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ORIGINAL RESEARCH

Cord Length, Umbilical Artery Lactate Concentration and Perinatal Outcomes of Babies with Nuchal Cord at Ile-Ife, Nigeria

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Abstract

Background: There is inconclusive evidence on the relevance of the nuchal cord in obstetric practice.
Objectives: This study aims to evaluate the umbilical artery lactate concentration and perinatal outcomes of babies born with a nuchal cord.
Methods: In a cross-sectional study at the Obafemi Awolowo University Teaching Hospital, babies born with a nuchal cord at term and matched controls without a nuchal cord were recruited between January 2017 and December 2018. Gestational age at delivery, meconium-stained liquor, foetal heart rate abnormalities, Caesarean section rates, cord lengths and umbilical artery lactate concentrations were compared. The umbilical artery lactate concentration was assayed with the Lactate-Plus®; neonatal acidosis was defined as cord lactate concentration > 4.9mmol/L.
Results: One hundred and forty-four babies with nuchal cords and 144 controls were recruited. The prevalence of nuchal cord was 3.4%, with 80% of the babies having a single loop. Babies with nuchal cords had longer mean cord length (57.7cm vs 45.4cm; p<0.01), higher mean umbilical artery lactate (4.93mmol/L vs 3.48mmol/L; p = 0.04), meconium-stained liquor (16% vs 3.2%; Relative risk = 4.6), more babies with Apgar score <7 at fifth minute (9 versus 4 babies) and increased perinatal mortality (55.5/1000 births vs 13.8/1,000 births; Relative risk = 4). There was a positive correlation between cord length and the number of nuchal loops (r = 0.5, p<0.01).
Conclusions: Nuchal cord is associated with abnormal cord lactate concentration and adverse perinatal outcomes. Prenatal reporting may enhance intrapartum surveillance and improve perinatal outcomes.

Keywords: Birth asphyxia, Cord lactate, Perinatal mortality, Meconium-stained liquor, Nuchal cord.

Introduction

The umbilical cord provides a vital conduit for the materno-foetal exchange of gases and the transfer of glucose, vitamins and other minerals essential for optimal foetal growth and development through the placenta. It also serves as a channel for excretion, thereby preventing the accumulation of toxic wastes within the foetus. These functions are sometimes interrupted by unanticipated events, collectively regarded as Umbilical Cord Accidents (UCA). These include cord prolapse, true cord knots, nuchal cords and cord entanglements in monoamniotic twins. [1, 2] Given the essential functions of the umbilical cord, UCAs could be immediately life-threatening to the foetus. While there are clear guidelines on the assessment, preventive steps and management of cord presentation and cord prolapse, [1] there is equipoise on how best to manage foetuses with prenatally diagnosed nuchal cords, defined as the presence of encircling loop(s) of umbilical cord around the foetal neck. [3]

An Indian study reported nuchal cord incidences of 5.32%, 1.14%, and 0.17% for one, two and three cord loops, respectively. [3] Nuchal cords with four or more loops around the foetal neck are rare, although six, eight and nine loops have been reported previously. [4, 5] Although the determinant of the number of nuchal loops remains unclear, it is proposed that this may be directly related to the length of the umbilical cord. While live births were recorded in all the referenced cases, the multiple loops, nevertheless, nuchal cord, especially if taut, may contribute to adverse obstetric outcomes, including meconium-staining of liquor, foetal heart rate abnormalities in labour, prolonged second stage of labour, increased need for surgical intervention in labour, perinatal asphyxia and perinatal mortality. [6]

With improved resolution in prenatal ultrasonography and the advent of power and colour Doppler scans, [7] it has become feasible to diagnose nuchal cords prenatally, as depicted in Figure 1.

