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ORIGINAL ARTICLE

Nuchal Cord Tension: Examining its Impact on Developmental Outcomes in Two-Year-Old Children

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Abstract

Introduction: Investigating how nuchal umbilical cord tension affects the developmental journey of newborns until their first year's completion.

Methods: Our study, conducted in two participating hospitals, spanned a duration of five years. The study encompassed newborns categorized into three groups: those with a tightly wrapped nuchal cord, those with a loosely wrapped nuchal cord, and a control group consisting of newborns without a nuchal cord. Both cohorts underwent evaluations utilizing Apgar scores and conventional cardiotocography (CTG) results. The developmental advancements of the newborns were assessed by employing the Munich Functional Scale upon reaching the conclusion of their initial year.

Results: The incidence of Apgar scores below 7 was markedly higher ($p<0.001$) among newborns with a nuchal cord when compared to the control group. Within the group of newborns with a nuchal cord, those with a tightly wrapped cord exhibited considerably lower Apgar scores in comparison to those with a loosely wrapped cord ($p<0.001$). Statistically significant pathological cardiotocographic findings were identified in newborns with a nuchal cord in comparison to the control group. Within the neonatal cohort, the cardiotocographic data of infants with a tightly wrapped nuchal cord were significantly lower than those with a loosely wrapped nuchal cord ($p<0.001$). At the age of two years, infants who were born with a tightly wrapped nuchal cord exhibited a notable developmental delay when compared to those born with a loosely wrapped nuchal cord and the control group ($p<0.001$).

Discussion and Conclusion: The presence of a nuchal cord poses a risk factor for subsequent developmental concerns. Timely identification of the nuchal cord, particularly when it is tightly wrapped around the neck, is of utmost importance in mitigating potential future health complications.

Keywords: Apgar score; Cardiotocographic findings; Developmental outcome; Nuchal cords.

Nuchal cord (NC) is defined as the complete wrapping of the umbilical cord around the neck of the fetus, encompassing a full 360 degrees[1]. Since ancient times, starting from the era of Hippocrates, the potential risks linked to this condition have been acknowledged, underscoring its influence on perinatal outcomes and morbidity[2,3]. Prior research has presented diverse estimates regarding the occurrence of NC, ranging from 9% to 30%, with a higher incidence noted as gestational age progresses[4,5]. Although there is no consensus among various studies regarding the association between NC and perinatal morbidity and mortality[5], a limited number of

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inquiries suggest that NC could indeed impact perinatal outcomes and potentially influence the future health of the child[5-7]. NC can be categorized into two distinct classifications: loose nuchal cord (l-NC) and tight nuchal cord (t-NC). When a t-NC occurs, there is constriction applied to the umbilical cord, impeding the blood flow through the narrower umbilical veins. Consequently, this restricted blood flow can give rise to hypovolemia, acidosis, and anemia[5,6]. As a result, tight nuchal cord (t-NC) is commonly linked to unfavorable perinatal outcomes and subsequent developmental difficulties in children[8,9]. The pathophysiological mechanisms stemming from the compression or blockage of umbilical veins lead to a reduction in cerebral blood flow, which in turn can cause hypotension, hypovolemia, and the potential for both reversible and permanent brain damage. These factors have enduring consequences for the developmental pathways of the central nervous system[5,6,8,10-12]. Our study aimed to investigate the significance of NC and the degree of cord tightness in relation to the neurodevelopmental outcomes of newborns by the conclusion of their first year of life.

Materials and Methods

Study Design

This retrospective case-control study was carried out over a period of five years, spanning from January 2015 to December 2020. The study cohort consisted of 200 newborns born at full term who were diagnosed with NC either during pregnancy or delivery, constituting the "examined group." A control group of 200 newborns without NC was also included. Our study has received approval from the research ethics committee in accordance with the fundamental principles of the Helsinki Declaration (Afyon Kocatepe University, 2030-KAEK-3,121-12.06.2021). Informed consent has been obtained from participants, and measures have been taken to ensure privacy. Throughout the study, utmost care has been taken to respect human rights and prioritize the safety of participants. Within the examined group, two subgroups were identified: one with tight NC (t-NC) and another with loose NC (l-NC). The control group was chosen among term deliveries at the same period with a 1:1 ratio.

