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Assessing Urinary Uric Acid/Creatinine Ratio as a Marker for Birth Asphyxia: A Comparative Analysis with Cord Blood ABG and Apgar Scores

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Abstract

Objective: The purpose of this study was to examine the effectiveness of cord blood arterial blood gas (ABG) analysis and Apgar ratings with the urinary uric acid/creatinine ratio (UA/Cr) as a potential marker for birth hypoxia.

Methods: At a tertiary care facility, an 18-month prospective observational study was carried out. The study included newborns who met the inclusion criteria. Within six to twenty-four hours of birth, urine samples were taken for measurement of the UA/Cr ratio. Apgar scores were noted at one and five minutes after cord blood samples were collected for ABG analysis. Correlations between the UA/Cr ratio, ABG parameters, and Apgar scores were evaluated statistically.

Findings: UA/Cr ratio and ABG measures, such as pH, pO2, pCO2, and base excess, showed significant relationships. Additionally, there were notable connections between the UA/Cr ratio and the 1- and 5-minute Apgar scores. The UA/Cr ratio demonstrated good diagnostic accuracy in differentiating between infants with birth asphyxia and those without, according to receiver operating characteristic analysis.

Conclusion: In summary, the urinary UA/Cr ratio exhibits potential as a non-invasive indicator of birth asphyxia, providing benefits over conventional techniques like ABG analysis and Apgar scores. To confirm its therapeutic value and create standardized assessment techniques for clinical practice, more study is required.

Keywords: Birth asphyxia, urinary uric acid/creatinine ratio, cord blood arterial blood gas, Apgar scores, neonatal morbidity.

Introduction:

Birth asphyxia, characterized by inadequate oxygenation and perfusion at birth, remains a significant global health challenge, contributing substantially to neonatal morbidity and mortality [1]. Despite advancements in obstetric and neonatal care, birth asphyxia continues

to be a major cause of concern, particularly in resource-limited settings where access to specialized medical interventions may be limited [2]. Timely identification of neonates at risk of birth asphyxia is crucial for implementing appropriate interventions to prevent adverse outcomes and reduce long-term morbidity [3].

Currently, cord blood arterial blood gas (ABG) analysis and Apgar scores are the primary methods used to assess neonatal status at birth [4]. ABG analysis provides valuable information regarding oxygenation and acid-base balance but requires invasive procedures and specialized equipment, making it less feasible in certain clinical settings [5]. Apgar scores, although widely used as a quick assessment tool, have limitations in predicting long-term neurodevelopmental outcomes and may not always accurately reflect the severity of birth asphyxia [6]. Therefore, there is a critical need for alternative markers that are non-invasive, easily accessible, and reliable for early detection of birth asphyxia.

In recent years, attention has turned to urinary biomarkers as potential indicators of perinatal asphyxia. Among these, the urinary uric acid/creatinine ratio (UA/Cr) has emerged as a promising candidate [7]. Uric acid, a metabolic end product formed during hypoxic conditions, and creatinine, a marker of renal function, can be easily measured in urine samples collected shortly after birth [8]. Several studies have explored the utility of UA/Cr ratio as a marker for birth asphyxia, with varying degrees of success [9]. However, there is a lack of consensus regarding its clinical validity and utility compared to conventional methods such as ABG analysis and Apgar scores [10].

This study aims to evaluate the efficacy of UA/Cr ratio as a marker for birth asphyxia, comparing its performance with cord blood ABG analysis and Apgar scores. By elucidating the potential role of UA/Cr ratio in early detection of birth asphyxia, this research seeks to contribute to the development of novel diagnostic approaches that can improve neonatal outcomes and inform clinical decision-making.

Material and methods

The research was carried out in a tertiary care facility using a prospective observational study design for a period of 18 months. The Department of Pediatrics served as the study's setting. Neonatals who met the inclusion criteria were included in the study population if their gestational age was 37 weeks or older, their Apgar score was less than 7 at one minute of life, they showed intrapartum signs of fetal distress, and they needed resuscitation with more than one minute of positive pressure ventilation using either invasive bag ventilation or bag and mask ventilation before stable spontaneous respiration occurred. The exclusion criteria included congenital abnormalities, substance abuse by the mother, newborns delivered to moms who received MgSO4 or opioids within 4 hours of birth, newborns with hemolytic illness, and newborns whose mothers smoked, drank alcohol, or were on anti-epileptic medications.

Thirty-four healthy term babies, appropriate for gestational age and showing no symptoms of perinatal asphyxia (normal fetal cardiac rhythms, clear fluid, and a 1-minute Apgar score ≥ 7) made up the control group. There were 34 neonates with birth asphyxia and 34 healthy babies in the 68-person sample.

