Original Article

A STUDY OF MYOCARDIAL FUNCTION BY ECHOCARDIOGRAPHY IN ELDERLY SUBJECTS

Venkata Mahesh Gandhavalla *[1], Chandra Sekhar Athikari [2], M. Venkatachalam [3], K. Munisekhar [4].

[1, 2] Assistant Professor, [3] Professor. Department of Physiology, S.V. Medical College, Tirupati, Andhra Pradesh, India.

[4] Tutor, Department of Physiology, SVIMS University, Tirupathi, Andhra Pradesh, India.

ABSTRACT

Back ground 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-Echocardiograhpy, diastolic dysfunction, elderly, myocardial function.

Address for correspondence: Dr. Venkata Mahesh Gandhavalla Assistant Professor of Physiology, S.V. Medical College, Tirupati, Andhra Pradesh, India. Phone: 9440535325,
Email: vmaheshgandhavalla@gmail.com

Access this Article online

Quick Response code

International Journal of Physiotherapy and Research
ISSN 2321- 1822
www.ijmhr.org/ijpr.html

Received: 05-03-2014 Accepted: 08-05-2014
Peer Review: 05-03-2014 Published: 11-06-2014

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.[1]

In India the average life expectancy has gone from 46.5 years in 1955 to 63 years in 2002. [2] 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,[3] 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.[4] The prevalence rate is about 3% in normal population.[5] Due to various age related changes myocardial stiffness occurs [6] 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.[7]

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 (SVRRGGH, 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.
4. H/o Cardio Vascular Disease.
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)/ Height^2 (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 [8] 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.

Age group (Years)	No. of subjects	MF - E (m/s) ± SD	MF - A (m/s) ± SD	MF-E / MF-A ± SD	LV-ESD (cms) ± SD	LV-EDD (cms) ± SD	LA (cms) ± SD	PW (cms) ± SD	IVS (cms) ± SD	EF% ± SD
Group I 25 - 34	19	0.76 ± 0.01	0.43 ± 0.01	1.75 ± 0.05	3.15 ± 0.1	4.53 ± 0.16	3.01 ± 0.07	0.77 ± 0.01	0.87 ± 0.03	74.31 ± 2.7
Group II 35 - 44	16	0.69 ± 0.05	0.45 ± 0.01	1.5 ± 0.13	3.37 ± 0.18	4.67 ± 0.2	3.2 ± 0.12	0.81 ± 0.03	0.88 ± 0.02	72.93 ± 1.18
Group III 45 - 54	23	0.61 ± 0.03	0.47 ± 0.007	1.26 ± 0.07	3.52 ± 0.11	4.81 ± 0.13	3.44 ± 0.1	0.91 ± 0.03	0.89 ± 0.01	70.91 ± 1.12
Group IV 55 - 64	17	0.56 ± 0.04	0.49 ± 0.008	1.16 ± 0.08	3.67 ± 0.08	5.05 ± 0.11	3.68 ± 0.11	0.97 ± 0.15	0.91 ± 0.04	68.52 ± 1.23
Group V 65 & above	25	0.54 ± 0.03	0.51 ± 0.006	1.07 ± 0.07	3.86 ± 0.23	5.25 ± 0.19	3.96 ± 0.13	1.04 ± 0.06	0.92 ± 0.06	65.05 ± 3.89
P value		< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
F value		128.37	149.96	201.99	60.23	61.73	238.38	174.47	22.01	110.19
Total	100	0.62 ± 0.09	0.49 ± 0.02	1.33 ± 0.26	3.54 ± 0.29	4.93 ± 0.31	3.49 ± 0.36	0.91 ± 0.06	0.89 ± 0.05	69.85 ± 3.89

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

Table1. Shows Echocardiographic parameters in all age groups. From this table it can be seen that MF - E velocity decrease and MF - A velocity increase with age. MF - E/ MF - A ratio decreases with age > 65 years. These values are statistically significant (P values < 0.0001) for age group of 65 years and above. Left ventricular end systolic diameter , Left ventricular end diastolic diameter, Left atrial diameter, Left ventricular posterior wall thickness, Interventricular septal thickness all are increasing with age 65 years and above, and ejection fraction decreases with age 65 years and above. These values are statically significant (P value < 0.0001).

