ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Correlation between antenatal and postnatal coiling index and its role in prediction of perinatal outcome: A prospective cohort study

Ankita Kumari[1], Vani Aditya[2], Shaila Mitra[3], Garima Maurya[4], Pratima Sharma[5], Harish Chandra Tiwari[6]

[1]Associate Professor, [2]Professor, [4]Assistant Professor, [5]Junior Resident, Department of Obstetrics and Gynecology, [3]Professor and Head, Department of Pathology, [6]Associate Professor, Department of Community Medicine, BRD Medical College, Gorakhpur, Uttar Pradesh, India

Submission: 24-10-2024 Revision: 04-01-2025 Publication: 01-02-2025

ABSTRACT

Background: The umbilical cord has pivotal role in the development, well-being, and survival of fetus and is vulnerable to kinking, torsion, and compression affecting perinatal outcome adversely. **Aims and Objectives:** This study was aimed to correlate the umbilical cord index measured antenatally using ultrasonography with that of the umbilical cord index measured postnatally and the association of this index with adverse fetal outcomes. **Materials and Methods:** This prospective cohort study was conducted on 124 antenatal cases of age group 18–35 years with term gestation with singleton pregnancy that attendant the outpatients department and indoor of Department of Obstetrics and Gynecology, Nehru Hospital B.R.D. Medical College, Gorakhpur over a period of 1 year (2019–2020). After detailed history, examination, and required antenatal care investigations, Ultrasonographic examination was done and antenatal umbilical coiling index (UCI) was calculated. The cases were followed up till delivery and postnatal UCI was also calculated and fetomaternal outcome was noted. Statistical analysis: Appropriate tests were applied where ever necessary. **Results:** The mean age was 25.71 ± 4.30 years. The risk of preeclampsia, fetal growth restriction, oligohydramnios was significantly high with antenatal and postnatal hypocoiling ($P < 0.001$) whereas the risk of gestational diabetes mellitus was significantly associated with antenatal and postnatal hypercoiling. The risk of low birth weight, preterm, low APGAR, neonatal intensive care unit admission and perinatal mortality were significantly high with postnatal hypocoiling ($P < 0.0001$). **Conclusion:** The present study concludes that abnormal UCI was associated with adverse perinatal outcomes. Quantification of degree of abnormal coiling in antepartum period is important.

Key words: Umbilical coiling index; Perinatal outcome; Hypocoiling; Hypercoiling

Access this article online

Website: https://ajmsjournal.info/index.php/AJMS/index

DOI: 10.71152/ajms.v16i2.4283

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

The umbilical cord or funiculus umbilicalis is the lifeline of the fetus as it supplies water, nutrient and oxygen.[1] The most mysterious character of human umbilical cord is the twisted or the spiral course of its component blood vessels.[2] The spiraling of the umbilical vessels develops as early as 28 days after conception and may be seen by ultrasonographic examination as early by 10 weeks of gestational age.[3]

The term umblical coiling index was coined by Strong et al.[3] A coil is defined as complete 360° spiral course of umbilical vessels around the whartons jelly.[4] Normal coiling index is approximately 1 coils per 5 cm of umbilical cord length.[4] Antenatal umbilical coiling index (UCI) is calculated as reciprocal value of distance between a pair of coil measure in cm from inner edge of an arterial or venous wall to the outer edge of the arterial or venous wall along the ipsilateral side of the umbilical cord. The final value is the average of three readings at three different segments of umbilical cord.[5,6]

Address for Correspondence:
Dr. Ankita Kumari, Associate Professor, Department of Obstetrics and Gynecology, BRD Medical College, Gorakhpur, Uttar Pradesh, India.
Mobile: +91-8953454787. **E-mail:** drankita09@gmail.com

After delivery umbilical cord coiling index is determined by dividing the total number of coils by total umbilical cord length in centimeter. An abnormal UCI include hypocoiled if UCI <10th percentile and hypercoiled, if UCI >90th percentile.[3,4]

It was found that hypocoiling (UCI <0.1 coils/cm) and hypercoiling (UCI >0.3 coils/cm) were both associated with increased fetal risk.[7-10] If abnormal umbilical coiling could be detected antenatally and predict adverse pregnancy outcome, then it would be useful to study UCI in utero to select pregnancies for intensive fetal monitoring and early intervention when required.

There were several studies on either antenatal UCI or postnatal UCI and perinatal outcome, respectively. However, there is paucity of literature on that antenatal coiling index could predict the UCI measured postnatally. The purpose of this study is to measure antenatal UCI by ultrasonography and to determine if this antenatal UCI predict the UCI measured postnatally and also to find association with adverse pregnancy outcome.

Aims and objectives

The aim of this study is to measure antenatal UCI by ultrasonography and to determine if this antenatal UCI predict the UCI measured postnatally and also to find association with adverse pregnancy outcome.

