

# Strain from A to Z: Technique, Analysis and Application

## Cases – Cardiac Amyloid & Strain

Julie Humphries

Acknowledgement Dr B Fitzgerald

1

### Previously with AL amyloidosis

- Untreated median survival previously documented at 12 months
- With the development of cardiomyopathy, the survival drops to 5 months
- Standard chemotherapy had no impact on survival

Falk RH, et al. N Engl J Med. 1997

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- High dose chemotherapy and peripheral blood stem cell transplantation (PBSCT) have been shown to dramatically improve survival with haematologic remission documented
- Overall median survival was said to improve to 48 months

Kyle RA. Br J Haematol. 2001  
Gertz MA, et al, Bone Marrow Transplant. 2000

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- In the late 1990s the Wesley Hospital began PBSCT for amyloid patients
- >400 patients with AL amyloidosis and or multiple myeloma treated
- 39 patients out this group have been identified with cardiac AL amyloidosis

4

## 4 groups based on prognosis:



### Group 1

- Too sick for PBSCT and die within 12 months of diagnosis

### Group 2

- Complete PBSCT, but do not show cardiac regression
- Survive less than 5 years from diagnosis

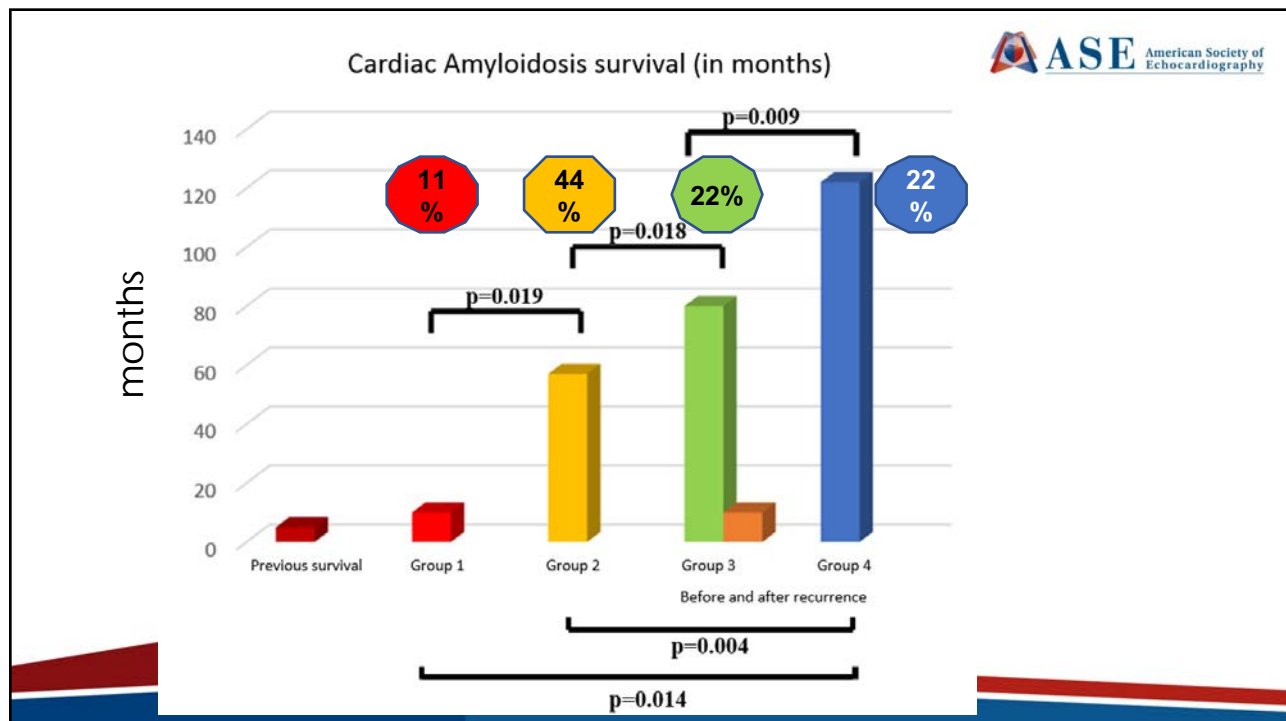
### Group 3

- Achieve haematologic remission and some cardiac regression
- Unfortunately develop disease recurrence (mean 6.5 years)
- Rapid progression with subsequent survival of 9 months

### Group 4

- Achieve prolonged and lasting survival, with no recurrence of disease (current mean survival > 9 years after diagnosis)

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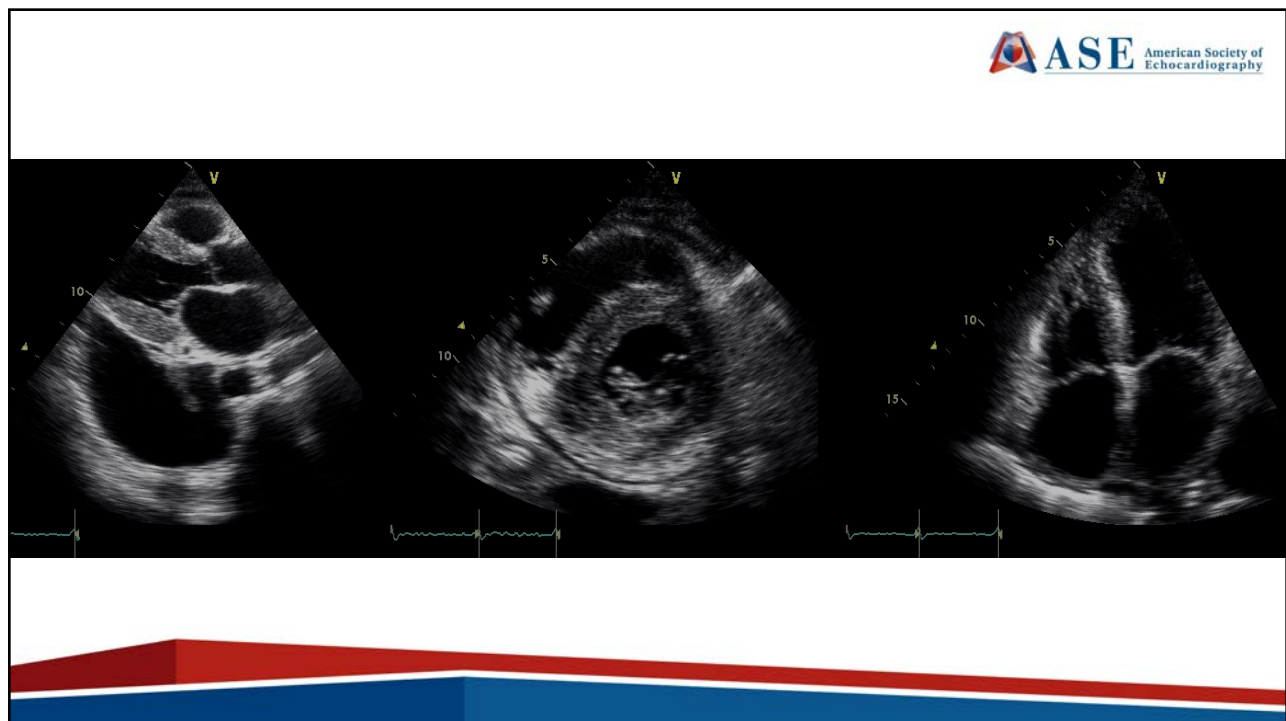
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## Case

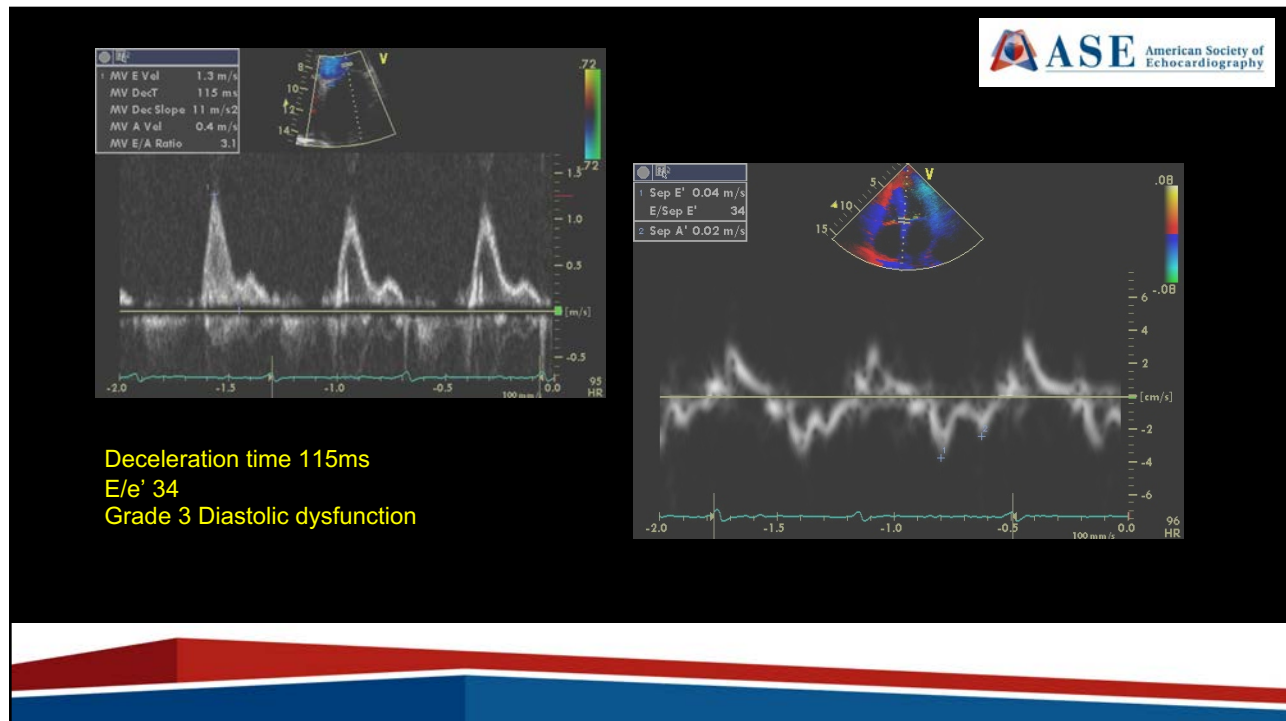


- 56F
- 12 month history of edema
- 3-4 month history of SOB/OE
- Outside TTE – “some diastolic dysfunction” only
- Referred to another cardiologist for 2<sup>nd</sup> opinion
  - Repeat TTE “suggestive of cardiac amyloidosis”
- Referred to The Wesley Hospital

