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Assessment of Umbilical Cord pH and APGAR Scores in Neonates Delivered by Cesarean Section Due to Fetal Distress

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ABSTRACT

Background and Objective: The APGAR score is commonly used to assess neonates for fetal distress and asphyxia, but a low score doesn't always mean fetal asphyxia has occurred. The non-stress test (NST) is another method used to monitor fetal health and decide when to end a pregnancy in emergencies, though it can sometimes inaccurately suggest hypoxia, leading to unnecessary cesarean sections. The aim of this study was to evaluate the umbilical cord PH and APGAR scores of neonates delivered by cesarean section due to fetal distress indicated by the NST.

Methods: In this analytical cross-sectional study, all 139 neonates with an impaired NST were enrolled in 2018. In addition to information such as 1st and 5th minute APGAR scores and umbilical cord pH, the demographic data of mothers and neonates were gathered.

Findings: In total, 252 impaired NST patterns were found in all studied neonates. Bradycardia and late decelerations had a significant relationship with acidosis. Moreover, late decelerations were associated with lower APGAR scores. Umbilical artery pH was significantly correlated with 1st-minute (r=0.34; P=0.001) and 5th-minute APGAR scores (r=0.32; P=0.001). Positive predictive value of NST was 48.9%.

Conclusion: The results showed that NST had a moderate positive predictive value for the diagnosis of fetal acidosis in neonates with tachycardia or non-reactive NST. There was a significant relationship between late deceleration and arterial acidosis with first and fifth minutes APGAR score in neonates. The mean total arterial acidosis rate was significantly lower in the group with APGAR score less than 7.

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Introduction

In recent decades, the prevalence of cesarean delivery has increased significantly worldwide. According to the most recent data, the prevalence of cesarean delivery is highest in Latin America, averaging 40.5%, and lowest in African countries, averaging 7.5%. In North America, Oceania, Europe and Asia, this rate is 25, 31.1, 32.3 and 19.2%, respectively [1, 2]. However, the World Health Organization (WHO) considers a cesarean delivery rate of up to 15% to be appropriate for the best outcome for both mother and child. Delivery by cesarean section is associated with various complications for both mother and child; major maternal complications include bleeding, complications of anesthesia, suture infections, endometritis, longer hospital stay, higher mortality rate than vaginal delivery, infertility and psychological problems such as depression. On the other hand, the fetus is at risk of respiratory problems, low APGAR score and increasing neonatal death [3, 4].

The NST is affected by a variety of factors, including hypoxia and fetal metabolic changes and all show changes, including bradycardia, tachycardia, lack of variability, flattening of the fetal heart rate and fluctuations. Reactive *NST* means at least two periods of rapid heartbeat within 20 minutes lasting at least 15 seconds and at least 15 beats above baseline. Bradycardia means familial hypocalciuric hypercalcemia (FHR) less than 120 beats per minute and tachycardia means FHR greater than 160 beats per minute. Long-term variability is defined as seeing 2-3 cycles of *FHR* changes of 6-25 beats in normal in a one-minute period [5].

Late and variable deceleration of the *FHR* may be associated with fetal distress and resultant acidosis, because unlike premature decelerations, late decelerations occur due to hypoxia and variable decelerations occur due to pressure on the umbilical cord [6].

One of the most important indicators of the health status of a newborn is the APGAR score, a scientific method for basic assessment of the infant immediately after birth to help identify infants who need immediate resuscitation for hypoxic acidosis [6]. Despite the value of the APGAR score in diagnosing neonates with fetal distress and intrauterine asphyxia, a low APGAR score does not necessarily indicate fetal asphyxia. Other factors may reduce the APGAR score, such as neonatal immaturity, maternal use of narcotics, sedatives, and magnesium sulfate, congenital myopathy and neuropathy, trauma to the spinal canal, pulmonary abnormalities (diaphragmatic hernias) and central nervous system abnormalities. Moreover, the APGAR score does not predict the next cerebral palsy in newborns [7, 8].

Some studies have identified arterial blood gasses (ABG), particularly umbilical cord blood gasses, which are most closely associated with the fetal metabolic level before birth as an appropriate measure to determine fetal distress. ABG disturbances of cord blood may indicate important pathological problems. In addition, ABG disturbances reflect various factors associated with birth. For example, in some studies, neonates born by cesarean section, had lower arterial blood PH, especially in cases of spinal (epidural) anesthesia had lower arterial blood pH, indicating the occurrence of asphyxia [8].

