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ORIGINAL ARTICLE

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Umbilical coiling index

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OBJECTIVE(S) : To find out whether abnormal umbilical coiling index (UCI) is related to adverse antenatal and perinatal outcomes.

METHOD(S) : One hundred of seven umbilical cords were examined. A coil was defined as a complete 360 degree spiral course of umbilical vessels around the Wharton's jelly. UCI was calculated by dividing the total number of coils by the umbilical cord length in centimeters. The outcomes measured were gestational age, intrauterine growth retardation, meconium staining, birth weight, apgar score, ponderal index, and pregnancy induced hypertension. Hypocoiled cords were those having UCI less than 10th centile, and hypercoiled cords those having UCI more than 90th centile. Statistical analysis was done by chi square test, Fishers exact test and the t test where applicable.

RESULTS : The mean UCI was 0.13±0.08. No coiling was seen in 6 (5.6%) cases. Anticlockwise coiling was significantly more frequent (t 3.02, P < 0.01) than clockwise coiling. In hypocoiled group low apgar score, meconium staining, and pregnancy induced hypertension were all significantly higher than in those with normal coiled group. Babies with apgar < 7 had significantly lower UCI than babies with apgar ≥ 7 (t 2.13, P < 0.05). No statistical significance was seen between the hypercoiled and normal coiled group

CONCLUSION(S) : Low UCI was associated with adverse antenatal and perinatal complications.

Key words: hypocoiling umbilical cord, hypercoiling umbilical cord, sonography, umbilical coiling index

Introduction

The umbilical cord is the life line of fetus as it supplies water, nutrients and oxygen. Its three blood vessels pass along the length of the cord in a coiled fashion. This coiling property of cord vessels was described as early as in 1521 by Berengarius. In 1954, umbilical coiling was first quantified by Edmonds [1] who divided the total number of coils by the umbilical cord length in centimeters and called it "The Index of Twist". He assigned positive and negative scores to clockwise and anticlockwise coiling, respectively. Later, Strong et al [2] simplified by eliminating these directional scores and named it "The Umbilical Coiling Index". An abnormal umbilical coiling index (UCI) has been reported to be related to adverse fetal outcomes [3-6]. Enough data on UCI and its relationship with perinatal outcome are not available in India. This study was undertaken to find out the UCI in Indian babies and its relationship with antepartum and intrapartum outcomes.

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Method

All singleton live babies with ≥ 28 weeks gestation born in clean labor room between 8 am and 4 pm over six working days and attended by a single observer, were included in the study. One hundred and seven cords were examined. After separating the baby from the umbilical cord, the cord was tied and cut as close to the placenta as possible. The umbilical cord was measured in its entirety, including the length of the placental end of the cord and the umbilical stump on the baby. The number of complete coils or spirals were counted from the neonatal end towards the placental end of the cord and expressed per centimeter. A coil was defined as a complete 360 degree spiral course of the umbilical vessels around the Wharton's jelly. Depending upon the direction of the course of vessels, umbilical cords were referred as clockwise,

anticlockwise, or straight. Perinatal factors studied were gestational age, intrauterine growth retardation (IUGR), meconium staining, birth weight, apgar score, ponderal index, and pregnancy induced hypertension (PIH). IUGR was assessed by standard curves [7]. Gestational age was calculated by the first day of last menstrual period or by new Ballard scores [8]. If there was more than two weeks discrepancy, new Ballard score was relied upon. Meconium staining included the presence of any concentration of the meconium noticed. An apgar score of less than seven at first minute was considered low. Premature delivery was considered to be a one at less than 37 completed weeks. Ponderal index was calculated using the formula: birth weight in grams/(length in centimeters) ^{3} × 100.

The centile values for UCI were calculated. We defined hypocoiled cords as those with UCI less than 10th percentile and hypercoiled cords as those with UCI more than 90th percentile. Data were analyzed using chi square test, Fisher's exact test, and the t-test where applicable. Statistical significance was defined as $P \leq 0.05$ for all analyses.

