RESEARCH PAPER

Correlation Of Urinary Uric Acid And Creatinine Ratio With Perinatal Asphyxia And Its Severity

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ABSTRACT

Background: Perinatal asphyxia remains a significant contributor to neonatal morbidity and mortality, particularly in low and middle income countries where access to advanced diagnostic facilities is limited.

Aims and Objectives: To assess the relationship between the UA/Cr ratio and the severity of hypoxic–ischaemic encephalopathy (HIE) along with primary objective to evaluate the correlation between the urinary uric acid to creatinine ratio and perinatal asphyxia and secondary objective to examine the association of selected perinatal risk factors with asphyxia.

Material and Methods: Present hospital-based cross-sectional study was conducted in the Neonatal Intensive Care Unit of Sree Balaji Medical College and Hospital, Chennai, over a period of 18 months from June 2024 to January 2026. A total of 60 term appropriate-for-gestational-age neonates were enrolled (n=30 neonates with perinatal asphyxia and n=30 without asphyxia). Diagnosis of perinatal asphyxia was established based on standard clinical and biochemical criteria, including low Apgar scores, metabolic acidosis, neurological dysfunction, and evidence of multi-organ involvement. A spot urine sample was collected within 6–24 hours of life, and urinary uric acid and creatinine levels were measured to calculate the UA/Cr ratio. The severity of HIE was assessed using the Modified Sarnat and Sarnat staging. **Results:** In the present study, a total of 30 newborns who had symptoms of neonatal asphyxia and 30 neonates who did not were included. Out of 60 participants, 31 (51.67%) were males and 29 (48.33%) were females. A ratio of 1.07 males to 1 female was determined. The average time for gestation was 39.1 ± 1.2 weeks, and the average weight at birth was 2.98 ± 0.42 kg. The mean urinary uric acid levels and UA/Cr ratio were significantly higher in asphyxiated neonates compared to non-asphyxiated controls ($p < 0.001$). The mean UA/Cr ratio in the asphyxia group was 2.71 ± 0.67, compared to 0.88 ± 0.06 in the control group. ROC curve analysis demonstrated excellent diagnostic accuracy of the UA/Cr ratio, with an area under the curve (AUC) of 0.976. A cut-off value of 1.80 provided optimal sensitivity (86.7%) and specificity (93.3%). Furthermore, a strong positive correlation was observed between the UA/Cr ratio and the severity of HIE ($r = 0.81$, $p < 0.001$), with progressively higher values noted from mild to severe stages

Conclusion: Study concluded that urinary uric acid to creatinine ratio is a simple, non-invasive, and reliable biochemical marker for the early diagnosis of perinatal asphyxia. Its strong correlation with disease severity further supports its role as a prognostic indicator.

Keywords: Perinatal Asphyxia, Urinary Uric Acid/Creatinine Ratio, Hypoxic–Ischaemic Encephalopathy, Neonatal Biomarkers, Early Diagnosis

How to cite this article: Premalakshmi G, Ramesh S, Nivedha, Ramana AV. Correlation Of Urinary Uric Acid And Creatinine Ratio With Perinatal Asphyxia And Its Severity. Int J Drug Deliv Technol. 2026;16(70s): 865-874. DOI: 10.25258/ijddt.16.70s.90

INTRODUCTION

Neonatal mortality and morbidity are mostly caused by perinatal asphyxia, which is especially prevalent in nations with low or medium socioeconomic levels. It is still a major cause of hypoxic-ischaemic encephalopathy (HIE), which may lead to mortality in neonates and neurological impairments later in life.[1-3] Early diagnosis is essential because prompt intervention may reduce the progression of hypoxic–ischaemic injury. However, in many settings, especially resource-limited centres, diagnosis still depends mainly on clinical findings and limited laboratory support. Diagnostic and treatment delays may occur due to the high cost and limited availability of advanced investigations such arterial blood gas analysis.[4]

Urinary biomarkers have gained importance because urine collection is simple, non-invasive, and economical. The urinary uric acid-to-creatinine ratio (UUA/Cr) is one such indicator that has shown effectiveness. A higher UUA/Cr ratio occurs in perinatal asphyxia due to elevated uric acid synthesis due to elevated ATP breakdown and relatively steady creatinine excretion.[5,6]

