

# Top 5 Situations Where I Find Strain Is Helpful

**Dr Sabe De, MD FRCPC FASE**  
**Associate Professor, University of Western Ontario**  
**Director of Echocardiography, London Health Science Center**  
**London, Ontario, Canada**

**Echo Hawaii, January 18, 2022**



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## Relevant Disclosures

**none**

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## Why use Strain



- **A marker of myocardial deformation that is easy to perform and reproducible**
- **Better temporal variability than standard echo parameters**
- **Established criteria for diagnosis**
- **Regional vs Global**
- **Aids with management of HFpEF**
- **Normal values for GLS: -19.7, we use absolute values to avoid confusion. Less than 16 is abnormal, above 18 is normal**

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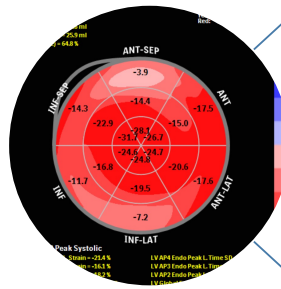
## Clinical Utility of Strain



Clinical Applications of STE	Sources of Variability	
Undifferentiated left ventricular hypertrophy	<b>Technical sources:</b>	<b>Clinical sources:</b>
Assessment of cardiotoxicity	Image quality / clip selection	Race / ethnic factors
Aortic stenosis	Contouring / region of interest	Age and gender differences
Ischemic heart disease	Tracking / timing	Hemodynamic factors
Regional strain	Choice of segmentation model	Medications
Other chambers (left atrial strain, right ventricular strain)	Choice of vendor	Volume status

Collier, P. et al. J Am Coll Cardiol. 2017;69(8):1043–56.

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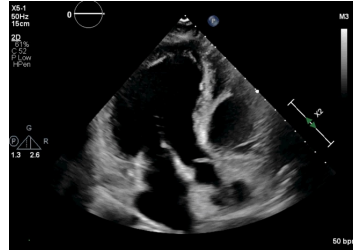
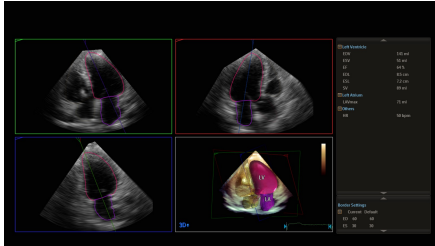
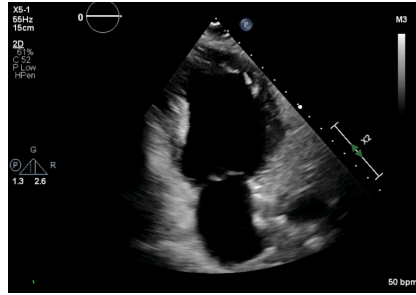
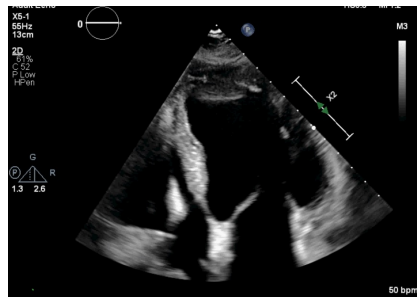


- Pattern Recognition
- Subclinical Dysfunction
- Regional Variation

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### Situation #1 - For patients with HFpEF Looking Beyond EF

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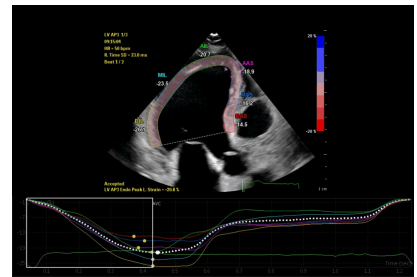
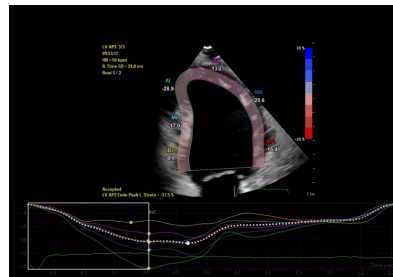
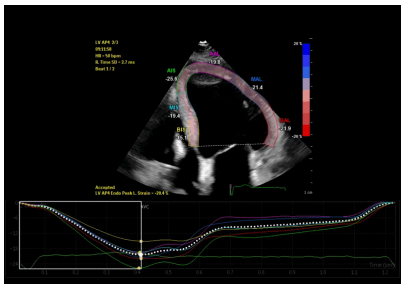


79 yo male with Normal LV

3D EF=64%

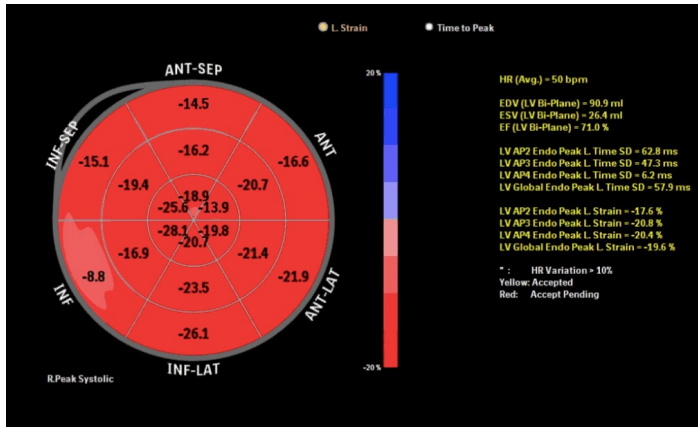
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# Longitudinal Strain Analysis



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GLS = -19.6%



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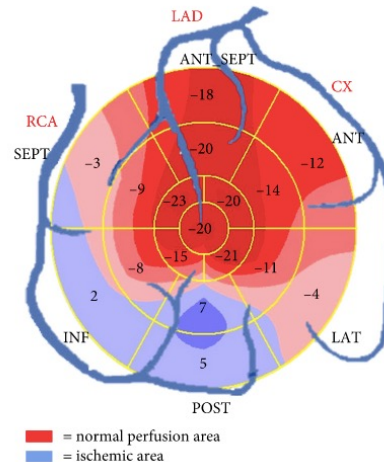
**Longitudinal 2D strain at rest predicts the presence of left main and three vessel coronary artery disease in patients without regional wall motion abnormality**

