

DOI: <http://dx.doi.org/10.18203/2320-1770.ijrcog20204021>

Original Research Article

Study of umbilical coiling index and perinatal outcome

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Received: 31 August 2020

Revised: 11 September 2020

Accepted: 14 September 2020

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ABSTRACT

Background: Study was to evaluate the relationship between umbilical coiling index (UCI) and hypo- and hyper coiling of the umbilical cord and parity, neonatal weight, Ponderal Index (PI), APGAR (Appearance, pulse, grimace, activity, and respiration) score, meconium staining of the amniotic fluid, Intrauterine growth restriction (IUGR), hypertensive disorders of pregnancy and delivery interventions.

Method: A prospective analytical study was performed from January 2017 to December 2018. Total of 300 patients giving birth at labour room of SCB Medical College, Cuttack were taken into study. Immediately following delivery, the umbilical cord was clamped at the foetal end and cut with scissors. UCI, mode of delivery and perinatal outcome was followed up.

Results: There were 149 lower segment caesarean sections accounting to 49.7% and 151 vaginal deliveries including instrumental deliveries which was accounting to 50.3%. Minimum number of coils observed was 2. The maximum number of coils observed was 50. Caesarean section was more in hypo coiling group. APGAR score at 5 min was calculated and there was a total of 109 neonates who had APGAR <7 at 5 minutes (36.33%) out of which there were 17 neonates with hypo coiling (2.33%), 77 neonates with normo-coiling (25.66%) and 15 neonates with hyper coiling (5%). Meconium staining and instrumental delivery was more associated with hyper coiling.

Conclusion: Both hyper-coiling and hypo-coiling had significant correlation with adverse perinatal outcome. If the UCI can be measured reliably in utero by ultrasound, then it might be a promising prognostic marker for adverse pregnancy outcome.

Keywords: Umbilical coiling index, Hyper-coiling, Hypo-coiling, Perinatal outcome, Meconium staining

INTRODUCTION

The umbilical cord is vital to the development, wellbeing, and survival of the foetus. The umbilical cord is protected by Wharton's jelly, amniotic fluid, helical pattern and coiling of vessels.

A coil is defined as complete 360-degree spiral course of umbilical vessels around the Wharton's jelly. The coiling property of cord vessels was described as early as 1521 by Berengarius and confirmed by Columbus in 1559 and by Frantius in 1564.¹ In 1600, Fabricius demonstrated that both right (dextral) and left (sinistral) helices of the umbilical cord exists.^{2,3}

In 1954, umbilical coiling was quantified by Edmonds who divided the total number of coils by the umbilical cord length in centimetres called it "Index of twist" and assigned positive and negative scores to clockwise and anticlockwise coiling respectively.⁴

The umbilical coiling index (UCI) was described by Strong et al. The UCI is a measure of the number of coils in the umbilical cord in relation to its length in centimetres.³

Several studies have addressed the correlations between abnormal cord coiling and adverse pregnancy outcome.

They all show an increase in adverse pregnancy outcome when there is abnormal cord coiling.

Aim and objective of the study

The purpose of the present study was to evaluate the relationship between UCI and hypo-and hyper coiling of the umbilical cord and parity, neonatal weight, ponderal index, APGAR score, meconium staining of the amniotic fluid, IUGR, hypertensive disorders of pregnancy and delivery interventions.

METHODS

A prospective analytical study was performed from January 2017 to December 2018. Total of 300 patients giving birth at labour room of SCB Medical College, Cuttack were taken into study.

Immediately following delivery, the umbilical cord was clamped at the fetal end and cut with scissors. The placenta was allowed to separate spontaneously. At the fetal end, the cord was cut 5 cm from the fetal insertion. The umbilical cord was measured in its entirety, including the placental end of the cord and umbilical stump on the baby i.e. 5 cm.

Total length of the cord=length of the placental end of the cord + length of the umbilical stump on the baby.

Number of complete coils or spirals were counted from the neonatal end towards the placental end of the cord. Depending on the direction of the coils they were referred as sinistral (left) and dextral (right). Accordingly, the UCI was calculated as follows:

$$UCI = \frac{\text{number of vascular coils in a cord}}{\text{length of the cord in centimetres}}$$

Inclusion criteria

Inclusion criteria were as follows: Healthy women with term gestation irrespective of parity, singleton pregnancy, live baby, both vaginal and Lower segment caesarean section (LSCS).

