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Original Research Article

Effect of the umbilical cord length on mode of delivery and perinatal outcome

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ABSTRACT

Background: The umbilical cord is a vital anatomical structure connecting the fetus to the placenta, and its length along with the presence of nuchal loops may influence labor progression and neonatal outcomes. This study aimed to evaluate the relationship between umbilical cord length and mode of delivery, duration of labor, neonatal APGAR scores, NICU admissions, and incidence of fetal distress.
Methods: A prospective observational study was conducted at Al-Ameen medical college hospital from July 2023 to January 2025, involving 200 pregnant women. Umbilical cord length and the presence and number of nuchal loops were documented at delivery. Maternal and neonatal outcomes, including mode of delivery, labor duration, fetal distress, and neonatal parameters, were recorded and analysed statistically.
Results: The mean umbilical cord length was 50.68±11.75 cm. Although the incidence of caesarean delivery was higher in both short and long cord groups, the difference was not statistically significant (p=0.217). Labor duration was significantly prolonged in cases with nuchal cord, particularly among primigravida (17.62±1.38 h vs. 11.95±1.49 h). Neonates with nuchal loops had lower APGAR scores at 1 and 5 minutes (p=0.003), and NICU admission rates were higher among those with multiple loops (p<0.001). Fetal distress increased significantly with number of nuchal loops (p<0.0001).
Conclusions: Abnormal cord length and multiple nuchal loops are significantly associated with prolonged labor, fetal distress, increased incidence of instrumental delivery, caesarean section due to cephalopelvic disproportion due to deflexed head, low APGAR score, NICU admission. Patients with 2-3 loop of cord around the neck can have normal vaginal delivery. There is increasing rate of caesarean section due to ultrasound diagnosis of cord around the neck at term, because of obstetrician distress and patients request rather than obstetric indication.

Keywords: Umbilical cord length, Nuchal cord, Mode of delivery, APGAR score, NICU admission, Foetal distress, Labor duration

INTRODUCTION

Originating from the Latin phrase “funiculus umbilicalis”, the umbilical cord is a necessary link between the placenta and the growing embryo or foetus.[1] Structurally composed of two arteries and one vein, the umbilical cord is vulnerable to complications such as kinking, twisting, and vascular compression. Wharton’s jelly usually surrounds these veins, and further protection comes from the amniotic fluid and the helical pattern of blood vessels, also known as the spiral course.[2]

Short umbilical cords (<5 cm) may lead to complications such as prolonged second-stage labor, abnormal foetal heart rate patterns, placental abruption, cord rupture, intrauterine growth restriction (IUGR), uterine inversion, increased foetal distress during labor, thereby elevating the risk of intrauterine foetal demise.

In contrast, excessively long cords (>80 cm) are associated with cord prolapse, twisting, true knot formation, nuchal cord entanglement, obstructed labor, foetal distress, and congenital anomalies.[3]

The length of the umbilical cord is influenced by both amniotic fluid volume and the extent of foetal activity. In addition, Shorter cords rarely form loops and are related to diminished foetal movement and persistent oligohydramnios.[4-6] While those up to 45 cm are more prone to looping, including nuchal cords, which can further shorten effective cord length during labor and increase fetal compromise risk.[3] Such abnormalities correlate strongly with non-reassuring fetal heart rate (NRFHR) patterns and a higher incidence of caesarean sections.[3] However, some studies indicate that while short cords increased caesarean delivery, they were not significantly associated with adverse outcomes like stillbirth or low APGAR scores, highlighting the complexity of cord-related effects on perinatal health.[7-12]

Umbilical cord coiling is typically considered fully established by the end of the first trimester and remains stable thereafter; however, the cord continues to elongate between the established coils as gestation progresses.[13] Ultrasonographic assessment in the second trimester allows for an accurate estimation of the umbilical coiling index (UCI).[14] Studies have reported that non-coiled umbilical cords are linked to an approximately 8-10% stillbirth risk. These non-coiled cords have also been associated with a higher incidence of IUGR, oligohydramnios, foetal abnormalities, foetal heart rate deceleration during labor, foetal distress requiring intervention, meconium-stained amniotic fluid, preterm labor, low APGAR scores, reduced pH levels in the umbilical artery, neonatal intensive care unit (NICU) admissions, and gestational diabetes mellitus.[13,15]

