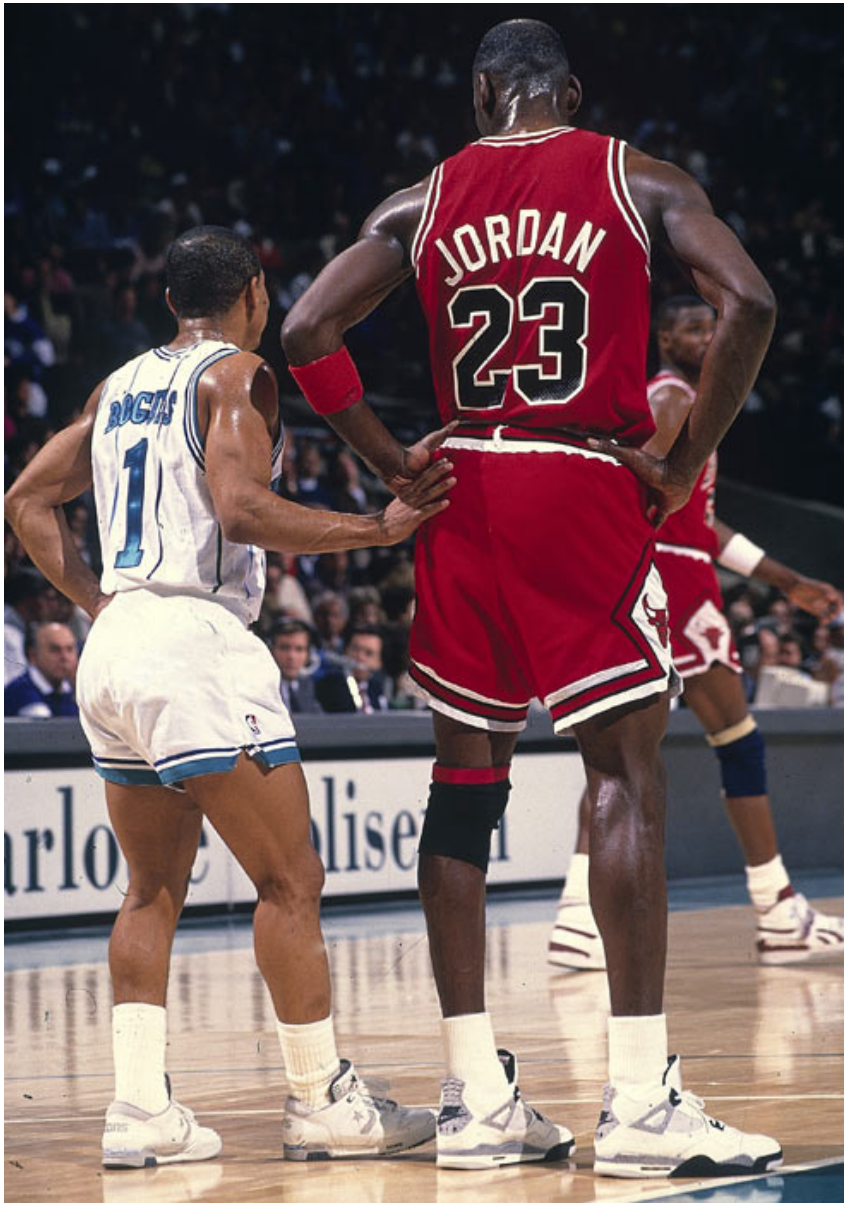
EVALUATION DE LA FONCTION VD en échocardiographie

Décembre 2015

Franck Levy

CENTRE CARDIO-THORACIQUE DE MONACO



Neglected / LV

Load dependancy +++

Lack of robust parameter

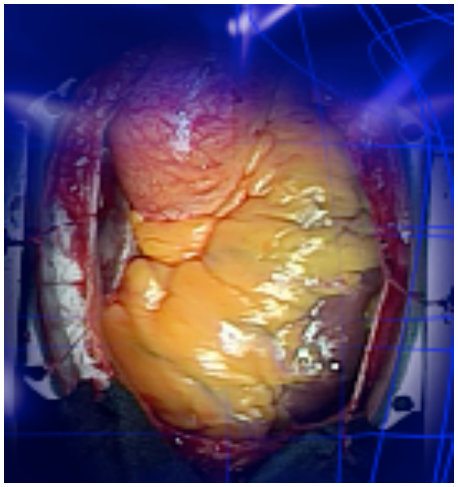
New indices ?

Anatomie?

Analyse morphologique?

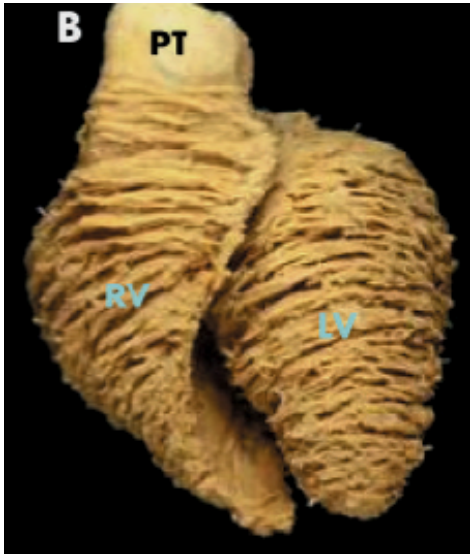
Analyse segmentaire?

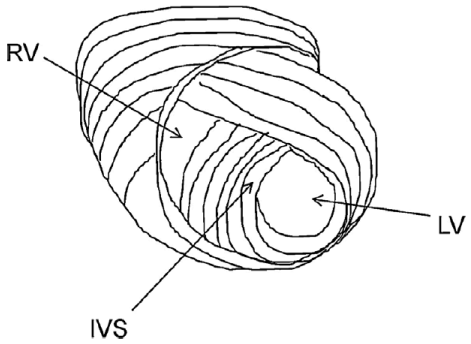
Fonction systolique? (Diastolique)?



Anatomy of the RV

- RV is hidden behind the sternum
- Complex Geometry: pyramidal
- Wrapped around the LV





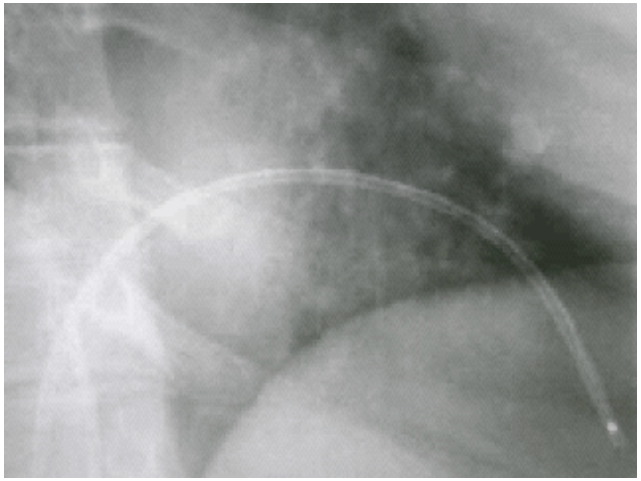
2 chambres

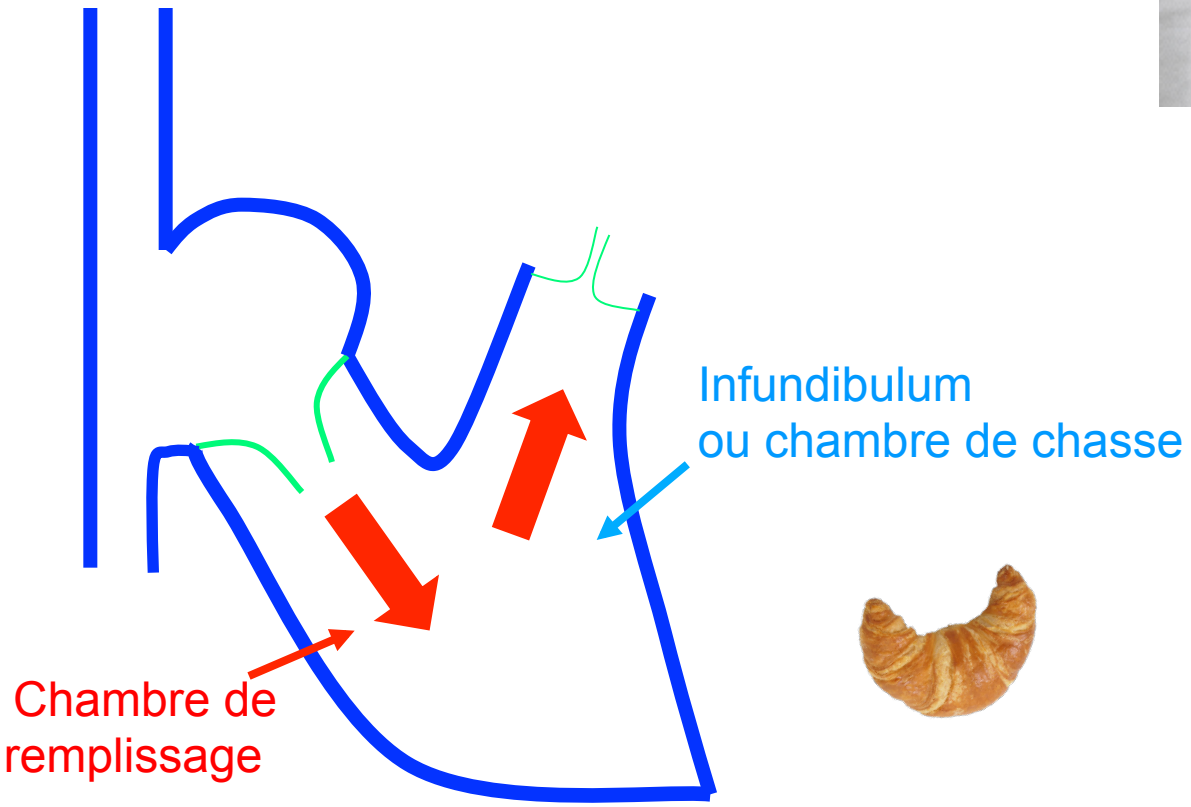
-Inflow chamber:

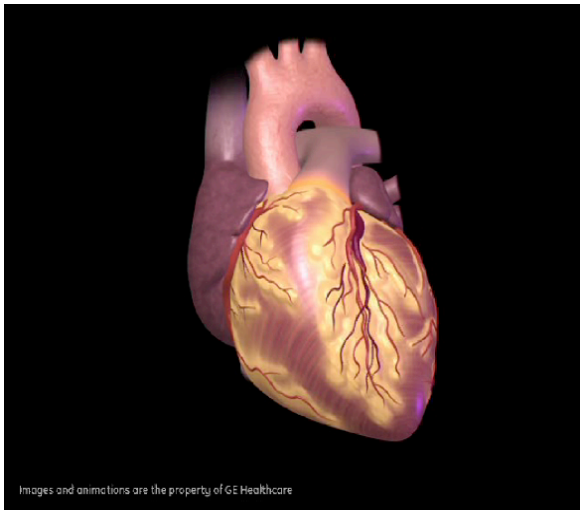
performs most of the pump function+++

-Outflow chamber (infundibulum):

only a peristaltic conduit







Interdépendance VD-VG

- Fibres interventriculaires communes
- Pompes en série
- Confinement dans le sac pericardique qui limite l'expansion du volume total du coeur

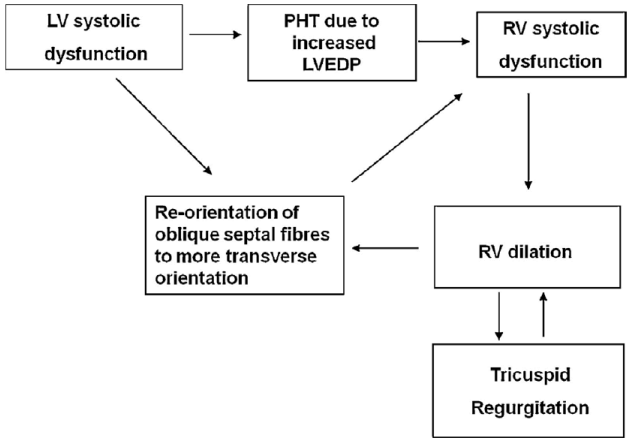


Figure 3. *Vicious cycle of RV dysfunction perpetuated by LV dysfunction.*

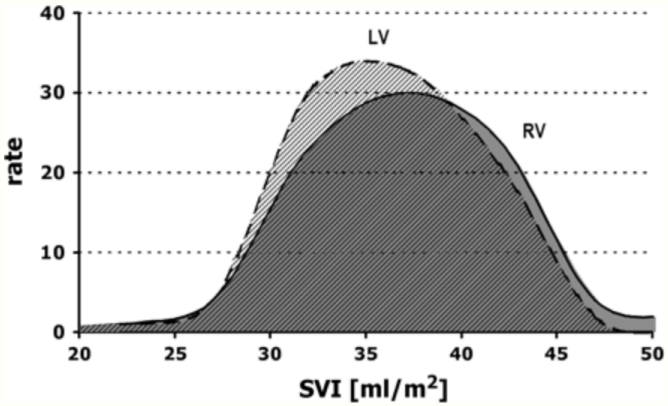
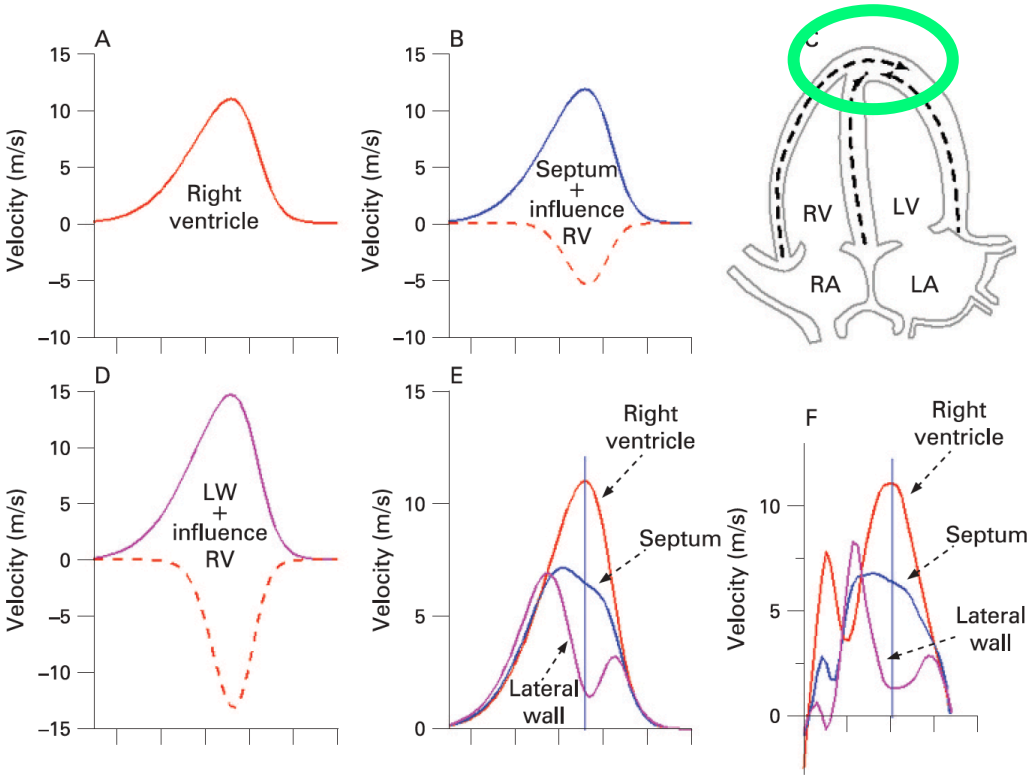
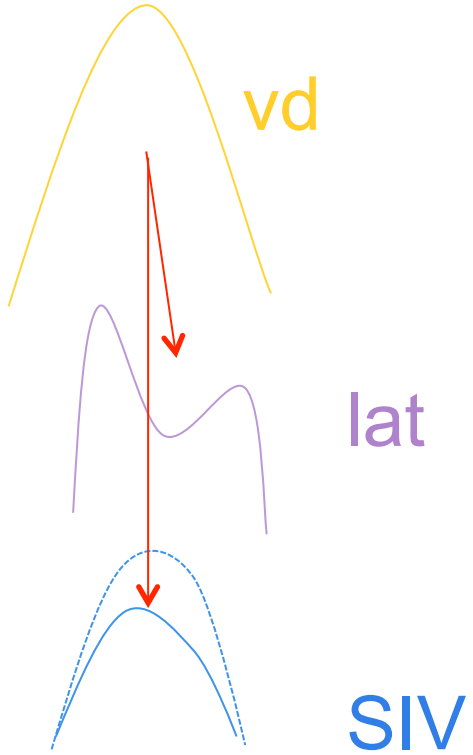


Figure 3
Distribution rate of indexed SVI of RV and LV in healthy population.

Interventricular interaction as a possible mechanism for the presence of a biphasic systolic velocity profile in normal left ventricular free walls

M Marciniak,[1] B Bijnens,[2,3] A Baltabaeva,[1] A Marciniak,[1] C Parsai,[1] P Claus,[3] G R Sutherland[1]





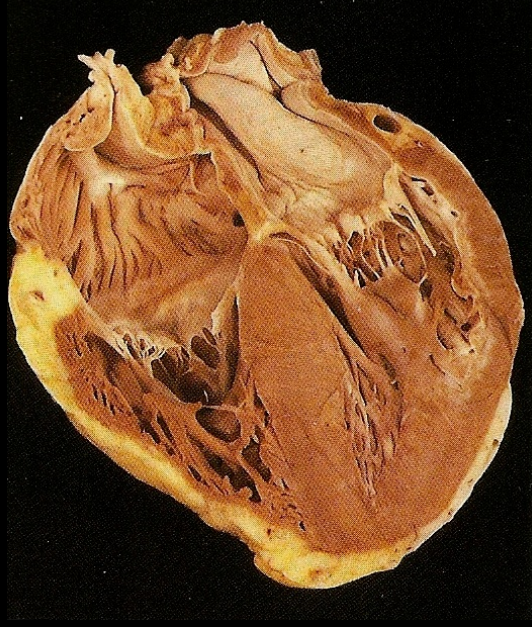
Anatomie?

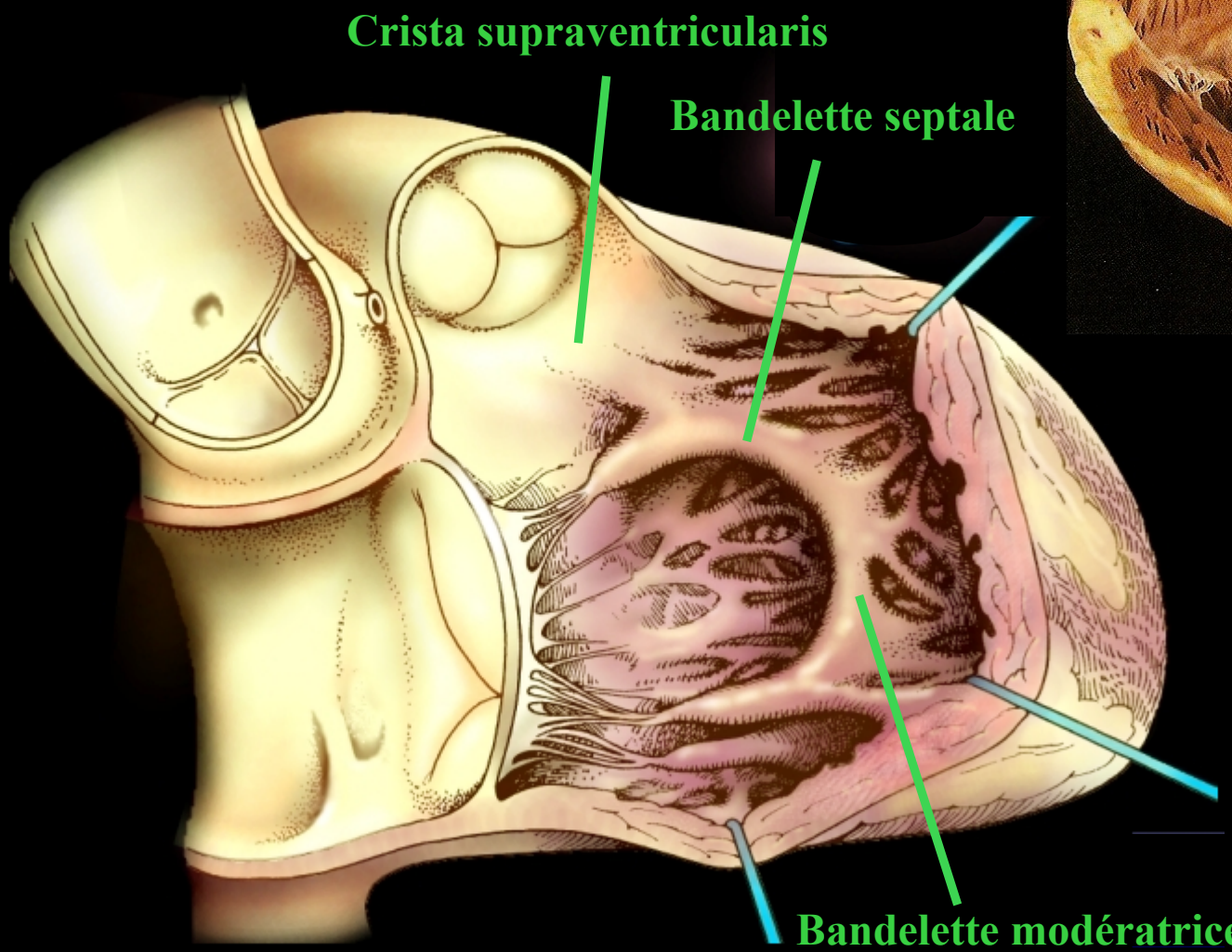
Analyse morphologique?

Analyse segmentaire?

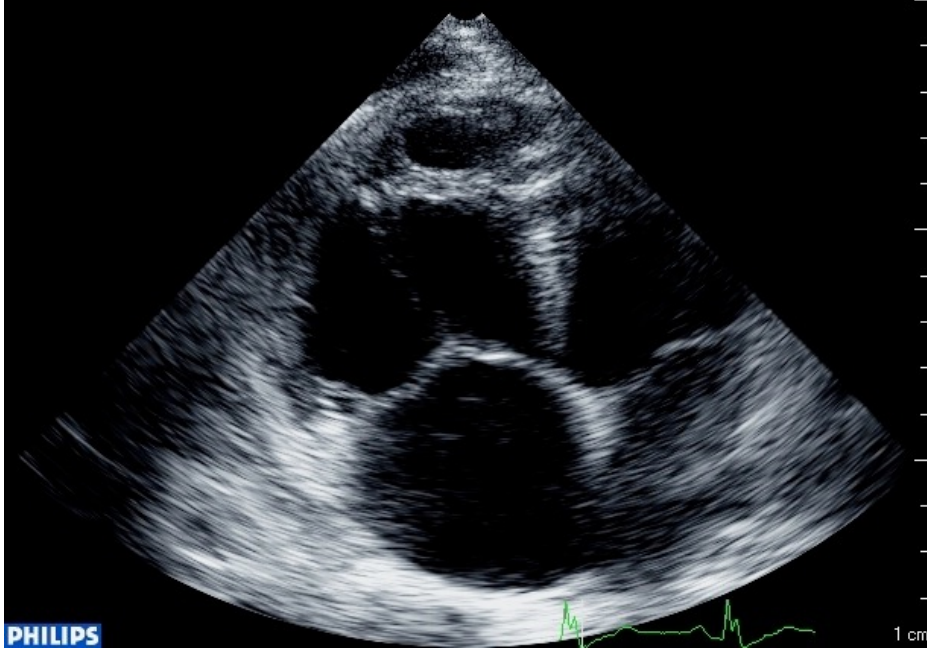
Fonction systolique? (Diastolique)?

Trabéculations



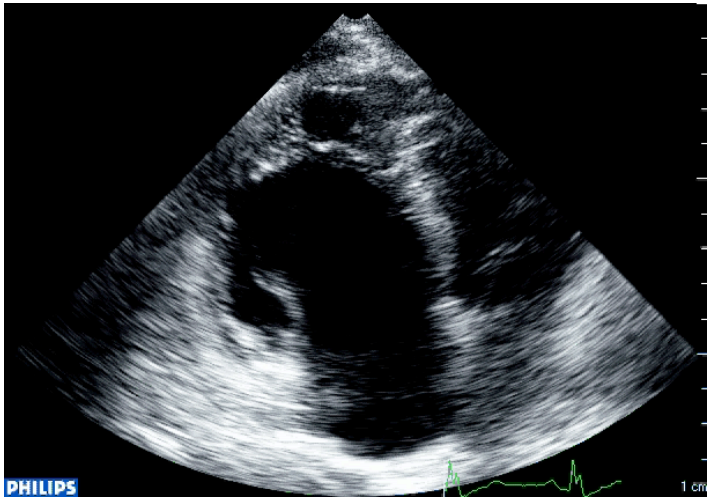


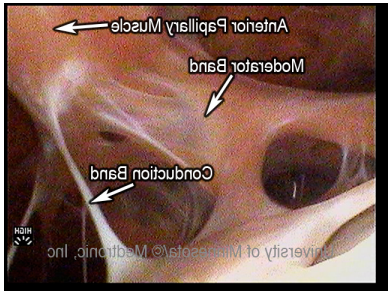
Trabéculations apicales



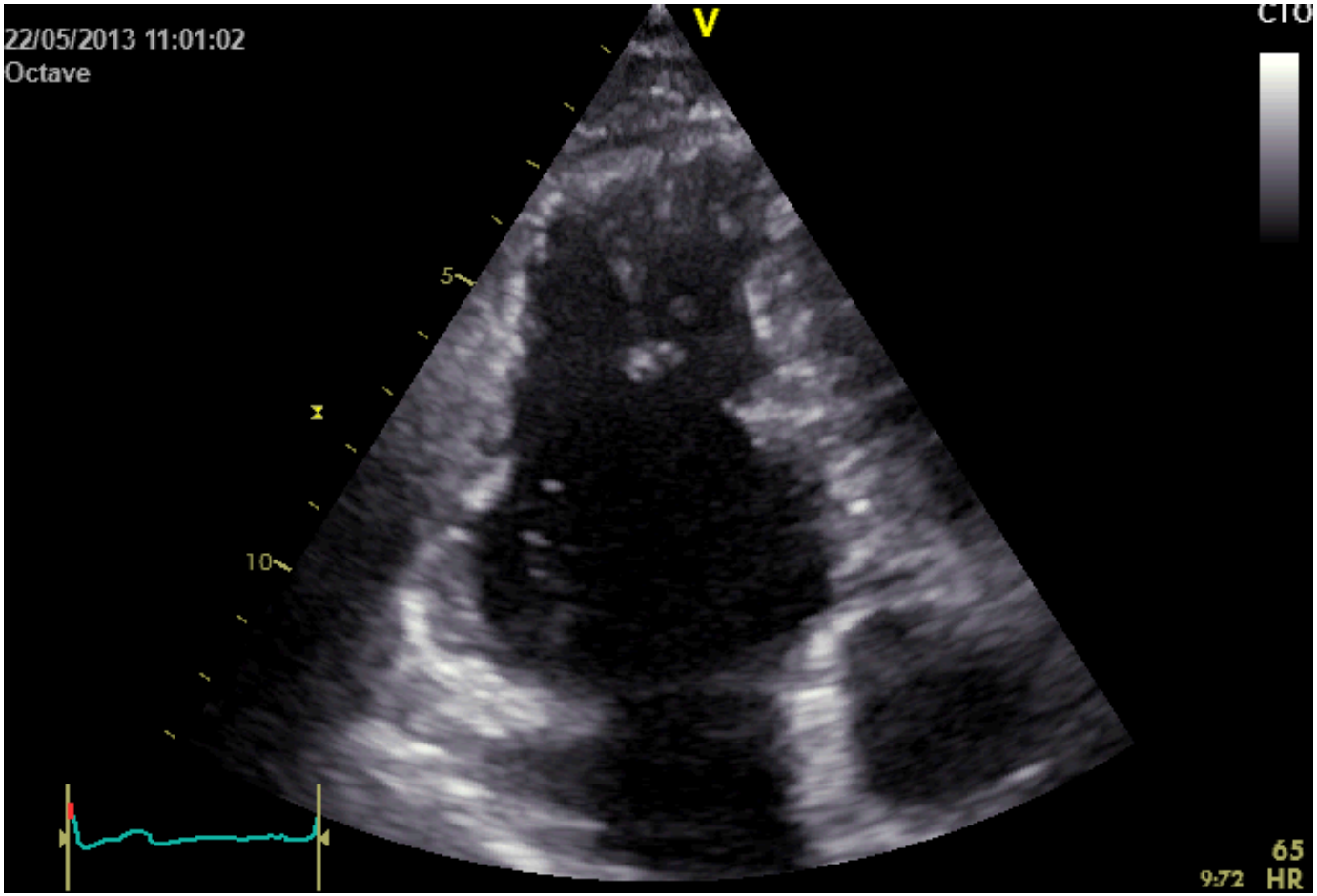
Bandelette modératrice

Il s’agit d’un muscle intra cavitaire attaché à la CCVD et allant vers le mur antérieur du VD

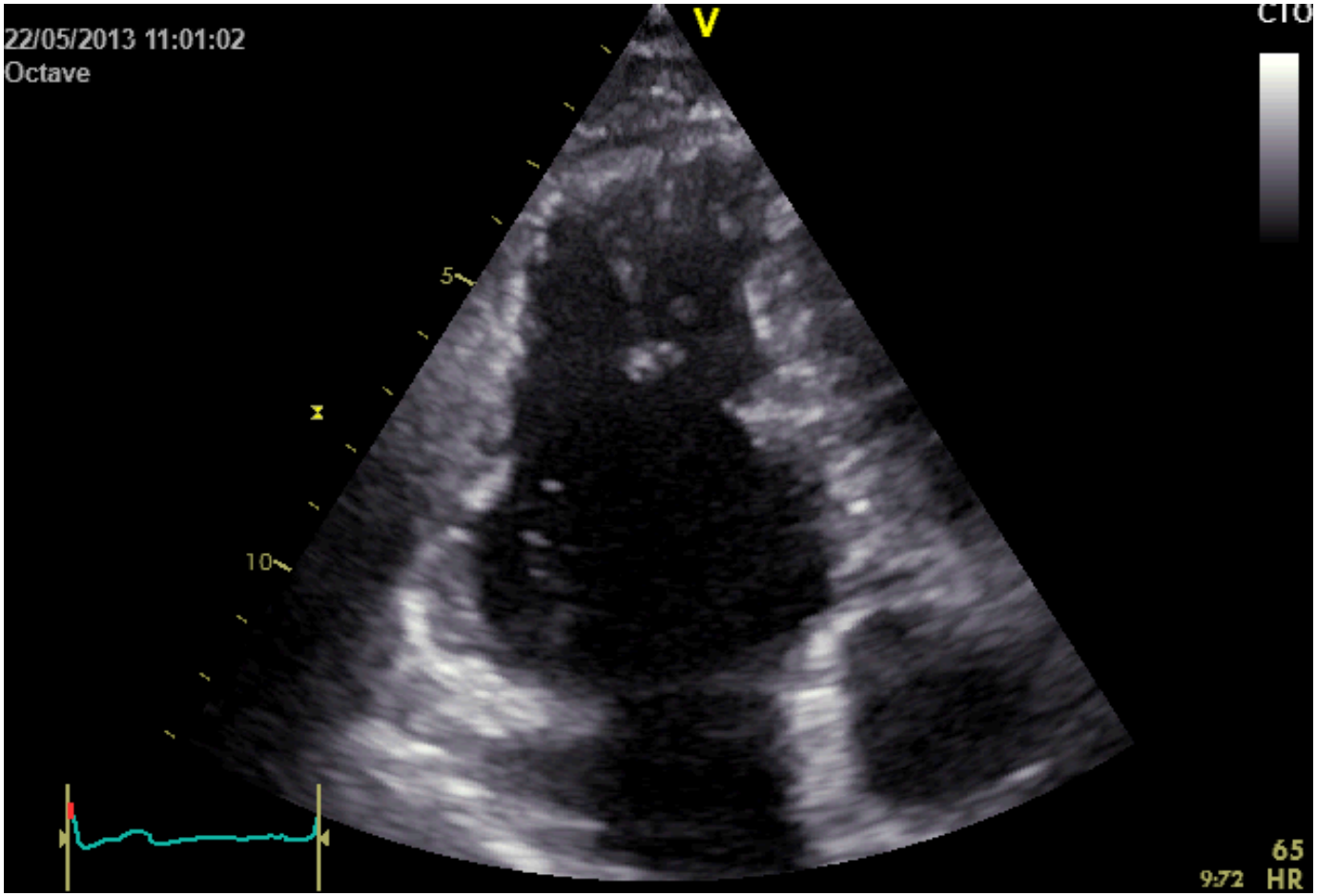




Bandelette modératrice


22/05/2013 11:01:02
Octave
V
5
10
65
HR

DAVD



Remerciements au Pr Marechaux et au Dr AL Castel

Comment évaluer le VD?