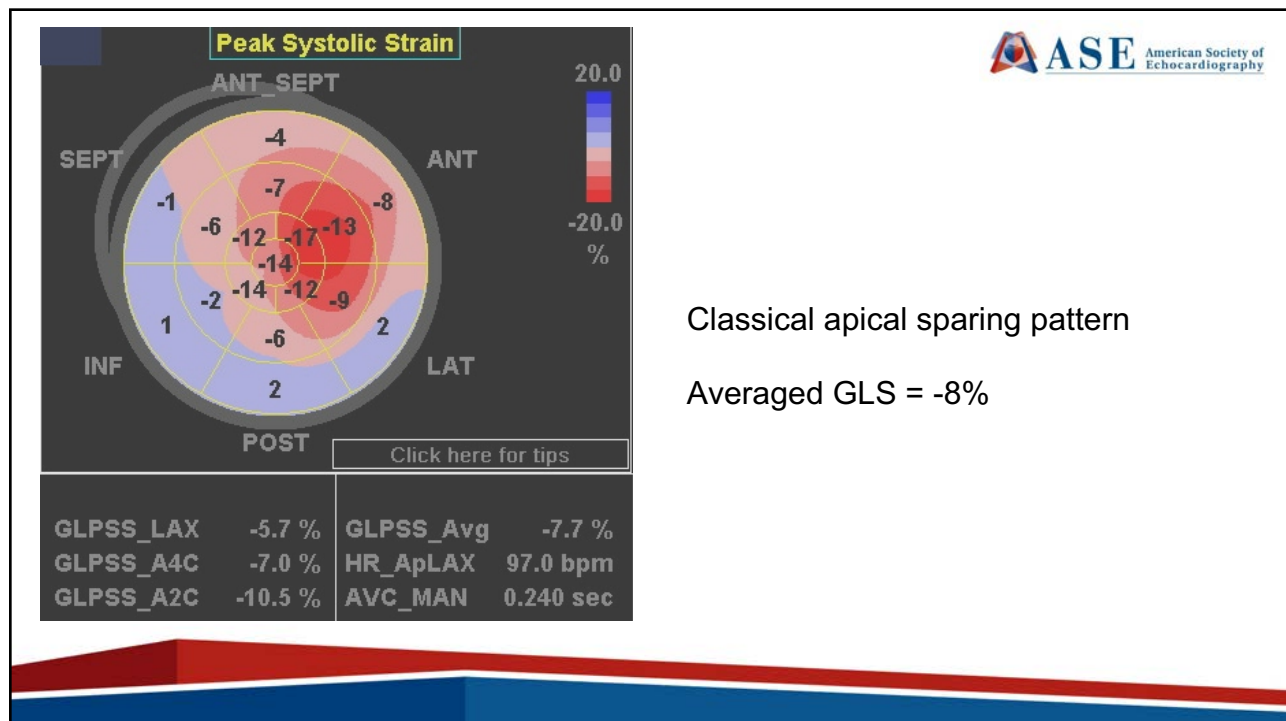
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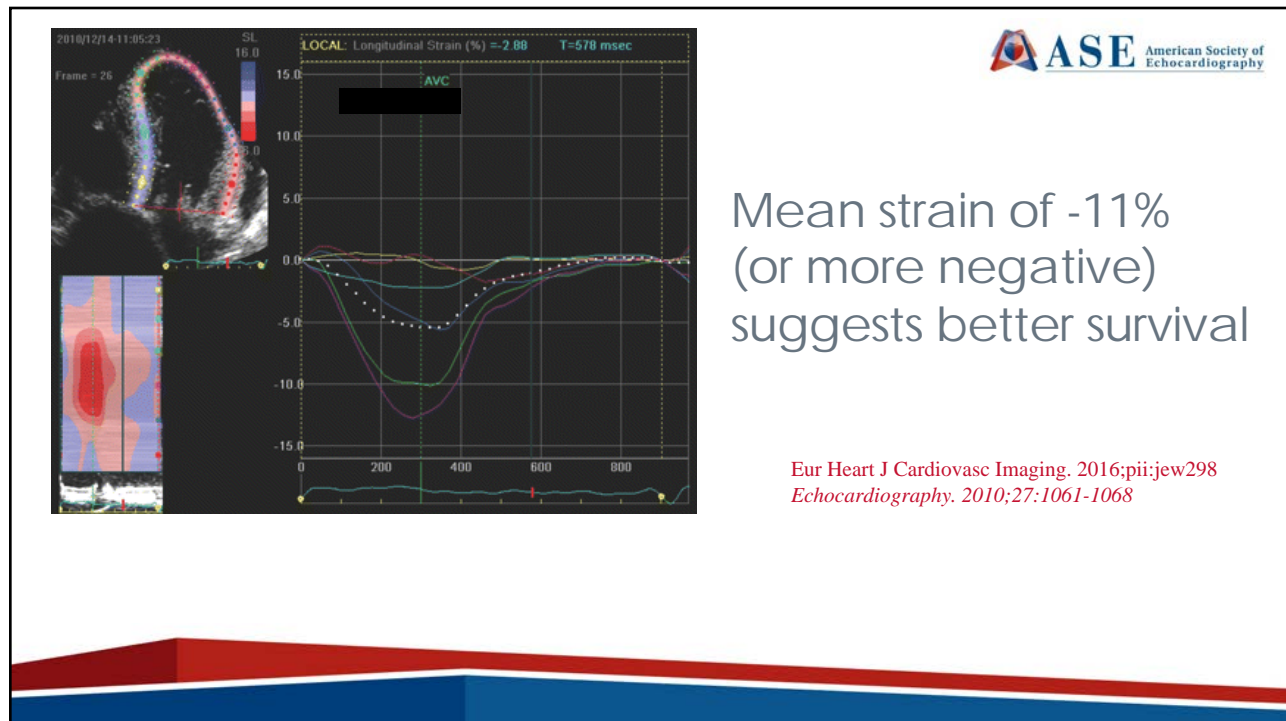
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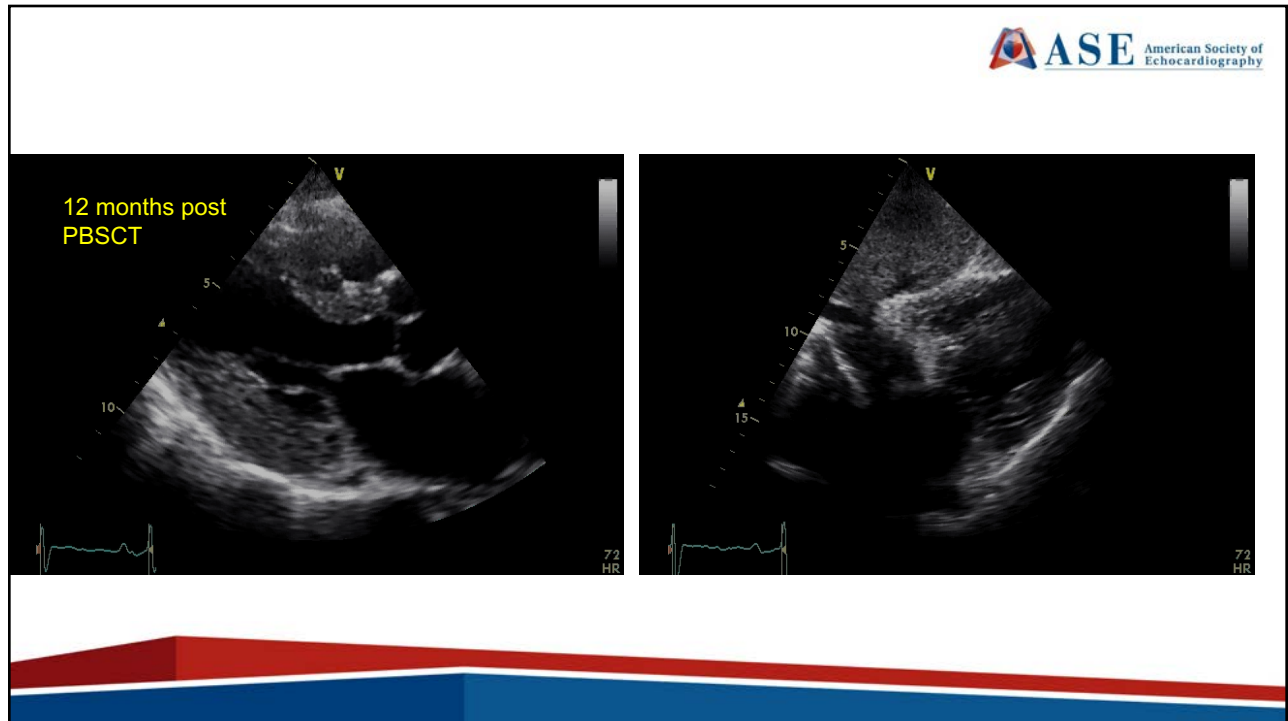


