The Correlation of Cord Arterial Blood Gas Analysis Results and Apgar Scores in Term Infants Without Fetal Distress

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INTRODUCTION

The Apgar score is a simple, reproducible scoring system developed by Virginia Apgar in 1952 to evaluate the postnatal condition of the newborn. This scoring is used to quickly assess the clinical condition of the newborn at 1- and 5-minute after birth. The Apgar score is obtained by evaluating 5 parameters (skin color, heart rate, reflexes, muscle tone, and respiratory activity). Especially, a 5-minute Apgar score below 7 indicates an increased risk of neonatal asphyxia. Apgar score of ≥7 in 1.9% and 2% of cases, respectively.

Conclusion: The 5-minute Apgar score of 7 or higher may not be sufficient to verify the well-being of a newborn. Relying only on the Apgar score may create the risk of missing some newborns with mild metabolic acidosis. The necessity of routine cord arterial blood gas analysis should be considered in prospective studies even if there are no signs of fetal distress and Apgar score ≥7.

Keywords: Apgar score, cord arterial blood gas, newborn, term infant

ABSTRACT

Objective: This study aimed to evaluate the necessity of cord arterial blood gas analysis in cases without fetal distress and normal Apgar score.

Materials and Methods: The cord arterial blood gas analysis and the 1- and 5-minute Apgar scores data of 1438 cases were evaluated. Newborns with fetal distress, neonates requiring cardiopulmonary resuscitation in the delivery room, congenital anomalies, severe and moderate acidemia (pH ≤7.1 at cord arterial blood gas analysis), and pre- and post-term newborns are excluded. Following cord arterial blood gas analysis, threshold values were accepted as abnormal pH <7.2, base excess ≥-6 mmol/L, lactate ≥5 mmol/L, bicarbonate <18 mmol/L, and partial pressure of carbon dioxide ≥50 mmHg. We evaluated the correlation between cord arterial blood gas analysis and 1- and 5-minute Apgar scores.

Results: There was a significant correlation between both 1- and 5-minute Apgar scores and cord arterial blood gas analysis values such as pH, lactate, and partial pressure of carbon dioxide (P < .001). In addition, a significant correlation was found between the 5-minute Apgar score of <7 and some cord arterial blood gas analysis abnormal threshold values (pH, bicarbonate, base excess) (P < .001). We found that some patients with mild acidemia had 1- and 5-minute Apgar scores of ≥7 in 1.9% and 2% of cases, respectively.

Conclusion: The 5-minute Apgar score of 7 or higher may not be sufficient to verify the well-being of a newborn. Relying only on the Apgar score may create the risk of missing some newborns with mild metabolic acidosis. The necessity of routine cord arterial blood gas analysis should be considered in prospective studies even if there are no signs of fetal distress and Apgar score ≥7.

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INTRODUCTION

The Apgar score is a simple, reproducible scoring system developed by Virginia Apgar in 1952 to evaluate the postnatal condition of the newborn. This scoring is used to quickly assess the clinical condition of the newborn at 1- and 5-minute after birth. The Apgar score is obtained by evaluating 5 parameters (skin color, heart rate, reflexes, muscle tone, and respiratory activity). Especially, a 5-minute Apgar score below 7 indicates an increased risk of neonatal asphyxia. This scoring system may be affected by prematurity, congenital anomalies, maternal drug use, and interobserver variability. However, recent literature shows that the Apgar score is effective in predicting neonatal well-being as it has been
Cord blood gases were taken into heparinized injection no: 162202. Ethics approval was obtained from Ethics Committee (reference no: 162202).

Apgar score data of 1438 cases were evaluated (Table 1). Finally, the cord ABGA and the 1- and 5-minute Apgar scores were calculated by pediatric senior residents and midwives, all certified in the neonatal resuscitation program. In this study, a 5-minute Apgar score between 7 and 10 had been determined as a safe range in terms of neonatal encephalopathy and long-term neurological outcomes. Therefore, in this study, an Apgar score between 7 and 10 was considered normal and <7 as low.

Cord ABGA threshold values indicating perinatal asphyxia had been reported as pH < 7.0 and BE ≥ −12 in some meta-analyses. In this study, threshold values set for severe, moderate, and mild acidemia in cord ABGA were accepted as pH ≤ 7.0 and pH between 7.0 and 7.1, and pH between 7.1 and 7.2, respectively. Cases with a pH value above 7.1 in cord ABGA were included in the study. Abnormal cord ABGA threshold values were accepted as pH < 7.2, BE > −6 mmol/L, lactate ≥ 5 mmol/L, bicarbonate (HCO3) < 18 mmol/L, and partial pressure of carbon dioxide (pCO2) ≥ 50 mmHg according to the previous studies.