Here, there is a need for an objective criterion for early detection of a newborn with asphyxia. The importance of fetal health and higher and non-illegal statistics of *WHO* and the need to reduce cesarean section without indication and also to evaluate the predictive value of *NST* test, especially in low risk pregnancies and the need for emergency cesarean delivery to save the fetal life and the mother and to increase the health of the baby and to improve the APGAR score of our babies. The aim of this study was to evaluate the pH and APGAR score of newborns by cesarean section due to fetal distress recorded in *NST* of pregnant women referred to Alavi Hospital in Ardabil in 2018.

Methods

In this prospective cross- sectional study, information on all 139 registered term pregnant women with cesarean delivery due to fetal distress in NST was collected from Sep 2018 to Sep 2019 at the maternity ward of Alavi Hospital in Ardabil city. First and fifth minute APGAR scores and infant umbilical cord pH were

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recorded. Inclusion criteria were NST disorders leading to cesarean section. Exclusion criteria included maternal criteria like severe pre-eclampsia - history of cesarean section – use of analgesics or magnesium sulfate by the mother - fetal factors like intrauterine growth retardation (IUGR), twins, meconium excretion, central nervous system abnormalities, diaphragmatic hernia and Choanal atresia.

Immediately after birth we take blood sample of umbilical arterial blood for ABG of neonates who their mothers had cesarean because of fetal distress in NST. In this study, pH <7.2 was considered as acidosis. The collected data were entered into SPSS version 21 and then analyzed using descriptive statistical methods in the form of tables and graphs. Besides, the t-test for mean comparison and Pearson correlation test were used to determine the correlation between the relevant quantitative variables. Additionally, the Chi-square test was utilized to delineate the relationship between different forms of NST disorder and the presence or absence of acidosis; in this test, the odds ratio (OR) to the risk of acidosis due to NST was calculated. A P value <0.05 was considered statistically significant level.

Results

All 139 newborns with a disturbed NST were included in this study. The mean age of pregnant women in the present study was 26.5±17.2 years. The mean age of mothers with newborns with acidosis was 25.8±5.8 years and the mean age of other mothers was 26.46±4.52 years and the difference was significant (P=0.043). The birth weight of the newborns in the present study was estimated to be 3281±361.22 grams. The mean weight of newborns with acidosis was 3261.54±377.62 grams and that of other neonates was 3300.66±346.39 grams and the difference was significant (P=0.038). The study of the frequency of abnormalities observed in neonatal *NST* showed that non-reactive *NST* was the most common abnormality observed in neonates who underwent emergency cesarean section. Some infants had more than one abnormality in their *NST* and a total of 252 abnormalities were observed in the infant *NST* (figure 1).

The association between late deceleration and bradycardia with acidosis in newborns was statistically significant (P=0.001, P=0.037) (table 1).

There was a significant relationship between late deceleration and arterial acidosis with first minute APGAR score in neonates (P=0.022). The mean total arterial acidosis rate was significantly lower in the group with APGAR score less than 7 at 7.13±0.14 than in the group with APGAR score ≥7 at 7.24±0.16 (P=0.001) (table 2).

Furthermore, the relationship between late deceleration and arterial acidity with the fifth-minute APGAR score was significant (P=0.022), (table 3). The presence of tachycardia in the neonatal *NST* was not associated with a decrease in the 1-minute and 5-minute neonatal APGAR scores. The association between the presence of a non-reactive *NST* and neonatal acidosis, and the 1-minute and 5-minute APGAR score was not significant (P>0.05). In general, the mean pH of umbilical artery blood in infants with a first minute APGAR score below 7 was significantly lower than the pH of arterial blood in other infants. A similar result was found when comparing APGAR acidity at the fifth minute. The correlation between the acidity of the umbilical arterial blood and the 1-minute APGAR score was in a moderate range; as the pH of the blood increased, the first-minute APGAR score of the neonates in the present study increased (r=0.34, P=0.001), (figure 2).

