The pattern of variations in the first trimester fetal heart rate in Indian population: a pilot study

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Background: Fetal heart rate is an indicator of fetal viability. During third trimester and labour the normal range of fetal heart rate is between 110-160 bpm as recommended by the international guidelines. Unlike this, the first trimester embryonic heart rate does not lie in the same range. During the first trimester the normal embryonic heart rate varies between each week of gestation, as determined by a few western studies. Indian studies on the same are not available. Objective of this study was to determine the trend of the fetal heart rate in first trimester of pregnancy in South Indian women.

Methods: Transvaginal scan was done in 51 pregnant women with singleton pregnancy attending the antenatal clinic in a medical college hospital. Crown rump length and fetal heart rate were measured and plotted on a graph. Also, the fetal heart rate at different gestational age of our study was compared with the fetal heart rates at the same gestational age from the studies in the western population.

Results: The range of fetal heart rate at different weeks of gestation was comparable to the heart rate variations as seen in the western population. The maximum heart rates at 9 weeks of gestation in our study was higher than the heart rate in the western population.

Conclusions: Possibility of variation in the fetal heart rates in the first trimester in different populations cannot be ruled out until confirmed by studies with large sample size.

Keywords: Embryonic heart rate, First trimester fetal heart rate, Indian population

INTRODUCTION

Fetal heart pulsations are the determinants of viability of pregnancy. The normal fetal heart rate ranges from 110-160 bpm as recommended by the international guidelines. During the third trimester and labour rates less than 110 and more than 160 bpm are considered as markers of fetal distress. In the first trimester fetal heart rate varies with every week of gestation. The fetal heart pulsations can be picked up as early as 34 days of gestation. The embryonic heart rate is considered to be normal if it is more than 100 bpm at 6 to 6+3 weeks and more than 120 bpm at 6+4 to 7 weeks of pregnancy. The heart rate progressively rises to reach a peak of up to 170 bpm by the 9-10 week of pregnancy and then decreases gradually to 130-140 bpm by term. There have been studies on the embryonic heart rate since 1988 in the Western population but none from India. The study by Hertzberg et al was the earliest on determining the fetal heart rate in 1988. Tezuka et al and Britten et al recorded a fetal heart rate of 97.7 bpm and 94 bpm at a very early gestation of 5 weeks. Stefos et al showed that the heart
rate could differ in a particular gestational week depending on the initial half or the latter half of
the week.\textsuperscript{4} The study by Tannirandorn et al, from Thailand is
the only study from south east Asian population.\textsuperscript{5} The
Hanprasert study showed that at 6-7 weeks of gestation
the heart rates are lesser, reached a maximum at 8 weeks
gestation and decreased gradually to 161 bpm at 14
weeks of gestation.\textsuperscript{6} The Hamela-olkowski study is the
latest of all the studies done in 2009.\textsuperscript{7} The present study
was designed to determine the fetal heart rate variation in
early pregnancy in Indian population and to compare it
with the previous studies.

**METHODS**

This was a prospective descriptive cross-sectional study
involving the pregnant women attending the antenatal
clinic in a medical college attached hospital over a period
of 30 days. The study period extended from July 1-30 in
2015. 51 pregnant women with gestational age ranging
from 5 week to 13 weeks were offered a transvaginal
viability scan. All pregnant women with singleton
pregnancies were included in the study. Pregnant women
with twin gestation were excluded from the study. In the
distribution of women according to their
gestational age we see that majority were
to their 11 weeks of gestation as shown in Table 1.

### Table 1: The distribution of the number of women according to their gestational age is as follows.

<table>
<thead>
<tr>
<th>Gestational age (weeks)</th>
<th>5-5+6</th>
<th>6-6+6</th>
<th>7-7+6</th>
<th>8-8+6</th>
<th>9-9+6</th>
<th>10-10+6</th>
<th>11-11+6</th>
<th>12-12+6</th>
<th>13-13+6</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of women</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>11</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 2: The embryonic/fetal heart rates at the respective gestational age and the mean fetal heart rate is as follows.

