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Original Article

Physiology Section

Study to Predict Vascular Dysfunctions in High Risk Young Adults- An Immediate Non-Invasive Investigation to Prevent Early Vascular Ageing

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ABSTRACT

Introduction: Normal vascular is associated with gradual change of vascular structure and function, resulting in increased arterial stiffening and decreased arterial compliance. Arterial stiffness is a marker of vascular ageing and a predictor of cardiovascular events. Premature or early vascular ageing is measured by pulse wave velocity or the arterial augmentation index based on pulse wave analysis.

Aim: To study the predictor of vascular dysfunctions in high risk young adult offsprings of type 2 diabetes mellitus and hypertensive parents.

Materials and Methods: The analytical cross-sectional studies were carried out in 90 subjects (45 males and 45 females), aged 18–25 years. They were divided into three groups based on their family history, known case of type 2 DM or hypertension in their parents. Group 1- control, Group 2- DM, Group 3-Hypertensive. In all subjects, anthropometrical data, blood pressure and peripheral pulse wave velocity were measured. One-way ANOVA was applied to determine the predictor factors of pulse wave velocity within and between groups. The following parameters were included in these analyses: age, gender, body mass index, hip waist index, heart rate, blood pressure and pulse wave velocity.

Results: A post-test analysis revealed that peripheral pulse wave velocity (PWV), early part of systolic phase (P1) was increased significantly than later part systolic phase (P2), p-value in both diabetic and hypertensive groups were compared with control group. ($p \leq 0.001$, ANOVA) Augmentation index (P2/P1) was also increased significantly in both diabetic and hypertensive groups than control group ($p \leq 0.001$, ANOVA).

Conclusion: The findings of present study suggest that, although related, peripheral augmentation index AIx and PWV provide early identification of high risk groups. Implication of life style modification is the first intervention to consider in adults followed by drug therapy to control risk factors. Specifically, AIx might provide a more sensitive marker of arterial aging in younger individuals.

Keywords: Augmentation index, Pulse wave velocity, Vascular dysfunctions

INTRODUCTION

Normal vascular aging is associated with gradual change of vascular structure and function, resulting in increased arterial stiffening and decreased arterial compliance. Arterial stiffness is a marker of vascular ageing and a predictor of cardiovascular events. In susceptible individuals with a family history of diabetes and hypertension, the vascular aging process occurs more rapidly. These types of premature or early vascular aging (EVA) eventually results in premature cardiovascular manifestations. This process is measurable by using physiological methods such as pulse wave velocity (PWV) or the arterial augmentation index (AIx) based on pulse wave analysis, as a marker of arterial stiffening and endothelial functions [1]. Arterial stiffness is a general term for the elasticity or compliance of the arteries. In healthy and compliant arteries the pressure waves (generated by the left ventricle) travel through the arterial tree and are reflected at multiple peripheral sites. As a result, the arterial pressure waveform at any site is a combination of the forward travelling waveform and the backward or reflection waveform [2]. PWV is a measure of the velocity of the arterial pressure waves passing along the aortic pathway. Increased arterial pressure wave velocity is indicative of harder arteries. The popular instrument for calculating PWV is non-invasive method of applanation tonometry. PWV is calculated using the average time difference and the arterial path length between the both measurement sites [3]. Measurement of the aortic pressure waveform gives measurement of central arterial pressure and hall mark of systemic arterial stiffness, such as Augmentation Pressure (AP) and Augmentation Index (AIx). These parameters are related to the reflected pressure waves from the peripheral arterial system [4].

Pulse pressure (an indirect measure of arterial stiffness) is a robust predictor of cardiovascular events [5]. Previous studies have reported that early vascular aging was found in young patients with primary hypertension in comparison with age- and sex-matched normotensive adults [6].

AIMS AND OBJECTIVES

1. To screen early and identify the high risk young adult off springs of Type 2 diabetes mellitus (DM) and hypertensive (HT) parents.
2. To find out and correlate the impact of waist hip ratio (WHR) on mean arterial pressure, pulse pressure and resting heart rate in young adult off springs of Type 2 DM and hypertensive parents with age matched healthy controls.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, Chennai Medical College Hospital and Research Centre, Trichy, Tamil Nadu, India, between April-Oct 2014.The study was started after getting approval from institutional ethical committee. Primary sampling unit in the study were the students of three colleges viz, a Medical, Engineering and an Arts college. The students enrolled in the students register was taken as the sampling frame. Students between the age group 18–25 years of both genders were taken as sampling unit.

Inclusion criteria

1. Young adult offsprings (both male and female) of known hypertensive parents (either father and mother or both).
2. Young adult off springs (both male and female) of known Type 2 diabetic parents (either father and mother or both).

