A Prospective Cross Sectional Study of Fetal Middle Cerebral Artery Peak Systolic Velocities

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The Doppler ultrasound evaluation of fetal Middle Cerebral Artery Peak Systolic Velocity (MCA-PSV) is believed to be of use in diagnosing fetal anemias irrespective of their cause. A study was therefore undertaken to evaluate the utility of fetal MCA-PSV in diagnosing fetal anemia in local obstetric population.

Fetal MCA-PSV was measured in 182 pregnant women who were primi gravida referred for antenatal ultrasound between 12 - 40 weeks of gestation. Statistical Analysis was done using Microsoft Excel 2007 and SPSS software version 12.

The correlation between gestational age and MCA-PSV was positive and statistically significant ($p < 0.05$). Out of 182, 12 fetuses had their MCA-PSV elevated enough to label them as being anemic. Severe maternal hypertension was seen in 4, fetal parvo virus B19 infection in 3, thalassemia in 3 and feto-maternal haemorrhage in 2.

Fetal MCA-PSV can be successfully used to evaluate fetal anemia in pregnant patients irrespective of underlying cause. Hence it should be used as a screening method and measured routinely in all patients as we do measurements for fetal biometry.

Key words: doppler study, fetal Anemia, middle cerebral artery

Global details on incidence of fetal anemia are incomplete as many cases go undiagnosed and unsuspected due to lack of appropriate diagnostic tests to do so. Fetal anemia could be the underlying cause in many cases of unexplained intrauterine deaths.

Invasive measures like cordocentesis to obtain fetal blood and amniocentesis to obtain liquor for spectrophotometry to assess presence of fetal anemia were the only tools available earlier until the discovery that increasing values of fetal Middle Cerebral Artery Peak Systolic Velocities **(MCA-PSV)** can indicate fetal anemia. Non invasive nature of this test is the cause of its global popularity and in fact fetal MCA-PSV measurements is now an established method for noninvasive assessment and follow up of fetal anemias.[1-4]

A prospective cross sectional study of fetal MCA-PSV was therefore undertaken to evaluate its utility in local community and to assess relation between MCA-PSV and gestational age because it has been reported that as pregnancy advances, the value of fetal MCA-PSV also increases. [1-5]

Materials and methods

The study was done at ultrasound clinic after approval from institutional ethical and research committee. Informed written consent was obtained from each participant prior to the study.

Gestational Age(weeks)	Observed MCA-PSV value cm/s	Cut Off value[3] of MCA-PSV	Etiology
15	31.2	30.3	Feto-maternal haemorrhage
15	32	30.3	Thalassemia
17	38	33.2	Parvo virus B19 infection
19	42	36.5	Parvo virus B19 infection
20	40	38.2	Thalassemia
22	46.3	41.9	Severe maternal hypertension
26	51.7	50.4	Feto-maternal haemorrhage
27	58.8	52.8	Thalassemia
28	56.0	55.4	Parvovirus B19 Infection, IUD
31	66.9	63.6	Severe maternal hypertension
37	94.7	84.0	Severe maternal hypertension
40	98.3	96.6	Severe maternal hypertension

Table 1.Table showing various details of anemic fetuses in this study

A total of 182 pregnant women who were primi gravida and between 12 to 40 weeks of gestation were randomly selected for the study.

Fetal MCA-PSV was recorded by the author who has more than ten years of experience in ultrasound, using Siemens G-60 Doppler ultrasound machine. During examination, the patient lies supine on the bed at ease. 3.5 MHz curvilinear transducer is used to obtain a transverse section of fetal head on grey scale imaging. The color mode is then switched on and fetal MCA is localized near circle of Willis. Using pulse Doppler, the MCA is then sampled just after its origin from the internal carotid arteries such that the angle of insonation is zero degrees. After obtaining a steady waveform the image is freezed and the peak of systolic velocity is measured **(Figure 1)**. Entire process takes around 5-15 minutes.

The data was compiled and relation between MCA-PSV and gestational age was analyzed using Karl Pearson`s Correlation Coefficient (r) and‘t’ test as test of significance. The MCA-PSV values were compared with standard published international values to evaluate whether fetal anemia was present or not.

Results

The values of all patients could be measured successfully and entire process took around 5-15 minutes per patient.

Bubble diagram with 3D - effect (Figure 2), demonstrates a positive correlation exists between gestational age and MCA-PSV indicating that there is a rise in MCA-PSV as pregnancy advances. This correlation was statistically significant as shown by p value of less than 0.05.

In this study 12 out of 182 fetuses had their MCA-PSV elevated enough to label them as being anemic as shown in Table 1. Severe maternal hypertension was seen in 4, fetal parvo virus B19 infection in 3, thalassemia in 3 and feto-maternal haemorrhage in 2.