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The diagnosis of perinatal asphyxia continues to be challenging in neonatal practice, particularly when early clinical signs are subtle or when access to advanced investigations is limited. In many centres, diagnosis still depends largely on Apgar score, clinical examination, and evidence of neurological dysfunction. Although these parameters are clinically useful, they may not always reflect the extent of underlying metabolic injury. For this reason, increasing attention has been directed towards identifying objective and practical biomarkers that can support early diagnosis in the immediate neonatal period.[5]

The UUA/Cr ratio has gained clinical importance because spot urine samples collected within the first 24 hours of life can be used for measurement. making it simple, non-invasive, and feasible in routine neonatal care. Hence, studying the correlation between UUA/Cr ratio and perinatal asphyxia may help determine whether this parameter can serve as a practical biochemical marker for early diagnosis in affected newborns.

The clinical severity of perinatal asphyxia is most commonly reflected by the extent of hypoxic–ischaemic encephalopathy (HIE), which remains an important determinant of neonatal outcome. Although clinical staging systems such as the Modified Sarnat and Sarnat classification are widely used, neurological signs may evolve over time and can sometimes underestimate the degree of underlying metabolic injury in the early neonatal period. This has led to interest in biochemical markers that may complement clinical assessment and help in identifying the severity of asphyxial insult more objectively.[5]

The UUA/Cr ratio has been planned not only as an indicative marker of perinatal asphyxia but also as a possible indicator of its severity. In hypoxic–ischaemic injury, greater depletion of cellular energy stores leads to greater purine degradation and increased uric acid production. As hypoxia severity increases, urinary uric acid excretion tends to rise, while creatinine remains relatively stable. Consequently, the UUA/Cr ratio may reflect the magnitude of hypoxic stress and tissue injury. Sociodemographic determinants also play a crucial role in influencing perinatal outcomes. Low socioeconomic status, poor access to healthcare facilities, and delayed referral systems have been consistently associated with a higher incidence of perinatal asphyxia. Studies have demonstrated that neonates born to mothers from lower socioeconomic backgrounds are at increased risk due to inadequate antenatal supervision and limited availability of skilled birth attendants.[7,8]

Therefore, exploring the link among the UUA/Cr ratio and the degree of prenatal hypoxia may help determine whether this marker can assist in early severity assessment and clinical risk stratification in affected neonates. Due to a lack of regional data on the diagnostic significance of UUA/Cr ratio, this study aimed to examine their link with the severity of hypoxic-ischaemic encephalopathy and their function in perinatal asphyxia.

MATERIAL AND METHODS

The present cross-sectional study was conducted in Sree Balaji Medical College and Hospital's Department of Paediatrics in Chennai, Tamil Nadu from June 2024 to January 2026. A total of 60 term appropriate-for-gestational-age neonates were enrolled (n=30 neonates with perinatal asphyxia and n=30 without asphyxia).

Inclusion Criteria

Thirty term AGA neonates who had perinatal asphyxia and thirty term AGA neonates who did not, both born during the same time period, were included.

Exclusion Criteria

Neonates having congenital abnormalities, maternal drug abuse, administration of magnesium sulfate or opioids to the mother within 4 hours prior to delivery, Erythroblastosis fetalis, Maternal alcohol consumption, Maternal smoking, Maternal use of antiepileptic medications, Hypovolemia during pregnancy and the postpartum period can occur in mothers due to conditions such as placenta previa, placental abruption, renal illness, or heart failure were excluded.

