

Original article:

Importance of middle cerebral artery Doppler in prediction of adverse perinatal outcome in unselected pregnancies of western Maharashtra population

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Abstract:

Objectives -

1. To evaluate the distribution of Doppler pulsatility index (PI) measurements of the middle cerebral artery in western Maharashtra population coming to tertiary care centre, Fetal Medicine unit, SKNMC, Pune.
2. To evaluate the distribution of these Doppler values with neonatal outcome.
3. To evaluate the distribution of these Doppler values with perinatal morbidity.

Materials and methods - A prospective analytical study was performed at Fetal Medicine Unit, SKNMC, Pune, from September 2014 to August 2017. Total 4579 women were screened at routine antenatal visit during this period, out of which 400 were selected.

Results - Low MCA PI values were associated increased rates of cesarean section, preterm birth, Low birth weight babies, NICU admissions and neonatal deaths.

Conclusion - Along with the standard antepartum methods (ultrasonography, cardiotocography and biophysical profile) it contributes to the predicting and monitoring of hypoxia and fetal suffering. It enables timely completion of birth and decrease of perinatal mortality and morbidity.

INTRODUCTION

The main complication of the placental insufficiency is the restricted fetal development, which is associated with higher perinatal morbidity and mortality.(1). The inappropriate interaction between the trophoblast and maternal tissues involved in its physiopathology,(2) promoting an increased resistance of the capillaries of terminal villi, with consequent reduction in maternal-fetal exchanges and fetal hypoxemia. As a result of hypoxemia, the fetus starts to present hemodynamic adaptations, a phenomenon known as centralization of fetal circulation.(3) This centralization is characterized by the redistribution of blood flow to vital organs such as the brain, heart, and adrenal glands, to the detriment of others such as the spleen, kidneys, and peripheral circulation. This is the “brain sparing effect”.

Vyas et al(4) first described the use of Doppler velocity in the fetal middle cerebral artery (MCA) to detect fetal anemia. Using the intensity weighted time-averaged mean velocity of the MCA, they succeeded in detecting only 50% of cases, however. In a sentinel study, Mari et al(5) used receiver operating characteristic analysis and established a threshold value of 1.5 multiples of the median (MoM) for the peak systolic velocity to predict moderate-to-severe fetal anemia in a series of patients with

redcellalloimmunization. Overall 98% of all stillbirths occur in low-income and middle-income countries; 77% in south Asia and sub-Saharan Africa (6). There is no substantial drop in cerebral palsy as there is hypoxia in antenatal period is around 70 %. There is urgent need to answer questions like when, how and where to deliver such compromised babies. Doppler investigation of the fetal circulation can give important clues to fetal well-being in a number of fetal conditions.

Based on the longitudinal analysis of the results of the MCA Doppler velocimetry, they suggest that the MCA PI is initially abnormal in most fetuses, but they observed an increase in the MCA PI with a tendency to normalization before birth or fetal death. Based on the analysis of MCA-PSV, they verified a well-defined pattern, with progressive increase according to the advance of gestational age, and tendency to mild reduction immediately preceding birth or fetal death. In the present study, the group of fetuses who died presented a higher median of the values of MCA-PSV when compared to the survival group. However, the increase was discreet, which differed from that described by Mari et al (7). The aim of this study was to determine the effect of using the gestational age-specific reference levels of the MCA doppler values on the prediction of adverse perinatal outcomes.

MATERIALS AND METHODS

A retrospective observational study was performed at Fetal Medicine Unit, SKNMC, Pune, from September 2014 to August 2017. Total 4579 women were screened at routine antenatal visit during this period, out of which 400 were selected.

Inclusion criteria -

1. Pregnant women more than or equal to 28 weeks of gestation.
2. Women who are willing to perform the doppler study (written informed consent taken).

Exclusion criteria -

1. Pregnant women who are less than 28 weeks of gestation.
2. Multifetal pregnancies.
3. Diagnosed case of IUGR either clinically or ultrasonographically.

This visit included recording of maternal characteristics and medical history, and estimation of fetal size from transabdominal ultrasound measurement of biparietal diameter fetal head circumference, abdominal circumference and femur length. Determination of gestational age was done from menstrual history or measurement of the fetal crown-rump length at 11 weeks - 13 weeks 6 days gestation or the fetal head circumference at 19–24 weeks (8).

