

## Evaluation of Umbilical Cord Coiling Index in late second trimester and its association with Perinatal Outcome

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### Abstract

**Background:** Umbilical cord plays a major role for foetal persistence during the intrauterine period. Reports had shown that abnormal umbilical cord coiling in the form of hypo or hypercoiling are associated with abnormal foetal outcome in the form of chromosomal disorders, intra-uterine deaths, growth retardation, meconium stained liquor, abnormal foetal heart rate and chorioamnionitis.

**Aim:** To evaluate the association between umbilical cord coiling index in the 2<sup>nd</sup> trimester and the perinatal outcome among the registered antenatal mothers.

**Methodology:** A prospective longitudinal study was conducted at the Institute of Obstetrics and Gynecology, Egmore Chennai for a period of one year between June 2012 to May 2013. A total of 385 women were recruited for the study. A semi-structured questionnaire was used for collecting the demographic details. The coiling index was measured using 3.5 MHz transabdominal transducer. Longitudinal images of the umbilical cord were taken, part of the cord which was freely floating in the amniotic fluid was taken, and the coiling index was calculated. Coiling index of less than the 10<sup>th</sup> percentile was considered as hypo coiled and above 90<sup>th</sup> percentile was considered as hypercoiled.

**Results:** The increase in the age of the mothers had shown a strong association in the development of abnormal umbilical coiling and the majority of the mothers with hypo coiled umbilical cord had delivered in less than 37 weeks of gestational age. The incidence of pregnancy induced hypertension and gestational diabetes mellitus had shown a statistically strong association with hypo coiled umbilical cord ( $p < .05$ ). Mothers with hypercoiled umbilical cord had a strong association in the development of abnormal cardiotocography ( $p < .05$ ) and meconium stained liquor and their foetal parameters like abnormal APGAR score and development of foetal distress were found to be more common.

**Conclusion:** Abnormal umbilical cord index had shown a strong association with adverse antenatal and neonatal events.

**Keywords:** Umbilical cord coiling index, Hypocoiled, hypercoiled, Perinatal outcomes.

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### Introduction

Umbilical cord serves a paramount role in foetal intrauterine persistence. The umbilical cord contains two arteries and one vein. It is protected by Wharton's jelly and amniotic fluid and the vessels are coiled in helical pattern<sup>1</sup>. At term the cord is 50 cms in length and it is coiled 10-11 spirals between the foetus and placenta<sup>2</sup>. The umbilical cord coiling usually starts at the 9<sup>th</sup> week of gestation and few reports had quoted that it may start even at the 20<sup>th</sup> week<sup>3</sup>. Umbilical cord coiling occurs both on right and left side but majority of the times it is left sided (5:1 ratio)<sup>4</sup>.

The exact mechanism of coiling was not known but certain hypothesis had been quoted for umbilical cord coiling. Foetal movements, embryo torsion, vascular growth rates of umbilicus and the muscle fibres that

were arranged on the walls of the umbilical artery were some of the causes for umbilical cord coiling.<sup>5</sup>

The term cord index was first coined by Edmonds in 1954. It is calculated by a formula as total number of coils in umbilical cord/ length of the cord after delivery<sup>6</sup>. The cord usually coils at a rate of one coil for every 5 cms. The term hypo coiled and hypercoiled indicates that the UCI value of less than 10<sup>th</sup> and more than 90<sup>th</sup> percentile respectively<sup>7-9</sup>.

Based on this criteria the normal umbilical cord index at the time of postpartum is 0.2 which was measured after the delivery of placenta and umbilical cord which was measured as 0.4 during the antenatal period which was measured using ultrasonogram<sup>10</sup>.

Reports had shown that abnormal umbilical cord coiling in the form of hypo or hyper coiling are associated with abnormal foetal outcome in the form of chromosomal disorders, intra-uterine deaths, growth retardation, meconium stained liquor, abnormal foetal heart rate<sup>11,12</sup> and few studies had shown that the poor perinatal outcome when examined retrospectively had shown abnormal coiling and insertion. The major cause for the abnormal pregnancy outcome due to hypo or hyper coiling is mainly due to the thrombosis in the

umbilical cord leading onto asphyxia and sudden foetal death<sup>13</sup>.

Umbilical cord coiling index being considered as one of the most important tool in the assessment of the fetal outcome, many studies related to it had been done in the western world, in India as such only very few studies had been conducted in assessing the fetal outcome with the umbilical cord coiling. So this study would give us an insight about how much the umbilical cord coiling is correlated with the perinatal outcomes.

### Aim

To assess the correlation between umbilical cord coiling index in the late 2<sup>nd</sup> trimester and the perinatal outcome among the registered antenatal mothers.