Methodology

The Neonatal Intensive Care Unit (NICU) at our institute prospectively collected data on infants admitted to the unit over 18 months. At the time of admission, a detailed perinatal history was obtained from the mother or caregiver. Information regarding antenatal factors, intrapartum events such as fetal distress and meconium-stained amniotic fluid, and immediate postnatal adaptation was systematically recorded. Baseline neonatal characteristics, including sex, gestational age, birth weight, socioeconomic status, mode of delivery, and Apgar scores at 1 and 5 minutes, were documented for all enrolled neonates. A comprehensive clinical evaluation, including a targeted neurological evaluation, was performed on each neonate. Using the Modified Ballard scoring system[9], the gestational age was determined. Hypotonia, seizures, altered awareness, and other clinical symptoms of HIE were rigorously observed in neonates with characteristics suggestive of perinatal hypoxia. The intensity of the encephalopathy was evaluated and categorised into Stages I, II, and III using the Modified Sarnat and Sarnat staging system.[10-12]

A standard blood gas analyzer was used to determine the pH of umbilical cord arterial blood samples taken at birth in order to enhance the diagnosis and severity evaluation of neonatal hypoxia. In addition, a spot urine sample was collected from each neonate within 6–24 hours of life under aseptic conditions. Jaffe's alkaline picrate approach to quantify urine creatinine levels and the spectrophotometric uricase method to measure urinary uric acid levels was used. The UUA/Cr ratio was subsequently calculated for each neonate.

A total of 60 term appropriate-for-gestational-age neonates were enrolled (n=30 neonates with perinatal asphyxia and n=30 without asphyxia).

Statistical analysis:

At the end of the study, the data was analysed by using the Statistical Package for the Social Sciences (SPSS), version 30. Descriptive statistics were utilised to summarise baseline characteristics and categorical data presented as percentages and frequencies. Continuous variables presented as mean±standard deviation and Chi-square test was used for categorical characteristics.

A p-value below 0.05 was deemed significant. The asphyxiated and non-asphyxiated neonates were compared using continuous variables using the independent Student's t-test. Correlation analysis was used to determine whether there was an association between the UUA/Cr ratio and the severity of HIE in neonates. A two-tailed p-value was used to evaluate statistical significance, and the correlation coefficient (r) was used to represent the strength and direction of the relationship. To determine how well the UUA/Cr ratio identified perinatal hypoxia, Receiver Operating Characteristic (ROC) curve analysis. As a measure of general accuracy, we computed the area under the curve-AUC. To find the best diagnostic threshold, several UUA/Cr ratio cut-off values was used and calculated their sensitivity, specificity, PPV, and NPV

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Ethical committee approval:

Sree Balaji Medical College and Hospital's Institutional Human Ethics Committee in Chennai was consulted to obtain ethical committee approval for this study vide letter No. [SBMCH/IHEC/2024/2205 Reference No.002].

In the present study, a total of 30 newborns who had symptoms of neonatal asphyxia and 30 neonates who did not were included. Out of 60 participants, 31 (51.67%) were males and 29 (48.33%) were females. A ratio of 1.07 males to 1 female was determined. The average time for gestation was 39.1 ± 1.2 weeks, and the average weight at birth was 2.98 ± 0.42 kg. There is a robust positive relationship between the UUA/Cr ratio and the extent of prenatal hypoxia. In the present study, more than half of the neonates were full term 32(53.3%), followed by early term neonates 18(30%), and a smaller proportion of babies were late term 10(16.7%)

The majority of participants belonged to socioeconomic status class III 24(40.0%), followed by class IV 17 (28.3%). Classes I and II together constituted 13 (21.7%) participants, with Class I accounting for 2 (3.3%) and Class II for 11 (18.3%), while 6 (10%) belonged to class V. With regard to mode of delivery, emergency LSCS constitutes the largest proportion 28(46.7%), followed by spontaneous vaginal delivery 22(36.7%). Assisted vaginal delivery accounts for 6(10%), while elective LSCS represents the smallest share 4(6.7%).

RESULTS

Table 1: Distribution According to Severity of Perinatal Asphyxia

Severity of Perinatal Asphyxia	Frequency (n)	Percentage (%)
Stage I (Mild)	19	63.3
Stage II (Moderate)	8	26.7
Stage III (Severe)	3	10
Total	30	100

The majority of cases were classified as Stage I (mild depression), accounting for 19 (63.3%) of the study population. Stage II (moderate depression) severity was observed in 8(26.7%), while Stage III (severe depression) cases constituted 3(10%). More than half of the neonates 16(53.34%) had mild depression at 1 minute, while 10 (33.33%) had moderate depression and 4 (13.33%) had severe depression. At 5 minutes, most of the neonates 19(63.33%) had mild depression, while 8(26.67%) had moderate depression and 3 (10%) had severe depression.