MCA was visualised by transabdominal colour doppler. Pulsed-wave Doppler was then used to assess impedance to flow; when three similar waveforms were obtained consecutively the PI was measured (9) Doppler studies were performed using Seimens Acuson X300 Ultrasound machine by single Fetal medicine specialist using 5-MHz sector transducers with spatial peak temporal average intensities below 50 mW/cm² and the high-pass filter at 50–100 Hz. For measurements of the middle cerebral artery an axial view of the fetal head was obtained at the level of the cerebral peduncles at base of skull, within 2 mm of internal carotid artery origin, then the color Doppler was used to visualize the circle of Willis, and the Doppler sample volume was placed within 1 cm of the origin of the middle cerebral artery that was easily identified as a major branch running anterolateral from the circle of Willis toward the lateral edge of the orbit. The sample volume size was 3 to 5 mm. Angle of insonation kept as close to 0° as

possible. Waveforms of good quality were collected and analyzed in the absence of fetal breathing movements. Waveform analysis was performed by measuring in the frozen display the maximum and minimum values of the velocity waveforms with the electronic calipers of the instrument (10).

All images taken during this study were stored at PACS (Picture archiving and communication system) electronic database at Fetal medicine department, SKNMC, Pune. When at least five consecutive uniform flow velocity waveforms with a high signal-to-noise ratio were obtained during periods of fetal rest and apnea the image was frozen and the waveforms were quantified using the PI.

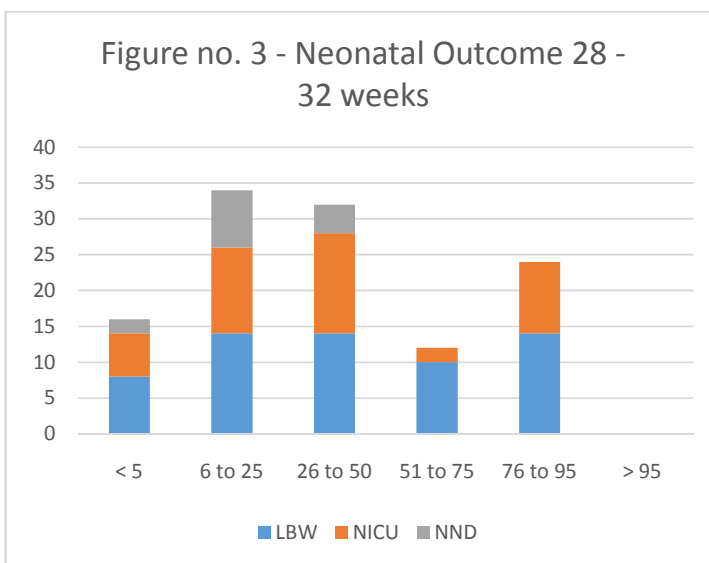
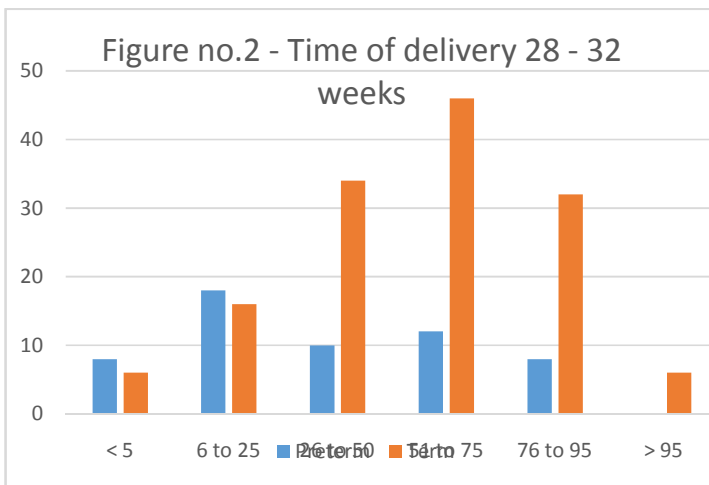
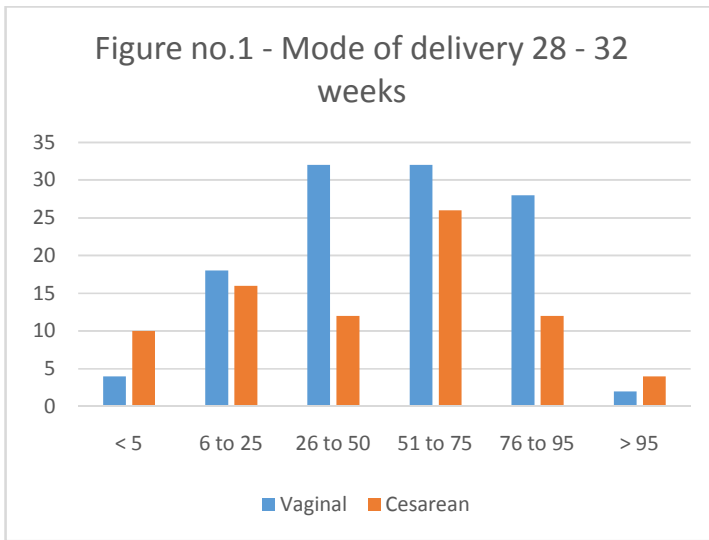
Maternal parameters studied were weeks of gestation, mode of delivery (vaginal or Cesarean section), complications during pregnancy (oligohydramnios, pregnancy induced hypertension).