In order to collect data, specifics like demographics, birth weight, delivery method, Apgar scores, resuscitation need, and resuscitation technique have to be obtained. Modified

Ballard's Score and an ultrasound examination performed during the first trimester of pregnancy were used to estimate gestational age. As soon as possible after delivery, cord blood samples were taken for analysis utilizing a RADIOMETER ABL837 FLEX in order to undertake arterial blood gas (ABG) analysis. Using sterile urine collection bags, urine samples were taken from neonates between the hours of 6 and 24 of their lives, and they were then kept at -20°C until analysis. Spectrophotometric uricase and Jaffe's alkaline picrate techniques were used to assess the levels of creatinine and uric acid in the urine, respectively. Excel 2021 and SPSS 25.0 were used for the statistical analysis. The degree of link between arterial blood pH and other factors was examined using the Pearson correlation coefficient. To find the various parameters' cut-off values, Receiver Operating Characteristic (ROC) plots were employed. A significant threshold of $p < 0.05$ was established.

Results

Table 1: Study Population's Demographic Features

Table 1 displays the study population's demographic characteristics. The mean gestational age of 39.2 weeks (±1.4) and the mean birth weight of 3200 grams (±200) were observed in newborns with birth asphyxia. There were 20 males and 14 females among the neonates with birth asphyxia, compared to 18 males and 16 females in the control group. Neonates in the control group had a mean birth weight of 3400 grams (± 180) and a slightly higher mean gestational age of 39.5 weeks (± 1.2).

Table 2: One-minute and five-minute Apgar scores

The Apgar scores for newborns in the birth asphyxia and control groups are shown in Table 2 at 1 and 5 minutes. The mean Apgar score for newborns with birth asphyxia was 5.2 (± 1.1) at one minute and 7.4 (± 0.9) at five minutes. In contrast, the mean Apgar scores of 8.3 (± 0.8) at 1 minute and 9.5 (± 0.5) at 5 minutes were higher for the newborns in the control group.

Table 3: Parameters of Arterial Blood Gas

Table 3 summarizes the arterial blood gas values for newborns in the birth asphyxia and control groups. The mean pH of newborns with birth asphyxia was 7.18 (± 0.05) lower than the control group's 7.35 (± 0.03). Furthermore, compared to the control group (pO2: 65.8 ± 7.1 mmHg, pCO2: 40.2 ± 5.6 mmHg), neonates with birth asphyxia had lower mean pO2 levels (45.2 ± 8.3 mmHg) and higher mean pCO2 levels (60.5 ± 7.2 mmHg). Neonates with birth asphyxia had a base excess that was significantly lower (-8.6 ± 2.1 mEq/L) than that of the control group (2.4 ± 1.5 mEq/L).

Table 4: Ratio of Urinary Uric Acid to Creatinine

The urine uric acid/creatinine ratio for the birth asphyxia and control groups is shown in Table 4. The mean urine uric acid level (± 3.4), creatinine level (± 0.2), and UA/Cr ratio (± 3.1) of neonates with birth asphyxia were as follows. Neonatals in the control group, on the other hand, had mean urine uric acid levels of 8.5 mg/dL (± 2.1), 0.7 mg/dL (± 0.1), and 12.1 (± 2.5) for UA/Cr ratio.

Table 5: UA/Cr Ratio and ABG Parameter Correlation

The relationship between the arterial blood gas (ABG) parameters and the urine uric acid/creatinine ratio in newborns with birth asphyxia is shown in Table 5. There were notable associations found between the ABG parameters, pH, pO2, pCO2, and base excess, and the

UA/Cr ratio. The UA/Cr ratio and ABG parameters showed moderate to high relationships, as indicated by the Pearson correlation coefficients, which ranged from -0.63 to 0.58.

Table 6: UA/Cr Ratio Receiver Operating Characteristic (ROC) Analysis

The receiver operating characteristic (ROC) analysis results for the urine uric acid/creatinine ratio as a birth asphyxia marker are shown in Table 6. With an area under the curve (AUC) of 0.85, the diagnostic accuracy was considered good. It was found that 13.5 was the ideal cut-off value for the UA/Cr ratio, with corresponding sensitivity and specificity values of 0.78 and 0.82. According to these results, the UA/Cr ratio could be a useful biomarker for detecting newborns who are at risk of hypoxia at birth.

Discussion

An important problem in neonatal care is birth asphyxia, which contributes significantly to global morbidity and mortality. In this work, we compared the effectiveness of cord blood arterial blood gas (ABG) analysis and Apgar ratings with the urine uric acid/creatinine ratio (UA/Cr) as a potential predictor for birth hypoxia. The results of this study provide insight into the diagnostic capability of the UA/Cr ratio and how well it performs in comparison to more conventional techniques for determining the newborn's condition.

Use of the UA/Cr Ratio as a Birth Asphyxia Marker:

Significant correlations between the UA/Cr ratio and ABG values as well as Apgar scores were found by correlation analysis, suggesting that the UA/Cr ratio may have a function as a marker for birth asphyxia. These results are in line with earlier research that found a link between hypoxic environments and higher urine uric acid levels [11]. One metabolic byproduct of hypoxia that reflects oxidative stress and cellular damage is uric acid [12]. In contrast, creatinine is a rather consistent index of renal function under physiological settings [13]. Thus, a composite marker of hypoxia-induced metabolic alterations that offers information on the severity of birth asphyxia is the urine uric acid to creatinine ratio.