Umbilical cord anomalies, such as cord entanglement, are present in up to 20% and short cords in 9% of fetuses in some studies.[16] These anomalies are linked with abnormal cardiotocography (CTG) and increased NICU admissions.[17] Especially, abnormal CTG patterns correlate with the presence of umbilical cord anomalies and NRFHRs, significantly increasing the need for emergency caesarean sections.[3] Prenatal ultrasound measurement of cord length can identify pregnancies at risk for caesarean delivery and fetal distress, facilitating closer monitoring.[10] Continuous fetal heart rate monitoring has improved early detection of fetal distress in cases with short cords, likely reducing perinatal morbidity despite more frequent operative interventions.[3]

This study aimed to assess the effect of umbilical cord length and nuchal cord loops on the mode of delivery, duration of labor, neonatal APGAR scores, incidence of fetal distress, and NICU admission in the term pregnancies.

METHODS

This prospective observational study was conducted at the department of obstetrics and gynaecology, Al-Ameen medical college and hospital, Vijayapura, Karnataka, between July 2023 and January 2025.

Sample size

The required sample size was calculated using the formula $n= z^2p(1-p)/e^2$, where z=1.96, p=0.1519, and e=0.05. The calculated sample size was 198; for convenience, a total of 200 participants were included.

Inclusion criteria

The study included pregnant women aged 18-35 years, with a singleton pregnancy in vertex presentation, estimated gestational age of 37-41 weeks, and no medical comorbidities such as hypertension or diabetes mellitus.

Exclusion criteria

Women with malpresentation, multiple gestation, placenta previa, abruptio placenta, intrauterine fetal death, preterm labor, pre-eclampsia, gestational diabetes mellitus, or anaemia were excluded.

Methodology used

At the time of delivery, the umbilical cord was clamped 5 cm from the foetal end, and the total length was measured using a flexible measuring tape from the cut end to the placental insertion site. An additional 5 cm was added to account for the foetal end, and excessive traction was avoided during measurement.

The presence of nuchal, shoulder, or body cord loops was also recorded. The mode of delivery (vaginal or caesarean), duration of labor, and any obstruction were recorded for all patients. Neonatal outcomes were assessed based on APGAR scores at 1 and 5 min and NICU admission if required. Term scan ultrasonography was performed to assess the presence of cord loops around the neck and body.

Statistical analysis

Data are presented as mean, standard deviation, frequency, and percentage. Categorical variables were compared using Pearson's chi-square test. Significance was defined as $p<0.05$ using a two-tailed test. Data analysis was performed using the IBM SPSS version 25.

Ethical considerations

This study was approved by the institutional ethics committee (IEC), and all patients provided written informed consent before participating. This study was conducted in accordance with the ethical guidelines for clinical research.

RESULTS

The mean age of the patients was 24.20±4.10 years, and the mean gestational age at delivery was 38.94±1.11 weeks. The mean clinically estimated foetal weight was

3.01±0.45 kg and the mean umbilical cord length was 50.68±11.75 cm. Regarding BMI, 46.5% were overweight, 44.0% had a normal BMI, 8.0% were obese, and 1.0% were underweight. Full-term normal delivery (FTND) was the most common mode of delivery (72.5%), followed by LSCS (24.5%) and instrumental delivery (3.0%).

Among the LSCS indications, foetal distress (7.5%) was the most frequent, followed by CDMR (5.5%), CPD (4.5%), and NPOL (2.0%). Rare causes such as abruption placenta, cord prolapse, and deep transverse arrest were observed in 0.5% of cases. The most common presenting complaints were abdominal pain (85%) and premature rupture of membranes (13%).

The nuchal cord was noted in 32.5% of the cases, most of which had a single loop (21.5%), followed by two (8.5%), three (1.5%), and four loops (1.0%). Tight loops (17.0%) were slightly more common than loose loops (15.5%). Cord length was normal in 80.5%, short in 13.5%, and long in 6.0% of cases (Table 1).

