

A Prospective Study of Umbilical Cord Coiling Index by Ultrasonography at Term Gestation and Perinatal Outcome

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ABSTRACT

INTRODUCTION: At term pregnancy, the umbilical cord plays a vital role in protecting fetal blood flow. A significant anatomical feature of the umbilical cord is the spiral or coiled pattern of its blood vessels, which starts forming by day 28 of gestation and is seen in 95% of fetuses by 9 weeks.

AIMS AND OBJECTIVES OF STUDY: The present study was aimed to assess Umbilical cord coiling index at term using ultrasonography and to correlate it with perinatal outcomes.

METHODS: The prenatal umbilical coiling index (UCI), calculated as the reciprocal of the distance (in cm) between two adjacent coils ($UCI = 1/\text{distance}$). Based on the Umbilical cord coiling index, the umbilical cord classified as: Normocoiled: $UCI \approx 0.4$, Hypocoiled: $UCI < 0.2$, Hypercoiled: $UCI > 0.6$. Perinatal outcomes assessed were meconium staining, Mode of delivery, Birth weight, Ponderal index, Apgar score, NICU admission.

RESULTS: Hypercoiled cords (9%) compared with normocoiled (80%) were significantly associated with higher incidence of cesarean delivery, Low Birth weight, Low Ponderal indices. Hypocoiled cords (11%) compared with normocoiled (80%) were significantly associated with meconium staining, Apgar score, increased NICU admissions.

CONCLUSION: Ultrasonographic evaluation of UCI at term gestation served as an important tool to predict adverse perinatal outcomes. Early detection of Hypercoiled and hypocoiled patterns allowed timely obstetric interventions and to reduce neonatal morbidity, mortality and NICU admissions.

Keywords: Normocoiled, Hypercoiled, Hypocoiled, Umbilical coiling index, Meconium staining

INTRODUCTION

Ian Donald says “the baby’s life hangs by a cord”, thus showing the importance of umbilical cord.[1] At term pregnancy, the umbilical cord plays a vital role in protecting fetal blood flow. It connects the fetal umbilicus to the chorionic plate of the placenta.[2]

The three blood vessels run along the cord in helical or coiled fashion.[3] The helical fashion of umbilical vessels is termed as spiral course.[4] The umbilical cord is vulnerable to kinking, compressions, traction and torsion which may affect the perinatal outcome.[5] The spiral or coiled pattern of Umbilical cord starts forming by day 28 of

gestation and is seen in 95 % of fetuses by 9 weeks.[6]

Early diagnosis of the umbilical cord coiling index by ultrasound examination during pregnancy, before active labor and study, is intended to lower perinatal and neonatal morbidity and mortality. A fetus's health and normal development depend on the umbilical blood flow, which is significantly impacted by the coiled shape of the Umbilical cord. As the number of coils in the cord construction rises, the driving pressure for a given blood flow rate also increases, according to the results. The helical construction is producing wall shear stresses (WSS) and interwoven streamlines along its helical length, as well as large spatial gradients over its cross-sectional perimeter. In circumstances of over coiling or under coiling, these gradients may hinder the development of the foetal cardiovascular system because the maximal wall shear stresses (WSS) are much less when the coils are spread apart. It appears that cases involving twisted or overcoiled cords produce extremely high values and gradients of WSS, which may put the developing baby at significant risk of developmental abnormalities. A normal Umbilical coiling index is approximately 0.2 after giving birth when the umbilical cord and placenta are inspected and 0.4 when the inspection is done before birth using ultrasonography.[7]

The umbilical cord coiling may be normocoiled, hypercoiled or hypocoiled. Both hypocoiled and hypercoiled umbilical cords are associated with adverse perinatal outcome such as Meconium staining, Mode of delivery, Birth weight, Ponderal index, Apgar score, Neonatal intensive care unit admission.[8]

Hence, this study is undertaken to assess the umbilical cord coiling index measured at term using ultrasonography and correlate it with perinatal outcomes.

MATERIALS & METHODS

Study site: Navodaya Medical College Hospital and Research Centre, Raichur

Study design: Prospective study

Study period: 1 year

Sample size: 100 samples

The antenatal Umbilical cord coiling was measured by a single reciprocal value of the distance between a pair of coils measured in cm from inner edge of an arterial or venous wall to the outer edge of next coil with the same side of umbilical cord, the direction being from placental end to fetal end. The final value of antenatal UCI was the average of three readings at three different segments of umbilical cord.[9]

Prenatal umbilical coiling index (UCI), is calculated as the reciprocal of the distance (in cm) between two adjacent coils ($UCI = 1/\text{distance}$). Based on the UCI, the umbilical cord classified as: Normocoiled: $UCI \approx 0.4$ (10th–90th percentile), Hypocoiled: $UCI < 0.2$ (<10th percentile), Hypercoiled: $UCI > 0.6$ (>90th percentile), Abnormal coiling (hypo- or hypercoiling) was associated with adverse perinatal outcomes. Perinatal outcomes assessed were Meconium staining, Mode of delivery, Birth weight, Ponderal index, Apgar score @ 1 min & @ 5 min, NICU admission.[10]

INCLUSION CRITERIA

- Booked singleton live pregnancy irrespective of parity
- Term gestation at the time of ultrasonography with no maternal and fetal complications
- Planned delivery at this institution.

