New aspects of Echocardiography in Hypertensive Heart Disease

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Euroheart Survey on HF
Distribution of Ejection Fraction

11,015 patients in 115 hospitals in 24 countries

Percentage of patients

Left Ventricular Ejection Fraction (%)

ESC Guidelines for the Diagnosis and Treatment of CHF - 2005
Diastolic dysfunction or Preserved Left Ventricular Ejection Fraction (PLVEF)

- Diastolic heart failure is often presumed to be present when symptoms and signs of heart failure occur in the presence of a PLVEF (normal ejection fraction/normal end-diastolic volume) at rest.

- Predominant diastolic dysfunction is relatively uncommon in younger patients but increases in importance in the elderly, in particular women, in whom systolic hypertension and myocardial hypertrophy with fibrosis are contributors to cardiac dysfunction.
PLVEF and diastolic dysfunction

PLVEF

Hypertension
Aortic stenosis
Ischaemia

Symptomatic "Diastolic heart Failure"

Diastolic dysfunction

Elderly Women
Progressive increase in cardiovascular morbidity (left) and all-cause mortality (right) rates from first to fifth quintile of distribution of LV mass index.
Cumulative survival by quintile of LV mass index

Left ventricular geometry at baseline and after 4.8 years antihypertensive treatment. (LIFE Trial)

Time course of combined primary endpoints (cardiovascular death, stroke, and myocardial infarction) in patient groups with different left ventricular geometry at final event-free in-treatment echocardiogram (all patterns P < 0.001 vs. normal geometry).

Dyastolic Dysfunction

- Impaired relaxation
- Elevated filling pressures

- Hypertension
- Ischemic heart disease
- Cardiomyopathies
- Systemic disease
- Valvular heart disease
Diastolic Dysfunction: Hypertension

- Ischemia
- Impaired Ca++ handling
- Small end systolic volume
- LV hypertrophy
- Myocardial fibrosis

↓ LV relaxation
↑ LV stiffness
Filling Patterns

- **Electrocardiogram (ECG):**
  - Normal
  - Impaired Relaxation
  - Restrictive

- **Pressures:**
  - LV
  - LA

- **Mitral:**
  - Normal
  - Impaired Relaxation
  - Restrictive
Diastolic function and Hypertension

Diastolic function in Hypertension

(A) $E'_{Lat}$ (cm/s)

- NT
- New HT
- HT

(B) $E/E'_{Lat}$

- NT
- New HT
- HT

Systolic function and Hypertension

Tissue Tracking and LV systolic function in HTN

NORMAL

Hypertensive

Tissue Tracking Score Index

LV Mass Index vs Tissue Tracking wall score index

Mitral Ring Displacement in HTN

<table>
<thead>
<tr>
<th></th>
<th>HNT</th>
<th>NTN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septum (mm)</td>
<td>10.1 ± 0.2\textsuperscript{†}</td>
<td>13.0 ± 0.3</td>
</tr>
<tr>
<td>Anterior wall (mm)</td>
<td>11.2 ± 0.3\textsuperscript{†}</td>
<td>13.5 ± 0.4</td>
</tr>
<tr>
<td>Lateral wall (mm)</td>
<td>13.8 ± 0.4</td>
<td>14.8 ± 0.4</td>
</tr>
<tr>
<td>Inferior wall (mm)</td>
<td>12.7 ± 0.3\textsuperscript{*}</td>
<td>14.4 ± 0.5</td>
</tr>
<tr>
<td>Average over the four walls (mm)</td>
<td>12.0 ± 0.3\textsuperscript{†}</td>
<td>13.9 ± 0.3</td>
</tr>
</tbody>
</table>

\textsuperscript{*}p < 0.005 and \textsuperscript{†}p < 0.0001.
Longitudinal Septal displacement and MAP

Patterns of Hypertensive Heart

Baltabaeva A et al
Eur J Echocardiogr
2007
Septal velocities, S/SR

HTN

Non HTN

Basal septal strain and wall thickness and MAP

Graph representing the parallel changes in mean Ea, longitudinal strain, as well as filling pressures, wall thickness and number of segments with altered relaxation pattern-Segmental diastolic dysfunction (DD).

