DOI: 10.7860/JCDR/2019/39722.12721

Original Article

Physiology Section

Effect of Deep Breathing on Cardiac Axis of Young Normal Subjects in Various Postures- A Pilot Study

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ABSTRACT

Introduction: Cardiac axis is altered in many physiological and pathological states. Hence its measurement is important. Position and movements of diaphragm determine the position of heart because the pericardium is firmly attached to the central tendon of the diaphragm. Effect of change in body posture and breathing on cardiac axis has not been well documented. The changes in cardiac axis during deep breathing are greater in aged patients.

Aim: To study the effect of deep breathing on cardiac axis of young normal subjects in various postures.

Materials and Methods: This was a cross-sectional study done on 45 normal healthy volunteers. After 10 min of supine rest, with the help of INCO RMS Vesta 101 electrocardiograph, ECG was recorded in leads I and aVF during eupnea, after maximum inspiration and after maximum expiration. The measurement was repeated in sitting and standing postures. The cardiac axis was calculated from Einthoven triangle. Data was analysed using ANOVA and inter-group was analysed using post-hoc test.

Results: Maximum inspiration produced a significant ($p<0.001$) increase in cardiac axis as compared to eupnea, in supine, sitting and standing postures. Maximum expiration produced a significant decrease in cardiac axis as compared to eupnea only in sitting ($p \leq 0.05$) and standing postures ($p \leq 0.01$).

Conclusion: Cardiac axis varies with posture as well as breathing. Maximum inspiration produces significant increase in cardiac axis whereas maximum expiration produces an insignificant decrease.

Keywords: Electrical axis of heart, Maximum expiration, Maximum inspiration

INTRODUCTION

Measurement of Cardiac Axis (CA) or electrical axis of heart is important because it can be altered in a variety of physiological and clinical conditions [1]. Change in body posture is commonly used in the management of patients with acute cardiopulmonary dysfunction [2]. Size, shape and position of heart are related to the body type, posture and respiration. Position of the heart is determined by movement and position of diaphragm. During maximum inspiration, diaphragm contracts and becomes flatter. As it does, the heart descends, moves backward, and rotates to the right, thus becoming more vertical, i.e., shift to right. The diaphragm relaxes during maximum expiration. These changes are less pronounced during quiet/normal breathing. In studies conducted by Singh MM et al., and Uematsu Y et al., it was demonstrated that deep inspiration shifted the mean frontal axis of P, QRS and T waves to the right [3,4]. Greater shift occurred for those subjects whose resting axis was between 0 to +30 degrees and lesser shift occurred in the subjects whose axis was between +60 to +90 degrees. Also, they stated that for none of the subjects, the axis changed from normal to abnormal degree [3]. Mohan M et al., have concluded that there is an increase in QRS axis during inspiratory phase of pranayam type of breathing as compared to eupnea whereas there is no significant change in axis during expiratory phase of pranayam type of breathing. These changes in axis were similar to those observed during the corresponding phases of deep breathing [5]. However, Smit D et al., have stated that the effect of different extreme breath holding positions on QRS complex is small [6]. Uematsu Y et al., concluded that the changes in cardiac axis during deep breathing are greater in aged patients [4]. So, there were controversial results obtained from previous studies regarding the effect of breathing on cardiac axis. Effect of change in body posture and breathing on cardiac axis has not been well documented. Also, no study has been done in younger age group (20-30 years). Hence, this study was conducted with the aim to study the effect of deep breathing on cardiac axis of young normal subjects in various postures.

