ORIGINAL ARTICLE

Antenatal Umbilical Cord Coiling Index and Adverse Perinatal Outcome: A Prospective Observational Study at A Tertiary Care Hospital in Multan

Atif Latif[1*], Shabeeh e Zahra[1], Sadaf Aziz[2], Mubashrah Aziz[3], Nausheen Sadiq[1], Ammara Iftkhar[1]

ABSTRACT

Objective: The study aims to determine the association between antenatal umbilical cord coiling index (aUCI) measured by Color Doppler ultrasonography in the late second trimester and adverse perinatal outcomes.

Study Design: Prospective observational study.

Place and Duration of Study: This study was conducted at the Department of Radiology, Combined Military Hospital, Multan, Pakistan from 1st January 2022 to 30th September 2022.

Methods: The study sample included 173 pregnant females aged 20-35 years. Females presenting at gestational age 20-24 weeks with a singleton pregnancy for a routine fetal anomaly scan were consecutively included after informed consent. The aUCI was calculated by taking the average of the reciprocal value of the distance (cm) between coil pairs at 03 different points in the middle segment of the umbilical cord. The subjects were categorized based on aUCI <10th percentile, between 10th and 90th percentile, and >90th percentile, respectively. All subjects were evaluated at delivery for perinatal outcomes, including mode of delivery, preterm delivery, low birth weight (LBW), intrauterine growth retardation (IUGR), APGAR score, admissions to the neonatal intensive care unit (NICU), and perinatal death. All the data was statistically analyzed. *P*-value <0.05 was considered significant.

Results: Out of 173 females, 97 were primigravida. Mean aUCI was 0.37 ± 0.073. The frequency of abnormal coiling index was 18.5%, 17 (9.8%) were categorized as hypercoiled, and 15 (8.7%) as hypocoiled. Hypocoiled index was significantly associated with preterm (RR= 7.54, *P*=.006), LBW (RR= 10.96, *P*=.001) and admission to NICU (RR= 6.36, *P*=.012) while hypercoiled index was significantly associated with perinatal death (RR= 6.58, *P*=.010), preterm (RR= 6.28, *P*=.012), admission to NICU (RR= 5.08, *P*=.024) and LBW (RR= 5.44, *P*=.020).

Conclusion: Abnormal antenatal umbilical cord coiling index is associated with various adverse perinatal outcomes. Thus, its measurement can help in identifying high-risk pregnancies.

Keywords: *APGAR Score, Color Doppler Ultrasonography, Low Birth Weight, Umbilical Cord.*

How to cite this: *Latif A, Zahra S, Aziz S, Aziz M, Sadiq N, Iftkhar A. Antenatal Umbilical Cord Coiling Index and Adverse Perinatal Outcome: A Prospective Observational Study at A Tertiary Care Hospital in Multan. Life and Science. 2025; 6(4): 510-515. doi: http://doi.org/10.37185/LnS.1.1.771*

[1]*Department of Radiology*
Combined Military Hospital (CMH), Multan, Pakistan
[2]*Department of Radiology*
Combined Military Hospital (CMH), Lahore, Pakistan
[3]*Department of Radiology*
Armed Forces Institute of Radiology & Imaging (AFIRI), Rawalpindi, Pakistan

Correspondence:
Dr. Altif Latif
Department of Radiology
Combined Military Hospital (CMH), Multan, Pakistan
E-mail: atif_latif98@yahoo.com

Received: July 20, 2024; 1st Revision Received: Nov 18, 2024
2nd Revision Received: May 17, 2025; Accepted: Jun 05, 2025

