BRIEF ARTICLE

Electrocardiography During the Third Trimester of Pregnancy: Description of its Characteristics

Electrocardiogramas durante el tercer trimestre de embarazo: descripción de sus características

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ABSTRACT

Objective: The aim of this study was to analyze the electrocardiographic characteristics in pregnant women without cardiovascular disease.
Methods: This was a descriptive, cross-sectional, multicenter study, including patients without cardiovascular disease in their third trimester of pregnancy, who underwent cardiac evaluation before delivery between April and July 2020. All patients signed the corresponding informed consent.
Results: A total of 80 tracings were analyzed. Median heart rate was 82 bpm (IQR 70-93 bpm) and median QRS axis was 54° (IQR 39°-71°). Q waves and ST-segment depression were observed in the inferior wall and from V4 to V6. Median QTc was 422 msec (IQR 404-445 msec) and median time from T-peak to T-end was 86 msec (IQR 74-95 msec).
Conclusion: The most common changes occurred in leads III and II, aVF and from V4 to V6. Main changes included Q waves and ST-segment depression. Axis deviations, sinus tachycardia or prolonged QTc were rare.

Key Words: Pregnancy Complications, Cardiovascular - Pregnancy Trimester, Third - Electrocardiography - Cardiovascular disease

RESUMEN

Objetivo: Analizar las características electrocardiográficas en embarazadas sin patología cardiovascular.
Material y métodos: Estudio de corte transversal, descriptivo, multicéntrico. Se incluyeron pacientes sin patología cardiovascular que cursaban el tercer trimestre de embarazo y que concurrieron a una evaluación cardiológica preparto entre abril y julio de 2020; todas ellas firmaron el consentimiento correspondiente.
Resultados: Se analizaron 80 trazados. La frecuencia cardíaca media fue 82 lpm (RIC: 70-93 lpm). La mediana del eje QRS fue 54° (RIC: 39°-71°). Se observaron ondas q e infradesnivel del segmento ST en cara inferior y de V4 a V6. La mediana del QTc fue 422 mseg (RIC: 404 mseg-445 mseg). La mediana del tiempo del pico de la onda T a su fin fue 86 mseg (RIC: 74-95 mseg).
Conclusión: Las alteraciones más frecuentes ocurrieron en DIII, DII, aVf y de V4 a V6. Las ondas q y el infra ST fueron los cambios principales. Fueron infrecuentes las desviaciones del eje, la taquicardia sinusal o el QTc prolongado.

Palabras clave: Complicaciones cardiovasculares del embarazo - Tercer trimestre del embarazo – Eletrocardiografía - Enfermedades cardiovasculares

INTRODUCTION

Cardiovascular (CV) disease in women has unique manifestations. This fact has gained institutional and public relevance in Argentina and worldwide. As a result, several initiatives have been implemented by different scientific societies, such as Women in Red of the Argentine Federation of Cardiology (FAC), and Women's Heart Disease Council of the Inter-American Society of Cardiology (SIAC), among others.

Pregnancy is a unique period of cardiovascular vulnerability, with unmet diagnostic and therapeutic needs. (1, 2). It imposes physiological changes on the CV system, (3) to satisfy an adequate perfusion of maternal and fetal organs. While these changes have been widely described in the literature, some of them may be mistaken for CV disease.

ST-T and repolarization abnormalities and the appearance of Q waves reported in the surface electrocardiogram (ECG) become more marked during the third trimester. These characteristics have been documented

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in previous publications, but are limited to the analysis of series of fewer than 100 patients in Asian populations with a mean age of 25 years. (4-9)

The purpose of this study was to evaluate the ECG and clinical characteristics of third trimester pregnant women with no history of cardiovascular disease, in the local population. In addition, ECG characteristics in pregnant women >40 years of age were analyzed.

METHODS

This was a descriptive, cross-sectional, multicenter study. including patients without cardiovascular disease in their third trimester of pregnancy undergoing cardiac evaluation before delivery at Diagnóstico Maipú, Pilar and Cabildo sites, between April and July 2020. All the patients signed the informed consent form to use their data for research purposes.

Clinical evaluation was carried out by a cardiologist using a standardized form to collect patient's history details and cardiovascular risk factors, and a physical examination. ECGs were obtained according to the standard 12-lead method, with a sweep speed of 25 mm/sec and an amplitude of 0.1 mm/mV, in 6 x 2 format with a long lead II rhythm strip, using a digital acquisition device (ECGview, ECCOSUR, Córdoba, Argentina). ECGs were analyzed offline by the first and second author using the electronic caliper and measurement differences were agreed by consensus.