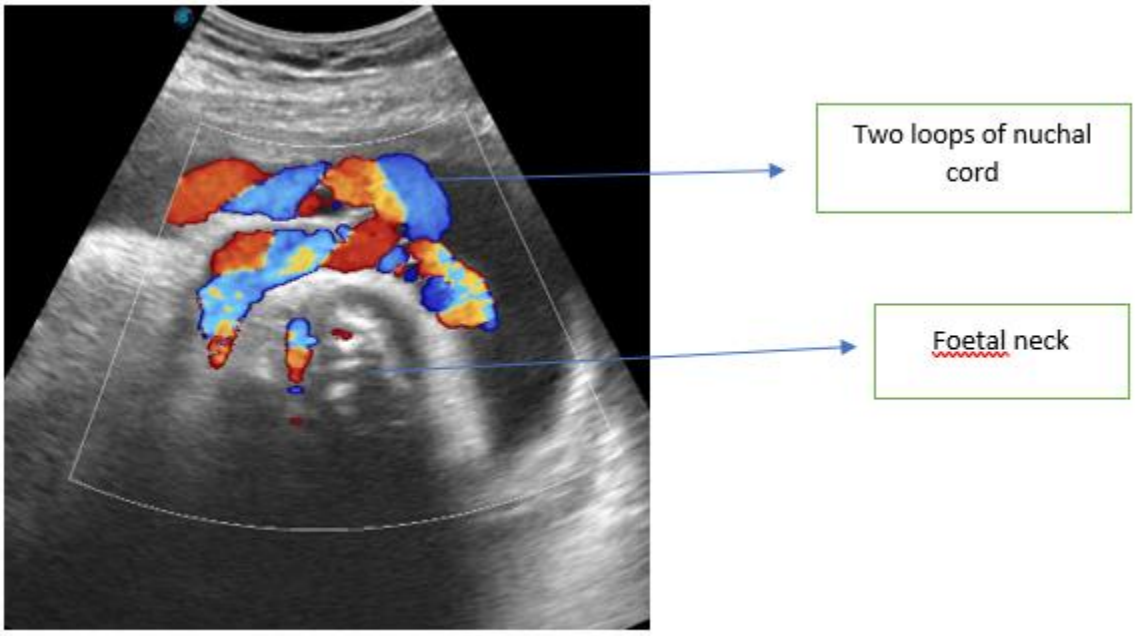

Figure 1: Prenatal sonographic image of nuchal cord, demonstrated with colour Doppler.

The sensitivity and specificity of prenatally diagnosed nuchal cord were 80.5% and 86.6%, respectively, from pooled data. [8] However, utilising this information to influence perinatal outcomes during clinical management directly is challenging, as most newborns with nuchal cords survive without morbidity. To this effect, it may be difficult to make recommendations on prenatal reporting and possible interventions for the nuchal cord, as other local and contextual factors may contribute to the eventual perinatal outcomes of such babies. To this effect, centres and regions with similar capabilities, human and material-wise, may preferably appraise the outcomes of such pregnancies and make appropriate recommendations.

Foetal hypoxia and acidosis manifest as perinatal asphyxia, which is detected using the APGAR score after delivery. The score is used to identify babies that require resuscitation postnatally, determine the extent of the needed resuscitation and appraise the transition of newborns into extra-uterine life. Despite its widespread relevance and proven benefits, the APGAR score has some limitations, as it could be subjective, with significant inter-observer variability. It may also be affected by other factors, such as maternal medications, anaesthesia and congenital anomalies, which may not be related to metabolic acidosis. [9] Umbilical artery lactate concentration may be measured in addition to the APGAR score, as lactate is a direct product of anaerobic metabolism, the predominant pathway in hypoxic foetuses. Therefore, this study was designed to evaluate the mean cord length, umbilical artery lactate concentration and perinatal outcomes of newborns with nuchal cords and to make recommendations based on the study's outcomes as appropriate to medical practitioners within the context of a Nigerian tertiary health facility.

Methods

This cross-sectional, analytical study was conducted at the Department of Obstetrics and Gynaecology and the Department of Paediatrics and Child Health of the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Osun State, Nigeria, from January 2017 to December 2018. The two departments are accredited for postgraduate speciality training and operate a consultant-led care system, with facilities for continuous electronic foetal monitoring in labour, obstetric Doppler ultrasonography and emergency Caesarean section. The Special Care Baby Unit has the capacity for continuous electronic monitoring, Continuous Positive Airway Pressure (CPAP), thermal and feeding support, and the administration of surfactants to newborns as necessary.

