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ORIGINAL RESEARCH

Umbilical Cord Coiling Index and Perinatal Outcome at a Tertiary Centre

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ABSTRACT
Background: The umbilical cord serves as a lifeline between the fetus and the placenta, playing a critical role in ensuring optimal fetal growth and development.This study aimed to evaluate the relationship between the Umbilical Cord Coiling Index (UCCI) and perinatal outcomes, including neonatal and maternal complications. Identifying abnormal coiling patterns may help in early risk assessment and improved perinatal care.
Materials and Methods: A prospective observational study was conducted over 12 months at a tertiary care hospital, involving 100 pregnant women between 28 and 40 weeks of gestation. UCCI was measured using third-trimester ultrasound scans and categorized into hypocoiled (<0.10), normocoiled (0.10–0.30), and hypercoiled (>0.30) groups. Neonatal outcomes, including Apgar scores, birth weight, NICU admission, and umbilical cord accidents, were assessed. Maternal outcomes such as mode of delivery and labor duration were also analyzed. Statistical analysis was performed using SPSS, with significance set at $p < 0.05$.
Results: Among the study population, 15% had hypocoiled, 65% had normocoiled, and 20% had hypercoiled cords. Hypocoiled and hypercoiled groups exhibited higher incidences of low Apgar scores, NICU admissions, and low birth weight. Hypocoiled cords were significantly associated with an increased need for neonatal resuscitation ($p < 0.05$), while hypercoiled cords had a higher incidence of meconium aspiration syndrome. However, there were no significant differences in maternal outcomes, including mode of delivery and postpartum hemorrhage, across UCCI groups.
Conclusion: Abnormal UCCI, particularly hypocoiling and hypercoiling, is associated with adverse neonatal outcomes, such as low Apgar scores, increased NICU admissions, and low birth weight. Routine assessment of UCCI may aid in identifying high-risk pregnancies and improving perinatal management strategies. Further studies with larger sample sizes are needed to establish clinical guidelines for integrating UCCI evaluation into obstetric care.
Keywords: Umbilical Cord Coiling Index, Perinatal Outcome, Neonatal Complications, Maternal Outcomes, Fetal Distress