MATERIALS AND METHODS

This prospective cohort, single-center study was conducted on 124 antenatal women with singleton pregnancy at term gestation (37–41 weeks) who were admitted to the indoor of Department of Obstetrics and Gynecology, BRD Medical College, Gorakhpur, from August 2020 to July 2021. Sample size was calculated on the basis of expected proportion of fetal abnormalities among hyper/hypocoiling cases using the formula of prevalence of disease in a certain population on risk discussed in "A. Indrayan, Basic methods of Medical research" by putting proportion of fetal abnormalities 30% and allowable error considered to be 8% absolute. Considering 95% confidence level, 90% power of study, the sample size was calculated to be 124 and the sampling technique was non-random convenience sampling. Women with multifetal gestation, fetus with gross congenital malformations, and those with single umbilical artery were excluded from the study. A written informed consent was obtained from all participants, ethical permission was granted from institutional ethical committee (21/CRC/2019 dated November 16, 2019). Detailed history, examination, required antenatal investigations, and ultrasonographic examination was done. A 5-MHz transabdominal curvilinear transducer (MEDISON SONAC 8000) was used to perform all ultrasonographic scans. The antenatal UCI (aUCI) was calculated at term gestation by a single observer as a reciprocal value of the pitch of one complete vascular coil, defined as the distance in centimeter from inner edge of an arterial wall to outer edge of the same arterial wall of the next coil ipsilaterally measured in mid-section of the umbilical cord.

Postnatally, umbilical cord coiling index (pUCI) or true UCI was calculated by dividing the total number of vascular coils in cord by total length of cord in centimeters.

Relevant maternal demographic data were collected. Clinical information such as pregnancy induced hypertension, gestational diabetes mellitus (GDM), oligohydramnios, meconium stained liquor, persistent non-reassuring fetal heart rate (FHR) in labor, instrumental delivery, or cesarean section, low birth weight (LBW), poor APGAR scores at 1 and 5 min, fetal growth restriction, and neonatal intensive care unit (NICU) admission was noted. The centile values were calculated and the subjects were divided into three groups, that is, normocoiling, hypocoiling, and hypercoiling, respectively. Hypocoiled cords were defined as those with UCI less than the 10th percentile and hypercoiled group as having values more than 90th percentile. Normocoiled group have UCI values between 10th and 90th percentile of the mean UCI.[3,4]

The hypocoiled and hypercoiled groups were compared with normocoiled group, and the association of the chosen maternal and fetal parameters with UCI (antenatal and true) was studied.

Statistical analysis

Data were analyzed using SPSS 20.0; Chi-square test was applied to 2×2 contingency table. Odds ratio and 95% confidence interval were used to evaluate association between adverse pregnancy outcome and under/over coiling.

RESULTS

In our study, the most frequent age range of the cases was 21–25 years (51.6%) followed by the age range of 26–30 years (29.0%). The average maternal age was 25.71±4.30 years (Figure 1). Majority of the antenatal women were primigravida (47.6%) and the mean gestational age was found to be (38.4±1.6) weeks. The mean antenatal UCI was found to be 0.31±0.12 (0.11–0.68) while the mean postnatal UCI was 0.29±0.12 (0.04–0.58). The aUCI below 0.16 taken as hypocoiling and the value of aUCI >0.46 was taken as hypercoiling. Similarly, the value of pUCI

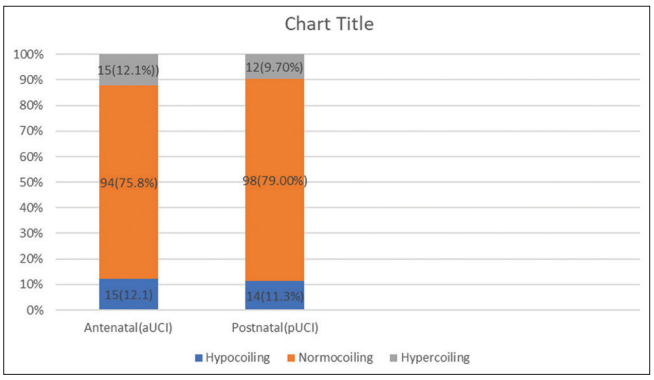

Figure 1: Distribution of frequency of antenatal and postnatal umbilical coiling index

<0.11 taken as hypocoiling and pUCI >0.44 was taken as hypercoiling.

Pre-eclampsia, intrauterine growth restriction (IUGR), oligohydroamnios, and previous uterine scar were found at higher risk for antenatal hypocoiling (RR=17.2, 15.7, 13.6, and 2.6, respectively, and P<0.0001) as compared to normocoiled groups. Antenatal hypercoiling was significantly associated with GDM. (RR=28.2, P<0.0001) (Table 1).

The association of postnatal hypocoiling was statistically significant with preeclampsia, IUGR and oligohydroamnios. (RR=19.3, 9.3, and 11.4, respectively, P<0.0001) whereas postnatal hypercoiling was significantly associated with GDM. (RR=36.8, P<0.0001).

The antenatal as well postnatal hypercoiling was significantly associated with Meconium-stained liquor. (RR=8.8, 24.5, respectively, and P<0.0001). However, no association was noted between meconium-stained liquor and antenatal and postnatal hypocoiling (RR=1.3 and 2.3, respectively; P>0.5) (Table 2).

The risk of abnormal CTG and non-reassuring FHR was found to be insignificant with antenatal and postnatal coiling index (P>0.05) (Table 3). No significant correlation was found between antenatal UCI as well as postnatal coiling index with mode of delivery (P value in a UCI group was 0.078 and P UCI was 0.205, respectively) (Table 4).

