Do early pregnancy ultrasound measurements correlate with fetal nuchal translucency at 11–14 weeks?

F. PREFUMO, G. CONDOUS, A. PAPAGEORGHIOU, B. THILAGANATHAN and T. BOURNE

Department of Obstetrics and Gynaecology, St George’s, University of London, London, UK

KEYWORDS: crown–rump length; gestational sac; heart rate; nuchal translucency; yolk sac

ABSTRACT

Objective To assess whether extremes in nuchal translucency (NT) thickness measurements at 11–14 weeks of gestation are preceded by departures from normal in early ultrasound biometry or embryonic heart rate in euploid fetuses.

Methods This was a retrospective analysis of data from women with singleton pregnancies examined in early pregnancy between June 2002 and January 2003, who subsequently had a nuchal translucency (NT) scan. The early pregnancy scan was performed transvaginally, and the crown–rump length (CRL), mean gestational sac diameter (GS), mean yolk sac diameter (YS) and embryonic heart rate (HR) were measured where possible. At the second scan CRL and NT were measured.

Results A total of 534 singleton pregnancies were included in the analysis. The mean maternal age was 30 (range, 14–45) years, and 59.4% of the patients were nulliparous. The mean CRL was 11.5 (range, 1.4–30.0) mm at the first scan and 62.8 (range, 42.0–88.0) mm at the second scan. GS, YS and HR measurements were obtained in 87.6%, 72.5% and 72.5% of cases, respectively. No statistically significant correlation was observed between NT and Z-scores of early pregnancy: GS (r = 0.013, P = 0.77), YS (r = 0.039, P = 0.44) or HR (r = 0.016, P = 0.76). GS, YS and HR were not significantly different in fetuses with NT measurements below the 10th percentile or above the 90th percentile (P = 0.24, 0.84 and 0.60, respectively).

Conclusion Ultrasound biometry and heart rate measured in early pregnancy are not related to nuchal translucency measurements at 11–14 weeks of gestation in chromosomally normal fetuses. Copyright © 2006 ISUOG. Published by John Wiley & Sons, Ltd.

INTRODUCTION

The early pregnancy ultrasound scan was initially introduced with the primary intentions of confirming the intrauterine location of the pregnancy, assessing fetal viability and measuring the fetal crown–rump length (CRL) to achieve accurate pregnancy dating. Improved resolution of ultrasound machines has made it possible to describe the normal anatomy of the fetus, to diagnose a wide range of fetal defects, and to measure fetal nuchal translucency (NT) thickness at the 11–14-week scan. There is extensive evidence that this provides effective screening for major chromosomal abnormalities. In addition, increased NT can also be associated with genetic syndromes, skeletal dysplasias and structural defects.

It is becoming common to observe women undergoing an early ultrasound scan in the first weeks of pregnancy for a variety of clinical indications, who subsequently have a nuchal scan for Down syndrome screening. We hypothesized that an increased NT may be preceded by departures from normal in early ultrasound biometry or embryonic heart rate.

METHODS

We retrospectively analyzed the data from women with intrauterine singleton pregnancies who were examined in our early pregnancy unit between June 2002 and January 2003 (first scan), and who subsequently had a nuchal translucency scan in our fetal medicine unit (second scan). Hospital records and regional cytogenetic registries were reviewed to determine the postnatal outcome for each subject. All fetuses with abnormal karyotype or major structural abnormalities were excluded from the study, as were cases of pregnancy loss.

The early pregnancy scans were carried out transvaginally using 5–9-MHz transducers on different ultrasound
All early pregnancy scans were performed by experienced clinical fellows. In each case, a thorough examination was performed to determine if the pregnancy was intrauterine, to identify and measure the gestational sac (GS), fetal crown–rump length (CRL), heart rate (HR) and yolk sac (YS). The CRL was measured as the greatest length of the fetus or embryo. The HR was recorded by M-mode imaging over at least three cycles. The mean YS diameter and the mean GS diameter were calculated by averaging three perpendicular diameters. Gestational age was calculated from the fetal CRL. At the second scan NT thickness was measured in viable pregnancies with a CRL between 42 and 88 mm employing a standardized technique. Measurements were obtained transabdominally using 3–7.5-MHz curvilinear transducers on different ultrasound systems. All scans were performed by sonographers certified in first-trimester ultrasonography by The Fetal Medicine Foundation.

Regression analysis was performed to assess the relationship between CRL, mean YS diameter, mean GS diameter and HR. In order to account for the variability related to CRL, individual measurements were converted into Z-scores, calculated as the (actual measurement – mean measurement for CRL)/standard deviation for CRL. When necessary, the method of scaled absolute residuals was applied. NT Z-scores were calculated based on previously published data. The correlation between different measurements was assessed by Pearson’s correlation coefficients. All calculations were performed using the SPSS software package (release 10.0.5, SPSS Inc., Chicago, IL, USA). Differences between groups were assessed by using a two-tailed pooled t-test. Statistical significance was assumed at \( P < 0.05 \). We calculated that in order to detect an \( r \) of 0.15 at a level of significance \( \alpha = 0.05 \) and with a power of 90%, a sample size of 460 pregnancies would be required.

