

UMBILICAL COILING INDEX ASSESSMENT DURING ROUTINE FETAL ANATOMIC SURVEY AS A PREDICTOR OF PREGNANCY OUTCOME

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ABSTRACT

Background: Fetal compromise, which significantly contributes to neonatal morbidity, remains a significant concern among obstetricians. Current antenatal risk assessment methods may not always effectively identify these cases, necessitating improvements. The Antenatal Umbilical Cord Coiling Index (AUCI) is a potential indicator for identifying pregnant women who require intensive monitoring both antepartum and intrapartum. This index, determined by antenatal ultrasound, remains stable throughout pregnancy. The aim of this study is to explore the association between AUCI and pregnancy outcomes. The aim and objective are to evaluate the relationship of sonographic measurement of UCI in second trimester (18–20 weeks) with the pregnancy outcome. **Materials and Methods:** AUCI was calculated in 100 pregnancies with confirmed dates and uncomplicated singleton pregnancy by ultrasound, who were referred to radiology department for routine fetal sonographic anatomic survey of gestational age 18-20 week. UCI was correlated with pregnancy outcome. **Result:** UCI was categorized as hypocoiled, normocoiled and hypercoiled cords. The mean UCI was 0.54. Hypocoiling was associated with oligohydramnios (25%), abruptio placenta (8.3%), preterm labor (25%), meconium-stained liquor (8.3%), fetal distress (8.3%), LSCS (50%), low birth weight (33.3%), poor Apgar score at 1 minute (8.3%) and NICU admission (16.7%). Hypercoiling was associated with IUGR (5.9%), placental abruption (5.9%), preterm labour (5.9%), meconium-stained liquor (11.8%), fetal distress (5.9%), LSCS (52.9%), low birth weight (23.5%), poor Apgar score at 1 minute (11.8%), poor Apgar score at 5 minutes (5.9%) and NICU admission (5.9%). However, there was no statistical significance found among the parameters mentioned above when compared with normocoiled subjects. **Conclusion:** In our study, no association was found between abnormal UCI and adverse pregnancy outcome. Therefore, it is necessary to formulate specific parameters that could serve as effective prognostic markers for anticipating adverse perinatal outcomes, and additional research is required to investigate and validate this hypothesis.

INTRODUCTION

The umbilical cord is a tube-like structure that links the developing fetus to the placenta of the mother.^[1] The umbilical cord, consisting of an outer layer of amnion, the gel-like Wharton's jelly, two arteries, and one vein, is structured to ensure continuous blood flow to the developing fetus.^[2] The umbilical cord plays a critical role in the development, health, and survival of the fetus. However, it is susceptible to potential issues such as kinking, compression, traction, and torsion, which can impact the outcome during childbirth. To safeguard against these risks,

the umbilical cord is naturally shielded by Wharton's jelly, the surrounding amniotic fluid, as well as its helical patterns and vessel coiling.^[3]

The umbilical vessels wrap around the cord in a complete 360° spiral, forming a coil.^[4] This coiling process begins as early as 4 weeks after conception, with nearly 95% of fetuses showing coiling by the 7th week. While the exact cause of coiling remains uncertain, several theories have been proposed by different authors. These include fetal movements, the embryo's active and passive torsion, changes in the rate at which umbilical blood vessels grow, fetal hemodynamic forces, and the configuration of the muscle fibers inside the umbilical artery walls. The

umbilical cord's helical characteristics provide it strength and flexibility also shielding the vessels from external forces that may otherwise impair blood flow.^[5]

As early as the first trimester of pregnancy, coiling of the umbilical vessels can be identified by ultrasound examinations.^[5] Calculating the Umbilical Coiling Index (UCI) is a commonly used method to assess the degree of umbilical cord coiling. The number of complete coils per centimeter of the cord is the definition of this parameter. In antenatal evaluations, the UCI is determined by measuring the distance between a pair of coils, expressed in centimeters, from the inner edge of an arterial or venous wall to the outer edge of the next coil along the same side of the umbilical cord, with the direction being from the placental end to the fetal end.^[6]

Abnormal coiling refers to umbilical cords that are either hypocoiled (undercoiled) or hypercoiled (overcoiled), with coiling index values falling below the 10th percentile or above the 90th percentile, respectively.^[6,7] The normal coiling index is typically 0.4 per centimeter, while an abnormal umbilical cord coiling index (UCI) is defined as either hypocoiled if UCI is equal to or less than 0.21, or hypercoiled if UCI is equal to or greater than 0.59.^[8] These cutoff values were established based on previous studies of umbilical cord coiling index (UCI) in normal pregnancies. These studies were specifically designed and conducted to establish reference values for cord coiling.