GUIDELINES AND STANDARDS

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography

Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography

Lawrence G. Rudski, MD, FASE, Chair, Wyman W. Lai, MD, MPH, FASE, Jonathan Afilalo, MD, Msc, Lanqi Hua, RDCS, FASE, Mark D. Handschumacher, BSc, Krishnaswamy Chandrasekaran, MD, FASE, Scott D. Solomon, MD, Eric K. Louie, MD, and Nelson B. Schiller, MD, *Montreal, Quebec, Canada; New York, New York; Boston, Massachusetts; Phoenix, Arizona; London, United Kingdom; San Francisco, California*

(J Am Soc Echocardiogr 2010;23:685-713.)

2010

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*

2015

Table 9 Recommendations for the echocardiographic assessment of RV function

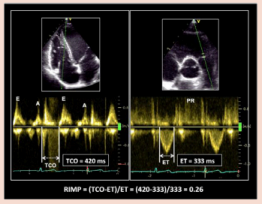
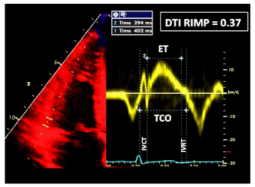
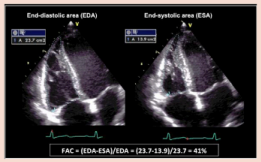
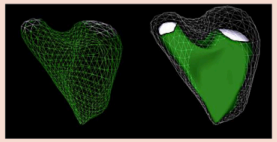
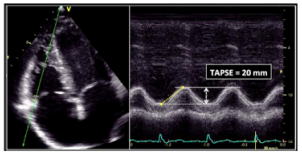
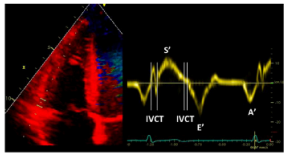
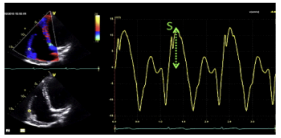
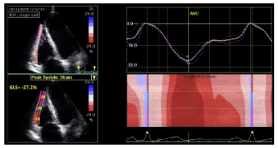
Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV global function Pulsed Doppler RIMP 	RIMP (Tei index) by pulsed Doppler: RIMP = (TCO − ET)/ET	• Prognostic value • Less affected by heart rate	• Requires matching for R-R intervals when measurements are performed on separate recordings • Unreliable when RA pressure is elevated
Tissue Doppler RIMP 	RIMP by tissue Doppler: RIMP = (IVRT + IVCT)/ET = (TCO − ET)/ET	• Less affected by heart rate • Single-beat recording with no need for R-R interval matching	• Unreliable when RA pressure is elevated
RV global systolic function FAC 	RV FAC in RV-focused apical four-chamber view: RV FAC (%) = 100 × (EDA − ESA)/EDA	• Established prognostic value • Reflects both longitudinal and radial components of RV contraction • Correlates with RV EF by CMR	• Neglects the contribution of RV outflow tract to overall systolic function • Only fair inter-observer reproducibility
EF 	Fractional RV volume change by 3D TTE: RV EF (%) = 100 × (EDV − ESV)/EDV	• Includes RV outflow tract contribution to overall function • Correlates with RV EF by CMR	• Dependent on adequate image quality • Load dependency • Requires offline analysis and experience • Prognostic value not established

Table 9 (*Continued*)

Echocardiographic imaging	Recommended methods	Advantages	Limitations
RV longitudinal systolic function TAPSE 	• Tricuspid annular longitudinal excursion by M-mode (mm), measured between end-diastole and peak systole • Proper alignment of M-mode cursor with the direction of RV longitudinal excursion should be achieved from the apical approach.	• Established prognostic value • Validated against radionuclide EF	• Angle dependency • Partially representative of RV global function*
Pulsed tissue Doppler S wave 	• Peak systolic velocity of tricuspid annulus by pulsed-wave DTI (cm/sec), obtained from the apical approach, in the view that achieves parallel alignment of Doppler beam with RV free wall longitudinal excursion	• Easy to perform • Reproducible • Validated against radionuclide EF • Established prognostic value	• Angle dependent • Not fully representative of RV global function, particularly after thoracotomy, pulmonary thromboendarterectomy or heart transplantation
Color tissue Doppler S wave 	• Peak systolic velocity of tricuspid annulus by color DTI (cm/sec)	• Sampling is performed after image acquisition • Allows multisite sampling on the same beat	• Angle dependent • Not fully representative of RV global function, particularly after thoracotomy, pulmonary thrombendarterectomy or heart transplantation • Lower absolute values and reference ranges than pulsed DTI S′ wave • Requires offline analysis
GLS 	• Peak value of 2D longitudinal speckle tracking derived strain, averaged over the three segments of the RV free wall in RV-focused apical four-chamber view (%)	• Angle independent • Established prognostic value	• Vendor dependent

EDA, End-diastolic area; *ESA*, end-systolic area; *ET*, ejection time; *GLS*, gold longitudinal strain; *IVCT*, isovolumic contraction time; *TCO*, tricuspid valve closure–to–opening time.

Comment?

Right ventricular diastolic function

Transtricuspid flow

- average of 5 beats or end expiratory
- No severe TR or AF
- E/A
- E/e'

Variability +++

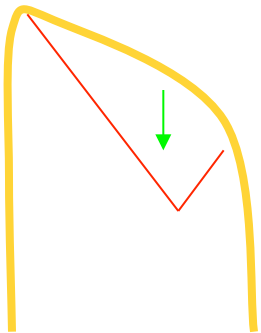
Recommendations: Measurement of RV diastolic function should be considered in patients with suspected RV impairment as a marker of early or subtle RV dysfunction, or in patients with known RV impairment as a marker of poor prognosis. Transtricuspid E/A ratio, E/E′ ratio, and RA size have been most validated and are the preferred measures(Table 6). **Grading of RV diastolic dysfunction should be done as follows: tricuspid E/A ratio < 0.8 suggests impaired relaxation, a tricuspid E/A ratio of 0.8 to 2.1 with an E/E′ ratio > 6 or diastolic flow predominance in the hepatic veins suggests pseudonormal filling, and a tricuspid E/A ratio > 2.1 with a deceleration time < 120 ms suggests restrictive filling (as does late diastolic antegrade flow in the pulmonary artery). Further studies are warranted to validate the sensitivity and specificity and the prognostic implications of this classification.**

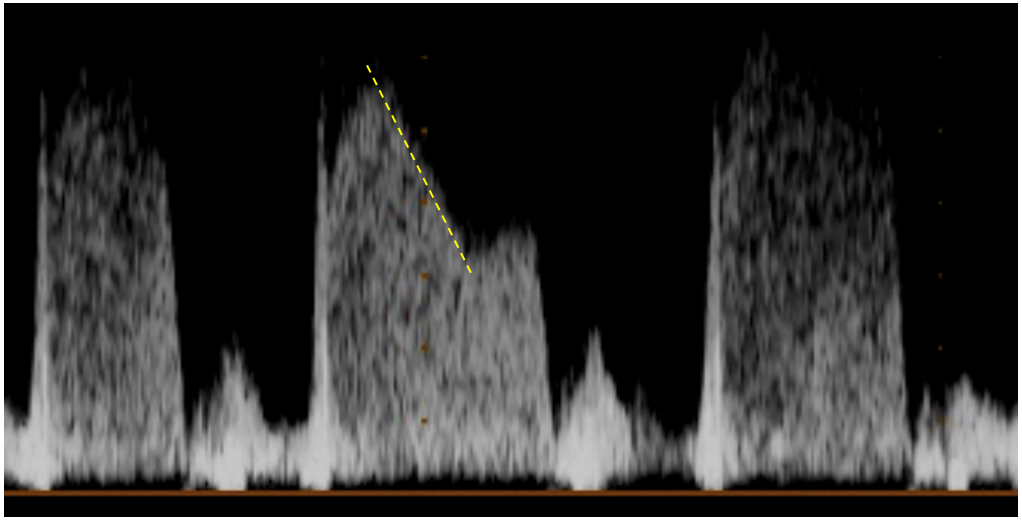
Right ventricular diastolic function

- Le flux d'insuffisance pulmonaire:
  - En cas de trouble de la compliance, diminution mésodiastolique brutale de la vitesse de l'IP correspondant traduisant le « dip plateau » *(la pression augmente brutalement en diastole entraînant une diminution du gradient AP/VD),*

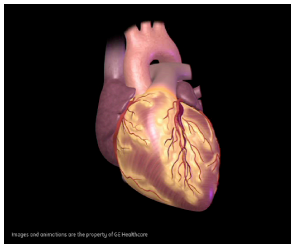
⇨ PHT court (surtout en inspiration) (<150ms)

- Se voit en cas de constriction et d'IDM VD

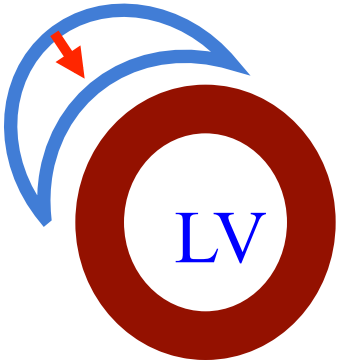




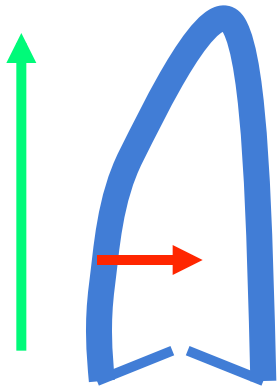
Right ventricular systolic function



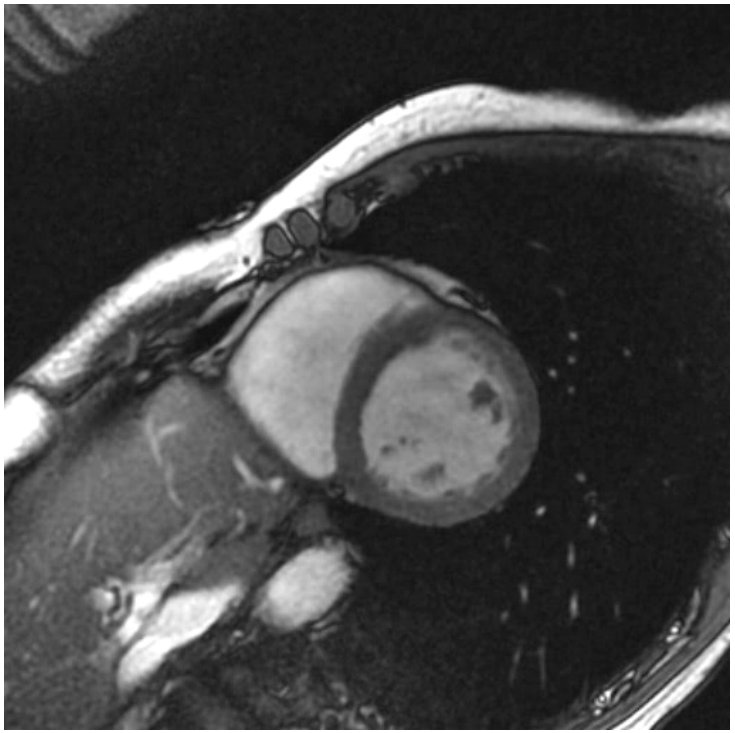
Contraction of the RV: 2 asssociated motions:

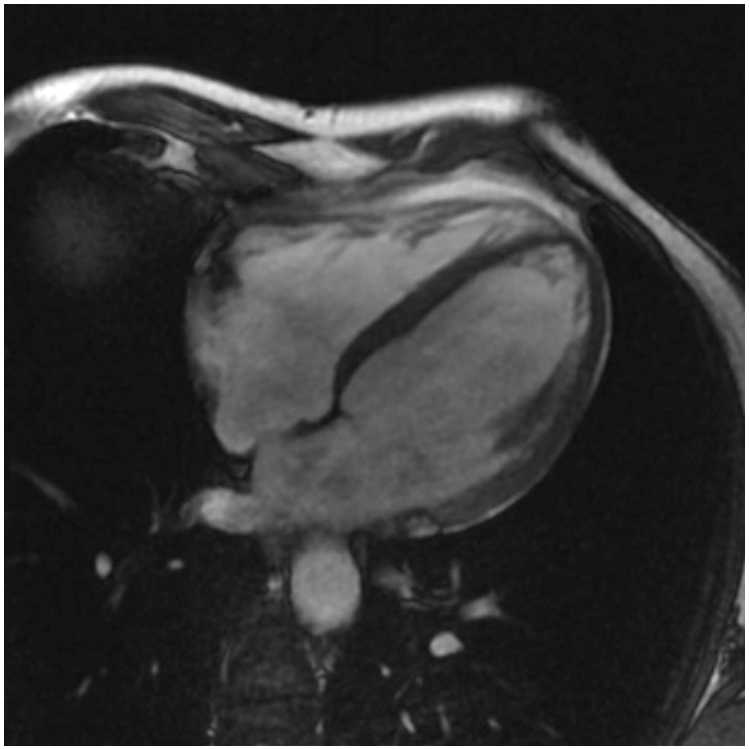


1) Radial Motion of free wall towards IV septum



2)Longitudinal motion





Analyze of the radial motion

-Visual estimation
(semi quantitative)

- RV fractional Area change

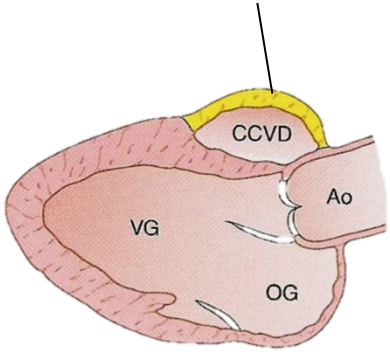
Use your eyes

Use your eyes

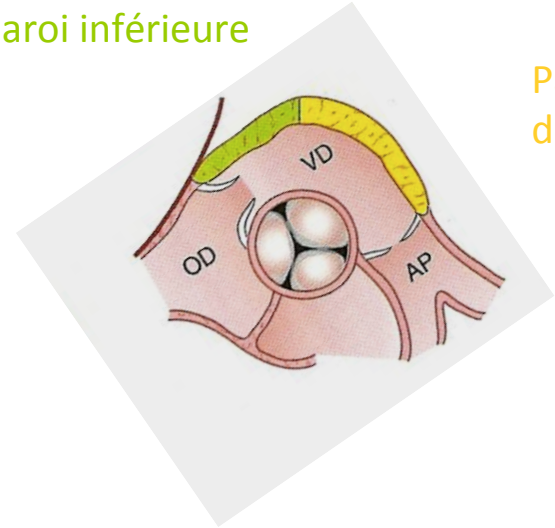
SUMMARY OF RECOMMENDATIONS FOR THE ASSESSMENT OF RIGHT VENTRICULAR SYSTOLIC FUNCTION

Visual assessment of RV systolic function gives the reader an initial qualitative evaluation of RV systolic function but remains insufficient in this era of standardization. There are several simple and reproduc-

Paroi antérieure de l'infundibulum



Paroi inférieure

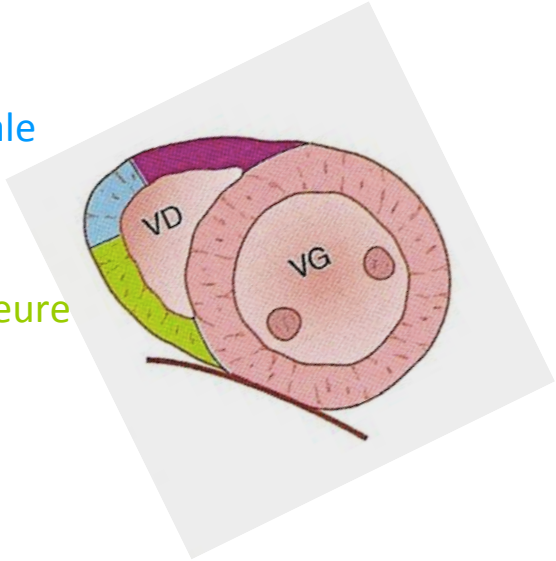


Paroi antérieure de l'infundibulum

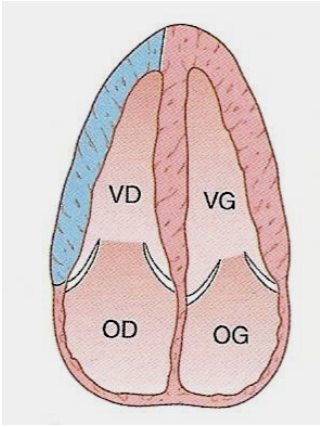
Paroi antérieure

Paroi latérale

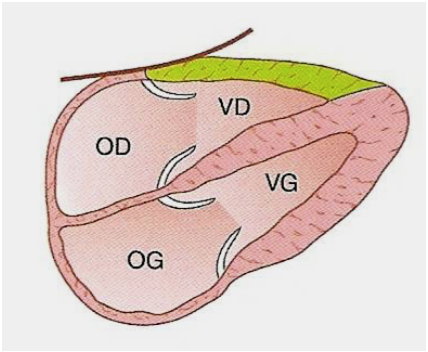
Paroi inférieure

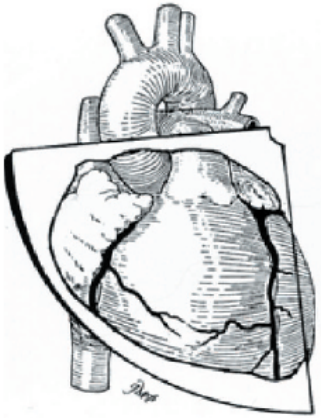


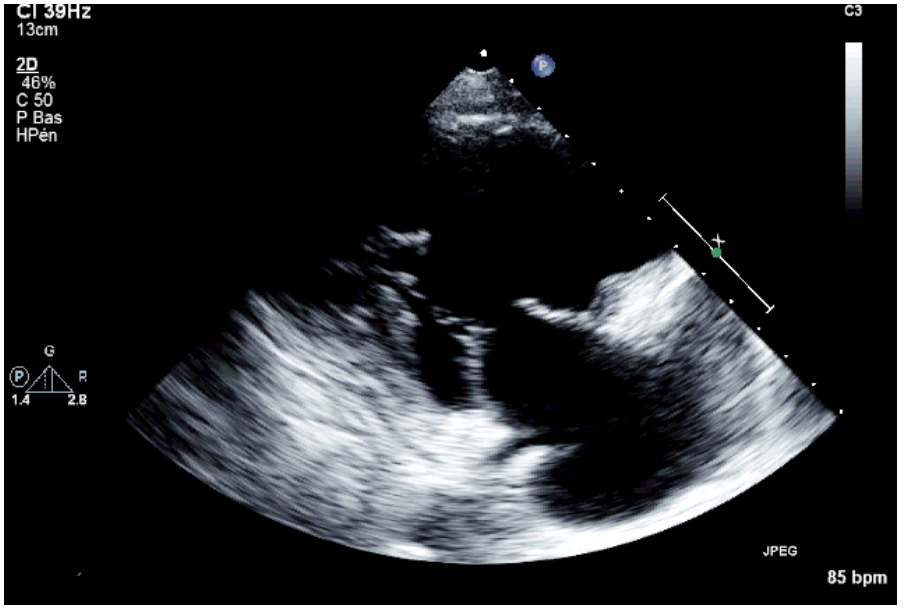
Paroi latérale

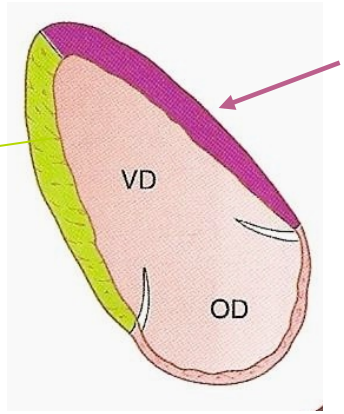


Paroi inférieure



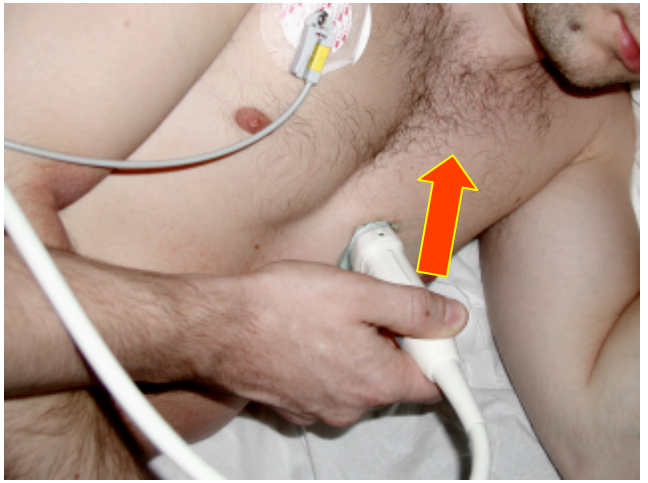




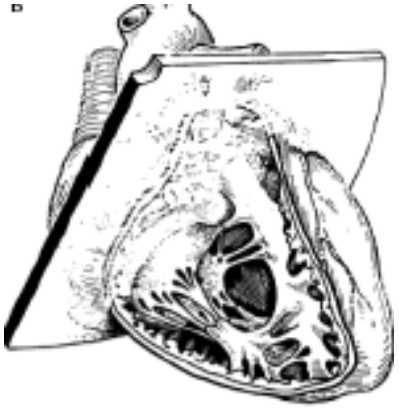


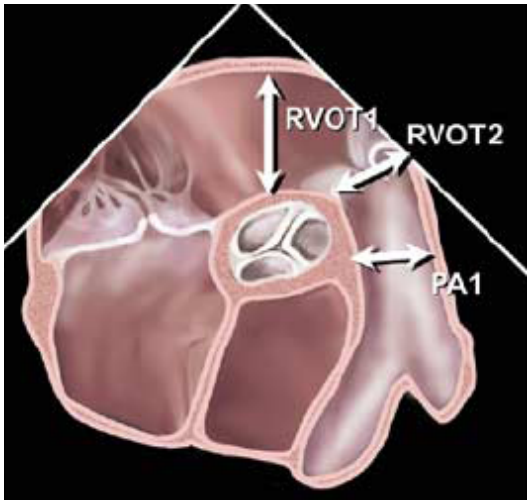
Paroi antérieure

Paroi inférieure



L'incidence parasternale petit axe (base)





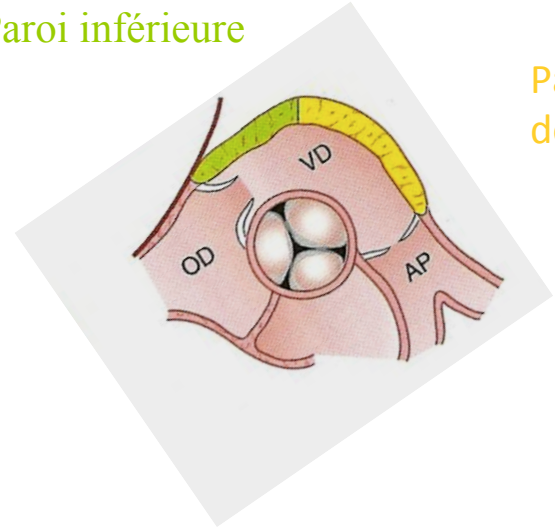
Normales

RVOT 1 25-29mm

CCVD 17-23mm

AP 15-21mm

Paroi inférieure



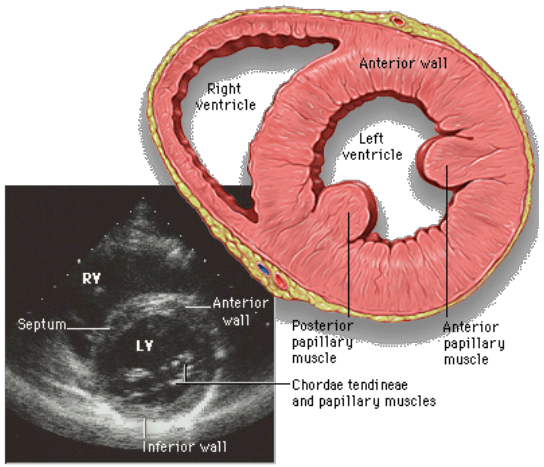
Paroi antérieure
de l'infundibulum

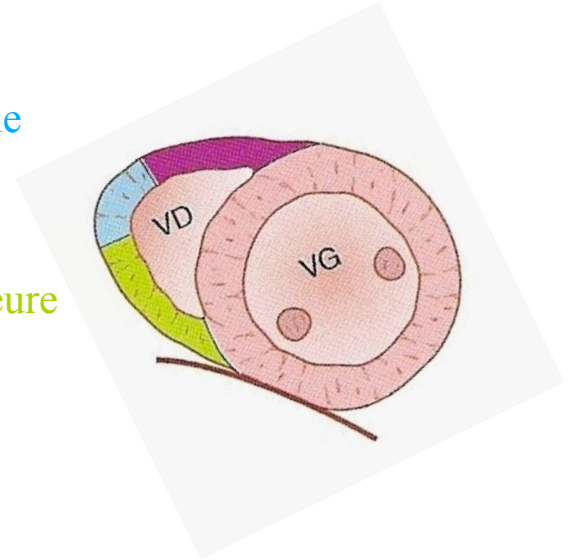
L'incidence parasternale petit axe (piliers)

Paroi antérieure

Paroi latérale

Paroi inférieure

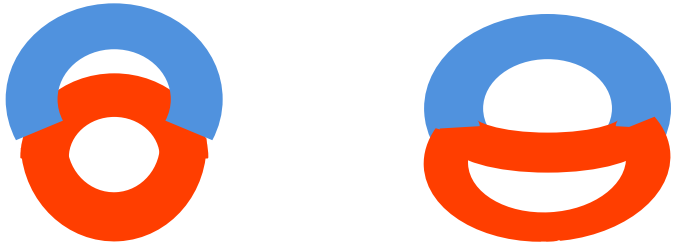




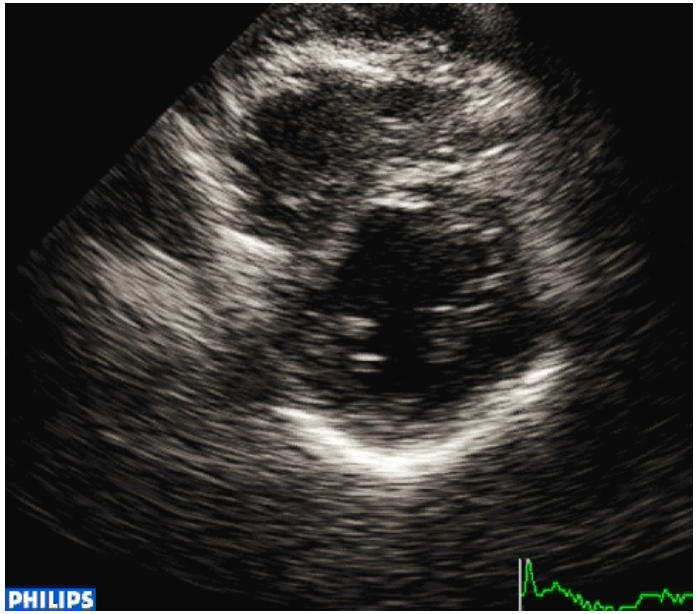
Comment est l'orientation du SIV?