The inclusion criteria for the study include term gestation and appropriately grown foetus for gestational age, as estimated by the patient's last menstrual period or early ultrasound scan when available. Pregnancies that were complicated by conditions that could predispose to perinatal asphyxia, including hypertensive disorders of pregnancy, diabetes mellitus, babies exposed to general anaesthetics at Caesarean section, severe congenital abnormalities that are incompatible with life or may cause cardio-respiratory distress, foetal growth restriction, prematurity and intra-uterine foetal demise were excluded.

Consecutive parturients were counselled about the need to record their data for this research using a purpose-designed proforma, if their babies were born with a nuchal cord or if they were selected for the control arm of the study. For each baby born with a nuchal cord between 37-41 weeks + 6 days gestation, another gestational-age

matched baby delivered without a nuchal cord was recruited into the study as a control. Data related to the socio-demographic characteristics of the parturients and their labour was recorded in the purpose-designed proforma, including the gestational age at delivery, presence of fresh meconium-staining of the liquor, foetal heart rate abnormalities in labour, duration of the second stage of labour, need for operative interventions, and the neonatal outcome up to seven days postpartum. Where assisted vaginal delivery or an emergency Caesarean section was undertaken, the indications were recorded accordingly. Ethical approval for this study was obtained from the Institutional Research Board (IRB/IEC/0004553/ERC/20/10/08).

The number of loops around the neck was recorded for babies with a nuchal cord at birth. Following delivery, the umbilical cords were divided between clamps. The babies were assessed and resuscitated as necessary by the Delivery Suite team on duty comprising midwives and doctors, depending on the Apgar scores assigned by the Delivery Suite Team. Immediately after delivery and clamping of the cord, the umbilical arteries were identified before delivery of the placenta, and 1 ml of blood was obtained from one of the vessels. The umbilical artery cord lactate concentration for each baby was determined by applying an equivalent of 5uml of cord blood to the Lactate-Plus® (Nova-Biomedicals) meter strip by a trained member of the Delivery Suite team, and the concentration of cord lactate was displayed within 15 seconds. Following the delivery of the placenta, the neonatal and placental ends of the divided umbilical cord were held taut and measured with silk sutures by the Doctor on duty in the Delivery Suite team. The actual length was after that determined as the sum of the two lengths of the silk sutures using the same standardised inelastic tape measures. Serial standardisation of the lactate meter was done weekly with the manufacturers' high- and low-control solutions. For this study, neonatal acidosis was defined as cord lactate concentration > 4.9mmol/L. [10]

Data analysis

This was done with IBM SPSS® 22.0, Chicago, USA. At a confidence interval of 95% and a power of 80%, the number of newborns required to detect a difference of at least 1.5mmol/l in the umbilical artery cord lactate concentrations was calculated to be 140 in each arm. [11] The mean duration of the second stage of labour was determined from when the patient started bearing down to the baby's delivery. Cord lengths and umbilical artery lactate concentrations of the two groups were compared using the T-test, and $P<0.05$ was considered statistically significant. Odds ratio and relative risk were calculated as necessary.

Results

There were 144 babies with nuchal cords out of 4,218 term deliveries, giving a prevalence of 3.4%. Overall, the mean age of the parturients was 31.03±5.13 years (range: 18-50 years), while the median parity was 2 (interquartile range: 1-3). The mean gestational age at delivery was comparable between the nuchal cord and the control groups, 38.4±2.0 weeks and 37.6±2.4 weeks, respectively. The duration of the second stage of labour was longer in the nuchal cord group, although the difference did not attain statistical significance, as depicted in Table I. There were 70 (48.6%) Caesarean deliveries in the nuchal cord group, compared with 56 (38.9%) Caesarean sections in the control group, as presented in Table I. Concerning the indications, 31 (21.5%) Caesarean sections were undertaken due to foetal distress in the nuchal cord group, compared with 10 (6.9%) surgeries among the control group (Odd ratio = 1.68).