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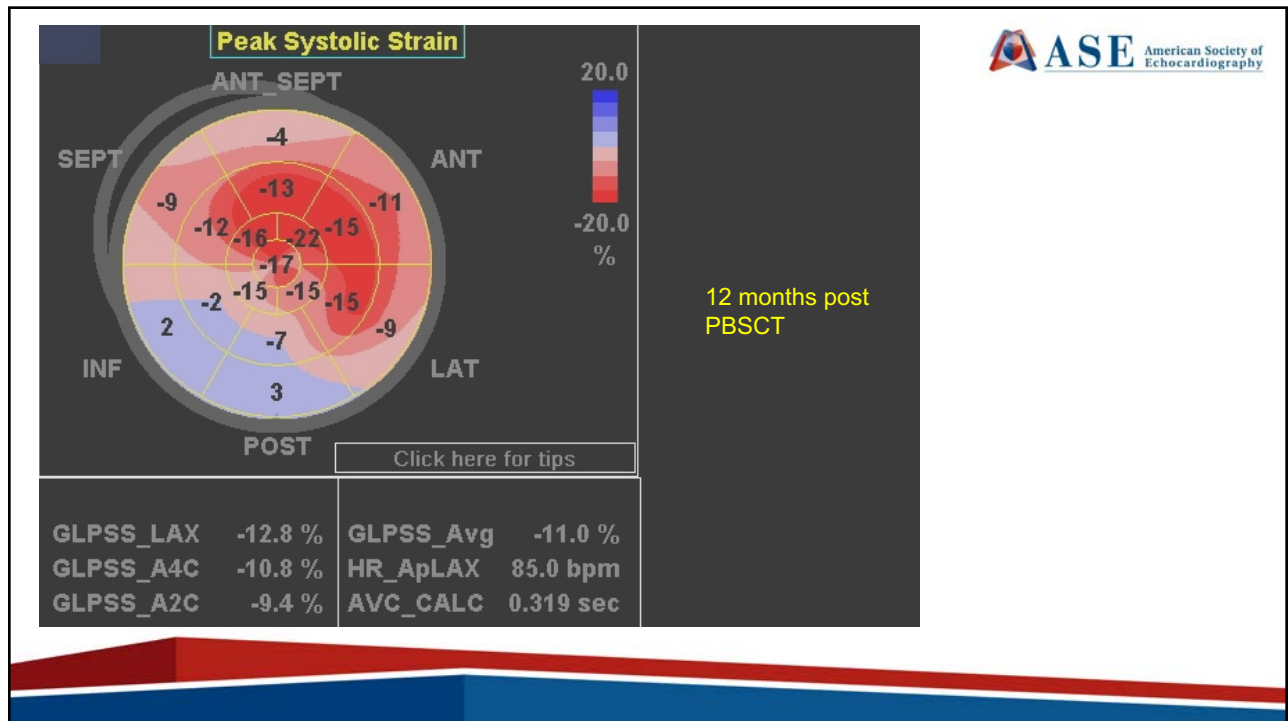
## Case

- Subsequent work up confirmed that she had biopsy proven multiple myeloma with AL amyloidosis
- PBSCT 2014
- Difficult clinical course through the next 6 months, with malaise, nausea and vomiting, fluid overload, hypotension, serositis, hyponatraemia, and renal impairment
- Steady recovery after that

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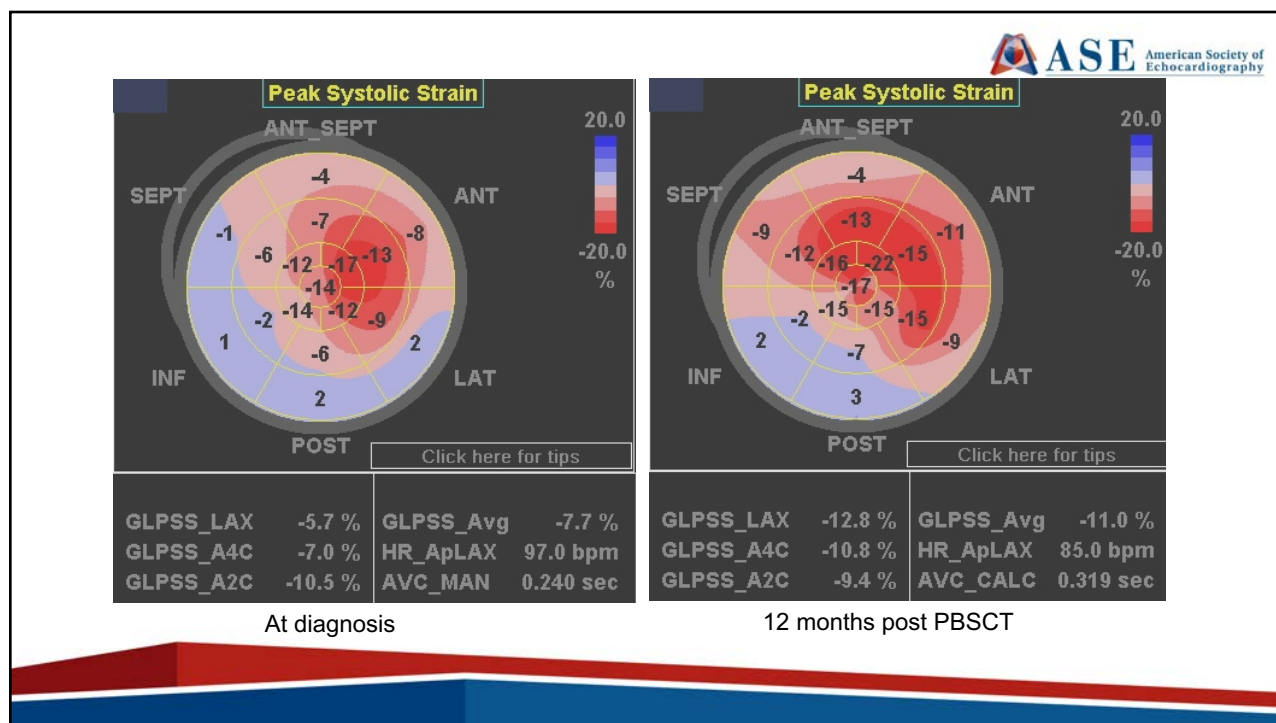


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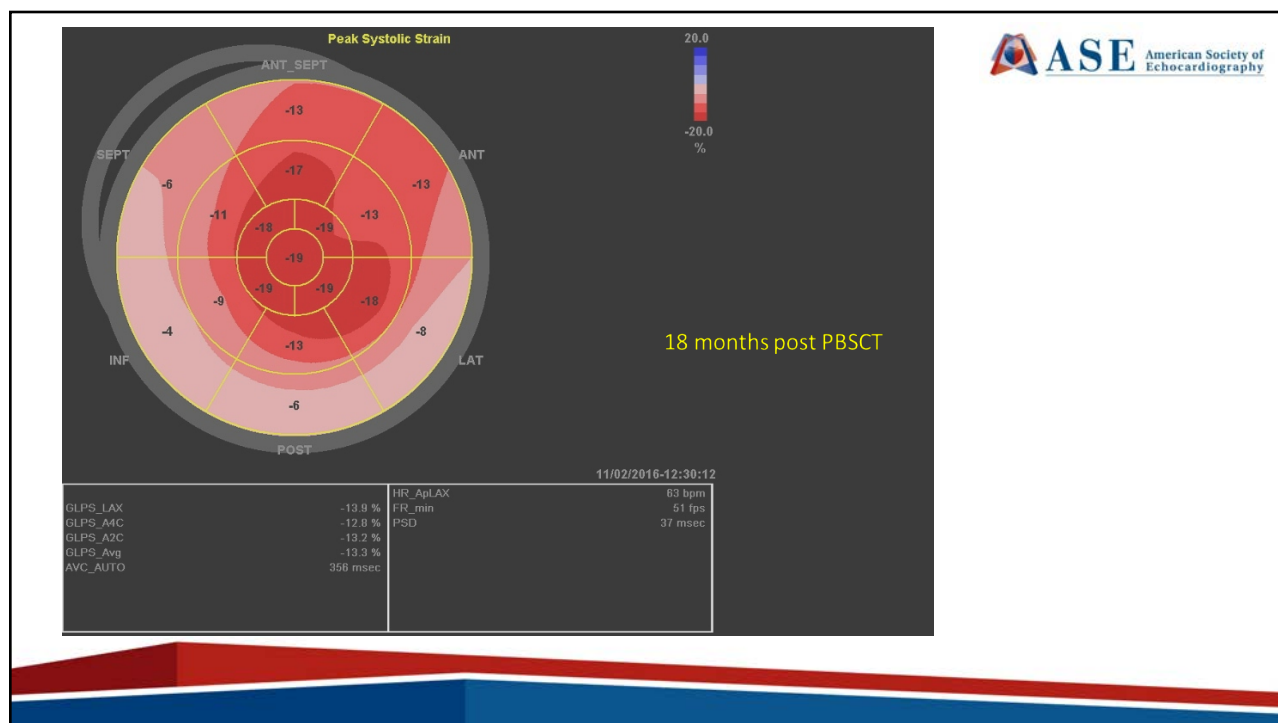


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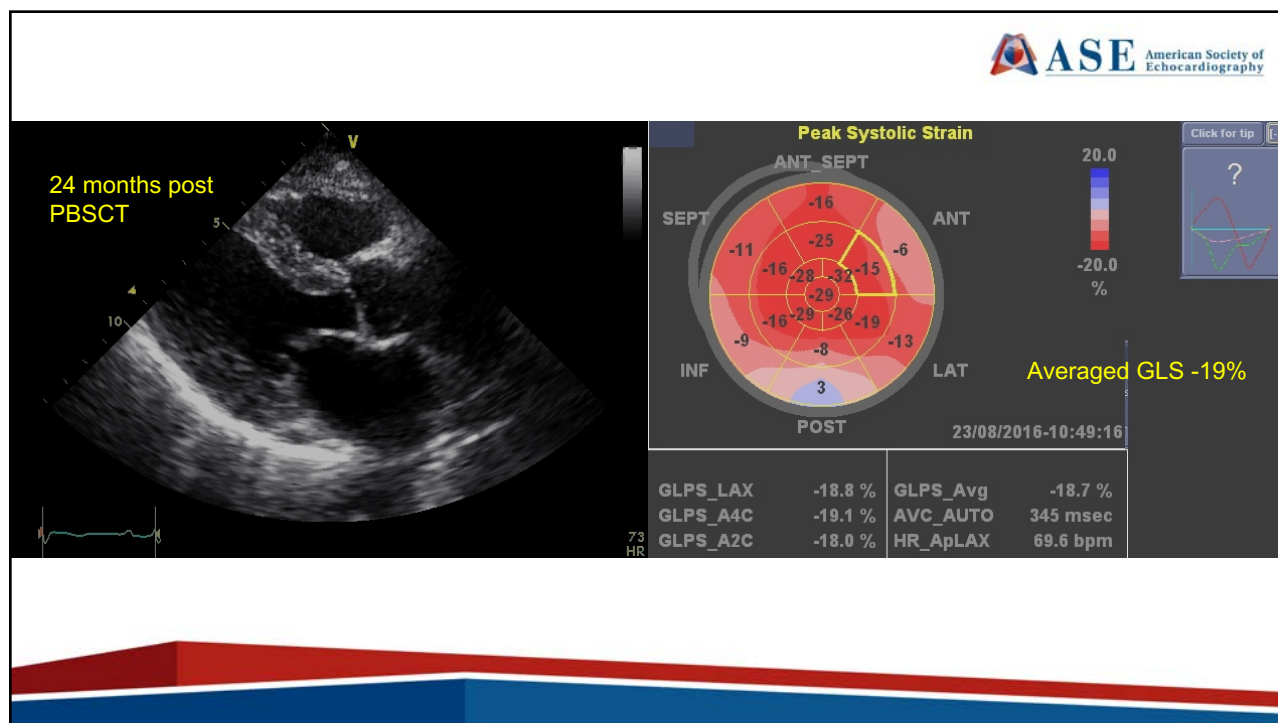


