Umbilical Cord Coiling Index at Term Gestation and Its Association with Perinatal Outcomes

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Abstract

Background: Umbilical coiling index (UCI) is the number of coils in the cord divided by the cord length in centimeters. .On the basis of UCI umbilical cords have been grouped as: hypocoiled,(UCI Less than 10th percentile) normocoiled (UCI between 10th–90th percentile) and hypercoiled (UCI More than 90th percentile).Various reports have shown that abnormal coiling index is associated with adverse perinatal outcomes.There is a wide variations among the various studies done so far. Some studies have reported significant association between abnormal UCI and adverse perinatal outcomes whereas few studies did not show significant association. **Material & Methods:** This prospective study was conducted on 200 randomly selected Indian pregnant women with singleton pregnancy at POG ≥37 weeks.The UCI less than 10th percentile and more than 90th percentile were considered as hypocoiled and hypercoiled respectively Then association between abnormal UCI and intrapartum events (fetal heart rate (FHR) abnormality, meconium stained liquor, mode of delivery)and neonatal outcome (birth weight, IUGR,Apgar score and need for NICU admission) were evaluated. **Results & Conclusion** The mean UCI was 0.21 ± 0.08 coils /cms. (9.50%) coils were hypocoiled 81%) were, normocoiled and hypercoiled were (9.50%). No statistically significant association was found between abnormal coiling and perinatal outcomes.

Keywords: *Umbilical cord coiling index (UCI) Hypercoiling umbilical cord, Hypocoiling umbilical cord, Fetal distress, Perinatal outcome, IUGR.*

Introduction

The umbilical cord is vital to the development, well-being and survival of the fetus. The most distinctive feature of the umbilical cord is the helical pattern of its vessels.A coil is defined as complete 360 degree spiral courses of umbilical vessels around the Wharton's jelly. In 1994, Strong et al found a way to unify the description of cord coiling and introduced the 'umbilical coiling index' (UCI), which is the number of coils in the cord divided by the cord length in centimeters.[1] Rana J et al[2] did the frequency distribution of umbilical cord index (UCI) and Umbilical cords have been grouped as hypocoiled (UCI less than 10th percentile),normocoiled (UCI between 10th–90th percentile and hypercoiled (UCI More than 90th percentile).It is believed that abnormal cord coiling is a chronic state, established in early gestation, that may have chronic (growth retardation) and acute (fetal intolerance to labor and fetal demise) effects on fetal well being.[1] The association shows wide variations among the various studies done so far.Various reports have shown that abnormal coiling index is associated with adverse perinatal outcomes[1, 7,9-13] .Other studies did not show significant association. [3, 16, 17]

Material & Methods

The present prospective study was conducted on

200 randomly selected Indian pregnant women with singleton pregnancy at POG ≥37 weeks who came for delivery or cesarean section in the Department of Obstetrics and Gynecology of Artemis Hospital Gurgaon ,a Tertiary care teaching hospital serving, a predominantly economically secure urban population. From June 2017 to May 2018. The study was reviewed and approved by hospital scientific and ethics review committee.

Inclusion criteria

patients with Singleton pregnancy with live fetus at POG ≥37 weeks who underwent vaginal delivery or cesarean section were included in this study. **Exclusion Criteria -**patients with multi fetal gestation, Congenitally malformed fetus on USG**,** patients with history of Smoking and drug abuse and those who were for cord blood banking were excluded from the study .

Sample-size was calculated according to the following formula

Formula:

$$n = \frac{z_{\alpha}^{2} p(1-p)}{m^{2}}$$

$N = n/ (1+ ((n-1)/F)$ Where N is required sample size for the finite population and n is sample size for infinite population. Taking the standard value of z is 1.96 and 3.2 % margin of error our required sample size for the (finite population) study was **N ~ 198.**

MethodologyPatients were selected after ruling out the exclusion criteria and taking written informed consent. Gestational age was calculated by the first day of last menstrual period in those who were sure of dates and had regular menstrual cycles. In those patients who were not sure of dates or had irregular cycles, a first trimester ultrasound was used for dating .Information sheet was provided to the participants. Demographic and clinical data were recorded in predesigned Performa. Detailed examination was done and patients were managed as per standard hospital protocols. These women were closely followed up for the entire period of labor and post partum till discharge from the hospital. Maternal and neonatal details were collected including antepartum, intrapartum and post partum till discharge from the hospital.