Measurements were made adjusting speed and scale as required. The QT interval was measured from the onset of the first QRS deflection to the end of the T wave, defined as the intersection of the isoelectric line with the tangent to the steepest slope of the descending T wave.

Statistical analysis

Categorical variables were expressed as absolute and relative frequencies and numerical variables as mean ± standard deviation or as median and interquartile range, according to their distribution. Differences between numerical variables were analyzed by means of the Mann-Whitney U-test, and those between categorical variables by the chi-square or Fisher's exact tests, as appropriate.

Ethical considerations

This study was approved by the Ethics Committee for Institutional Research. It was decided that no additional consent other than that signed by the patients when they visited the center was required, as it was a retrospective study, without intervention, and because all the patients signing the consent form were expressly asked if their data could be used for clinical research.

RESULTS

Eighty pregnant patients with a median gestational age of 35 weeks (IQR 33-36 weeks), 10 (12.5%) of which were >40 years old, were included in the study. Clinical characteristics are summarized in Table 1.

Median heart rate (HR) was 82 bpm (IQR 70-93 bpm) and median QRS axis was 54° (IQR 39°-71°) (Table 2). Axis deviations >90° were found in 2 patients, and <0° in another 2 patients. Systolic-diastolic interval (SDI) and lead III Q and T wave morphology was observed in 5 patients (6.3%). The inferior wall presented Q waves (lead II 37.5%, lead III 46.3%, aVF 43.8%) and ST-segment depression (lead II 23.8%, lead III 15%, aVF 22.5%), and the low lateral wall (V4 10%, V5 23.8%, V6 25%), (V4 13.8%, V5 12.5%, V6 13.8%), respectively. Altered Q waves and ST-segment were never observed simultaneously in the low lateral wall. Neither were alterations found in V4-V5 without V6 having identical alterations.

Negative T waves were observed mainly in V1 and lead III, 80% and 16.3%, respectively. These changes were less common in V2 (7.5%) and V3 (1.3%). Alterations with >10% frequency are shown in Figure 1.

Median QTc by Bazett's formula was 422 msec (IQR 404-445 msec). Median time from T-peak to T-end was 86 msec (IQR 74-95 msec). Negative T waves were rarely observed in V2-V3 and aVL. Table 3 describes the changes by lead.

Ten patients >40 years old were included. Median age was 42 years (IQR 40-44 years). Except for history of diabetes (DM) (3 out of 10 patients >40 years vs. 2 out of 70 patients <40 years, p = 0.013), the distribution of comorbidities and ECG variables were not significantly different (Table 4). There were no differences between the presence of Q waves, ST-segment depression or T-wave abnormalities.

Table 1. ECG and Clinical Characteristics

Clinical variables	Median (IQR) or frequency (%)
Age	35 (32-38)
Weight (kg)	71.5 (65-80)
Height (m)	1.63 (1.60-1.68)
BSA (m2)	1.78 (1.7-1.87)
BMI (kg/m2)	26.3 (24.9-28.8)
wGA	35 (33-36)
SBP (mmHg)	110 (100-120)
DBP (mmHg)	69.3 (60-75)
HR	82 (70-93)
HTN	1 (1.3%)
DLP	9 (11.3%)
DM	5 (6.3%)
Current SMK	8 (10%)
BMI >30 (kg/m2)	11 (13.8%)
>40 years	10 (12.5%)
ECG variables	
P duration (msec)	100 (92-108)
PR (msec)	132 (120-152)
PR segment (msec)	36 (24-44)
P wave axis (°)	53 (36-68)
QRS axis (°)	54 (39-71)
QRS duration (msec)	80 (72-88)
QTc duration (Bazett) (msec)	422 (404-445)
T-peak to T-end (msec)	86 (74-95)