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

Division of Cardiology, Cardiac and Vascular Centre, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, no. 50, Irwon-dong, Gangnam-gu, Seoul 135-710, Korea

Received 15 December 2008; accepted after revision 2 April 2009; online publish-ahead-of-print 28 April 2009

- Study of 108 patients with left main or 3 vessel CAD without regional wall motion abnormality (RWMA) looking at GLS
- GLS cutoff of -17.9% has sensitivity and specificity of 79% for predicting severe CAD

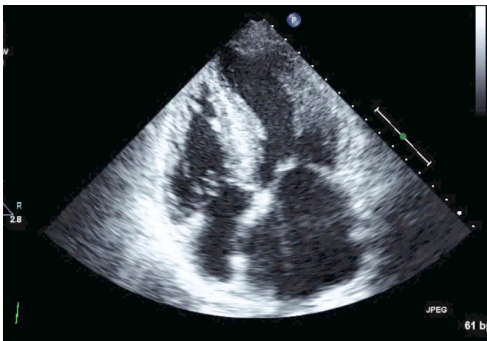


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## Situation #2. Unexplained LVH

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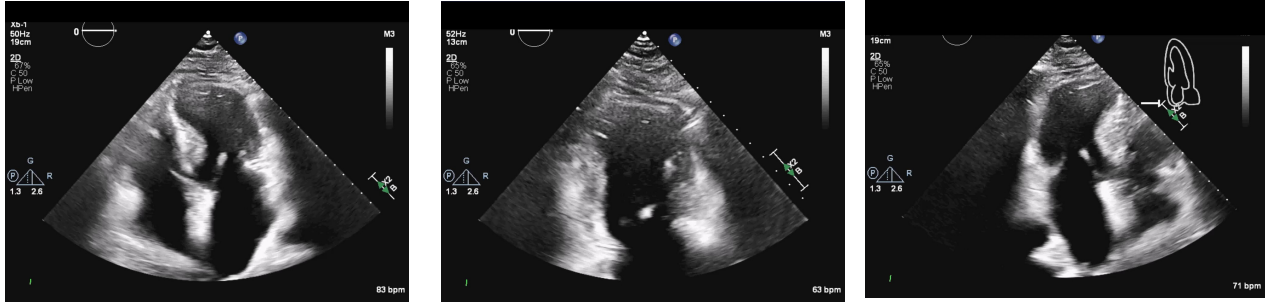
## HFpEF with LVH



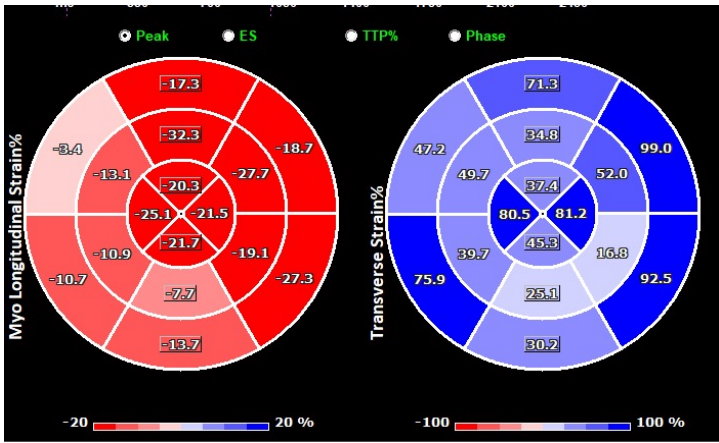
- **Heterogeneous Disease**
- **Differential:**
  - **Hypertensive heart disease**
  - **Valvular disease**
  - **Fabry**
  - **HCM**
  - **Amyloidosis**

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# 55 year old male with HFpEF



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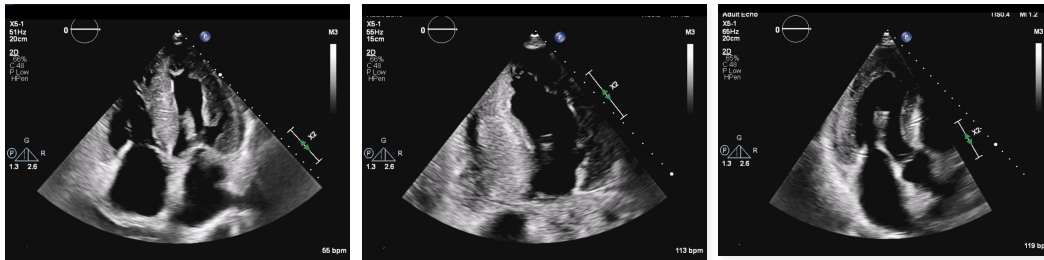


Reduced strain noted at anteroseptum, inferoseptum and inferior wall  
Diagnosis: Hypertrophic Cardiomyopathy

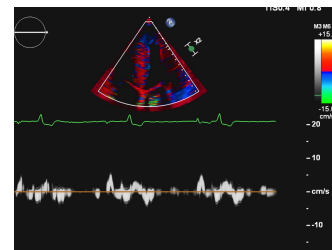
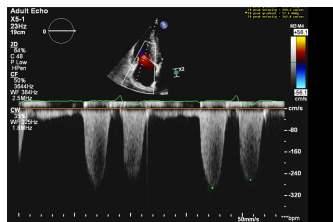
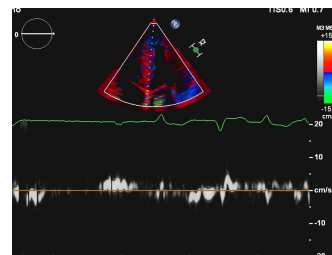
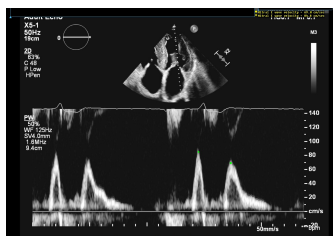
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# 81 yo female with HFpEF

