

Effect of Obesity on Electrocardiographic P-Wave Dispersion among Healthy Adults

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Abstract

Background: Obesity has a strong impact on cardiovascular changes which is manifested in electrocardiogram (ECG). P-wave dispersion (Pd or PWD) is a non-invasive ECG marker for atrial remodelling and predictor of atrial fibrillation (AF). PWD is defined as the difference between the maximum and minimum P-wave duration recorded from the 12 ECG leads.

Aims and Objectives: To study the variations in electrocardiographic P-wave duration and dispersion in relation to obesity and to find out significance of these variations.

Materials and Method: A comparative cross-sectional study were conducted among 80 healthy adults of 18 to 40 years age groups. These adults were further divided into two group non-obese and obese according to their BMI. ECG recording was done for each subject and P-wave duration and dispersion were calculated in the department of physiology I.G.I.M.S, Patna.

Results: Statistically parameters were analysed by independent samples test. We found significantly higher P-wave dispersion in obese group in comparison to non-obese group ($p < 0.001$).

Conclusion: Obesity lead to prolongation of P-wave duration even in younger healthy adults. This prolongation of the P-wave duration increases the possibility of left atrial enlargement and atrial fibrillation. Hence the present study helps in creating awareness among obese so that they can change their lifestyle in order to prevent the onset of the deleterious effects of obesity on their health.

Keywords: Obesity, BMI, ECG, P-wave, P-wave dispersion, Atrial fibrillation

Introduction

Obesity is defined as a disease process in which excess body fat has accumulated to an extent that health may be adversely affected. According to WHO classification of body mass index (BMI) a person whose BMI is more than or equal to 30 Kg/m² is obese and when BMI is between 18.5 to 24.99 then the person is considered normal¹. Obesity is the first wave of a defined cluster of non-communicable diseases called 'New World Syndrome's creating an enormous

socioeconomic and public health burden². It has a strong impact on cardiovascular changes which is manifested in electrocardiogram (ECG)³. Currently it is a serious public health problem with established cardiovascular co-morbidities and a major cause of sudden death in developed as well as developing countries⁴. According to the National Family Health Survey-4 (NFHS-4) in 2015-16 conducted by Ministry of Health and Family Welfare (MOHFW) in India, the percentage of men and women aged 15-49 years who are obese are 19% and 21% respectively⁵. In a large prospective study 'Framingham Heart study' there is evidence for inclusion of obesity as a major modifiable cardiovascular risk factor by American Heart Association and also sudden cardiac death has been reported 40 times higher in obese men and women⁶. Wang et al⁷ and Seyfeli et al⁸ have showed that obesity as

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a potential risk factor for atrial fibrillation (AF) and P-wave dispersion is highly specific in screening healthy obese individuals for the risk of cardiovascular diseases.

It has been observed for more than last fifty years that obesity induces changes in the normal ECG pattern in young healthy adults⁹. Pd is a measure of heterogeneity of atrial refractoriness and prolongation of Pd shows the intraatrial and interatrial non-uniform conduction. Studies have shown that Pd prolongation is an independent risk factor for development of atrial fibrillation¹⁰. Few studies have been conducted on effect of obesity on the duration and dispersion of P-wave and it is non-invasive and cost effective tool for early detection of patients who are at risk of cardiac arrhythmias and it is also important for developing country like India. Therefore, this study was undertaken to investigate the dispersion of P-wave in healthy young adults in order to prevent them for the risk of cardiovascular disease in future.

Materials and Method

The study was conducted in the Department of Physiology, Indira Gandhi Institute of Medical Science, Patna. Design of the study was cross - sectional observational and a total 80 young healthy adults both male and female aged between 18 to 40 years participated voluntarily in the study. The study protocol was approved by the Institutional ethical committee. Written informed consents were taken from all the participants after explaining the study protocol.

Subjects were divided into two groups based on the BMI:

Group A – Normal/Non-obese (BMI: 18.5 – 24.99kg/m²) =40 (20 males and 20 females)

Group B – Obese (BMI \geq 30kg/m²) =40 (20 males and 20 females)

Subjects with history of cardiovascular disease, respiratory disease, thyroid disorder, diabetes, smoking, neuropsychiatric disorder, menstrual abnormality etc were excluded from study.

