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Umbilical Cord Coiling Index as a Marker of Perinatal Outcome in Primigravida in the Institute of Health Sciences

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ABSTRACT

Background: The umbilical coiling index (UCI) reflects the helical pattern of umbilical vessels and serves as a potential marker for fetal well-being. Abnormal coiling—either hypocoiling or hypercoiling—has been associated with adverse perinatal outcomes. This study aimed to evaluate the UCI in primigravida women and its association with maternal factors and perinatal outcomes.

Methods: This observational study was conducted at the Department of Obstetrics and Gynecology, AJ Institute of Medical Sciences, Mangalore, from October 2016 to August 2018. A total of 302 placentas and umbilical cords were examined. The length of the umbilical cord was assessed with a firm, non-elastic measuring tape. The total number of vascular coils was then recorded by tracing the cord from the fetal end up to the placental insertion. The umbilical coiling index was derived by dividing the total coils by the cord length in centimeters. Cords were classified as hypocoiled (<10th percentile), normocoiled (10^{th}–90^{th} percentile), or hypercoiled (>90^{th} percentile). Maternal characteristics, obstetric variables, neonatal outcomes, and perinatal complications were recorded.

Results: Among 302 cases, 237 (78.5%) were normocoiled, 35 (11.6%) hypocoiled, and 30 (9.9%) hypercoiled. Socioeconomic status was not significantly associated with UCI (p=0.63). Hypertensive disorders of pregnancy were present in 42 cases, of which 7 (16.7%) had hypocoiling and 4 (9.5%) had hypercoiling; the association was not statistically significant (p=0.54). Abnormal FHR was observed in 18.2% of cases.

Conclusion: Abnormal UCI was associated with several adverse perinatal parameters, although statistical significance varied. Early antenatal detection of abnormal coiling may help identify fetuses at risk and guide clinical management. Further prospective studies are required to clarify the role and mechanisms of abnormal umbilical coiling.

Key-words: Cords, Umbilical coiling index (UCI), Primigravida, Placenta, Mangalore

INTRODUCTION

The umbilical cord is a conduit between the developing embryo or fetus and the placenta. It contains two arteries and one vein, embedded within Wharton's jelly and covered by a single layer of amniotic membrane, providing essential nutrition and oxygen to the fetus [1]. Wharton's jelly protects the cord, the amniotic fluid and the helical or coiled arrangement of umbilical vessels.

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The three vessels of the umbilical cord run in a coiled pattern along its length. This coiling provides flexibility and strength and protects the vessels from external forces that could compromise fetal blood flow [2]. Bergarius first described the coiling characteristics of umbilical vessels in 1521, and Edmonds quantified the coiling pattern in 1954 [1]. Strong *et al.* [4] later observed that non-coiled umbilical vessels were associated with increased perinatal morbidity and mortality, leading to the development of UCI [2,3].

A coil is defined as a complete 360-degree spiral turn of the umbilical vessels around Wharton's jelly [4]. Abnormal coiling, including hypocoiling and hypercoiling, has been associated with adverse perinatal outcomes in multiple studies [5–7]. Tripathy *et al.* demonstrated that abnormal

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UCI correlates with fetal compromise and socioeconomic variations [8]. Other studies have shown similar findings regarding the association between coiling patterns and perinatal outcomes [9–12].

The umbilical cord is the lifeline of the fetus, transporting oxygen and nutrients from the placenta. It extends from the fetal umbilicus to the chorionic plate and typically measures 0.8–2.0 cm in diameter, with an average length of 55 cm and a range of 30–100 cm [13]. A cord shorter than 30 cm is considered abnormally short. Folding and tortuosity of vessels can create surface nodulations or "false knots," which are essentially vascular varices [14]. Wharton's jelly surrounds the vessels and provides mechanical protection. The two umbilical arteries, smaller in diameter than the vein, arise from the internal iliac arteries and follow a helical course around the vein until they reach the placenta [15].

MATERIALS AND METHODS

Study Setting- The study was conducted in the Department of Obstetrics and Gynecology at AJ Institute of Medical Sciences and Research Centre, Mangalore, Karnataka, which functions as a tertiary care referral center. Between October 2016 and August 2018, a total of 302 placentas and their corresponding umbilical cords were examined, and all specimens were assessed in an unfixed state.

Blinding- All observations were made by a single examiner who was blinded to maternal characteristics and pregnancy outcomes.

