

# Hypertensive heart disease and failure

Prof. Dr. Alan Fraser  
Cardiff University

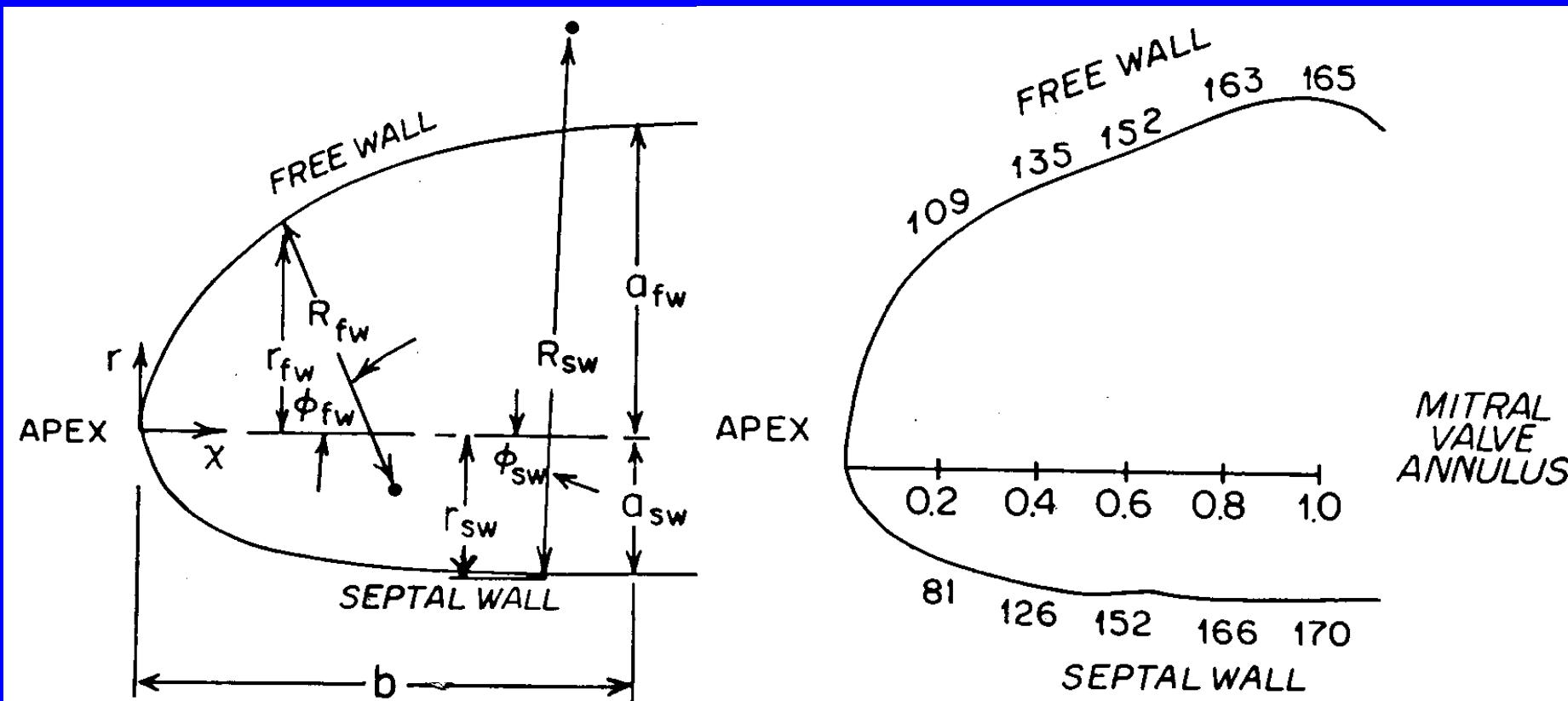
# The heart in hypertension

---

- Pathophysiology of LV adaptation
- Regional development of hypertrophy
- Stress testing
  - inducible outflow tract obstruction
  - diastolic stress testing
  - long-axis functional reserve

# Non-uniform systolic stress in LV wall

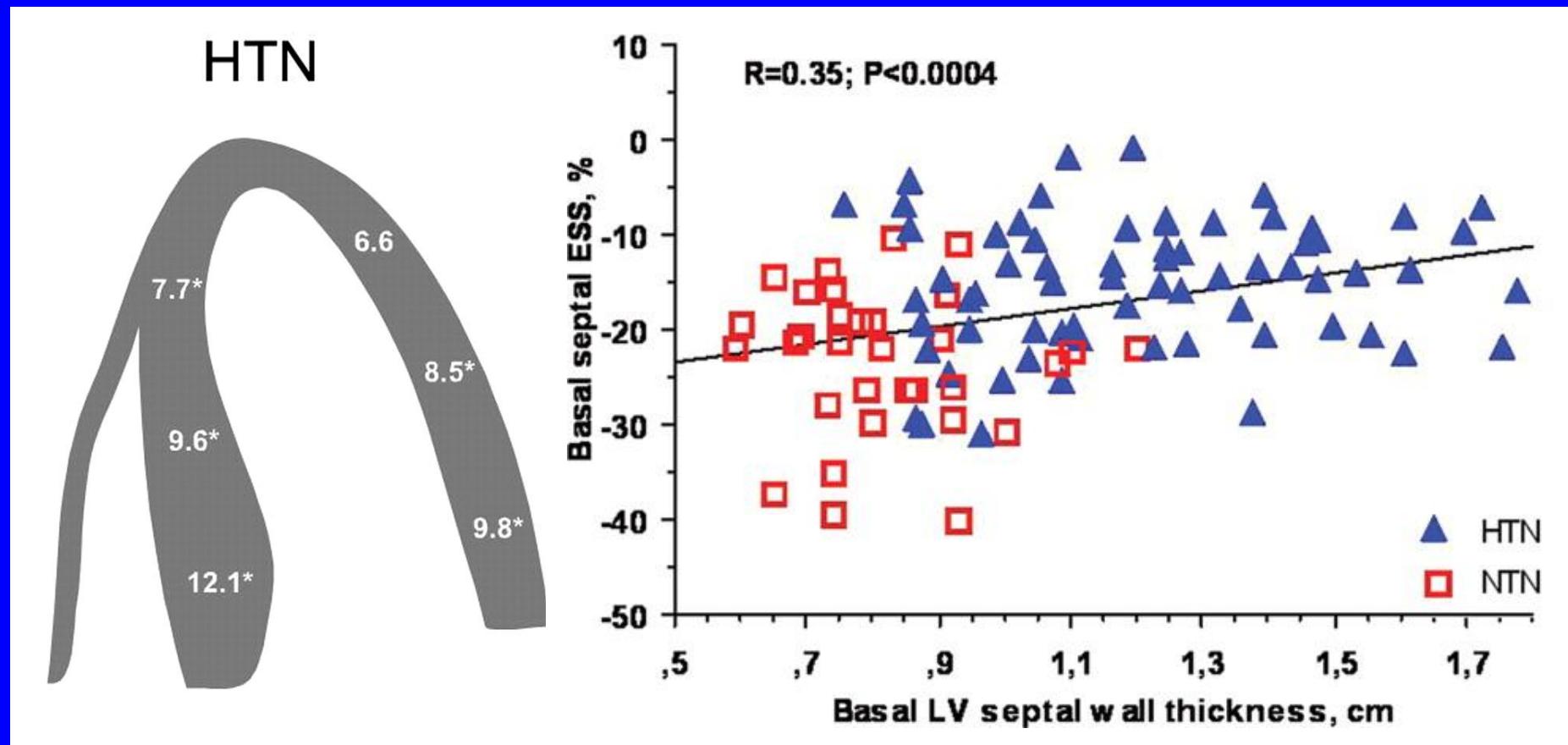
*Radius of curvature greater in septum*



Heng MK et al, Am Heart J 1985; 110: 84

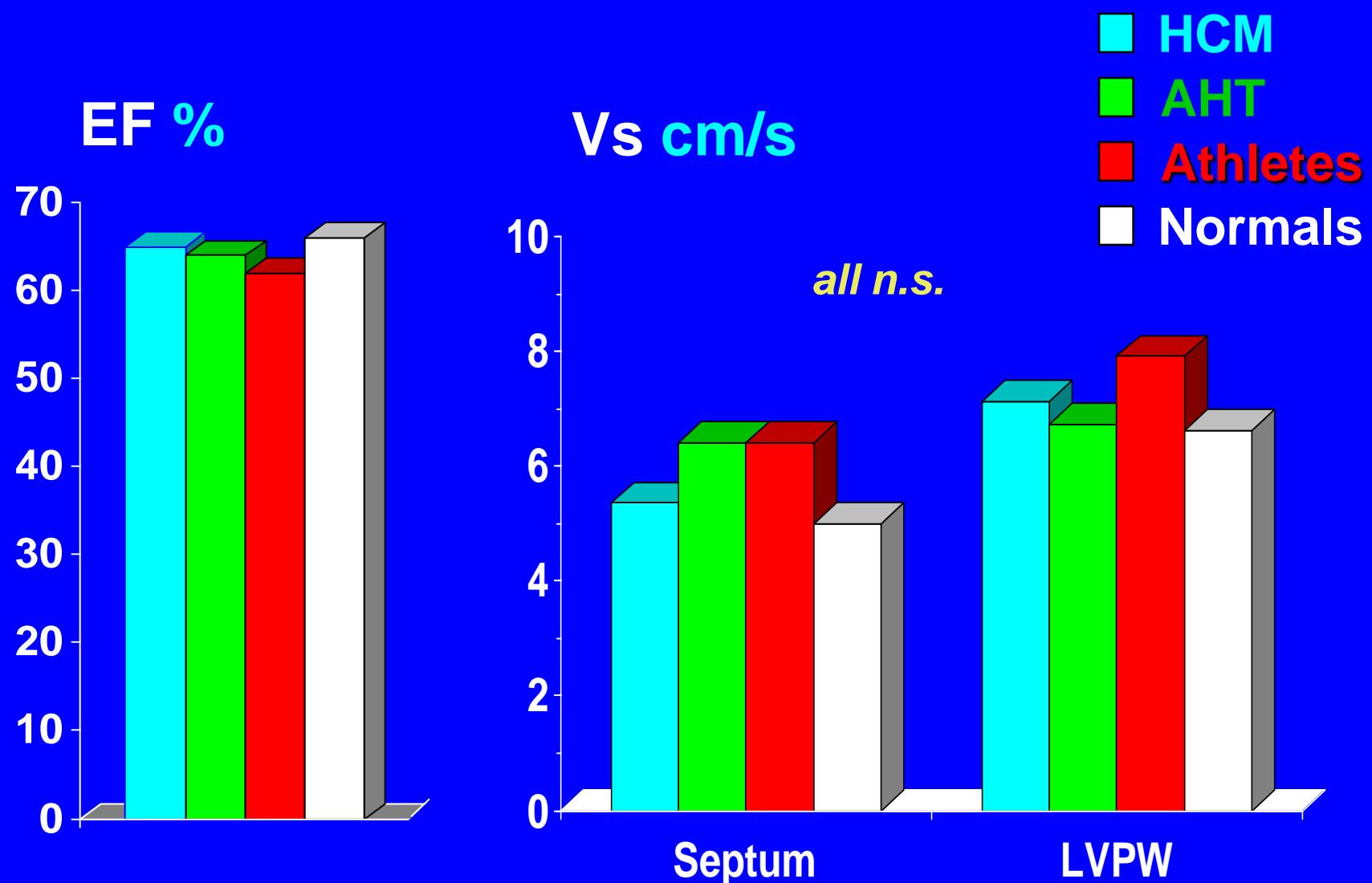
# Asymmetrical development of LVH in hypertension