The inclusion criteria for this study included pregnancies that were normal and resulted in full-term deliveries. In these cases, the umbilical cord was observed to be wrapped around the neck either once or multiple times, without any other abnormalities. However, certain cases were excluded from the study, such as preterm deliveries (less than 37 weeks), pregnancies with complications like maternal infections, bleeding disorders, metabolic or hemodynamic disorders, and fetal anomalies.

The fetal heart rate (FHR) was observed and recorded using a technique called cardiotocography (CTG). The CTG findings were classified into two categories: regular or pathological. A regular CTG was defined as a fetal heart rate ranging from 110 to 160 beats per minute. Any deviations from this range were considered pathological. Additionally, the newborns' condition was assessed using the Apgar scoring system, which is a standard method. This assessment was conducted at one and five minutes after birth, and scores ranged from 0 to 10.

Cord tightness was assessed using Peesay's classification, which included four grades (I to IV) indicating progressively more severe clinical symptoms related to cord compression. The growth and development of all children were consistently monitored at an outpatient clinic, with scheduled follow-up visits and neurological assessments conducted during the first year of life. The Munich developmental scale (MFED) was utilized to assess different facets of development, such as motor skills, sensory abilities, speech development, and socialization. After the completion of the first year, the neurodevelopmental outcomes were categorized as normal, slightly deviating, or deviating based on the findings from the MFED evaluation. If any deviations were detected, additional assessments were performed to evaluate hearing and vision.

The study was designed to investigate the correlation between NC and neurodevelopmental outcomes, while considering the severity of cord tightness. Through comprehensive evaluations and close monitoring of the children throughout the first year, the study aimed to gain valuable insights into the potential effects of NC on early developmental paths.

Results

For the purpose of analysis, 400 newborns were categorized into two separate groups: the examined group and the control group. The examined group comprised 200 newborns who had NC wrapped around their neck either once or multiple times. The examined group was then subdivided into two subgroups, namely l-NC and t-NC, each consisting of 100 newborns. On the other hand, the control group consisted of 200 newborns who did not have NC. Newborns with NC (both l-NC and t-NC) had notably lower Apgar scores in comparison to the control group ($p<0.001$) (Table 1).

Table 1. APGAR score in the examined group (compared to newborns with t-NC and l-NC)

Apgar	t - NC N (%)	l- NC N (%)	p*
1-3	15	0	<0.001
4-7	33	5	
8-10	52	95	

(t-NC) tight nuchal cord; (l-NC) loose nuchal cord.

Table 2. Assessment of neurodevelopmental outcomes at the first year of life for both the t-NC group and the l-NC group

	Normal	Abnormal	p*
t-NC			
St1	92	21	<0.001
St2	6	61	
St3	2	12	
St4	0	5	
l-NC			

(t-NC) tight nuchal cord; (l-NC) loose nuchal cord.

Table 3. Comparison of Neurodevelopmental outcome in newborns with NC (I e NC and t-NC) and without NC at age 1 year

	Control %	NC %	p
Deviation	5	70	<0.001
Regular	195	129	
Exitus	0	1	

NC: Nuchal cord.

Peesay's grading system demonstrated that among newborns with t-NC, 47 (75%) were categorized as grade I, 37 (75%) as grade II, 11 (0%) as grade III, and 5 (5%) as grade IV. Newborns with t-NC exhibited considerably lower Apgar scores compared to those with l-NC. Furthermore, the prevalence of pathological cardiotocography (CTG) findings was higher in newborns with t-NC than in those with l-NC. The assessment conducted at the end of the first year using the Munich Functional Scale for the Evaluation of the Development of Infants (MFED) indicated that newborns with l-NC had more favorable developmental outcomes. Out of the total, 173 (25%) demonstrated typical development, while 27 (75%) showed variations. Among newborns with t-NC, 82 (77%) exhibited normal psychomotor development. Our research demonstrated significant neurodevelopmental discrepancies in newborns with t-NC when compared to both the control group and newborns with l-NC (χ^2=34.19, p<0.001). A few patients with minor deviations (two patients) and extreme values (one patient) during testing were excluded from the analysis. Table 2 presented the evaluation of neurodevelopment at the end of the first year of life for both t-NC (graded by Peesay) and l-NC. The statistical analysis indicated a noteworthy neurodevelopmental difference in children with t-NC at the age of one (χ^2=34.19, p<0.001).