The incidence of LBW and pre-term birth was significantly associated with antenatal hypocoiling group (RR=9.7 and 37.6, P<0.0001) as compared to the antenatal hypercoiling (RR=0.0 and P>0.05) and normocoiling group.

The postnatal hypocoiling was at high risk for LBW, preterm, low APGAR in 1 min and 5 min and NICU admission. (RR=5.4, 42.0, 8.8, 10.5, and 21.0, respectively, and P<0.0001). The length of stay in NICU and perinatal mortality were significantly high with postnatal hypocoiling (P=0.003 and 0.008, respectively) (Table 5).

Table 1: Distribution of cases according to sociodemographic profile

Maternal characteristics	No. of cases (n=124)	Percentage
Age (years)		
18–20	7	5.6
21–25	64	51.6
26–30	36	29.0
>30	17	13.7
Gravidity		
G1	59	47.6
G2	31	25.0
≥G3	34	27.4
Gestational age (weeks)		
37	14	11.3
37–38	27	21.8
38–39	30	24.2
39–40	21	16.6
40–41	19	15.3
41–42	13	10.3
Socioeconomic status		
Upper	2	1.6
Middle	31	25.0
Lower	91	73.4
Dwellers		
Rural	75	60.5
Urban	49	39.5
Booking status		
Booked	57	46.0
Unbooked	67	54.0
Religion		
Hindu	111	89.5
Muslim	12	9.7
Others	1	0.8
Literacy		
Illiterate	24	19.4
Primary	28	22.6
High school	26	21.0
Intermediate	31	25.0
Graduate and above	15	12.1

The highly significant positive correlation was found between postnatal UCI and antenatal UCI (r=0.912, P<0.001) (Figure 2) further the regression equation for estimating pUCI by aUCI is given by,

pUCI=−0.004+0.938 (aUCI).

On the other hand, the regression equation for estimating aUCI by pUCI is given by, aUCI=0.056+0.887 (pUCI).

DISCUSSION

In our study, we enrolled 124 antenatal women who met inclusion criteria and measured their UCI antenatally and postnatally. The maximum value of the antenatal UCI (aUCI) was 0.68 and the minimum value was 0.11 respectively.

Table 2: Association of antenatal and postnatal umbilical coiling index with maternal high risk

Maternal high risk (no. of cases)	Antenatal					Postnatal				
	Normocoiling (n=94)	Hypocoiling (n=15)	Hypercoiling (n=15)	Hypo wrt normo	Hype wrt normo	Normo coiling (n=98)	Hypocoiling (n=14)	Hypercoiling (n=12)	Hypo wrt normo	Hyper wrt normo
	aUCI	aUCI <0.16	aUCI >0.46			pUCI	pUCI <0.11	pUCI >0.44		
	No (%)	No (%)	No %			No %	No %	No %		
Preeclampsia (15)	4 (4.3)	11 (73.3)	0 (0.0)	RR=17.2, P<0.0001	RR=0.0, P=0.416	4 (4.1)	11 (78.6)	0 (0.0)	RR=19,3 P<0.0001	RR=0.0, P<0.476
IUGR (7)	2 (2.1)	5 (33.3)	0 (0.0)	RR=15.7, P<0.0001	RR=0.0, P=0.569	3 (3.1)	4 (28.6)	0 (0.0)	RR=9.3, P=0.0002	RR=0.0, P=0.539
GDM (11)	2 (2.1)	0 (0.0)	9 (60.0)	RR=0.0, P=0.569	RR=28.2, P<0.0001	2 (2.0)	0 (0.0)	9 (75.0)	RR=0.0, P=0.590	RR=36.8, P<0.0001
Placenta previa (6)	5 (5.3)	0 0.0	1 (6.7)	RR=0.0, P=0.360	RR=1.3, P=0.832	5 (5.1)	0 (0.0)	1 (8.3)	RR=0.0, P=0.387	RR=1.6, P=0.642
Abruptio placentae (2)	2 (2.1)	0 0.0	0 (0.0)	RR=0.0, P=0.569	RR=0.0, P=0.569	2 (2.0)	0 (0.0)	0 (0.0)	RR=0.0, P=0.590	RR=0.0, P=0.617
Polyhydromnios (5)	3 (3.2)	0 0.0	2 (13.3)	RR=0.0, P=0.483	RR=4.2, P=0.081	4 (4.1)	0 (0.0)	1 (8.3)	RR=0.0, P=0.441	RR=2.0, P=0.505
Oligohydromnios (21)	6 (6.4)	13 (86.7)	0 (0.0)	RR=13.6, P<0.0001	RR=0.0, P=0.314	8 (8.2)	13 (92.9)	0 (0.0)	RR=11.4, P<0.0001	RR=0.0, P=0.304
Previous uterine scar (21)	12 (12.8)	5 (33.3)	4 (26.7)	RR=2.6, P=0.041	RR=2.1, P=0.158	10 (10.2)	5 (35.7)	6 (50.0)	RR=3.5, P=0.009	RR=4.9, P=0.0002
Medical complication (10)	6 (6.4)	2 (13.3)	2 (13.3)	RR=2.1, P=0.338	RR=2.1, P=0.338	6 (6.1)	2 (14.3)	2 (16.7)	RR=2.3, P=0.267	RR=2.7, P=0.184

