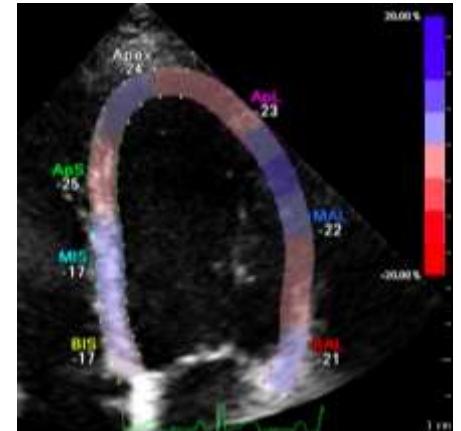
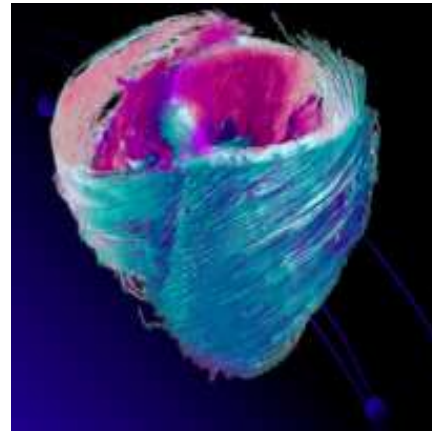
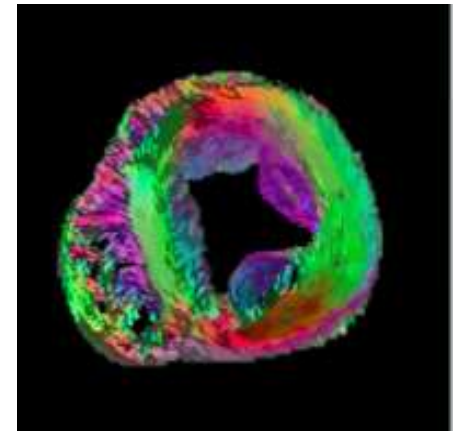
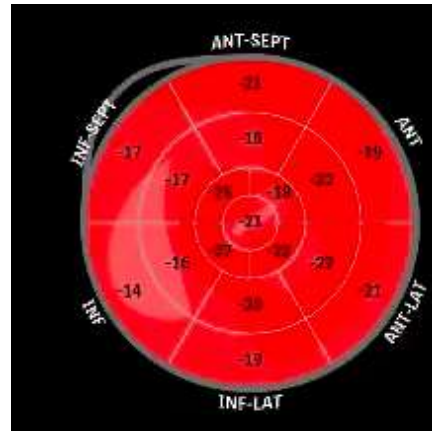




# 2D strain

...En pratique courante ?



H.BELGHITI



# Introduction



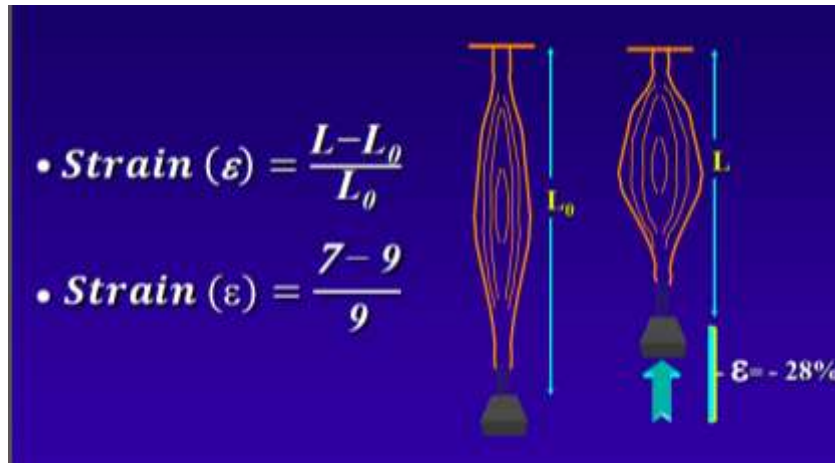
- FEVG : paramètre important en clinique +++
- L'évaluation ETT 2D de la FEVG est limitée par :
  - Dépendance aux conditions de charge
  - Mesures influencées par qualité de l'image
  - Erreurs et variabilité (10-15%)
  - Sensibilité insuffisante dans la détection d'une atteinte cardiaque infra-clinique
  - Analyse de la fonction régionale = subjective
- Strain = nouveau paramètre étudiant la déformation myocardique

Outil de recherche → Outil de routine



# Définitions

- Index qui exprime la déformation tissulaire en fonction d'une force appliquée (stress)

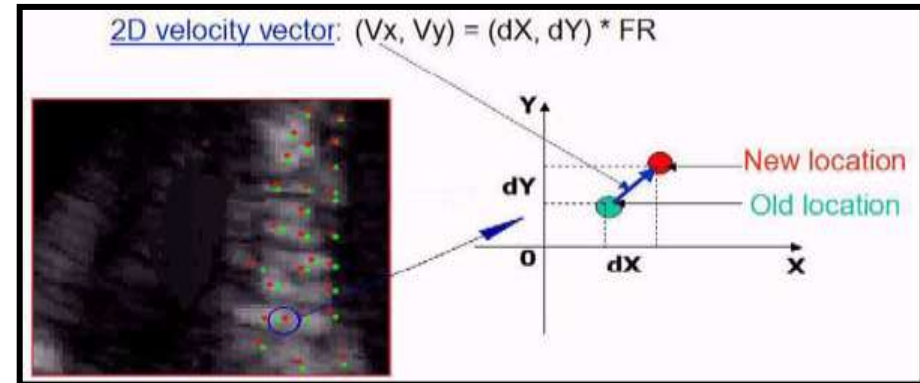
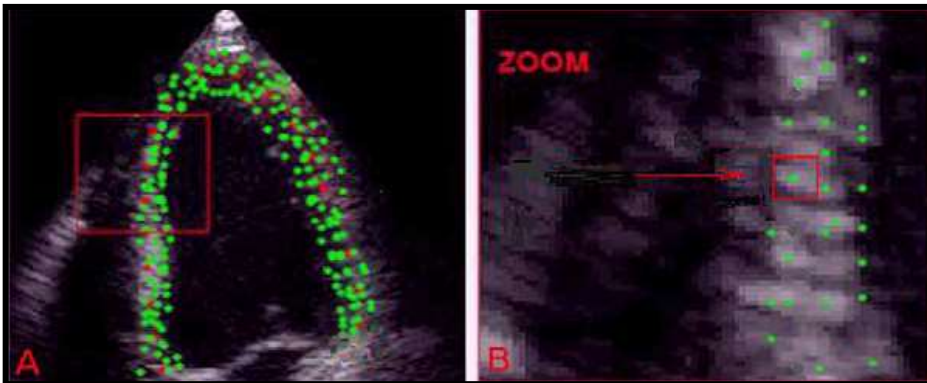


- Allongement (+amincissement) => strain +
- Raccourcissement (+épaississement) => strain -
- Strain Rate : Strain / t : exprimé en s<sup>-1</sup>



# Strain bidimensionnel

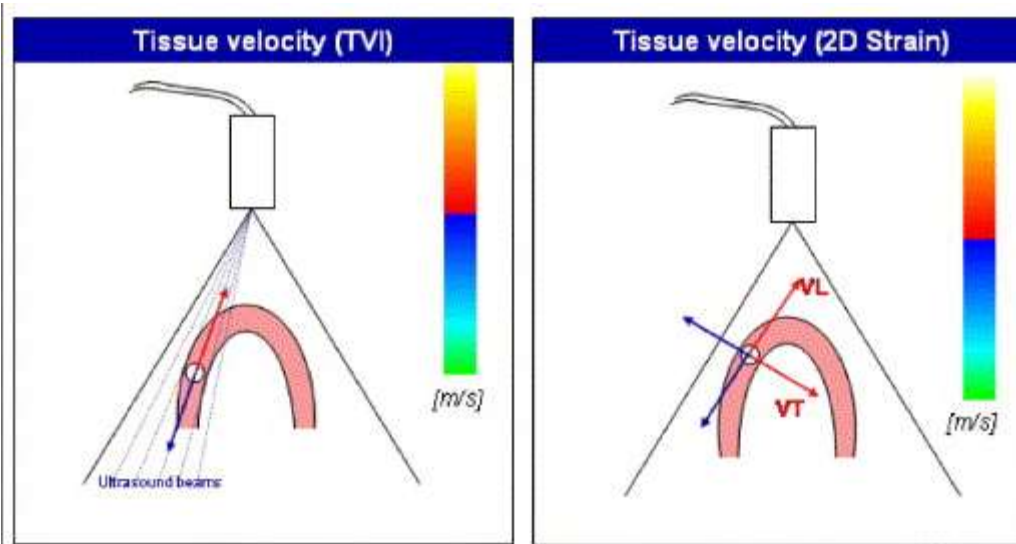
- Imagerie bidimensionnelle en échelle de gris
- « Speckles » : marqueurs acoustiques « naturels »
- « Tracking » : repérage de la position de ces marqueurs acoustiques durant les différentes phases du cycle cardiaque





# Strain bidimensionnel

- Nouvelle technique permettant de s'affranchir en partie des contraintes du DTI :
  - angle
  - meilleure résolution latérale.
  - ⊗ Mouvements passifs

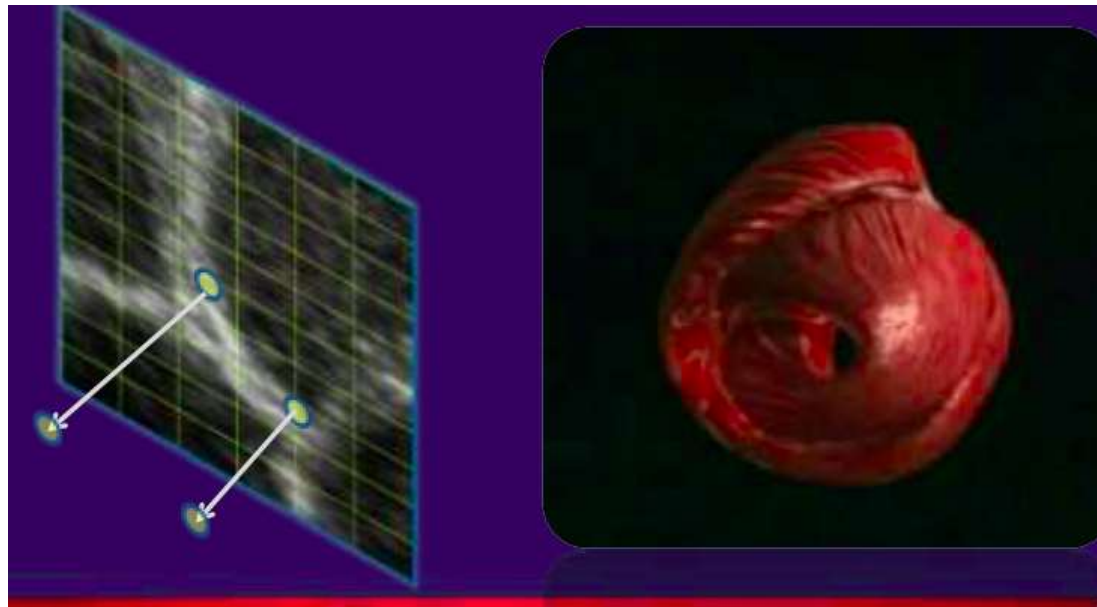


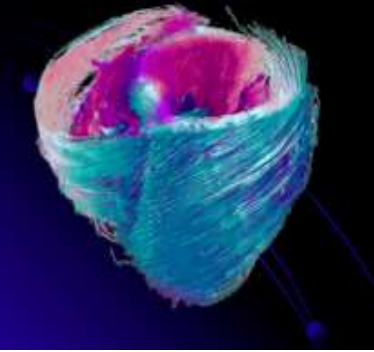
*Perk G. JASE 2007;20:234-43*



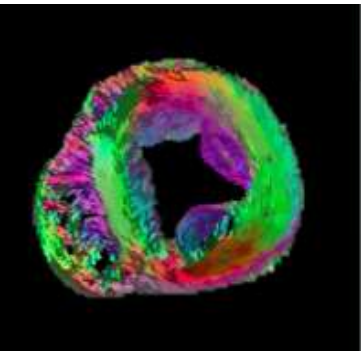
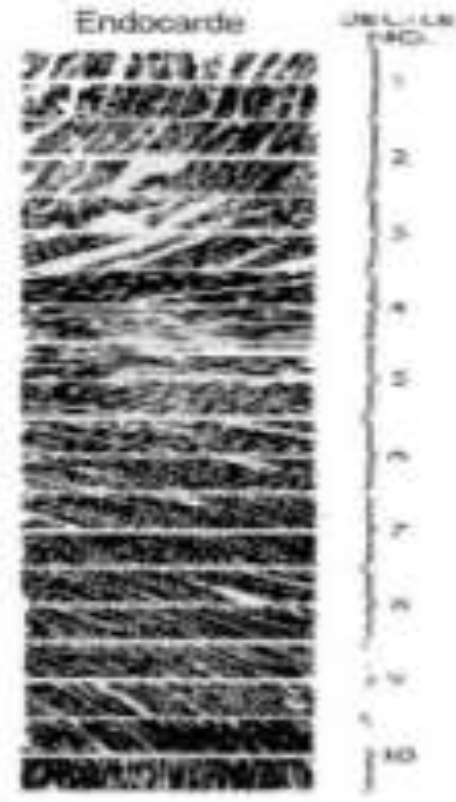
# Problème du 2D strain

- Mouvement de translation du cœur dans le thorax : « speckle » ne reste pas dans le même plan





# Architecture du myocarde




Steeter et Hanna Circ Res 1973; 33:656



# Analyse de la Fonction Systolique: Rappel physiologique



 cinétique complexe qui peut être décomposée en mouvements de :

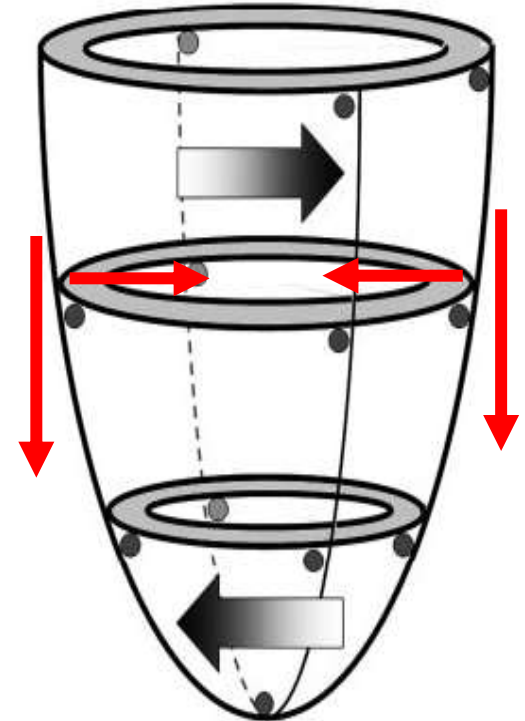
- Contractions :

- Longitudinale** → analysable voie apicale

- Radiale** → analysable voie parasternale

- Circonférentielle** avec **torsion** du VG sur lui-même (twist), entre l'apex et la base

- Translation dans thorax

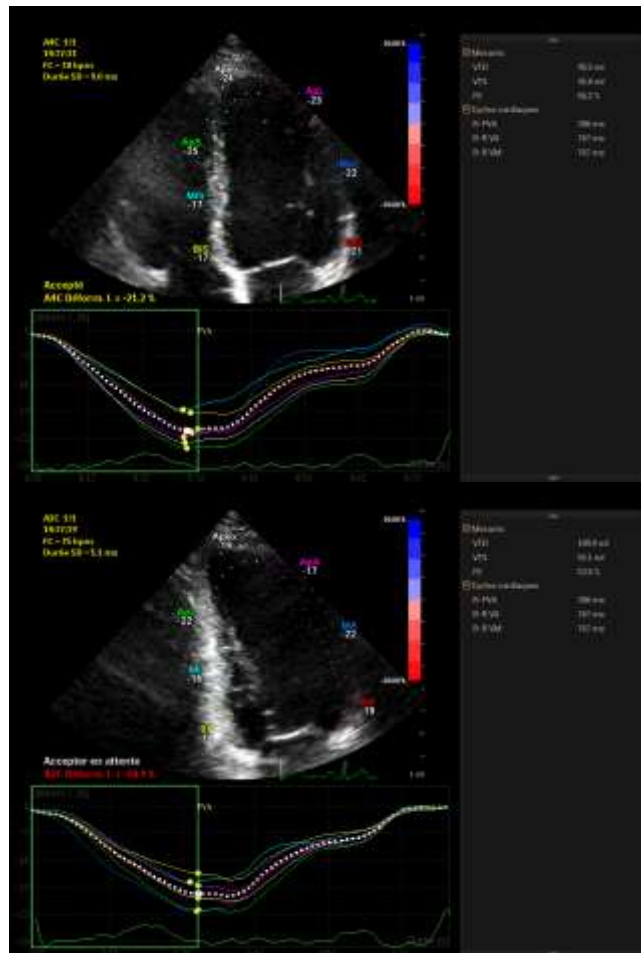


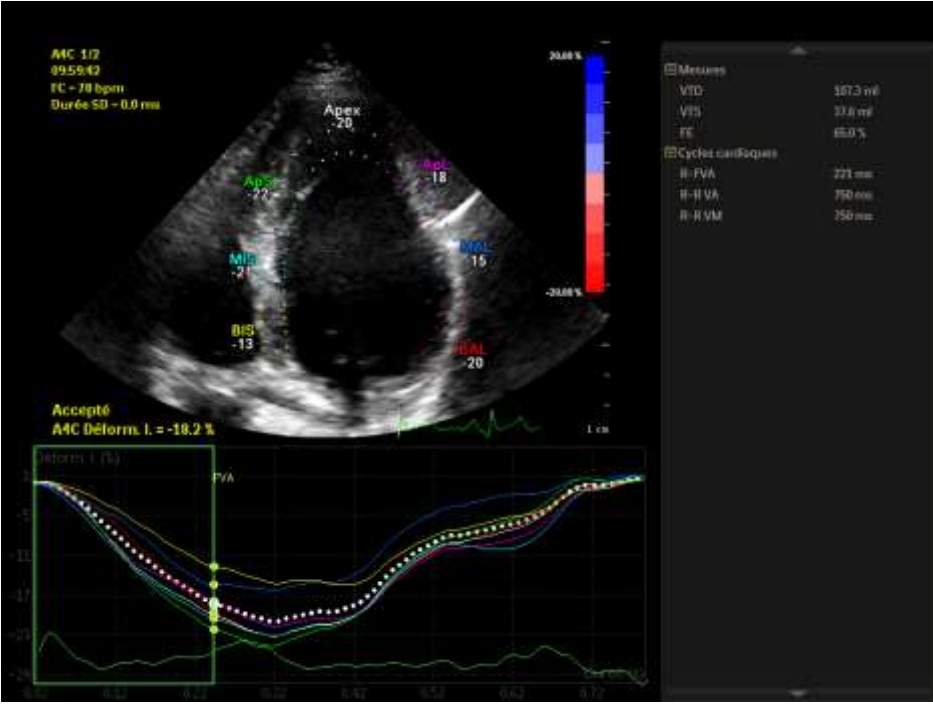
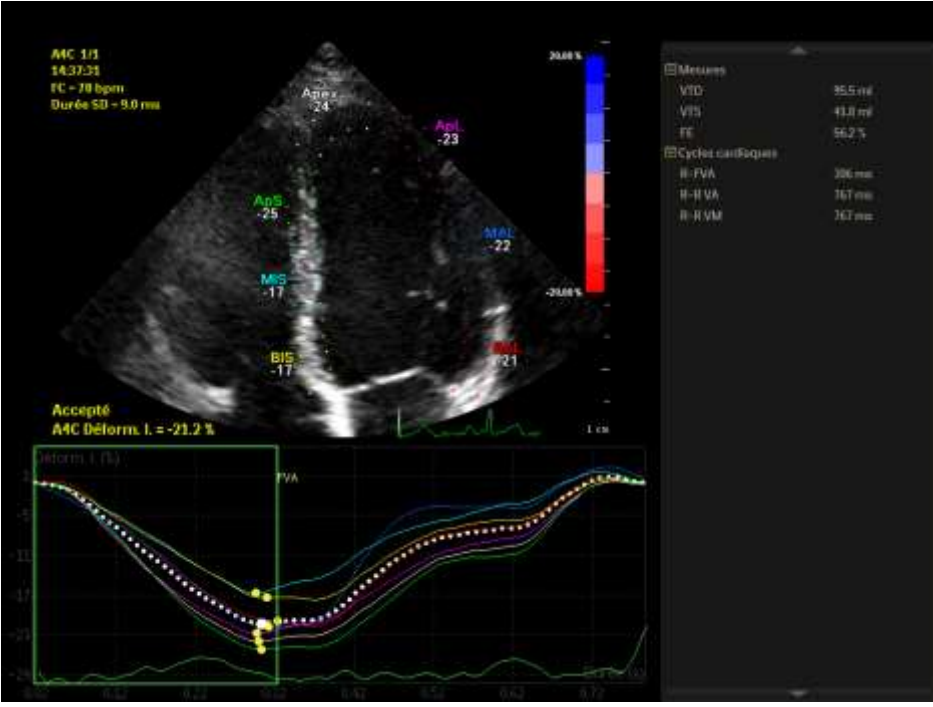




