A STUDY OF MYOCARDIAL FUNCTION BY ECHOCARDIOGRAPHY IN ELDERLY SUBJECTS
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Background and Objectives: Age related changes in cardiovascular function are known to occur in elderly subjects and the prevalence of diastolic abnormality is substantially higher than systolic component. The prevalence rate is about 3% in normal population. Due to various age related changes myocardial stiffness occurs which manifests as failure of myocardium to relax fully. This results in diastolic dysfunction, which may even progress to diastolic failure. This study was undertaken to determine age related changes in myocardial function in elderly subjects by Doppler echocardiography.

Methods: 100 subjects in the age group of 25 years to 65 years and above underwent 2D Echocardiography and Doppler testing.

Results: The results showed that there is a decrease in velocity of early diastolic filling (MF - E wave), ejection fraction, heart rate, and increase in velocity of late diastolic filling (MF - A wave), diameter of left atrium, left ventricle end systolic and end diastolic diameters, thickness of inter ventricular septum and posterior wall of left ventricle, systolic and diastolic blood pressures and pulse pressure. (P value < 0.0001 for all parameters).

Interpretation and Conclusion: All these changes indicate the presence of diastolic dysfunction in elderly age group which is a prelude to diastolic failure. Early interventions at this stage may prove to be more beneficial.

KEYWORDS: Doppler, 2D-Echocardiography, diastolic dysfunction, elderly, myocardial function.

ABSTRACT

INTRODUCTION
Aging is a natural phenomenon that every life undergoes. There is no universal definition of elderly, and no accurate biomarker for aging exists. The physiological changes associated with aging do not appear at a specific age and do not proceed at the same pace in all individuals. Most definitions of elderly are based on chronological age. The World Health Organization uses 60 years of age as elderly.

In India the average life expectancy has gone from 46.5 years in 1955 to 63 years in 2002. Hence the health care of elderly in the society has emerged as an increasingly important issue in the recent years. As the elderly proportion of our population expands, maintaining health and wellness of the aged will continue to be an important research priority in the near future. Age related changes in cardiovascular function are known to occur in elderly subjects and the prevalence of diastolic abnormality is substantially higher than systolic component. The prevalence rate is about 3% in normal population. Due to various age related changes myocardial stiffness occurs i.e. failure of myocardium to relax fully. This results in diastolic dysfunction, which may even progress to diastolic failure.
People with diastolic dysfunction are asymptomatic, and also the diastolic dysfunction is most often a prelude to diastolic failure. Therefore, early detection of diastolic dysfunction is important because interventions are likely to yield better results at this stage. This work was carried out to determine changes in diastolic filling as assessed by Doppler Echocardiography in elderly subjects and to establish the relationship between the age and diastolic function of heart.

MATERIALS AND METHODS
This study was undertaken by the Department of Physiology, Sri Venkateswara Medical College, Tirupathi in various institutions (SVRRGH, SVIMS, Bollineni Hospital, Anasuya Institute of Medical Sciences) for a period of 2 years. The subjects were out patients attending these institutions aged between 25 to 65 years and above, who volunteered to take part in the study. The approval of Medical ethics committee of S.V. Medical College, Tirupathi was taken. The procedure was explained and written consent was obtained from the subjects. All the subjects underwent a detailed clinical examination. The subjects were selected under the following criteria.

Inclusion Criteria:
1. Age between 25 years to 65 years and above.
2. Normal and Healthy individuals of both sexes.
3. BMI < 25.
4. Blood pressure within normal range for all age groups
5. No h/o of diabetes mellitus or other cardiovascular diseases.

Exclusion Criteria:
1. Age < 25 years.
2. H/o Hypertension.
3. H/o Diabetes mellitus.
5. BMI > 25.
6. Other Systemic Diseases

PROCEDURE OF EXAMINATION
After taking the written consent from the subjects. Detailed history of Hypertension, Diabetes mellitus, other cardio vascular diseases, drug therapy, life style, nutrition, health behavior and psychological factors was taken.