74 untreated mild / moderate HTN vs. 34 controls



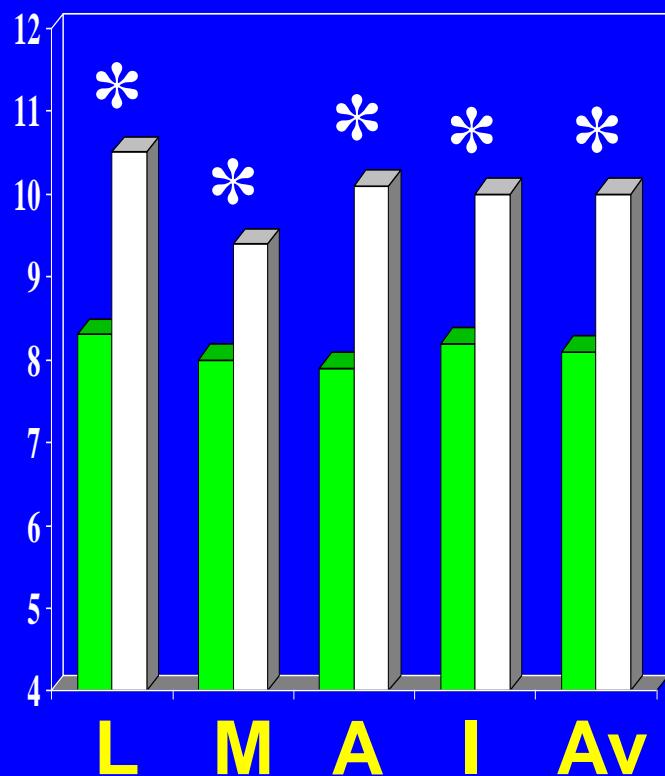
Baltaeva A et al, Eur J Echocardiogr 2008; 9: 501-8

# Global and radial LV function in hypertrophy (n = 80)

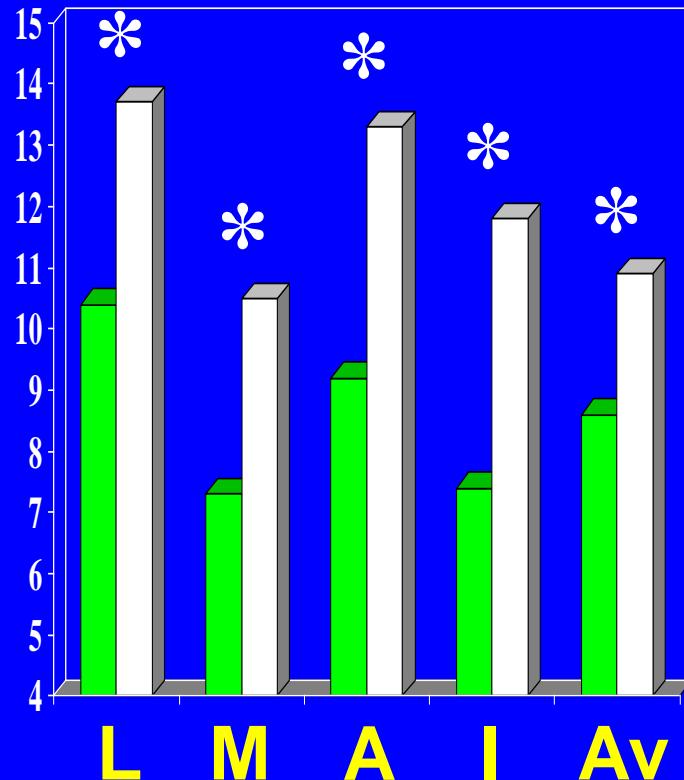


# Long-axis dysfunction in hypertension

V<sub>s</sub> cm/s



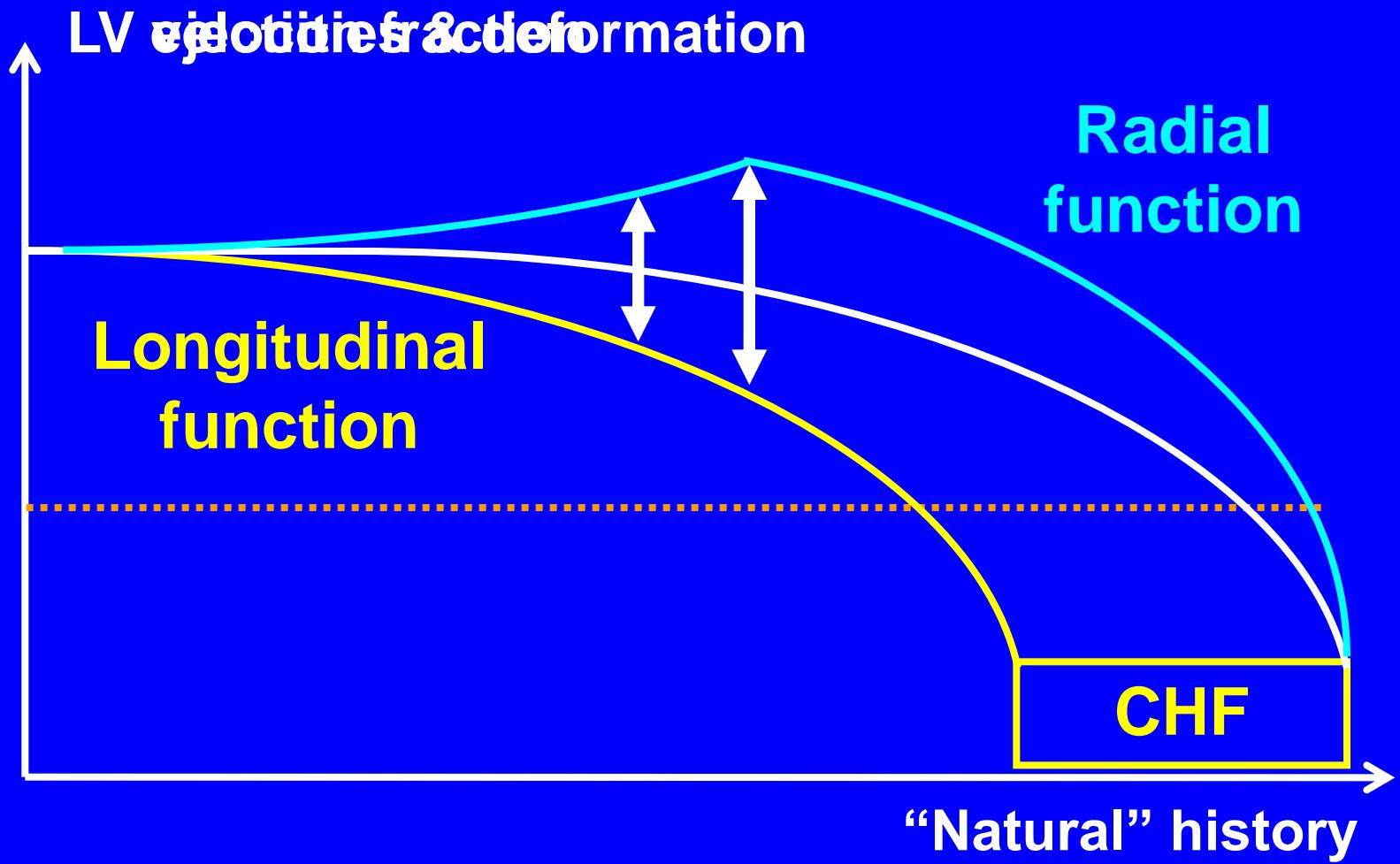
V<sub>e</sub> cm/s



\* p<0.05  
■ HT and LVH  
□ Normal subjects

Vinereanu D et al, Am J Cardiol 2001; 88: 53

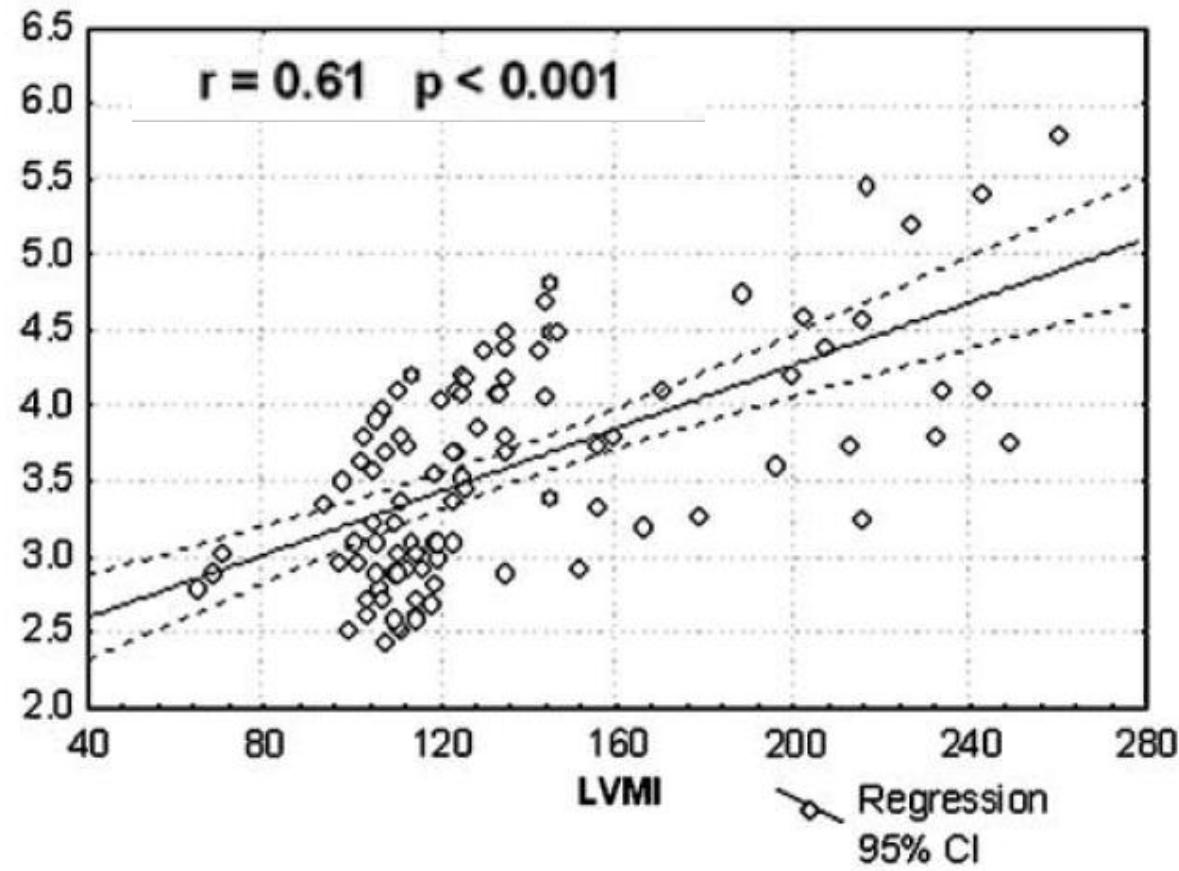
# Progression of LV dysfunction in hypertension