# Composantes du strain :

## 1 - Strain longitudinal

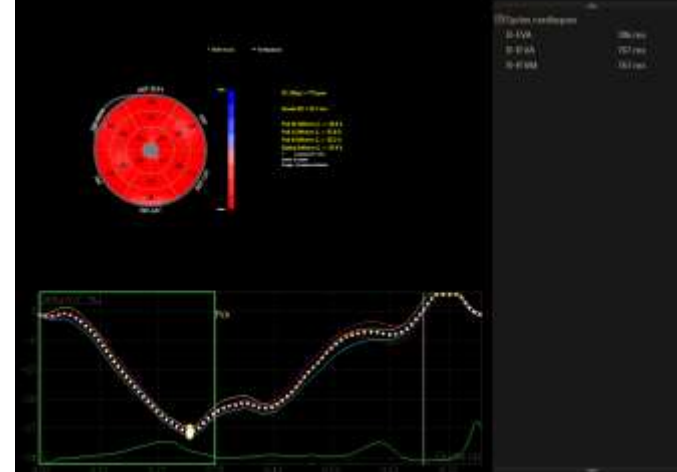
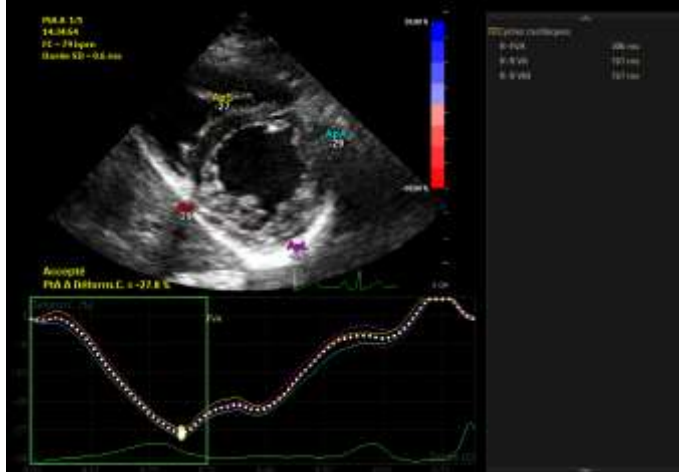
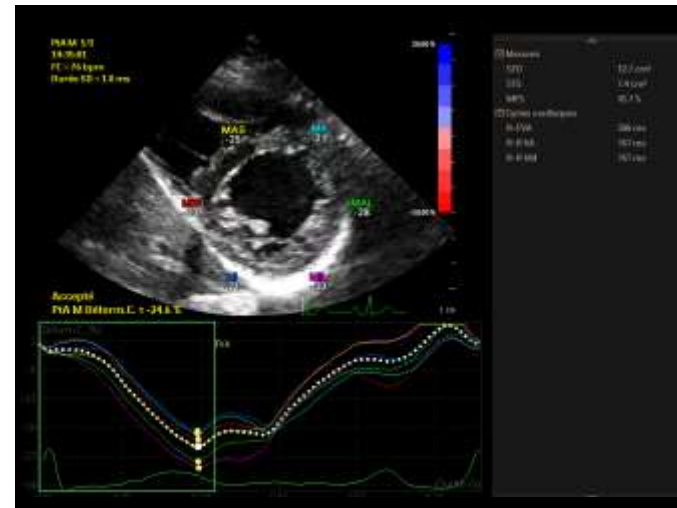
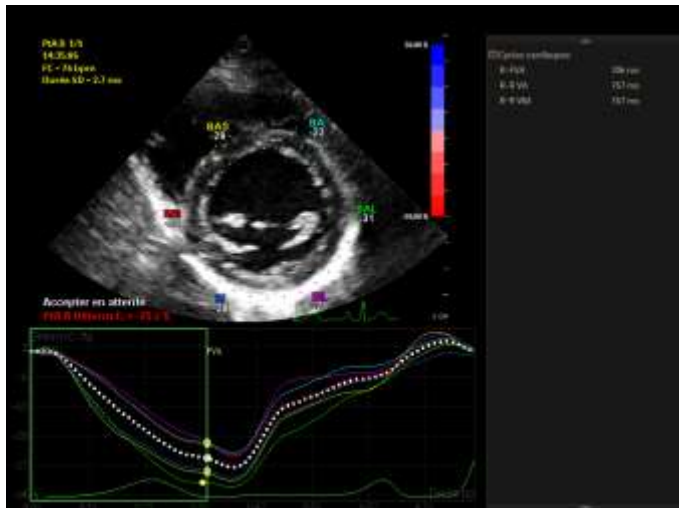






# Composantes du strain :

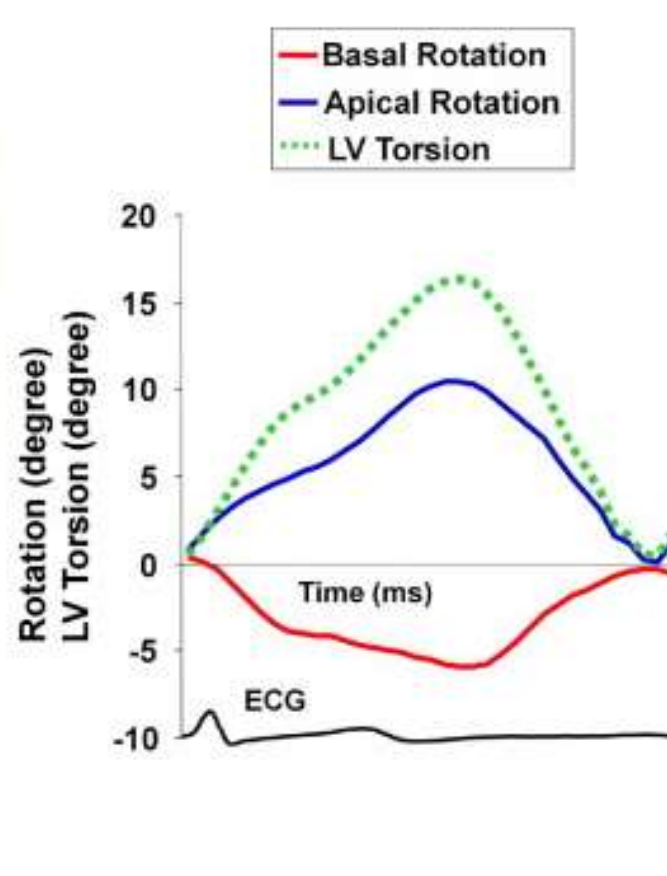
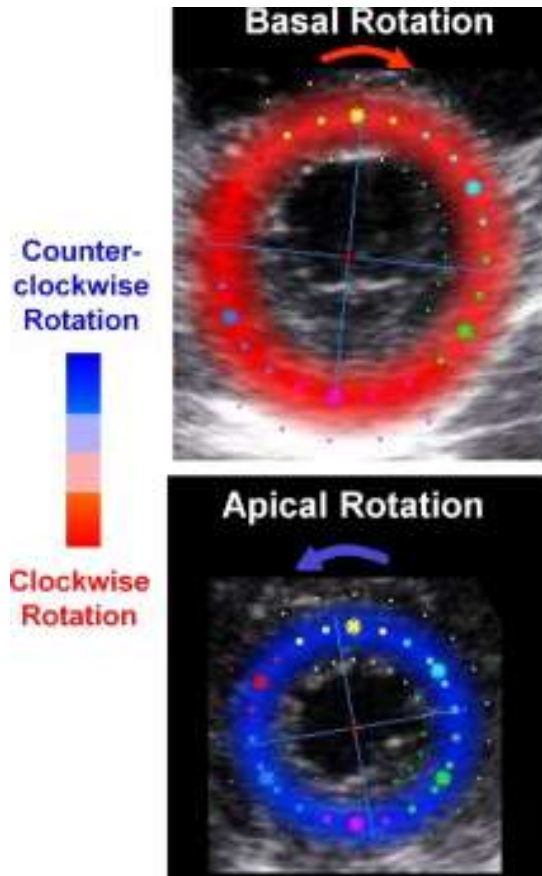
## 2 – Strain radial



+

# Composantes du strain :

## 3 – Strain circonférentiel

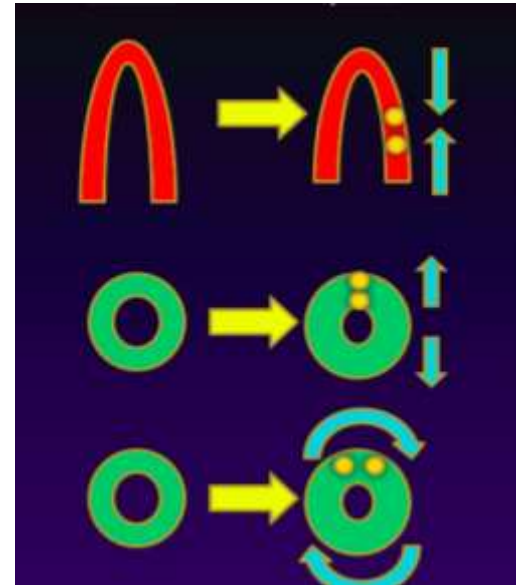




# Valeurs normales



- Strain longitudinal : -18 à - 20%
- Strain Radial : +25 à +45%
- Strain circonférentiel: -18 à 22%



## Reproductibilité

Meilleure pour le strain longitudinal (7-8%)

que pour le strain circonférentiel (10%) et le strain radial (12-15%)



# Valeurs normales



**Table 2.** Comparison of Segmental Values (Mean and SD) for LV Strain (TQ <3), With a Repeated Measures Design

|              | All Levels   | Apical      | Mid         | Basal       | p Value (Levels) |
|--------------|--------------|-------------|-------------|-------------|------------------|
| All walls    | -18.6 ± 5.1  | -20.2 ± 5.6 | -18.7 ± 3.8 | -17.0 ± 5.2 | <0.0001          |
| Anterior     | -19.5 ± 4.2  | -19.4 ± 5.4 | -18.8 ± 3.4 | -20.1 ± 4.0 | 0.001            |
| Anteroseptal | -18.8 ± 4.2  | -18.8 ± 5.9 | -19.4 ± 3.2 | -18.3 ± 3.5 | 0.001            |
| Inferior     | -20.0 ± 4.5* | -22.5 ± 4.5 | -20.4 ± 3.5 | -17.1 ± 3.9 | <0.0001          |
| Lateral      | -18.3 ± 4.7  | -19.2 ± 5.4 | -18.1 ± 3.5 | -17.8 ± 5.0 | 0.06             |
| Posterior    | -16.3 ± 6.3† | -17.7 ± 6.0 | -16.8 ± 5.0 | -14.6 ± 7.4 | <0.0001          |
| Septal       | -18.3 ± 5.3  | -22.3 ± 4.8 | -18.7 ± 3.0 | -13.7 ± 4.0 | <0.0001          |
| p (walls)    | <0.0001      | <0.0001     | <0.0001     | <0.0001     |                  |

\*Inferior was significantly different from all other walls ( $p < 0.001$  except anterior  $p = 0.02$ ), in the comparison of walls at all levels. †Posterior was significantly different from all other walls ( $p < 0.0001$ ). In the comparison of levels in all walls, each level was significantly different ( $p < 0.0001$ ).

LV = left ventricular; TQ = tracking quality.



# Valeurs normales



|           | Femmes                    |                             | Hommes                    |                             |
|-----------|---------------------------|-----------------------------|---------------------------|-----------------------------|
|           | Strain télésystolique (%) | Pic systolique de SR        | Strain télésystolique (%) | Pic systolique de SR        |
| < 40 ans  | -17,9 % (2,1)             | -1,09s <sup>-1</sup> (0,12) | -16,8 % (2,0)             | -1,06s <sup>-1</sup> (0,13) |
| 40-60 ans | -17,6 % (2,1)             | -1,06s <sup>-1</sup> (0,13) | -18,8 % (2,2)             | -1,01s <sup>-1</sup> (0,12) |
| > 60 ans  | -15,9 % (2,4)             | -0,97s <sup>-1</sup> (0,14) | -15,5 % (2,4)             | -0,97s <sup>-1</sup> (0,14) |
| Total     | -17,4 % (2,3)             | -1,05s <sup>-1</sup> (0,13) | -15,9 % (2,3)             | -1,01s <sup>-1</sup> (0,13) |

Eur J Echocardiogr, 2010 ; 11 : 176-183

**Normal** more negative than -18%  
**Borderline** between -16% and -18%  
**Abnormal** less negative than -16 %

+

# 2D strain



... A la pratique





# Principales applications



1. Insuffisance cardiaque
2. Cardiopathie ischémique
3. Cardiomyopathies
4. Valvulopathies
5. Chimiothérapie cardiotoxique`
6. Cardiopathies congénitales