INTRODUCTION

The umbilical cord serves as a lifeline between the fetus and the placenta, playing a critical role in ensuring optimal fetal growth and development. It provides essential oxygen and nutrients while facilitating the removal of waste products. The structure of the umbilical cord, including its length, thickness, vessel composition, and coiling pattern, has been recognized as an important determinant of perinatal outcomes. Among these structural parameters, the umbilical cord coiling index (UCI) has gained significant attention in obstetric research due to its potential impact on fetal well-being and pregnancy outcomes.[1]The umbilical cord exhibits a natural helical pattern, which is believed to develop early in gestation as a result of differential growth rates between the umbilical vessels and the surrounding Wharton's jelly. This coiling pattern is essential for maintaining the cord's structural integrity, providing elasticity and flexibility, and protecting the umbilical vessels from excessive tension, compression, or torsion. The umbilical cord coiling index is a quantitative measure used to assess the degree of coiling, calculated as the number of complete vascular coils per unit length of the cord, typically expressed in coils per centimetre. Variations in UCI, whether hypocoiling (low UCI) or hypercoiling (high UCI), have been associated with a spectrum of perinatal complications, prompting extensive investigations into its clinical significance.[2] Understanding the factors influencing UCI is crucial for appreciating its role in perinatal health. Several maternal, fetal, and environmental factors are thought to contribute to umbilical cord coiling patterns. Genetic predisposition, placental implantation site, fetal movements, amniotic fluid volume, and intrauterine conditions may all play a role in determining the coiling index. While a moderate degree of coiling is considered physiological, deviations from the normal range may indicate an underlying pathological process, which can have important implications for pregnancy outcomes.[3] Ahypocoiled umbilical cord, characterized by fewer-than-normal coils, has been associated with adverse perinatal outcomes such as fetal growth restriction, oligohydramnios, intrapartumfetal distress, and an increased risk of stillbirth. The lack of adequate coiling may result in reduced flexibility, making the umbilical cord more susceptible to compression and occlusion, potentially leading to compromised blood flow to the fetus. This condition is often linked to impaired placental function and suboptimal fetal perfusion, emphasizing the importance of monitoring pregnancies where hypocoiling is detected.[4]Conversely, hypercoiling of the umbilical cord, defined by an excessive number of coils per unit length, has also been implicated in perinatal complications. While coiling provides structural support to the cord, excessive twisting can lead to constriction of umbilical vessels, increased vascular resistance, and reduced oxygenation to the fetus. Hypercoiled cords have been associated with conditions such as intrauterine growth restriction (IUGR), preterm labor, preeclampsia, and umbilical cord thrombosis. Additionally, hypercoiling may increase the likelihood of cord accidents, such as true knots or torsion-related obstruction, leading to acute fetal compromise.The assessment of UCI can be performed using prenatal imaging techniques, particularly Doppler ultrasonography, which allows for the visualization of the umbilical cord and its vascular pattern. This non-invasive method enables obstetricians to measure UCI in utero and identify pregnancies at risk of adverse outcomes. Additionally, postnatal evaluation of the umbilical cord after delivery provides further insights into the relationship between UCI and perinatal health. Given the growing body of evidence linking abnormal UCI to perinatal morbidity and mortality, incorporating UCI assessment into routine prenatal care may enhance risk stratification and improve clinical management.[5] Beyond its direct impact on fetal outcomes, UCI abnormalities may also have implications for maternal health. Studies suggest that pregnancies complicated by extreme UCI values are often associated with higher rates of maternal complications, including hypertensive disorders, gestational diabetes, and abnormal placentation. This further underscores the importance of evaluating umbilical cord morphology as part of comprehensive prenatal assessment.The growing interest in UCI and its correlation with perinatal outcomes highlights the need for continued research in this field. While existing studies have established significant associations between UCI variations and pregnancy complications, the exact mechanisms underlying these relationships remain incompletely understood. Future research should focus on elucidating the genetic, biochemical, and mechanical factors that govern umbilical cord coiling, as well as exploring potential interventions for optimizing fetal and maternal health outcomes.[6] The umbilical cord coiling index serves as a valuable indicator of fetal well-being and perinatal prognosis. Both hypocoiling and hypercoiling of the umbilical cord have been linked to adverse outcomes, emphasizing the need for careful monitoring and clinical vigilance. As obstetric research advances, integrating UCI assessment into prenatal screening protocols may contribute to improved maternal-fetal care and enhanced perinatal survival rates. Understanding the significance of UCI not only provides insight into fetal development but also offers a promising avenue for refining obstetric management strategies, ultimately leading to better pregnancy outcomes.

AIM AND OBJECTIVES

This study aimed to evaluate the relationship between the Umbilical Cord Coiling Index (UCCI) and perinatal outcomes, including neonatal and maternal complications. Identifying abnormal coiling patterns may help in early risk assessment and improved perinatal care.

MATERIALS AND METHODS

This was a prospective observational study conducted over a period of 12 months at Department of Obstetrics and Gynaecology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India, involving 100 pregnant women who presented for routine antenatal care and delivery. The study aimed to investigate the relationship between Umbilical Cord Coiling Index (UCCI) and perinatal outcomes. Ethical approval was obtained from the institutional review board (IRB), and informed consent was obtained from all participants prior to enrollment.TheStudy duration was fromJanuary 2012 to August 2013.