# Radial / circumferential left ventricular function *is increased* in essential hypertension

VS  
Mid-  
anteroseptal  
segment  
in PSAX

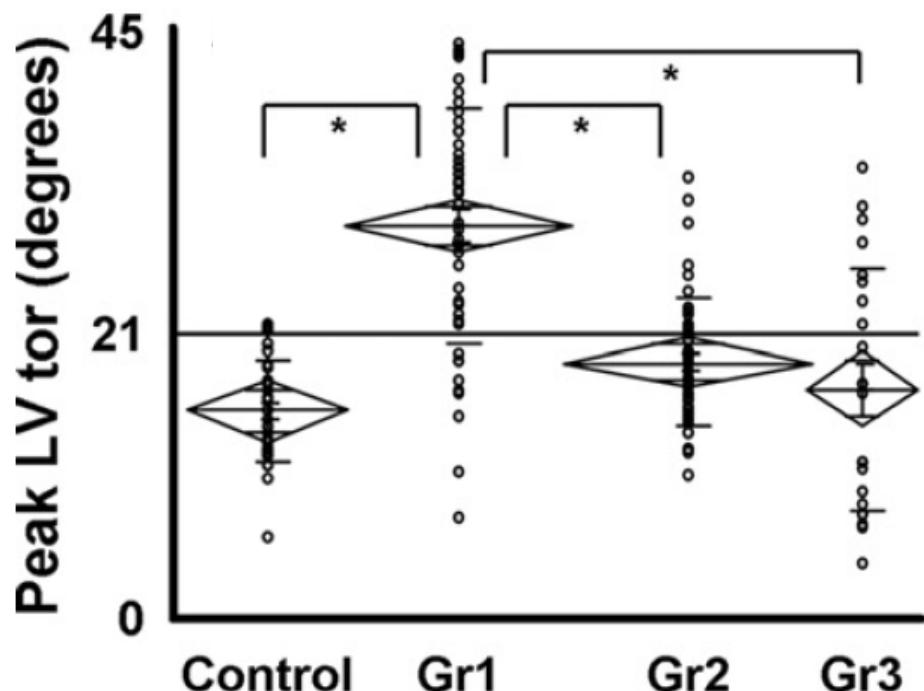
102 pts &  
33 controls



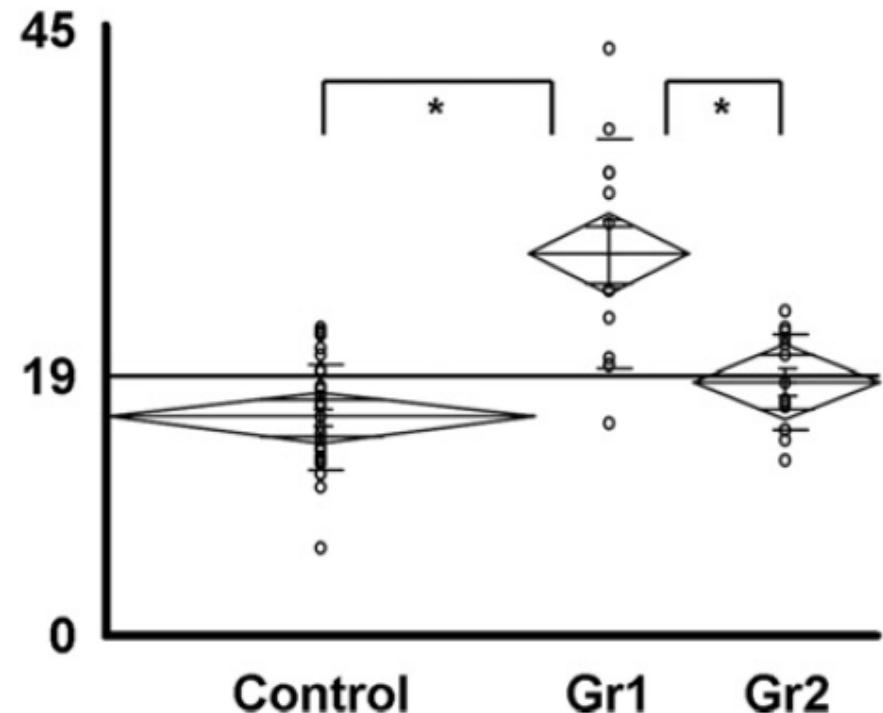
Przewlocka-Kosmala M et al, J Hum Hypertension 2006; 20: 666-71

# Left ventricular torsion in hypertension

By severity of diastolic dysfunction



In hypertension, + / - diastolic dysfunction



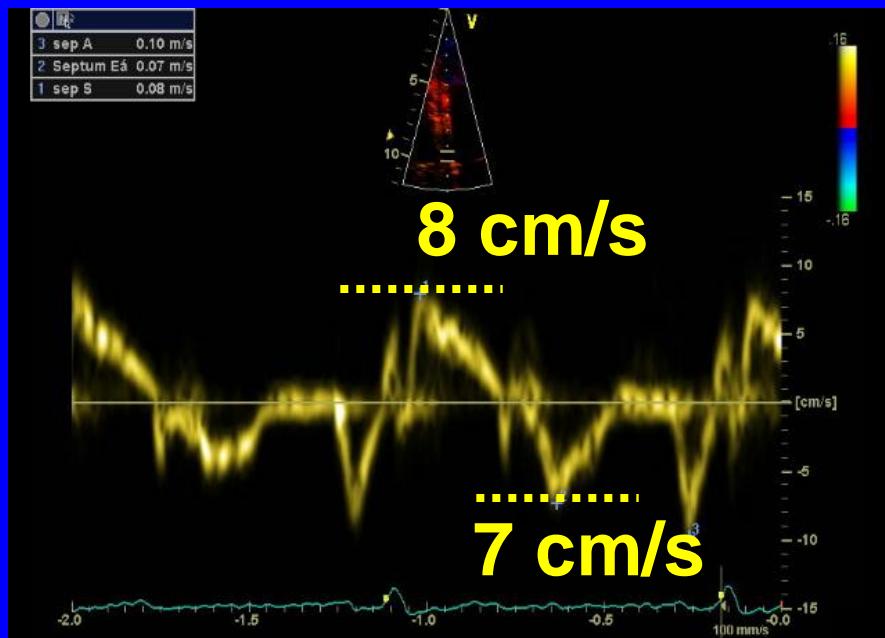
116 patients with normal EF and diastolic dysfunction vs 32 controls

Park SJ et al,  
JASE 2008

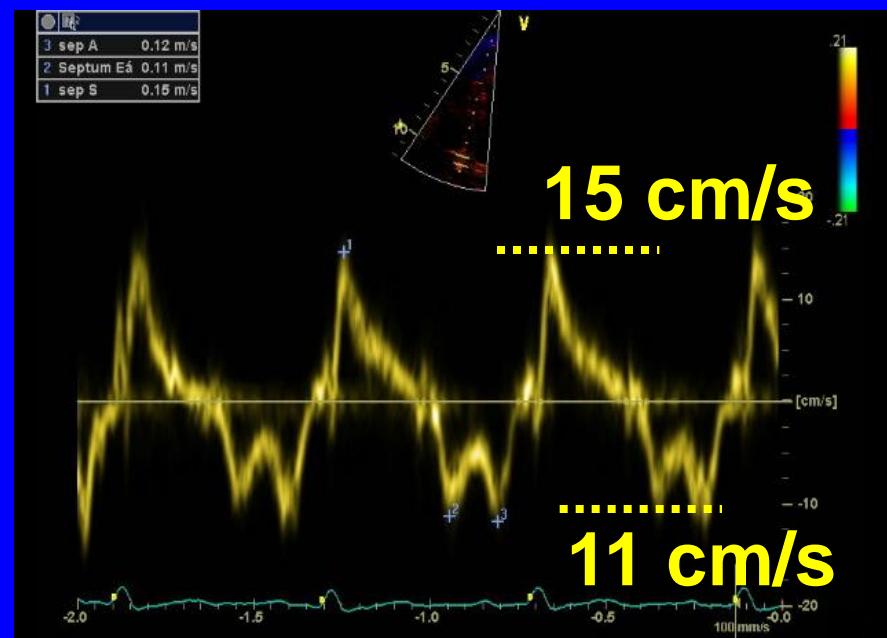
# Longitudinal functional reserve

## Healthy control subject, ♂ aged 72

Rest (HR 56/min)



Exercise (HR 101/min)



$\Delta V_s$  7 cm/s

$\Delta V_e$  4 cm/s

courtesy of Y Tan and J Sanderson

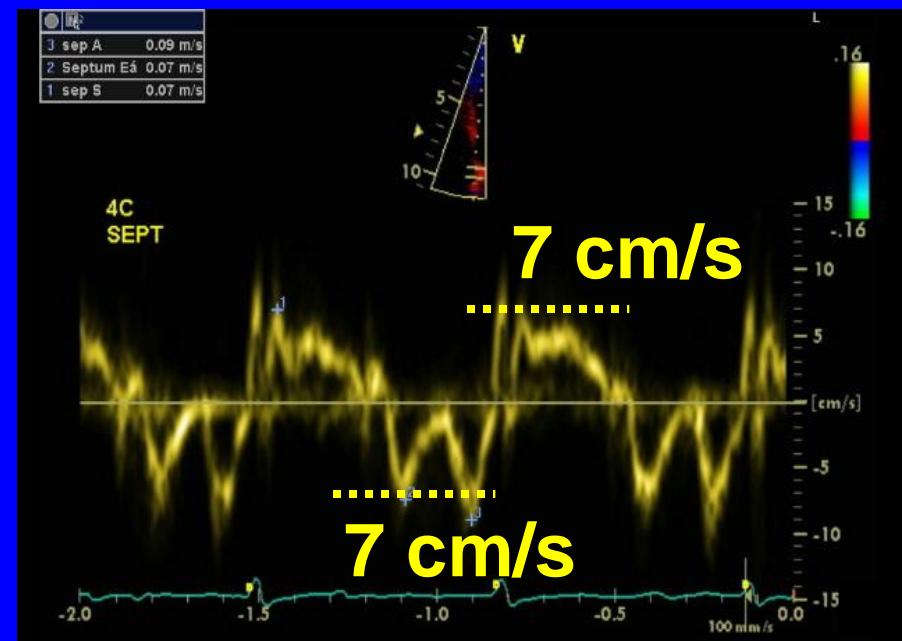
# Longitudinal functional reserve

## Dyspnoeic patient with normal EF, ♀ aged 77

Rest (HR 64/min)



Exercise (HR 87/min)



$\Delta V_s$  1 cm/s  
 $\Delta V_e$  1 cm/s

Supine exercise / offline analysis  
courtesy of Y Tan and J Sanderson

## Longitudinal functional reserve in HFNEF

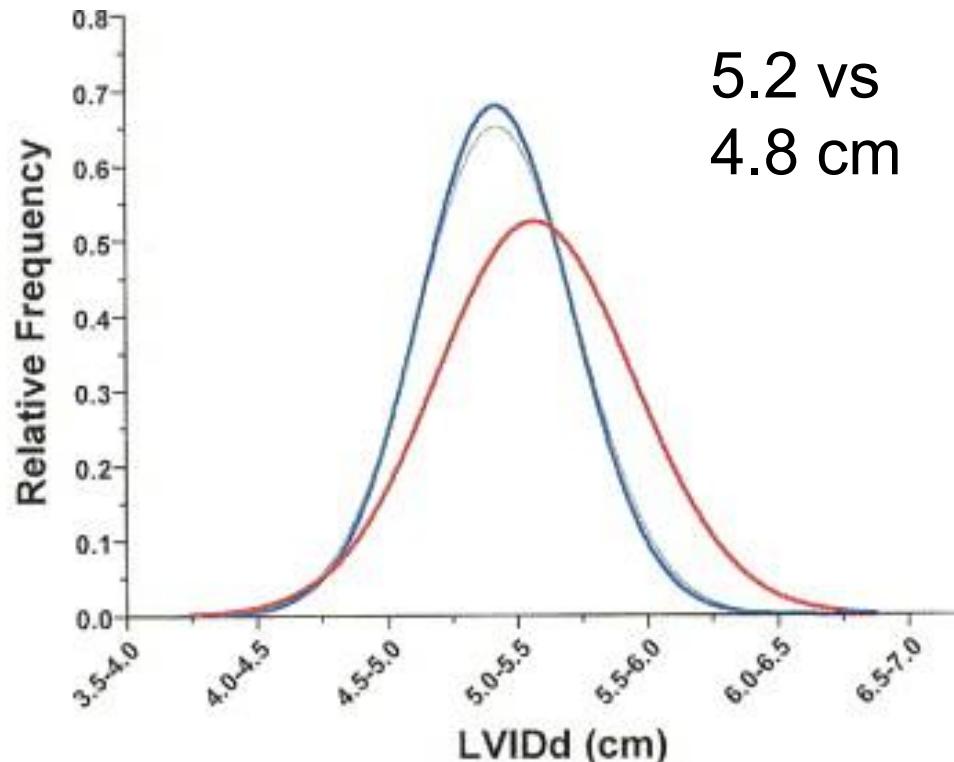
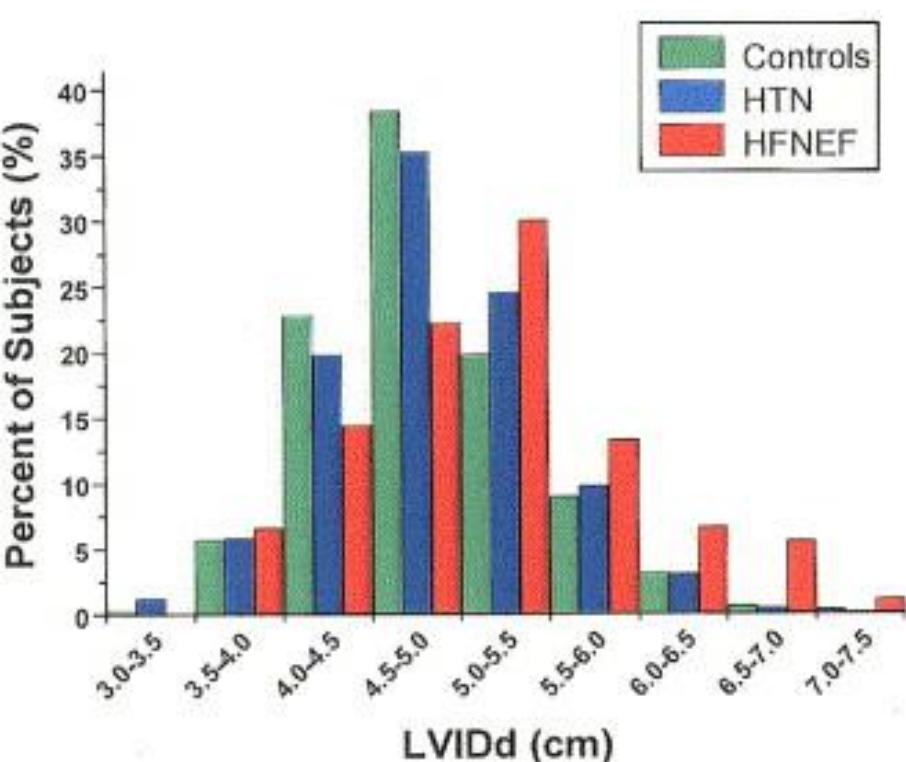
	31 Patients	36 Controls
Age (years)	71 ±8	70 ±7
BMI (kg/m <sup>2</sup> )	29.7±4.5*	24.6±3.9
VO <sub>2</sub> max (ml/min/kg)	17.3±3.1*	30.9±5.9
LV EF (%)	62.4±6.3	63.1±7.7
LV Mass Index (g/m <sup>2</sup> )	80.1±24.1	84.1±21.3
LA Volume Index (ml/m <sup>2</sup> )	27.6±8.4	24.6±8.2
E/A	0.81±0.18	0.88±0.26
DT at rest (ms)	247±52	259±45
Diastolic LFR Index (cm/s)	1.8±1.5*	3.2±2.7
Systolic LFR Index (cm/s)	1.1±1.4*	2.1±1.3