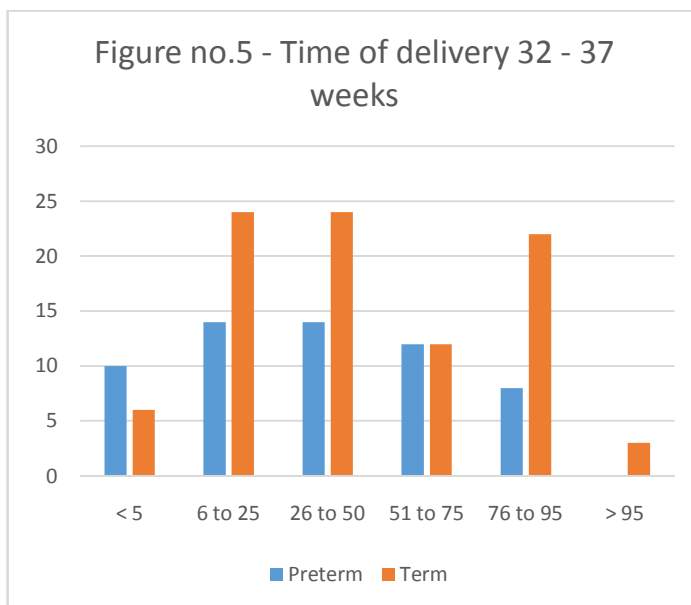
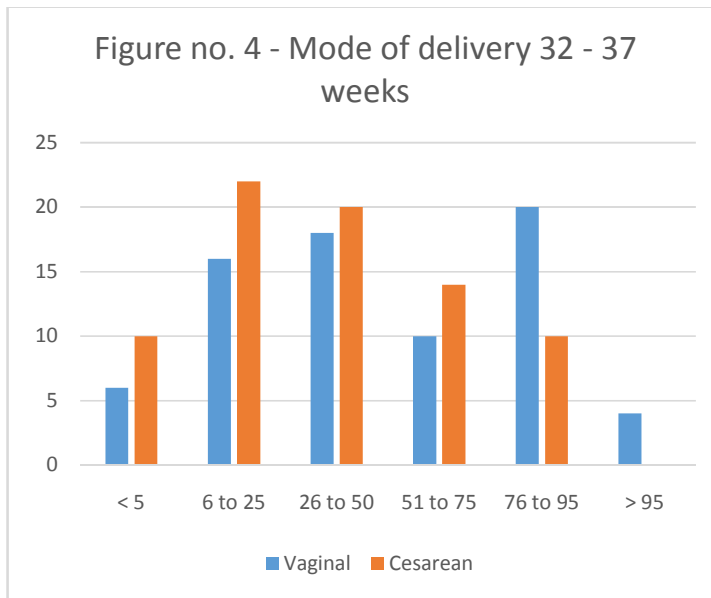
Neonatal parameters studied were birth weight, NICU admissions, neonatal death. Newborns were classified as small for gestational age (SGA) if their birth weight was below the 10th percentile for gestational age according to Brenner et al. (11). SGA newborns were considered growth retarded if they showed signs of malnutrition (decreased amount of subcutaneous fat, hypoglycemia, hyperbilirubinemia, hypocalcemia, hyperviscosity syndrome) in the immediate neonatal period. Preterm delivery was defined as delivery before 37 completed weeks. Neonatal morbidity was assessed by the length of stay in the neonatal intensive care unit. We have taken help of Barcelona fetal medicine calculator and perinatology calculators as derivation of MoM and percentile value is required for better prediction than mere numbers.

