An Indian Study of a Novel Non-invasive Method of Screening for Foetal Anaemia

SUSHIL. G. KACHEWAR, SIDDAPPA.G. GANDAGE, HEMANT. J. PAWAR

ABSTRACT

Purpose: The assessment of foetal Middle Cerebral Artery Peak Systolic Velocity (MCA-PSV) is useful in non-invasively diagnosing foetal anaemias, irrespective of their cause. A study was therefore undertaken to find out its effectiveness in the local obstetric population.

Materials and methods: Doppler ultrasound measurements of foetal MCA-PSV were done in 1200 pregnant women who were referred for antenatal ultrasound between 12-40 weeks of gestation. The statistical analysis was done by using Microsoft Excel 2007 and SPSS software, version 12.

Results: A statistically significant (p < 0.05) positive correlation was found to exist between the gestational age and MCA-PSV. 14 foetuses had their MCA-PSV elevated enough to label them as being anaemic. Iso-immunization was seen in 4 foetuses, severe maternal hypertension in 4, foetal parvo virus B19 infection in 3 and thalassemia in 3. Also, a disturbed MCA waveform pattern (The K-G waveform) was transiently seen in few cases with normal MCA-PSV values (The Pravara Effect).

Conclusion: Foetal MCA-PSV can objectively demonstrate foetal anaemia in pregnant patients, irrespective of the underlying cause. Every effort must therefore be made to use this non-invasive test to look for foetal anaemia in the obstetric population.

Key Words: Foetal Anaemia, Middle cerebral artery, Non-invasive test, Color Doppler Ultrasound, KG Waveform, Pravara Effect, Mind

INTRODUCTION

The accurate figures of foetal anaemia are scarce throughout the world, as those who are afflicted are often unreported, undiagnosed and even unsuspected. It is possible that many unexplained intra-uterine deaths may in fact be due to the yet undiagnosed foetal anaemia. The inadequate knowledge about the availability of a rapid and effective non invasive diagnostic test also plays a vital role in this grim scenario.

Until recently, everyone relied on invasive measures like cordocentesis to obtain foetal blood and amniocentesis to obtain liquor for spectrophotometry, to assess the presence of foetal anaemia. But, the mounting evidence that the elevated values of foetal Middle Cerebral Artery Peak Systolic Velocities (MCA-PSV) can indicate foetal anaemia has ushered in a new angle to the entire perspective on foetal anaemia. This test soon became popular due to its non-invasive nature and it is now being routinely used for the non-invasive assessment and the follow up of foetal anaemias [1-4]. As very few studies have been reported [1,5] on this topic from the developing world, we undertook a prospective, cross sectional study on foetal MCA-PSV to evaluate its utility in the local community and also to validate whether the value of the foetal MCA-PSV increased with the advances in pregnancy, as had been reported earlier, [1-6].

MATERIALS AND METHODS

After prior approval from the institutional ethical and research committees, this study was carried out in the ultrasound section. An informed written consent was obtained from each participant. 1200 women who had singleton pregnancies with a gestational age between 12 to 40 weeks were randomly selected for the study.

The foetal MCA-PSV was recorded by a single observer who had more than ten years of experience in ultrasound, by using a Siemens G-60 Doppler ultrasound machine. With the patient lying supine and at ease on the bed, a transverse section of the foetal head was obtained on the B mode imaging by using a 3.5 MHz curvilinear transducer. The colour mode was then switched on and the foetal MCA was localized near the circle of Willis. After the visualization of the entire length of the MCA, a pulse Doppler was used to sample it just after its origin from the internal carotid arteries, while the angle of insonation was kept at nearly zero degrees. After obtaining a steady waveform, the image was frozen and the peak of the systolic velocity was measured [Table/Fig 1]. The entire process took around 5-15 minutes.

The data was compiled and statistically analyzed by using Microsoft Excel 2007 and SPSS software, version 12. The correlation between MCA-PSV and the gestational age was assessed by using the Karl Pearson’s Correlation Coefficient (r) and the “t”-test as a test of significance. The MCA-PSV values were compared with the standard published international values to evaluate whether foetal anaemia was present or not.

RESULTS

The scatter diagram [Table/Fig 2] shows the correlation between the gestational age of the foetus and its MCA-PSV. As shown by the upward slope of the line, a positive correlation was found to
exist between the two, indicating that there was an increase in
the MCA-PSV as the pregnancy advanced. This correlation was
statistically significant (p < 0.05).

In this study, 14 foetuses had their MCA-PSV elevated enough
to label them as being anaemic. These cases with anaemia had
focally elevated values as has been demonstrated in the Radar
Diagram [Table/Fig 3].

