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To what extent do the presentation of fetus, amniotic fluid index and fetal weight at term affect the cardiac axis?

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Abstract

Objective: To analyse the change in cardiac axis with advancing gestational age and the factors that may affect it.

Methods: 45 healthy pregnant women in 20th weeks of gestation were enrolled to the study. The cardiac axis was noted for each participant. The same group was once more assessed at term and the change in cardiac axis was calculated with the difference of cardiac axis at term and the 20th gestational weeks. Change in cardiac axis with advancing gestational weeks and factors that may affect it such as amniotic fluid index (AFI), estimated fetal weight (EFW) at term, actual birth weight and presentation of the fetus at term were evaluated.

Results: The median of ages was 28.0 (IQR = 12.0) years within a range of 18–39 years. The median of change in cardiac axis was 11.0 (IQR = 9.0) degrees within a range of 3.0–47.0 degrees. The change in cardiac axis in regard to the fetal presenting part was 11.0 (IQR = 8.0) degrees in vertex presentation and 23.50 (IQR = 21.0) degrees in breech presentation. 81.1% of the variation in change in cardiac axis was found to be due to the actual birth weight and fetal presentation, with each 100 g increase in actual birth weight leads to an increase of 0.375 degrees in cardiac axis.

Conclusion: EFW at term, presentation of the fetus and the actual birth weight were all found to be significant in predicting the change in cardiac axis, but not AFI. These findings may have future potential value in evaluating electrocardiogram (ECG), especially of pregnants with extremes of left axis deviation (polyhydramnios, large fetus or breech presentation). Clinicians should be cautious during the interpretation of the ECG in pregnants, especially in those with extremes of left axis deviation because of either polyhydramnios, large fetus or breech presentation.

Keywords: Amniotic fluid index; Cardiac axis; Fetal weight; Fetal presentation; Pregnancy

Introduction

Pregnancy, although a physiological phenomenon, causes major changes in women's body with a burden of great extent put on many organ systems, particularly the cardiovascular system. The increased demand for the support of the fetus is compensated by the reserve capacity of the pregnant through both mechanical and physiological processes. Mechanical shifting of the heart with the growing fetus and uterus with accompanying hemodynamic changes is all responsible for the electrocardiographic (ECG) changes observed during the course of pregnancy. The major hemodynamic changes include increased circulating volume and increased cardiac output to pump this increased load starting as early as 5 weeks of gestation and sometimes may simulate heart diseases [1]. One of the most consistent findings in the literature is the physiological and reversible myocardial hypertrophy during pregnancy, in which the left ventricular mass increases as a compensatory mechanism to overload caused by repetitive physical exertion [2]. It is important to differentiate normal changes inherent to pregnancy itself from true pathologic changes in order not to fail to detect and appropriately treat heart disease when it does exist [3].

Cardiac axis is defined as the mean direction of the action potentials traveling through the ventricles during ventricular depolarization. Ventricular depolarization (activation) is

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represented by the QRS complex and the cardiac axis is usually measured by the extremity leads in the frontal plane. Although the vector of the cardiac axis originates from the atrioventricular (AV) node, it points towards the left ventricle because of the massive size of the left ventricle. The actual anatomical axis of the heart is related to its electrocardiographic axis and the orientation of the heart within the thoracic cavity affects the formation of the cardiac electric field on body surface. The position of heart in the chest changes with a slight rotation and deviation of apex to the left during the course of normal pregnancy [4,5]. The electrical axis is defined in degrees with respect to the horizontal line. The value of cardiac axis is between −30 degrees and +90 degrees with normal situation of the heart. Cardiac axis may be altered either when there is any change in anatomical position of the heart such as dextrocardia, thoracic anomalies, pregnancy, ascites, obesity or in the presence of any cardiopulmonary pathology such as myocardial infarction, recent ischemia, pulmonary thromboembolism, concentric and dilated cardiomyopathies and conduction anomalies.

Certain ECG findings, most of being reversible adaptive changes, were reported in normal pregnancies. These changes were attributed not only to the anatomic reposition of the pregnant's heart within thoracic cavity but also the functional changes in cardiodynamics. The most common ECG finding associated with pregnancy is the QRS axis deviation, which is suggestive of left axis deviation changing during the gestational period. To accurately detect cardiac diseases during pregnancy, it is important to know what is a normal and what is a pathological change of the QRS axis are in pregnant women, and factors affecting this change. Decreased voltage in QRS complex, alterations in T and P waves are also possible findings [6].

