ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 01 | January - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RESISTIVE INDEX OF ANTERIOR CEREBRAL ARTERY IN LATE ONSET NEONATAL SEPSIS

Paediatrics

Dr. S Kunal Tejus Junior Resident, Department Of Pediatrics Rajarajeswari Medical College & Hospital, Bengaluru- 560074

Dr. Venkatesh Murthy DV Assistant Professor & Consultant Neonatalogist, Department Of Neonatalogy Rajarajeswari Medical College & Hospital, Bengaluru- 560074

Dr. Prema R Professor, Department Of Pediatrics Rajarajeswari Medical College & Hospital, Bengaluru- 560074

Dr. Adarsh E HOD & Professor, Department Of Pediatrics Rajarajeswari Medical College & Hospital, Bengaluru- 560074

ABSTRACT

Background And Objectives: Point of care neonatal ultrasound is a valuable tool for evaluating the heart, brain, lungs, and abdomen in cases of neonatal sepsis. Understanding blood flow in the brain during neonatal sepsis is complex and not well understood. This study aimed to measure blood flow in the brain by checking the resistive index (RI) of the anterior cerebral artery in babies with late-onset neonatal sepsis (LONS). **Methods:** All newborns admitted to our neonatal intensive care unit from January 2023 to June 2024 with suspected late-onset neonatal sepsis (LONS) had a bedside trans-cranial Doppler ultrasound to measure the resistive index (RI) of the anterior cerebral artery within 24 hours of showing symptoms. Babies with congenital heart disease, birth asphyxia, major birth defects, and genetic syndromes were excluded. Only those with a positive culture were included in the final analysis. **Results:** Out of suspected late-onset neonatal sepsis (LONS) cases, 23 had positive cultures and were analyzed. The mean admission weight was 2.04 kg, and the mean gestational age was 33+2 weeks. The most common bacteria found was Klebsiella pneumoniae & Escherichia coli. The resistive index (RI) was high in 52.2% (12 out of 23), normal in 39.1% (9 out of 23) and low in 8.7% (2 out of 23) of the cases. **Conclusions:** Late-onset neonatal sepsis (LONS) is a complex condition, and our study found it is linked with a high resistive index (RI) majority of cases, suggesting reduced brain blood flow.

KEYWORDS

INTRODUCTION

Neonatal sepsis, particularly among preterm infants, represents a formidable clinical challenge, associated with severe morbidity, elevated mortality rates, and considerable healthcare expenditures.[1,2] The global increase in premature births has directly contributed to a rise in neonatal sepsis cases, underscoring the complexities of effective management for healthcare practitioners.[3,4] Neonatal sepsis is stratified into early-onset sepsis (EOS) and late-onset sepsis (LOS), based on the timing of infection onset. EOS is typically attributed to pathogens acquired antenatally or intrapartum, whereas LOS results from postnatal exposure to organisms, either in healthcare settings or from the broader community.

Despite advancements in neonatal medicine, mortality rates associated with LOS remain distressingly high, ranging from 5% to 15% in numerous neonatal care units.[5] Coagulase-negative Staphylococcus (CoNS) is frequently implicated as the predominant pathogen in LOS; however, pathogen profiles exhibit considerable regional and temporal variability.[6,7] Accurate identification of LOS pathogens and ongoing surveillance of their antimicrobial resistance patterns are imperative for refining empirical therapeutic protocols and formulating cost-effective interventions aimed at mitigating neonatal mortality.

Blood culture remains the diagnostic gold standard for neonatal sepsis, yet its sensitivity is limited, varying between 50% and 80%.[8] When pathogens breach the bloodstream, the ensuing sequelae can be severe, encompassing septic shock, multi-organ failure, and disseminated intravascular coagulation. The hemodynamic alterations associated with sepsis are intricate and not yet entirely elucidated. Point-of-care neonatal ultrasound has emerged as an indispensable tool, permitting clinicians to evaluate critical structures such as the heart, brain, lungs, and abdomen in neonates with suspected sepsis.

