Effect of Posture on Electrical Axis of Heart During Different Phases of Breathing in Normal Subjects

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Abstract

Introduction: Body postural changes are commonly used in the management of patients with acute cardiopulmonary dysfunction. Size, shape and position of heart are related to the body type, posture and respiration. Effect of change in body posture on electrical axis of heart has not been well documented. .The present study was conducted to study the effect of posture on electrical axis of heart during different phases of breathing in normal subjects.

Aim: To study the effect of posture on electrical axis of heart during different phases of breathing.

Materials and Method: With the help of INCO RMS Vesta 101 electrocardiograph, ECG was recorded in the following normal breathing, deep inspiration and deep expiration in supine, standing and sitting posture.

Results: The mean cardiac axis after deep expiration in supine posture was +47.29 degrees, in the sitting posture it was +32.67 degrees and in standing posture it was +30.69 degrees. The decrease in cardiac axis upon assuming sitting posture was significantly different from the value obtained during supine posture ($P<0.05$). The decrease in cardiac axis upon assuming standing posture was significantly different from the value obtained during supine posture ($P<0.01$).

Conclusion: It was found inter-individual variability in electrical axis of heart which can be explained on the basis of orientation of heart in the chest. In the present study, the decrease in cardiac axis due to postural variation from supine to sitting and standing was more pronounced after deep expiration. There was decrease in electrical axis of heart (shift to left) when subject changed the posture from supine to sitting and standing.

Keywords: *Posture, Electrical axis, Breathing*

Introduction

Electrical axis of heart or cardiac axis is altered in various physiological and clinical conditions, hence it is important to measure[1]. Body postural changes 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 heart is determined by position and movements of diaphragm because the central tendon of diaphragm is firmly attached to pericardium. During deep inspiration, diaphragm becomes flat when it contracts. As it does, the heart descends, rotates to the right, moves backward and thus becomes more vertical, i.e. shift to right. During deep expiration, the diaphragm relaxes, elevates, and movements of the heart are converse to those occurring during deep inspiration. During normal breathing (eupnea), these changes are less pronounced. Effect of change in body posture on electrical axis of heart has not been well documented.

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Also this study has not been done in younger age group (20-30 years). So this study was undertaken to determine the effect of posture on electrical axis of heart during different phases of breathing. Even slight movements of the body disturb the analysis of cardiovascular dynamics[3]. The position of heart has an influence on the shape of ECG. Body changes from supine to standing posture and phases of respiration have been attributed to the changes in ECG[4]. In patients with cardiopulmonary dysfunction, change in body position is commonly used intervention. These changes in body position are often manifested as axis shifts in the ECG which results in ST segment changes. Hence can be misclassified as acute ischemic events during ambulatory monitoring[5, 6]. In a study conducted by Swenson et al (2011), they concluded that even a few centimeter changes in heart position were sufficient to produce ST-segment changes which mimic acute myocardial ischemia[7]. Hence, the axis shifts during postural changes have important clinical applications. The above concept has been proven in many studies. Likewise, Mohan et al (1987), Dougherty (1970) in their study stated that the body postural change produces the change in anatomical orientation of heart within the thorax resulting in alteration of cardiac axis[8, 9]. This statement is also proven by Ng et al (2001) who concluded that these postural variations produce changes in QRS amplitude, ST segment and T-wave inversions. But when compared to QRS shifts, P-wave shifts are larger and poorly correlated with QRS axis shifts[10]. Another study by Jones et al (2003) showed that postural variation from lying to sitting and standing postures produces decrease in RWA (R-wave amplitude) which is due to shift of axis to right. The other reason being change in cardiac volume[2]. Also Marín et al (1988) have stated that the R wave voltage varies with changes in heart position and the body mass is not an important modifier of RWA in light overweight, normal and thin individuals[11]. MacLeod et al (2000) have stated that the geometric position of heart could be a large source of variation in body surface potentials[12]. In another study, Swenson et al (2011) concluded that the variations in surface potentials are not only due to body postural changes but also due to changes in respiration[7]. Hoekema et al (1999) have commented that there is inter-individual variability of ECG in normal healthy subjects. Part of this variability is due to position of heart in the chest and also due to orientation relative to the electrodes. However the changes made in moving the electrodes did not reduce the inter individual variations[13]. Engblom et al (2005) have stated that, as age advances, change in electrical axis of heart is not by the change in anatomical axis. They concluded that there is no simple relationship between anatomical and electrical axes of heart[14]. Also in another study by Grant (1953), it was found that when the mean QRS axis changed to 180 degrees, the anatomical position of left ventricle changed only to less than 45 degrees[15]. Similar study done by Dougherty (1970) concluded that for every 1 degree change in position of heart, the QRS axis altered to 3 degrees[9]. Madias (2006) commented that the standard ECG recorded in supine and standing postures are interchangeable with stress ECG recorded in sitting, standing and supine postures[16].

