UMBILICAL CORD COILING INDEX AS A MARKER OF MATERNAL AND PERINATAL OUTCOME: A RETROSPECTIVE STUDY

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ABSTRACT

Introduction
The umbilical cord or funis forms the connecting link between the fetus and the placenta. An abnormal UCI includes both hypo and hyper coiled cords. An abnormal UCI has been reported to be related to adverse perinatal outcome.

Objectives:
To study the association between UCI and i) intrapartum events (fetal distress, meconium staining), ii) mode of delivery and iii) perinatal outcomes (birth weight, Apgar score, NICU admission).

Methods:
A prospective analytical study was performed in our institute on 200 patients over a period of 2 years.
The UCI was measured by ultrasound using the method suggested by Degani et al. Its association with various maternal and perinatal risk factors was noted. The results were statistically analyzed with the Chi-square test and SPSS version 13.0.

Results:
There was significant correlation (p value 0.003) between the hypercoiled cords and intrauterine growth restriction of the babies. Apgar score at 1 min\4 and 5 min\7 was highly significant (p\0.001) with hypocoiled cords. Meconium staining was significantly
(p value 0.001) associated with the hypocoiled cords in the present study.

Conclusion:
The hypocoiled cords are associated with the meconium staining and low Apgar score. The hypercoiled cords are associated with intra uterine growth restriction

Keywords: Hypocoiling ,Hypercoiling, umbilical cord, Umbilical coiling index

INTRODUCTION

The umbilical cord or funis forms the connecting link between the fetus and the placenta; it is vital to the development, well-being and survival of the fetus [1].
Though the umbilical cord is protected by Wharton's jelly, amniotic fluid, helical patterns, and coiling of vessels [2, 3, 4], it is vulnerable to kinking, compressions, traction, and torsion which may affect the perinatal outcome. [5, 6,7, 8, 9,10]

Coiling and its effect on the fetus:
The coiling of the umbilical vessels develops as early as 6 weeks after conception and is present in about 95% of fetuses by 9 weeks [11] The number of twists is believed to be constant

throughout pregnancy.[12, 13] It is unclear whether abnormal coiling is a cause or consequence of pathology. [14] Abnormalities of the cord can be detected antenatally with modern ultrasound techniques. [15]The umbilical coiling index (UCI) represents the umbilical cord coiling. Prenatal outcomes such as fetal distress, IUGR and IUFD during parturition are linked to Coiling Level. Decreased and increased spiralling of the cord is currently thought to increase the risk of cord compression. [16, 15, 17]
Fetuses with few or no coils (straight cords) are predisposed to develop fetal morbidity. [16, 15, 18]

Aim of the study
To study the association between umbilical cord coiling index and
• Intrapartum events: Fetal distress and meconium staining of liquor
• Mode of delivery
• Perinatal outcome: Birth weight, Apgar score and NICU admission due to birth asphyxia.

MATERIALS AND METHODS;
This was a prospective analytical study done in our institute (Dept of obstetrics and gynecology, King George Hospital) over a period of 1year (from July 2020 to August 2021),

Study population
All pregnant woman attending OPD, admitted in the antenatal ward and labour room
The following inclusion and exclusion criteria were followed to select the study group

Inclusion criteria
Age: 19 -35
Singleton pregnancy irrespective of parity
Gestational age > 34 weeks
Presence of three vessel umbilical cord

Exclusion criteria
Gross fetal anomalies
Multiple pregnancies
Oligohydramnios or polyhydramnios as defined by an amniotic fluid index of <5 cm or >25 cm, respectively. [19]
Presence of a single artery in the umbilical cord
Pre-existing maternal medical conditions (like diabetes mellitus, hypertension, renal disorders, and anemia) that can interfere with fetal growth.

Of the total antenatal women admitted within the study period, 200 women, who fulfilled the inclusion criteria were included. A thorough history was elicited and recorded.
The UCI was measured beyond 34 weeks of gestation using 3.5 MHz trans-abdominal transducer by a single sonologist using Degani et al. [13] method. It was calculated as the 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. [20] The final value is the average of three readings at three different segments of umbilical cord. [2]For term pregnancy, hypo-coiled is UCI < 0.2 while hyper-coiled is UCI > 0.6, while the average normal UCI is 0.4. [21]. Other ultrasound parameters including fetal bi-parietal diameter, head circumference, abdominal

circumference, and femoral length, amniotic fluid index, placental position and grading were also noted.