<table>
<thead>
<tr>
<th>Gestational age (weeks)</th>
<th>Fetal heart rate range (Beats per minute)</th>
<th>Mean fetal heart rate (Beats per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 - 5+6</td>
<td>109 (n=1)</td>
<td>-</td>
</tr>
<tr>
<td>6 - 6+6</td>
<td>104 - 199</td>
<td>136</td>
</tr>
<tr>
<td>7 - 7+6</td>
<td>99 - 173</td>
<td>148</td>
</tr>
<tr>
<td>8 - 8+6</td>
<td>140 - 194</td>
<td>166.4</td>
</tr>
<tr>
<td>9 - 9+6</td>
<td>158 - 183</td>
<td>174</td>
</tr>
<tr>
<td>10 - 10+6</td>
<td>163 - 183</td>
<td>177.4</td>
</tr>
<tr>
<td>11 - 11+6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12 - 12+6</td>
<td>162 (n=1)</td>
<td>-</td>
</tr>
<tr>
<td>13 - 13+6</td>
<td>168 (n=1)</td>
<td>-</td>
</tr>
</tbody>
</table>

Mean fetal heart rate for 5,12and 13 week of gestation could not be calculated since (n=1) in those gestations.

The women were distributed into different gestational
ages from 5 weeks to 13 weeks as shown in Table 2.
Fetal heart rates noted in a particular week of gestation
were taken as a range between the highest and the lowest
rate noted in that particular week of gestation. Mean
value of the heart rate was calculated for a particular
week of gestation where n >1.

The mean fetal heart rate at each gestational week were
plotted on a graph as shown below in Figure 1. In case of
the gestational weeks where the mean could not be

The angle between the ultrasound beam and direction of
blood flow was maintained below 450 for umbilical
artery. The umbilical artery was studied in a free loop.
Umblical artery (UA) systolic diastolic ratio >2SD above
mean or absent or reversed end diastolic flow in
umbilical artery was taken as abnormal. UA PI and UA
RI were measured and value >2SD was taken as
abnormal. The middle cerebral artery was visualised at
the circle of Willis and was insonated soon after its origin
from internal carotid artery and the angle of insonation
kept close to 00. The pulsatility index was measured and
cerebroumbilical PI ratio calculated. MCA-RI was
considered abnormal if measurement was 2 SD below the
mean. All the ultrasound evaluations were done by a
single obstetrician with expertise in doppler sonography.

### Statistical analysis

Data was entered in Microsoft excel and was analysed
using descriptive statistics like mean and proportions.

### RESULTS

In the distribution of women according to their
gestational age we see that majority were between 6-9
weeks of gestation (n=44) and only 7 women were seen
in the other gestational weeks. There were no women in
their 11 weeks of gestation as shown in Table 1.

...
calculated (n=1), the only available value was plotted on the graph. The graph depicts the changes of the fetal heart rate with increasing gestational age. The embryonic heart rate rises gradually from 109 bpm at 5 weeks of gestation to reach a peak at the 10 weeks of gestation and there after gradually falls to a plateau. This graph is a pilot endeavour of the study.

**DISCUSSION**

Fetal heart pulsations serve as the criteria for confirmation of fetal viability. Fetal heart rate pulsations in early pregnancy were studied since 1988. The embryonic heart rate can be seen as early as 34 days of gestation. Subsequently it rises steeply to reach a peak by 9 to 10 weeks of gestation, followed by a gradual fall to 161 beats per minute at 14 weeks of gestation. The embryonic heart rate is considered to be normal if it is more than 100 bpm at 6 to 6+3 weeks and more than 120bmp at 6+4 to 7 weeks of pregnancy.

Determining what rate is normal for a particular gestation in early pregnancy is very important. The clinical benefit of this is that embryonic heart rates lesser than the expected can prognosticate the pregnancy outcome. Few studies have shown that bradycardia in early pregnancy leads to miscarriage. So, thorough knowledge of the changes in the fetal heart rate week by week is essential to the treating clinician.

![Graph depicting changes of the fetal heart rate with increasing gestational age](image)

At 5,12 and 13 weeks of gestation since n=1, mean could not be calculated and the same values were used for constructing the graph.

**Figure 1: Variation of the mean fetal heart rate with respect to gestation in our study.**

<table>
<thead>
<tr>
<th>Period of gestation in weeks</th>
<th>Hertzberg et al²</th>
<th>Tezuka et al³</th>
<th>Britten et al¹</th>
<th>Stefos et al⁴</th>
<th>Tannirandorn et al⁵ (Thai study)</th>
<th>Hanprasertpong et al⁶</th>
<th>Hamela-Olkowska et al⁷</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>101</td>
<td>97.7</td>
<td>94</td>
<td></td>
<td>111±14 (42-45 days)</td>
<td>124 (40-44 days)</td>
<td>116±21 (46-49 days)</td>
<td>109</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125±15 (46-49 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>145±14 (50-52 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>157±13 (53-56 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>143</td>
<td>174.7</td>
<td>166</td>
<td></td>
<td>177 (60-64 days)</td>
<td></td>
<td></td>
<td>166.4</td>
</tr>
<tr>
<td>9</td>
<td>137-144</td>
<td></td>
<td>166</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>172±9</td>
<td></td>
<td></td>
<td>177</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>165±7</td>
<td></td>
<td></td>
<td>162</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>159 (95-99 days)</td>
<td></td>
<td></td>
<td>168</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>161</td>
</tr>
</tbody>
</table>