Introduction

Umbilical cord is the most vital yet delicate link between fetus and mother, as wisely said, “the baby's life hangs by a cord.”[1] Umbilical cord has three vessels coiled in a usual helical pattern under the protection of amniotic fluid.[2] Various studies have been conducted so far to analyze the association of umbilical cord characteristics like the number of vessels, the amount of Wharton's jelly, cord length, the type of placental insertion, cord thickness, blood flow patterns, cord diameter, and coiling with possible maternal and fetal complications. Among

these, the umbilical cord coiling index (UCI) has shown significant correlation with various antenatal and perinatal pathologies in some studies.[3] UCI is defined by the number of vascular coils of the umbilical cord in units of length (cm) of cord.[4] Abnormally coiled cords can be hypocoiled (UCI <10th percentile) or hypercoiled (UCI>90th percentile).[5] Though the cause for umbilical coiling is not clear, studies confer that umbilical cord coiling noticeably modulates blood flow through the umbilical cord, and abnormal umbilical cord coiling can lead to fetal distress and chronic intrauterine growth retardation (IUGR).[2] It is assumed that UCI can be precisely calculated in the second trimester, called antenatal UCI (aUCI), as the umbilical coiling is fully developed by the end of the first trimester and does not change subsequently; rather, the cord lengthens between the established coils.[6,7]

Doppler analysis of uterine arteries is a noninvasive and cost-effective test to assess aUCI and identify pregnancies anticipated to end with an adverse perinatal outcome.[8] aUCI is calculated as the reciprocal value of the distance between a pair of coils measured in cm from the inner edge of an arterial or venous wall to the outer edge of the next coil along the ipsilateral side of the umbilical cord at the late second trimester.[9] Preferably, measurements of three distinct segments or two to three consecutive segments in the middle region are taken to calculate the mean aUCI.

Data on the relationship between aUCI and perinatal outcome are scarce in our country. This study aims to calculate the aUCI by Doppler ultrasound in the late second trimester and find its association with adverse perinatal outcomes in pregnant women visiting this hospital.

Methods

This prospective observational study was carried out from January 2022 to September 2022 after the approval from Institutional Ethical Review Board of the hospital vide letter no: ERC/18/2021, dated: 13 November 2021, Considering the proportion of preterm birth in hypocoiled and normocoiled groups as 46.8% and 2.7% respectively while keeping probability of type I error at 0.05 and power of test at 0.8, a sample size of at least 14 in each of hypocoiled, hypercolied and normocoiled groups was obtained using WHO sample size calculator.[10]

Females aged 20-35 years with an uncomplicated singleton pregnancy of gestational age 20-24 weeks were included in the study by a non-probability consecutive sampling technique after informed written consent. Exclusion criteria were a history of complicated pregnancy, such as Diabetes mellitus, hypertension, anemia, placenta praevia, placental abruption, and fetal congenital anomalies. All subjects underwent an umbilical artery doppler study by a consultant radiologist with at least 3 years of post-fellowship experience. aUCI was measured at three distinct segments in the middle region of the umbilical cord as the reciprocal value of the distance between a pair of coils measured in cm from the inner edge of an arterial or venous wall to the outer edge of the next coil along the ipsilateral side of the umbilical cord. Mean aUCI was calculated and categorized as normocoiled /hypercoiled /hypocoiled based on aUCI value between the 10th and 90th percentile, >90th percentile, and <10th percentile, respectively. All the subjects were followed till their admission to the labor room and the start of active labor. Perinatal outcome was observed as mode of delivery, preterm delivery, birth weight, intrauterine growth retardation, APGAR score, admissions to neonatal intensive care (NICU), and perinatal death. Preterm delivery was defined as delivery at <37 gestational weeks. An APGAR score of <7 at 5 minutes was considered low. Low birth weight (LBW) was defined as neonatal birth weight less than 2,500 g, while intrauterine growth retardation (IUGR) was diagnosed when fetal weight was below the 10th percentile for its gestational age. All the obtained data were noted on a proforma designed for the study.

The collected data were analyzed using SPSS 25.0. Results were reported as mean ± standard deviation (SD) for quantitative variables like age, gestational age, aUCI, while categorical variables like parity, preterm delivery, LBW, low Apgar score, emergency lower segment cesarean section (EmLSCS), and NICU admission were described as frequencies and percentages. Quantitative variables were compared using an independent t-test. The chi-square test was used to evaluate the association between aUCI and adverse perinatal outcomes. At a 95% confidence

interval, a *P*-value < 0.05 was considered statistically significant.