In this study, we first evaluated the correlation between 1- and 5-minute Apgar scores and cord ABGA. Subsequently, we studied the correlation between low 1- and 5-minute Apgar scores of <7 and abnormal threshold values of cord ABGA parameters.

Statistical Analysis
Statistical Package for the Statistical Package for Social Sciences version 21.0 software (IBM Corp.; Armonk, NY, USA) was used for statistical analysis. Continuous variables (Apgar score, pH, lactate, HCO3, pCO2, BE) were presented as median (min-max) and as mean ± standard deviation data of all cases were as follows: 1-minute Apgar score was 7.65 ± 1.05, 5-minute Apgar score was 8.88 ± 0.73, pH was 7.34 ± 0.056, lactate (mmol/L) was 2.37 ± 1.68, HCO3 (mmHg) was 21.82 ± 2.13, pCO2 (mmHg) was 44.27 ± 7.97, and BE (mEq/L) was −2.33 ± 2.59.

When the association between Apgar scores (1- and 5-minute) and cord ABGA parameters (pH, lactate, BE, HCO3,
pCO₂ was evaluated, a significant correlation was found between pH, lactate, pCO₂, and Apgar scores (1- and 5-minute) (P < .001). This correlation ratio was very weak (r = 0.01-0.19), with 1-minute Apgar score and cord ABGA correlation ratio being highest with lactate (r = 0.119) and lowest with pH (r = 0.092), and 5-minute Apgar score and cord ABGA correlation ratio was highest with pCO₂ (r = 0.118) and lowest with pH (r = 0.095). There was no significant correlation between HCO₃, BE, and Apgar scores (Table 1).

No association was found between any abnormal threshold values of cord ABGA (pH, lactate, BE, HCO₃, pCO₂) and a 1-minute Apgar score of <7 (Table 2).

A statistically significant correlation was detected between a 5-minute Apgar score of <7 and pH, HCO₃, and BE abnormal threshold values (P < .001). This correlation ratio was very weak (r: 0.01-0.19), the correlation ratio was highest with pH (r: 0.130) and slightest with HCO₃ (r: 0.072). There was no significant correlation between lactate and pCO₂ abnormal threshold values and a 5-minute Apgar score (Table 3). In the evaluation of cord ABGA in patients with 5-minute Apgar score of ≥7, in 92 cases, the lactate value was ≥5 mmol/L; in 28 cases,
pH value was <7.2; in 75 cases, HCO3 value was <18 mmol/L; and in 116 cases, BE value was <−6 mEq/L (Table 3). Metabolic acidosis and lactic acidemia were not detected in patients whose first cord ABGA showed mild acidemia and lactic acidemia before discharge, and there were no pathological findings related to their physical examination and nutrition.

**DISCUSSION**

This study evaluated the association between Apgar scores and cord ABGA in term newborns who were not known to have fetal distress at the prenatal period. We found a correlation between cord ABGA parameters (pH, lactate, and pCO₂) and Apgar score both at 1- and 5-minute. An association was also found between a low 5-minute Apgar score of <7 and pH, HCO3, and BE abnormal threshold values. It has been shown that pH is the most important parameter to show the acidemia status in cord blood gas and it is a result of the balance between lactate and BE from other parameters.5,6 Similarly, our results showed that pH, one of the cord ABGA parameters, is important to demonstrate mild acidemia. While the 1-minute Apgar score does not provide much information about the newborn’s long and short-term outcomes, the 5-minute Apgar score is more valuable. It has been reported that any 1-minute Apgar score between 0 and 3 does not predict the outcome of the newborn.7,8 However, a low 5-minute Apgar score indicates an increased relative risk of cerebral palsy, which is reported to be 20-100 times higher than that of infants with a 5-minute Apgar score of 7-10.9,10 The relevant literature also reports a correlation between a low 5-minute Apgar score and neonatal hypoxia and mortality.11,12 Currently, pH and BE values in cord ABGA are considered to determine newborns who have experienced antenatal hypoxia requiring hypothermia to prevent the poor outcome.13 Similarly, in our study, it was observed that abnormal cord ABGA values of pH, HCO3, and BE were associated with a low 5-minute Apgar score (Table 3).