- Detailed clinical examination was done.
- Blood pressure was taken as a mean of two readings on the left arm, measured under standardized condition with the participant seated (after 5 minutes rest).
- Body mass index was calculated by the formula BMI = Weight (kgs)/ Height² (mts)
- The subjects were scrutinized based on the exclusion criteria and the subjects fit for the study were taken for Echocardiography.

- Echocardiogram was recorded in a standardized fashion in the presence of an eminent cardiologist.

Out of 112 subjects selected for the study, eight were first time diagnosed as hypertensive and six were found to have mild ischemic changes. 100 subjects were finally selected for the study.

Echocardiographic Measurements:
Two-dimensional Echocardiograms from standard left parasternal and apical windows were derived. M-mode echocardiograms, and Doppler recordings were performed by an expert sonologist on a commercially available Echocardiography. (Philips - Echo Doppler USA model No. MC MD 02AA, type: M2540 - 66500, Volts ~ 100 - 240; Frame rate: 50 - 60 Hz; A:1.0 - 0.6).

Measurements of M - mode guided calculation of Left ventricular mass were taken just below the tips of the mitral valve. Left ventricular internal end diastolic diameter (LV - EDD) and end systolic diameter (LV - ESD), Interventricular septal thickness (IVST), Left ventricular posterior wall thickness (LV - PWT), left atrial diameter (LA) and Left ventricular ejection fraction (LV - EF) were performed.

Doppler Echocardiographic recordings were performed by pulsed wave Doppler with the sample volume at the tips of the mitral valve in the apical four -chamber view. Early diastolic peak velocity (MF - E wave) and Late diastolic peak velocity (MF - A wave), and ratios of early and late diastolic velocities (E/A) were determined.
Statistical analysis:
The data of the Doppler Echocardiographic measurements, blood pressure and heart rate recordings was presented as mean and standard deviation for each age group. The younger age group was compared with the older age group by using unpaired t test and P value < 0.05 was considered significant.

RESULTS AND TABLES
The following are the results for Doppler Echocardiographic measurements, blood pressure and heart rate recordings.

Table 1: Echocardiographic parameters in all age groups.

<table>
<thead>
<tr>
<th>Age group (Years)</th>
<th>No. of subjects</th>
<th>MF-E (m/s) ± SD</th>
<th>MF-A (m/s) ± SD</th>
<th>MF-E/MF-A ± SD</th>
<th>LV-ESD (cm) ± SD</th>
<th>LV-EDD (cm) ± SD</th>
<th>LA (cm) ± SD</th>
<th>PW (cm) ± SD</th>
<th>IVS (cm) ± SD</th>
<th>EF% ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I 25 - 34</td>
<td>19</td>
<td>0.76 ± 0.01</td>
<td>0.43 ± 0.01</td>
<td>1.75 ± 0.05</td>
<td>3.15 ± 0.1</td>
<td>4.53 ± 0.16</td>
<td>3.01 ± 0.07</td>
<td>0.77 ± 0.01</td>
<td>0.87 ± 0.03</td>
<td>74.31 ± 2.7</td>
</tr>
<tr>
<td>Group II 35 - 44</td>
<td>16</td>
<td>0.69 ± 0.05</td>
<td>0.45 ± 0.01</td>
<td>1.5 ± 0.13</td>
<td>3.37 ± 0.18</td>
<td>4.67 ± 0.2</td>
<td>3.2 ± 0.12</td>
<td>0.81 ± 0.03</td>
<td>0.88 ± 0.02</td>
<td>72.92 ± 1.18</td>
</tr>
<tr>
<td>Group III 45 - 54</td>
<td>23</td>
<td>0.61 ± 0.03</td>
<td>0.47 ± 0.007</td>
<td>1.26 ± 0.07</td>
<td>3.32 ± 0.11</td>
<td>4.81 ± 0.13</td>
<td>3.44 ± 0.1</td>
<td>0.91 ± 0.03</td>
<td>0.89 ± 0.01</td>
<td>70.91 ± 1.12</td>
</tr>
<tr>
<td>Group IV 55 - 64</td>
<td>17</td>
<td>0.56 ± 0.04</td>
<td>0.49 ± 0.008</td>
<td>1.16 ± 0.08</td>
<td>3.00 ± 0.11</td>
<td>4.68 ± 0.11</td>
<td>0.97 ± 0.15</td>
<td>0.91 ± 0.04</td>
<td>68.52 ± 1.23</td>
<td></td>
</tr>
<tr>
<td>Group V 65 &amp; above</td>
<td>25</td>
<td>0.54 ± 0.03</td>
<td>0.51 ± 0.006</td>
<td>1.07 ± 0.07</td>
<td>3.88 ± 0.23</td>
<td>5.25 ± 0.19</td>
<td>3.96 ± 0.13</td>
<td>1.04 ± 0.06</td>
<td>0.92 ± 0.06</td>
<td>65.05 ± 3.89</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td>F value</td>
<td></td>
<td>128.37</td>
<td>149.96</td>
<td>201.99</td>
<td>60.23</td>
<td>61.73</td>
<td>238.38</td>
<td>174.47</td>
<td>22.01</td>
<td>110.19</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>0.62 ± 0.09</td>
<td>0.49 ± 0.02</td>
<td>1.33 ± 0.26</td>
<td>3.34 ± 0.29</td>
<td>4.90 ± 0.31</td>
<td>3.49 ± 0.36</td>
<td>0.91 ± 0.06</td>
<td>0.89 ± 0.05</td>
<td>69.05 ± 3.89</td>
</tr>
</tbody>
</table>

