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# MEAN ELECTRICAL AXIS OF HEART IN RELATION TO BODY MASS INDEX

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ABSTRACT

*The study was conducted on 51 healthy male volunteer students in March-2008. The volunteers were taken from the various departments of Punjabi University, Patiala. All volunteers were adults within the age range of 18 to 23 years with no vascular abnormalities. They were divided into three groups based upon BMI values (Gr.-I BMI below 20; Gr.-II BMI between 20 to 25 and Gr.-III BMI above 25) All the anthropometric and ECG measurements were carried out under controlled conditions in quiet air-conditioned room with temperature and humidity levels controlled at 23 ± $2^0$ Celsius and 55% ± 5% respectively using standard equipments and techniques. It was concluded that Fat deposition and Skinfold thickness was reported minimum in Gr.-I followed by Gr.-II and maximum in Gr.-III. The results shows that electrical activity direction of atria and the ventricles during depolarisation has shown non-significant differences in all BMI Groups, but there is a trend of shifting QRS axis towards the left with increase in BMI. It is observed that body weight is positively correlated to QRS duration(r= 0.284, Significant at 5%), it means over weight were more prone to develop aberration in the ventricular depolarization and blocks in the ventricular conduction system. It is also examined that greater BMI has shifted the electrical activity of repolarization of the ventricles to the left (BMI is negatively correlated to the direction of ventricular repolarization)*

*Keywords: BMI, Electrical Axis and LAD.*

## INTRODUCTION:

The advent of electrocardiogram was very important for the understanding of electrical activity of the heart and paved way for understanding the physiology and pathology related to its functioning assessment of degree of axis of mean QRS vector (mean electrical axis of the heart) is one of the important parameter in ECG, as it provides information about the conduction defect and also the hypertrophy of the ventricles of the heart (Zehender et al, 1990). Usually the cardiologist and physicians are able to determine this axis just by inspecting the ECG recording in six of the limb leads within a range of 10 of the actual mean QRS axis (MQRSA) without influencing the diagnosis and localization of the defect (schamroth,1990). But in instances of the left axis deviation of about-30°, differentiation between left ventricular enlargement and left incomplete hemi block (Bayes de Luna, 1993) and of minimal right axis deviation, accurate assessment of the case. A simple but accurate method for assessment of the MQRSA is plotting the net voltage (voltage of R wave 0f the S wave of the same QRS complex in Lead-I and Lead-III on the axis of the respective leads. The mean electrical axis tells us the net direction of the depolarization of the ventricles. The mean electrical axis for the heart normally lies between -30° and +90° (some textbooks say the normal range is 0 to +90° is termed a left axis deviation (LAD) and greater than +90° is termed a right axis deviation (RAD). Axis deviations can be caused by increased cardiac muscle mass (e.g., left ventricular hypertrophy), changes in the sequence of ventricular activation (e. g., conduction defects), or because of ventricular regions incapable of being activated (e.g., infracted tissue)

Master (1928) found RAD after right spontaneous or artificial pneumo-thorax, coronary type ST segment and T waves after left spontaneous and lower voltage of QRS and T after artificial pneumothorax. He attributed the changes to torsion of the heart and interposition of air. Anderson (1929) observed a tendency to RAD after artificial pneumo-thorax and considered that RAD indicated adaptation of the heart to the strain of artificial pneumothorax and a better prognosis. Hansen and King (1930) noted changes in QRS and P waves in artificial pneumothorax and attributed this to change in position of the heart but not related to type or extent of collapse. Von der Weth found that left phrenic paralysis always caused LAD while right phrenic paralysis caused RAD in the majority. Hansen and Maly (1933-34) found change in axis in 63% cases after thoracoplasty without predictable relation to the collapse, a strong tendency to LAD after phrenic paralysis and to a lesser extent , RAD after right phrenic paralysis and T wave changes, sometimes of injury type American' Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (2005) found shift of axis to right after artificial pneumothorax in a large majority of cases, and observed that adhesion and effusion tend to causes LAD.

Analysis of recorded ECGs depends on many factors including the capabilities of the recording/analysis equipment, student/faculty preparedness and willingness, and focus of the laboratory. Certainly, how heart rate varies under various treatments is of interest. New computer-based ECG systems, however, permit detailed analysis of interval (e.g., QT), segments (P-R and S-T), wave durations (P and QRS), heart rate variability, and signal voltage (e.g., QRS amplitude). It may be of interest to study how some of these dependent variables influence others. For example, the mammalian QT interval is typically inversely related to heart rate, but not in a linear fashion, however, has suggested that the QT interval and heart rate are independent in anesthetized rainbow trout.

