ORIGINAL ARTICLE

The Effect of Nuchal Cord on Umbilical Cord Blood Gases and Neonatal Outcomes

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ABSTRACT

Aim: To investigate the perinatal outcome and umbilical cord blood gases in two groups of neonates with and without nuchal cord in Rasht.

Methods: This cohort study was performed on 168 pregnant women with term pregnancy referred to Azzahra hospital in Rasht in 2018. Two groups) with and without nuchal cord**)** , were compared in maternal demographic characteristics, PH, and cord blood gases and perinatal variables **.**SPSS-20 was used**.** Chi-square and Fisher-exact test were used to compare the qualitative and quantitative data. Mann-Whitney test was used for non-normal distribution. $p<0.05$ was taken as the significant level.

Results: The mean of cord blood pH in the nuchal cord group was lower than in the group without nuchal cord, which was statistically significant difference ($p=0.005$).

There were no statistically significant differences in the other parameters related to umbilical cord blood gases and perinatal outcomes in the two groups. There was no statistically significant in PH and other umbilical cord blood gases in neonates with single and multiple nuchal cord ($p=0.06$)

Conclusion: The findings of this study showed that although the nuchal cord leads to a decrease in the PH of the arterial blood of the umbilical cord, however, this decrease is clinically insignificant. In other arterial blood gas parameters, there was no significant difference between two groups with and without nuchal cord. There may be different results in studies with larger sample sizes and simultaneous test of arterial and venous blood gases.

Keywords: Perinatal outcomes, umbilical cord blood gases, nuchal cord

INTRODUCTION

Nuchal cord is defined as a wrapped 360-degree of the umbilical cord around the neck of the fetus, which occurs in 10–29% of pregnancies. Some studies have reported that nuchal cord is not associated with perinatal morbidity and mortality[1,3].

But other studies have shown that nuchal cord can cause short and long-term complications for newborns, such as increased meconium excretion, abnormal fetal heart rate pattern, Apgar scores at 5 minutes<7, Intrauterine fetal death (IUFD), Intrauterine fetal growth retardation (IUGR), and cesarean section[5,4].The number of loops plays an important role[6]. Various studies have reported a strong association between low arterial pH with adverse short and long-term neonatal outcomes[7-9]. Measuring cord blood can be a tool for clinical decision making to initiate urgent care for the neonate[10,11]; Increasing knowledge and helping to find the pathogenesis of disability in neonates with cerebral palsy and other disabilities[12,10] also can be helpful tools in assessing the quality of care during labor (13, 14). It can also be legally useful for adverse neonatal outcomes[13]. But the routine use of it such as high-risk pregnancies in neonatal with nuchul cord or low-risk pregnancies is still controversial[10,13,15]. Some studies have reported that nuchal cord had an effect on cord blood gas even before the onset of labor in neonates undergoing elective cesarean section and lower cord pH was observed in the group with nuchal cord[16]. According to some contradictory results, abnormal umbilical cord blood gas levels, even based on five different classifications in neonates with nuchal cord underlying cesarean, didn`t have any associations with adverse neonatal outcomes (Apgar score below 7, sepsis, necrotizing enterocolitis, intraventricular hemorrhage, etc.). Therefore, the routine use of blood gas measurements is still controversial[17]. It has also been noted in one study that the analysis of umbilical arterial blood gases had no advantage over Apgar score in the diagnosis of encephalopathy or death in Grade 2 neonates in

cardiography[18]. Some studies have even suggested that cord blood gas measurements prior to the start of the active phase laboratory are unnecessary and have recommended further studies[16]. Nuchal cord does not appear to be a benign problem[19]. The reason for these differences in the results of the studies may be that there is still no clear cutoff for PH and umbilical arterial blood gases indicating the onset of adverse neonatal outcome[17]. Differences in study findings are largely due to differences in sample size, different methodology as well as numerous factors influencing normal blood gas levels[20]. However, in most studies, they reported that nuchal cord has no effect on pregnancy outcomes and cord blood gas analysis has been suggested to assess metabolic and respiratory acidosis[21] so that it can be used as a useful predictor for the diagnosis of asphyxia at delivery[22].

