UMBILICAL COILING INDEX AS A MARKER OF PERINATAL OUTCOME

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ABSTRACT

BACKGROUND
Umbilical cord is the lifeline of the foetus, which contains three vessels in a coiled fashion. Total number of coils divided by umbilical cord length centimetres is called Umbilical Coiling Index (UCI). Abnormal umbilical coiling index has been related to adverse perinatal outcome.

MATERIALS AND METHODS
Sample Size 600.
Singleton live cephalic deliveries after 37 weeks both vaginal and caesarean section were included. Immediately after delivery, umbilical cord is clamped at 5 cm from the foetal end and cut. Length of cord is measured. No. of coils measured as one complete 360° spiral course of vessels.

$$\text{Umbilical Coiling Index (UCI)} = \frac{\text{Total No. of Complete Vascular Coils}}{\text{Total Length of Cord in Centimeters}}$$

At the end, mean umbilical coiling index is calculated. Normocoiled group was having UCI values between 10th and 90th percentile, hypocoiled group was having <10th percentile and hypercoiled group was having UCI >90th percentile. Outcomes measured were maternal age, meconium-stained amniotic fluid, foetal growth restriction, 5 mins. APGAR scores, neonatal intensive care unit admissions and hypoglycaemia. Statistical analysis was performed using SPSS software and chi-square test. P value of <0.05 was regarded as statistically significant.

SETTINGS AND DESIGN- Descriptive study conducted from January 2014 to June 2014 in Dept. of Obstetrics and Gynaecology, Govt. Medical College, Kottayam.

RESULTS
The mean UCI is 0.23±0.11/cm. With a minimum of 0.02/cm and maximum of 0.6/cm. UCI of hypocoiled group was <0.08 and that of hypercoiled group was >0.3. Out of 600 subject, 485 (80.8%) had normocoiling, 58 (9.7%) had hypocoiling and 57 (9.5%) had hypercoiling. 23 (40%) subjects with hypocoiling had foetal growth restriction (P value <0.05 significant) 2 large for gestational age (4%) babies had hypercoiling (P value <0.05). In the hypocoiled group, 22 (38%) had meconium-stained amniotic fluid, which was significant. There was significant association between hypocoiling and low normal amniotic fluid index, oligohydramnios, low 5' APGAR scores and neonatal intensive care unit admission. 15 (26%) babies had hypoglycaemia in the hypocoiled group while only 7 (12%) in hypercoiled group had hypoglycaemia (P value <0.005).

KEYWORDS
(MeSH): Umbilical Cord, Foetal Growth Restriction, Oligohydramnios, Hypoglycaemia.

BACKGROUND
The umbilical cord is a physiological conduit between developing foetus and placenta providing nutrients and oxygen necessary for life in utero. It has two arteries and one vein, an outer amnion and Wharton's jelly.[1]

The umbilical cord develops from yolk sac and allantois. It forms by 5th week of development.[2] The umbilical cord in a full-term neonate is about 50 cm long and 2 cms. in diameter.[3] The integrity of umbilical cord vessels is maintained by two principal factors - spiral coiling and Wharton's jelly. It is the spiraling of vessels, which is thought to provide stability against buckling or compression.[4,5] The mechanism by which physiological coiling occurs still remain uncertain. It may be related to early foetal activity and haemodynamic factors.[6] In recent years, there has been increasing interest in cord coiling. The difference in coiling was described as an antenatal marker identifying foetus at risk.

However, majority of pregnancies with overcoiled or undercoiled umbilical cords have a normal outcome. The question arises as to whether there are simply associations with no clinical significance or whether the cord coiling pattern can lead directly to adverse pregnancy outcomes.[6]

Aim of Study
To determine association of umbilical coiling index measured postnatally with adverse perinatal outcome.

MATERIALS AND METHODS
The study included 600 patients attending labour room in Dept. of OBG, Govt. Medical College, Kottayam, from January 2014 to June 2014. Singleton live, cephalic deliveries after 37 weeks both vaginal or caesarean section were included. Immediately after delivery, the umbilical cord is clamped at the foetal end cut with scissors taking care not to milk the cord. Cord is cut 5 cm from foetal insertion. The rest of cord up to placental insertion is measured in centimetres and 5 cm is added to it. A coil is taken as one complete 360° spiral coarse of umbilical vessels. The number of coils of the entire core is counted and Umbilical Coiling Index (UCI) is calculated as follows.

$$\text{Umbilical Coiling Index} = \frac{\text{Total No. of Complete Vascular Coils}}{\text{Total Length of Cord in Centimeters}}$$

At the end of sample collection, mean UCI is calculated. On the basis of the latter, they are grouped as normocoiled group (UCI values between 10th and 90th percentile of mean), hypocoiled group (UCI values <10th percentile), hypercoiled group (>90th percentile). All foetuses included in the study was observed and followed up to measure outcome variables. Outcomes measured were maternal age and parity, meconium-stained amniotic fluid, foetal growth restriction, low 5' mins. APGAR scores, low normal amniotic fluid index and oligohydramnios, neonatal intensive care unit admissions and hypoglycaemia. Ethical committee clearance from Govt. Medical College, Kottayam, was obtained. Statistical analyses was performed using SPSS Software (version 10.0, SPSS, Inc. Chicago, IL). Statistical significance of values were analysed using chi-square test. P value of <0.05 was regarded as statistically significant.