### RESULTS

A total of 534 singleton pregnancies were included in the analysis. The median maternal age was 30 (range, 14–45) years, and 59.4% of the patients were nulliparous. The indications for the early pregnancy scan were bleeding in 30.5% of cases (\( n = 163 \)), abdominal pain in 25.5% (\( n = 136 \)), uncertain dates in 18.0% (\( n = 96 \)), maternal anxiety in 6.2% (\( n = 33 \)) and other in 34.4% (\( n = 184 \)). In 78 cases there were two or more of the above indications for the scan. The median CRL was 11.5

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**Table 1 Linear regression models**

<table>
<thead>
<tr>
<th>CRL interval (mm)</th>
<th>Regression equation</th>
<th>Standard deviation</th>
<th>( r^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean yolk sac diameter</td>
<td>3.4479 + (0.0530 \times CRL)</td>
<td>0.6581</td>
<td>0.21</td>
</tr>
<tr>
<td>Mean gestational sac diameter</td>
<td>12.0309 + (0.9605 \times CRL)</td>
<td>4.6819</td>
<td>0.63</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>(-0.1194 \times CRL^2 + (6.1459 \times CRL) + 93.308)</td>
<td>(-0.2178 \times CRL + 16.312)</td>
<td>0.60</td>
</tr>
</tbody>
</table>

CRL, crown–rump length.
Table 2 Comparison of early pregnancy biometry and heart rate in fetuses with nuchal translucency (NT) measurements below the 10th percentile or above the 90th percentile. Values are shown as mean ± standard deviation.

<table>
<thead>
<tr>
<th>Measure</th>
<th>NT &lt; 10th percentile (n = 54)</th>
<th>NT &gt; 90th percentile (n = 53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yolk sac diameter Z-score</td>
<td>−0.046 ± 1.222</td>
<td>−0.0014 ± 0.822</td>
<td>0.84</td>
</tr>
<tr>
<td>Gestational sac diameter Z-score</td>
<td>−0.287 ± 0.972</td>
<td>−0.057 ± 0.914</td>
<td>0.24</td>
</tr>
<tr>
<td>Heart rate Z-score</td>
<td>0.009 ± 0.729</td>
<td>−0.157 ± 1.836</td>
<td>0.60</td>
</tr>
</tbody>
</table>

DISCUSSION

In this study we correlate early pregnancy biometry and fetal HR with NT measured at 11–14 weeks of pregnancy in pregnancies with normal outcome. To our knowledge this is the first study examining this relationship. We demonstrate that ultrasound biometry and HR measured in early pregnancy show no correlation with NT measured subsequently, and that extremes in NT measurements are not preceded by departures from normal in early ultrasound biometry or embryonic heart rate.

Both early pregnancy and NT measurements are known to be potential predictors of pregnancy complications. A slow HR, discrepancy between CRL and the diameter of the GS, and discrepancy between menstrual and sonographic age of more than 1 week, have all been demonstrated to be significantly associated with adverse pregnancy outcome. In addition, there is extensive

Figure 3 Heart rate against crown–rump length, presented with mean ± 2 standard deviation regression lines.

Figure 4 Scatter plot of gestational sac diameter Z-scores against nuchal translucency Z-scores. Pearson’s $r = 0.013$, $P = 0.77$.

Figure 5 Scatter plot of yolk sac diameter Z-scores against nuchal translucency Z-scores. Pearson’s $r = 0.039$, $P = 0.44$.

Figure 6 Scatter plot of heart rate Z-scores against nuchal translucency Z-scores. Pearson’s $r = 0.016$, $P = 0.76$. 

observed for the Z-scores between any of the early scan measurements and NT measured at the second scan (Figures 4–6). GS, YS and HR were not significantly different comparing fetuses with NT measurements below the 10th percentile or above the 90th percentile (Table 2).
Evidence that increased NT is also associated with adverse pregnancy outcome. We originally hypothesized that a common pathophysiological mechanism could underlie the association between all these different ultrasound predictors and abnormal outcome of the pregnancy.

However, the negative findings of the present study do not support a common physiological pathway in chromosomally normal fetuses, thereby suggesting that departures from the mean at early ultrasound examination do not affect NT based screening in ongoing pregnancies. Additionally, there were no significant differences in GS, YS, HR and NT measurements between pregnancies presenting with and without early vaginal bleeding (data not shown), suggesting that bleeding is not associated with abnormalities of early embryoplacental development in pregnancies that are viable, and confirming that it does not affect subsequent NT based screening.

Although gross and non-specific, early pregnancy ultrasound biometry and HR measurements are the earliest and most widely available methods for assessing the normal development of the embryoplacental unit. The lack of any association between these measurements in the present data set suggests that other methods will be required to investigate the eventual relationship between the early phases of embryonic and placental development and NT pathophysiology.

REFERENCES