This study concentrates on assessing cerebral blood flow in late-onset neonatal sepsis (LONS) by quantifying the resistive index (RI) of the anterior cerebral artery, aiming to yield insights that could inform targeted interventions and ultimately enhance neonatal outcomes.

MATERIALS AND METHODS

All neonates admitted to our Neonatal Intensive Care Unit (NICU) from January 2023 to June 2024 with clinical suspicion of late-onset neonatal sepsis (LONS) underwent a bedside trans-cranial Doppler ultrasound with PHILLIPS CX50. This procedure was performed within 24 hours of symptom onset to assess the resistive index (RI) of the anterior cerebral artery, a critical parameter that may reflect alterations in cerebral blood flow associated with sepsis. The anterior cerebral artery (ACA) was identified with Doppler ultrasound in the sagittal plane through anterior fontanel. Pulse Doppler was added to measure the velocity of blood in ACA. Peak systolic velocity (PSV) and end diastolic velocity (EDV) were recorded in thermo-neutral environment ensuring normal body temperature without any pressure provocation in quiet neonate using oral dextrose as a pacifier with continuous monitoring of oxygen saturation and vitals. The RI is calculated using the formula RI = (PSV – EDV)/ PSV. Proven sepsis was defined as positive culture in blood, cerebrospinal fluid, or urine.

Inclusion Criteria:

1. Neonates admitted to the NICU from January 2023 to June 2024
2. Suspected cases of late-onset neonatal sepsis (LONS)
3. Positive culture confirming the presence of infection

Exclusion Criteria:

1. Neonates with congenital heart disease
2. Cases of birth asphyxia
3. Presence of major congenital anomalies
4. Diagnosed genetic syndromes

These conditions were excluded as they could independently influence the cerebral resistive index, thereby introducing confounding factors into the results. Thus, only neonates meeting the inclusion criteria and with a confirmed positive culture were included in the final analysis. This rigorous approach was designed to isolate and elucidate the relationship between the resistive index and late-onset neonatal sepsis, offering a more precise understanding of the potential role of trans-cranial Doppler ultrasound in the early identification and management of this condition in the NICU setting.

Statistical Analysis

Qualitative data were presented as frequencies and percentages, while quantitative data were expressed as mean (standard deviation). Statistical analysis was conducted using SPSS software, version 20.0.

RESULTS

Among 40 suspected cases of late-onset neonatal sepsis (LONS), 23

were culture-positive and included in the analysis. The cohort comprised 12 male (52.17%) and 11 female (47.83%) neonates. The mean birth weight was 2.04 ± 0.76 kg, with a mean gestational age of 33 weeks and 2 days. The average age at presentation was 8.1 ± 6.2 days.

Table 1: Demographic And General Information.

Parametrs	Values
Male/ Female	12/11 (52.17% /47.83%)
Mean Birth Weight (in kg)	2.04±0.7
Mean Gestational Age (in weeks)	33+2 weeks
Mean age at presentation (in days)	8.1±6.2

Table 2 presents the distribution of organisms isolated from these cases. Klebsiella pneumoniae was the most prevalent, identified in 30% of cases, followed by Escherichia coli (17.5%), Stahylococcus epidermis (13%) & Pseudomonas aeruginosa (13%). Remaining organisms are listed in the table.

Table 2: Distribution of cases According to Organisms Isolated.

Organisms	No. of isolated	Percentage
Klebsiella Pneumoniae	7	30
Escherichia coli	4	17.5
Staphylococcus epidermidis	3	13
Pseudomonas aeruginosa	3	13
Acinetobacter baumanni	2	8.5
Enterobacter cloacae	2	8.5
Staphylococcus aureus	1	4.5
Citrobacter species	1	4.5

Table 3 displays the resistive index (RI) distribution among cases. A high RI (>0.82) was observed in 52.17% of cases, a normal RI (0.68–0.82) in 39.13%, and a low RI (<0.66) in 8.70% of cases.