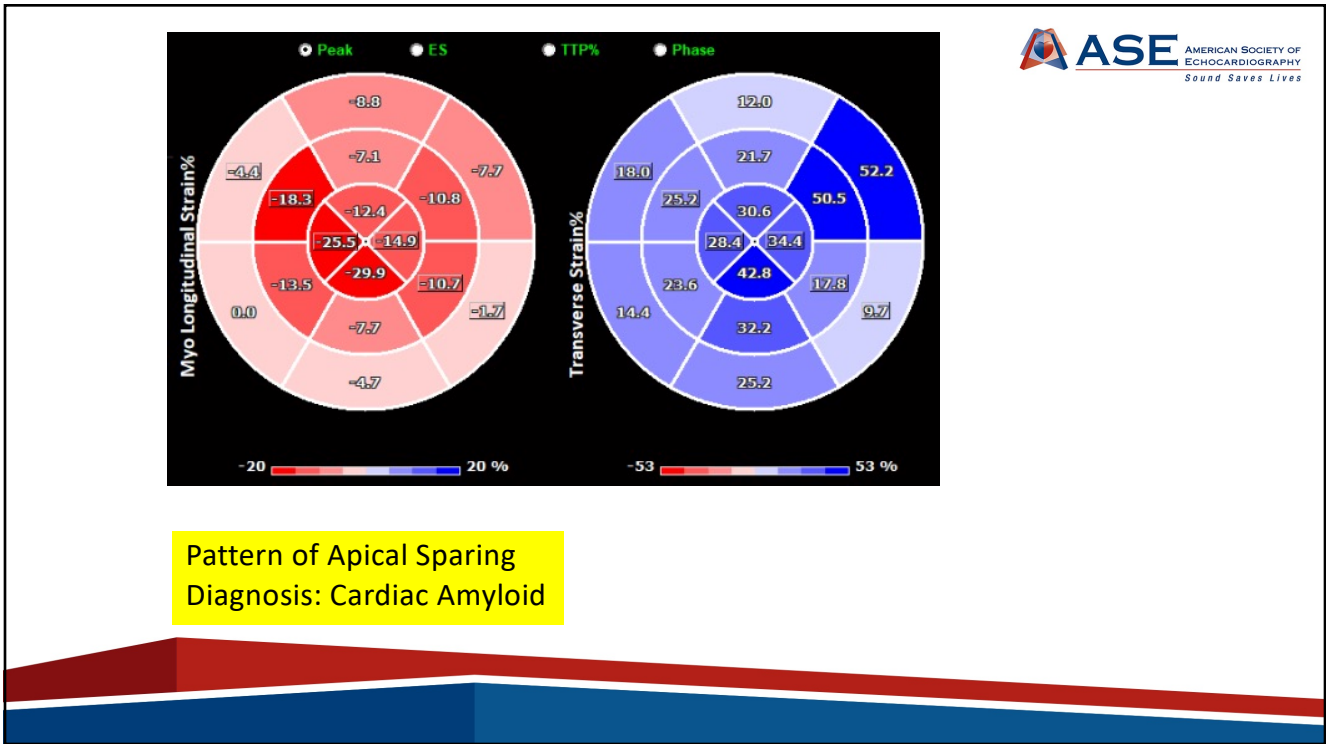


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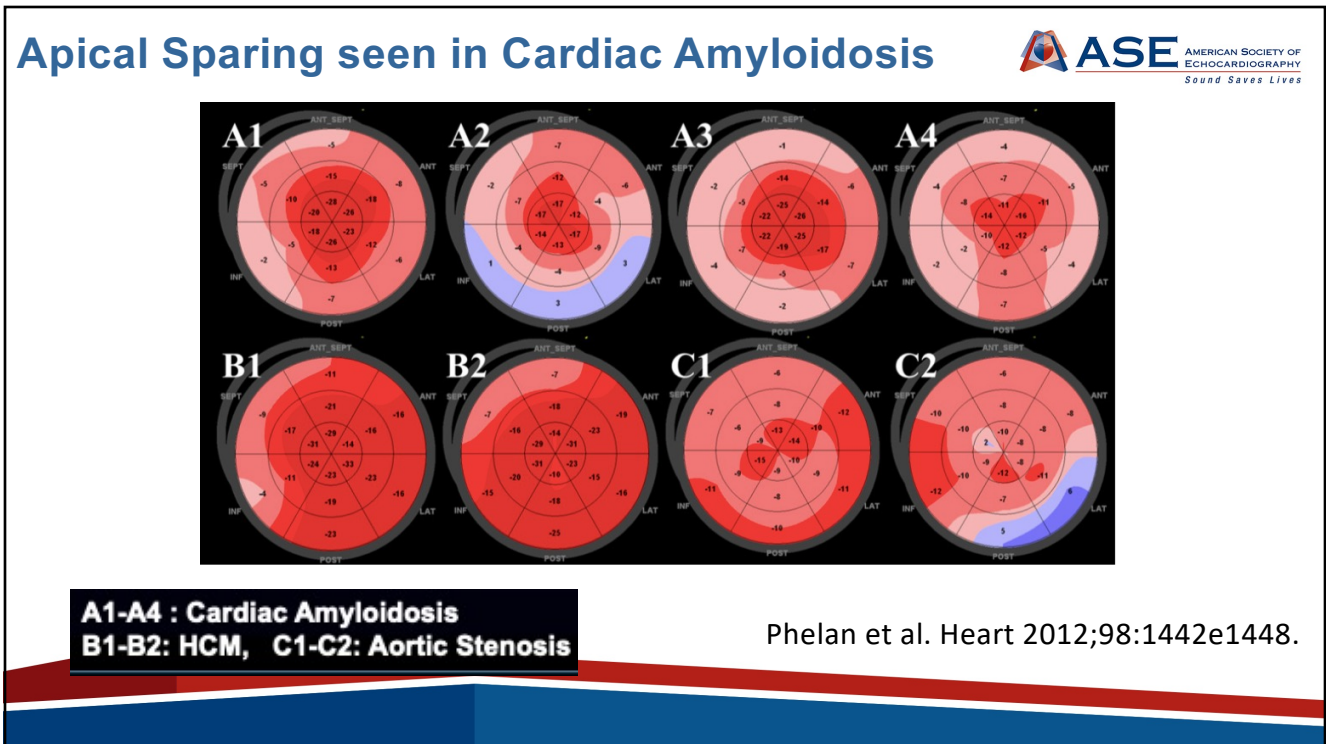


