Measurement of Baroreflex & Sympathetic Control of Haemodynamics in Mid Pregnancy by Orthostatic Test

Neeta Bachlaus

Department of Physiology, Government Medical college, Surat-395001

Abstract:

Pregnancy induces changes in the endocrinal and neural regulatory mechanisms affecting the cardiovascular system. The endocrinal manifestations of increased steroid hormone causes volume overload, which ultimately puts stress on the autonomic activity. Orthostatic dysregulation leads to spontaneous abortion, low birth weight infant and still birth.

In the orthostatic test, reloading of the baroreceptors causes an increase in the blood pressure along with a rapid decrease in the heart rate within 30 seconds of standing up, which stabilizes by the end of 3 minutes. The haemodynamic changes of increased blood volume, increased cardiac output, decreased peripheral resistance and manifestations of endocrinal functions causing volume overload are maximal in the mid term pregnancy. In our study comparison of 30 mid term pregnant women with an equal number of non pregnant (purposive) control subjects was made by measuring instantaneous increase in heart rate (IIHR); heart rate difference (HRDiff.); orthostatic blood pressure at 30 seconds (OSBP 30); orthostatic blood pressure at the end of 3 minutes (OSBP 3) and Maximum (Max.)/ Minimum (Min.) ratio. The statistical analysis was done by students unpaired ‘t’ test. The percentage difference of Max./Min. ratio among pregnant as compared to non pregnant was significant (p<0.017) though it remained within physiological limits.

Key Words: Mid term pregnancy, Resting heart rate, Orthostatic stress, Maximum/Minimum ratio, Baroreflex.

Introduction:

Pregnancy divests all bodily functions otherwise devoted to the preservation of milieu interior for the favourable growth and development of the foetus. The reigns of body control functions are held conjointly by the autonomic nervous system and the endocrinal system. Autonomic nervous system preponderates over the endocrinal system in the control of haemodynamic changes associated with pregnancy. Inadequate or lack of prenatal care as observed more in developing countries is responsible for spontaneous abortions, low birth weight infant and still birth. This carnage can be attributed to the orthostatic dysregulation occurring due to deficiency of autonomic nervous control mechanism in pregnancy.

Material and Methods:

The fact that the maximum haemodynamic alterations occur at mid term of pregnancy, we performed the test by randomized selection of 30 women with singleton pregnancy attending the antenatal clinic of New Civil Hospital, Surat, in their 20th to 29th gestational weeks. The control group comprised of equal number of non pregnant women of comparable age and accessibility. The mean age in the control and cases was 26.8 years (range 19 to 38) and 25.2 years (range 20 to 35) respectively. The study being quantitative in nature, 30 cases in each group was considered to be adequate for statistical inference. The variations regarding physical fitness, body weight for height, haematocrit & hemoglobin level (within limits) were allowed in both groups.

The subjects were familiarized with the laboratory surroundings, equipments and examination procedures to minimize the fluctuation in values caused by anxiety. The recordings were taken between 10a.m. to 12 Noon. There was a minimum gap of two hours between the breakfast and the recording of observations.

The blood pressure was measured by the pneumatically inflated micro computerized Vital max 800 non – invasive pulse blood pressure monitor. The observations were corroborated by the standard auscultatory Riva-Rocci method with the help of pneumatically operated mercurial type syphgmomanometer. The appearance (Phase-I) and the apparent disappearance (Phase-V) of the Korotkoff’s sound marked the systolic and diastolic pressure respectively.