Parturition details including gestational age at delivery (preterm and term deliveries), abnormal CTG patterns, color of amniotic fluid, mode of delivery (vaginal delivery or LSCS) , birth weight and sex , APGAR at 1 and 5 minutes and NICU admission were recorded and tabulated. Maternal factors like age, gravidity, gestational age at delivery and mode of delivery were noted. The relationship between UCI and neonatal factors like meconium staining of liquor, birth weight, APGAR score of neonates, NICU admission were evaluated. Results of the present study were tabulated, compared and analyzed. All the women and babies, including those admitted in NICU, were followed till discharge.

Ethical considerations

The Institutional Ethical Committee clearance was obtained. Written informed consent was obtained from every individual of the study. Confidentiality of every patient was maintained.

Statistical methods

The data were entered in a Microsoft Excel spread sheet, and analyses were done using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive analyses of data were done by calculating mean, median, mode, and standard deviation. Categorical variables were expressed as frequencies and percentages. Chi square tests were applied. $p<0.05$ were considered statistically significant.

RESULTS

Incidence

Most (151, 75.5%) of the umbilical cords were normocoiled; 27(13.5%) were hypocoiled and the remaining 22(11%) were hypercoiled

Age group

Most of the study population was in the (20-25) years age group. It was noted that the incidence of abnormal coiling (hypo and hyper coiling) increases at extremes of age.

Parity

Of the 200 patients included in this study, 107 (53.5%) were primigravidas and the remaining 93 (46.5%) were multigravidas. Table 1

Gestational age at delivery

48.1 %(13) of the women in hypocoiled group delivered before 37 weeks of gestation as compared to 18.18% in hyper coiled and 3.9%(4)in normocoiled groups. Table 1

Mode of delivery

48.1% of the hypocoiled group and 54.54% of the hypercoiled group were delivered by caesarean section whereas only 31.1% of normocoiled group had to be delivered by caesarean section.

Abnormal CTG

The incidence of abnormal CTG was significantly higher in the abnormally coiled groups (hypercoiled group: 27.27%, hypocoiled group: 37%) as compared to normocoliled (11.9%)

groups.

Meconium stained liquor

The incidence of meconium stained liquor was significantly higher in the of the hypercoiled group (54.5%) as compared to normocoiled (11.2%) and hypocoiled (11%) groups. Table 1

Birth weight

The mean birth weight in the abnormally coiled groups was significantly lower than the normocoiled group. It was 2.51 kg, 2.61 kg in the hypo and hypercoiled groups respectively and 2.74 kg in the normocoiled group. Thus, mean birth was lowest in hypocoiled group.

Gender of newborn

The incidence of female child birth is significantly higher in the hypo coiled group (70.3%).

APGAR score

APGAR scores at one min were low in the abnormally coiled groups; 18.5% of the hypocoiled group and 27.3% of the hypercoiled group had an APGAR < 7 at 1 min after birth as compared to 5.9% in the normocoiled group. Table 1

Admission to NICU

The admission to NICU was more among the abnormally coiled groups: 36.4% and 37% in the hypercoiled and the hypocoiled groups respectively, as compared to 7.9% in the normocoiled group, which was statistically significant. Table 1

DISCUSSION

The umbilical coiling index has been found to be an effective indicator of perinatal outcome. Several studies in the past have correlated the relationship between perinatal outcomes and the UCI. The present study is a prospective observational study done at King George Hospital, Visakhapatnam on antenatal evaluation of umbilical cord coiling index and its effects on maternal and perinatal outcome.

Mean UCI

The mean UCI in the present study is 0.37 ± 0.10. This was higher as compared to other studies. (Strong et al [15]: 0.21 + 0.07, Rana et al [16]: 0.19 + 0.1, De Laat et al [22]: 0.17 + 0.009, Chitra et al [23]: 0.24 + 0.09 and Ercal et al [24]: 0.20 + 0.07.

