

DIU imagerie cardiovasculaire

Echographie cardiaque et maladie coronaire

Dr Martine BARTHELET
PH service d'exploration fonctionnelle
GHE LYON

Dans la maladie coronaire

L'échographie cardiaque

- ne permettra pas la visualisation directe des artères coronaires
- mais recherchera à mettre en évidence les effets d'une sténose coronaire
 - Anomalie de fonction myocardique
 - Anomalie de la perfusion myocardique

Dans la maladie coronaire

Deux situations cliniques:

- Douleur thoracique aiguë
- Recherche d'une ischémie d'effort

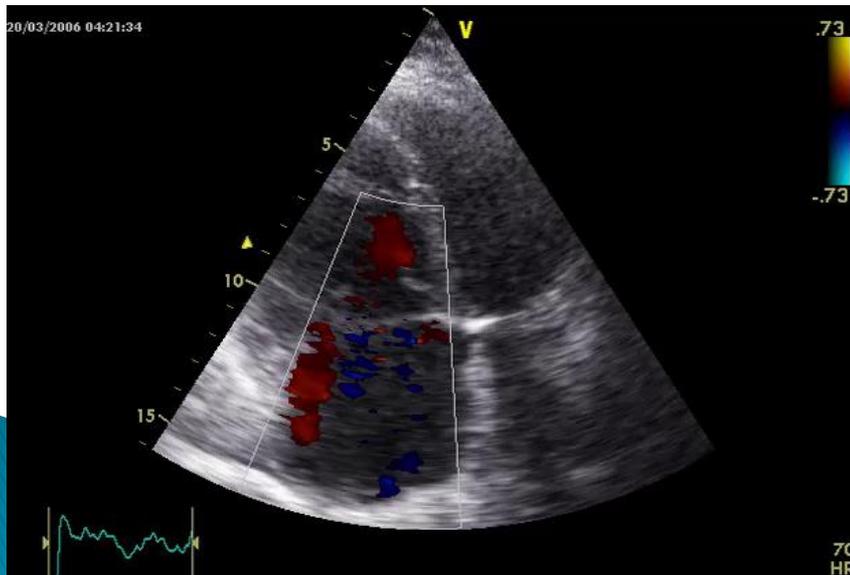
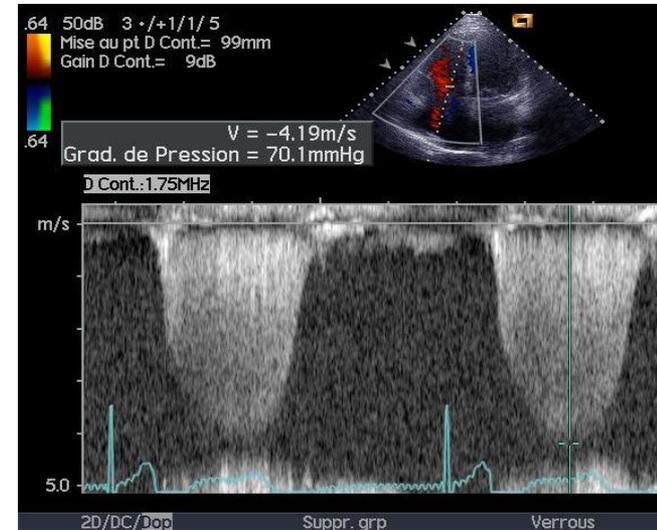
Douleur thoracique aigu