Corresponding Author: Dr. Neeta Bachlaus, 1, Saptarishi Row House, Ravishankar Sankul, Bhatar Char Rasta, Surat-395017
Phone No.: 02612335051, 09426147663
E mail : neetabachlaus@yahoo.in
The subjects were asked to lie down in supine posture for a period of 5 minutes followed by an erect posture brought about swiftly, unaided for the next three minutes and subsequently reverting back to supine posture for another 2 minutes span. Sequential measurements of blood pressure and heart rate were made at the end of 4 minutes of rest in supine position, 30 seconds after standing up, at the end of 3 minutes of erect posture and again after 2 minutes of lying down. Electrocardiogram in Lead II was recorded for 20 seconds after 20 seconds of standing. The variables recorded were:

1. Instantaneous increase in heart rate (IIHR): It is the difference between the instantaneous peak heart rate after standing up and the resting heart rate (Page & Watkins, 1977).
2. Heart rate difference (HR Diff.): The difference between the heart rates at the 4 minutes of lying down in supine position and at the end of 3 minutes in standing position.
3. Maximum/Minimum ratio: This is the ratio of the longest R-R interval to the shortest interval during the 20 seconds period after standing up (Ewing et al, 1978).
4. Orthostatic systolic blood pressure (records obtained at the end of 30 seconds and 3 minutes): This is measured as the difference of the systolic values obtained at the end of 30 seconds and 3 minutes, and the resting value obtained in the supine posture.

The data obtained was statistically analysed by using unpaired ‘t’ test.

**Observations:**

The general parameters in pregnant and non-pregnant women found to be statistically insignificant which confirmed that both the groups drawn by random and purposive sampling were from the same population (Table I). The resting heart rate was observed to be higher in the pregnant than in the non-pregnant group, the difference was statistically significant. Both systolic and diastolic pressures were significantly lower in pregnant women than in controls (Table II).

The maximum/minimum ratio was significantly low in the pregnant group than in the controls. No significant difference was seen in the instantaneous increase in heart rate (IIHR) and the heart rate difference (HR Diff.) between the two groups. The mean change in orthostatic systolic blood pressure at

### Table I: Showing general parameters in pregnant & non pregnant groups:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pregnant Mean ± S.D.</th>
<th>Non pregnant Mean ± S.D.</th>
<th>P-value &lt; 0.05</th>
<th>*Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>25.23±3.41</td>
<td>26.77±5.6</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Height (cms)</td>
<td>151.67±5.74</td>
<td>152.07±4.44</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>48.43±8.15</td>
<td>50.27±7.86</td>
<td>0.383</td>
<td></td>
</tr>
<tr>
<td>Gestational Weeks</td>
<td>25.23±2.11</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin (gm %)</td>
<td>9.88±1.05</td>
<td>10.57±1.21</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

### Table II: Showing resting heart rate & blood pressure in pregnant and non-pregnant groups.

<table>
<thead>
<tr>
<th>Resting Values</th>
<th>Pregnant Mean ± S.D.</th>
<th>Non pregnant Mean ± S.D.</th>
<th>P-value &lt; 0.05</th>
<th>*Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>88.77±14.13</td>
<td>77.87±9.43</td>
<td>&lt; 0.001*</td>
<td></td>
</tr>
<tr>
<td>Systolic B.P.</td>
<td>104.27±10.45</td>
<td>111.17±9.46</td>
<td>&lt; 0.01*</td>
<td></td>
</tr>
<tr>
<td>Diastolic B.P.</td>
<td>68.57±7.16</td>
<td>74.33±7.2</td>
<td>&lt; 0.0008*</td>
<td></td>
</tr>
</tbody>
</table>