The traditional assumption has been examined that there is a close relationship between the electrical and anatomical axis of the heart. Keeping in mind the observations of the researchers that electrical activity direction is linked to anatomical position of chest cavity, the aim of the study was to investigate the effect of body mass index on the mean electrical activity direction in Males.



METHODOLOGY:

The study was conducted on 51 male volunteers, all healthy students in March-2008. The volunteers were taken from the various departments of Punjabi University, Patiala. All volunteers were adults within the age range of 18 to 23 years with no vascular abnormalities and were healthy. The subjects were thoroughly informed about the objectives of the study. None of the subjects had taken any medication during the course of study. All the measurements were carried out under controlled conditions in quiet air-conditioned room with temperature and humidity levels controlled at $23 \pm 2^0$ Celsius and 55% ± 5% respectively.

The Following equipments were used for the morphological and physiological measurements:-

- Portable weighting machine, Anthropometric rod & Harpenden skin fold caliper.

- Couch (for making the subject lie down) & Computerized ECG machine (for Recording ECG)

i. Procedure for calculating Body Mass Index:

Body Mass Index (BMI) was calculated by the following formula:

$$\text{BMI} = \frac{\text{Body Weight in Kgs}}{(\text{Height in meters})^2}$$

ii. Procedure for calculating Body Composition:

BODY DENSITY =1.1599-0.0717 Log (Biceps + Triceps + Sub scapular + Suprailiac)

(By using the Durnin and Womersley ,1974)

$$\text{Percent Body Fat} = \left(\frac{4.95}{BodyDensity} - 4.50\right) X100 \qquad \text{(by Siri, 1961)}$$

Total body fat (kgs) = % Body Fat x Body Weight (kg)

The raw demographic data of electrocardiographic recordings was fed to the computer (P-III HCL Make) and then by using SPSS version 10 software Mean, SD, SEM were calculated and ANOVA were applied.

RESULTS AND DISCUSSION:

As shown in table I, all anthropometric variables represented their mean, SD and Anova F values, grouped on the basis of BMI values. In height BMI above 25 (Group-III) has maximum height followed by Group II (BMI between 20-25) and minimum in Group-I (BMI below 20), but no significant difference were observed.

Table 1

Mean, S.D., and ANOVA F- Values of Height, Weight, Skin folds and % Body Fat in Males Grouped by BMI

| S. No | Anthropometric Parameters | Groups | S | Mean | S.D. | ANOVA F- Value |
|---|---|---|---|---|---|---|
| | HEIGHT | BMI below 20 | 10 | 175.1 | 6.60 | 0.23 (NS) |
| | | BMI between 20 to 25 | 24 | 174.33 | 6.63 | |
| | | BMI Above 25 | 15 | 175.66 | 4.53 | |
| | | Total | 49 | 174.89 | 5.97 | |
| | WEIGHT | BMI below 20 | 10 | 58.3 | 6.02 | 53.07** |
| | | BMI between 20 to 25 | 24 | 67 | 6.70 | |
| | | BMI Above 25 | 15 | 82.07 | 4.42 | |
| | | Total | 49 | 69.84 | 10.60 | |
| | BICEPS | BMI below 20 | 10 | 10.4 | 1.5776 | 8.28** |
| | | BMI between 20 to 25 | 24 | 11.9167 | 2.3575 | |
| | | BMI Above 25 | 15 | 13.7333 | 1.7512 | |
| | | Total | 49 | 12.1633 | 2.3394 | |
| | TRICEPS | BMI below 20 | 10 | 12.7 | 2.7508 | 5.33** |
| | | BMI between 20 to 25 | 24 | 14.5833 | 3.0633 | |
| | | BMI Above 25 | 15 | 22.9333 | 25.5356 | |
| | | Total | 49 | 16.7551 | 14.6224 | |
| | SUBSCAPULAR | BMI below 20 | 10 | 14.9 | 2.9231 | 4.12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | BMI between 20 to 25 | 24 | 17 | 4.1178 | |
| | | BMI Above 25 | 15 | 18.8 | 1.8205 | |
| | | Total | 49 | 17.1224 | 3.551 | |
| | SUPRA-ILIAC | BMI below 20 | 10 | 16.6 | 3.34 | 5.07** |
| | | BMI between 20 to 25 | 24 | 18.9167 | 4.3129 | |
| | | BMI Above 25 | 15 | 21.1333 | 1.6847 | |
| | | Total | 49 | 19.1224 | 3.8004 | |
| | % BODYFAT | BMI below 20 | 10 | 27.8869 | 2.7385 | 7.83** |
| | | BMI between 20 to 25 | 24 | 29.8188 | 2.6344 | |
| | | BMI Above 25 | 15 | 32.55 | 3.6142 | |
| | | Total | 49 | 30.2606 | 3.3839 | |

* Significant at 5% level.