Regarding the lack of consensus on the relationship between umbilical nuchal cord with umbilical cord blood gases, prenatal outcomes, the vital importance of this state, and insufficient similar studies, we decided to compare the cord blood gases in two groups of neonates with and without umbilical nuchal cord.

MATERIALS AND METHODS

This was a prospective cohort study, after Obtaining permission from the Ethics Committee of Gilan University of Medical Sciences under the code IR.GUMS.REC.1397.250, and obtaining informed consent from the participants, the status of arterial blood gases and perinatal complications (outcome) in two groups of neonates with nuchal cord (positive exposure) and without nuchal cord (negative exposure) was evaluated. The study population included all healthy pregnant women with term pregnancy that referred to Alzahra Hospital in Rasht for termination of pregnancy from March to February 2018. In this study, after meeting the inclusion and exclusion criteria, non-random sampling was done in the order of referral to hospital. Based on the results of Oenderogluet al.'s study (23), required sample size with 95% confidence and 80% test power was determined to investigate 84 people in each group by the two-way statistical difference.

The Inclusion criteria were the existence or not existence of the nuchal cord in both groups, including pregnant mothers with term pregnancy (37-42 weeks), single pregnancy, cephalic presentation, and live fetus entered the active phase of labor. In the presence of dichotomy, placental abruption, congenital anomaly, maternal medical illness (preeclampsia - diabetes), intrauterine growth restriction, recurrent cesarean, the history of myomectomy, macrosomia, inappropriate head and hip, fetal and cesarean deaths for any other reasons (e.g. orthopedic reasons, etc.) these mothers were excluded from the study. Data were collected from all eligible women in active phase of labor, and information, including maternal age, gestational age, pregnancy history, was recorded. All neonates at birth (cesarean section - normal) with nuchal cord were considered as the exposure group and those withoutnuchal cord as the non-exposed group.

In order to evaluate cord blood gases, including PH, Po2, PCO2, HCO3 and base excess, immediately after birth blood samples were obtained from the cord artery of 2 cc in the heparin syringe for both groups and were sent at most in 10 minutes to the laboratory. The cord blood gas status was then determined by a standard device. Parameters until the duration of the active phase of labor, type of delivery, birth weight, sex of the fetus, the number of nuchal cord bends, the first and fifth minute Apgar, nuchal excretion and need to NICU were recorded. The parameters of active phase duration up to delivery, type of delivery, weight and sex of the fetus, the number of nuchal cord, first and fifth minute Apgar, nuchal excretion and NICU requirement were recorded.

Data Management and Analysis: Data were analyzed using SPSS 21 software. Quantitative data are presented as mean and standard deviation or median (minimum - maximum) and the qualitative data is displayed as a frequency. Using Q-Q Plot and Shapiro-Wilk tests, normal distribution of the quantitative variables of the study were measured in sub-groups. To compare the qualitative data between the two groups, respectively, chi square and Fisher exact test and in quantitative variables with non-normal distribution Mann Whitney test was used. The statistical significance of the tests was considered $p < 0.05$

RESULTS

In the present study, 168 eligible neonates including 84 with nuchal cord and 84 without nuchal cord were evaluated. The initial specifications of the participants are given in Table 1. As can be seen, the average age of mothers without nuchal cord was lower than the mothers in with a nuchal cord. But this difference was not statistically significant (p=0.173). Also, gestational age and pregnancy history were similar in the two groups and there was no significant difference between the two groups (Table 1).

In neonates with nuchal cord the majority of cases had one round nuchal cord: 69 cases (82.1%). Then there were two rounds in 12(14.3%) and three rounds and more (3.6%) respectively. The mean pH of cord blood in neonates born with nuchal cord was 7.25 (6.67- 7.40), which was 7.22 in nuchal neonates (7.27-94.31). It was found that there was a statistically significant difference (p= 0.005), although it was not clinically significant. According to the definition of acidemia in infants with a pH below 7, (2.4%) 2 patients in the nuchal cord group and 3.6% in the group without nuchal cord had acidemia. As you can see, the difference between other parameters related to cord blood gases, including PCo2, Po2, HCo3 and Base excess in the two groups with and without nuchal cord was not statistically significant (Table 2).