Orientation diagnostique en urgence

Echocardiographie

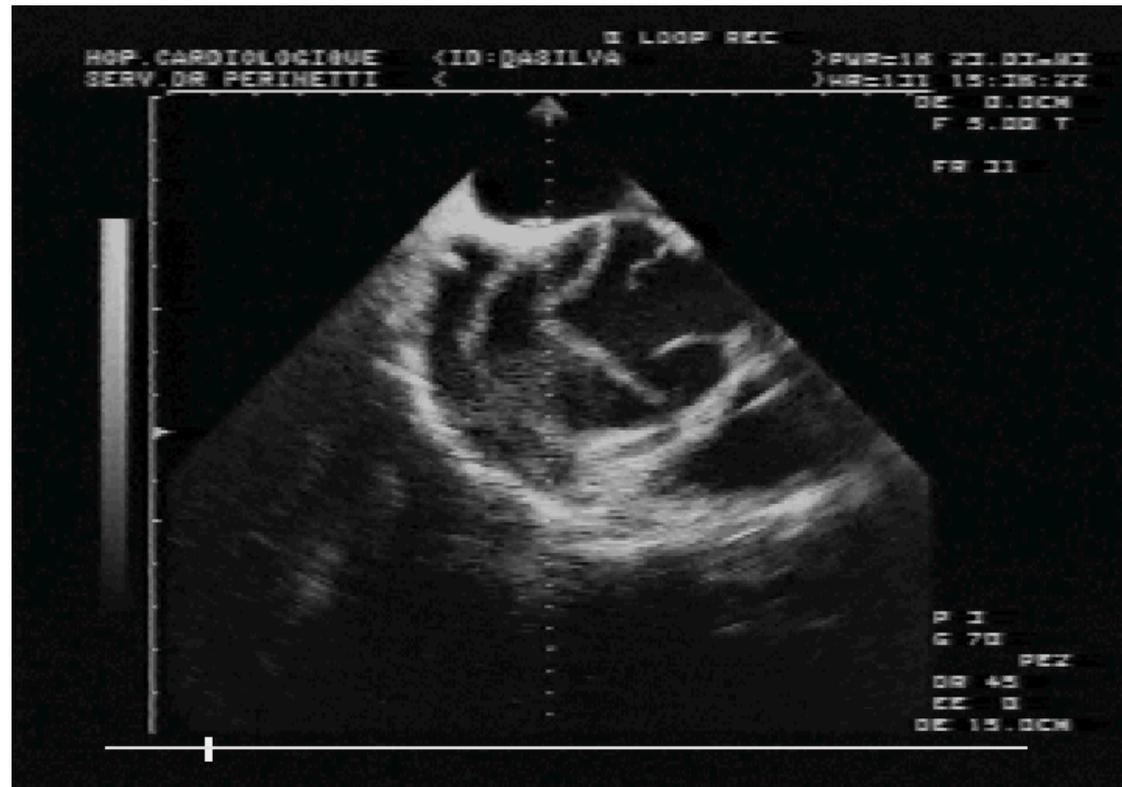
=> Avantages +++ cadre de urgence

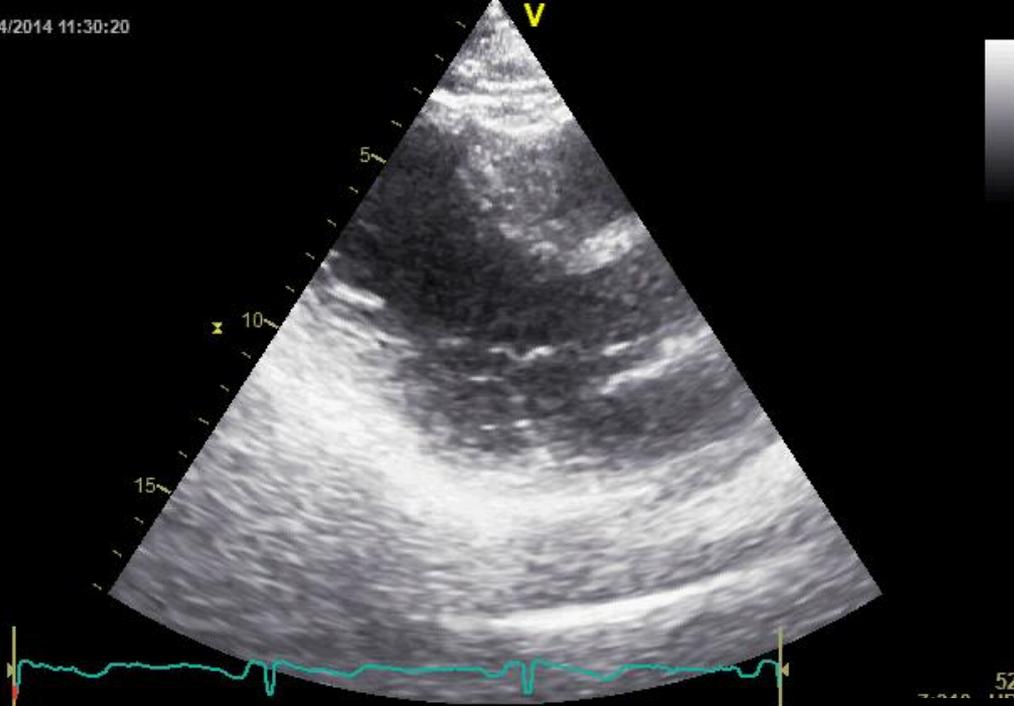
=> Diagnostic différentiel



Diagnostic différentiel

- ▶ Dissection aortique

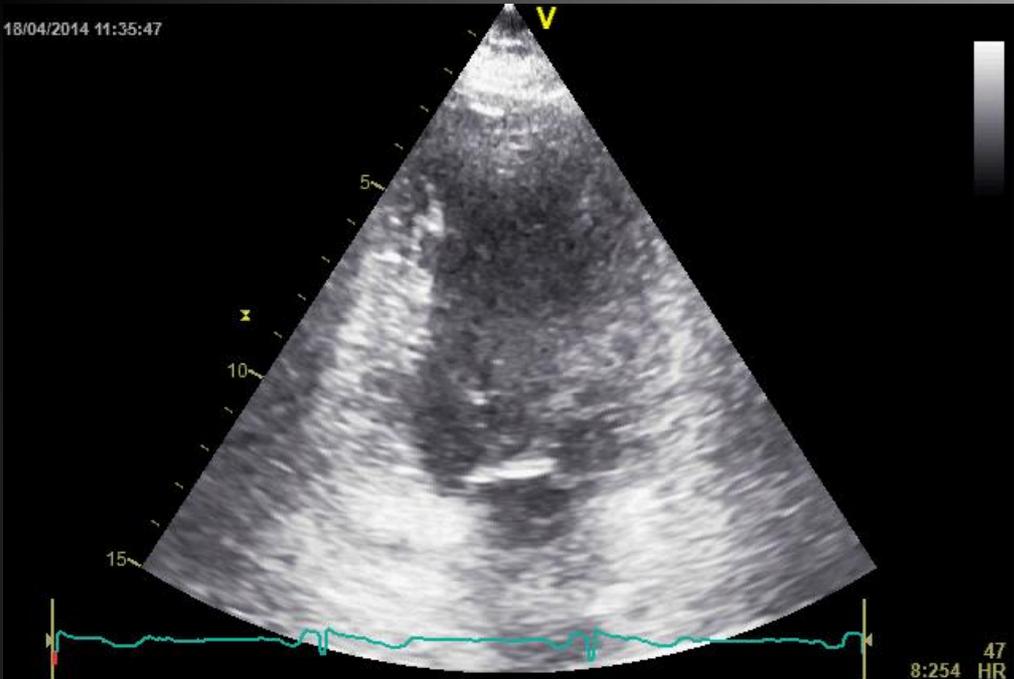




Atteinte de la contraction segmentaire VG

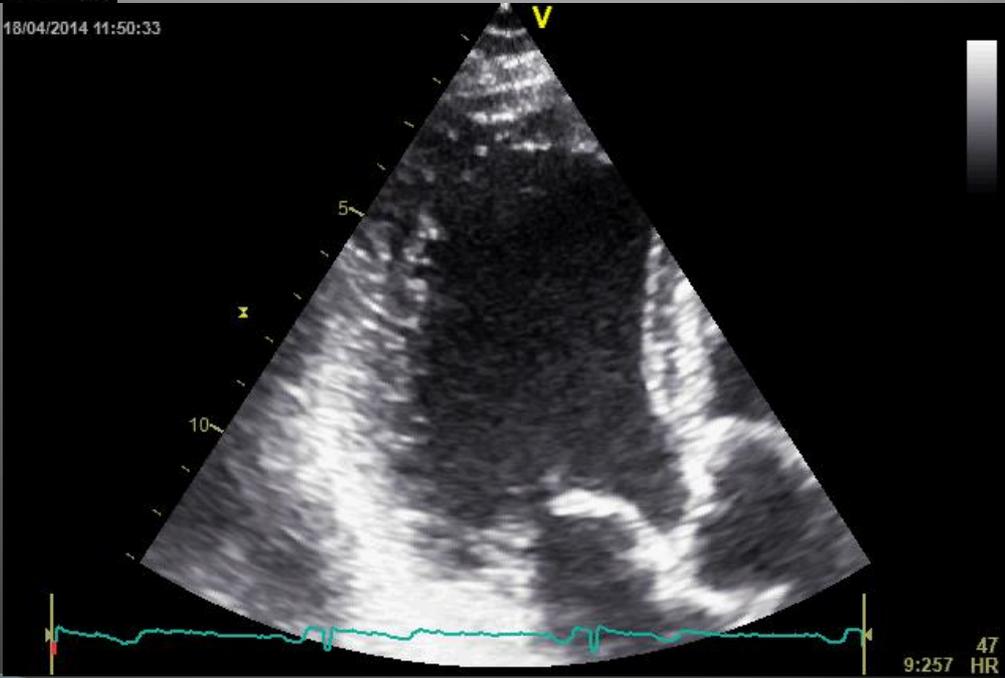


18/04/2014 11:35:47



Sténose IVA

18/04/2014 11:50:33



9:257 HR

Dans le syndrome coronarien aigu

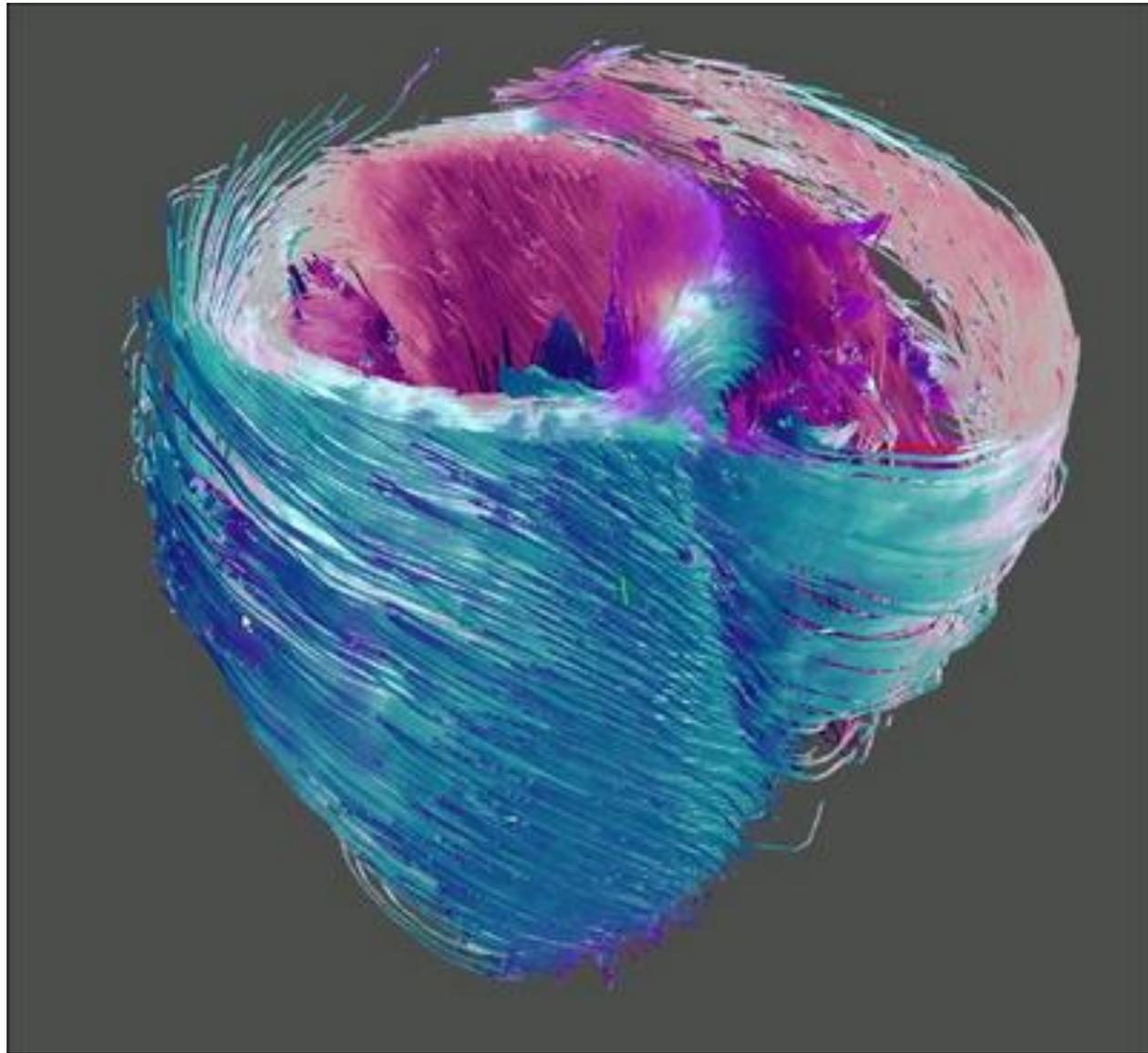
Echocardiographie permet une orientation diagnostique

- Sensibilité élevée pour diagnostic d'un IDM (92-93%), d'une ischémie (88%)
- Spécificité limitée (53-57% IDM, 78% ischémie)

Wei K, JACC Cardiovascular Imaging 2010

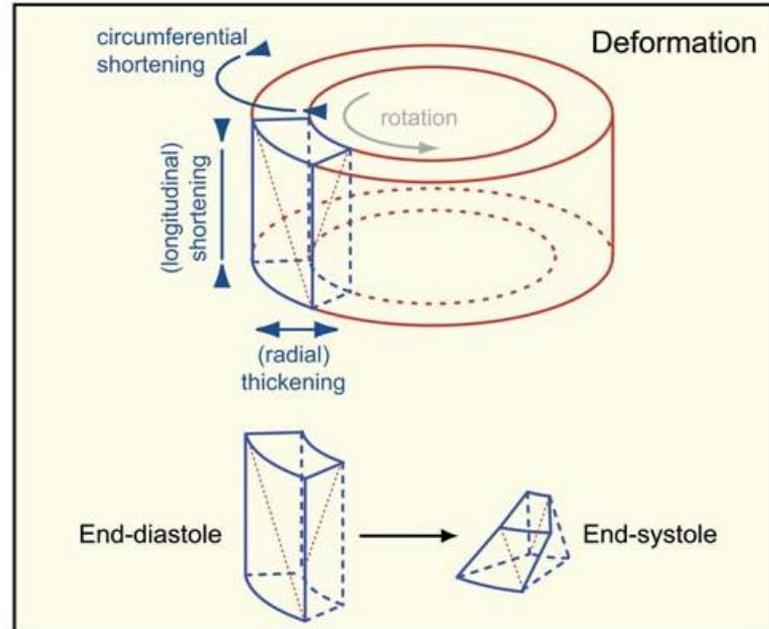
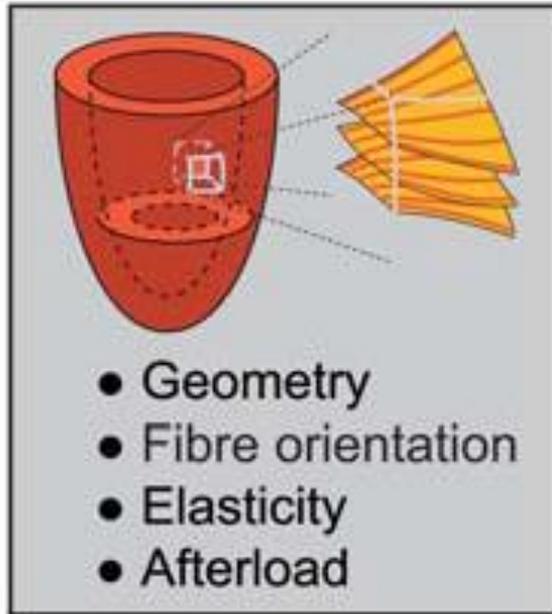
⇒ *Amélioration potentielle par:*

- *Une analyse plus fine de la fonction contractile*
- *par étude de la déformation myocardique*



Dans le syndrome coronarien aigu

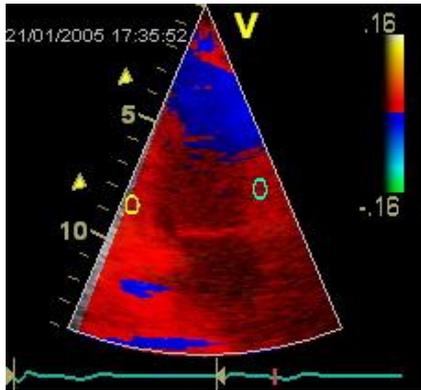
Étude des paramètres de déformation myocardique



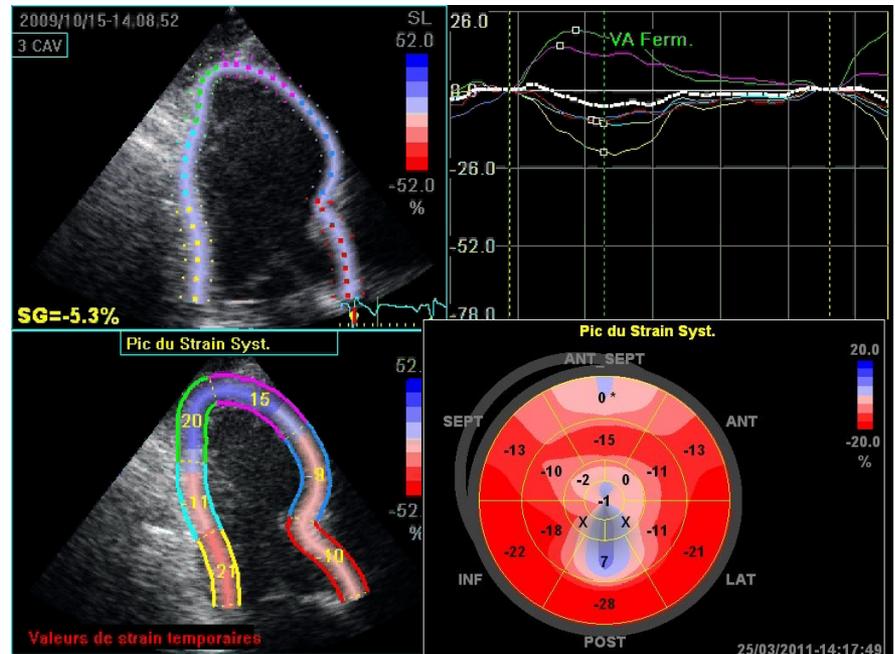
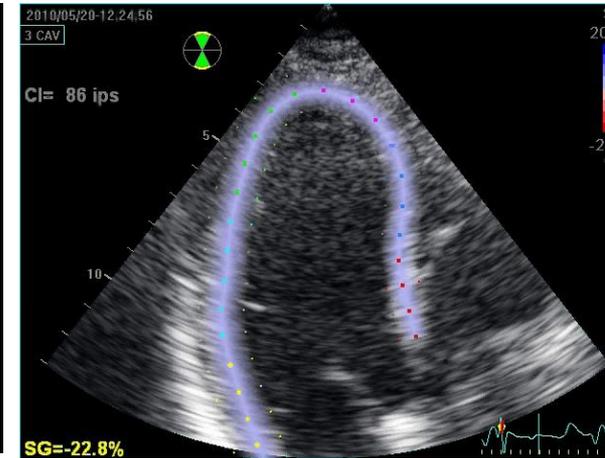
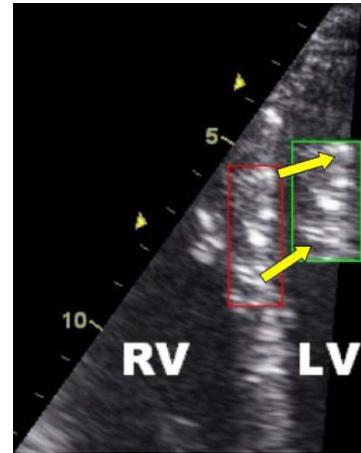
Several of the methods for global assessment concentrate only on radial function, **ignoring longitudinal function**, which in most cardiac pathology is altered before changes occur in radial indices.

Quantification de la fonction régionale

Tissue Doppler imaging

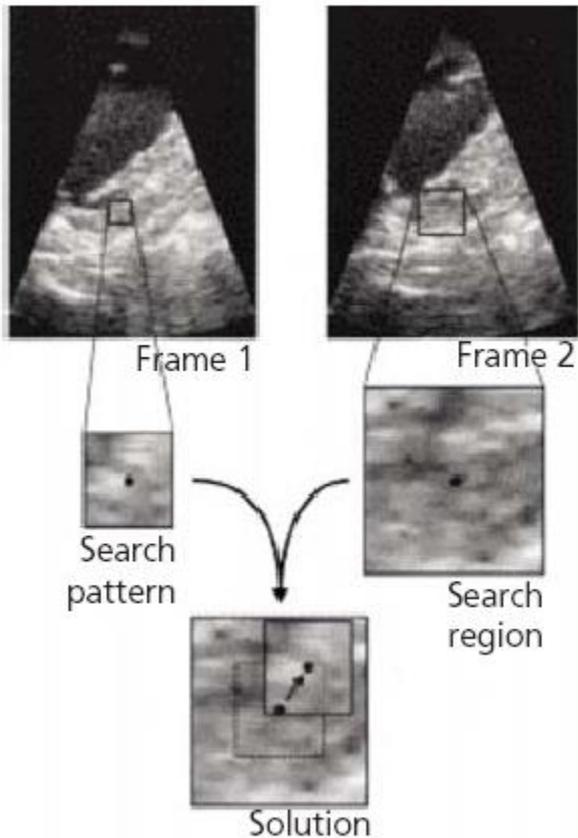


2D Speckle tracking imaging



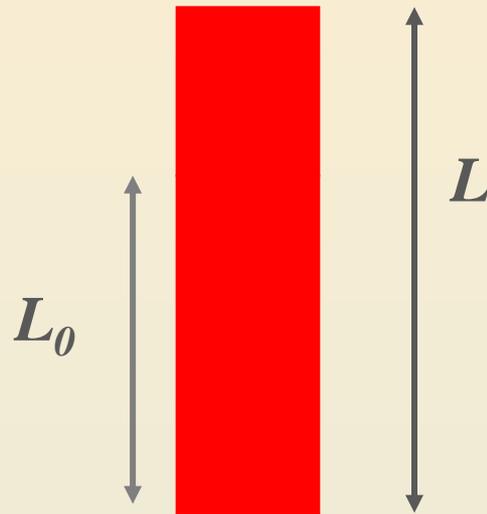
Méthodes d'évaluation du 2D strain

Le 2D Strain



- **Répérage d'un « speckle » dans le segment étudié**
- **Suivi du speckle au cours du cycle cardiaque**
- **Calcul de son déplacement**
- **Normalisation selon l'axe choisi**

Etude de la déformation myocardique ou strain



$$\textit{Strain} = \frac{L - L_0}{L}$$

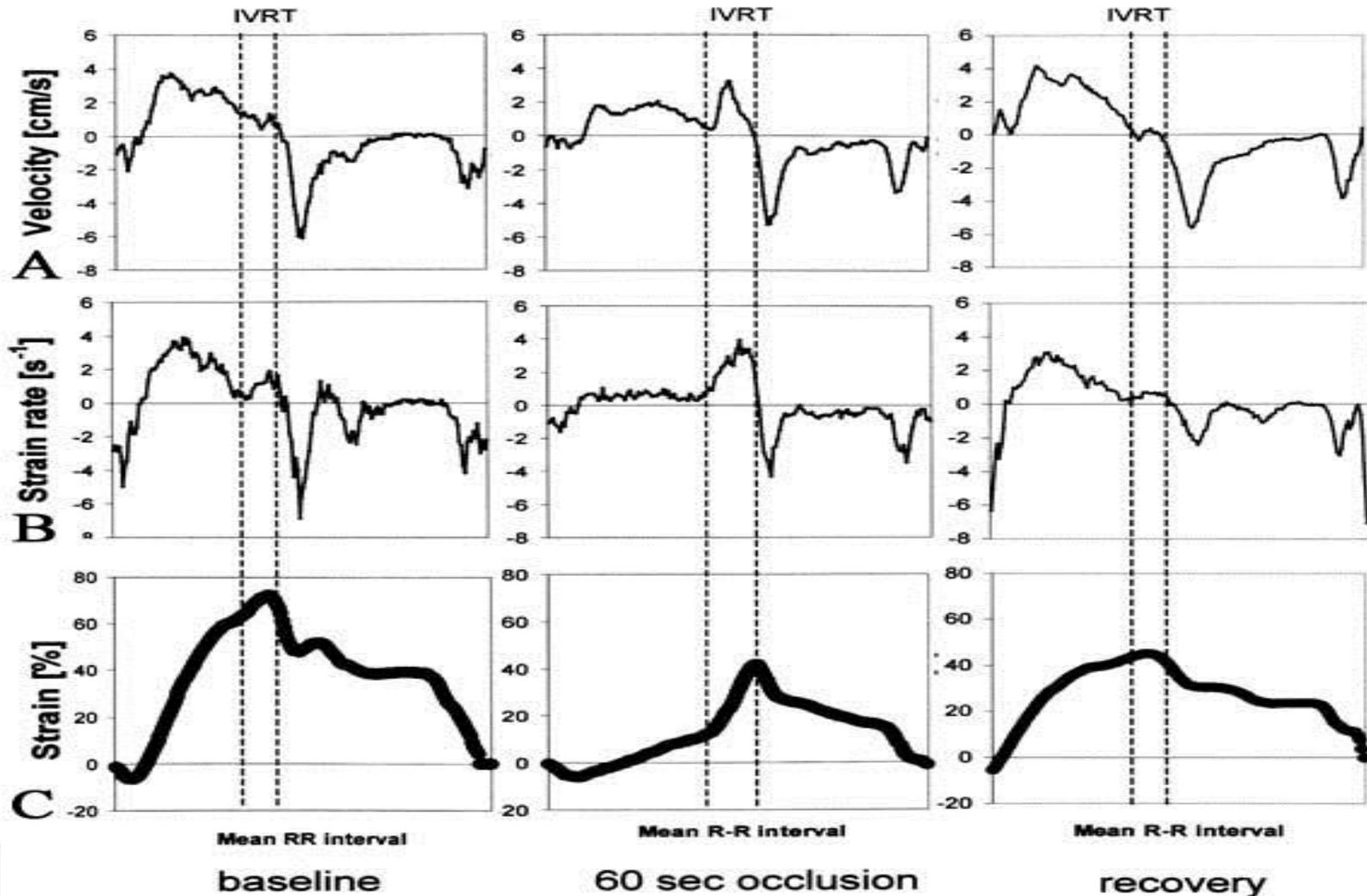
Unité = %

Résultat positif si le segment s'agrandit
Résultat négatif si le segment se raccourcit