However, conducting a thorough assessment of neurodevelopment at the end of the first year was challenging due to the restricted number of patients in t-NC grades I-IV. The data provides a comprehensive overview of all grades of t-NC in comparison to l-NC. Remarkably, at two years of age, there were neurodevelopmental discrepancies observed in 55 instances (34.38%) within the test group, whereas only one case (0.87%) exhibited deviations in the control group. This difference was statistically significant (χ^2*=45.829, p<0.001) as indicated in Table 3.

Discussion

The primary objective of this study was to explore the occurrence and consequences of NC on outcomes related to neonatal health and neurodevelopment in full-term newborns. In our research, we observed a higher incidence of NC (29.01%) compared to previous studies that encompassed both preterm and full-term infants, where the reported incidence ranged from 6% to 29%. This discrepancy can be attributed to our exclusive focus on term newborns. Additionally, a higher proportion of male newborns with NC was observed, consistent with findings from other studies. Our results revealed a significant association between NC and lower Apgar scores, indicating severe asphyxia. Specifically, newborns with tight NC (t-NC), particularly in stages III and IV, exhibited significantly lower Apgar scores. However, using oxygen saturation measured by SpO2 monitoring as an indicator of asphyxia lacked sensitivity in detecting compromised oxygenation. Prolonged pathological cardiotocography (CTG) findings were observed in a considerable number of newborns with NC, but not all of them exhibited neurodevelopmental deviations. Measuring the pH value of umbilical veins (arteries) would have offered a more dependable parameter, but it was not practically achievable within the scope of our study.

Tracking fetal heart rate (FHR) via CTG revealed irregular patterns in response to fetal asphyxia, which can contribute to alterations in cerebral blood flow and early brain damage, potentially leading to neurodevelopmental deviations. Nevertheless, there is limited research available that has specifically investigated the connection between abnormal cardiotocography (CTG) results during

childbirth, NC, and the subsequent neurodevelopmental outcomes in children. The findings of our study revealed a significant proportion of neurodevelopmental disparities in children with NC when evaluated using the Munich Functional Scale for the Evaluation of the Development of Infants (MFED). When comparing children with NC to the control group, we noted significant neurodevelopmental variations in the former. Furthermore, when differentiating between tight NC (t-NC) and loose NC (l-NC), we found a statistically significant rise in neurodevelopmental deviations among one-year-old children with t-NC.

Other studies have also reported a decrease in psychomotor scores and signs of hypoxia in infants with NC. Our findings align with these studies, highlighting the association between NC, low Apgar scores, pathological CTG patterns, and poorer neurodevelopmental outcomes. However, some studies fail to establish a correlation, indicating the need for further investigation. The adverse socio-economic conditions and inadequate perinatal healthcare provisions in Türkiye may contribute to the observed outcomes. Similar research in other war-affected nations with low Gross Domestic Product has shown similar trends. Therefore, early intrauterine diagnosis, particularly of t-NC, is crucial to identify potential risks of asphyxia, hypoxia, ischemia, and subsequent brain damage, ultimately leading to developmental deviations. Comprehensive monitoring of all developmental parameters is essential, as few studies have conducted prospective long-term monitoring of these children's development.

Limitations of Study

The principal factor constraining the scope of our study is its retrospective planning. Additionally, our study had limitations in terms of short-term monitoring throughout the first year of life, and few studies have extended their monitoring to encompass neurodevelopment over an extended period. However, previous research with a small sample size has demonstrated a significant proportion of infants with t-NC experiencing neurodevelopmental deviations due to pathophysiological mechanisms.

Conclusion

NC represents a risk factor that may contribute to subsequent neurodevelopmental deviations. The prompt detection of NC, coupled with the presence of abnormal cardiotocography (CTG) results and a low Apgar score below 7 (especially in instances of tight NC), plays a crucial role in preventing future health complications. Early prenatal identification of NC, careful monitoring during childbirth, and swift recognition of neurodevelopmental discrepancies contribute to enhanced developmental outcomes for affected children.

Ethics Committee Approval: The study was approved by the Afyon Kocatepe University Clinical Research Ethics Committee (no: 2030-KAEK-3,121, date: 12/06/2021).

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