Calculation of UCI-After vaginal delivery or cesarean section, after separating the baby from the umbilical cord, the cord was tied and cut close to the placenta. Without being stretched, the cord was examined. The entire umbilical cord was measured in centimeter including the length of the placental end of the cord and the umbilical stump on the baby. The numbers of complete coils (360 degree spiral course) were counted and UCI was calculated by the formula (the total number of coils / total length of cord in centimeters). The percentile value of the umbilical coiling index was calculated. The UCI less than 10th percentile and more than 90th percentile were considered as hypocoiled and hypercoiled respectively.

The antenatal(age, parity, gestational age, gestational hypertension(GHT), gestational diabetes mellitus(GDM),IUGR),Intrapartum(modeofdelivery, fetal heart rate (FHR) abnormalities,meconium stained liquor (MSL) and neonatal factors (Apgar score, birth weight and admission to neonatal intensive care unit (NICU) were recorded. The data obtained was entered and managed in Microsoft Excel 2010 spreadsheet and analyzed.Variables were summarized into means or medians for continuous variables and percentage for categorical variables. The baseline characteristics of maternal age and parity were compared between groups with normal and abnormal UCI to ascertain their comparability

Statistical analysis -The Kolmogorov–Smirnov tests were performed to assess normality. The continuous data was shown as Mean ±Standard

Deviation and categorical data was represented as absolute numbers and percentages .For continuous data parametric data were analyzed with student's T-Test/ Z-Test. Non-parametric data were analyzed with the Mann–Whitney U-test. Nominal categorical data between the groups was compared using Chi-square test or Fisher's exact test as appropriate. Correlation used for measuring the linear relationship between two continuous variables. All major data analysis packages as well as spreadsheets, such as Microsoft Excel used as per requirement. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

Result and Discussion

The mean UCI in our study was 0.21 ± 0.08 which was similar to the study done by Kikelomo T. Adesina et al (0.21 ± 0.099)and Sabrie(0.20±0.08), in their respective studies.[3,4] This agreement confirms that our sample population was appropriate for conducting this study

The value for the 10th percentile was calculated as 0.11coils/ cm and the value for the 90th percentile came out to be 0.32coils/ cm. Accordingly, the division of cases was as follows:hypocoiled group-(9.50%), normocoiled group (81%)and hypercoiled group(9.50%).The average maternal was 30.66 years. The maximum number of patients were in the age group 31-35 years (table1).

TABLE 1- AGE DISTRIBUTION

Age (years)	No. of patients	Percentage
20-25	20	10
26-30	72	36
31-35	90	45
36-40	18	9

Majority of the patients were nulliparous (table2).

TABLE 2 - PARITY DISTRIBUTION

Parity	No. of patients	Percentage
0	121	60.50
1	75	37.50
2	3	1.50
3	1	0.50

The mean gestational age at the time of delivery was 38 weeks with standard deviation of ±2.98 (table3).

TABLE 3 - GESTATIONAL AGE DISTRIBUTION

Group	GA (< 39 Weeks)	GA (≥ 39 Weeks)
Hypocoiled	14	5.00
Normocoiled	115	47.00
Hypercoiled	13	6.00

9.5% patients had gestational hypertension, gestational. diabetes mellitus complicated 11%,

24% of pregnancies were complicated by intrauterine growth restriction (IUGR) {AC<10th centile on USG}.15.5% of patients had non-reassuring fetal heart rate during some stage of labor in the form of prolonged decelerations, loss of beat to beat variability and type 1 decelerations. 10 % patients had meconium staining of liquor (any amount of meconium).33.5 % of the patients delivered vaginally and 66.5% had an operative delivery (10.5% vacuum, 31% elective LSCS and, 25% emergency LSCS .10% had an emergency cesarean section for fetal distress).

16% of the new born were low birth weight babies (birth weight<2.5 kg). All were appropriate for the gestational age. The mean birth weight came out to be 2.9 kg. Minimum birth weight was 2 kg and maximum birth weight was 4.2 kg. All babies had Apgar scores in the range of 6-8 at 1 minute and 5 minutes interval. None of the neonates required admission to NICU for respiratory distress (table 4)