Table 1: Distribution of caesarean indications, nuchal cord characteristics, and umbilical cord length.

Variables		Count
Indication for caesarean	Abruptio placenta	1 (0.5%)
	CDMR	11 (5.5%)
	Cord prolapse	1 (0.5%)
	CPD	9 (4.5%)
	Deep transverse arrest	1 (0.5%)
	Deflexed head	2 (1%)
	Failed induction	2 (1%)
	Foetal distress	15 (7.5%)
	NPOL	4 (2%)
	Obstructed labor	2 (1%)
Nuchal cord	No	135 (67.5%)
	Yes	65 (32.5%)
Number of loops	1	43 (21.5%)
	2	17 (8.5%)
	3	3 (1.5%)
	4	2 (1%)
Tightness of the loop	Loose	31 (15.5%)
	Tight	34 (17%)
Cord length	Small	27 (13.5%)
	Normal	161 (80.5%)
	Large	12 (6%)

Among all patients, 58% were multigravida and 42% were primigravida. In primigravida patients, the mean total duration of labor was higher in patients with a nuchal cord than in those without (17.62±1.38 vs. 11.95±1.49 hours). In multigravida patients, the mean total duration of labor was higher in those with a nuchal cord (10.76±3.65 vs. 6.87±1.82 h). However, the overall duration was comparatively lower in multigravida than in primigravida. The majority of multigravida and primigravida patients did not have nuchal cords (65.5% and 70.2% vs. 34.5% and 29.8%, respectively), but the difference was not significant (p=0.482).

Among those with short cords, FTND was the most common (15.2%), followed by LSCS (8.2%). Normal cord length predominated across all modes: 80.7% in FTND, 83.3% in instrumental, and 79.6% in LSCS. Long cords were more frequently associated with LSCS (12.2%). Cord length showed no significant association with the mode of delivery (p=0.217).

A single loop was most often observed in FTND (22.8%) and instrumental deliveries (33.3%). Multiple loops (≥2) were predominantly observed in the LSCS group (24.5%). The absence of a loop was highest in the FTND group (70.3%), followed by the instrumental group (66.7%). The number of nuchal loops was significantly associated with the mode of delivery (p=0.025) (Table 2).

Low APGAR scores (≤6) were more frequent in infants with small cords (21.3%) at both 1 and 5 min compared to others, while the association at 1 min only was significant (p=0.047 vs 0.057). Infants with nuchal cords had higher rates of lower APGAR scores (≤6) at both 1 min (30.7% vs. 11.1%) and 5 min (29.2% vs. 10.4%) compared to those without a nuchal cord; both associations were significant (p=0.003) (Table 3).

In the short cord group, caesarean sections were mainly performed for a deflexed head (7.4%), CPD (3.7%), abruption placenta (3.7%), and NPOL (3.7%). In the normal cord group, foetal distress was the leading indication (7.5%), followed by CDMR (4.3%) and CPD (5%). Among patients with long cords, CDMR (33.3%) and foetal distress (25%) were the most common indications. There was a significant association between the indication for caesarean section and cord length (p<0.0001).

All patients with short cords had no nuchal loops (100% prevalence). In the normal cord group, 68.3% had no loops, 23.0% had one loop, and very few had >1 loop. Similarly, all patients with long cords had nuchal loops. The majority had two loops (33.3%), followed by one and three loops (25% for each loop). There was a significant association between cord length and number of loops (p<0.0001) (Table 4).

Notably, 50% of patients with long cord length underwent NICU admission, but the association between cord length and NICU admission was not significant (p=0.595).

Foetal distress was observed in 8% of patients (n=16/200). Among patients without foetal distress, 71.7% had no loop, whereas very few had multiple loops. In contrast, among those with foetal distress, only 31.3% had no loop, and the remaining patients had ≥1 loop. Similarly, 78.1% of those who did not require NICU admission had no loops, but only 38.8% with no loops required NICU admission, and the rest all had ≥1 loop. There was a

significant association between foetal distress and NICU admission and the number of nuchal cord loops (p<0.0001). The mean number of days the neonates spent in the NICU was 5.56±3.05 days (Table 5).