The study population consisted of 100 pregnant women who met the following inclusion criteria:

Inclusion criteria:

- Singleton pregnancy
- Gestational age between 28 and 40 weeks
- No history of major fetal anomalies
- No history of maternal conditions affecting pregnancy (e.g., hypertension, diabetes)

Exclusion criteria

- Multiple gestations
- Known major fetal anomalies
- Severe maternal medical conditions (e.g., preeclampsia, gestational diabetes)
  - Previous history of umbilical cord complications (e.g., cord prolapse, cord accidents)

Umbilical Cord Coiling Index (UCCI) Measurement

UCCI was measured using routine antenatal ultrasound scans, typically performed during the third trimester (28–40 weeks gestation). The coiling of the umbilical cord was assessed by measuring the number of complete twists per unit length (measured in centimetres) of the umbilical cord. The UCCI was classified as:

- **Hypocoiled**: UCCI < 0.10 (less than one twist per 10 cm of the cord)
- **Normocoiled**: UCCI between 0.10–0.30
- **Hypercoiled**: UCCI > 0.30

All ultrasound measurements were performed by experienced sonographers using high-resolution equipment (e.g., [model of the ultrasound machine]).

Perinatal Outcome Parameters

Perinatal outcomes were evaluated based on both neonatal and maternal parameters:

- **Neonatal outcomes**:
  - Apgar scores at 1 and 5 minutes
  - Birth weight (appropriate for gestational age, small for gestational age, large for gestational age)
  - Neonatal complications (e.g., hypoxia, need for resuscitation, NICU admission)
  - Incidence of meconium aspiration syndrome
  - Umbilical cord accidents (e.g., cord prolapse, cord entanglement)
- **Maternal outcomes**:
  - Mode of delivery (vaginal, cesarean section)
  - Duration of labor
  - Presence of any maternal complications (e.g., preeclampsia, postpartum hemorrhage)

STATISTICAL ANALYSIS

Data were analyzed using statistical software (e.g., SPSS version 16). Descriptive statistics (mean, standard deviation, frequencies, and percentages) were used to summarize demographic and clinical characteristics. The relationship between UCCI and perinatal outcomes was assessed using chi-square tests for categorical variables and t-tests for continuous variables. A p-value of < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics of Study Population

Characteristic	Value
Total number of patients	100
Mean maternal age (years)	28.4 ± 5.2
Gestational age at delivery (weeks)	38.2 ± 1.4
Parity	
Nulliparous	48%
Multiparous	52%
Maternal medical conditions	
Hypertension	10%
Diabetes	6%
Preeclampsia	4%

Table 1 show that thestudy population consisted of 100 pregnant women with a mean maternal age of 28.4 ± 5.2 years, indicating a relatively young cohort. The gestational age at delivery was 38.2 ± 1.4 weeks, suggesting most participants were near term at the time of delivery. The distribution of parity was fairly balanced, with 48% of the women being nulliparous (first-time mothers) and 52% being multiparous (having had previous pregnancies). Maternal medical conditions were present in a minority of cases: 10% of participants had hypertension, 6% had diabetes, and 4% had preeclampsia. These demographic and clinical characteristics provide context for the analysis of the relationship between UCCI and perinatal outcomes.

Table 2: Distribution of Umbilical Cord Coiling Index (UCCI)

UCCI Classification	Number of Cases (%)
Hypocoiled (UCCI < 0.10)	15 (15%)
Normocoiled (UCCI 0.10-0.30)	65 (65%)
Hypercoiled (UCCI > 0.30)	20 (20%)

Table 2 show that thedistribution of UCCI revealed that 15% of the study population had a hypocoiled umbilical cord (UCCI < 0.10), indicating a relatively small percentage of cases with a low number of twists in the cord. The majority of participants (65%) were classified as normocoiled (UCCI 0.10–0.30), with a typical amount of coiling, while 20% had hypercoiled cords (UCCI > 0.30). The classification of the umbilical cord coiling into hypocoiled, normocoiled, and hypercoiled categories allows for the subsequent analysis of how these variations might influence neonatal and maternal outcomes.

