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Re-evaluation of umbilical cord coiling index in adverse pregnancy outcome – Does it have role in obstetric management?

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ABSTRACT

Introduction: The placenta with the umbilical cord is a vital link between the mother and fetus. Umbilical cord supplies water, nutrients and oxygen from the mother to the fetus. The most unique character of the umbilical cord is its coiling, where the contents of the cord course in a coiled helical fashion. The umbilical coiling index (UCI) can be measured antenatally using ultrasonography. In the present study we have attempted to assess the UCI antenatally by ultrasound screening and correlate abnormal antenatal UCI with the adverse maternal and neonatal outcome of pregnancy.

Aims: To study umbilical coiling index ultrasonographically and to correlate it with pregnancy outcome.

Methodology: 150 antenatal cases in the second trimester of pregnancy between 22 and 28weeks of gestation attending the outpatient department were included for the study in a continuous manner and subjected to antenatal UCI measurement. The cases were followed up till delivery and various factors were noted.

Results: We confirmed that maternal medical comorbidities (gestational hypertension and anemia) have a significant correlation with abnormal umbilical cord coiling index, either hyper-coiling or hypo-coiling or both. Some studies have shown a particular adverse effect being manifested in both hypo and hypercoiling. In the present study significant correlation of abnormal coiling has been found with only anaemia and hypertension in pregnancy. The question, therefore, arises:

"Does abnormal UCI have any significant role in prediction of adverse outcome in pregnancy or is it just a random association?" This study does not reflect any significant role of abnormal UCI in the prediction of adverse perinatal outcome. Hence efforts to monitor UCI in the antenatal period may not have any justification in the present scenario. The latest edition of William's Obstetrics also makes a similar comment. A population based larger study to generate cut offs for hypo and hyper coiling and finding any association between abnormal coiling and perinatal outcome may throw more light on the utility of UCI as a predictor of adverse outcome in pregnancy.

Introduction

The placenta with the umbilical cord is a vital link between the mother and fetus. Umbilical cord supplies water, nutrients and oxygen from the mother to the fetus. dIt has 3 blood vessels, two arteries and one vein that pass along the length of the cord in a coiled fashion. The umbilical cord is protected by Wharton's jelly, amniotic fluid and the helical pattern due to coiling of vessels [1].

The most unique character of the umbilical cord is its coiling, where the contents of the cord course in a coiled helical fashion. Various theories have been put forward to explain this coiling, like twisting as an inherent property of the cord itself or twisting due to fetal movements. A coil is defined as a complete 360^0 spiral course of umbilical vessels around the Wharton's jelly. The number of coils seen in first trimester is roughly the same as that seen at term [2].

The umbilical cord coiling was first quantified by Edmonds in 1954 who divided the total number of coils in the umbilical cord by the length of the cord in centimetres and called it "The Index of Twist". He assigned positive and negative scores to clockwise and anti-clockwise coiling respectively [3]. Strong et al. later simplified this by eliminating the directional scores and named it "The Umbilical Coiling Index"(UCI), [4] which is now used as the standard method to quantify the degree of

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umbilical vascular coiling.

The umbilical cord coiling index can be measured antenatally using ultrasonography and has been described by R Sharma et al.[5]This measurement is more precise during the late second trimester when the amount of amniotic fluid relative to fetal size is usually greater than at term, allowing visualization of a larger part of the cord. 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 along the ipsilateral side of umbilical cord is used to calculate antenatal UCI, the direction being from placental end to fetal end [6].

The present study was conducted to study umbilical cord coiling index in the second trimester of gestation and evaluate its association with outcome of pregnancy.

Methodology

This prospective observational cohort study was conducted at a tertiary care teaching hospital over a period of two years (2019–2021).150 antenatal cases in the second trimester of pregnancy between 22 and 28weeks of gestation with live singleton pregnancy attending the OPD were included for the study in a continuous manner. Women with twin gestation or an anomalous fetus were excluded.

The sample size was calculated by considering the number of patients showing coiling abnormalities like hypo-coiling or hyper-coiling. In a study conducted by YS Jo et al., [7] on association between second trimester UCI and perinatal outcome, the incidence of low birth weight was 36% in hypo-coiled groups and 10% in normo-coiled groups. Entering this data in WINPEPI software, at 5% level of significance and power of study 80%, the sample size was approximately 96. The third group of hyper- coiled was also included and the total sample size was approximated to 150.

