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Fetal heart assessment in the first trimester of pregnancy: influence of crown-rump length and maternal body mass index

Avaliação do coração fetal no primeiro trimestre de gestação: influência do comprimento cabeça-nádega e índice de massa corporal materna

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Abstract

Objective: **To evaluate the influence of the crown-rump length and body mass index on sonographic evaluation of the fetal heart using abdominal and vaginal routes in the first trimester of pregnancy.**

Methods: We conducted a cross-sectional study with 57 pregnant women between 12-14 weeks (CRL≤ 84 mm). We evaluated the following fetal cardiac plans using the abdominal and vaginal routes: four-chamber view, right ventricle outflow tract, left ventricle outflow tract and aortic arch. We used the B-mode, color Doppler and four-dimensional ultrasonography (spatio-temporal image correlation). To evaluate the influence of crown-rump length and body mass index in the assessment of fetal cardiac planes, we used the t test unpaired.

Results: There were no statistically significant differences in the rates of success and failure between abdominal and vaginal routes in relation to body mass index, however, there was a higher failure rate in vaginal assessment using B mode associated with color Doppler (*P*<0.01).

Conclusion: The crown-rump length and body mass index had no interference in fetal cardiac assessment in the first trimester of pregnancy.

Descriptors: Fetal heart. Color Doppler. Ultrasonography, Doppler, Color. Crown-rump length. Body mass index.

Resumo

Objetivo: **Avaliar a influência do comprimento cabeça-nádega e do índice de massa corporal na avaliação ultrassonográfica do coração fetal, pelas vias abdominal e vaginal, no primeiro trimestre de gestação.**

Métodos: **Realizou-se um estudo de corte transversal com 57 gestantes normais entre 12 a 14 semanas (CCN ≤ 84 mm). Foram avaliados os seguintes planos cardíacos, pelas vias abdominal e vaginal: quatro câmaras, via de saída do ventrículo direito, via de saída do ventrículo esquerdo e arco aórtico. Utilizou-**

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Abbreviations, acronyms & symbols	
CRL	crown-rump length
CHD	Congenital Heart Disease
BMI	Body Mass Index
STIC	Spatio-temporal image correlation

se o modo B, Doppler colorido e ultrassonografia de quarta dimensão (*spatio-temporal image correlation)*. Para avaliar a influência do comprimento cabeça-nádega e índice de massa corporal na avaliação dos planos cardíacos fetal, utilizou-se o teste t não-pareado.

***Resultados:* Não se observou diferenças estaticamente significativas nas taxas de sucesso e insucesso entre as vias abdominal e vaginal em relação ao índice de massa corporal, contudo, observou-se maior taxa de insucesso na avaliação vaginal utilizando o modo B associado ao Doppler colorido (*P*<0,01).**

***Conclusão:* O índice de massa corporal e o comprimento cabeça-nádega não tiveram interferência na avaliação cardíaca fetal no primeiro trimestre de gestação.**

***Descritores:* Coração fetal. Doppler colorido. Ultrassonografia Doppler em cores. Estatura cabeça-cóccix. Índice de massa corporal.**

INTRODUCTION

Congenital heart disease (CHD) are the most common birth defects, affecting 5-8 per 1,000 live births [1]. Early diagnosis of CHD allows better prenatal care and referral of pregnant women to tertiary center of cardiology and neonatal cardiac surgery.

Fetal cardiac assessment through abdominal approach during the examination of screening for chromosomal defects in first trimester of pregnancy allows the evaluation of the four-chamber plane, and enable the diagnosis of 44.8% of CHD [2]. The vaginal ultrasound has been used for almost 20 years for fetal cardiac evaluation at the end of the first trimester of pregnancy, allowing the assessment of the four-chamber plane in addition to the extended examination [3]. The three-dimensional ultrasound using spatio-temporal image correlation (STIC) software has been used in the first trimester through the abdominal approach, demonstrating that cardiac volumes sent via an internet link allowed us to obtain standard cardiac planes [4].

The first trimester screening is important, not only for the calculation of risk for chromosomal defects, but also to correct dating of gestational age, assessment of some fetal malformations and determination of chorionicity in cases of twin pregnancies [5,6].