The correlation between the acidity of the blood in the umbilical artery and the APGAR score at the fifth minute was moderate (r=0.32, P=0.001), in cases without severe acidosis; no such correlation was observed in cases without severe acidosis (figure 3). In other words, with increasing blood pH, the 5-minute APGAR score of the neonates in the present study was increased, but after eliminating 16 neonates with severe acidosis (PH< 7), the relationship between PH and 5-minute APGAR score was not significant (P>0.05). Finally, studying all cases of impaired NST in relation to the diagnosis of neonatal acidosis, the existence of a positive predictive value for fetal acidosis was about 48.9%. The mean total fetal acidosis in the group with APGAR score <7 was 7.13±0.14, significantly lower than that (7.24±0.16) in the group with APGAR score ≥7, (P=0.001).

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Table 1. Relation between type of NST disorders and acidosis in neonates

NST		With acidosis		Without acidosis		Total		P-value	OR
		N	%	N	%	N	%		
Late deceleration	+	31	70.5	13	29.5	44	100	0.001	3.7
	-	37	38.9	58	61.1	95	100		
Variable deceleration	+	31	59.6	21	40.4	52	100	0.051	2
	-	37	42.5	50	57.5	87	100		
Bradycardia	+	23	63.9	13	36.1	36	100	0.037	2.3
	-	45	43.7	58	56.3	103	100		
Tachycardia	+	19	52.8	17	47.2	36	100	0.59	1.23
	-	49	47.6	54	52.4	103	100		
Non-reactive NST	+	46	54.8	38	45.2	84	100	0.089	1.81
	-	22	40	33	60	55	100		

Table 2. Relation between type of NST disorders and 1-minute APGAR score in neonates

APGAR Score / NST Status		less than 7		≥7		Total		P-value	OR
		N	%	N	%	N	%		
Late deceleration	+	18	40.9	26	59.1	44	100	0.022	2.4
	-	21	22.1	74	77.9	95	100		
Variable deceleration	+	16	30.8	36	69.2	52	100	0.58	1.24
	-	23	26.4	64	73.6	87	100		
Bradycardia	+	13	36.1	23	63.9	36	100	0.21	1.7
	-	26	25.2	77	74.8	103	100		
Tachycardia	+	12	33.3	24	66.7	36	100	0.41	1.4
	-	27	26.2	76	73.8	103	100		
Non-reactive NST	+	22	26.2	62	73.8	84	100	0.54	0.8
	-	17	30.9	38	69.1	55	100		
Atrial Acidosis rate		7.13±0.14		7.24±0.16				0.001	

Table 3. Relation between type of NST disorders and 5-minute APGAR score in neonates

APGAR Score / NST disorders		less than 8		≥8		Total		P-value	OR
		n	%	n	%	n	%		
Late deceleration	+	10	22.7	34	77.3	44	100	0.022	2.4
	-	7	7.4	88	92.6	95	100		
Variable deceleration	+	3	5.8	49	94.2	52	100	0.58	1.24
	-	14	16.1	73	83.9	87	100		
Bradycardia	+	5	13.9	31	86.1	36	100	0.21	1.7
	-	12	11.7	91	88.3	103	100		
Tachycardia	+	4	11.1	32	88.9	36	100	0.41	1.4
	-	13	12.6	90	87.4	103	100		
Non-reactive NST	+	10	11.9	74	88.1	84	100	0.54	0.8
	-	7	12.7	48	87.3	55	100		
Atrial Acidosis rate		7.23±0.15		7.1±0.19				0.001	

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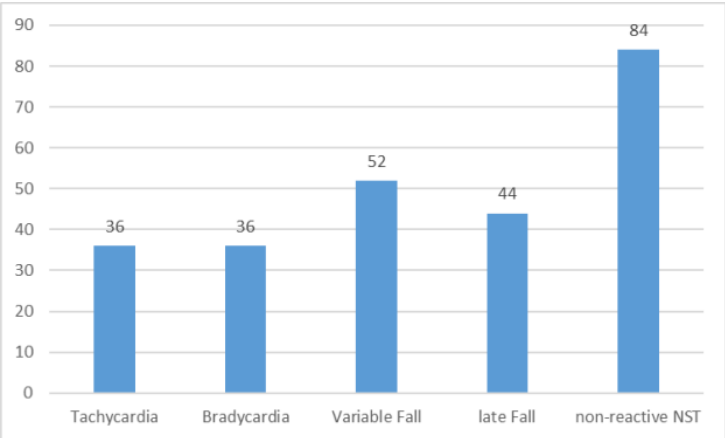