Numerous studies have investigated the correlation between umbilical cord coiling index (UCI) and different maternal and fetal outcomes, but most of these have relied on postnatal UCI measurements. However, advancements in ultrasound technology now enable the examination of cord disorders before birth. Consequently, there has been a resurgence of interest in this area, leading to several recent reports focusing on abnormalities of cord coiling.

Hypocoiled cord has been linked with a higher occurrence of various adverse outcomes, including fetal death, intrapartum FHR deceleration, operative delivery due to fetal distress, low Apgar scores, genetic disorders and congenital anomalies, intra-amniotic infection, and premature birth.^[9,10] This marks underlying intrinsic abnormal development and increased risk of acute reduction in blood flow due to kinking. Conversely, hypercoiling of the cord has been linked with fetal growth restriction, perinatal fetalacidemia and asphyxiation, vascular thrombosis, and abnormal cord narrowing. This is primarily due to the increased likelihood of compression-induced insufficient blood circulation and the susceptibility to the development of fetoplacental vascular thrombosis.^[9,11] Consequently, it appears that abnormal coiling is chronic disorder that developed early in gestation that can affect the fetus in both acute and chronic ways.^[9]

Sonographic measurements of the umbilical cord in the first trimester might be difficult and result in inaccurate measurement. Similarly, in the third

trimester when the volume of amniotic fluid decreases, it becomes more difficult to distinguish between umbilical cord coiling and torsion, further increasing the likelihood of measurement errors.^[9,12] Thus, for our study, measurements of the umbilical coiling index were conducted between 18 and 20 weeks, during the anomaly scan.

The purpose of our study was to assess antenatal umbilical coiling during the second trimester and its potential correlation with adverse pregnancy outcomes. By conducting a straightforward and cost-effective determination of the antenatal umbilical coiling index during the second trimester anomaly scan, we tried to identify pregnancies at higher risk. This could facilitate more vigilant antenatal follow-up and intensified fetal monitoring during labor.

MATERIALS AND METHODS

Study Design: This was a prospective observational study conducted on 100 singleton healthy pregnant women of gestational age 18–20 weeks who were referred to the Department of Radiodiagnosis, Christian Medical College and Hospital, Ludhiana, for a routine fetal sonographic anatomic survey during the time period from September 15th, 2022, to April 30th, 2024. All patients fulfilling the inclusion criteria were included in the study following the approval of the institutional review committee.

Inclusion Criteria

1. Singleton pregnancy of any parity
2. Gestational age between 18 and 20 weeks
3. Normal amniotic fluid
4. Presence of three vesseled umbilical cord
5. Consenting to participate in the study.

Exclusion Criteria

1. Multiple pregnancy
2. Fetal congenital anomaly
3. Maternal medical disorders like diabetes mellitus and hypertension that could interfere with fetal growth
4. If the patient could not be followed till delivery for any reason
5. Any umbilical cord or placental anomaly

After approval from the institutional review committee and institutional ethics committee, all healthy pregnant women of gestational age 18–20 weeks who came to our department for a routine fetal sonographic anatomical survey and fulfilled the participant inclusion and exclusion criteria were enrolled in this study. The objectives of the study were discussed in detail with the patients, and they were provided with the patient information sheet. Signed informed consent was obtained from each participant.

Ultrasonography: Ultrasound examinations were performed using the HDX-11E system (Philips Medical Systems) with a 3.5 MHz convex transducer. Transabdominal scanning was conducted, and a longitudinal section of the umbilical cord was obtained at maximum magnification.