VD

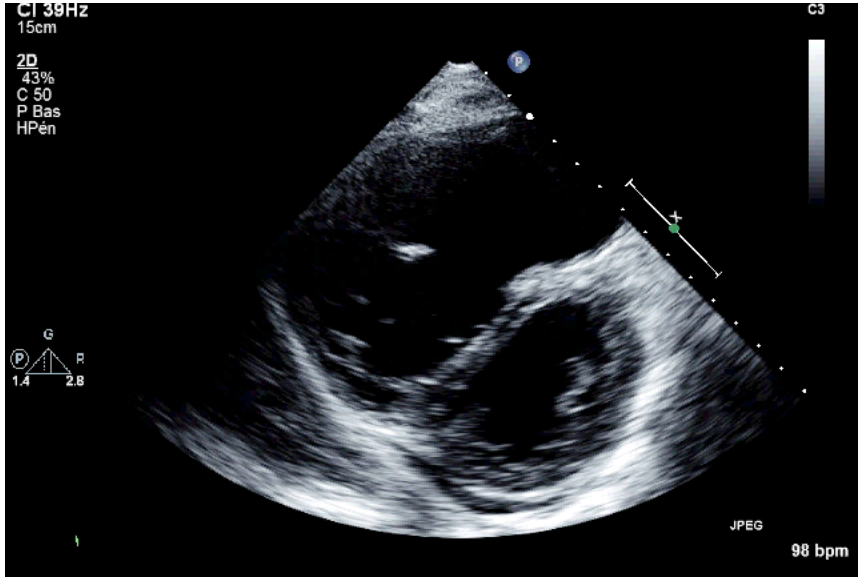
VG



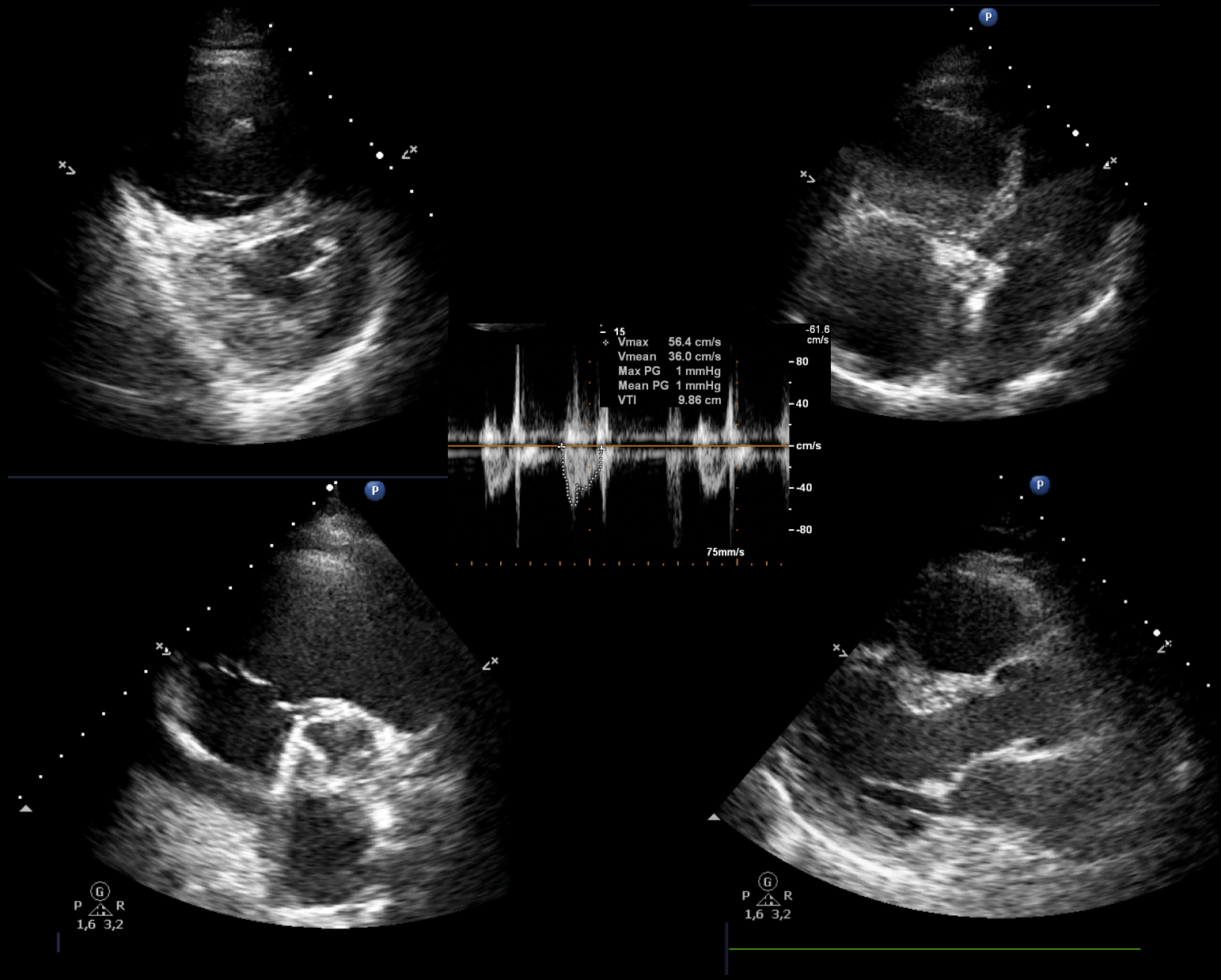
Healthy



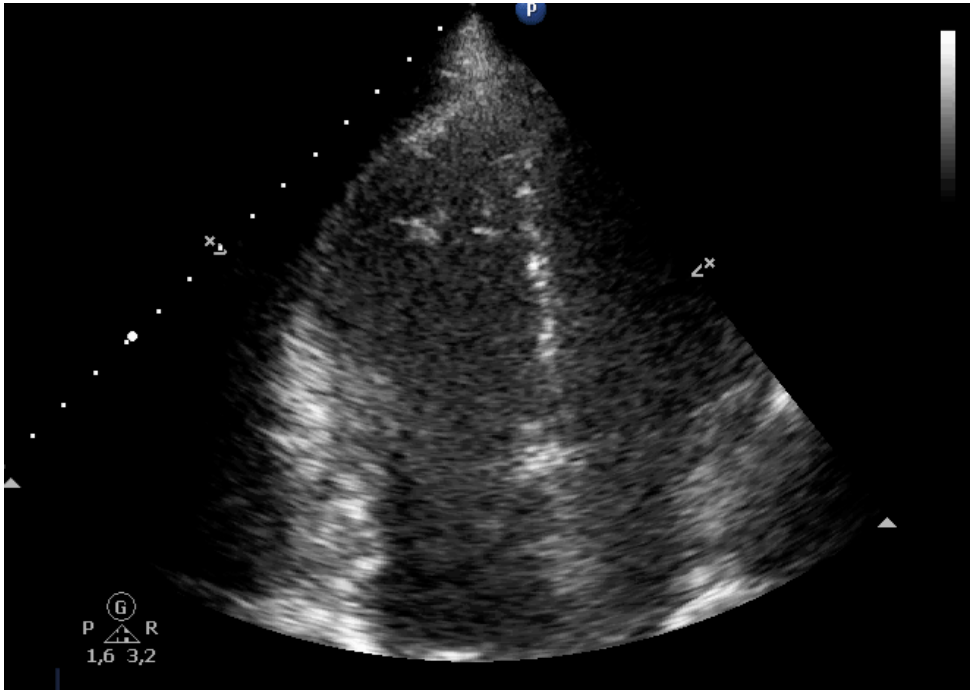
Chronic PH



Embolie pulmonaire proximale bilaterale



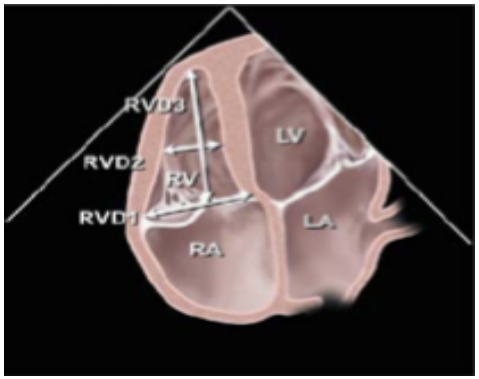
Signe de Mc Connell



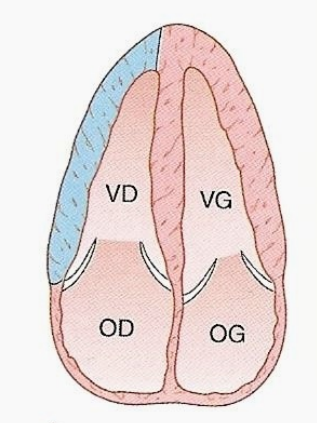
96-100% specificity

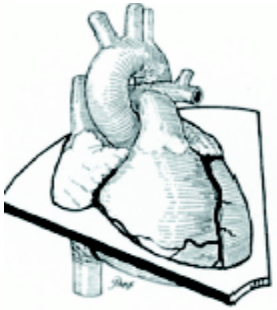
Distinguish between Acute Pulmonary embolism and chronic PH

L’incidence apicale 4 cavités



Paroi latérale

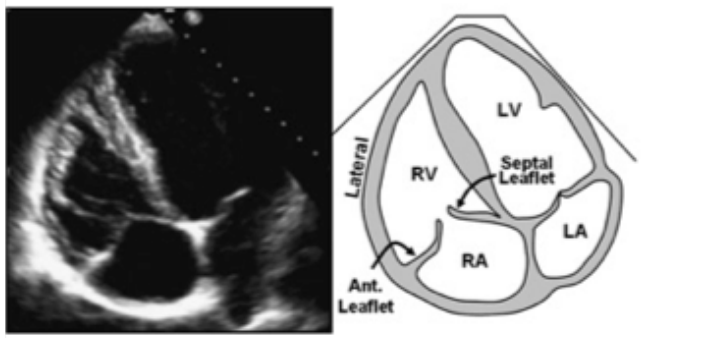




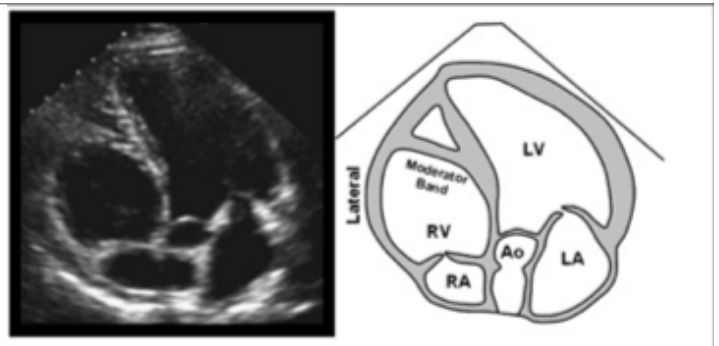
Normales:

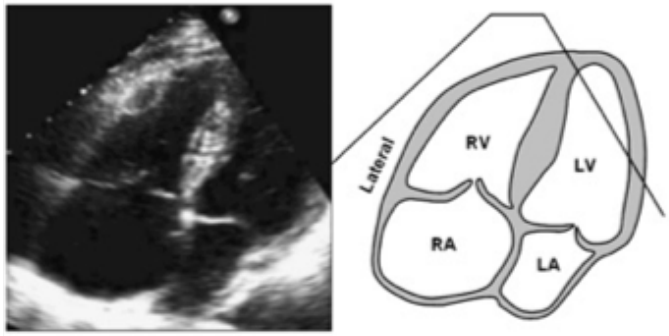
RVD1 (base) 20-28mm

RVD2 (mid) 27-33mm

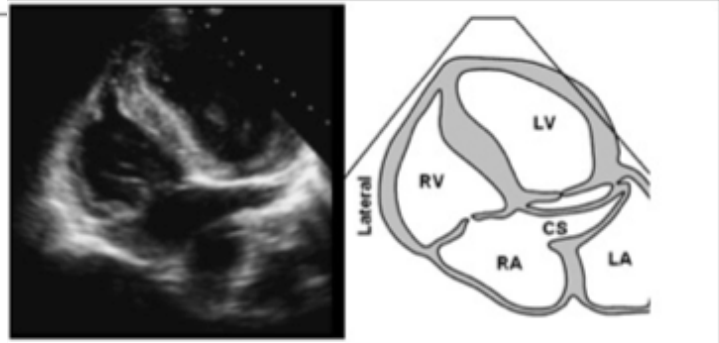


RV focused apical 4-chamber

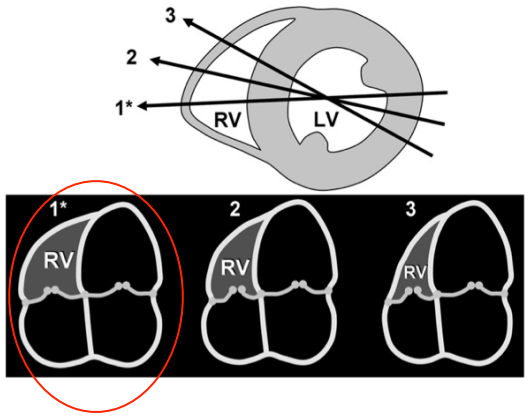


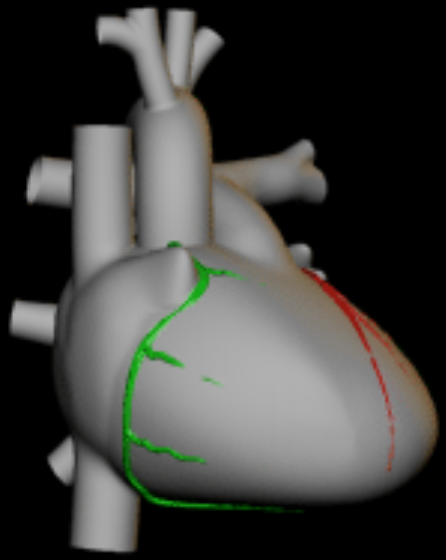


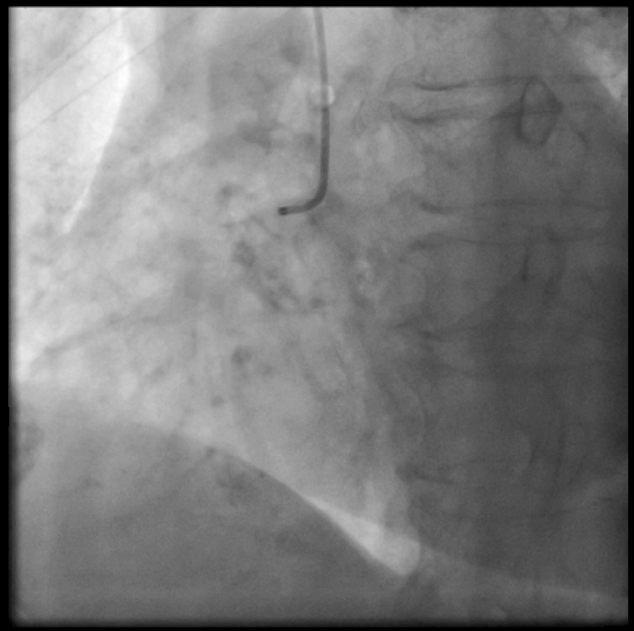
RV modified apical 4-chamber

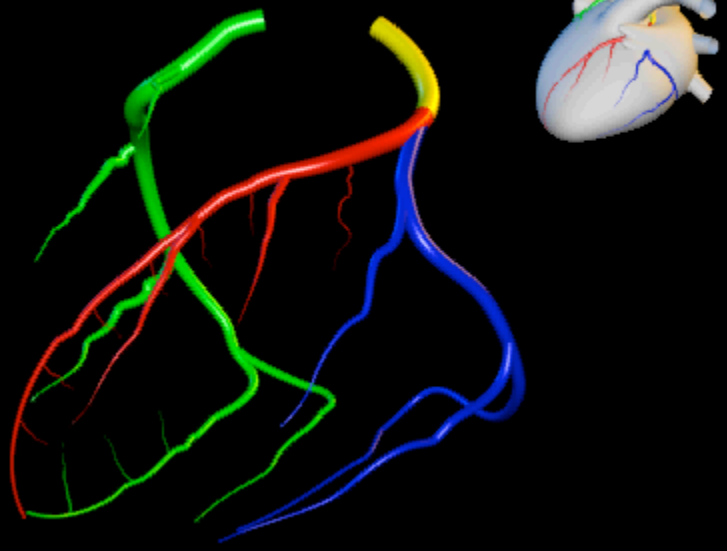


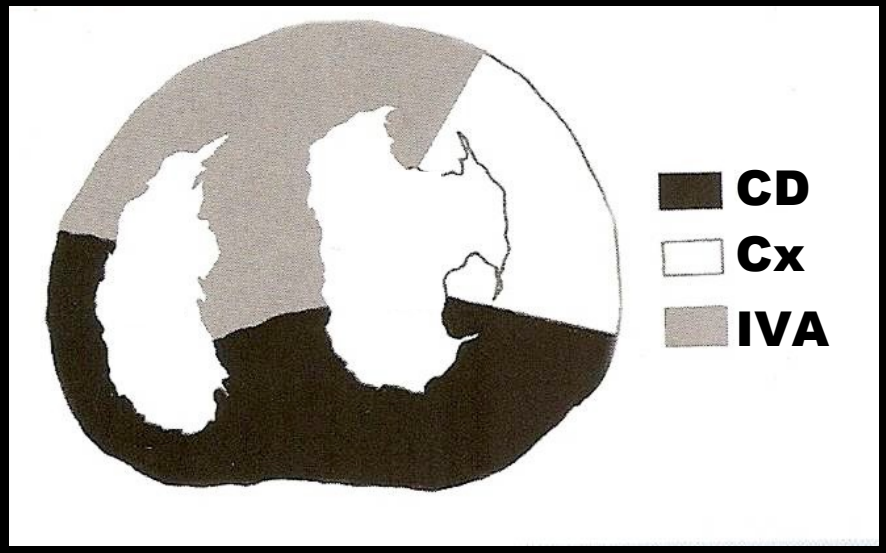
Apical coronary sinus view

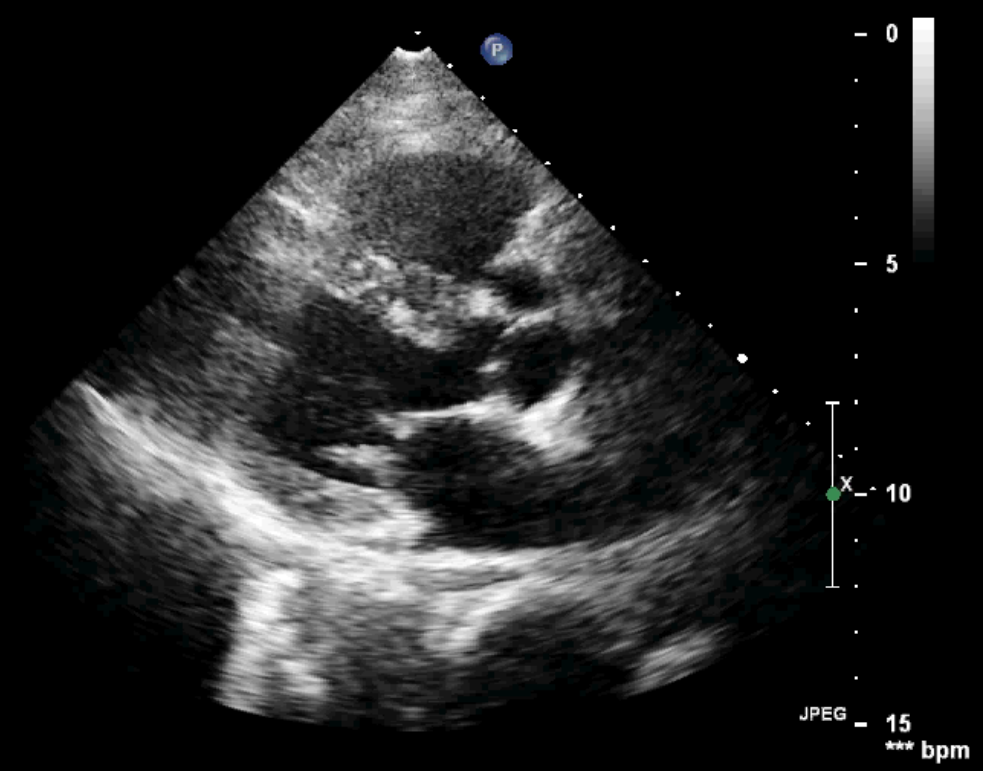


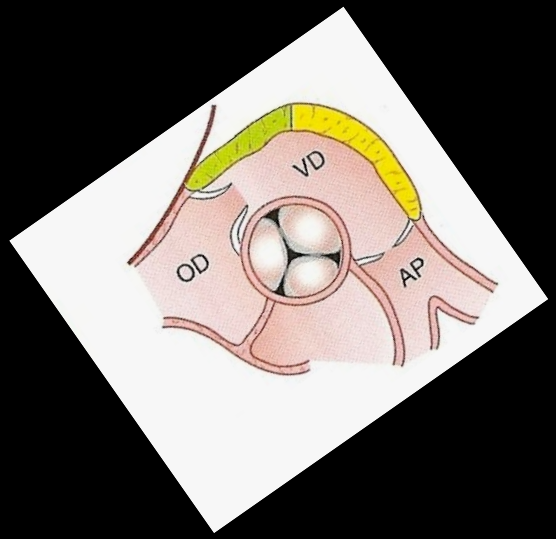


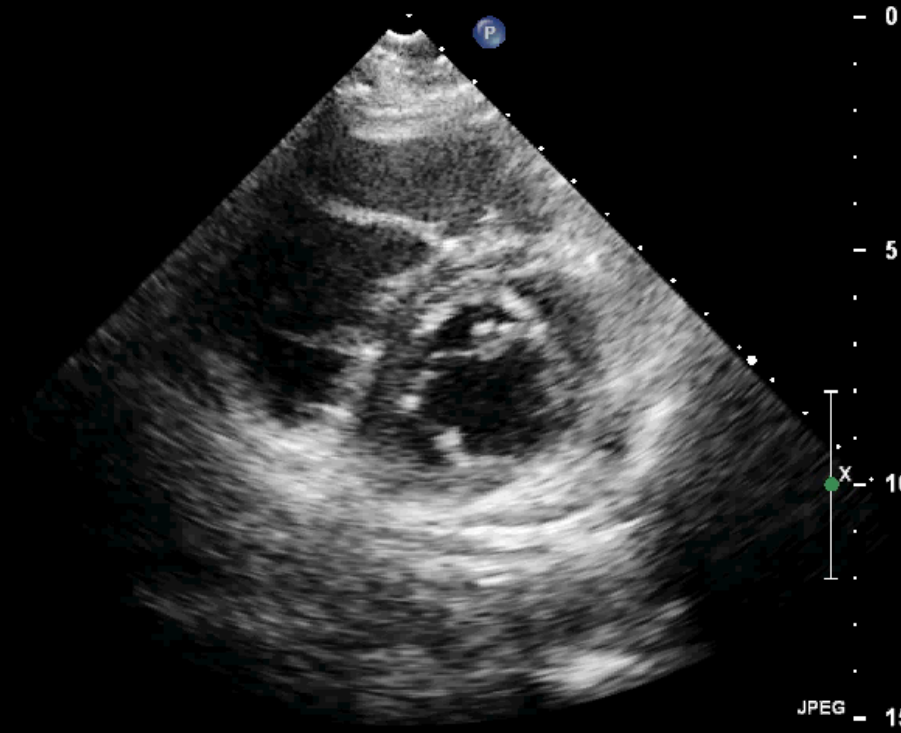





CD
Cx
IVA

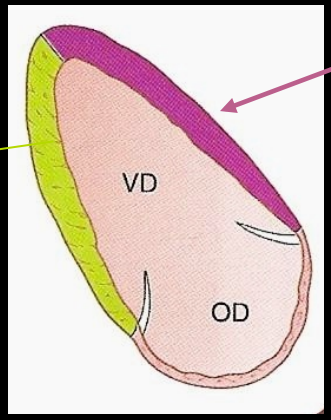

P
0
5
X
10
JPEG
15
*** bpm

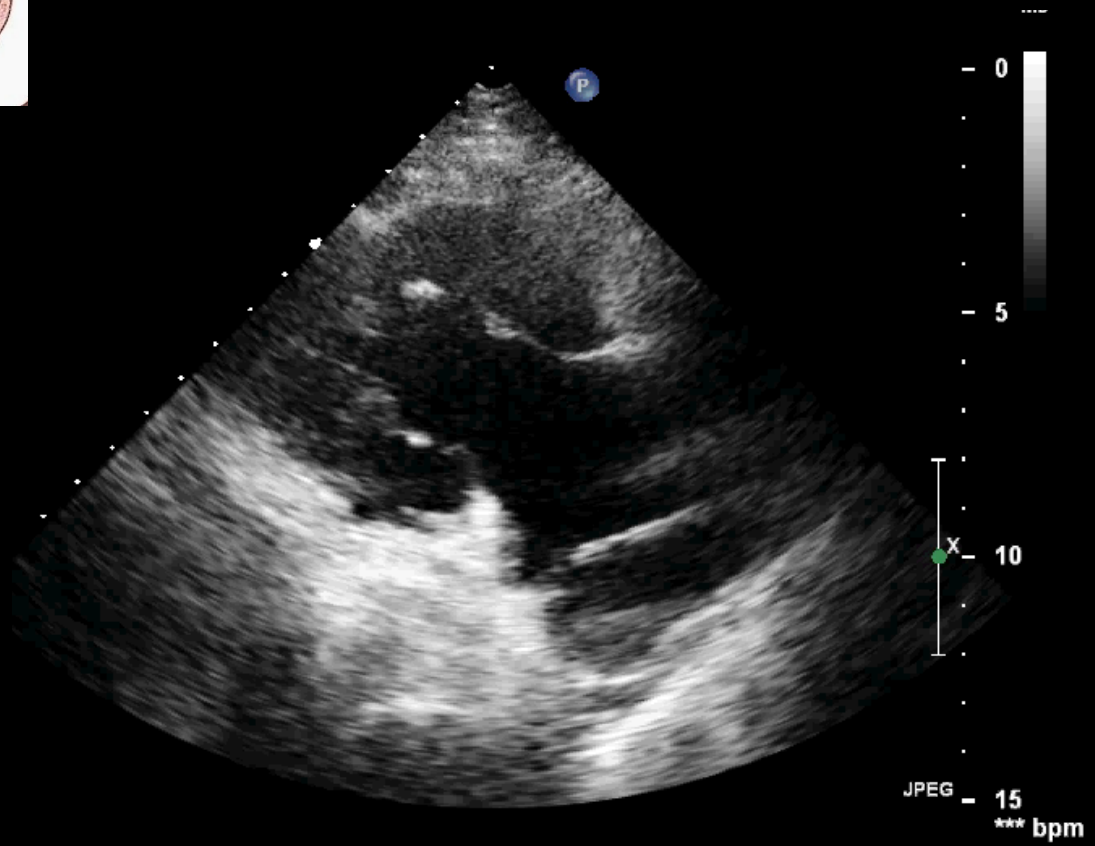

VD
OD
AP

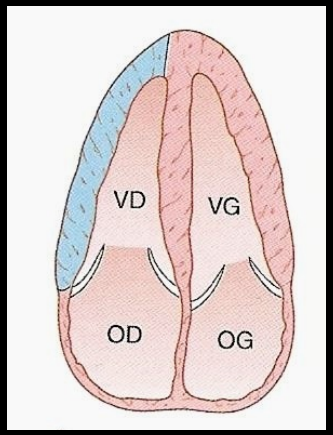

P
0
5
X
JPEG

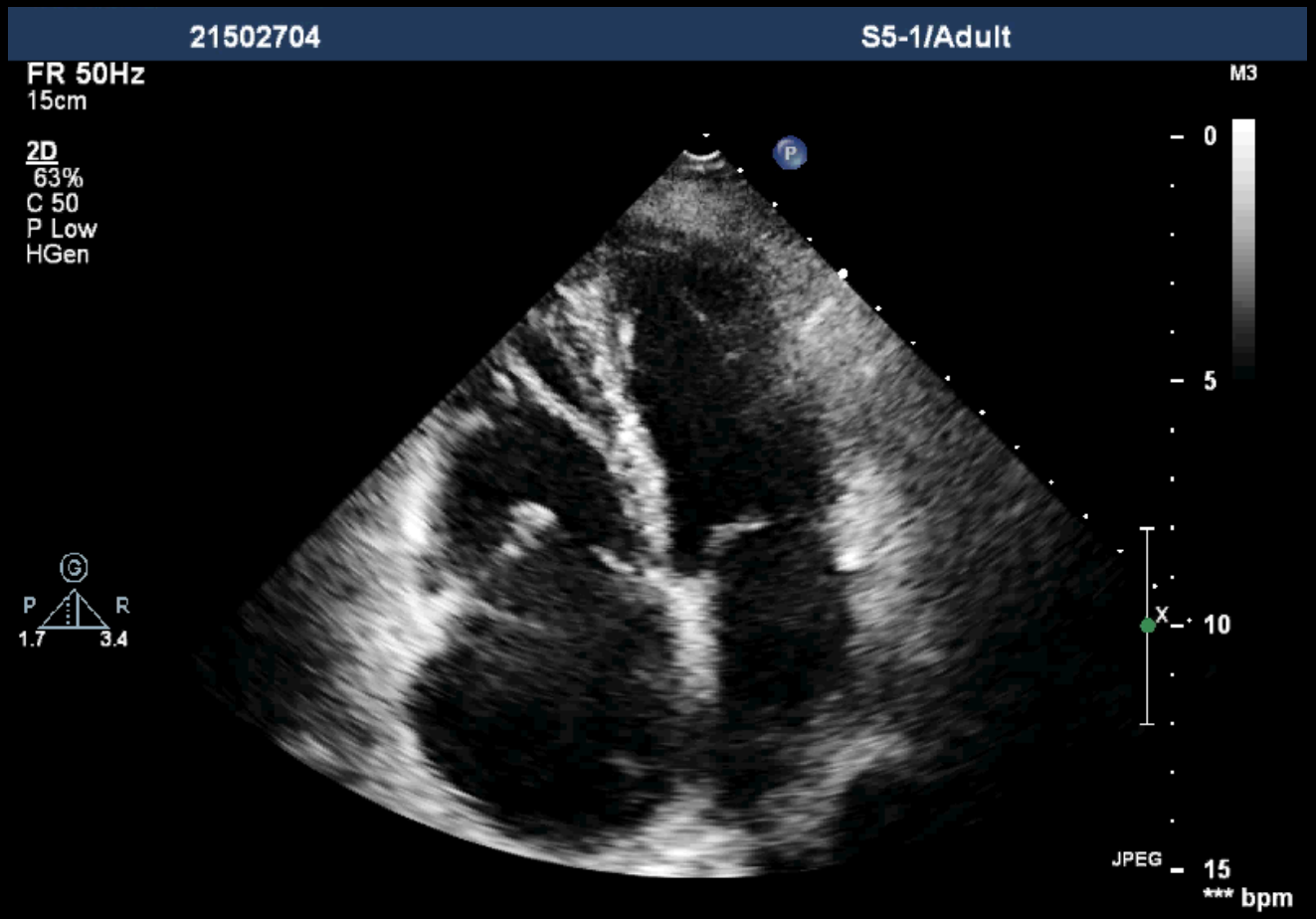
Paroi antérieure

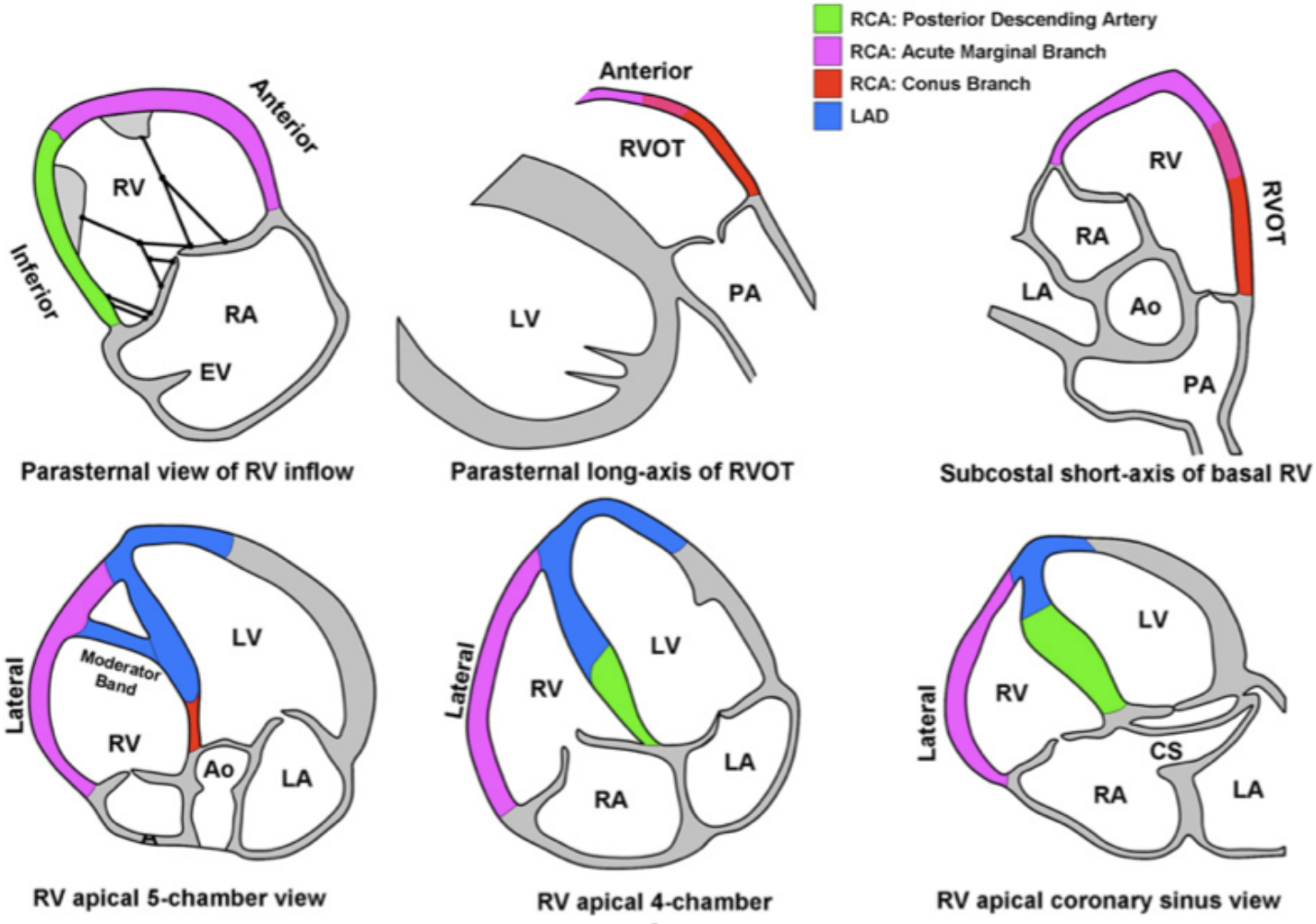
Paroi inférieure






VD
VG
OD
OG


21502704
S5-1/Adult
FR 50Hz
15cm
2D
63%
C 50
P Low
HGen
M3
0
5
10
15
JPEG
*** bpm
P
R
1.7
3.4



Guidelines for the echocardiographic assessment of the right heart in adults
J Am Soc Echocardiogr 2010; 23:685-713

RV fractional Area change

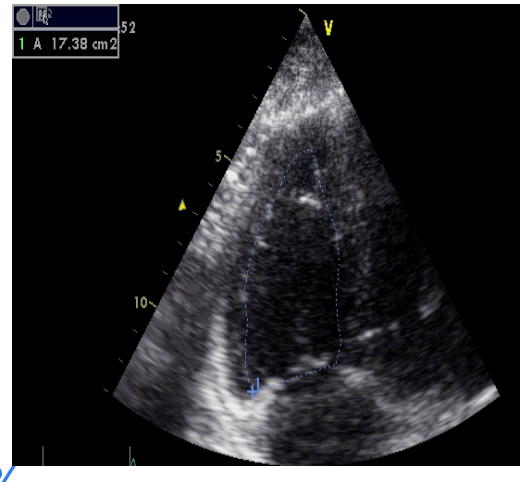
- In Apical 4 chambers view:
  - diast Area: 20 ± 4 cm^2
  - Syst Area: 11 ± 3cm^2

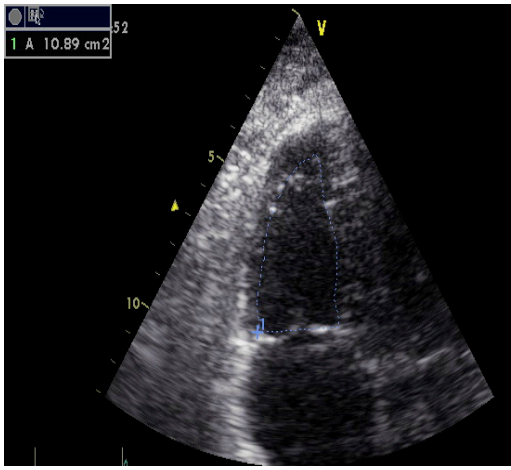
- RV fractional Area change

(diast Area – syst area)/ diast Area)

<u>normal</u> : 46 ± 7% [32 à 60%]

mildly abnormal : 25-31%
moderately abnormal: 18-24%
severely abnormal: ≤ 17%





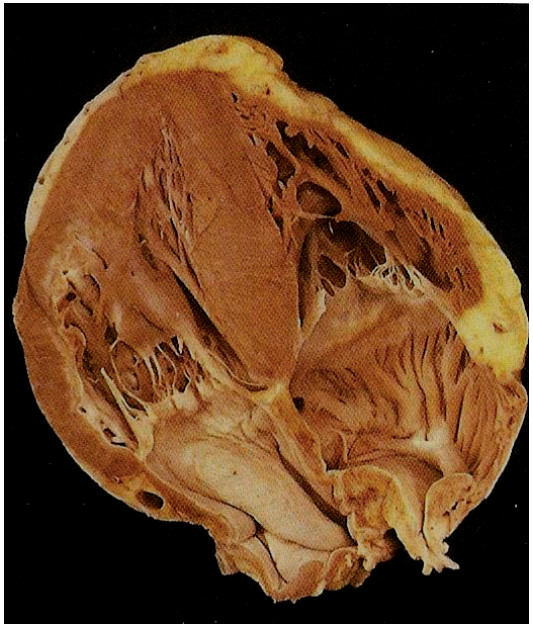
FRS= 41%

Pros:

estimation of the RV EF (r = 0.88 with MRI)

No geometric asumption.