A written informed consent was taken from all patients participating in the study. The screening procedure was explained to the patients before being recruited. Detailed history was taken from the participants including obstetric, past and family history. General and systemic examination including obstetric examination was carried out. Thereafter all cases between 22 and 28weeks of gestation were advised to undergo obstetric ultrasonography, which also included calculation of UCI. A dedicated sonologist, in consultation with the HOD of Radiology department, performed all the sonographies to nullify observer bias. After collecting the UCI for the 150 participants, cases whose UCI was lower than the 10th percentile were classified as hypo-coiled, those between 10th and 90th percentile were classed as normo-coiled, and cases higher than the 90th percentile were grouped as hyper-coiled cord [7].

Patients were asked to attend regular antenatal clinic and special attention was given to the development of adverse maternal and fetal complications like gestational hypertension, gestational diabetes mellitus (GDM), anemia, intrauterine growth restriction(IUGR), oligohydramnios, preterm labor. The cases were followed up till delivery. At delivery following factors were noted:

- Type of delivery: vaginal or caesarean
- Indication of caesarean section
- Birth weight
- APGAR score
- NICU admission

Measurement of umbilical cord coiling index

The coiling index was measured using 3.5 MHz transabdominal transducer. Longitudinal images of the umbilical cord were taken. That part of the cord which was freely floating in the amniotic fluid was focussed, and the coiling index calculated using the method suggested by R Sharma et al.[5] The distance between the coils was measured, along one side of the umbilical cord from inner edge of the arterial or venous wall to the outer edge of the next coil. The reciprocal of this distance in cm was the ultrasonological umbilical cord coiling index. (Fig. 1).

Data was entered in EXCEL sheet, tabulated, analysed using Epi7/ WinPepi. Qualitative data was summarized using proportions and Fisher's exact test was used for statistical significance.

Ethical committee clearance was obtained before commencement of the study.

Results

In our study, UCI below the 10th percentile (0.08) was seen in 8.67% of the cases which were considered as hypo-coiled cords, UCI above the 90th percentile (0.76) were hyper-coiled and was seen in 10% of cases and the remaining 81.33% showing UCI between 10th – 90th percentile were considered normo-coiling.The majority of the patients, that is, 122 out of 150 had a normal coiling index and the remaining 28 participants showed an abnormal coiling index.(Table 1).

47(31.3%) out of 150 patients developed some form of comorbidities like anemia, gestational diabetes mellitus, hypothyroidism and hypertension. 14(29.78%) cases out of the 47 were associated with an abnormal, hyper or hypo-coiling index. (Table 2). The association of UCI with maternal comorbidities was analysed. Out of the hyper-coiled patients, 40.0% developed gestational hypertension, followed by 6.7% showing GDM. Among the hypo-coiled patients, 30.8% had anaemia, 23.1% had hypothyroidism. The association of abnormal UCI with both anaemia and gestational hypertension was statistically significant. (Table 3).

43(28.67%) patients had some form of antepartum adverse effect in the form of antepartum haemorrhage (APH), intrauterine foetal death (IUFD), intrauterine growth restriction (IUGR)or oligohydramnios. 25.58% of them had either hypo-coiled or hyper coiled UCI. The association between abnormal UCI and antepartum adverse effects was not statistically significant. (Table 4). Out of 11cases of IUFD, 2 of them showed either form of abnormal coiling, one each of hyper and hypo-coiling. The association between UCI and IUFD was not statistically significant. (Table 5).

Analysing the 1-minuteAPGAR score at birth, a total of 33 babies showed a depressed score of < 7 out of which 4(12.12%) showed hyper-coiling and 5(15.15%) had hypo-coiling and the remaining 72.73% babies had normo-coiling.(Table 6) Of the 53 babies that required NICU admission after birth, 14 babies showed abnormal coiling index in the form of hyper-coiling or hypo-coiling that corresponded to 15.38% and 11.54% respectively.(Table 7) This association between the abnormal

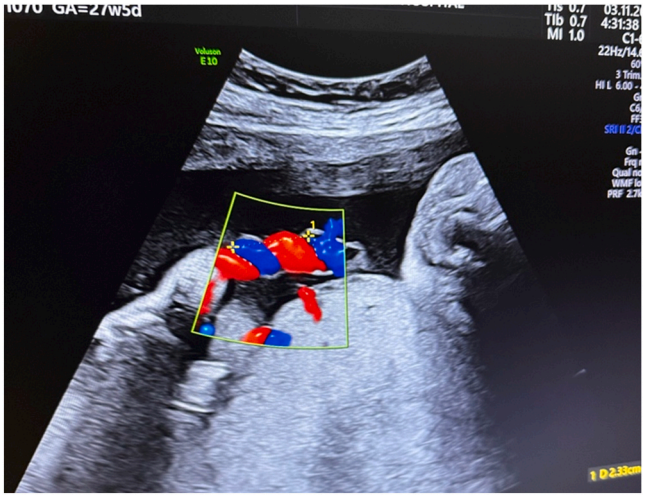

Fig. 1. Ultrasound measurement of UCI.