The changes in cardiac axis are understood only to some extent, since very few studies have been done. Not only mechanical factors but also complex hemodynamic changes, changes in serum electrolytes and sex hormones were all previously studied and found to affect the ECG findings. Besides many contributing factors, we just aim to find out the individual contributions of each of the 4 factors to the change in cardiac axis with advancing gestational weeks: presentation of the fetus, amniotic fluid index (AFI) and estimated fetal weight (EFW) and actual birth weight, all of them acting through mechanical shifting of the diaphragm leading to elevation. The particular contributions of each of these factors to the change in cardiac axis were analyzed.

Materials and methods

Setting and selection of groups

The study was performed prospectively at a tertiary referral hospital in Ankara, Turkey among pregnant women who were followed-up and delivered at the same hospital between January 2014 and April 2015. The study was approved by the Institutional Review Board.

Measures used

Fifty-eight healthy women at the 20th weeks of gestation with singleton pregnancies were recruited for the study. Active presence or a history of organic cardiopulmonary disease (including cardiomyopathies, cardiac conduction anomalies, myocardial ischemic attack, rheumatic valve disease, pulmonary embolism), renal disease, chronic or pregnancy-induced hypertension, preeclampsia, thyroid disease, diabetes, obesity (a body mass index (BMI) ≥ 30), severe anemia, oligohydramnios and polyhydramnios at term and those under chronic medication were the exclusion criteria for the study. Out of 58 participants, 13 were later excluded from the study group; 9 lost for follow-up and did not visit our hospital for delivery, 1 pregnant developing preeclampsia and severe intrauterine growth retardation (IUGR) in the third trimester, 1 pregnant with a BMI increase reaching ≥ 30 before term, 1 pregnant with polyhydramnios at term and 1 pregnant with preterm premature rupture of membranes and delivered at 35th weeks. A total of 45 eligible pregnant women were followed-up reaching term and delivered in our hospital. All pregnant women had an ECG and obstetric ultrasonographic examination both at 20th weeks of gestation and at term (40th weeks of gestation). Age, parity, route of delivery, fetal birth weights and sonographic findings of fetal presentation, AFI and EFW measurements were noted for each pregnant woman.

AFI was calculated with the four-quadrant technique in which the deepest and unobstructed vertical length of each pocket was added to the other with normal values in the range of 5–25 cm. Oligohydramnios was defined as an AFI measurement of <5 cm. Polyhydramnios was defined as an AFI measurement of >25 cm. EFW was calculated with the software embedded in the ultrasonography equipment using Hadlock biparietal diameter (BPD)/femur length (FL)/abdominal circumference (AC) (formula 3) (Log 10 birth weight = 1.4787 + 0.001837 (BPD)2 + 0.0458 (AC) + 0.158 (FL) − 0.003343 (AC × FL)).

The same ECG equipment was used in evaluation of all participants (Nihon Kohden Cardiofax M, Model ECG-1350 K, Nihon Kohden Corporation, Japan). The electrocardiographic data for cardiac axis were processed with the embedded software of the equipment. This software also determines the common wave onsets, offsets and amplitudes. Standard resting 12-lead surface ECGs were recorded in all participants at 50 mm/s and 1 mV/cm standardization with Nihon Kohden Cardiofax M. All the paper hardcopies of ECG were later evaluated and revised if necessary by a senior cardiologist, blinded to the study design. Hexaxial reference system was used to calculate the cardiac axis. Before the beginning of the study, the intra-subject and inter-observer reproducibility of cardiac axis measurements had been demonstrated by 2 senior cardiologist in 10 pregnant women with correlation coefficients of 0.628 and 0.651 for intra-subject and inter-observer average measures, respectively.

Statistical analysis

The data were analyzed by the commercially available software, Statistic Package for Social Sciences (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). The change in cardiac axis was calculated with the difference of cardiac axis at term and at the 20th gestational week. The relevance of the distribution of continuous variables