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A STUDY ON THE EFFECT OF AGE RELATED CARDIO VASCULAR CHANGES ON THE DOPPLER ECHO CARDIOGRAPHIC E-WAVE PATTERN IN NORMAL HEALTHY INDIVIDUALS

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ABSTRACT

Back ground and objectives: Cardiovascular changes occur as age advances resulting in the deviation of normal cardiac function. Both systolic and diastolic disturbances are expected, but diastolic filling defects are presented early without any clinical symptoms due to stiffening of myocardium and failure to relax fully. This can be identified by the echocardiography in the form of E-wave pattern changes. If this is not detected early, it may lead to abnormality, dysfunction and failure. The present study was done to detect these early changes in the E-wave pattern reflecting the left ventricular early diastolic filling velocity in normal healthy individuals by Doppler echocardiography.

Methods: Total 100 healthy individuals between 25 -75 years were selected for the study, and were subjected to 2D Doppler Echocardiography.

Results: The test results showed that there is a decrease in the left ventricular early diastolic filling velocity represented by E-wave and the corresponding increase in the left ventricular late diastolic filling velocity promoted by the atrial contraction represented as A-wave, supported by the increase in left atrial diameter. These results indicate the failure of left ventricular relaxation. It is also observed that there is gradual increase in left ventricular end systolic and diastolic diameters along with increase in systolic and diastolic blood pressures indicating the left ventricular wall and vascular stiffness. There is a decrease in E/A ratio, heart rate and ejection fraction but within physiological limits. P-value of all the parameters is < 0.0001.

Interpretation & Conclusion: The above results shows the age related changes in myocardium and blood vessels presented as decrease in elasticity and stiffness producing diastolic abnormalities without clinical symptoms in healthy individuals. So it is essential to detect these abnormalities early and intervene to prevent the dysfunction and failure.

KEYWORDS : 2D Doppler Echocardiography, Diastolic abnormality, Diastolic dysfunction, Diastolic failure.

INTRODUCTION

Aging is a continuous physiological process observed in every living being. Its onset and progress is not alike in all. Aging occurs in all functional systems of our body limiting the maximal capacity and decrease reserve capacity of an individual, which results in less ability to match the output in response to stress. The effects of aging are observed usually after 60 years of age. The proportion of the people aged 60 years and above is projected to increase 12% in 2015 to about 22% in 2050 globally[16]. Global average life expectancy increased 5.5 years from 2000 to 2016 reaching 72.0 years[17]. So health care of the aged has become more important in the recent years.

Cardiovascular diseases are the most frequently diagnosed and leading cause of death in elderly people above 65 years of age. The incidences of heart failure are approximately 80% in people aged 65 years and above, out of which one third of the cases are predominantly diastolic heart failure[18]. Diastolic heart failure with preserved systolic function is more common with slightly better prognosis. The prevalence rate of the diastolic abnormality in general population is 11.1% [3]. So early detection and timely intervention will promote the better quality of life in aged.

As the age advances the myocardium become stiff and fails to relax completely resulting in decreased compliance of the ventricle. During isovolumetric relaxation period of the diastole, required suction pressure is not generated in the ventricle leading to the decreased ventricular early diastolic filling velocity represented by the E-wave of the echocardiogram. Since the ventricles are not filled properly, blood if forcefully emptied into ventricle during late ventricular filling stage of the diastole causing the raise in ventricular late diastolic filling velocity represented by A-wave of the echocardiogram. The early sign of the diastolic abnormality is decrease in the ventricular early diastolic filling velocity[10] reflects as decrease in the amplitude of the E-wave detected by the Doppler echocardiography. Similarly vascular changes also occur resulting in raised blood pressures further increase the load on the heart.

Individuals with diastolic abnormality are mostly asymptomatic[10], since heart tries to maintain the systolic function. So, early recognition is essential to prevent dysfunction and failure. Treatment at this stage will also give better results. Hence this study is mainly aimed to identify the changes in the E-wave pattern in normal healthy individuals of different age groups reflecting the ventricular early diastolic filling velocities due to age related cardiovascular changes by the Doppler echocardiography.