Figure 1. Frequency of NST abnormalities in all studied neonates

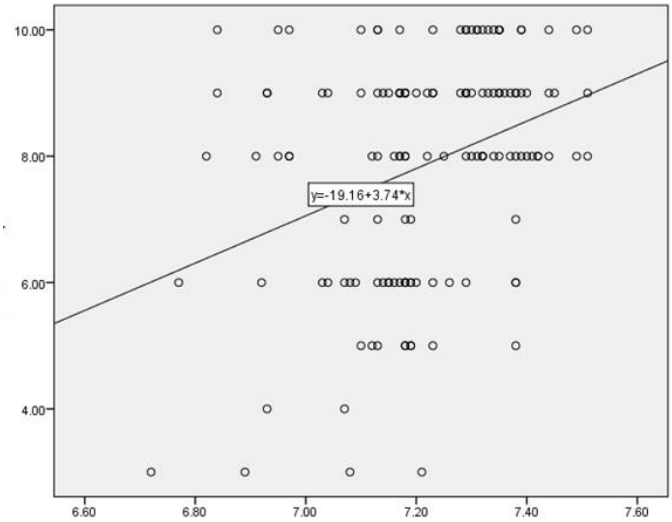


Figure 2. Correlation between acidosis rate and first-minute APGAR score

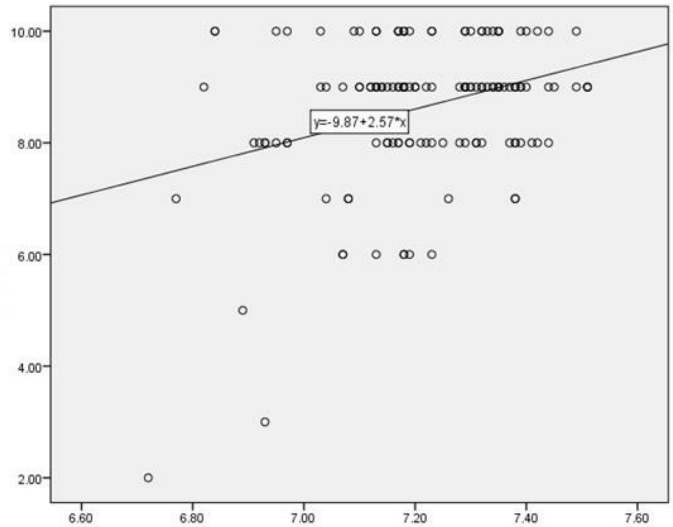


Figure 3. Correlation between acidosis rate and five-minute APGAR score

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Discussion

In the present study, the 5-minute APGAR score of the neonates was lower than the average APGAR score in the same study only in cases of late deceleration. In a study by Patel et al. (2015), *NST* was presented as a tool with high negative predictive value suitable for screening high-risk fetuses in high-risk pregnancies [13]. It should be noted that due to the determination of APGAR value by different operators between the two studies, the reported result may not be readily generalizable to the generality. In the present study, 68 neonates whose *NST* was consistent with fetal distress, had umbilical artery blood acidosis, with this interpretation, the positive predictive value of *NST* in determining acidosis was estimated to be 48.9%. In the study by Lotfalizadeh et al., although it was reported that the umbilical artery pH of infants with abnormal BPP score was lower, statistical surveys showed no difference between the arterial pH of these infants and other infants. However, a categorical examination of neonates based on the presence or absence of acidosis indicated further deterioration of *BPP* and *NST* tests in the presence of acidosis; in other words, when acidosis was determined at birth, these two tests had a positive predictive value of 68 % and 64 % and a negative predictive value of 82 % and 70.4% [14]. In a study by Valadan et al., *NST* was identified as the most sensitive test among *BPP* tests for the diagnosis of acidosis in newborns. In this study, the positive and negative predictive value of *BPP* in the diagnosis of fetal distress was estimated to be 50 and 98.1%, respectively. In this study, it was found that the reactivity of fetal heart rate and respiratory movements disappears when the pH of the umbilical artery reaches less than 7.2 [15]. In a study by Okamura et al., examination of the pH of the umbilical vein showed higher acidity in non-reactive *NST* than in reactive cases [16]. Some studies suggest that increasing the *NST* time reduces the reporting of non-reactive cases, such that for tests longer than 40 minutes, 5% of *NST* cases are non-reactive and for tests longer than 80 minutes, only 2% of *NST* cases are reported as non-reactive [17, 18]. It should be kept in mind that prolonging the *NST* time may also be challenging, because in the presence of fetal distress, especially severe fetal distress, terminating the pregnancy as soon as possible may prevent irreversible harm to the newborn.