EXCLUSION CRITERIA

- Multiple pregnancies
- Preterm deliveries
- Cord prolapses
- Placental abnormalities
- IUGR, Intrauterine death, Pregnancy with Medical disorders or obstetric complications (pre-eclampsia, antepartum hemorrhage, malpresentations, Gross fetal anomalies)
- Women not willing for the participation in the study

STATISTICAL ANALYSIS

Categorical outcomes (meconium staining, mode of delivery, birth weight <2.5 kg, ponderal index <2.5, Apgar score, NICU admission) were compared between normocoiled and hypo/coiled /hypercoiled

groups using chi-square test. Statistical significance was set at $\alpha=0.05$.

Analyses were performed in SPSS Software version 31.

RESULTS

Table 1. Distribution of cases according to antenatal UCI

	NUMBER OF CASES (n=100)	PERCENTAGE
NORMOCOILED	80	80%
HYPERCOILED	9	9%
HYPOCOILED	11	11%
TOTAL	100	100%

The study involved Antenatal Umbilical cord coiling index by ultrasonography which showed 80 % cases to be Normocoiled, 9% to be Hypercoiled and 11 % to be Hypocoiled.

Table 2. comparison of meconium-stained amniotic fluid by antenatal UCI

Meconium-stained amniotic fluid	YES	NO	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	8 (10)	72 (90)	80 (100)	
Hypercoiled (n=9) No. (%)	2 (22.2)	7 (77.8)	9 (100)	P=0.271
Hypocoiled (n=11) No. (%)	5 (45.5)	6 (54.5)	11 (100)	P=0.002
Total (n=100) (%)	15 (15)	85 (85)	100 (100)	

A statistically significant difference was observed (P=0.002) between the normocoiled and hypo/coiled.

Table 3. Comparison of Mode of delivery by antenatal UCI

Mode of delivery	NVD	LSCS	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	46 (57.5)	34 (42.5)	80 (100)	
Hypercoiled (n=9) No. (%)	1 (11.1)	8 (89.9)	9 (100)	P=0.008
Hypocoiled (n=11) No. (%)	4 (36.4)	7 (63.6)	11 (100)	P=0.210
Total (n=100) (%)	51 (51)	49 (49)	100 (100)	

Out of 80 pregnant women with normocoiled, 42.5% underwent LSCS while 89.9% pregnant women with hypercoiled underwent LSCS

A statistically significant difference was observed (p=0.008) between the normocoiled and hypercoiled group.

Table 4. Comparison of Birth weight by antenatal UCI

Birth weight (gm)	< 2500	2500-4000	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	8 (10)	72 (90)	80 (100)	
Hypercoiled (n=9) No. (%)	4 (44.4)	5 (55.2)	9 (100)	P=0.004
Hypocoiled (n=11) No. (%)	3 (27.3)	8 (72.7)	11 (100)	P=0.100
TOTAL (n=100)	15 (15)	85 (85)	100 (100)	

The P = value of 0.004 suggests statistically significant association between Hypercoiled and normocoiled group.

Table 5. Comparison of ponderal index by antenatal UCI

Ponderal index	<2.5	>2.5	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	48 (70)	32 (30)	80 (100)	
Hypercoiled (n=9) No. (%)	9 (100)	0 (0)	9 (100)	P= 0.017
Hypocoiled (n=11) No. (%)	7 (63.64)	4 (36.36)	11 (100)	P=0.811
Total (n=100) (%)	64 (64)	36 (36)	100 (100)	

Out of 80 pregnant women with normocoiled, 70 % has ponderal index < 2.5, while 100% pregnant women with hypercoiled group has ponderal index < 2.5.

A statistically significant difference was observed (P =0.017) between the normocoiled and hypercoiled group.

Table 6. Comparison of Apgar score at 1 minute by antenatal UCI

Apgar score at 1 minute	<4	>=4	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	5 (6.25)	75 (93.75)	80 (100)	
Hypercoiled (n=9) No. (%)	1 (11.1)	8 (88.9)	9 (100)	P=0.577
Hypocoiled (n=11) No. (%)	6 (54.5)	5 (45.5)	11 (100)	P=0.0000036
Total (n=100) (%)	12 (12)	88 (88)	100 (100)	

A statistically significant difference was observed (P = 0.0000036) between the normocoiled and hypocoiled groups.