Methods of collection of data:

Measurement of BMI:

Body weight was measured on portable weighing machine without shoes and lightly clothed, and height

was measured in barefoot using stadiometer. The subject stood against a standard meter scale, ears and the infra-orbital margins lay in one horizontal plane. Body weight was recorded in kilograms on an empty bladder and before lunch. BMI was calculated as body weight in kilogram divided by the square of the body height in meters.

$$[\text{BMI} = \text{Weight (kg)} / \text{Height (m}^2\text{)}]$$

Measurement of Blood Pressure

Blood pressure (systolic blood pressure and diastolic blood pressure) was recorded in supine position in the right upper arm after the subject had rested for at least 5 minutes with standard mercury sphygmomanometer to the nearest 2 mmHg.

Electrocardiographic recording

The electrocardiographic recording was done by using 3– channel ECG machine by Medicaid India. To avoid from diurnal variations, we took ECG recordings of all subjects at the same time interval (10:00 am - 12 noon)¹¹. The speed of ECG paper was 25 mm/sec and the voltage was 1mv/cm. A resting ECG was recorded in lying posture after duly assuring them the non-invasive nature of the procedure and after resting of 10 min in a well – ventilated quiet room. The subject's chest, forearms and legs were uncovered. Objects such as electronic gadgets, metallic ornaments etc. were removed to avoid interference. Location for placing electrodes on arms and legs was selected by choosing a place where there was minimum movement. Sufficient quantity of ECG gel was applied approximately 2cm on the skin at the chosen location to ensure good electrical contacts. Limb electrodes were clipped to subject's skin to give proper contact. Chest leads were placed over six different locations. Care was taken so that gel does not smear between the chest electrode sites.

Measurement of P-wave dispersion (Pd)

All ECG papers were scanned and digital files were created. Then after doing 200% magnification P-wave duration was measured using Adobe Photoshop-7 software. Pd was derived by subtracting the minimum P-wave duration from the maximum in any of the 12 ECG leads. P-wave onset was determined as the initial deflection from the isoelectric baseline defined by the T-P segment and the P-wave offset was defined as the junction of the end of the P wave and its return to

baseline¹².

Statistical analysis:

The data was compiled in Microsoft excel and analysed using SPSS (Statistical Package for Social Sciences) version 20. The variables were expressed as mean and standard deviation, and P value <0.05 was considered statistically significant. Independent sample

t-test was used to compare the results of obese to non-obese control group subjects.

Results

The results were expressed as mean± standard deviation. There was no significant difference in age, sex and height between obese and non –obese group but a significant difference were found in weight and BMI between groups (Table 1)

Table1: Comparison of baseline anthropometric data between non-obese and obese group.

Parameters	Group A (Non-obese) (N=40)	Group B (Obese) (N=40)	p – value
Age (Years)	23.10±4.67	28.80±3.38	NS
Weight (Kg)	57.57±7.88	81.27±7.67	<0.001
Height (meter)	1.61±0.08	1.57±0.06	NS
BMI(Kg/m ²)	22.11±1.88	32.71±2.07	<0.001

Obese group had higher SBP, DBP, HR, maximum P-wave duration, minimum P-wave duration and P-wave dispersion compared to non-obese and statistical significant (p<0.001) was found (Table 2).

Table 2: Baseline assessment of cardiovascular parameters (Blood pressure, Heart rate and P-wave duration and dispersion)

Variables	Group A (Non-obese)	Group B (Obese)	p- value
SBP (mm of Hg)	113.30±7.86	128.15±6.03	<0.001
DBP (mm of Hg)	75.60±5.03	84.20±3.64	<0.001
HR (b/m)	78.55±4.17	87.50±8.98	<0.001
Pmax (ms)	88.60±13.75	116.10±6.29	<0.001
Pmin (ms)	54.75±10.57	70.10±7.37	<0.001
Pd (ms)	34.15±5.96	46.15±5.48	<0.001

SBP- Systolic blood pressure, DBP – Diastolic blood pressure, HR- Heart Rate, Pmax- P wave maximum, Pmin- P wave minimum, Pd- P wave dispersion.