Results

Out of 177 females enrolled for this study, 04 were lost to follow-up; thus, 173 females were considered for final analysis. The overall mean maternal age was 25.6±3.7 years±, and the mean gestational age was 22.3±1.12 weeks at the time of ultrasound. The frequency of primigravida was 97 (56%). The mean aUCI was 0.37 ± 0.073. The aUCI of < 0.28 was considered hypocoiled and aUCI >0.48 was considered as hypercoiled, aUCI >0.48 was considered as hypercoiled, while aUCI 0.28-0.48 was considered normocoiled. Following the mentioned cut-offs, the frequency of abnormal aUCI in our study population was 18.5% as 141 (81.5%) subjects were categorized in normocoiled, 15 (8.7%) in hypocoiled, and 17 (9.8%) in hypercoiled group. (Figure. 1). There was no significant difference in gravida status, mean age, and mean gestational age at ultrasound time among the aUCI groups. However, the mean gestational age at time of delivery was significantly low in subjects with abnormal aUCI, especially in the hypocoiled group, as shown in Table 1.

Table 1: Comparison of Baseline characteristics among antenatal umbilical cord coiling index (aUCI) groups

Variable	Overall N=173	Normocoiled N=141	Hypocoiled N=15	Hypercoiled N=17	*P* value
Maternal age, years Mean±SD	25.6±3.7	25.6±3.67	24.6±3.5	26.6±3.7	.311
Gravida, N(%) Primigravida Multigravida	97 (56) 76 (44)	78 (55) 63 (45)	9 (60) 6 (40)	10 (59) 7 (41)	.915
Gestational age at time of sonography, weeks Mean±±SD	22.3±1.12	22.3±1.11	22.5±1.14	22.2±1.19	.715
Gestational age at time of delivery, weeks Mean±SD	38.6±1.35	38.8±1.2	37.4±1.8	38.3±1.6	<.001

Table 2: Association of adverse perinatal outcomes with hypocoiled and hypercoiled groups

Variables	Normo coiled (N=141)	Hypo-coiled (N=15)	RR	*P*- value	Hyper-coiled (N=17)	RR	*P*- value
Preterm	5 (3.5)	3 (20)	7.54	.006	3 (17.6)	6.28	0.012
LBW	14 (9.9)	6 (40)	10.96	.001	5 (29.4)	5.44	0.02
IUGR	9 (6.4)	2 (13.3)	0.99	.317	3 (17.6)	2.74	0.098
A/S<7 at 5 min	8 (5.7)	2 (13.3)	1.33	.25	2 (11.8)	0.95	0.33
Emergency LSCS	20 (14.2)	3 (20)	0.37	.546	4 (23.5)	1.63	0.311
NICU admission	10 (7.1)	4 (26.7)	6.36	.012	4 (23.5)	5.08	0.024
Perinatal death	2 (1.4)	1 (6.7)	1.98	.159	2 (11.8)	6.58	0.010

Evaluation of aUCI and perinatal outcomes using the chi-square test revealed that hypocoiled index was significantly associated with preterm delivery (RR= 7.54, *P*=0.006), LBW (RR= 10.96, *P*=0.001), and admission to NICU (RR= 6.84, *P*=0.008). In contrast, the hypercoiled index has a significant association with perinatal death (RR= 6.58, *P*=.010), preterm (RR= 6.28, *P*=.012), admission to NICU (RR= 5.08,

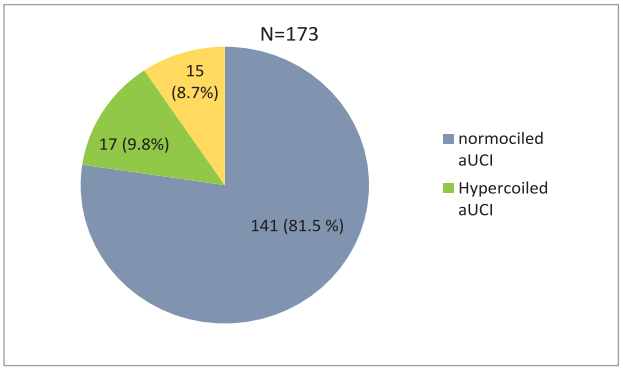

Fig.1: Categorization of subjects according to antenatal umbilical cord coiling index (aUCI) (N=173)

P=.024), and LBW(RR= 5.44, *P*=.020) (Table 2). However, no significant association of any abnormal coiling index group was found with IUGR, low Apgar score, and EmLSCS as shown in Table 2.

