Perinatal features and umbilical cord blood gases in newborns complicated with nuchal cord

Lütfü S. Önderoğlu[1], Polat Dursun[2], Tekin Durukan[1]

Department of Obstetrics and Gyneocology, [1]Hacettepe University Faculty of Medicine and [2]Başkent University Faculty of Medicine, Ankara, Turkey

SUMMARY: Önderoğlu LS, Dursun P, Durukan T. Perinatal features and umbilical cord blood gases in newborns complicated with nuchal cord. Turk J Pediatr 2008; 50: 466-470.

Presence of nuchal cord (NC) is associated with transient decrease of umbilical cord blood flow. However, the exact perinatal effect of presence of NC in a newborn is still under debate. The aim of this study was to evaluate the perinatal complications and umbilical cord blood gases of deliveries complicated with NC and summarize the associated literature. Gestational age-matched term singleton pregnancies complicated with NC (n=160) were compared with neonates without NC (n=160). Patients' files and Labor and Delivery Unit database were used to extract maternal age, gestational age, presence of NC, number of nuchal loops around fetal neck, intrapartum complications and umbilical cord blood gases. pH, pO_2, pCO_2, HCO_3^-, O_2 saturation, and base excess were determined in all patients. Mean maternal age, mean gestational age, and birth weight were not significantly different between the two groups (p>0.05). Occurrence of oligohydramnios, intrauterine growth retardation (IUGR), intrapartum abnormalities and Apgar scores <7 at 1 minute were not significantly different between the groups (p>0.05). However, umbilical cord blood pH (7.32 vs. 7.30, p=0.048), pO_2 (37.4±18.1 vs. 31.7±14.4, p=0.01) and O2 saturation (57.4±21.8 vs. 48.3±20.4, p=0.005) were significantly lower in the NC group compared with the controls. Furthermore, the number of Apgar scores <7 at 1 minute was significantly higher in neonates with multiple NC (28.1% vs. 9.2%, p=0.007), and intrapartum abnormalities were more frequently seen in newborns with multiple NC (31.3% vs.15.6%, p=0.04). The results of this study suggest that presence of single NC may negatively affect the umbilical cord blood gases without significant perinatal complications. However, multiple NC may also increase the development of intrapartum complications and lower Apgar scores. Perinatal effects of NC should be investigated with a large prospective study.

Key words: nuchal cord, umbilical cord blood gases, cord accidents, perinatal complications, intrauterine growth retardation, oligohydramnios, intrapartum complications.

Twenty to sixty percent of all fetal deaths are attributed to fetal asphyxia. However, the etiology in all cases of fetal asphyxia is not exactly understood. Asphyxia is most frequently seen as a result of reduced placental circulation, but in rare cases it might develop secondary to umbilical cord complications. Cord accidents compromise 5-18% of all fatal fetal asphyxia cases and 10% of stillbirths were due to umbilical cord complications[1,2]. Nuchal cord (NC) is the one of the most common complications of the umbilical cord and it can be defined as the umbilical cord being wrapped 360° around the fetal neck. It is estimated that NC affects 23% to 33% of all pregnancies. Multiple NC is found in 2.5-8.3% of all pregnancies[3]. The presence of NC associated with transient decrease in umbilical cord blood flow has been demonstrated[4]. However, the exact perinatal effect of NC is still under debate[5-30]. In this study, we aimed to investigate the effect of NC on perinatal complications and umbilical cord blood gases.

Material and Methods

We retrospectively evaluated our department's database to identify neonates born with NC between 2002-2004. We identified 160 consecutive singleton pregnancies complicated with NC eligible for the analysis of all the study parameters. Among them, 32 (10.6%) were complicated with two or more NC. One hundred sixty consecutive singleton term neonates uncomplicated with NC delivered vaginally during the same period served as the control group.

Eligibility criteria for inclusion in the analysis were as follows:

1. Term singleton pregnancies (37-42 weeks),
2. Spontaneous pregnancy
3. Vertex presentation
4. No congenital malformation
5. No maternal medical problems
6. No evidence of infection
7. Availability of all the study parameters.