Almost always feasible.

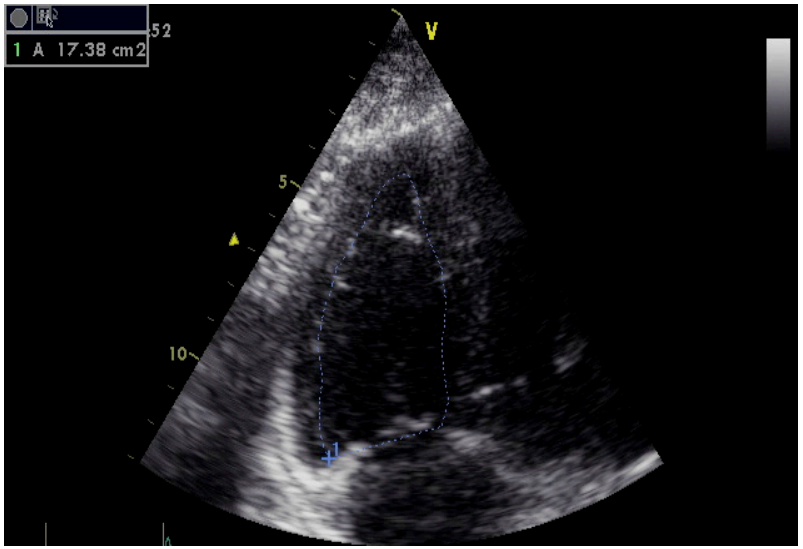


cons:

Neglects outflow tract

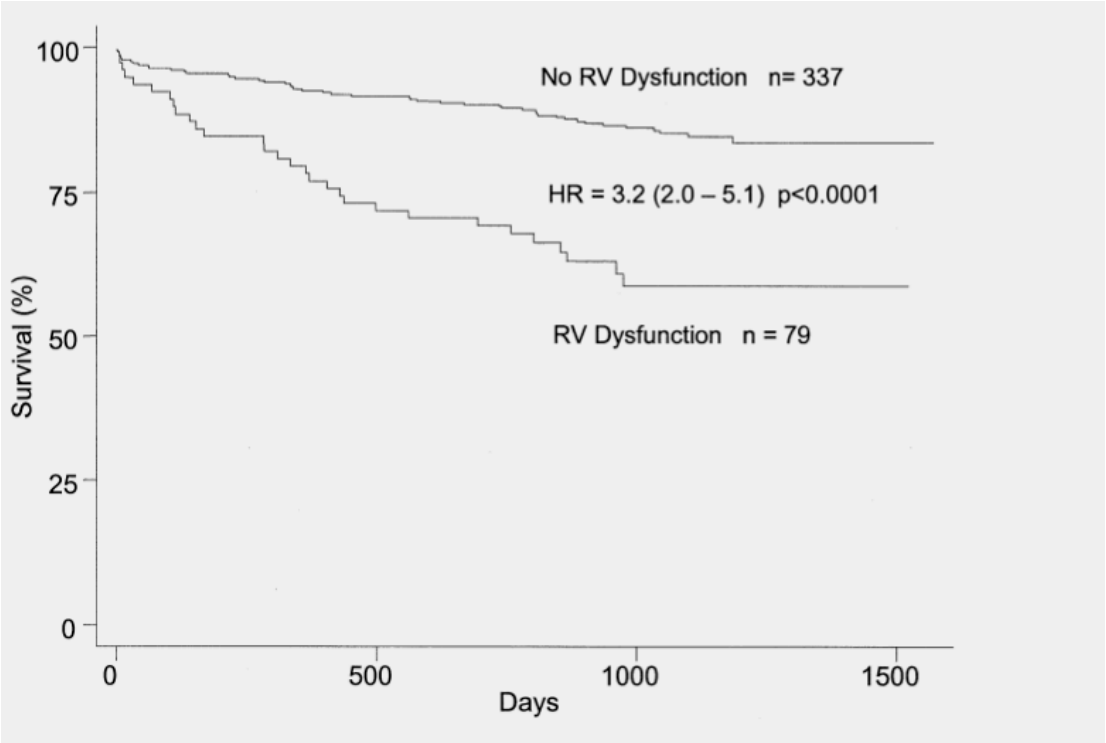
Endocardial borders (trabeculations) Apex?

Reproductibility….



RV fractional Area change

Right Ventricular Dysfunction and Risk of Heart Failure and Mortality After Myocardial Infarction



SAVE study Zornoff et al.

JACC Vol. 39, No. 9, 2002
May 1, 2002:1450–5

RV fractional Area change

Recommendations: Two-dimensional Fractional Area Change is one of the recommended methods of quantitatively estimating RV function, with a lower reference value for normal RV systolic function of 35%.

2D RV Ejection Fraction

in apical 4C,

Normal range : >45% (45-70%)

Underestimated (RVOT)

Disk summation Method

Recommendations: Two dimensionally derived estimation of RV EF is not recommended, because of the heterogeneity of methods and the numerous geometric assumptions.

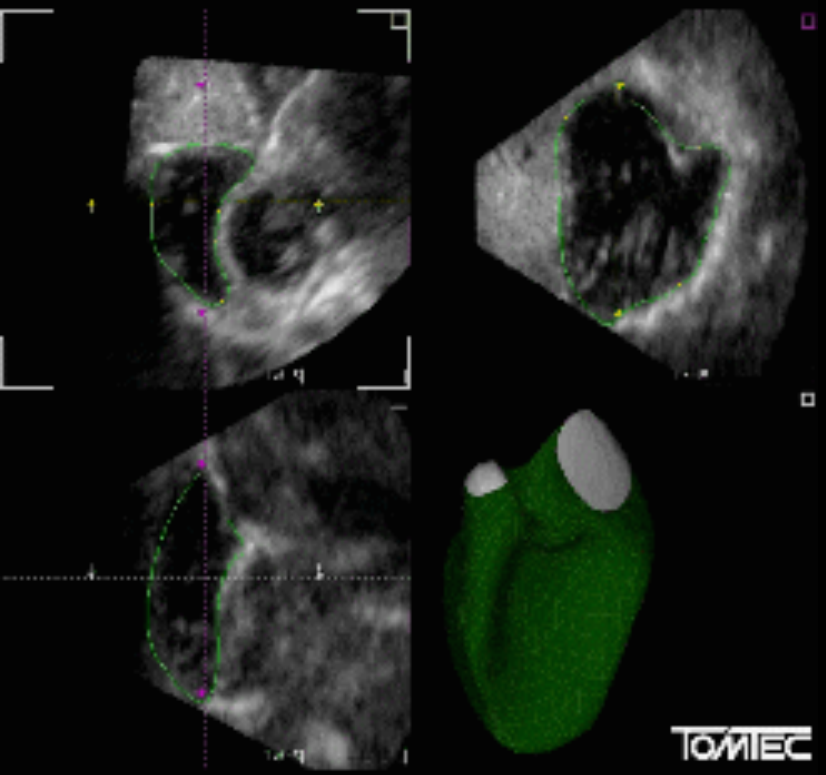
3D RV Ejection Fraction

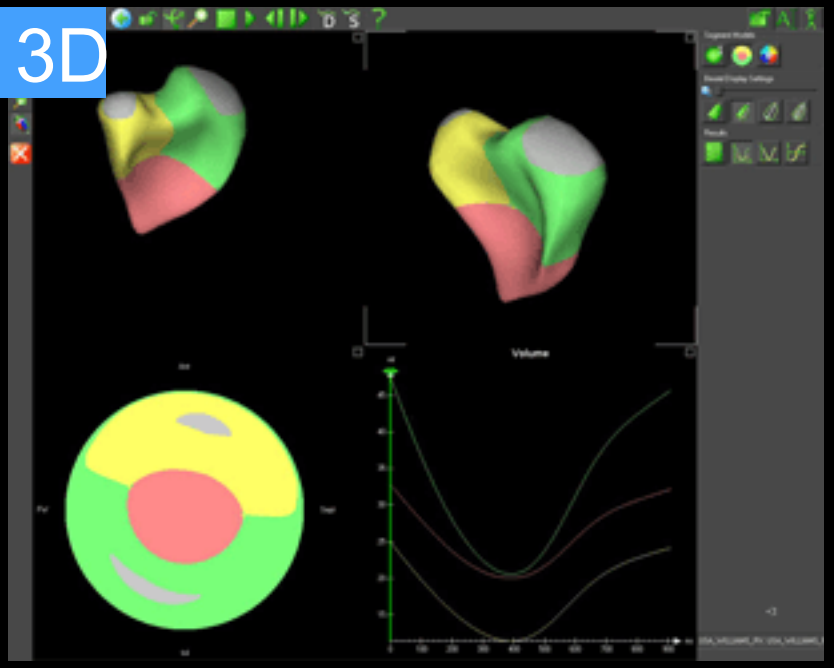
Time consuming

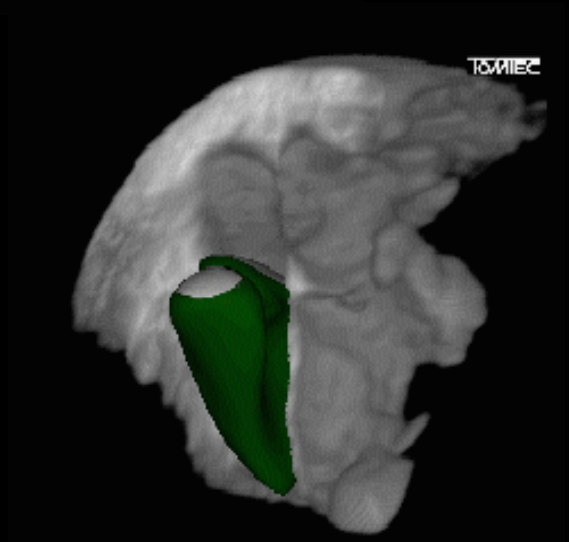
Few data in dilated and dysfunctional ventricles…

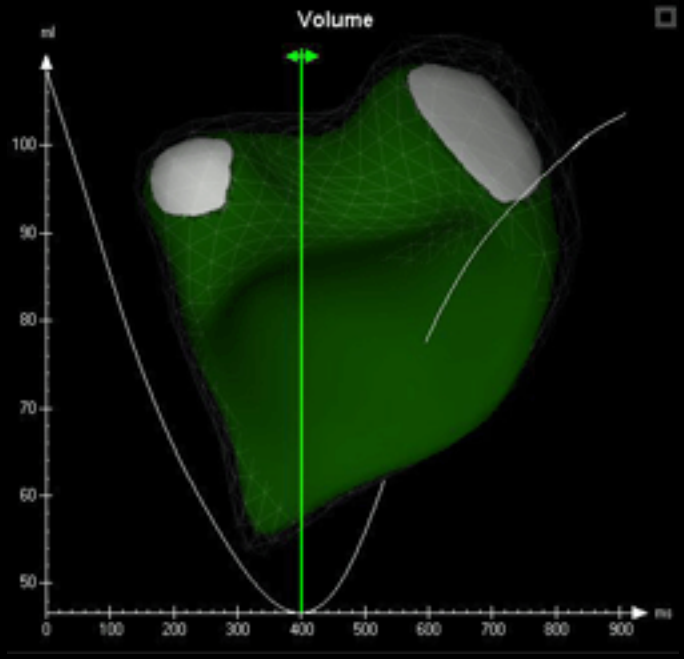
Recommendations: In studies in selected patients with RV dilatation or dysfunction, 3D echocardiography using the disk summation method may be used to report RV EFs. A lower reference limit of 44% has been obtained from pooled data. Until more studies are published, it may be reasonable to reserve 3D methods for serial volume and EF determinations.

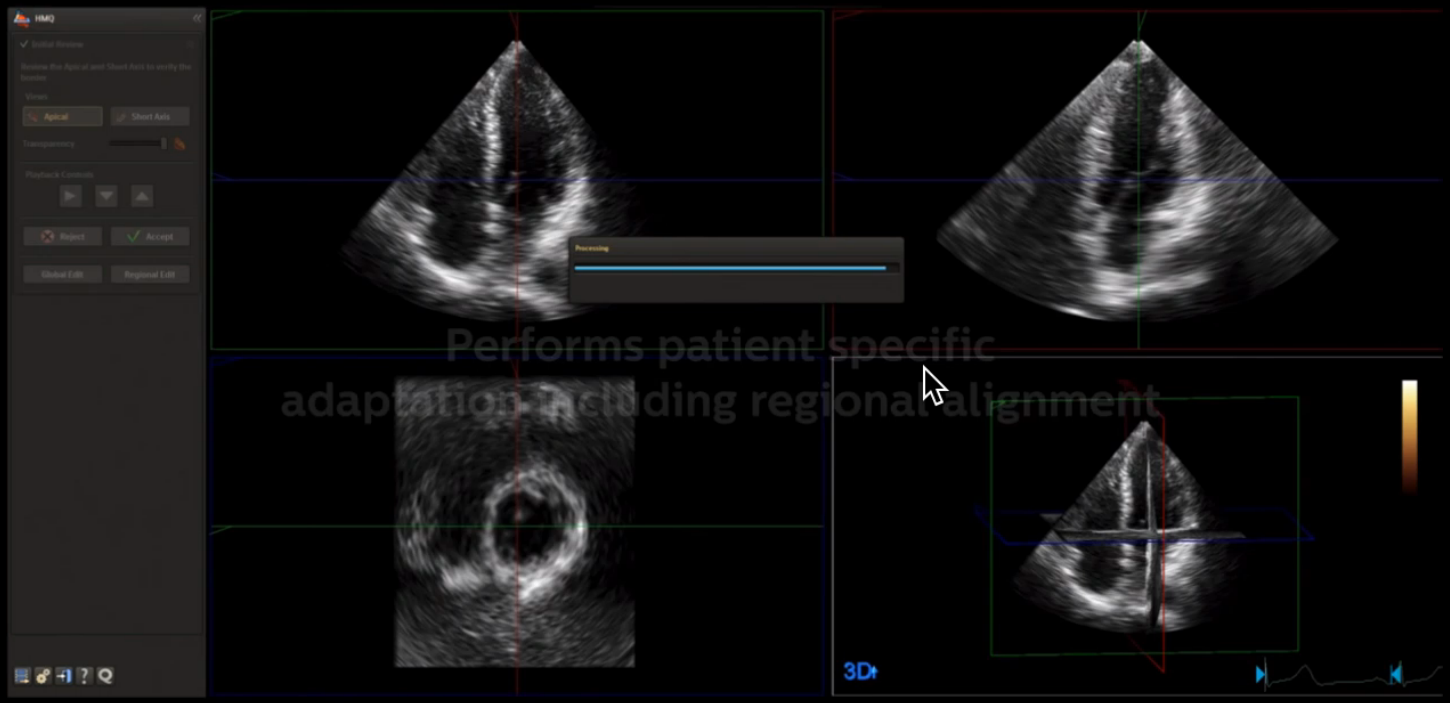
Echo 3D


TOMTEC


Volume


TOMTEC


Volume
ml
100
90
80
70
60
50
0
100
200
300
400
500
600
700
800
900
ms

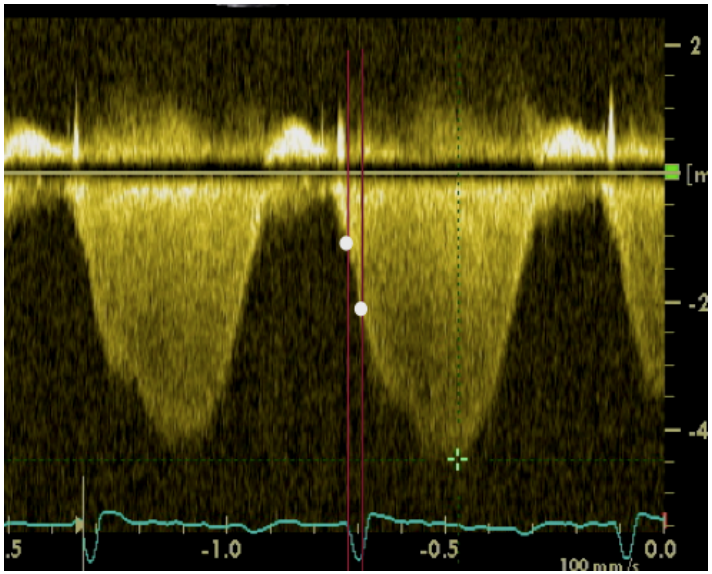


Performs patient specific adaptation including regional alignment

Actual processing time

Non volumetric methods

Dp/Dt sur IT

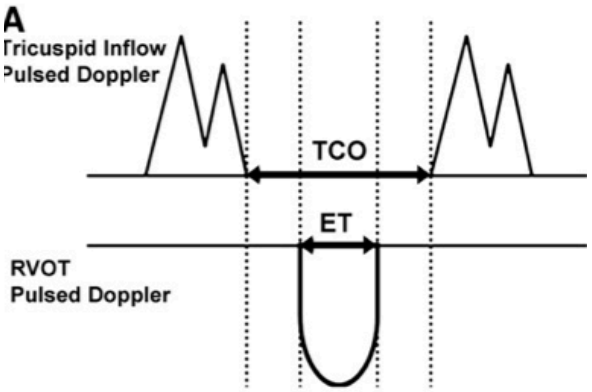


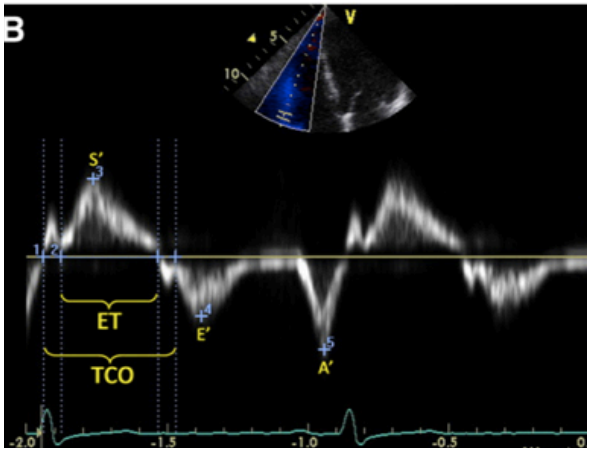
Dt between 1 and 2 m/s

Dp = 12mmHg

Recommendations: Because of the lack of data in normal subjects, RV dP/dt cannot be recommended for routine uses. It can be considered in subjects with suspected RV dysfunction. RV dP/dt < approximately 400 mm Hg/s is likely abnormal.

Tei index ??



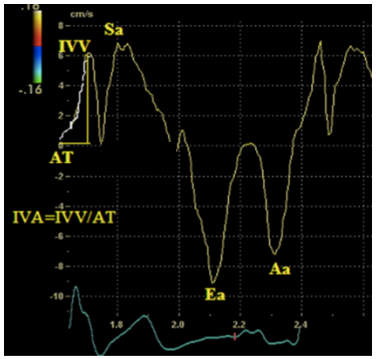


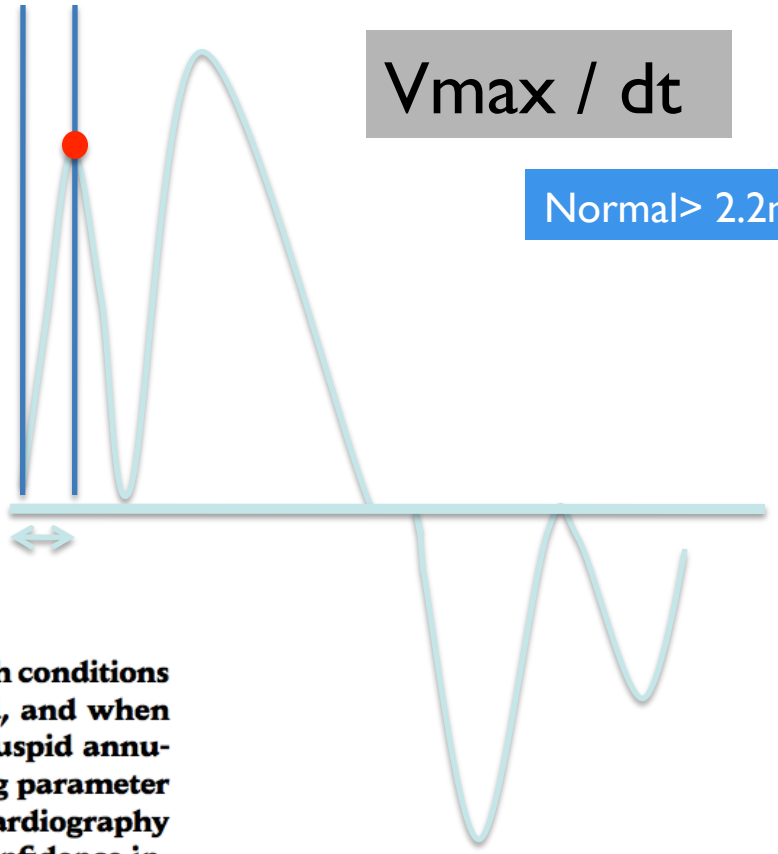
$$MPI = \frac{TCO-ET}{ET} = \frac{CIV+RIV}{ET}$$

Normal < 0.40 / 0.55

Recommendations: The MPI may be used for initial and serial measurements as an estimate of RV function in complement with other quantitative and nonquantitative measures. The upper reference limit for the right-sided MPI is 0.40 using the pulsed Doppler method and 0.55 using the pulsed tissue Doppler method. It should not be used as the sole quantitative method for evaluation of RV function and should not be used with irregular heart rates.

Myocardial Acceleration during isovolumic contraction





Vmax / dt

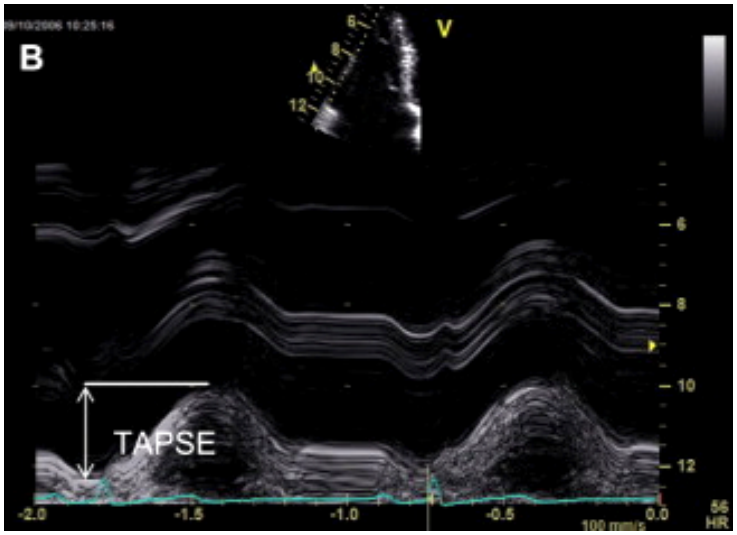
Normal> 2.2m/s^2

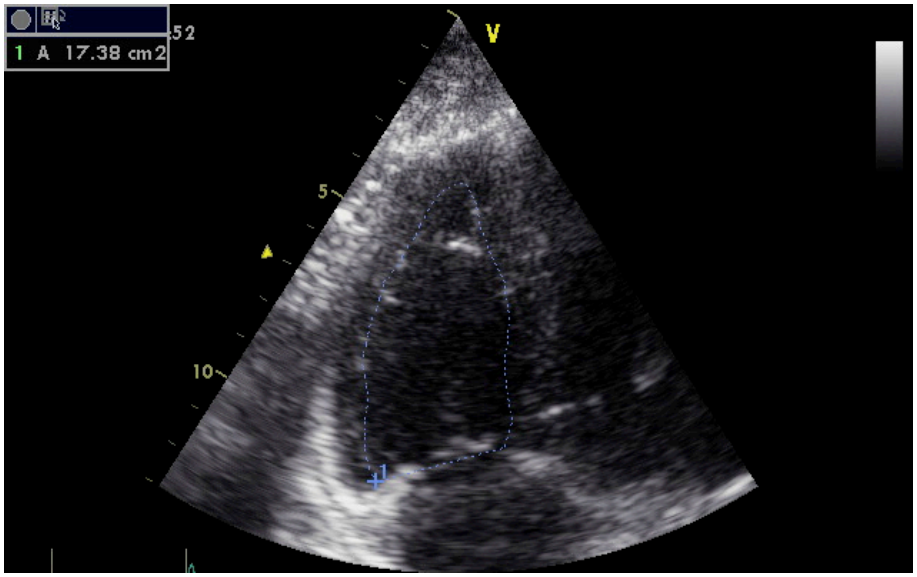
Recommendations: In studies in patients with conditions affected by RV function, RV IVA may be used, and when used, it should be measured at the lateral tricuspid annulus. RV IVA is not recommended as a screening parameter for RV systolic function in the general echocardiography laboratory population. Because of the broad confidence interval around its lower reference limit, no reference value can be recommended.

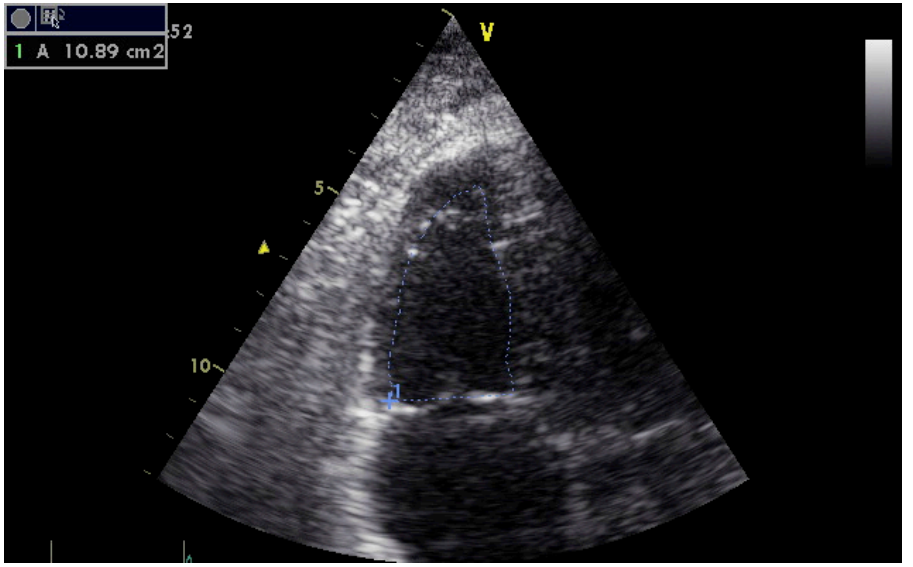
Analyze of the longitudinal motion

Tricuspid Annular Plane systolic excursion(TAPSE)

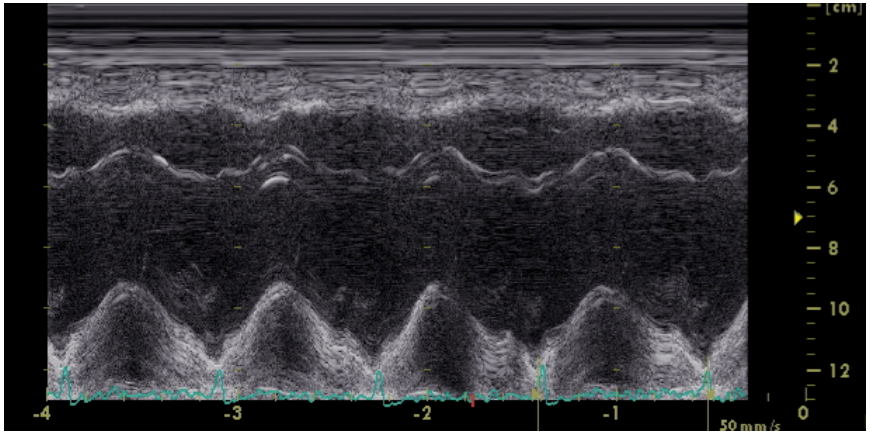
- Proposed as a surrogate to RVEF by Kaul et al.in 1984.
- correlation with RVEF (r=0.48 to 0,92) ?
- Normal range 22±4mm [miller] (15 to 20mm)







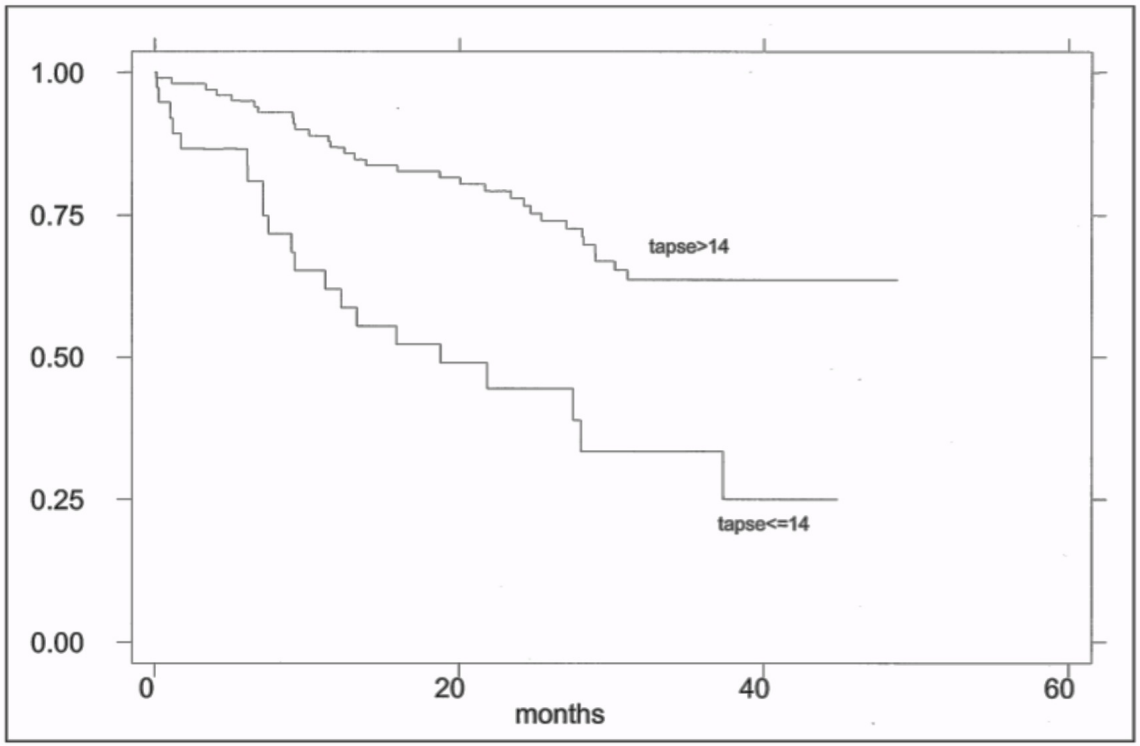
FRS= 41%



TAPSE = 28mm

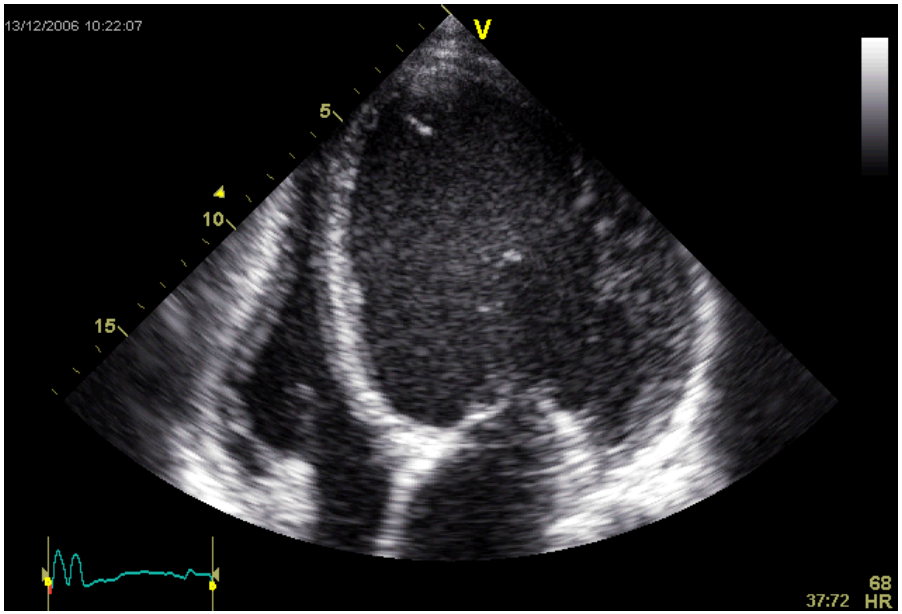
Prognostic Usefulness of the Tricuspid Annular Plane Systolic Excursion in Patients With Congestive Heart Failure Secondary to Idiopathic or Ischemic Dilated Cardiomyopathy

Stefano Ghio, MD, Franco Recusani, MD, Catherine Klersy, MD, Roberta Sebastiani, MD, Maria Luisa Laudisa, MD, Carlo Campana, MD, Antonello Gavazzi, MD, and Luigi Tavazzi, MD



(Am J Cardiol 2000;85:837–842)

CRT



REVERSE TRIAL

Randomized, n=610

- TAPSE is an independent predictor of
  - LV reverse remodeling
  - a favorable clinical outcome

  - in patients with mildly symptomatic systolic HF (I –II)

- TAPSE does not modulate the effect of CRT
  ≠ NYHA III-IV
- CRT does not improve RV systolic function as assessed by TAPSE

REVERSE Clinical Trial

Kjaergaard J et al. J Card Fail. 2011 Feb;17(2):100-7.

