

A Prospective Study on the Importance of Colour Doppler Neuro Sonography in Assessing the Short -Term Prognosis among Full-Term Neonates with Perinatal Asphyxia

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ABSTRACT

Aim & objective: The aim of the study was to determine the role of blood flow parameters evaluated by color Doppler ultrasonography in neonates with birth asphyxia and correlate it with the short term prognostic outcome mortality.

Methods: Color Doppler ultrasound was performed at the bedside within the first 24 hours after birth. Measurements were done with a 2–5 MHz convex or phased array transducer of computed sonography system. The transducer will be positioned on the anterior fontanelle to perceive hemodynamic parameters of bilateral middle cerebral arteries, and anterior cerebral artery including peak Systolic Flow Velocity (PSFV), End-Diastolic Flow Velocity (EDFV), Time-averaged Mean Flow Velocity (TMFV), Pulsatility Index (PI) and Resistive Index (RI). All the indices were measured over three complete cardiac cycles.

Results: In our study most of the mothers belonged to 21-30 years age group. Among them 68 percent of the babies were delivered by normal labour and rest by LSCS. Among our study group 79 percent of the babies weighed between 2-3 kg. Course of labour were uneventful in most of the cases. Endotracheal Intubation was required in 18 babies, bag and mask ventilation in 21 babies and chest compression in 3 babies. Hospital stay of more than 10 days was required in only a few babies. Commonest diagnosis was birth asphyxia followed by HIE and MAS. Total of 18 infants died in our study population. Most common cause of death was severe birth asphyxia. Ventilator support was required in 16 neonates. Inotropes were used in 18 babies. Resistive Index (RI) and Pulsatility Index (PI) seem to be increased in babies with poor prognosis. Similarly PSFV and EDFV were decreased in babies with poor prognosis.

Conclusion: In conclusion, the present study confirms a role for Cranial Doppler measurements like RI, PI, PSFV and EDFV, in conjunction with other clinical information, as a safe and cost-efficient method for prognostication of outcome in neonatal HIE. Considering the prognostic potential of RI in neonates with HIE, it is desirable that neonatologists get familiar with the optimal usage of this imaging modality, especially in settings lacking sophisticated neuroimaging techniques. This study results also opens the gates for further research with more specific end points to further confirm the importance of Cranial Doppler and its factors as a tool to assess the severity and mortality.

Keywords: Perinatal asphyxia, End-diastolic flow VELOCITY, Peak systolic flow velocity, Resistive index, Pulsatility index

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INTRODUCTION

Perinatal asphyxia is one of the main reasons for

mortality and morbidity among newborns, with an estimated incidence of 1–8 / 1000 live births according to different studies [1]. The rapid advances in neonatal intensive care of late have reduced the incidence of poor prognosis of asphyxia like adverse neuro developmental outcomes. However, birth asphyxia is the important cause of hypoxic-ischemic brain injury in neonates born at term [2]. It is always a must to evaluate the severity of asphyxia to plan proper treatment and to prevent brain damage [3]. Computed Tomography (CT) is generally of minimal help in this state due to numerous reasons [4]. MRI will be more useful but it cannot be used in the

bedside. Colour Doppler is widely used nowadays which gives more information [5, 6]. There are not much studies related to this modality. Thus, our study intends to discover the early diagnostic value of observing cerebral hemodynamic changes with Doppler ultrasound for neonatal HIE.

According to the recommendations of the American Academy of Neurology and the Practice Committee of the Child Neurology Society, the measurements of Resistive Index (RI) and End Diastolic Flow Velocity (EDFV) in the anterior cerebral artery are done in order to evaluate cerebral perfusion and predict an outcome. An increase in EDFV indicates local or diffuse vasodilatation, caused by increased pCO₂ in case of asphyxia and accumulation of metabolites [7, 8]. However, in many countries, color Doppler ultrasonography is not widely applied in daily practice, and data on its diagnostic and prognostic potential remain scarce. It has been proven through many studies that compromised cerebral blood flow has an important role in the pathogenesis of HIE in neonates. Yet studies conducted so far have been insufficient to explain how changes in blood circulation parameters are related to short term prognosis like mortality.