# L'insuffisance cardiaque

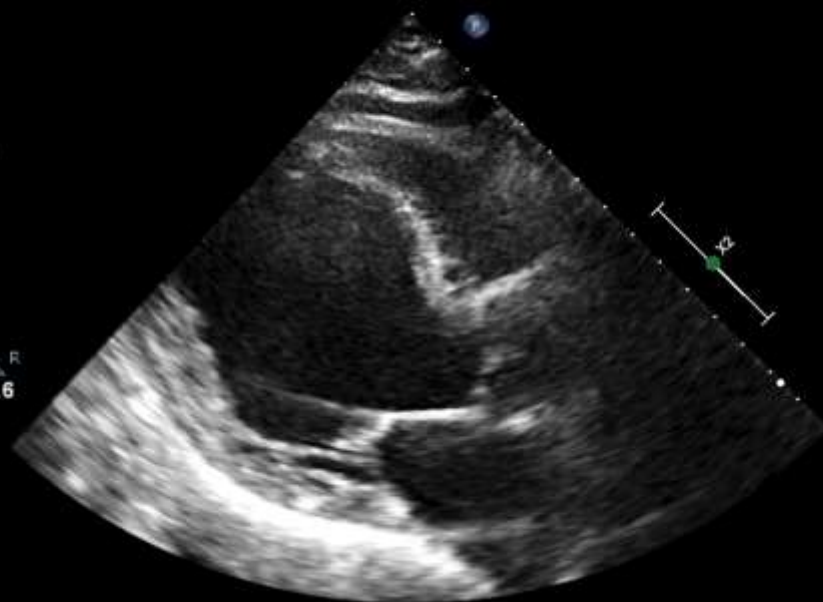
Echo adulte  
S4-2  
51Hz  
15cm

2D  
78%  
C 50  
P Bas  
HGen

P R  
1.8 3.6

TIS0.6 MI 1.3

M3



90 bpm

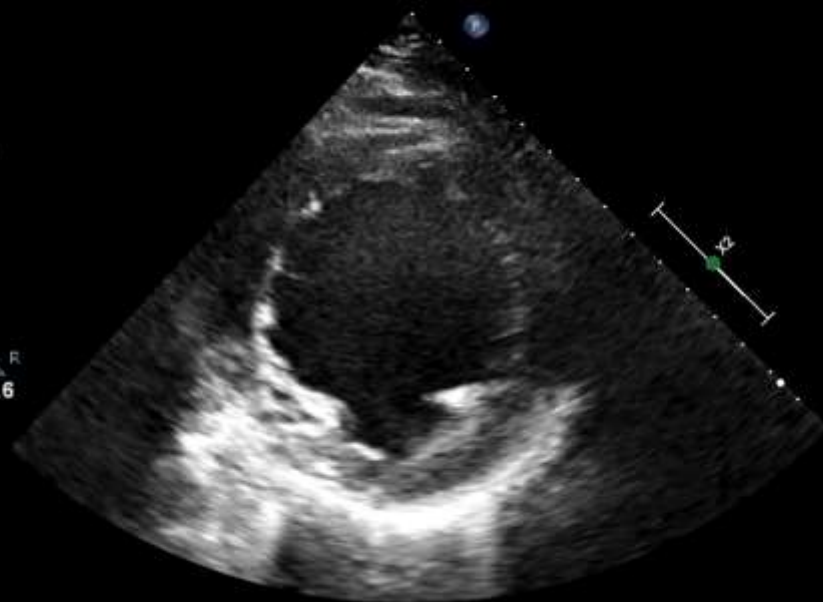
Echo adulte  
S4-2  
51Hz  
15cm

2D  
78%  
C 50  
P Bas  
HGen

P R  
1.8 3.6

TIS0.6 MI 1.3

M3



87 bpm

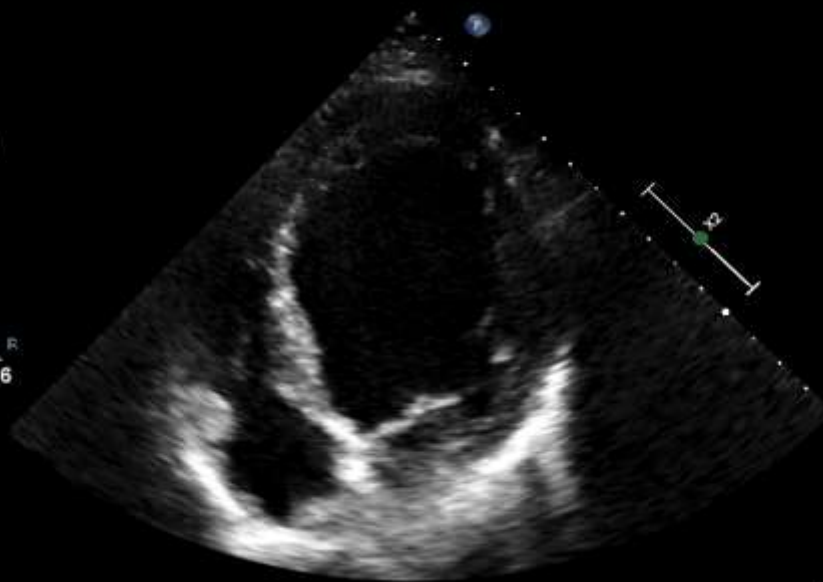
Echo adulte  
S4-2  
49Hz  
16cm

2D  
78%  
C 50  
P Bas  
HGen

P R  
1.8 3.6

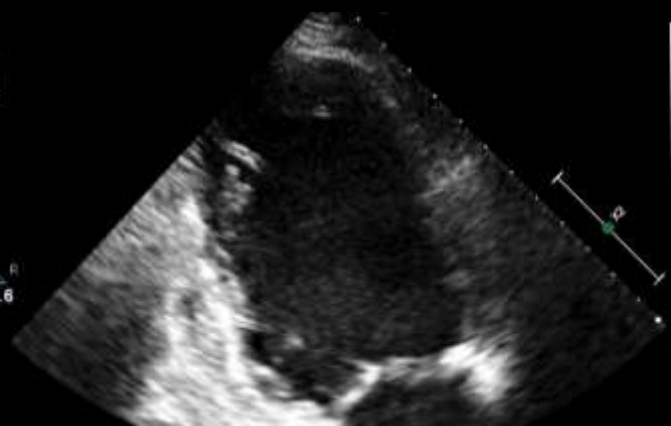
TIS0.5 MI 1.3

M3



87 bpm

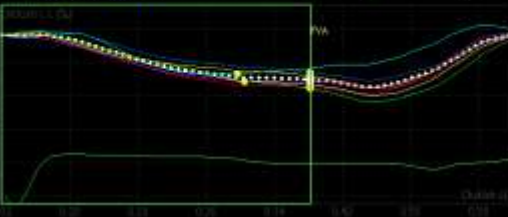
P R  
1.8 3.6





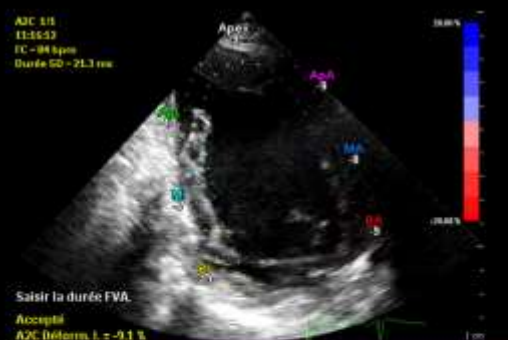
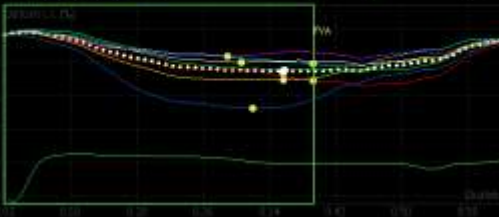
Mesures  
 VTD 1755 ms  
 VTS 1313 ms  
 FC 147 %

Cycles cardiaques  
 0-0 VV 431 ms  
 0-0 VA 712 ms  
 0-0 VM 712 ms



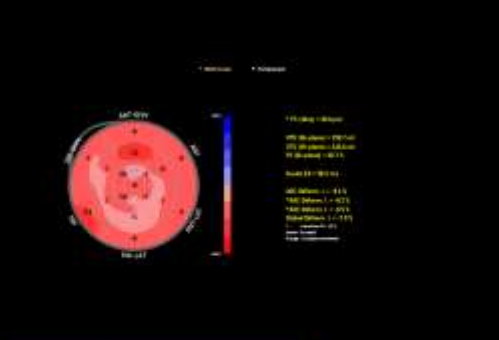
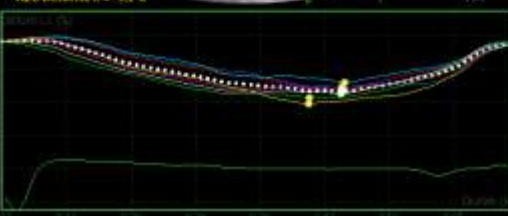
Mesures  
 VTD 1755 ms  
 VTS 1313 ms  
 FC 147 %

Cycles cardiaques  
 0-0 VV 431 ms  
 0-0 VA 712 ms  
 0-0 VM 712 ms



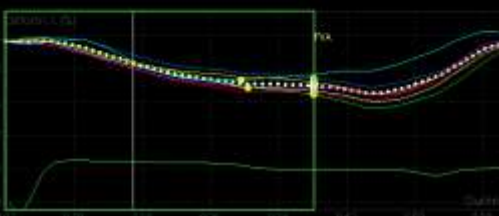
Mesures  
 VTD 1463 ms  
 VTS 862 ms  
 FC 152 %

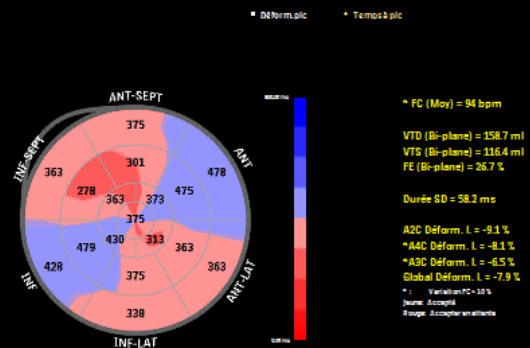
Cycles cardiaques  
 0-0 VV 712 ms  
 0-0 VA 712 ms



Mesures  
 VTD 1755 ms  
 VTS 1313 ms  
 FC 147 %

Cycles cardiaques  
 0-0 VV 431 ms  
 0-0 VA 712 ms  
 0-0 VM 712 ms





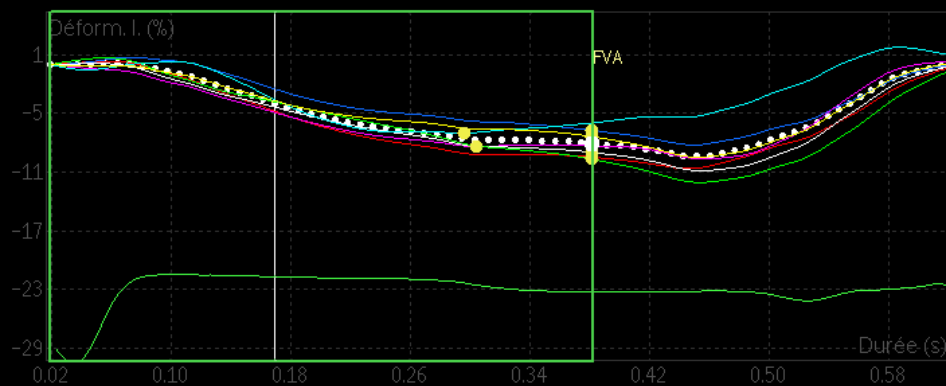
\* FC (Moy) = 94 bpm  
 VTD (Bi-plane) = 158.7 ml  
 VTS (Bi-plane) = 116.4 ml  
 FE (Bi-plane) = 26.7 %  
 Durée SD = 58.2 ms  
 A2C Déform. L = -9.1 %  
 \*A4C Déform. L = -8.1 %  
 \*A3C Déform. L = -6.5 %  
 Global Déform. L = -7.9 %  
 \* : Variation FC > 10 %  
 Norme: Accepted  
 Rouge: 20 images en attente

Mesures

VTD 176.5 ml  
 VTS 133.0 ml  
 FE 24.7 %

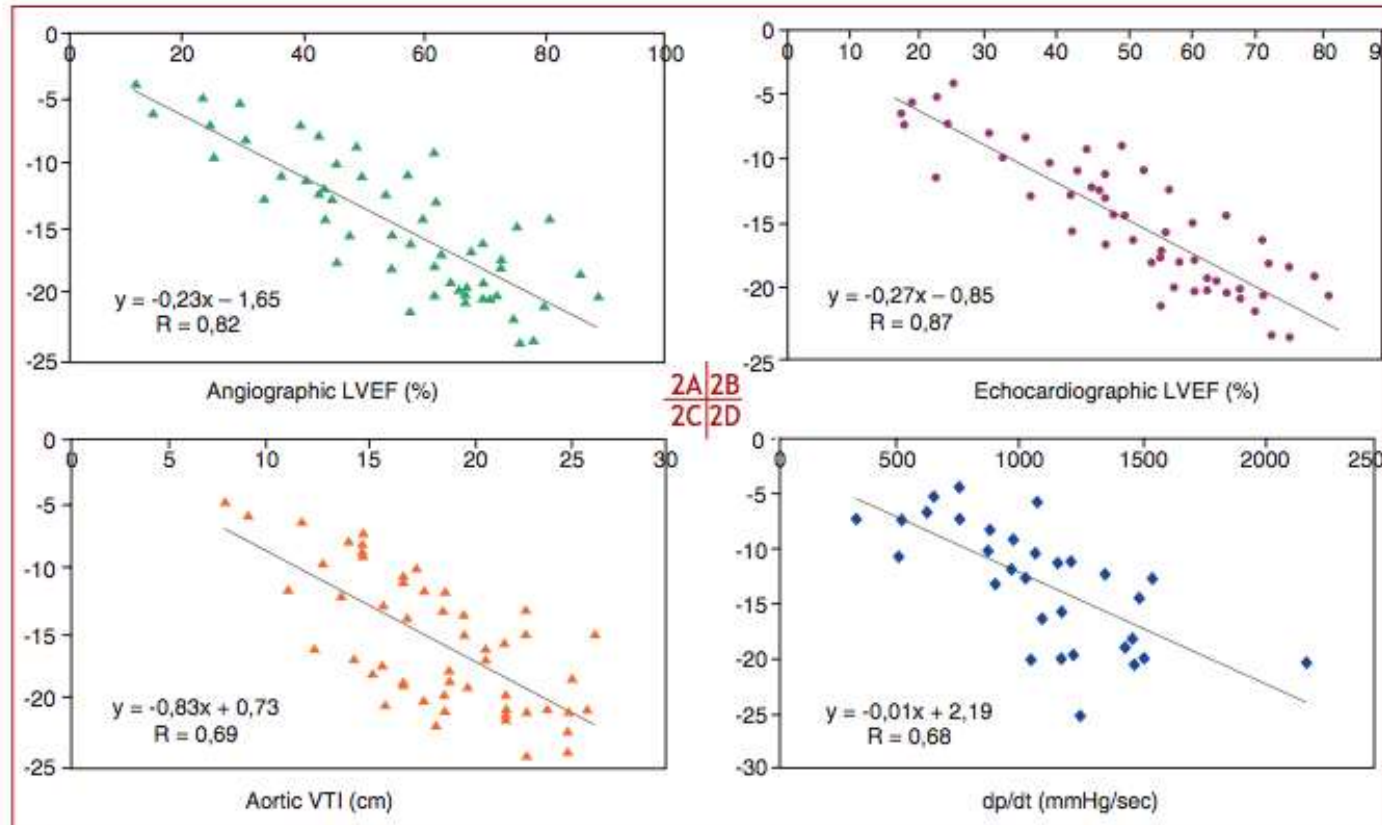
Cycles cardiaques

R-FVA 431 ms  
 R-R VA 712 ms  
 R-R VM 712 ms



+

# 1-Correlation strain - FEVG



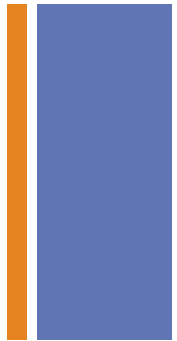
**Figure 2.** Linear regression of 2D strain compared with angiographic LVEF (A), echocardiographic LVEF (B), aortic VTI (C) and Doppler-derived dp/dt (D).

H. Belghiti<sup>a</sup>, S. Brette<sup>a</sup>, S. Lafitte<sup>a,\*</sup>, P. Reant<sup>a</sup>,  
 F. Picard<sup>a</sup>, K. Serri<sup>a</sup>, M. Lafitte<sup>a</sup>, M. Courregelongue<sup>a</sup>,  
 P. Dos Santos<sup>a</sup>, H. Douard<sup>a</sup>, R. Roudaut<sup>a</sup>, A. DeMaria<sup>b</sup>

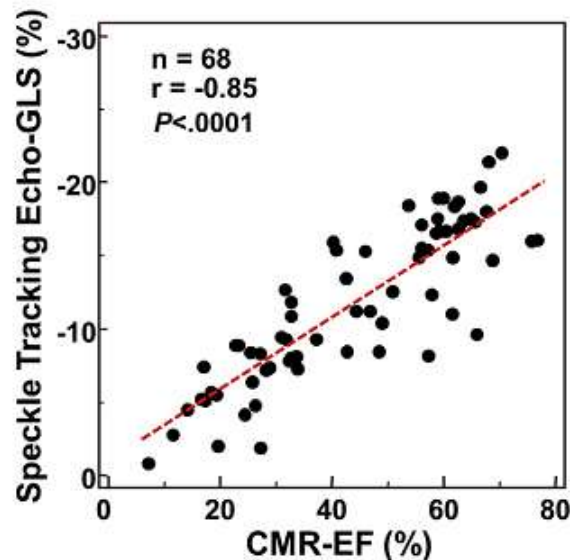
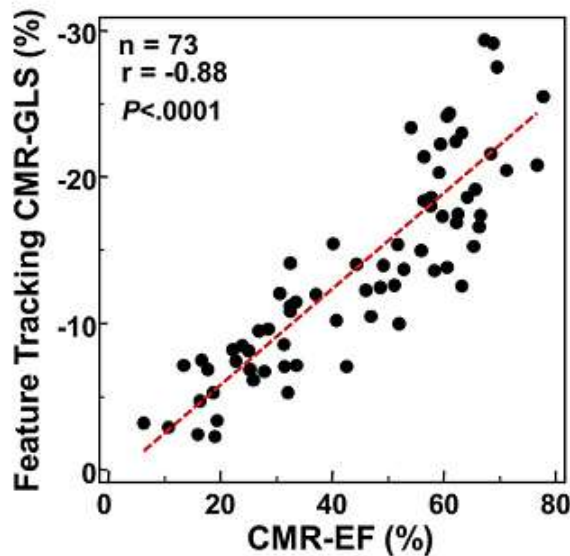


# Global Longitudinal Strain and Global Circumferential Strain by Speckle-Tracking Echocardiography and Feature-Tracking Cardiac Magnetic Resonance Imaging: Comparison with Left Ventricular Ejection Fraction

Toshinari Onishi, MD, Samir K. Saha, MD, Antonia Delgado-Montero, MD, Daniel R. Ludwig, MD, Tetsuaki Onishi, MD, Erik B. Schelbert, MD, MS, David Schwartzman, MD, and John Gorcsan, III, MD, *Pittsburgh, Pennsylvania; and Stockholm, Sweden*



**GLS > - 11% ↔ FEVG < 35%**

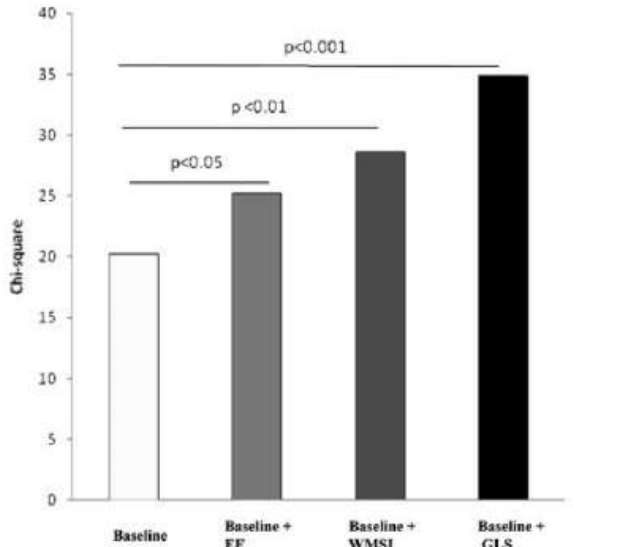


Se = 85% Spé = 89%

$$\text{FEVG} = 3 \times \text{GLS} + 8 \%$$

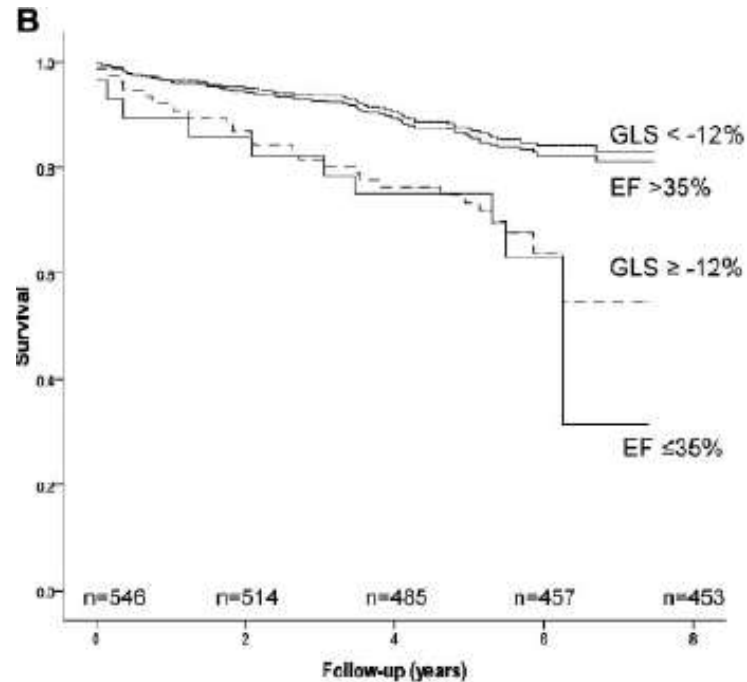


# 2- Valeur Pronostic



|              | HR   | p      | HR   | p     | HR   | p     | HR   | p      |
|--------------|------|--------|------|-------|------|-------|------|--------|
| Age          | 1.46 | <0.001 |      |       |      |       |      |        |
| Diabetes     | 1.66 | 0.02   |      |       |      |       |      |        |
| Hypertension | 1.39 | 0.14   |      |       |      |       |      |        |
| EF           |      |        | 1.23 | <0.05 |      |       |      |        |
| WMSI         |      |        |      |       | 1.28 | <0.01 |      |        |
| GLS          |      |        |      |       |      |       | 1.45 | <0.001 |