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**A Echo-Red Flags**

- Pleural/Pericardial Effusion
- Thick Right Ventricle
- Thick Valves
- Thick Interatrial Septum
- Low Stroke Volume
- Paradoxical Low Flow Low Gradient AS

**B Restrictive LV Filling**


- Mitral Inflow Doppler
- Pulmonary Vein Doppler
- Lateral Mitral Annular TDI

**C Global Longitudinal Strain: Amyloidosis vs. Normal**

- Left Ventricular GLS: Amyloidosis
- Left Ventricular GLS: Normal
- Atrial GLS: Amyloidosis
- Atrial GLS: Normal

Dorballa et al. J Am Coll Cardiol Img 2020;13:1368–83

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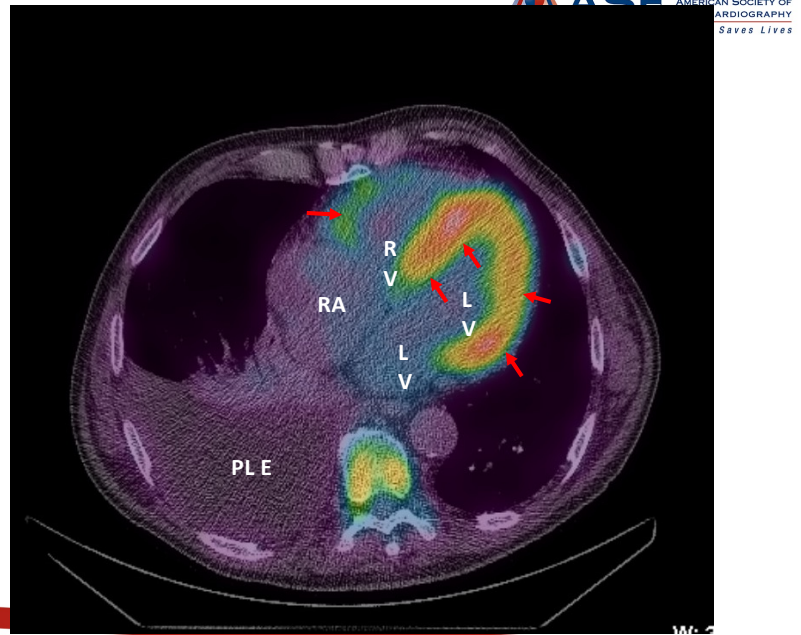
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    graph TD
      A[Cardiac amyloidosis suspected based on standard heart failure work-up, including cardiac imaging with either echocardiography and/or CMR, troponin and BNP/NTproBNP] --> B[Screen for plasma cell dyscrasia – serum and urine protein electrophoresis with immunofixation, serum free light chain assay]
      B --> C[AL amyloidosis suspected – monoclonal protein present]
      B --> D[ATTR amyloidosis suspected – monoclonal protein absent]
      C --> E[Hematology referral – biopsy of involved organ, typically EMB, renal, BMB or fat pad (which cannot exclude systemic amyloidosis) with MS or IHC if positive†]
      E --> F[AL cardiac amyloidosis – (or other type by EMB with MS or IHC)‡]
      E --> G[Cardiac amyloidosis excluded*]
      D --> H[Tc-99m-PYP scan – if unavailable perform EMB with MS or IHC if positive†]
      H --> I[ATTR cardiac amyloidosis – perform TTR genetic testing]
      H --> J[Cardiac amyloidosis excluded – if equivocal results consider EMB*]
      I --> K[Positive - hATTR]
      I --> L[Negative - wtATTR]
  
```