Patients' files and Labor and Delivery Unit database and computerized laboratory database were used to extract maternal age, gestational age, gravida, parity, presence of NC, number of nuchal loops around fetal neck, Apgar scores, perinatal complications including oligohydramnios, small for gestational age (SGA), intrauterine growth retardation (IUGR), meconium staining, intrapartum fetal heart rate abnormalities and umbilical cord blood gases. pH, pO_2, pCO_2, HCO_3^-, O_2 saturation, and base excess were determined in all patients. Apgar scores of the neonates were assessed by a pediatrician in the delivery room.

Blood samples from an umbilical artery were drawn into heparinized syringes from the placental side of the clamped umbilical cord. The pH, pCO_2, pO_2, HCO_3^- and base excess were assessed using a standard laboratory blood gas machine. Student's t test, Mann-Whitney U and chi-square tests were used for statistical analysis. Statistical significance level was set at 0.05.

Results

Mean age (29.6±5.0 vs. 29.1±5.7), gestational age ($38^{2/7}$ vs. $38^{4/7}$), gravida (2.3±1.4 vs. 2.3±1.3) and birth weight (3178±595 vs. 3146±539) were not significantly different between the two groups (Table I). However, mean parity was significantly higher in the NC group (0.91±0.8 vs.0.7±0.8, p=0.01). NC was also seen more frequently in multiparous women compared with nulliparous women (34.9% vs. 65.1%, p=0.01). Furthermore, presence of oligohydramnios (11.2% vs. 6.9%, p=0.24), IUGR/SGA (14.9% vs. 12.5%, p=0.54), and intrapartum abnormalities (15.6% vs. 16.9%, p=0.76) as well as overall perinatal complications (34% vs. 28.8%, p=0.32) were not significantly different between the two groups. Apgar scores <7 at 1 minute were also not significantly different between the groups. However, umbilical cord blood pH (7.3 vs. 7.3, p=0.048), PO_2 (37.4±18.1 vs. 31.7±14.4, p=0.01) and O_2 saturation (57.4±21.8 vs. 48.3±20.4, p=0.005) were significantly lower in the NC group compared with the control group (Table II). Multiple NC was seen in 10.6% (n=32) of all neonates analyzed in this study, while this figure was 20% among the NC group. Further comparison of these babies with the control group did not reveal significant differences with respect to antepartum complications including oligohydramnios and presence of IUGR/SGA. However, Apgar scores <7 at 1 minute were significantly higher in neonates with multiple NC (28.1% vs. 9.2%, p=0.007). Furthermore,

Table I. Demographic Features of the Groups

	Nuchal cord (–)	Nuchal cord (+)	P
Maternal age	29.55±5.0	29.08±5.7	0.45
Gestational age	$38^{2/7}$	$38^{4/7}$	0.34
Gravida	2.3±1.4	2.3±1.3	0.73
Parity	0.66±0.8	0.91±0.8	0.01
Birth weight	3178±595	3146±539	0.62
History of previous pregnancy			0.01
Nulliparous	59 (50.9%)	45 (34.9%)	
Multiparous	57 (49.1%)	84 (65.1%)	

Table II. Umbilical Cord Blood Gases in Deliveries Complicated with Nuchal Cord

	Nuchal cord (–)	Nuchal cord (+)	P
pH	7.32	7.30	0.048
PO_2	37.4±18.1	31.7±14.4	0.01
PCO_2	43.6±9.5	45.8±9.4	0.13
HCO_3^-	22.3±3.9	22.9±5.3	0.95
O_2 saturation	57.4±21.8	48.3±20.4	0.005
BE	-3.7±3.3	-3.8±3.1	0.87

BE: Base excess.

intrapartum abnormalities including abnormal fetal heart rate and meconium staining were more frequently seen in newborns with multiple NC (31.3% vs. 15.6%, p=0.04). Parity of women delivering fetuses with multiple NC was significantly higher than in controls (1.1±0.9 vs.0.7±0.9, p=0.009). There was one stillbirth complicated with five nuchal loops.

