10.5005/jp-journals-10016-1072

ORIGINAL ARTICLE

An Untold Story of Indian Fetal Middle Cerebral Artery Peak Systolic Velocities

[1]Sushil Kachewar, [2]Sidappa G Gandage, [3]Hemant J Pawar

ABSTRACT

Although noninvasive diagnosis of anemia in fetus by measuring the middle cerebral artery peak systolic velocity (MCA-PSV) is practised and extensively researched in the developed world, such studies from the developing world are rare. India is the home for many hemoglobinopathies and cases of Rh alloimmunization are also reported here. Hence, it is expected that fetal anemias will be quite common. So in addition to an awareness about the correct method of measuring MCA-PSV and knowledge about changes that occur in the waveforms with advancing gestational age, it is important to know the normal values at various gestational ages in an Indian setting. Demonstrating these normal values was the primary goal of the current study.

Context: Fetal anemia can be adequately tackled only if it is diagnosed on time. Fetal MCA-PSV has the potential to reliably predict fetal anemia. Scientific studies across the globe are a testimony to this fact. As such studies from rural setups are lacking, this study was initiated.

Aims: To demonstrate the normal values of fetal MCA-PSV at various gestational ages in an Indian setting by using the standard internationally accepted protocol.

Settings and design: The ultrasound wing of radiodiagnosis department of a rural medical college was the site of this study. Permission from institutional research cell and ethical committee was obtained for study on fetal MCA-PSV. Written informed consent from every pregnant mother who participated in the study was also obtained. A cross-sectional and prospective observational study was conducted over the last 9 months.

Materials and methods: A total of 60 measurements of fetal MCA-PSV were conducted in normal 20 pregnant women referred for routine obstetric scan at 12, 24, and 36 weeks of gestation respectively, by a single radiologist on color Doppler ultrasound machine. In each fetus the proximal MCA, soon after its origin, was evaluated.

Statistical analysis: The observations were entered in Microsoft Excel sheet and statistical analysis was done by using SPSS statistical software version 12. The relation between fetal MCA-PSV and gestational age was studied using the Karl Pearson's correlation coefficient. The significance of difference was studied using the t-test.

Results: MCA-PSV increased with increasing gestational age, suggesting positive correlation between the two. Better waveforms and increasing PSV were visualized with advancing gestational age.

Conclusion: Fetal anemia can be accurately predicted only if the MCA-PSV is scientifically measured and compared with normal values in a given setting. This study demonstrates the normal values at various gestational ages in an Indian setting.

Keywords: Fetal anemia, Middle cerebral artery peak systolic velocity, Doppler.

How to cite this article: Kachewar S, Gandage SG, Pawar HJ. An Untold Story of Indian Fetal Middle Cerebral Artery Peak Systolic Velocities. Int J Infertil Fetal Med 2014;5(1):8-11.

Source of support: Nil

Conflict of interest: None

Date of Received: 07-06-13

Date of Acceptance: 03-04-14

Date of Publication: April 2014

[1,3]Associate Professor, [2]Professor and Head

[1,2]Department of Radiodiagnosis, Rural Medical College, Loni Maharashtra, India

[3]Department of Medical Records and Statistics, Rural Medical College, Loni, Maharashtra, India

Corresponding Author: Sushil Kachewar, Associate Professor, Department of Radiodiagnosis, Rural Medical College, Loni, Maharashtra, India, e-mail: sushilkachewar@hotmail.com

INTRODUCTION

Vital statistics about the contribution of fetal anemia to feto-maternal mortality and morbidity are lacking as many times this entity remains undiagnosed or even unsuspected for the lack of awareness about simple diagnostic test. Earliest methods to diagnose fetal anemia were spectrophotometry of fluid obtained by amniocentesis or examination of cord blood obtained by cordocentesis. But the invasive nature of these tests was a deterrent to their wide scale use for screening of unsuspected fetuses.[1,2]

Hence, soon after the discovery that elevated fetal middle cerebral artery peak systolic velocity (MCA-PSV) can indicate fetal anemia satisfactorily and noninvasively, Doppler ultrasound of fetal MCA received a warm welcome all over the globe.[3,4]

Literature on this technique from India is scanty and hence this study was, therefore, undertaken with an aim to demonstrate the normal values of fetal MCA-PSV at various gestational ages in an Indian setting by using the standard internationally accepted protocol.