MATERIALS AND METHODS

The present pilot study was conducted on 45 healthy subjects based on convenient sampling which has a cross-sectional study design, conducted in the Department of Physiology from June 2013-August 2014. Young healthy volunteers in the age group of 20-30 years were recruited excluding pregnant women and subjects having cardio-respiratory diseases. Prior to commencement of study, approval from Institute Human Ethics Committee (IHEC approval no.: MGMCRI/MD/MS/2013/58) was obtained. The nature of the study and procedure were explained to them. Informed written consent was obtained from them. The selected subjects were instructed to come for recording the next day, about 2-3 hours after a light breakfast. With the help of INCO RMS Vesta 101 electrocardiograph, ECG was recorded in the following manner. The subject was asked to lie supine and completely relaxed in a couch for 10 minutes. Before fixing the lead, skin was thoroughly cleaned with spirit over the left and right wrists and ankles after which ECG jelly was applied. All four limb leads were connected. The subject was instructed not to perform any movement while recording was being made. ECG was recorded in lead I and lead aVF for about ten QRS complexes. Markings were made on the ECG strip at the beginning of normal inspiration and expiration. If there was any artefact, recording was repeated. This completed the recording of ECG in supine posture during eupnea (normal quiet breathing). Then the subject was asked to hold his/her breath after maximum inspiration (breathe in deeply to full capacity). ECG was again recorded in lead I as well as lead aVF. Then the subject was asked to hold his/her breath after maximum expiration (breathe out to full capacity). ECG was recorded in lead I and aVF. This completed the recording of ECG in lead I and aVF in supine posture during eupnea, after maximum inspiration and maximum expiration. In the same manner, ECG in lead I and lead aVF was recorded in sitting as well as standing posture also. The recorded ECG was gathered and the mean QRS amplitudes were measured for maximum inspiration and maximum expiration. For eupnea, the mean QRS amplitude was measured for the QRS complexes which were marked after normal expiration. Cardiac axis was measured using Einthoven triangle [7]. The mean QRS amplitude (net potential) was measured from lead I and lead aVF in ECG by subtracting S wave from R wave. This net potential was plotted on the axis of respective leads and perpendicular lines were drawn from each. The point of intersection of these two perpendicular lines was joined to the centre of the triangle to give the vector. This line represents the amplitude and orientation of QRS vector or electrical axis of the heart or CA. The exact value of cardiac axis in degree was measured using protractor.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software (version 16). The data was presented as mean±SE and was analysed by using ANOVA. Intra-group differences of means between maximum inspiration and eupnea, and maximum expiration and eupnea during various postures were compared using post hoc (ANOVA). The differences were considered statistically significant if probability of chance was less than 0.05 ($p \leq 0.05$).

RESULTS

The present work was conducted in the Department of Physiology, Mahatma Gandhi Medical College and Research Institute (MGMC and RI) with the principal aim to study the effect of breathing on cardiac axis in various postures. The study included 45 healthy volunteers (male: 33.34%, female: 66.67%) in the age group of 20-30 years (mean age: 24.8 yrs). The mean cardiac axis in supine posture during eupnea was +55.84 degrees [Table/Fig-1]. After maximum inspiration, it was +70.18 degrees and after maximum expiration it was +47.29 degrees. The increase in cardiac axis after maximum inspiration was significantly different from the value obtained during eupnea ($p \leq 0.001$). The decrease in cardiac axis after maximum expiration was not significantly different from the value obtained during eupnea ($p > 0.05$). The mean cardiac axis in sitting posture during eupnea was +47.51 degrees [Table/Fig-1]. After maximum inspiration, it was +70.22 degrees and after maximum expiration it was +32.67 degrees. The increase in cardiac axis after maximum inspiration was significantly different from the value obtained during eupnea ($p \leq 0.001$). The decrease in cardiac axis after maximum expiration was also significantly different from the value obtained during eupnea ($p < 0.05$). The mean cardiac axis in standing posture during eupnea was +49.33 degrees [Table/Fig-1]. After maximum inspiration, it was +70.80 degrees and after maximum expiration it was +30.69 degrees. The increase in cardiac axis after maximum inspiration was significantly different from the value obtained during eupnea ($p < 0.001$). The decrease in cardiac axis after maximum expiration was also significantly different from the value obtained during eupnea ($p < 0.01$).

	Eupnea (mean±SD)	Maximum Inspiration (mean±SD)	Maximum Expiration (mean±SD)
Supine	55.84±2.73	70.18±1.71	47.29±2.96
Sitting	47.51±4.16	70.22±2.87	32.67±3.79
Standing	49.33±3.68	70.80±2.33	30.69±3.74

[Table/Fig-1]: Effect of breathing on cardiac axis in supine, sitting and standing postures.
Data represented as (mean±SD)

Hence the present study inferred that the increase in cardiac axis after maximum inspiration was significant ($p \leq 0.001$) in all the three postures [Table/Fig-2], whereas, the decrease in cardiac axis after maximum expiration was significant in sitting ($p \leq 0.05$) and standing postures ($p \leq 0.01$) but not in supine posture ($p > 0.05$).