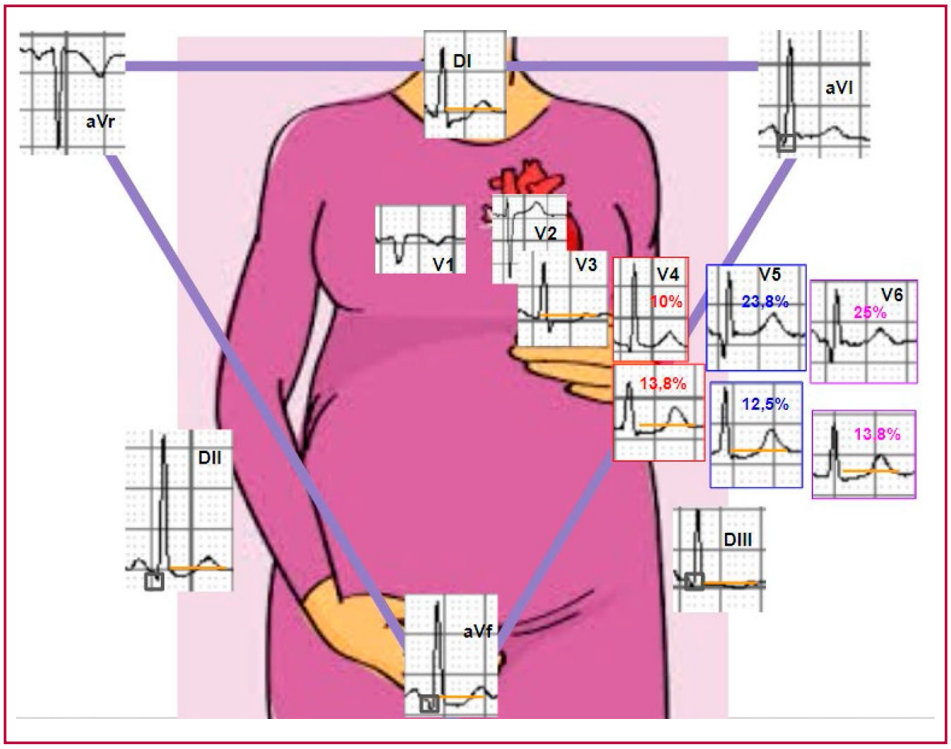
BSA: Body surface area. BMI: Body mass index. wGA: Weeks of gestational age. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HR: Heart rate. HTN: Hypertension. DLP: Dyslipidemia. DM: Diabetes mellitus. SMK: Smoking.

Table 2. ECG and Clinical Characteristics According to Patients' Age

	< 40 years (N = 70)	> 40 years (N = 10)	P =
Age	34 (31-37)	42 (40-44)	0.001
wGA	35 (33-36)	33 (32-35)	0.237
HTN	1 (1%)	0 (0%)	1
DLP	8 (11%)	1 (10%)	1
DM	2 (3%)	3 (30%)	0.013
SMK	7 (10%)	1 (10%)	0.5
Weight (kg)	71 (64-80)	75 (66-83)	0.528
Height (cm)	163 (160-168)	162 (158-167)	0.414
BMI (kg/m^2)	26 (25-28)	28 (25-32)	0.335
BSA (m^2)	1.78 (1.7 – 1.9)	1.82 (1.72-1.86)	0.801
SBP (mmHg)	110 (101-120)	110 (100-120)	0.789
DBP (mmHg)	70 (60-75)	70 (60-80)	0.885
HR	84 (71-94)	79 (67-82)	0.128
P duration (msec)	100 (92-108)	94 (91-116)	0.866
PR duration (msec)	132 (120-152)	136 (115-157)	0.252
PR segment	36 (24-46)	40 (20-44)	0.769
P axis (°)	53 (40-68)	50 (28-70)	0.535
QRS axis (°)	59 (39-73)	42 (17-71)	0.310
QRS duration (°)	80 (71-90)	76 (71-84)	0.668
QTc duration (Bazett) (msec)	422 (404-441)	436 (393-448)	0.996
T-peak to T-end (msec)	86 (73-96)	86 (79-95)	0.707

Abbreviations as in Table 1.
Continuous variables are expressed as median and IQR, and categorical variables as absolute and relative frequencies.

Table 3. Changes according to lead with a frequency >10%



DISCUSSION

In our study, we observed absence of changes typically associated with pregnancy: sinus tachycardia, and horizontal or left-deviated QRS axis. The most common changes included Q waves in the inferior and low lateral wall, and up to 1 mm ST-segment depression in those leads. Pregnant patients >40 years of age showed higher prevalence of DM, but there were no differences in ECG parameters when compared with younger pregnant women.