Discussion

Fetal distress is the cornerstone of perinatal morbidity and mortality. The coiled structure of the umbilical cord is a physiological adaptation to prevent fetal distress by providing structural stability, flexibility, and protection to the umbilical vessels and maintaining a smooth fetal blood supply.[11,12] So, measurement of changes in umbilical cord coiling can be used to assess the risk of fetal distress.[13] One such promising predictor is the Umbilical Cord Coiling Index (UCI), which is an affordable, easily accessible, and noninvasive test. More studies have examined association of abnormal postnatal UCI (pUCI) rather than antenatal UCI (aUCI) with poor perinatal outcomes.[14] Moreover, such data have not yet been published from Pakistan.[9] The current study provided estimates of aUCI in a representative sample of pregnant women and has evaluated the association of aUCI with various adverse perinatal outcomes to assess the role of aUCI as a predictor. It has revealed the following significant findings: First, abnormal aUCI measure in the late second trimester has a positive association with various adverse perinatal outcomes. Second, females with hypocoiled aUCI have a higher risk of preterm delivery, LBW, and neonate admission to NICU, while female with hypercoiled index has a significant risk of perinatal death, NICU admission, preterm delivery, and LBW. Third, the abnormal coiling index has no significant association with IUGR, low Apgar score, and EmLSCS.

The frequency of abnormal aUCI in the present study was 18.5%, which was fairly consistent with findings of Bhojwani P et al. (26%), Satoskar P et al. (21%), and Singireddy N et al. (18.7%).[10,15,16] Mean aUCI was 0.37± 0.073 coils/cm with 0.28 and 0.48 coils/cm as cutoffs for hypocoiled and hypercoiled categories, respectively. This was consistent with findings of a similar study by Mittal A et al., with a mean aUCI of 0.36±0.07, 0.26 as hypocoiled and 0.46 as hypercoiled group cutoffs.[17] Differences in mean aUCI and its range in other studies were due to differences in gestational age at the time of aUCI measurement and the presence of comorbidities affecting aUCI.[6,10,11] Our study did not reveal a significant relationship between aUCI and gravida status, which was inconsistent with the findings of Chitra T et al. There was a significant association of both hypocoiled and hypercoiled groups with preterm delivery, as also shown by De Laat MW et al. and Rana J et al. However, some of the studies demonstrated that only the hypocoiled index was significantly associated with preterm.[18-20] Both hypocoiled and hypercoiled groups in this study have revealed a positive association with low birth weight, which was in line with the fact stated by Predanic and Perni that aUCI was a good predictor of neonatal birth weight.[21] This association was probably due to a higher rate of preterm deliveries in both groups and a relatively higher frequency of IUGR in the hypercoiled group.[17] Our study has also revealed a significant association of both hypocoiled and hypercoiled indices with neonatal admission to the intensive care unit, as found in other studies.[9,10,15-17] Though very few studies have evaluated perinatal mortality and aUCI, Dutman AC et al. and Horn LC et al. have revealed positive association of hyper coiling with perinatal death, as also found in our study probably due to interruption of feto-placental circulation by hypercoiling.[22,23] Pergialiotis V et al. also revealed in their meta-analysis that both hypercoiled and hypocoiled indices had a positive correlation with intrauterine death.[8] A recent review by Kalluru PK et al. has also supported the findings of this study.[9] They observed that an abnormal coiling index was associated with an adverse perinatal outcome. However, other umbilical cord anatomical features, in addition to aUCI, must be assessed to improve the prediction of adverse perinatal outcomes. Moreover,

the causal relationship between aUCI and the underlying pathology of adverse perinatal outcome has not yet been established.[9]

There are certain limitations in our study, like a small sample size, non-availability of standardized cutoffs for abnormal aUCI, operator bias due to a single measurement of aUCI, and not incorporating other umbilical cord characteristics. Thus, larger multicentre and population-based studies should be carried out to establish a standardized protocol for measuring and interpreting the antenatal umbilical cord coiling index and to evaluate the enhancement in its predictive value by combining with other umbilical cord anatomical factors.