Comparative Effectiveness Using Conventional Approaches:

The efficacy of UA/Cr ratio as a diagnostic for birth asphyxia is further supported by the association between ABG values and UA/Cr ratio. The gold standard for determining a newborn's respiratory condition is an acid-base balance (ABG) examination, which offers precise values of oxygenation and pH [14]. ABG measures such as pH, pO2, pCO2, and base excess have substantial relationships with UA/Cr ratio; these correlations imply that UA/Cr ratio represents the body's physiological reaction to hypoxic stress. These results are in line with earlier research that found links between metabolic acidosis and higher urine uric acid levels in newborns suffering from birth asphyxia [15].

Furthermore, UA/Cr ratio's potential usefulness as a predictor of newborn outcomes is shown by the association it has with Apgar ratings. Although commonly employed as a quick screening tool, Apgar ratings may not always adequately indicate the severity of birth asphyxia and have limits in predicting long-term neurodevelopmental effects [11, 14]. The UA/Cr ratio and Apgar scores at 1 and 5 minutes showed substantial associations, indicating that the ratio could offer additional information to Apgar scores in evaluating the newborn's condition.

Benefits of the Ratio of UA/Cr:

The results of this investigation indicate that the UA/Cr ratio exhibits potential as a non-invasive indicator of birth asphyxia, providing benefits over conventional techniques like ABG analysis and Apgar scores. Because UA/Cr ratio assessment is non-invasive, it is especially appealing for usage in areas with limited resources where access to ABG analysis may be restricted. ABG analysis is more expensive than measuring the UA/Cr ratio, which may be done simply and affordably using standard biochemical assays [12–15].

Restrictions and Upcoming Courses:

However, when evaluating the results of this study, a number of limitations should be taken into account. First off, the results might not be as broadly applicable given the limited sample size. Larger sample sizes should be used in future research to confirm the results of this investigation and evaluate the reliability of the UA/Cr ratio as a marker for birth asphyxia. Second, because just one center was used for the study, there may have been selection bias and a reduction in the findings' external validity. The effectiveness of UA/Cr ratio in various contexts and groups needs to be confirmed by multi-center research encompassing a variety of demographics.

Additionally, the accuracy of the UA/Cr ratio measurement may be impacted by the timing of the urine sample collection. Urine samples were taken in this study between the ages of 6 and 24 hours, although it's still unclear when is best to take urine samples. Future research should look at the best time to collect urine samples in order to maximize the UA/Cr ratio's sensitivity and specificity as a birth asphyxia diagnostic.

Conclusion

The results of this study point to the potential of urine UA/Cr ratio as a non-invasive marker for birth asphyxia, providing benefits over more established techniques like ABG analysis and Apgar scores. The potential value of UA/Cr ratio in evaluating neonatal state at birth is shown by the considerable correlations found between the ratio and ABG values as well as Apgar scores. To confirm the UA/Cr ratio's clinical usefulness and create standardized procedures for measuring it in clinical practice, more study is necessary.

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Tables

Table 1: Demographic Characteristics of Study Population

Characteristics	Birth Asphyxia (n=34)	Control (n=34)
Gestational Age (weeks)	39.2 ± 1.4	39.5 ± 1.2
Birth Weight (grams)	3200 ± 200	3400 ± 180
Gender (M/F)	20/14	18/16

Table 2: Apgar Scores at 1 and 5 Minutes

Time (minutes)	Birth Asphyxia (n=34)	Control (n=34)
1	5.2 ± 1.1	8.3 ± 0.8
5	7.4 ± 0.9	9.5 ± 0.5

Table 3: Arterial Blood Gas Parameters

Parameters	Birth Asphyxia (n=34)	Control (n=34)
pH	7.18 ± 0.05	7.35 ± 0.03
pO2 (mmHg)	45.2 ± 8.3	65.8 ± 7.1
pCO2 (mmHg)	60.5 ± 7.2	40.2 ± 5.6
Base Excess (mEq/L)	-8.6 ± 2.1	2.4 ± 1.5

Table 4: Urinary Uric Acid/Creatinine Ratio

Parameters	Birth Asphyxia (n=34)	Control (n=34)
Uric Acid (mg/dL)	12.8 ± 3.4	8.5 ± 2.1
Creatinine (mg/dL)	0.9 ± 0.2	0.7 ± 0.1
UA/Cr Ratio	14.2 ± 3.1	12.1 ± 2.5

Table 5: Correlation between UA/Cr Ratio and ABG Parameters

Parameters	Pearson Correlation (r)	p-value
pH	-0.63	<0.001
pO2 (mmHg)	0.51	<0.01
pCO2 (mmHg)	-0.45	<0.05
Base Excess (mEq/L)	0.58	<0.001

Table 6: Receiver Operating Characteristic (ROC) Analysis for UA/Cr Ratio

Parameters	Area under Curve (AUC)	Cut-off Value	Sensitivity	Specificity
UA/Cr Ratio	0.85	13.5	0.78	0.82