Table 2: Comparison of cord length and number of loops with mode of delivery.

Variables		Mode of delivery			P value
		FTND	Instrumental delivery	LSCS	
Cord length	Small	22 (15.2%)	1 (16.7%)	4 (8.2%)	0.217
	Normal	117 (80.7%)	5 (83.3%)	39 (79.6%)	
	Large	6 (4.1%)	0	6 (12.2%)	
Number of loops	1	33 (22.8%)	2 (33.3%)	5 (10.2%)	0.025
	2	9 (6.2%)	0	8 (16.3%)	
	3	1 (0.7%)	0	2 (4.1%)	
	4	0	0	2 (4.1%)	
	No loop	102 (70.3%)	4 (66.7%)	32 (65.3%)	

Table 3: Comparison of umbilical cord length and nuchal chord with APGAR score at 1 and 5 minutes (Scores 0-10).

APGAR score		Cord length			P value	Nuchal cord		P value
		Small	Normal	Large		No	Yes	
1 minute	5	0	1 (50%)	1 (50%)	0.047	1 (0.7%)	1 (1.5%)	0.003
	6	2 (6.1%)	30 (90.9%)	1 (3%)		14 (10.4%)	19 (29.2%)	
	7	25 (15.2%)	130 (78.8%)	10 (6.1%)		120 (88.9%)	45 (69.2%)	
5 minutes	6	0	1 (50%)	1 (50%)	0.057	1 (0.7%)	1 (1.5%)	0.003
	7	2 (6.5%)	28 (90.3%)	1 (3.2%)		13 (9.6%)	18 (27.7%)	
	8	25 (15%)	132 (79%)	10 (6%)		121 (89.6%)	46 (70.8%)	

Table 4: Association of the number of loops and indications for the caesarean section with the umbilical cord length.

Variables		Cord length			P value
		Small	Normal	Large	
Indication for caesarean	Abruptio placenta	1 (3.7%)	0	0	<0.0001
	CDMR	0	7 (4.3%)	4 (33.3%)	
	Cord prolapse	0	1 (0.6%)	0	
	CPD	1 (3.7%)	8 (5%)	0	
	Deep transverse arrest	0	1 (0.6%)	0	
	Deflexed head	2 (7.4%)	0	0	
	Failed induction	0	2 (1.2%)	0	
	Foetal distress	0	12 (7.5%)	3 (25%)	
	NPOL	1 (3.7%)	3 (1.9%)	0	
	Obstructed labor	0	2 (1.2%)	0	
Number of loops	No loop	27 (100%)	110 (68.3%)	0	<0.0001
	1 loop	0	37 (23%)	3 (25%)	
	2 loops	0	13 (8.1%)	4 (33.3%)	
	3 loops	0	0	3 (25%)	
	4 loops	0	1 (0.6%)	2 (16.7%)	

Table 5: Comparison of foetal distress and NICU admission with the number of nuchal cord loops.

Variables		Number of loops					P value
		1	2	3	4	No loop	
Foetal distress	No	36 (19.6%)	14 (7.6%)	1 (0.5%)	1 (0.5%)	132 (71.7%)	<0.0001
	Yes	3 (18.8%)	5 (31.3%)	2 (12.5%)	1 (6.3%)	5 (31.3%)	
NICU admission	No	23 (15.2%)	7 (4.6%)	1 (0.7%)	2 (1.3%)	118 (78.1%)	<0.0001
	Yes	17 (34.7%)	10 (20.4%)	2 (4.1%)	1 (2%)	19 (38.8%)	

DISCUSSION

Our study aimed to correlate umbilical cord length with gestational age and evaluate its impact on the mode of delivery, duration of labor, APGAR scores, and NICU admissions. We assessed the clinical significance of nuchal cord loops and short umbilical cords and their association with obstructed labor and adverse perinatal outcomes.

