Screening for Cardiac Anomalies During the Early Second Trimester (as part of the Triple/combined Test Ultrasound) – Accomplishments and Limits

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ABSTRACT Part of the SONOSEROSCREEN PROJECT, we study at the beginning of the first trimester a group of biochemical and ultrasound variables. Regardless the results obtained, all the patients enrolled in this cohort is subject to a second study in the early second trimester that encompasses the dosage of AFP, iA, β-hCG, uE3 an an ultrasound exam targeted at precise biometry and fetal morphology. We tried to evaluate the achievable accomplishments and limits of fetal heart evaluation at 16-20 weeks ultrasound. We evaluated the heart (four chambers and great vessels) at all patients that came for the early second trimester evaluation (stage II of our study). All patients were reassessed at 24 weeks. Correct heart scanning is possible at the triple test ultrasound (16 – 20 weeks), but needs an experienced sonographer, who masters the Color Doppler, patients and a high end ultrasound machine.

KEY WORDS Echocardiography, fetal heart, triple test

Introduction

Part of the SONOSEROSCREEN PROJECT, we study at the beginning of the first trimester a group of biochemical and ultrasound variables: PAPP-A, HCG, NT measurements and spectral Doppler values at the level of ductus venosus (Arantzius) and at the level of the tricuspid valve. Regardless the results obtained, all the patients enrolled in this cohort is subject to a second study in the early second trimester that encompasses the dosage of AFP, iA, β-hCG, uE3 an an ultrasound exam targeted at precise biometry and fetal morphology.

![Fig. 1](image)

We tried to evaluate the achievable accomplishments and limits of fetal heart evaluation at 16-20 weeks ultrasound. We evaluated the heart (four chambers and great vessels) at all patients that came for the early second trimester evaluation (stage II of our study). All patients were reassessed at 24 weeks.

Today there is a constant preoccupation for lowering the age for fetal echocardiography, most studies having a 13- to 16 weeks targeted age and a high risk target population. Studies on unselected population were done at a gestational age between 11 and 17 weeks (see below) show a detection rate inferior to the 20-24 weeks ultrasound, but they also shows an interest in lowering the gestational age at which the cardiac screening (and all morphology for that matter) is performed and it is possible that in the future it will all be done at the time of the double test.

<table>
<thead>
<tr>
<th>Author</th>
<th>Age (weeks)</th>
<th>Images obtained</th>
<th>Risk</th>
<th>Normal</th>
<th>Cases</th>
<th>11-17 SA</th>
<th>20-24 SA</th>
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</thead>
<tbody>
<tr>
<td>Achiron</td>
<td>13-15</td>
<td>98% low</td>
<td>660</td>
<td>6</td>
<td>50% 50%</td>
<td>50% 50%</td>
<td></td>
</tr>
<tr>
<td>Yagel</td>
<td>13-16</td>
<td>99% low</td>
<td>6924</td>
<td>66</td>
<td>64% 81%</td>
<td>64% 81%</td>
<td></td>
</tr>
<tr>
<td>Economides</td>
<td>12-13</td>
<td>low</td>
<td>1632</td>
<td>3</td>
<td>0%   33%</td>
<td>0% 33%</td>
<td></td>
</tr>
<tr>
<td>Whitlow</td>
<td>11-14</td>
<td>low</td>
<td>6443</td>
<td>10</td>
<td>40% 60%</td>
<td>40% 60%</td>
<td></td>
</tr>
<tr>
<td>Rustico</td>
<td>13-15 &lt;50%</td>
<td>low</td>
<td>4785</td>
<td>41</td>
<td>10% 32%</td>
<td>10% 32%</td>
<td></td>
</tr>
<tr>
<td>Bronshtein</td>
<td>11-17 99%</td>
<td>low</td>
<td>30148</td>
<td>127</td>
<td>97% 99%</td>
<td>97% 99%</td>
<td></td>
</tr>
</tbody>
</table>

Methods:

The cohort included 327 patients enrolled in the SONOSEROSCREEN PROJECT that presented for the triple test. All ultrasound exams were performed on a Voluson PRO (General Electric), acquired through the SONOSEROSCREEN PROJECT.
Today the method of choice to exam the fetal heart is sequential segmental analysis which applies the following principles:
- most anomalies are simple
- complex anomalies are a combination of simple anomalies
- so followed systematically and logically all anomalies are simple or a group of simple anomalies

**First step – establishing the situs**

The normal image - stomach on the left, aorta on the left near to the fetal spine, vena cava anterior and to the right of the fetal spine - corresponds to situs solitus. (Fig. 2)

![Fig. 2](image)

**Atrio-ventricular connections - the four chamber view: (fig 3, 4)**
- Two atriae
- Two ventricles
- Right atrium communicates with the right ventricle
- Left atrium communicates with the left ventricle

![Fig. 3](image)

![Fig. 4](image)

On the four chamber view we should also check for the correct function and morphology:
- Cardiac size (about one third of the thoracic area)
- Cardiac Axis (ideally about 45 degrees)
- Pericardial effusions - normally absent
- Regular rhythm
- Atrioventricular Valves - presence of the normal off-setting.
- Ventricular Identity - RV is more muscular and triangular with a moderator band

**Ventricular - arterial connections – great vessels evaluation:**

**Concordant:**
Left ventricle (LV) - Aorta
Right ventricle (RV) - Pulmonary Trunk
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Discordant:
- TGA (transposition of great vessels)
- "Double outlet ventricle"
- "Single outlet heart"
but with multiple pathological variants:

- 3% of TGAs
with an overall rate of 48%.
BUT great vessels evaluation rises the odds at 78%.

Results and analysis:
We followed several aspects:
Obtaining the four chamber view/ outflow tracts at the triple test ultrasound versus the 24 weeks ultrasound:

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Number of cases</th>
<th>Four chamber view</th>
<th>Outflow tracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-20 weeks</td>
<td>327</td>
<td>297</td>
<td>221</td>
</tr>
<tr>
<td>24 weeks</td>
<td>326</td>
<td>326</td>
<td>323</td>
</tr>
</tbody>
</table>

Evaluation of the outflow tracts at the 16-18 weeks was the hardest to obtain by sonographers with limited experience in the evaluation of the fetal heart but it was obtained in a larger percentage by those who make routine heart scanning.

Detection of malformations. We had 3 cases of cardiac anomalies:

<table>
<thead>
<tr>
<th>Cases</th>
<th>Age at the moment of the diagnosis</th>
<th>Biochemical analysis</th>
<th>Amniocentesis</th>
<th>Evolutie</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 case of Fallot Tetralogy</td>
<td>Suspected at 17 weeks and confirmed at 20 weeks</td>
<td>Low risk.</td>
<td>No</td>
<td>Continues surveillance in a center with Cardiac Surgery facilities.</td>
</tr>
<tr>
<td>1 case of ventricular septal defect (VSD)</td>
<td>24 weeks Low risk</td>
<td>No</td>
<td>Favorable.</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions:

Results show important differences between the 16 and 20 weeks examinations and are all inferior to the 24 weeks scan (done by the same sonographer).

There are also noticeable differences between an experienced examiner and a beginner (resident during the obstetrics ultrasound rotation).

Color Doppler ultrasound is of great help in outflow tract evaluation.

Time necessary for a correct heart evaluation prolongs the examination with about 10 minutes and is longer than the time necessary at 24 weeks.

Correct heart scanning is possible at the triple test ultrasound (16 – 20 weeks), but needs an experienced sonographer, who masters the Color Doppler, patients and a high end ultrasound machine.

References
10. Carvalho JS, Ho SY, Shinebourne EA. Sequential segmental analysis.
1.