The body mass index (BMI) and crown-rump length (CRL) can be factors that influence fetal cardiac assessment in the first trimester through abdominal approach [7], however, there are no descriptions of the influence of these parameters in vaginal or STIC approaches.

The aim of this study is to assess the influence of BMI and CRL in the assessment of fetal cardiac planes, through vaginal and abdominal approaches, using B mode, color Doppler and STIC.

METHODS

We performed a prospective cross-sectional study with healthy pregnant women between 12 and 14 weeks of gestation, from July 2011 to July 2012. This study was approved by the Research Ethics Committee of the Federal University of São Paulo (UNIFESP), whereas women who agreed to participate signed a voluntary written informed consent. Inclusion criteria were singleton pregnancies, with measurement of CRL from 45 mm to 84 mm. We performed a single measure of CRL, which also served to the correct dating of gestational age.

Patients were randomly selected, with the examinations in two Voluson 730 Expert and E8 devices (General Electric Healthcare, Zipf, Austria) equipped with volumetric convex (RAB4-8L) and endocardial (RIC5-9W) transducers. Cardiac assessment was performed by a single examiner (AIFL) immediately after the screening of the first trimester. Initially, we used the abdominal approach, associating the B mode to color Doppler, followed by vaginal approach. We aimed to obtain the plans of four heart chambers, left ventricular outflow tract and right ventricular outflow tract and aortic arch. In the plane of the four heart chambers, size, axis and symmetry of the chambers were assessed.

In the plans of the right and left ventricular outflow tract, there was the crossing of the great vessels, in addition to the similarity of their diameters. The plane of the aortic arch allowed the identification of the descending aorta. We considered "successful" when all four planes were obtained

by abdominal and/or vaginal and "unsuccessful" when obtaining three or fewer plans.

After the two-dimensional evaluation, the assessment was performed by STIC associated with color Doppler. A four-dimensional assessment was performed immediately after the two-dimensional, starting with an abdominal approach, followed by vaginal. The acquisition of the STIC volumes was performed in the plane of the four heart chambers, wherever possible with the fetal back at 6h, with a scan time of 10 seconds and aperture angle of 20°.

The maximum scan time for each method was 30 minutes. All women returned at the age between 20 and 24 weeks for completion of two-dimensional echocardiography, in order to confirm normal fetal heart anatomy. The women were not followed-up, not being obtained their neonatal outcomes.

Statistical analysis was performed using SPSS software version 18.0 (SPSS Inc. Chicago, IL, USA). To assess the influence of BMI and CRL in fetal cardiac evaluation by abdominal and vaginal approaches, we used the unpaired t test. We used a significance level of $P<0.05$.

RESULTS

We assessed 57 pregnant women between 12 and 14 weeks (19 patients in each gestational age) who agreed to participate in the study, and 4 were not included because they had not the CRL > 84 mm. Therefore, for final statistical analysis were considered 53 pregnant women. The average maternal age was 27.8 ± 5.5 years (range of 14-39 years). The average CRL was 71.5 ± 8.6 mm (range of 55.9 to 84 mm). The median maternal BMI was 23.8 ± 2.6 kg/m2 (range of 17.5 to 29.9 kg/m^2).

BMI did not influence the performance of the methods (B mode, color Doppler and STIC) when using the vaginal approach, but in the abdominal approach, although with no statistically significant differences, the findings suggest that it is more difficult for a satisfactory examination as BMI increases (Table 1). Regarding the CRL, there was greater failure rate in assessing through vaginal approach when using color Doppler and B modes ($P<0.01$) (Table 2).

Table 1. Review of significant difference between the mean body mass index and the success or failure of the method by vaginal/abdominal approaches

	(BMI) Success	(BMI) Failure	*P**
B mode (vaginal)	23.74	23.89	0.85
B mode + Color Doppler (vaginal)	23.49	24.00	0.52
STIC (vaginal)	23.48	24.15	0.36
B mode (abdominal)	23.10	24.29	0.11
B mode + Color Doppler (abdominal)	23.59	24.02	0.56
STIC (abdominal)	23.10	24.47	0.06

**unpaired t test; STIC: spatio-temporal image correlation, BMI: body mass index.*

Table 2. Review of significant difference between the average crown-rump length and the success or not of the method by vaginal/abdominal approaches