Graph representing the relation of mean longitudinal strain with altered segmental relaxation

[segmental diastolic dysfunction (DD): number of LV segments with abnormal relaxation]

Hypertensive Heart Disease

Sousa C, Gonçalves S, Pinto FJ Rev Port Cardiol 2010;29:49
<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>HTN</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS (%)</td>
<td>-19.98 ± 2.17</td>
<td>-18.28 ± 3.09</td>
<td>p = 0.015*</td>
</tr>
<tr>
<td>GSRs (1/sec)</td>
<td>-1.03 ± 0.14</td>
<td>-0.94 ± 0.19</td>
<td>p = 0.021*</td>
</tr>
<tr>
<td>GSRe (1/sec)</td>
<td>1.43 ± 0.33</td>
<td>1.03 ± 0.28</td>
<td>p &lt;0.001*</td>
</tr>
<tr>
<td>GSRa (1/sec)</td>
<td>0.89 ± 0.19</td>
<td>0.94 ± 0.27</td>
<td>p = 0.234</td>
</tr>
</tbody>
</table>

Gonçalves S, Pinto FJ ESC 2009
Hypertensive Heart Disease

Cut-off-19,95
Sensitivity 74,%
Specificity 58,8%

GS(%) ROC Curve

Cut-off-1,25
Sensitivity 82,9%
Specificity 76,5%

GSRe (1/sec) ROC Curve

Gonçalves S, Pinto FJ ESC 2009
LV longitudinal and radial function in essential hypertension

- N=81 pts
- LV longitudinal systolic fx and radial deformation (strain-sE, SR, postsystolic strain psE)

<table>
<thead>
<tr>
<th>sE (%)</th>
<th>Controls</th>
<th>NYHA I</th>
<th>NYHA II</th>
<th>NYHA III</th>
<th>NYHA IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal basal</td>
<td>17,5+/-2,9</td>
<td>12,4+/-5,1*</td>
<td>12,2+/-4,8*</td>
<td>11,1+/-4,1*</td>
<td>4,3+/-3,8*§</td>
</tr>
<tr>
<td>Septal mid-api</td>
<td>20,7+/-4,8</td>
<td>20,6+/-4,1</td>
<td>20,7+/-3,3</td>
<td>17,1+/-4,2*</td>
<td>7,4+/-4,7*§</td>
</tr>
<tr>
<td>Lateral basal</td>
<td>21,1+/-3,7</td>
<td>21,1+/-3,6</td>
<td>16,4+/-4,1*</td>
<td>15,6+/-4,8*</td>
<td>6,7+/-4,4*§</td>
</tr>
<tr>
<td>Lateral mid-api</td>
<td>22,06+/-2,9</td>
<td>20,5+/ 3,9</td>
<td>19,8+/-2,7</td>
<td>17,3+/-4,4*</td>
<td>10,7+/-3,9*§</td>
</tr>
<tr>
<td>Posterior basal</td>
<td>39,7+/-11,6</td>
<td>50,8+/-12,7*</td>
<td>39,7+/-15,5.</td>
<td>37,2+/-13,2.</td>
<td>16,3+/-9,1*§</td>
</tr>
</tbody>
</table>

p<0.05: * - vs controls; § - vs NYHA I, II and III; † - vs NYHA I; ‡ - vs NYHA I and II

Plaksej R et al. EUROECHO 2007
LV longitudinal and radial function in essential hypertension

- In hypertensive pts:
  - LV longitudinal fx progressively deteriorates from NYHA cl I to IV
  - LV radial fx enhances in the early phase (compensatory response?) and then declines

Plaksej R et al. EUROECHO 2007
The importance of RV function
RV Dysfunction as a predictor of mortality in heart failure

Kjaergaard J et al Eur J Heart Failure 2007;9:610
# Tricuspid annular velocities/motion

<table>
<thead>
<tr>
<th></th>
<th>Systolic Velocity (s - cm/s)</th>
<th>Early Diastolic velocity (e' - cm/s)</th>
<th>Late diastolic velocity (a' - cm/s)</th>
<th>Tricuspid Annular motion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=28)</td>
<td>19.3 +/- 4.5</td>
<td>16.3 +/- 3.4</td>
<td>13.2 +/- 3.9</td>
<td>29.6 +/- 5.5</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=31)</td>
<td>12.3 +/- 3.1</td>
<td>9.12 +/- 3.0</td>
<td>13.9 +/- 4.7</td>
<td>24.4 +/- 8.9</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>ns</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Sousa C, Gonçalves S, Pinto FJ 2008
Peak systolic strain (peak ε, top left panel), and systolic (SSR, bottom left panel) and diastolic (early, ESR, top right panel, and late, ASR, bottom right panel) strain rate by ascending 24 h systolic blood pressure tertiles (n = 29, 30, and 30, respectively, cut-offs: 117 and 130 mmHg).

Assessment of RV/LV Function in Hypertension

- Early impairment of systolic and diastolic function can be detected by tissue velocities and myocardial deformation parameters at early stages in hypertensive pts.
- RV as a risk marker for HTN?
- Monitoring therapeutic interventions?
Assessing RV and LV Function in HTN

Thank you