Discussion

It is not a recent idea that cord accidents may cause fetal distress and intrapartum complications. It has been reported that coiling of the umbilical cord had been described as "one of the dangers of eighth month" by Hippocrates or an unknown disciple in a book entitled "De Octimestri Partu". In 1657, Harvey suggested that interruption of umbilical cord blood flow may be a cause of fetal death in the fetus with cord compression. In 1750, the British obstetrician William Smeille described a stillbirth fetus with four nuchal loops[7,8].

The etiology and pathogenesis of NC are not exactly understood. However, there are some risk factors, including length of the cord, hyperactivity of the fetus, male gender, monozygotic twins, prior history of cord accidents, and posterior localization of the placenta. NC can be classified into two types according to be pattern of looping: type A, nuchal loop that encircles the fetal neck in an unlocked pattern, and type B, nuchal loop that encircles the neck in a locked pattern. Type A can undo itself but type B cannot. In a prospective review of NC, the type B pattern occurred in 1 in 50 births. Cesarean section and stillbirth were more associated with type B pattern[9,10].

In modern obstetrics, Kan-Pun-Shui and Eastman[11] published the first well-designed study about NC and its perinatal effects in 1957. In this study, the incidence of one and two nuchal loops around the fetal neck was 20% and 2.5%, respectively, and the authors could not demonstrate any relationship between presence of NC and perinatal mortality[11]. Two subsequent studies also found no relationship between NC and poor perinatal outcomes[12,13]. In the study of Morrison[1], 48% of full-term asphyxiated infants had cord accidents. Stembera and Horska[4] also reported that presence of NC was associated with transient decrease in umbilical cord blood flow. Although some studies suggest that presence of NC may associate with poor perinatal outcomes, other studies could not demonstrate a negative effect of NC on the fetus. Therefore, there is an on-going debate about the perinatal effects of NC[10,14-17].

Carey et al.[17] investigated the effect of NC on birth weight. In their study, the mean birth weight did not significantly differ in newborns with one or multiple NC compared with the control group (3,206 g or 3,135 g vs. 3,252 g; F=.08, P=.7). However, Lipitz et al.[18] reported that incidence of NC was significantly lower in infants weighing less than 2000 g at birth. On the other hand, Osak et al.[14] reported that infants with the cord around the neck were slightly smaller (3481±467 versus 3548±475 g, p<0.001). Although Sornes[15] suggested fetal growth restriction is associated with umbilical cord encirclement and also that severity of growth restriction was positively related with the number of encirclements, we could not show any significant differences with respect to oligohydramnios and/or SGA/IUGR between the groups. In our study, mean birth weight was 3146±539 in the NC group while it was 3178±595 in the control group (p=0.62). Thus, we believe that birth weight is not affected by presence of NC, as concluded by Carey et al.[17]. Furthermore, we found that presence of NC was significantly associated with parity. Both single and multiple NC

were more frequently observed in multiparous compared with nulliparous women. However, we could not explain the relationship between parity and the development of NC.

Some authors reported increased prevalence of intrapartum fetal heart rate abnormalities, meconium staining and low Apgar scores in fetuses born with NC[4,19-21]. Larson et al.[21] reported that presence of multiple NC entanglements was significantly related with abnormal fetal heart rate pattern during labor ($p<0.001$) and that infants were more likely to have meconium ($p=0.013$), a low 1-minute Apgar score ($p<0.001$), and a low umbilical artery pH (≤7.10). In our study, intrapartum abnormalities including meconium staining, abnormal fetal heart rate patterns and acute fetal distress were not significantly different in fetuses complicated with single NC compared with the controls. However, when we compared neonates complicated with multiple NC with controls, we saw that fetuses complicated with multiple NC had significantly higher rates of intrapartum abnormalities (15.6% vs. 31.3%, $p=0.04$), as suggested by Larson et al.[21]. We also had one stillbirth complicated with five nuchal loops around the fetal neck.