TAPSE

Advantages:

Simple, reproductible, fast

Disadvantages:

- 1 segment represents a complex 3D motion
- angle dependent
- load dependent
- ! After cardiac surgery

Recommendations: TAPSE should be used routinely as a simple method of estimating RV function, with a lower reference value for impaired RV systolic function of 16 mm. **17 mm**

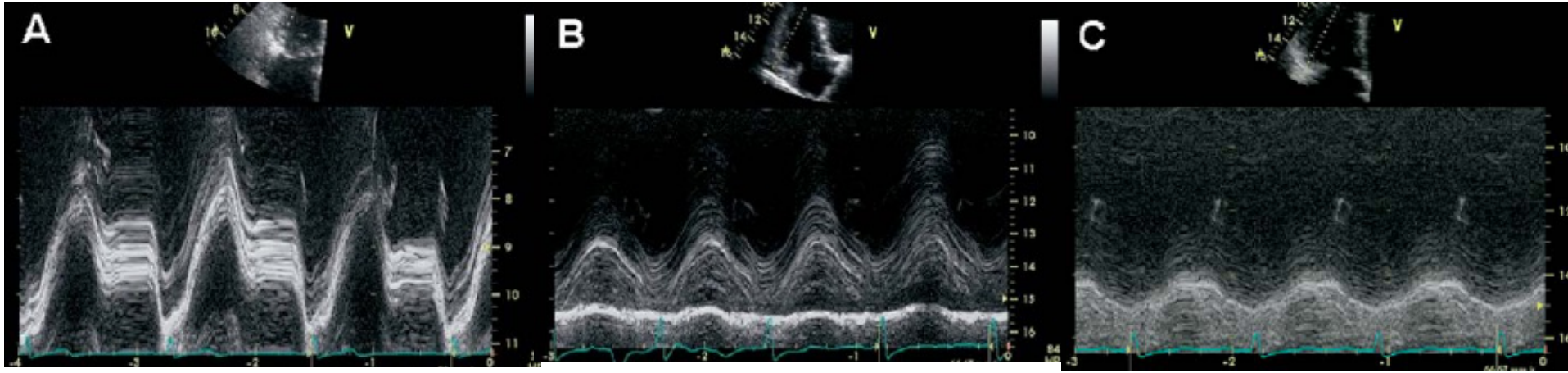
2010 2015

but …

Right Ventricular Systolic Function Is Not the Sole Determinant of Tricuspid Annular Motion

Angel López-Candales, MD*, Navin Rajagopalan, MD, Neil Saxena, MD, Beth Gulyasy, RDCS, Kathy Edelman, RDCS, and Raveen Bazaz, MD

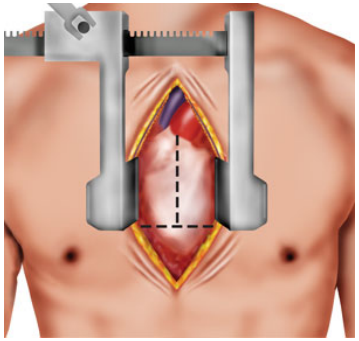
Am J Cardiol 2006;98: 973–977



Normal
RV and LV function

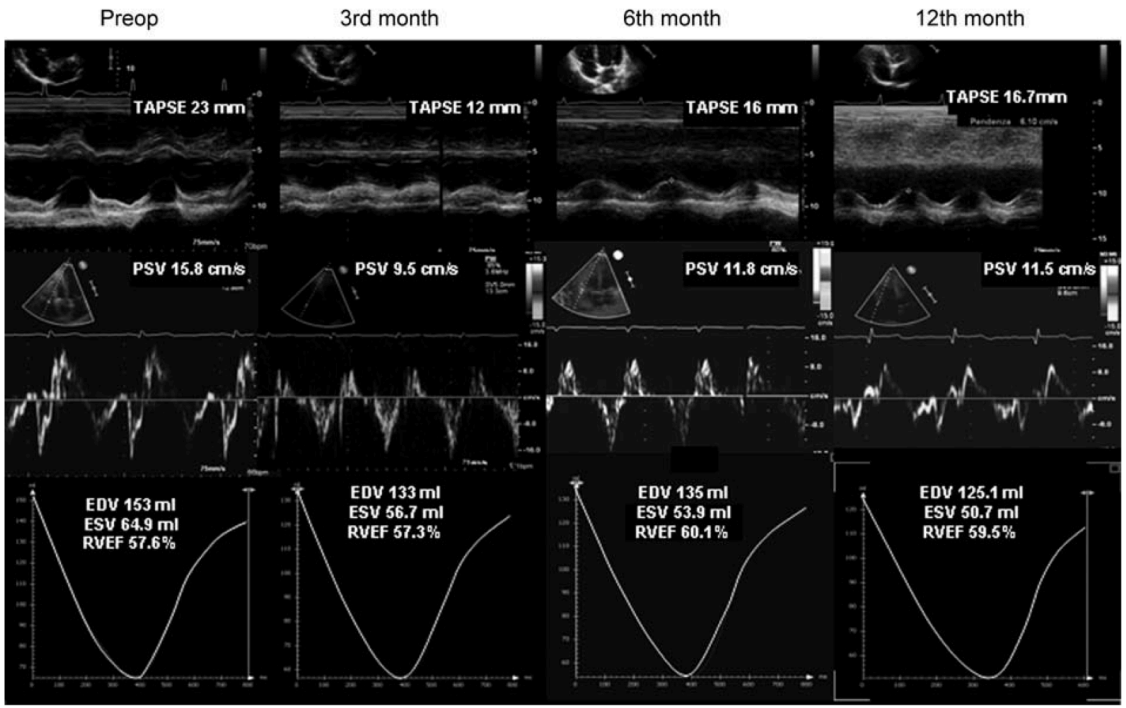
RV Systolic dysfct
Normal LVEF

Both LV and RV
dysfunction



Is right ventricular systolic function reduced after cardiac surgery? A two- and three-dimensional echocardiographic study

Gloria Tamborini[1]*, Manuela Muratori[1], Denise Brusoni[1], Fabrizio Celeste[1], Francesco Maffessanti[1,2], Enrico G. Caiani[2], Francesco Alamanni[1], and Mauro Pepi[1]



Protection myocardique du vd insuffisante pendant la CEC
↘ de la contraction longitudinale et ↗ radiale
Indice global plutôt que TAPSE

European Journal of Echocardiography (2009) 10, 630–634

Tdi

Advantages:

Simple, reproductible, fast

Disadvantages:

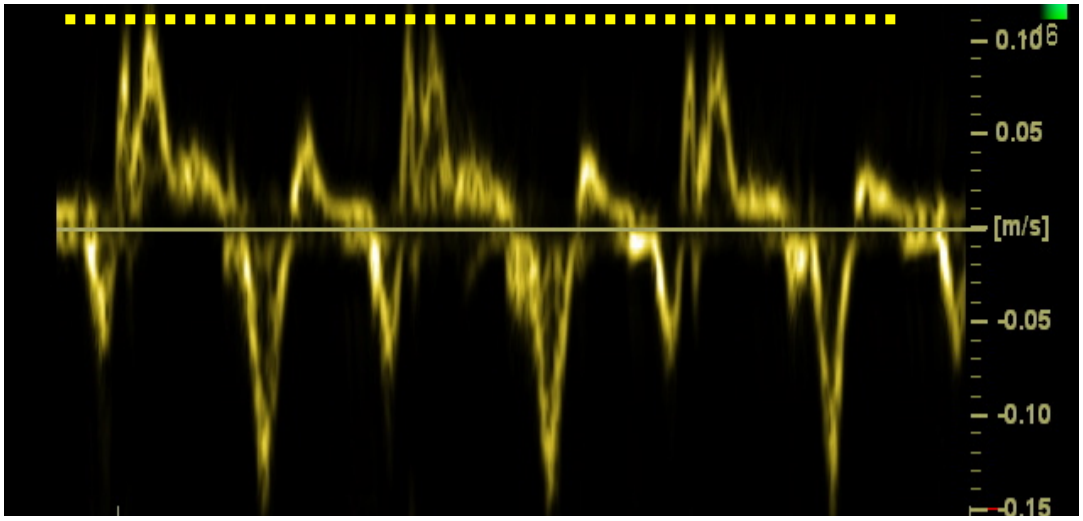
1 segment represents a complex 3D motion

angle dependent

load dependent

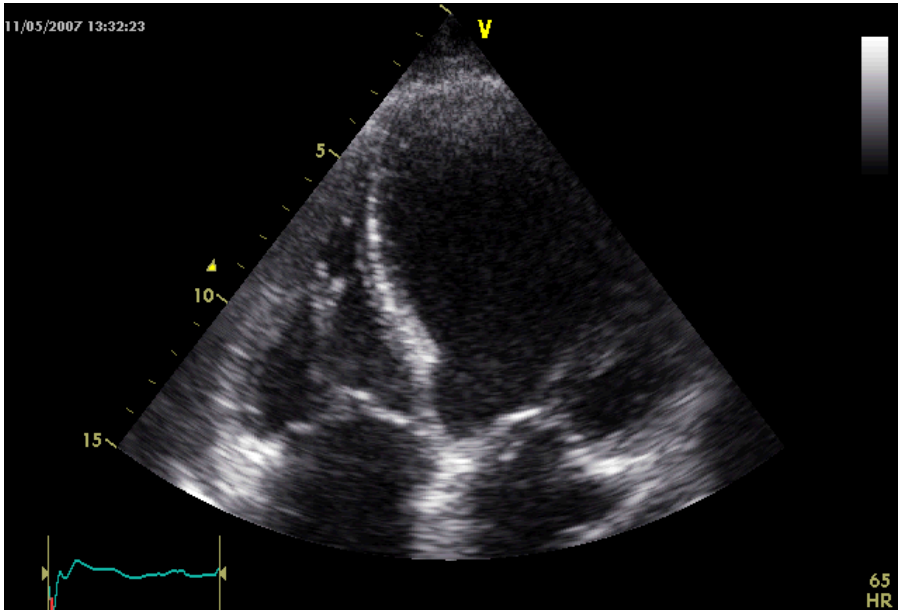
Recommendations: Interrogation of S′ by *pulsed* tissue Doppler is a simple and reproducible measure to assess *basal* RV free wall function and should be used in the assessment of RV function. S′ < 10 cm/s should raise the suspicion for abnormal RV function, particularly in a younger adult patient. There are insufficient data in the elderly. Offline analysis by *color-coded* tissue Doppler currently remains a research tool, with less data and wider confidence intervals for normal values.

Peak systolic velocity of the lateral tricuspid annulus (using Tdi)

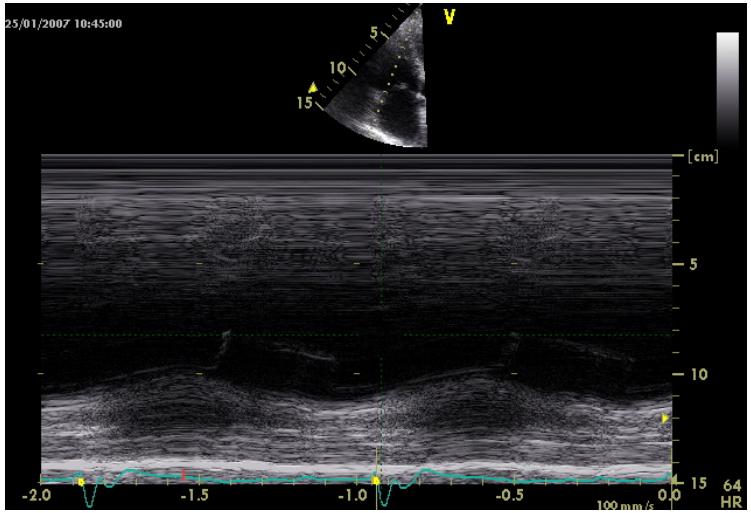


- Good correlations with isotopic RVEF
- Sa **> 15 cm/s: normal RV systolic function**
- Sa **< 11.5 cm/s : RVEF < 45%**

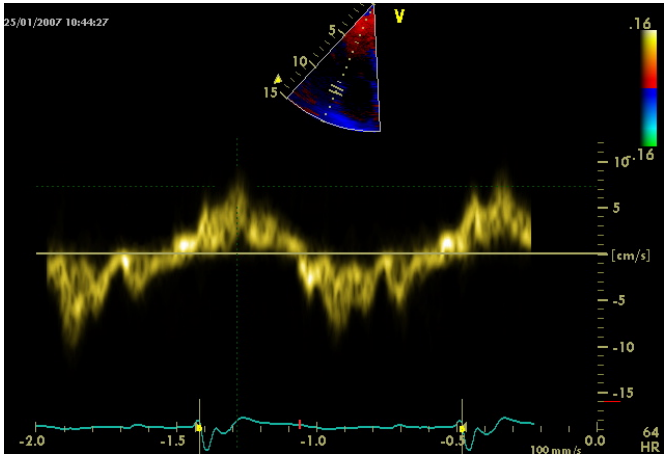
Sa and TAPSE: reduced value when significant TR



FRS 30%



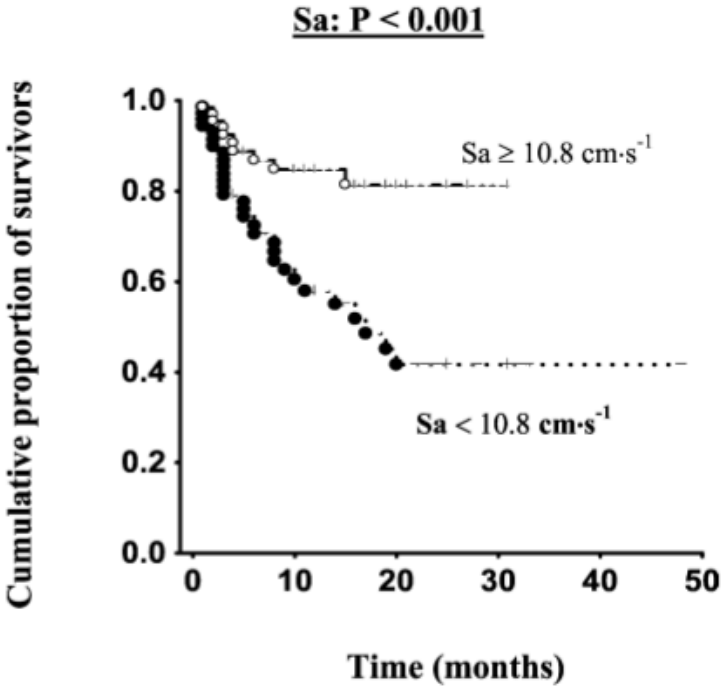
TAPSE 10mm



S à 8cm/s

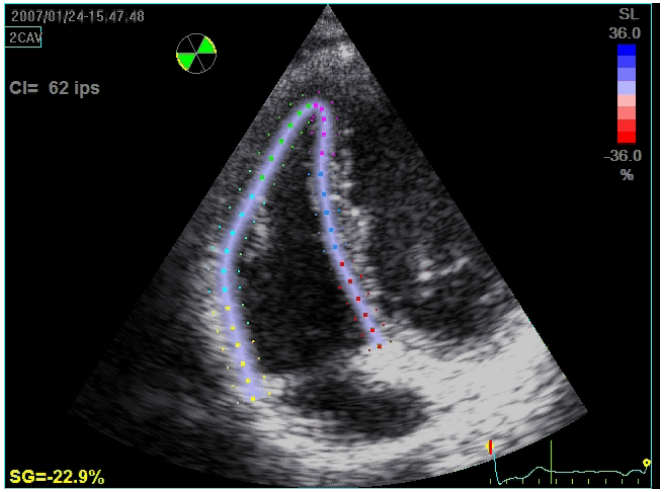
Prognostic value of S in heart failure

n = 139



Meluzin et al., Eur J Echocardiography (2003) 4, 262–271

2D strain



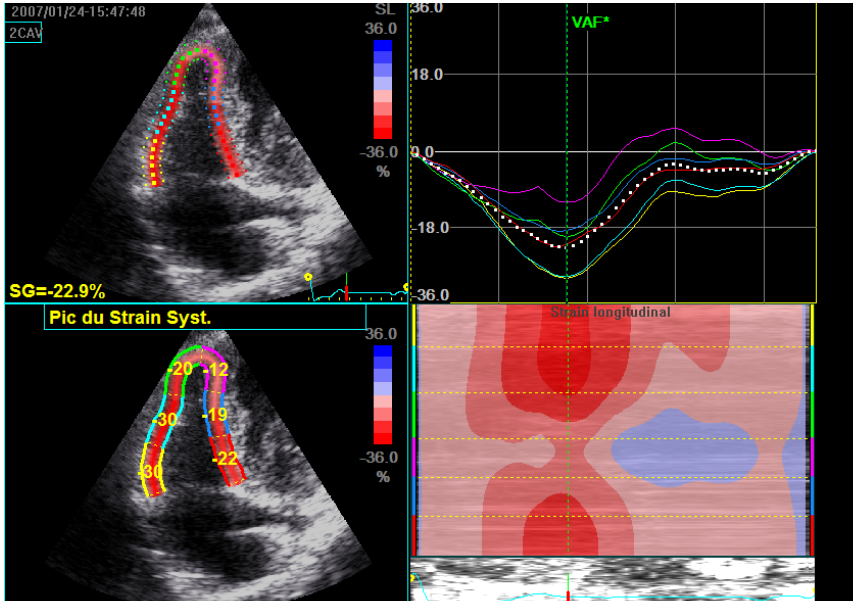


Table 10 Normal values for parameters of RV function

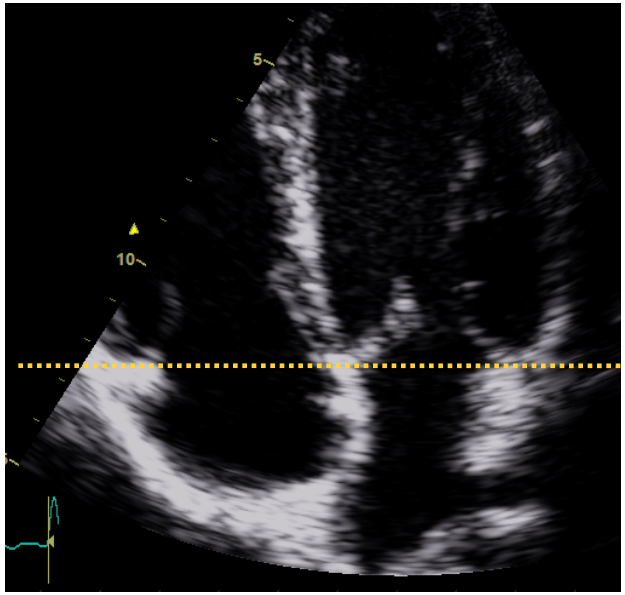
Parameter	Mean ± SD	Abnormality threshold
TAPSE (mm)	24 ± 3.5	<17
Pulsed Doppler S wave (cm/sec)	14.1 ± 2.3	<9.5
Color Doppler S wave (cm/sec)	9.7 ± 1.85	<6.0
RV fractional area change (%)	49 ± 7	<35
RV free wall 2D strain* (%)	−29 ± 4.5	>−20 (<20 in magnitude with the negative sign)

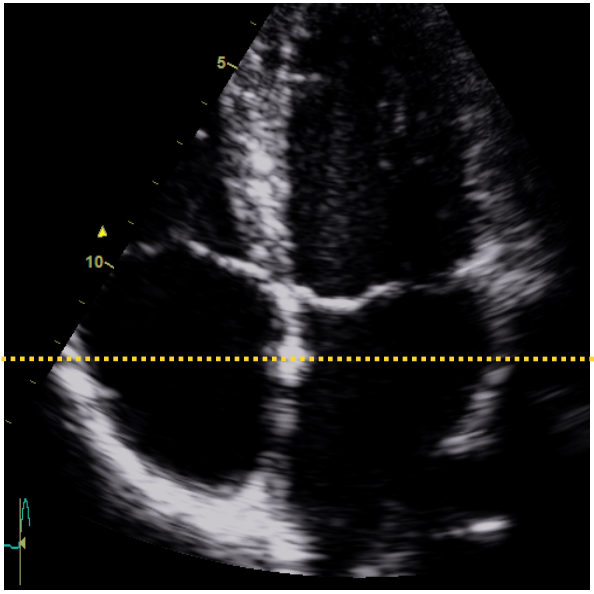
Normal value = -24 ± 5% *(AmJ Cardiol 2006)*

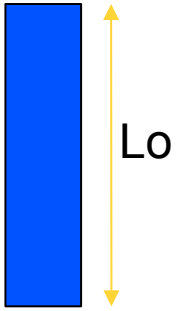
Longitudinal Strain

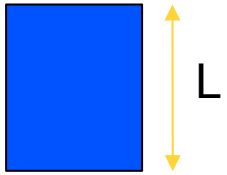
Diastole

Systole

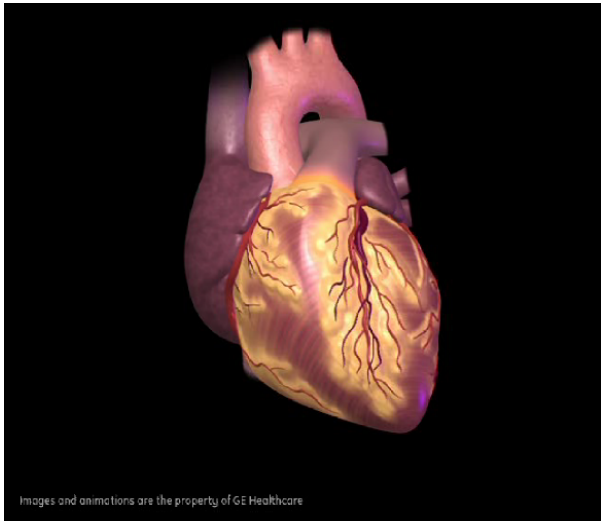




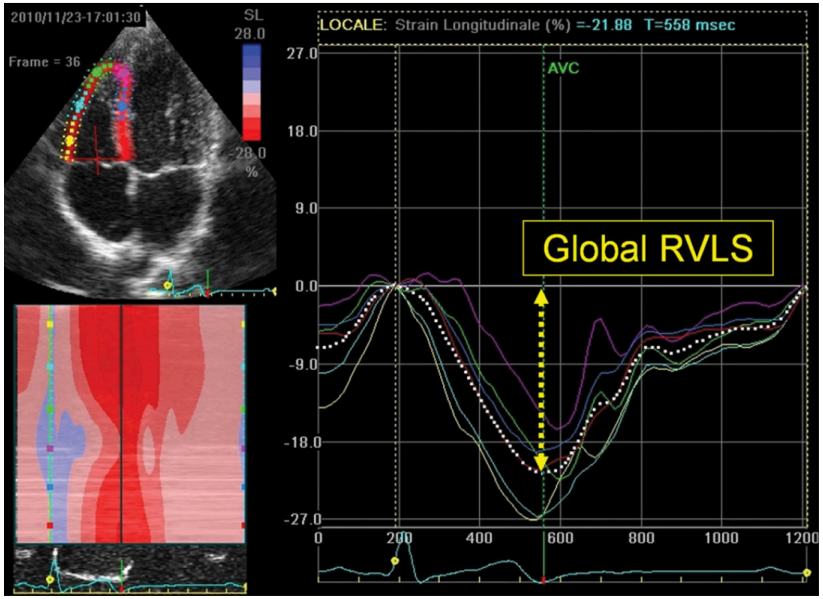


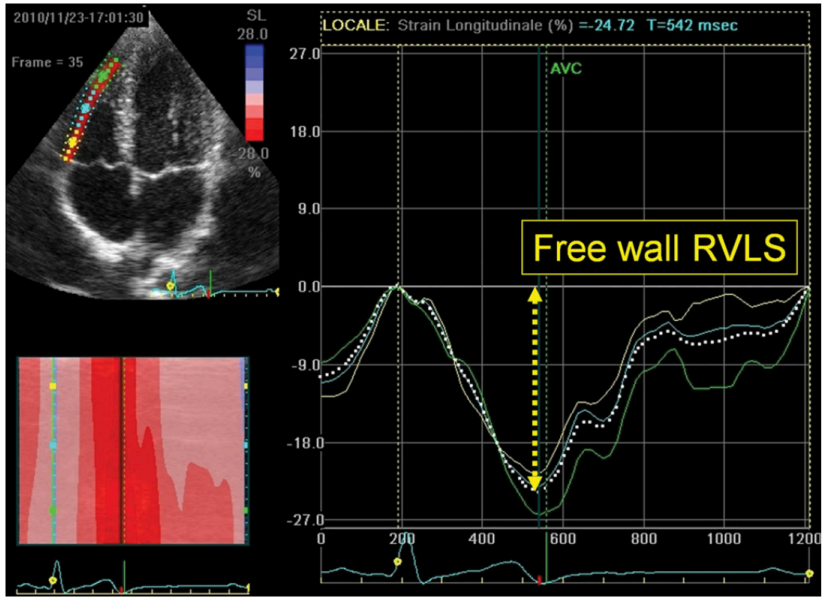


Strain = $\frac{L-Lo}{Lo}$ → **% negative**



2 ways to use it





Global strain

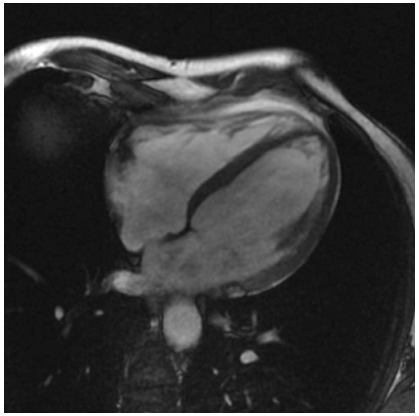
(including IV septum)

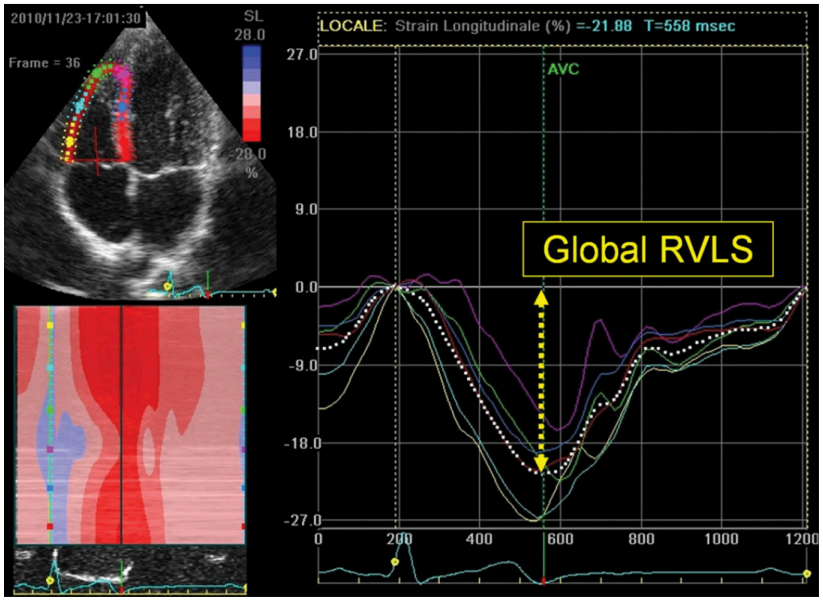
Free wall strain

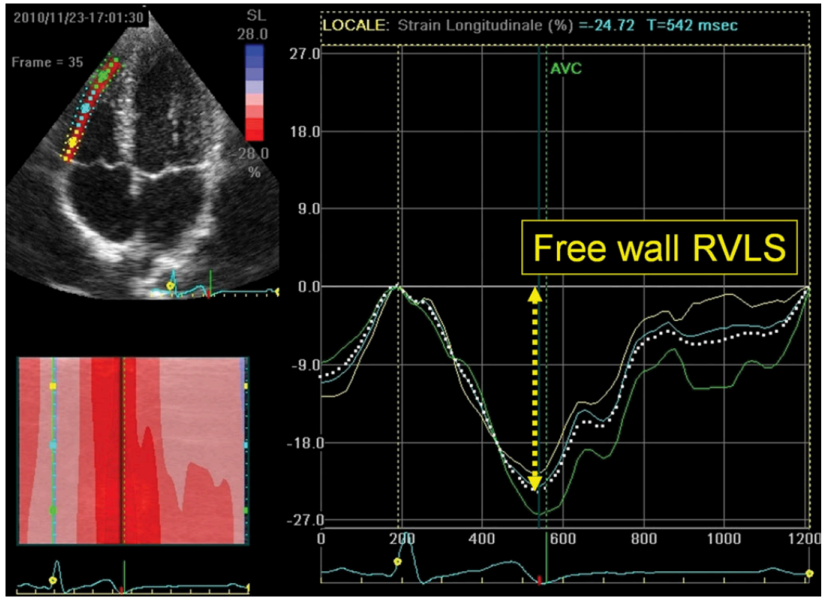
(excluding IV septum)

Traditional and innovative echocardiographic parameters for the analysis of right ventricular performance in comparison with cardiac magnetic resonance

Marta Focardi[1†], Matteo Cameli[1†*], Salvatore Francesco Carbone[2], Alberto Massoni[1], Raffaella De Vito[1], Matteo Lisi[1], and Sergio Mondillo[1]







European Heart Journal – Cardiovascular Imaging (2015) 16, 47–52

Traditional and innovative echocardiographic parameters for the analysis of right ventricular performance in comparison with cardiac magnetic resonance

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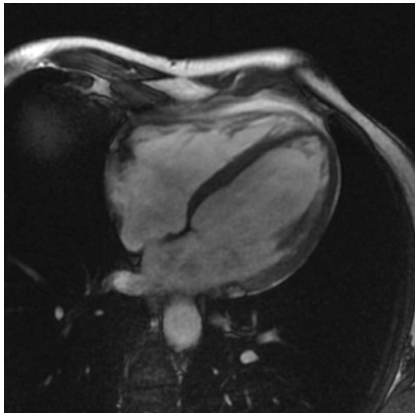


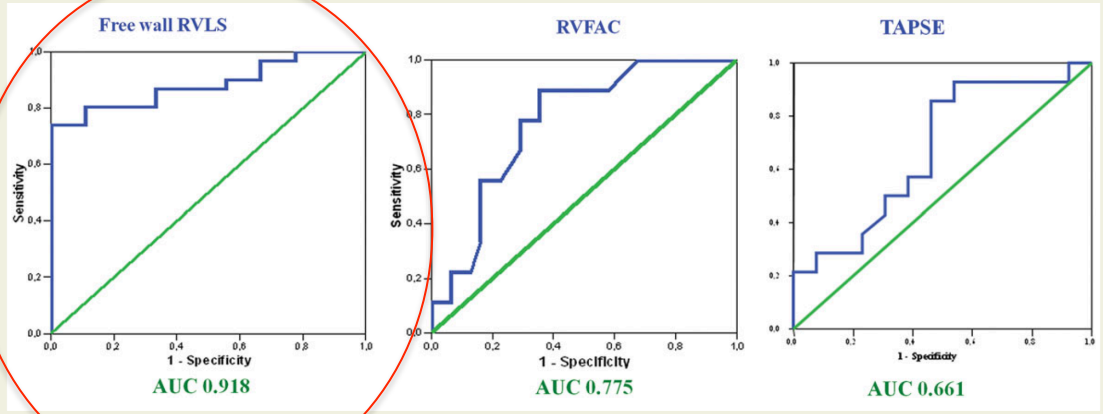
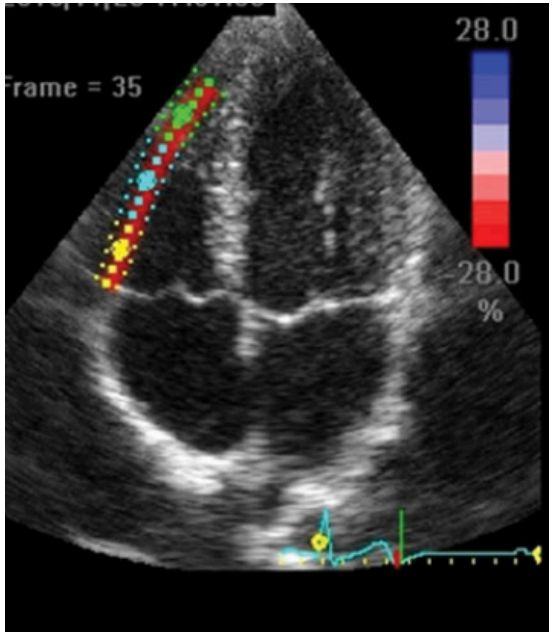


Figure 3: ROC curves regarding diagnostic accuracy in predicting a depressed RVEF.