Table 1
Frequency distribution based on UCI.

TYPE OF COILING	Frequency	Percent	95% CI
Hyper coiling	15	10.00%	5.92–15.61
Hypo coiling	13	8.67%	4.91–14.01
Normo coiling	122	81.33%	74.50–86.97
Total	150	100.00%	

Table 2
Association between UCI and maternal comorbidity.

	All maternal comorbidity		
TYPE OF COILING	No	Yes	Total
Hyper	8	7	15
Row%	53.33%	46.67%	100.00%
Col%	7.77%	14.89%	10.00%
Hypo	6	7	13
Row%	46.15%	53.85%	100.00%
Col%	5.83%	14.89%	8.67%
Normo	89	33	122
Row%	72.95%	27.05%	100.00%
Col%	86.41%	70.21%	81.33%
TOTAL	103	47	150
Row%	68.67%	31.33%	100.00%
Col%	100.00%	100.00%	100.00%

Fisher's Exact: p value 0.057

Table 3
Association between various maternal comorbidities and UCI.

Comorbidity	Hypercoil (15)	Hypocoil (13)	Normocoil (122)	P value (Fisher's exact)
Anaemia	0	4(30.8%)	3(2.5%)	0.0017
GDM	1(6.7%)	0	11(9.02%)	0.84
Hypothyroidism	0	3(23.1%)	8(6.6%)	0.06
Hypertension	6(40%)	1(7.7%)	16(13.1%)	0.03

Table 4
Association between UCI and antepartum adverse effects.

	Antepartum adverse effect		
TYPE OF COILING	No	Yes	Total
Hyper	10	5	15
Row%	66.67%	33.33%	100.00%
Col%	9.35%	11.63%	10.00%
Hypo	7	6	13
Row%	53.85%	46.15%	100.00%
Col%	6.54%	13.95%	8.67%
Normo	90	32	122
Row%	73.77%	26.23%	100.00%
Col%	84.11%	74.42%	81.33%
TOTAL	107	43	150
Row%	71.33%	28.67%	100.00%
Col%	100.00%	100.00%	100.00%

Fisher's Exact: p value 0.28

coiling index and the neonatal outcome was not statistically significant.

Discussion

Since the time umbilical coiling was first quantified antenatally [5] by ultrasonological measurement of umbilical cord coiling index and post-delivery by physical examination of the placenta [8], various studies have been carried out to explore the significance of this coiling. Most of these studies, however, are based on postpartum physical examination. In the present study we have attempted antenatal ultrasonographic assessment of UCI and evaluate the association of abnormal

Table 5
Association between UCI and IUFD.

	IUFD		
TYPE OF COILING	No	Yes	Total
Hyper	14	1	15
Row%	93.33%	6.67%	100.00%
Col%	10.07%	9.09%	10.00%
Hypo	12	1	13
Row%	92.31%	7.69%	100.00%
Col%	8.63%	9.09%	8.67%
Normo	113	9	122
Row%	92.62%	7.38%	100.00%
Col%	81.29%	81.82%	81.33%
TOTAL	139	11	150
Row%	92.67%	7.33%	100.00%
Col%	100.00%	100.00%	100.00%

Fisher's Exact: p value 1

Table 6
Correlation between UCI and APGAR at 1 min of birth.

	LOW APGAR		
TYPE OF COILING	No	Yes	Total
Hyper	11	4	15
Row%	73.33%	26.67%	100.00%
Col%	9.40%	12.12%	10.00%
Hypo	8	5	13
Row%	61.54%	38.46%	100.00%
Col%	6.84%	15.15%	8.67%
Normo	98	24	122
Row%	80.33%	19.67%	100.00%
Col%	83.76%	72.73%	81.33%
TOTAL	117	33	150
Row%	78.00%	22.00%	100.00%
Col%	100.00%	100.00%	100.00%

Fisher's Exact: p value 0.21

Table 7
Correlation between UCI and NICU admissions.