IUGR: Intrauterine growth restriction, GDM: Gestational diabetes mellitus, pUCI: Postnatal umbilical coiling index, aUCI: Antenatal umbilical coiling index

Table 3: Association of antenatal and postnatal hypo/hypercoiling with abnormal intrapartum findings

abnormal Intrapartum (no. of cases)	Antenatal					Postnatal				
	Normocoiling (n=94)	Hypocoiling (n=15)	Hypercoiling (n=15)	Hypo wrt normo	Hyper wrt normo	Normocoiling (n=98)	Hypocoiling (n=14)	Hypercoiling (n=12)	Hypo wrt normo	Hyper wrt normo
	No (%)	No %	No %			No %	No %	No %		
Meconium stained liquor (13)	5 (5.3)	1 (6.7)	7 (46.7)	RR=1.3, P=0.832	RR=8.8, P<0.0001	3 (3.1)	1 (7.1)	9 (75.0)	RR=2.3, P=0.441	RR=24.5, P<0.0001
Abnormal CTG (5)	2 (2.1)	0 (0.0)	3 (20.0)	RR=0.0, P=0.569	RR=0.0, P=0.569	3 (3.1)	0 (0.0)	2 (16.7)	RR=0.0, P<0.507	RR=5.4, P=0.033
Non reassuring FHR (02)	2 (2.1)	0 (0.0)	0 (0.0)	RR=0.0, P=0.569	RR=0.0, P=0.569	2 (2.0)	0 (0.0)	0 (0.0)	RR=0.0, P=0.590	RR=0.0, P=0.617

FHR: Fetal heart rate

Table 4: Distribution of cases according to mode of delivery

Mode of delivery	No (n=124)	%	aUCI			pUCI		
			Hypocoiled (%)	Normocoiled (%)	Hypercoiled (%)	Hypocoiled (%)	Normocoiled (%)	Hypercoiled (%)
VD	31	25.00	8 (25.8)	19 (61.3)	4 (12.9)	6 (19.4)	20 (64.5)	5 (16.1)
LSCS	89	71.77	7 (7.9)	72 (80.9)	10 (11.2)	8 (9)	74 (83.1)	7 (7.9)
assisted VD	4	3.23	0	3 (75.0)	1 (25.0)	0	4 (100)	0
Total	124	100	15 (12.1)	94 (75.8)	15 (12.1)	14 (11.3)	98 (79)	12 (9.7)
Chi-square				8.41			5.92	
P-value				0.078			0.205	

pUCI: Postnatal umbilical coiling index, aUCI: Antenatal umbilical coiling index

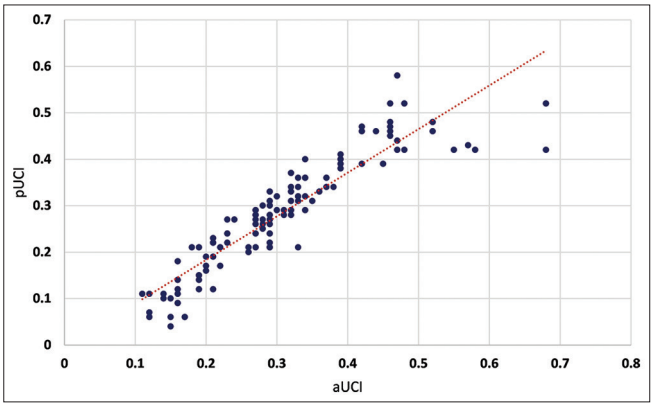

Figure 2: Correlation and regression analysis between antenatal umbilical coiling index and postnatal umbilical coiling index

In the present study, the mean aUCI at term gestational age was (0.31±0.12). This was comparable with finding of Degani et al., and their mean aUCI was (0.44±0.11).[5]

However, in the study performed by Mittal et al., at mean gestational age 22.05, the mean aUCI was (0.36+0.07).[9]

Sharma et al., found the mean UCI to be 0.41 when calculated at 18–22 weeks of gestation.[10] However, the mean UCI was 0.30 in the study by de Laat et al., who calculated the coiling index at gestational age anywhere between 28 weeks to term.[11]

In this study, cases were followed up to delivery and postnatal UCI was also measured. The maximum and minimum value of the postnatal UCI was 0.58 and 0.04, respectively. The mean value of pUCI was (0.29±0.12) in the present study which was comparable to other studies.[3-5,7] In present study, the values for 10th percentile were calculated as 0.16 coils/cm and the value for the 90th percentile was 0.44 coils/cm.

UCI and maternal risk factors

In the current series, we enrolled 124 women with maternal high-risk factor which included preeclampsia, IUGR, GDM, polyhydramnios, oligohydramnios, placenta previa, abruptio placentae, previous uterine scar, and other medical conditions such as thyroid disorder and heart disease were studied. The risk of preeclampsia was significantly high with antenatal hypocoiling (RR=17.2, P=0.0001), this was contrary to the study performed by Mittal et al., who found no association of abnormal coiling and pre-eclampsia.[9]

However, a study done by Tohma et al., showed that there was an increased incidence of preeclampsia in the hypocoiled group (26.09%) as compared to the normocoiled group (3.93%).[12]

Postnatal hypocoiling was also found to be significantly associated with pre-eclampsia (P<0.0001); this was consistent with the result obtained by Chitra et al., Mustafa and Said and Gupta et al.,[4,7,13] In postnatal UCI, hypocoiling group had <0.11 value and hypercoiling group had value >0.46, which very similar to a study done by de Laat et al., (<0.07) and hypercoiling group considered when value >0.30 (Table 6).