Y Tan and J Sanderson, JACC 2009; 54: 36-46

# Patients with heart failure & normal ejection fraction have increased LV end-diastolic diameter

## The Cardiovascular Health Study

499 controls, 2184 hypertensive, 167 HFNEF patients



Maurer MS et al, J Am Coll Cardiol 2007; 49: 972-81

# The heart in hypertension – Clinical cases

---

## Untreated hypertension

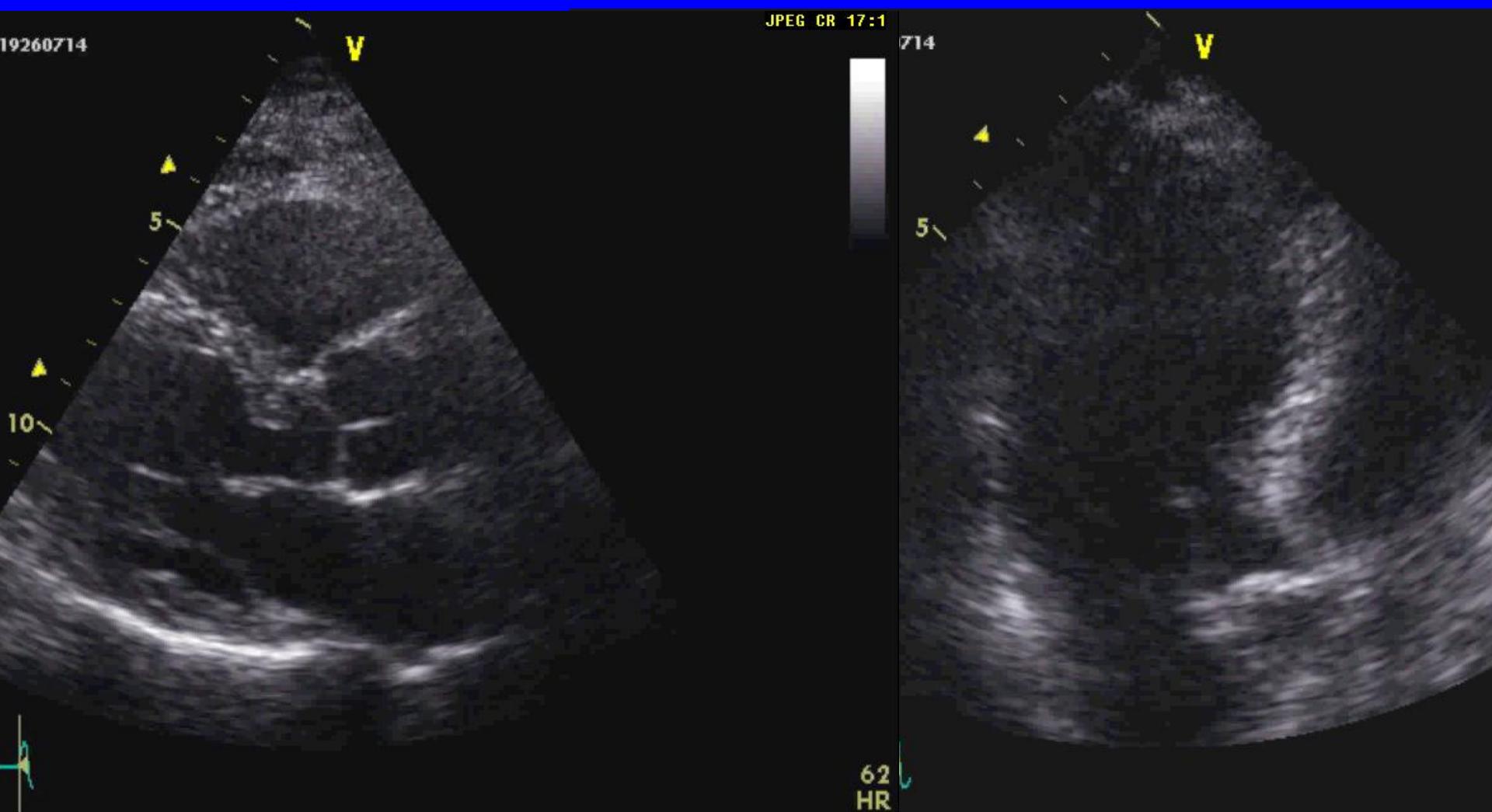
1. Asymptomatic LV dysfunction
2. Dyspnoea & chest tightness on exertion
3. Acute pulmonary oedema

## Treated hypertension

4. Dyspnoea on exertion

1

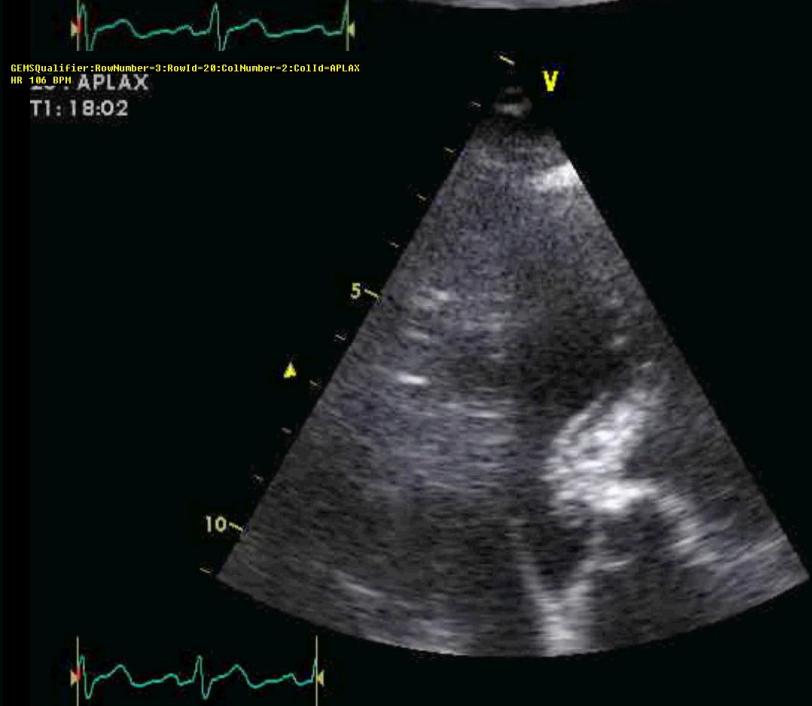
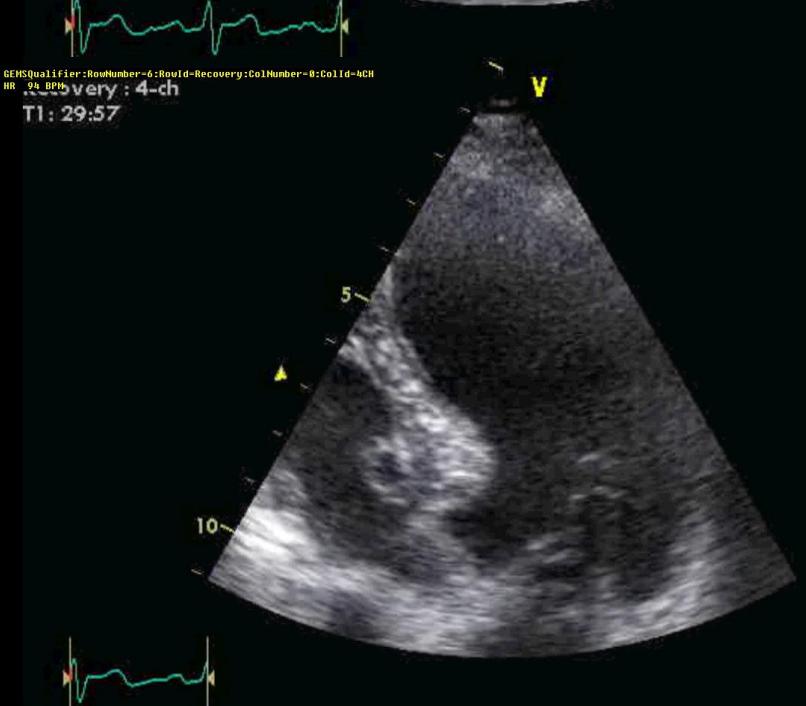
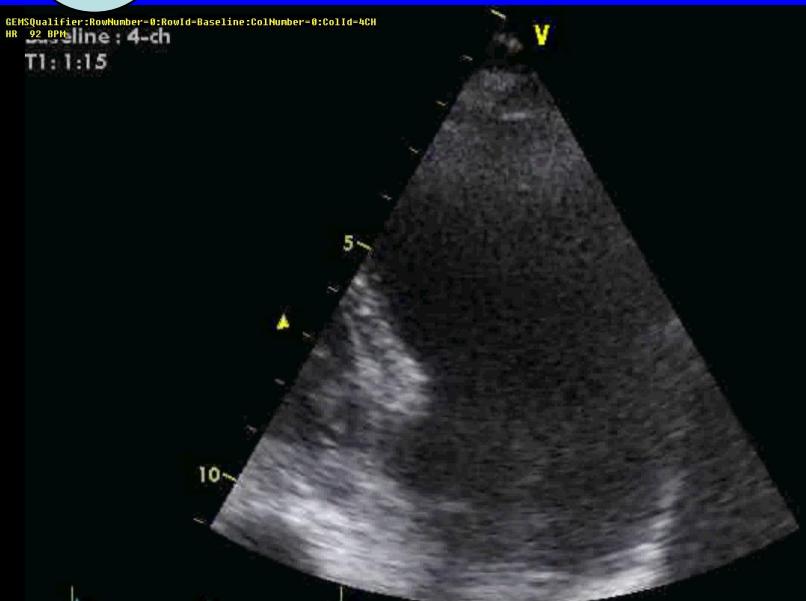
# Eccentric LVH in 60 year-old lady at screening



→ ↑central arterial stiffness *not* "sigmoid septum", "mutation-negative sigmoidal HCM", or "discrete upper septal hypertrophy"