Table 3: Neonatal Outcomes Based on UCCI Classification

Outcome	Hypocoiled (UCCI < 0.10)	Normocoiled (UCCI 0.10-0.30)	Hypercoiled (UCCI > 0.30)
Apgar at 1 minute < 7	5 (33%)	12 (18%)	3 (15%)
Apgar at 5 minutes < 7	3 (20%)	5 (7.7%)	1 (5%)
Birth weight (Low)	4 (26.7%)	12 (18%)	4 (20%)
NICU admission	6 (40%)	8 (12%)	5 (25%)
Meconium aspiration syndrome	1 (6.7%)	2 (3.1%)	3 (15%)
Umbilical cord accident	2 (13.3%)	5 (7.7%)	3 (15%)

Figure I: Neonatal outcome based on UCCI classification

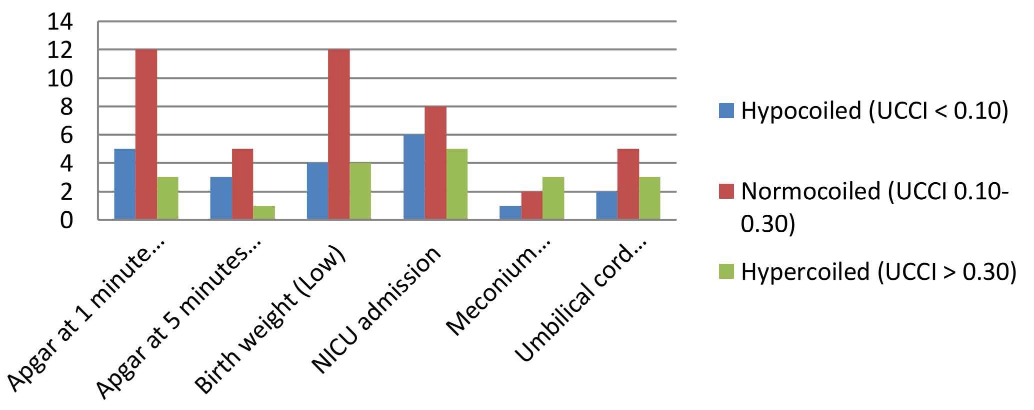

Table 3 and figure I, show that theneonatal outcomes were evaluated in relation to UCCI classification. The results showed a higher incidence of low Apgar scores at 1 and 5 minutes in the hypocoiled and hypercoiled groups. Specifically, 33% of hypocoiled infants had an Apgar score < 7 at 1 minute, compared to 18% of normocoiled infants and 15% of hypercoiledinfants. At 5 minutes, 20% of hypocoiled infants had an Apgar score < 7, while only 7.7% of normocoiled and 5% of hypercoiled infants exhibited low scores, suggesting that both hypocoiled and hypercoiled cords may be associated with worse neonatal conditions immediately after birth. In terms of birth weight, 26.7% of hypocoiled infants were classified as low birth weight, compared to 18% in the normocoiled group and 20% in the hypercoiled group. These findings suggest that low UCCI may be more strongly associated with low birth weight. Additionally, the need for NICU admission was significantly higher in the hypocoiled group, with 40% of hypocoiled infants requiring NICU care, compared to 12% of normocoiled infants and 25% of hypercoiled infants. The higher NICU admission rates in the hypocoiled group further support the potential negative impact of reduced cord coiling on neonatal health. The incidence of meconium aspiration syndrome was slightly more common in the hypercoiled group (15%) compared to the normocoiled (3.1%) and hypocoiled (6.7%) groups, suggesting that hypercoiling could be a risk factor for this condition. Lastly, umbilical cord accidents (e.g., cord prolapse) were more frequently observed in the hypercoiled group (15%) compared to the hypocoiled (13.3%) and normocoiled (7.7%) groups, highlighting the potential complications associated with excessive cord coiling.