Based on the results of the childbirth characteristics, fetal weight (g), Apgar at the first and fifth minutes and median of interval active phase to delivery in the two groups with and without nuchal cord were not significantly different. Also, there was no statistically significant difference between the methods of delivery, sex of the fetus, nuchal excretion and the need for NICU in the two groups with and without nuchal cord (Table 3).

The Comparison of arterial blood gases based on the number of nuchal round revealed that only the median cord blood pH was higher in neonates with one nuchal cord than in the group with two or more rounds of nuchal cord (7.25

compared to 7.29), which was not statistically significant (p = 0.066) (Table 4).

Comparing the mean pH of cord blood in neonates born with three-round and more nuchal cords with neonates with two-round nuchal cord showed that the median pH in three-round nuchal cord was 7.30 (7.29-7.35) In contrast, 7.24 (7.20-7.36) was in the group with two-round nuchal cords. Although it was higher in the group of three rounds of the middle nuchal cord, due to the small number of samples (3 versus 12 person) in these subgroups the result of the test (p-value) was not valid and will not be reported.

Comparing the mean pH of cord blood by type of delivery using Mann Whitney test showed that the mean pH of cord blood in 33 neonates born by cesarean was higher than 135 neonates with normal vaginal delivery (7.25 Vs.7.23). This difference was also statistically significant (p = 0.013) .