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

Age group (Years)	No. of subjects	SBP mmHg ± SD	DBP mmHg ± SD	PP mmHg ± SD	HR Per min ± SD
Group I 25 - 34	19	111.78 ± 7.29	76.63 ± 7.57	36.15 ± 8.3	87.6 ± 3.48
Group II 35 - 44	16	118.12 ± 6.42	79.12 ± 7.22	40.82 ± 4	84.3 ± 4.44
Group III 45 - 54	23	127.56 ± 6.46	84.26 ± 4.31	43.31 ± 6.28	80.14 ± 8.94
Group IV 55 - 64	17	134.11 ± 3.77	87.64 ± 4.96	46.47 ± 4.38	77.56 ± 7.84
Group V 65 & above	25	139.6 ± 2.3	90.64 ± 2.49	48.96 ± 2.77	74.08 ± 3.31
P value		< 0.0001	< 0.0001	< 0.0001	< 0.0001
F value		87.28	27.64	19.95	45.26
Total	100	127.18 ± 11.61	84.3 ± 7.78	42.88 ± 7.27	79.06 ± 13.01

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 $SERCA_2$.[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.[1]

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,

3.86 +/- 0.23 respectively. Similarly the left ventricular end diastolic diameter (LV-EDD) is also increasing from group I (4.53 +/- 0.16) to group V (5.25 +/- 0.19), indicating mild left ventricular dilatation. The left atrial (LA) diameter is increasing from the group I (3.01 +/ - 0.07) to group V (3.96 +/- 0.13), indicating clear left atrial dilatation. These results are correlating with the results of M. fischer et al.[5] Gardin JM et al.,[25] Grandi AM et al.[26]

In this study there is a slight fall of ejection fraction in older group (65.05 +/- 3.89) when compared with the younger group (74.31 +/- 2.7). In a study by M.Fischer et al., he evaluated the ejection fraction in the older group as 64.5 +/- 7.2 with p value < 0.01,[5] which coincides with our results. As per Zipes also the ejection fraction declines with age and may be due to an acute increase in after load. [1]

Systolic blood pressure in our study showed steady increase from group I (111.78 +/- 7.29) to group V (139.6 +/- 2.3), indicating increased pressure in the left ventricle due to age related aortic wall changes. There is increase in diastolic blood pressure also from group I (76.63 +/- 7.57) to group V (90.64 +/- 2.49), reflecting the increased peripheral vascular resistance due to age related changes in the vessel wall. The pulse pressure is gradually increased in the study group from group I (36.15 +/- 8.3) to group V (48.96 +/- 2.77). These results correlate with the study of Landahl S. et al.,[27] & Ueda K. et al.[28]

In our study heart rate is decreasing from group I (87.6 +/- 3.48) to group V (74.08 +/- 3.31). This decrease in heart rate with age may be due to decreased SA node activity, [29] also the cells in the SA node are destroyed as many as 90% by the age of 75 years and sinoatrial conduction is decreased with age.[1] Dropout of atrial pacemaker cell with age resulting in a decrease in intrinsic heart rate. [30]

CONCLUSION

From the present study we conclude that there are age related changes in diastolic function of the Heart. When compared with young adults there is a definite decrease in the diastolic function (diastolic dysfunction) in elderly subjects.

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 beneficia

Conflicts of interest: None

REFERENCES

1. Zipes, "Pathophysiology of Aging", Braunwald's heart disease a text book of Cardiovascular medicine, seventh edition, page: 1925-1946, 187-210, 457-507,653,1491-92.
2. K.Park, "Life expectancy", Preventive and Social Medicine, eighteenth edition, Page – 355.
3. Christopher Haslett, " Principles of geriatric medicine", Davidson's principles and practice of medicine, 18th edition, page- 1066.
4. Villari B, Vassalli G, Schneider J, et al., " Age dependency of left ventricular diastolic function in pressure overload hypertrophy." J Am Coll Cardiol. 1997 Jan; 29 (1): 181- 6.
5. M.Fischer, A. Baessler, et.al. "Prevalence of left ventricular diastolic dysfunction in the community: Results from a Doppler echocardiographic – based survey of population sample", Eur. Heart.J. 2003, 24: 320 – 328.
6. Redfield MM, Jacobsen SJ, Borlaug BA, et al., "Age and gender related ventricular- vascular stiffening: a community-based study.", Circulation. 2005 Oct 11; 112 (15): 2254-62.
7. David E.Mohrman, "Effect of aging", Cardiovascular physiology, fourth edition, page – 189 – 190.
8. Sahn DJ. DeMaria A, Kisslo J, et al., The committee on M-mode standardization of the American Society of Echocardiography. Recommendations regarding quantitation in M-mode echocardiography: results of a survey of echocardiographic measurements. Circulation. 1978; 58: 1072-1082.
9. Morgan S, Smith H, Simpson I, et al., Prevalence and clinical characteristics of left ventricular dysfunction among elderly patients in general practice setting: cross sectional survey. BMJ. 1999 Feb 6; 318 (7180): 368-72.
10. Phillips E.Gates, Hirofumi Tanaka, Jayne Graves, et al., Left ventricular structure and diastolic function with human ageing. Eur Heart J. 2003 Dec; 24(24) : 2213-20.
11. Vlahovic A, popovic AD, Evaluation of left ventricular diastolic function using Doppler echocardiography. Med Pregl. 1999 Jan-Fed; 52(1-2): 13-8.
12. Kitzman DW, Sheikh KH, Beere PA, et al. Age – elated alterations of Doppler left ventricular filling indexes in normal subjects are independent of left ventricular mass, heart rate, contractility and loading conditions. J Am Coll Cardiol, 1991 Nov 1; 18(5); 1243 – 50.
13. Marantz PR, Tobin JN, Derby CA, et al., Age- associat-