Measurement of Umbilical Cord Length- The total cord length was measured using a non-stretchable inch tape.
The measurement included:

- Placental end of the cord,
- Entire visible cord length, and
- Umbilical stump attached to the baby.

Counting of Umbilical Coils- The total number of vascular coils was assessed by examining the cord from the fetal end toward the placental side. Each coil was considered a full 360-degree rotation of the umbilical vessels around Wharton's jelly, following the definition originally outlined by Strong *et al.* [4].

Direction of Coiling- The direction of coiling was noted as:

- **Sinistral:** right-to-left, anti-clockwise
- **Dextral:** left-to-right, clockwise

Classification of UCI- The coiling index was classified as:

- **Hypocoiled:** UCI < 10^{th} percentile
- **Normocoiled:** UCI between 10^{th} and 90^{th} percentile
- **Hypercoiled:** UCI > 90^{th} percentile

Maternal Variables- The following maternal and obstetric data were collected:

- Maternal age
- Gestational age at delivery
- Socioeconomic status
- Parity
- Obstetric history
- Mode of delivery
- Instrumental delivery or LSCS for fetal distress
- Hypertensive disorders of pregnancy
- Gestational diabetes mellitus

Neonatal Variables

- Birth weight
- Sex of the neonate
- Preterm/term status
- APGAR scores
- Meconium-stained liquor
- Low birth weight
- Neonatal condition until the second postnatal day

Placental Examination- The placenta and umbilical cord were examined for:

- Cord insertion type
- Presence of two arteries and one vein
- Number of coils
- ZMacroscopic abnormalities
- Microscopic evaluation for chorioamnionitis, funisitis, or chronic hypoxia was not performed.

Statistical Analysis- The collected data were processed using conventional statistical techniques. Categorical variables were summarized as frequencies and percentages. Relationships between UCI groups and selected maternal and neonatal characteristics were examined using the Chi-square test. $p<0.05$ was taken as the threshold for statistical significance.

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RESULTS

Table 1 presents the socioeconomic status of the study population using the Modified BG Prasad Classification. A total of 302 subjects were included, of which the majority belonged to Grade III SES (84.8%), while 15.2% belonged to Grade IV. Table 1 shows the presence of abnormal fetal heart rate among the 302 subjects. Abnormal FHR was detected in 55 cases (18.2%), whereas 247 cases (81.8%) had normal FHR patterns.

Table 1: Distribution of Socioeconomic Status (SES) and Abnormal Fetal Heart Rate (FHR)

	Frequency	**Percentage (%)**
Socioeconomic Status (SES)		
Gade III	256	84.8
Grade IV	46	15.2
Total	302	100
Abnormal (FHR)		
Yes	55	18.2
No	247	81.8
Total	302	100

Table 2 describes the relationship between hypertensive disorders of pregnancy and UCI categories. Among 42 hypertensive cases, hypocoiling was found in 16.7% and hypercoiling in 9.5%. No statistically significant association was observed ($\chi^2 = 1.22$, $p = 0.54$).

Table 2: Association of Hypertensive Disorders of Pregnancy with Umbilical Coiling Index (UCI)

UCI		**HTN**		**Total**
		Yes	**No**	
Normocoiling	Count	31	206	237
	%	73.8%	79.2%	78.5%
Hypocoiling	Count	7	28	35
	%	16.7%	10.8%	11.6%
Hyper coiling	Count	4	26	30
	%	9.5%	10%	9.9%
Total	Count	42	260	302
	%	100%	100%	100%

Fig. 1 illustrates the proportion of subjects across different socioeconomic classes using the Modified BG Prasad scale. It highlights that the majority belonged to Grade III socioeconomic status.

Fig. 2 shows the age-wise distribution of primigravida women included in the study. It depicts the number of participants within each age category during the study period.