Association of gender, gestational age, socio-economic status and mode of delivery with perinatal asphyxia

Table 2: Association of various parameters with perinatal asphyxia

GENDER	PERINATAL ASPHYXIA		χ^2	p value
	PRESENT n (%)	ABSENT n (%)		
Male	16 (51.6)	15 (48.4)	0.067	0.796
Female	14 (48.3)	15 (51.7)		
GESTATIONAL AGE				
Early term	13 (72.2)	5 (27.8)	5.56	0.062
Full term	12 (37.5)	20 (62.5)		
Late term	5 (50)	5 (50)		
SOCIOECONOMIC STATUS (Modified BG Prasad Scale)				

Class I	1 (50)	1 (50)	5.64	0.228
Class II	3 (27.3)	8 (72.7)		
Class III	11 (45.8)	13 (54.2)		
Class IV	10 (58.8)	7 (41.2)		
Class V	5 (83.3)	1 (16.7)		
MODE OF DELIVERY				
Spontaneous vaginal	6 (27.3)	16 (72.7)	7.50	0.058
Assisted vaginal	4 (66.7)	2 (33.3)		
Emergency LSCS	17 (60.7)	11 (39.3)		
Elective LSCS	3 (75)	1 (25)		

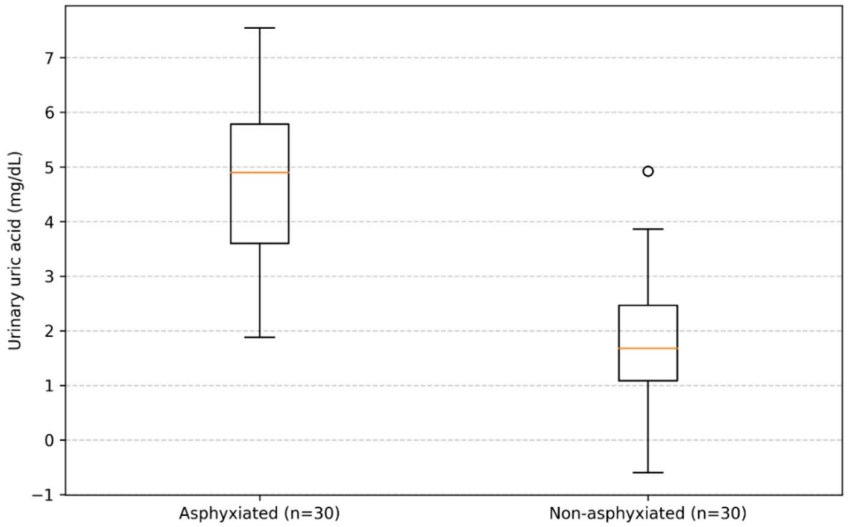
Table 2 shows that males constituted a slightly higher proportion of neonates with perinatal asphyxia (51.6%) compared to females (48.3%). The association between gender and perinatal asphyxia was not found to be statistically significant ($\chi^2 = 0.067$, $p = 0.796$). Early-term neonates constituted a higher proportion among those with perinatal asphyxia (72.2%) compared to those without asphyxia (27.8%). In contrast, full-term neonates were more common in the non-asphyxiated group (62.5%) than in the asphyxiated group (37.5%), while late-term births showed equal distribution in both groups (50%). The association between gestational age and perinatal asphyxia was not found to be statistically significant ($\chi^2 = 5.56$, $p = 0.062$). Most neonates belonged to Class III and Class IV socioeconomic status in both groups. Class IV (58.8%) and Class V (83.3%) were relatively more common among neonates with perinatal asphyxia, whereas Class II (72.7%) and Class III (54.2%) were more frequent among non-asphyxiated neonates. The association between socioeconomic status and perinatal asphyxia was not found to be statistically significant ($\chi^2 = 5.64$, $p = 0.228$). Emergency LSCS and assisted vaginal delivery were more common in the perinatal asphyxia group, while spontaneous vaginal delivery was more frequent in the non-asphyxia group. The association between mode of delivery and perinatal asphyxia was not found to be statistically significant ($\chi^2 = 7.50$, $p = 0.058$).

