Early transvaginal ultrasound following an accurately dated pregnancy: the importance of finding a yolk sac or fetal heart motion*

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Our goals were to determine the prognostic value of a yolk sac or fetal heart motion seen during an early accurately dated transvaginal ultrasound (TVU). We reviewed 225 consecutive pregnancies for fetal heart motion data. Furthermore, 63 pregnancies following in-vitro fertilization were reviewed for yolk sac information. The TVU was performed between 5 and 6 weeks following presumed conception (heart motion data) and between 22 and 32 days following in-vitro fertilization (yolk sac data). Pregnancies were followed until an ongoing pregnancy or spontaneous abortion was documented. The presence of a yolk sac between 22 and 32 days from fertilization was associated with the development of fetal heart motion in 94% of cases. The absence of the yolk sac by 32 days after fertilization was always associated with a poor outcome. In women <36 years of age, the presence of fetal heart motion was associated with a spontaneous abortion in only 4.5% of the cases. However, the incidence of spontaneous abortion following fetal heart motion increased to 10% in women 36–39 years and 29% in women ≥40 years of age. The presence of heart motion should not be considered a reassuring sign in the older woman. These data have implications regarding early embryology and the counselling of infertility patients.

Key words: fetal heart motion/IVF/spontaneous abortion/transvaginal ultrasound/yolk sac

Introduction

Since its introduction in the mid-1980s, transvaginal ultrasonography (TVU) has become an important tool in the diagnosis and management of early intrauterine and ectopic pregnancies. The ability of the TVU to image the endometrial cavity with greater clarity than transabdominal ultrasound has improved the ability to diagnose early abnormal pregnancies. The earlier diagnosis of an abnormal pregnancy (intrauterine or ectopic) can lead to appropriate medical treatment or perhaps a minimally invasive procedure. Furthermore, infertility patients often need an accurate early assessment of their pregnancy to prepare for the future and aid in their emotional well-being.

Many studies have focused on early gestational landmarks in an attempt to delineate normal from abnormal pregnancies. These landmarks often include the presence of an intrauterine sac, yolk sac, fetal pole and heart motion. Many of these studies are difficult to interpret since the dating is often done from a last menstrual period. The goals of this study were twofold. First, our aim was to determine the predictive value of the presence or absence of a yolk sac at an early accurately dated TVU. Second, our aim was to determine the predictive value of fetal heart motion following an early accurately dated TVU. To accomplish these goals we studied women with a known date of fertilization or ovulation.

Materials and methods

Patient information

Infertility records between January 1991 and June 1996 were reviewed for inclusion in the study based on the presence of fetal heart motion following a known date of ovulation. Also, consecutive in-vitro fertilization (IVF) pregnancy charts were evaluated for possible inclusion based on the presence of an early TVU 22–32 days post-fertilization. In all couples, the TVU was performed by one of two experienced sonographers (C.S.H. or P.B.) and accurate information regarding pregnancy outcome was obtained. The IVF patients (n = 63) received luteal phase gonadotrophin-releasing hormone agonist and began gonadotrophin therapy when suppressed. The most common IVF diagnoses were tubal disease (42%), male factor (24%), endometriosis (15%), and unexplained infertility (11%). The mean female age for the IVF couples was 33.6 years (range 25–41). Embryo transfers were performed either 2 or 3 days following fertilization. The TVU was performed using a 5 MHz transducer and the presence or absence of both an intrauterine sac and a yolk sac were documented. These data were used for the yolk sac analysis.

In addition to the IVF records, 225 other pregnancies with positive fetal heart motion documented by TVU between 35 and 42 days from ovulation were followed until a spontaneous abortion or a live birth was documented. These data were used for the predictive value of fetal heart motion.

Analysis

An ongoing pregnancy was defined as either delivered or beyond 20 weeks with positive fetal heart motion. The positive predictive value was defined as the number of true positive observations divided by the total positive observations multiplied by 100. The negative predictive value was defined as the true negative observations divided by the total negative observations multiplied by 100. \( \chi^2 \) and Fisher’s exact test were used to compare proportions between variables. A \( P \) value <0.05 was considered statistically significant.