METHODOLOGY

Maternal history and other details were obtained from

Table 1: Natural Labour constituted about 51% in our study.

Mode of delivery	No of patients	Percentage
Labour Naturalis	58	51%
LSCS	37	32%
Assisted vaginal delivery	20	17%

Table 2: Course of labour was uneventful in 83%, prolonged first stage in 1%, prolonged 2nd stage in 12% and obstructed labour in 4%.

Course of labour	No of patients	Percentage
Uneventful	95	83%
Prolonged 1st stage	1	1%
Prolonged 2nd stage	14	12%
Obstructed	5	4%

Table 3: In the study, 55% patients had Birth Asphyxia, Hypoxic ischemic encephalopathy in 22 %, Meconium aspiration syndrome in 14%, Meningitis in 1 %, RDS in 1%.

Final diagnosis	No Of Patients	Percentage
Birth asphyxia	63	55%
HIE of new-born	26	22%
Meningitis	1	1%
Neonatal aspiration of meconium	16	14%
RDS of new-born	1	1%
Any other	8	7%

Table 4: Out of total 18 deaths, 95% were having HIE, 5 % with meconium aspiration syndrome.

Cause of death	No of patients	Percentage
HIE/Moderate -Severe Birth Asphyxia	17	95%
Meconium Aspiration Syndrome	1	5%

Table 5: Ventilator support was required for only 16 patients.

Ventilator required	No of patients	Percentage
Yes	16	14%
No	99	86%

the mother's case sheet. After getting informed consent from the parents newborns delivered in the VMKVMC hospital that fulfill the inclusion and exclusion criteria were included in the study. Color Doppler cranial ultrasound was performed at the bedside within the first 24 h after birth while the newborn is awake and calm or when asleep. Measurements were done with a 2–5 MHz convex or phased array transducer of computed sonography system. The transducer was placed on the anterior fontanelle to detect hemodynamic parameters of bilateral anterior and middle cerebral arteries, including Peak Systolic Flow Velocity (PSFV), End-Diastolic Flow Velocity (EDFV), Time-averaged Mean Flow Velocity (TMFV), Pulsatility Index (PI) and Resistive Index (RI). All the indices were measured over three complete cardiac cycles.

Statistical Analysis

Done using SPSS Software version 21.0. Statistical methods were used based on variables and outcomes [Tables 1-7]. Mann hitney Score was used for non-parametric test and Student t test to compare parameters of ultrasound.

RESULTS

Table 6: Inotropes were used only in 18 patients.

Inotropes Used	No Of Patients	Percentage
Yes	18	16%
No	97	84%

Table 7: Pulsatility Index, Resistive Index, Peak Systolic Flow Velocity, End Diastolic Flow Velocity was compared with the final outcome and discussed in detail.

Cranial Doppler indices	Mean	Sd
RI	0.62	0.12
PI	1.2	0.09
PSFV	24.31	3.2
EDFV	14.92	1.86

DISCUSSION

In our study, we selected around 115 patients and did a prospective observational study for a period of one year from January 2022 – January 2023. We included Neonates who were full-Term (≥ 37 Weeks of Gestation), Neonates born with Perinatal Hypoxia Or Asphyxia requiring Resuscitation, Apgar Score At 5 Min ≤ 7 Points, with Foetal Acidosis (Umbilical Artery Blood Ph < 7.2).

We excluded patients who were pre-term (< 37 Weeks of Gestation), neonates with Congenital anomalies, Chromosome Abnormalities, Hemolytic Disease of the New-Born, and intra- cranial infection, severe sepsis with hemodynamic disturbances, or suspected Metabolic Diseases.

In Our Study, we started with analyzing the age of the mother. Most of the Mothers (76%) were of age between 21-30 Years which is the commonest reproductive age group. This was similar to a study done by Bongartset, where the mean age was around 22.7 Years.

In our study group, among Mothers 23% were prim mothers. Second Gravida is the most common with 59 Percent, while third gravida was 18%. A study done by Kiyani et al which dealt with these factors where most of the mothers were between 1-3 Gravida, i.e. 64.80% (N=127) while 35.20 % (N=69) had ≥ 4 gravida, Mean And Standard Deviation was 3.45 (+0.87). These results were similar to our studies.