Results

We evaluated 107 cords at birth, out of these 49(45.8%) were of female and 58(54.2%) of male babies. The mean umbilical cord length was 44.3±9.2 cm. The mean number of coils was 5.8±3.8. No umbilical cord coiling was seen in 6 (5.6%) cases. All umbilical cords had three blood vessels. The mean UCI was 0.13±0.08 (Figure 1). Anticlockwise coils were seen in 82 (76.6%) cases while clockwise coils were seen in 19 (17.8%) cases, giving a ratio of 4.3:1.

Anticlockwise coiling was significantly more common (t 3.02, P<0.01). When we compared the hypocoiled group (n=11) with the normocoiled group (n=86), low apgar score, PIH in mother and meconium staining were all significantly higher (P <0.05) in the former (Table 1). There was no statistically significant difference between the hypercoiled group (n=10) and the normocoiled group in any of the parameter studied (Table 1). Also no statistically significant difference was seen between the hypocoiled group and the normocoiled group when gestation period, IUGR, birth weight, and ponderal index were considered. The 12 (11.2%) babies with low apgar score of < 7 had the mean UCI of 0.08±0.05 compared to 0.14 in 95 babies with apgar ≥ 7 (t 2.13, P < 0.05) (Table 2).

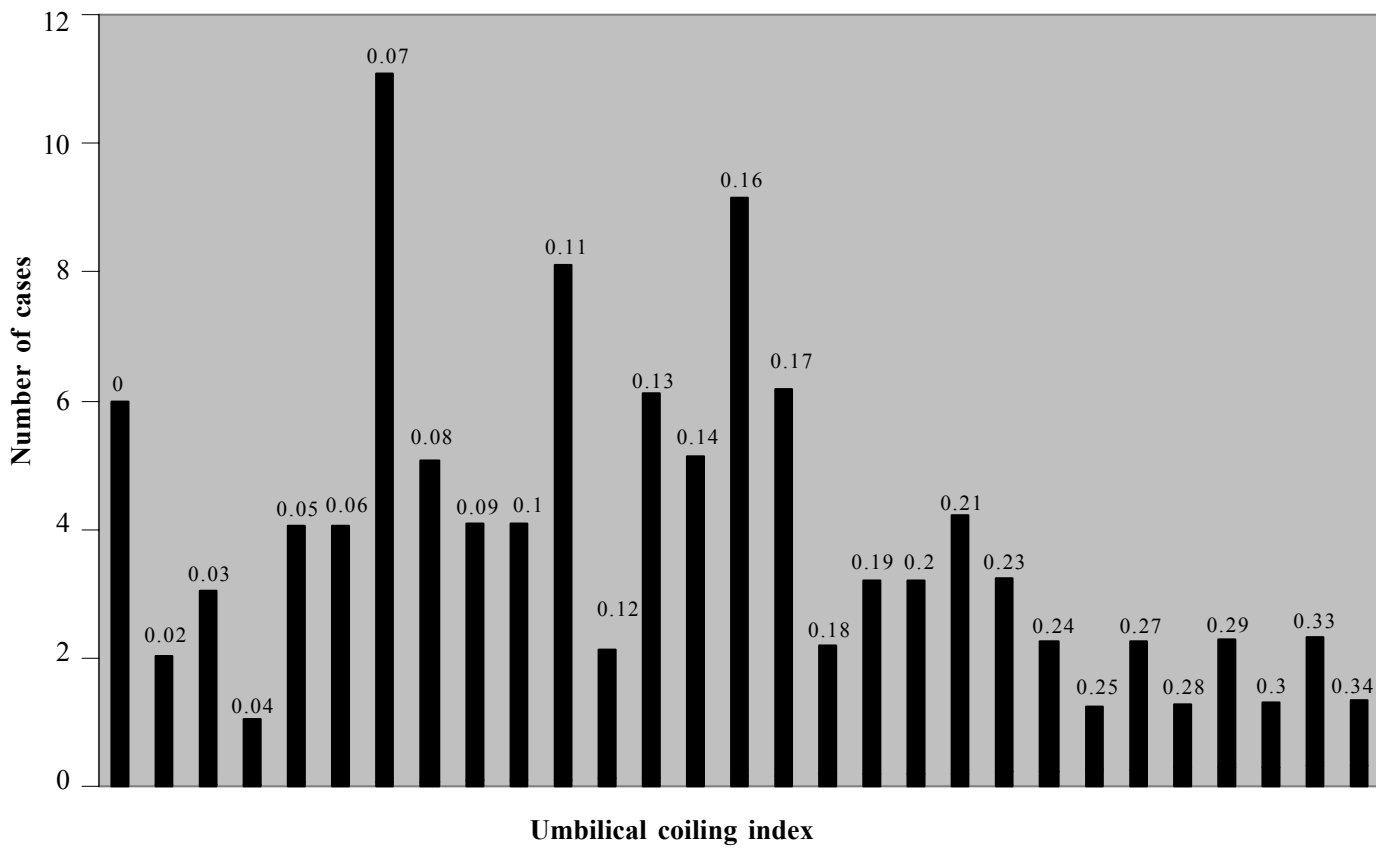

Figure 1. Frequency distribution of umbilical coiling index.

Table 1. Umbilical coiling index and neonatal / perinatal outcome.

Outcome	Hypocoiled (n=11)	Normocoiled (n=86)	P[a]	Hypercoiled (n =10)
Pregnancy induced hypertension	4 (36.36%)	8 (9.3%)	<0.05	1 (10%)
Apgar < 7	4 (36.36%)	8 (9.3%)	<0.05	0 (0%)
Meconium present	7 (63.6%)	25 (29.1%)	<0.05	2 (20%)
Birth weight < 2500g	4 (36.36%)	21 (24.4%)	NS	3 (30%)
Intrauterine growth retardation	3 (27.3%)	14 (16.3%)	NS	3 (30%)
