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Research Article

"The Effect Of Therapeutic Hypothermia On Blood Flow Velocities Of Middle Cerebral Artery, Celiac Artery, And Superior Mesenteric Artery In Term Neonates With Hypoxic Ischemic Encephalopathy"

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ABSTRACT
Objective- To study the blood flow velocities in the middle cerebral artery, celiac artery and superior mesenteric artery in neonates requiring therapeutic hypothermic for hypoxic ischemic encephalopathy.
Methods- The study included 30 neonates with gestational age greater than or equal to 36 weeks admitted to NICU within 6 hours of life. Doppler ultrasound was used to measure the blood flow velocities in middle cerebral artery, celiac artery and superior mesenteric artery during cooling and rewarming phases of therapeutic hypothermia. Blood flow velocities were determined and resistive index was calculated.
Results- The mean increase in RI in middle cerebral artery from cooling to rewarming phase was statistically significant with p value of 0.032. However, the mean increase in RI in superior mesenteric artery and celiac arteries from cooling to rewarming phases were statistically insignificant.
Conclusion- The resistive index in the middle cerebral artery increased significantly during the rewarming phase of therapeutic hypothermia.

Keywords : neonates,therapeutic hypothermia,superior mesenteric artery,middle cerebral artery,celiac artery,hypoxic ischemic encephalopathy

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Introduction:
Hypoxic ischemia encephalopathy is the most common cause of morbidity and mortality in term neonates. The incidence ranges from 10-20 per 1000 live births in low and middle-income countries [1]. Physiological factors such as carbon dioxide, oxygen, hydrogen ions, adenosine, arachidonic acid, nitric oxide, and potassium play a significant role in cerebral autoregulation. [2]. The hypoxia triggers the diving reflex redistributing the blood from non-vital organs like the kidney, gut, and skin to vital organs like the brain, heart, and adrenals. Different studies have documented cerebral, renal, and superior mesenteric blood flow after birth asphyxia [3]. Therapeutic hypothermia is the proven therapy in hypoxic ischemic encephalopathy. The cerebral hemodynamic changes are extensively evaluated by Doppler ultrasound [4]. The bedside ultrasound Doppler helps in determining the cerebral blood flow velocity including the resistive index during the cooling and rewarming phase.

Objectives: To observe difference in the blood flow velocities in celiac artery, superior mesenteric artery, and middle cerebral artery between cooling and rewarming phase of therapeutic hypothermia.

Methodology:
Neonates admitted to level 3 NICU fulfilling inclusion criteria were enrolled for the study. It was a prospective observational study for a period of 18 months. Neonates requiring Therapeutic hypothermia (TH) for hypoxic-ischemic encephalopathy were included in the study. Neonates with congenital malformations and refusal of consent were excluded. Neonate of gestational age greater than or equal to 36 weeks and admitted to NICU within 6 hours of life were enrolled in the study. Ethical clearance was taken. APGAR score of ≤5 at 10 minutes, needing assisted ventilation at birth continued for ≥5 minutes and metabolic acidosis with PH <7.1 and/or base deficit of ≥16mmol/liter in cord blood or any blood gas done within the first hour of life or at admission, neurological criteria included presence of neonatal seizures, physical examination consistent with moderate to severe encephalopathy staged by modified Sarnath staging and evidence of encephalopathy in aEEG using Olympic Brainz monitor for at least 20 minutes of admission were considered. At admission, if 2 physiological and 1 neurological criterion were met, TH was initiated. The baby was kept NPO during the start of the study. However, later due to a change in unit protocol, the enteral feed was initiated on day 2 of cooling. Neonates were monitored for seizures using aEEG until rewarming was completed.GE LOGIQ-e portable ultrasound machine was used for recording middle cerebral artery Doppler. One reading was taken on each day of cooling and one reading after rewarming. Ultrasound Doppler was performed by the post-graduate fellow under the guidance of Radiologist. The probe was kept in the subcoastal sagittal plane to determine the celiac and superior mesenteric artery. The middle cerebral artery flow was determined by placing the probe over the pterion portion of the temporal bone. readings were taken in the following manner: 1st reading-within 24 hours of cooling 2nd reading -between 24-48 hours of cooling 3rd -between 48-72 hours of cooling 4th reading-after rewarming phase within 96 hours of life Blood flow velocities were determined and resistive indices of CA, SMA, and MCA were calculated. Resistive index was calculated as RI=(S-D)/S, where S= peak systolic flow and D= peak diastolic flow.

Statistical Analysis:
Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean and standard deviation. The paired t-test was used to test the null hypothesis that the average of the differences between a series of paired observations is zero. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale with in each group. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

Results:

Table 1: Mode of delivery- frequency distribution of population studied

Mode of delivery	Number	%
Normal vaginal delivery	7	23.3
Emergency LSCS	11	36.7
Vacuum-assisted vaginal delivery	12	40
Total	30	100

Table 2: Comparison of mean Resistive index in celiac artery between cooling and rewarming - Student t-test (Paired).