Discussion

It has been shown that 39% premature births, 31% low birth weight, and 10% of newborns require blood transfusions in relation to a control group[6]. Thus fetal

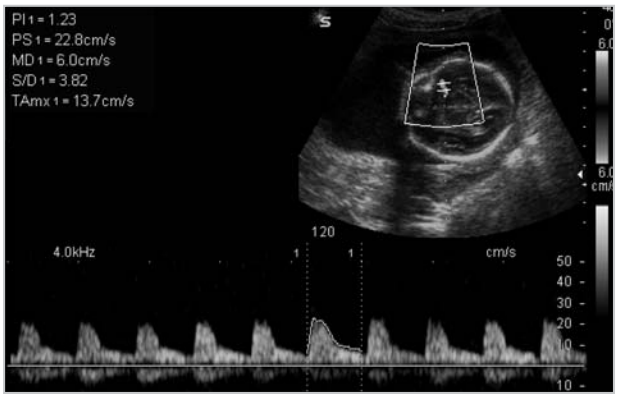

Figure 1: Correct method to measure fetal MCA-PSV at origin of proximal MCA

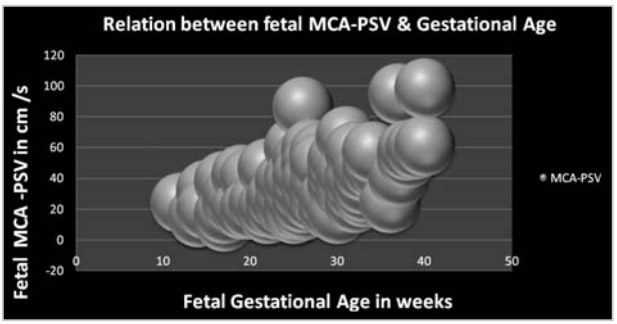

Figure 2: Bubble diagram showing relation between fetal MCA-PSV in cm/s and gestational

anemia appears to be quite common and needs prompt diagnosis for successful timely management.

Important causes for fetal anemias are red blood cells alloimmunization, parvo virus B-19 infection, twin-twin-transfusion syndrome and feto-maternal hemorrhage.[1-6]

Amniocentesis and cordocentesis are used for quantifying fetal anemias. But it has questionable results before the 27th week and can cause complications such as feto-maternal hemorrhage, which may further worsen the severity of the disease[7]. Cordocentesis on the other hand has a higher risk for fetal loss than amniocentesis, and feto-maternal hemorrhage and increased sensitization is possible after transplacental puncture[8]. Other known complications of these invasive methods to diagnose fetal anemia are procedure-related pregnancy loss, fetal bradycardia, bleeding, premature rupture of membranes and enhanced risks of infection due to intravascular access for direct measurement of fetal hemoglobin and for transfusion.[3]

So a noninvasive method to measure the degree of fetal anemia was being searched globally until measurement of fetal MCA-PSV emerged as the more sensitive and specific non invasive test than other parameters like intrahepatic umbilical venous maximum velocity, liver length, and spleen perimeter.[9, 10] With the knowledge that is gained on using MCAPPSV, invasive diagnostic techniques can safely be avoided when normal MCA flow velocity is found.[11]The fetal cerebral circulation changes have been proved to be more useful and reliable than the umbilical arteries.[12]

Measuring fetal MCA-PSV is fast, simple, efficient and has better reproducibility and minimal inter or intra observer variability due to which it is universally accepted as a non-invasive method of fetal hemoglobin estimation. The peak systolic velocity increases secondary to the lowered viscosity of anemic blood. Hence increased cardiac output results in a peak velocity inversely related to hemoglobin value. [3, 13]

The weaker correlation between fetal hemoglobin and MCA-PSV when the fetus is normal or mildly anemic is; becomes stronger as the hemoglobin decreases further.[3] A decreases in elevated values and even normalization of the MCA-PSV has also been demonstrated after correction of fetal anemia ; thereby reducing the number of unnecessary amniocentesis and cordocentesis for diagnosing fetal anemia.[14]

Our study is in agreement with other studies in that the MCA-PSV increases with advancing gestational age.[2, 15, 16, and 17]

Elevated MCA-PSV values were seen in 12 patients and they were labeled as being anemic. Their causes and outcomes are shown in Table 2.

Advantages of this study are that it is the first regional study to demonstrate the successful utilization of non invasive method of fetal MCA-PSV Doppler measurement to diagnose fetal anemia. A light can now be thrown on many unexplained scenarios adding to intra and perinatal mortality and morbidity. Strengths of the study were that it is population based and was done on a representative sample from a rural population. Measurements were made according to standardized protocols that were followed by other researchers

Limitation of the study is that such studies need to be done in other populations with larger samples. To the best of our knowledge, a study describing such local use of fetal MCA-PSV values has not been reported previously from this geographic region.

Conclusions

The results of our study clearly indicate that there is a significant positive correlation between MCA-PSV values and gestational age. This non invasive test can be successfully used for diagnosing as well as managing fetal anemia and thereby knowing the actual incidence of this ailment so as to take appropriate measures for managing this malady.

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