MATERIAL & METHODS

This study was done by the department of Physiology, Guntur Medical College, Guntur in Government general hospital, Guntur for a period of 3 years. These subjects were selected from the out patients attending the hospital aged between 25 - 75 years, who volunteered for the study.

After the approval of the Medical ethics committee, Guntur Medical College, Guntur, the procedure was explained and written consent is obtained from the subjects. All the volunteers were thoroughly examined clinically before the procedure. Subject's selection was done as per the inclusion criteria.

INCLUSION CRITERIA:

1. Age between 25 – 75 years
2. Healthy normal individuals of both gender
3. BMI < 25
4. Blood pressure normal to that particular age
5. No H/o Diabetes mellitus, Hypertension, Cardiovascular, Renal and other systemic diseases
6. No H/o medication for any other ailments

Procedure: After obtaining the written consent from the volunteers detailed history of any ailments, profession, life style, nutrition, smoking, alcoholism, behavior and psychological factors were noted. A complete systemic examination was done.

Blood pressure was taken as average of three readings on the left arm under standard conditions in sitting position by mercury sphygmomanometer.

Body mass index was derived by the formula BMI = weight (Kg) / Height (m^2).

After completion of the clinical examination the selected subjects were listed for Doppler echocardiography. Doppler echocardiogram was recorded in a standard procedure under the surveillance of an eminent Cardiologist.

Doppler echocardiographic measurements: 2D echocardiographic recordings from left parasternal and apical windows were taken. An expert sonologist has done the M-mode echocardiogram and Doppler recording on the commercially available Echocardiograph. (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).

M-mode guided measurements of left ventricular mass were taken just below the mitral valve. Left ventricular chamber end diastolic diameter (LVEDD) and end systolic diameter (LVESD), Inter ventricular septal thickness (IVS), Left ventricular posterior wall thickness (PW), left atrial diameter (LAD) and Left ventricular ejection fraction (EF) were recorded.

Doppler echocardiographic recording in the apical four-chamber view was done by pulsed wave Doppler with the sample volume at the tips of the mitral valve. Early diastolic filling velocity (E-wave) and Late diastolic filling velocity (A-wave), and ratio of early and late diastolic velocities (E/A) was recorded.

STATISTICALANALYSIS:
The Doppler Echocardiographic measurements, heart rate, and blood pressure recording data were presented as mean and standard deviation (SD) 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.

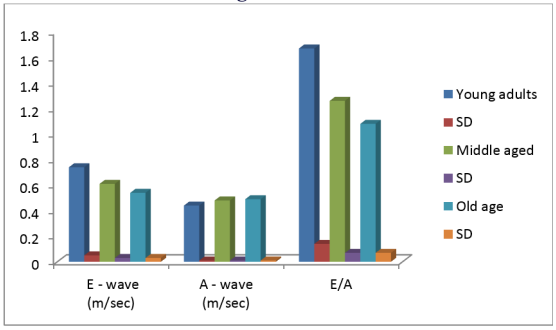
RESULTS:
The parameters of different age groups are tabulated in the following.

Table.1: Doppler echocardiographic measurements

Age group (years)	Number of subjects	LVEDD (cms) ± SD	LVESD (cms) ± SD	LAD (cms) ± SD	PW (cms) ± SD	IVS (cms) ± SD	EF (%) ± SD	E-Wave (m/s) ± SD	A-Wave (m/s) ± SD	E/A ± SD
Young adults (25 - 40)	31	4.55 ± 0.16	3.21 ± 0.14	3.07 ± 0.11	0.78 ± 0.02	0.87 ± 0.02	72.25 ± 3.45	0.74 ± 0.05	0.44 ± 0.01	1.67 ± 0.14
Middle age (40 - 60)	35	5.0 ± 0.13	3.61 ± 0.1	3.47 ± 0.13	0.91 ± 0.04	0.89 ± 0.02	67.80 ± 1.23	0.61 ± 0.03	0.48 ± 0.01	1.26 ± 0.07
Old age (60 - 75)	34	5.2 ± 0.19	3.77 ± 0.24	3.9 ± 0.14	1.02 ± 0.05	0.95 ± 0.07	64.47 ± 1.76	0.54 ± 0.03	0.49 ± 0.01	1.08 ± 0.07
P – value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table.1: From these Doppler echocardiographic measurements it is observed that there is gradual decrease in the early diastolic filling velocities (E-wave) and increase in the late diastolic filling velocities (A-wave) with a corresponding in decrease in E/A ratio from the young adults to old age group. These values are statistically significant with P-value <0.0001. The left ventricular end diastolic diameter, left ventricular end systolic diameter, left atrial diameters is increased. Increase in the thickness of the left ventricular posterior wall and inter ventricular septum is seen, but the ejection fraction is decreased along with the age. These values are also statistically significant with P-value <0.0001.

