Presence of Left Ventricular Hypertrophy is associated with Higher Tei Index and Left Atrial Pressure in Left Ventricular Diastolic Dysfunction

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Disclosures

No conflict of Interest
Objective of the Study

To assess the impact of left ventricular hypertrophy (LVH) in global cardiac performance in patients with left ventricular diastolic dysfunction (LVDD).
Background of the study

- Approximately 40-50% of heart failure is due to left ventricular diastolic dysfunction (LVDD) with preserved systolic function\(^1\).

- Heart failure is a growing major public health problem with a rise in prevalence by 1% annually\(^2\).

\(^1\)Paulus WJ et al. Eur Heart J. 2007
Background of the study

- In heart failure, myocardial remodeling starts before the onset of symptoms.

- Early identification of subclinical LVDD and the timely medical intervention may reduce heart failure events.
Background of the study

LVDD is common in patients of:

- Advanced age
- Female gender
- Diabetes
- Obesity
- Hypertension
- Left ventricular (LV) hypertrophy

Biological/Physiological causes:
- Advanced age
- Female gender

Pathological Causes:
- Diabetes
- Obesity
- Hypertension
- Left ventricular (LV) hypertrophy
Although a variety of conditions are suggested to cause LVDD, it is still unclear if clinical implications of LVDD are same among different etiologies, especially between biological and pathological causes of LVDD.
Background of the study

- At times measurement of left ventricular dysfunction is difficult, however, Left Atrial (LA) pressure and Tei index correlate fairly well with the degree and severity of heart failure.

- Tei index, also known as Myocardial Performance index (MPI) is a Doppler derived time interval index of combined systolic and diastolic function.
In this study, we hypothesized that Left Atrial (LA) pressure and Tei index are higher in LVDD with LVH (pathological) than LVDD without LVH (biological).

We estimated LA pressure, Tei index and other echocardiographic parameters and compared between 2 groups.
Selection of study groups:

- Total 500 LVDD patients, of whom 250 patients with LVH and 250 patients without LVH, were randomly selected from our echo database.
Methodology

Patients’ with LVDD

Excluded
- Atrial Fibrillation
- Hypertrophic cardiomyopathy
- Tachycardia
- EF<50%
- Restrictive Pattern LVDD

LVH Group
- 250 Patients

Non-LVH Group
- 250 Patients

>1000 patients screened from Echo database
Exclusion from study groups:

- Patients with atrial fibrillation, tachycardia, and hypertrophic cardiomyopathy
- LV ejection fraction (EF) less than 50 %
- Patients of restrictive LVDD patterns were also excluded because Tei-index could become inaccurate
**Methodology**

- LVH was defined by LV mass index (g/m²) as per ASE guidelines [>88 in females and >102 in males]

- LVDD was defined by:
  - Abnormal $E/A$ (early diastolic filling)/A (late diastolic filling) velocities pattern, which is either reversed or pseudo-normalized in Pulse waved Doppler.
  - Abnormal $E'/A'$ (early diastolic)/A' (late diastolic) pattern by tissue Doppler.

Methodology

Normal mitral inflow pattern acquired by PW Doppler
Methodology

Tissue Doppler – Normal Profile
Methodology

**Diastolic Dysfunction Classification**

- Normal Diastolic Function Pattern
- Relaxation Deficit Pattern
- Pseudonormal Pattern
- Restrictive Pattern

**Mitral Flow**
- 0.75 < E/A < 1.5
- DTE > 140 ms

**Tissue Doppler**
- E/E’ < 10

**E/A**
- E/A ≤ 0.75
- 0.75 < E/A < 1.5
- E/A > 1.5

**DTE**
- DTE > 140 ms
- DTE < 140 ms
Methodology

- Left atrial pressure (LAP) was estimated by the formula: \[1.9 + 1.24 \times \left[ \frac{\text{early mitral inflow velocity (E)}}{\text{early mitral annular velocity (E')}} \right] \]\(^1\).

