

## Umbilical coiling index as a marker of perinatal outcome: An analytical study at Navodaya Medical College, Raichur

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### ABSTRACT

**Objectives:** To measure the umbilical coiling index (UCI) postnatally and to study its association with adverse antenatal and perinatal outcome. **Materials and Methods:** This prospective study was carried out in the department of pediatrics at Navodaya Medical College, Raichur, Karnataka, from June to July 2016. 200 patients who were in active labor irrespective of their parities, who had singleton pregnancies with live babies who were either delivered by vaginal, instrumental, or lower segmental cesarean section were included in the study and multiple pregnancies, malpresentations, previously diagnosed intrauterine device, and elective cesarean section were excluded. UCI was calculated at the time of delivery by dividing the total number of coils by the total umbilical cord length in centimeters. Its association with various maternal and perinatal risk factors was noted. The statistical tests were the Chi-square test and assessed with EPI Info Version 12.0 software and statistically analyzed. **Results:** The mean UCI was  $0.25 \pm 0.03$ . Hypocoiling or UCI  $< 10^{\text{th}}$  percentile ( $< 0.11$ ) was found to be significantly associated with low APGAR at 1 min and 5 min, meconium stained liquor (MSL), abruptio, abnormal fetal heart rate (FHR), neonatal intensive care unit (NICU) admission, low birth weight, and intrauterine growth restriction. Hypercoiling or UCI  $> 90^{\text{th}}$  percentile ( $> 0.37$ ) was found to be associated with pregnancy-induced hypertension, preterm, diabetes mellitus, postpartum hemorrhage, polyhydramnios, NICU admission, abnormal FHR, MSL, and low APGAR at 1 min. **Conclusion:** Abnormal UCI is associated with several antenatal and perinatal adverse features.

**Key words:** Hypercoiling, Hypocoiling, Normocoiling, Umbilical coiling index

The umbilical cord is cardinal to the fetus because it supplies water, nutrients, and oxygen. Umbilical cord length is influenced positively by both volumes of amniotic fluid and fetal mobility [1]. Wharton's jelly, amniotic fluid, helical patterns, and coiling of vessels protect the umbilical cord. Coiling can be attributed to fetal movements, active, or passive torsion of the embryo, difference in the growth of umbilical vessels, hemodynamic forces of fetus, and the arrangements of muscular fibers in the umbilical arterial wall. Mathematically speaking, the vessels of the cord are wound as cylindrical helices, rather than spirals, but both terms are used interchangeably to avoid confusion [2].

Umbilical cord develops coiling as early as 28 days after conception and completed in 95% of fetuses by 9 weeks. The helices may be seen by ultrasonographic examination as early as during the first trimester of pregnancy [3]. Normal coiling index is approximately 1 coil/5 cm of umbilical cord length. Number of coils in umbilical cord may vary between 0 and 40. Umbilical coiling appears to confer turgor to the umbilical unit, producing a strong as well as flexible cord. Since lengthening of the cord occurs from the fetal end, which represents long-term fetal well-being [4].

The  $360^\circ$  spiral course of umbilical vessels forms a coil. Umbilical coiling index (UCI) can be defined as the total number of coils divided by the total length of the cord in centimeters. UCI frequency distribution was studied by Chitra et al. [5], and they grouped the UCI as follows: Hypocoiled ( $< 10^{\text{th}}$  percentile); normocoiled ( $10^{\text{th}}-90^{\text{th}}$  percentile); hypercoiled ( $> 90^{\text{th}}$  percentile) [5]. At risk, fetuses can be identified by the difference in coiling. UCI can be calculated antenatally by ultrasonography or postnatally, however, only limited data are available. This study aims at calculating the UCI postnatally and its association with perinatal morbidity and mortality.

### MATERIALS AND METHODS

A prospective analytical study was performed in our institute over a period of 2-month. This study was approved by the Institute Ethical Committee. A total number of 200 pregnant women were randomly chosen by a single observer from those who got admitted to the labor ward. Deliveries occurring after 28 weeks of gestation with singleton, cephalic presentations were included in the study. Multiple pregnancies, malpresentations, and previously diagnosed intrauterine device were excluded.

The following maternal factors were recorded - booked/unbooked, age, parity, pregnancy-induced hypertension (PIH), gestational diabetes mellitus (GDM), gestational age, preterm, abruptio placenta, oligohydramnios, and polyhydramnios. Intrapartum factors such as mode of delivery, fetal heart rate (FHR) abnormalities, meconium stained liquor (MSL), and postpartum hemorrhage (PPH) were noted. Neonatal factors such as APGAR, birth weight, gestational age, admission to neonatal intensive care unit (NICU), and any congenital anomaly were also noted.

