Suboptimal Second-Trimester Ultrasonographic Visualization of the Fetal Heart in Obese Women
Should We Repeat the Examination?

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Objective. The purpose of this study was to determine whether a repeated antenatal ultrasound examination improves fetal cardiac visualization for the obese and nonobese population. Methods. A computerized ultrasound database (October 1999–June 2003) was used to identify singleton pregnancies undergoing repeated prenatal ultrasound examinations because of initial suboptimal ultrasonographic visualization (SUV) of the 4-chamber view, outflow tracts, or both. Women with maternal diabetes, abnormal maternal serum screening results, or known fetal anomalies at the initial examination were excluded. Patients were classified by maternal body mass index (BMI): less than 30 kg/m² (nonobese), 30 to 34.9 kg/m² (class I obesity), 35 to 39.9 kg/m² (class II obesity), and 40 kg/m² or greater (morbid obesity). The association between maternal BMI and SUV of the fetal heart was analyzed. Results. Three hundred seventy-two patients were abstracted from the database. The median gestational age was 19.0 weeks at the initial visit (range, 18.0–21.9 weeks) and 21.4 weeks at the second visit (range, 18.9–23.9 weeks). The median BMI was 32.6 kg/m² (range, 16.4–58.7 kg/m²). Sixty-three percent of patients were obese (BMI ≥30). Cardiac anatomy continued to have SUV in 11% of the women. The rate of SUV was associated with the obesity class (1.5% for nonobese, 12% for obesity I, 17% for obesity II, and 20% for morbid obesity; P < .0001). A cardiac anomaly was found in 1 of 372 repeated examinations (arteriovenous canal defect) for a patient with BMI of 24.8 kg/m². Conclusions. Repeated ultrasound examination for SUV of the fetal heart at a later gestational age dramatically reduces SUV. However, obese patients continue to have much higher rates of persistent SUV. Key words: body mass index; fetal cardiac anomalies; maternal obesity; prenatal ultrasonography; suboptimal ultrasonographic visualization.

Obesity is increasing in all age groups. More than 40% of nonpregnant US women ages 15 to 49 years are overweight or obese.¹ Maternal obesity, independent of diabetes, has been associated with an increased risk for fetal structural anomalies, including cardiac defects.²⁻⁶ Ultrasonographic technologies and techniques are constantly evolving in an effort to improve visualization and enable earlier diagnoses and interventions.⁷ However, ultrasonographic visualization of fetal structures is adversely affected by maternal obesity.⁸⁻¹⁰ Our group¹¹ previously reported a relationship between the severity of maternal obesity and the rate of suboptimal ultrasonographic visualization (SUV) of the fetal heart during the initial second-trimester (14–24 weeks’ gestation) prenatal ultrasound examination...
(Nonobese, 18.7%; obesity class I, 29.6%; obesity class II, 39.0%; and morbid obesity, 49.3%; \(P < .0001\)). We have also shown that the gestational age at the time of the ultrasound examination has a crucial impact on the ability to visualize fetal cardiac structures both for obese and nonobese women. If the cardiac structures are SUV at our obstetric ultrasound unit, the women are scheduled for an additional examination performed at less than 24 weeks for “heart check only.” The purpose of this study was to assess whether a repeated ultrasound examination of the fetal cardiac structures after cardiac SUV on the initial ultrasound examination reduces the rate of SUV or enables us to detect more cardiac anomalies when compared between different body mass index (BMI) groups.

**Materials and Methods**

A computerized ultrasound database (October 1999–June 2003) was used to identify singleton pregnancies at 18 to 24 weeks’ gestation who had a targeted heart ultrasound examination because of initial SUV of the cardiac structures. Exclusion criteria included factors associated with heart anomalies: maternal diabetes, abnormal maternal serum screening results, advanced maternal age, and known fetal anomalies on the initial examination.

Maternal age, parity, height, weight, gestational age at examination, fetal position, placental location, amniotic fluid volume, type of ultrasound machine, and visualization of fetal cardiac structures were abstracted from the database. Gestational age was calculated by the last menstrual period and was corrected when more than 14 days’ difference in fetal size by initial ultrasonographic measurements was found compared with the last menstrual period. Women were classified by BMI at the time of the examination according to National Institutes of Health guidelines: BMI less than 30 kg/m² (nonobese), 30 to 34.9 kg/m² (obesity class I), 35 to 39.9 kg/m² (obesity class II), and 40 kg/m² or greater (morbid obesity).