	NICU Admission		
TYPE OF COILING	NO	Yes	Total
Hyper	7	8	15
Row%	46.67%	53.33%	100.00%
Col%	7.22%	15.38%	10.00%
Hypo	7	6	13
Row%	53.85%	46.15%	100.00%
Col%	7.22%	11.54%	8.67%
Normo	83	39	122
Row%	68.03%	32%	100.00%
Col%	85.57%	73.08%	81.33%
TOTAL	97	53	150
Row%	64.67%	34.67%	100.00%
Col%	100.00%	100.00%	100.00%

Fisher's Exact: p value 0.15

UCI with outcome of pregnancy.

The distribution of the total number of abnormal coiling, which was 18.67%, in this study of 150 cases, showed hypo-coiling in 8.67% and hyper-coiling in 10%; rest were normocoiled (81.33%). Study conducted on antenatal umbilical cord coiling and perinatal outcome by Ankita Mittal et al., demonstrated that out of the total 200 women 81% had normo-coiling, 8% had hypo-coiling and remaining 10% had hyper-coiling [9]. Takkellapati Aanandini et al., in their study on 207 participants had a result of 80% with normo-coiled cords,9.6% with hypo-coiled cords and 10% with hyper-coiled cords [10].

31.33% cases in this study had medical comorbidities. Out of these comorbidities, statistically significant association was found only in cases of anaemia with hypo-coiling (p value 0.0017) and hypertension

with hyper-coiling (p value 0.03). Hence our inference was that abnormal coiling index has a significant association with development of some maternal comorbidities, but cannot be extrapolated to all such cases. Comorbidities like gestational diabetes, which have multiple etiologic factors, may not have any consistent correlation like abnormal UCI. Out of the total 12 GDM cases in our study 11 cases showed normal coiling index and 1 case showed hyper-coiling. Singh et al., in their study found a strong association between cases with GDM and hyper-coiled cords [11]. There were a total 23 cases that developed gestational hypertension in our study and among these 9 had an abnormal UCI (6 hyper-coiled and 3 hypo-coiled). Hyper-coiling of the umbilical cord showed a statistically significant association with gestational hypertension. Lv Wen and Milani et al., also showed a significant association between gestational hypertension and abnormal UCI [12,13]. Tripathy et al., in their study stated that there was a significant relationship between gestational hypertension and hypo-coiling [14].

Of the 11 IUFDs in our study,2 had abnormal UCI (1 hyper-coiling and 1 hypo-coiling). Dutman Ac and Horn LC et al., in their study found umbilical cord hyper-coiling association with IUFD [15,16]. In the metanalysis conducted by Pergialiotis V et al., it was seen that both hyper-coiling and hypo-coiling of the cord is correlated with intrauterine fetal death [17].

We found 22% infants having a depressed APGAR score. Our study did not have any significant association between the low APGAR score and abnormal UCI. Bindu Sharma et al., showed a significant association between abnormal UCI and depressed APGAR score [18]. However similar association was not found by Aanandini et al.,[9]in their study.

35.3% newborns required NICU admissions and these did not have any statistically significant association with abnormal UCI. However significant correlation were observed in the studies of Pergialiotis V et al.[17]and Sharma et al. [18].

Conclusion

1. Articles on this topic have used different methods of measuring UCI. They are either antenatal ultrasound with colour Doppler or physical examination of the cord post-delivery.
2. The 10th and 90th percentile cut-offs for hypo and hyper-coiling are different in different studies depending on population studied [14, 18].
3. The adverse effects of abnormal coiling and also the association of a particular adverse event with the type of abnormal coiling is also different in different studies [13,14].
4. Some studies have shown a particular adverse effect being manifested in both hypo and hypercoiling [17,18].
5. In the present study significant correlation of abnormal coiling has been found with only anaemia and hypertension in pregnancy.
6. The question, therefore, arises:

   "Does abnormal UCI have any significant role in prediction of adverse outcome in pregnancy or is it just a random association?"

7. This study does not reflect any significant role of abnormal UCI in the prediction of adverse perinatal outcome. Hence efforts to monitor UCI in the antenatal period may not have any justification in the present scenario. The latest edition of William's Obstetrics also makes a similar comment [19].
8. A population based larger study to generate cut offs for hypo and hyper coiling and finding any association between abnormal coiling and perinatal outcome may throw more light on the utility of UCI as a predictor of adverse outcome in pregnancy.

Intellectual property

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

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Ethical statement

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

IRB approval was obtained (required for studies and series of 3 or more cases).

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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