Exclusion criteria

1. History of any other chronic illness.
2. Smokers and alcoholics.
3. Subjects currently on medication against systemic diseases.
4. The subjects who were found to be both diabetic and hypertensive.

Procedure

Analytical cross-sectional study was conducted in the Department of Physiology, in a tertiary care teaching hospital. The students were selected by using simple randomized sampling method. On the day of assessment, participants reported to the Department of Physiology, Chennai Medical College Hospital and Research Centre between 10 and 12 AM, at least two hours after breakfast. Students were taken based on simple random technique by using random number tables. Estimated sample size was 90 and divided into three groups based on a structured questionnaire to identify the presence of type 2 DM or hypertension in their parents.

Group 1 = Control group

Group 2= Young adult off springs (both male and female) of known Type 2 diabetic parents.

Group 3= Young adult off springs (both male and female) of known hypertensive parents.

The volunteers were explained in detail about the study protocol and informed consent was obtained from them. All the students participated voluntary and anonymously. Then, the below -mentioned parameters were recorded. We administered these tests in the following order as are given here, to all the participants.

The following parameters were used for data collection.

1. Anthropometry [7]:

- Body mass index (BMI) was calculated by the formula Weight (kg)/Height (m^2)
- Waist to hip ratio (WHR).

2. Physiological parameters:

- Resting heart rate, systolic blood pressure, diastolic blood pressure, means arterial blood pressure, pulse pressure.
- Arterial wave form analysis: The PPG signals were taken from the individual using Photoplethysmography unit with a sampling rate of 1000 samples/second. The frequency response for PPG it was 0.05-10Hz. It was obtained by using reflection type PPG sensor, these signal are amplified using a PPG amplifier and were interfaced with the PC using DAQ (NI USB-6009), The NI USB-6009 was a USB (Universal Serial Bus) based data acquisition (DAQ) and control device with analog input and output and digital input and output. The signals were then acquired using Lab VIEW software and aids in real time implementation and augmentation index was calculated.
- (Peripheral augmentation index (pAI) is defined as the ratio of late systolic pressure (P2) to early systolic pressure (P1): pAI = P2 / P1) [8-10].

STATISTICAL ANALYSIS

The data were entered in Microsoft Excel. Statistical analysis was carried out by using Statistical Package for Social Sciences (IBM SPSS Statistics 21). Both descriptive and inference statistical analysis were used to analyse the data. The descriptive data was presented as frequencies and percentages. The normality of the continuous data was tested using Kolmogorov Smirnov test. The normally distributed continuous data was presented as mean with standard deviation. An unpaired t-test was done to compare parameters between male and female subject's values. One-way ANOVA was performed to analyse the data. P-value ≤ 0.05 was considered as significant.

RESULTS

The results of our study were much in accordance with previous studies. The mean age was 18.00±0.50yrs. Average BMI was 21.10 ±3.44 for male, 20.13 ±3.31in case of female. [Table/Fig-1] shows that, a post-test analysis revealed that peripheral PWV, early part of systolic phase (P1) was increased significantly than later part of systolic phase (P2), p-value in both diabetic and hypertensive groups were compared with the control group (p≤0.001, ANOVA). Augmentation index (P2/P1) was also increased significantly in both diabetic and hypertensive groups than control group (p≤0.001, ANOVA). There were no significant differences found in HR, SBP, DBP, BMI, W/H ratio in all three groups. [Table/Fig-2] compares the anthropometric and physiological parameters between male and female group (gender difference). In males; WHR was increased (0.826±0.05) and HR was decreased (74.28±13.52) significantly

Parameters n=90	C (30) =1	DM (30)=2	HT(30) =3	F/df	p-value
BMI	20.47±3.28	20.47±4.01	20.91±2.88	.164/ (2,87)	0.849
WH Ratio	0.788±0.011	0.796±0.014	0.791±0.09	.099/ (2,87)	0.906
HR	77.06±1.92	81.9±2.28	76.4±2.373	1.854/ (2,87)	0.163
SBP	117.53±2.09	120.46±2.45	123.6±2.40	1.705/ (2,87)	0.188
DBP	68.43±1.23	69.93±1.64	72.03±1.61	1.434/ (2,87)	0.244
Peak1 (Early Systolic)	3.09±0.136	3.12±0.147	3.16±0.09	9.252/ (2,87)	.001***
Peak2 (Late Systolic)	2.79±0.127	3.12±0.147	3.16±0.09	2.691/ (2,87)	0.073
Augumentation Index	0.902±0.006	0.842±0.004	0.816±0.010	23.596/ (2,87)	.001***