European Heart Journal – Cardiovascular Imaging (2015) 16, 47–52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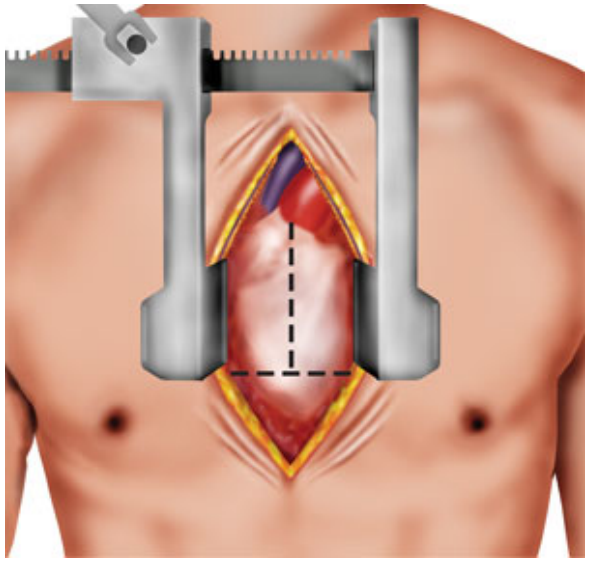
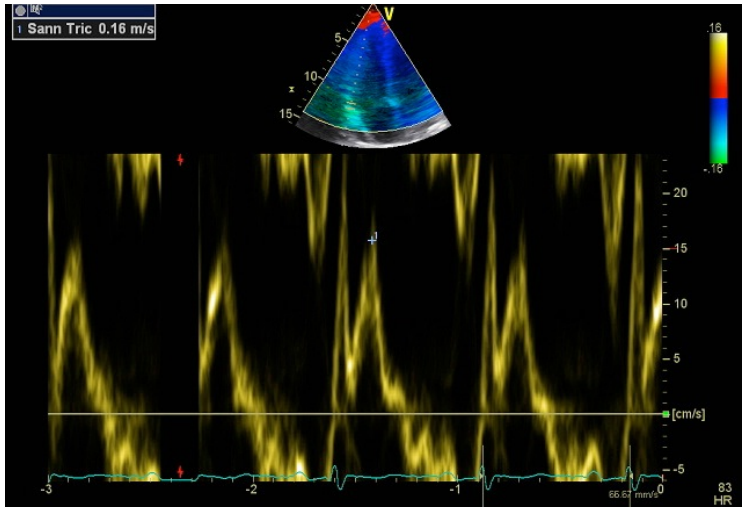


2D STRAIN in Pulmonary Hypertension

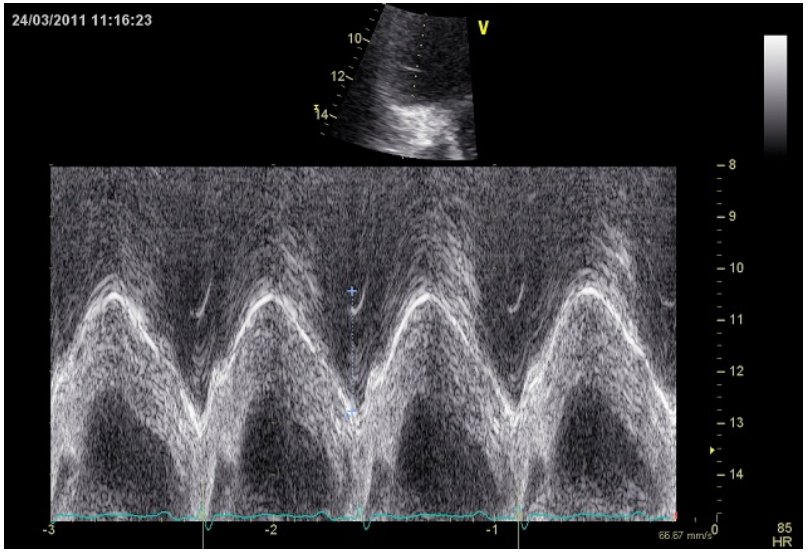
	Pulmonary Hypertension (n=36)	Healthy Volunteers (n=39)	P value
Global Strain VD (%)	-16 ± 4	-23 ± 3	<.001
Strain segment basal paroi libre (%)	-19 ± 7	-27 ± 5	<.001
TAPSE (mm)	12 ± 3	18 ± 3	<.001
FRS VD (%)	31 ± 10	45 ± 8	<.001
Indice d'asynchronisme VD sur 6 segments (ms)	63 ± 21	25 ± 15	<.001

Kalogeropoulos et al. J Am Soc Echogcardiogr 2008;21:1028-34

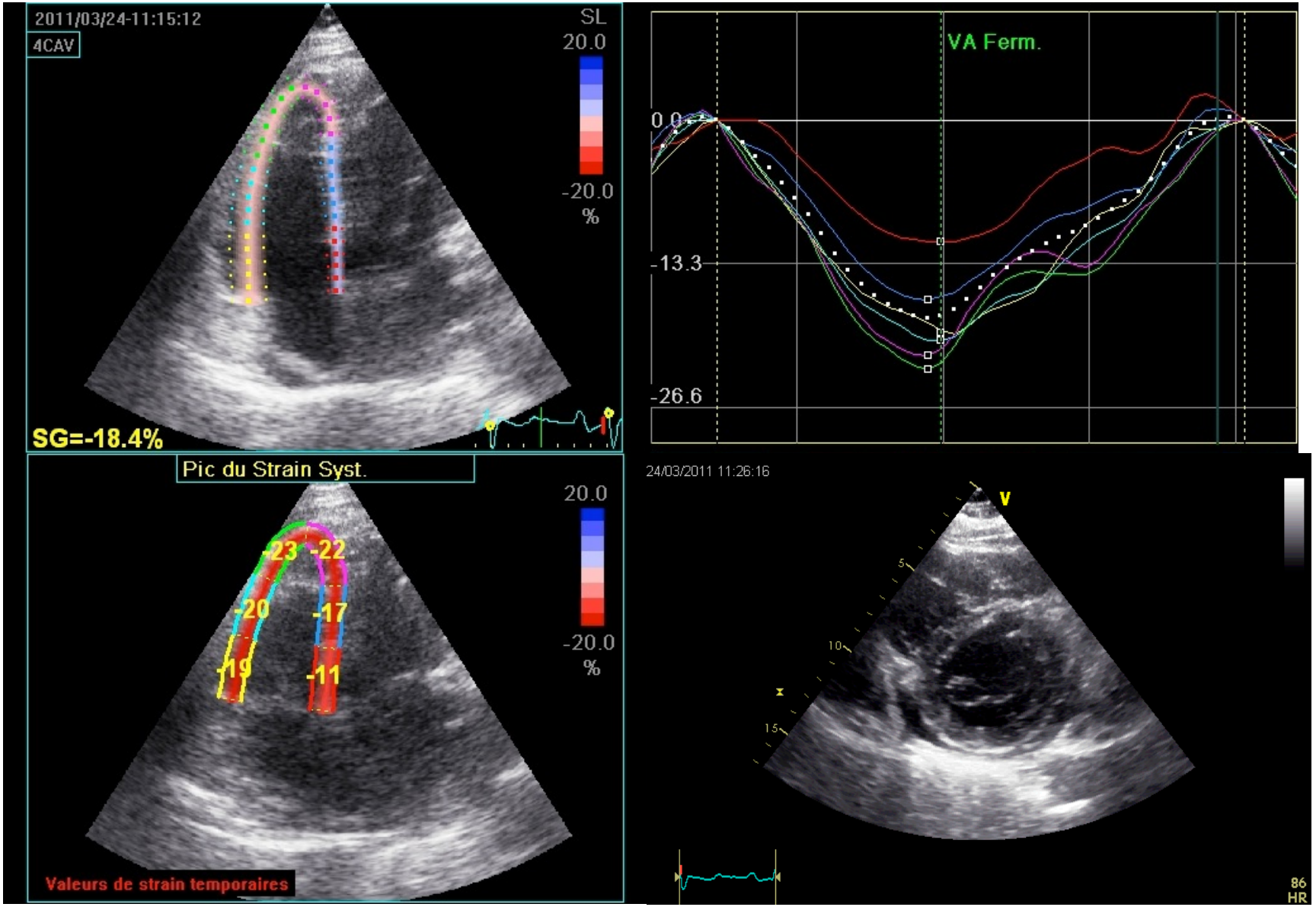
Pulmonary hypertension (HIV+)



S =16 cm/s



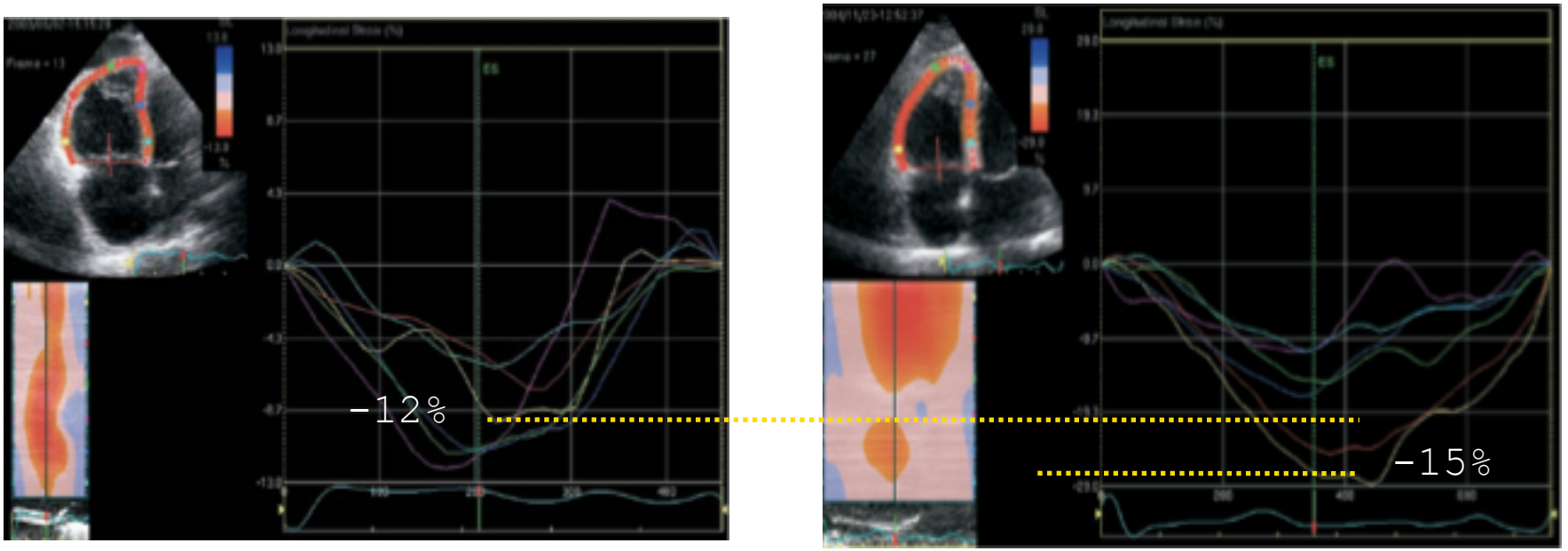
TAPSE =22 mm


2011/03/24-11:15:12
4CAV
SL
20.0
-20.0
%
SG=-18.4%
VA Ferm.
0.0
-13.3
-26.6
Pic du Strain Syst.
20.0
-20.0
%
-23
-22
-20
-17
-19
-11
Valeurs de strain temporaires
24/03/2011 11:26:16
V
5
10
15
86
HR

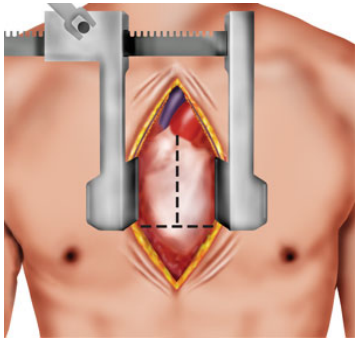
2D STRAIN in Pulmonary Hypertension

2D strain in **basal segment decreased** **in** Pulmonary Hypertension (-8.8 ±4.1%)

Improvement after 6 to 11 months of vasodilator therapy mois (-13 ± 6%)

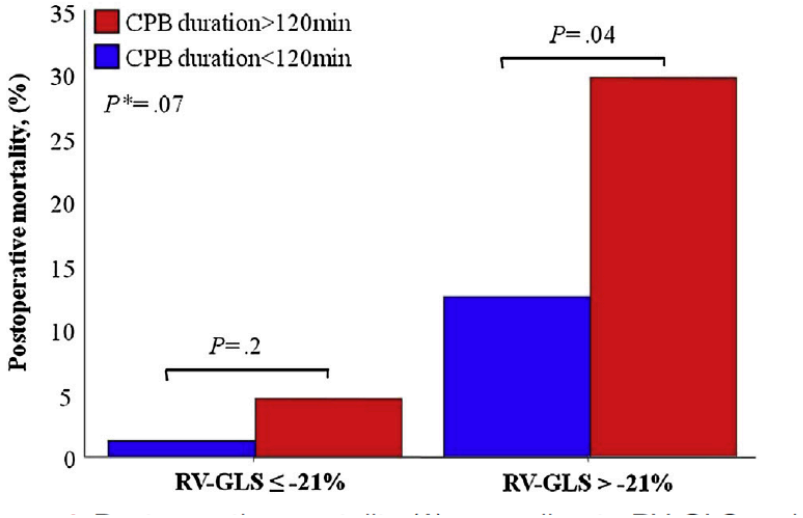


Borges et al. ***Am J Cardiol 2006;98:530 –534)***



Prognostic Value of Right Ventricular Two-Dimensional Global Strain in Patients Referred for Cardiac Surgery

Julien Ternacle, MD, Matthieu Berry, MD, Thomas Cognet, MD, Martin Kloeckner, MD, Thibaud Damy, MD, PhD, Jean-Luc Monin, MD, PhD, Jean-Paul Couetil, MD, PhD, Jean-Luc Dubois-Rande, MD, PhD, Pascal Gueret, MD, PhD, and Pascal Lim, MD, PhD, *Creteil and Toulouse, France*



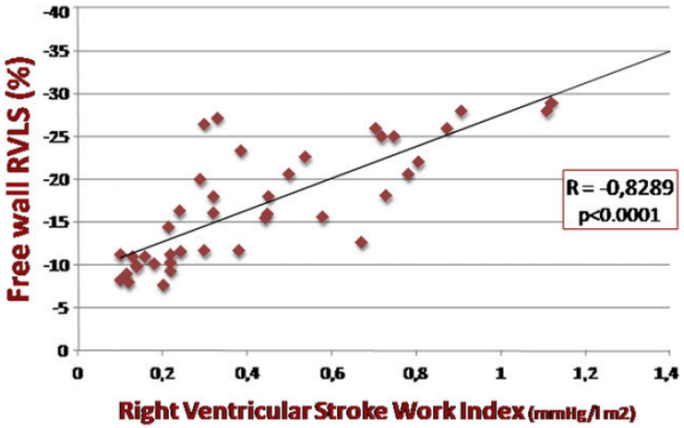
CONCLUSIONS

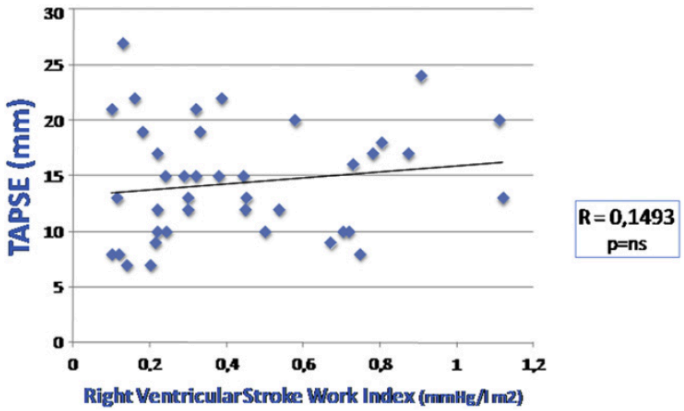
RV dysfunction strongly impacts on postoperative outcome in patients referred for cardiac surgery. Increased postoperative mortality is observed not only in patients with RVFAC < 35% but also in those with preserved RVFAC but impaired RV-GLS.

J Am Soc Echocardiogr 2013;26:721-6

Journal of Cardiac Failure Vol. 18 No. 3 2012

Right Ventricular Longitudinal Strain Correlates Well With Right Ventricular Stroke Work Index in Patients With Advanced Heart Failure Referred for Heart Transplantation





Meilleure corrélation avec le Stroke work index (indice de référence kt de reserve contractile vd)

Echocardiography in the Management of Patients with Left Ventricular Assist Devices: Recommendations from the American Society of Echocardiography

Raymond F. Stainback, MD, FASE, Chair, Jerry D. Estep, MD, FASE, Co-Chair, Deborah A. Agler, RCT, RDCS, FASE, Emma J. Birks, MD, PhD, Merri Bremer, RN, RDCS, EdD, FASE, Judy Hung, MD, FASE, James N. Kirkpatrick, MD, FASE, Joseph G. Rogers, MD, and Nishant R. Shah, MD, MSc, *Houston, Texas; Cleveland, Ohio; Louisville, Kentucky; Rochester, Minnesota; Boston, Massachusetts; Philadelphia, Pennsylvania; and Durham, North Carolina*

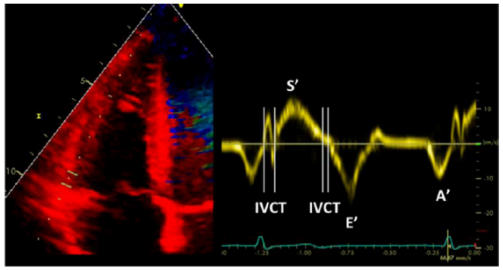
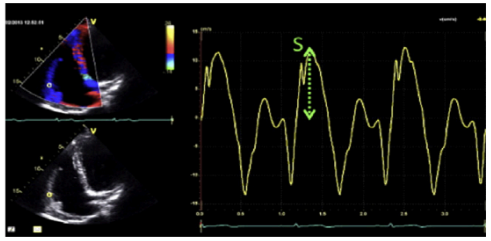
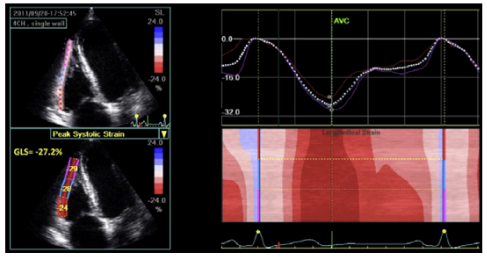
Table 1 Preimplantation TTE/TEE "*red-flag*" findings

Left Ventricle and Interventricular Septum
Small LV size, particularly with increased LV trabeculation
LV thrombus
LV apical aneurysm
Ventricular septal defect
Right Ventricle
RV dilatation
RV systolic dysfunction
Atria, Interatrial Septum, and Inferior Vena Cava
Left atrial appendage thrombus
PFO or atrial septal defect
Valvular Abnormalities
Any prosthetic valve (especially mechanical AV or MV)
> mild AR
≥ moderate MS
≥ moderate TR or > mild TS
> mild PS; ≥ moderate PR
Other
Any congenital heart disease
Aortic pathology: aneurysm, dissection, atheroma, coarctation
Mobile mass lesion
Other shunts: patent ductus arteriosus, intrapulmonary

be performed and communicated in the interpretation.

Echocardiographic signs of RV dysfunction should not be considered in isolation. They should be integrated with a patient's clinical signs and symptoms of possible right-sided heart failure syndrome. Clinically severe preoperative RV dysfunction may prompt the HF team to consider planned biventricular MCS, as this may lead to better outcomes than delayed conversion of an LVAD to biventricular MCS.[23] Some patients with less than severe RV dysfunction at preoperative assessment will develop severe RV dysfunction after LVAD implantation. This complication, defined by the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS)[24] as the requirement of an RV assist device (RVAD) or >14 consecutive days of intravenous (IV) inotropic support, has an estimated prevalence of 13% to 44% and is associated with significant morbidity and mortality.[25,26] Preliminary data suggest that there may be preoperative echocardiographic parameters predictive of severe postoperative RV dysfunction. In studies that included clinical parameters in their multivariable models, an RV absolute peak longitudinal strain of <9.6%[27] and an RV: LV end-diastolic diameter ratio of >0.75[28] were identified as potential independently predictive echocardiographic parameters. More recent data by Ka[29] cy for predicting post LVAD an one RV echocardiograp ler imaging and RV speckl re used in aggregate. Given the lack of consensus thus far regarding the predictive value of any single echocardiographic parameter, an aggregate assessment utilizing relevant left-sided parameters (eg, indexed left atrial volume, indexed LV size) and right-sided parameters (eg, RV parameters described above, TR severity,[30] and right atrial [RA] pressure estimation) is likely the optimal approach for now.[4,31]

SLG < 9.6%

Pulsed tissue Doppler S wave 	• Peak systolic velocity of tricuspid annulus by pulsed-wave DTI (cm/sec), obtained from the apical approach, in the view that achieves parallel alignment of Doppler beam with RV free wall longitudinal excursion	• Easy to perform • Reproducible • Validated against radionuclide EF • Established prognostic value	• Angle dependent • Not fully representative of RV global function, particularly after thoracotomy, pulmonary thromboendarterectomy or heart transplantation
Color tissue Doppler S wave 	• Peak systolic velocity of tricuspid annulus by color DTI (cm/sec)	• Sampling is performed after image acquisition • Allows multisite sampling on the same beat	• Angle dependent • Not fully representative of RV global function, particularly after thoracotomy, pulmonary thrombendarterectomy or heart transplantation • Lower absolute values and reference ranges than pulsed DTI S′ wave • Requires offline analysis
GLS 	• Peak value of 2D longitudinal speckle tracking derived strain, averaged over the three segments of the RV free wall in RV-focused apical four-chamber view (%)	• Angle independent • Established prognostic value	• Vendor dependent

EDA, End-diastolic area; *ESA*, end-systolic area; *ET*, ejection time; *GLS,* gold longitudinal strain; *IVCT*, isovolumic valve closure–to–opening time.

GE Healthcare

?

PHILIPS

Archives of Cardiovascular Disease (2014) 107, 96—104

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Elsevier Masson France EM|consulte www.em-consulte.com/en

CLINICAL RESEARCH

Prospective comparison of speckle tracking longitudinal bidimensional strain between two vendors

Comparaison prospective de la déformation longitudinale bidimensionnelle par *speckle tracking* entre 2 vendeurs

Anne-Laure Castel[a], Catherine Szymanski[b,c], François Delelis[a], Franck Levy[c], Aymeric Menet[a], Amandine Mailliet[a], Nathalie Marotte[a], Pierre Graux[a], Christophe Tribouilloy[b,c], Sylvestre Maréchaux[a,b,*]

[a] *Université Lille Nord de France, GCS-Groupement des Hôpitaux de l'Institut Catholique de Lille, Faculté Libre de Médecine, Université Catholique de Lille, Lomme, France*
[b] *INSERM U 1088, Université de Picardie, Amiens, France*
[c] *Centre Hospitalier Universitaire d'Amiens, Amiens, France*

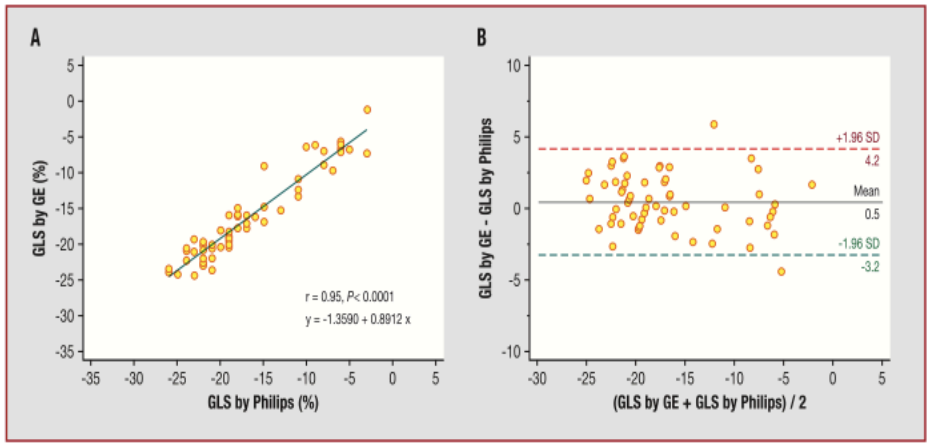


Figure 4. (A) Correlation between global longitudinal strain (GLS) by Philips and General Electric (GE): the line is the regression line; *r* is Pearson's correlation coefficient. (B) Scatterplot of the difference between GLS by Philips and GE and the mean values obtained by the two software products. SD: standard deviation.