TABLE 4- UCI and its association with maternal and perinatal outcomes

GHT	NO (n= 181)	YES (n= 19)	P value
Hypocoiled	17	2	P1 0.876
Normocoiled	148	14	
Hypercoiled	16	3	P2 0.551
GDM	NO(n= 178)	YES (n= 22)	P value
Hypocoiled	17	2	P1 0.756
Normocoiled	144	18	
Hypercoiled	17	2	P2 0.756
IUGR	NO (n= 152)	YES (n= 48)	P value
Hypocoiled	13	6	P10.708
Normocoiled	122	40	
Hypercoiled	17	2	P20.272
CTG	(R) (n= 169)	(NR) (n= 31)	P value
Hypocoiled	16	3	P10.928
Normocoiled	140	22	

Cont... **TABLE 4- UCI and its association with maternal and perinatal outcomes**

Hypercoiled	13	6	P20.085
MSL	(NO) (n= 180)	(YES) (n= 20)	P value
Hypocoiled	19	0	P10.285
Normocoiled	145	17	
Hypercoiled	16	3	P20.756
Mode of Delivery	Normal (NVD) (n= 67)	Instrumental (VACUUM) (n= 21)	P value
Hypocoiled	3	3	P10.933
Normocoiled	57	17	
Hypercoiled	7	1	$P_2$0.259
	(NVD) (n= 67)	Emergency LSCS (n= 50)	**P value**
Hypocoiled	3	3	$P_1$0.933
Normocoiled	57	37	
Hypercoiled	7	10	$P_2$0.135
LBW	**NO (n= 168)**	**YES (n= 32)**	**P value**
Hypocoiled	13	6	$P_1$0.104
Normocoiled	139	23	
Hypercoiled	16	3	$P_2$0.874

GHT=gestational hypertension, GDM= Gestational diabetes mellitus, IUGR= Intrauterine growth restriction, CTG= Cardiotocography, MSL= Meconium stained liquor,p_1=p value calculated for hypocoiled cords p_2= p value calculated for hypercoiled cords

Table 5: Studies examining umbilical cord coiling (UCI) index and adverse pregnancy outcomes

Study	**N**	***Hypocoiled***	***Hypercoiled***
Strong *et al*.[1] 1994	100	Aneuploidy, fetal distress,MSL	CTG abnormalities
Kikelomo T. Adesina et al[3](2017)	436	No adverse perinatal outcome	congenital abnormalities., No other adverse perinatal outcome
Ezimokhai*et al*.[7] 2000	657	-	LBW, LBW, fetal distress
Chitra et al[9]	1000	hypertensive disorders,abruptio placentae, preterm labor, oligohydramnios, and fetal heart rate abnormalities.	diabetes mellitus, polyhydramnios, cesarean delivery, congenital anomalies, and respiratory distress of the newborn.
De Laat*et al*.[10] 2007	565	fetal anomaly, low Apgar score at 5 min	IUD, PTB, fetal anomaly, hypoxia, LBW
Kashanian et *al*[11] 2006	699	Apgar score at 5 min, AFI <5	Low Apgar score at 5 min, AFI <5, meconium, LBW

***Cont...* TABLE 4- UCI and its association with maternal and perinatal outcomes**

Patil [12]et al.,(2013)	200	low Apgar MSL, and NICU admissions	intrauterine growth restriction, LBW
Devaru and Thusoo[13],(2012)	100	low Apgar score at 5 min MSL,	intrauterine growth restriction
Ndolo JM,92018)[16]	430	No association found with adverse perinatal outcome	No association found with adverse perinatal outcome
van Dijk [17]	122	No association found with adverse perinatal outcome	No association found with adverse perinatal outcome
Present study	200	No association found with adverse perinatal outcome	No association found with adverse perinatal outcome

In our study no statistically significant association found with GHT and abnormal UCI (p1=0.876& p20.55). Shilpa et al and Mittal A et al also did not find significant association between pre eclampsia, and abnormal UCI.[5, 6] Ezimokhai M et al, Gupta et al and Chitra et al demonstrated a significant association between hypocoiling preeclampsia and GHT.[7, 8, 9] They gave explanation that the coiled umbilical cord, because of its elastic properties, is able to resist external forces that might compromise the umbilical vascular flow. The coiled umbilical cord acts like a semi erectile organ that is more resistant to snarling torsion, stretch, and compression than the noncoiled one. This might explain the association of hypocoiling with preeclampsia and GHT .