Incidence of abnormal coiling index

The incidence of abnormal coiling was 24.5 % in our study (hypo coiled 13.5% and hypercoiled 11%). This was similar to other studies.[Patil et al [25] Kashanian et et al [26] Chitra et al[23] Milani et al [27]] Hussein et al [28].Table 2

Age

In our study, majority of the women (67%) were in the 21-25 years age group; 22% were under 20 years of age and 10% were over 30 years of age. The mean maternal age in this study in normocoiled group was 24.5, in hypocoiled group was 24.5 and 23.14 in hypercoiled group. It was noted that the incidence of abnormal coiling (hypo and hyper coiling) increases at extremes of age (<20 &>30). Similar findings were observed by other authors as well Ezimokhai et al. [11]

Parity

In our study, on comparing UCI with parity, there was no statistical significance between primigravida and multigravida. Similar observations were made in other studies as well Milani et al[27] Bhojwani et al [2] 2016 Sharma et al [3]

Gestational age at delivery

In the present study, the incidence of preterm delivery was highest in the hypocoiled group, (48.1%). The association between hypocoiling and preterm delivery was extremely significant (p value < 0.0001). Similar results were shown by Chitra et al [35] (17.09%),Bhojwani et al [2] (46.8%) and Mittal et al [29] (16.6%) though explanations regarding the cause for preterm delivery were not given. However, Gupta et al [1], observed that preterm deliveries were highest in normocoiled group (18.6%).

Mode of delivery

In our study 48.1% of hypocoiled group and 54.54 % of hypercoiled group underwent caesarean section as compared to 31.1% of the normocoiled group. Thus, abnormal coiling was strongly associated with increased LSCS rates. (p value < than 0.0001). Many studies (Mustafa et al [30],Chitra et al[23] Bhojwani et al[2]) have shown similar association between increased LSCS rates and abnormal coiling index. Mittal et al [29] have observed that LSCS rate were almost similar in both hypocoiled and hypercoiled groups. Table 3

Meconium stained liquor

In the present study there was significant association between hypercoiling and meconium staining of the liquor(54.5%). (p value < 0.001). Chitra et al [23] and Mustafa et al [29] showed similar results (31.57% and 31.1% respectively). However, this was in contrast to studies by Gupta et al 2006[1] , Milani et al [27] and Bhojwani et al [2] in which meconium staining of liquor was highest in hypocoiled group, (i.e. 63.6%, 7.7% and 68.7% respectively). Table 3

Sex of the baby

In our study, there was predominance of girl child (70.37%) in the hypocoiled group. However there was no significant correlation between the sex of the baby and abnormal coiling index in other studies.

Birth weight

In our study, there was significant association between low birth weight babies and hypocoiling. (p value < 0.001). The high incidence of LBW babies in the hypocoiled group could be because of the increased incidence of preterm labour. Similar results were seen in the study by Sharma et al [3]. It is known that adequate coiling prevents compression of the

cord; hypocoiling over a period of time, may compromise fetoplacental circulation, thus resulting in growth restriction. [23]

Abnormal fetal heart rate patterns

In our study 37% of the hypocoiled group and 27.27% of hypercoiled group had abnormal fetal heart patterns in comparison to 11.9% of the normocoiled group. Thus fetal heart rate variations were significantly associated with abnormal coiling. (p value < 0.001). Chitra et al [23], Mustafa et al [30] and Mittal et al [29] also observed similar results. This can be explained by the fact that abnormally coiled umbilical cords were less flexible and more prone to kinking & torsion. Hence, these fetuses do not withstand the stress during labour. Coiling provides turgor and compression resistant properties to the umbilical cord which become compromised when it becomes hypocoiled. Rana et al [16]. Table 3

Low APGAR scores

In our study, abnormally coiled groups were associated with low APGAR scores at birth. The incidence of low APGAR scores was highest among the hypercoiled group. (p value < 0.001). Similar findings were observed by Chitra et al [23]. However, Bhojwani et al [2], Gupta et al [1] and Mustafa et al [30] (observed that incidence of low APGAR scores was highest in the hypocoiled group.(31.2%, 36.36% and 6.45% respectively). Table 3

Admission to NICU

In our study, 36.36% of the babies born to mothers of the hyper coiled group , 37% of the babies of the hypocoiled group 7.9% of babies in the normocoiled group were admitted to NICU for various reasons. Thus, admission of babies to the NICU was significantly increased in abnormally coiled groups (p value < 0.001). Mustafa et al [53 30] and Patil et al[25] Milani et al [51 27] Bhojwani et al [2] also showed similar results. The reason may be derived linearly from the associations between FHR decelerations, operative delivery, and initial low APGAR [23]. Table 3

CONCLUSION AND RECOMMENDATONS

Abnormal umbilical cord coiling can be detected during the fetal anatomic survey in the second trimester without significantly increasing the examination time [3]. Our study suggests that abnormal coiling index is associated with adverse perinatal outcomes. Therefore, monitoring umbilical cord coiling and calculating UCI can provide valuable insights into fetal development, identifying potential risks and predicting adverse outcomes, enabling early intervention and improved perinatal outcomes [21].