Gestational age <37weeks	2 (18.2%)	16 (18.6%)	NS	1 (10%)
Ponderal index (<2.5)	4 (36.36%)	39 (45.3%)	NS	3 (30%)

[a] - comparison between hypocoiled and normocoiled group.
There were no statistically significant differences between normocoiled and hypercoiled group.

Table 2. Mean umbilical coiling index and perinatal factors.

Perinatal factors	Number	Mean umbilical coiling index ± SD	t-value	P
Gestation age				
< 37wks	19	0.13±0.07	0.38	NS
≥ 37 wks	88	0.13±0.08		
Sex				
Female	49	0.13±0.09	0.51	NS
Male	58	0.14±0.08		
Direction				
Anticlockwise.	82	0.14±0.08	3.02	<0.01
Clockwise	19	0.09±0.08		
Pregnancy induced hypertention				
Absent	94	0.14±0.08	1.64	NS
Present	13	0.10±0.09		
Apgar				
< 7	12	0.08±0.08	2.13	<0.05
≥7	95	0.14±0.08		
Intrauterine growth retardation				
Absent	87	0.13±0.08	0.39	NS
Present	20	0.14±0.10		

NS – Not significant

Discussion

The umbilical cord and its vital blood vessels are the most vulnerable part of the fetal anatomy. The total number of coils for any particular cord is believed to be established early in the gestation [9, 10]. The pattern of coiling develops during the second and third trimesters, presumably due to snarls in the cord, and this coiling changes as the pregnancy advances. Despite the belief that umbilical vascular coiling occurs early in gestation, it is not yet known whether this coiling is a genetic or acquired event. Several theories have been proposed to explain the umbilical cord twist including those that interpret the twist as inherent to the cord itself, and those that explain the twist as a result of active or passive rotation of the fetus [1]. Regardless of its origin, umbilical coiling appears to confer turgor to the umbilical unit, producing a cord that is strong but flexible [11].

