



Original Work

A study of different scenarios of fetal middle cerebral artery peak systolic velocity in an Indian population

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ABSTRACT: Fetal Middle Cerebral Artery Peak Systolic Velocity (MCA-PSV) is being increasingly used for non-invasively diagnosing fetal anemias irrespective of their cause. A study was therefore undertaken to find out what different scenarios can be encountered in the local obstetric population. Doppler ultrasound measurements of fetal MCA-PSV were done in 1200 pregnant women who were referred for antenatal ultrasound between 12 - 40 weeks of gestation. Statistical analysis was done using Microsoft Excel 2007 and SPSS software version 12. The different scenarios encountered in this study were then compiled and are presented here. With increasing gestational age, the value of MCA-PSV was seen to increase correspondingly in all normal fetuses. This correlation between the two was thus positive and was found to be statistically significant ($p < 0.05$). Abnormally raised values of MCA-PSV were seen in fetuses with severe anemia due to ABO-Rh Iso-immunization which left untreated, ultimately resulted in fetal hydrops. Almost similar and normal values were seen in separate as well as conjoint healthy twins. Abnormally elevated values were seen in twins with discordant growths. Fetal MCA-PSV is very useful to confirm the presence or absence of fetal anemia irrespective of underlying cause in singleton as well as twin pregnancies. For complete assessment, it is essential that the specialist is thoroughly aware of the different scenarios that can be encountered while using this non-invasive method.

KEY WORDS: *Fetal Anemia; Middle cerebral artery; Non-invasive Doppler*

INTRODUCTION

Timely diagnosis of fetal anemia can result in fruitful pregnancies. Although cordocentesis and amniocentesis can give an estimate of fetal hemoglobin status, both of these methods are invasive in nature. Hence, when it was realized that elevated values of fetal Middle Cerebral Artery Peak Systolic Velocities (MCA-PSV) can indicate fetal anemia, this test soon became popular as it is non-invasive in nature and is now increasingly used globally.¹⁻⁴

As very few studies on this topic from the developing world are reported^{1,5}, we undertook a prospective cross-sectional study of fetal MCA-PSV to evaluate its utility in the local community

and also to validate whether the value of fetal MCA-PSV increases with advance of pregnancy as has been reported earlier.¹⁻⁵

METHODOLOGY

After prior approval from institutional ethical and research committees the study was done in the ultrasound section. Informed written consent was obtained from each participant.

1200 women having singleton pregnancies with a gestation age between 12 and 40 weeks were randomly selected for the study. Pregnancies with different types of twins were also included for complete coverage of this topic.

Fetal MCA-PSV was recorded by a single observer who has more than ten years of experience in ultrasound, using Siemens G-60 Doppler ultrasound machine. With the patient supine at ease on the bed, a transverse section of fetal head is obtained on B mode imaging using a 3.5 MHz

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curvilinear transducer. The color mode is then switched on and fetal MCA is localized near circle of Willis. After visualization of the entire length of MCA, pulse Doppler is used to sample it just after its origin from the internal carotid arteries keeping angle of insonation at nearly zero degrees. After obtaining a steady waveform the image is frozen and the peak of systolic velocity is measured. Entire process takes around 5-15 minutes. The relation between gestational age of the fetus and MCA-PSV was analyzed. Various scenarios in which fetal MCA was successfully utilized for analyzing different conditions were then compiled and are presented here.

RESULT

Figure 1 shows the relation between gestational age of the fetus and MCA-PSV. As shown by the upward slope of the line a positive correlation exists between the two indicating that there is an increase in the MCA-PSV as pregnancy advances. This correlation was statistically significant ($p < 0.05$).

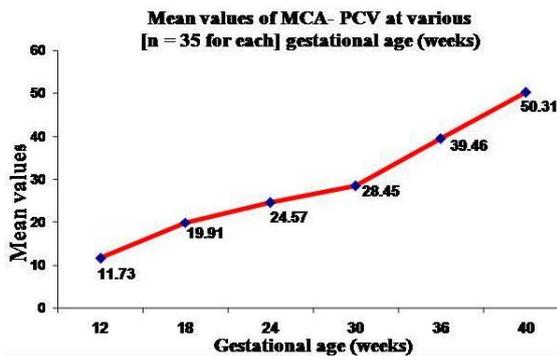


Figure 1: positive correlation between fetal MCA-PSV and fetal gestational age in weeks

Table 1 shows Mean and Standard Deviation (SD) values of MCA-PCV at selected gestational age (weeks) of cases under study.