The antenatal umbilical coiling index (UCI) was calculated as the reciprocal of the distance (in cm) between the inner wall of a vessel and the outer edge of the adjacent coil along the ipsilateral side of the cord. ($UCI=1/\text{distance between the inner edge of an arterial or venous wall and the outer edge of the next coil}$). [Figure 1]. Measurements were taken at three sites: near the fetal insertion, near the placental insertion, and at an intermediate segment. The mean of these three measurements was used to calculate the UCI. Initial grayscale assessment was followed by confirmation using Color Doppler to improve accuracy and reduce intra-observer bias.^[13]



Figure 1: shows the measurement technique of antenatal umbilical coiling index (antenatal UCI) with doppler.

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Following delivery, the following data regarding the patient were collected from obstetric records to correlate with umbilical cord parameters obtained by Doppler ultrasound:

1. Antenatal events:

- IUGR
- Oligohydramnios
- Abruptio placenta

2. Intra-natal events:

- Preterm labour
- Intrapartum fetal heart rate abnormalities
- Meconium-stained liquor
- Mode of delivery

3. Neonatal events:

- Low birth weight
- Poor Apgar scores
- NICU admission
- Intrauterine death

Centile values were calculated, and subjects were classified into three groups: normocoiled cords, hypocoiled cords ($UCI \leq 10\text{th percentile}$), and hypercoiled cords ($UCI \geq 90\text{th percentile}$). Perinatal outcomes among these three groups were compared and statistically analyzed.

Sample size: The proportion of participants who had hypocoiled cords was assumed to be 20%.^[9] Thus, the minimum sample size was calculated to be $n = 100$ using the formula $n = Z^2 * p * (1-p) / d^2$, where Z is the standard normal deviation at the 95% confidence level (1.96), p is the proportion of hypocoiled patients, and d is the margin of error (8%).

Statistical analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 28.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean \pm standard deviation, and categorical variables as percentages. The chi-square test was used for categorical variables, and One-way ANOVA for comparison among groups. A p -value < 0.05 was considered statistically significant.

RESULTS

A total of 100 pregnant women were included in the study. The mean umbilical cord coiling index (UCI) was 0.54 ± 0.21 , with values ranging from 0.12 to 1.0. The 10th and 90th percentiles were 0.20 and 0.76, respectively. Based on these cutoffs, 12% of cases were classified as hypocoiled ($UCI \leq 0.20$), 17% as hypercoiled ($UCI \geq 0.76$), and 71% as normocoiled. Mean age of the study population was 28.4 ± 4.1 years with ages ranging from 20-39 years. Majority of the study subjects were within the age group of 25 to 29 yrs.

Majority of the patients with hypocoiled cord (66.7%), hypercoiled cord (47.1%) and normocoiled cord (45.1%) belong to the age group of 25-29 years. No association was found between umbilical coiling index and maternal age based on the P value of 0.593.

Table 1: Demographic characteristics

	Total	Hypocoiled group	Normocoiled group	Hypercoiled group	P Value
Number of cases	100(100%)	12 (12%)	71 (71%)	17 (17%)	
Maternal age (In Years)					
20-24	15 (15.0%)	2 (16.7%)	12 (16.9%)	1(5.9%)	0.593
25-29	48 (48.0%)	8 (66.6%)	32(45.1%)	8(47.1%)	
30-34	26 (26.0%)	2 (16.7%)	18(25.4%)	6(35.3%)	
35-39	11 (11.0%)	0(0.0%)	9(12.6%)	2(11.8%)	
Gravidity					
Primigravida	40(40.0%)	5 (41.7%)	29(40.8%)	6(35.3%)	0.909
Multigravida	60(60.0%)	7(58.3%)	42(59.2%)	11(64.7%)	

In the total study population, 40% were primigravida and 60% were multigravida. In the hypocoiled group, 41.7% were primigravida and 58.3% were multigravida; in the normocoiled group, 40.8% were

primigravida and 59.2% were multigravida; and in the hypercoiled group, 35.3% were primigravida and 64.7% were multigravida. There was no significant

association between coiling index and gravidity ($p = 0.909$). [Table 1]