Table 3: Comparison of Urinary Uric Acid Levels Between Asphyxiated and Non-Asphyxiated Neonates

Parameter	PERINATAL ASPHYXIA		MD	95% CI of MD	t value	p value
	PRESENT (Mean±SD)	ABSENT (Mean±SD)				
Urinary uric acid (mg/dL)	4.65 ± 1.42	1.72± 1.21	2.93	2.24 – 3.62	8.61	**<0.001**[#]

Independent Student's t-test applied. MD = Mean Difference; CI = Confidence Interval; #p < 0.001, statistically significant.

Figure 1: Comparison of Urinary Uric Acid Levels Between Asphyxiated and Non-Asphyxiated Neonates



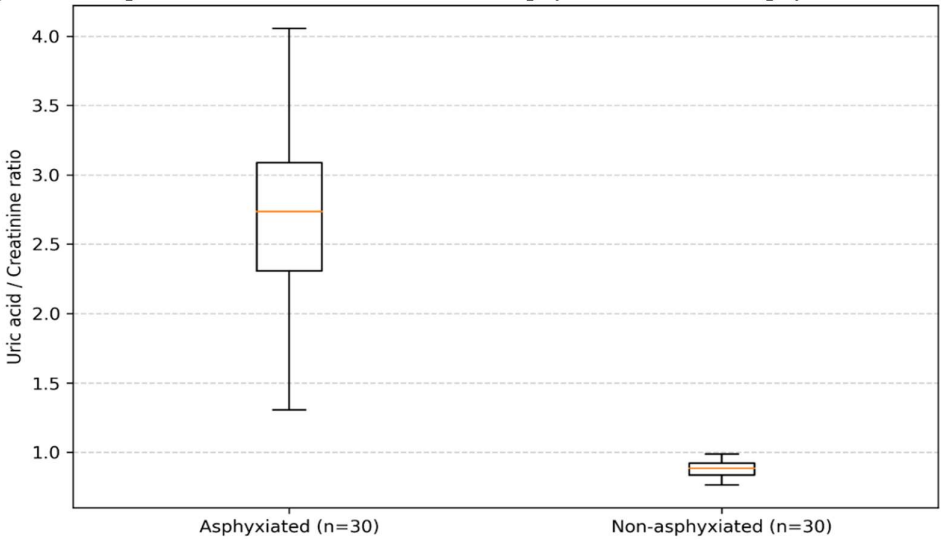
Box plot showing urinary uric acid levels in asphyxiated and non-asphyxiated neonates. Asphyxiated neonates demonstrated significantly higher urinary uric acid levels (4.65 ± 1.42 mg/dL) compared to non-asphyxiated neonates (1.72 ± 1.21 mg/dL), with a mean difference of 2.93 mg/dL (t = 8.61, p < 0.001).

Table 4: Comparison of UUA/Cr Ratio Between Asphyxiated and Non-Asphyxiated Neonates

Parameter	PERINATAL ASPHYXIA		MD	95% CI of MD	t value	p value
	PRESENT (Mean+SD)	ABSENT (Mean+SD)				
Uric acid / Creatinine ratio	2.71± 0.67	0.88 ± 0.06	1.83	1.60 – 2.06	15.42	**<0.001#**

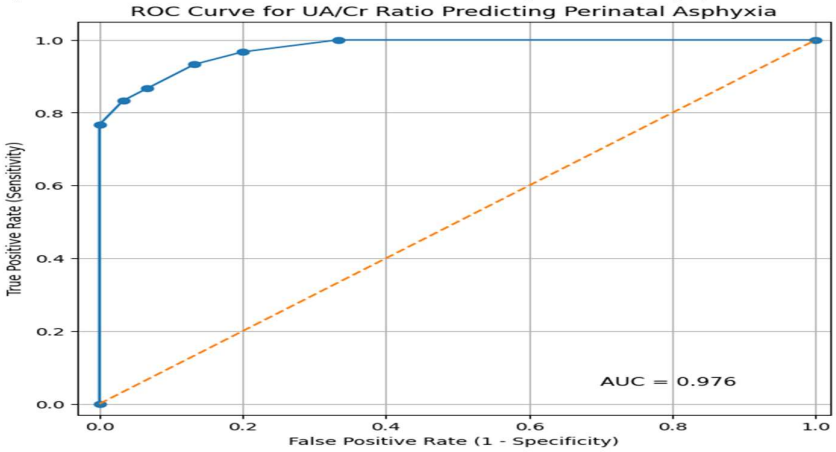
Independent Student's t-test applied. MD = Mean Difference; CI = Confidence Interval; #p < 0.001, statistically significant.