Aim

To study the effect of posture on electrical axis of heart during different phases of breathing.

Materials and Method

This was a cross-sectional study done on 45 normal healthy volunteers conducted in the Department of Physiology, Mahatma Gandhi Medical College & Research Institute, Pondicherry. Prior to commencement of study, approval from Institute Human Ethics Committee was obtained. Young healthy volunteers in the age group of 20-30 years were recruited. 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 deep 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 deep 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 deep inspiration and deep 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 deep inspiration and deep 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. 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 axes 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. The exact value of cardiac axis in degree was measured using protractor. 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 supine and sitting, and supine and standing during eupnea, deep inspiration and deep expiration were compared using post hoc (ANOVA). The differences were considered statistically significant if probability of chance was less than 0.05 ($P<0.05$)

Results

The present work was conducted in the department of Physiology, MGMC & RI with the principal aim to study the effect of posture on electrical axis of heart during different phases of breathing. The study included 45 healthy volunteers in the age group of 20 – 30 years. The mean electrical axis of heart during eupnea in supine posture was +55.84 (Table 1), in the sitting posture it was +47.51 degrees and in standing posture it was +49.33 degrees. The decrease in electrical axis of heart upon assuming sitting posture was not significantly different from the value obtained during supine posture ($P>0.05$). The decrease in cardiac axis upon assuming standing posture was not significantly different from the value obtained during supine posture ($P>0.05$). The mean electrical axis of heart after deep inspiration in supine posture was +70.18 degrees (Table 1), in the sitting posture it was +70.22 degrees and in standing posture it was +70.80 degrees. The increase in cardiac axis upon assuming sitting posture was not significantly different from the value obtained during supine posture ($P>0.05$). The increase in cardiac axis upon assuming standing posture was not significantly different from the value obtained during supine posture ($P>0.05$). The mean cardiac axis after deep expiration in supine posture was +47.29 degrees (Table 1), in the sitting posture it was +32.67 degrees and in standing posture it was +30.69 degrees. The decrease in cardiac axis upon assuming sitting posture was significantly different from the value obtained during supine posture ($P<0.05$). The decrease in cardiac axis upon assuming standing posture was significantly different from the value obtained during supine posture ($P<0.01$). Hence the present study inferred that the difference in electrical axis of heart during various postures was significant only after deep expiration ($P<0.01$) but not during eupnea and deep inspiration (Table 2).

Table 1: Effect of posture on electrical axis of heart in various phases of breathing.

	Eupnea (mean±SD)	**Deep Inspiration (mean±SD)**	**Deep 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

Data represented as (mean±SD)

Table 2: Level of significance of electrical axis of heart between supine, sitting and standing postures during eupnea, after deep inspiration and after deep expiration.

	ANOVA (P value)			Post hoc (P value)
		Supine	Sitting	0.267
Eupnea	0.227	Supine	Standing	0.406
		Sitting	Standing	0.983
		Supine	Sitting	1.000
Deep inspiration	0.979	Supine	Standing	0.995
		Sitting	Standing	0.998
		Supine	Sitting	0.011*
Deep expiration	0.002**	Supine	Standing	0.003**
		Sitting	Standing	0.917

*P<0.05, **P, <0.01

Discussion

The present work was conducted to study the effect of posture on electrical axis of heart in different phases of breathing in young healthy subjects. The known concept of heart 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 electrical axis of heart in 45 normal subjects in different postures during different phases of breathing like eupnea, deep inspiration and deep expiration was compared. In the present study, it was found inter-individual variability in electrical axis of heart which can be explained on the basis of orientation of heart in the chest. The normal electrical axis of heart is generally said to be –30 to +110 degrees[17]. But in the present study on 45 normal subjects, the lowest value of electrical axis of heart was -21 degrees and the highest value was +135 degrees. Such "abnormal" axis may occur in some normal individuals. In such cases, thorough evaluation of all the parameters of ECG is to be made to exclude myocardial disease[18]. Though changes in electrical axis of heart were observed during different postures in the present study, they were not statistically significant. Other workers have observed that changes in body posture and movement lead to changes in cardiac axis[8–10]. In the present study, there was decrease in electrical axis of heart (shift to left) when subject changed the posture from supine to sitting and standing. Our observation is contrast to a study conducted by Jones et al (2003) in which the cardiac axis increased (shift to right) with postural variation from supine to sitting and standing postures[2]. In the present study, the decrease in cardiac axis due to postural variation from supine to sitting and standing was more pronounced after deep expiration. The probable cause for this could not be explained.

Conclusion

It was found inter-individual variability in electrical axis of heart which can be explained on the basis of orientation of heart in the chest. In the present study, the decrease in cardiac axis due to postural variation from supine to sitting and standing was more pronounced after deep expiration. There was decrease in electrical axis of heart (shift to left) when subject changed the posture from supine to sitting and standing.

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