1. MF - E = MF - E wave  
2. MF - A = MF - A wave  
3. MF - E / MF - A = Ratio  
4. LV - ESD = Left Ventricular End Systolic Diameter  
5. LV - EDD = Left Ventricular End Diastolic Diameter  
6. LA = Left Atrial diameter  
7. PW = Left Ventricular Posterior Wall thickness  
8. IVS = Interventricular septal thickness  
9. EF% = Ejection Fraction percentage  
10. SD = Standard Deviation

Table 2: Shows blood pressure and heart rate values in all age groups.

<table>
<thead>
<tr>
<th>Age group (Years)</th>
<th>No. of subjects</th>
<th>SBP mmHg ± SD</th>
<th>DBP mmHg ± SD</th>
<th>PP mmHg ± SD</th>
<th>HR Per min ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I 25 - 34</td>
<td>19</td>
<td>111.78 ± 7.29</td>
<td>76.63 ± 7.57</td>
<td>36.15 ± 8.3</td>
<td>87.6 ± 3.48</td>
</tr>
<tr>
<td>Group II 35 - 44</td>
<td>16</td>
<td>118.12 ± 6.42</td>
<td>79.12 ± 7.22</td>
<td>40.82 ± 4</td>
<td>84.3 ± 4.44</td>
</tr>
<tr>
<td>Group III 45 - 54</td>
<td>23</td>
<td>127.56 ± 6.46</td>
<td>84.26 ± 4.31</td>
<td>43.31 ± 6.28</td>
<td>80.14 ± 8.94</td>
</tr>
<tr>
<td>Group IV 55 - 64</td>
<td>17</td>
<td>134.11 ± 3.77</td>
<td>87.64 ± 4.96</td>
<td>46.47 ± 4.38</td>
<td>77.56 ± 7.84</td>
</tr>
<tr>
<td>Group V 65 &amp; above</td>
<td>25</td>
<td>139.6 ± 2.3</td>
<td>90.64 ± 2.49</td>
<td>48.96 ± 2.77</td>
<td>74.08 ± 3.31</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>F value</td>
<td></td>
<td>87.28</td>
<td>27.64</td>
<td>19.95</td>
<td>45.26</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>127.18 ± 11.61</td>
<td>84.3 ± 7.78</td>
<td>42.88 ± 7.27</td>
<td>79.06 ± 13.01</td>
</tr>
</tbody>
</table>
Table 2. Shows blood pressure and heart rate values in all age groups. From this table it can be seen that systolic blood pressure, diastolic pressure, pulse pressure are all increasing with age and heart rate decreasing with age. These values are statistically significant (P value < 0.0001) for age group of 65 years and above.