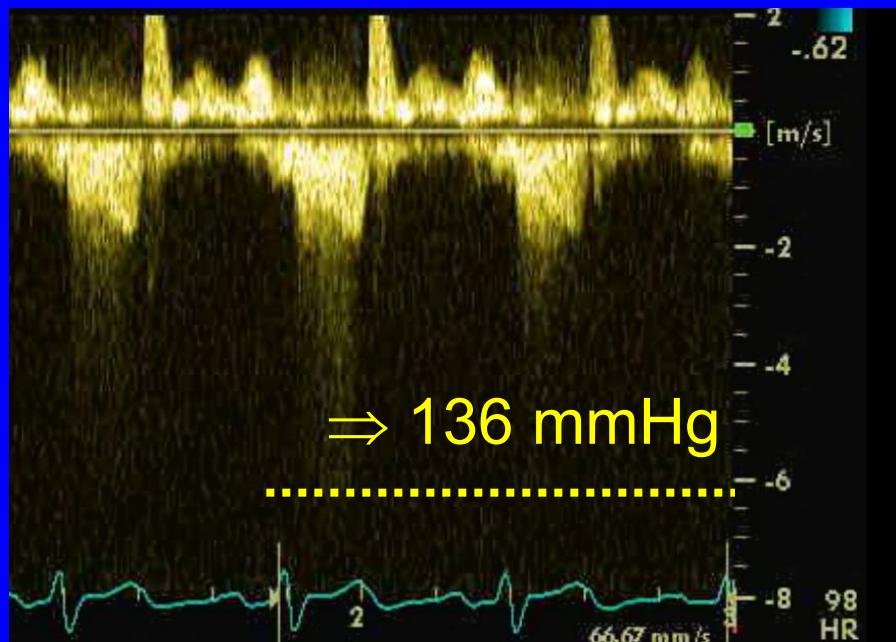
2

# Dobutamine stress in untreated hypertension

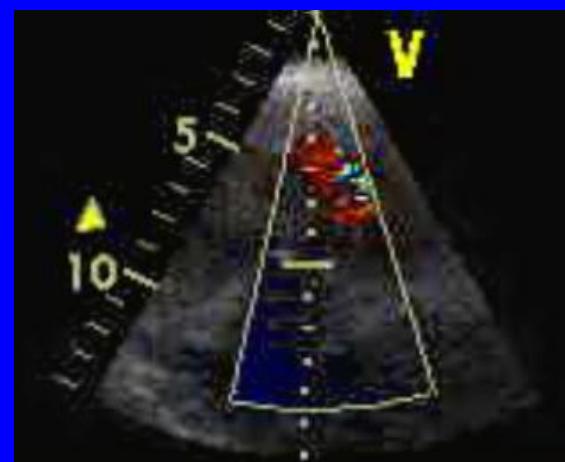
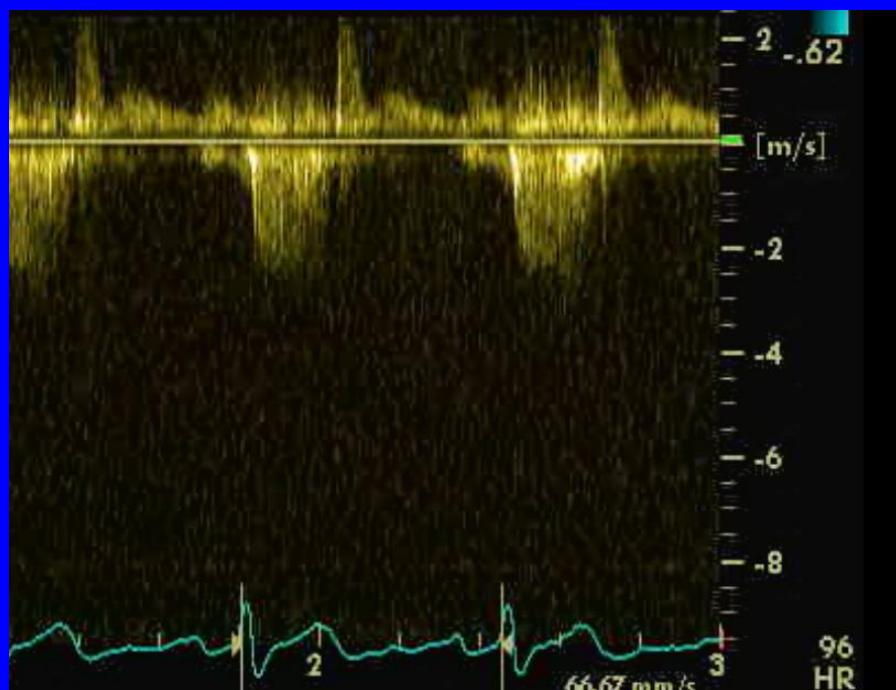