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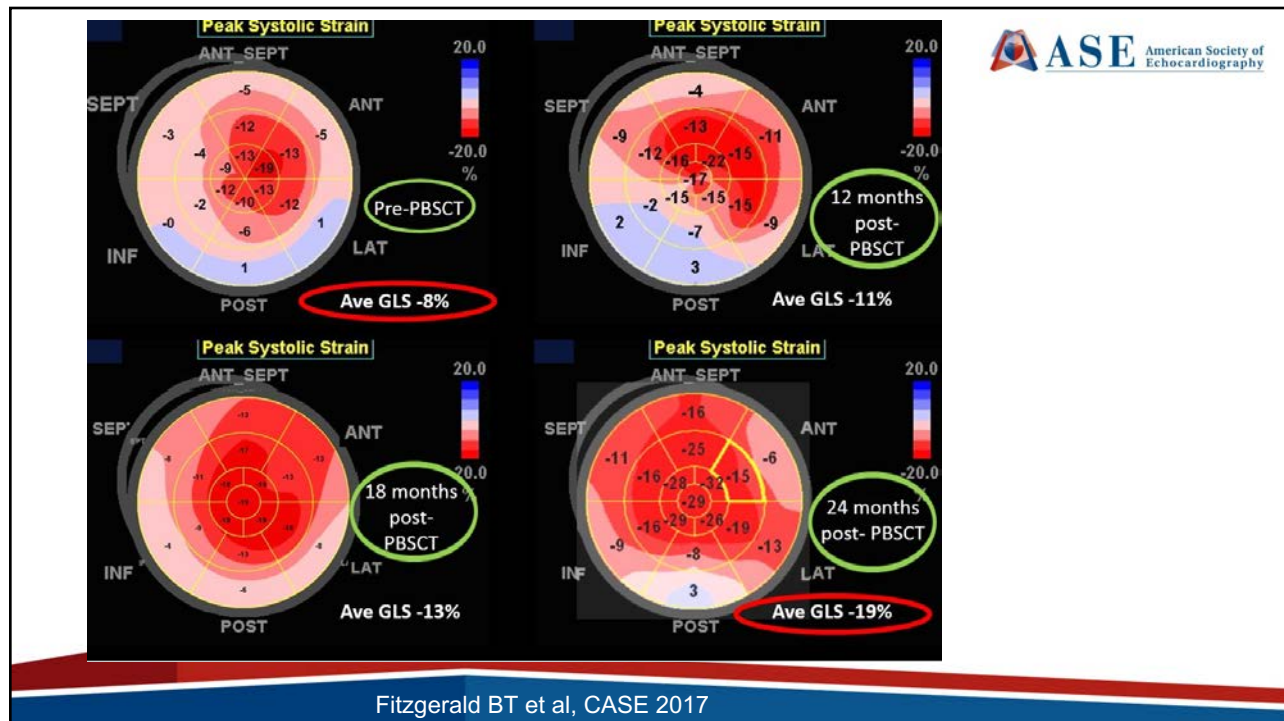




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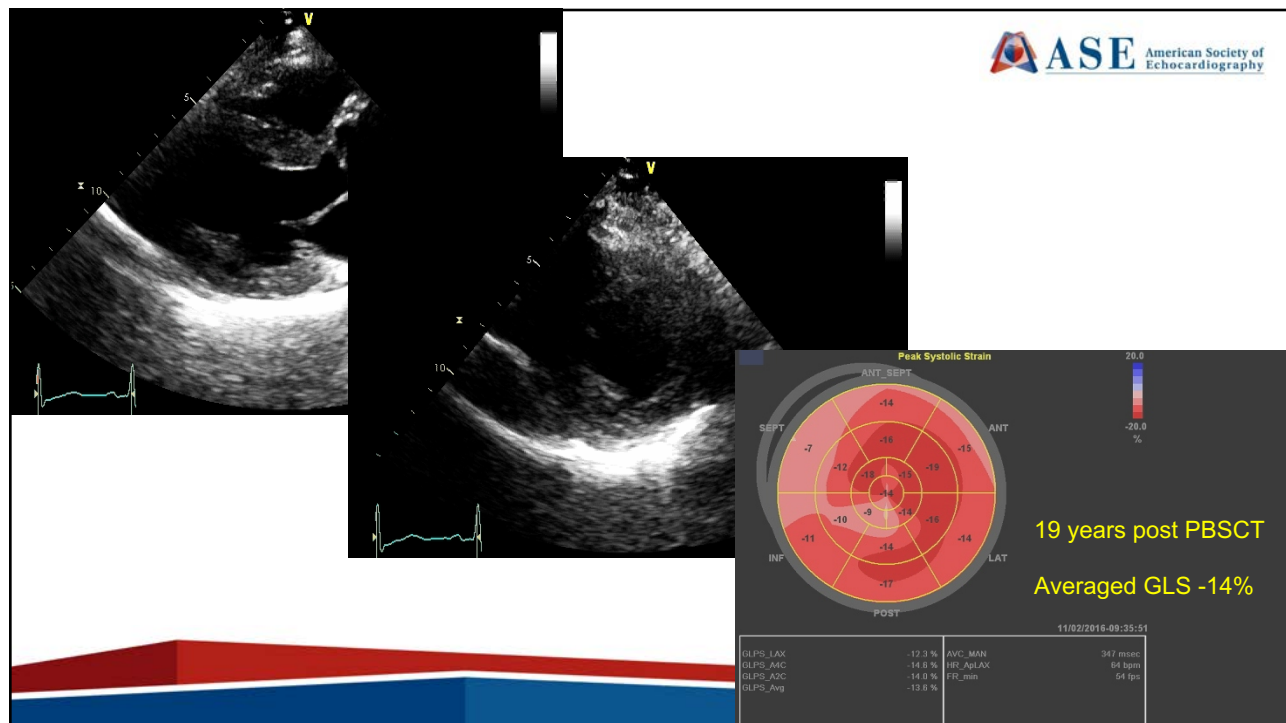


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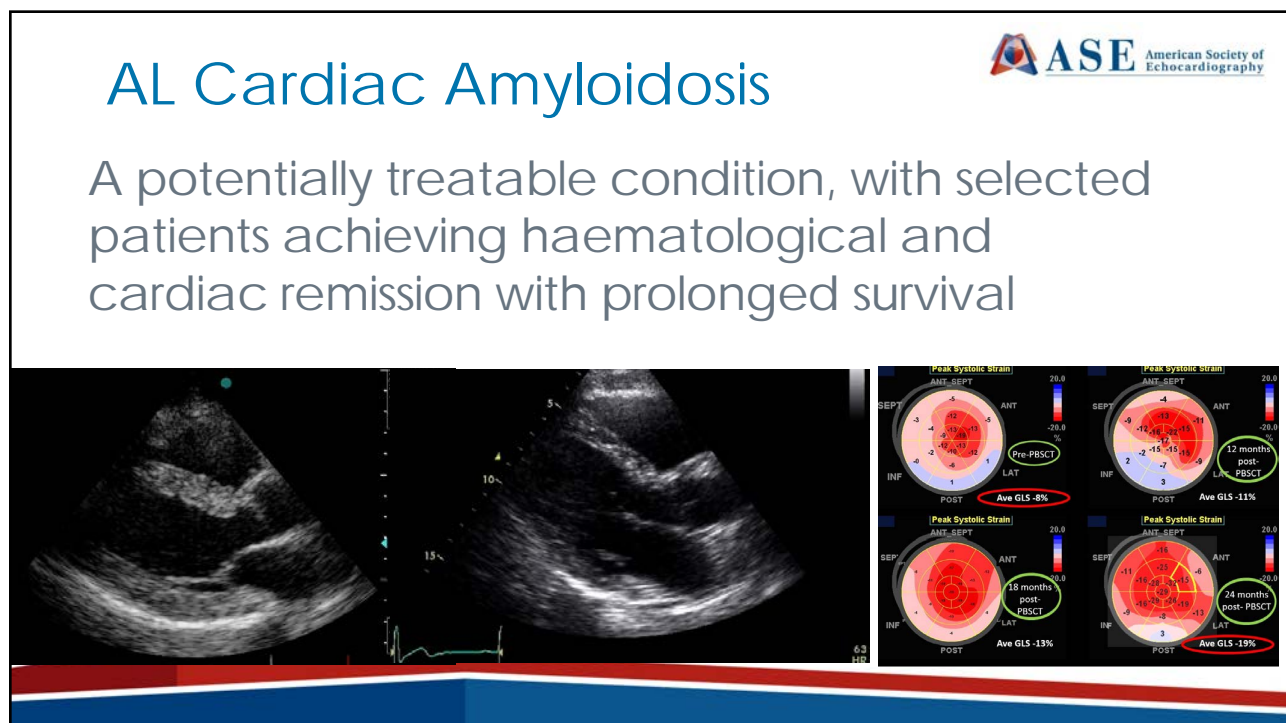
## Case

- 41F
- 1998 Multiple myeloma and AL amyloidosis
- BMT 1999
- 20 years since diagnosis & 19 years post PBSCT
- Well, no symptoms
- No recurrence of haematological or cardiac processes

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21



22

# Strain from A to Z: Technique, Analysis and Application

## RV Strain – The Basics

Julie Humphries

1

## Key Measurements

- ✓ TAPSE
- ✓ RV Annular TDI
- ✓ RV IMP (Tei)<sup>TE ordered</sup>
- ✓ RV FAC
- ✓ RV Strain

2

# The Facts



RV has many structural differences to the LV and as a result has been poorly appreciated and understood, with the primary focus of cardiovascular function on the LV

RV function is an important prognostic indicator in many CV disease states and newer indices are providing insights into disease progression and management

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# The Facts



RV dysfunction is **common** and is generally underreported

RV systolic & diastolic function is easily measured

Most haemodynamic information is readily obtained

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# The Facts

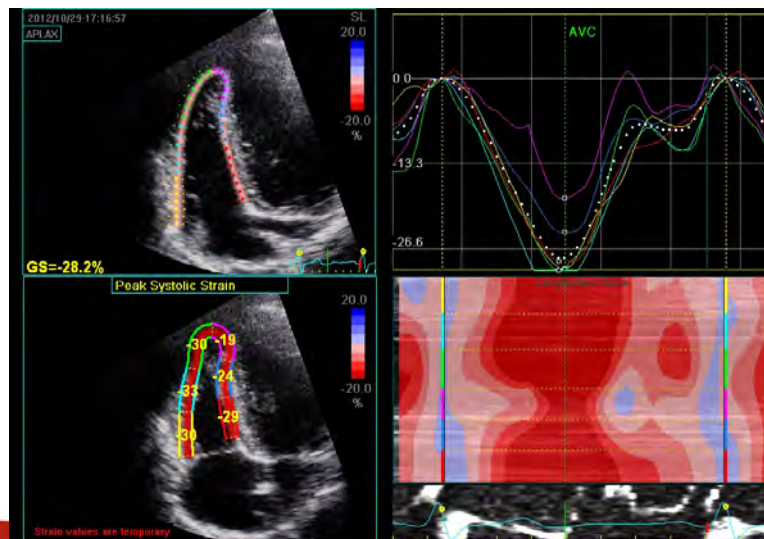


*Visual RV function assessment is  
not accurate or reliable*

Understanding the right ventricle lends  
great insight into management of  
disease and patient prognosis

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## RV Strain



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# What about RV Strain?