EF = ejection fraction, WMSI = wall motion score index, GLS = global longitudinal strain



**Circulation**  
Cardiovascular Imaging

American Heart Association  
Learn and Live

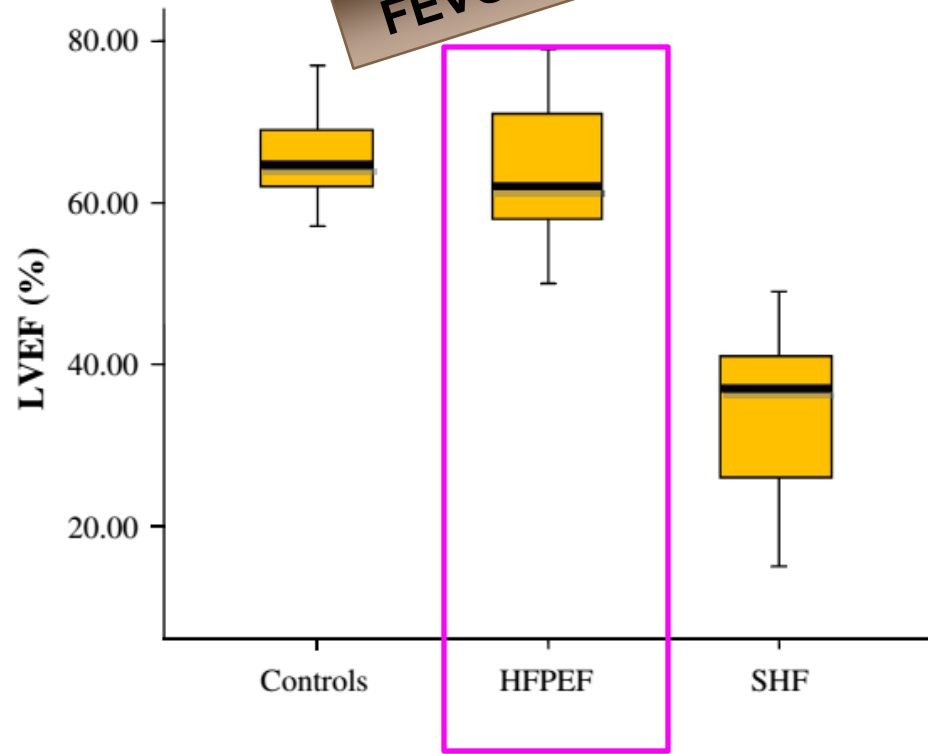




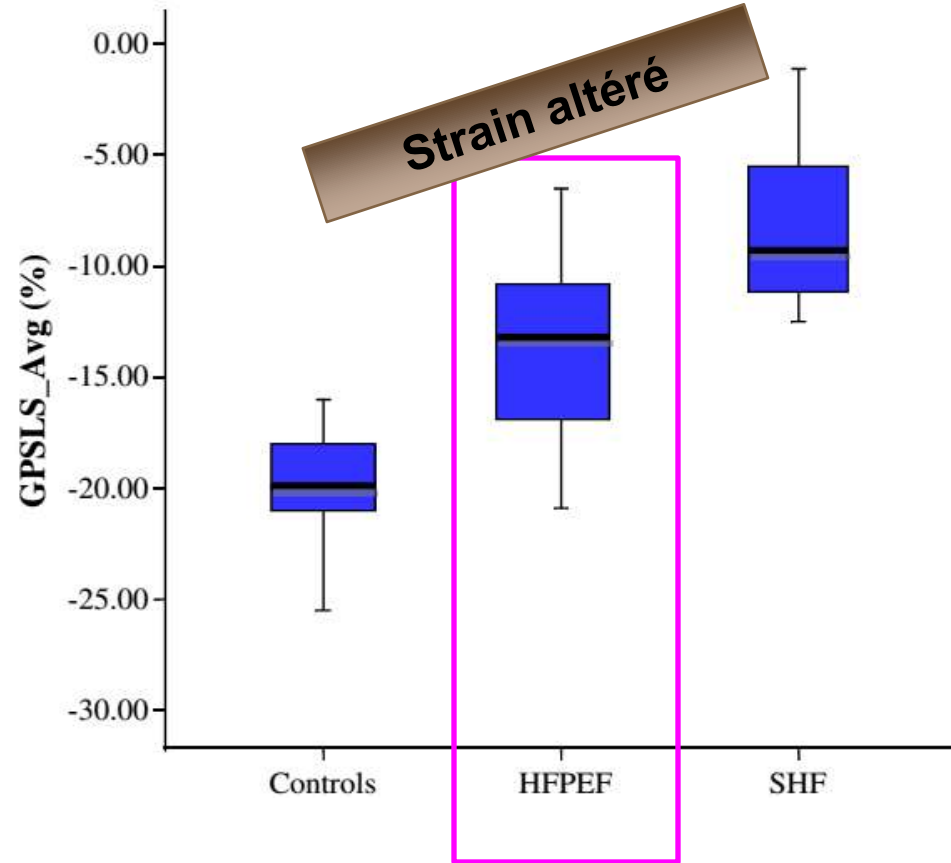
# Insuffisance cardiaque FSP



**FEVG conservée**

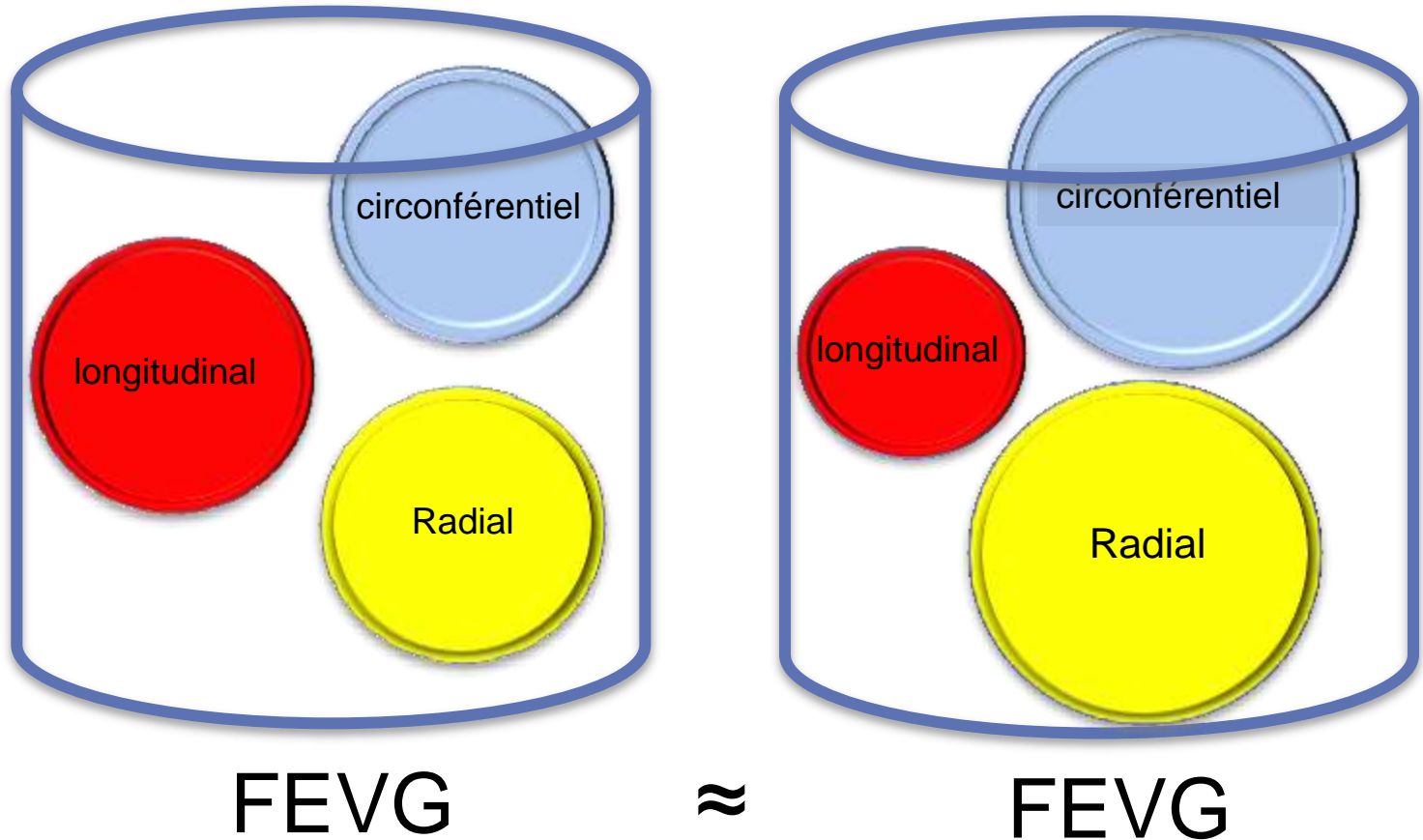


**Strain altéré**





# Insuffisance cardiaque FSP



FEVG préservée /SLG abaissé



# Intérêts du strain dans l'Insuffisance cardiaque



- Évaluation fiable de la fonction systolique globale et régionale
  - Valeur pronostic
  - Diagnostic d'ICFSP
  - Suivi thérapeutique



# La cardiopathie ischémique

Echo adulte

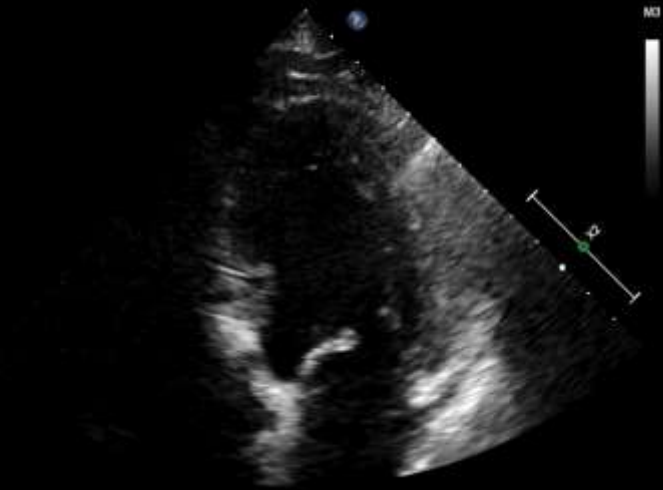
S4-2  
56Hz  
13cm

2D  
72%  
C 50  
P Bas  
HGen

⑤  
P R  
1.8 3.6

TIS0.6 MI 1.3

MI



77 bpm

Echo adulte

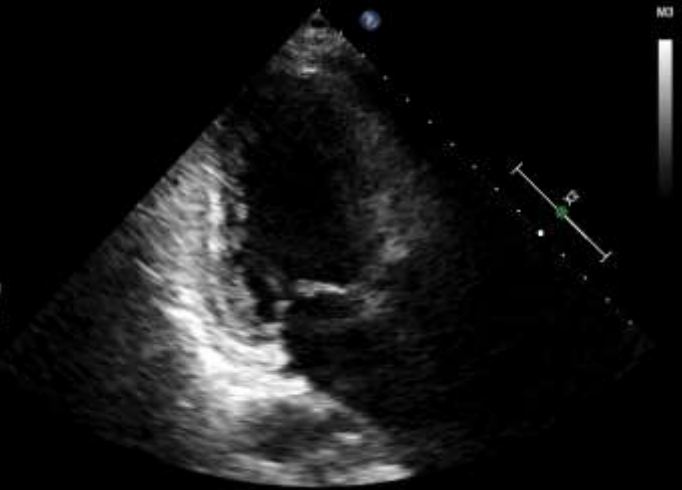
S4-2  
51Hz  
13cm

2D  
73%  
C 50  
P Bas  
HGen

⑤  
P R  
1.8 3.6

TIS0.6 MI 1.3

MI



69 bpm

Echo adulte

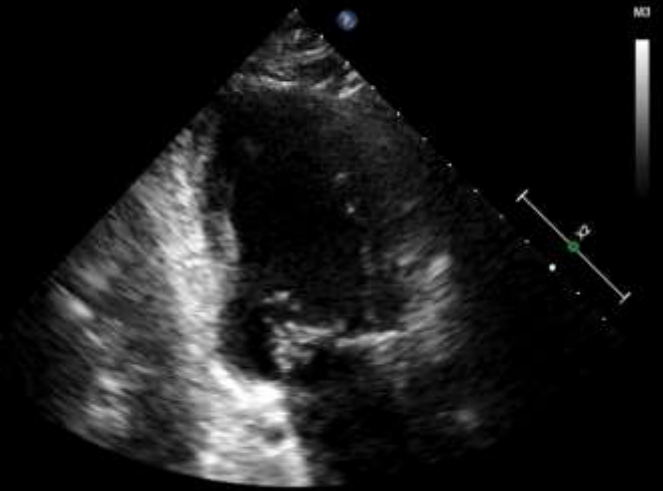
S4-2  
56Hz  
13cm

2D  
72%  
C 50  
P Bas  
HGen

⑤  
P R  
1.8 3.6

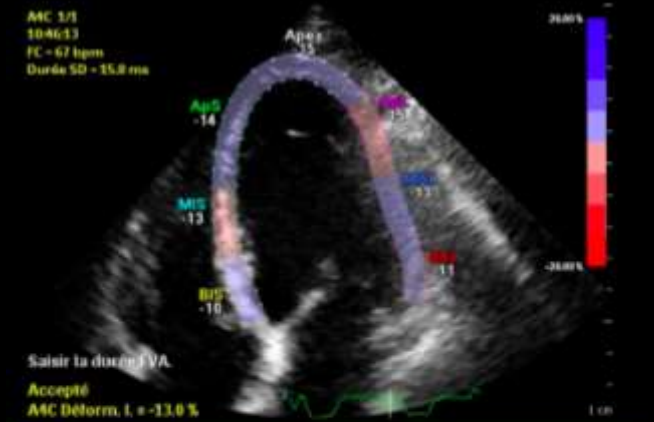
TIS0.6 MI 1.3

MI

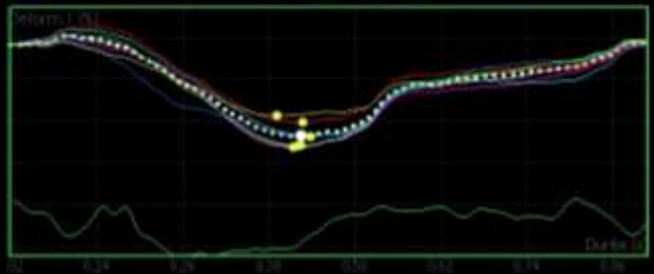


64 bpm

A1C 1/1  
10:46:13  
FC = 67 bpm  
Durée SD = 15.8 ms



Accepté  
A1C Déform. I. = -13.0 %



A3C 1/1  
10:46:46  
\* FC = 78 bpm  
(\* Variation FC >10 %)  
Durée SD = 24.8 ms



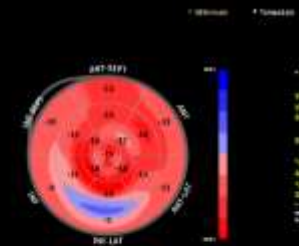
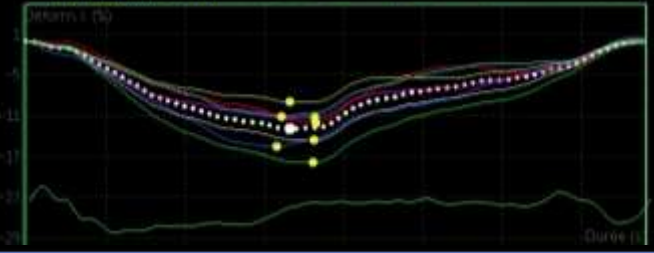
Accepté  
\* A3C Déform. I. = -13.0 %



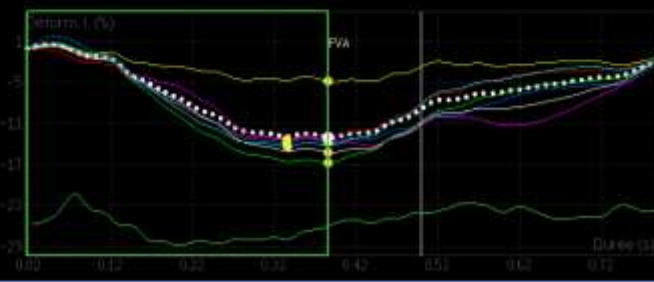
A2C 1/1  
10:46:29  
\* FC = 77 bpm  
(\* Variation FC >10 %)  
Durée SD = 20.4 ms



Accepté  
\* A2C Déform. I. = -12.9 %



\* FC (Mean) = 76 bpm  
\* FC (SD) = 10.3 bpm  
\* FC (Min) = 63.3 bpm  
\* FC (Max) = 88.7 bpm  
\* FC (Variation) = 25.4 bpm  
\* FC (Coefficient) = 0.33  
Durée SD = 20.4 ms  
\* A2C Déform. I. = -12.9 %  
\* A2C Déform. II. = -12.9 %  
\* A2C Déform. III. = -12.9 %  
\* A2C Déform. IV. = -12.9 %  
\* A2C Déform. V. = -12.9 %  
\* A2C Déform. VI. = -12.9 %  
\* A2C Déform. VII. = -12.9 %  
\* A2C Déform. VIII. = -12.9 %  
\* A2C Déform. IX. = -12.9 %  
\* A2C Déform. X. = -12.9 %  
\* A2C Déform. XI. = -12.9 %  
\* A2C Déform. XII. = -12.9 %





# 1- Détection de l'ischémie

Longitudinal 2D strain at rest predicts the presence of left main and three vessel coronary artery disease in patients without regional wall motion abnormality

Jin-Oh Choi, Sung Won Cho, Young Bin Song, Soo Jin Cho, Bong Gun Song, Sang-Chol Lee, and Seung Woo Park\*

Altération **Strain** longitudinal  
sans trouble de la cinétique



Corrélée à la sévérité de Maladie coronaire :  
atteinte **tri-tronculaire** ou atteinte du **TCG**



# 2- évaluation de la transmuralité (viabilité)

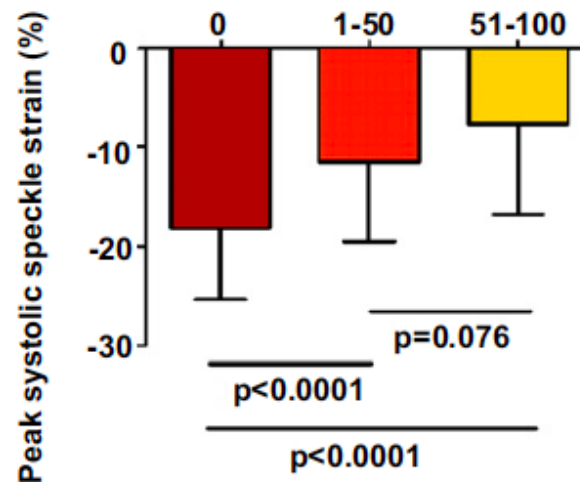
JACC: CARDIOVASCULAR IMAGING  
© 2009 BY THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION  
PUBLISHED BY ELSEVIER INC.

