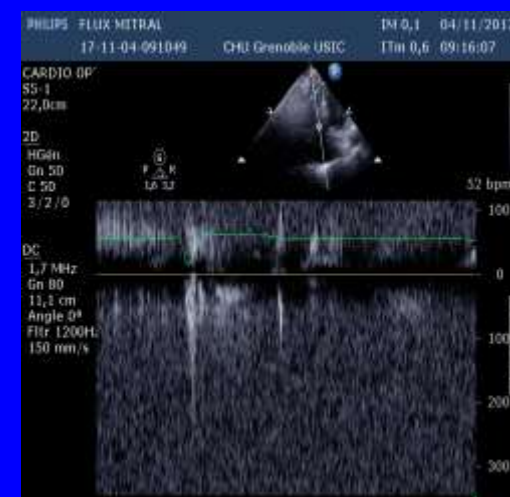
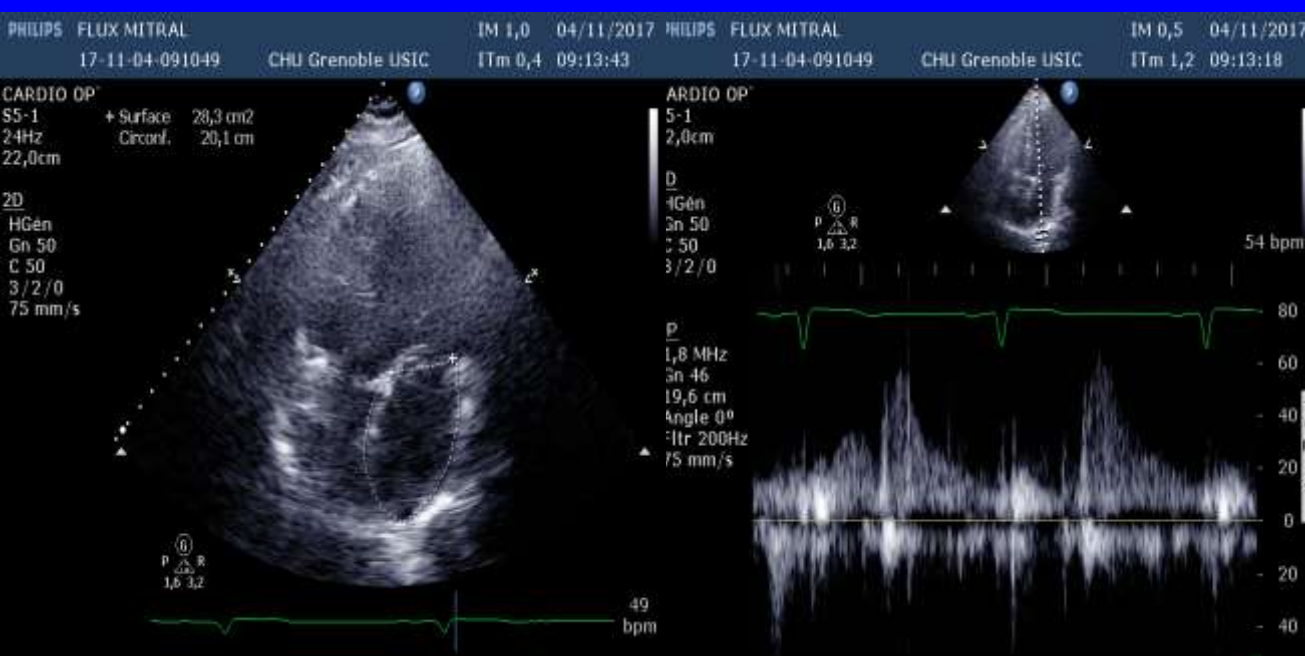


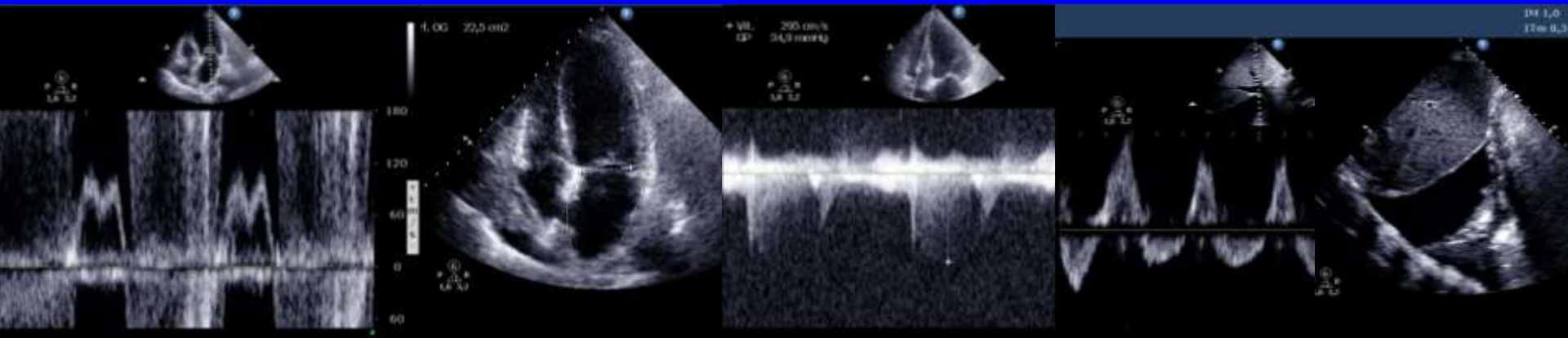




Symptômes d'IVG
E/e' <8...

Onde L
OG dilatée
D>S





NATISPRAY

