Hypertensive heart disease and failure

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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

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

Vinereanu D et al, AJC 2001; 88: 53
Long-axis dysfunction in hypertension

Vinereanu D et al, Am J Cardiol 2001; 88: 53
Progression of LV dysfunction in hypertension

- Longitudinal function
- Radial function

LV velocities & deformation

“Natural” history

CHF
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)

ΔVs 7 cm/s
ΔVe 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)

Supine exercise / offline analysis
courtesy of Y Tan and J Sanderson
# Longitudinal functional reserve in HFNEF

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

<table>
<thead>
<tr>
<th></th>
<th>31 Patients</th>
<th>36 Controls</th>
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<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>71 ±8</td>
<td>70 ±7</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>29.7±4.5*</td>
<td>24.6±3.9</td>
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<tr>
<td><strong>VO₂ max (ml/min/kg)</strong></td>
<td>17.3±3.1*</td>
<td>30.9±5.9</td>
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<tr>
<td><strong>LV EF (%)</strong></td>
<td>62.4±6.3</td>
<td>63.1±7.7</td>
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<tr>
<td><strong>LV Mass Index (g/m²)</strong></td>
<td>80.1±24.1</td>
<td>84.1±21.3</td>
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<tr>
<td><strong>LA Volume Index (ml/m²)</strong></td>
<td>27.6±8.4</td>
<td>24.6±8.2</td>
</tr>
<tr>
<td><strong>E/A</strong></td>
<td>0.81±0.18</td>
<td>0.88±0.26</td>
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<tr>
<td><strong>DT at rest (ms)</strong></td>
<td>247±52</td>
<td>259±45</td>
</tr>
<tr>
<td><strong>Diastolic LFR Index (cm/s)</strong></td>
<td>1.8±1.5*</td>
<td>3.2±2.7</td>
</tr>
<tr>
<td><strong>Systolic LFR Index (cm/s)</strong></td>
<td>1.1±1.4*</td>
<td>2.1±1.3</td>
</tr>
</tbody>
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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
Eccentric LVH in 60 year-old lady at screening

⇒ ↑central arterial stiffness not “sigmoid septum”, “mutation-negative sigmoidal HCM”, or “discrete upper septal hypertrophy”
Dobutamine stress in untreated hypertension
Peak stress

Recovery

⇒ 136 mmHg
Provokable intracavitary gradients in “Tako Tsubo”

F aged 38, new diagnosis HTN, 215/120 mmHg
Subclinical diastolic and systolic dysfunction

Valsalva manoeuvre

E/ Ve ~12

APLAX
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
Lateral
E' 4 cm/s

Medial
E' 3 cm/s

$E/Ve' = \frac{75}{3.5} = 21.4$
75% of Ve (E’) 3.5 cm/s = 2.6, at age 80 yrs?

Ve (mean)

AGE y

20 30 40 50 60 70 80 90

MYDISE study database

JASE 2003; 16:906

JASE 2004; 17:132
Evidence of diastolic dysfunction?

- E/E’ > 15
- 15 > E/E’ > 8
- NTproBNP > 220

Heart failure with normal ejection fraction

Paulus W et al, Eur Heart J 2007
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