[Table/Fig-1]: Parameters of different group analysis (within and between) by One-way ANOVA. (C=1, DM=2, HT=3)
(Control group =1, Diabetic group=2, Hypertension group=3).
HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, P1 early systolic peak, P2 (late systolic peak), Augmentation index (P2/P1) (*p≤0.05.,**p≤0.01,***p≤0.001)

Parameters n=45	M1, F2	Mean ± SD	Sig.(2-tailed) p-value	95% Confidence Interval of the Difference	
				Lower	Upper
BMI	1	21.10±3.44	.176	-.44307	2.38929
	2	20.13±3.31			
WH Ratio	1	0.826±0.05	.001***	.0466271	.0921223
	2	0.757±0.05			
HR	1	74.28±13.52	.001***	-13.15627	-3.51039
	2	82.62±9.05			
SBP	1	118.44±12.25	.123	-9.51020	1.15464
	2	122.62±13.18			
DBP	1	71.13±8.47	.256	-1.47574	5.47574
	2	69.133±8.11			
Peak 1 (Early Systolic)	1	3.45±0.72	.303	-.49966	.15743
	2	3.62±0.841			
Peak 2 (Late Systolic)	1	3.00±0.683	.719	-.34689	.24022
	2	3.05±0.717			
Augumentation Index	1	0.86±0.066	.114	-.005023	.045892
	2	0.84±0.05			

[Table/Fig-2]: Comparison of anthropometric and physiological parameters between Male and Female group (Gender Difference)
An unpaired t-test was done to compare parameters between male and female subject's values. HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, P1 early systolic peak, P2 (late systolic peak), Augmentation index (P2/P1) (*p≤0.05.,**p≤0.01,***p≤0.001)

than females (0.757±0.05) (82.62±9.05) respectively (p≤0.001, unpaired t-test). There were no significant differences found in BMI, SBP, DBP, P1 early systolic peak, P2 (late systolic peak), augmentation index (AIx) in both groups.

DISCUSSION

Previous cross-sectional study of aortic pulse-wave velocity (PWV) was shown to be associated with cardiovascular risk, as calculated from the Framingham equations [11]. Our study finding was concordance with Satoru S et al., have reported that the recent methods for measurement of arterial stiffness, described the physiological mechanisms that utilize arterial stiffness as an independent marker of cardiovascular disease [12]. Manimegalai et al., found that the arterial stiffness could produces cardiac disorders, the severity of stiffness can be obtained by measuring the augmentation index of a pulse wave. Augmentation Index is a primary factor to develop future risk for cardio vascular dysfunction. The degree of arterial stiffness was calculated for estimating cardiac risk of the patient [13]. The present study suggests that early diagnosis of high risk young adults who were more prone for vascular dysfunctions should be identified. This study shows that the significant impact of waist hip ratio, heart rate, blood pressure on pulse wave velocity and augmentation index in study group as compared with age matched healthy controls. Age and large artery stiffness was independent key predictor of cardiovascular mortality [13-19].

Aortic PWV and AIx can be assessed by different non-invasive techniques. Central AIx was one of the most sensitive markers of arterial aging in younger individuals. The traditional approach to reduction of risk of cardiovascular disease events has been done by screening of healthy population for risk factor and intervene with non-pharmacological approach for those whose measurements level were defined as normal (primary prevention) or intensive pharmacological approach those individuals who have suffered from cardiovascular event (secondary prevention) [20]. Mean blood pressure played an important role for determination of higher PWV in young adults. These findings suggest that the non-invasive analysis of the vascular structure and function by measuring PWV can be useful for the identification of early vascular involvement in young individuals [21]. This study measure arterial stiffness and endothelial function using non-invasive technique with help of previous study literature [22].

LIMITATION OF THE STUDY

There is a need to study and compare with other factors that affect the early vascular aging. The study fails to record and analyse the resting short term HRV (Heart rate variability), which may help to support the present study findings.

CONCLUSION AND RECOMMENDATION

The primary prevention of premature vascular aging is done by early screening of high risk young adults. Introduction of early non-pharmacological modifiable life style intervention which helps to reduce the incidence of early arterial aging in advance. The pharmacological therapy will be useful to control risk factors such as hypertension, diabetes and metabolic syndrome in addition to the conservative management. Measurement of waist circumference and PWV are important reliable predictor of subclinical atherosclerosis in obese young adults. This study showed significant difference in pulse wave velocity of both men and women.The above mentioned interventions should start in acute phase in life to prevent further risk of cardiovascular problem, maintain good quality of life and increase the life expectancy of young adult offsprings of known type 2 DM and hypertensive parents. Our findings suggest that, although related, AIx and PWV provide different information. Specifically, AIx might provide a more sensitive marker of arterial aging in younger individuals.

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