## Editorial

### Right Ventricular Strain in Pulmonary Hypertension Flavor du Jour or Enduring Prognostic Index?

Circ Cardiovasc Imaging, September 2013

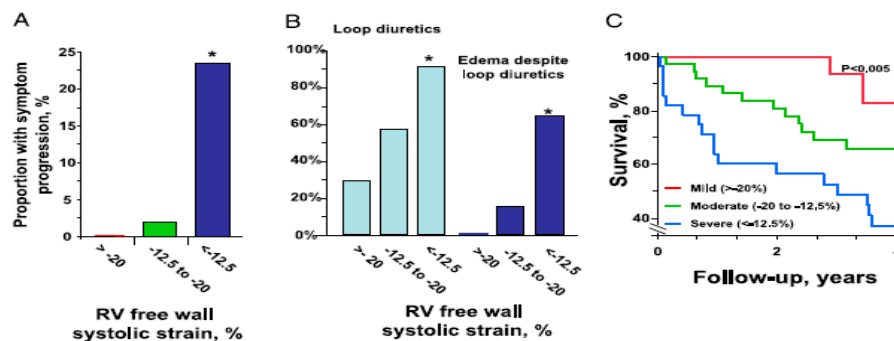
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### Right Ventricular Strain for Prediction of Survival in Patients With Pulmonary Arterial Hypertension



Arun Sachdev, MD; Hector R. Villarraga, MD; Robert P. Frantz, MD;  
Michael D. McGoon, MD, FCCP; Ju-Feng Hsiao, MD; Joseph F. Maalouf, MD;  
Naser M. Ammash, MD; Robert B. McCully, MD; Fletcher A. Miller, MD;  
Patricia A. Pellikka, MD; Jae K. Oh, MD; and Garvan C. Kane, MD, PhD, FCCP

- N=80 PH patients, retrospective VVI strain



Sachdev, et al. Chest 2011;139:1299-1309

8



## Original Article

### Outcome Prediction by Quantitative Right Ventricular Function Assessment in 575 Subjects Evaluated for Pulmonary Hypertension

Nowell M. Fine, MD; Libo Chen, MD; Paul M. Bastiansen, RDCS; Robert P. Frantz, MD; Patricia A. Pellikka, MD; Jae K. Oh, MD; Garvan C. Kane, MD, PhD

over a median of 16.5 (interquartile range, 7.6–20.0) months. There were 406 patients with PH (71%) (74% group 1, 14%

**Conclusions** – Quantitative assessment of RV free-wall systolic strain is feasible and is a powerful predictor of the clinical outcome of patients with known or suspected PH.

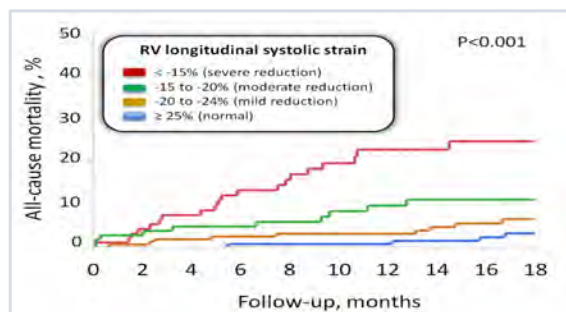
*Conclusions*—Quantitative assessment of RV free-wall systolic strain is feasible and is a powerful predictor of the clinical outcome of patients with known or suspected PH. (*Circ Cardiovasc Imaging*. 2013;6:711-721.)

Fine et al, *Circ Cardiovasc Imaging*, 2013;6:711-721

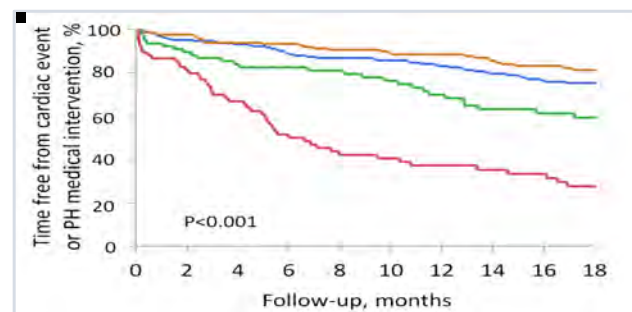
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## RV Strain Predicts Outcomes in PH

ASE American Society of Echocardiography



**All-cause mortality**



**Time free of cardiac events or PH medical intervention**

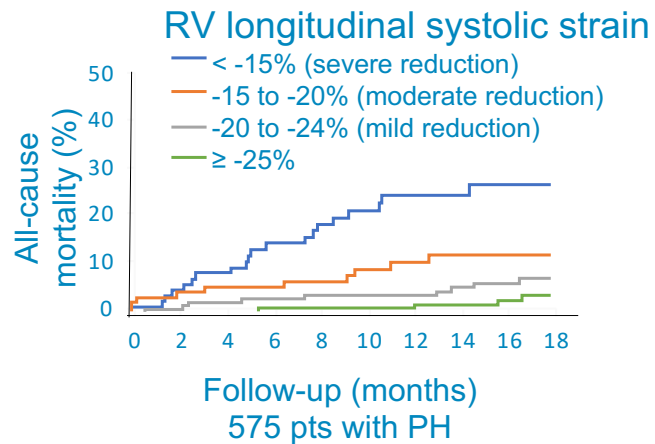
Fine NM et al *Circ Cardiovasc Imaging* 2013; 6: 711-21

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## RV Peak Systolic Strain outcome predictor in PH



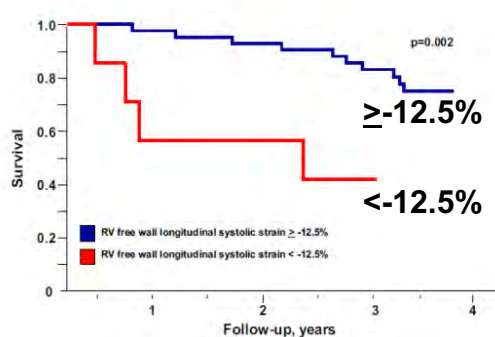
- Disease progression
- Right heart failure
- Mortality
- Newly diagnosed and following treatment



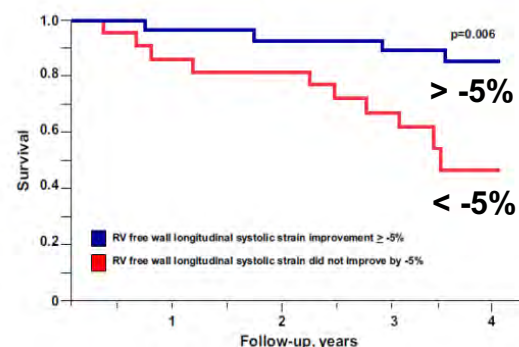
Fine NM et al Circ Cardiovasc Imaging 2013; 6: 711-21

11

## RV free wall strain in treated patients with PPH 50 patients – pre and 6/12 post PPH Rx



Free wall strain at f/up and prognosis



Improved free wall strain at f/up and prognosis  
Correlated with symptom improvement and BNP

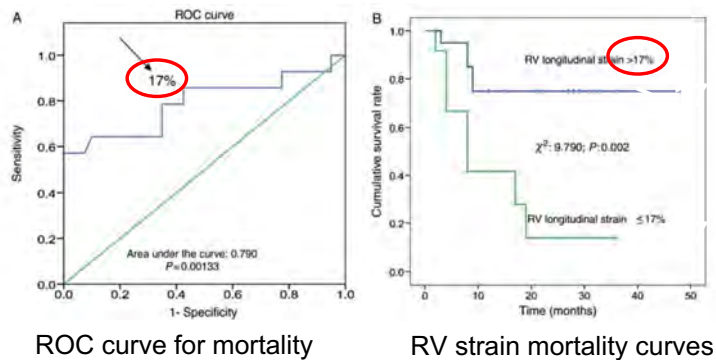
Hardegree EL, Kane GC et al Am J Cardiol 2013; 111: 143-148

12

## RV free wall strain in AL Amyloidosis

52 biopsy proven patients

19 months median f/up



RV free wall strain was only echocardiographic predictor of prognosis, superior to standard 2D, Doppler and TVI