### Graph I: Showing comparison of resting heart rate in cases & control.

### Table III: Showing heart rate and blood pressure responses to orthostatic test in pregnant and non pregnant groups.

<table>
<thead>
<tr>
<th>Orthostatic Test</th>
<th>Pregnant Mean ± S.D.</th>
<th>Non pregnant Mean ± S.D.</th>
<th>P-value &lt; 0.05</th>
<th>*Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIHR (beats/min)</td>
<td>14.36±11.3</td>
<td>11.8±7.54</td>
<td>0.312</td>
<td></td>
</tr>
<tr>
<td>HR Diff. (beats/min)</td>
<td>18.5±11.92</td>
<td>13.93±7.16</td>
<td>0.083</td>
<td></td>
</tr>
<tr>
<td>Max./Min. ratio</td>
<td>1.26±0.131</td>
<td>1.35±0.15</td>
<td>0.017*</td>
<td></td>
</tr>
<tr>
<td>OSBP 30 seconds</td>
<td>6.1±5.57</td>
<td>7.43±5.3</td>
<td>0.354</td>
<td></td>
</tr>
<tr>
<td>OSBP 3 minutes</td>
<td>1.8±5.93</td>
<td>4.83±6.2</td>
<td>0.059</td>
<td></td>
</tr>
</tbody>
</table>
30 seconds and 3 minutes (OSBP 30 & OSBP 3) respectively was similar in the two groups.

Discussion:
In the rendition of hemodynamics of a pregnant woman the changes in the cardio-respiratory system at rest should be considered. During pregnancy there is an increase in the blood volume, heart rate and cardiac output while peripheral resistance and resting blood pressure decreases (Hytten & Leitch, 1971). The statistically significant increase in the resting heart rate of the pregnant women in our study may be explained by the Bainbridge reflex occurring due to the increase in the end diastolic volume caused by haemodilution.

In the orthostatic test there is immediate vagal withdrawal on standing from the lying down position which reflexly increases the heart rate, therefore, the shortest R-R interval is observed at the 15th beat, thereafter, there is a gradual lengthening of the R-R interval exhibiting the minimum heart rate at the 30th beat due to spontaneous vagal reactivation (Ewing et al, 1980). This initial biphasic heart rate response to standing is reflected in the maximum/minimum ratio and is significant in the mid term pregnancy.

The instantaneous increase in heart rate was similar in both groups. A significant response was found in the study by Ekholm et al (1993) in the second trimester, but the difference became insignificant only when the resting heart rate was used as a covariate. The difference in the heart rate at the end of 3 minutes of standing and resting heart rate was similar in both the pregnant and non pregnant groups. Orthostatic pulse reaction has been found to be pronounced in the first trimester (Sandstorm, 1974). In the orthostatic test, the sustenance of tachycardia is by virtue of sympathetic stimulation. The duration of pregnancy seems to influence the heart rate difference between supine and standing posture.

There was no difference in systolic blood pressure response between the pregnant and non pregnant groups. In the non pregnant women there was a fall in the central venous filling pressure, stroke volume and cardiac output caused by the pooling of blood from the thorax into the veins in the legs on standing up from supine position. (Avery et al, 2001) Decreased stimulation of the high pressure baroreceptors as the arterial pressure falls and decreased stimulation of cardiopulmonary receptors because of diminished right ventricular filling pressure leads to reflex vasoconstriction and recovery of the diastolic blood pressure. Reloading of the arterial baroreceptors causes an increase in blood pressure (Jayawardana, 2001). When cardiopulmonary receptors are unloaded by orthostatic stress, sympathetic outflow rises. This leads to increase in total peripheral resistance (Smith et al 1990). Normally the diastolic pressure rises by about 10mm of Hg while the systolic blood pressure remains essentially stable.

The orthostatic test induces vasoconstriction which is diminished in pregnancy leading to the diminution of both the systemic and pulmonary resistance (Clark et al, 1991). In contrast to the non pregnant subjects, the central blood volume remains practically unchanged after standing up in mid pregnancy. Most reports agree that both the systolic and diastolic pressures change in the same way in the pregnant and non pregnant women during orthostatic stress. The increased blood volume seems to improve hemodynamic stability, especially during mid pregnancy.

Conclusion:
The orthostatic test was characterized by significantly smaller maximum/minimum ratio in the pregnant group as the biphasic heart rate response is reduced during pregnancy, implying a diminished baroreflex induced slowing of the heart rate. The results suggest that a rearrangement of the autonomic tone takes place in normal pregnancy.

Bibliography:
5. Ewing DJ, Campbell IW, Murray A, Neilson JM, Clark...