SUBJECTS AND METHODS

Permission from institutional research cell and ethical committee was obtained before starting this study antenatal ultrasound unit located in radiodiagnosis department of this institute. Each pregnant participant gave written consent prior to this study.

A total of 60 fetal MCA-PSV values were measured in 20 normal pregnant women, once each at 12, 24, and

36 weeks of gestation respectively. The normal outcome of these pregnancies was confirmed by the birth of a normal healthy full-term child. Normal mothers with healthy fetuses were randomly selected for the study from patients who had come for routine obstetric scan. Mothers with diabetes, hypertension, and renal problems were excluded from this study. Fetuses with structurally abnormalities on ultrasound were also excluded.

Standard technique[5] was followed by a single experienced radiologist recorded fetal MCA-PSV on Siemens G-60 Doppler ultrasound machine (Fig. 1).

Microsoft Excel 2007 was used to evaluate the date of this study. The required statistical parameters were scientifically obtained using the SPSS Version 12 statistical analysis software. The median and standard deviation (SD) values of fetal MCA-PCV at 12, 24, and 36 weeks of gestation were determined. The Tukey-Kramer Multiple Comparison test was applied at 1% level of significance. Fitted percentiles of peak systolic blood flow velocity in the fetal MCA-PSV were also determined. Karl Pearson's Correlation Coefficient (r) was used to study the relation between fetal MCA-PSV and gestational age. Standard t-test was used to study the significance of difference.

RESULTS

The mean and SD values of MCA-PCV at various gestational age (weeks) calculated at 95% confidence interval are shown in Table 1.

The range of SD observed at 12 weeks of gestation was between ± 2.51, SD range at 24 weeks of gestation was from ± 3.96, and at 36 weeks of gestation was ± 9.64. Thus, in this study, the range of SD gradually increased with increasing gestational age.

As shown in scatter diagram (Fig. 2), on charting fetal MCA-PSV against gestational age in weeks, it was observed that MCA-PSV increased with advancing gestational age.

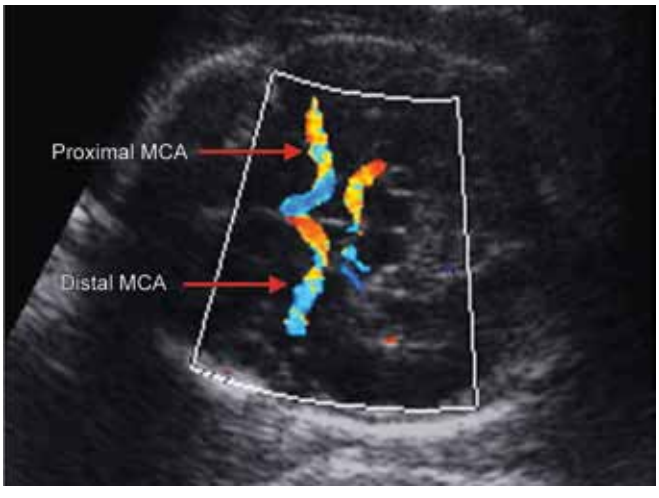

Fig. 1: Location of middle cerebral artery on color flow imaging

Table 1: Mean and standard deviation values of middle cerebral artery peak systolic velocity at various gestational age (weeks) calculated at 95% confidence interval

Gestation (weeks)	*Mean ± SD*	*95% confidence interval*	
		Lower	*Upper*
12	13.13 ± 2.51	11.00	17.21
24	22.57 ± 3.96	18.20	27.93
36	34.46 ± 9.64	24.14	43.77