RV dysfunction appears late in disease, but dramatically worsens prognosis

RV FW strain + BNP strongest predictors of death

Capelli F, Perfetto F et al Eur Heart J – CV Imaging 2012; 13: 416-22

13

## RV strain after Primary PCI for MI

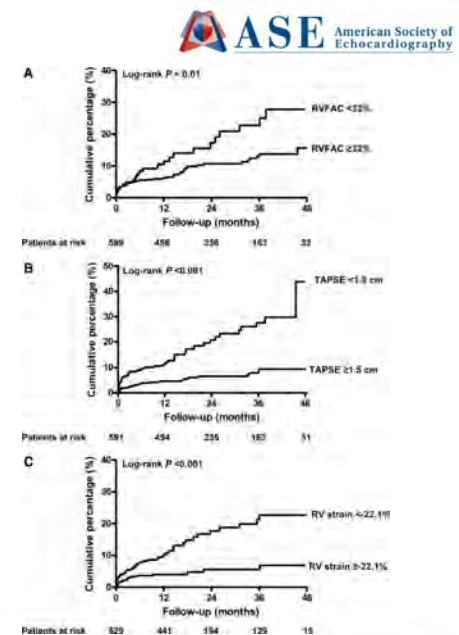
621 patients 2 years f/up

Echo within 48 hours of admission

End point - All cause mortality, reinfarction and hospitalisation for CCF

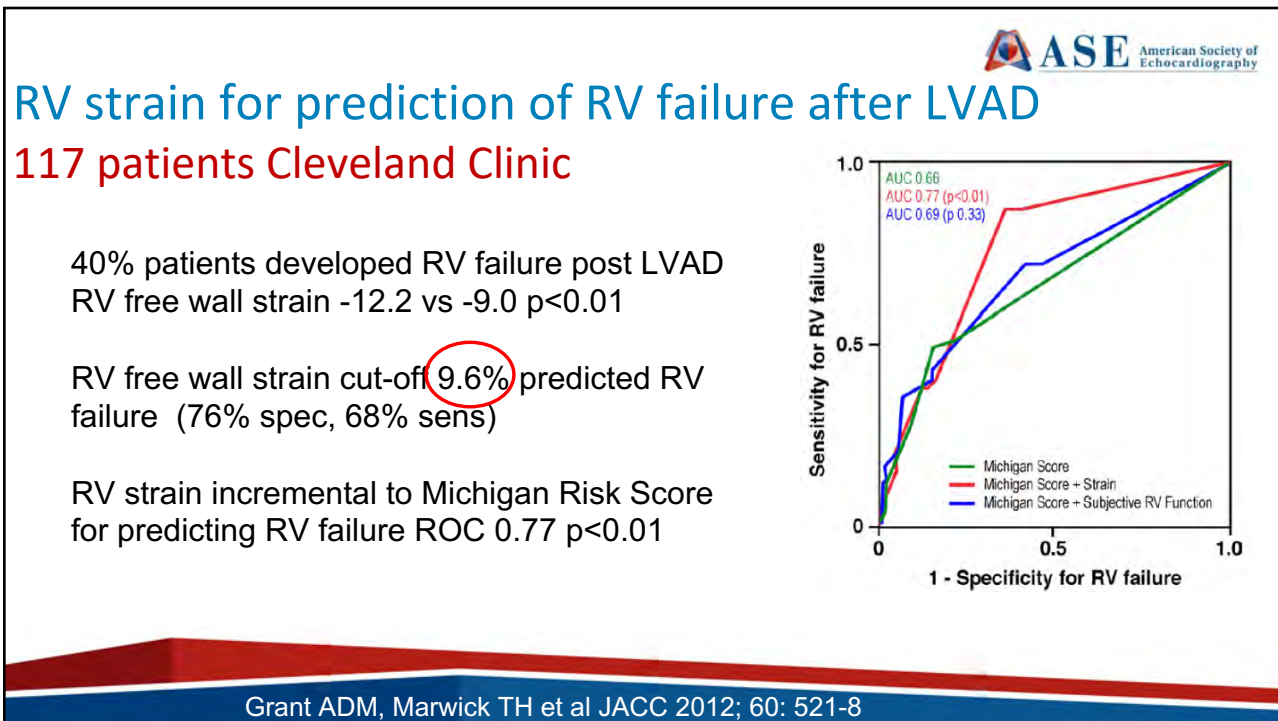
RVFAC (32%), TAPSE (1.5cm), RV strain (-22%) all univariate predictors of worse outcome

RV strain (-22%) provided incremental value to clinical information, infarct characteristics, LV function and RVFAC

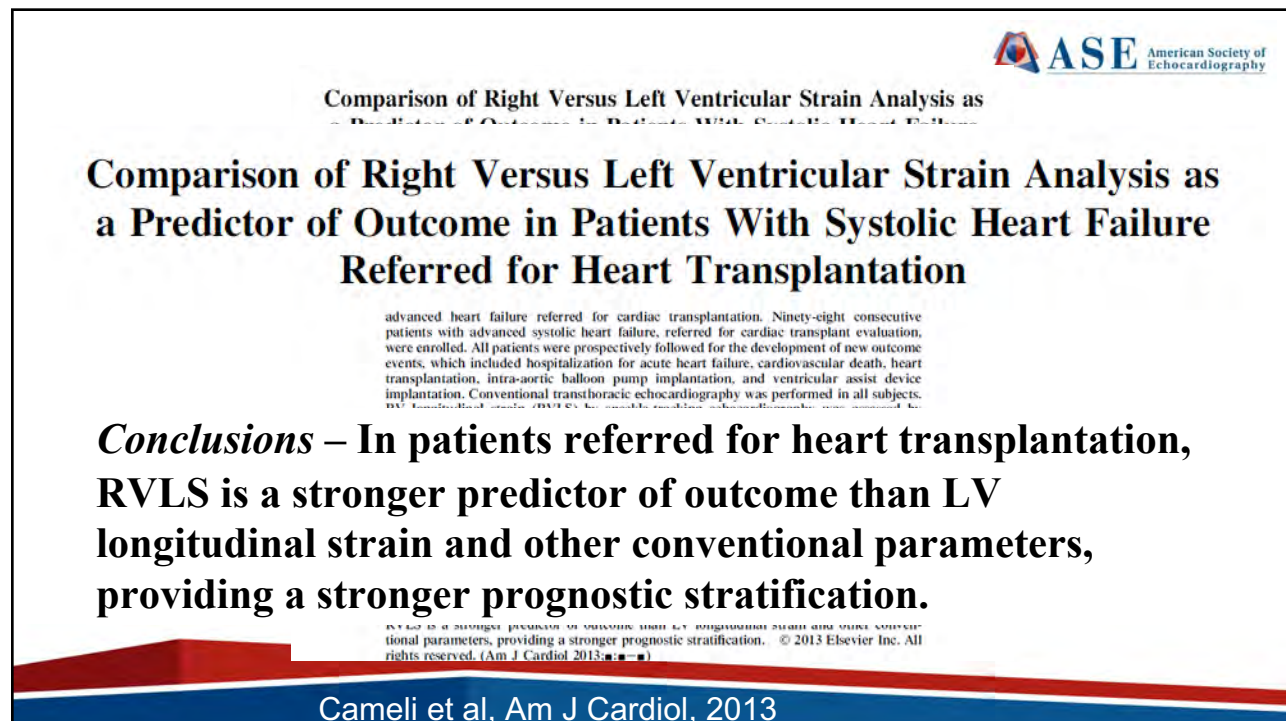


Antoni ML, Bax JJ et al Circ Cardiovasc Imaging 2010; 3: 264-71

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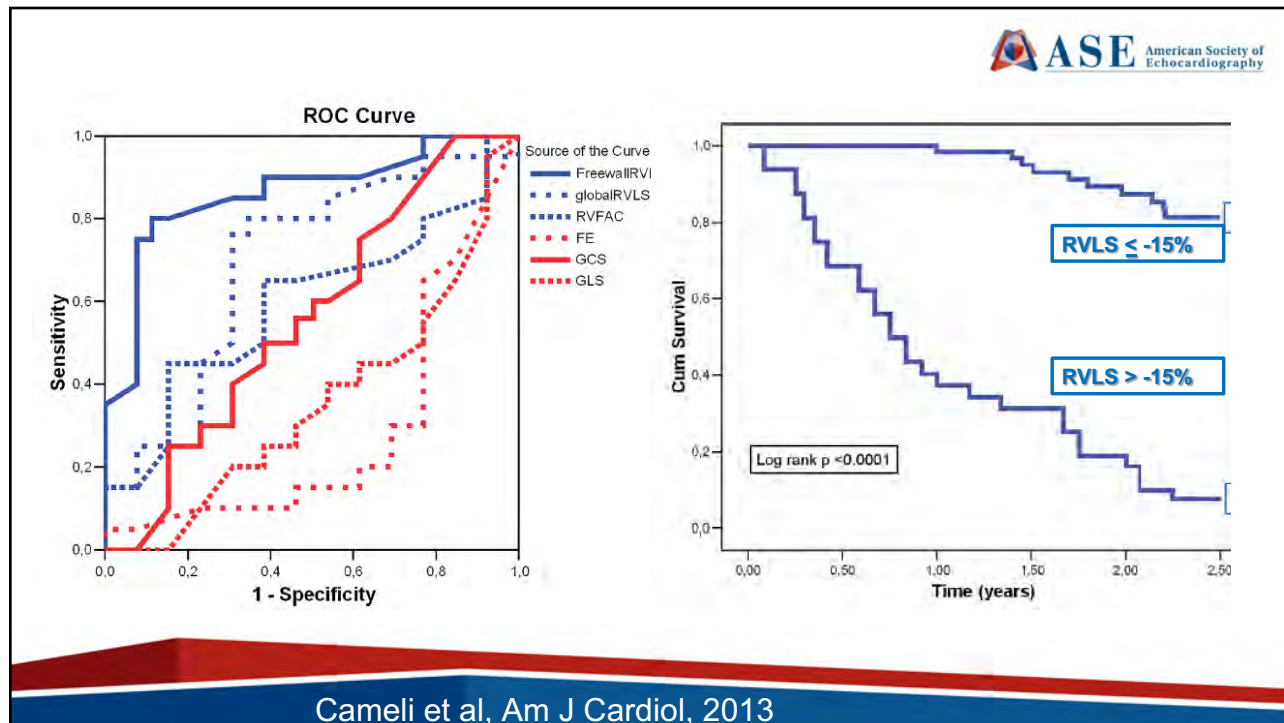