	(CRL) Success	(CRL) Failure	*P**
B mode (vaginal)	69.78	72.24	0.34
B mode + Color Doppler (vaginal)	66.78	73.54	<0.01
STIC (vaginal)	69.32	73.30	0.13
B mode (abdominal)	73.51	70.28	0.19
B mode + Color Doppler (abdominal)	73.95	68.89	0.09
STIC (abdominal)	71.73	71.31	0.86

** unpaired t test; STIC: spatio-temporal image correlation; CRL: crown-rump length*

DISCUSSION

In this study we assessed the influence of BMI and CRL in evaluating standardized cardiac planes between 12-14 weeks of gestation, through abdominal and vaginal approaches, through B mode, Color Doppler and spatio-temporal image correlation. To our knowledge, there are no studies in the literature with similar methodology.

Obstetric oltrasonography of obese women is difficult and in some situations can become a real challenge for physicians. In a study comparing obese women (BMI ≥ 30kg/m^2) versus non-obese pregnant women (BMI < 30kg/ m^2) who underwent second trimester ultrasound, it was found that suboptimal visualization rates increased significantly in obese group, both for the heart (37% versus 19%) and fetal column (43% vs. 29%) [8].

In the first trimester, only one study assessede the influence of BMI on fetal cardiac evaluation [7]. In this study, 103 pregnant women between 11 and 13 weeks and 6 days were examined, through abdominal approach using B mode and, in some cases, associated with color Doppler. They did not found no influence of BMI in cardiac assessment (*P*=0.752) [7]. Similarly, in our study, assessing 54 pregnant women between 12 and 14 weeks, there was also no influence of BMI. One possible explanation would be the fact that at the end of the first trimester, most of the women maintains prepregnancy BMI, in addition, the mean BMI of our group was 23.8 kg/m^2, and no pregnant woman had a BMI≥ 30kg/ m^2. Other studies have reported the influence of maternal BMI as a visualization of the fetal heart in the first trimester of pregnancy [9-11]. Even the guideline of the American Institute of Ultrasound in Medicine (AIUM) for fetal cardiac evaluation refers to a technical limitation in the case of obese patients, due to acoustic shadows in the third trimester. They reported the need for assessments at different times, in addition to optimization of the device and focus adjustment, frequency, gain, magnification, temporal and harmonic [12] resolution. In relation to the influence of CRL, we observed failure rate statistically significant only for the group assessed by vaginal approach using color Doppler and B mode (*P*<0.01). In a previous study of the screening in the first trimester, the CRL showed a factor of influence on quality of nuchal translucency measurement [13]. Regarding fetal cardiac evaluation, there is only one study that assessed the influence of the CRL [7].

In this study, the authors observed no influence of CRL in fetal cardiac assessment (*P*=0.899), with a mean of CRL of 72.1 mm [7], however, it was performed only the assessment by laparotomy. In our study, the mean CRL was 71.5 mm and we used the abdominal and vaginal approaches in all cases. The higher failure rate in vaginal approach is due to the need for prior learning curve, plus the need for experienced examiners to obtain the standardized cardiac plans. In a study by Vimpeli et al. [14], who assessed 584 fetuses with CRL between 41 and 78 mm, the rate of success in getting all cardiac plans was only 58%.

As limitation of the study, we noted that all pregnant women were randomly selected, so that the results were adversely affected due to the absence of women with BMI ≥ 30kg/ m^2. Maybe if we had selected patients knowingly obese or with certain diseases prior to pregnancy such as diabetes mellitus we could infer the real impact of maternal BMI in assessing the quality of fetal cardiac examination in the first trimester of pregnancy.

CONCLUSION

Concluding, we found no influence of the index of body mass and crown-rump length in fetal cardiac assessment between 12-14 weeks gestation. The assessment through vaginal approach needs more prior training, and experienced examiners in this pathway. Subsequent studies using populations of previously obese women are needed to prove the real influence of body mass index in fetal cardiac assessment in the first trimester of pregnancy.

Authors' roles & responsibilities

DBSP	Main coordinatination
AIFL	Data collection
EAJ	Preparation of the article for publication
LMMN	Adjunct coordenation
WPM	Statistical analysis
AFM	Final review

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