Table I: Comparison of the demographic and biometric profile of babies with nuchal cord and the controls

Variable	*Nuchal cord*		*Statistics*
	Present	*Absent*	
Mean EGA at delivery (weeks)	38.4±2.0	37.6±2.4	p = 0.056
Mean Duration of 2nd stage (minutes)	28.3±3.9	17.9±2.4	p = 0.245
Mean Birth weight SD (Kg)	3.03 ± 0.57kg	2.83 ± 0.62kg	p = 0.095
Caesarean section: n (%)	70 (48.6)	56 (38.9)	
Caesarean section for foetal distress (%)	31 (21.5%)	10 (6.9%)	
Mean Cord length (cm)	57.7	45.4	p<0.001
Mean Cord lactate concentration (mmol/L)	4.93	3.48	p<0.001

EGA – Estimated Gestational Age; SD – Standard deviation.

Table I shows no statistically significant difference in the mean birth weight of babies born with and without nuchal cords (p = 0.095). Babies with nuchal cords had significantly longer mean cord lengths (57.7 cm vs 45.4 cm; p<0.01). There was a positive correlation between cord length and the number of nuchal loops of the cord (r = 0.5, p<0.01). Table II shows that most babies (80.6%) had only one cord loop around the neck.

Table II: Distribution of newborns based on the number of loops of the nuchal cord (N = 144)

Number of loops	*Frequency*	*Percentage*
1	116	80.6
2	18	12.5
3	6	4.2
4	4	2.7

Twenty-three and five babies had fresh meconium-staining of liquor in the nuchal and control groups, respectively (16% vs 3.2%; Relative risk = 4.6). Babies with nuchal cord had significantly higher mean umbilical artery lactate (4.93 mmol/L vs 3.48 mmol/L; p = 0.04). More babies in the nuchal cord group (11 (7.2%) versus 4 (2.8%), RR = 2.75) had umbilical artery cord lactate greater than 4.9mmol/L.

Apgar score less than seven at the fifth-minute post-delivery was more prevalent in the nuchal cord group (9 (6.2%) babies versus 4 (2.8%) babies in the control group, and this translated to a correspondingly higher number of admissions into the neonatal care unit amongst newborns with nuchal cord at birth. All 13 babies with Apgar scores less than seven at the fifth minute of life had umbilical artery cord lactate greater than 4.9mmol/L. However, two other babies in the nuchal cord group had elevated arterial lactate concentrations but with normal APGAR scores at birth; both babies were admitted into the NICU within 24 hours of delivery. The prevalence of stillbirth was higher in the nuchal cord group but not statistically significant (7 (4.9%) vs 2 (1.4%); p = 0.178). In addition, there was one early neonatal death on the third day of life from complications of birth asphyxia in the nuchal cord group, while no death was recorded in the control group. Overall, the perinatal mortality rates of the nuchal cord and the control groups were 55.5/1000 total births and 13.8/1,000 total births, respectively (Relative risk = 4.0). Five stillbirths had a single loop of the nuchal cord, while two babies had two loops. There was no statistically significant relationship

between the number of loops around the neck and the risk of having a stillbirth (p = 0.475).

Discussion

The nuchal cord was associated with longer mean cord length, significantly higher Caesarean section rates, increased risk of hospitalisation in the neonatal intensive care unit and increased relative risk of perinatal mortality compared with babies delivered without a nuchal cord in the present study. The comparable birth weights among babies with nuchal cord and the control group, in tandem with reports from an earlier study, [12] however, suggests that the effects of the nuchal cord on obstetric outcomes reflect an acute compromise in umbilico-placental circulation, rather than a chronic impediment to blood flow.