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Results

In the 63 IVF patients there were 65 yolk sacs available for review. Sixty-one yolk sacs became ongoing (94%) and four underwent spontaneous abortion or regression. The breakdown of yolk sacs based on the timing and the pregnancy outcome is shown in Table I.

When the TVU data were grouped into 22–26 days post-fertilization and 27–32 days post-fertilization, the following could be demonstrated. First, 14 yolk sacs were seen between 22 and 26 days post-fertilization, and all these pregnancies became ongoing. In six cases, the yolk sac was absent and the pregnancy became ongoing. Second, 51 yolk sacs were seen between 27 and 32 days post-fertilization and 47 of these pregnancies (92%) became ongoing. Third, there were only four (8%) yolk sacs seen between 27 and 32 days post-fertilization that underwent either a spontaneous abortion or regression.

The positive predictive value for the yolk sac between 22 and 32 days post-fertilization was 94%. In other words, the presence of a yolk sac between 22 and 32 days post-fertilization was associated with development of fetal heart motion 94% of the time. However, the negative predictive value for a yolk sac during this same time frame was 73%. In other words, the absence of a yolk sac was associated with a spontaneous abortion 73% of the time. Finally, the negative predictive value for the yolk sac between 27 and 32 days post-fertilization was 100%. In other words, the absence of the yolk sac by 32 days post-fertilization was always associated with a poor pregnancy outcome.

The spontaneous abortion rate following fetal heart motion correlated to maternal age for the 225 non-IVF pregnancies is shown in Table II. A significant difference in the spontaneous abortion rate was seen between women ≤35 and >35 years (4.5% vs 18%, P < 0.05). The infertility diagnosis did not affect the abortion rate.

Discussion

The TVU has become a valuable tool in the diagnosis and management of the first trimester pregnancy (Dodson, 1991; Timor-Tritsch and Rottem, 1991; Deaton and Huffman, 1995). There are many indications for a TVU in the first trimester including, but not limited to, a risk for an ectopic pregnancy or a multiple gestation, and the emotional well-being of a couple receiving infertility treatment. There has been a steady increase in the incidence of ectopic pregnancies during the past several years and currently 2% of all pregnancies are ectopic in origin (Centers for Disease Control, 1992; Hemsell and Cunningham, 1992). Infertile patients who conceive spontaneously or through IVF are at increased risk for an ectopic pregnancy, and the presence of an early intrauterine and yolk sac can be very reassuring. In addition to an ectopic, 15–20% of all clinically recognized pregnancies end in spontaneous abortion (Dickey et al., 1992). Therefore, another goal of an early TVU is to determine the quality of the pregnancy. This information is vitally important to an infertile couple who have been trying several years to conceive and have much invested in the outcome.

The chorionic cavity forms 16–20 days after fertilization, and the gestational sac is generally detectable by TVU at 21 days from fertilization (Fossom et al., 1988). The yolk sac can be detected between 21 and 26 days from fertilization, and its diameter and shape have also been correlated with pregnancy outcome (Nyberg et al., 1988; Lindsay et al., 1992). Lindsay and co-workers established the normal size of the yolk sac in pregnancies and showed that a yolk sac diameter outside the 95% confidence limits was frequently associated with a poor pregnancy outcome. Our data reveal that the presence of a yolk sac between 22 and 32 days post-fertilization was associated with the development of heart motion 94% of the time. This would imply that the development of fetal landmarks in a normal time frame is a reassuring sign. Furthermore, the presence of a yolk sac between 22 and 26 days post-fertilization was always associated with a poor pregnancy outcome. These data, in association with the data of Nyberg et al. (1988) would place the appearance of the yolk sac in a normal pregnancy between 21 and 26 days post-fertilization. It is possible that the use of a higher resolution probe (i.e. 7 mHz) would affect the results and alter the conclusions.