JPEG CR 58:1

50%  
JPG 56:1106  
50%

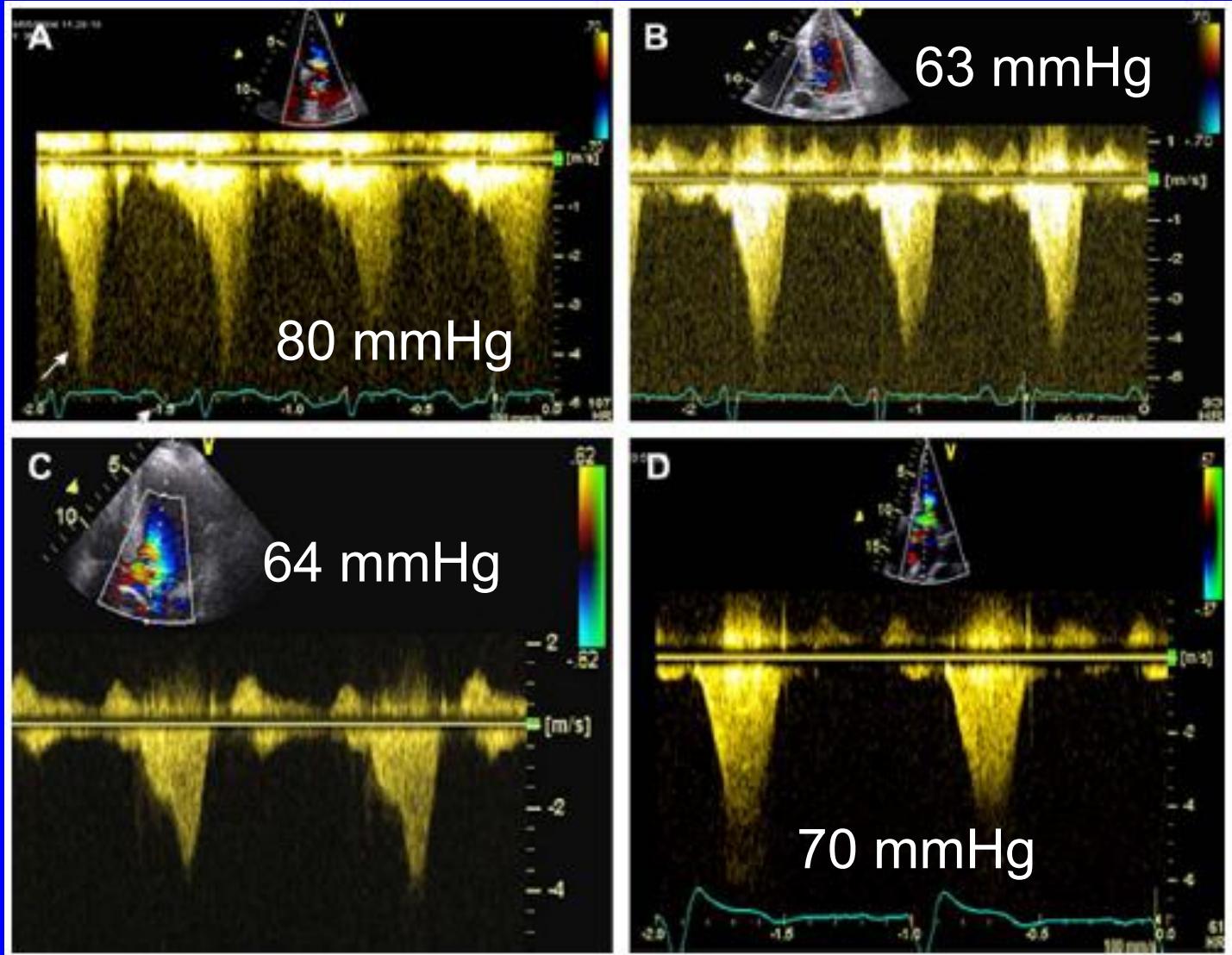


Peak stress



Recovery

# Provokable intracavitary gradients in “Tako Tsubo”

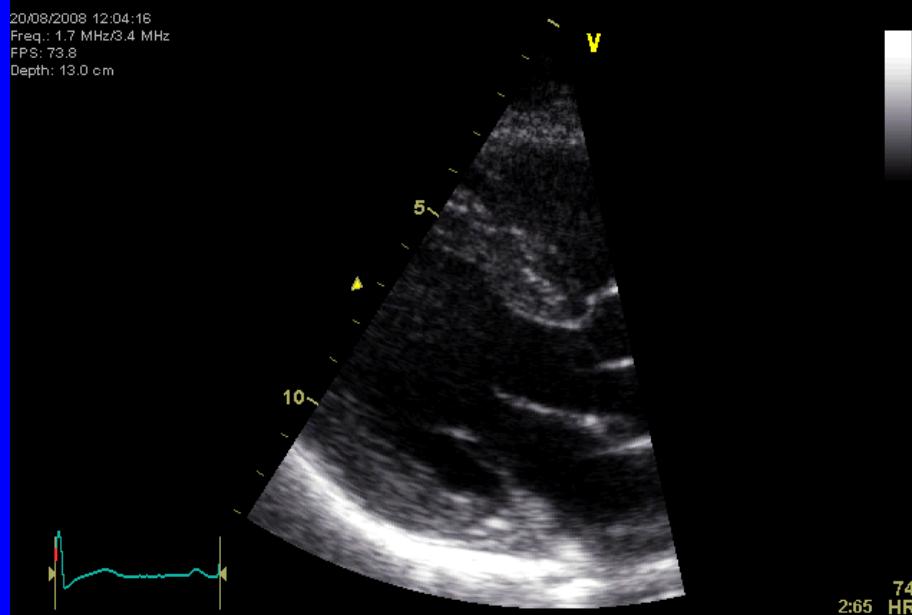


*Merli E et al, Eur J Echocardiogr 2006; 7: 53-61*

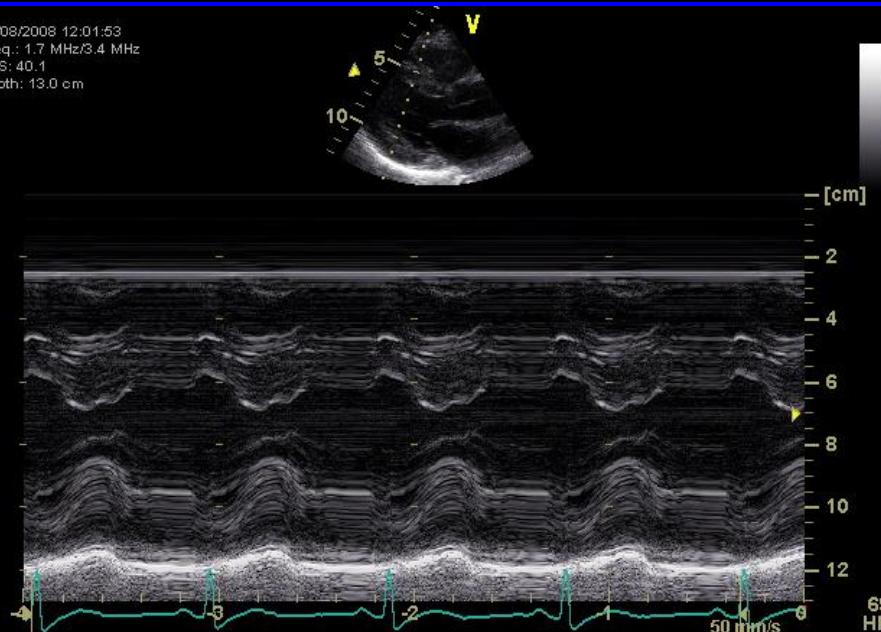
3

F aged 38, new diagnosis HTN, 215/120 mmHg

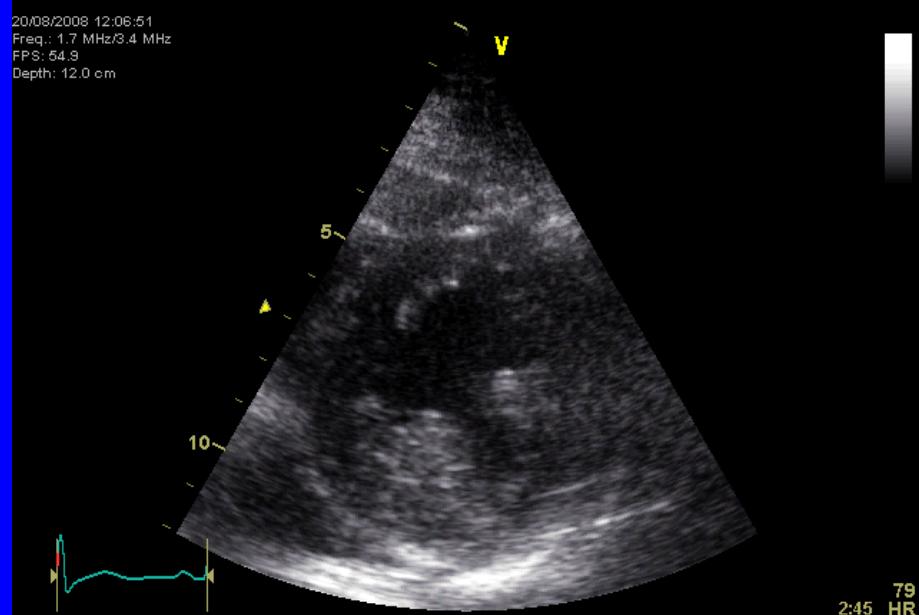
20/08/2008 12:04:16  
Freq.: 1.7 MHz/3.4 MHz  
FPS: 73.8  
Depth: 13.0 cm



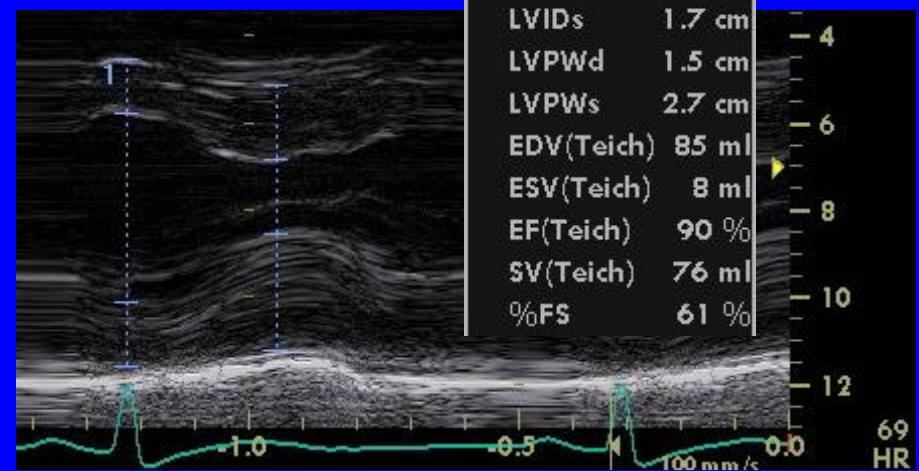
20/08/2008 12:01:53  
Freq.: 1.7 MHz/3.4 MHz  
FPS: 40.1  
Depth: 13.0 cm



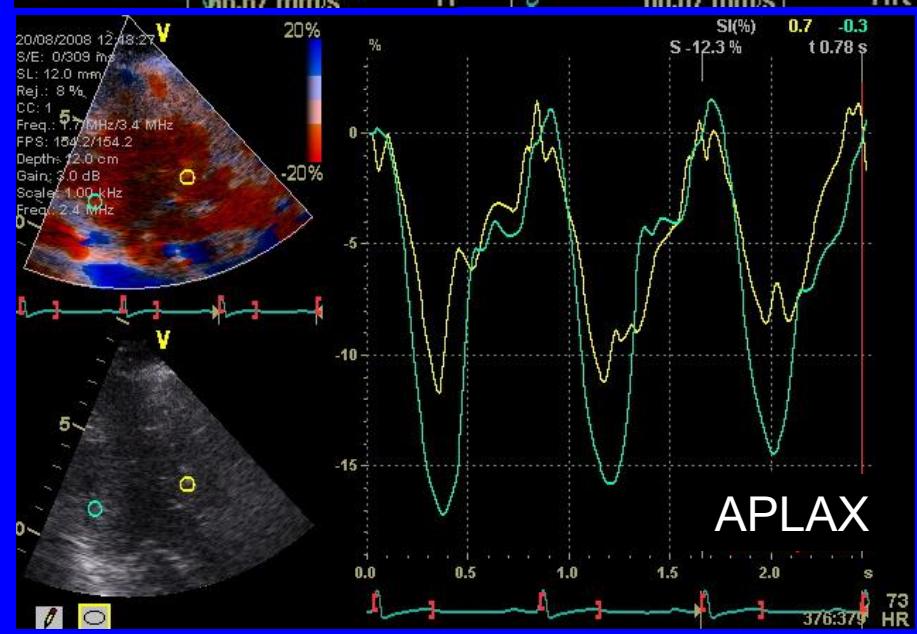
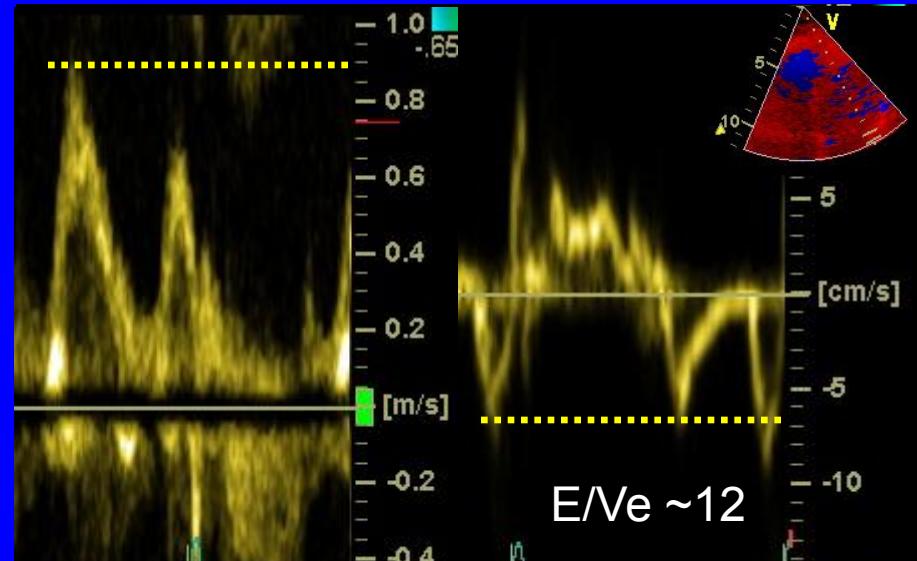
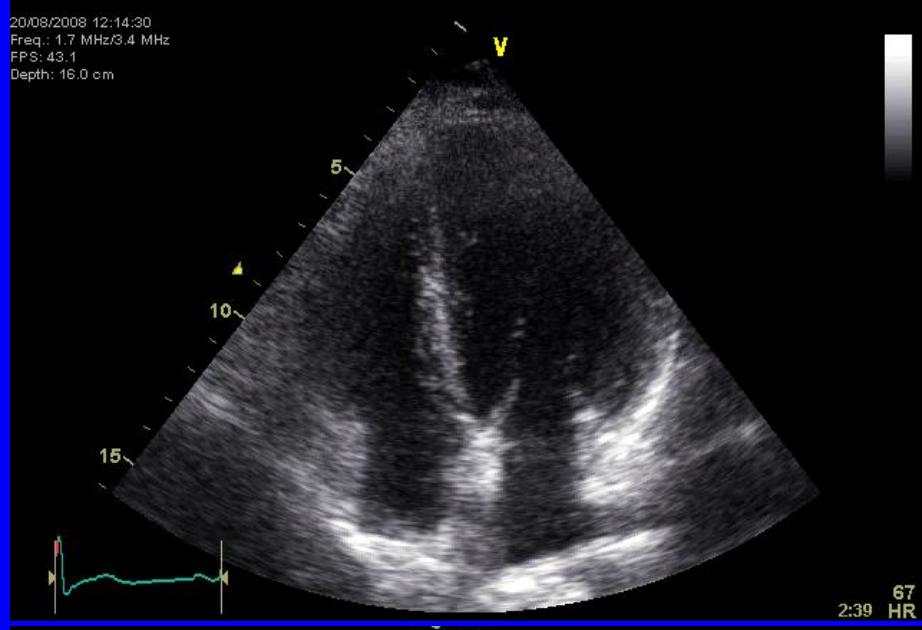
20/08/2008 12:06:51  
Freq.: 1.7 MHz/3.4 MHz  
FPS: 54.9  
Depth: 12.0 cm



1 IVSd	1.2 cm
IVSs	1.7 cm
LVIDd	4.3 cm
LVIDs	1.7 cm
LVPWd	1.5 cm
LVPWs	2.7 cm
EDV(Teich)	85 ml
ESV(Teich)	8 ml
EF(Teich)	90 %
SV(Teich)	76 ml
%FS	61 %