Exclusion criteria

Exclusion criteria was as follows: Multiple gestation, cord prolapse, placental abnormalities and congenital anomalies.

The following data was collected: Maternal age, gestational age at delivery, parity, obstetric history, mode of delivery, instrumental deliveries or LSCS for foetal distress, sex and birth weight of the neonate, Cardiotocography (CTG) patterns, APGAR scores, meconium staining of amniotic fluid, hypertensive

disorders of pregnancy, IUGR. The condition of the neonate was followed till the day of discharge.

Statistical tools

The statistical analysis of the data was done using appropriate statistical tests, carried out by Statistical package for social sciences (SPSS) version 19.

A p values less than 0.001 was taken to denote significant relationship.

RESULTS

Maternal age ranged from 18 to 38 years with a mean of 25.38±3.90 year. The mean gestational age of this group was 37±3 weeks (range 32 to 42 weeks). There were 161 primigravida (53.7%) and 139 multi-gravida (46.3%). There were 120 women with gestational age <36 weeks which accounted to 40%. There were 121 with gestational age between 36 weeks 1 day to 40 weeks (40.33%). The remaining were in the gestational age of >40 weeks which accounted to 19.66%. There were 149 lower segment caesarean sections accounting to 49.7% and 151 vaginal deliveries including instrumental deliveries which was accounting to 50.3%.

Among the 300 neonates 157 were female babies (52.3%) and 143 were male babies (47.6%). Mean birth weight was 2342.33±710.33 gm. Minimum being 1000 gm and maximum being 3500 gm. Mean PI was 1.83±0.49. Minimum PI was 0.78 and maximum PI was 3.16. APGAR scoring was done at 1 minute and 5 minutes of birth and neonates <7 required Neonatal intensive care unit (NICU) admission accounting to 36.33%. APGAR >7 at 5 minutes were seen in 191 neonates accounting to 63.66%.

Table 1: Direction of twisting/coiling.

Direction of twist	Frequency	Percentage
Sinistral	182	60.66
Dextral	118	39.33
Total	300	100

Mean umbilical cord length was 55.40±5.76 cm. Minimum length observed was 55 cm and maximum length was 70 cm. Minimum number of coils observed was 2. The maximum number of coils observed was 50. The mean number of coils was 16.88±12.44. Sinistral direction of twist was more common than dextral (Table 1). The 10th percentile of UCI was 0.03, values below which was taken as hypo coiling. The 90th percentile was 0.75, values above which was taken as hyper coiling. The coiling index was in the range of 0.30±0.2 which was taken as normo-coiling. The p value of correlation of parity and UCI was found to be 0.554 which was statistically insignificant (Table 2).

Table 2: Correlation between parity and UCI.

Parity	Hypo-coiling (%)	Normo-coiling (%)	Hyper-coiling (%)	Total (%)	P value
Primi	18 (6)	132 (44)	11 (3.66)	161 (53.66)	0.554
Multi	17 (5.66)	108 (36)	14 (4.66)	139 (46.33)	
Total	35 (11.66)	240 (80)	25 (8.33)	300 (100)	

Table 3: Correlation between mode of delivery and UCI.

Mode of delivery	Hypo-coiling (%)	Normo-coiling (%)	Hyper-coiling (%)	Total (%)	P value
Cesarean	27 (9)	114 (38)	8 (2.66)	149 (49.66)	0.001
Vaginal	8 (2.66)	126 (42)	17 (5.66)	151 (50.33)	
Total	35 (11.66)	240 (80)	25 (8.33)	300 (100)	

Table 4: Correlation between direction of twist and UCI.

Direction of twist	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	P value
Sinistral	25 (8.33)	141 (47)	16 (5.33)	182 (60.66)	0.888
Dextral	10 (3.33)	99 (33)	9 (3)	118 (39.33)	
Total	35 (11.66)	240 (80)	25 (8.33)	300 (100)	

Table 5: Correlation Between APGAR at 5 minute and UCI.