Hankins et al.[20] reported that newborns with NC had an increased prevalence of umbilical artery acidemia and more variable fetal heart rate decelerations in the first and second stages of labor. Also, Martin et al.[22] recently reported increased prevalence of acidosis in newborns with NC compared with the controls. Similar to Martin et al.[22], we found that umbilical artery pH (7.32 vs. 7.30, $p=0.048$), pO2 (37.4 ± 18.1 vs. 31.7 ± 14.4, $p=0.01$), and O2 saturation (57.4 ± 21.8 vs. 48.3 ± 20.4, $p=0.005$) were significantly lower in neonates complicated with NC. NC was reported as associated with transient decrease in umbilical cord blood flow especially during active labor[4]. Worsening of the umbilical cord blood gases may be explained by this mechanical obstruction of the umbilical cord.

Larson et al.[21] reported that presence of multiple NC was associated with low Apgar scores at 1 minute. In our study population, we could not determine any significant differences with respect to presence of single NC and Apgar scores at 1 minute. However, neonates with multiple NC had significantly lower Apgar scores at 1 minute compared with the control group. Some authors have suggested that presence of NC may increase the risk of severe spastic cerebral palsy[16]. It has also been reported that presence of tight NC may increase free oxygen radical activity in the umbilical cord blood of fetuses[30]. Clapp et al.[5] suggested that the presence of tight or multiple NC might be associated with development of subclinical deficit in neurodevelopmental performance at 1 year of age[5]. Nelson and Grether[31] also reported that there may be an association between tight NC and unexplained spastic quadriplegia. However, Greenwood and Impey[32] could not demonstrate an association between cerebral palsy and NC. Pregnancies complicated with multiple NC may demonstrate higher rates of intrapartum abnormalities and low Apgar scores. Also, NC may have long-term developmental effects. While it might thus be suggested that pregnancies complicated with NC should be followed as high-risk pregnancies, this should be confirmed in large prospective studies.

We conclude that the presence of single NC may negatively affect the umbilical cord blood gases without significant perinatal complications, while presence of multiple NC may increase the development of intrapartum complications such as meconium staining, abnormal fetal heart rate and acute fetal distress. Perinatal effects and long-term complications of NC should be investigated with large prospective studies in order to eliminate the potential confounding factors of the retrospective studies.

REFERENCES

1. Singer DB, Macpherson T. Fetal death and the macerated stillborn fetus. In: Wigglesworth JS, Singer DB (eds.). Textbook of Fetal and Perinatal Pathology Vol. 1. Boston: Blackwell Scientific Publications; 1991: 266-267.
2. Hansen HS, Hillersborg B. Antepartum looping of the umbilical cord. Acta Obstet Gynecol Scand 1988; 67: 475-476.
3. Larson LD, Rayburn WF, Crosby S, Thurnau GR. Multiple nuchal cord entanglements and intrapartum complications. Am J Obst Gynecol 1995; 173: 1228-1231.
4. Stembera ZK, Horska S. The influence of coiling of the umbilical cord around the neck of the fetus on its gas metabolism and acid-base balance. Biol Neonate 1972; 20: 214-225.
5. Clapp JF 3rd, Stepanchak W, Hashimoto K, Ehrenberg H, Lopez B. The natural history of antenatal nuchal cords. Am J Obstet Gynecol 2003; 189: 488-493.