	Mean	Standard deviation	Significance (P-value)
Resistive index of celiac – **cooling phase**	.5983	.08437	.732
Resistive index of celiac – **rewarming phase**	.6059	.11329	

Table 3: Comparison of mean Resistive index of superior mesenteric artery between cooling and rewarming - Student t-test (Paired)

	Mean	Standard deviation	Significance (P-value)
Resistive index of the superior mesenteric artery – **cooling phase**	.6480	.08556	.343
Resistive index of the superior mesenteric artery – **rewarming phase**	.6667	.10815	

Table 4: Comparison of mean Resistive index of middle cerebral artery between cooling and rewarming - Student t-test (Paired).

	Mean	Standard deviation	Significance (P-value)
Resistive index of the middle cerebral artery – **cooling phase**	.5948	.07891	.032
Resistive index of the middle cerebral artery- **rewarming phase**	.6414	.11592	

DISCUSSION

Therapeutic hypothermia is now the standard of care in moderate and severe hypoxic-ischemic encephalopathy [5]. Most of the neonates were delivered by vacuum-assisted vaginal delivery, which was closely followed by emergency LSCS but was statistically insignificant. However, a study done by Guta Kune et al in central Ethiopia showed that many of the babies undergoing therapeutic hypothermia were delivered by emergency LSCS [6]. We calculated the resistive index (RI) of celiac, superior mesenteric, and middle cerebral arteries during the cooling and rewarming phase of therapeutic hypothermia. The mean RI in the celiac artery was found to be 0.59 in the cooling phase and 0.60 in rewarming phase which was statistically not significant. The mean RI in the superior mesenteric artery was found to be 0.64 in the cooling phase and 0.66 in rewarming which was statistically not significant. The mean RI in the middle cerebral artery during the cooling and rewarming phase was 0.59 and 0.64 respectively was found to be statistically significant. It was statistically significant only in MCA. However, the RI was within the normal range (0.56-0.80) [7].

Tai Wei-Wu et al enrolled 20 neonates in their study. As per their study methodology systolic flow, diastolic flow, and resistive indices were calculated. The RI of the middle cerebral artery showed no significant difference in flow between the cooling and rewarming phases of TH [8].

Another study by Pilvi Ilves et demonstrated a mean blood flow increase in all the cerebral arteries and a decrease in the RI in asphyxiated neonates with severe HIE. The most increase in the mean blood flow velocity was seen at 36-71.9 hours. A severe positive correlation was found between mean blood flow velocity in the cerebral artery and the severity of HIE. However, in this paper therapeutic cooling was not initiated in neonates with asphyxia [3]. Overall, the RI was in the increasing trend in all arteries in the rewarming phase.

LIMITATION OF THE STUDY:

1. Small sample size
2. Intra-observer variability was not determined.

References:

1. Rasineni GK, Panigrahy N, Rath SN, Chinnaboina M, Konanki R, Chirla DK, Madduri S. Diagnostic and Therapeutic Roles of the "Omics" in Hypoxic–Ischemic Encephalopathy in Neonates. Bioengineering. 2022 Sep 22;9(10):498.
2. Venkatesh IH. The Doppler ultrasound: A bedside tool to understand cerebral autoregulation in

neonates. Journal of Clinical Neonatology 2020;9:231-4.

3. Ilves, P., Lintrop, M., Talvik, I., Muug, K., & Maipuu, L. (2009). Changes in cerebral and visceral blood flow velocities in asphyxiated term neonates with hypoxic-ischemic encephalopathy. *Journal of ultrasound in medicine: official journal of the American Institute of Ultrasound in Medicine*, *28*(11), 1471–1480.
4. Liu, J., Cao, H. Y., Huang, X. H., & Wang, Q. (2007). The pattern and early diagnostic value of Doppler ultrasound for neonatal hypoxic-ischemic encephalopathy. *Journal of tropical pediatrics*, *53*(5), 351–354.
5. Peliowski-Davidovich, A., & Canadian Paediatric Society, Fetus and Newborn Committee (2012). Hypothermia for newborns with hypoxic ischemic encephalopathy. *Paediatrics & child health*, *17*(1), 41–46.
6. Kune, G., Oljira, H., Wakgari, N., Zerihun, E., & Aboma, M. (2021). Determinants of birth asphyxia among newborns delivered in public hospitals of West Shoa Zone, Central Ethiopia: A case-control study. *PloS one*, *16*(3), e0248504.
7. Kumar, A. S., Chandrasekaran, A., Asokan, R., & Gopinathan, K. (2016). Prognostic Value of Resistive Index in Neonates with Hypoxic Ischemic Encephalopathy. *Indian pediatrics*, *53*(12), 1079–1082.
8. Wu, T. W., Tamrazi, B., Soleymani, S., Seri, I., & Noori, S. (2018). Hemodynamic Changes During Rewarming Phase of Whole-Body Hypothermia Therapy in Neonates with Hypoxic-Ischemic Encephalopathy. *The Journal of pediatrics*, *197*, 68–74.e2.