Table 2: Antenatal Outcome

	Total	Hypocoiled group	Normocoiled group	Hypercoiled group	P Value
IUGR	4.0(4.0%)	0 (0.0%)	3 (4.2%)	1 (5.9%)	0.717
Oligohydramnios	12(12%)	3 (25%)	9(12.7%)	0(0.0%)	0.118
Placental abruption	4(4.0%)	1(8.3%)	2(2.8%)	1(5.9%)	0.606

Intrauterine growth restriction (IUGR) was observed in 4% of cases. The incidence was 0% in the hypocoiled group, 4.2% in the normocoiled group, and 5.9% in the hypercoiled group, with no statistically significant association between UCI and IUGR ($p = 0.717$).

Oligohydramnios occurred in 12% of the study population. It was more frequent in the hypocoiled group (25%) compared to the normocoiled group

(12.7%), and was not observed in the hypercoiled group. However, this difference did not reach statistical significance ($p = 0.118$).

Placental abruption was noted in 4% of cases, distributed as 8.3% in the hypocoiled group, 2.8% in the normocoiled group, and 5.9% in the hypercoiled group, with no significant association ($p = 0.606$). [Table 2]

Table 3: Intra natal outcome

	Total	Hypocoiled group	Normocoiled group	Hypercoiled group	P Value
Preterm labor	11(11%)	3(25%)	7(9.9%)	1(5.9%)	0.229
Meconium-stained liquor	4(4%)	1(8.3%)	1(1.4%)	2(11.8%)	0.106
Fetal distress	7(7%)	1(8.3%)	5(7.0%)	1(5.9%)	0.968
Mode of delivery					
Normal vaginal delivery	64(64%)	6(50%)	50(70.4%)	8(47.1%)	0.110
Caesarean section	36 (36%)	6(50%)	21(29.6%)	9(52.9%)	

Preterm labor occurred in 11% of pregnancies. The incidence was higher in the hypocoiled group (25%) compared to the normocoiled (9.9%) and hypercoiled groups (5.9%), though this difference was not statistically significant ($p = 0.229$).

Meconium-stained liquor was present in 4% of cases, occurring in 8.3% of the hypocoiled group, 1.4% of the normocoiled group, and 11.8% of the hypercoiled group. No significant association was found ($p = 0.106$).

Fetal distress was observed in 7% of cases, with comparable distribution across hypocoiled (8.3%),

normocoiled (7.0%), and hypercoiled (5.9%) groups ($p = 0.968$). No association was found between umbilical coiling index and fetal distress in our study ($P = 0.968$). [Table 3]

Out of the total 100 study subjects, 64% of women had normal vaginal delivery and 36% underwent caesarean section. Caesarean section rates were higher in the hypocoiled (50%) and hypercoiled (52.9%) groups compared to the normocoiled group (29.6%), but the association was not statistically significant ($p = 0.110$). [Table 3]

Table 4: Neonatal Outcome

	Total	Hypocoiled group	Normocoiled group	Hypercoiled group	P Value
Low birth weight	15(15%)	4(33.3%)	7(9.9%)	4(23.5%)	0.060
Low Apgar at 1 minutes (≤ 7)	6(6.0%)	1(8.3%)	3(4.2%)	2(11.8%)	0.469
Low Apgar at 5 minutes (≤ 7)	4(4.0%)	0(0.0%)	3(4.2%)	1(5.9%)	0.717
NICU admission	5(5.0%)	2(16.7%)	2(2.8%)	1(5.9%)	0.123

Low birth weight (<2.5 kg) was observed in 15% of neonates. The incidence was highest in the hypocoiled group (33.3%), followed by the hypercoiled group (23.5%) and normocoiled group (9.9%). No association was observed between the umbilical coiling index and birth weight in our study (p -value = 0.060).