### Methodology

**Study area and study period:** A prospective study was conducted at the Institute of Obstetrics and Gynecology, Egmore Chennai for a period of one year between June 2012 to May 2013. All the registered antenatal mothers during that period were included in the study. Multiple pregnancies, babies with congenital anomalies, malpositions, umbilical cord with single umbilical artery and mothers with the history of previous caesarean section were excluded from the study. The study was carried out after obtaining the clearance from the institutional ethical committee and the informed consent was obtained from all the patients. The Umbilical cord coiling index was calculated sonographically between 24-28 weeks.

**Procedure:** The coiling index was measured using 3.5 MHz transabdominal transducer. Longitudinal images of the umbilical cord were taken, part of the cord which was freely floating in the amniotic fluid was taken, and the coiling index was calculated using the method suggested by Degani et al<sup>14</sup>. The distance between the coils were measured along one side of the umbilical cord from the outer edge of the arterial or venous wall to the next coil. The umbilical cord coiling index was measured by using the following formula Umbilical coiling index (UCI) = Total number of complete vascular coiling/Total length of cord (cm).

**Study sample:** Coiling index of less than the 10<sup>th</sup> percentile was considered as hypocoiled and above 90<sup>th</sup> percentile was considered as hypercoiled. A total of 385 women were recruited for the study in the second trimester and umbilical cord coiling index was determined using ultrasonogram. Among them there was difficulty in calculating the coiling index in 14 women due to inability to achieve appropriate imaging

of the umbilical cord, 62 women did not come back to our institution for delivery and 9 antenatal women underwent elective caesarean sections for breech, placenta praevia and CPD major were excluded from the study. Hence the data of 300 mothers were finally taken for the analysis.

**Statistical analysis:** All the data were entered and analysed using SPSS version 18 and the association between the umbilical coiling index and the perinatal outcome were assessed using chi-square test.

### Results

Among the total study population 226 antenatal mothers had normocoiled umbilical cord and 37 of them had hypocoiled and hypercoiled umbilical artery. Mother's age, parity and the gestational age association with umbilical cord coiling was shown in Table 1. It is seen from the table that as the age of the mother increases the incidence of the umbilical artery hypocoiling and hypercoiling increases and the difference was found to be statistically significant. The parity among the antenatal mothers did not show any difference in the occurrence of the umbilical cord hypo or hypercoiling. The majority of the antenatal mothers who had hypocoiling of the umbilical cord delivered within the gestational age of less than 37 weeks than the mothers with normocoiled umbilical cord and the difference was found to be statistically significant ( $p < .05$ ).

The various medical disorders that were reported among the antenatal mothers were pregnancy induced hypertension (PIH), gestational diabetes mellitus (GDM), anemia, hypothyroid, epilepsy and congenital heart diseases like ASD and VSD. Among them PIH and GDM showed a statistically significant association with the incidence of umbilical cord hypocoiling (Table 2).

The association between the intra-natal events and the umbilical cord coiling was shown in Table 3. It is seen from the table that for the patients with hypercoiled umbilical artery the incidence of abnormal cardiotocography was very high and similarly the occurrence of meconium stained liquor was also very high among them and their association was found to be statistically significant.

The umbilical cord coiling index when compared with the various fetal outcomes had shown a strong association among the mothers with hypercoiled umbilical artery after delivery the neonate had developed some respiratory problems and got admitted to neonatal ICU and for majority of the neonates the APGAR score at 1min was less than 7 (Table 4).

**Table 1: Age, parity and gestational age wise distribution of the umbilical cord coiling among the study population**

Variables		Normocoiled	Hypocoiled	Hypercoiled
Age	16 – 20 (n=39)	24 (61.5%)	9 (23%)	6 (15.3%)
	21 – 25 (n=141)	114 (80.8%)	12 (8.5%)	15 (10.6%)
	26 – 30 (n=89)	73 (82%)	8 (8.9%)	8 (8.9%)
	31 – 35 (n=29)	13 (44.8%)	8 (27.5%)	8 (27.5%)
	36 – 40 (n=2)	2 (100%)	0	0
P value		0.817	0.0421	0.0367
Parity	Primi (n=163)	114 (69.9%)	21 (12.8%)	28 (17.1%)
	Multi (n=137)	112 (81.7%)	16 (11.6%)	9 (6.5%)
P value		0.862	0.917	0.0621
Gestational age <37 weeks (n=34)		15 (44.1%)	16 (47%)	3 (8.8%)
37 – 40 weeks (n=214)		163 (76.1%)	21 (9.8%)	31 (14.4%)
> 40 weeks (n=51)		48 (94.1%)	0	3 (5.8%)
P value		0.538	0.0251	0.319