The causes of anaemia in these patients are shown in [Table/
Fig 1]. Iso-immunization was seen in 4 patients, severe maternal
hypertension in 4, foetal parvo virus B19 infection in 3 and
thalassaemia in 3. The mean foetal MCA-PSV which was found at
various gestational ages in the foetus with its normal outcome, is
shown in the Bar diagram [Table/Fig 5]. In this study, we also came
across a disturbed MCA waveform pattern (named as the K-G
waveform- after Kachewar and Gandage; the researchers in this

<table>
<thead>
<tr>
<th>Gestational Age(weeks)</th>
<th>Observed MCA-PSV value cm/s</th>
<th>Cut Off value3 of MCA-PSV</th>
<th>Aetiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>32</td>
<td>30.3</td>
<td>Thalassemia</td>
</tr>
<tr>
<td>17</td>
<td>38</td>
<td>33.2</td>
<td>Parvo virus B19 infection</td>
</tr>
<tr>
<td>19</td>
<td>42</td>
<td>36.5</td>
<td>Parvo virus B19 infection</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>38.2</td>
<td>Thalassemia</td>
</tr>
<tr>
<td>22</td>
<td>46.3</td>
<td>41.9</td>
<td>Severe maternal hypertension</td>
</tr>
<tr>
<td>26</td>
<td>51.7</td>
<td>50.4</td>
<td>Iso-immunization</td>
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<tr>
<td>26</td>
<td>66</td>
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<tr>
<td>28</td>
<td>56.0</td>
<td>55.4</td>
<td>Parvovirus B19 Infection</td>
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<td>31</td>
<td>66.9</td>
<td>63.6</td>
<td>Severe maternal hypertension</td>
</tr>
<tr>
<td>34</td>
<td>76</td>
<td>70</td>
<td>Iso-immunization</td>
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<tr>
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<td>84.0</td>
<td>Severe maternal hypertension</td>
</tr>
<tr>
<td>40</td>
<td>98.3</td>
<td>96.6</td>
<td>Severe maternal hypertension</td>
</tr>
</tbody>
</table>

[Table/Fig-3]: Radar diagram showing focal elevations of fetal MCA-
PSV in anemic cases at given gestational age shown as circles of differ-
ent circumferences.
Hence, a global search was on for a satisfactory non-invasive method to assess foetal anaemia. The doppler ultrasound based quantification of MCA-PSV was shown to be a more sensitive, specific and non-invasive test than other parameters like intrahepatic umbilical venous maximum velocity, liver length, and spleen perimeter [14,15]. The confidence in the foetal MCA PSV has reached such levels that invasive diagnostic techniques can safely be avoided if the MCA flow velocity is found to be normal [16]. Moreover, the changes in the foetal cerebral arteries are more useful and reliable than those in the umbilical arteries, [17].

The global acceptance of the Doppler ultrasound based foetal MCA-PSV measurement as a non-invasive method of foetal haemoglobin estimation stems from the very fact that it is quick easy, and widely reproducible and that it has minimal inter or intra observer variability. It is the reduced viscosity of the blood in foetal anaemia which manifests as an elevation in the peak systolic velocity, so as to provide adequate nutrients and oxygen to the brain. The peak velocity is thus inversely related to the haemoglobin value and to the results from the increased cardiac output, [3,18].

The inverse correlation between foetal haemoglobin and MCA-PSV is weaker to begin with, when the foetus is normal or mildly anaemic and it gradually becomes stronger and statistically significant with the increasing severity of the anaemia [3]. These elevated values gradually reduce and even fall in the normal range when the foetal anaemia is adequately treated, so that ultimately the number of the unnecessary and invasive amniocentesis and cordocentesis prescriptions for diagnosing foetal anaemia can be effectively reduced, [19].

Overall, the results of this study are in harmony with those of other studies, in that the MCA-PSV increases with the advancing gestational age [2, 5, 6, 20, 21, 22]. In our study, elevated MCA-PSV values were seen in 14 patients and they were labeled as anaemic. Their causes are shown in [Table/Fig 4].

The strength of this study was that it was the first regional study to demonstrate the successful utilization of the non invasive method of foetal MCA-PSV Doppler measurement to diagnose foetal anaemia, although few case reports had been reported earlier [23,24]. The usage of this method enables the visualization of the cases which result in intra and perinatal mortality and morbidity, with fresh eyes. The strength of this study was that it was population based and that a representative sample from the rural population was involved. An internationally standardized protocol was followed in this research project. The measurements were made as they were made by other researchers.

However, we feel that this study should be conducted on a wider scale and in populations who reside in different geographic localities. We feel that this is the first regional study on this topic as till date, we have not come across any such study from this geographic locality. Moreover, this study adds a new dimension to the current literature on the foetal MCA velocity waveform in the form of the contribution of the K-G wave [6] and the Pravara effect [6].

CONCLUSION

The positive correlation between the MCA-PSV values and the gestational age which has been described in international studies, was confirmed by this regional study. The successful utilization of this non invasive test adds a silver lining to the management of foetal anaemia. The identification of the K-G wave and the description of the Pravara effect indicate that although a lot has been done globally on this topic, still there are certain dimensions
of the foetal MCA waveform that are lying unexplored. There is therefore a scope for more research.

REFERENCES


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FINANCIAL OR OTHER COMPETING INTERESTS:
None.