1-3 min after delivery, the umbilical cord was clamped at the fetal end and cut with scissors taking care not to milk the cord (as the latter might affect the UCI). The placenta was allowed to separate spontaneously. At the fetal end, the cord was cut 5 cm from the fetal insertion. The rest of the cord from the cut end to the placental insertion was measured (in cm). 5 cm was added to the length of the measured cord. At the end of sample collection, the mean UCI was calculated, and subjects were grouped as normocoiled group (UCI - 10<sup>th</sup>-90<sup>th</sup> percentile of mean UCI), hypocoiled group (UCI - <10<sup>th</sup> percentile), and hypercoiled group (UCI - >90<sup>th</sup> percentile of mean).

The hypocoiled and hypercoiled groups were compared with the normocoiled group, and associations of various parameters with UCI were studied. The statistical tests were the Chi-square test and the Fisher's exact test. The values were entered and assessed with Epi Info Version 12.0 software and statistically analyzed.  $p < 0.05$  was regarded as statistically significant.

## RESULTS

The mean length of the umbilical cord was  $51.34 \pm 11.34$  cm. The mean number of coils per umbilical cord was  $12.76 \pm 3.38$ . The mean UCI was  $0.25 \pm 0.03$  coils per cm. Normocoiled was predominant (80.0% cases), whereas 10.0% cases were hypocoiled, and 10.0% were hypercoiled as shown in Table 1.

**Table 1: UCI**

Parameter	Number	Minimum	Maximum	Mean	Standard deviation
Length	200	35.7	110	59.83	13.49
Number of coils	200	4	22	13.1	5.38
UCI	200	0.06	0.44	0.025	0.03

UCI: Umbilical coiling index

**Table 2: Association of coiling with maternal factors**

Parameter	Normocoiled	Hypocoiled	p value	Hypercoiled	p value	Total
Age (20-34 years)	140	16	0.314	18	1.000	
Age >35 years	20	4	0.314	2	1.000	
PIH	65 (82.2%)	11 (14%)	0.220	3 (3.8%)	0.026*	79
DM	24 (66.7%)	3 (8.3%)	1.000	9 (25%)	0.001*	36
Abruptio	16 (66.7%)	7 (29.1%)	0.002*	1 (4.2%)	0.698	24
Oligohydramnios	24 (80%)	6 (20%)	0.110	0 (0)	0.080	30
Polyhydramnios	20 (74%)	1 (3.7%)	0.476	6 (22.3%)	0.036*	27
Preterm Labor	50 (82%)	9 (14.8%)	0.217	2 (3.2%)	0.048*	61

PIH: Pregnancy-induced hypertension, DM: Diabetes mellitus, \*:  $p < 0.05$

The distribution frequencies of the three groups according to the maternal factors have been shown in Table 2. Among antenatal risk factors, hypertensive disorders ( $p=0.026$ ), GDM ( $p=0.001$ ), preterm labor ( $p=0.048$ ), and polyhydramnios ( $p=0.036$ ) were found to be significantly associated with hypercoiling, whereas abruptio placenta had a significant association with hypocoiling ( $p=0.002$ ). No significant association was found between UCI and age, oligohydramnios or type of delivery (lower segmental cesarean section, vaginal, or instrumental) (Table 3). FHR abnormalities were associated with both hypo (21.0%) and hypercoiling (16.4%). Both hypo and hypercoiling were significantly associated with MSL ( $p=0.000$ ,  $p=0.007$ ). PPH was also found to be significantly associated with hypercoiling ( $p=0.000$ ). Low APGAR at 1 min has significant association with both hypo ( $p=0.000$ ) and hypercoiling ( $p=0.000$ ), whereas low APGAR at 5 min was significantly associated with hypocoiling ( $p=0.036$ ), NICU admission was significantly associated with both hypo ( $p=0.000$ ) and hypercoiling ( $p=0.000$ ). Low birth weight (LBW) and intrauterine growth restriction (IUGR) were significantly associated with hypocoiling ( $p=0.020$  and  $p=0.031$ , respectively) (Table 4).

## DISCUSSION

The UCI is an indicator of perinatal outcome. The aim of this study was to find the relationship between UCI and various antenatal and perinatal factors. The mean UCI in our study was  $0.25 \pm 0.03$  which was similar to the study done by others as shown in Table 5.

In our study, we found that PIH was significantly associated with hypercoiling ( $p=0.026$ ) similar to a study done by Tripathy et al. [6]. We found significant association of GDM and with hypercoiling similar to study done by Chitra et al. [5]. Abruptio placentae were found to have a significant association with hypocoiling ( $p=0.002$ ) which is similar to study done by Chitra et al. [5]. We did not find any association for oligohydramnios with either hypocoiling or hypercoiling, whereas polyhydramnios had a significant association with hypercoiling ( $p=0.036$ ) similar to study done by Chitra et al. [5]. This can be explained by Edmond's hypothesis [7] stating that rotatory movement of embryo causes twisting of umbilical cord, and increase in the liquor amnii causes more rotary movements of the fetus and