The coiled umbilical cord, because of its elastic properties can resist external forces that might compromise the umbilical vascular flow. It also acts like a semierectile organ that is more resistant to snarling torsion, stretch, and compression than the non-coiled one (Machin et al.,); this might explain the association of hypocoiling with preeclampsia.[17]

In present study, the risk of hypocoiling in antenatal and postnatal UCI was significantly high with IUGR (aUCI, RR=15.7, P<0.0001), (pUCI, RR=9.3, P=0.0002), and oligohydramnios (P<0.0001), which was similar to the study done by Gupta et al., and Chitra et al.,[4,7] While Kashanian et al., found oligohydramnios to be significantly associated with both groups.[18]

The current study indicated that women with a blood sugar disorder had mostly hypercoiled umbilical cord in current pregnancy. This results were consistent to the studies done by Chitra et al., and Mustafa and Said[7,13] However,

Table 5: Association of antenatal and postnatal hypo/hypercoiling with perinatal outcome

Perinatal outcome (no of cases)	Antenatal					Postnatal				
	Normocoiling (n=94)	Hypocoiling (n=15)	Hypercoiling (n=15)	Hypo wrt Normo	Hyper wrt Normo	Normocoiling (n=98)	Hypocoiling (n=14)	Hypercoiling (n=12)	Hypo wrt Normo	Hyper Wrt Normo
	No %	No %	No %			No %	No %	No %		
Birth weight<2.5 kg (23)	9 (9.6)	14 (93.3)	0 (0.0)	RR=9.7, P<0.0001	RR=0.0, P=0.211	13 (13.3)	10 (71.4)	0 (0.0)	RR=5.4, P<0.0001	RR=0.0, P=0.179
Birth weight>4kg (1)	1 (1.1)	0 (0.0)	0 (0.0)	RR=0.0, P=0.688	RR=0.0, P=0.211	1 (1.0)	0 (0.0)	0 (0.0)	RR=0.0, P=0.704	RR=0.0, P=0.725
Female neonates (54)	45 (47.9)	5 (33.3)	4 (26.7)	NA	NA	47 (48.0)	5 (35.7)	2 (16.7)	NA	NA
Male neonates (70)	50 (53.2)	10 (66.7)	10 (66.7)	NA	NA	51 (52.0)	9 (64.3)	10 (83.3)	NA	NA
Pre-term (14)	2 (2.1)	12 (80.0)	0 (0.0)	RR=37.6, P<0.0001	RR=0.0, P=0.569	2 (2.0)	12 (85.7)	0 (0.0)	RR=42.0, P<0.0001	RR=0.0, P=0.617
IUGR (4)	2 (2.1)	2 (13.3)	0 (0.0)	RR=6.3, P=0.032	RR=0.0, P=0.569	2 (2.0)	2 (14.3)	0 (0.0)	RR=7.0, P=0.021	RR=0.0, P=0.617
APGAR<4 in 1 min (10)	2 (2.1)	6 (40.0)	2 (13.3)	RR=18.8, P<0.0001	RR=6.3, P=0.032	4 (4.1)	5 (35.7)	1 (8.3)	RR=8.8, P<0.0001	RR=2.0, P=0.505
APGAR<7 in 5 min (20)	9 (9.6)	9 (60.0)	2 (13.3)	RR=6.3, P<0.0001	RR=1.4, P=0.654	8 (8.2)	12 (85.7)	0 (0.0)	RR=10.5, P<0.0001	RR=0.0, P=0.304
NICU admission (18)	2 (2.1)	15 (100.0)	1 (6.7)	RR=47.0, P<0.0001	RR=3.1, P=0.318	4 (4.1)	12 (85.7)	2 (16.7)	RR=21.0, P<0.0001	RR=4.1, P=0.070
Stay in NICU (10)	6 (6.4)	4 (26.7)	0 (0.0)	RR=4.2, P=0.011	RR=0.0, P=0.314	5 (5.1)	4 (28.6)	1 (8.3)	RR=5.6, P=0.003	RR=1.6, P=0.642
Perinatal mortality (1)	0 (0.0)	1 (6.7)	0 (0.0)	RR=NA, P=0.012	RR=N, P=NA	0 (0.0)	1 (7.1)	0 (0.0)	RR=NA, P=0.008	RR=NA, P=NA

IUGR: Intrauterine growth restriction, NICU: Neonatal intensive care unit

Ezimokhai et al., found significant association of GDM with both types of coiling disorders.[19]

UCI with intrapartum factor

The current study has demonstrated a significant association between meconium staining and hypercoiling (RR=8.8, P<0.0001) in comparison to hypocoiling and normocoiling group. We also found that hypercoiling in meconium staining is significantly high in postnatal umbilical index (RR=24.5, P<0.0001). This was in accordance to the study performed by Sharma et al.,[10] who studied total 408 umbilical cords and observed that meconium staining had a significant correlation with hypercoiling (22/30 i.e. 73.33%, P<0.001).