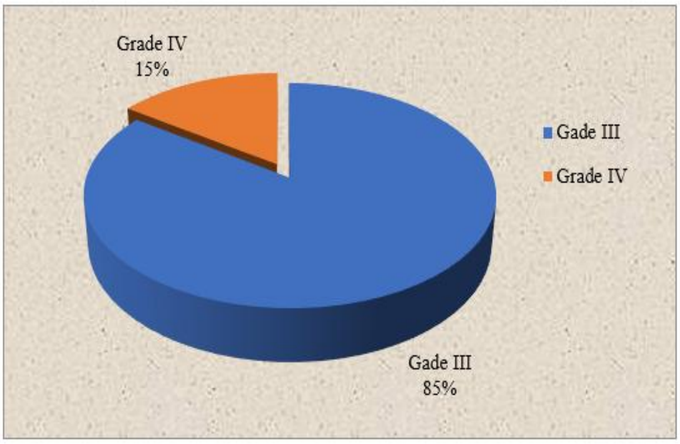

Fig. 1: Distribution of Socioeconomic Status

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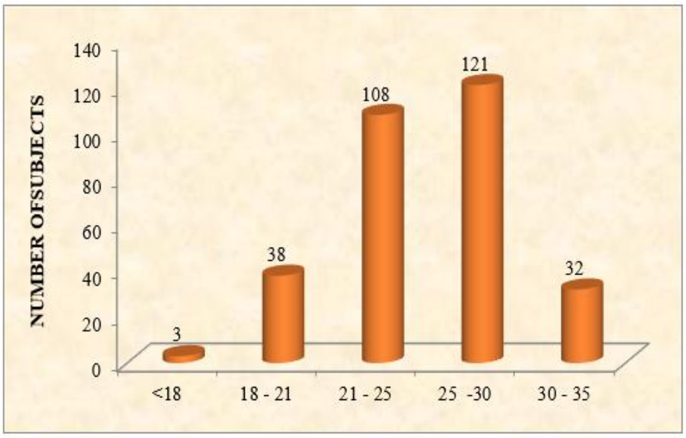

Fig. 2: Age Distribution of the Subjects

DISCUSSION

In the present study, the distribution of the umbilical coiling index showed that most cords were normocoiled, with smaller proportions demonstrating hypo- or hypercoiling. Similar findings have been reported previously, where normal coiling was seen in the majority of pregnancies, and deviations from this pattern were linked with adverse fetal outcomes [16,17].

The protective role of coiling has been emphasized in multiple studies. The helical structure imparts tensile strength, prevents compression, and maintains uninterrupted fetoplacental blood flow. Abnormally low coiling makes the cord more susceptible to torsion, kinking, and impaired perfusion, potentially contributing to fetal distress, growth restriction, and adverse perinatal outcomes [18]. Conversely, hypercoiling has been associated with vascular resistance, chronic hypoxia, and increased perinatal complications [19].

In our study, hypocoiling was not significantly associated with hypertensive disorders of pregnancy, although earlier research has demonstrated a significant relationship between hypocoiling and maternal hypertension [20]. The discrepancy may be attributed to differences in population, sample size, and variability in percentile-based cutoffs. Nevertheless, abnormal UCI remains an important predictor of suboptimal fetoplacental circulation.

Several studies have evaluated the predictive value of antenatal ultrasound for identifying abnormal UCI. Prenatal detection of noncoiled vessels has been associated with an increased risk of adverse pregnancy outcomes, including fetal growth restriction, oligohydramnios, and abnormal Doppler indices [21]. This supports the concept that screening for UCI abnormalities may improve antenatal surveillance and early detection of at-risk fetuses.

Review-based evidence suggests that UCI is influenced by both fetal movement and intrinsic vascular development. The majority of reviewed literature highlights a consistent association between extreme coiling patterns and poor neonatal outcomes, reinforcing the importance of recognizing these abnormalities in clinical practice [22]. Studies have also demonstrated that abnormal UCI in both normal and high-risk pregnancies is associated with operative delivery for fetal distress, low APGAR scores, meconium-stained liquor, and increased neonatal admissions [23,24].

Overall, evidence from multiple studies supports UCI as a meaningful marker of fetal well-being. Although variability exists across populations, severe deviations in coiling consistently indicate compromised fetoplacental circulation and a higher likelihood of perinatal complications. Therefore, the umbilical coiling index remains an important and reliable tool for assessing fetal risk and guiding obstetric management [25].

CONCLUSIONS

In conclusion, deviations in the umbilical coiling index are associated with multiple unfavorable perinatal outcomes, although the strength of this association varies across studies. Assessing the degree of vascular coiling during the antenatal period is valuable, as early identification of abnormal patterns may help recognize fetuses at increased risk and guide timely clinical intervention. Nevertheless, larger, well-designed prospective studies are needed to clarify the underlying mechanisms of umbilical coiling and its overall impact on neonatal health.

CONTRIBUTION OF AUTHORS

Research Concept- Dr. Soumyarani T, Dr. Prakash
Research Design- Dr. Soumyarani T, Dr. Sunita
Supervision- Dr. Soumyarani T
Materials- Dr. Prakash, Dr. Sunita
Data Collection- Dr. Soumyarani T
Data Analysis and Interpretation- Dr. Prakash
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