APGAR at 5 min	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	P value
<7	17 (2.33)	77 (25.66)	15 (5)	109 (36.33)	0.001
>7	18 (6)	163 (54.33)	10 (3.33)	191 (63.66)	
Total	35 (11.66)	240 (80)	25 (8.33)	300 (100)	

Table 6: Correlation between IUGR and UCI.

IUGR	UCI				P value
	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	
	20 (0.66)	19 (6.33)	4 (1.33)	25 (8.33)	0.019

Table 7: Correlation between hypertensive disorders of pregnancy and UCI.

HDP	UCI				P value
	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	
	18 (16)	37 (12.33)	0	55 (18.33)	0.001

Table 8: Correlation between instrumental delivery and UCI.

Instrumental delivery	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	P value
Forceps	0	18 (41.86)	4 (9.30)	22 (51.16)	<0.001
Vacuum	2 (4.65)	14 (32.55)	5 (11.62)	21 (48.83)	
Total	2 (4.65)	32 (74.41)	9 (20.93)	43 (100)	

Table 9: Correlation between meconium staining liquor and UCI.

Meconium liquor	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	P value
	17 (5.66%)	45 (15%)	59 (19.66%)	67 (22.33%)	<0.001

Table 10: Correlation between CTG and UCI.

CTG	Hypo coiling (%)	Normo-coiling (%)	Hyper coiling (%)	Total (%)	P value
Normal	11 (3.66)	78 (26)	8 (2.66)	97 (32.33)	0.467
Pathological	13 (4.33)	70 (23.33)	11 (3.66)	94 (31.33)	
Suspicious	11 (3.66)	92 (30.66)	6 (2)	109 (36.33)	
Total	35 (11.66)	240 (80)	25 (8.33)	300 (100)	

Correlation between mode of delivery and UCI had p value of 0.001 which was statistically significant indicating that caesarean section was more in hypo coiling group (Table 3). For correlation between PI and UCI the p value was 0.571 which was statistically insignificant. For correlation between direction of twist and UCI, p value was 0.888 which was statistically insignificant (Table 4).

APGAR score at 5 minutes was calculated and there was a total of 109 neonates who had APGAR <7 at 5 minutes (36.33%) out of which there were 17 neonates with hypo coiling (2.33%), 77 neonates with normo-coiling (25.66%) and 15 neonates with hyper coiling (5%). The p value was 0.001 suggestive of statistical significance. Hypo coiling was significant at APGAR score <7 at 5 minutes (Table 5). There was a total of 25 patients who were diagnosed to have IUGR (8.33%). Out of these 2 had hypo coiling (0.66%), 19 had normo-coiling (6.33%) and 4 had hyper coiling (1.33%). The p value was 0.019 which was statistically insignificant. Suggesting that hypo and hyper coiling is not associated with IUGR (Table 6). Hypertensive disorders of pregnancy was associated with hypo coiling. (Table 7). Instrumental delivery was more associated with hyper coiling. (Table 8)

There were 67 cases with meconium stained liquor out of which 17 had hypo coiling (%), 45 had normo-coiling (%) and 5 had hyper coiling (%). The p value was <0.001 which was statistically significant implying that meconium stained liquor was associated with hyper coiling (Table 9). There was no significant relation between CTG and UCI (Table 10).

DISCUSSION

Parity

In our study, there were a total 161 primigravida out of 300 women. Out of which 18 had hypo coiling (6%), 132 normo-coiling (44%) and 11 with hyper coiling (3.66%). There were 139 multigravidas, out of which 17 had hypo coiling (5.66%), 108 normo-coiling (36%) and 14 with hyper coiling (4.66%). The p value was found to be 0.554 which was statistically insignificant. Similar results were shown by many authors including Chitra et al.⁵

Gestational age

UCI was correlated with the gestational age. The p value was 0.467 which was statistically insignificant. Similar results were shown by strong et al and de Laat et al though

explanations regarding the cause for preterm delivery were not given.⁶ Whereas, Rana et al found preterm deliveries to be associated with hyper coiling.⁷