ed changes in diastolic filling: Doppler E/A ratio is not associated with congestive heart failure in the elderly. South Med J. 1994 Jul; 87 (7): 728-35.
14. Prasad A, Popovic ZB, Arbab- Zadeh A, et al. The effects of aging and physical activity on Doppler measures of diastolic function. Am J Cardiol. 2007 Jun 15; 99 (12); 1629 – 36.
15. Lakatta EG, Sollott SJ. Perspective on mammalian cardiovascular aging: humans to molecules. Comp Biochem physiol A mol integr physiol, 2002 Aug; 132 (4); 699 – 721.
16. Mathew S. Maurer,MD, Daniel spevack, MD, et.al. "Diastolic dysfunction",J Am coll Cardiol, 2004;44:1543 – 1549.
17. Rengo F, Vitale D, Ferrara N, et al. Aging and left ventricular diastolic function. Cardiologia.1991 Dec; 36 (12 suppl 1); 247 – 53.
18. Abd El-Aziz TA. A-wave acceleration: a new Doppler echocardiographic index for evaluation of left ventricular diastolic dysfunction in elderly patients. Angiology. 2008 Aug-sep; 59 (4): 435-41.
19. Modena MG, Mattioli AV, Mattioli G. Right ventricular pacing and left ventricular filling pattern. An echo- Doppler study. Chest 1991; 100; 744-747.
20. Swine C. Aging of heart function in man. Presse Med, 1992 Jul 22; 21(26): 1261 – 21.
21. Svanborg A. Age- related changes in cardiac physiology. Can they be postponed or treated by drugs? Drugs Aging. 1997 Jun; 10(6): 463-72.
22. Ganau A, Saba PS, Roman MJ, et al., Ageing induces left ventricular concentric remodeling in normotensive subjects. J Hypertens. 1995 Dec; 13 (12 pt 2): 1818-22.
23. Andren B, Lind L, Hedenstierna G, et al., Left ventricular diastolic function in a population sample of Elderly Men. Echocardiography. 1998 Jul; 15 (5): 433- 450.
24. Gottdiener JS, Kitzman DW, Aurigemma GP, et al., Left atrial volume, geometry, and function in systolic and diastolic heart failure of persons >or= 65years of age (the cardiovascular health study). Am J Cardiol. 2006 Jan 1;97 (1) : 83-9.
25. Gardin JM, Henry WL, Savage DD,et al., Echocardiographic measurements in normal subjects: evaluation of an adult population without clinically apparent heart disease. J Clin Ultra Sound, 1979; 7: 439-447.
26. Grandi AM, Venco A, Barzizza F, et al., Influence of age and sex on left ventricular anatomy and function in normals. Cardiology.1992; 81 (1): 8 – 13.
27. Landahl S, Bengtsson C, Sigurdsson JA, et al. Age - related changes in blood pressure. Hypertension. 1986 Nov; 8 (11): 1044 – 9.
28. Ueda K, Omae T, Fujishima M. Physiological and biochemical changes in ageing – based on a population survey in a Japanese community, Hisayama. Ann Acad Med Singapore. 1987 Jan; 16 (1): 35 – 41.
29. G.K.Pal. Physiological changes in geriatric age group. Textbook of Medical physiology, first edition, page – 1054,180.
30. Cheitlin MD, Cardiovascular Physiology – changes with aging. Am J Geriatr Cardiol. 2003 Jan – Feb; 12 (1): 9 - 13.

How to cite this article:

Venkata Mahesh Gandhavalla, Chandra Sekhar Athikari, M. Venkatachalam, K.Munisekhar.A STUDY OF MYOCARDIAL FUNCTION BY ECHOCARDIOGRAPHY IN ELDERLY SUBJECTS. Int J Physiother Res 2014;2(3):561-66.