Figure.1:



This bar diagram clearly presents the decrease in the Left ventricular early diastolic filling velocity (E-wave), increase in the Left ventricular late diastolic filling velocity (A-wave) and decrease in the E/A ratio from young adults to old age,

Table.2: Other parameters

Age group (years)	Number of subjects	HR (Beats /min) ±SD	S.BP (mmHg) ± SD	D.BP (mmHg) ± SD	PP (mmHg) ± SD
Young adults (25 - 40)	31	87.03 ± 3.92	114.12 ± 7.55	76.51 ± 7.04	37.61 ± 7.41
Middle age (40 - 60)	35	76.80 ± 5.66	128.05 ± 7.21	86.11 ± 5.52	41.94 ± 6.14
Old age (60 - 75)	34	74.11 ± 4.59	138.17 ± 3.66	89.52 ± 4.06	48.64 ± 2.90
P – value		<0.0001	<0.0001	<0.0001	<0.0001

HR : Heart rate
S-BP : Systolic blood pressure
D-BP : Diastolic blood pressure
PP : Pulse pressure

Table.2: These results show that there is increase in the systolic blood pressure, diastolic blood pressure and pulse pressures as the age advances with decrease in the heart rate. All these results are statistically significant with P-value <0.0001.

DISCUSSION
As age advances cardiovascular changes occur in body causing both systolic and diastolic abnormalities, but more frequently diastolic[12,3]. Heart tries to adapt structurally to maintain the systolic function undisturbed; even then there will be mild decrease in the systolic function with a gross change in diastolic. As age advances the ventricular wall becomes stiff and fails to relax completely due to age related molecular changes occur in the myocardium like collagen deposition, changes in extra cellular matrix, hypertrophy of myocytes with altered myocardial calcium handling[18,11]. Age related molecular changes are also seen in the vascular system particularly in the great

vessels i.e increased matrix and collagen, loss of elastic fibers, increased calcification[18,9]. These changes decrease elasticity and increase vascular stiffness. The loss of compliance results in increased impedance for ejection and raises the systolic blood pressure[14]. Increased vascular resistance imposes great afterload on the left ventricle, due to which the left ventricle is subjected to parietal tension. This chronic elevated pressure on left ventricle initially dilates followed by gradual hypertrophy[4,13]. This hypertrophy of left ventricle prolongs relaxation time and decrease compliance during diastole, resulting in reduced early diastolic filling rate[18,1]. This major change in diastolic dynamics is compensated by left atrial dilatation and more vigorous atrial contraction occurs to increase atrial contribution for the late diastolic filling[18,6].

In ours study "***A study on the effect of age related cardio vascular changes on the Doppler echocardiographic E-wave pattern in normal healthy individuals***" we are presenting the Doppler echocardiographic reading of 100 individuals in three groups, young adults between 25 – 40 years, Middle age 40 – 60 years and old age 60 – 75 years of age. These results clearly show the decrease in early diastolic filling velocity (E-wave) and corresponding increase in the late diastolic filling velocity (A-wave) with a decrease in the E/A ratio. There is also increase in the systolic blood pressure, diastolic blood pressure and pulse pressures with a related increase in the left ventricular end diastolic diameter, left ventricular end systolic diameter and left atrial diameter along with increased thickness in the left ventricular posterior wall and inter ventricular septum. Heart rate and ejection fraction is decreased, but within physiological range.