Contrary to this, Strong et al., studied 100 cases and found that meconium staining was associated with UCI values of <10th percentile.[3] However, Chitra et al., found that meconium staining was significantly associated with both the groups.[7]

UCI with mode of delivery

Association of UCI with the mode of delivery was studied and was statistically not significant. This was consistent with the study done by Strong et al., and Monga et al., who showed no association of UCI with a mode of delivery.[3,20] However, this was in contrast to the findings of Rana et al., De Laat et al., Nivedita et al., and Chholak et al., who found an association of cesarean section with hypocoiling.[11,21-23]

UCI with perinatal outcome

In this study, the risk of LBW was significantly high with antenatal hypocoiling (RR=9.7, P<0.0001) when compared to antenatal hypercoiling (RR=0.0, P=0.211). Similar results were found with postnatal hypocoiling and LBW (RR=5.4, P<0.0001). This was comparable to studies conducted by Chitra et al., Monga et al., Sharma et al., and Tohma et al.[7,10,12,13,20] This was contrary to studies performed by De Laat et al., and Rana et al., who shown an association between hypercoiling and LBW[11,21] (Table 7).

Strong et al., De Laat et al., Bhojwani et al., showed an association between preterm labor and hypocoiling, whereas Rana et al., Chholak et al., found hypercoiling was significantly associated with preterm labor.[3,11,21,23,25] They believed that hypercoiling is an adaptive response to fetal hemodynamic changes, which initiate preterm labour on reaching a certain threshold. But in this study risk of preterm was associated with both antenatal as well as postnatal hypocoiling.

In present study antenatal hypocoiling was significantly associated with IUGR, (P=0.032), risk of low APGAR in

Table 6: Comparison of different studies for association of maternal risk factors with antenatal and postnatal coiling abnormalities

UCI Type	Study	Year/ Pace of study	Hypocoiled	Hypercoiled
aUCI	Sahoo et al.[14]	2015 Maharashtra, India	Oligohydramnios (P<0.01)	Preterm labour (P=0.4)
aUCI	Khan et al.[15]	2019 Madhya Pradesh, India	Oligohydramnios (P=0.0002)	PIH (P=0.0001), Abruption (P=0.0001), FGR (P=0.0138)
aUCI	Tohma et al.[12]	2014 Turkey	Preeclampsia (26.09%), GDM (10.53%), FGR (5.26%)	Preeclampsia (21.05%), GDM (13.04%), FGR (21.74%)
aUCI	Present study	2023 Uttar Pradesh, India	Preeclampsia (P<0.0001), IUGR (P<0.0001), Oligohydroamnios (P<0.0001) and previous uterine scar (P<0.041)	GDM (P<0.0001)
pUCI	Chitra et al.[7]	2012 Pondicherry, India	Preterm birth (P=0.04), abruption (P=0.019), oligohydramnios (P=0.013), hypertensive disorder of pregnancy (P=0.030)	Polyhydramnios (P=0.015), GDM (P=0.035)
pUCI	Singh et al.[16]	2020 Odisha, India	Hypertensive disorder of pregnancy (P=0.001)	
pUCI	Present study	2023 Uttar Pradesh, India	Preeclampsia (P<0.0001), Oligohydramnios (P<0.0001), FGR (P<0.0002), previous uterine scar (P<0.009)	GDM (P<0.0001), previous uterine scar (P<0.0002)

pUCI: Postnatal umbilical coiling index, aUCI: Antenatal umbilical coiling index, GDM: Gestational diabetes mellitus, FGR: Fetal growth restriction, IUGR: Intrauterine growth restriction

Table 7: Comparison of antenatal and postnatal UCI with perinatal outcome

UCI Type	Study	Year/ Pace of study	Hypocoiled	Hypercoiled
aUCI	Bansal et al.[24]	2016 Rajasthan, India	IUGR (P=0.03), LBW, APGAR at 1 min<5 (P<0.001)	
aUCI	Predanic et al.[6]	2005 New York	LBW, MSAF, Non reassuring FHR	LBW, MSAF, Non reassuring FHR
aUCI	Sahoo et al.[14]	2015 Maharashtra, India	MSAF (P=0.05), fetal distress (P=0.02), IUD (P=0.009)	MSAF (P=0.005), Fetal distress (P=0.004)
aUCI	Present study	2023 Uttar Pradesh, India	LBW (P<0.0001), PTB (P<0.0001)	MSAF (P<0.0001)
pUCI	Khan et al.[15]	2019 Madhya Pradesh, India	Non reassuring FHR (P=0.026)	Low birth weight (P=0.016), low APGAR at 1 min and 5 min (P<0.001)
pUCI	Chitra et al.[7]	2012 Pondicherry, India	Non reassuring FHR (P<0.001), MSAF (P=0.020), Low Apgar (P=0.047), LBW (P=0.011)	Non-reassuring FHR (P<0.001), MSAF (P<0.001), low apgar (P=0.14), LBW (P=0.001), anamolies (p<0.001)
pUCI	deLaate et al.[11]	2007 Netherlands	IUD (OR=4.09), Fetal anomaly (OR=0.178), Low Apgar at 5 min (P=0.03)	IUD (OR=3.74), PTB (OR=1.91), Fetal anomaly (OR=1.79), hypoxia (OR=1.82), LBW (p=0.01)
pUCI	Present study	2023 Uttar Pradesh, India	LBW (P<0.0001), PTB (P<0.0001), Low apgar (P<0.0001), NICU admission (P<0.0001), perinatal mortality (P<0.008)	MSAF (P<0.0001)