Figure 2: Comparison of UUA/Cr Ratio Between Asphyxiated and Non-Asphyxiated Neonates



Independent student t-test showed a statistically significant increase in the UUA/Cr ratio in neonates with perinatal asphyxia (2.71 ± 0.67) compared to those without asphyxia (0.88 ± 0.06), t = 15.42, p < 0.001.

Figure 3: ROC Curve of the UUA/Cr Ratio Among Perinatal Asphyxia Neonates



The UUA/Cr ratio was found to have a high diagnostic accuracy in predicting perinatal asphyxia, according to the ROC curve analysis. With an AUC of 0.976, the UUA/UC ratio demonstrated an exceptionally strong capacity to differentiate between infants that were asphyxiated and those that were not.

Table 5: Sensitivity, Specificity, PPV, and NPV of Various Cut-off Values of Uric Acid / Creatinine Ratio for Detecting Perinatal Asphyxia

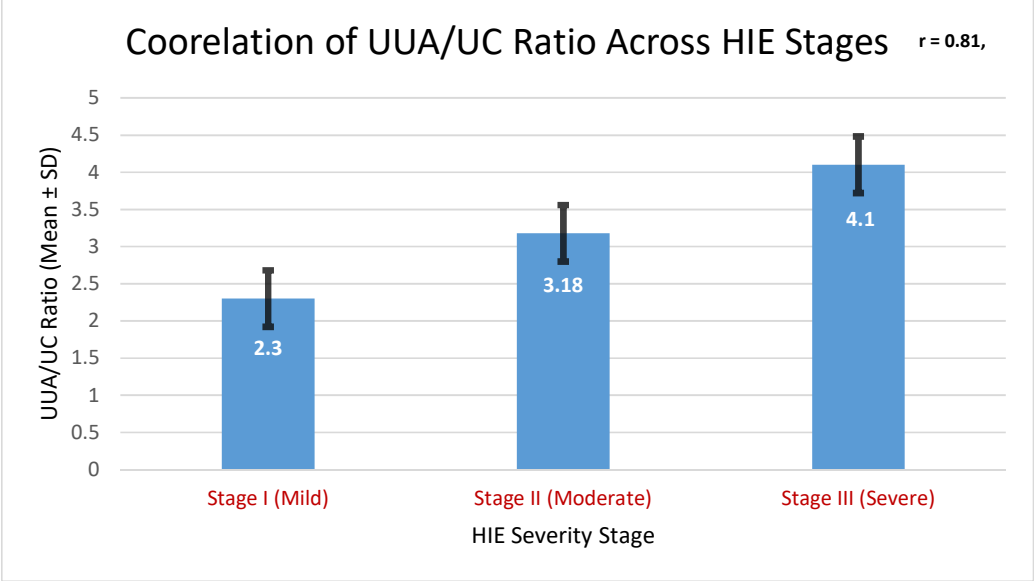
UUA/Cr Ratio Cut-off	Asphyxia Yes (n = 30)		Asphyxia No (n = 30)		Sensitivity	Specificity	PPV (%)	NPV (%)
	TP	FN	FP	TN				
1.00	30	0	10	20	1.000	0.667	75.0	100.0
1.20	29	1	6	24	0.967	0.800	82.9	96.0
1.50	28	2	4	26	0.933	0.867	87.5	92.9
1.80	26	4	2	28	0.867	0.933	92.9	87.5
2.00	25	5	1	29	0.833	0.967	96.2	85.3
2.20	23	7	0	30	0.767	1.000	100.0	81.1