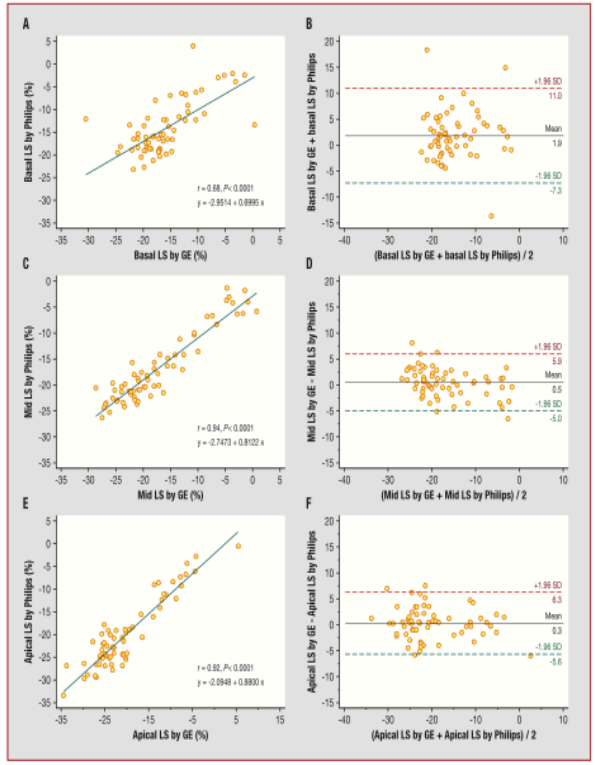
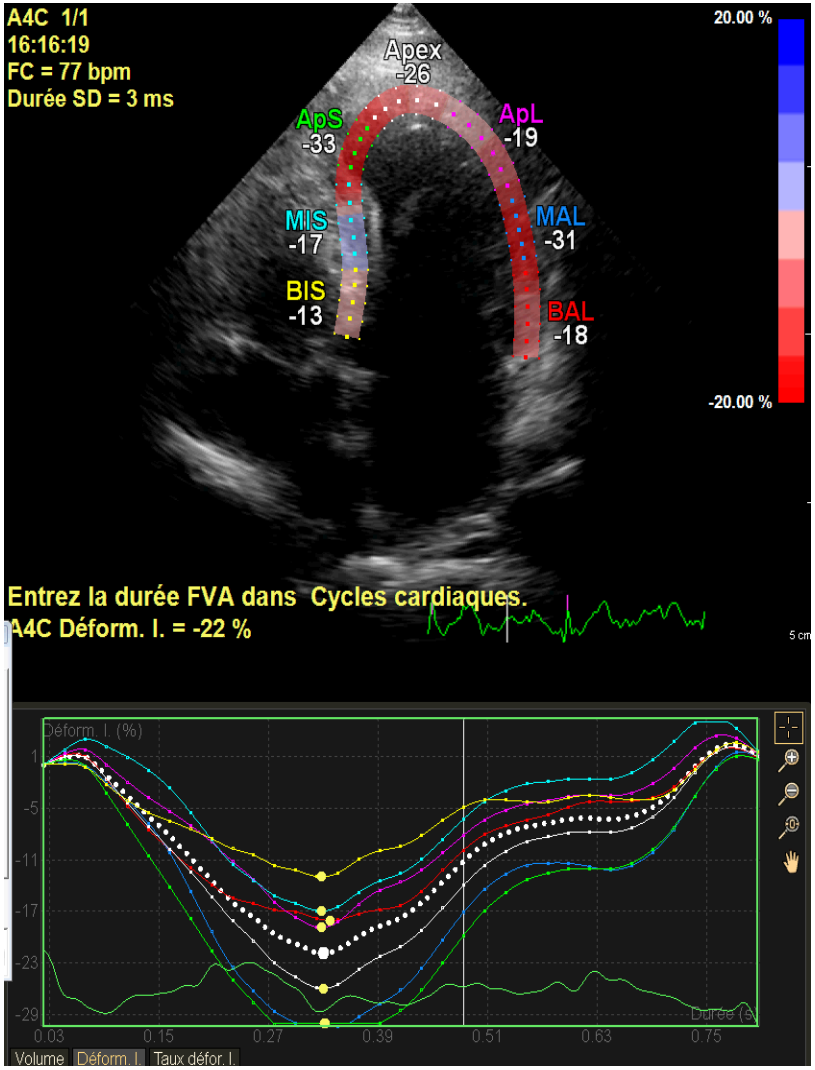


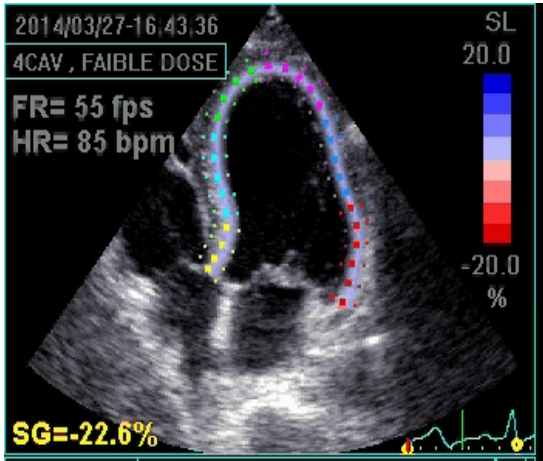
Figure 5. Correlation between (A) basal, (C) midventricular and (E) apical longitudinal strain (LS) by Philips and General Electric (GE): the line is the regression line; *r* is Pearson's correlation coefficient. Scatterplots of the differences between basal, midventricular and apical LS by Philips and GE and the mean values obtained by the two software products are presented in (B), (D) and (F), respectively. SD: standard deviation.

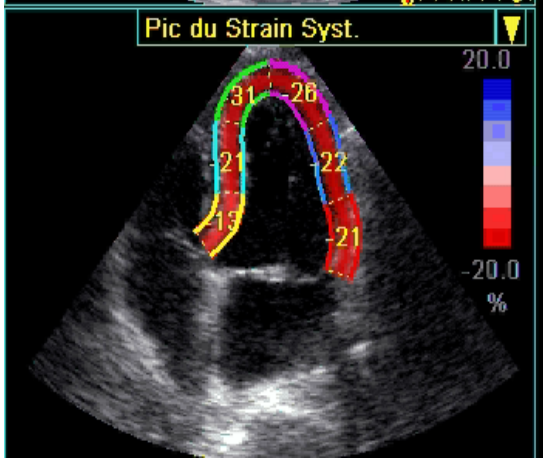
of what is measured by these techniques. However, in a recent meta-analysis of normal ranges of LV strain, blood

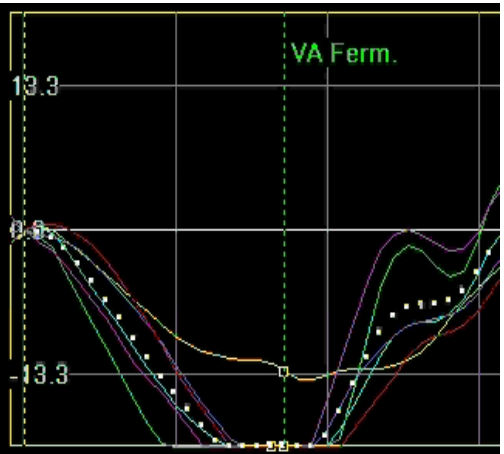
reports, we found a good agreement between GLS values obtained by two recent speckle tracking software products

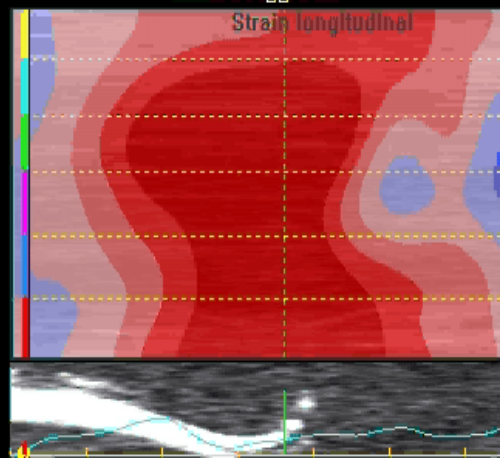
Reproductibilité moins bonne sur les segments basaux


A4C 1/1
16:16:19
FC = 77 bpm
Durée SD = 3 ms
20.00 %
Apex
-26
ApS
-33
ApL
-19
MIS
-17
MAL
-31
BIS
-13
BAL
-18
-20.00 %
Entrez la durée FVA dans Cycles cardiaques.
A4C Déform. l. = -22 %
5 cm
Déform. l. (%)
1
-5
-11
-17
-23
-29
0.03
0.15
0.27
0.39
0.51
0.63
0.75
Durée (s
Volume
Déform. l.
Taux défor. l.


2014/03/27-16:43:36
4CAV , FAIBLE DOSE
FR= 55 fps
HR= 85 bpm
SL
20.0
-20.0
%
SG=-22.6%


Pic du Strain Syst.
20.0
-20.0
%
31
-26
-21
-22
-19
-21


VA Ferm.
13.3
-13.3


Strain longitudinal

Conclusions

Multiple parameters and windows

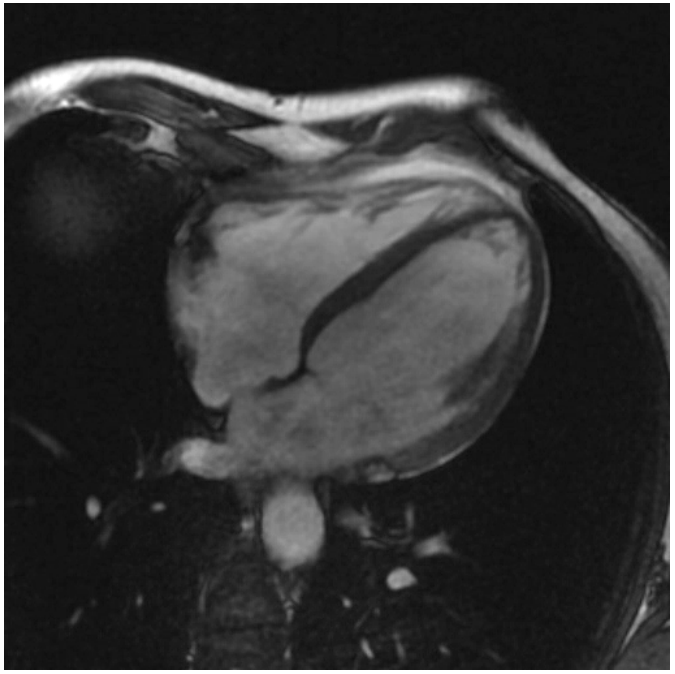
The Suffering RV is dilated : measure it !

Abnormal motions of the IV septum and visual assessment +++

Simple RV systolic parameters:

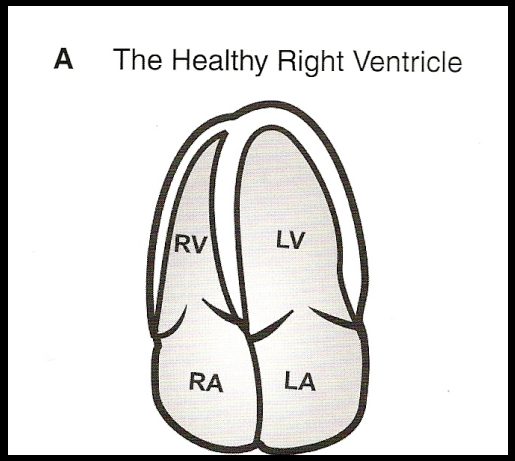
FAC (35%) **/ TAPSE** (17mm) / s dti (9.5cm/s)

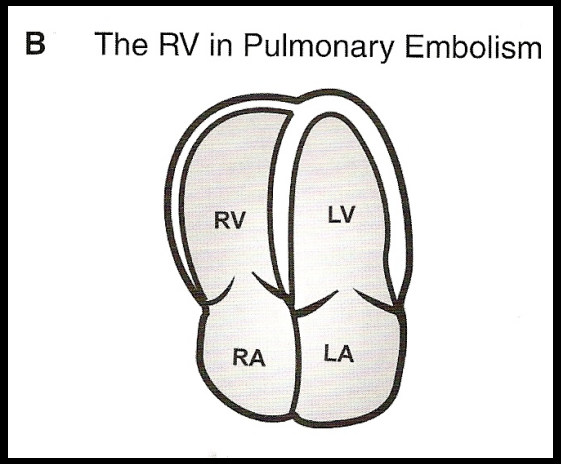
2D strain (> -20%) 3D < 45%

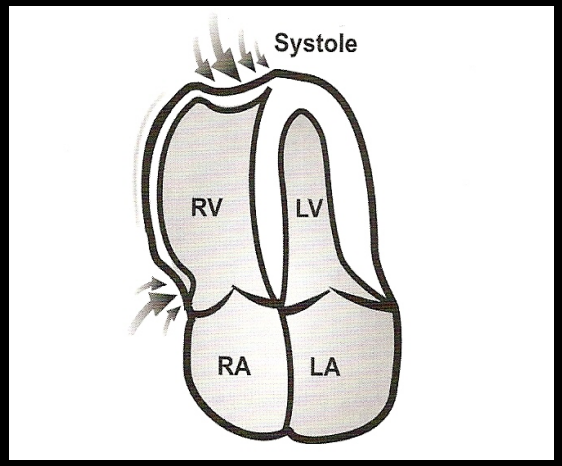


Physiologie du VD

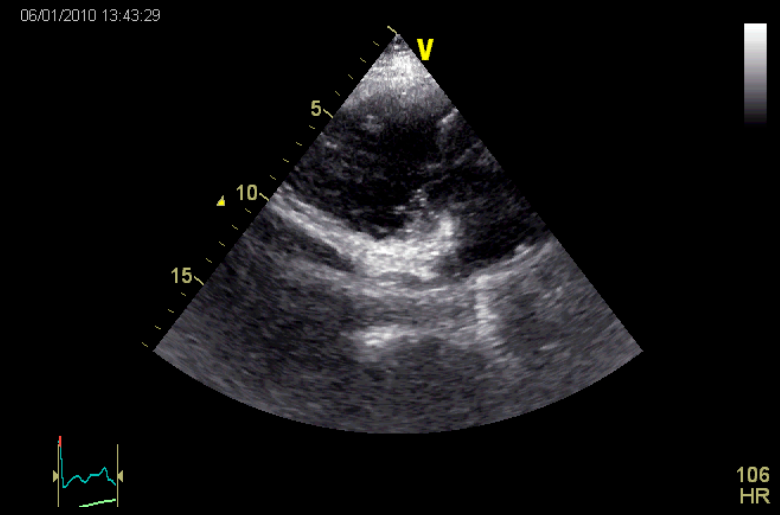
- Ainsi, le vd travaille dans un système à basses pressions et sa compliance est importante.
- Une élévation de post charge se traduit alors par une dilatation aigue puis lorsqu'elle est chronique par une hypertrophie concentrique.

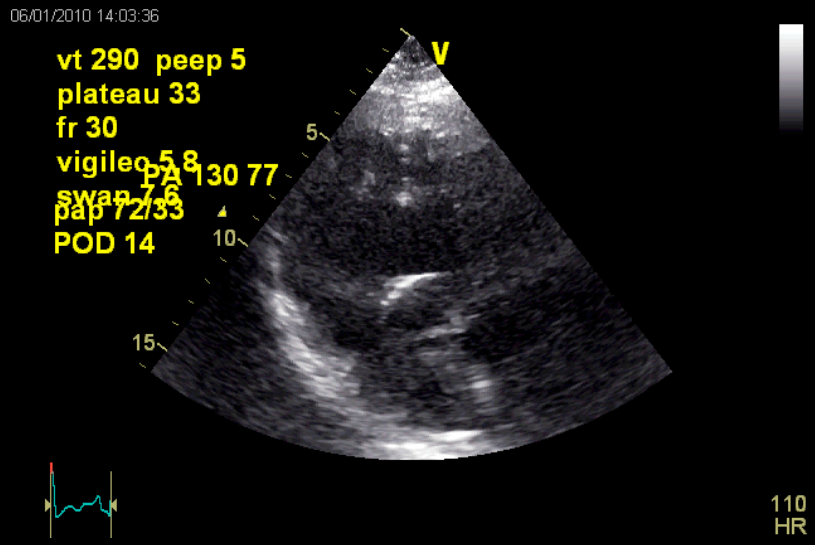


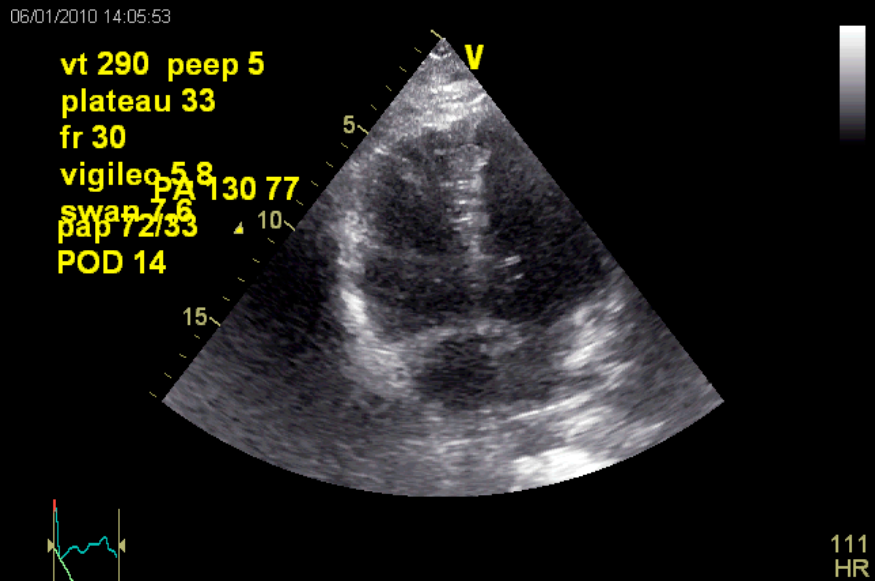


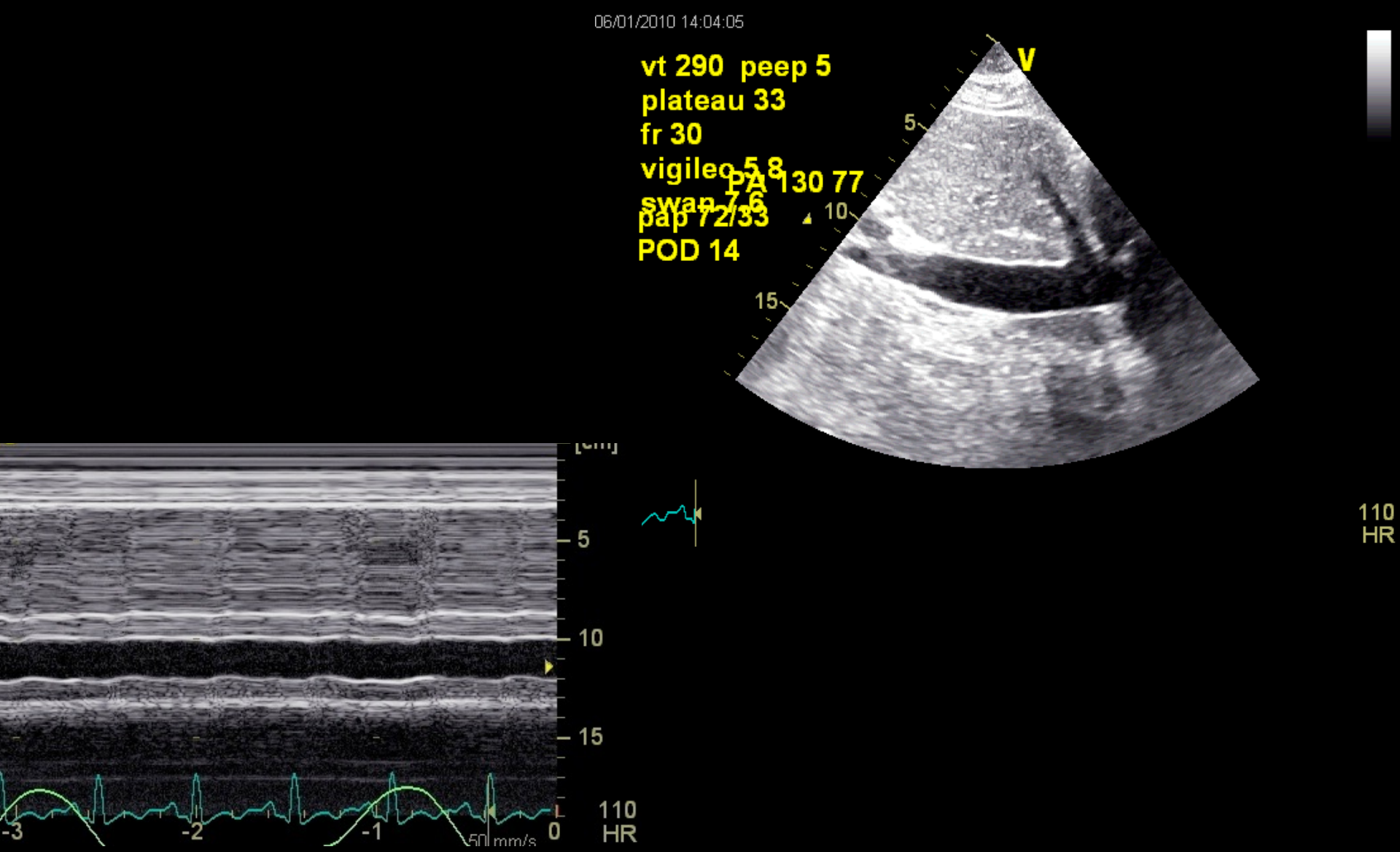


SDRA Grippe A H1N1

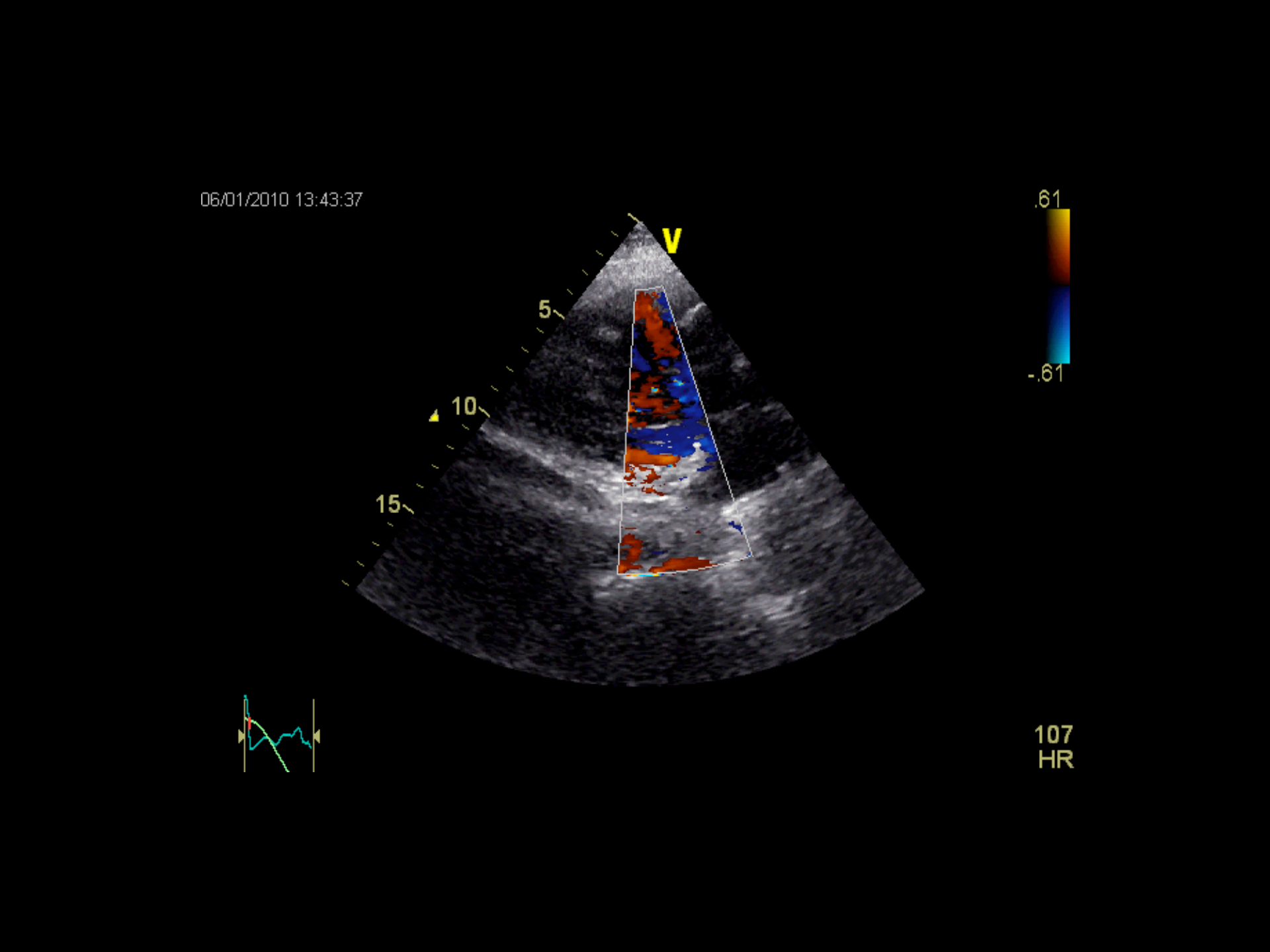


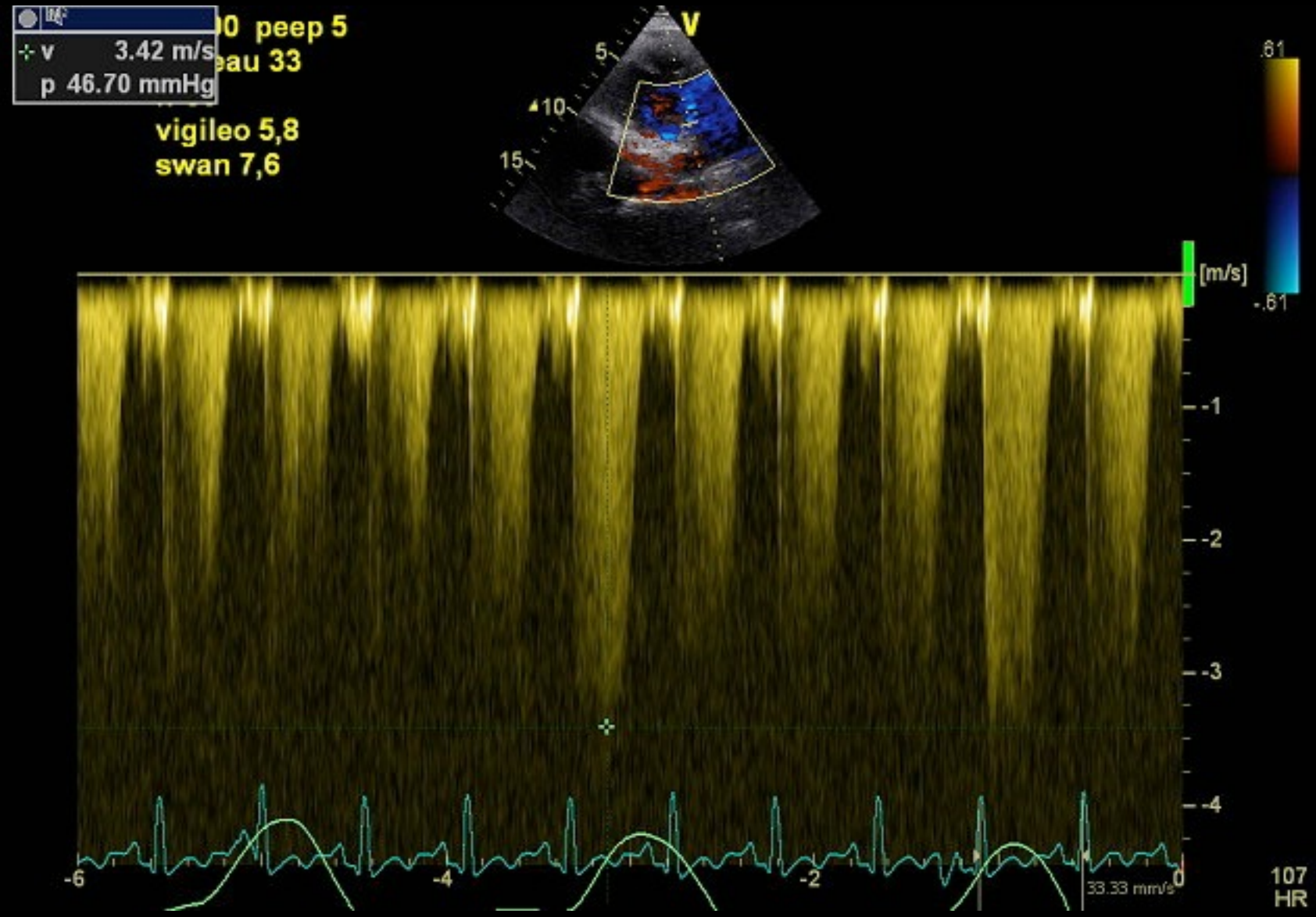




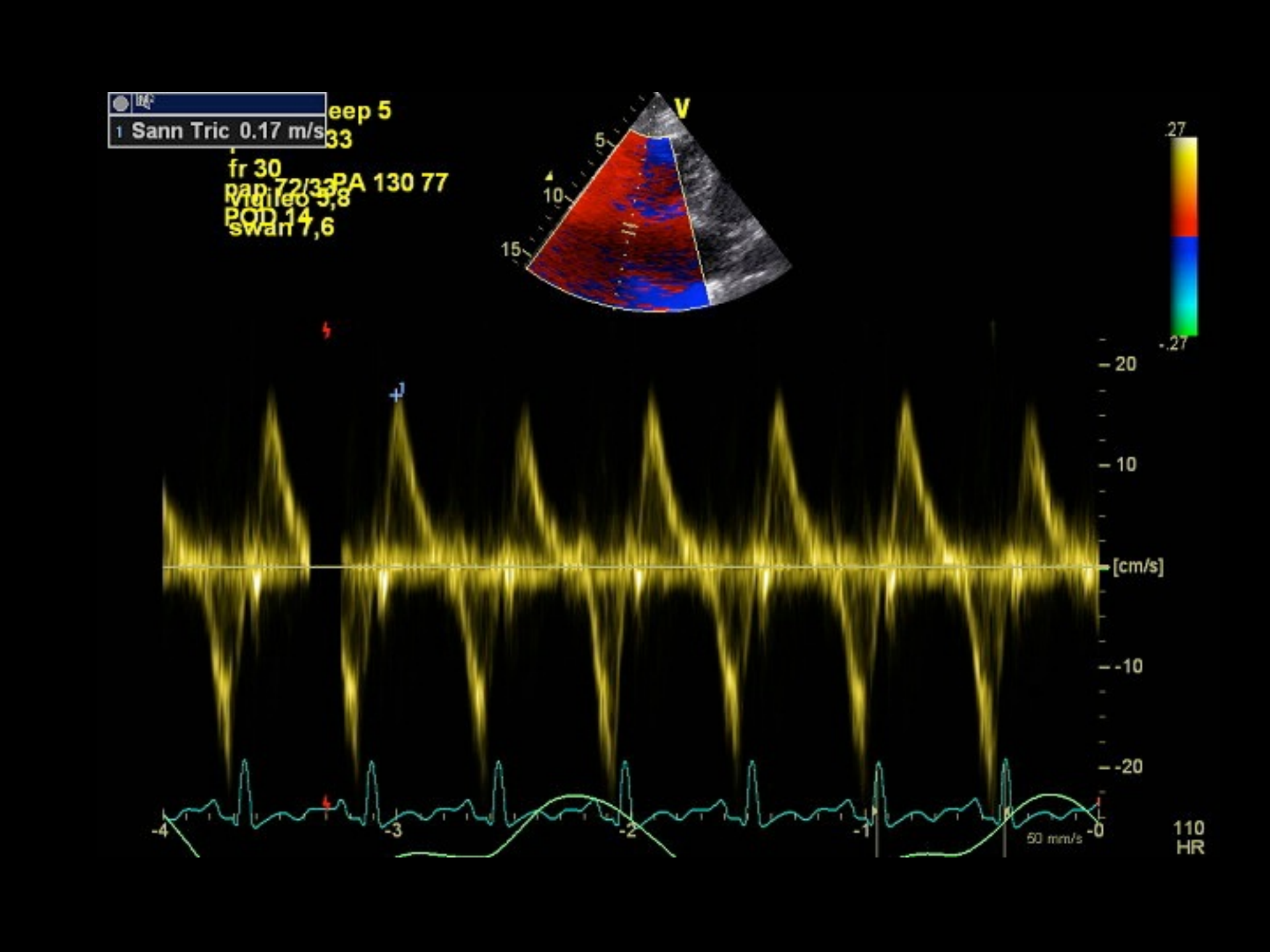


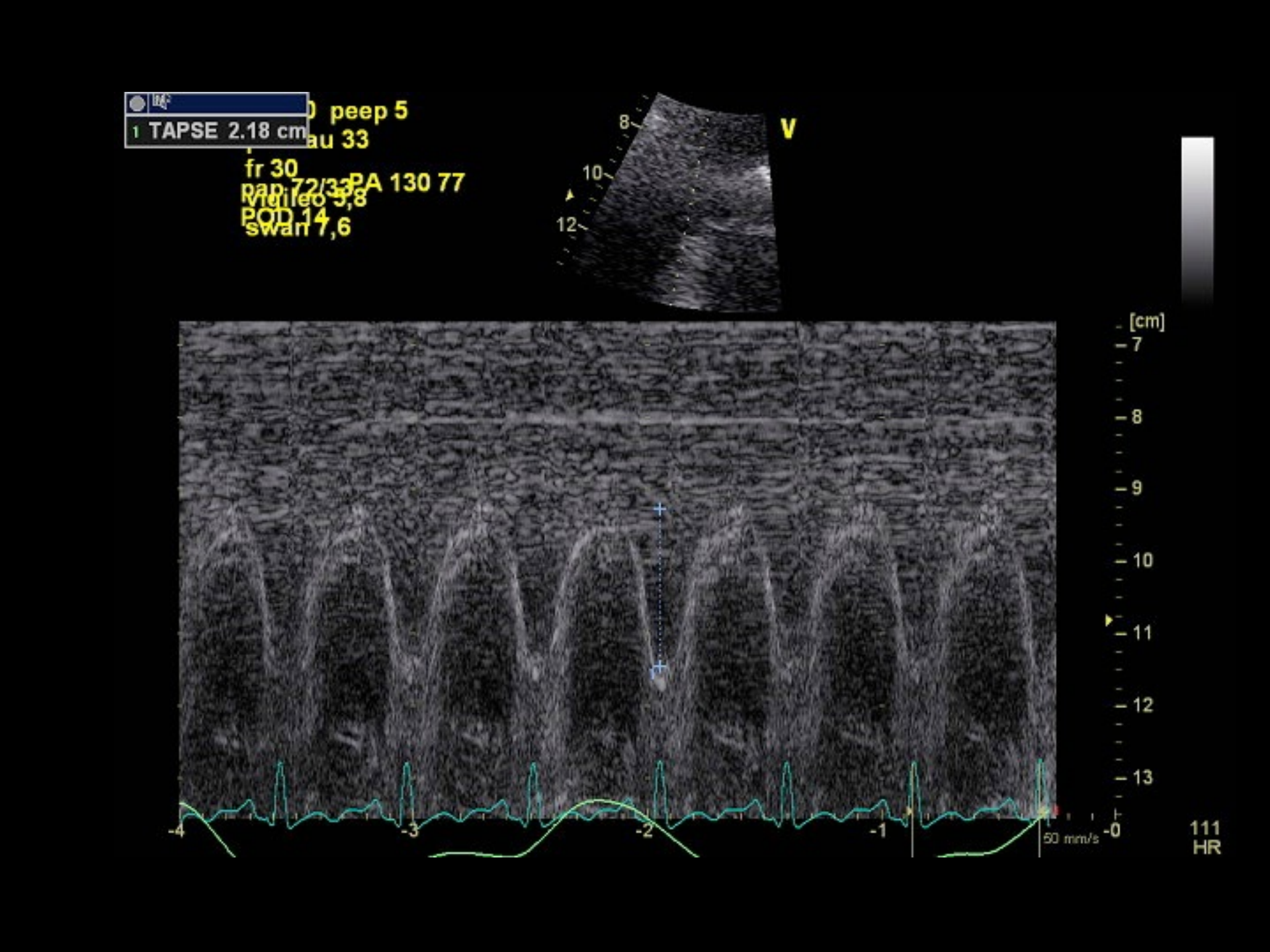
Pod estimée 15 à 20mmHg mesurée (swan 14)