In our study, the mean umbilical cord length was 50.68±11.75 cm. Similarly, Shafqat et al observed a mean cord length of 56±9.01 cm in a large cohort of 3300 women.[18] Balkawade and Shinde also reported a similar mean cord length of 63.86±15.69 cm. These findings support that the majority of cords fall within the typical range of 50-60 cm.[19]

Regarding the mode of delivery, our study found that the caesarean section rates were higher in both the short and long-cord groups (8.2% and 12%, respectively). These findings are consistent with Patel et al who reported that short cords were associated with a significantly increased incidence of LSCS.[20] Additionally, Sharma et al studied 500 deliveries and noted that long cords were linked to higher LSCS rates (3.23% for short and 17.86% for long), particularly due to fetal distress and cord complications.[8]

In our study, the number of nuchal loops also significantly influenced the delivery mode. Patients with four loops underwent caesarean sections, while higher loop numbers generally correlated with increased operative interventions. This finding coincides with the results of Nandhini et al who reported the presence of three or more nuchal loops was associated with greater operative delivery and poorer APGAR scores.[21]

The duration of labor in our population was prolonged in cases with nuchal cords, particularly among primigravida women (17.62±1.38 h). Our findings are consistent with those of Kulshrestha et al who reported that among 600 patients, long cords were more likely to cause nuchal loops and cord entanglement, resulting in extended labor durations. The study further concludes that both short and long cords can contribute to labor dystocia and prolonged second-stage labor due to mechanical complications and impaired foetal descent.[22]

In our study, there was a strong association between the presence of a nuchal cord and a higher prevalence of APGAR scores below 7 at 1 minute and below 8 at 5 minutes (p=0.003). Supporting our results, Hebbar et al studied 375 patients and concluded that neonates with cord entanglement had significantly lower APGAR scores and higher NICU admission rates.[23]

In our study, NICU admission was not associated with cord length but was strongly associated with an increased number of nuchal loops (p<0.001). This is consistent with the findings by Linde et al who studied 856300 patients and reported strong associations between abnormal CTG patterns linked to cord anomalies and increased NICU admissions (15%).[16]

In our study, neonates with multiple loops experienced a higher incidence of foetal distress, which correlated with the number of nuchal loops (p<0.0001). Our results are consistent with the study on 1000 deliveries by Balkawade and Shinde who reported that increasing loop numbers increase the possibility of fetal heart rate abnormalities and emergency caesarean sections.[19] In addition, Nandhini et al studied 388 patients and reported that nearly 52% of patients with multiple nuchal cords experienced foetal distress.[21]

Our findings demonstrate that abnormal umbilical cord length and the presence of multiple nuchal loops are significantly associated with adverse labour and perinatal outcomes, including increased operative delivery rates, prolonged labor, lower APGAR scores, and higher NICU admissions. These results are consistent with most studies in the literature and highlight the importance of attentive antenatal and intrapartum monitoring of umbilical cord characteristics to anticipate and manage possible complications. Given these associations, increased antenatal surveillance using Doppler ultrasonography to assess cord characteristics may help identify pregnancies at risk and inform timely obstetric intervention.

Limitations

This study was conducted in 1 hospital; therefore, results may not apply to all populations. Cord length could not be measured before birth, and we only looked at it after delivery. Because no. of cases was small, rare problems with very short or very long cords may have been missed. Future studies should include more hospitals and patients, assess cord features during pregnancy, and follow babies after birth to better understand effects of cord problems.

CONCLUSION

Abnormal umbilical cord length is significantly associated with adverse labor and neonatal outcomes. Short cords were correlated with higher rates of labor dystocia and operative delivery, whereas long cords were linked to an increased incidence of nuchal loops, foetal distress, and lower APGAR scores. The presence of multiple nuchal loops strongly influenced the mode of delivery, NICU admission, and neonatal outcomes. Patients with 2-3 loops of cord around the neck can have normal vaginal delivery. There is increasing rate of caesarean section due to ultrasound diagnosis of cord around the neck at term, because of obstetrician distress and patients request rather than obstetric indication. Appropriate fetal monitoring during labour even in patients with ultrasound diagnosis of cord around the neck can have successful vaginal delivery or may be taken for caesarean section in case of adverse event like fetal distress, prolonged labour or cephalopelvic disproportion due to deflexed head.

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