An Apgar score ≤ 7 at 1 minute was observed in 6% of neonates, distributed as 8.3% in the hypocoiled group, 4.2% in the normocoiled group, and 11.8% in the hypercoiled group ($p = 0.469$). At 5 minutes, 4% of neonates had Apgar scores ≤ 7 , occurring in 0% of the hypocoiled group, 4.2% of the normocoiled group, and 5.9% of the hypercoiled group ($p = 0.717$). No association was observed between the umbilical coiling index and Apgar score. [Table 4]

NICU admission was required in 5% of neonates overall. Admission rates were higher in the hypocoiled group (16.7%) compared to the normocoiled (2.8%) and hypercoiled (5.9%) groups; however, this association was not statistically significant ($p = 0.123$). [Table 4]

In the study population, there were no cases of intrauterine death.

DISCUSSION

The mean umbilical coiling index for 100 women was 0.54 ± 0.21 . Normocoiled umbilical cords in our study population were found to be within the range of 0.20 to 0.76 (10th to 90th percentile). The umbilical coiling index at the 10th and 90th percentiles for our study was found to be 0.20 and 0.76. 12% of the

population had hypocoiled cord (≤ 10 th percentile), and 17% of the population had hypercoiled cord (≥ 90 th percentile).

Arora R et al,^[1] conducted a study in 100 pregnant females and reported a mean UCI of $0.56 \pm 0.01/\text{cm}$, which is similar to our study. Predanic et al,^[7] in their research, found that the average umbilical coiling index (UCI) was 0.40, with sonographic assessment conducted around 18–23 weeks of gestation.

The mean age of the study participants was 28.4 ± 4.1 years. No significant association was observed between UCI and the age of the patient in our study. These findings are consistent with those of Feyl-Woboso et al,^[14] and Jo et al.^[12]

No significant association was found between UCI and fetal distress (p-value = 0.968). The findings are consistent with those of Arora R et al,^[1] and Sharma R et al.^[9]

The association of UCI with mode of delivery was studied and is statistically not significant with a p-value of 0.110. This is consistent with the study done by Strong et al.^[15]

Tahmasebi et al. showed no significant correlation between AUCI and birth weight, which was similar to the present study.^[16] Our study demonstrated no significant association between low birth weight and UCI.

In our study, no significant statistical association was found between the Apgar score at 1 and 5 minutes and UCI. In a prospective study executed by Bagchi S et al. on 100 patients, it was observed that hypocoiled cords were associated with a poor Apgar score at 1 minute.^[3] In another study by Padmanabhan et al,^[17] 130 umbilical cords were studied, and it was found that in hypocoiled cords, there was a significant low Apgar score. Apgar score at 5 minutes and its association with UCI were studied by Bagchi S et al., but they did not find any statistically significant correlation.^[3]

A good Apgar score at 5 minutes in our study may be due to timely intervention, as all cases were monitored by continuous cardiotocography (CTG), and hence there is no prolonged hypoxia in utero. Immediate effective resuscitation improved the babies' Apgar score at 5 minutes, as they never went into secondary apnea.

Agarwal et al. stated that hypercoiling of the umbilical cords was associated with NICU admission.^[18] However, in the present study, there was no statistical significance between UCI and NICU admission.

Limitations: This was a prospective observational study and we measured the umbilical coiling index by USG only once in the course of study period. The prime limitations of our study are that it had a moderate patient number and it was a mono-center study. Since USG was used to evaluate umbilical coiling index, there was a possibility for both observer bias (intra-observer variability) and instrumental bias.

Strength

The strength of our study is that it is a prospective study and a single observer was involved, thus eliminating the inter-observer bias. It is a non-invasive procedure and can be performed safely during the routine anomaly scan.

CONCLUSION

This study has explored the correlation between the sonographically measured Umbilical coiling index and pregnancy outcome of pregnant females undergoing routine anomaly scan in the state of Punjab. In the present study there was no association between antenatal umbilical cord coiling index and adverse pregnancy outcome. However, the number of subjects was not significantly high enough for the desired population, to achieve a statistically significant value. Pregnancies with abnormal umbilical cord coiling index may have normal outcome, however, further studies are necessary to establish these findings. Hence, it is necessary to evaluate this parameter with large groups to find definite association which might serve as a predictive marker for fetal health in the near future.