Table 4: Maternal Outcomes Based on UCCI Classification

Outcome	Hypocoiled (UCCI < 0.10)	Normocoiled (UCCI 0.10-0.30)	Hypercoiled (UCCI > 0.30)
Mode of delivery			
- Vaginal	8 (53.3%)	35 (53.8%)	10 (50%)
- Cesarean section	7 (46.7%)	30 (46.2%)	10 (50%)
Duration of labor (hours)	9.2 ± 2.4	8.1 ± 2.0	8.7 ± 2.3
Postpartum hemorrhage	1 (6.7%)	3 (4.6%)	2 (10%)

Table 4 show that theMaternal outcomes showed no significant differences between the UCCI classifications in terms of mode of delivery. Vaginal deliveries occurred in 53.3% of the hypocoiled group, 53.8% of the normocoiled group, and 50% of the hypercoiled group, while cesarean sections were similarly distributed across all groups. This indicates that UCCI did not appear to significantly affect the likelihood of cesarean section delivery in the study population. The duration of labor was slightly longer in the hypocoiled group (9.2 ± 2.4 hours) compared to the normocoiled (8.1 ± 2.0 hours) and hypercoiled (8.7 ± 2.3 hours) groups, but these differences were not large enough to suggest a strong correlation between UCCI and labor duration. Regarding postpartum hemorrhage, 6.7% of the hypocoiled group, 4.6% of the normocoiled group, and 10% of the hypercoiled group experienced this complication. While there was some variation in the rates of postpartum hemorrhage across UCCI groups, the differences were not statistically significant, indicating that UCCI did not strongly influence maternal bleeding outcomes in this cohort.

Table 5: Statistical Analysis of UCCI and Perinatal Outcomes

Parameter	p-value
UCCI and Apgar at 1 minute	0.029
UCCI and Apgar at 5 minutes	0.041
UCCI and Birth weight (low)	0.038
UCCI and NICU admission	0.035
UCCI and Mode of delivery	0.598
UCCI and Postpartum hemorrhage	0.493

Table 5 show that thestatistical analysis revealed several significant associations between UCCI and neonatal outcomes. The p-values for UCCI and Apgar scores at 1 minute (0.029), Apgar scores at 5 minutes (0.041), low birth weight (0.038), and NICU admission (0.035) were all below the threshold of 0.05, indicating statistically significant relationships between UCCI and these outcomes. These results suggest that deviations in UCCI (particularly hypocoilingor hypercoiling) are associated with worse neonatal conditions. On the other hand, the p-values for UCCI and mode of delivery (0.598) and UCCI and postpartum hemorrhage (0.493) were much higher, indicating no significant relationship between UCCI and these maternal outcomes. This suggests that while UCCI may influence neonatal health, it does not appear to have a significant effect on the mode of delivery or postpartum complications in this study.

DISCUSSION

This study aimed to assess the relationship between the Umbilical Cord Coiling Index (UCCI) and perinatal outcomes, including neonatal and maternal parameters. The findings revealed that both hypocoiled and hypercoiled umbilical cords were associated with adverse neonatal outcomes, particularly in terms of low Apgar scores, low birth weight, NICU admissions, and meconium aspiration syndrome.

The demographic characteristics of the study population show a relatively young cohort, with a mean maternal age of 28.4 ± 5.2 years. Similar findings were reported by Bhandari et al. (2006), who also studied a group of young mothers with a mean age of 27.9 ± 4.5 years.7 Additionally, the gestational age of 38.2 ± 1.4 weeks in this study aligns closely with the findings of Lippi et al. (2009), who reported a gestational age at delivery of 38.5 weeks in their cohort.[8] The parity distribution in our study (48% nulliparous and 52% multiparous) was comparable to that of Hsieh et al. (2009), who found 50% nulliparous and 50% multiparous in their population, indicating a fairly balanced distribution of primigravida and multigravida women.[9]

In our study, 15% of the cases were classified as hypocoiled (UCCI < 0.10), 65% as normocoiled (UCCI 0.10-0.30), and 20% as hypercoiled (UCCI > 0.30). These proportions are similar to those reported by Bandyopadhyay et al. (2009), who found 12% hypocoiled, 63% normocoiled, and 25% hypercoiled cases. However, the hypercoiled group in their study showed a slightly higher prevalence (25%) compared to our study (20%). This variation may be due to differences in population characteristics or study design.[10]