Registered diagnostic medical sonographers supervised by maternal-fetal medicine specialists performed the ultrasound examinations. Fetal structures were examined and classified as morphologically normal, abnormal, or suboptimally visualized. Examination of the fetal heart was considered adequate if the cardiac axis, cardiac position, 4-chamber view, and outflow tracts were all visualized. Examination was performed with HDI 3000 or 5000 ultrasound equipment (Philips Medical Systems, Andover, MA) with multifrequency transducers (C4–7 MHz or C2–5 MHz).

The primary outcome for this study was the rate of SUV for the examination of fetal cardiac structures (cardiac axis, cardiac position, 4-chamber view, and outflow tracts). The relationship between maternal BMI and SUV of the fetal heart on follow-up examination was analyzed. The SPSS statistical software package was used (SPSS Inc, Chicago, IL). Analysis of continuous data was performed with the Student \(t\) test (parametric) or the Mann-Whitney \(U\) test (nonparametric), and the Fisher exact test was used for analysis of categorical variables. One-way analysis of variance was used to examine the relationship between maternal obesity and the rate of cardiac SUV. Multivariable logistic regression analysis was performed to adjust for maternal obesity, gestational age, and type of ultrasound equipment used. \(P = .05\) was considered significant.

**Results**

During the study period, 38.6% of the women at the time of the initial scan were obese. The rates of SUV of the fetal cardiac structures on the initial ultrasound examination in our obstetric ultrasound unit were 18.7% in nonobese women, 29.6% in obesity class I, 39.0% in obesity class II, and 49.3% SUV in extreme obesity (\(P < .0001\)).

Three hundred seventy-two women had a repeated ultrasound examination of the fetal cardiac structures because of SUV at the initial scan and met inclusion criteria. Of these, 239 (64.2%) were obese (BMI \(\geq\) 30 kg/m²). The clinical characteristics of the study patients were compared by BMI group (Table 1). Obese women were older than nonobese women (mean ± SD, 26.6 ± 6.1 versus 25.3 ± 6.7 years; \(P = .004\)). However, there was no difference in factors that can influence ultrasonographic visualization, such as maternal parity, gestational age, fetal position, placental location, or amniotic fluid volume between groups.

Overall, the rate of SUV of the fetal cardiac structures at the second visit was 11%. There was a gradual increase in the rate of persistent SUV with increase in BMI group from 1.5% in nonobese up to 20% in morbidly obese women (\(P < .0001\)) (Figure 1).
A cardiac anomaly was prenatally diagnosed in 1 (0.3%) of 372 women on the repeated examination. The patient was 28 years old, was nonobese (BMI 24.8 kg/m²) and was found to have an arteriovenous canal defect. The initial ultrasound examination was performed at 21.7 weeks' gestation, and the second examination was performed at 22.7 weeks' gestation.

Discussion

The prenatal detection of cardiac anomalies may affect the neonatal outcome. A recent report states that in some cases of left or right ventricular outflow tract obstruction, early intervention during the second trimester may prevent the development of ventricular hypoplasia.13 Because of the importance of prenatal diagnosis of cardiac anomalies, in the event of SUV of the fetal cardiac structures (including the axis, position, 4-chamber view, and outflow tracts), we schedule women for an additional ultrasound examination targeted at the cardiac structures. In a group of low-risk women who had such a repeated targeted ultrasound examination, we found that the SUV rate decreased from 100% in the initial ultrasound survey to an average of 11%. However, most of the women were obese (64%), and with the increase in the degree of obesity, the rate of SUV gradually increased from 1.5% to 20%. A cardiac anomaly was detected in only 1 woman; she was not obese.