In our study, median HR was 82 bpm. Only 9 patients exceeded 100 bpm. This is different from the publication by Adamson et al (4) and Sumalatha et al. Those authors reported that sinus tachycardia was the most common finding, and that average HR was 100 bpm, respectively. In keeping with our findings, other authors have published average HR between 80 and 85 bpm. (6, 9) Increased HR is one of the mechanisms used to increase cardiac output. This is due to decreased parasympathetic tone (11) and increased automaticity of the hyperpolarization-activated, nonspecific cation current (Ih). However, there are still no explanations as to why these changes occur, since the studies conducted to elucidate the effect of gestational hormones on the cardiac muscle have had contradictory results. (7)

The QRS axis was not significantly different from that described in the study by Sunitha et al, (5) who found that the average axis was 46°, or that mean axis was 40° in the third trimester of pregnancy, as described by Carruth et al. (8) In general, the pregnant patient's heart is horizontal due to the uterus effect; however, it would seem that, in spite of this, it would not be far from the expected range for a non-pregnant woman.

The occurrence of Q wave in lead III is considered as normal in most people, in the absence of additional changes in other contiguous leads. In our study, we observed that between 30% and 40% of the patients presented Q wave in the inferior wall that could be accompanied by changes in the T wave. This was also observed by Chaudhary et al, (9) who reported that up to 30% of patients had Q waves in leads III and II, and aVF. Similar findings were reported by Sunitha et al. The presence of Q waves in precordial leads -from V3 to V6- has been described by both authors, but with different frequencies (between 10% and 60%). In our study, the frequency of Q waves increased from V4 to V6, not exceeding 25% in V6. We also observed that there was no Q wave in the precordial leads if there was no Q wave in V6, and neither were Q waves observed simultaneously with ST-segment alterations. This observation could be useful to distinguish Q waves associated with structural pathology; however, further research is needed. The genesis of Q waves is still a matter of discussion; in our study, we cannot attribute Q waves to left axis deviation.

Another finding in our study was the occurrence of ST-segment depression in all the leads except for V2. The highest frequency was observed in lead II, aVF, and lead I; it was also frequent from V3 to V6. When a stricter definition of ST-segment depression (-1 mm) was used, its frequency changed to 10% in lead II and aVF, and up to 5% in left precordial leads. These findings are in contrast with those in previous studies, in which ST-segment depression was observed in only one patient. (9) Conversely, ST-segment elevation >1 mm was only observed in V1 and V2, and was infrequent.

In our study, inverted T waves were most commonly observed in the right precordial leads from V1 to V3, and were less common as they moved away from V1. Consistent with previous studies, (4) the occurrence of inverted T in lead III was the most frequent observation in limb leads.

Median time from T-peak to T-end, a surrogate for myocardial repolarization heterogeneity, was 86 msec, in agreement with the study by Tanindi et al, (6) which in turn, was substantially different from controls. Despite this, QT corrected by Bazett's formula was found to be within the normal interval in 72% of patients. Those with long QTc (18% of patients) presented a mean of 454 msec, none exceeding 480 msec.

The reasons for QT alterations in pregnancy are still controversial; in animal and human model studies, it is believed that estrogens may affect cardiac repolarization. (12) Data on QTc change during the menstrual cycle show contradictory results. (13-15) Further studies are required to understand the molecular mechanisms of these changes in ventricular repolarization.

In our study, no differences were observed between ECGs in pregnant women younger and older than 40 years, but we found a small but statistically significant difference in the prevalence of DM. Advanced maternal age is independently associated with increased maternal and fetal risk. (17) In 12.5% of our sample pregnant women were over 40 years of age. Although it is a small sample in absolute numbers, it is consistent with that published by Claramonte Nieto et al, (18) who also showed an association between DM and maternal age, in line with our findings. In addition, the increase in gestational age is a worldwide trend, in some countries being the only age segment with rising fertility rates. (16)

Our study is observational in nature and is subject to all the biases inherent to its design. We have no control group to compare the ECGs with a non-pregnant cohort.

CONCLUSIONS

Electrocardiographic tracings of patients in their third trimester of pregnancy rarely showed sinus tachycardia; most of them had the QRS axis in the first quadrant. The occurrence of Q waves and of ST-segment depression in the inferior and low lateral wall were common. Negative T waves were observed in right precordial leads. QTc was within normal limits or

slightly increased due to longer time from T-peak to T-end. No differences in tracings were found in patients when compared according to their age.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material)

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