One of the crucial findings of this study is the presence of cases with normal Apgar scores but abnormal cord ABGA parameters. A recent large-scale study by Sabol et al.14 showed abnormal results in cord ABGA of newborns with normal Apgar scores. In this study, 6.6% of cases had an increased lactate level (>5 mmol/L), and 5.4% had decreased HCO3 even with a normal 1-minute Apgar score. About 2% of the newborns were mild acidic (pH between 7.1 and 7.2), and 6.4% had increased lactate levels with a normal 5-minute Apgar score. In cord ABGA, pH < 7.0 and base deficit ≥ −12 values are generally accepted cut-off values that increase the risk of pathological acidosis, seizures, neonatal encephalopathy, and cerebral palsy.15,16 If the pH value is higher than 7.2 in cord ABGA, the risk of neonatal encephalopathy is negligible. However, the risk of encephalopathy continues in newborns with a pH below 7.2.17-23 In a prospective study by Mousa et al.,24 when the short-term results of cases with pH above and below 7.2 in cord ABGA were examined, it was found that resuscitation, convulsions, hypoxic encephalopathy, hospitalization, and hospital stay were longer in cases with cord ABGA pH below 7.2. High lactate values are closely associated with metabolic acidosis, mortality, and morbidity and can be used as a predictive marker of end tissue oxygenation.25,26 It has been reported in previous studies that a high lactate value can be regarded as a poor prognostic factor, but a definite cut-off value has not been accepted.27-29 For these reasons, it would be reasonable to detect and closely follow up newborns with the stable postnatal clinic and normal Apgar scores but abnormal cord ABGA. We planned another study to evaluate the neurological development of patients with normal Apgar scores but high lactate levels in their cord ABGA.

Our study found the mean pH value in term newborns without any fetal distress to be 7.34 ± 0.056. Previous studies found the pH of cord ABGA in uncomplicated deliveries between 7.24 and 7.27.30-32 In addition, in a comprehensive study conducted by

| Table 2. The Relationship Between the Threshold Values of Cord Artery Blood Gas Analysis and the 1-Minute Apgar Score |
|---------------------------------------------------------------|
| **Measurement** | **Threshold** | **Apgar Score <7** | **Apgar Score ≥7** | **a** | **P** |
|-----------------|---------------|-------------------|-------------------|------|------|
| pH              | <7.2          | 6 (3.8)           | 24 (1.9)          | 0.042| .114 |
|                 | ≥7.2          | 153 (96.2)        | 1255 (98.1)       |      |      |
| Lactate (mmol/L)| <5            | 150 (94.3)        | 1195 (93.4)       | 0.012| .661 |
|                 | ≥5            | 9 (5.7)           | 84 (6.6)          |      |      |
| HCO3 (mmol/L)   | <18           | 8 (5.0)           | 69 (5.4)          | −0.005| .846 |
|                 | ≥18           | 181 (95.0)        | 1210 (94.6)       |      |      |
| pCO2 (mmHg)     | <50           | 118 (74.2)        | 1001 (78.3)       | −0.031| .246 |
|                 | ≥50           | 41 (25.8)         | 278 (21.7)        |      |      |
| BE (mEq/L)      | <−6           | 17 (10.7)         | 102 (8.0)         | 0.031| .241 |
|                 | ≥−6           | 142 (89.3)        | 1177 (92.0)       |      |      |
| **Measurement** | **Threshold** | **Apgar Score <7** | **Apgar Score ≥7** | **a** | **P** |
|-----------------|---------------|-------------------|-------------------|------|------|
| pH              | <7.2          | 2 (28.6)          | 28 (2.0)          | 0.130| <.001|
|                 | ≥7.2          | 5 (71.4)          | 1403 (98.0)       |      |      |
| Lactate (mmol/L)| <5            | 6 (85.7)          | 1339 (93.6)       | −0.022| .399 |
|                 | ≥5            | 1 (14.3)          | 92 (6.4)          |      |      |
| HCO3 (mmol/L)   | <18           | 2 (28.6)          | 75 (5.2)          | 0.072| .006 |
|                 | ≥18           | 5 (71.4)          | 1356 (94.8)       |      |      |
| pCO2 (mmHg)     | <50           | 4 (57.1)          | 1115 (77.9)       | −0.035| .187 |
|                 | ≥50           | 3 (42.9)          | 316 (22.1)        |      |      |
| BE (mEq/L)      | <−6           | 3 (42.9)          | 116 (8.1)         | 0.088| .001 |
|                 | ≥−6           | 4 (57.1)          | 1315 (91.9)       |      |      |

Data are given as number (%); Phi correlation: α = 0.01-0.19, very weak relationship; α = 0.20-0.29, weak relationship; α = 0.30-0.39, medium relationship; α = 0.40-0.69, strong relationship; α = ≥0.70, very strong relationship. HCO3, bicarbonate; pCO2, partial pressure of carbon dioxide; BE, base excess.
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