** Significant at 1% level

In other all anthropometric parameters (like weight, all skin folds and % body fat), the minimum mean values were reported in Group I (BMI below 20) followed by Group II (BMI between 20 to 25) and maximum in Group III (BMI above 25). On applying ANOVA, F values were found significant at 1% level in all anthropometric parameters except height.

Table 2 depicts post hoc't' test values and mean differences of various anthropometric parameter, which have significant F value of ANOVA . In all anthropometric parameters , Group I and Group II has shown non significant mean differences, but Group I & Group III and Group II & Group III has shown significant mean differences at 1% and 5% level respectively.

Table 2

Comparison of Mean differences of Anthropometric parameters among the Three BMI Groups as Revealed by Scheffe post Hoc Tests

| Anthropometric parameters | Groups | Groups | Significant Mean Difference |
|---|---|---|---|
| WEIGHT | BMI below 20 | BMI between 20 to 25 | -8.7** |
| | BMI below 20 | BMI Above 25 | -23.7667** |
| | BMI between 20 to 25 | BMI Above 25 | -15.0667** |
| BiCEPS | BMI below 20 | BMI between 20 to 25 | 1.52 |
| | BMI below 20 | BMI Above 25 | 3.33** |
| | BMI between 20 to 25 | BMI Above 25 | 1.82 |
| TRICEPS | BMI below 20 | BMI between 20 to 25 | 1.88 |
| | BMI below 20 | BMI Above 25 | 3.57** |
| | BMI between 20 to 25 | BMI Above 25 | 1.68 |
| SUBSCAPULAR | BMI below 20 | BMI between 20 to 25 | 2.1 |
| | BMI below 20 | BMI Above 25 | 3.90* |
| | BMI between 20 to 25 | BMI Above 25 | 1.80 |

| | | | |
|---|---|---|---|
| SUPRA_ILIAC | BMI below 20 | BMI between 20 to 25 | 2.32 |
| | BMI below 20 | BMI Above 25 | 4.53** |
| | BMI between 20 to 25 | BMI Above 25 | 2.22 |
| % BODY FAT | BMI below 20 | BMI between 20 to 25 | 1.93 |
| | BMI below 20 | BMI Above 25 | 4.66** |
| | BMI between 20 to 25 | BMI Above 25 | 2.73* |

* Significant at 5% level.

** Significant at 1% level.

Table 3 denoted mean, SD and ANOVA F values of ECG parameter of Group I, II and III which has shown non significant differences with each other. The results shows that electrical activity direction of atria and the ventricles during depolarisation has shown non-significant differences in all BMI Groups, but there is a trend of shifting QRS axis towards the left with increase in BMI.