Table 3: Distribution Of Resistive Index Values In Study Population.

Resistive Index	No. of cases	Percentage
<0.066 (low)	2	8.70
0.68 - 0.82 (normal)	9	39.13
> 0.82 (high)	12	52.17
Total	23	100

DISCUSSION

The incidence and causative organisms of sepsis exhibit geographical variability. In our study, we observed a slight male preponderance, with 52.17% of cases being male and 47.83% female. This finding is consistent with the research conducted by Gatseva et al.[9], which reported a male-to-female ratio of 70% to 30%. Similarly, Deshpande et al.[10] noted a ratio of 1.2:1, with 54.8% males and 45.2% females in their cohort. These results align with prior studies, which have suggested that the elevated incidence of septicemia in males—ranging from 59% to 82%—may be attributed to factors related to gamma globulin synthesis, a process regulated by the X chromosome.

In our study, Klebsiella pneumoniae emerged as the most frequently isolated pathogen, present in 30% of cases. Escherichia coli was isolated in 17.5% of cases, while Staphylococcus epidermidis, Pseudomonas aeruginosa, Staphylococcus aureus, Acinetobacter baumannii, Enterobacter cloacae and Citrobacter species were isolated too. Gatseva et al.[9] similarly reported that Klebsiella pneumoniae accounted for 50% of cases of late-onset sepsis (LOS), followed by Gram-positive Staphylococci species at 21%. Other less prevalent pathogens included Escherichia coli, Serratia species, and Enterobacter species. Likewise, studies by Deshpande et al.[10] and Sawhney et al.[11] corroborated these findings, identifying Klebsiella species as the predominant pathogens, which constituted 45.75% of culture-positive cases, with Staphylococcus aureus being the second most common, found in 25.7% of cases.

Our analysis indicated that a high resistive index (RI) greater than 0.82 was present in 52.17% of cases, while a normal RI (ranging from 0.68 to 0.82) was observed in 39.13% of cases. A low RI (less than 0.66) was recorded in 8.70% of the cases. Numerous studies have documented severely impaired vasomotor reactivity, which can lead to vasodilation and increased cerebral blood flow (CBF). Conversely, other research has demonstrated decreased CBF velocity, along with elevated pulsatility index (PI) and resistive index (RI) in patients diagnosed with sepsis.[12,13]

Research specifically focused on measuring cerebral blood flow (CBF) in sepsis remains limited. For instance, Bowton et al. demonstrated that CBF is reduced in septic patients, irrespective of fluctuations in blood pressure or cardiac output, utilizing the xenon clearance technique to assess CBF in nine individuals.[13] Similarly, Maekawa et al.[14] observed significantly lower CBF in six patients suffering from sepsis-associated delirium compared to a cohort of awake controls. Furthermore, in an experimental model of human endotoxemia, Moller and colleagues reported a decline in CBF following an intravenous bolus of endotoxin administered to healthy volunteers.[15] Consistent with these findings, our study also identified a reduction in diastolic flow in neonates diagnosed with late-onset neonatal sepsis (LONS), which resulted in elevated values of the resistive index (RI).

This study is not without limitations. Notably, the small sample size constrains the generalizability of our findings, and cerebral blood flow (CBF) was assessed only once during the study. Consequently, we were unable to evaluate the temporal fluctuations of CBF over the course of the illness. Future studies with larger sample sizes and longitudinal assessments of CBF are warranted to further elucidate these relationships.