Figure 1. CONSORT flowchart of the study

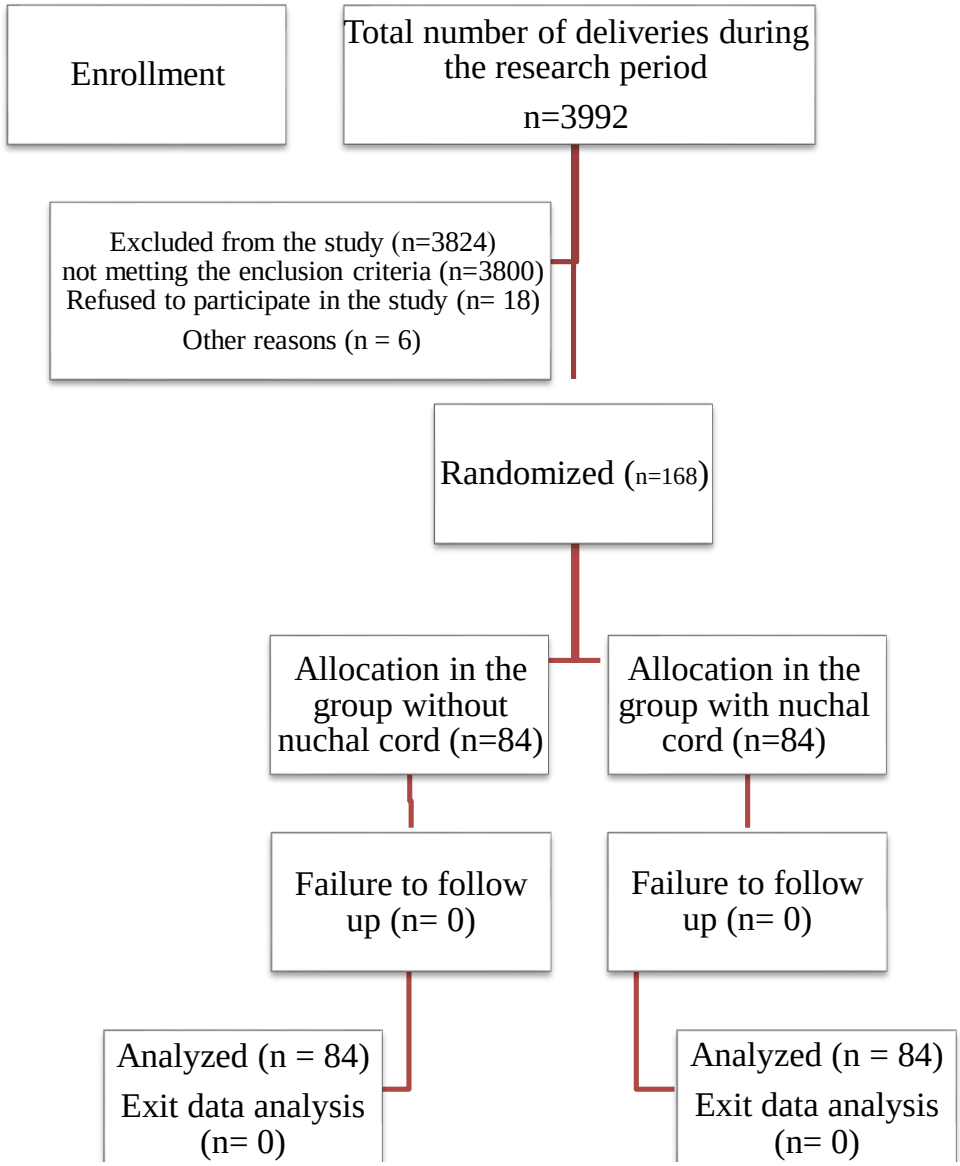

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Table 1: Demographic and delivery characteristics of mothers in two groups with and without nuchal cord

Variables		With nuchal cord (n=84)	Without nuchal cord (n=84)	p value
Mother's age (years) (M±SD)		28.60±5.79	27.36±5.93	0.173*
Gestational age (days) (M±SD)		275.66±7.04	274.28±7.62	0.225*
Pregnancy history Frequency (%)	First pregnancy	46 (50.0)	46 (50.0)	0.581**
	Second pregnancy	30 (53.6)	26 (46.4)	
	Third pregnancy and more	8 (40.0)	12 (60.0)	

*Independent T Test **Chi-Square Test

Table 2: Acid-base and arterial status of neonatal cord arteries in two groups with and without nuchal cord

Variables Medan (Minimum - Maximum)	With nuchal cord (n=84)	Without nuchal cord (n=84)	p value
pH of cord blood	7.22 (6.94-7.31)	7.25 (6.67-7.40)	0.005*
PCo2	44.75 (4.10-86.30)	43.45 (24.70-92.90)	0.066*
Po2	25.30 (20.30-31.30)	24.80 (19.70-43.60)	0.322*
$HCo3^-$	19.70 (10.80-25.20)	19.20 (7.90-26.10)	0.722*
Base excess	7.75 (4.30-19.90)	8.20 (-4.50-102.00)	0.538*

*Mann-Whitney Test

Table 3: Peripartum features in two groups with and without nuchal cord

Variables		With nuchal cord(n=84)	Without nuchal cord(n=84)	p value
Fetal weight (g) Median (Minimum - Maximum)		3200 (2320-4800)	3200 (2320-4800)	0.594*
First minute APGAR Median (Minimum - Maximum)		9 (2-9)	9 (6-9)	0.489*
Fifth minute Apgar Median (Minimum - Maximum)		10 (4-10)	10 (8-10)	0.570*
Active Phase to Delivery (Minutes) Median (Minimum - Maximum)		127.50 (15-6000)	140.0 (40-1690)	0.653*
Mode of delivery Frequency (%)	vaginal	66 (78.6)	69 (82.1)	0.560*
	cesarean	18 (21.4)	15 (17.9)	
Sex of the fetus Frequency (%)	female	43 (51.2)	49 (58.3)	0.352**
	male	41 (48.8)	35 (41.7)	
Meconium Excretion Frequency (%)	yes	21 (25.0)	14 (16.7)	0.184**
	no	63 (75.0)	70 (83.3)	
Need to NICU	yes	2 (2.4)	0 (0)	0.497***
	no	82 (97.6)	84 (100)	

*Mann-Whitney Test **Chi-Square Test *** Fisher exact test

Table 4: Comparison of umbilical cord gases according to number of round nuchal cord in two groups with and without nuchal cord (n = 84)

Variables Median (Minimum - Maximum)	Number of round nuchal cord		P value
	one round (n=69)	≥ 2 round (n=15)	
pH of cord blood	7.29 (7.20-7.36)	7.26 (6.67-7.40)	0.066*
PCo2	44.40 (34.10-55.00)	44.00 (24.70-92.90)	0.267*
Po2	24.80 (16.10-26.10)	24.80 (19.70-43.60)	0.752*
$HCo3^-$	19.80 (16.10-26.10)	19.20 (7.90-24.80)	0.483*
Base excess	8.20 (1.30-11.10)	8.20 (-4.50-102.00)	0.480*