Similarly in our study group 27 Patients had Hemoglobin level less than 10gms while rest had more than 10gms. Extensive literature review revealed that Iron Deficiency is a global nutritional problem affecting up to 52% Of pregnant women. Throughout pregnancy, Iron Deficiency Anemia adversely affects the maternal and fetal well-being, and is linked to increased morbidity and fetal death. Adverse perinatal outcomes include Intrauterine Growth Retardation, Prematurity, and Low Birth Weight, all with significant mortality risks. These were explained well in studies done by Abu Et al. In our study group, most of the neonates were delivered through normal vaginal delivery, among 78 delivered , 20 were delivered by assisted Vaginal Delivery like Forceps Or Vacuum and rest were delivered by Cesarean. These results were in similar to study done by Kiyani Et Al. where mode of delivery was spontaneous vertex

delivery in 44.39%, Caesarean Section in 32.14%, while 23.47% was instrumental delivery.

Among these 115 mothers spontaneous labour was common with 70% had spontaneous while rest 30% had induced labour. Also course of labour was uneventful in 83% of patients while rest had prolonged or obstructed labour. These studies were similar to studies done by Babus Et al.

Among total 115 babies in our study group 79 were male babies and rest were female babies. After delivery we weighed the babies in a standard weighing scale . Among 115 babies in our study around 79% (N=91) were between 2-3 Kg while only 4 babies were of low birth weight. In a study done by Kiyani Et Al too mean weight of the Newborns was calculated as 2621.37 (+74.21) grams.

In our study group as a whole the mean age of mothers were 24.76, mean baby weight is 2.76, mean heart rate Is 143.6 beats per minute, mean respiratory rate Is 61.73 per minute and mean duration of stay in Hospital was 8.81 days.

Further we analyzed Apgar score at 1 min where 76% (N=88) had Apgar score between 4-7 and rest had less than that, whereas after 5 minutes almost 96% of patients had Apgar between 4-7. Hence Mean Apgar at 1 min was 4.12 and at 5 Min was 5.98. Similar results were seen in study done by Bhagwani Et Al. Apgar Score of ≤ 3 at 1minute were found in 58 babies (40%) And 87 babies (60%) had a score of 4-6 at 1 minute where all babies selected had Apgar score fewer than 7. Coming to heart rate most of patients (77%) had heart rate between 120-160 per minute while about 11% of patients had heart rate less than 120 and 12% had heart rate more than 160.

Respiratory rate was normal in 36 patients and was abnormal in 79 patients. Similar results on heart rate and respiratory rate was seen in studies done by Mcguireet Al.

When we evaluated the type of resuscitation required, tactile stimulation was enough in 73 babies while rest needed one of methods like Bag And Mask Ventilation, Chest Compression or endotracheal intubation. Berglund Et Al did a study on this which showed multiple methods of resuscitation similar to this study. Coming to the duration of stay in the hospital most of babies were in the

hospital for less than 10 days, while rest required more than that. This is probably a straight forward parameter where babies who are ill with asphyxia needs a longer stay for complete recovery and better prognosis. Coming to final diagnosis, most common diagnosis was birth asphyxia followed by Hypoxic ischemic encephalopathy of newborn. Meconium Aspiration Syndrome was seen in 16 cases while rest had other causes which are similar to a study done by Endrichet Al.

In our study 15 percent of babies died while the rest recovered and discharged. The cause of death in almost all cases were HIE with Birth Asphyxia. This is similar to study done by Ekowochiet Al where the case Fatality Rate was 18%. In our study, we classified the neonates according to Sranat and Sarnat Staging for HIE, most of the patients were in stage 1 (81%) while 17 babies were in stage 2 and 5 in stage 3. Outcome depend on staging where stage 2 & 3 had more mortality than stage 1 HIE babies. Similarly in our study, population 16 babies required ventilator and 18 babies required Inotropes during management.