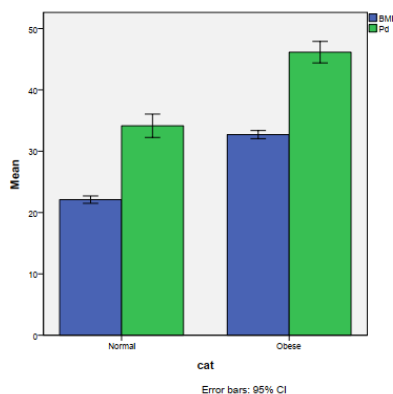


Figure 1: Showing mean values P-wave dispersion in non-obese (normal) and obese groups.

Discussion

The resting ECG has proved its value as a diagnostic tool for detecting “silent” heart disease^{13,14}. Apart from its use in the clinical context, the ECG has been employed as a prognostic tool in apparently healthy subjects. An increase in body fat significantly alters the autonomic functioning of an individual, cardiovascular functions being one of them. An obese individual has altered cardiovascular parameters which get reflected in various ECG variables.

P wave dispersion is an easy, simple, and non-invasive electrocardiographic marker to predict atrial

arrhythmias such as AF¹⁵ and its maximum duration represents atrial activation time. The clinical significance of P-wave duration has been demonstrated in many conditions such as paroxysmal AF, obesity, hypertension and coronary artery disease etc^{16,17,18}.

In our study, statistically significant increase in heart rate, systolic blood pressure and diastolic blood pressure was found in obese when compared to non-obese individuals. Similar findings were reported by Alberto Salvadori et al.¹⁹, Hugh R. Peterson et al.²⁰, Narkiewicz et al.²¹ and Gilles Paradis et al.²². Activation of the sympathetic nervous system occurs early in the course of obesity and it is an important contributor to the regulation of both the cardiovascular system and energy expenditure²³. Studies showed that heart rate increases with increase in percentage of body fat. A 10% increase in body weight is associated with a decline in parasympathetic tone accompanied by a rise in heart rate and conversely, heart rate declines during weight reduction. This is of importance because higher heart rate is associated with increased mortality rates. Julius S et al. reported a positive relationship between heart rate and development of hypertension in adolescents²⁴.

In our study, obese subjects had significantly higher P-wave maximum duration, minimum P-wave duration and P-wave dispersion compared with non-obese. Thus, it can be said that P wave duration is longer in obese individuals. Left atrial enlargement leads to atrial fibrillation which contributes to increase in the P wave duration. In obese individuals, left atrial enlargement and electrical instability may be caused by elevated plasma volume, ventricular diastolic dysfunction and enhanced neurohormonal activity. In addition, the autonomic control of the heart is abnormal in obese subjects due to prevalence of sympathetic over parasympathetic limb of the autonomic balance. This affects intraatrial and interatrial conduction times and leave them prone to develop atrial arrhythmias, such as atrial fibrillation. Duru and his colleagues noted that P wave duration and dispersion significantly decreased after substantial (10%) weight loss and the decrease in the level of P wave dispersion clearly correlated with the percentage of weight loss²⁵. The present study is concurrent with Kosar F et al²⁶. and Liu T et al²⁷. who have reported that left atrial enlargement may influence the P-wave duration.

Therefore, structural and electrophysiological

changes in the atrial myocardium caused by weight gain play a role in the prolongation of P-wave. Furthermore, interstitial fibrosis of myocardium can cause prolongation of PD by forming heterogeneity in atrial conduction velocity and atrial refractoriness in obese subjects.

Limitations:

1. We did not classify whether obesity in our participants was central or visceral.
2. We did not measure neurohumoral parameters and did not perform echocardiography to measure left atrial size.

Conclusions

Obesity leads to significant increase in systolic blood pressure, diastolic blood pressure and heart rate, thus increasing the risk of coronary heart disease and hypertension in these subjects. Prolongation of the P-wave duration increases the possibility of left atrial enlargement and atrial fibrillation.

Thus, it can be concluded that apparently healthy obese individuals may have higher anthropometric values and abnormal P-wave findings. Hence the present study gives an insight on the variations in P-wave in healthy adults who are obese and thereby helps in creating awareness so that; they can change their lifestyle in order to prevent the onset of the deleterious effects of obesity on their health.

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