*P value derived by applying chi-square test*

**Table 2: Association between obstetric medical disorders and umbilical cord coiling index among the study population**

Obstetric medical disorders	Normocoiled(n=226)	Hypocoiled (n=37)	Hypercoiled (n=37)	P value
Pregnancy induced hypertension	15 (6.6%)	16 (43.2%)	5 (13.5%)	<.0001
Gestational diabetes mellitus	14 (6.1%)	8 (21.6%)	5 (13.5%)	0.0341
Anemia	32 (14.1%)	6 (16.2%)	7 (18.9%)	0.784
Hypothyroid	7 (3%)	1 (2.7%)	1 (2.7%)	0.852
Epilepsy	5 (2.2%)	0	1 (2.7%)	0.715
ASD/VSD	4 (1.7%)	0	1 (2.7%)	0.806

*P value derived by applying chi-square test*

**Table 3: Association between intra-natal events and the umbilical cord coiling index among the study population**

Intra-natal events	Normocoiled(n=226)	Hypocoiled (n=37)	Hypercoiled (n=37)	P value
Abnormal cardiotocography	23 (10.1%)	11 (29.7%)	16 (43.2%)	<.0001
Emergency LSCS	70 (30.9%)	18 (48.6%)	20 (54%)	0.628
Incidence of meconium stained liquor	22 (9.7%)	4 (10.8%)	22 (59.4%)	<.001
Incidence of abruption	0	2 (5.4%)	0	0.294

*P value derived by applying chi-square test*

**Table 4: Association between foetal events and the umbilical cord coiling index among the study population**

Foetal events	Normocoiled(n=226)	Hypocoiled (n=37)	Hypercoiled (n=37)	P value
Intra-uterine death	1 (0.4%)	2 (5.4%)	0	0.392
Admission to NICU	14 (6.1%)	15 (40.5%)	17 (45.9%)	0.0381
Mean birth weight (kgs)	2.86	2.59	2.74	0.872
APGAR score of <7 at 1 min	15 (6.6%)	6 (16.2%)	9 (24.3%)	<.0001

*P value derived by applying chi-square test*

## Discussions

The mean umbilical cord coiling index in our study population is  $0.38 \pm 0.03$  and it is almost in par with the studies done by Gupta et al<sup>15</sup> and Chitra et al<sup>16</sup>. The mean number ( $8.6 \pm 3.82$ ) of coils per umbilical cord in this study is lower than that ( $12.59 \pm 5.8$ ) reported by Chitra et al<sup>16</sup> but higher than the figure ( $5.8 \pm 3.8$ ) reported by Gupta et al<sup>15</sup>. The difference between these studies might be due the different type of protocols followed by the authors. In our study we clamped the cords, as the unclamped cords will show a slight overestimation of the umbilical cord index<sup>17</sup>. In the present study it was shown that as the age of the mother increases the incidence in the abnormality of UCI increases and the similar type of results was also quoted by Chitra et al<sup>16</sup> and Ezimokhai M et al<sup>18</sup>.

In the current study pregnancy induced hypertension had a strong association with the incidence of hypocoiling of cord and similar type of results were also shown in the previous studies<sup>16,19,20</sup>. The reasons quoted for this association is the coiled cord due to its elastic properties were able to resist external forces which would compromise the vascular flow of the umbilical cord. In our study we also had a significant association between umbilical cord hypocoiling and the incidence of GDM but there are no proper theories to explain the association and whereas no other studies had shown this association, so further research is needed in this area.

In the present study a statistically significant association was established between meconium staining and the abnormal coiling index and this results was in agreement with the results shown in previous studies<sup>5,21,22</sup>, but there was some studies which were contradicting to this association<sup>23,24</sup>. The incidence of abnormal cardiotocography is more common in hypocoiled umbilical cord in our study, which is due to the ability of the cord to resist vascular compression or torsion<sup>25</sup>.

Our study had shown a strong association between the foetal distress and the hypocoiled cords, which had been proved previously in few studies<sup>26</sup> quoting the reason as these cords are more prone for compression and hence compromising the foeto-placental circulation. Few studies had shown that the babies which were born to the mothers with the hypocoiling of the cord were small for gestational age whereas in our study the mean weight of the neonate did not show any statistical difference which were born to the mothers with umbilical cord rather normocoiled mothers or hypocoiled

So detecting the cord abnormalities during the antenatal period would be helpful in strict monitoring of the foetus during the intrapartum period and the umbilical cord index can be used as a promising prognostic marker for any adverse event in pregnancy.

## Conclusion

Umbilical coiling index was found to be an important predictor of adverse perinatal outcome. Antenatally calculated abnormal UCI was found with some perinatal complications in neonates. The adverse events that were reported in mothers who had abnormal coiling index were PIH, gestational diabetes mellitus, abnormal cardiotocography and meconium stained liquor and whereas the adverse events that were reported among the infants were low APGAR score and respiratory distress warranting them for NICU admission. To conclude, abnormal umbilical coiling index is associated with several adverse antenatal and neonatal events. The association had shown wide variations among the few studies which had been done so far.

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