C'est la déformation d'un segment myocardique

Ischémie aigue

Etude des paramètres de déformation myocardique



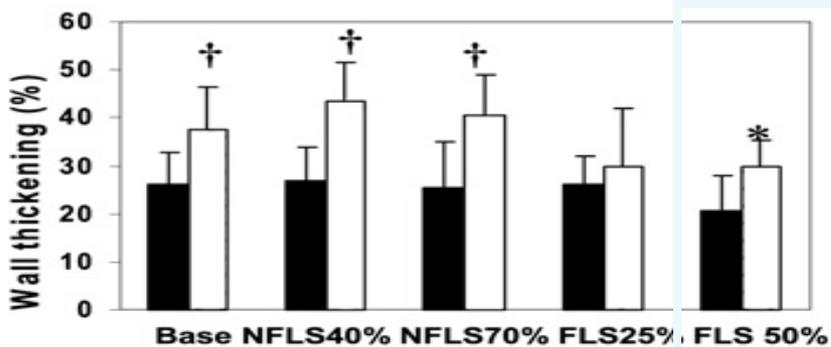
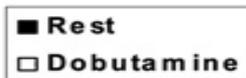
Syndrome coronarien aigu

retentissement sur de déformation myocardique

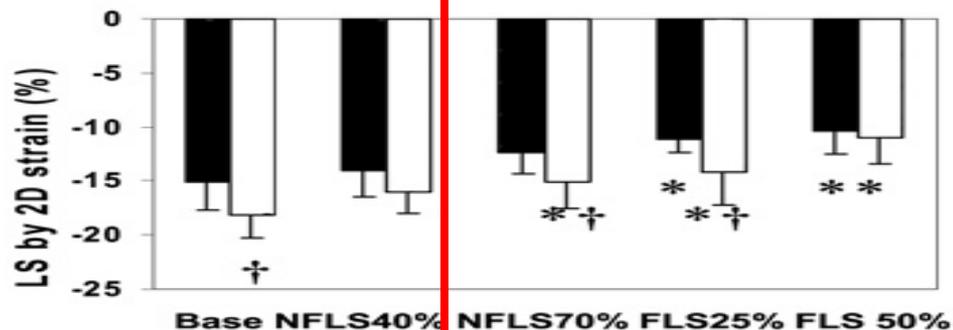
Radial Function

Longitudinal and Circonférential Function

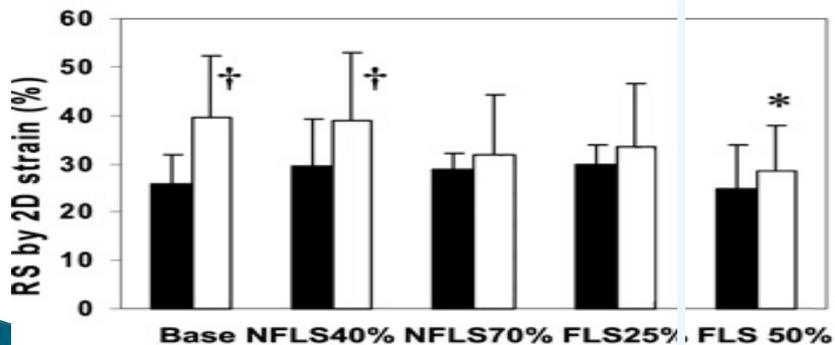
WT in risk area



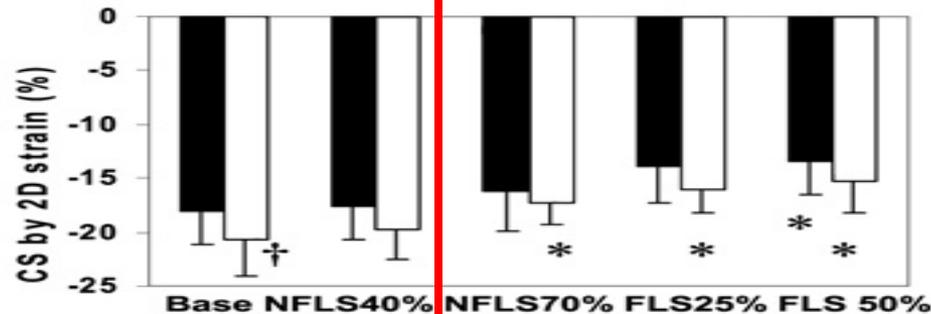
LS in risk area



RS in risk area



CS in risk area



Strain et analyse segmentaire

Utile en routine pour une paroi « douteuse à l'œil »

- **2D speckle très rapide**
- **approche de la fonction longitudinale (difficile à l'œil)**

Intérêt pour l'étude de la viabilité sous faibles doses de dobutamine

- **Doppler tissulaire (Hoffmann, JACC 2002)**
- **2D strain (Migrino et al. JASE 2007)**

Intérêt théorique pour l'échographie de stress mais

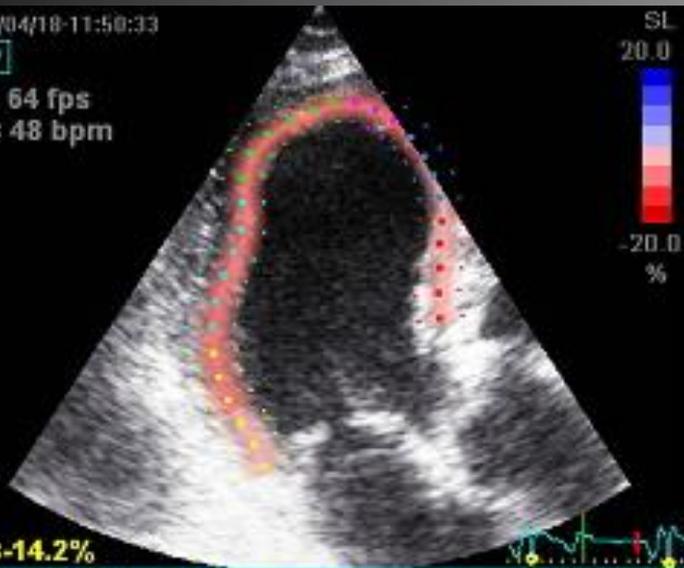
- **très long et d'un apport limité pour le Doppler tissulaire**
- **limité au-delà de 120/mn de FC pour le 2D speckle**

2014/04/18-11:50:33

3 CAV

FR= 64 fps

HR= 48 bpm

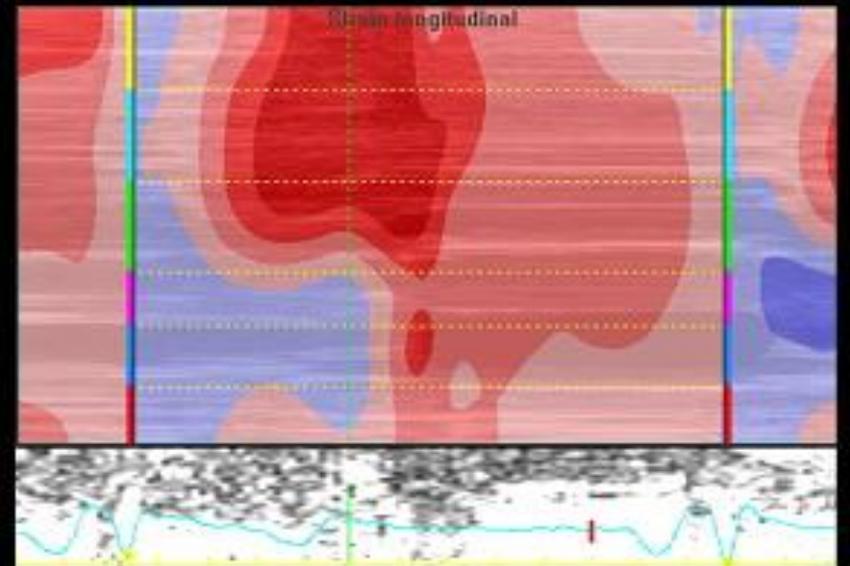
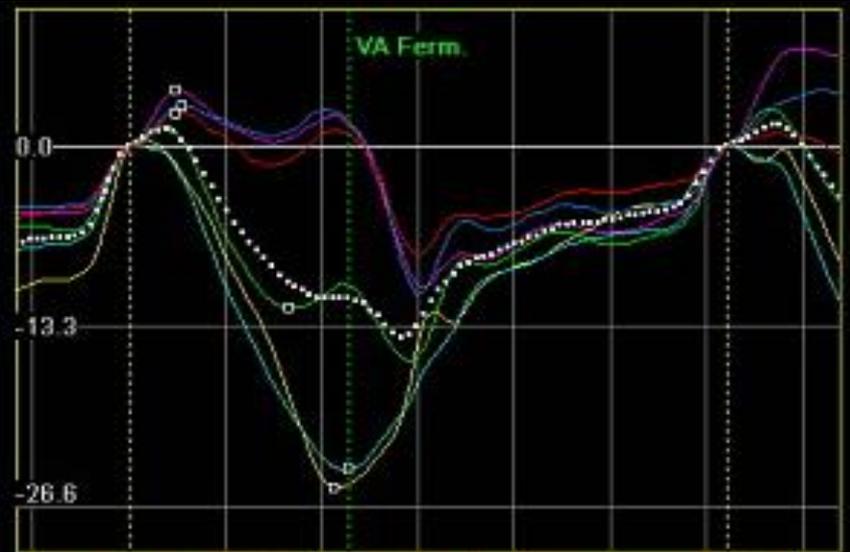


SG=-14.2%

Pic du Strain Syst.



Valeurs de strain temporaires



2014/04/18-11:49:37

4CAV

FR= 64 fps

HR= 49 bpm

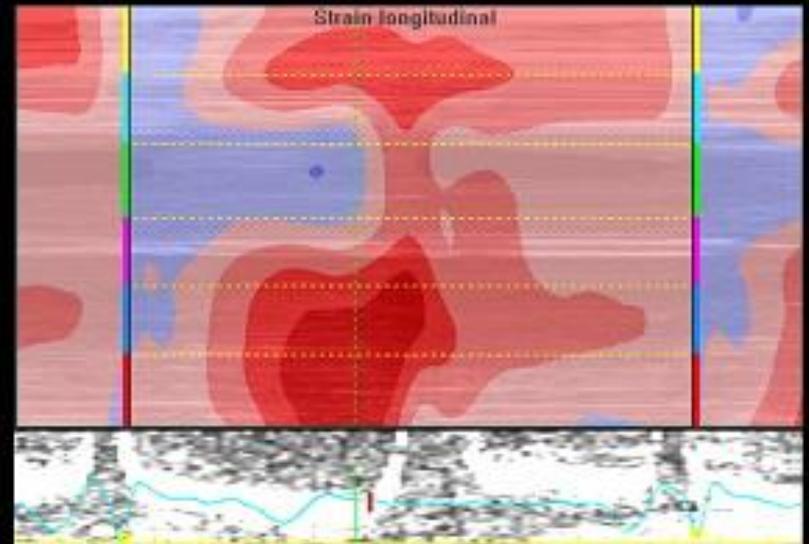
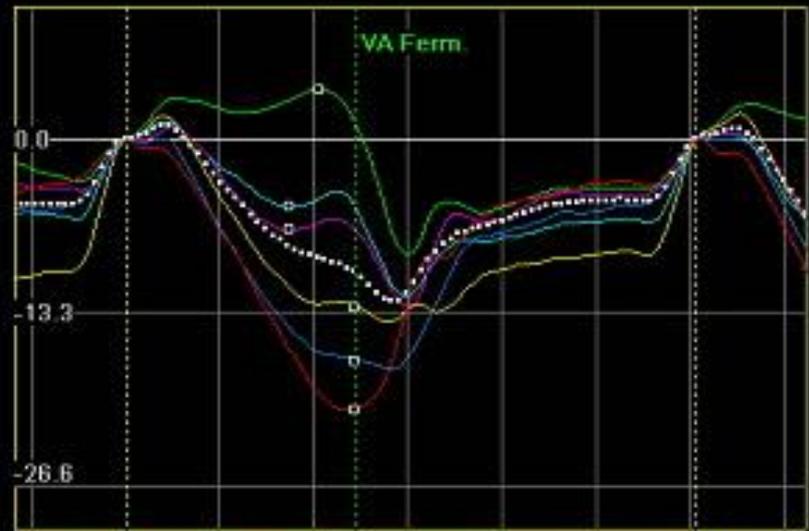


SG=-12.5%

Pic du Strain Syst.