Various studies determining the embryonic heart rates and their findings have been tabulated in Table 3. All the studies were based on western population except the one by Tannirandorn et al which is based on south east Asian population. The study by Hertzberg et al was the earliest on determining the fetal heart rate in 1988. It recorded a heart rate of 101 bpm at 5 weeks of gestation while Tezuka et al and Britten et al recorded a fetal heart rate of 97.7 bpm and 94 bpm (the lowest heart rate among all studies including the present study) at 5 weeks of gestation. Stefos et al determined fetal heart rates between 6-7 weeks of gestation and showed that the heart rates were consistent from 6-7 weeks onwards.
rate could differ in a particular gestational week depending on the initial half or the latter half of the week. The Thai study and the present study at 9 weeks of gestation recorded a heart rate of 177 bpm and 174 bpm respectively which is relatively higher when compared with the Hertzberg study showing 137-144 bpm at the same gestation. The Hanprasert6 study showed a rate of 161 bpm at 14 weeks of gestation indicating that the fetal heart rate touches the standard 110-160 bpm by 14 weeks. The Hamela-olkowsk study which is the latest in the series recorded values which are comparable with the present study. 

| Table 4: Comparison of the fetal heart rates of different studies and the mean heart rate of present study at different gestational ages. |
|---|---|---|---|
| POG (weeks) | Lowest heart rate of all studies | Present study mean heart rate | Highest heart rate of all studies |
| 5 | 941 | 109 | 101<sup>2</sup> |
| 6 | 111<sup>4</sup> | 136 | 125<sup>4</sup> |
| 7 | 145<sup>4</sup> | 148 | 157<sup>4</sup> |
| 8 | 143<sup>2</sup> | 166.4 | 174.7<sup>3</sup> |
| 9 | 137<sup>2</sup> | 174 | 177<sup>2</sup> |
| 10 | - | 177 | 172<sup>2</sup> |
| 13 | - | 168 | 159<sup>3</sup> |

Superscripts indicate the references.

In the present study mean fetal heart rate at a particular gestation was compared between the findings of the western studies by compiling them into the lowest and the highest heart rate at a particular gestation as depicted in Table 4.

From Table 4, it is seen that during 5 weeks and 6 weeks of gestation the mean heart rate from our study was higher than the highest heart rate among the various studies at that gestation. The maximum heart rate is reached at the 9 weeks 5 and 10 weeks 7 of gestation in 2 different studies and in our study the maximum rate was at the 10 weeks of gestation. The trend of the fetal heart rate in our study is similar to the other studies during the 7, 8 and 9 weeks. Only the study by Hertzberg et al shows lesser heart rate at 8 and 9 weeks of gestation reaching a maximum of only 144 bpm at the 9 weeks in comparison to other studies. The study on the Thai population which is the only study on the South Asian population the maximum heart rate is reached at the 9 weeks unlike in our study at the 10 weeks and at the 13 week the fetal heart rate was lesser than in our study indicating a much steeper fall. 

This study is the first of its kind on Indian women to create a population specific graph of fetal heart rate in the first trimester and studies with large sample size are warranted to create a fetal heart rate normogram specific to Indian population.

CONCLUSION

Fetal heart rate in early pregnancy is not similar to the heart rate in term gestation. It follows a steep rise followed by a plateau and then gradually decreases to reach the term fetal heart. Knowledge of this is important to prevent unwanted fear about the prognosis of the pregnancy. In our study the pattern of fetal heart variation in the first trimester was comparable to that of the Caucasian women. Variation in the maximum heart rate at 9 weeks of gestation was seen among different populations. So, we can conclude that there could be some difference in the fetal heart rate pattern among different populations which needs a large study to confirm the finding and to establish a population based normogram.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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5. Tannirandorn Y, Manotaya S, Uerpairojkit B, Tanawattanacharoen S, Wacharaprechanont T, Charoenvidhya D. Reference intervals for first