As results of various studies show wide variations, more and larger studies are required to confirm the reliability and validity of antenatal coiling index measurement.

Measurement of UCI should be made an integral part of antenatal ultrasound.

Further research is required to determine the most appropriate time for measurement of the UCI that would accurately reflect the perinatal outcome

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LIST OF TABLES

Table1: UCI in relation to parity, meconium stained liquor, admission to NICU & gestational age at delivery

	UCI			
	NORMAL	HYPOCOILED	HYPERCOILED	P- VALUE
PARITY				
PRIMI GRAVIDA	79	14	14	0.023
MULTIGRAVIDA	72	13	8	
MECONIUM STAINED LIQUOR				
YES	17	3	12	<0.001
NO	134	24	10	
ADMISSIONS TO NICU				
YES	12(7.9%)	10(37%)	8(36.36%)	<0.001
NO	139(92.1%)	1(63%)	1(63.64%)	
CTG				
NORMAL	133	17	16	<0.001
ABNORMAL	18	10	6	
GESTATIONAL AGE AT DELIVERY				
34-37 WEEKS	6	13	4	<0.0001
37-40 WEEKS	113	14	16	
>40 WEEKS	32	0	2	
APGAR SCORE AT 1 MIN				
<7	9	5	6	<0.001
>7	`144	22	16	

Table 2: Incidence of abnormal coiling in various studies

INCIDENCE OF ABNORMAL COILING		
STUDY	HYPOCOILED (%)	HYPERCOILED (%)
Patil et al [25]	11.5	10.5
Kashanianet et al [26]	12.4	11.1
Chitra et al [23]	11.7	10
Milani et al [27]	9.8	10.3
Hussein et al [28]	15	9
Present Study	13.5	11

Table 3: Comparison of preterm deliveries, LCSS rates, incidence of meconium stained liqour, abnormal CTG, low APGAR score, NICU admissions in various studies.

PRETERM DELIVERIES IN VARIOUS STUDIES			
STUDY	NORMOCOILED	HYPOCOILED (%)	HYPERCOILED
Gupta et al [23]	18.6	18.2	10
Chitra et al [23]	8.3	17.09	14
Mittal et al [29]	3.08	16.6	10
Bhojwani et al [2]	2.7	46.8	0
PRESENT STUDY	3.9	48.1	18,1
LSCS RATE IN VARIOUS STUDIES			
Chitra et al [23]	9.29	16.1	21.5
Mittal et al [29]	3.08	11.11	10
Bhojwani et al [2]	28.3	34.3	20
Mustafa et al [30]	16.1	16.1	16.1

PRESENT STUDY	31.1	48.1	54.54
MECONIUM STAINED LIQUOR IN VARIOUS STUDIES			
Gupta et al [1]	29.1	63.6	20
Chitra et al [23]	17.11	26.49	31.57
Mustafa et al [30]	22.3	28.5	31.1
Bhojwani et al [2]	4.7	68.7	5
Milani et al [27]	1.9	7.7	0
PRESENT STUDY	11.2	11.1	54.5
CTG IN VARIOUS STUDIES			
Chitra et al [23]	14.9	29.05	30
Mustafa et al [30]	2.6	13.5	8.88
Mittal et al (52)	5.55	33.3	20
PRESENT STUDY	11.9	37	27.27
APGAR SCORE <7 IN VARIOUS STUDIES			
Gupta et al[1]	9.3	36.36	0
Chitra et al[23]	3.95	8.54	10
Mustafa et al[30]	5.12	6.45	5.55

Bhojwani et al[2]	10.8	31.2	15
PRESENT STUDY	5.9	18.5	27.27
NICU ADMISSIONS IN VARIOUS STUDIES			
Patil et al [25]	12,2	43.5	33.36
Mustafa et al[30]	2.69	5.35	7.89
Bhojwani et al[2]	8.1	28.12	5
Milani et al [27]	21.5	15.4	22
PRESENT STUDY	7.9	37	36.36

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