Valeurs de strain temporees

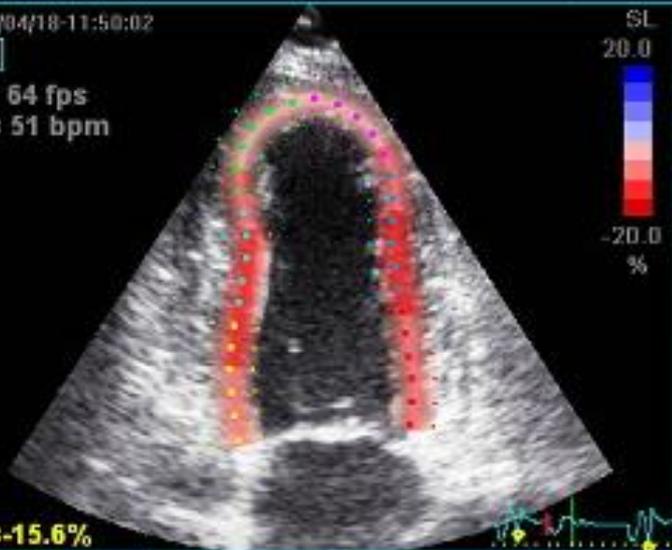


2014/04/18-11:50:02

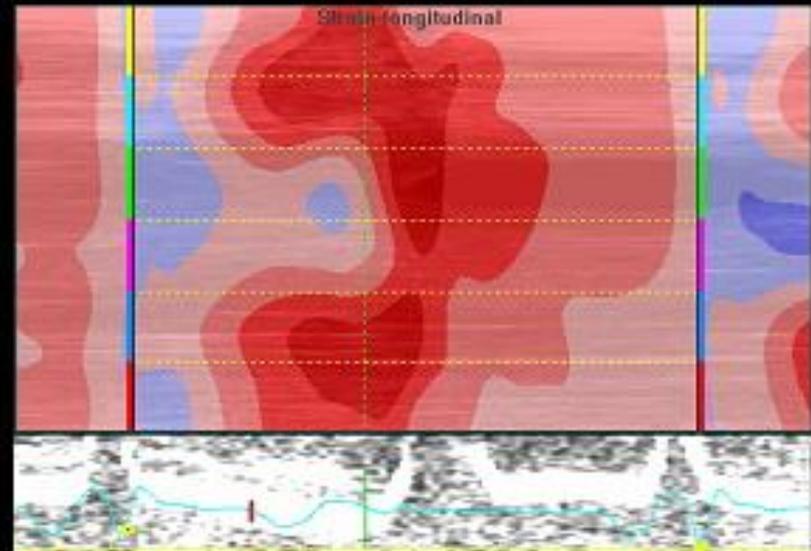
2CAV

FR= 64 fps

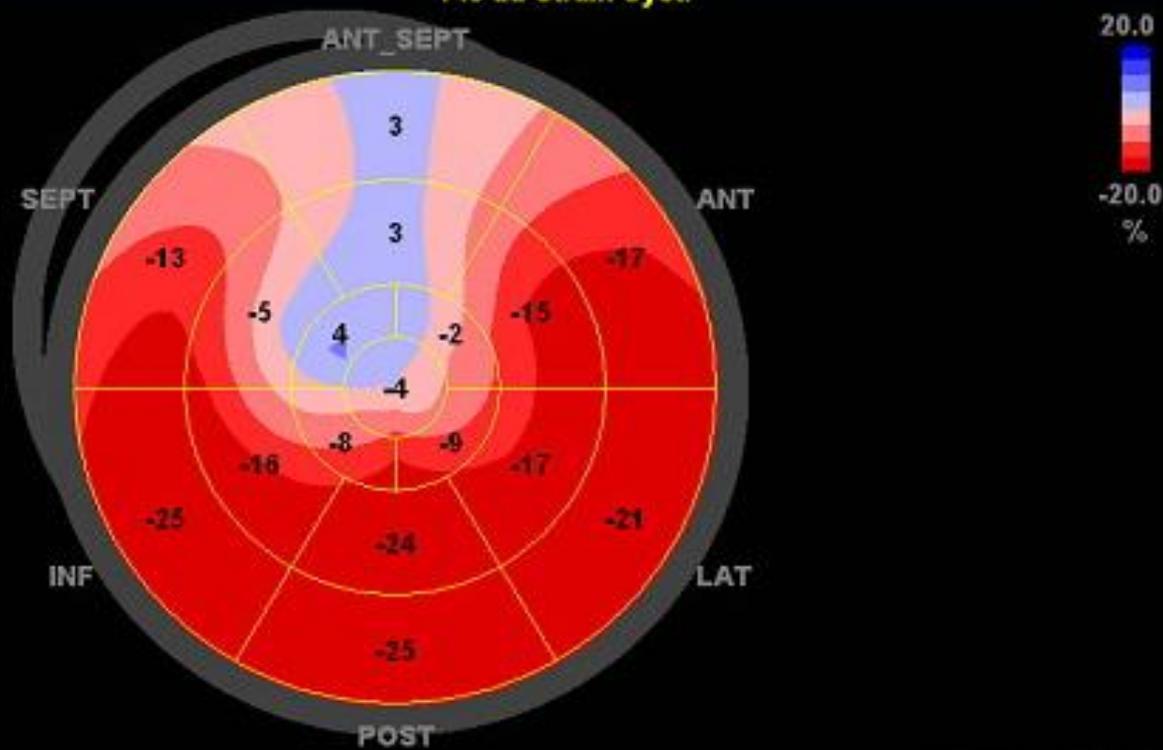
HR= 51 bpm



Pic du Strain Syst.



Pic du Strain Syst.

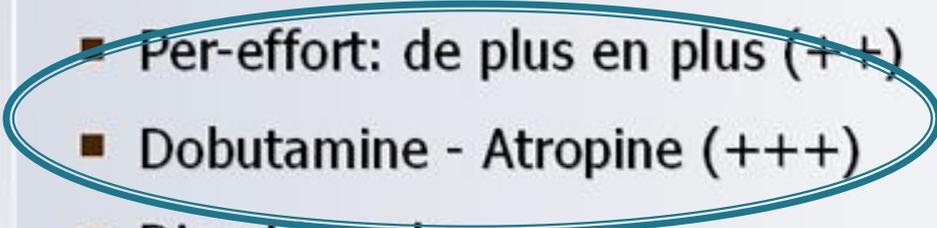


18/04/2014-12:04:28

GLPS_LAX	-14.2 %	AVC_AUTO	488 msec
GLPS_MC	-12.5 %	HR_ApLAX	48 bpm
GLPS_A2C	-15.6 %	FR_min	64 fps
GLPS_Avg	-14.1 %		

Recherche d'une ischémie

test de provocation

- Post-effort : US++, peu employé car décevant
- Per-effort: de plus en plus (++)
- Dobutamine - Atropine (+++) 
- Dipyridamole
- Autres :
 - Adénosine (scinti++)
 - Pacing

Les Epreuves de Stress

	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG ^{a, 91, 94, 95}	45-50	85-90
Exercise stress echocardiography ⁹⁶	80-85	80-88
Exercise stress SPECT ⁹⁶⁻⁹⁹	73-92	63-87
Dobutamine stress echocardiography ⁹⁶	79-83	82-86
Dobutamine stress MRI ^{b, 100}	79-88	81-91
Vasodilator stress echocardiography ⁹⁶	72-79	92-95
Vasodilator stress SPECT ^{96, 99}	90-91	75-84
Vasodilator stress MRI ^{b, 98, 100-102}	67-94	61-85
Coronary CTA ^{c, 103-105}	95-99	64-83
Vasodilator stress PET ^{97, 99, 106}	81-97	74-91

20 mm

30 mm

3h

45 mm

40 mm

Le moins sensible

Le moins spécifique

Le plus spécifique

Le plus sensible

LE STRESS { Effort (EE, Echo et Scintigraphie)
Pharmacologique : Dobutamine ou Persantine (Echo, IRM, et PET)

Test de provocation de l'ischémie myocardique Echo d'effort

pendant l'effort sur table d'examen avec pédalier

Avantage:

- Plus physiologique
- Évaluation d'une IM ischémique

Inconvénients:

Moindre qualité d'acquisitions (polypnée...)



Protocole d'échographie d'effort

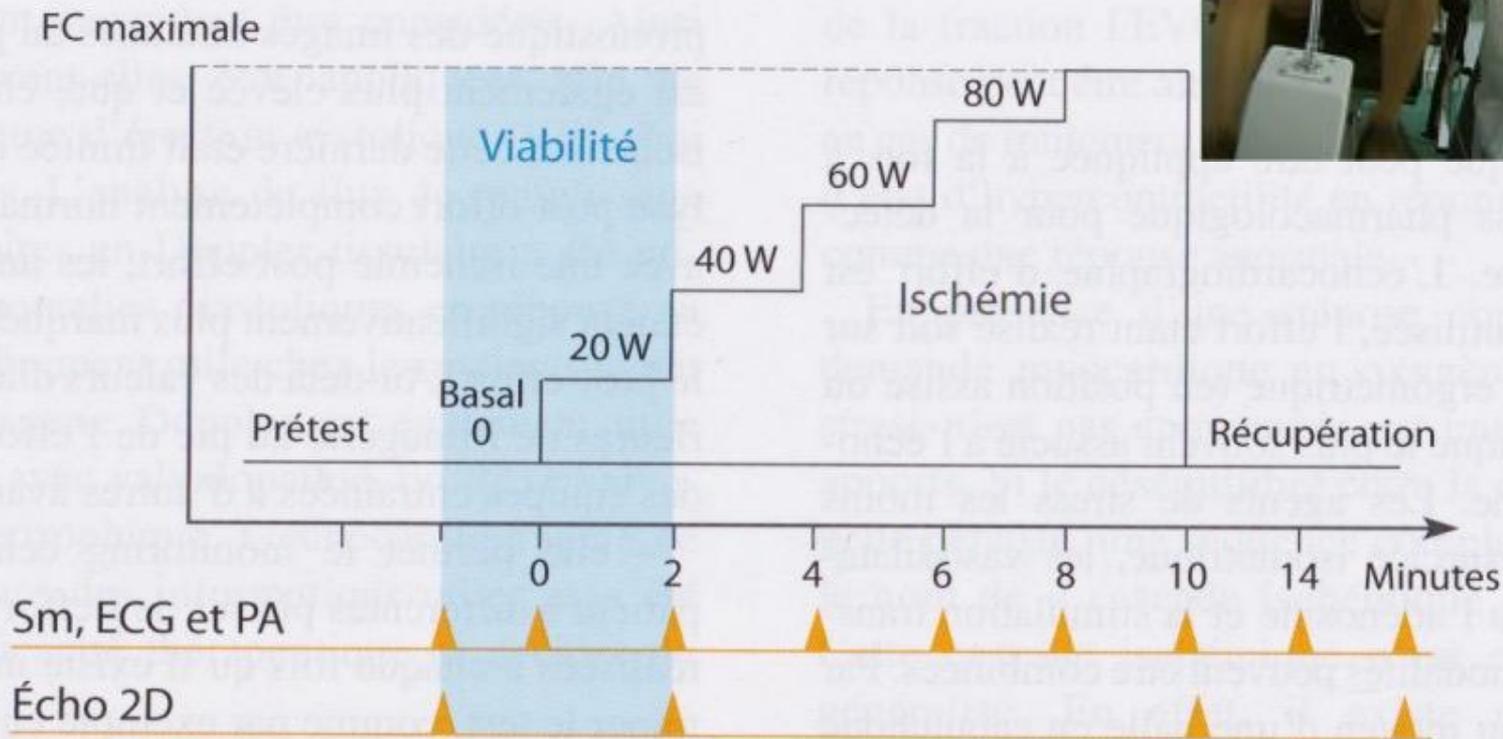


Figure 35-2 Protocole d'échocardiographie d'effort.

Protocole d'échographie dobutamine

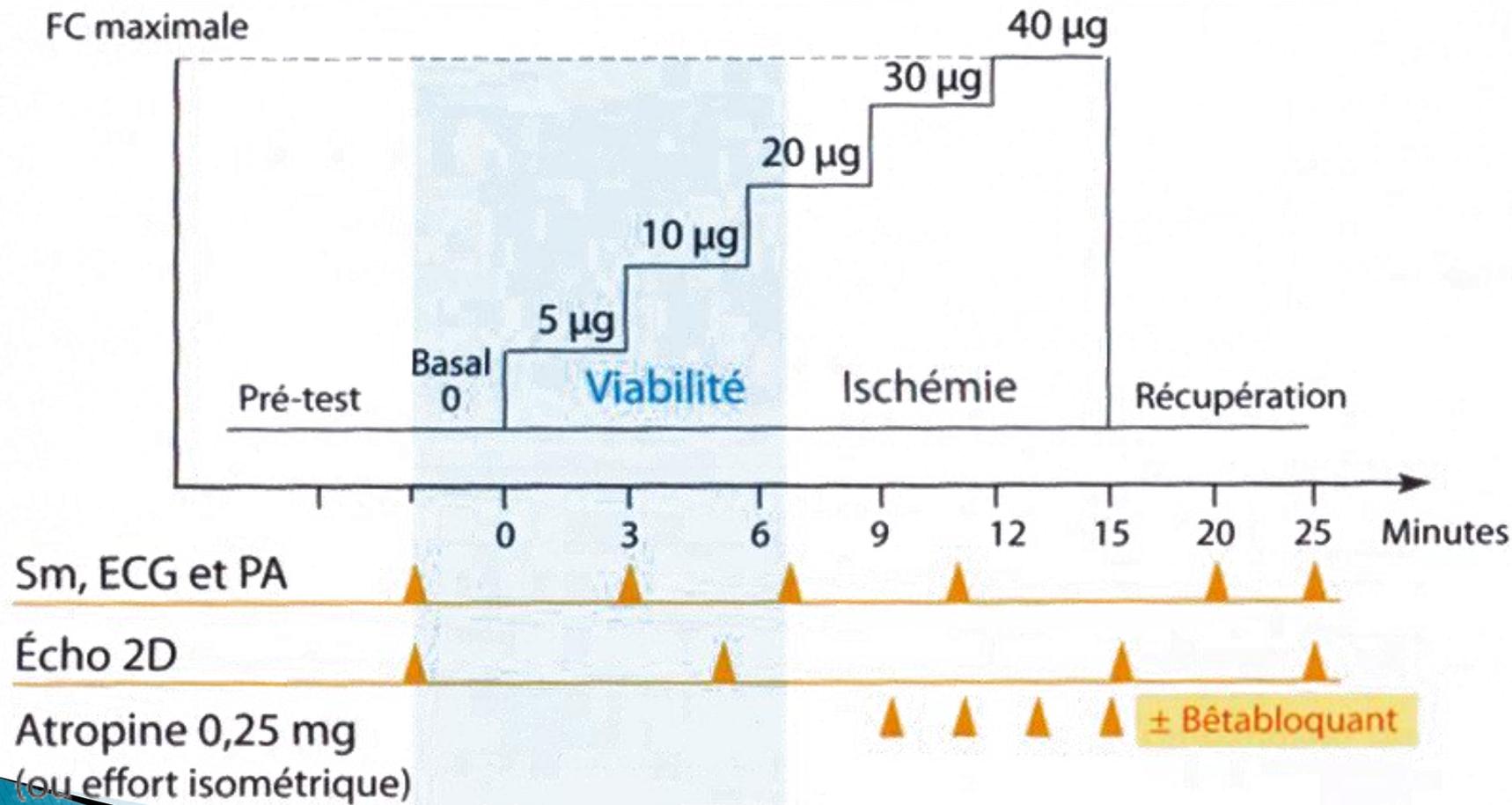
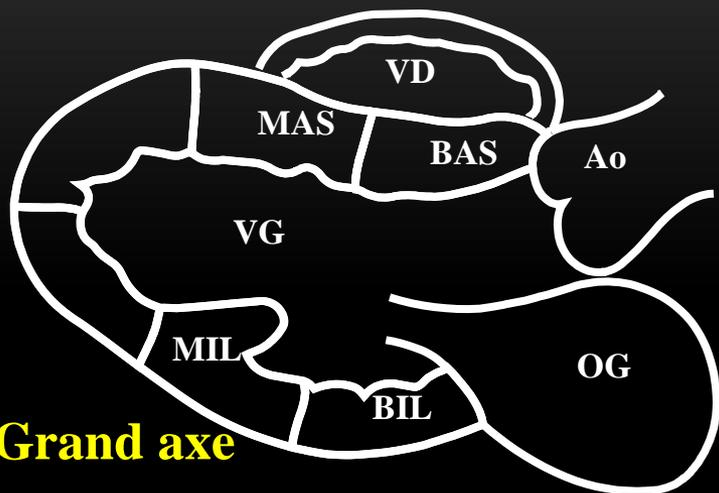
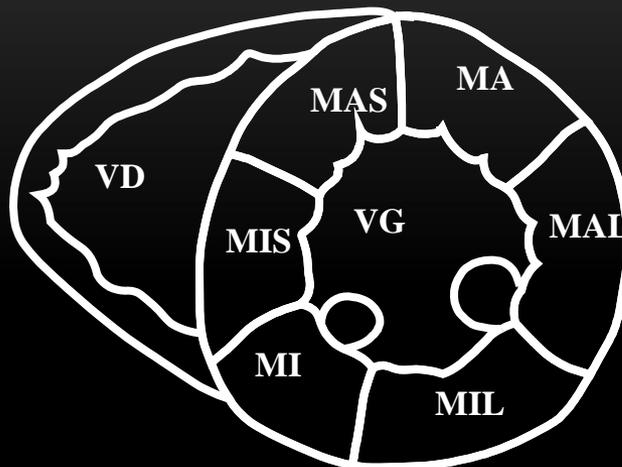