RESULTS
The mean umbilical cord length in the present study including 600 subjects was 40.29±8.9 cm, minimum length being 20 cm and maximum 64 cm. Mean no. of coils were 8.85±3.78 with minimum number of coils being 1 and maximum being 21. The mean UCI in the present study is 0.23±0.11/cm with minimum of 0.02/cm and maximum of 0.6/cm (Table 1). The UCI of hypocoiled group that is lower than 10th percentile was <0.08. UCI of hypercoiled group that in more than 90th percentile was >0.3. Out of 600 subjects, 485 (80.8%) were having normocoiling, 58 (9.7%) were having hypocoiling and 57 (9.5%) were having hypercoiling (Table 2). In all age groups, majority were having normocoiling.

A decreasing trend of hypocoiling and hypercoiling was observed with advancing age (Table 2). Similarly, it was observed that both hypo and hypercoiling decreases as parity advances (Table 3). Meconium-Stained Amniotic Fluid (MSAF) was observed in 22 patients (38%) of hypocoiled group, which was found to be statistically significant. Meconium-stained amniotic fluid was observed to be decreasing with increasing UCI (Tables 4). 31% of hypocoiled group and 33% of hypercoiled group had low normal Amniotic Fluid Index (AFI). In both hypocoiled and hypercoiled group, there was significant association between low normal AFI and oligohydramnios (Table 5). None of the patients in this group had high normal AFI. Hence, a decreasing trend of oligohydramnios was observed with increasing UCI. 40% of subjects in the hypocoiling group had Foetal Growth Restriction (FGR), while only 5% of hypercoiling group had FGR. This association was found to be statistically significant (P value<0.05) Hypercoiling and LGA (Large for gestational age) also had significant association (Table 6).

Out of 58 subjects in hypocoiled group 26 (45%) had low APGAR scores, which was found to be statistically significant (P value <0.05). None of the babies in hypercoiled group had low APGAR scores (Table 7). So, also there was significant association between NICU admission and hypocoiling. 72% of babies in the hypocoiled group required NICU admission (Table 8). 15 out of 58 babies (26%) in the hypocoiled group had hypoglycaemia in the immediate neonatal period, which was found to be significant only 3% of babies in normocoiled group had hypoglycaemia (Table 9).

	N	Mean	SD	Minimum	Maximum
Umbilical Cord Length	600	40.295	8.9833	20.0	64.0
No. of Coils	600	8.850	3.7822	1.0	21.0
UCI	600	0.2300	0.1186	0.02	0.60

Table 1: Mean and Standard Deviation of Umbilical Cord Length, No. of Coils and Umbilical Coiling Index (UCI)

UCI		Age			Total
		<=19 Yrs.	20 to 35 Yrs.	>35 Yrs.	
Hypocoiled	N	7	46	5	
	%	11.3%	9.7%	8.1%	9.7%
Normocoiled	N	40	388	57	485
	%	64.5%	81.5%	91.9%	80.8%
Hypercoiled	N	15	42	0	57
	%	24.2%	8.8%	0.0%	9.5%
Total		62	476	62	600

Table 2: Frequency Distribution of Age and UCI

UCI		Parity			Total
		Nulliparous	Primi	Multiparous	
Hypocoiled	N	7	30	21	58
	%	15.6%	9.5%	8.8%	9.7%
Normocoiled	N	28	255	202	485
	%	62.2%	80.7%	84.5%	80.8%
Hypercoiled	N	10	31	16	57
	%	22.2%	9.8%	6.7%	9.5%
Total	N	45	316	239	600

Table 3: Frequency Distribution of Parity and UCI

UCI	MSAF		Total	X^2	P value
	No	Yes			
Hypocoiled	36 (62%)	22 (38%)	58 (100%)		
Normocoiled	407 (84%)	78 (16%)	485 (100%)	25.7	P>0.05
Hypercoiled	55 (96%)	2 (4%)	57 (100%)		
Total	498	102	600		

Table 4: UCI and MSAF (Meconium-Stained Amniotic Fluid)

UCI	AFI				Total	X^2	P value
	Normal	Low normal	Oligohydramnios	High normal			
Hypocoiled	34 (59%)	18 (31%)	6 (10%)	0	58 (100%)		
Normocoiled	407 (84%)	44 (9%)	21 (4%)	13 (3%)	485 (100%)	52.4	P<0.05
Hypercoiled	38 (67%)	19 (33%)	0	0	57 (100%)		
Total	479	81	27	13	600		

Table 5: UCI and AFI (Amniotic Fluid Index)