**DISCUSSION**

The age related changes in cardiovascular system affect both systolic and diastolic function. Pumping of blood being the major function of heart during systole, the heart adapts to maintain the systolic function undisturbed. Even then mild decrease in systolic function is seen with age. In contrast the diastolic function varies grossly due to structural changes that occur in heart as age advances.9,10

In this study we are reporting Doppler Echocardiographic readings in a total of 100 subjects, out of these 47 are females and 53 are males. They were divided into five different age groups. The results shows that there is a decrease in velocity of early diastolic filling (MF-E wave), ejection fraction, and heart rate, and increase in velocity of late diastolic filling (MF-A wave), systolic and diastolic blood pressures, pulse pressure, diameter of left atrium, left ventricular end systole and end diastole diameters, thickness of inter ventricular septum and posterior wall of left ventricle.

In the normal young individuals early diastolic ventricular filling velocity (E wave) exceeds the late diastolic ventricular filling velocity (A wave) 11 and E/A ratio will be greater than 1.2.1 With impaired relaxation of left ventricle this ratio declines and the rate of decay of E wave velocities increase. 12,13 This impaired ventricular relaxation is due to age related molecular changes that occur in the ventricular myocardium i.e. collagen deposition, and extra cellular matrix changes contributing to loss of cells, hypertrophy of myocytes with changes in myosin sub forms and altered myocardial calcium handling 14 such as delayed intracellular ionized calcium uptake by cardiac myocyte sarcoplasmic reticulum due to decreased activity of SERCA2. 15,16,17,1 As the E wave velocities are decreasing, the heart adapts to maintain the normal cardiac output by increasing atrial contraction reflected as rise in A wave. 18

Doppler echocardiography reports in our study show that the MF-E wave is gradually decreasing from group I (0.76 +/- 0.01) to group V (0.54 +/- 0.03) with p value <0.0001, which indicates the decrease in velocity of early diastolic filling, and MF-A wave is increasing from group I (0.43 +/- 0.01) to group V (0.51 +/- 0.006) with p value < 0.0001, indicating the increased velocity of late diastolic filling. MF-E / MF-A ratio is decreasing in the study groups from group I (1.75 +/- 0.05) to group V (1.07 +/- 0.07) with p value <0.0001. These results match with the studies of MC Modena et al., M.Fischer et al., Prasad A et al. 19,5,14

Age related molecular changes also occur in the vascular system particularly in the aorta i.e. migration of activated vascular smooth muscle cells into the intima, increased matrix and collagen, loss of elastic fibers, increased fibronectin, and calcification. 16,1 These changes decrease elasticity and increase stiffness of arterial system. Loss of aortic elasticity results in increased impedance of ejection and raises systolic blood pressure. 20 Increased aortic stiffness imposes great afterload on the left ventricle, due to which the left ventricle is subjected to parietal tension. Thus left ventricle responds to this chronic elevated pressure by initial dilatation followed by gradual wall thickening. 21 This progressive concentric hypertrophy 22 of left ventricle prolongs relaxation time and decrease compliance 23 during diastole, resulting in reduced early diastolic filling rate. This major modification of diastolic dynamics is compensated by left atrial dilatation 24 and more vigorous atrial contraction to increase atrial contribution for the late diastolic filling. 4

In our study there is a gradual increase in thickness of left ventricular posterior wall (LVPW) from group I (0.77 +/- 0.01) to group V (0.97 +/- 0.15), and inter ventricular septum (IVS) form group I (0.87 +/- 0.03) to group V (0.89 +/- 0.05), indicating the slight hypertrophic changes in the left ventricle. There are also minor changes in the diameters of left ventricle and left atrium as the left ventricular end systolic diameter (LV-ESD) is increasing from the younger group to older group with the mean valves 3.15 +/- 0.1,
These changes may occur at an early age or may lead to diastolic failure when associated with risk factors like hypertension, diabetes mellitus, obesity and other cardiovascular diseases. Therefore early interventions at this stage may prove to be beneficial.

**Conflicts of interest:** None

**REFERENCES**

13. Marantz PR, Tobin JN, Derby CA, et al., Age- associat-