Figure 35-3 Protocole d'échocardiographie de stress sous dobutamine.

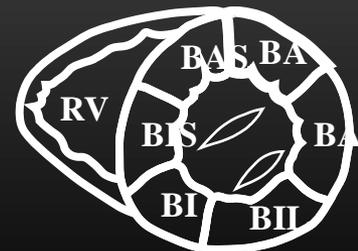
Classification 17 sgts



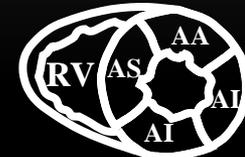
Grand axe



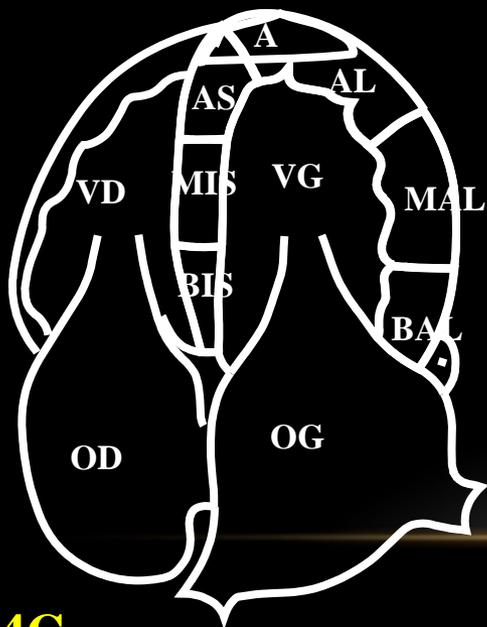
Petit axe médio V



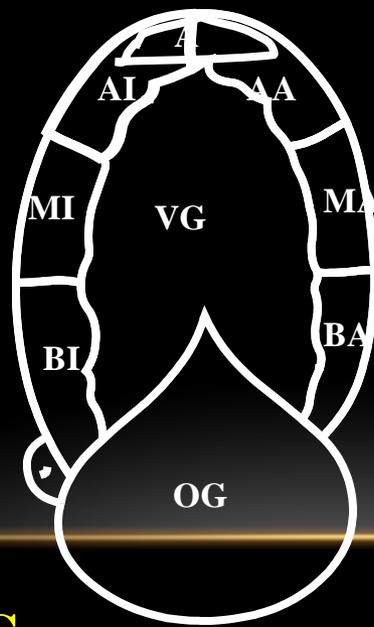
Petit axe Basal



Petit axe Apical



4C



2C

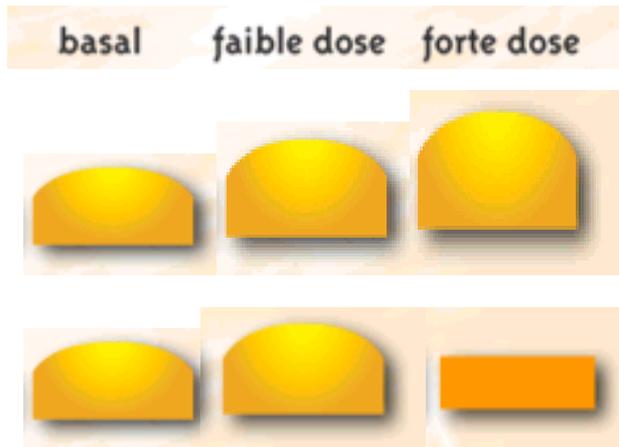
- BAS: segment basal antéroseptal
- MAS: segment moyen antéroseptal
- BIL: segment basal inférolatéral
- MIL: segment moyen inférolatéral
- BA: segment basal antérieur
- MA: segment moyen antérieur
- AA: segment apical antérieur
- BI: segment basal inférieur
- MI: segment moyen inférieur
- AI: segment apical inférieur
- BAL: segment basal antérolatéral
- MAL: segment moyen antérolatéral
- AL: segment apical latéral
- BIS: segment basal inféroseptal
- MIS: segment moyen inféroseptal
- AIS: segment apical septal
- A: apex

Description de la cinétique

- ▶ **Acquisition de 5 incidences à chaque palier**
 - basal
 - faible dose
 - pic
 - récupération
- ▶ **Score segmentaire au niveau des 17 segments**
 - 0 ininterprétable
 - 1 normal
 - 2 hypokinésie
 - 3 akinésie
 - 4 dyskinésie
- ▶ **Détermination du Wall motion score index (WMSI)**

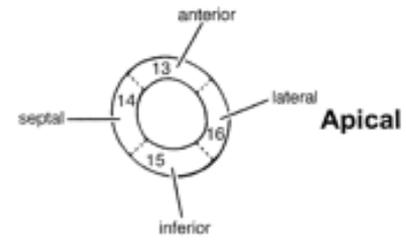
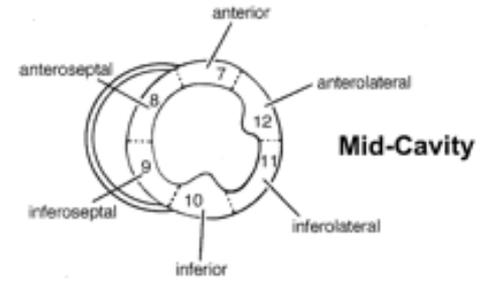
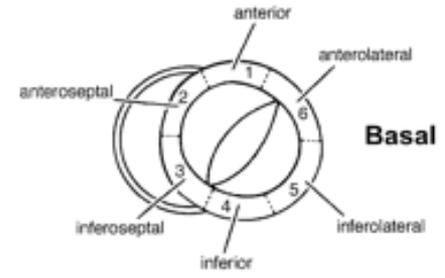
Test de provocation de l'ischémie myocardique

Analyse segmentaire

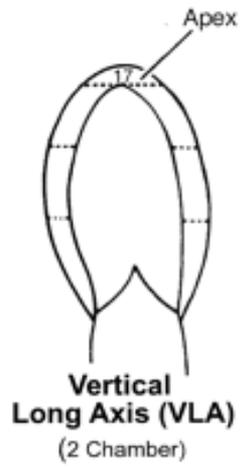
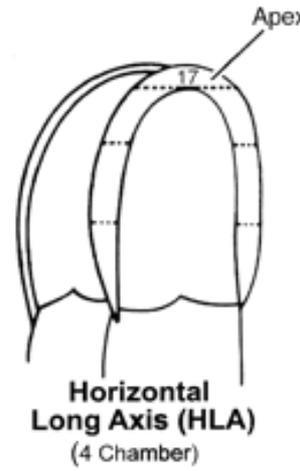


NORMALE

ISCHEMIE



Short Axis (SA)



Définition de l'ischémie en stress écho

Dégradation de la cinétique segmentaire au cours du stress dans **au moins 2 segments contigus** ou **un segment dans deux territoires différents**

Relation entre les différentes vues BD et la perfusion coronarienne

Incidences - Segmentation

Distribution:

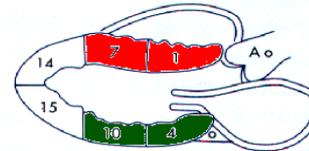
IVA

CX

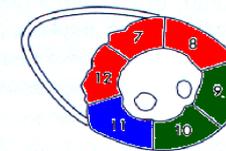
CD

PARASTERNALE

Longitudinale

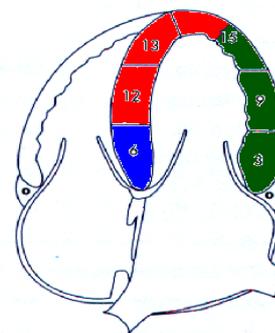


Transverse

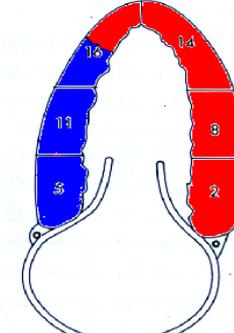


APICALE

Quatre cavités



Deux cavités



Contre indications

- ▶ Fenêtre acoustique insuffisant (pas plus de 2 segments non visualisables)
- ▶ ETT d'effort :
 - Instabilité clinique : SCA <3 jours, IVG décompensée, HTA \geq 220/120, hypotension <100 mmHg
 - Impossibilité d'atteindre FC cible (faible activité physique ...)
- ▶ ETT dobutamine :
 - Trouble rythme ventriculaire
 - CMH obstructive
 - RA serre (forte dose)
 - FEVG très altérée (forte dose)
 - Relative : FA (risque de récurrence si FA paroxystique; difficulté d'examen si persistante)
- ▶ Atropine : Glaucome par fermeture de l'angle; adénome prostatique

Echographie de stress et estimation de la survie dans la cardiopathie ischémique chronique

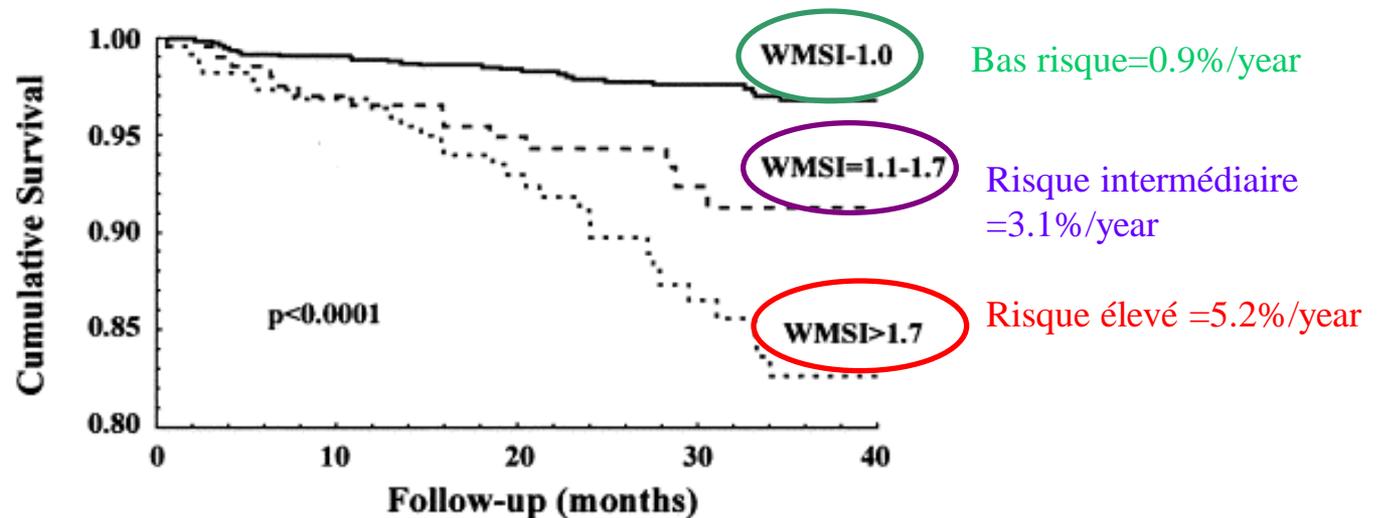
1,500 patients who underwent either exercise or pharmacologic stress