In consideration of the abnormal versus normal coiling distribution in our study, we observed that 10th and 90th percentiles for UCI were in agreement with the previous studies [5,6, 11-13]. The mean UCI in our study was lower

(0.13±0.08) as compared to 0.20 ± 0.1 reported by Ercal et al [5], 0.21 ± 0.07 by Strong et al [2], and 0.19 ± 0.1 by Rana et al [6]. A recent metaanalysis showed the normal coiling index to be 0.17 ± 0.009 completed spirals per centimeter [13]. We were not able to ascertain as to why our mean UCI was lower than that of the other workers. However, a difference in the antenatal UCI and UCI at birth has been reported [14]. This could be explained by a sonographic error in the sampling of different umbilical cord segments with discordant coiling pattern or by the possibility of a dynamically evolving UCI with advancing gestational age [14]. It has also been seen that coiling density is not similar in all segments of umbilical cord. Increased coiling was found at the fetal end compared with the placental and middle segments [15]. We did not find such variation. The direction of UCI is predominantly found anticlockwise by all the workers [1-3, 11]. The direction of anticlockwise and clockwise umbilical coiling in the present study was in the ratio of 4.3:1. However, Lacro et al [3] showed a ratio of 8:1 between anticlockwise and clockwise coiling. We also found significant difference in the mean UCI between anticlockwise and clockwise coiling. The reason for this finding remains unexplained. However, the predominance of anticlockwise twists is the result of more forceful paddling with the right arm of a fetus who has already established handedness [3], or the cord twist is the result of either active or passive rotation of the fetus [1]. The incidence of cords without any coil was 5.6% in our study, which is in agreement with the findings of Lacro et al [3] (5%) and Rana et al [6] (4.9%).

Our study highlights that lower UCI in newborns is associated with PIH in mother, meconium staining, and low apgar score. The vessels of the cord like all hollow cylinders are prone to torsion, compression, tension, and subsequent interruption of the blood flow. This risk is minimiszed by their helical disposition. The coiled umbilical cord, perhaps 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 semierectile organ that is more resistant to snarling torsion, stretch, and compression than noncoiled one. This is referred to as "spontaneous internal ballottement" and likened to the action of a concertina [10]. Workers found higher incidence of operative intervention for fetal distress [8,11], preterm delivery, growth retardation, oligohydramnios, operative delivery and meconium staining [2], fetal heart rate distrubances [8], and low cord pH [5] among fetuses with hypocoiled cords. These findings are in agreement with the present study. A recently published study showed no statistical difference for apgar score at 1 and at 5 minutes, higher prevalence of interventional deliveries, and the meconium stained amniotic fluid in labor between the groups with normal and abnormal coiling [12]. Notwithstanding these observations, the metaanalysis pointed out the fact that hypocoiling is associated with increased incidence of fetal demise, intrapartum fetal heart rate decelerations, operative delivery, fetal distress, and chorio-amnionitis [13]. We did not find any significant relationship between UCI and ponderal index, birth weight, gestation, fetal sex, and IUGR. This is in contrast to the study by Rana et al [6], who noted that premature delivery and low birth weight were associated with hypercoiled cords.

The findings of the present study point out that low UCI is an indicator of perinatal complications. Antenatal detection of this abnormal coiling index by ultrasound can lead to identification of fetus at risk. The sensitivity values of antenatal sonography to predict hypocoiling and hypercoiling were 78.9% and 25.4%, respectively [14]. Thus while UCI can be measured easily and reliably in the second trimester, these estimates do not accurately reflect the UCI at term [16]. Clearly, quantitating the degree of umbilical vascular coiling cannot be of significant use unless the technic can be applied to the antepartum period. Therefore, more prospective studies are required to have detailed information on the role and mechanism of umbilical coiling and its impact on the newborn.

Conclusion

Low umbilical coiling index is an indicator of adverse perinatal outcome. It is associated with low apgar score, meconium staining, and pregnancy induced hypertension. Therefore, antenatal detection of coiling index can identify fetus at risk.

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