# Subclinical diastolic and systolic dysfunction



4

M, aged 80, hypertensive (BP 175/66 mmHg), NYHA 2b

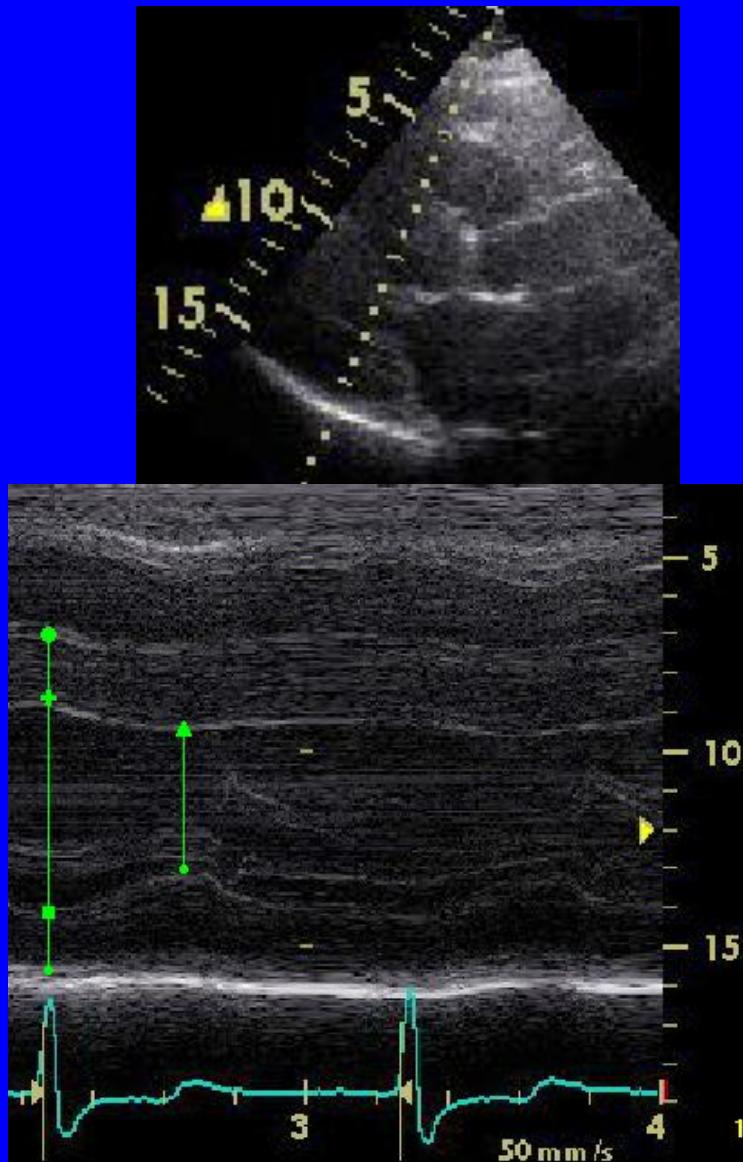


**Septal thickness 1.6 cm**

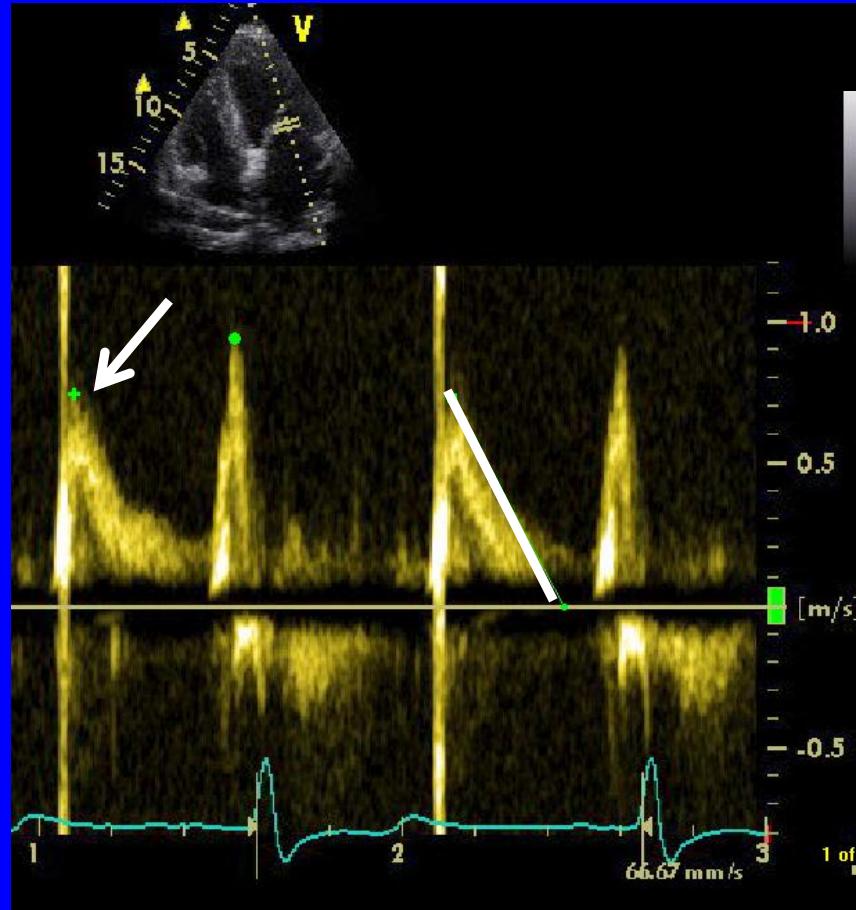
**Posterior wall thickness 1.5 cm**

**LV diastole 5.5 cm, systole 3.6 cm**

**Fractional shortening 35%**

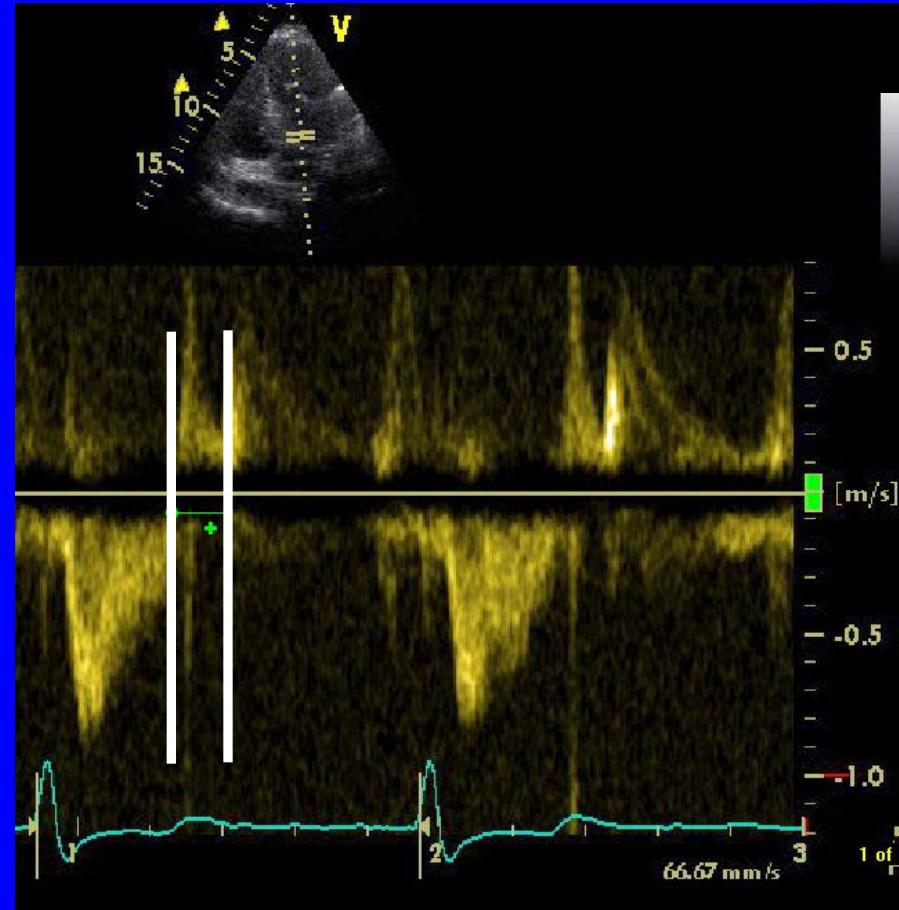


# Diastolic function in hypertensive heart failure

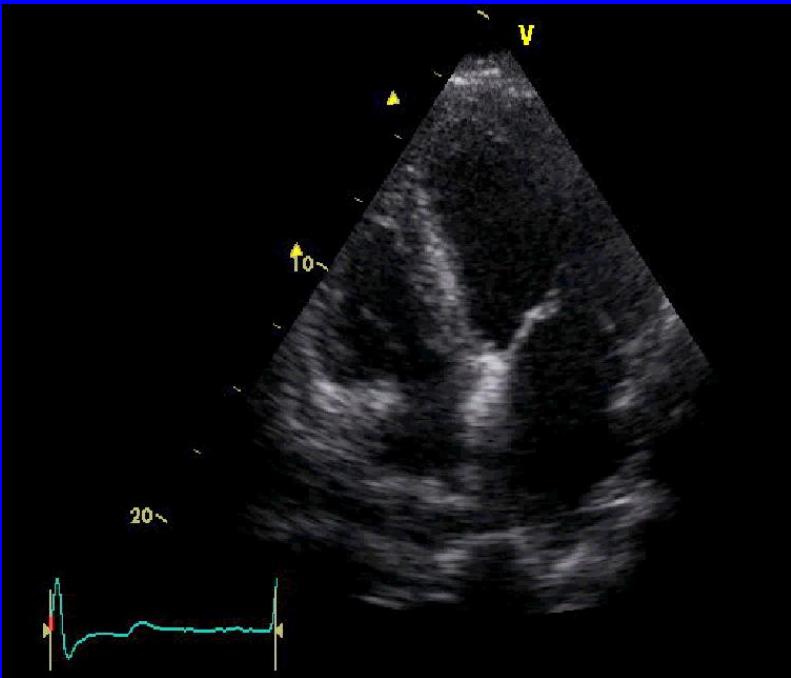


E velocity **0.75 m/s**

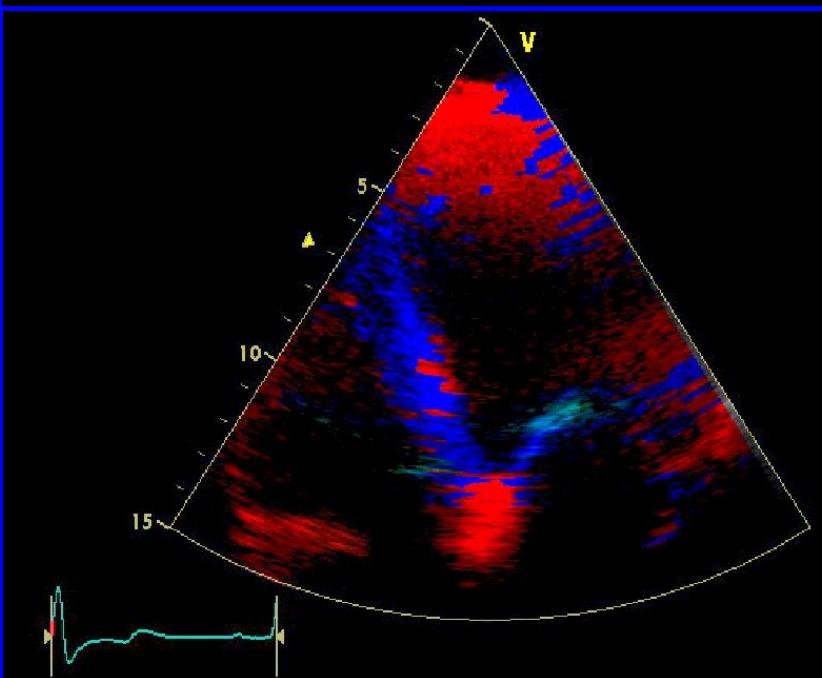
E deceleration time **300 ms**



Isovolumic relaxation  
time **150 ms**



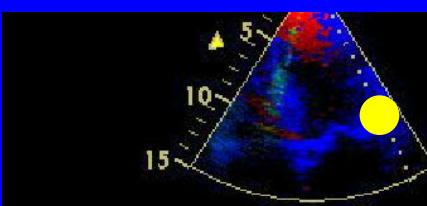
JPEG CR 30:1



JPEG CR 20:1



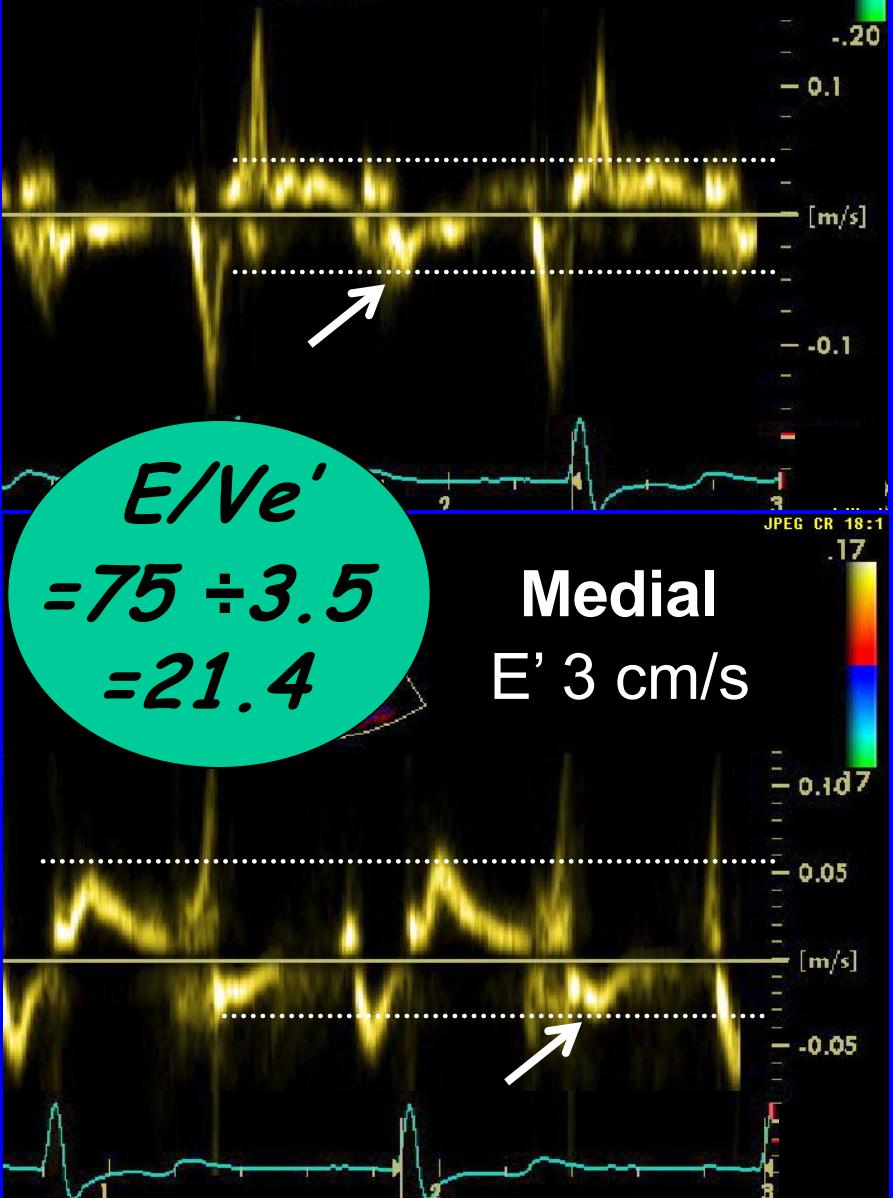
$$\begin{aligned} E/Ve' \\ = 75 \div 3.5 \\ = 21.4 \end{aligned}$$