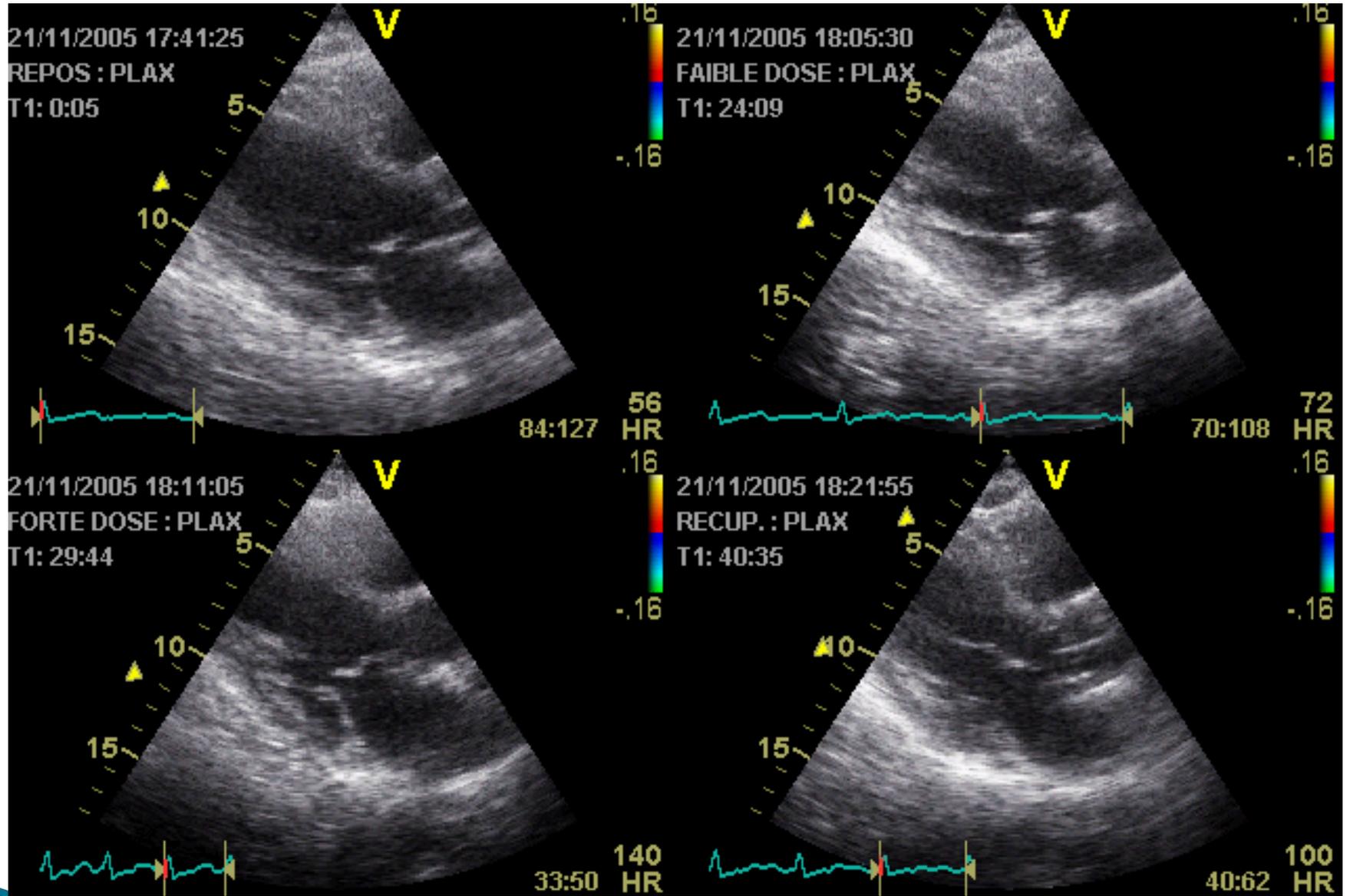
Analyse multivariée: prédictif d'événements cardiaques

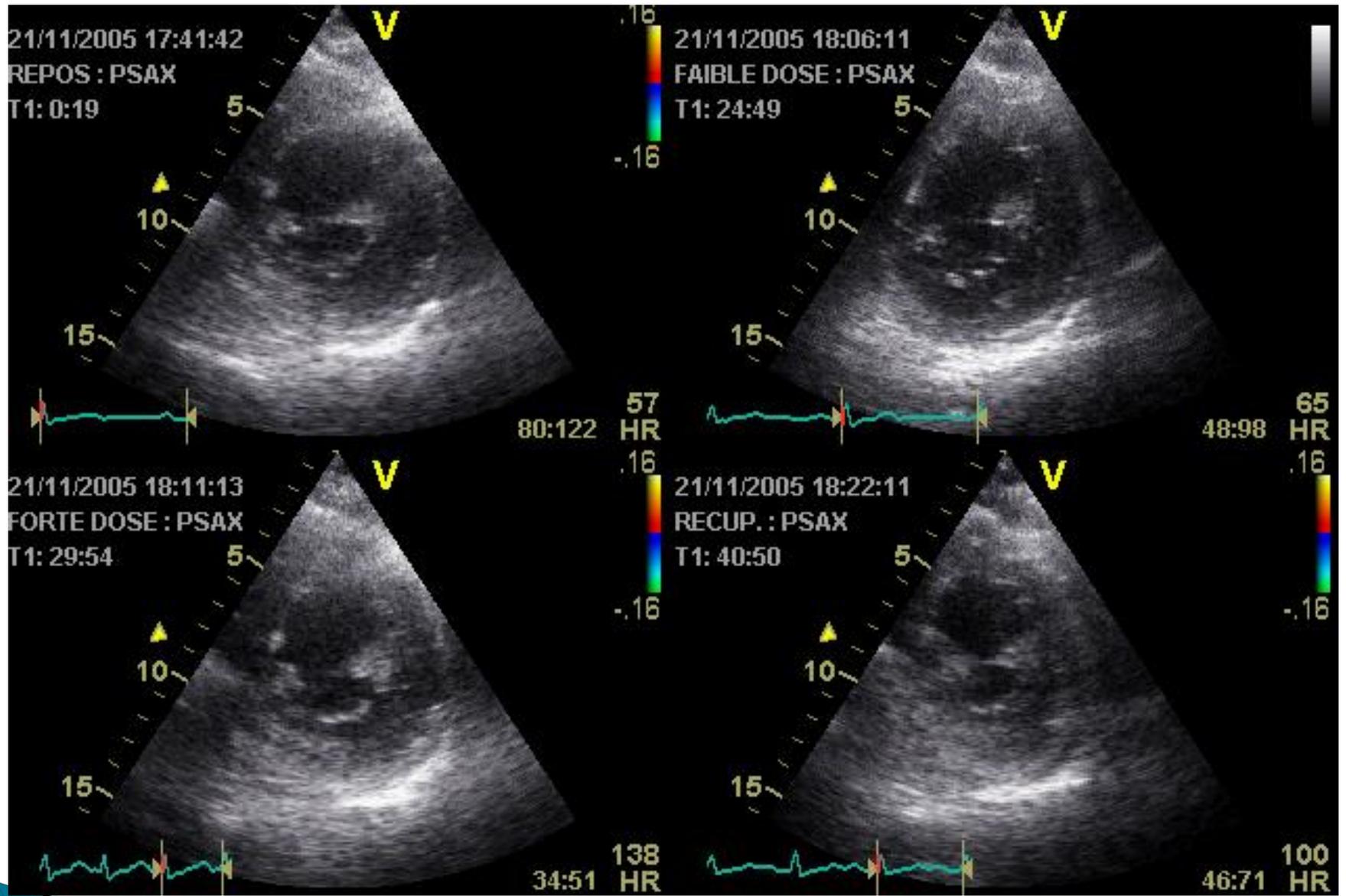
- Fraction d'éjection VG (%)

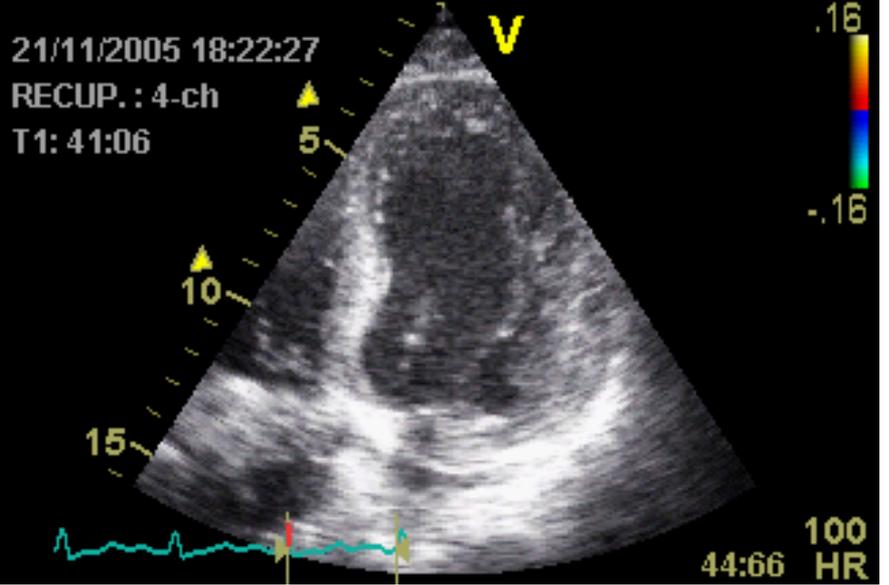
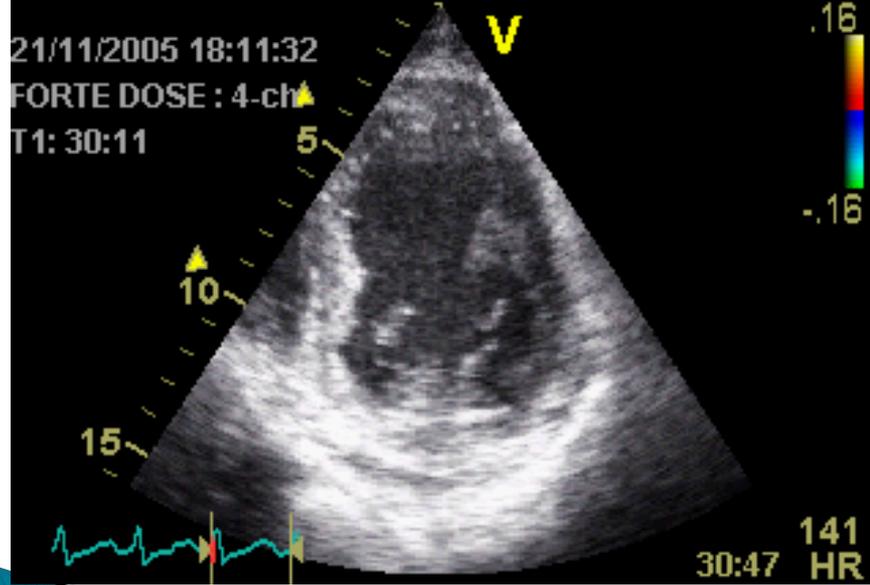
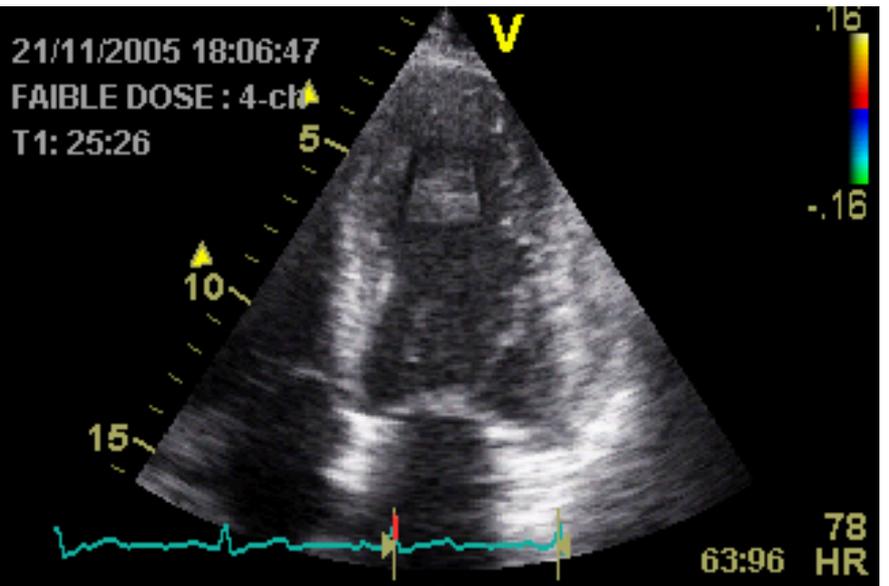
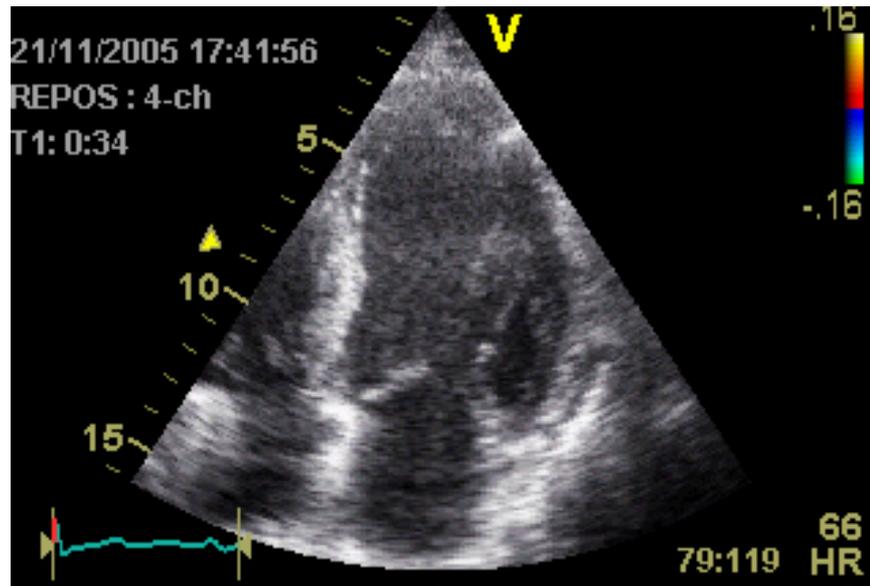
- WM score au pic