pUCI: Postnatal umbilical coiling index, aUCI: Antenatal umbilical coiling index, LBW: Low birth weight, NICU: Neonatal intensive care unit, FHR: Fetal heart rate, MSAF: Meconium-stained amniotic fluid

1 min (P<0.0001) and 5 min, NICU admission as compared to hypercoiling and normocoiling.

Similarly risk of postnatal hypocoiling is significant in IUGR, low APGAR score and NICU admission. The study done by Monga et al., De Laat et al., Padmanabhan et al., De Laat et al., and Gupta et al., found significantly low APGAR in hypocoiling groups.[4,11,20,26,27]

In conflict to our study, Chitra et al., noted a significant association with low APGAR in both hypocoiling and hypercoiling.[7] In the present study, hypocoiled group was associated with NICU admission (P<0.0001), which was similar to Patil et al.[22] This is contrary to the findings of Bhojwani et al., who found more NICU admission in hypercoiled groups.[28] However, there was no correlation was found between hypercoiling group and NICU admission (P=0.07).

Strong et al., found that the incidence of fetal death was significantly more in the non-coiled group.[3] In the study by Rahi and Devaru and Thusoo observed higher NICU admission in both the hypocoiled and hypercoiled groups.[28,29]

Mittal et al., Monga et al., and Jo et al., found a significant association between abnormal antenatal UCI with perinatal outcome.[9,20,30] Furthermore, the studies conducted by Chitra et al., Patil et al., Gupta et al., and Mustafa and Said observed a significant association between abnormal postnatal UCI and perinatal outcome.[4,7,22]

Limitations of the study

Major limitations of this study were that it had a small sample size, and it was a single-center study.

CONCLUSION

The current study concludes that abnormal coiling index (aUCI as well as pUCI) was associated with adverse maternal and neonatal outcome. Detection of abnormal umbilical coiling in utero by ultrasonography will help to select pregnancies for intensive fetal monitoring and early intervention when required. Thus, it can be an innovative approach towards preventive perinatology.

ACKNOWLEDGMENT

The authors are grateful to Dr. R. K. Jain, Head of Department, Department of Radiology, BRD Medical College, Gorakhpur for their valuable support in the study. The authors also like to thank the study participants whose input was invaluable to the success of this work.