In young adults end diastolic filling velocity (E-wave) will be greater than the late diastolic filling velocity (A-wave) and E/A ratio will be more than 1.2. Where as in old age, the age related myocardial changes hinder the fall of intra ventricular pressure during the isovolumetric relaxation period of the diastole, dampening the early diastolic filling velocity that reflects as decrease in the amplitude of the E-wave. As the ventricles are not filled properly during early diastolic filling stage, more blood is pumped during the late diastolic filling stage which correspond the atrial systole of the cardiac cycle increase the late diastolic filling velocity A-wave. Due to these numerical change in the E and A waves the E/A ratio is decreased.

In the present study the E-wave is decreased from the young adult group 0.74 ± 0.05 m/sec to old age group 0.54 ± 0.03 m/sec with p value <0.0001, this reflects the decrease in the Early diastolic filling velocity. A-wave is increased from the young adult group 0.44 ± 0.01 m/sec to old age group 0.49 ± 0.01 m/ sec with p value <0.0001 presents the increase in the Late diastolic filling velocity. E/A ratio is decreased in the study from the young adult group 1.67 ± 0.14 to old age group 1.08 ± 0.07 with p value <0.0001. These results are concurring with the studies of M.Fischer et al., Downes TR et al., Andren B et al[1,3,6].

Systolic blood pressure shows great increase in our study from young adult group 114.13 ± 7.55 mmHg to old age group 138.17 ± 3.66 mmHg, indicating aortic wall stiffness imposing impedance to ventricular output. Diastolic blood pressure is increased from young adult group 76.51 ± 7.04 mmHg to old age group 89.52 ± 4.06 mmHg, reflecting the increased peripheral vascular resistance. The pulse pressure is also increased from young adult group 37.61 ± 7.41 mmHg to old age group 48.64 ± 2.90 mmHg. P value of these parameters is <0.0001. These results are matching with the studies of Landahl S. et al., Ueda K. et al[8,15].

Left ventricular end diastolic diameter (LVEDD) is increased from young adult group 4.55 ± 0.16 cms to old age group 5.20 ± 0.19 cms. Similarly the left ventricular end systolic diameter (LVESD) is increased from young adult group 3.21 ± 0.14 cms to old age group 3.77 ± 0.24 cms, indicating mild left ventricular dilatation. The left atrial diameter (LAD) is also increased from young adult group 3.07 ± 0.11 cms to old age group 3.90 ± 0.14 cms, indicating clear left atrial dilatation. Increased thickness of left ventricular posterior wall (PW) from young adult group 0.78 ± 0.02 cms to old age group 1.02 ± 0.05 cms, and inter ventricular septum (IVS) form young adult group 0.87 ± 0.02 cms to old age group 0.95 ± 0.07 cms is observed in this study, indicating hypertrophic changes in the left ventricle. P value for these readings is < 0.0001. These results are correlating with the results of Gardin JM et al., M. fischer et al., Grandi AM et al[5,3,7].

There is a decrease in ejection fraction form young adult group 72.25 ± 3.45% to old age group 64.47 ± 1.76% with p value < 0.0001 in this study may be due to an increase in the after load. This is coinciding with the study of M.Fischer et al[3]. Heart rate is also decreased form young adult group 87.03 ± 3.92 beats/min to old age group 74.11 ± 4.5 beats/min with p value < 0.0001 may be due to decreased SA node activity, and decreased sino-atrial conduction with age[18].

CONCLUSION

From this study we conclude that age related cardiovascular changes lead to diastolic abnormalities in heart. When compared with young adults there is a clear decrease in the early diastolic filling velocity E-wave in elderly subjects, which may be the early sign of the diastolic abnormality. These individuals are asymptomatic with almost normal systolic function. If this is not identified and attended at this stage, it may lead to diastolic dysfunction and failure. Comorbid conditions like hypertension, diabetes mellitus which are common in the old age will accelerate these changes. So early detection and timely intervention will definitely improve the quality of life in aged and improve the longevity of the individual.

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