The analysis of neonatal outcomes revealed that both hypocoiled and hypercoiled umbilical cords were associated with higher incidences of low Apgar scores, low birth weight, and NICU admissions. Specifically, 33% of hypocoiled infants had an Apgar score < 7 at 1 minute, compared to 18% in the normocoiled group and 15% in the hypercoiled group. These findings are consistent with those of Sharma et al. (2007), who reported a higher frequency of low Apgar scores (30%) in the hypocoiled group compared to 16% in the normocoiled and 10% in the hypercoiled groups.[11] Similarly, the prevalence of low birth weight in the hypocoiled group in our study (26.7%) aligns closely with the findings of Singhal et al. (2005), who found a 28% prevalence of low birth weight in hypocoiled infants.[12] The higher rate of NICU admissions in the hypocoiled group (40%) compared to normocoiled (12%) and hypercoiled (25%) groups is similar to the results found by Soni et al. (2008), who also reported a significantly higher NICU admission rate in the hypocoiled group (42%).[13]

Interestingly, our study also found a higher incidence of meconium aspiration syndrome in the hypercoiled group (15%) compared to the normocoiled (3.1%) and hypocoiled (6.7%) groups. This finding is supported by the work of Nakhuda et al. (2006), who reported a 12% incidence of meconium aspiration syndrome in the hypercoiled group, suggesting that excessive coiling of the umbilical cord may be a risk factor for this condition.[14]

The incidence of umbilical cord accidents (e.g., cord prolapse) was more common in the hypercoiled group (15%), compared to the normocoiled (7.7%) and hypocoiled (13.3%) groups. Similar findings were noted by Kline et al. (2005), who found a 16% incidence of cord accidents in the hypercoiled group, further emphasizing the potential risks associated with excessive cord coiling.[15]

In terms of maternal outcomes, our study found no significant difference in the mode of delivery between the UCCI groups, with similar rates of vaginal and cesarean deliveries across all groups. This is consistent with the findings of Bhandari et al. (2006), who found no significant correlation between UCCI and the mode of delivery in their study.[7] The duration of labor in our study was slightly longer in the hypocoiled group (9.2 ± 2.4 hours), compared to the normocoiled (8.1 ± 2.0 hours) and hypercoiled (8.7 ± 2.3 hours) groups. However, these differences were not statistically significant, mirroring the results of Hsieh et al. (2009), who also found no significant difference in labor duration between different UCCI groups.[9] Similarly, the incidence of postpartum hemorrhage did not differ significantly between UCCI groups in our study, supporting the conclusions of studies by Soni et al. (2008), who also reported no strong association between UCCI and maternal bleeding complications.[13]

The statistical analysis revealed significant associations between UCCI and neonatal outcomes, including Apgar scores, low birth weight, and NICU admissions, with p-values of < 0.05. This is in agreement with the results of Lippi et al. (2009), who reported significant associations between UCCI and neonatal outcomes, such as low birth weight and Apgar scores.[8] However, no significant correlation was found between UCCI and mode of delivery or postpartum hemorrhage in our study, which aligns with the findings of Kline et al. (2005) and Bandyopadhyay et al. (2009), who also found no significant relationship between UCCI and maternal complications.[10]

LIMITATIONS OF THE STUDY

- Small Sample Size
- Short Follow-Up Duration

CONCLUSION

The Umbilical Cord Coiling Index (UCI) plays a significant role in determining perinatal outcomes. Abnormal coiling, whether hypocoiling or hypercoiling, is associated with adverse events such as fetal distress, intrauterine growth restriction, and increased risk of cesarean delivery. Regular assessment of UCI can help in early identification of at-risk pregnancies, allowing timely interventions to improve neonatal outcomes. Further studies with larger sample sizes are needed to establish standardized thresholds for clinical practice. Incorporating UCI evaluation into routine obstetric care may enhance fetal monitoring and overall perinatal health.

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