In our study diabetes mellitus (DM,) was not found to be significantly associated with both hypocoiled and hypercoiled cords (☐1=0.756, p2=0.756). Shilpa et al& de Laat et al also did not find any statistically significant association between GDM and abnormal UCI.[5, 10] Ezimokhai et al however, found significant association of GDM with both hypocoiled and hypercoiled.[7] Chitra et al also observed that the incidence of GDM was statistically significant in hypercoiled subjects.[9] None of the patients enrolled in the study done by Mittal A et al developed gestational diabetes mellitus (GDM) and hence they could not study its association with abnormal coiling index.[6]Intrauterine growth restriction (IUGR) was noted in 48 (24%) cases in our study, six patients belonged to the hypocoiled group and two patients belonged to the hypercoiled group. IUGR and abnormal coiling were not found to be significantly associated (p1=0.708, p2=0.272). Ezimokhai et al, de Laat et al, Patil et al and Devaru &Thusoo in their respective studies noted the significant association between hypercoiling and small for gestational age fetuses.[7, 10,, 12,13]

Abnormal coiling index was not associated with FHR variations in our study (p1=0.085,p2=0.089). Similar results were seen by Kikelomo T. Adesina et al and Shilpa et al. [3,5] FHR variations were found to have a highly significant association with both hypocoiled and hypercoiled in the study done by Chitra et al (both instances P <0.001).[9] Strong et and de Laat el al also found a consistent association between intrapartum FHR decelerations and abnormal UCI.[1,10].According to them hypocoiled and hypercoiled cords are less flexible or more prone to kinking and torsion which makes them less tolerant to withstand the stress

of labor. Rana J et al. and Ercal Tet al found FHR decelerations to be significantly associated with hypocoiled cords[2, 14] Rana J et al explained that coiling provides turgor and compression resistant properties to the cord which become compromised as the cord becomes hypocoiled.[2]

There was no statistically significant association between umbilical coiling and meconium staining of liquor in the present study. Similar results were shown in the study done by Kikelomo T. Adesina et al and Jo YS et al[3, 15]. Meconium staining of the amniotic fluid was found to have a significant association with both hypocoiled (P =0.020) and hypercoiled cords (P <0.001) in the study done by Chitra T et al. [9]Similar findings were noted in studies done by Strong et al and Ezimokhai et al. They did not offer a specific explanation for the observation.[1, 7]

Operative deliveries did not have significant association with extremes of UCI in our study including instrumental deliveries (p1=0.933,p2=0.259) and Emergency Cesarean deliveries (p1=0.933 ,p2=0.135). Instrumental deliveries did not have any association with extremes of UCI in the study conducted by by chitra T et al[9].Rana J et al and Eric T at el found positive association between operative delivery, for fetal distress and abnormal UCI.[2, 9, 14]

An Apgar score of < 4 at 1 min and a score of < 7 at 5 min were taken as poor Apgar scores at 1 minute and 5 minute respectively. No babies in either hypocoiled or hypercoiled groups had a poor Apgar score hence no association could be calulated. Low Apgr was found to have a significant relationship with both hypocoiled and hypercoiled in the study done by Gupta et al, Chitra T et al , and Kashanian et al.[8,9,11]None of the babies in the study group were admitted to the NICU and hence its association with abnormal coiling indices could not be studied. Our study results are comparable to the study done by Kikelomo T. Adesina et al and van Dijk et al. [3,17].

No statistically significant association was found between abnormal umbilical coiling and LBW (p1=0.104, p2=0.874) in our study. Both hypocoiling and hypercoiling were found to be significantly associated with low birth weight in the study done by Mittal et al & Chitra T et al. [6,9] JoYS et al did observe that hypocoiling was associated with low birth weight, their study did not find any relation between birth weight and hypercoiling.[15]. de Laat et al and Kashanian et al also find a significant relationship between hypercoiling and low weight at birth.[10,11]

Conclusion; No statistically significant association was found between abnormal UCI and adverse perinatal outcomes in this study. Most likely reason of this conclusion can be attributed to our well equipped centre with availability of CTG(continous tocography) machine for all laboring patients where appropriate actions were taken well on time in case of non- reassuring CTG. Also all patients included in the study were booked and received good antenatal care throughout and delivered at term gestation. Other factors include economically secure, well educated patients.The association shows wide variations among the various studies done so far. Some studies have reported significant association between abnormal UCI and adverse perinatal outcomes [1.7, 9-13] whereas other studies are similar to the present study [3, 16, 17]. Further studies need to be done for large sample size.

Limitation of the Study Small sample size

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Conflict of Interests. There was no conflict of interests among the authors of this study.

Ethical approval The study was reviewed and approved by hospital ethics review committee.

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