*Mann-Whitney Test

DISCUSSION

The findings of the present study showed that the presence of nuchal cord is associated with a lower pH level of umbilical artery blood, although this difference is clinically negligible, and there was no association between nuchal cords with other cord blood gases. Some studies, such as Gursoya[16], Oenderoglu[23] and Shabani[24], as in the present study, reported lower PH levels in cord blood. But according to the findings of Akkaya[2] and Gonen[17] there was no difference in the level of cord blood pH in the presence or absence of nuchal cord and Gonen reported abnormal cord blood gas analysis in the unusual low-risk population (2.3%) and in high-risk pregnancies (14.4%)[17], although the present data imply the influence of nuchal cord on cord blood parameters, the pH level of cord blood is within the normal range and is clinically irrelevant. On the other hand, the reason for this difference in the results of studies may be due to the heterogeneity of the study groups, because the inclusion criteria for delivery, high-risk and low-risk pregnancies have been varied in studies, each of which may influence umbilical cord blood

gases. Similar to the Gursoya study, which reported that nuchal cord had an effect on umbilical cord blood gas even before the onset of labor in neonates undergoing elective cesarean[16], but not associated with poor neonatal outcomes. For this reason, cord blood gas measurements prior to the active phase of labor have been considered unnecessary and further studies have been recommended[16]. Other reasons for the differences in the findings include not mentioning sampling of which cord blood vessels and the size of the different study samples.

Studies on the odd range of abnormal umbilical cord blood gases to determine pathology, clinical manifestations, or fetal acidemia is insufficiant. And in most studies, the criterion used by the old definition is pH less than 7/20[8,25]. But recent studies report thresholds associated with neonatal mortality and morbidity at pH levels below 7/20[28,26]. In the review study, this threshold was reported at pH 7 to 7.24[9,29] and in the cohort study the neurologic complication level was reported to be pH about 7.10[28,30] and pH between 7/26 and 7/30 have been reported as the lowest level for neonatal complications[8]. In the present study, as in other contradictory and congruent studies, the pH level was in the normal range. One of the main reasons for the suggestion of routine measurement of cord blood gases is to reduce mortality and morbidity in high-risk infants so that they can receive better quality care[10,14]. On the other hand, there is controversy about the clinical significance of the cord blood gas analysis because it is considered unnecessary intervention in low-risk labor due to increased costs and time[10]. Therefore, it is suggested that umbilical cord blood gas analysis be selective rather than routine because of its clinical role.

In the present study, like Akkaya[24], Karunandhi[4], Akkaya[2], it was observed that the majority of infants had a single nuchal cord also, it was observed that multiple nuchal cord had no effect on arterial cord blood gas, and due to the small number of samples in the group, with a multiplicity of nuchal cord between the two groups there were no comparisons between the two groups of pregnancy outcomes. In the study of Akkaya et al., as in the present study, no relationship was found between the pH of cord blood and the number of nuchal cord wrapped. However, the decrease in amniotic fluid volume, increased fetal distress, cesarean section and neonates born with male gender were more in the group with a large number of nuchal cord[2]. But in the study by Oenderoglu et al., the multiplicity of nuchal cord had a negative effect on the pH and blood gas of the umbilical artery and subsequently increased neonates with an Apgar score below seven minutes of first birth and complications[23]. Also, Gonen found that in normal delivery, cases where there were two or more nuchal cord loops were more likely to have IUGR and other fetal distresses during labor, and when there were three or more loops with intrauterine death, IUGR, and when the number of loops is three or more, it is associated with intrauterine death, IUGR, and increased cesarean and a low Apgar score, but one loop is not associated with poor pregnancy outcomes[17].

Although most previous studies have reported that nuchal cord is associated with adverse neonatal outcomes, differences in findings may be due to differences in inclusion criteria, sample size, and research method. Thus, since the majority of studies as well as the present study had the majority of single nuchal cord and the number of specimens in the multiplex nuchal cord group was small, more sample size studies are needed in this group. In the present study, similar to the study of Oenderoglu[23], Gonen[17] and Gursoya[16], there was no association between abnormal cord blood gas and delivery characteristics such as active phase interval to delivery, neonatal weight, first and fifth minute Apgar, type of delivery, Fetal sex, frequency of meconium excretion and NICU requirement were not observed in the two groups with and without nuchal cord. However, studies with contradictory results to the present study found that neonatal outcomes such as meconium excretion, fetal abnormal heart rate and Apgar score less than 7 were greater in the group with nuchal cord than in the group without nuchal cord[4,23,24].