- Tei-Index was calculated by the formula: isovolumic contraction time plus isovolumic relaxation time divided by ejection time\(^2\). [Normal < 0.4 in adults]


Methodology
Methodology

\[ MPI = \frac{(a - b)}{b} \]
\[ = \frac{(ICT + IRT)}{ET} \]
Methodology

- Statistical analysis was done by the unpaired T-test and Chi-Square test
- IRB approval was obtained
## Results - Clinical Characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>LVH Group*</th>
<th>Non-LVH Group*</th>
<th>P Values**</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>72.03±13.663</td>
<td>68.1±14.131</td>
<td>0.002</td>
<td>1.481 to 6.367</td>
</tr>
<tr>
<td>Female</td>
<td>180 (72%)</td>
<td>157 (63%)</td>
<td>0.028</td>
<td>-0.174 to -0.01</td>
</tr>
<tr>
<td>African American</td>
<td>78 (31%)</td>
<td>75 (30%)</td>
<td>0.771</td>
<td>-0.069 to 0.093</td>
</tr>
<tr>
<td>Caucasian</td>
<td>151 (61%)</td>
<td>162 (65%)</td>
<td>0.308</td>
<td>-0.129 to 0.040</td>
</tr>
<tr>
<td>Other Races</td>
<td>21 (8%)</td>
<td>13 (5%)</td>
<td>0.155</td>
<td>-0.012 to 0.076</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>30.56±18.42</td>
<td>30.03±8.26</td>
<td>0.682</td>
<td>-1.98 to 3.032</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.31±1.25</td>
<td>1.13±0.86</td>
<td>0.067</td>
<td>-0.012 to 0.364</td>
</tr>
<tr>
<td>Tobacco abuse</td>
<td>100 (40%)</td>
<td>113 (45%)</td>
<td>0.278</td>
<td>-0.135 to 0.039</td>
</tr>
<tr>
<td>COPD</td>
<td>55 (22%)</td>
<td>68 (27%)</td>
<td>0.254</td>
<td>-0.12 to 0.032</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>118 (47%)</td>
<td>108 (43%)</td>
<td>0.42</td>
<td>-0.052 to 0.124</td>
</tr>
</tbody>
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*Values are Mean±1 SD or number(%)  
** P value significant at < 0.001
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<tr>
<td>Diabetes</td>
<td>80 (32%)</td>
<td>75 (30%)</td>
<td>0.63</td>
<td>-0.061 to 0.101</td>
</tr>
<tr>
<td>CAD</td>
<td>58 (23%)</td>
<td>53 (21%)</td>
<td>0.667</td>
<td>-0.057 to 0.089</td>
</tr>
<tr>
<td>Hypertension</td>
<td>218 (87%)</td>
<td>190 (76%)</td>
<td>0.001**</td>
<td>0.077 to 0.18</td>
</tr>
<tr>
<td>ACE-I/ARB</td>
<td>108 (43%)</td>
<td>115 (46%)</td>
<td>0.472</td>
<td>-0.119 to 0.055</td>
</tr>
<tr>
<td>Diuretics</td>
<td>90 (36%)</td>
<td>80 (32%)</td>
<td>0.299</td>
<td>-0.039 to 0.127</td>
</tr>
<tr>
<td>CCB</td>
<td>93 (37%)</td>
<td>70 (28%)</td>
<td>0.022</td>
<td>0.014 to 0.178</td>
</tr>
<tr>
<td>Beta-blocker</td>
<td>120 (48%)</td>
<td>85 (34%)</td>
<td>0.001**</td>
<td>0.054 to 0.226</td>
</tr>
<tr>
<td>Statins</td>
<td>118 (47%)</td>
<td>108 (43%)</td>
<td>0.369</td>
<td>-0.047 to 0.127</td>
</tr>
<tr>
<td>Aspirin/Plavix</td>
<td>110 (44%)</td>
<td>120 (48%)</td>
<td>0.37</td>
<td>-0.05 to 0.13</td>
</tr>
</tbody>
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Clinical characteristics of patient profiles

- **Age (years):**
  - LVH Group: 72.03
  - Non-LVH group: 68.1

- **BMI (Kg/m²):**
  - LVH Group: 30.56
  - Non-LVH group: 30.03

- **Creatinine (mg/dl):**
  - LVH Group: 1.31
  - Non-LVH group: 1.13

*P < 0.001
Clinical characteristics of patient profiles

- Female: LVH Group 72%, Non-LVH group 63%
- African American: LVH Group 31%, Non-LVH group 30%
- Caucasian: LVH Group 61%, Non-LVH group 65%
- Other Races: LVH Group 8%, Non-LVH group 5%