6. Assimakopoulos E, Zafrakas M, Garmiris P, et al. Nuchal cord detected by ultrasound at term is associated with mode of delivery and perinatal outcome. Eur J Obstet Gynecol Reprod Biol 2005 Jun 4; [Epub ahead of print].
7. Rejane SS, Philippe J, Cheryl T, Lynn D. Ultrasound diagnosis of quintuple nuchal cord entanglement and fetal stress: http://www.thefetus.net/sections/articles/Cord_placenta_ membranes_amniotic_fluid/Nuchal_cord_Silva_norris.html
8. Collins JH, Collins C, Collins C. Silent risk: issues about the human umbilical cord: http://www.preginst.com/
9. Collins JH. Nuchal cord type A and type B. Am J Obstet Gynecol 1997; 177: 94.
10. Dursun P, Salman C, Özyüncü O, Aksu T. Nuchal cord type B associated with an excessively long umbilical cord as a cause of stillbirth: a case report. Clin Exp Obstet Gynecol 2004; 31: 158-159.
11. Kan-Pun-Shui, Eastman NJ. Coiling of the umbilical cord around the foetal neck. J Obstet Gynaecol Br Emp1957; 64: 227-228.
12. Dippel L. Maligned umbilical cord entanglements. Am J Obstet Gynecol 1964; 88: 1012-1017.
13. Spellacy WN, Gravem H, Fish RO. The umbilical cord complications of true knots, nuchal coils and cords around the body: report from the collaborative study of cerebral palsy. Am J Obstet Gynecol 1966; 94: 1136-1142.
14. Osak R, Webster KM, Bocking AD, Campbell MK, Richardson BS. Nuchal cord at birth impacts on fetal size relative to that of the placenta. Early Hum Dev 1997; 49: 193-202.
15. Sornes T. Umbilical cord encirclements and fetal growth restriction. Obstet Gynecol 1995; 86: 725-728.
16. Nelson KB, Grether JK. Potentially asphyxiating conditions and spastic cerebral palsy in infants of normal birth weight. Am J Obstet Gynecol 1998; 179: 507-513.
17. Carey JC, Rayburn WF. Nuchal cord encirclements and birth weight. J Reprod Med 2003; 48: 460-462.
18. Lipitz S, Seidman DS, Gale R, et al. Is fetal growth affected by cord entanglement? J Perinatol 1993; 13: 385-388.
19. Fisher EL. Cord entanglements and fetal prognosis. Obstet Gynecol 1964; 23: 608-609.
20. Hankins GD, Snyder RR, Hauth JC, Gilstrap LC, Hammond T. Nuchal cords and neonatal outcome. Obstet Gynecol 1987; 70: 687–691.
21. Larson JD, Rayburn WF, Crosby S, Thurnau GR. Multiple nuchal cord entanglements and intrapartum complications. Am J Obstet Gynecol 1995; 173: 1228-1231.
22. Martin GC, Green RS, Holzman IR. Acidosis in newborns with nuchal cords and normal Apgar scores. J Perinatol 2005; 25: 162-165.
23. Strong TH Jr, Sarno AP, Paul RH. Significance of intrapartum amniotic fluid volume in the presence of nuchal cords. J Reprod Med 1992; 37: 718-720.
24. D'Antona D, Aldrich CJ, Spencer JA, Delpy D, Reynolds EO, Wyatt JS. Effect of nuchal cord on fetal cerebral haemodynamics and oxygenation measured by near infrared spectroscopy during labour. Eur J Obstet Gynecol Reprod Biol 1995; 59: 205-209.
25. Jauniaux E, Ramsay B, Peellaerts C, Scholler Y. Perinatal features of pregnancies complicated by nuchal cord. Am J Perinatol 1995; 12: 255-288.
26. Larson JD, Rayburn WF, Harlan VL. Nuchal cord entanglements and gestational age. Am J Perinatol 1997; 14: 555-557.
27. Carey JC, Rayburn WF. Nuchal cord encirclements and risk of stillbirth. Int J Gynaecol Obstet 2000; 69: 173-174.
28. Gonzalez-Quintero VH, Tolaymat L, Muller AC, Izquierdo L, O'Sullivan MJ, Martin D. Outcomes of pregnancies with sonographically detected nuchal cords remote from delivery. J Ultrasound Med 2004; 23: 43-47.
29. Mastrobattista JM, Hollier LM, Yeomans ER, et al. Effects of nuchal cord on birthweight and immediate neonatal outcomes. Am J Perinatol 2005; 22: 83-85.
30. Wang CC, Rogers MS. Lipid peroxidation in cord blood: the effects of umbilical nuchal cord. Br J Obstet Gynaecol 1997; 104: 251-255.
31. Nelson KB, Grether JK. Potentially asphyxiating conditions and spastic cerebral palsy in infants of normal birth weight. Am J Obstet Gynecol 1998; 179: 507-513.
32. Greenwood C, Impey L. The association of nuchal cord with cerebral palsy is influenced by recording bias. Early Hum Dev 2002; 68: 15-19.