VOL. 2, NO. 1, 2009  
ISSN 1936-878X/09/\$36.00  
DOI:10.1016/j.jcmg.2008.10.007

## Diagnostic Capability and Reproducibility of Strain by Doppler and by Speckle Tracking in Patients With Acute Myocardial Infarction

Benthe Sjøli, MD,\* Stein Ørn, MD,† Bjørnar Grenne, MD,\* Halfdan Ihlen, MD, PhD,‡  
Thor Edvardsen, MD, PhD,‡ Harald Brunvand, MD, PhD\*

i) Segmental infarct size by ceCMR (%)

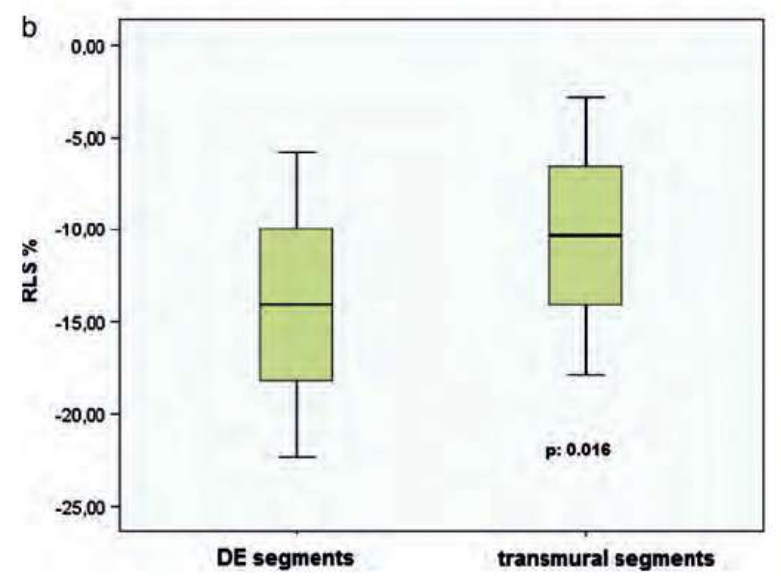
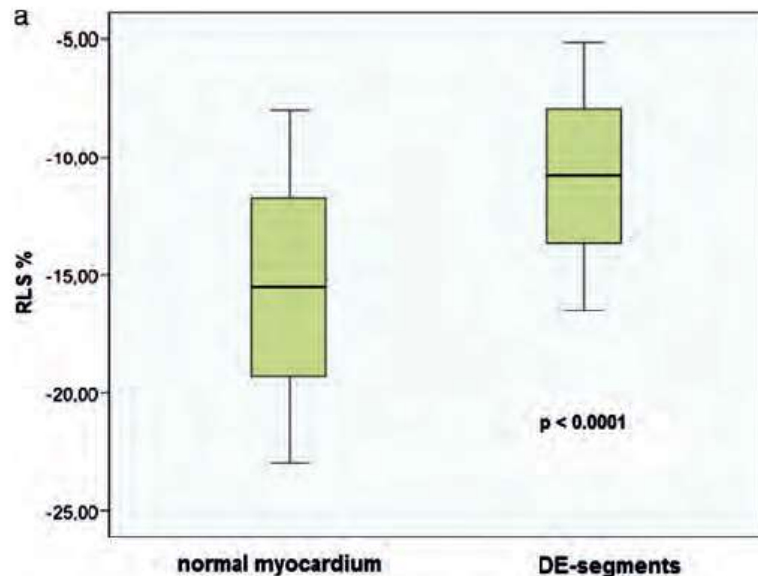






## Global and regional longitudinal strain assessed by two-dimensional speckle tracking echocardiography identifies early myocardial dysfunction and transmural extent of myocardial scar in patients with acute ST elevation myocardial infarction and relatively preserved LV function

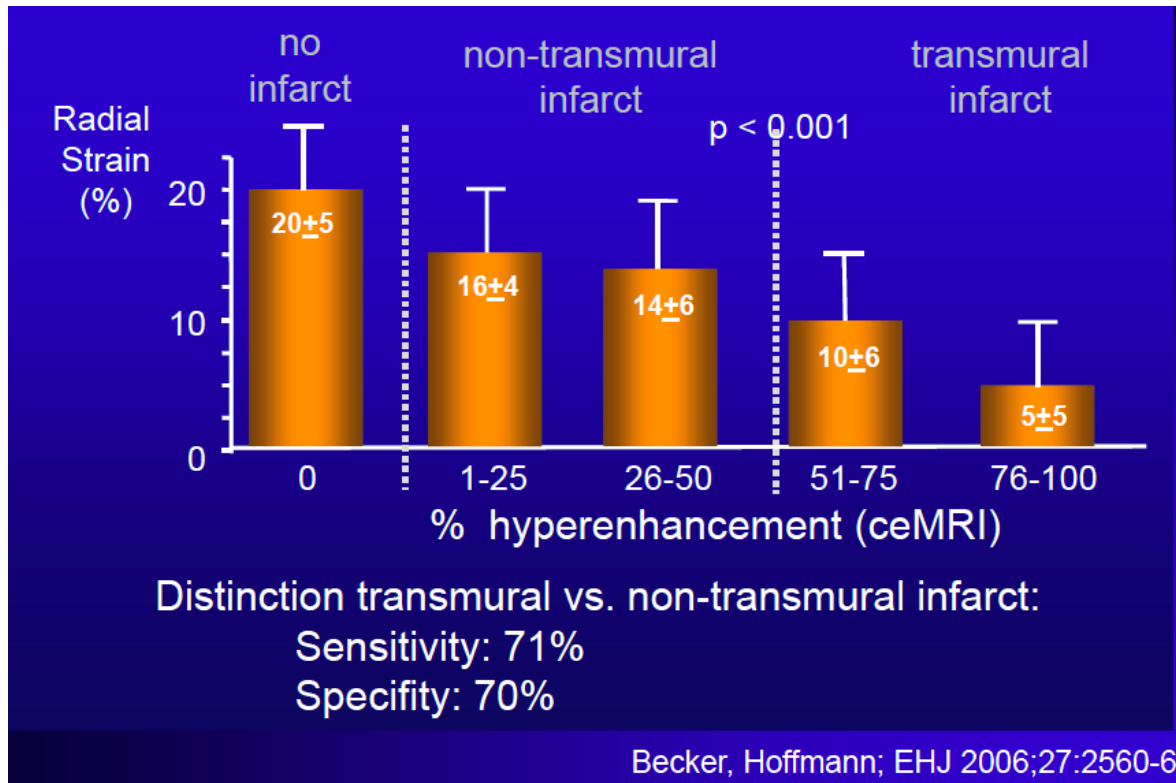
S. Cimino<sup>1</sup>, E. Canali<sup>1</sup>, V. Petronilli<sup>1</sup>, F. Cicogna<sup>1</sup>, L. De Luca<sup>1</sup>, M. Francone<sup>2</sup>, G. Sardella<sup>1</sup>, C. Iacoboni<sup>1</sup>, and L. Agati<sup>1\*</sup>



Cut off : - 12.3% (Se 82% et Sp 78% )



# Relation entre le strain Radial et la viabilité à l'IRM



Cut off SR = 16.5%



# Intérêts du strain dans l'Insuffisance coronaire

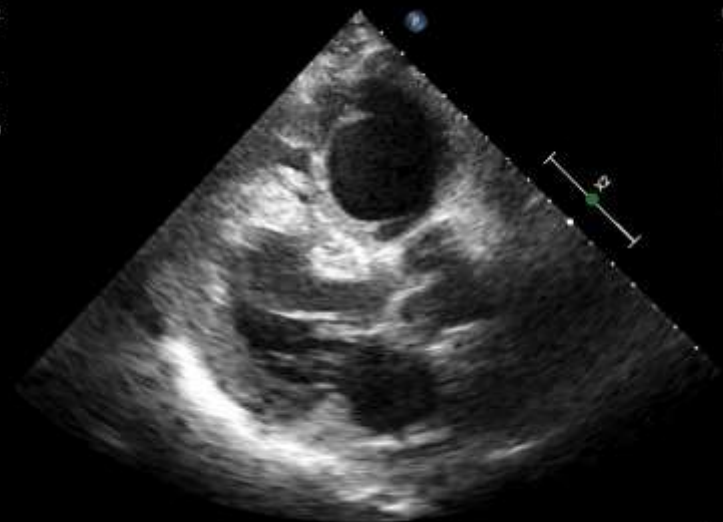


- Reconnaissance de l'ischémie myocardique (GLS , RLS)
  - évaluer la transmuralité (viabilité) (RCS, RRS)
  - Intérêt pronostic



# Les cardiomyopathies

Echo adulte  
S4-2  
47Hz  
17cm  
2D  
62%  
C 50  
P Bas  
HGen



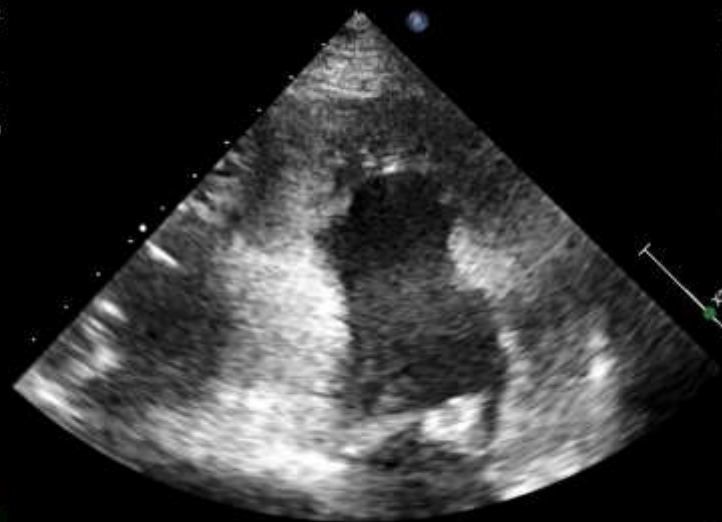
TIS0.5 MI 1.3

M3



66 bpm

Echo adulte  
S4-2  
62Hz  
11cm  
2D  
77%  
C 50  
P Bas  
HGen



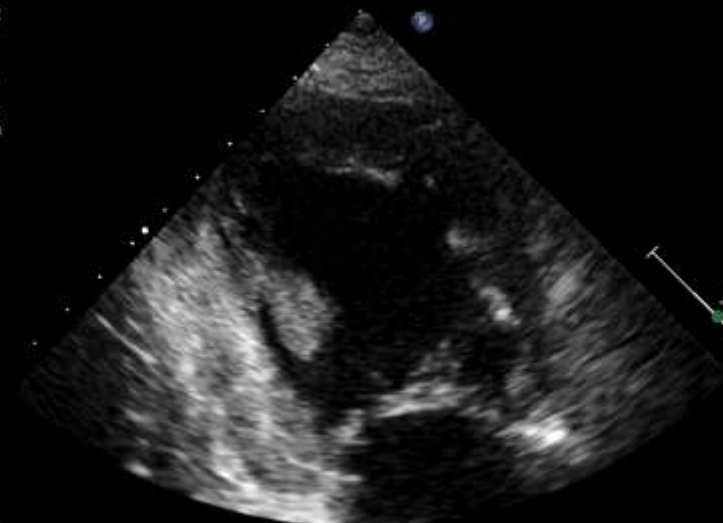
TIS0.7 MI 1.3

M3



73 bpm

Echo adulte  
S4-2  
62Hz  
11cm  
2D  
70%  
C 50  
P Bas  
HGen



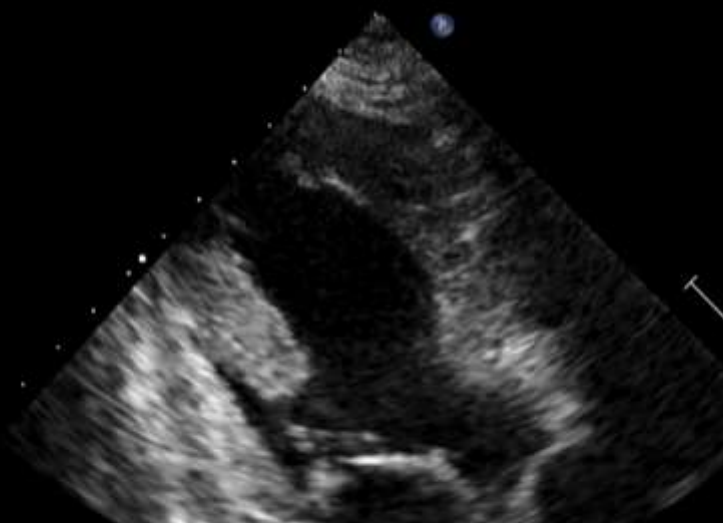
TIS0.7 MI 1.3

M3



52 bpm

Echo adulte  
S4-2  
62Hz  
11cm  
2D  
70%  
C 50  
P Bas  
HGen



TIS0.7 MI 1.3

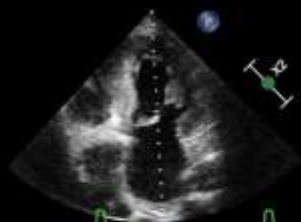
M3



71 bpm

Echo adulte  
S4-2  
49Hz  
16cm

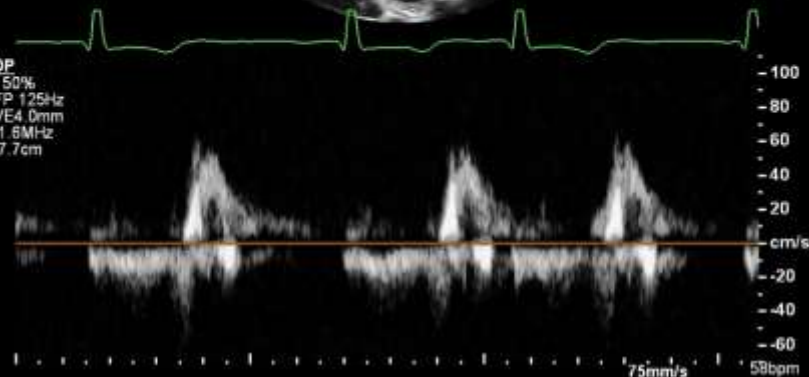
2D  
78%  
C 50  
P Bas  
HGén



ITm0.5 IM 0.7

M3

DP  
50%  
FP 125Hz  
VE4.0mm  
1.6MHz  
7.7cm



Echo adulte  
S4-2  
22Hz  
17cm

2D  
81%  
C 50  
P Bas  
HGén  
Coul  
88%  
4000Hz  
FP 399Hz  
2.5MHz



ITm0.5 IM 0.1

M3 M4

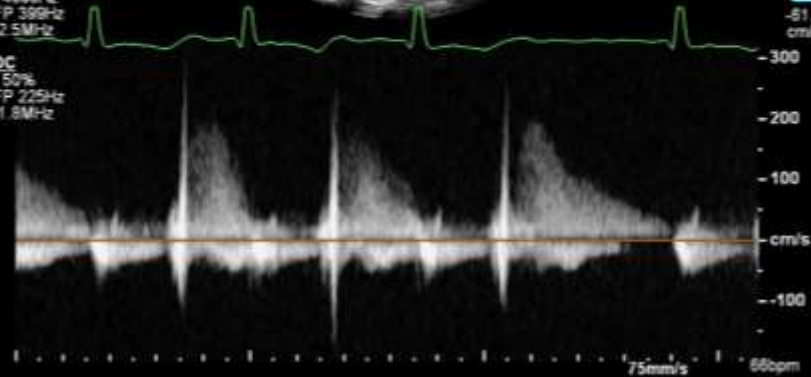
+51.6

cm/s

-51.6

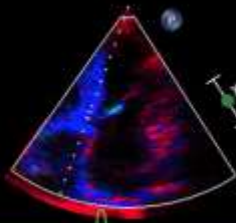
cm/s

DC  
50%  
FP 225Hz  
1.8MHz



Echo adulte  
S4-2  
63Hz  
16cm

2D  
75%  
C 35  
P Bas  
HGén  
TDI  
68%  
3.4MHz



ITm0.7 IM 0.6

M3 M6

+15.0

cm/s

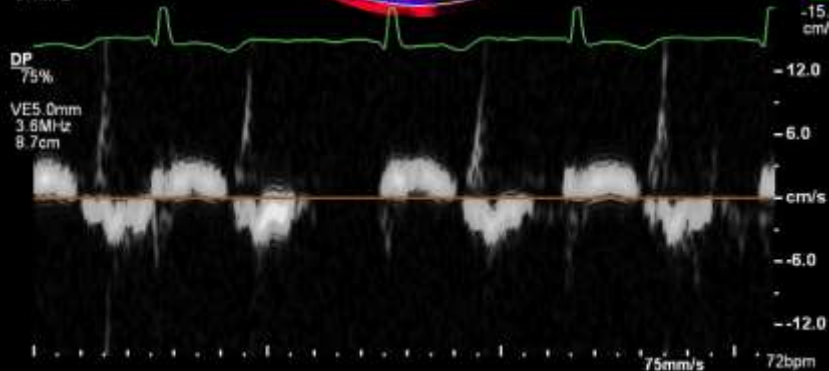
-15.0

cm/s

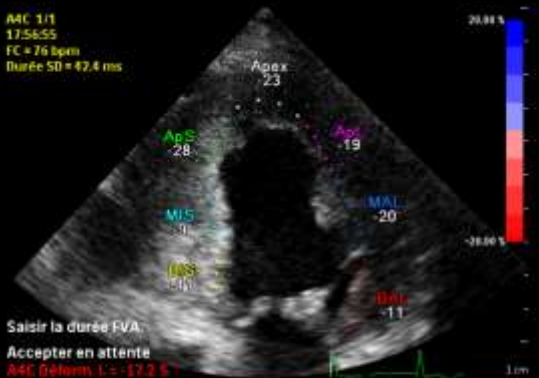
DP

75%

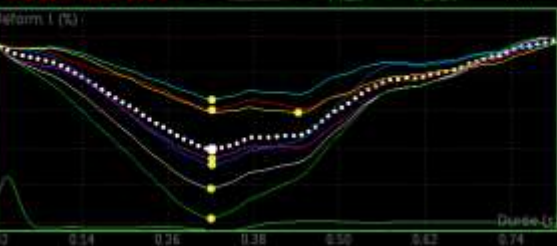
VE5.0mm  
3.6MHz  
8.7cm



A4C 1/1  
17:56:55  
FC = 76 bpm  
Durée SD = 47.4 ms

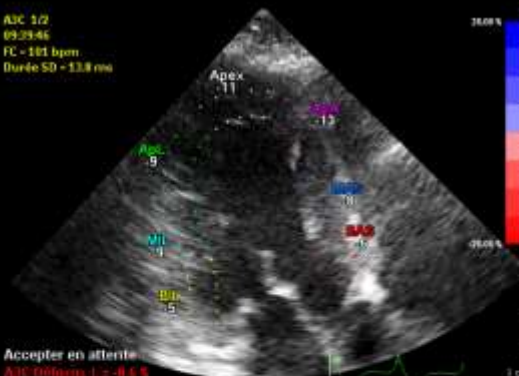


Saisir la durée FVA  
Accepter en attente  
A4C Déform. L = -17.2 %



| Mesures           |        |
|-------------------|--------|
| VTD               | 624 ml |
| VTS               | 153 ml |
| FE                | 76.8 % |
| Cycles cardiaques |        |
| R-R VA            | 780 ms |
| R-R VM            | 780 ms |