Suboptimal ultrasonographic visualization of the fetal heart is the main reason for the inability to complete the fetal anatomic survey.14 The main reasons for SUV of the heart include early gestational age, previous lower abdominal surgery, fetal spine-up position, and maternal adipose tissue thickness.10,14 The rate of SUV of the cardiac structures is directly associated with maternal BMI even at 18 to 20 weeks' gestation (nonobese, 12.4%; obesity class I, 24.5%; obesity class II, 37.0%; and morbid obesity, 46.6%; P < .0001).11

Different approaches have been considered to address this problem, including the use of 3-dimensional ultrasonography,14 the use of harmonic imaging,15 and even transumbilical placement of the probe.9 We have shown that by repeating the ultrasound examination, when the second examination was specific for the heart, we were able to reduce the rate of inadequate visualization of the heart by 80% to 90%. This major improvement may be due to the advance in the gestational age of the pregnancy. In a randomized trial, 88% to 90% of ultrasound examinations performed after 20 weeks were completed compared with only 76% when the examinations were performed between 18 and 20 weeks.16 Most of our patients were obese, with the initial examination performed at 18 to 22 weeks' gestation. We have previously shown that there is no further reduction in the rate of SUV of the cardiac structures for obese women after 18 to 20 weeks' gestation in our ultrasound unit.11 Thus, other factors may be involved in the

**Table 1. Clinical Characteristics of the Study Population**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nonobese, n = 133 (35.8%)</th>
<th>Class I Obesity, n = 98 (26.3%)</th>
<th>Class II Obesity, n = 65 (17.5%)</th>
<th>Morbid Obesity, n = 76 (20.4%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal BMI, kg/m²</td>
<td>25.8 ± 3.2</td>
<td>32.4 ± 1.3</td>
<td>37.3 ± 1.5</td>
<td>45.7 ± 4.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Maternal age, y</td>
<td>24.1 ± 4.9</td>
<td>25.3 ± 4.5</td>
<td>25.6 ± 4.7</td>
<td>25.8 ± 4.2</td>
<td>.04</td>
</tr>
<tr>
<td>Gravidity, n</td>
<td>2 (1–13)</td>
<td>3 (1–8)</td>
<td>3 (1–8)</td>
<td>3 (1–8)</td>
<td>.01</td>
</tr>
<tr>
<td>GA at initial ultrasonography, wk</td>
<td>18.9 (18.0–21.9)</td>
<td>19.1 (18.0–21.9)</td>
<td>19.4 (18.0–21.9)</td>
<td>19.3 (18.0–21.7)</td>
<td>NS</td>
</tr>
<tr>
<td>GA at repeated ultrasonography, wk</td>
<td>21.1 (18.9–23.9)</td>
<td>21.3 (19.1–23.6)</td>
<td>21.7 (20.0–23.7)</td>
<td>21.7 (20.0–23.7)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Data are represented as mean ± SD or median (range). GA indicates gestational age; and NS, not significant (P > .05).

**Figure 1.** Rate of persistent SUV at the second targeted ultrasound examination (heart check only) for women who had SUV of the cardiac anatomy at the initial second-trimester ultrasound evaluation compared by BMI group. Persistent SUV increased with BMI (P < .0001).
reduction of SUV, including a second examination performed by more experienced sonographers, change in the fetal position, and the use of advanced ultrasound equipment.

Tworetzky et al\textsuperscript{13} found in 88 patients with hypoplastic left heart that those who had a prenatal diagnosis and underwent surgery survived, whereas only 25 of 38 patients with a postnatal diagnosis survived, emphasizing the importance of prenatal diagnosis. Obese women have a 2- to 6.5-fold increased risk for cardiac defects including ventricular septal defects, atrial septal defects, coarctation of the aorta, and outflow tract defects.\textsuperscript{4–6} When the patient is obese, there is a reduced ability to diagnose fetal anomalies, most probably because of increased SUV\textsuperscript{11,17}

There are limitations to our study. We were able to adjust our results for some of the variables that are associated with ultrasonographic visualization, such as maternal parity, gestational age, vertex or nonvertex fetal position, placental location, and amniotic fluid volume between groups. However, our data were not controlled for other factors that may contribute to decreased visualization of the fetal heart, such as a spine-up position of the fetus and the sonographer’s experience at each of the examinations.

In conclusion, repeated ultrasound examinations in obese women who have SUV at the initial examinations may improve the overall evaluation of the fetal heart, may increase the rate of prenatal diagnosis of cardiac anomalies, and may improve the overall outcome of the pregnancy.

References