Mode of delivery

There was a total of 149 caesarean deliveries (49.66%). Out of which 27 patients (9%) had hypo coiling, 114 patients (38%) patients had normo-coiling and 8 patients (2.66%) had hyper coiling. There was a total of 151 vaginal deliveries conducted (50.33%) including instrumental deliveries. Out of which 8 patients had hypo coiling (2.66%), 126 patients had normo-coiling (42%) and 17 patients had hyper coiling (5.66%). The p value was 0.001 which was statistically significant indicating that caesarean section was more in hypo coiling group. There were 43 instrumental deliveries out of which 2 had hypo coiling and 9 and hyper coiling and the remaining 32 had normo-coiling. The p value was 0.001 which statistically implies that hyper coiling was more significant in instrumental deliveries. Many authors have shown association between instrumental deliveries and caesarean section with abnormal UCI.

Gender and UCI

There were 157 female neonates out of which 22 had hypo coiling (7.33%), 117 normo-coiling (39%) and 18 hyper coiling (6%). Among the 143 male neonates, 13 had hypo coiling (4.33%), 123 normo-coiling (41%) and 7 hyper coiling (2.33%). The p value was 0.475 which is statistically insignificant. Similar results were shown in a study by Van Dijk et al.⁸

Birth weight and UCI

There were 160 neonates with birth weight <2500 gm out of which 16 had hypo coiling (5.33%), 129 normo-coiling (43%) and 15 hyper coiling (5%). The rest 140 patients had birth weight >2500 gm out of which 19 had hypo coiling (6.33%), 111 normo-coiling (37%) and 10 had hyper coiling (3.33%). The p value was 0.527 which was statistically insignificant. Similar results were shown by Revathi et al.⁹

Ponderal index and UCI

There were 271 neonates with ponderal index <2.5 out of which 32 had hypo coiling (10.66%), 215 normo-coiling (71.66%) and 24 hyper coiling (8%) 29 neonates had PI >2.5, out of which 3 had hypo coiling (1%), 25 normo-

coiling (8.33%) and 1 had hyper coiling (0.33%). The p value was 0.571 which was statistically insignificant. These results were in agreement with Gupta S et al which concluded that there was no statistical significance between hypo coiled and hyper coiled in association with PI.¹

CTG pattern and UCI

All patients in this study were subjected to CTG. Normal patterns were seen in 97 patients (32.33%). Hypo coiling was seen in 11 patients (3.66%), 78 normo-coiling (26%) and 8 hyper coiling (2.66%). 94 had pathological patterns, out of which 13 had hypo coiling (4.33%), 70 normo-coiling (23.33%) and 11 hyper coiling (31.33%). Suspicious patterns were seen in 109 patients, 11 had hypo coiling (3.66%), 92 normo-coiling (30.66%) and 6 had hyper coiling (2%). The p value was found to be 0.467 which was statistically insignificant. Similar results were found in a study by Rana et al. Our study showed no significance in comparison to studies by Chitra et al, Strong et al and de Laat et al which showed that foetal heart rate variations were significantly associated with both hypo coiling and hyper coiling.^{5,6,10}

APGAR score and UCI

APGAR score at 5 min was calculated and there was a total of 109 neonates who had APGAR <7 at 5 minutes (36.33%). Out of which there were 17 neonates with hypo coiling (2.33%), 77 neonates with normo-coiling (25.66%) and 15 neonates with hyper coiling (5%). There was a total of 191 neonates who had APGAR score at 5 minutes >7 (63.66%). Out of these neonates 18 had hypo coiling (6%), 163 had normo-coiling (54.33%) and 10 had hyper coiling (3.33%). The p value was 0.001 suggestive of statistical significance. Hypo coiling was significant at APGAR score <7 at 5 minutes. Several studies showed significant relationship with both hypo coiling and hyper coiling in association with APGAR score.

Cord length

In our study the mean umbilical coil length was 55.40±5.76 cm. The minimum length observed was 55 cm and the maximum length was 70 cm. According to literature, at term the umbilical cord has an average length of 55 cm (usual range 30-100 cm).