REFERENCES

1. Arora R, Mohi MK, Kaur M, Kaur G, Kaur SP. Ultrasonographic evaluation of antenatal umbilical cord coiling index (aUCI) in second trimester of gestation and pregnancy outcome. *Int J Reprod Contracept Obstet Gynecol.* 2018; 7: 4623-28.
2. Bagchi S, Monga R, Sah S. Correlation of Antenatal Umbilical Cord Coiling Index with Perinatal Outcome. *J South Asian Fed Obstet Gynecol.* 2018; 10: 127-30.
3. Chitra T, Sushanth YS, Raghavan S. Umbilical coiling index as a marker of perinatal outcome: an analytical study. *ObstetGynecol Int.* 2012; 2012: 213689.
4. Kumar S and Chetty S. Umbilical coiling index as a marker of perinatal outcome: An analytical study at Navodaya Medical College, Raichur. *Indian J Child Health.* 2017; 4: 18-21.
5. Mittal A, Nanda S, Sen J. Antenatal umbilical coiling index as a predictor of perinatal outcome. *Arch Gynecol Obstet.* 2015; 291: 763-68.
6. Sharma B, Bhardwaj N, Gupta S, Gupta PK, Verma A, Malviya K. Association of umbilical coiling index by colour Doppler ultrasonography at 18–22 weeks of gestation and perinatal outcome. *J ObstetGynaecol India.* 2012; 62: 650-54.
7. Predanic M, Perni SC, Chasen ST, Baergen RN, Chervenak FA. Ultrasound evaluation of abnormal umbilical cord coiling in second trimester of gestation in association with adverse pregnancy outcome. *Am J Obstet Gynecol.* 2005; 193: 387-94.
8. Bhoite A and Kadam D. Prediction of pregnancy outcome by umbilical coiling index. *J Cardiovasc Dis Res.* 2020; 11: 46–51.
9. Sharma R, Radhakrishnan G, Manchanda S, Singh S. Umbilical coiling index assessment during routine fetal anatomic survey: a screening tool for fetuses at risk. *J ObstetGynaecol India.* 2018; 68: 369-75.
10. Sebire NJ. Pathophysiological significance of abnormal umbilical cord coiling index. *Ultrasound Obstet Gynecol.* 2007; 30: 804-06.
11. Clerici G, Antonelli C, Rizzo G, Kanninen TT, Di Renzo GC. Atypical hemodynamic pattern in fetuses with hypercoiled umbilical cord and growth restriction. *J Matern Fetal Neonatal Med.* 2013; 26: 558-62.

12. Jo YS, Jang DK, Lee G. The sonographic umbilical cord coiling in late second trimester of gestation and perinatal outcomes. *Int J Medical Sci.* 2011; 8: 594.
13. Bhojwani P, Sharma R, Bhojwani L, Bhatnagar B. Correlation of Antenatal Umbilical Cord Coiling Index with Perinatal Outcome Using Color Doppler at Late Second Trimester. *Int J Contemp Med.* 2016; 3: 2722-4.
14. Feyl-Woboso PA, Omo-Aghoja LO. Umbilical cord coiling index in women of south eastern Nigeria. *J Womens Health Issues Care.* 2014; 3: 4.
15. Strong TH Jr, Elliott JP, Radin TG. Non-coiled umbilical blood vessels: a new marker for the fetus at risk. *Obstet Gynecol.* 1993; 81: 409-11.
16. Tahmasebi M, Alighanbari R. Evaluation of umbilical cord thickness, cross-sectional area, and coiling index as predictors of pregnancy outcome. *Indian J Radiol Imaging.* 2011; 21: 195.
17. Padmanabhan LD, Mhaskar R, Mhaskar A. Umbilical vascular coiling and the perinatal outcome. *J ObstetGynecol India.* 2001; 51: 43-4.
18. Agarwal S, Purohit RC, Jain G. Umbilical cord coiling index and perinatal outcome in normal and abnormal pregnancies. *Sch J App Med Sci.* 2014; 2: 447-50..