The reported prevalence of the nuchal cord in this study is similar to the prevalence reported in earlier studies. [8, 12] Although a higher prevalence of 22% was previously reported in a meta-analysis, the population in that study demonstrated significant heterogeneity, and other cord abnormalities, including cord knots and cord entanglements, were included in the analysis. [8] True cord knots and nuchal cords are reportedly associated with longer cord lengths. [13] Although a meta-analysis reported the mean cord length at 39 weeks to be 55 cm among a heterogenous pool of newborns across different ethnic settings, [8] there is no universally accepted gestational age-specific normative reference for umbilical cord length. To address this, the present study utilised gestational age-matched controls at term from the same population. This confirmed that the umbilical cords were, on average, about 12 cm longer among newborns compared to those without nuchal cords. The significant correlation with the number of loops around the foetal neck further underscores the relevance of the length of the cord. The reasons some newborns may have longer umbilical cords than others, thereby predisposing them to heightened risks of cord accidents, is still a subject of further research. Most of the neonates in this study had a single loop of nuchal cord, in tandem with the findings from an earlier study which reported the incidence of single cord loop to be 77% of all babies born with nuchal cord. [3] Also, as reported earlier, the number of nuchal loops did not correlate with the risk of stillbirths, [3] further indicating that other factors may contribute to the dangers of adverse outcomes beyond the number of nuchal loops.

So far, the data from previous studies regarding the association between nuchal cords and adverse obstetric outcomes are conflicting. While a study reported significantly higher adverse obstetric outcomes, [14] others could not corroborate this assertion. [3, 15] In the present study, the findings support increased risks of adverse outcomes. It is indeed possible that the impact of nuchal cords on obstetric outcomes may also depend on other factors that transcend how tightly wound the cord is or the number of loops. Other contextual factors, such as the delivery setting, availability of continuous electronic monitoring in labour, emergency preparedness for intervention for foetal heart rate abnormalities, the decision-to-delivery interval during obstetric emergencies and the capacity for neonatal resuscitation may contribute significantly to the eventual perinatal outcomes of such babies.

This study confirmed that the mean umbilical artery cord lactate concentration was significantly higher among foetuses with a nuchal cord than the controls. A higher proportion of newborns in the nuchal cord group had lactate concentrations above the normative reference. Furthermore, metabolic acidosis was diagnosed in two babies that later needed Neonatal Intensive Care Unit admission, despite having normal APGAR scores at birth.

Surveillance was instituted for the two babies at birth, resulting in the early detection of depressed activities. As observed in the present study, the higher sensitivity of umbilical artery lactate in predicting neonatal morbidity is comparable to results from an earlier study [16] that reported that lactate is superior to APGAR score and cord pH at predicting adverse neonatal outcomes. The hand-held lactate meter technology adopted for this study had been shown to have 99.7% accuracy when compared with the YSI 2300 Stat Plus Analyzer, a laboratory reference method for analysing serum lactate concentration. [17] The hand-held device method may become even more helpful, especially in low- and middle-income countries, as previously reported by researchers in Malawi. [18]

One of the strengths of this study is the prospective enrolment of babies born with a nuchal cord, resulting in the generation of complete and accurate data. In addition, using arterial lactate measurement to assess neonatal acidosis mitigated the possible bias inherent in using APGAR scores alone. Lastly, the inclusion of a control group makes a direct comparison of the parameters among babies with and those without nuchal cord feasible. A limitation of the study is the use of a hand-held lactate meter, which has yet to be approved for research purposes. However, the study outcomes remained the same, as the meter's accuracy had earlier been validated. [17, 18] Due to the high subjectivity in assessing the tension in nuchal cords, this was not addressed in this study. Further research on estimating the tension in nuchal cords may be necessary to address this limitation objectively.

Conclusion

The delicate balance between reducing stillbirths and other adverse perinatal outcomes on the one hand, and the risks of antenatal or intrapartum obstetric interventions on the other, can only be achieved by conducting appropriately designed studies. The nuchal cord is associated with abnormal umbilical artery cord lactate concentration and a heightened risk of adverse perinatal outcomes compared with babies born without nuchal cords in this study. While the optimal management of prenatally diagnosed nuchal cords remains challenging, the opportunity to offer improved surveillance, including continuous electronic foetal monitoring in labour, may justify antenatal reporting of nuchal cords as this may ultimately translate to improved perinatal outcomes. Further research is recommended on this subject to provide additional evidence that may guide recommendations and the development of guidelines.

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Authors' Contributions: AIO, BOO1 and AOA conceived and designed the study. AIO, BOO1, AOA, BOO2, SOO, AHC and AT conducted data collection, analysis and interpretation. AIO drafted the manuscript. All the authors critically reviewed the manuscript for sound intellectual content and approved the final version of the manuscript.

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