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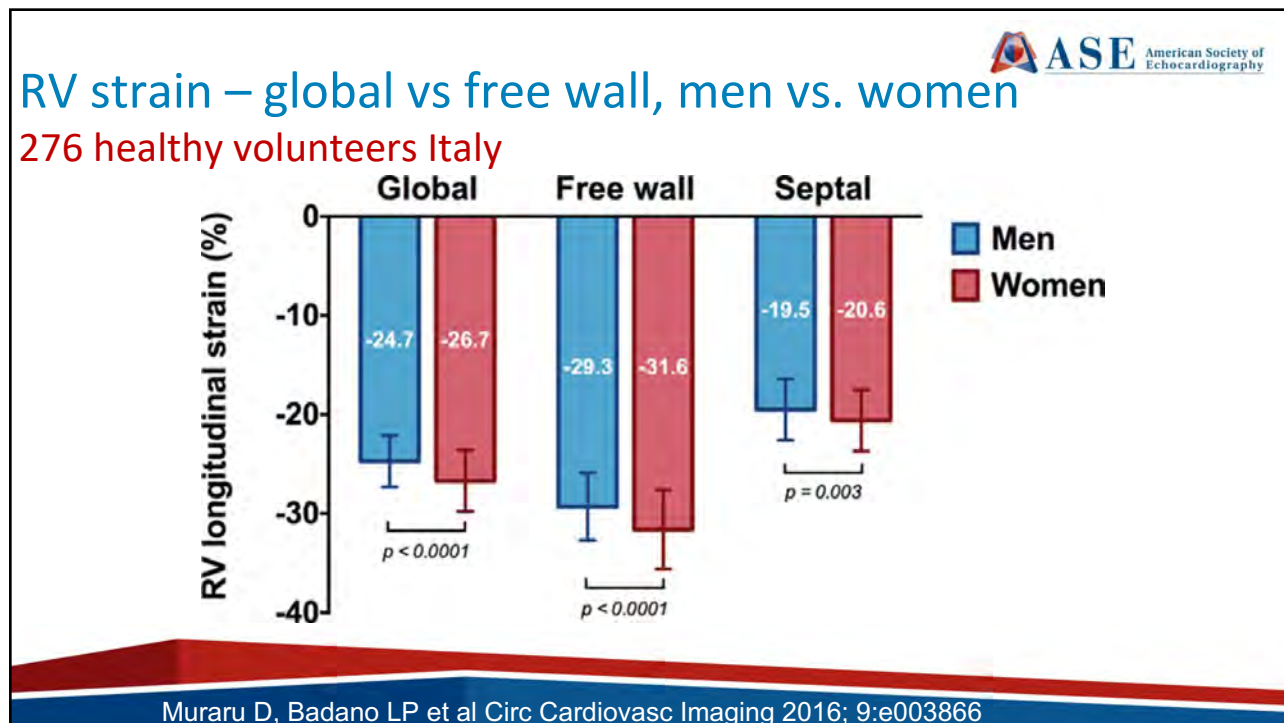


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## RV Strain – Technical Considerations

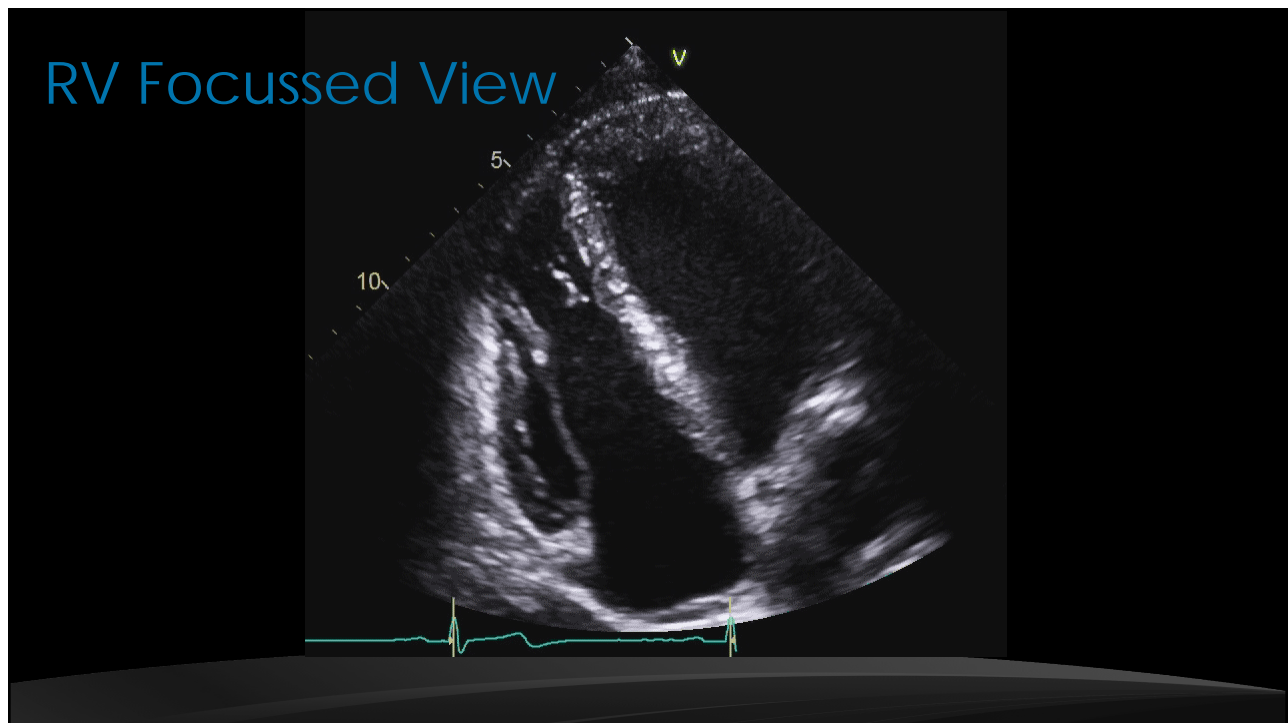


- ▶ RV focussed view – angle independent
- ▶ Frame rate >50 fps
- ▶ Free wall vs. global strain
- ▶ Region of Interest (ROI)
  - ▶ Composed of 3 concentric lines
    - Endocardial border
    - Epicardial border
    - Midmyocardial layer

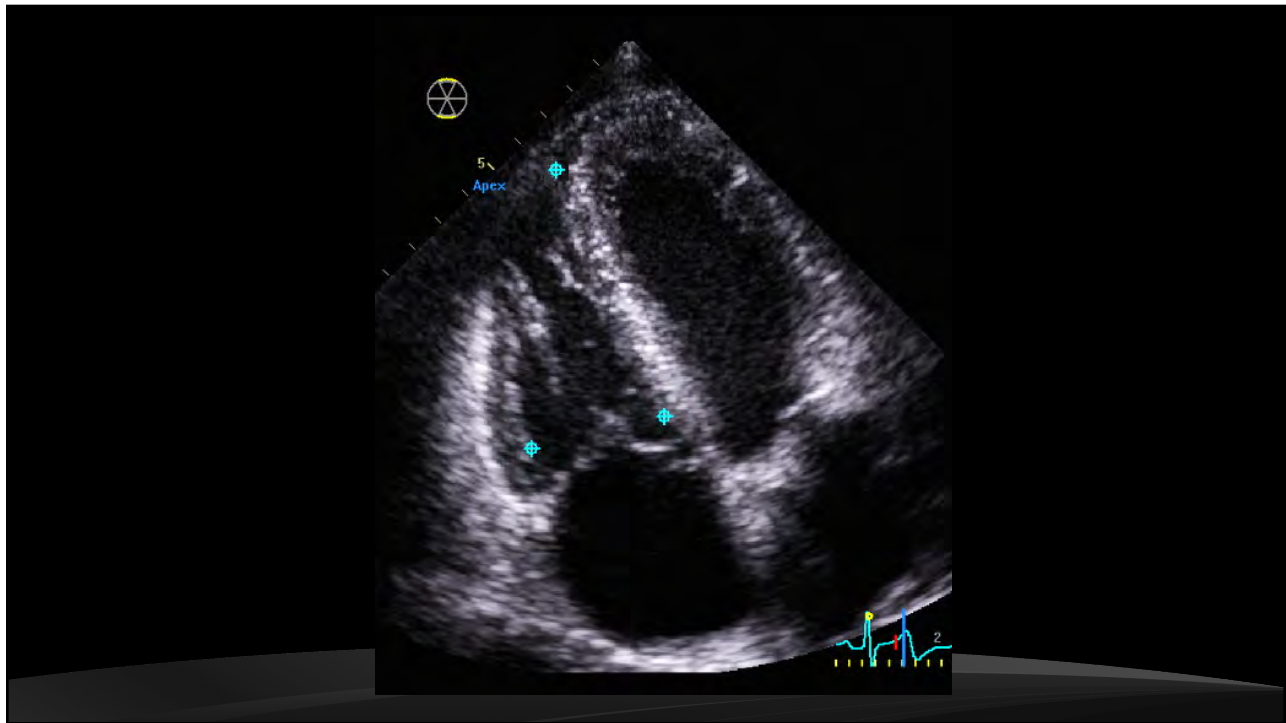


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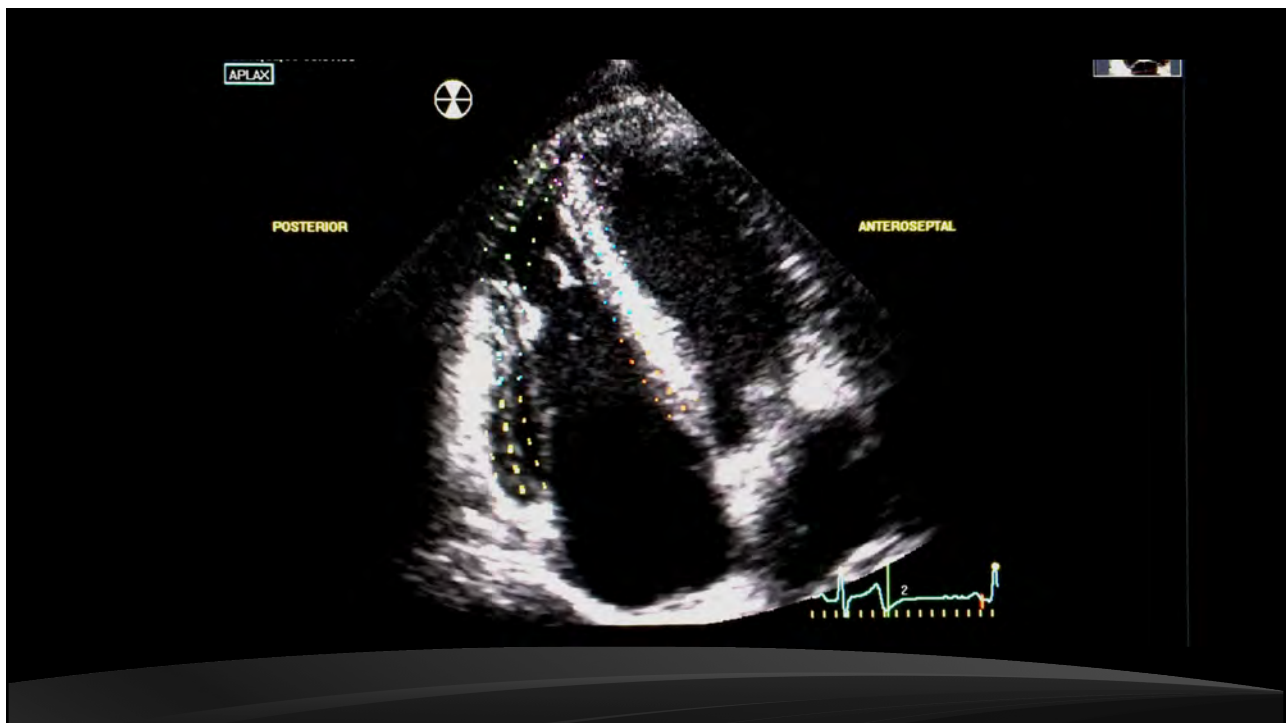
## RV Focussed View