The diagnostic performance of different UUA/Cr ratio cut-off values is shown in Table. A cut-off of 1.80 provided the best balance between sensitivity (86.7%) and specificity (93.3%) for detecting perinatal asphyxia

Table 6: Correlation of UUA/UC Ratio with HIE Severity

HIE Stage	Number of Cases (n)	UUA/UC Ratio (Mean ± SD)	Correlation coefficient (r)	p value
Stage I (Mild)	19	2.30 ± 0.32	0.81	<0.001#
Stage II (Moderate)	8	3.18 ± 0.41		
Stage III (Severe)	3	4.10 ± 0.38		
Total	30	2.72 ± 0.67		

Figure 4: Correlation of UUA/UC Ratio with HIE Severity



As hypoxic ischemic encephalopathy became more severe, the mean UUA/Cr ratio rose steadily. In Stage I, the averageUUA/UC ratio was 2.30 ± 0.32, in Stage II, it was 3.18 ± 0.41, and in Stage III, it was 4.10 ± 0.38. A robust positive link between the UUA/UC ratio and HIE stage was revealed by the correlation analysis ($r = 0.81$, $p < 0.001$).

DISCUSSION

Newborns suffer greatly from perinatal asphyxia, which is a leading cause of neonatal death and illness globally. The management of early diagnosis is greatly hindered by the absence of easy, dependable, and cost-effective diagnostic instruments, which is a major obstacle to prompt intervention. Arterial blood gas analysis and other helpful investigations for hypoxia assessment are not always accessible or affordable in primary and secondary healthcare settings that receive a high volume of patients. Because of this restriction, there is an urgent need for inexpensive and readily available biomarkers to help with early identification and direct clinical decision-making, especially in areas with low resources. In the present study, Stage I HIE constituted 19 (63.3%), Stage II 8 (26.7%), and Stage III 3 (10%), indicating a predominance of mild encephalopathy. Prempunpong et al,[13] in the PRIME study, reported that mild encephalopathy formed an important proportion of NICU-managed cases, which is in concurrence with the present study, where mild HIE predominated. Babbo et al.[3] also emphasized that improved neonatal care and early recognition have increased identification of the milder spectrum of neonatal encephalopathy, which is in concurrence with the present findings.

In the present study, males constituted 16 (51.6%) and females 14 (48.3%), with no statistically significant association ($p = 0.796$). Sunny et al.,[14] in a multicenter study, identified male sex as a predictor of birth asphyxia, which is in non-concurrence with the present study. Hill et al.[15] also reported increased biological vulnerability of male neonates to hypoxic–ischemic brain injury, which is in non-concurrence with the present clinical findings. The absence of significant gender association in the present study may be related to the smaller sample size and the hospital-based study design.

In the present study, early-term neonates showed a higher proportion of perinatal asphyxia (72.2%) compared with full-term and late-term neonates, though the association was not statistically significant ($p = 0.062$). Delnord and Zeitlin,[16] reported that early-term birth is associated with higher neonatal morbidity because of relative physiological immaturity, which is in concurrence with the present findings. Sunny et al.[14] identified increased risk in post-term neonates, which is in non-concurrence with the present trend. These differences may be due to differences in obstetric profile and sample distribution.

In the present study, higher proportions were observed in lower socioeconomic classes, though not statistically significant ($p = 0.228$). Blume et al[17] demonstrated an association between disadvantaged socioeconomic status and neonatal encephalopathy, which is in concurrence with the present findings. Kukka et al[18] also highlighted the greater burden of neonatal encephalopathy in low-resource settings, which is in concurrence. However, the lack of statistical significance in the present study suggests that socioeconomic status may act indirectly through healthcare access, maternal nutrition, and quality of intrapartum care rather than as an isolated determinant.

In the present study, higher proportions were observed in emergency LSCS and assisted delivery, though not statistically significant ($p = 0.058$). Graham et al.[19] emphasized that intrapartum hypoxia-ischemia and neonatal encephalopathy are multifactorial and that operative delivery often reflects preceding fetal compromise rather than being a direct cause, which is in concurrence with the present findings. Delnord and

Zeitlin.[16] also found assisted delivery to be associated with birth asphyxia, which is in partial concurrence. Therefore, mode of delivery is better interpreted as an indicator of intrapartum distress than as an independent causal factor.