| Gestational Age in weeks | Sample Size (n) for each week | Mean ± SD |
|--------------------------|-------------------------------|---------------|
| 12 | 35 | 11.73 ± 2.51 |
| 18 | 35 | 19.91 ± 4.09 |
| 24 | 35 | 24.57 ± 3.96 |
| 30 | 35 | 28.45 ± 6.90 |
| 36 | 35 | 39.46 ± 9.64 |
| 40 | 35 | 50.31 ± 13.36 |

DISCUSSION

Red blood cell alloimmunization, twin-twin-transfusion syndrome, parvovirus B-19 infection, and fetomaternal hemorrhage are the prevalent

causes.¹⁻⁶ ABO Rh incompatibility results in severe hemolytic disease of newborn in India, Sri Lanka and Bangladesh and it often requires multiple exchange transfusions.⁷⁻⁹ Anti C and anti E in two Rh D positive women have also resulted in severe hemolytic disease postnatally.¹⁰ Newer alternatives were being searched for noninvasively diagnosing fetal anemia as the traditional methods of amniocentesis and cordocentesis had a risk of complications like fetomaternal hemorrhage and fetal loss.^{11,12} Premature rupture of membranes and enhanced risks of infection are also known to occur.³ Apart from parameters like intrahepatic umbilical venous maximum velocity, liver length, and spleen perimeter, fetal MCA-PSV was also analysed.^{13,14} MCA-PSV analysis by Doppler ultrasound is highly sensitive and more specific non-invasive test than the rest.¹⁵ It is also seen to be more useful and reliable than the umbilical arteries.¹⁶ Fetal MCA-PSV is inversely related to hemoglobin value and results from increased cardiac output.^{3, 17} This non-invasive method is quick and has minimal inter or intra-observer variability.

Overall results of this study are in harmony with other studies in that the MCA-PSV increases with advancing gestational age.^{2, 19- 21}

Normal MCA-PSV pattern is shown in **Figure 2**. It shows a steady rise with advancing gestational age. Initially undetectable diastolic flow is better appreciated in second trimester and better still in third trimester fetuses. This finding is in agreement with that published in literature.^{21,22}

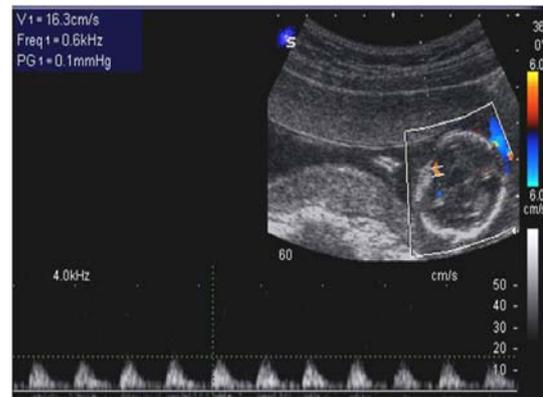


Figure 2: Normal MCA-PSV pattern in a first trimester fetus

Elevated MCA-PSV in allo-immunized patient is shown in **Figure 3**. The fetus was found to be severely anemic. This finding is in concurrence with the finding mentioned in literature that significantly elevated MCA-PSV (>1.5 Multiple of Median -MoM) can detect severely anemic fetuses with a haemoglobin concentration <0.65 MoM that require invasive intervention.²³

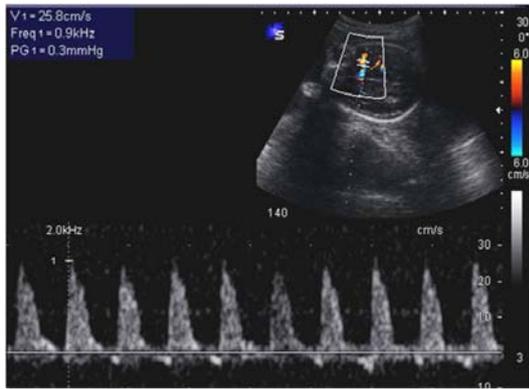


Figure 3: Elevated MCA-PSV in allo-immunized patient

Twins with similar and normal MCA-PSV pattern are shown in **Figure 4**. Our finding that uncomplicated twin pregnancies have almost similar MCA PSV values as in singleton pregnancies have been observed in international studies as well.^{24,25} A median inter-twin MCA PSV difference of approximately 5 cm/s has been found. No significant correlation has yet been demonstrated between the inter-twin MCA PSV difference and discordance in monochorionic (MC) or dichorionic (DC) twin gestations.^{24, 25}