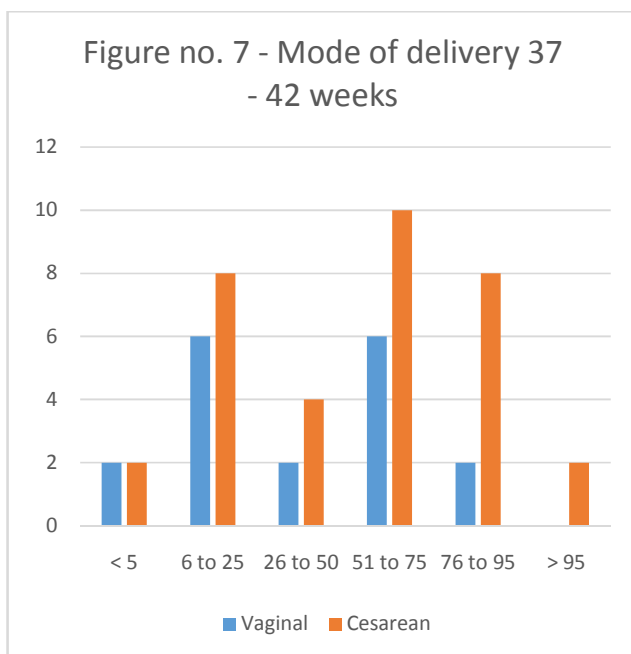
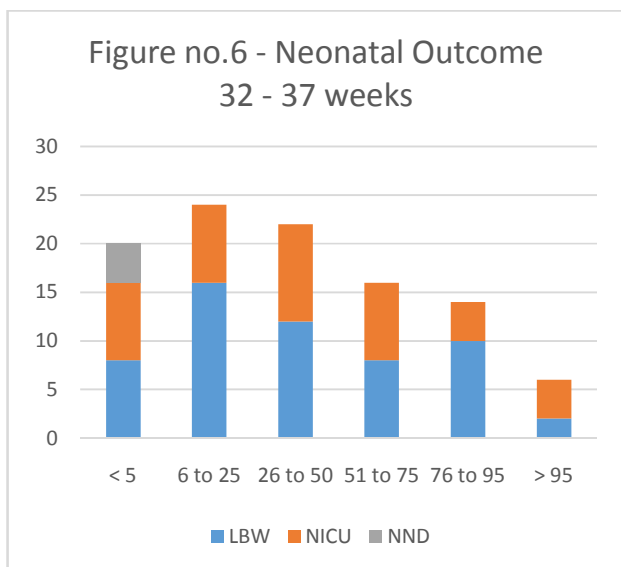
RESULT

Maternal and perinatal characteristics were evaluated and sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated. Appropriate for gestational age (AGA) was defined as birth weight or estimated fetal weight between 10th and 90th centiles. Cesarean section rate is increased when MCA PI was <5th centile or >95th centile between 28 to 32 weeks of gestation. Cesarean section rate increases gradually as MCA PI decreases from 32 weeks and above.

We have found that low MCA PI (<5th centile) was associated with increased cesarean section rate though this reason was not considered as indication for cesarean section. As gestational age advances from 32 weeks onwards, MCA PI <5th centile is associated with preterm births and increased NICU admissions. Normalisation of MCA PI after initial low values also were indicative of poor prognosis. Not all low MCA PI values were associated with bad perinatal outcome but we categorically found that low MCA PI with raised MCA PSV (peak systolic velocity) is associated with bad perinatal outcome.







DISCUSSION

Low MCA PI indicates a fetal hypoxic compromise at any gestational age. MCA PI < 5th centile is associated with stormy outcome of a neonate. In few cases, there was deterioration and severe fetal acidosis within 48 hours demonstrated with decelerations in non-stress test. This study analyzed the factors associated with neonatal death in pregnancies with early diagnosed placental insufficiency, and found that the outcome of neonatal death was associated with low MCA PI at which the birth occurs. Some studies suggest that the degree of cerebral circulation vasodilation did not exert any influence on survival, which appears to depend on the degree of impairment of the fetoplacental circulation. (12) Despite the vasodilation, the protection of the fetal central nervous system would not be sufficiently effective to be an independent factor influencing the neonatal mortality.

We have found out that not all MCA PI have bad poor neonatal outcome, but low MCA PI with raised PSV was associated with confirmed poor outcome. Nomura et al did not demonstrate only association between the results of fetal MCA PI and neonatal mortality(12). These authors concluded that high values of MCA-PSV (peak systolic velocity) predicted the perinatal mortality. Based on the longitudinal analysis of the results of the MCA Doppler velocimetry, they suggest that the MCA PI is initially abnormal in most fetuses, but they observed an increase in the MCA PI with a tendency to normalization before birth or fetal death.(13)

CONCLUSION

Middle cerebral artery flow velocimetry studies should be an integral parameter while evaluating in utero health of fetus. This may help to improve pregnancy management, identification and assessment of at risk fetuses at earliest gestational age as compared to other antepartum test modalities. This will help in early intervention and therapy. Though sensitivity and specificity of MCA PI alone is not evaluated over a period of time, this helps to improve fetal health.

Along with the standard antepartum methods (ultrasonography, cardiotocography and biophysical profile) MCA PI contributes to the prediction and monitoring of hypoxia and fetal suffering. It predicts timely completion of birth and decrease of perinatal mortality and morbidity.

LIMITATIONS –

1. Biases of selective assessment of a population referred for scan assessment a term so there will be a slightly higher than the expected proportion of at risk fetuses.
2. The results of the ultrasound and Doppler assessment were not blinded, giving rise to the possibility of subsequent clinical intervention and a 'treatment effect' in view of fetal safety.
3. The threshold for the diagnosis of fetal compromise is also likely to have been influenced by changing personnel and attitudes toward intrapartum management.

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