In the present study, urinary uric acid levels were significantly higher in asphyxiated neonates (4.65 ± 1.42 vs 1.72 ± 1.21 mg/dL, $p < 0.001$). Rainaldi and Perlman,[20] explained that hypoxia causes ATP depletion and accelerated purine degradation, resulting in increased uric acid production, which is in concurrence with the present findings. Bader et al[21] demonstrated that urinary uric acid-related indices are elevated in asphyxiated neonates, which is in concurrence. These findings indicate that urinary uric acid reflects the early biochemical response to hypoxic–ischemic injury and supports its role as a useful supportive marker.

In the present study, the UUA/Cr ratio was significantly elevated in asphyxiated neonates (2.71 ± 0.67 vs 0.88 ± 0.06, $p < 0.001$). Bader et al[21] first demonstrated that the UUA/Cr ratio is significantly higher in neonates with perinatal asphyxia and correlates with severity, which is in concurrence. Akisü and Kültürsay,[22] also found that the ratio is useful both for identifying perinatal asphyxia and for reflecting the severity of hypoxic–ischemic encephalopathy, which is in concurrence. The UUA/Cr ratio is more informative than uric acid alone because it corrects for urine concentration and hydration-related variability. Therefore, it provides a more standardized biochemical reflection of tissue hypoxia and reperfusion injury. Its consistent elevation across studies strengthens its clinical utility as an early adjunctive diagnostic marker.

In the present study, the UUA/Cr ratio showed excellent diagnostic performance, with an AUC of 0.976, sensitivity of 86.7%, and specificity of 93.3%. Bellos et al,[23] in a meta-analysis, concluded that UUA/Cr ratio is a rapid and easily detectable biomarker that may help identify neonates at risk of perinatal asphyxia and hypoxic–ischemic encephalopathy, which is in concurrence. Patel et al.[24] also supported its utility as a simple and useful non-invasive marker, which is in concurrence. These findings demonstrate that the UUA/Cr ratio has excellent discriminative ability and may serve as a reliable, low-cost, and non-invasive diagnostic biomarker in perinatal asphyxia.

In the present study, the UUA/Cr ratio increased progressively with severity and showed a strong positive correlation ($r = 0.81$, $p < 0.001$). Bader et al[21] documented that the UUA/Cr ratio rises with increasing severity of asphyxia, which is in concurrence. Akisü and Kültürsay,[22] also demonstrated that the ratio increases with worsening hypoxic–ischemic encephalopathy, which is in concurrence. Tekgül et al.[25] reported that uric acid-related biochemical indices have prognostic relevance and are associated with severity and short-term outcome, which is in concurrence. The progressive increase in UUA/Cr ratio with advancing HIE stage suggests that it reflects the magnitude of hypoxic injury and metabolic derangement. Thus, it may serve not only as a diagnostic biomarker but also as a useful prognostic indicator for assessing disease severity.

CONCLUSION

Current evidence concludes that UUA/Cr is a simple, non-invasive biochemical indicator that may help identify newborns who have had prenatal hypoxia. The ratio is useful for early detection of hypoxic damage, as it was shown to be considerably greater in newborns with asphyxia than in non-asphyxiated controls. A strong positive correlation was also observed among the UUA/Cr ratio and the severity of hypoxic–ischaemic encephalopathy, showing that the biomarker may serve not only as a diagnostic aid but also as an indicator of disease severity. The excellent diagnostic accuracy demonstrated by ROC analysis further supports its reliability in distinguishing affected neonates from healthy newborns. A practical and economical alternative to sophisticated diagnostic studies, the UUA/Cr ratio offers a practical and affordable alternative that can support early clinical decision-making. Thus, this study highlights its potential role as an adjunctive tool in the diagnosis and severity assessment of perinatal asphyxia, particularly in resource-limited neonatal care settings. Validating these findings and strengthening their use in routine clinical practice requires additional large-scale, multicenter investigations.

Funding

This study received no external funding.

Conflict of Interest

None

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