CCS/CHFS Position Paper on Cardiac Amyloidosis

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The myocardial uptake is greater than the rib uptake (Grade 3)



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### Situation #3 - "Asymptomatic" Valvular Heart Disease



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### 3. “Asymptomatic” Valvular Heart Disease

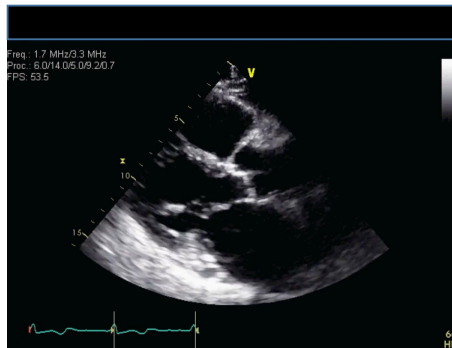


Markers of Ventricular Decompensation are either based on EF or linear 2D dimensions

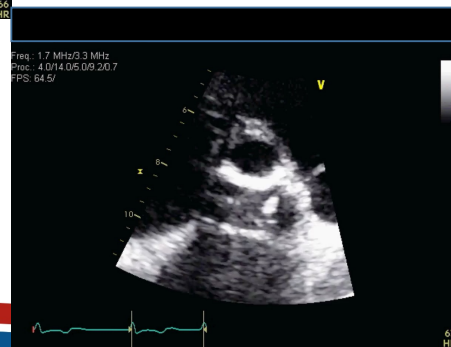
Valvular Lesion	Marker of LV Decompensation for Surgery
Severe Aortic Stenosis	EF<50%
Severe Aortic Regurgitation	EF<55%, LVESD >50 mm, LVEDD > 75 mm
Severe Mitral Regurgitation	EF ≤ 60%, LVESD ≥ 40 mm

ACC/AHA 2020 Valve Guidelines. Circulation. 2021;143:e72–e227

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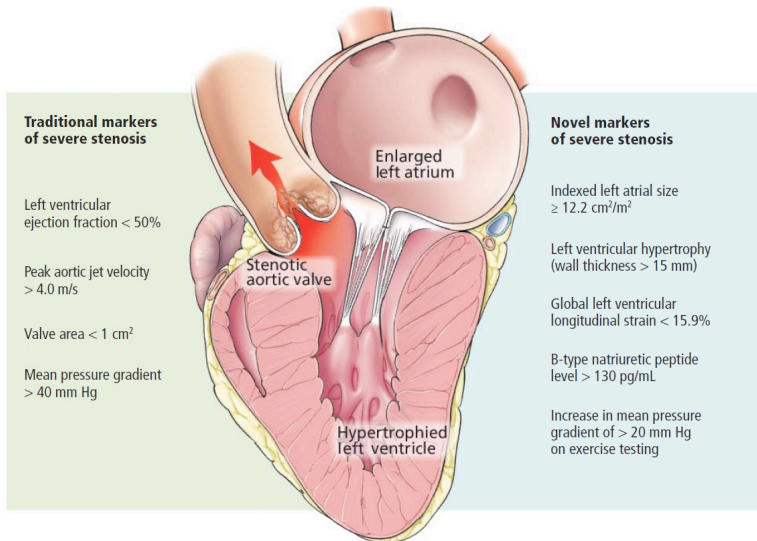
Aortic Stenosis  
 Peak velocity 3 m/s  
 Peak gradient 36 mm Hg  
 Mean gradient 18.3  
 AVA 0.59 cm<sup>2</sup>  
 Stroke vol index 17.4 ml/m<sup>2</sup>



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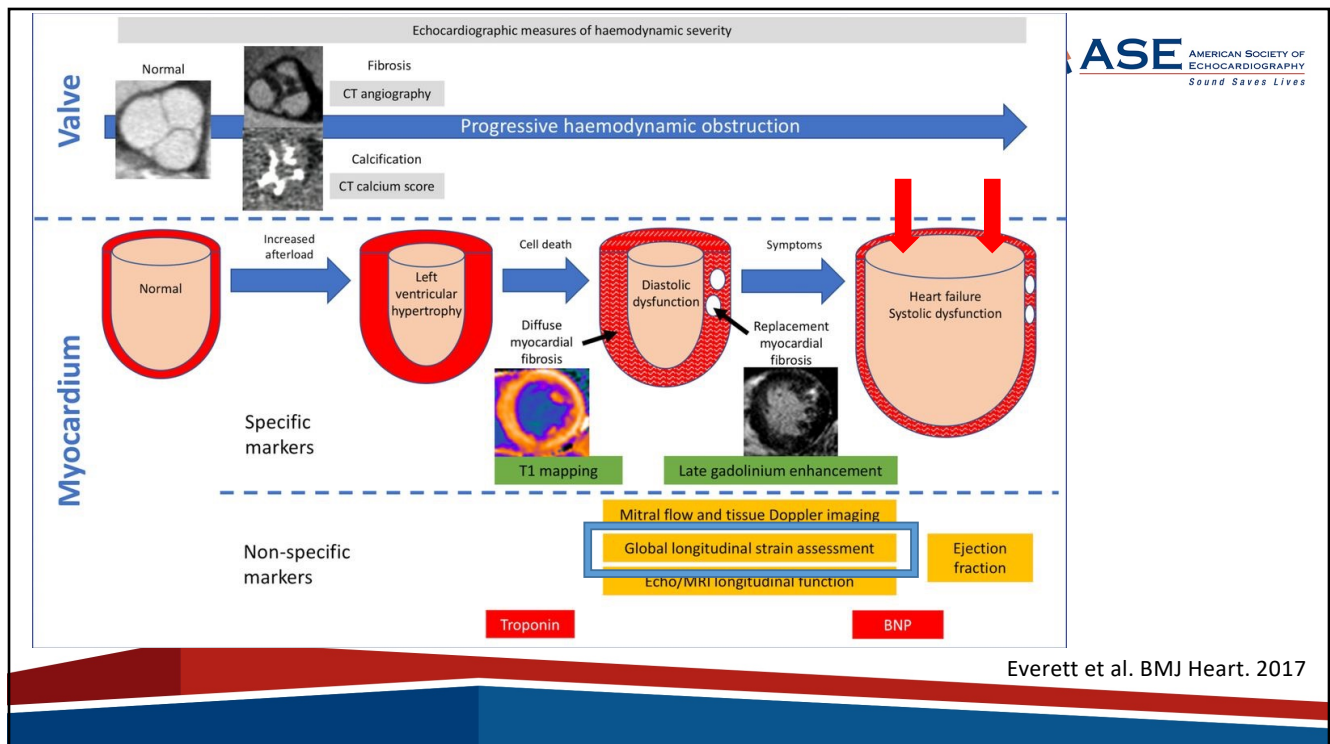


# New markers to assess aortic stenosis



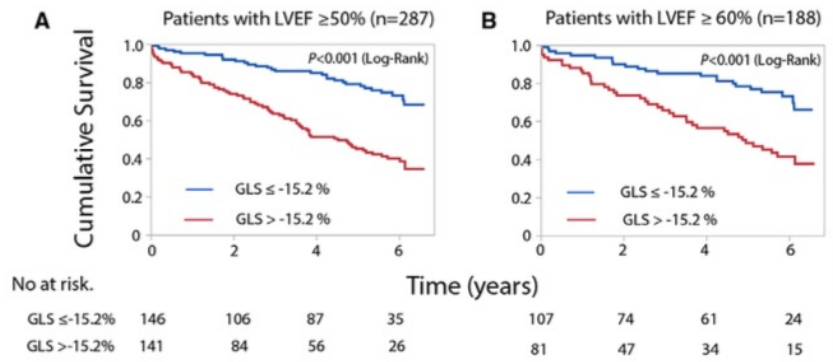
McCarthy et al. Cleveland Clinic Journal of Medicine. 2016

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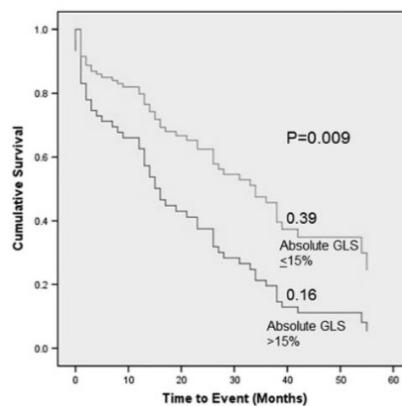
## Reduced GLS is associated with increased mortality in patients with moderate aortic stenosis



Zhu et al. *Circ Cardiovasc Imaging*. 2020

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## Abnormal GLS is associated with reduced Survival in asymptomatic patients with Severe AS



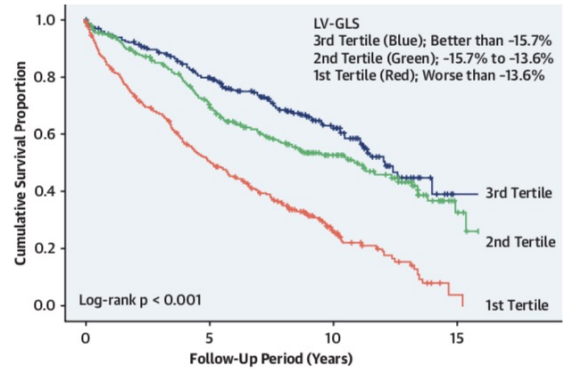
Yingchoncharoen et al. *Circ Cardiovasc Imaging*. 2012;5:719-725