In the present study, neonatal birth weight was similar in the two groups, with an average of 3200 g. Carey[31] and karundihi[4] reported similar results, but Liptiz et al reported that the majority of neonates with a nuchal cord were less than 2000g[32] it seems reasonable that considering the importance of umbilical cord feeding as any abnormality in the cord structure such as the cervical cord, will decrease blood supply and subsequently weight loss in infants, but in various studies this result was different in terms of sample size and study population.

In the present study, there was no difference between the two groups with and without nuchal cord in first and fifth minute Apgar score. But in the study of karundihi[4] and oenderglou[23]. It was reported that there was a significant difference between the two groups in the first minute Apgar score. Also, in Rezaee`s study[24]. It was observed that there is a significant relationship between Apgar score and umbilical arterial gases at the first hour of birth and considering that nuchal cord may decrease arterial umbilical cord blood pH, this may be of great importance in the treatment of neonates with low Apgar score. But in Zahoor study[1] as in the present study, there was no difference in Apgar score between the two groups. Since almost all the nutrients needed for umbilical cord growth and maturation reach the fetus, umbilical and functional abnormalities have a significant and direct impact on the outcomes of delivery[33] and considering that the cord of the cervix reduces the pH of the arterial cord blood, it seems appropriate to routinely measure umbilical arterial blood gases in neonates with a low Apgar score[34]. Meena's study has also suggested that measuring cord blood pH with Apgar score can be a useful predictor of severity, duration of asphyxia, and its short-term consequences[35]. On the other hand, differences in the outcome of pregnancy can be attributed to sample size, different inclusion criteria in related studies.

In order to investigate the underlying factors, the two groups were compared in terms of maternal age, gestational age, and pregnancy history there was no difference between the two groups. In the studies of karundihi[4] and Oenderogluo[23], there were no differences between the two groups in terms of these underlying factors. In the Zanjani`s study[24], the two groups were similar in terms of gestational age, pregnancy history and preterm delivery, but the age of the mothers in the nuchal cord group was higher than the group without nuchal cord

blood. Pearson correlation was used to study the effect of maternal age on blood pH and no relationship was found between maternal age and PH in neonatal cord blood. In the study of Ogueh et al[36] maternal age was also higher in the complicating pregnancy with the nucleus cord. According to the results, it seems that the effect of nuchal cord on pregnancy outcome is independent of the above factors, but the effect of maternal age is still in doubt.

CONCLUSION

The findings of this study showed that although nuchal cord results in a decrease in cord blood pH, this decrease is not clinically significant and also there is not significant difference in other parameters of arterial blood gas. Even themultiplicity nuchal cord did not affect umbilical arterial blood gases. Due to anxiety in mother and unnecessary premature intervention it was recommended that, in pregnancy ultrasound, the existence of nuchal cord not be mentioned.

Study limitations: One of the limitations of the study is the low sample size, especially in groups with multiple nuchal cords to compare the effects and their effects on cord blood gases. Cord blood gases were also measured after delivery, which may not reflect the reality of the acidic and the perinatal status of the fetus.

Some studies have suggested that nuchal cord can be effective on perinatal outcomes and umbilical cord blood gases and has been used to diagnose asphyxia in nuchal cord pregnancies. On the other hand, some contradictory studies have indicated that nuchal cord had no effect on perinatal outcomes and due to anxiety in mother and unnecessary premature intervention it was recommended that, in pregnancy ultrasound, the existence of nuchal cord not be mentioned.

Suggestions: Based on previous studies and the findings of the present study, it seems that prospective studies with larger sample size and simultaneous measurement of umbilical and venous arterial gases and evaluation of neonatal and perinatal outcomes will help to achieve more accurate results.

Conflict of Interest: No potential conflict of interest relevant to this study was reported.

Ethical Statements: The study was approved by the ethical committee of Guilan University of Medical Sciences (No. IR.GUMS.REC.1397.250). Also, all the participants filled and signed informed consent forms.

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