Number of coils

The mean number of coils was 16.88±12.44 in our study. The minimum number of coils observed was 2. The maximum number of coils observed was 50. Compared to Strong et al the total number of coils seen was between 0 to 40.³ A study by Rana et al found that the mean number of coils was per umbilical cord was 10.33±6.0.⁷ Coiling was not uniform throughout the length of the cord. Increased coiling was observed at foetal side and least at the placental end of the cord. The cords with no coiling was not included due to practicality in calculation of the

coiling index. But the foetuses with no coiling were found to have adverse perinatal outcome.

Direction of coiling

There were 182 cases with sinistral coiling (60.66%) and dextral accounting to 118 (39.33%). According to literature, sinistral spiralling (left) is four to eight times more common than the dextral spiralling and sometimes mixed spiralling has also been reported. It is not clear why sinistral is more common than the dextral. In our study there was no statistically significance between direction of coiling and perinatal outcome.

Mean UCI

The mean umbilical cord coiling index was 0.30±0.2 in our study. Below is a table which shows mean UCI of various studies.

We are not able to ascertain as to why are mean was higher compared to other studies.

Table 11: Mean UCI in various studies.

Studies	UCI
Strong et al ³	0.21±0.07
Rana et al ⁷	0.19±0.1
Ercal et al ¹¹	0.20±0.1
Ezimokhai et al ¹²	0.26±0.09
De Laat et al ⁶	0.17±0.009
Present study	0.30±0.2

Correlation between hypertensive disorders and UCI

There were 55 patients with hypertensive disorders of pregnancy which includes the spectra of gestational hypertension, pre-eclampsia, and eclampsia. Out of these 55 patients, 18 had hypo-coiling (6%), 37 had normo-coiling (12.33%). There were no hyper-coiling found in these patients. The p value was 0.001 which was statistically significant implies that hypertensive disorders of pregnancy was associated with hypo coiling. Ezhimokhai et al also demonstrated a significant association between non-coiled cords and pre-eclampsia.¹² Chitra et al, Gupta et al also reported similar results.^{1,5} The coiled umbilical cord, because of its elastic properties, is able to resist external forces that might compromise the umbilical vascular flow.⁵ The coiled umbilical cord acts like a semi-erectile organ that is more resistant to snarling torsion, stretch and compression than the non-coiled/ hypo coiled one. This might explain the association of hypo coiling with preeclampsia.

Meconium stained liquor

There were 67 cases with meconium stained liquor. Out of which 17 had hypo coiling (%), 45 had normo-coiling (%) and 5 had hyper coiling (%). The p value was <0.001 which was statistically significant. Implying that

meconium stained liquor was associated with hyper coiling. As compared to Strong et al and Ezhimokai et al they found meconium stained liquor to be significantly associated with both hypo coiling and hyper coiling.^{3,12} No proper explanations were given by either of the authors for the same.

IUGR and UCI

There was a total of 25 patients who were diagnosed to have IUGR (8.33%). Out of these 2 had hypo coiling (0.66%), 19 had normo-coiling (6.33%) and 4 had hyper coiling (1.33%). The p value was 0.019 which was statistically insignificant suggesting that hypo and hyper coiling is not associated with IUGR. Similar results were shown in a study by Rana et al.⁷

CONCLUSION

In consideration of the abnormal UCI and its correlation with adverse perinatal outcome in present study, it was observed that 10th and 90th percentile of UCI correlated well with several other studies. The mean umbilical cord coiling index was 0.30 ± 0.2 in our study. There was no correlation between parity, gestational age, gender of the new-born, birth weight, PI, CTG patterns and direction of coiling and UCI. Caesarean section showed significant association with hypo coiling. Instrumental deliveries showed significant correlation with hyper coiling. Hypo coiling had significant association with APGAR score <7 at 5 minutes. Hypertensive disorders of pregnancy were associated with hypo coiling. Meconium stained liquor was associated with hyper coiling. There was no significant association between IUGR and hypo coiling or hyper coiling. Thus, both hyper coiling and hypo coiling had significant correlation with adverse perinatal outcome. If the umbilical coiling index can be measured reliably in utero by ultrasound, then it might be a promising prognostic marker for adverse pregnancy outcome.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Singh S, Pai S, Sahu B. Study of umbilical coiling index and perinatal outcome. *Int J Reprod Contracept Obstet Gynecol* 2020;9:3977-82.