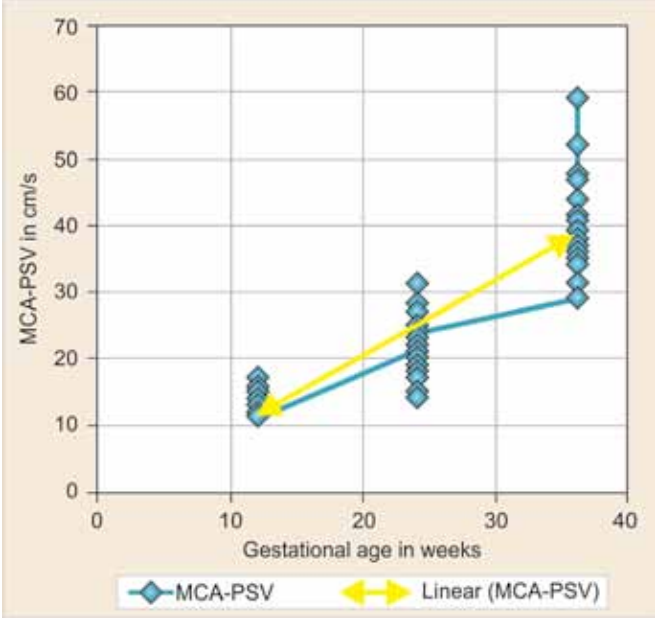

Fig. 2: Scatter diagram depicting relationship between fetal middle cerebral artery peak systolic velocity and gestational age. The yellow line shows a positive linear correlation between the two. Blue stacks are the number of observations at 12, 24, and 36 weeks of gestation respectively

Thus, a positive correlation was observed between the two as demonstrated by yellow colored line. The value of Karl Pearson's correlation coefficient (r) for positive correlation between gestational age and fetal MCA-PSV was ± 0.52. As per the 't' test, this correlation was significant ($p < 0.05$).

The Tukey-Kramer multiple comparison test at 1% level of significance demonstrated normal distribution that was highly significant ($p < 0.01$).

DISCUSSION

Apart from red blood cell alloimmunization, parvo virus B-19 infection, twin-twin-transfusion syndrome and fetomaternal hemorrhage can also cause fetal anemias.[3,4] The occurrence of intrauterine as well as perinatal morbidity and mortality can be brought down only if a prompt diagnosis and appropriate intervention is done.

Other tests to detect fetal anemia like spectrophotometry of fluid obtained by amniocentesis or examination of cord blood obtained by cordocentesis have received a setback due to their invasive nature and associated risks.[1-3,6,7]

Other noninvasive methods like measuring spleen perimeter, hepatic span, and maximum velocity in intrahepatic

umbilical vein have sidetracked because measuring fetal MCA-PSV has been found to be the most sensitive and specific technique.[8,9] If normal results emerge after a properly done MCA-PSV testing, the invasive diagnostic techniques can be safely avoided or delayed[10] because fetal cerebral circulation changes are better predictors of fetal status rather than the changes in umbilical arteries.[11]

Fetal MCA-PSV increases in anemia as anemic blood has low viscosity. The increased cardiac output in anemia also adds to the rise in MCA-PSV values.[3,12]

The relation between MCA-PSV and fetal hemoglobin is weak when the fetus is normal or mildly anemic and it strengthens with increasing severity of anemia.[3] Posttherapy, as anemia decreases, the MCA-PSV values also normalize.[13]

In this study, we have seen that the value of fetal MCA-PSV gradually rises with increasing gestational age. Similar observations have been made by other researchers.[1,5,14]

We have also observed that as gestational age advances, fetal MCA-PSV can be better evaluated as the vessel can be better identified and sampled. This fact is depicted in Figures 3 to 5. Figure 3 shows MCA-PSV waveform pattern at 12 weeks of gestation. The waveforms are subtle and followed by a space in between. Figure 4 shows MCA-PSV waveform pattern at 24 weeks of gestation.

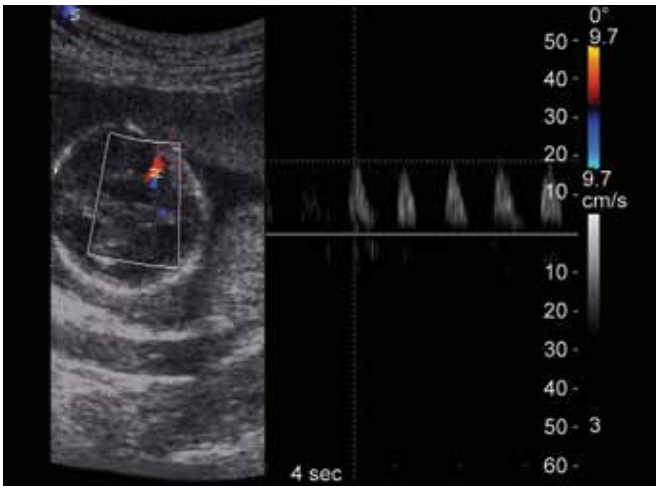

Fig. 3: Normal middle cerebral artery peak systolic velocity in a fetus at 12 weeks of gestation

The vessel is better appreciated and sampled than at 12 weeks gestation state. As seen in Figure 4, MCA is still better seen and can be sampled at 36 weeks. Increase in size of body parts, stabilized body movement pattern, and status of liquor help in better visualization of this vessel.