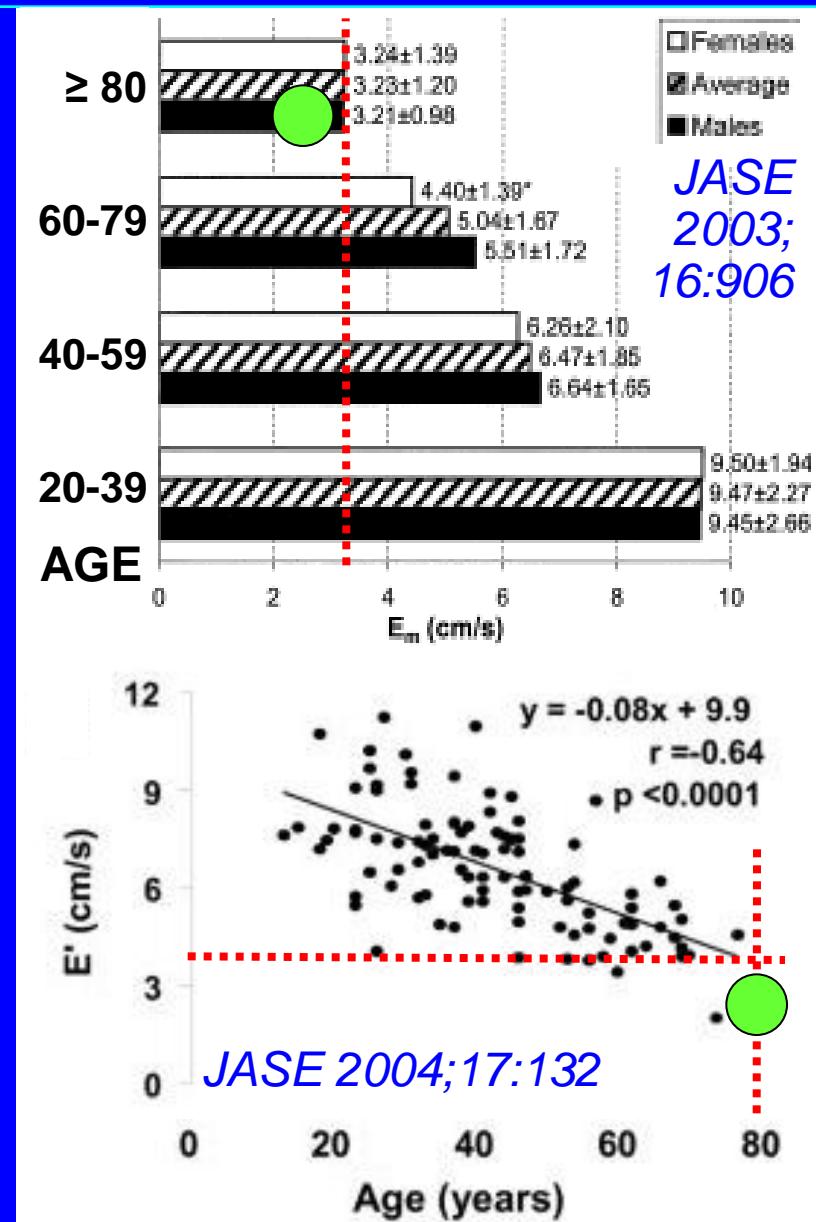
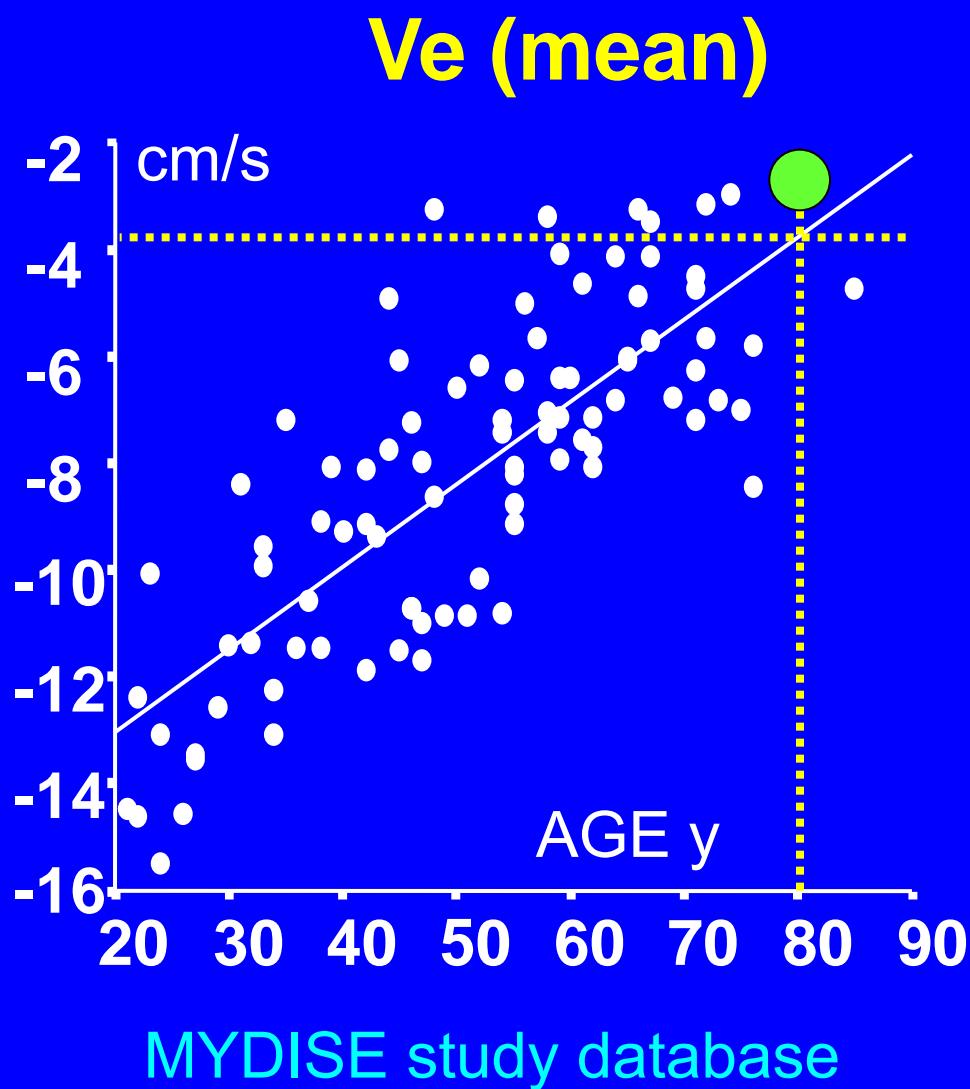
56

HR

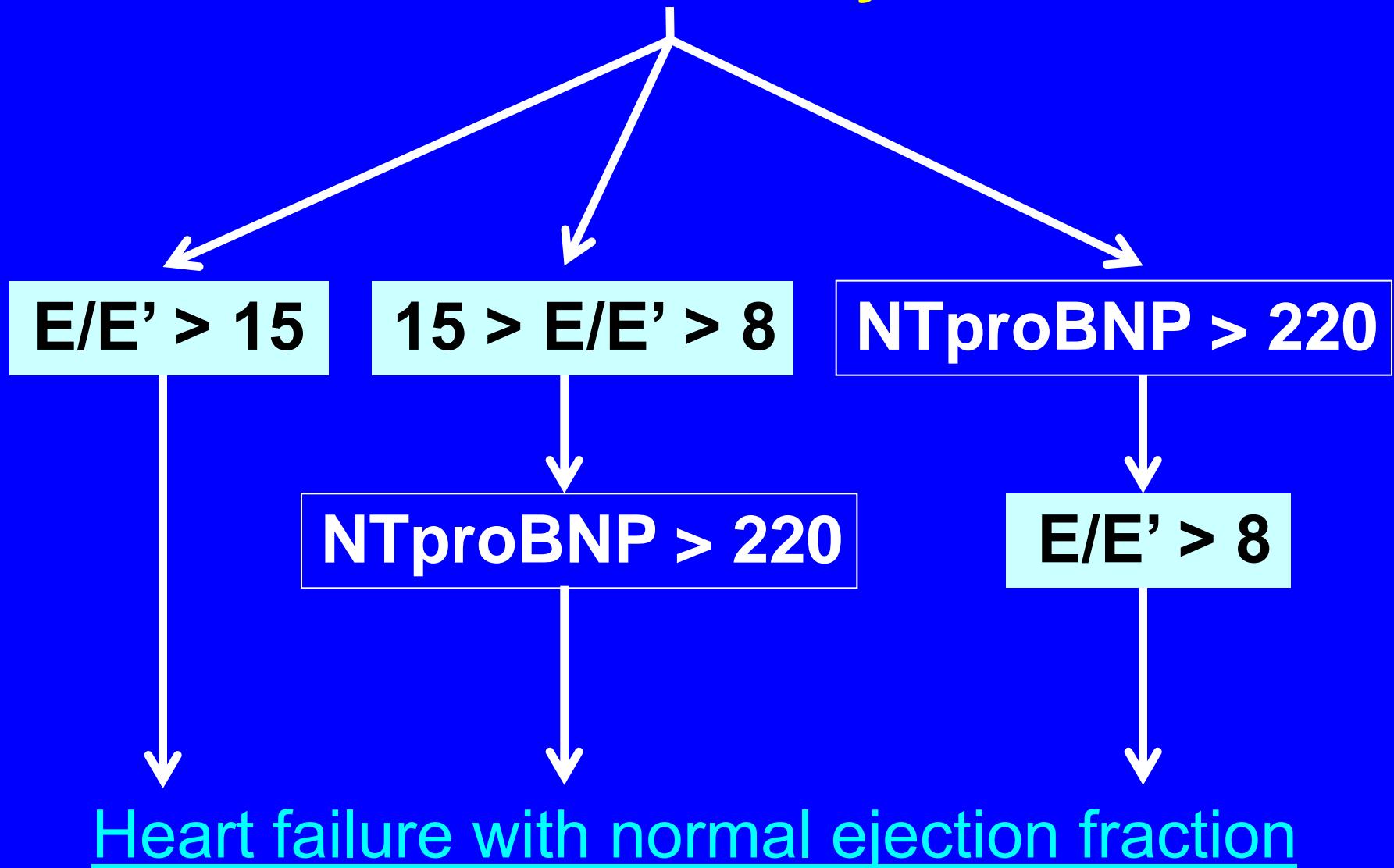
Lateral  
E' 4 cm/s



75% of Ve (E') 3.5 cm/s = 2.6, at age 80 yrs ?



# Evidence of diastolic dysfunction ?



# Hypertensive heart disease and failure

---

- Systolic loading most affects the septum
- Interstitial fibrosis impairs long-axis function
- Radial function increases, EF maintained
- Long-axis systolic & diastolic function decline from subclinical dysfunction to disease
- Tests of functional reserve invaluable
- HFNEF is regional systolic dysfunction