Several studies have examined the importance of multiple

### Table I. Presence or absence of yolk sac between 22–32 days post-fertilization and pregnancy outcome

<table>
<thead>
<tr>
<th>Yolk sac</th>
<th>22–26 days</th>
<th>27–32 days</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ongoing</td>
<td>Spontaneous</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Positive</td>
<td>14</td>
<td>47</td>
<td>61</td>
</tr>
<tr>
<td>Negative</td>
<td>6</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table II. Spontaneous abortion rates stratified by maternal age

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of patients</th>
<th>Number of spontaneous abortions</th>
<th>Spontaneous abortion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤30</td>
<td>66</td>
<td>2</td>
<td>3%</td>
</tr>
<tr>
<td>31–35</td>
<td>88</td>
<td>5</td>
<td>6%</td>
</tr>
<tr>
<td>36–39</td>
<td>57</td>
<td>9</td>
<td>16%*</td>
</tr>
<tr>
<td>≥40</td>
<td>14</td>
<td>4</td>
<td>29%</td>
</tr>
</tbody>
</table>

*P < 0.05, ≤35 years versus > 35 years of age.
TVU parameters during normal and abnormal pregnancies. The sac diameter, crown-rump length, and fetal heart rate all show linear growth with respect to gestational age (Coulam et al., 1996). Furthermore, the authors showed that a small fetal pole (2 mm) correlates to a relatively low heart rate (75 beats/min). The heart rate gradually increases with the sac size and crown-rump length. A recent study also examined the crown-rump length and karyotype in normal and abnormal pregnancies (Bessho et al., 1995). The authors concluded that an abnormal karyotype was found in 16/24 (67%) of the fetuses that aborted following the documentation of heart motion. Furthermore, in the spontaneous abortions, the ratio of actual to expected crown-rump length was significantly lower than in ongoing pregnancies (0.74 vs 0.98, P < 0.05). Several Doppler characteristics such as uterine artery pulsatility index and end diastolic flow were examined in the first trimester in normal and karyotypically abnormal pregnancies (Jauniaux et al., 1996). Except for an increase in the fetal heart rate in trisomy 21, the authors found no other differences in the normal versus the abnormal groups.

The documentation of fetal heart motion in the first trimester by TVU has been considered a reassuring sign for an ongoing pregnancy. Although the spontaneous abortion rate for all first trimester clinical pregnancies is approximately 15–20%, it drops to less than 5% following the documentation of cardiac activity (Achiron et al., 1991; Nazari et al., 1991). A woman’s ability to become pregnant decreases with age, both in natural cycles (Menken et al., 1986) and with IVF (Piette et al., 1990; Tan et al., 1992; Rosenbloom et al., 1995; Hull et al., 1996). In a large study, the number of oocytes and embryos as well as the clinical pregnancy rate and live birth rate has been shown to decrease dramatically in the 40-and-over age group (Hull et al., 1996). Studies have also shown that the rate of spontaneous abortion following cardiac activity is influenced by maternal age (Rosen et al., 1999; Goldstein, 1992). In the infertile population, two recent studies have shown a higher spontaneous abortion rate of 6.5–7.1% following cardiac activity (Wood-Molo et al., 1993; Smith and Buyalos, 1996).

Our study is in agreement with the results of Smith and Buyalos (1996), showing that cardiac activity is not necessarily a reassuring sign in the older patient. While the abortion rate was low in the woman ≤35 years of age (4.5%), it rose to 18% in the woman >35 years of age. Experience with donor oocytes indicates that the age of the oocyte is the single most important predictor of reproductive success (Levran et al., 1991). These data support the concept that the increased spontaneous abortion rate in infertility patients is age-dependent. Our data suggest that in previously infertile women cardiac activity should not be considered a predictor of pregnancy success if the patient is 36 years of age or older.

Most infertility couples feel a strong need to determine the quality of their pregnancy as early as possible. Our goal as reproductive health professionals should be to treat both the emotional and physical symptoms of the couple. Most gynaecologists use the appearance of fetal heart motion as a reassuring sign for the couple (Fossum et al., 1988; Achiron et al., 1991; Goldstein, 1992). Many IVF centres will frequently perform a very early TVU in order to document the presence of a gestational sac. While this information may be helpful for programme statistics and ruling out an ectopic pregnancy, providers are often hesitant to give the couple much information regarding the quality of their pregnancy. In our study, information gathered from a very early TVU (22–32 days post-fertilization) can be very valuable in determining the quality of the pregnancy if careful attention is paid to the yolk sac. However, optimism should be guarded in a woman 36 years of age or older even in the presence of cardiac activity.

References


Ultrasound predictors of pregnancy success


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