In this study, we have also observed that results from proximal portion of proximal MCA nearest to ultrasound transducer show better reproducibility. This fact too is in agreement with observations of other researchers.

We have also seen that the standard deviation in measured MCA-PSV values becomes more with advancing age as has been present in other studies but not remained unnoticed.

The strengths of this study are that in addition to demonstrating how to scientifically measure fetal MCA-PSV, it also highlights the changing trends in MCA-PSV with advancing gestational age. Trimester-wise depiction of MCA waveform patterns that was lacking in other studies has been adequately covered in this study. This study successfully demonstrates the normal values of fetal MCA-PSV at various gestational ages in an Indian setting by using the standard internationally accepted protocol.

We, therefore, believe that by knowing the normal values in our setting, concerned specialist can compare their measurements and decide about the presence of fetal anemia. But, there is an element of caution that is needed here. One has to always keep in mind that MCA-PSV assessment should be reserved for those patients who are at risk of having an anemic fetus-indiscriminate use of the MCA-PSV without a clear indication may cause more harm than good. It is neither wise nor good medical care to screen every patient with the MCA-PSV; and if the value is elevated, to assume

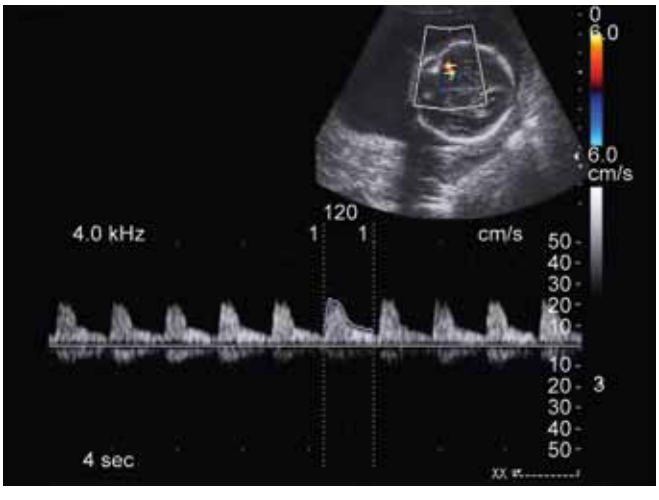

Fig. 4: Normal middle cerebral artery peak systolic velocity in a fetus at 24 weeks of gestation

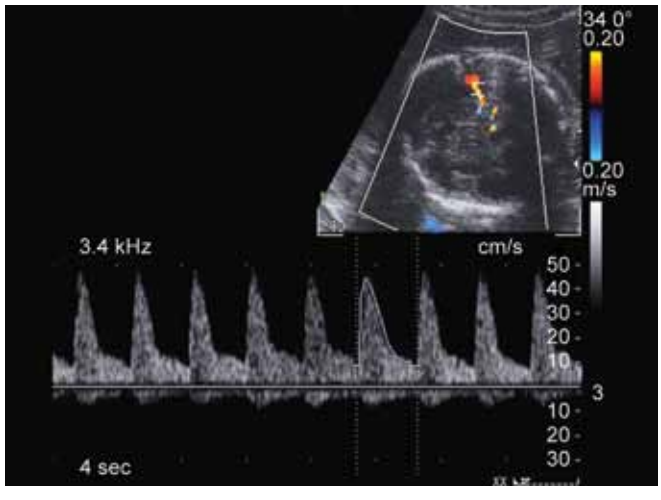

Fig. 5: Normal middle cerebral artery peak systolic velocity in a fetus at 36 weeks of gestation