Conclusion

Abnormal antenatal umbilical cord coiling index measured in the late second trimester has a positive association with various adverse perinatal outcomes. An increased risk of preterm delivery, low birth weight, and neonatal admission to the intensive care unit was observed in pregnancies with hypocoiled and hypercoiled indices, while a significant risk of perinatal death was also found in pregnancies with hypercoiled indices. Thus, antenatal umbilical cord coiling index measurement at late second trimester can predict adverse perinatal outcomes.

Acknowledgement: None

Conflict of Interest: The authors declare no conflict of interest

Grant Support and Financial Disclosure: None

REFERENCES

1. Aafreen A, Pankaj A, Pankaj A. A Prospective Study to the Evaluate Umbilical Coiling Index as a Marker of Maternal Outcome. Journal of South Asian Federation of Obstetrics and Gynaecology. 2023; 15: 654-7. doi: 10.5005/jp-journals-10006-2350
2. Asha DE, Ramesh S, Hamsalekha NA, Huchegowda S. Umbilical coiling index and its relation to perinatal outcome. Journal of Clinical Obstetrics & Gynecology. 2021; 31: 6-13. doi: 10.5336/jcog.2020-78828
3. Subashini G, Anitha C, Gopinath G, Ramyathangam K, Ganesan G. A longitudinal analytical study on umbilical cord coiling index as a predictor of pregnancy outcome. Cureus. 2023; 15: e35680. doi: 10.7759/cureus.35680
4. Adsul P, Hol K, Chaudhari S, Dube S. Umbilical coiling index and its relationship with perinatal outcomes International Journal of Advanced Research. 2022; 10**:** 494-502. doi: 10.21474/IJAR01/14915
5. Das E, Singh V, Agrawal S, Pati SK. Prediction of preeclampsia using first-trimester uterine artery Doppler and pregnancy-associated plasma protein-a (PAPP-A): a prospective study in Chhattisgarh, India. Cureus. 2022; 14: e22026. doi: 10.7759/cureus.22026
6. Biradar A, Kori S, Patil N, Mudanur SR. Umbilical coiling index and its association with perinatal mortality and morbidity in a low resource tertiary care hospital of northern Karnataka - a prospective observational study. The New Indian Journal of OBGYN. 2020; 7: 10-5. doi: 10.21276/obgyn.2020.7.3
7. Jan S, Qamar A, Javed MA, Zulfiqar S, Jamil S, Aziz M. Umbilical Cord Coiling Index as A Marker of Perinatal Outcome: Umbilical Cord Coiling Index for Perinatal Outcome. Pakistan Journal of Health Sciences. 2024; 5: 209–14. doi: 10.54393/pjhs.v5i11.2426
8. Pergialiotis V, Kotrogianni P, Koutaki D, Christopoulos-Timogiannakis E, Papantoniou N, Daskalakis G. Umbilical cord coiling index for the prediction of adverse pregnancy outcomes: a meta-analysis and sequential analysis. The Journal of Maternal-Fetal & Neonatal Medicine. 2020; 33: 4022-9. doi: 10.1080/14767058.2019.1594187
9. Kalluru PK, Kalluru HR, Allagadda TR, Talur M, Gonepogu MC, Gupta S. Abnormal umbilical cord coiling and association with pregnancy factors. Journal of the Turkish German Gynecological Association. 2024; 25: 44-52. doi: 10.4274/jtgga.galenos.2023.2023-3-3
10. 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. International Journal of Contemporary Medical Research 2016; 3: 2722-4
11. Aanandini T, John LB, Rathod S. Antenatal umbilical cord coiling index as a predictor of pregnancy outcome. Indian Journal of Obstetrics and Gynecology Research. 2021; 8: 383–7. doi: 10.18231/j.ijogr.2021.078
12. Reddy DDN, Anuradha CR, Kandasamy V. Association between Umbilical Cord Coiling Index and Perinatal Outcome. Journal of South Asian Federation of Obstetrics and Gynaecology. 2024; 16: 17–9. doi: 10.5005/jp-journals-10006-2308
13. Hoseinalipour Z, Javadian M, Nasiri-Amiri F, Nikbakht HA, Pahlavan Z. Adverse pregnancy outcomes and the abnormal umbilical cord coiling index. Journal of Neonatal-Perinatal Medicine. 2024; 17: 681-8. doi: 10.3233/NPM-230106
14. Nguyen TTN, Nguyen HT, Cao NT, Nguyen PN, Truong TLG, Le MT, et al. Umbilical cord coiling index in predicting neonatal outcomes: a single-center cross-sectional study from Vietnam. The Journal of Maternal-Fetal & Neonatal Medicine. 2025; 38: 2517763 doi: 10.1080/14767058.2025.2517763
15. Satoskar P. A Study to Assess the Association between Umbilical Cord Coiling Index and Perinatal Outcomes. Journal of South Asian Federation of Obstetrics and Gynaecology. 2018; 11: 243-5. doi: 10.5005/jp-journals-10006-1697
16. Singireddy N, Chugh A, Bal H, Jadhav SL. Re-evaluation of umbilical cord coiling index in adverse pregnancy outcome–Does it have role in obstetric management?. European Journal of Obstetrics & Gynecology and