ANOVA (p-value)	Post-hoc (p-value)		
Supine 0.0001***	Eupnea	Max. inspiration	<0.001***
	Eupnea	Max. expiration	0.106
	Max. inspiration	Max. expiration	<0.001***
Sitting 0.0001***	Eupnea	Max. inspiration	<0.001***
	Eupnea	Max. expiration	0.030*
	Max. inspiration	Max. expiration	<0.001***
Standing 0.0001***	Eupnea	Max. inspiration	<0.001***
	Eupnea	Max. expiration	0.002**
	Max. inspiration	Max. expiration	<0.001***

[Table/Fig-2]: Level of significance of cardiac axis between eupnea, maximum inspiration and maximum expiration in supine, sitting and standing postures.
*p<0.05, **p<0.01, ***p<0.001

DISCUSSION

The present work was conducted to study the effect of breathing on cardiac axis in young healthy subjects. The known concept of cardiac axis is that it varies from individual to individual, and also from time to time in the same individual. These variations are related to the body type, posture and respiration. In the present study, the cardiac axis of 45 normal subjects were compared in various phases of breathing like eupnea, maximum inspiration and maximum expiration in supine, sitting and standing postures. In the present study, we found inter-individual variability in cardiac axis which can be explained on the basis of orientation of heart in the chest. This observation is similar to a study conducted by Dougherty JD which stated that, for each degree of change in position of heart there is about 3° change in frontal QRS axis [8]. It was also found that even slight changes in breathing (normal respiration/eupnea) produce variations in cardiac axis. The changes in cardiac axis were more pronounced in maximum breathing (maximum inspiration and maximum expiration). In the present study, the effect of maximum breathing on cardiac axis during various postures was observed. It was found that the cardiac axis significantly increases after maximum inspiration as compared to eupnea. Similar observation was found in studies conducted by Singh MM et al., and Uematsu Y et al., [3,4]. In the present study, the significant increase in cardiac axis after maximum inspiration as compared to eupnea was observed in all the 3 postures (supine, sitting as well as standing). It was also found that the cardiac axis decreases (shift to left) after maximum expiration as compared to eupnea. This decrease in cardiac axis after maximum expiration was significant in sitting and standing postures but not in supine posture. In view of this, the study demonstrates that respiration induced changes in cardiac axis are influenced by posture. Similar findings are reported in a latest study which showed that -9 degree change in P axis with sitting, a -4 degree change in QRS axis when standing, and 3.8 degree increase in T vector were seen with change of position [9]. In another recent study also, it was proved that the reclining and sitting ECG show a significant variation of mean QRS axis as compared to supine position [10]. Athletes are more prone to cardiac ischemic attacks because of their hypertrophied heart. Every athlete should be recommended to maintain their health record with the progress of cardiac axis over time so that any change in the cardiac axis can be evaluated effortlessly.

LIMITATION

The present study has a few limitations. The ECG machine used in the present study could not record the ECG in lead I and lead aVF simultaneously. Also measuring the amplitude of QRS from ECG recording is subjective. Hence, even slight changes in QRS amplitude will vary with the cardiac axis. The recording of ECG during eupnea was not standardised. The cardiac axis varies even with slight change in breathing or position of body. Hence during eupnea which consists of both inspiration and expiration, the ECG recording should have been considered either during inspiration or during expiration for all the subjects. But this is practically difficult to observe, as the chest movement during normal breathing is less pronounced in some individuals.

CONCLUSION

Cardiac axis varies with posture as well as breathing. Maximum inspiration produces significant increase in cardiac axis whereas maximum expiration produces an insignificant decrease.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Oct 03, 2018**
Date of Peer Review: **Nov 16, 2018**
Date of Acceptance: **Jan 22, 2019**
Date of Publishing: **Mar 01, 2019**