Table 7. Comparison of Apgar score at 5 minutes by antenatal UCI

Apgar score at 5 minutes	<7	>=7	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	6 (7.5)	74 (92.5)	80 (100)	
Hypercoiled (n=9) No. (%)	1 (11.1)	8 (88.9)	9 (100)	P=0.707
Hypocoiled (n=11) No. (%)	3 (27.3)	8 (72.7)	11 (100)	P=0.0396
Total (n=100) (%)	10 (10)	90 (90)	100 (100)	

The P = value of 0.0396 suggests statistically significant association between Hypocoiled and normocoiled group for Apgar score at 5 minutes.

Table 8. Comparison of NICU admission by antenatal UCI

NICU Admission	YES	NO	TOTAL	P VALUE
Normocoiled (n=80) No. (%)	10 (12.5)	70 (87.5)	80 (100)	
Hypercoiled (n=9) No. (%)	3 (33.4)	6 (66.6)	9 (100)	P=0.095
Hypocoiled (n=11) No. (%)	4 (36.4)	7 (63.6)	11 (100)	P=0.038
Total (n=100) (%)	17 (17)	83 (83)	100 (100)	

Out of 80 pregnant women with normocoiled, 12.5 % has NICU admission, while 36.4% pregnant women with hypocoiled group has NICU admission.

A statistically significant difference was observed (P = 0.038) between the normocoiled and hypocoiled.

Summary of results

Hypercoiled cords (9%) compared with normocoiled (80%) were significantly associated with

- Higher incidence of cesarean delivery
- Low birth weight
- Low ponderal indices

Hypocoiled cords (11%) compared with normocoiled (80%) were significantly associated with

- Meconium staining

- Apgar score at 1 min < 4 & Apgar score at 5 min < 7
- increased NICU admissions

DISCUSSION

In present study, meconium staining of amniotic fluid was significantly associated with hypocoiling 45.5% than those with normocoiling group 10% with P value = 0.002. Gupta et al found that in hypocoiled group 63.6%, meconium staining was significantly higher than those with normocoiling group 29.1% with P value = < 0.05. Monika et al, Rahi et al observed similar results in their studies.

In present study LSCS rate was significantly associated with hypercoiling group with 89.9% compared to normocoiled group 42.5% with P value =0.008. Similarly, Saleem et al found LSCS rate, significantly

associated with hypercoiled group 100% than those with normocoiled group 46.1% with P value = 0.008.

In present study birth weight < 2.5kg was significantly associated with hypercoiling group 44.4% compared to normocoiled group 10 % with P value = 0.004. Similarly, Aruna et al found birth weight < 2.5 kg, significantly associated with hypercoiled group 50% than those with normocoiled group 20 % with P value <0.001. Monika et al observed similar results in their studies.

In present study, Low ponderal index was significantly associated with hypercoiling group with 100% while only 70% in normocoiled group with P value = 0.017. similarly, Nivedita et al found significant association with hypercoiled group 95.2% than those with normocoiled group 69.2 % with P value = 0.022.

In present study, Apgar score at 1 minute < 4 and 5 minutes < 7 was significantly higher in babies with hypocoiled cords 54.5% and 27.3% than those with normocoiled cords 6.25% and 7.5% respectively with P value =0.0000036 & P value = 0.0396 respectively.

Nivedita et al found significant association with hypocoiled group 30.4% and 30.4% than those with normocoiled group 14.7% and 12.2% respectively with P value = 0.072 & P value = 0.065. Monika et al. and Saleem et al. found similar results in their studies.

In present study, NICU admissions were more in hypocoiled groups 36.4% as compared to normocoiled group 12.5% which is significantly associated with P value = 0.038. Monika et al found significant association with hypocoiled group 39.2% than those with normocoiled group 24.3% with P value = 0.01. Poonam et al, Saleem et al. and Nivedita et al. found similar results in their studies.

CONCLUSION

A fetus's health and normal development depend on adequate umbilical blood flow, which can be significantly influenced by the coiling pattern of the umbilical cord. Ultrasonography was performed at term to assess the umbilical cord coiling index,

revealing various coiling patterns, including normocoiling, hypercoiling, and hypocoiling.

Ultrasonographic evaluation of Umbilical cord coiling index at term gestation can serve as an important tool to predict adverse perinatal outcomes like meconium stained amniotic fluid, increased LSCS rate, Low birth weight, low Ponderal index, apgar score and increased NICU admission.

Early detection of Hypercoiled and hypocoiled patterns allows timely obstetric interventions and to reduce neonatal morbidity, mortality and NICU admissions.

Declaration by Authors

Ethical Approval: Approved. Ethical clearance for the study was obtained from the institutional ethics committee of Navodaya medical college Hospital & Research centre, Raichur.

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Conflict of Interest: The authors declare no conflict of interest.

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