We correlated the outcome among the babies with the Cranial Doppler indices. Also we correlated the need of inotropes, ventilator and Sarnat and Sarnat Staging of HIE with the resistive Index measured through cranial Doppler. Among various parameters of cranial Doppler we took four parameters for analysis. Pulsatility index, resistive index, peak systolic flow velocity, end diastolic flow velocity with the final outcome i.e., death or alive in both anterior cerebral artery and middle cerebral artery.

To start with anterior cerebral artery, first we analyzed resistive index which was inversely proportional to outcome. There was significantly higher values in neonates who died in comparison with neonates who were alive with a mean of 0.77 in died neonates and 0.59 in alive babies. Two of three studies examining RI values as long-term predictors of outcome found worse outcomes among neonates with higher RI values as done by Estad et al. Next we analyzed the pulsatility index which is also inversely proportional to the outcome. There was significantly higher values in neonates who died in comparison with neonates who were alive with a mean of 1.29 in died neonates and 1.19 in alive babies. Measurements using cranial Doppler ultrasonography suggest that increased cerebral blood flow velocity and a low cerebral artery pulsatility index are present after asphyxia. Further we analyzed the PSFV and EDFV; both are directly proportional to the outcome. There were significantly lower values in neonates who died in comparison with neonates who were alive with a mean PSFV of 21.72 in died neonates and 24.79 in alive babies. Similarly in EDFV to mean was 11.67 in died neonates and 15.52 in alive neonates.

Similar evaluation was done in middle cerebral artery indices too. First we analyzed resistive index which was inversely proportional to outcome. There was significantly higher values in neonates who died in comparison with neonates who were alive with a mean

of 0.8 in died neonates and 0.6 in alive babies. Next we analyzed the pulsatility index which is also inversely proportional to the outcome. There was significantly higher values in neonates who died in comparison with neonates who were alive with a mean of 1.38 in died neonates and 1.21 in alive babies. Further we analyzed the PSFV and EDFV; both are directly proportional to the outcome. There were significantly lower values in neonates who died in comparison with neonates who were alive with a mean PSFV of 22.2 in died neonates and 25.17 in alive babies. Similarly in EDFV to mean was 12.15 in died neonates and 15.85 in alive neonates. We further analyzed the resistive index alone in both anterior and middle cerebral arteries and correlated with the HIE staging, ventilator requirement and inotrope usage. To start with staging of HIE, there was increase in the RI values with worsening of stage in both ACA and MCA. Similar results were seen in ventilator requirement and inotrope usage in relation with RI where in all factors increase in RI has an bad outcome – either morbidity or mortality.

These results of colour Doppler were done previously in studies done by Senthil et al where loss of cerebral autoregulation in HIE can predispose to reduced/absent diastolic blood flow in cerebral arteries leading to increased RI (>0.80) or elevated diastolic flow due to arterial vasodilation resulting in reduced RI [10,14]. Decreased RI has been well documented in asphyxia and found to increase the risk of death or cerebral palsy by 23.4 times. There is increase in RI in early stages of asphyxia where as it falls at later stages when disease worsens and prognosis become worse as done in study by Gerner et al. In general, RI values should generally stabilize into the normal range 48 hours post-injury . failure to do so more than 72 hours post-injury, which equates with the time period in which post-cooling RI values were obtained, may therefore suggest a more severe brain injury and subsequently worse motor outcome. Also the study suggest that pre-cooling RI <0.60 may broadly differentiate neonates who are more likely to have outcomes of severe neuro developmental disability or death by ages 20-32 months, hence abnormal RI levels has a bad prognosis. Similarly other values have a similar effect on the prognosis of the neonates.

CONCLUSION

In conclusion, the present study confirms a role for cranial Doppler measurements like RI, PI, PSFV and EDFV in conjunction with other clinical information as a safe and cost-efficient method for prognostication of outcome in neonatal HIE. Considering the prognostic potential of RI in neonates with HIE, it is desirable that neonatologists get familiar with the optimal usage of this imaging modality, especially in settings lacking sophisticated neuroimaging techniques. This study results also opens the gates for further research with more specific end points to further confirm the importance of cranial Doppler and its factors as a tool to assess the severity and mortality.

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