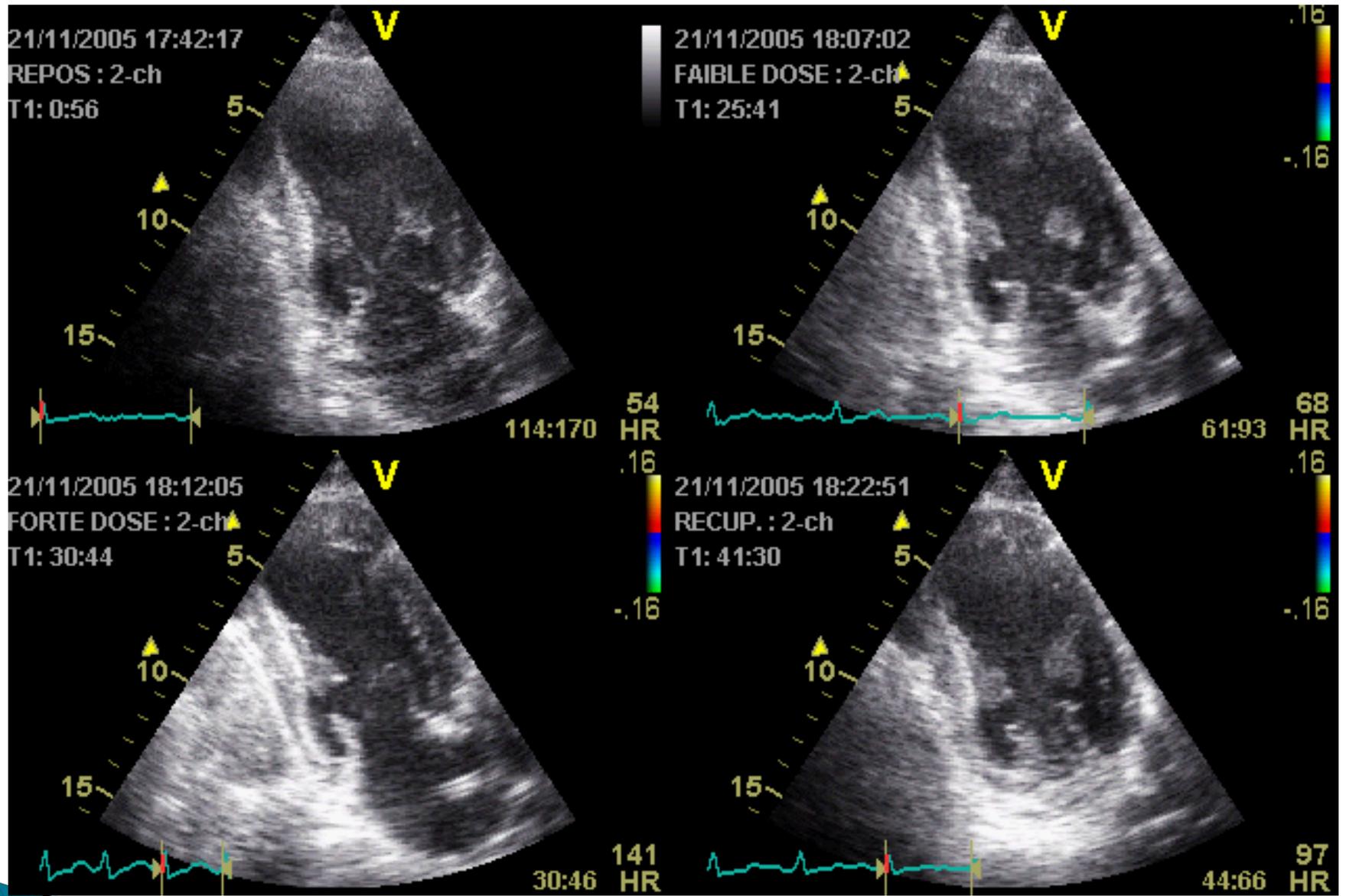
(corrélé à l'extension et sévérité des anomalies de contraction)

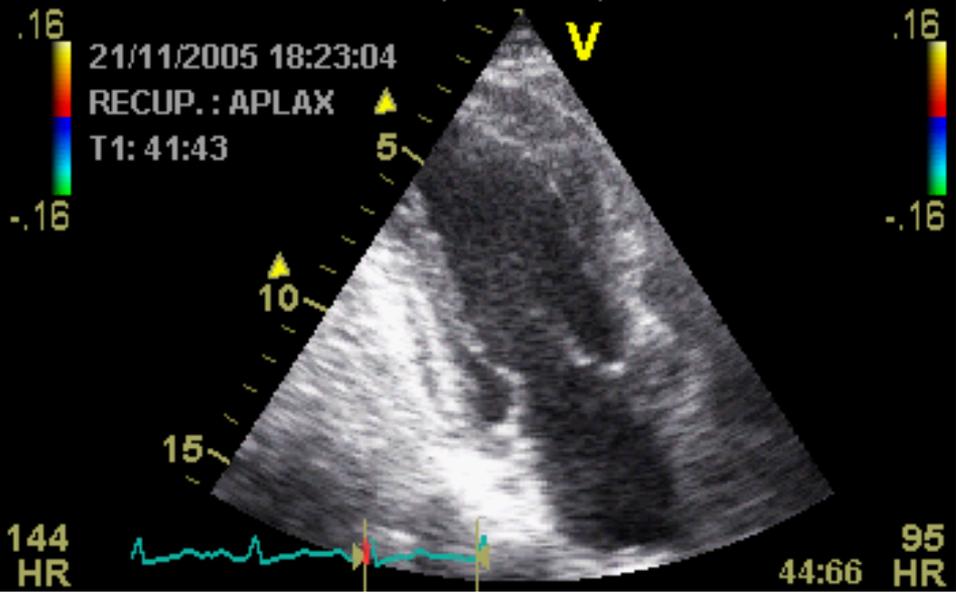
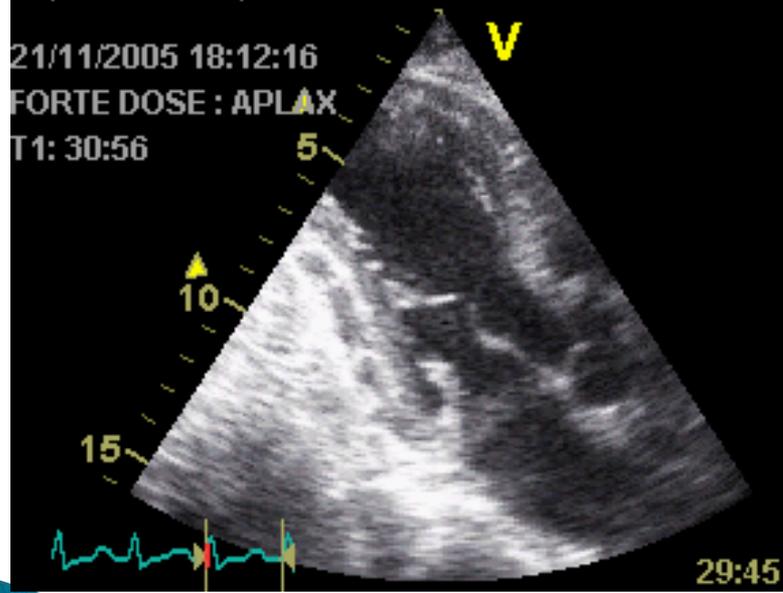
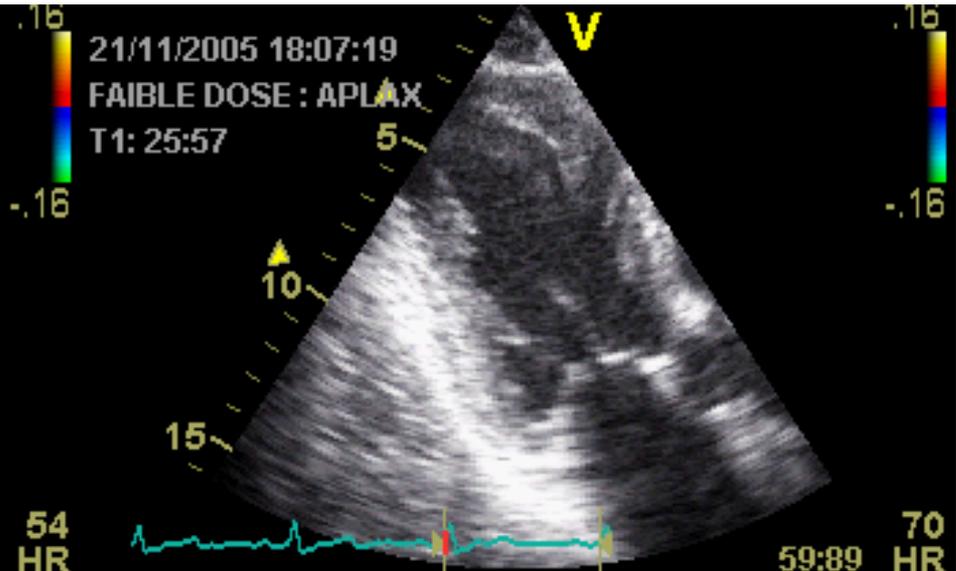
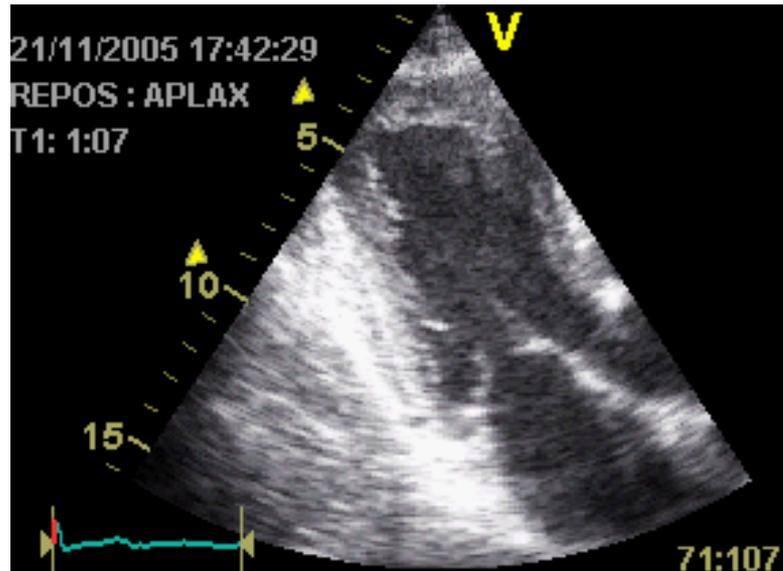