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## Mixed aortic valve disease At least Moderate AS + At least Moderate AR



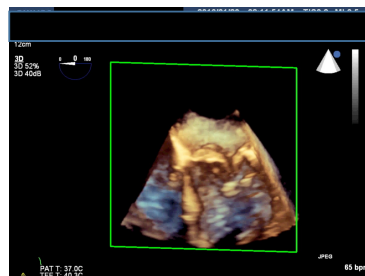
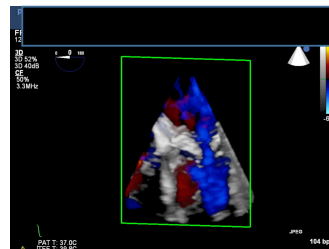
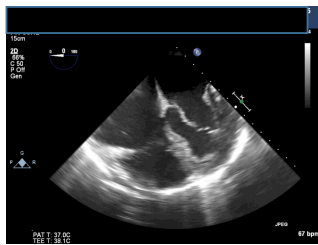
- 783 patients evaluated over 5.6 years
- EF>50% in all patients
- GLS independently predictive and linear relationship with mortality
- Tertiles of GLS predicted risk



Number at risk	0	5	10	15
3rd Tertile	260	201	169	130
2nd Tertile	261	196	150	106
1st Tertile	262	167	116	80

Saijo, Y. et al. J Am Coll Cardiol Img. 2021;14(7):1324-34.

## Mitral Regurgitation

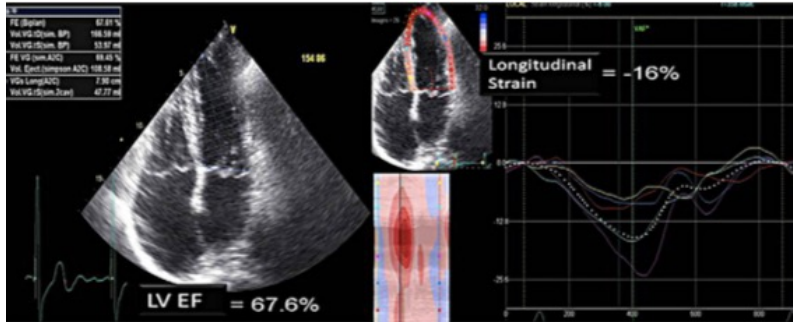




### Predictive Value of Global Longitudinal Strain in a Surgical Population of Organic Mitral Regurgitation



Sophie Masle, MD, Frederic Schnell, MD, Christophe Thebault, MD, Herve Corbineau, MD, PhD,  
Marcel Laurent, MD, Stephanie Hamonic, Eng, David Veillard, MD, Philippe Mabo, MD, PhD,  
Alain Leguerrier, MD, and Erwan Donal, MD, PhD, *Rennes, France*



Postoperative LV dysfunction was associated with reduced preop absolute GLS of 17 or lower



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### Situation #4 - Subclinical LV dysfunction



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## 4. Subclinical LV dysfunction

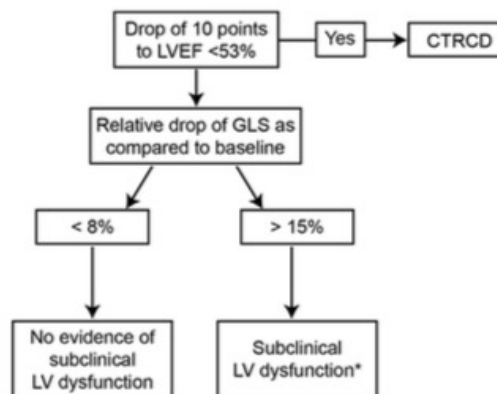


- Changes in GLS and Regional strain are subclinical markers that precede development of a fulminant cardiomyopathy
- GLS and regional strain can be applied to any patient at risk

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### EXPERT CONSENSUS STATEMENT

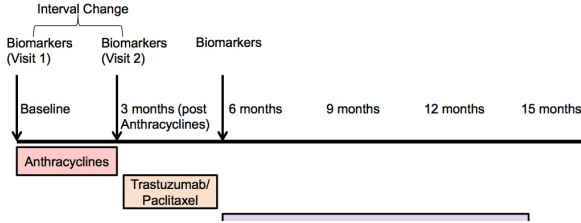
Expert Consensus for Multimodality Imaging  
Evaluation of Adult Patients during and after Cancer  
Therapy: A Report from the American Society of  