*P < 0.001
Clinical characteristics of patient profiles

- Tobacco abuse: LVH Group 40, Non-LVH group 45
- COPD: LVH Group 22, Non-LVH group 27
- Dyslipidemia: LVH Group 47, Non-LVH group 43
- Diabetes: LVH Group 32, Non-LVH group 30
- CAD: LVH Group 23, Non-LVH group 21
- Hypertension: LVH Group 87, Non-LVH group 76
- ACE-I/ARB: LVH Group 43, Non-LVH group 46
- Diuretics: LVH Group 36, Non-LVH group 32
- CCB: LVH Group 37, Non-LVH group 28
- Beta-blocker: LVH Group 48, Non-LVH group 43
- Statins: LVH Group 47, Non-LVH group 43
- Aspirin/Plavix: LVH Group 44, Non-LVH group 48

*P<0.001
### Results-Echocardiographic Indices

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</thead>
<tbody>
<tr>
<td>LV mass Index (g/m²)</td>
<td>118.91±27.49</td>
<td>72.47±13.74</td>
<td>0.0001**</td>
<td>42.61 to 50.25</td>
</tr>
<tr>
<td>LA size (cm)</td>
<td>3.8±0.67</td>
<td>3.53±0.68</td>
<td>0.0001**</td>
<td>0.14 to 0.38</td>
</tr>
<tr>
<td>PAP (mmHg)</td>
<td>36.59±11.76</td>
<td>34.176±9.27</td>
<td>0.02</td>
<td>0.38 to 4.46</td>
</tr>
<tr>
<td>EF (%)</td>
<td>63.82±6.88</td>
<td>64.87±7.29</td>
<td>0.1</td>
<td>-2.29 to 0.20</td>
</tr>
<tr>
<td>E/A</td>
<td>1.17±4.322</td>
<td>1.8±8.46</td>
<td>0.292</td>
<td>-1.81 to 0.55</td>
</tr>
<tr>
<td>IVRT (msec)</td>
<td>97.52±24.42</td>
<td>95.99±21.29</td>
<td>0.456</td>
<td>-2.49 to 5.55</td>
</tr>
<tr>
<td>DT</td>
<td>255.45±61.96</td>
<td>242.56±59.39</td>
<td>0.02</td>
<td>-23.54 to -2.21</td>
</tr>
<tr>
<td>E/E'</td>
<td>8.44±3.29</td>
<td>6.86±2.45</td>
<td>0.0001**</td>
<td>1.06 to 2.08</td>
</tr>
<tr>
<td>LAP</td>
<td>12.36±4.08</td>
<td>10.41±3.03</td>
<td>0.0001**</td>
<td>1.32 to 2.58</td>
</tr>
<tr>
<td>Tei-index</td>
<td>0.57±0.22</td>
<td>0.50±0.19</td>
<td>0.001**</td>
<td>0.02 to 0.37</td>
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Echocardiographic Indices of patients

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*P<0.001
**Echocardiographic Indices of patients**

- **LAP (mmHg)**: LVH Group 12.36, Non-LVH Group 10.41
- **E/E'**: LVH Group 8.44, Non-LVH Group 6.86
- **LA size (cm)**: LVH Group 3.8, Non-LVH Group 3.53
- **E/A**: LVH Group 1.17, Non-LVH Group 1.8
- **Tei-index**: LVH Group 0.57, Non-LVH Group 0.5

*P < 0.001
Summary of Results

1. There was no significant difference in left ventricular ejection fraction (EF), renal function, pulmonary arterial pressure or use of diuretics between the two groups.

2. HTN and use of Beta-blocker were more common in the LVH group.
Summary of Results

3. LA size, LAP, and Tei index were significantly greater in the LVH group.
LVDD patients have higher LAP and worsened global LV function when LVH is accompanied.
Conclusions

Our study suggests that biological LVDD may be more benign, with less adverse effects on the global cardiac function, when compared with pathological LVDD.

Worsened LVDD is an independent predictor of mortality\(^1\); Hence patients of pathological LVDD may benefit from close monitoring and early medical intervention.

\(^1\)Aljaroudi W, et al Circulation 2012
Further investigation will be needed to find whether this result can be extrapolated to LVDD of other pathological etiologies (i.e. obesity, diabetes, etc.)
Acknowledgements

- Keiko Saito, MD
- Echo Lab Staffs at Sisters of Charity Hospital
- Dr. Woodman & Dr. Qazi