Figure 4: Twins with similar and normal MCA-PSV pattern

Twins with dissimilar MCA-PSV pattern are shown in **Figure 5**. Elevated PSV is seen in one. Use of MCA-PSV enabled us to noninvasively compare anemic and non-anemic twins in the same intrauterine environment. In fact MCA-PSV can precisely detect the anemia in one of the twins irrespective of the underlying cause. This observation is also backed by a study mentioned in the literature.²⁶ Even in the absence of twin oligo-polyhydramnios sequence, twin-twin transfusion syndrome is still possible and so should not be excluded. On the contrary, Doppler studies including the measurement of the middle cerebral artery peak systolic velocity should be routinely performed even in seemingly uncomplicated twins.²⁶

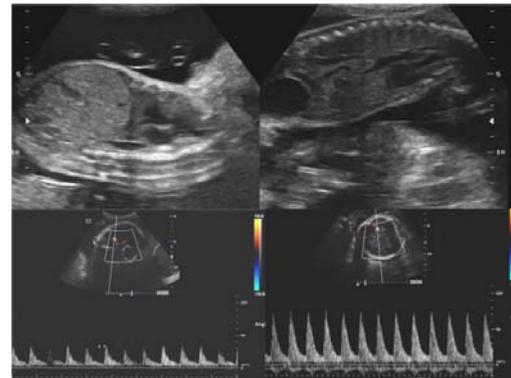


Figure 5: Twins with dissimilar MCA-PSV pattern. Elevated PSV is seen in one

Similar MCA-PSV in twins with fused thorax and abdomen are shown in **Figure 6**. This is the first report of MCA-PSV in conjoint twins. Moreover even in MC or DC twins no significant correlation has been yet demonstrated between the inter-twin MCA PSV difference and discordance in MC or DC twin gestations.^{24, 25}

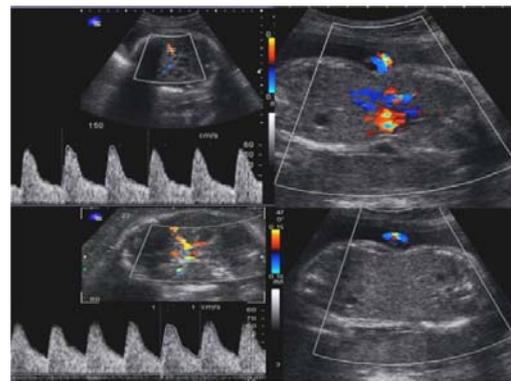


Figure 6: Similar MCA-PSV in twins with fused thorax and abdomen

Elevated MCA-PSV in a patient with fetal hydrops is shown in **Figure 7**. Immune as well as non-immune fetal hydrops present with significantly elevated fetal MCA-PSV as has been described in the published literature.^{4, 6, 7}

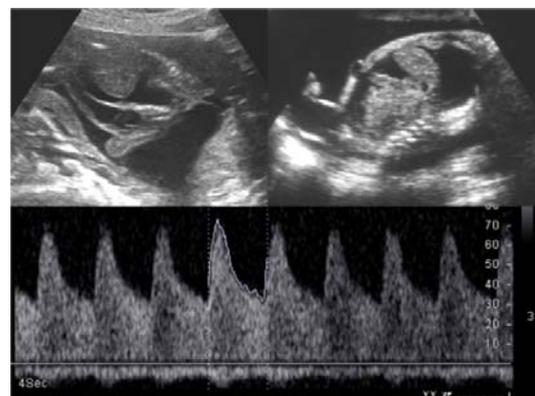


Figure 7: Elevated MCA-PSV in a patient with fetal hydrops

The strength of this study is that it is the first regional study to demonstrate the successful application of non-invasive method of fetal MCA-PSV Doppler measurement to diagnose fetal anemia in various scenarios, although few case reports have been reported earlier.^{27, 28} Backbone of the study is that it is population based and it included a representative sample from rural population. Internationally standardized protocol was followed in this research project. Measurements were made according to methods that were followed by other researchers. We feel that the intra and perinatal mortality and morbidity can be reduced by using MCA-PSV in all suspected conditions. In fact we would even recommend its use at least once in each pregnancy so that even unsuspected cases are not missed.

We believe this to be the first regional study on this topic as till date we have not come across any such study from this geographic locality. Nevertheless, bigger studies in populations residing in different geographic localities would further add to our knowledge on this frontier.

CONCLUSION

This study confirms the positive correlation between MCA-PSV values and gestational age as has been declared by international studies. Commonly encountered scenarios in which MCA-PSV has been indicative of presence or absence of fetal anemia have been elicited for the understanding of one and all with the Good Samaritan intent of educating masses to eradicate intrauterine clashes.

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