Echocardiography and the European Association of  
Cardiovascular Imaging



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## Early Increases in Multiple Biomarkers Predict Subsequent Cardiotoxicity in Patients With Breast Cancer Treated With Doxorubicin, Taxanes, and Trastuzumab



PhD,<sup>‡</sup> Benjamin French, PhD,<sup>\*†</sup> MD,<sup>||</sup> Victor Cohen, MD,<sup>¶</sup> <sup>\*\*</sup> Randolph P. Martin, MD,<sup>††</sup> n, PhD,<sup>‡‡</sup> Jonathan Passeri, MD,<sup>‡</sup> *Cleveland, Ohio; Houston, Texas;*

**Table 4. Sensitivity, Specificity, PPV, and NPV of the Predictors of Cardiotoxicity**


Predictors (Measured At the Completion of Anthracyclines)	Sensitivity	Specificity	PPV	NPV
Long strain <19%	17/23 (74%) (0.51–0.90)	40/55 (73%) (0.59–0.84)	17/32 (53%)	40/46 (87%)
usTnI >30 pg/mL	11/23 (48%) (0.27–0.69)	40/55 (73%) (0.59–0.84)	11/26 (44%)	40/52 (77%)
Long strain <19% and usTnI>30 pg/mL	8/23 (35%) (0.16–0.57)	51/55 (93%) (0.82–0.98)	8/12 (67%)	51/66 (77%)
Long strain <19% or usTnI>30 pg/mL	20/23 (87%) (0.66–0.97)	29/55 (53%) (0.39–0.66)	20/46 (43%)	29/32 (91%)

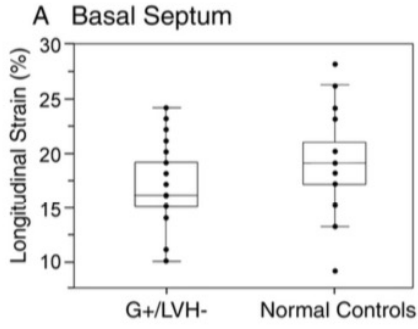
PPV indicates positive predictive value; NPV, negative predictive value; and usTnI, ultrasensitive troponin I. Long strain is peak systolic longitudinal myocardial strain. The 95% exact CIs are provided in brackets.

Negative predictive value of 91% for GLS and troponin

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## Subclinical echocardiographic abnormalities in phenotype-negative carriers of myosin-binding protein C3 gene mutation for hypertrophic cardiomyopathy





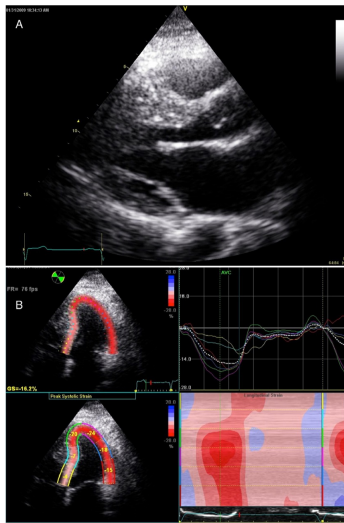
**A Basal Septum**

Longitudinal Strain (%)

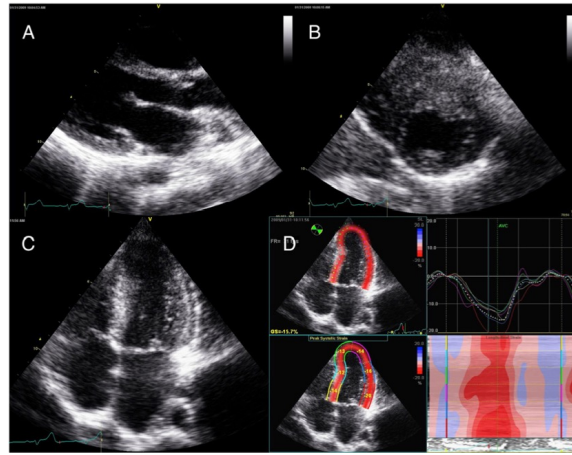
G+/LVH-      Normal Controls