REFERENCES

1. Benirschke K and Kaufmann P. Pathology of the Human Placenta. 3rd ed. New York: Springer; 1995. p. 324.
2. Chaurasia BD and Agrawal BM. Helical structure of the human umbilical cord. Acta Anat (Basel). 1979;103(2):226-230. https://doi.org/10.1159/000145013
3. Strong TH Jr., Jarles DL, Vega JS and Feldman DB. The umbilical coiling index. Am J Obstet Gynecol. 1994;170(1 Pt 1):29-32.
4. Gupta S, Faridi MM and Krishnan J. Umbilical coiling index. J. Obstet Gynecol India. 2006;56(4):315-319.
5. Degani S, Lewingsky RM, Berger H and Spiegel D. Sonographic estimation of umbilical coiling index and correlation with Doppler flow characteristics. Obstet Gynecol. 1995;86(6):990-993. https://doi.org/10.1016/0029-7844(95)00307-d
6. Predanic M and Perni SC. Ultrasound evaluation of abnormal umbilical cord coiling in second trimester of gestation in association with adverse pregnancy outcome. Am J Obstet Gynecol. 2005;193(2):387-941. https://doi.org/10.1016/j.ajog.2004.12.092
7. Chitra T, Sushanth YS and Raghavan S. Umbilical coiling index as a marker of perinatal outcome: An analytical study. Obstet Gynaecol Int. 2012;2012:213689. https://doi.org/10.1155/2012/213689
8. Strong TH Jr., Elliot JP and Radin TG. Non-coiled umbilical blood vessels: A new marker for the fetal risk. Obstet Gynecol. 1993;81(3):409-411.
9. Mittal A, Nanda S and Sen J. Antenatal umbilical coiling index as a predictor of perinatal outcome. Arch Gynecol Obstet. 2015;291(4):763-768. https://doi.org/10.1007/s00404-014-3456-5
10. Sharma R, Radhakrishnan G, Manchanda S and Singh S. Umbilical coiling index assessment during routine fetal anatomic survey: A screening tool for fetuses at risk. J Obstet Gynecol India. 2018;68(5):369-375. https://doi.org/10.1007/s13224-017-1046-8
11. De Laat MW, Franx A, Van Alderen ED, Nikkels PG and Visser GH. The umbilical coiling index, a review of the literature. J Matern Fetal Neonatal Med. 2005;17(2):93-100. https://doi.org/10.1080/14767050400028899
12. Machine GA, Aakerman J and Gilbert-Barnen E. Abnormal umbilical cord coiling is associated with adverse perinatal outcome. Pediatr Dev Pathol. 2000;3(5):462-471. https://doi.org/10.1007/s100240010103
13. Kashanian M, Akbarian A and Kouhpayehzadeh J. The Umbilical coiling index and adverse perinatal outcome. Int J Gynecol Obstet. 2006;95(1):8-13. https://doi.org/10.1016/I.ifgo.2006.05.029
14. Mustafa SJ and Said AM. Association of umbilical coiling index in normal and complicated pregnancies. Diyala J Med. 2013;5(1):15-22.
15. Ezimokhai M, Rizk DE and Thomas L. Maternal risk factor for abnormal vascular coiling of umbilical cord. Am J Perinatol. 2000;17(8):441-445. https://doi.org/10.1055/5-2000-13452
16. Sahoo K, Mahajan A, Shaha P and Kshirsagar NS. Evaluation of umbilical coiling index as a predictor of pregnancy outcome. Int J Health Sci Res. 2015;5(3):92-100.
17. Khan T and Thakur R. Association of postnatal umbilical coiling index with maternal and perinatal outcome. Int J Clin Obstetr Gynaecol. 2019;3(1):144-149. https://doi.org/10.33545/gynae.2019.v3.i1c.25
18. Tohma YA, Altay MM, Turgut D, Coşkun S, Ünlübilgin E, Esin S, et al. Second trimester umblical coiling index and perinatal outcomes. Gynecol Obstet Reprod Med. 2014;20(3):135-134.
19. Singh S, Pai S and Sahu B. Study of umbilical coiling index and perinatal outcome. Int J Reprod Contracept Obstet Gynecol. 2020;9:3977-3982.
20. Monga R, Goel JK, Bagchi S, Sah S and Goel R. Correlation of antenatal umbilical cord coiling index with perinatal outcome. J South Asian Feder Obst Gynae. 2018;10(2):127-130.
21. Rana J, Ebert GA and Kappy KA. Adverse perinatal outcome in patients with an abnormal umbilical coiling index. Obstet Gynecol. 1995;85(4):573-577. https://doi.org/10.1016/0029-7844(94)00435-G
22. Patil NS, Kulkarni SR and Lohitashwa R. Umbilical cord coiling index and perinatal outcome. J Clin Diagn Res. 2013;7(8):1675-1677. https://doi.org/10.7860/JCDR/2013/5135.3224
23. Chholak D, Gupta P and Khajotia S. Study to evaluate association of umbilical coiling index and perinatal outcome. Int J Reprod Contracept Obstet Gynecol. 2017;6(2):408-412. https://doi.org/10.18203/2320-1770.ijrcog20170025
24. Bhojwani P, Sharma R, Bhojwani L and Bhatnagar B. Correlation of antenatal umbilical cord coiling index with perinatal outcome using color Doppler at late second trimester. Int J Contemp Med Res. 2016;3(9):2722-2724.
25. Padmanabhan LD, Mheskar R and Mheskar A. Umbilical vascular coiling and the perinatal outcome. J Obstet Gynecol India. 2001;51(6):43-44.
26. De Laat MW, Frank A, Bots ML, Visser GH and Nikkels GJ. Umbilical coiling index in normal and complicated pregnancies. Obstet Gynecol. 2006;107(5):1049-1055.

https://doi.org/10.1097/01.AOG.0000209197.84185.15

27. Rahi GA. Relationship of umbilical coiling index and perinatal outcome. Int J Reprod Contraception Obstetr Gynecol. 2017;6(10):4433-4436.
28. Devaru D and Thusoo M. Umbilical coiling index and the perinatal outcome. J Obstet Gynaecol India. 2012;62(1):43-46.
    https://doi.org/10.1007/s13224-012-0158-4
29. Bansal A, Garg S, Sharma U and Rathore SB. Correlation of antenatal and postnatal umbilical coiling index for determining the perinatal outcome. IOSR J Dent Med Sci. 2016;(1):125-131.
30. Jo YS, Jang DK and Lee G. The sonographic umbilical cord coiling in late second trimester of gestation and perinatal outcomes. Int J Med Sci. 2011;8(7):594-598.
    https://doi.org/10.7150/ijms.8.594

Authors Contribution:
AK- Drafting the article, revising it critically and final approval of the version; **VA-** Concept and design of study; **SM-** Manuscript review and interpretation of data; **GM-** Drafting the article; **PS-** Data acquisition; **HCT-** Data analysis.

Work attributed to:
Department of Obstetrics and Gynecology and BRD Medical College, Gorakhpur, Uttar Pradesh, India.

Orcid ID:
Ankita Kumari - https://orcid.org/0000-0002-9791-5041
Vani Aditya - https://orcid.org/0000-0002-0199-1673
Shaila Mitra - https://orcid.org/0000-0001-7328-3273
Garima Maurya - https://orcid.org/0000-0002-5173-8932
Pratima Sharma - https://orcid.org/0009-0005-3332-6933
Dr. Harish Chandra Tiwari - https://orcid.org/0000-0002-2038-7666

Source of Support: Nil, **Conflicts of Interest:** None declared.