A3C 1/2  
09:29:46  
FC = 101 bpm  
Durée SD = 13.8 ms

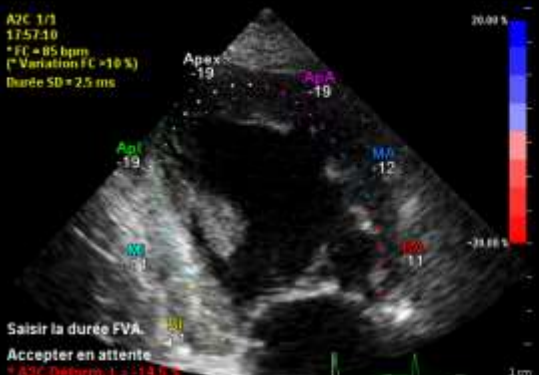


Accepter en attente  
A3C Déform. L = -8.6 %

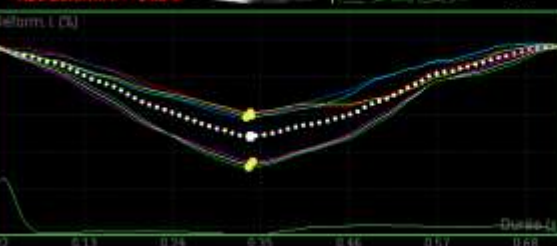


| Cycle cardiaque |        |
|-----------------|--------|
| R-R VA          | 380 ms |
| R-R VM          | 380 ms |
| R-R VM          | 580 ms |

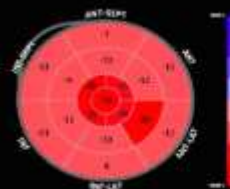
A2C 1/1  
17:57:10  
\* FC = 85 bpm  
(\* Variation FC > 10 %)  
Durée SD = 2.5 ms



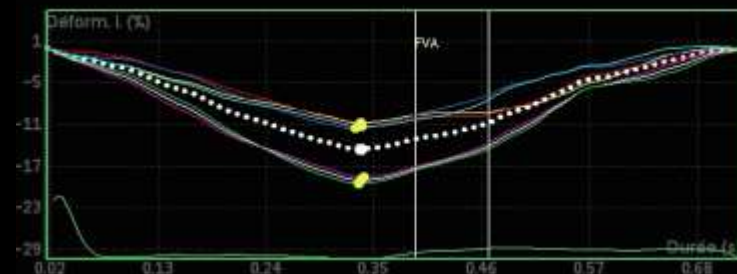
Saisir la durée FVA  
Accepter en attente  
\* A2C Déform. L = -14.3 %



| Mesures           |          |
|-------------------|----------|
| VTD               | 125.3 ml |
| VTS               | 60.0 ml  |
| FE                | 45.2 %   |
| Cycles cardiaques |          |
| R-R VA            | 730 ms   |
| R-R VM            | 730 ms   |



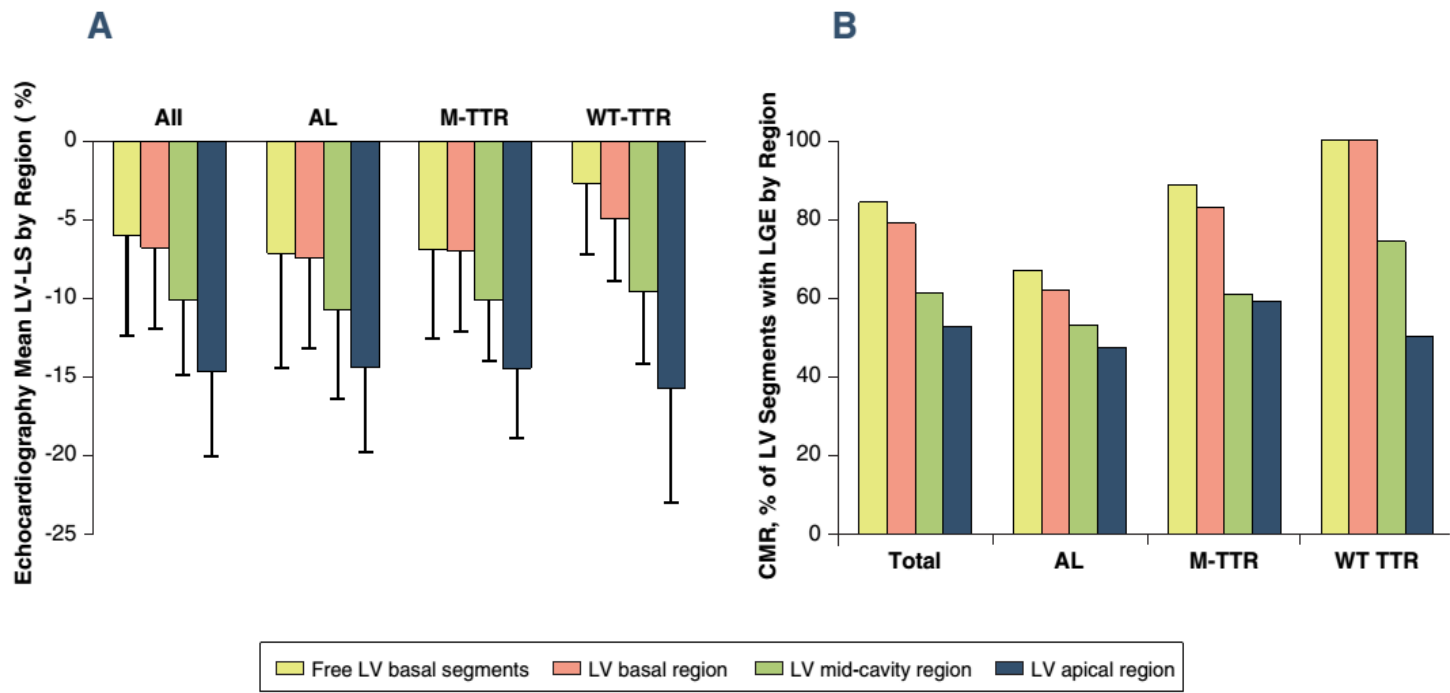
\* FC (Moy) = 81 bpm  
VTD (Moy) = 147 ml  
VTS (Moy) = 68 ml  
FE (Moy) = 46.2 %  
Durée SD = 82.3 ms  
\* A2C Déform. L = -18.3 %  
A2C Déform. L = -17.2 %  
A2C Déform. L = -18.8 %  
Durée de Déform. L = 143.5 ms  
A2C Déform. L = -14.3 %  
A2C Déform. L = -14.3 %  
A2C Déform. L = -14.3 %  
A2C Déform. L = -14.3 %  
A2C Déform. L = -14.3 %



# Strain et amylose : 1. intérêt diagnostique



FIGURE 3 LV Regional Variations of LS and LGE (CMR)



Ternacle et al.

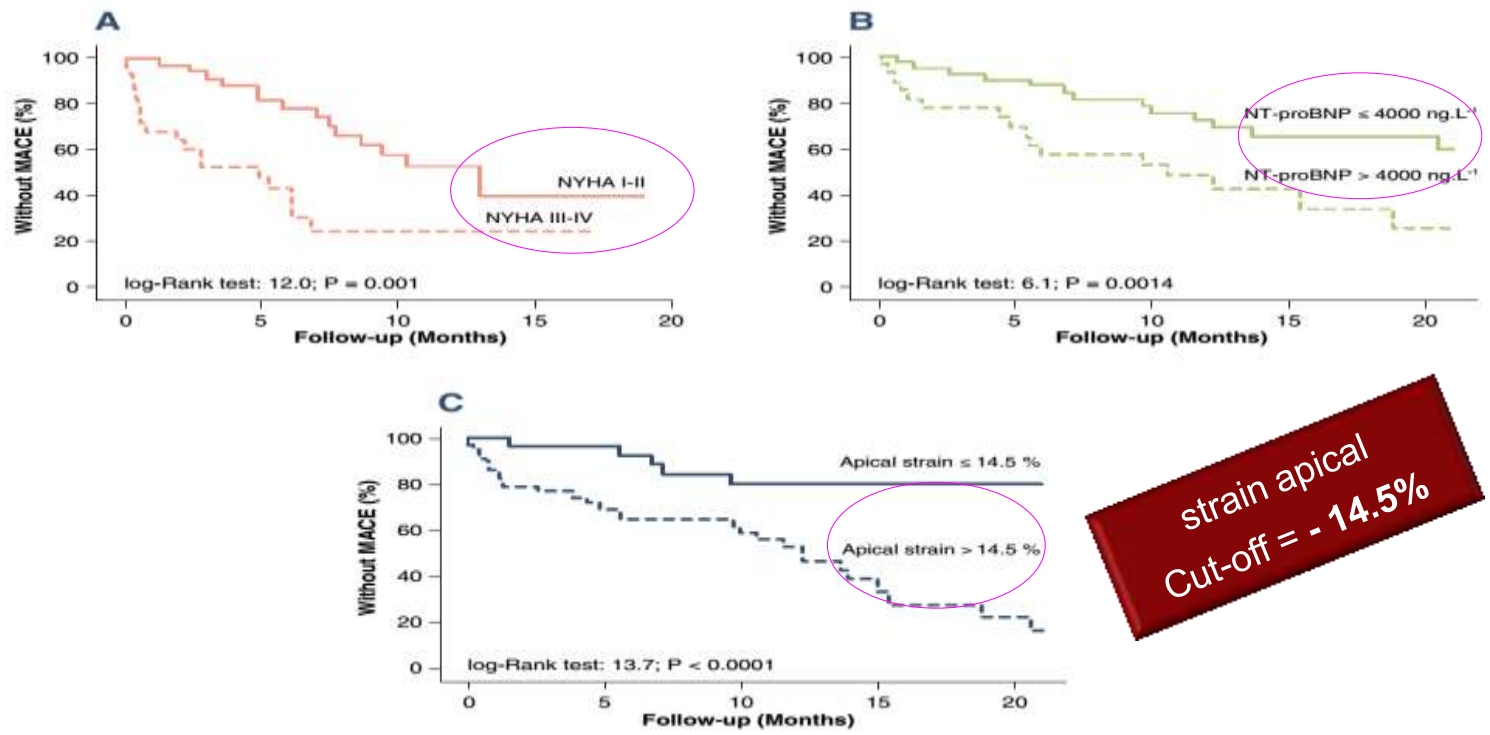
2D Speckle Tracking in Cardiac Amyloidosis

Altération Strain ↔ Rehaussement tardif IRM ↔ Dépôts amyloïdes\*



# Strain et amylose : 2- intérêt pronostic

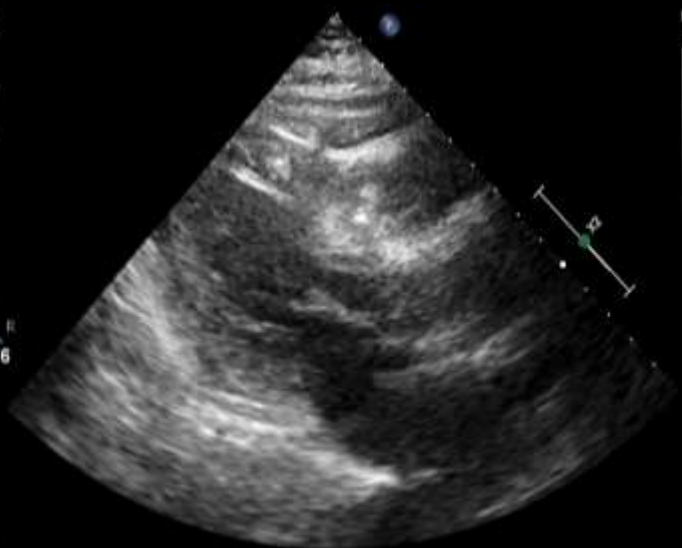
FIGURE 3 Survival Analysis According to Prognostic Markers



Altération **Strain apical** = puissant facteur prédictif d'événements CV majeurs

51Hz  
15cm  
2D  
70%  
C 50  
P Bas  
HGén

③  
P R  
1.8 3.6



M3



73 bpm

15cm  
2D  
71%  
C 50  
P Bas  
HGén

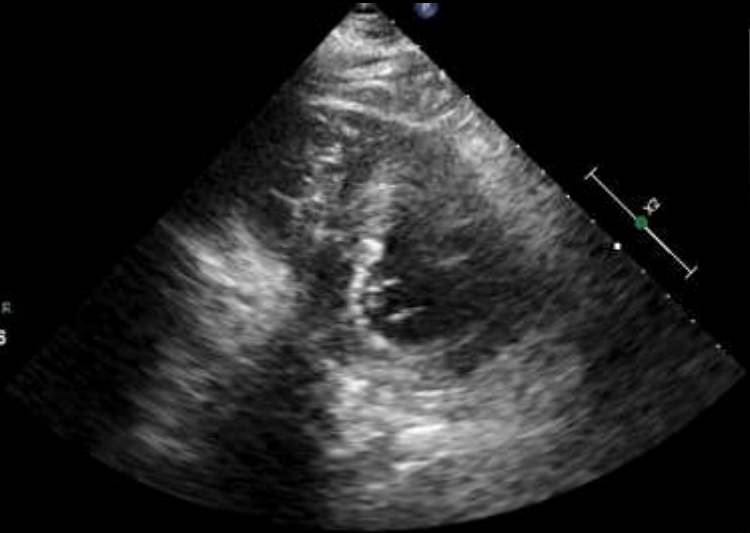
③  
P R  
1.8 3.6



85 bpm

15cm  
2D  
70%  
C 50  
P Bas  
HGén

③  
P R  
1.8 3.6



84 bpm

2D  
70%  
C 50  
P Bas  
HGén

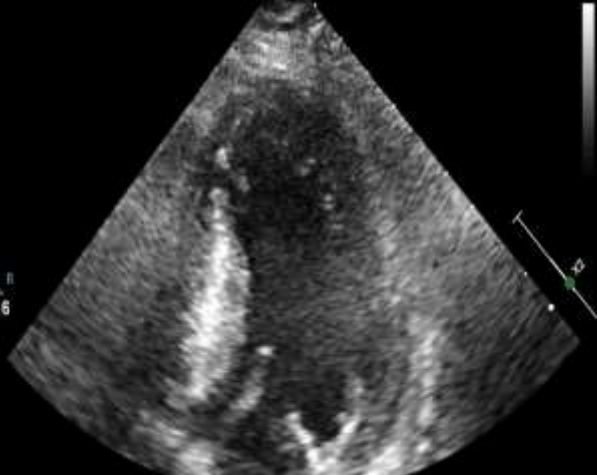
③  
P R  
1.8 3.6



82 bpm

2D  
72%  
C 50  
P Bas  
HGen

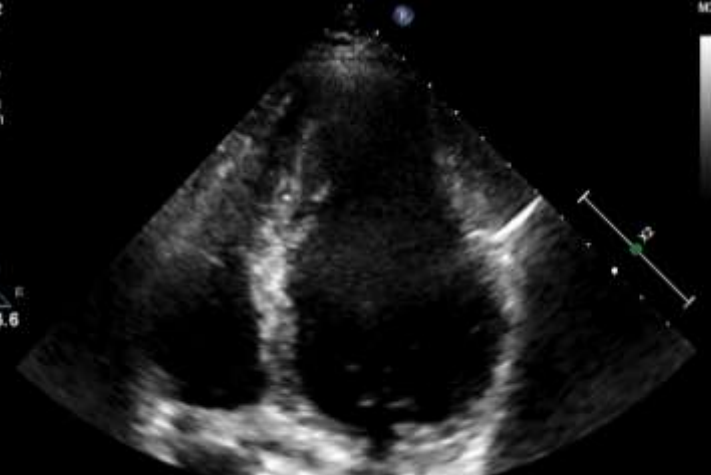
③  
P R  
1.8 3.6



56Hz  
13cm

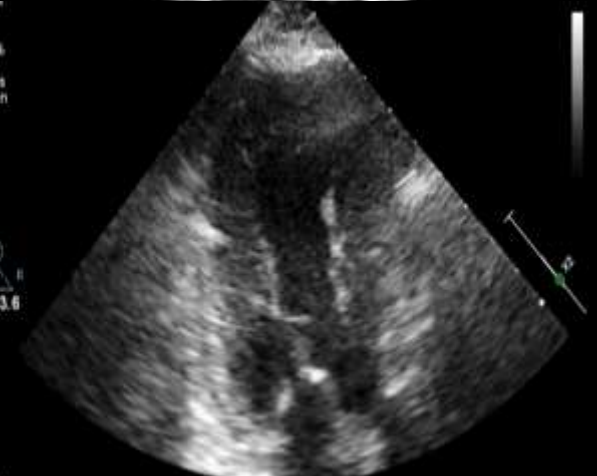
2D  
70%  
C 50  
P Bas  
HGen

③  
P R  
1.8 3.6



11cm  
2D  
72%  
C 50  
P Bas  
HGen

③  
P R  
1.8 3.6



59Hz  
12cm

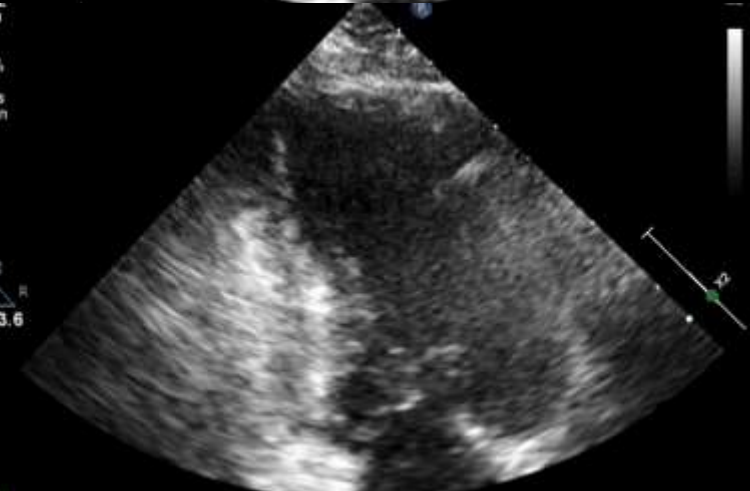
2D  
69%  
C 50  
P Bas  
HGen

③  
P R  
1.8 3.6



11cm  
2D  
72%  
C 50  
P Bas  
HGen

③  
P R  
1.8 3.6



12cm  
2D  
69%  
C 50  
P Bas  
HGen

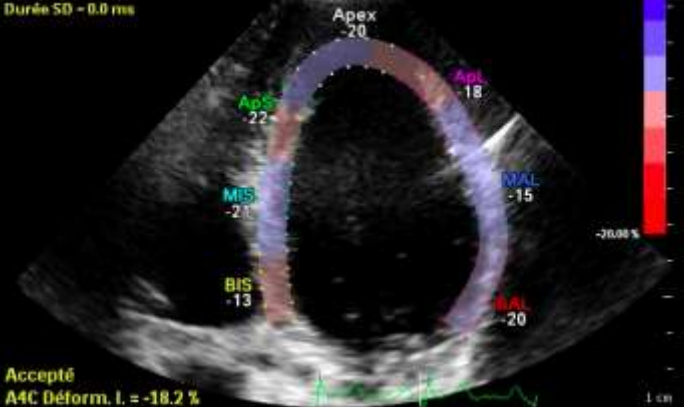
③  
P R  
1.8 3.6



A4C 1/1  
09:34:56  
FC - 101 bpm  
Durée SD - 13.9 ms



A4C 1/2  
09:59:42  
FC - 78 bpm  
Durée SD - 0.0 ms



AJC 1/2  
09:39:46  
FC - 101 bpm  
Durée SD - 13.8 ms



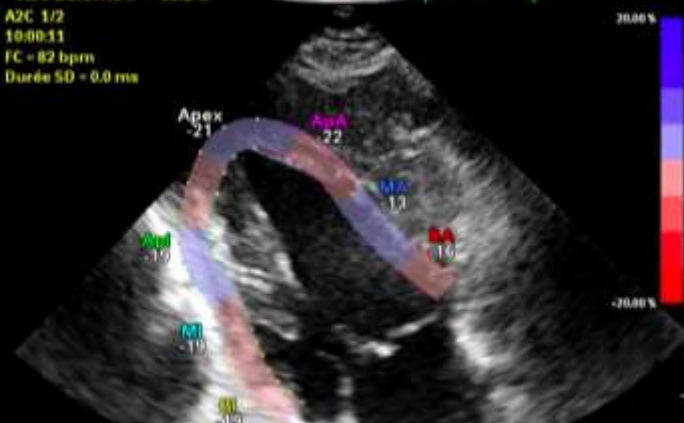
Accepté  
A4C Déform. l. = -18.2 %



Accepter en attente  
AJC Déform. l. = -8.6 %



Accepté  
A4C Déform. l. = -16.2 %



+

# 1. Intérêt diagnostique du Strain dans la CMH

- Déformation longitudinale
- Footballeurs/CMH/témoins
- Strain global
  - -20% athlètes vs -14% CMH