In the present study, the 1-minute APGAR score of infants with acidosis was significantly lower than that of other neonates; however, the relationship between the pH score and the 1-minute APGAR score of these infants was poorly estimated. Some studies showed that the 5-minute APGAR score of infants with impaired *NST* and acidosis was significantly lower than other infants, which was in line with other studies by Rezayee et al. and Mojibian et al. [9, 18]. In a study by Ahmadpour-Kacho et al., no correlation was found between the 1-minute APGAR score of infants in mothers with low-risk pregnancies and the umbilical artery pH [12]. Martin et al. reported that although arterial blood pH was significantly lower in neonates with a twisted umbilical cord than in other neonates, the 1-minute APGAR score of these neonates was not significantly different [19]. Moreover, Mobasheri et al. found that one of the predictors of APGAR score in the first minute was the pH of umbilical artery blood [11]. Although the 1-minute APGAR score does not reflect late-onset neonatal complications, in severe cases they require serious measures to save the life of the newborn.

In the present study, cases of acidosis and a 5-minute APGAR score of less than 8 were associated. However, further studies showed that the APGAR score of neonates with impaired *NST* and mild acidosis was not significantly different from other neonates. In cases with pH> 7, the 5-minute APGAR score was significantly lower than in other neonates. In the study by Mojibian et al., the 5-minute APGAR score of neonates with impaired *NST* was estimated to be 9.67±0.82 on average, which was significantly lower than the average 5-minute APGAR score of other neonates [9]. In the study of Martin et al., although arterial blood pH was significantly lower in infants with twisted umbilical cords than in other infants, the 5-minute APGAR score of these infants was not significantly different from that of other infants [19]. A study by Hogan et al. found that infants with a 5-minute APGAR score of less than 7 were significantly more likely to have acidemia than infants with a higher APGAR score [20]. However, assessing the extent to which *NST*-based decision making can predict infants' 5-minute APGAR scores requires investigation on a larger scale and consideration of a different group as a control.

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The mean age of pregnant women in the present study was 26.5± 17.18 years and there was a significant age difference between mothers of infants with acidosis and other mothers. The results of the current study are in agreement with other studies done in elsewhere [9-11].

In the present study, the mean total weight of the neonates was 3281± 36.22 grams, and no significant difference was found between the weight of the infants with acidosis and that of the other newborns. In the study of Mojibian et al., the mean birth weight of the newborns with abnormal *NST* was 3015.22±572.86, which was not significantly different from other neonates [9].

Ahmadpour-Kacho et al. stated that the mean birth weight of term infants in mothers with low-risk pregnancies was 203 ±3198.48 grams [12]. However, in many studies, low birth weight is one of the known risk factors for acidosis. The probable reason for the discrepancy between the present study and other studies may be related to the inclusion and exclusion criteria. Acidosis may be secondary to prolonged hypoxia in cases like *IUGR* and preterm birth, both of which were among the exclusion criteria of the present study. On the other hand, prolonged vaginal delivery and dystocia may also lead to asphyxia and acidosis, which was practically not to the case in the studied neonates according to the ongoing study.

Conclusion

The results indicated that *NST* had a moderate positive predictive value in the diagnosis of fetal acidosis in the neonate with tachycardia or non-reactive *NST*. The prolonged *NST* must be performed to avoid unnecessary cesarean delivery. Because of the correlation between disturbances in the of 5-minute APGAR score and pH with late deceleration, this deceleration should be seriously considered. Finally, it is suggested that prospective studies with large sample size and considering other groups like control group and high risk pregnancies, delivery method and so on and broader diagnostic modalities like *NST*, *BPP*, and their subgroups should be studied and sensitivity, specificity, positive and negative predictive values of each should be evaluated in comparison with other diagnostic modalities.

Due to the absence of a parallel control group of neonates with non-reactive *NST*, the negative predictive value, sensitivity and specificity of *NST* in the diagnosis of neonatal acidemia could not be evaluated in this study. One of the limitations of the present study is the lack of another group as a control group for additional studies in terms of estimating indicators such as sensitivity, specificity, and negative predictive value.

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Conflict of interests

There was no conflict of interest.

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Ethical Code

This study was extracted from the Medical Doctorate thesis and was approved by the Ardabil University of Medical Sciences ethical committee and registered by ethical code IR.ARUMS.REC.1398.172.

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