Table 3

Mean, S.D., and ANOVA F- Values of ECG parameters in Males Grouped by BMI

| S. No | ECG Parameters | Groups | N | Mean | S.D. | ANOVA F- Value |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | P-AXIS | BMI below 20 | 10 | 67.6 | 21.8133 | 1.80( NS) |
| | | BMI between | 24 | 63.2917 | 18.4379 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 20 to 25 | | | | |
| | | BMI Above 25 | 15 | 50.9333 | 31.9519 | |
| | | Total | 49 | 60.3878 | 24.3489 | |
| 2 | QRS-AXIS | BMI below 20 | 10 | 70.9 | 15.645 | 0.97( NS) |
| | | BMI between 20 to 25 | 24 | 62 | 20.2678 | |
| | | BMI Above 25 | 15 | 58.8 | 26.6865 | |
| | | Total | 49 | 62.8367 | 21.6664 | |
| 3 | T-AXIS | BMI below 20 | 10 | 46.2 | 14.3124 | 3.70( NS) |
| | | BMI between 20 to 25 | 24 | 45.2083 | 17.0727 | |
| | | BMI Above 25 | 15 | 29.8667 | 22.8469 | |
| | | Total | 49 | 40.7143 | 19.5821 | |
| 4 | P-DURATION | BMI below 20 | 10 | 98.9 | 7.2641 | 0.91( NS) |
| | | BMI between 20 to 25 | 24 | 98.8333 | 15.0468 | |
| | | BMI Above 25 | 15 | 104.1333 | 11.0121 | |
| | | Total | 49 | 100.4694 | 12.641 | |
| 5 | PR-DURATION | BMI below 20 | 10 | 158.7 | 16.5935 | 1.16( NS) |
| | | BMI between 20 to 25 | 24 | 148.5833 | 17.2373 | |
| | | BMI Above 25 | 15 | 150.7333 | 19.1105 | |
| | | Total | 49 | 151.3061 | 17.7684 | |
| 6 | QRS-DURATION | BMI below 20 | 10 | 90.3 | 10.1658 | 2.20( NS) |
| | | BMI between 20 to 25 | 24 | 96.9583 | 7.959 | |
| | | BMI Above 25 | 15 | 99 | 13.7061 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Total | 49 | 96.2245 | 10.701 | |
| 7 | QT-INTERVAL | BMI below 20 | 10 | 343 | 41.0609 | 0.05( NS) |
| | | BMI between 20 to 25 | 24 | 346.5833 | 29.3405 | |
| | | BMI Above 25 | 15 | 345.2 | 26.0609 | |
| | | Total | 49 | 345.4286 | 30.4733 | |
| 8 | QTC-INTERVAL | BMI below 20 | 10 | 361.2 | 14.7332 | 0.23( NS) |
| | | BMI between 20 to 25 | 24 | 360.875 | 15.9818 | |
| | | BMI Above 25 | 15 | 357.2667 | 21.9495 | |
| | | Total | 49 | 359.8367 | 17.5099 | |

Table 4

Correlation Matrix between ECG and Anthropometric Parameters

| Correlation Matrix | P AXIS | T AXIS | P Duration | PR Duration | QRS Duration | QT Interval | QTC Interval | BMI | Height |
|---|---|---|---|---|---|---|---|---|---|
| T AXIS | 0.62 | | | | | | | | |
| P Duration | -0.03 | -0.11 | | | | | | | |
| PR Duration | -0.192 | -0.077 | 0.247 | | | | | | |
| QRS Duration | 0.183 | -0.058 | 0.108 | -0.341 | | | | | |
| QT | -0.233 | -0.256 | 0.031 | -0.13 | 0.184 | | | | |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interval | | | | | | | | | |
| QTC Interval | -0.086 | -0.353 | 0.015 | -0.258 | 0.294 | 0.707 | | | |
| BMI | -0.178 | -0.329 | 0.08 | -0.215 | 0.261 | -0.021 | -0.073 | | |
| Height | -0.099 | 0.021 | 0.083 | 0.086 | 0.086 | 0.152 | 0.171 | | |
| Weight | -0.186 | -0.273 | 0.111 | -0.157 | 0.284 | 0.037 | -0.003 | 0.898 | 0.428 |

Table 4 reveal correlation matrix between ECG and anthropometric parameters. It is observed that body weight is positively correlated to QRS duration(r= 0.284, Significant at 5%), it means over weight were more prone to develop aberration in the ventricular depolarization and blocks in the ventricular conduction system. It is also examined that greater BMI has shifted the electrical activity of repolarization of the ventricles to the left (BMI is negatively correlated to the direction of ventricular repolarization). Among ECG parameters, significant correlation were examined between P-Axis & T- Axis, QRS duration & PR duration, QTC interval & T- Axis, QTC interval &QRS duration, QTC interval & QT interval. In anthropometric parameters, significant correlation was reported between BMI & weight and weight and height.



CONCLUSIONS:

It was concluded that electrical activity direction of atria and the ventricles during depolarisation has shown non-significant differences in all BMI Groups, but there is a trend of shifting QRS axis towards the left with increase in BMI.

The finding of this study indicates that body weight is positively correlated to QRS duration(r= 0.284, Significant at 5%), it means over weight were more prone to develop aberration in the ventricular depolarization and blocks in the ventricular conduction system.

It was concluded that greater BMI has shifted the electrical activity of repolarization of the ventricles to the left (BMI is negatively correlated to the direction of ventricular repolarization).

It was concluded in this study that with increase in BMI, all skin folds taken and % body fat also increase.

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