Reproductive Biology: X. 2024; 21: 100265. doi: 10.1016/j.eurox.2023.100265
17. Mittal A, Nanda S, Sen J. Antenatal umbilical coiling index as a predictor of perinatal outcome. Archives of Gynecology and Obstetrics. 2015; 291: 763-8. doi: 10.1007/s00404-014-3456-5
18. Chitra T, Sushanth YS, Raghavan S. Umbilical coiling index as a marker of perinatal outcome: an analytical study. Obstetrics and gynecology international. 2012; 2012: 213689. doi: 10.1155/2012/213689
19. de Laat MW, Franx A, Bots ML, Visser GH, Nikkels PG. Umbilical coiling index in normal and complicated pregnancies. Obstetrics & Gynecology. 2006; 107: 1049-55. doi: 10.1097/01.AOG.0000209197.84185.15
20. Rana J, Ebert GA, Kappy KA. Adverse perinatal outcome in patients with an abnormal umbilical coiling index. Obstetrics & Gynecology. 1995; 85: 573-7. doi: 10.1016/0029-7844(94)00435-G
21. Predanic M, Perni SC. Absence of a relationship between umbilical cord thickness and coiling patterns. Journal of ultrasound in medicine. 2005; 24: 1491-6. doi: 10.7863/jum.2005.24.11.1491
22. Dutman AC, Nikkels PG. Umbilical hypercoiling in 2nd-and 3rd-trimester intrauterine fetal death. Pediatric and Developmental Pathology. 2015; 18: 10-6. doi: 10.2350/13-10-1390-OA.1
23. Horn LC, Faber R, Stepan H, Simon E, Robel R, Wittekind C. Umbilical Cord Hypercoiling and Thinning: A Rare Cause of Intrauterine Death in the Second Trimester of Pregnancy. Pediatric and Developmental Pathology. 2006; 9: 20-4. doi:10.2350/08-05-0095.1

Author Contributions

AL: Conception and design of the work
SZ: Manuscript writing for methodology design and investigation
SA: Data acquisition, curation, and statistical analysis
MA: Validation of data, interpretation, and write-up of results
NS: Revising, editing, and supervising for intellectual content
AI: Writing the original draft, proofreading, and approval for final submission