*Lafitte S Am J Cardiol 2007; 100: 128-32*

- D'Andréa (ESC 2010)

- 650 athlètes (280 résistants et 370 endurants)

- LV GLS -17% témoins, -17,2% résistants, -18,1% endurants

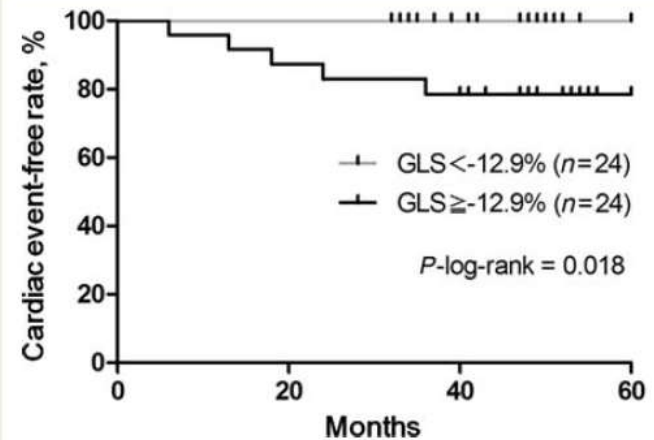
+

## 2. Intérêt pronostic du strain dans la CMH

**Table 3** Correlation between %LGE and study parameters

|                          | <i>r</i> | <i>P</i> -value |
|--------------------------|----------|-----------------|
| Age                      | 0.009    | 0.953           |
| Left atrial volume index | 0.220    | 0.151           |
| Ejection fraction        | -0.171   | 0.268           |
| <i>E/A</i>               | 0.080    | 0.604           |
| <i>e'</i>                | -0.378   | 0.011           |
| <i>Vp</i>                | -0.352   | 0.045           |
| LV pressure gradient     | 0.045    | 0.773           |
| LV mass index            | 0.563    | <0.001          |
| BNP                      | 0.042    | 0.832           |
| GLS                      | 0.595    | <0.001          |

Abbreviations as in Table 2.

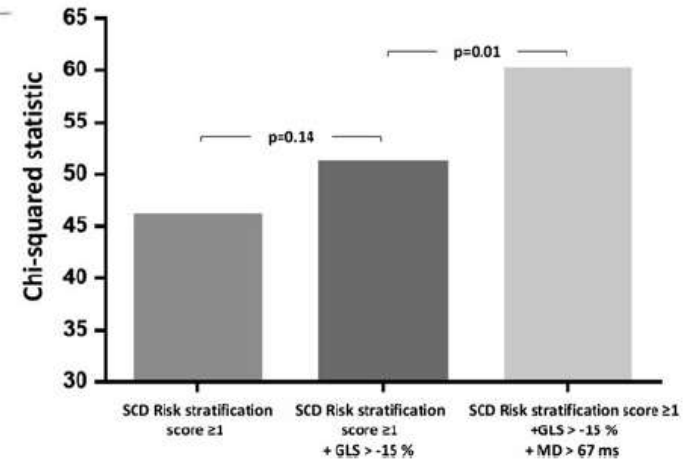
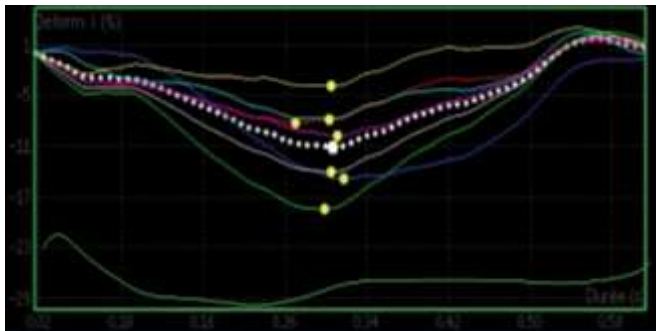
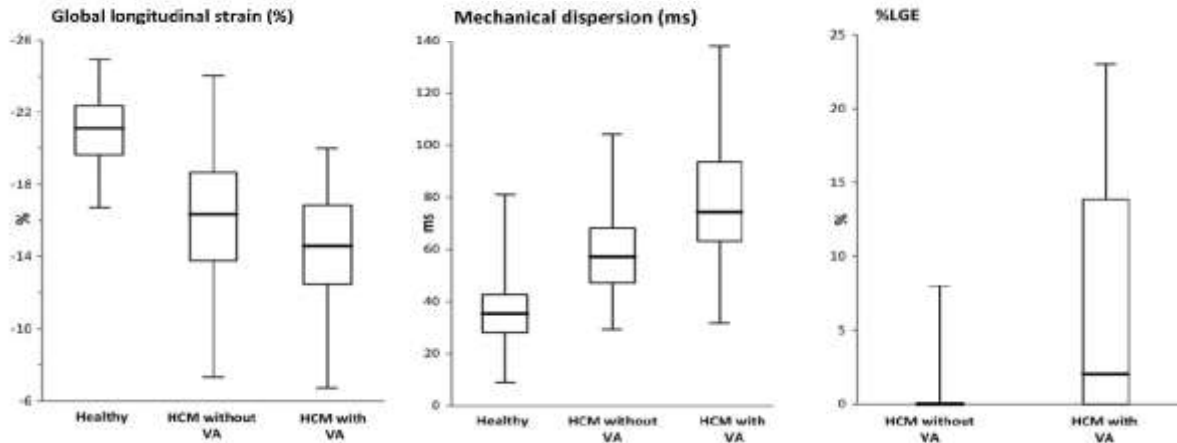


**Figure 2** Kaplan–Meier event-free curves of patients with HCM stratified in two groups according to the median level of GLS. HCM, hypertrophic cardiomyopathy; GLS, global longitudinal strain.

**Makoto Saito**

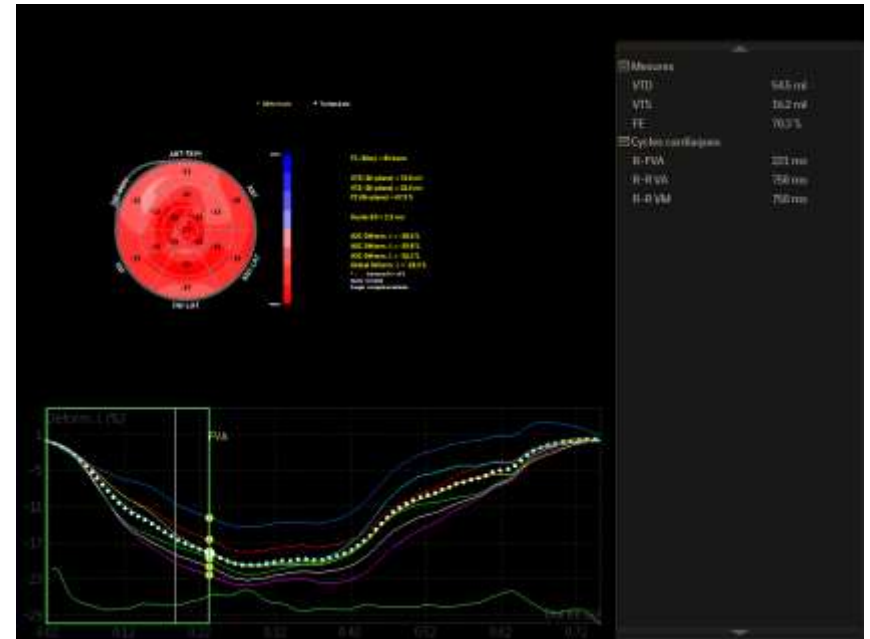
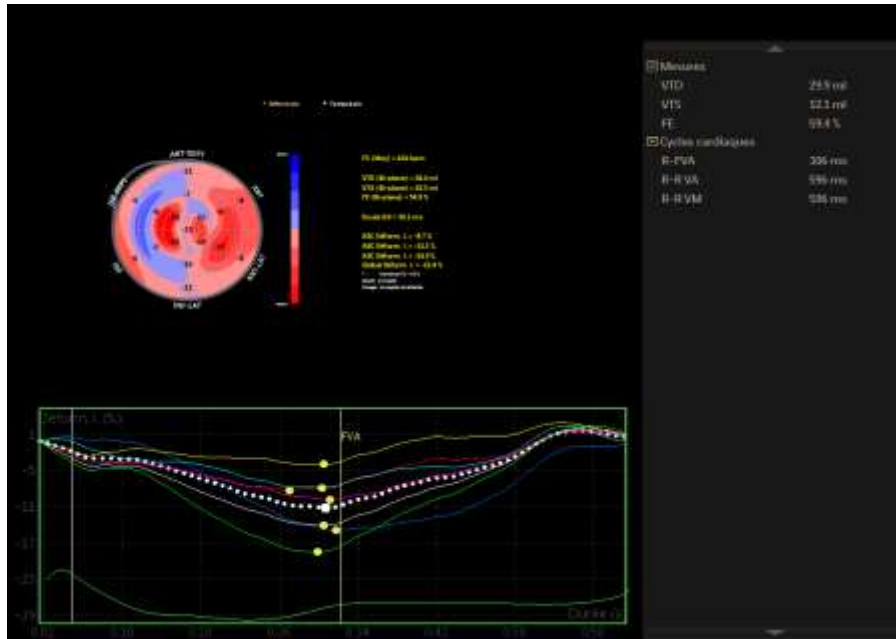
European Heart Journal – Cardiovascular Imaging (2012) **13**, 617–623  
doi:10.1093/ejchocard/jer318

# + 2. Intérêt pronostic du strain dans la CMH





# Dispersion mécanique



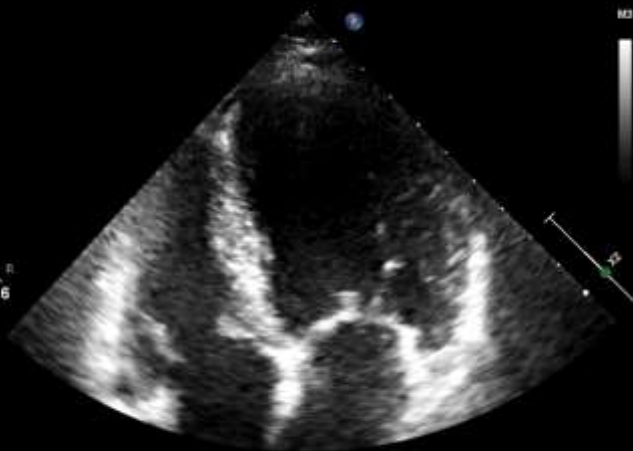




# Les valvulopathies

# Le rétrécissement aortique

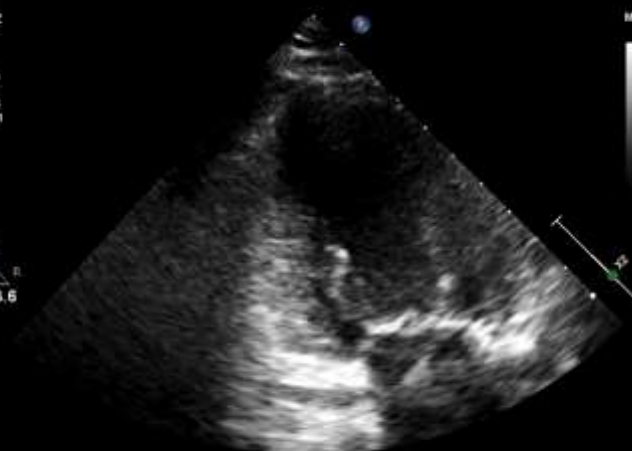
Echo adulte  
S4-2  
62Hz  
11cm  
2D  
72%  
C 50  
P Bas  
HGen



1.8 3.6

64 bpm

Echo adulte  
S4-2  
62Hz  
11cm  
2D  
72%  
C 50  
P Bas  
HGen



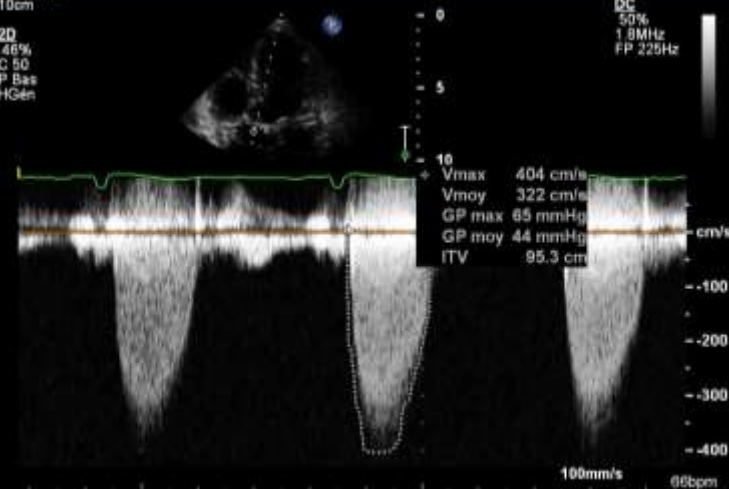
1.8 3.6

64 bpm

CI 64Hz

10cm

2D  
46%  
C 50  
P Bas  
HGen



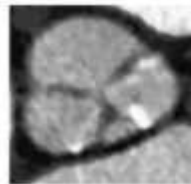
100mm/s 66bpm

+

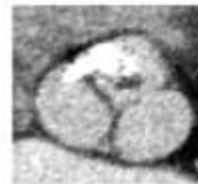
# Pronostic dans le Rao serré asymptomatique



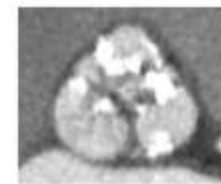
SEVERITY



Mild

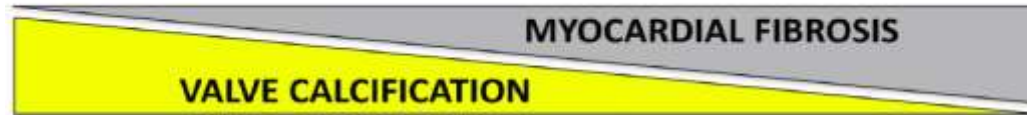


Moderate

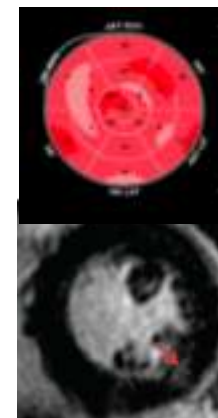
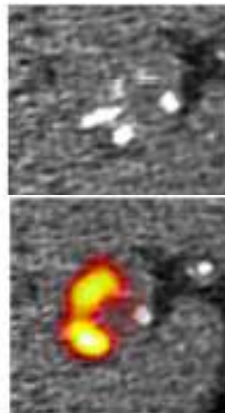


Severe

FOCUS OF  
ASSESSMENT



IMAGING



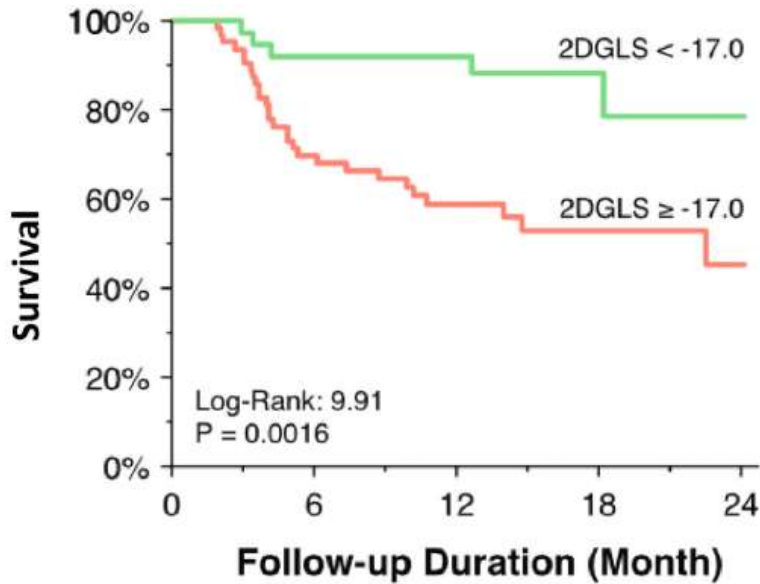
BIOLOGY

BNP

TROPONIN

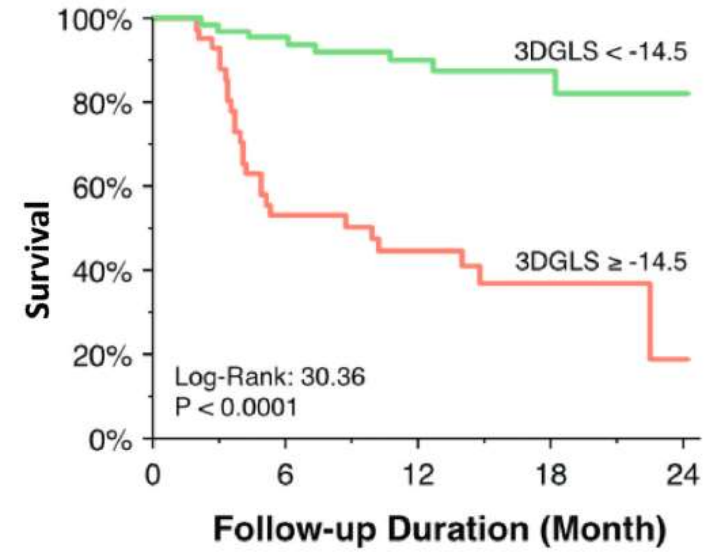


# Intérêt pronostic du strain dans le Rao serré asymptomatique



Patients at risk

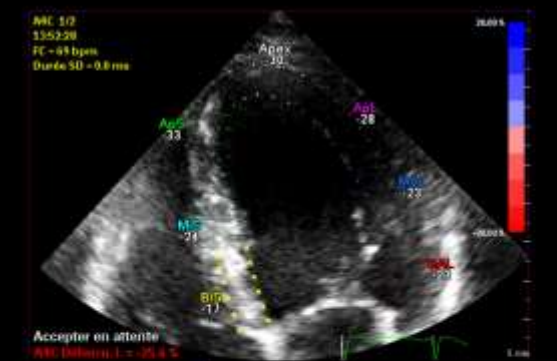
|      |    |    |    |   |
|------|----|----|----|---|
| — 38 | 34 | 28 | 10 | 6 |
| — 64 | 43 | 33 | 14 | 7 |