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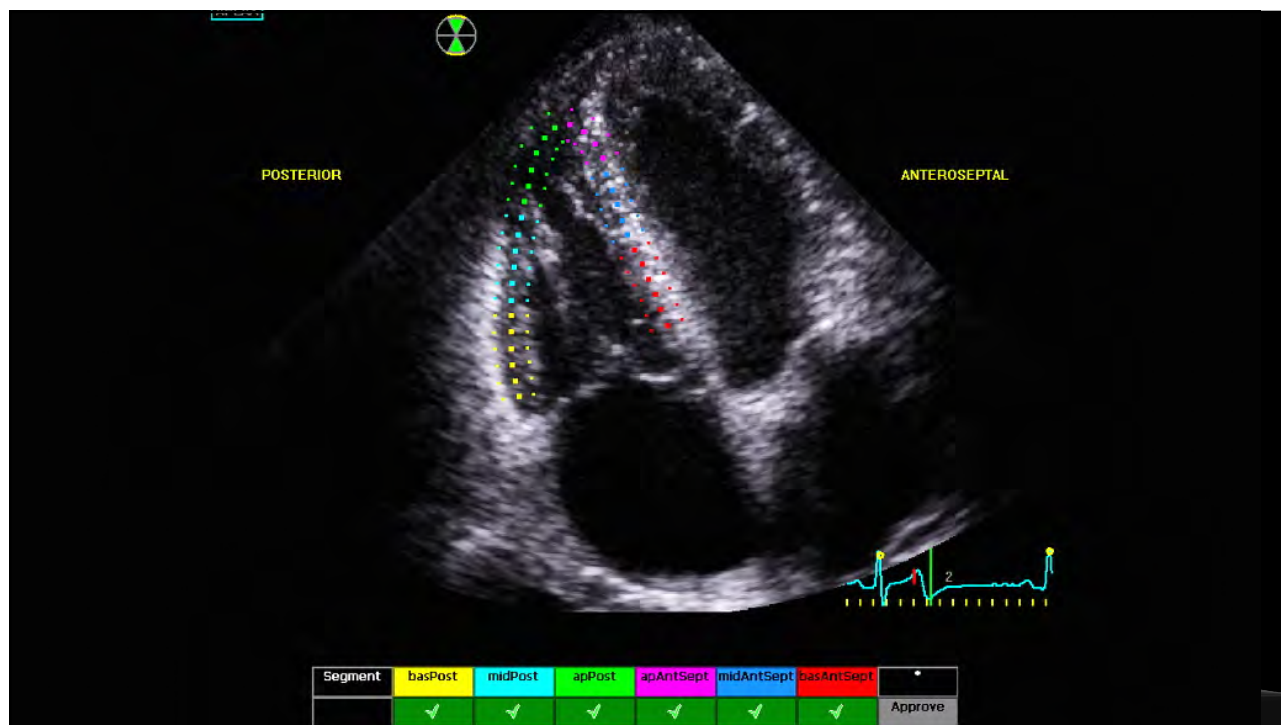


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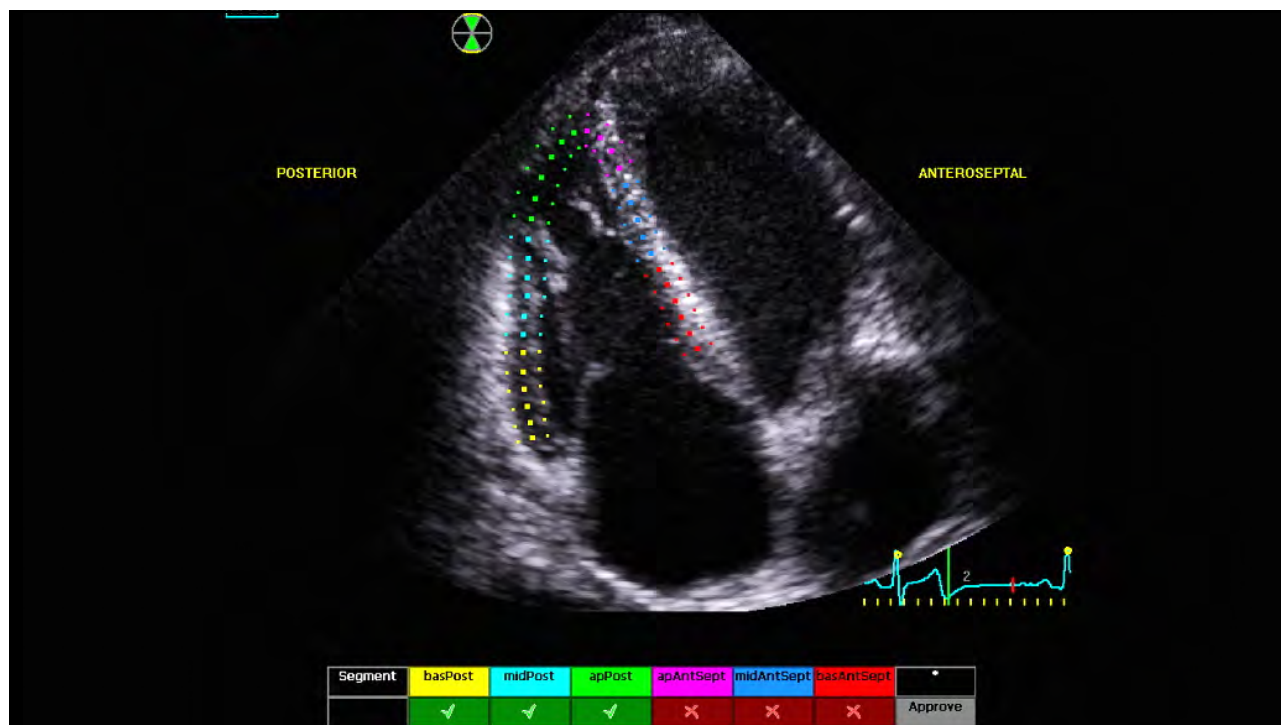


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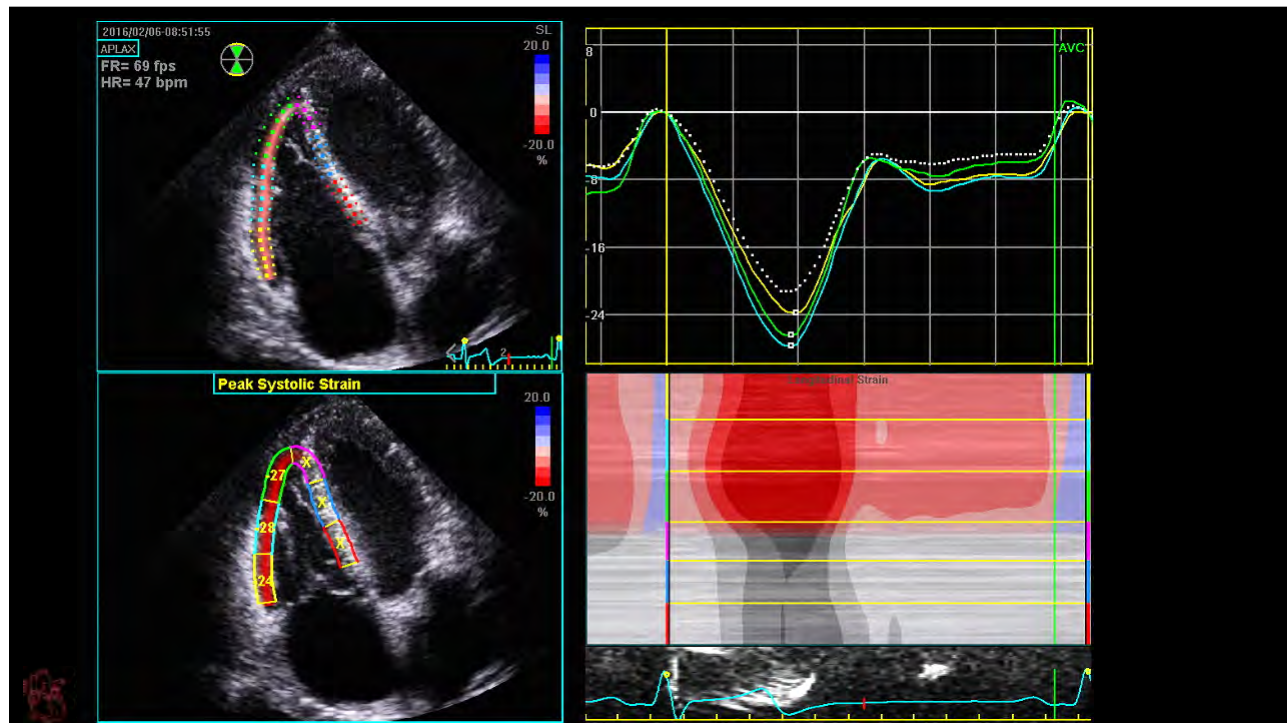




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## RV Strain



### Advantages

- May provide useful additional information in disease states to predict outcomes
- Can be performed on-line/off-line
- Less operator dependent

### Pitfalls

- Limited experience with use
- Time consuming
- Not part of routine clinical practice yet
- No “normal” ranges established

26

# Key Measurements

- ✓ TAPSE
- ✓ RV Annular TDI
- ✓ RV IMP (Tei)
- ✓ RV FAC
- ✓ RV Strain