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### Speckle Tracking in MYBPC3 Mutation



42 yo male with ASH



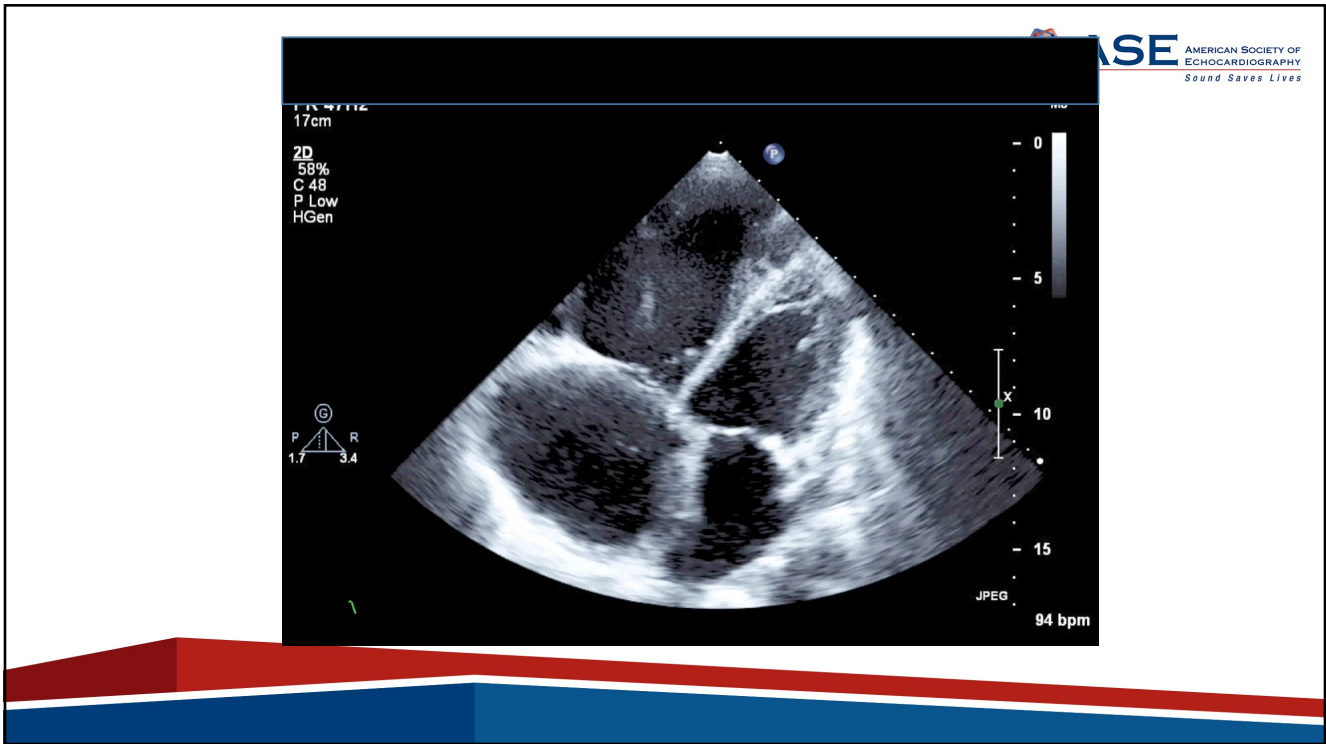
14 yo son with apical variant HCM

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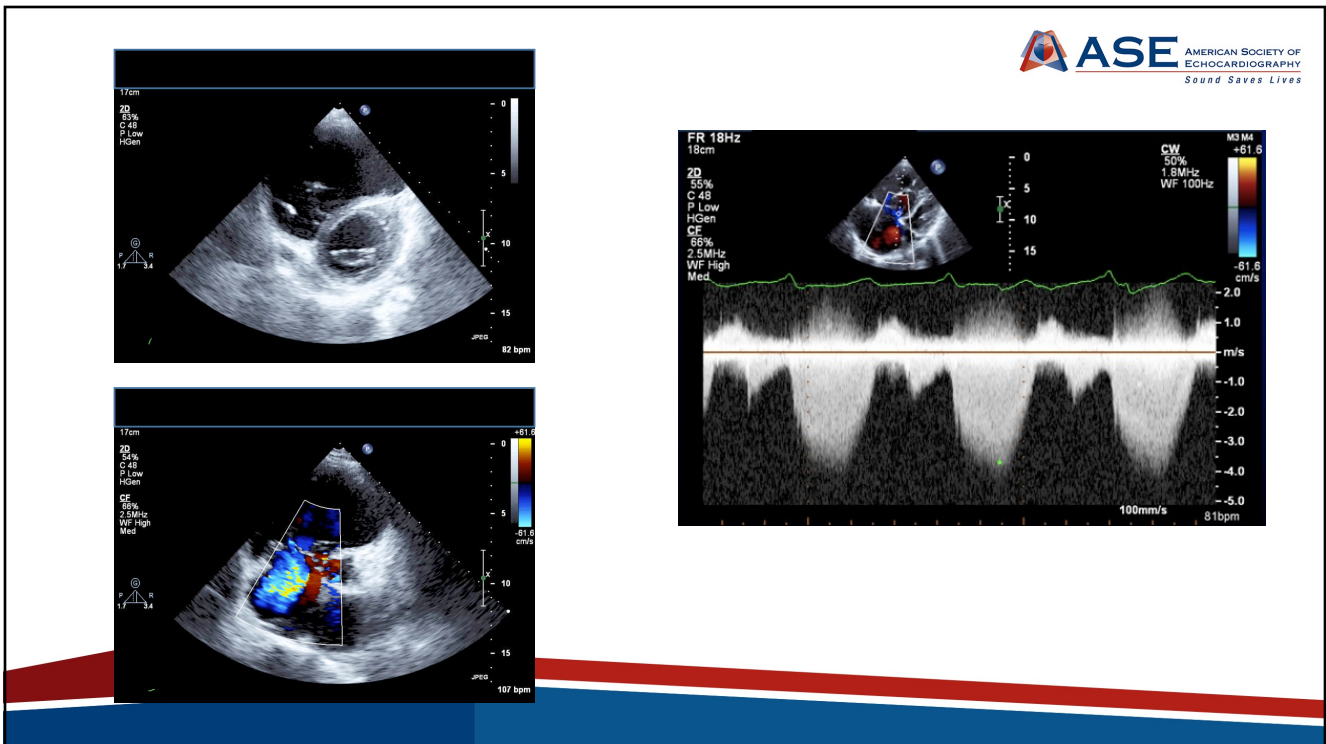


## Situation #5 - The “Forgotten” RV

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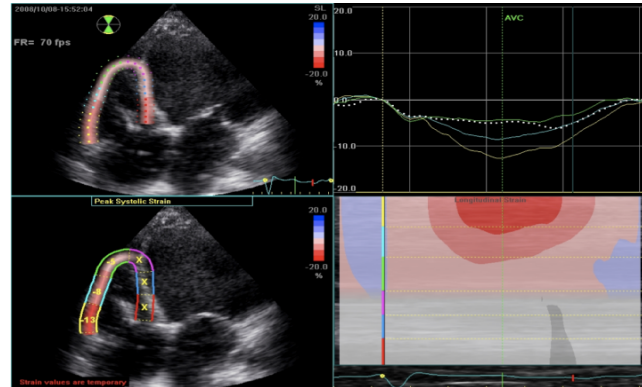
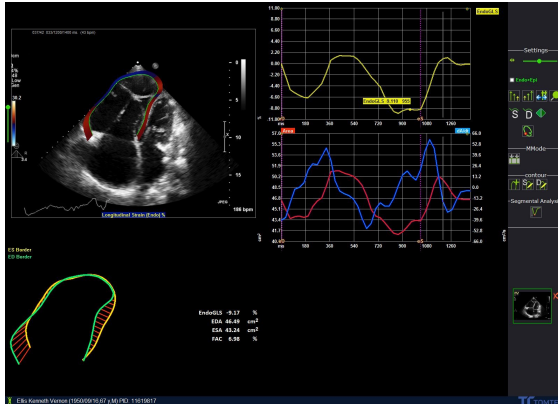


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## RV Strain



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## Why is RV Strain Useful *A Brief Literature Review*

- Has correlated with BNP, 6MWT, and hemodynamic data (Park et al. Korean Circ J 2015;45(5):398-407)
- Survival has correlated with RV strain values. One study of 576 patients showed that mortality increased 1.46 fold for each drop in RV strain by 6.7% (Fine et al, Circ Card Imaging 2013)
- RV strain was lower in patients with systemic sclerosis, serving as a potential predictor for development of PH (Mukherjee et al. Circ Card Imaging 2016)

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## Conclusions



1. **Strain should be considered an easy to use, reproducible imaging modality that detects subclinical myocardial changes**
2. **Strain is of particular prognostic and diagnostic use in most cardiovascular diseases, including the detection of CAD, and the assessment of LVH.**
3. **Strain may represent subclinical changes in ventricular decompensation in response to valvular heart disease**
4. **RV strain can be helpful in patients with or without pulmonary hypertension.**

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## Thank-you!



**Twitter: @drsabede**

**E-mail: Sabe.De@lhsc.on.ca**

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