**Table 3: Association of coiling with perinatal factors**

Parameter	Normocoiled (%)	Hypocoiled (%)	p value	Hyper coiled	p value	Total
LSCS	47 (72.3)	8 (12.3)	0.331	10 (15.4)	0.062	65
Vaginal	100 (82.6)	12 (9.9)	0.828	9 (7.5)	0.137	121
Instrumental	13 (93)	0 (0)	0.366	1 (7)	1.000	14
Abnormal FHR	42 (62.6)	14 (21)	0.000	11 (16.4)	0.008*	67
MSL	30 (60)	11 (22)	0.000	9 (18)	0.007*	50
PPH	2 (40)	0 (0)	1.000	3 (60)	0.000*	05

LSCS: Lower segmental cesarean section, FHR: Fetal heart rate, MSL: Meconium-stained liquor, PPH: Postpartum hemorrhage, \*: p<0.05

**Table 4: Association of coiling with neonatal factors**

Parameter	Normocoiled (%)	Hypocoiled	p value	Hypercoiled (%)	p value	Total
Low APGAR at 1 min(<7)	20 (50)	9 (22.5)	0.000*	11 (27.5)	0.000*	40
Low APGAR at 5 min	15 (65.2)	5 (21.8)	0.036*	3 (13)	0.428	23
NICU admission	20 (50)	9 (22.5)	0.000*	11 (27.5)	0.000*	40
Birth weight<2.5 kg	23 (74.2)	7 (22.6)	0.020*	1 (3.2)	0.482	31
IUGR	8 (66.7)	4 (33.3)	0.031*	0 (0)	0.601	12
Anomalies	2 (50%)	0 (0)	1.000	2 (50)	0.062	04

NICU: Neonatal intensive care unit, IUGR: Intrauterine growth restriction, \*: p<0.05

**Table 5: UCI values in different studies**

Strong et al. [4]	0.21±0.07
Rana et al. [8]	0.19±0.1
Ercal et al. [10]	0.20±0.1
Ezimekhai et al. [11]	0.26±0.09
Laat et al. [9]	0.17±0.009
Chitra et al. [5]	0.24±0.09
Our study	0.25±0.03

UCI: Umbilical coiling index

more coiling. Our study found a significant association between preterm labor and hypercoiling (p=0.004). Rana et al. [8] and Laa et al. [9] found an association between hypercoiling and preterm delivery.

Significant association of abnormal FHR patterns is seen with both hypocoiling and hypercoiling. In both instances, p value was found to be significant (p=0.000 and p=0.008). Literature has found a consistent association between intrapartum FHR decelerations and abnormal UCI. Strong et al. [4], Laa et al. [9], and Chitra et al. [5] found that hypocoiling and hypercoiling were associated with FHR decelerations and vulnerable to kinking and torsion which makes them less tolerant to withstand the stress of labor due to low flexibility. Rana et al. [8] and Ercal et al. [10] found FHR decelerations to be significantly associated with hypocoiled. Rana et al. [8] felt that hypocoiling compromises turgor and compression resistance properties of the cord. MSL had a significant association with both hypo (p=0.020) and hypercoiling (p<0.001) and consistent with results of Strong et al. [4], Ezimekhai et al. [11], and Chitra et al. [5]. Type of delivery did not have any association with UCI in our study. PPH in our study was found to have a significant association with hypercoiling similar to study done by Chitra et al. [5].

Both hypo and hypercoiling were found to have a significant association with low APGAR at 1 min and low APGAR at

5 min was associated with hypocoiling similar to study done by Tripathy et al. [6]. LBW (birth weight <2.5 kg) was significantly associated with hypocoiling (p=0.02). Respiratory distress (and NICU admission) was found to be significantly associated with both hypo (p=0.000) and hypercoiling (p=0.000) in our study. Similarly, Chitra et al. [5] and Laa et al. [9] found that both acute and chronic hypoxia were associated with hypercoiling. Again, the reason may be derived linearly from the associations between FHR decelerations, operative intervention, and initial low APGAR at 1 min. Our study demonstrated a significant association between IUGR babies and hypocoiling (p=0.031). Chitra et al. [5] and Strong et al. [4] obtained a similar result in their studies. They summarized that compression of the cord is prevented by adequate coiling, and hypocoiling in long run, results in reduced fetoplacental circulation; thus, resulting in growth restriction. To conclude, adverse antenatal and neonatal features are associated with abnormal UCI. The association shows wide variations among the various studies done so far. Antenatal study of UCI should be followed, to confirm diagnosis at an earlier gestational age.

## CONCLUSION

Several antenatal and perinatal adverse features were associated with abnormal UCI. In our study, we found that hypercoiling was associated with PIH, preterm, GDM, polyhydramnios, NICU admissions, abnormal FHR, MSL, PPH, and low APGAR at 1 min. On the other hand, hypocoiling was associated with IUGR, LBW, abruption, MSL, abnormal FHR, NICU admissions, and low APGAR at 1 and 5 min.

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