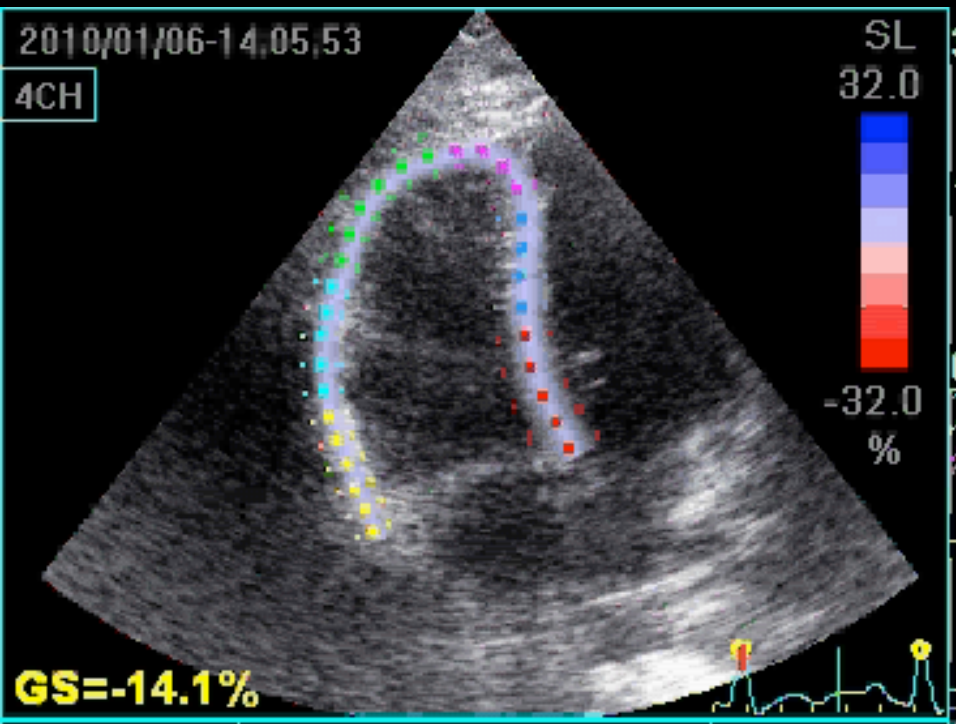

06/01/2010 13:43:37
V
5
10
15
.61
-.61
107
HR

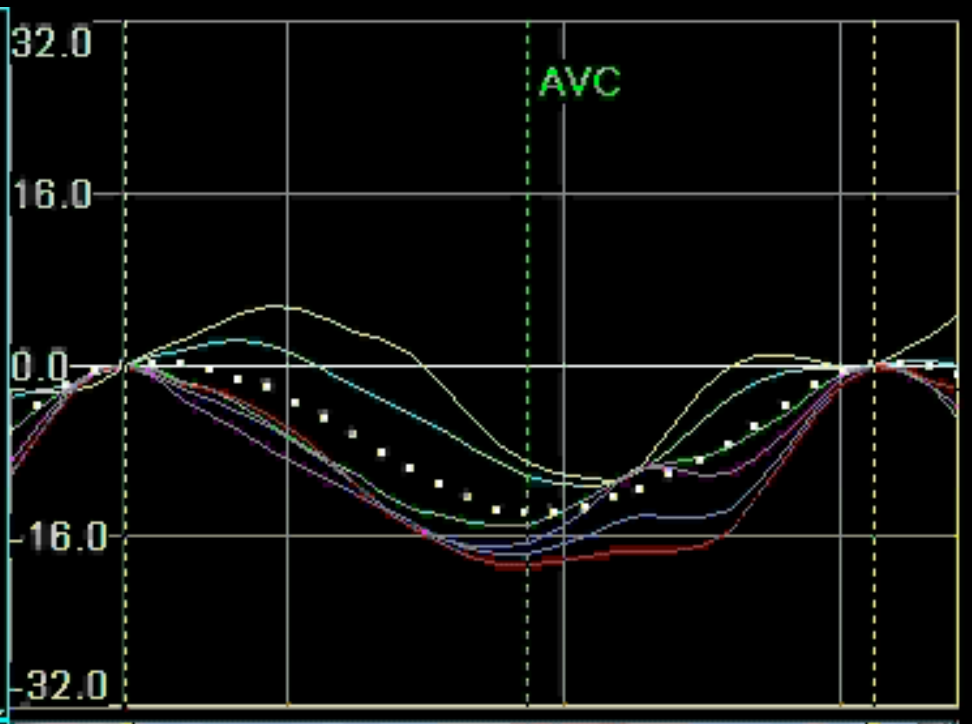


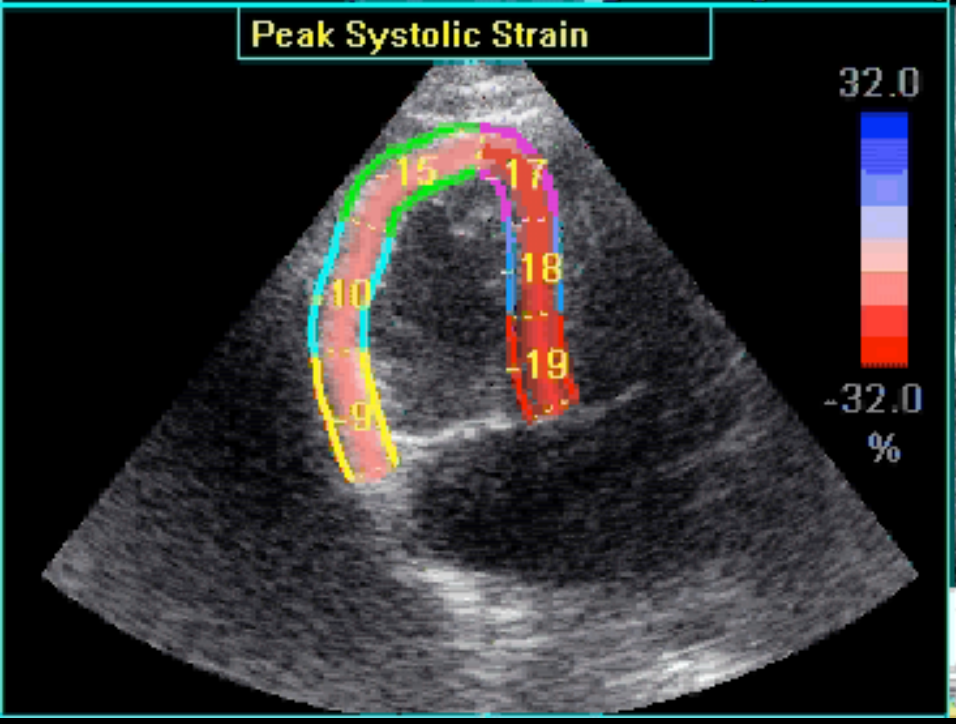
Paps estimée à 61 à 66mmHg (swan: 72)

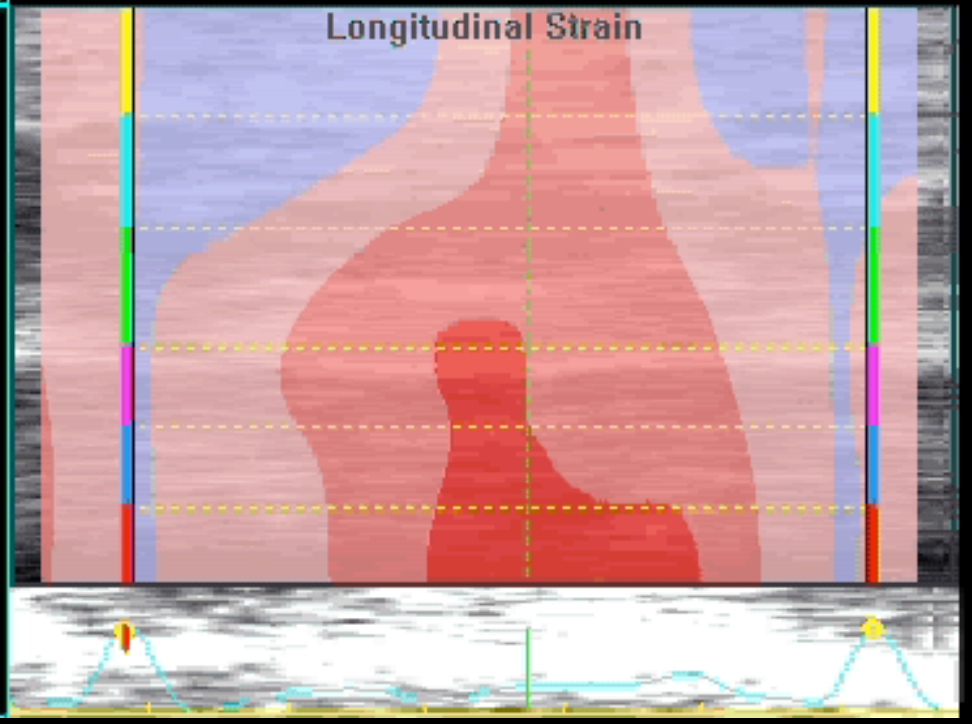

1 Sann Tric 0.17 m/s
eep 5
33
fr 30
PA 130 77
POD 14
swan 7,6
V
5
10
15
.27
-.27
20
10
[cm/s]
-10
-20
-4
-3
-2
-1
-0
50 mm/s
110
HR


1 TAPSE 2.18 cm
peep 5
au 33
fr 30
PA 130 77
POD 14
swan 7,6
8
10
12
V
[cm]
7
8
9
10
11
12
13
-4
-3
-2
-1
-0
50 mm/s
111
HR


2010/01/06-14:05:53
4CH
SL
32.0
-32.0
%
GS=-14.1%


32.0
16.0
0.0
-16.0
-32.0
AVC


Peak Systolic Strain
32.0
-32.0
%
15
17
18
10
19
9


Longitudinal Strain

RV ESPAR
(End-systolic pressure-area relationship)

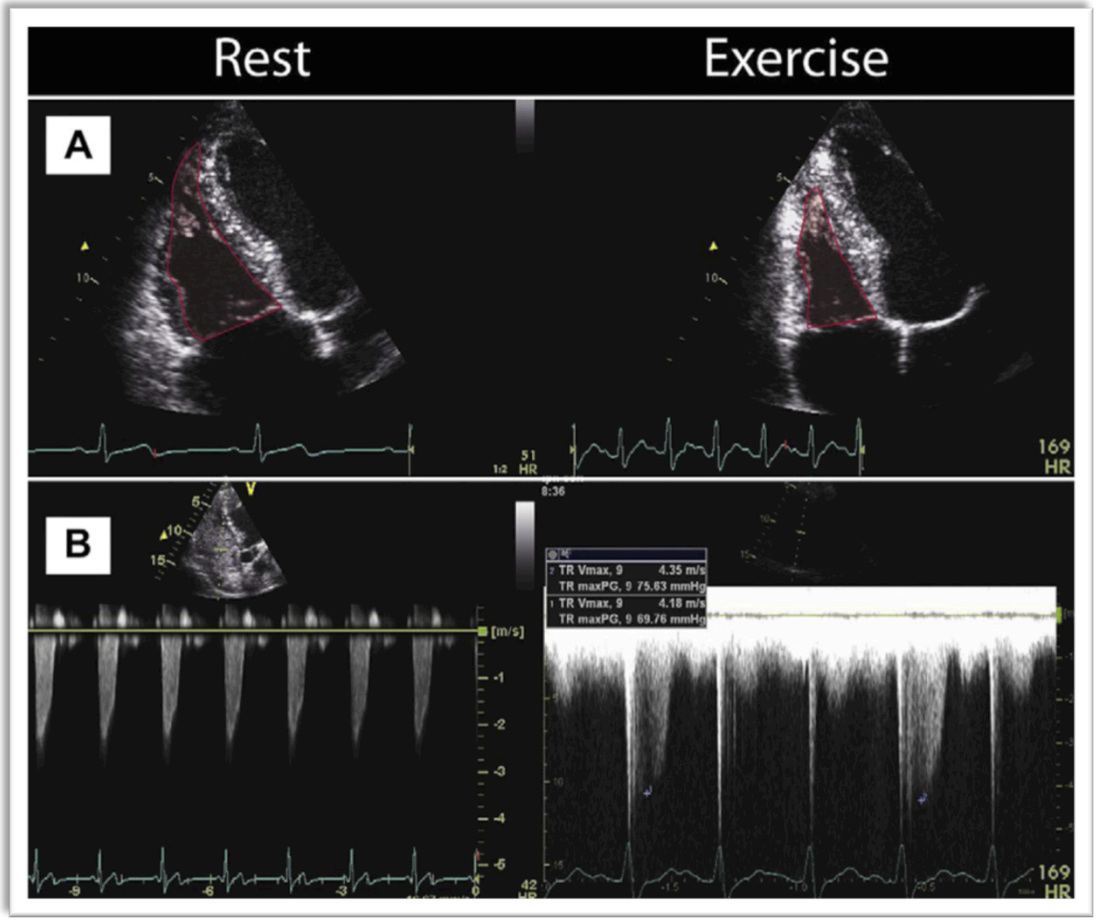
Paps /Surface telesystolique VD

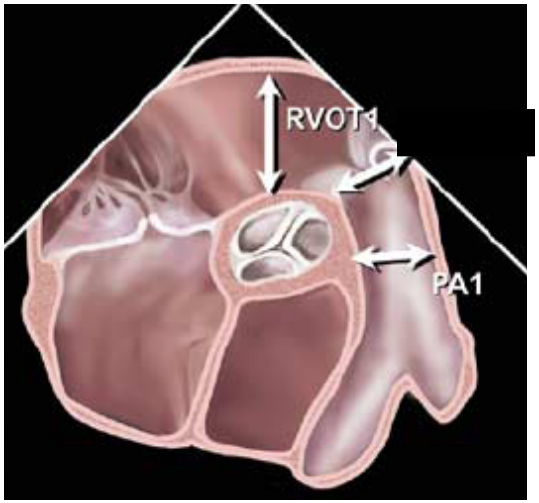
21mmHg /16 cm2

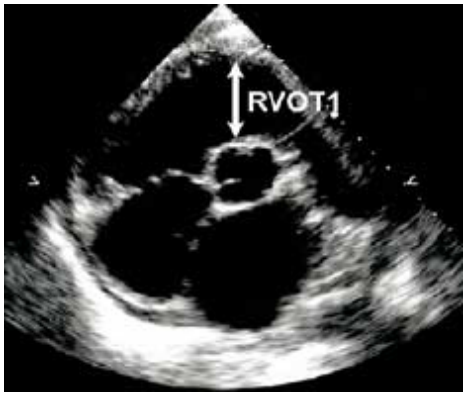
= 1.3

75mmHg / 7.5cm2

= 10







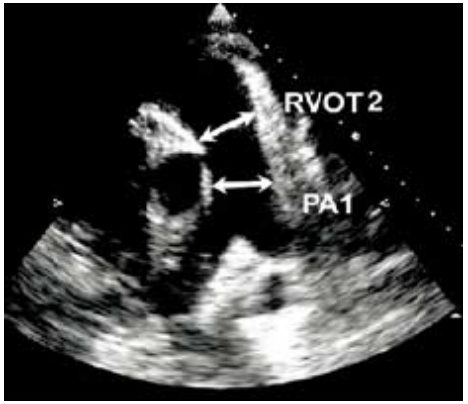
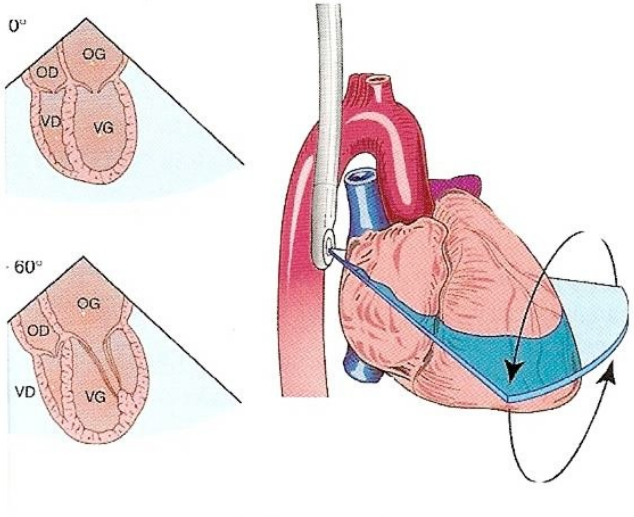


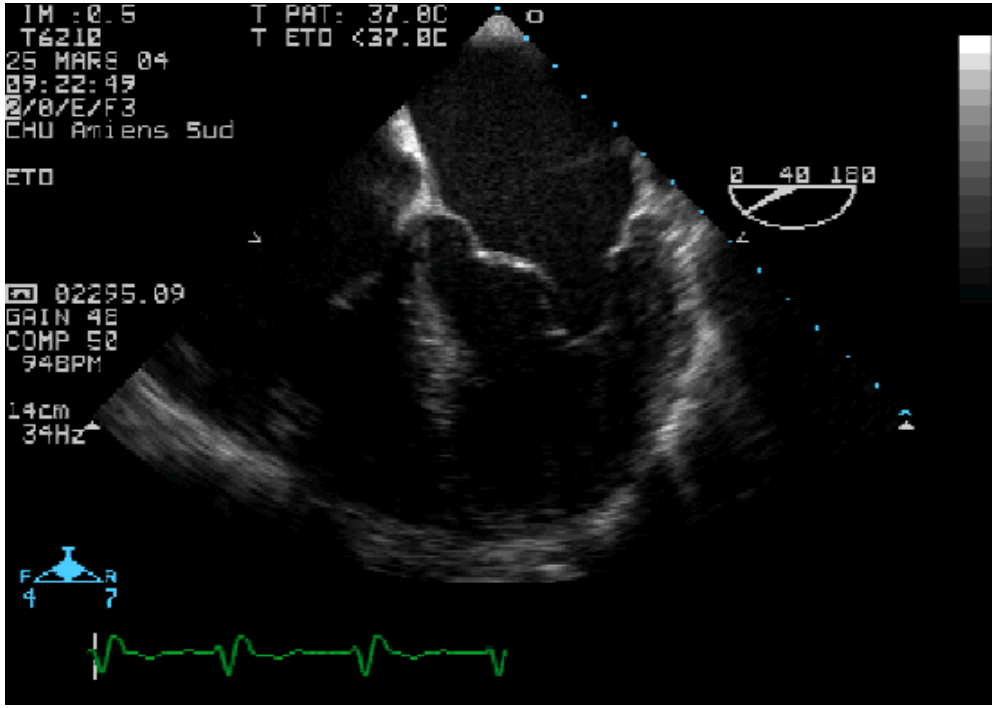
Table 7 Reference limits and partition values of right ventricular and pulmonary artery size

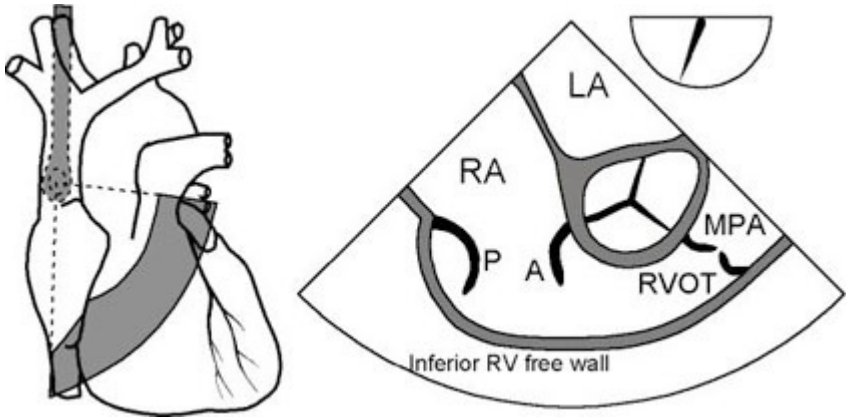
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
RV dimensions (Figure 12)				
Basal RV diameter (RVD 1), cm	2.0–2.8	2.9–3.3	3.4–3.8	≥3.9
Mid-RV diameter (RVD 2), cm	2.7–3.3	3.4–3.7	3.8–4.1	≥4.2
Base-to-apex length (RVD 3), cm	7.1–7.9	8.0–8.5	8.6–9.1	≥9.2
RVOT diameters (Figure 13, 14)				
Above aortic valve (RVOT 1), cm	2.5–2.9	3.0–3.2	3.3–3.5	≥3.6
Above pulmonic valve (RVOT 2), cm	1.7–2.3	2.4–2.7	2.8–3.1	≥3.2
PA diameter				
Below pulmonic valve (PA 1), cm	1.5–2.1	2.2–2.5	2.6–2.9	≥3.0

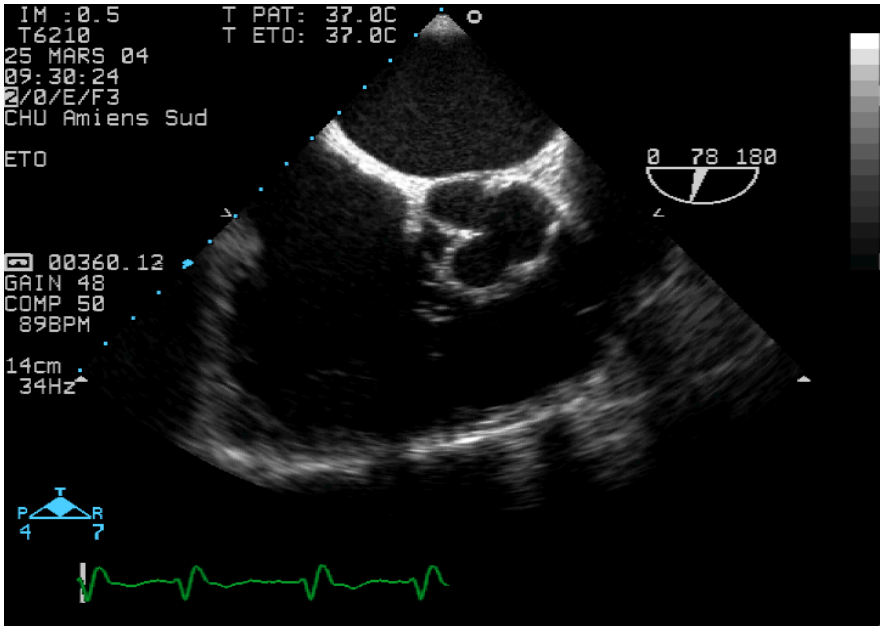
RV, Right ventricular; *RVOT*, right ventricular outflow tract; *PA*, pulmonary artery.
Data from Foale et al.[76]

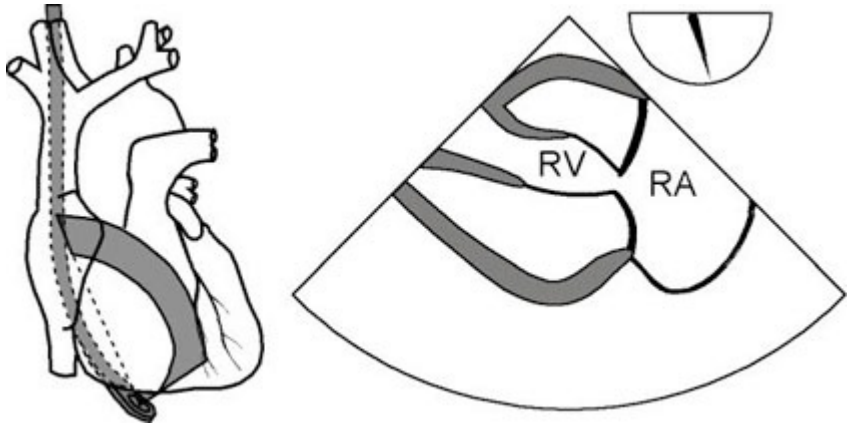
INCIDENCES DU COEUR DROIT EN ETO


0°
OG
OD
VD
VG
60°
OG
OD
VD
VG

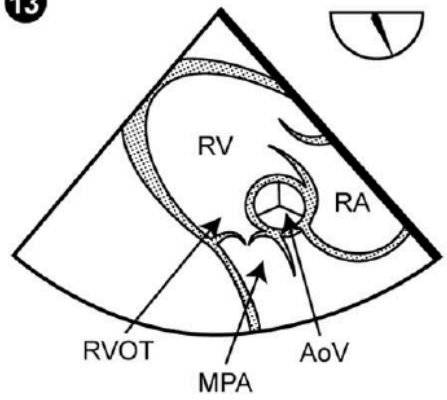

IM :0.5
T6210
25 MARS 04
09:22:49
2/0/E/F3
CHU Amiens Sud
ETO
T PAT: 37.0C
T ETO <37.0C
0 40 180
02255.09
GAIN 48
COMP 50
94BPM
14cm
34Hz
P
R
4
7


LA
RA
MPA
P
A
RVOT
Inferior RV free wall

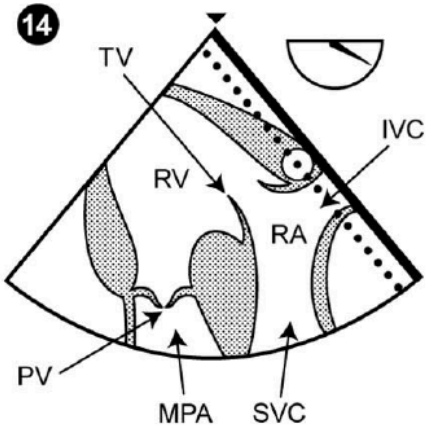

IM :0.5
T6210
25 MARS 04
09:30:24
2/0/E/F3
CHU Amiens Sud
ETO
T PAT: 37.0C
T ETO: 37.0C
0 78 180
00360.12
GAIN 48
COMP 50
89BPM
14cm
34Hz
P
R
4
7



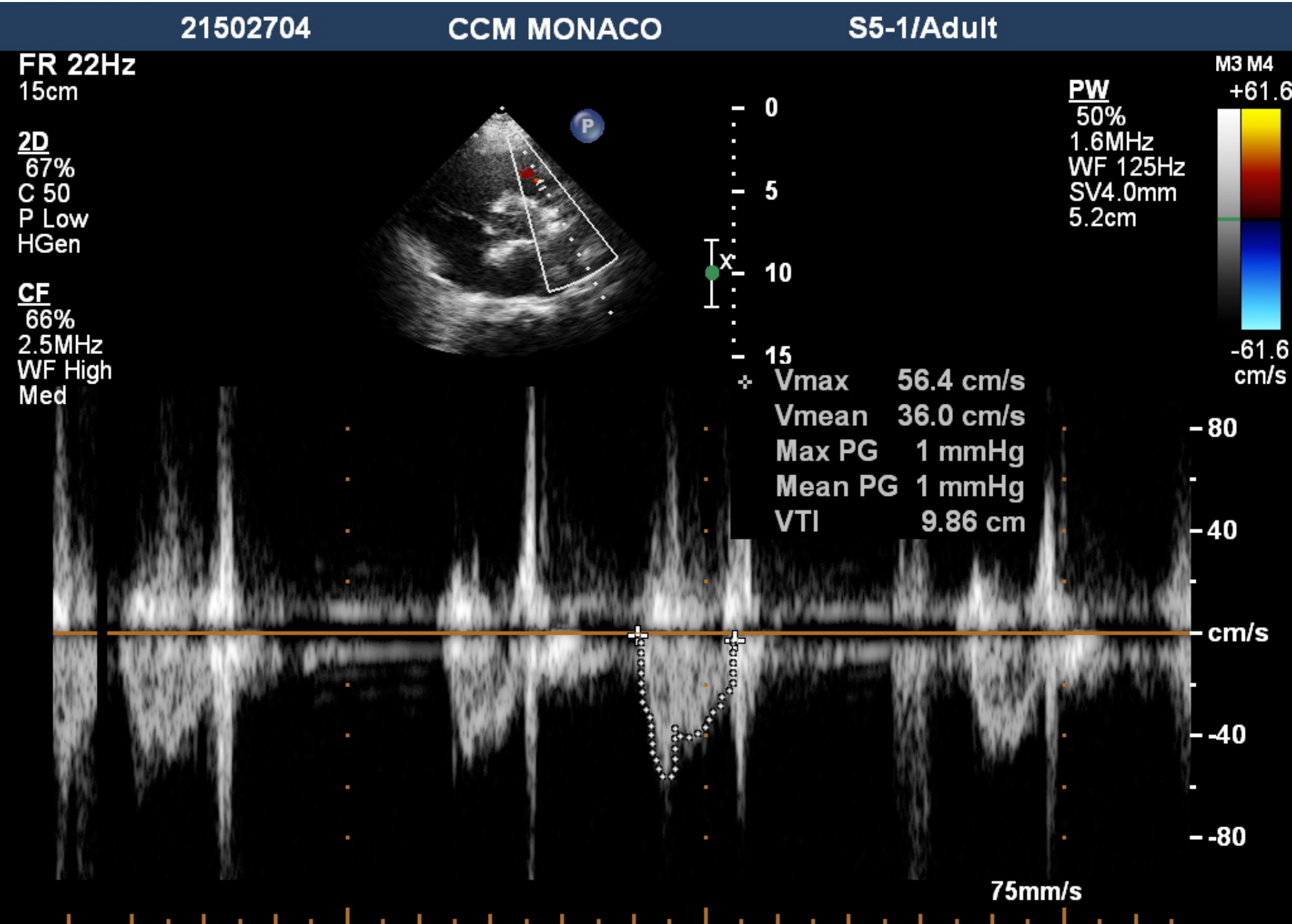
Deep transgastric



Deep TG RV outflow



Deep TG in/outflow


21502704
CCM MONACO
S5-1/Adult
FR 22Hz
15cm
2D
67%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
PW
50%
1.6MHz
WF 125Hz
SV4.0mm
5.2cm
M3 M4
+61.6
-61.6
cm/s
0
5
10
15
Vmax 56.4 cm/s
Vmean 36.0 cm/s
Max PG 1 mmHg
Mean PG 1 mmHg
VTI 9.86 cm
80
40
cm/s
-40
-80
75mm/s