that the fetus is anemic. This may create unnecessary anxiety and iatrogenic investigation. For example, if fetal-maternal hemorrhage is suspected, because of absent fetal movements and sinusoidal fetal heart rate tracing, an elevated MCA-PSV may strengthen the suspicion. On the contrary, an elevated MCA-PSV, in the presence of a reassuring fetal heart rate tracing and no anemia risk, does not indicate pathology—it may represent a false-positive case. Therefore, no intervention is indicated when an elevated MCA-PSV value is found in the absence of the risk of fetal anemia. Thrust should, therefore, be on the usage of this technique to evaluate clinically suspected pregnancies in the appropriate fetomaternal setting; with an aim to reduce the burden of intrauterine and perinatal mortality and morbidity.

CONCLUSION

Globally, used parameter of measuring fetal MCA-PSV to noninvasively assess the presence of fetal anemia needs wide-scale acceptance in the developing world. This study demonstrates the normal values of fetal MCA-PSV at various gestational ages in an Indian setting. Although judicious use of this technique in appropriate clinical setting can be very useful, one has to remember that indiscriminate usage in every pregnant lady can be harmful.

ACKNOWLEDGMENT

The authors would like to thank all the participants in this study without whose cooperation the study would not have seen the light of this day.

REFERENCES

1. Liley AW. Liquor amnii analysis in the management of pregnancy complicated by rhesus sensitization. Am J Obstet Gynecol 1961: 82:1359-1370.
2. Nicolaides KH, Soothill PW, Rodeck CH, Clewell W. Rh disease: intravascular fetal blood transfusion by cordocentesis. Fetal Ther 1986;1:185-192.
3. Mari G, Deter RL, Carpenter RL, Rahman F, Zimmerman R, Moise KJ, et al. Noninvasive diagnosis by Doppler ultrasonography of fetal anemia due to maternal red-cell alloimmunization. Collaborative Group for Doppler Assessment of the Blood Velocity in Anemic Fetuses. N Engl J Med 2000;342:9-14.
4. Hernandez-Andrade E, Scheier M, Dezerega V, Carmo A, Nicolaides KH. Fetal middle cerebral artery peak systolic velocity in the investigation of nonimmune hydrops. Ultrasound Obstet Gynecol 2004;23:442.
5. Mari G, Abuhamad AZ, Cosmi E, Segata M, Altaye M, Akiyama M. Middle cerebral artery peak systolic velocity: technique and variability. J Ultrasound Med 2005;24:425-430.
6. Bowman JM, Pollock JM. Transplacental fetal haemorrhage after amniocentesis. Obstet Gynecol 1985;66:749-754.
7. MacGregor SN, Silver RK, Sholl JS. Enhanced sensitization after cordocentesis in a rhesus-isoimmunized pregnancy. Am J Obstet Gynecol 1991;165:382-383.
8. Dukler D, Oepkes D, Seaward G, Windrim R, Ryan G. Noninvasive tests to predict fetal anemia: a study comparing Doppler and ultrasound parameters. Am J Obstet Gynecol 2003;188: 1310-1314.
9. Hobbins JC. Use of ultrasound in complicated pregnancies. Clin Perinatol 1980;7:397-411.
10. Oepkes D, Meerman RH, Vandenbussche FP, Van Kamp IL, Kok FG, Kanhai HH. Ultrasonographic fetal spleen measurements in red blood cell-alloimmunized pregnancies. Am J Obstet Gynecol 1993;169:121-128.
11. Arduini D, Rizzo G. Prediction of fetal outcome in small for gestational age fetuses: comparison of Doppler measurements obtained from different fetal vessels. J Perinat Med 1992;20:29-38.
12. Fan FC, Chen RYZ, Schuessler GB, Chien S. Effects of hematocrit variations on regional hemodynamics and oxygen transport in the dog. Am J Physiol 1980;238:H545-H552.
13. Stefos T, Cosmi E, Detti L, Mari G. Correction of fetal anemia on the MCA-PSV. Obstet Gynecol 2002;99:211-215.
14. Scheier M, Hernandez-Andrade E, Carmo A, Dezerega V, Nicolaides KH. Prediction of fetal anemia in rhesus disease by measurement of fetal middle cerebral artery peak systolic velocity. Ultrasound Obstet Gynecol 2004; 23:432-436.