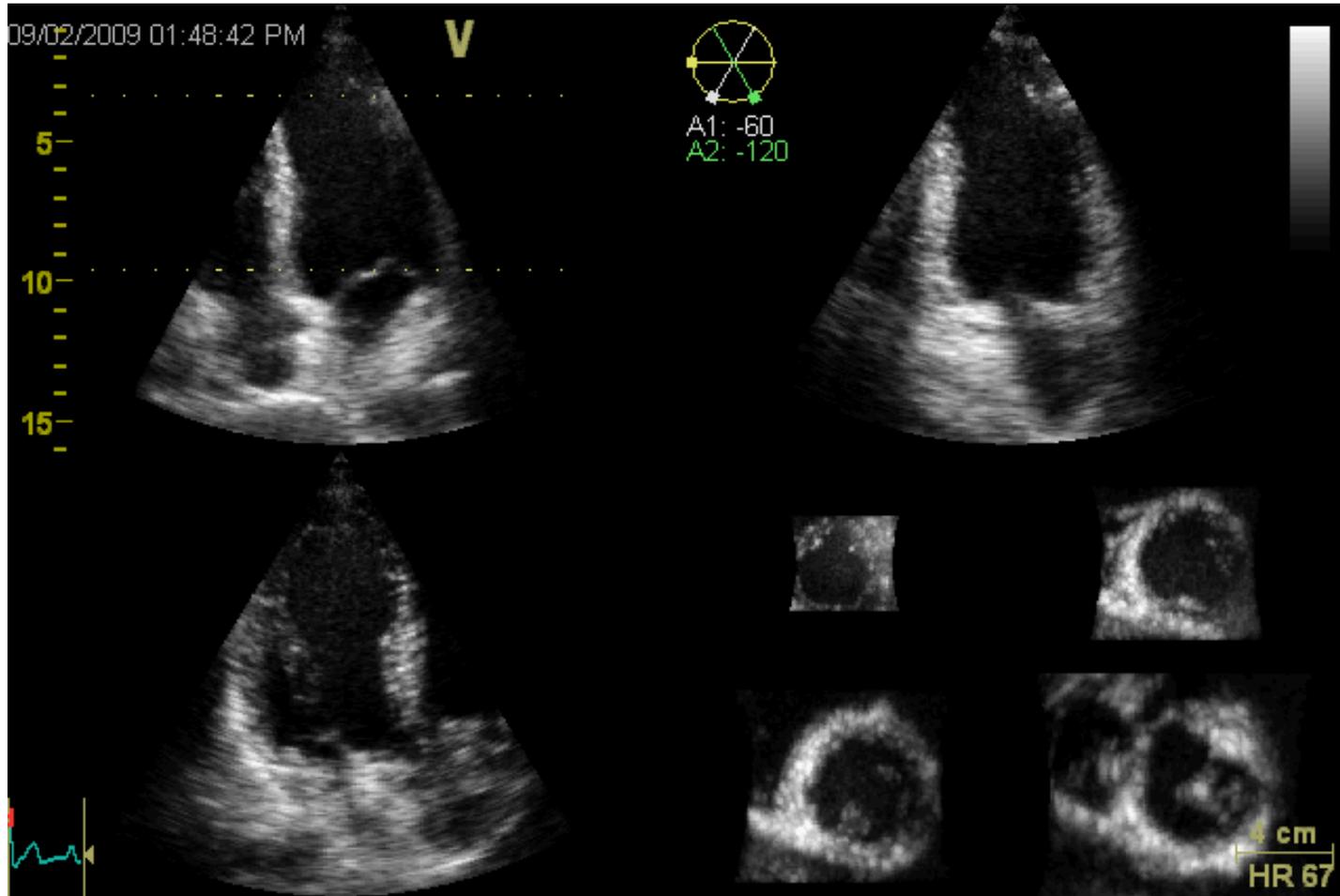






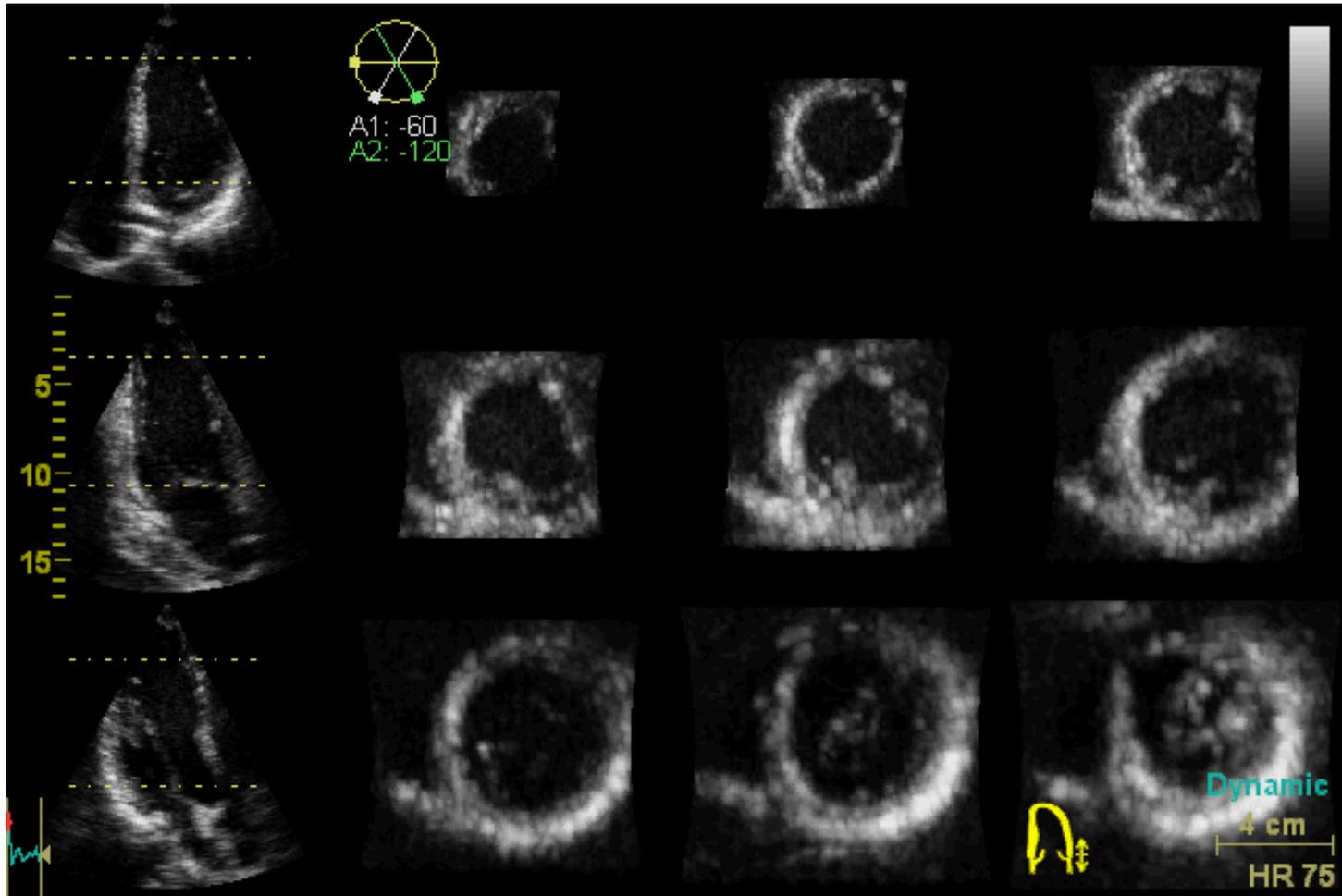
Test de provocation de l'ischémie myocardique

Intérêt de l'échographie 3D



Test de provocation de l'ischémie myocardique

Intérêt de l'échographie 3D



Limites de l'échographie de stress

- Analyse qualitative
 - Courbe d'apprentissage/ pb de reproductibilité
 - Qualité de l'imagerie insuffisante dans 10/20 % cas
- 

ETT de contraste

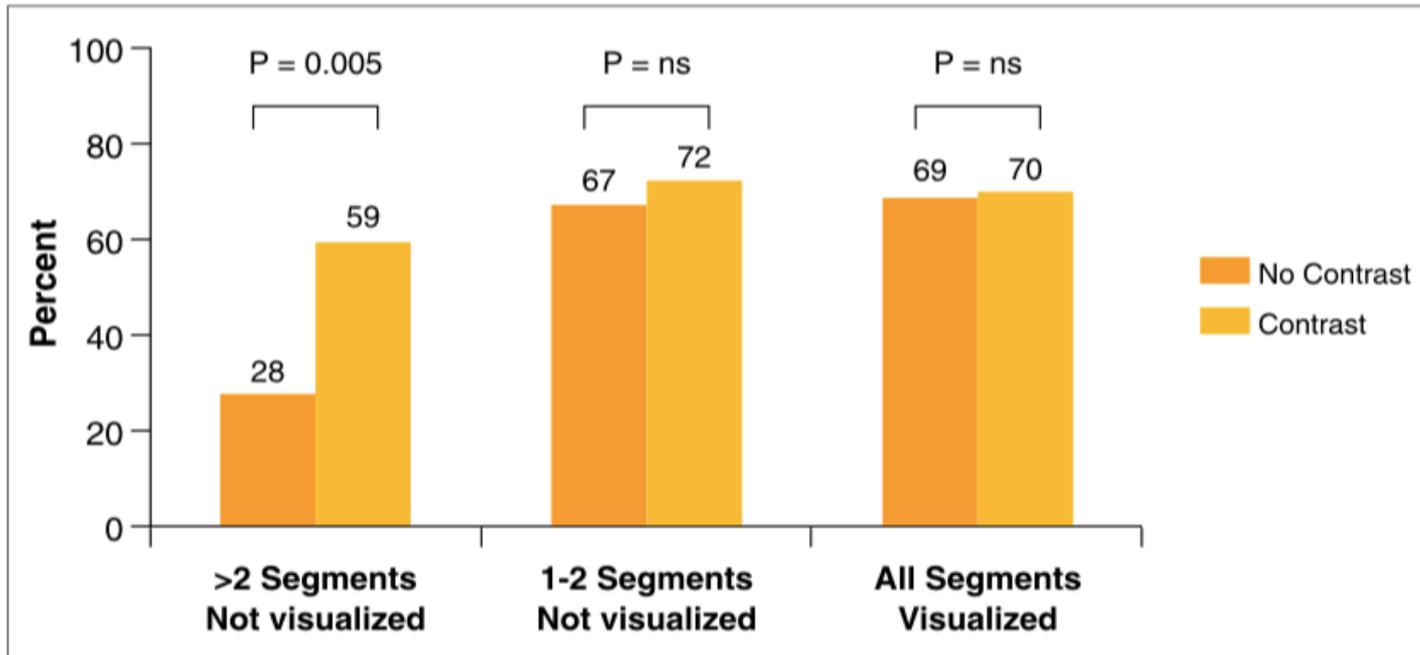


Figure 7. Effect of Contrast Agent Use on Accuracy of DSE in Relation to the Number of Segments Visualized

A significant impact of the use of a contrast agent on accuracy of dobutamine stress echocardiography (DSE) was seen when >2 myocardial segments were not visualized in unenhanced studies. Lesser impact was seen when 1 to 2 segments were not seen, and no impact was observed if all segments were already visualized.

Echographie de stress

Intérêt de l'échographie de contraste



European Journal of Echocardiography (2009) 10, 194–212
doi:10.1093/ejehocard/jep005

EAE RECOMMENDATIONS

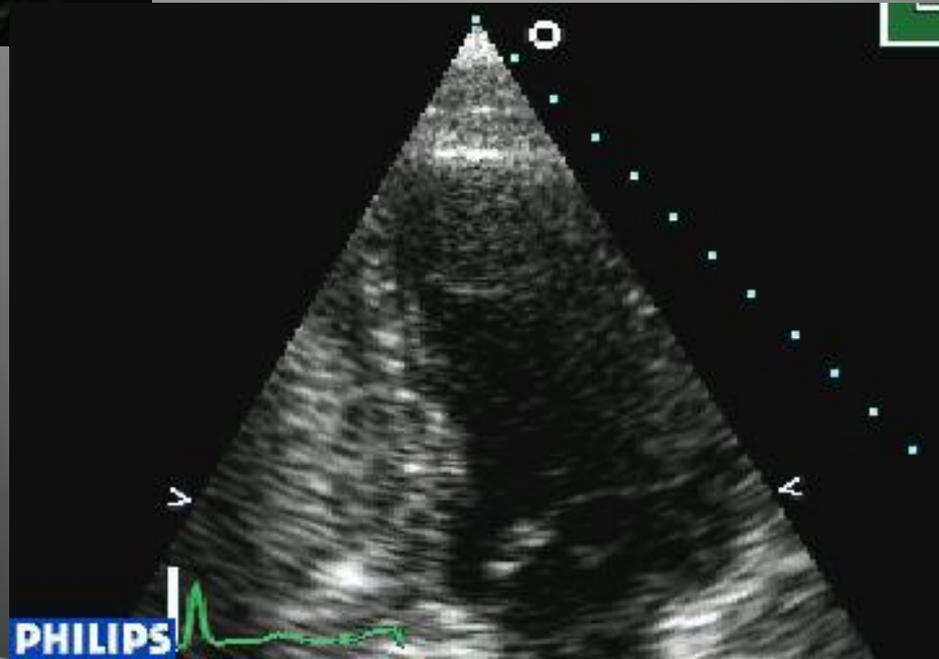
Indications for use of contrast in stress echocardiography

When two or more endocardial border contiguous segments of LV are not well visualized in order to:

- To obtain diagnostic assessment of segmental wall motion and thickening at rest and stress
- To increase the proportion of diagnostic studies
- To increase reader confidence in interpretation

Echo de contraste

- ▶ Réservé aux patients **peu échogènes**
- ▶ Si deux segments contigus non visualisés
Dans moins de 10 % des cas
- ▶ Utilisation du **SONOVUE**
- ▶ **CI:** I resp , I hépatique , IR sévère , SCA , IDM
< 8 jours



PER

PHILIPS

MI: 0.2
S3
23 MAY 03
10:27:52
2/0/A/T3
JOHN RADCLIFFE
CARDIOLOGY
DSE
MCKENNA
MARGARET
0304876

GAIN 95
COMP 50
115BPM

13CM
25HZ

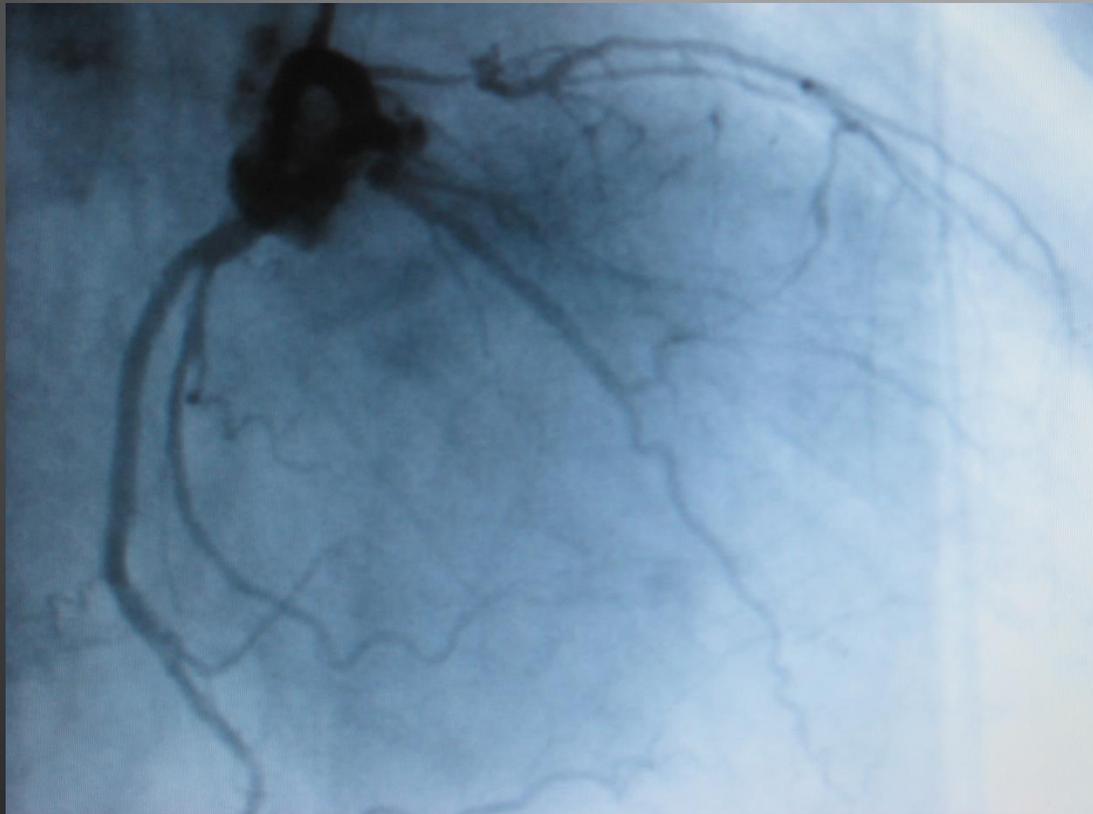
25:04
((O))
2.5

PHILIPS



CORONAROGRAPHIE

- Sténo-thrombose de IVA proximale
- CX normale
- Plaque CD



Indications : Douleur thoracique

Typical angina (definite)	Meets all three of the following characteristics: <ul style="list-style-type: none"> • substernal chest discomfort of characteristic quality and duration; • provoked by exertion or emotional stress; • relieved by rest and/or nitrates within minutes.
Atypical angina (probable)	Meets two of these characteristics.
Non-anginal chest pain	Lacks or meets only one or none of the characteristics.

Age	Typical angina		Atypical angina		Non-anginal pain	
	Men	Women	Men	Women	Men	Women
30-39	59	28	29	10	18	5
40-49	69	37	38	14	25	8
50-59	77	47	49	20	34	12
60-69	84	58	59	28	44	17
70-79	89	68	69	37	54	24
>80	93	76	78	47	65	32

Probabilité pré test		Examen
	<15%	Pas d'examen
	15-65%	EE ou imagerie
	65-85%	Imagerie
	>85%	Coronarographie

Task Force M, Montalescot G, Sechtem U, Achenbach S, Andreotti F, Arden C, et al. **2013 ESC guidelines** on the management of stable coronary artery disease: the Task Force on the management of stable coronary artery disease of the European Society of Cardiology. European heart journal. 2013;34(38):2949-3003.

Indications : non coronarien

In asymptomatic adults with diabetes or asymptomatic adults with a strong family history of CAD or when previous risk assessment testing suggests high risk of CAD, such as a coronary artery calcium score of 400 or greater stress imaging tests (MPI, stress echocardiography, perfusion CMR) may be considered for advanced CV risk assessment.	IIb	C
In low- or intermediate-risk (based on SCORE) asymptomatic adults stress imaging tests are not indicated for further CV risk assessment.	III	C

Indications : coronarien

- ▶ Pas de données montrant qu'un suivi avec des tests fonctionnels permettrait une amélioration du pronostic des patients coronariens asymptomatiques

An exercise ECG or stress imaging if appropriate is recommended in the presence of recurrent or new symptoms once instability has been ruled out.	I	C
Reassessment of the prognosis using stress testing may be considered in asymptomatic patients after the expiration of the period for which the previous test was felt to be valid ("warranty period").	IIb	C

Task Force M, Montalescot G, Sechtem U, Achenbach S, Andreotti F, Arden C, et al. **2013 ESC guidelines** on the management of stable coronary artery disease: the Task Force on the management of stable coronary artery disease of the European Society of Cardiology. *European heart journal*. 2013;34(38):2949–3003.