Patients at risk

|      |    |    |    |    |
|------|----|----|----|----|
| — 63 | 57 | 42 | 17 | 11 |
| — 41 | 22 | 16 | 7  | 2  |

Nagata Y, Takeuchi M, Wu VC, Izumo M, Suzuki K, Sato K, Seo Y, Akashi YJ, Aonuma K, Otsuji Y. Prognostic value of LV deformation parameters using 2D and 3D speckle-tracking echocardiography in asymptomatic patients with severe aortic stenosis and preserved LV ejection fraction. JACC Cardiovasc Imaging. 2015; 8:235-45. [PubMed: 25682511]

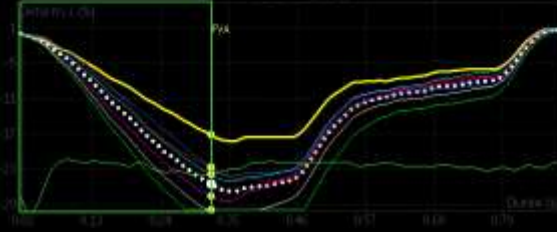


Mesures

|     |         |
|-----|---------|
| VTD | 44.3 ml |
| VTS | 13.2 ml |
| FE  | 70.2 %  |

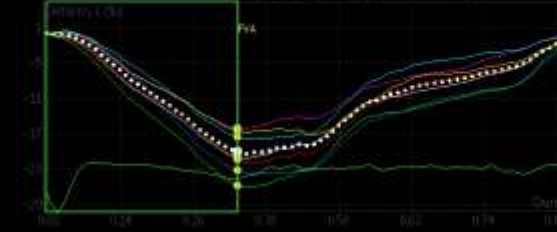
Cycles cardiaques

|       |       |
|-------|-------|
| R-FVA | 33 ms |
| R-RVA | 93 ms |
| R-RVM | 93 ms |



Cycles cardiaques

|       |       |
|-------|-------|
| R-FVA | 32 ms |
| R-RVA | 93 ms |
| R-RVM | 93 ms |

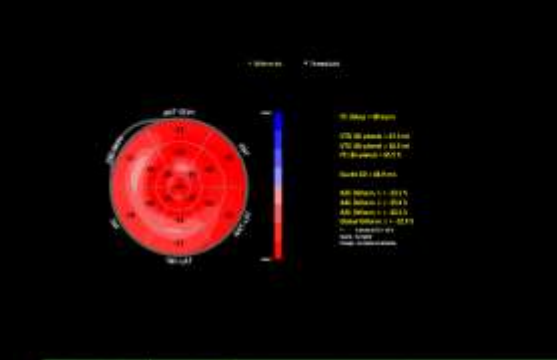
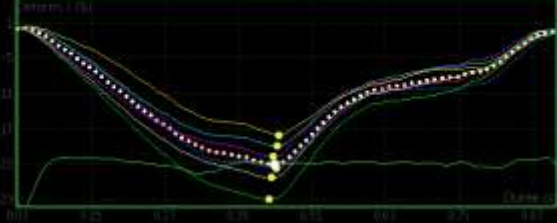


Mesures

|     |         |
|-----|---------|
| VTD | 50.3 ml |
| VTS | 13.4 ml |
| FE  | 61.5 %  |

Cycles cardiaques

|       |       |
|-------|-------|
| R-FVA | 30 ms |
| R-RVA | 93 ms |

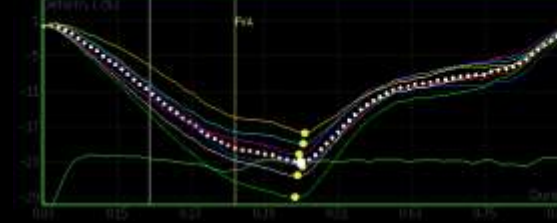


Mesures

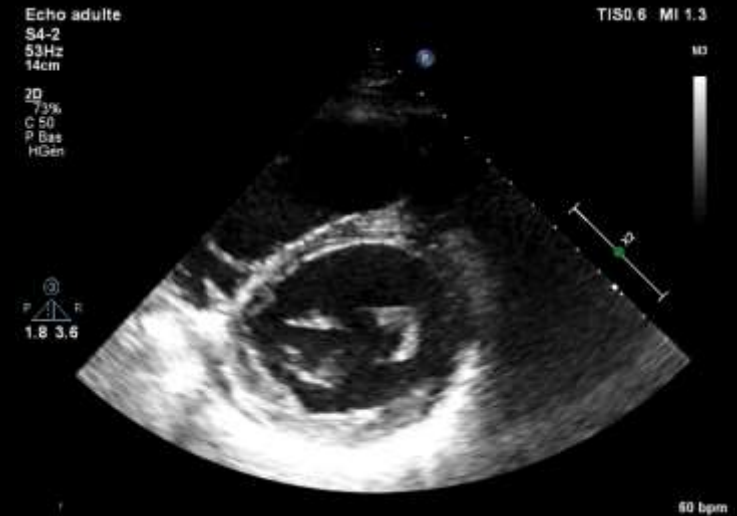
|     |         |
|-----|---------|
| VTD | 50.3 ml |
| VTS | 13.4 ml |
| FE  | 61.5 %  |

Cycles cardiaques

|       |       |
|-------|-------|
| R-FVA | 30 ms |
| R-RVA | 93 ms |
| R-RVM | 93 ms |



# L'insuffisance mitrale

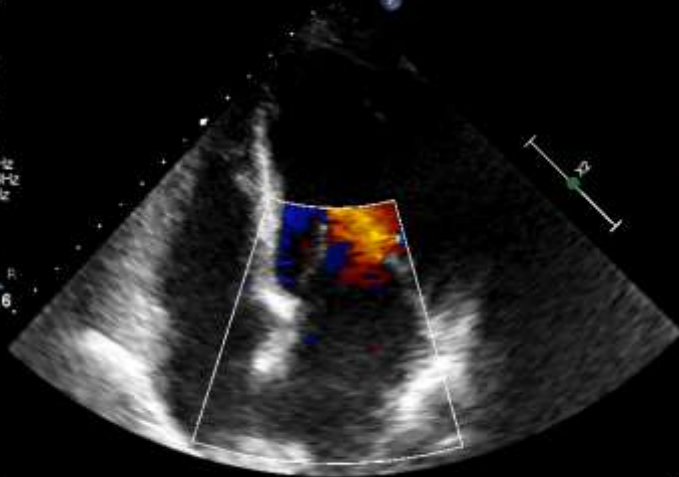


Echo adulte  
S4-2  
18Hz  
16cm

2D  
74%  
C 50  
P Bas  
HGén

Coul  
68%  
4000Hz  
FP 389Hz  
2.5MHz

P R  
1.8 3.6



61 bpm

TIS1.1 MI 1.3

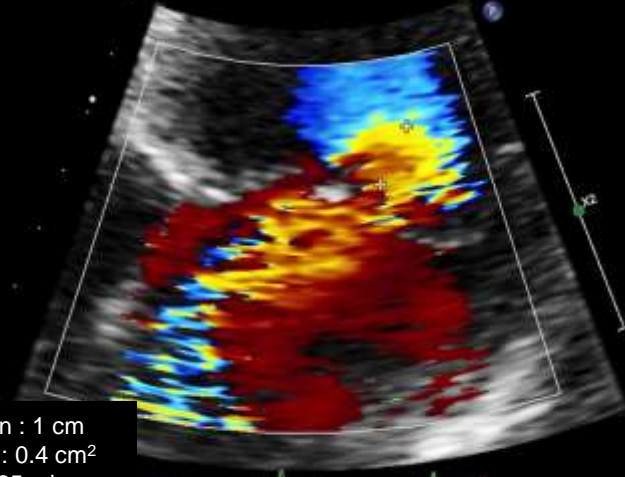
M3 M4  
+81.6  
-81.6  
cm/s

Echo adulte  
S4-2  
20Hz  
14cm

2D  
75%  
C 50  
P Bas  
HGén

Coul  
68%  
4000Hz  
FP 389Hz  
2.5MHz

P R  
1.8 3.6



57 bpm

ITm1.1 IM 1.2

M3 M4  
+92.4  
-30.8  
cm/s

Rayon : 1 cm  
SOR : 0.4 cm<sup>2</sup>  
VR : 65 ml

Echo adulte  
S4-2  
43Hz  
19cm

2D  
75%  
C 50  
P Bas  
HGén

P R  
1.8 3.6



57 bpm

ITm0.5 IM 1.3

M3

DTD à 60 mm  
DTS : 38 mm  
SIV : 9 mm  
PP : 8 mm  
FEVG à 66%

Echo adulte  
S4-2  
20Hz  
19cm

2D  
75%  
C 50  
P Bas  
HGén

Coul  
68%  
4000Hz  
FP 389Hz  
2.5MHz

DC  
30%  
FP 225Hz  
1.8MHz

P R  
1.8 3.6



56 bpm

ITm0.5 IM 0.1

M3 M4  
+81.6  
-81.6  
cm/s

♦ Vit 249 cm/s  
GP 25 mmHg

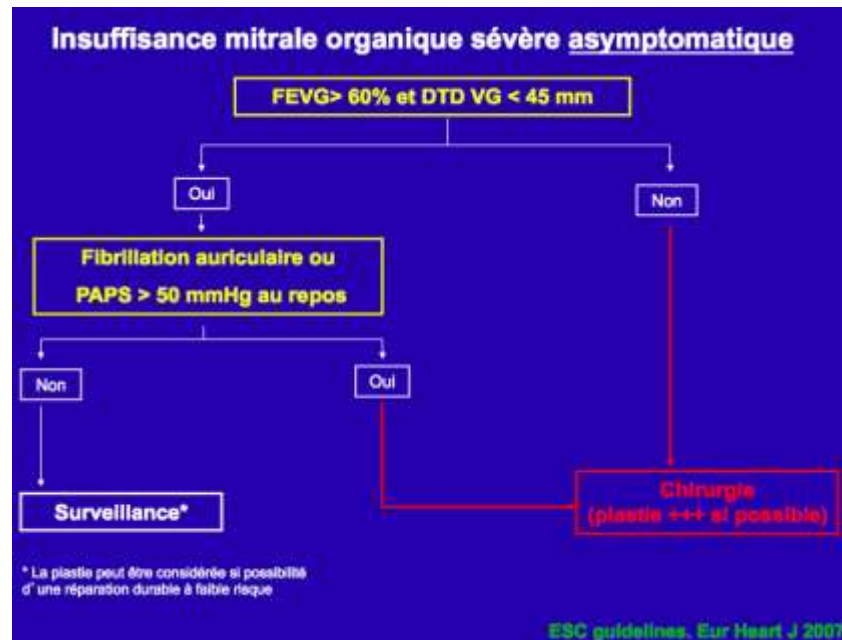
♦ Surf OG 35.0 cm<sup>2</sup>

75mm/s



# Problématique dans l'IM sévère asymptotique

- FEVG calculée par Simpson surestime la FEVG réelle du patient:
  - FEVG réelle = FEVG calculée - fraction de régurgitation







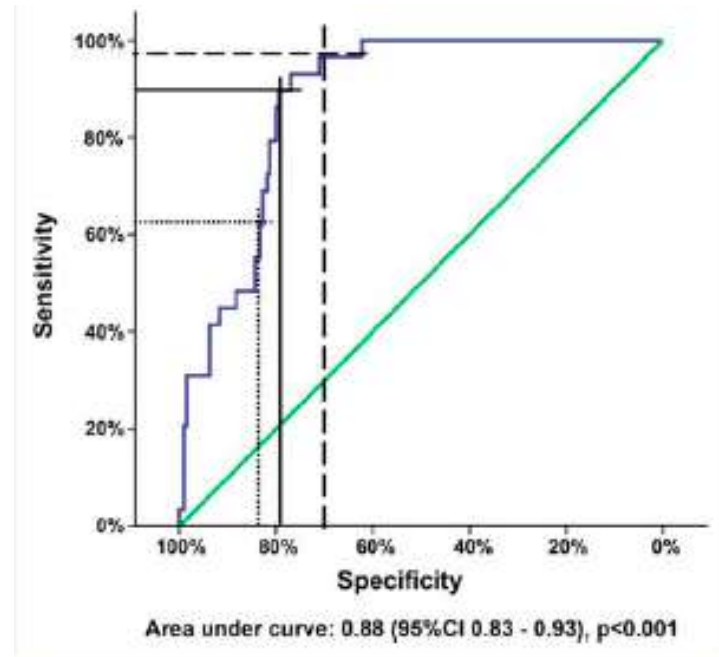
# Global longitudinal strain predicts left ventricular dysfunction after mitral valve repair

Tomasz G. Witkowski<sup>1,2</sup>, James D. Thomas<sup>3</sup>, Philippe J.M.R. Debonnaire<sup>1</sup>,

**Table 3** Predictors of LVEF at long-term follow-up after mitral valve corrective surgery: uni- and multivariate linear regression analysis

| Univariate models                   | R     | Adjusted R <sup>2</sup> | P-value |
|-------------------------------------|-------|-------------------------|---------|
| LV ejection fraction                | 0.386 | 0.145                   | <0.001  |
| LV end-systolic diameter            | 0.320 | 0.099                   | <0.001  |
| Right ventricular systolic pressure | 0.052 | 0.003                   | 0.433   |
| Atrial fibrillation                 | 0.210 | 0.040                   | 0.001   |
| LV global longitudinal strain       | 0.583 | 0.337                   | <0.001  |
| Multivariate model                  |       |                         |         |
| LV ejection fraction                | 0.416 | 0.166                   | <0.001  |
| LV end-systolic diameter            |       |                         |         |
| Multivariate model                  |       |                         |         |
| LV ejection fraction                | 0.434 | 0.178                   | <0.001  |
| LV end-systolic diameter            |       |                         |         |
| Atrial fibrillation                 |       |                         |         |
| Multivariate model                  |       |                         |         |
| LV ejection fraction                | 0.605 | 0.355                   | <0.001  |
| LV end-systolic diameter            |       |                         |         |
| Atrial fibrillation                 |       |                         |         |
| LV global longitudinal strain       |       |                         |         |

Parameters that were statistically significant at the univariate analysis were sequentially included in the multivariate analysis in order to test the gain in predictive accuracy of the model.  
 LV, left ventricular.

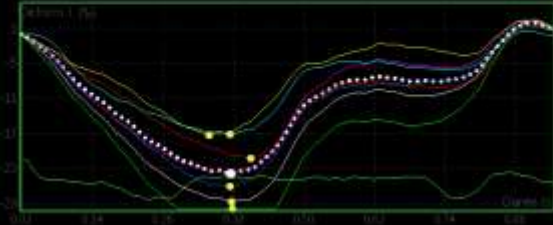


Cut Off : SLG - 19.9%

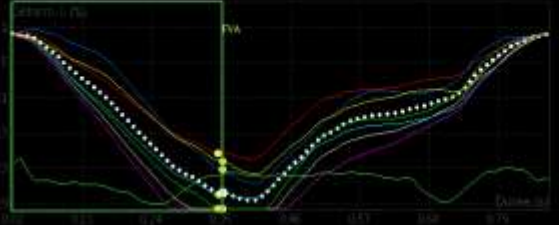


**Mesure**  
 V01 144 ml  
 V15 114 ml  
 FE 61.2 %

**ECycles cardiogram**  
 R-R VA 307 ms  
 R-R VM 309 ms

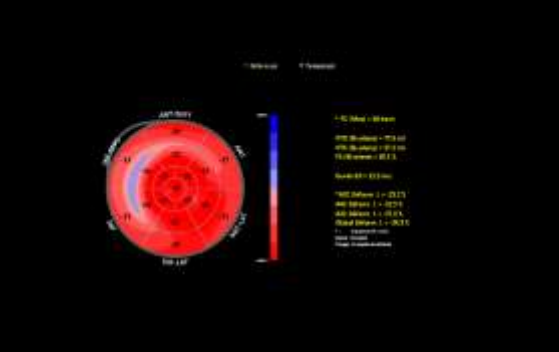
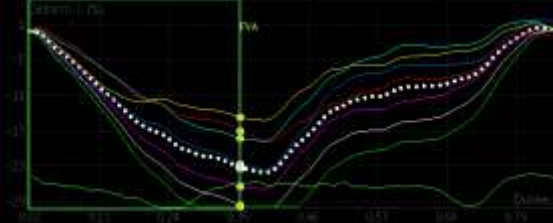


**ECycles cardiogram**  
 R-R VA 307 ms  
 R-R VM 309 ms

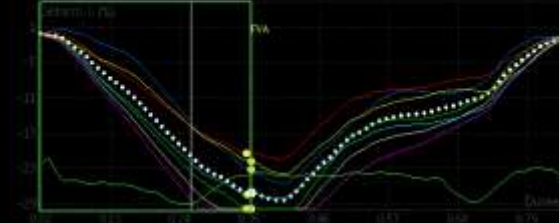


**Mesure**  
 V01 85.6 ml  
 V15 20.9 ml  
 FE 61.1 %

**ECycles cardiogram**  
 R-R VA 307 ms  
 R-R VM 309 ms



**ECycles cardiogram**  
 R-R VA 307 ms  
 R-R VM 309 ms





# Conclusion



- Paramètre quantification contractilité myocardique.
- Bonne faisabilité, simplicité et reproductibilité (inter et intra-operateur)
- Intérêts :
  - Diagnostic
  - Pronostic +++
    - ⇒ Implications thérapeutiques potentielles +++
- Limites :
  - Absence de valeurs seuils universelles
  - Variabilité inter vendeurs

**A intégrer dans la pratique écho de routine.**