CONCLUSION

Late-onset neonatal sepsis (LONS) represents a distinct and intricate hemodynamic condition, one that remains insufficiently understood in neonatal medicine. Gram-negative bacterial infections are predominant in cases of LONS, and our research identifies a correlation with increased resistive index (RI), signifying diminished cerebral blood flow (CBF). Consequently, point-of-care transcranial sonography emerges as an invaluable diagnostic tool in identifying this altered cerebral perfusion in neonatal sepsis. Beyond its non-invasive nature, this modality is portable, utilizes non-ionizing radiation, and is both precise and economically viable. It facilitates simultaneous visualization of cranial structures and the measurement of absolute cerebral blood flow velocity (CBFV), with the added benefit of enabling serial and repetitive assessments, thus supporting the timely initiation of treatment.

REFERENCES

1. Seale AC, Blencowe H, Manu AA, Nair H, Bahl R, Qazi SA, Zaidi AK, et al. Estimates of possible severe bacterial infection in neonates in sub-saharan africa, south asia, and latin america for 2012: a systematic review and meta analysis. Lancet Infect Dis. 2014;14:731–41.
2. Hibberd PL, Hansen NI, Wang ME, Goudar SS, Pasha O, Esamai F, Chomba E, et al. Trends in the incidence of possible severe bacterial infection and case fatality rates in rural communities in sub-saharan africa, south asia and latin america, 2010-2013: a multicenter prospective cohort study. Reprod Health. 2016;13:65.
3. Beck S, Wojdyla D, Say L, Betran AP, Merialdi M, Requejo JH, Rubens C, et al. The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. Bull World Health Organ. 2010;88:31–8.
4. Callaghan WM, MacDorman MF, Rasmussen SA, Qin C, Lackritz EM. The contribution of preterm birth to infant mortality rates in the United States. Pediatrics. 2006;118:1566–73.
5. Babazono A, Kitajima H, Nishimaki S, Nakamura T, Shiga S, Hayakawa M, Tanaka T, et al. Risk factors for nosocomial infection in the neonatal intensive care unit by the japanese nosocomial infection surveillance (janis). Acta Med Okayama. 2008;62:261–8.
6. Al-Taiar A, Hammoud MS, Cuiqing L, Lee JK, Lui KM, Nakwan N, Isaacs D. Neonatal infections in China, Malaysia, Hong Kong and Thailand. Arch Dis Child Fetal Neonatal Ed. 2013;98:F249–55.
7. Jiang Y, Kuang L, Wang H, Li L, Zhou W, Li M. The clinical characteristics of neonatal sepsis infection in Southwest China. Intern Med. 2016;55:597–603.
8. Singh M. Neonatal septicemia. In: Care of the Newborn, 6th ed. New Delhi: Sagar Publications; 2004:209-216.
9. Gatseva P, Blazhev A, Yordanov Z, Atanasova V. Early Diagnostic Markers of LateOnset Neonatal Sepsis. Pediatr. Rep. 2023; 15.
10. Yengkhom R, Suryawanshi P, Ingale S, Gupta B, Deshpande S. Resistive Index in LateOnset Neonatal Sepsis. Journal of Neonatology 2018; 32(4).
11. Sawhney N, Shinu P, Singh VA. Bacteriological profile and antibiotic susceptibility pattern of neonatal septicaemia in a tertiary care hospital. Int J Curr Microbiol App Sci. 2015;4(10):977-984.
12. Furukawa S, Sameshima H, Ikenoue T. Circulatory disturbances during the first postnatal 24 hours in extremely premature infants 25 weeks or less of gestation with histological fetal inflammation. J Obstet Gynaecol. 2008;34:27-33.
13. Szatmári S, Végh T, Csomós Á, et al. Impaired cerebrovascular reactivity in sepsis associated encephalopathy studied by acetazolamide test. Crit Care. 2010;14:R50.
14. Maekawa T, Fujii Y, Sadamitsu D, et al. Cerebral circulation and metabolism in patients with septic encephalopathy. Am J Emerg Med. 1991;9:139-143. doi: 10.1016/0735 6757(91)90175-J.
15. Moller K, Strauss GI, Qvist J, et al. Cerebral blood flow and oxidative metabolism during human endotoxemia. J Cereb Blood Flow Metab. 2002;22:1262-1270.