UCI	Birth Weight			Total	X^2	P value
	Normal	FGR	LGA			
Hypocoiled	35 (60%)	23 (40%)	0	58 (100%)		
Normocoiled	396 (82%)	85 (17.5%)	4 (0.5%)	485 (100%)	27.8	P<0.05
Hypercoiled	52 (91%)	3 (5%)	2 (4%)	57 (100%)		
Total	483	111	6	600		

Table 6: UCI and Birth Weight

UCI	5'APGAR			X^2	P value
	Normal	Low	Total		
Hypocoiled	32 (55%)	26 (45%)	58 (100%)	56.7	P<0.05
Normocoiled	427 (88%)	58 (12%)	485 (100%)		
Hypercoiled	57 (100%)	0	57 (100%)		
Total	**516**	**84**	**600**		

Table 7: UCI and 5 mins. APGAR Score

UCI	NICU Admission		Total	X^2	P value
	No	Yes			
Hypocoiled	16 (28%)	42 (72%)	58 (100%)	61.7	P<0.05
Normocoiled	357 (74%)	128 (26%)	485 (100%)		
Hypercoiled	50 (88%)	7 (12%)	57 (100%)		
Total	**423**	**177**	**600**		

Table 8: UCI and NICU Admission

UCI	Hypoglycaemia		Total	X2	P value
	No	Yes			
Hypocoiled	43 (74%)	15 (26%)	58 (100%)	50.5	P<0.05
Normocoiled	470 (97%)	15 (3%)	485 (100%)		
Hypercoiled	50 (88%)	7 (12%)	57 (100%)		
Total	**563**	**37**	**600**		

Table 9: UCI and Hypoglycaemia

DISCUSSION

The current study was conducted to find out the relationship between Umbilical Coiling Index (UCI) and various perinatal factors in normal and complicated pregnancies. We observed that 10th and 90th percentiles for UCI (<0.08 and >0.3) was in agreement with previous studies done by Chitra et al[7] (10th and 90th percentile <0.09 and >0.36) Gupta et al[8] (10th and 90th percentile <0.1 and >0.3) and Kashanian et al[9] (10th and 90th percentile <0.08 and >0.4). The mean UCI in our study was 0.23±0.11, which was similar in study by Chitra et al[7] in 2012. In present study, low normal AFI and oligohydramnios had significant association with both hypo and hypercoiling of umbilical cord. This can be explained by Edmond's hypothesis[10] that twists of umbilical cord is a result of rotary movement imparted by embryo, hence less liquor, less amount of coiling. Meconium staining has significant association with hypocoiling.

Mechanism could be undercoiled cords are more susceptible to acute kinking and therefore marked cessation of blood flow. The flow dynamic studies suggest that flow though coiled tube is associated with greater resistance to flow than straight tube. Foetal growth restriction and low Apgar scores were found to be significantly associated with hypocoiled group in our study, which was shown in earlier studies too (Strong et al[11] and Machin et al[4]). This disagreed with other studies who found a consistent association with FGR and hypercoiling (Rana et al).[12] Significant association of hypocoiling and neonatal intensive care unit admission could be due to low 5' Apgar Scores, meconium-stained amniotic fluid and foetal growth restriction.

The helical course of umbilical vessels is established by 9 weeks. Reynolds et al[13] postulated that the umbilical cord is a pistonless pulsometer pumping system acting as a cardiac assist pump to sustain venous return from placenta. The foetal blood is pumped through the umbilical vein by slight, but definite variations in venous pressure, which is generated from the force of arterial pressure pulse. Hence, the presence of vascular coils plays a central role in determining the blood flow from the placenta to the foetus. This mechanism is of utmost importance when placental resistance is particularly elevated. Therefore, a reduced number of coils could be responsible for reduced umbilical flow, which in turn leads to foetal growth impairment.

Umbilical coiling index can also be measured antenatally. The sonographic assessment of coiling pattern is performed in different umbilical cord segments in order to exclude segmental anomalies like false knots. Colour flow mapping could be used to enhance the definition of umbilical cord architecture. The length of one complete umbilical vascular coil (Distance between the right outer surface of consecutive arterial coils) is measured in a longitudinal midsection of umbilical cord and a mean of three measurements is used for analysis. The normal umbilical coiling index in various studies was 0.4 when measured by antenatal ultrasonography and 0.2 when measured postnatally by examination of delivered placenta. This discrepancy could be due to the fact that umbilical vessels are distended with blood antenatally and this mechanical distension will result in tighter apparent coiling of helical vessels.[(14,15)]

Mladen et al[16] assessed umbilical coiling index antenatally in second trimester with ultrasonography. On follow up, they found that abnormal umbilical coiling index was associated with higher rate of preterm labour, low birth weight babies and neonatal intensive care unit admissions.

CONCLUSION

Abnormal umbilical coiling index is associated with adverse perinatal outcome such as foetal growth restriction, meconium stained amniotic fluid, oligohydramnios, low APGAR scores, hypoglycemia and NICU admissions. Alterations in morphology and ultrastructure of umbilical cord components can hence affect fetoplacental dynamics leading to adverse perinatal outcome.

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