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Umbilical Coiling Index and Perinatal Outcome

Priyanka Gaikwad[1*] and Kiran Patole[2]

[1]PG Resident, Department of Obstetrics and Gynaecology Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik 422003, India; gaikwadp24@gmail.com
[2]Professor & Head, Department of Obstetrics and Gynaecology Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik 422003, India

Abstract

Objective(s): To study the association of umbilical coiling index and perinatal outcome. **Method(s):** One hundred and eighty five umbilical cords were examined. A coil is 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 in terms of IUGR, fetal heart rate abnormalities during labor, meconium stained amniotic fluid, number of assisted deliveries was required, NICU admission, FSB, birth weight, ponderal index, various maternal medical illnesses. Hypocoiling was considered with UCI less than the 10th percentile and hypercoiling was considered UCI greater than the 90th percentile. Statistical analysis was done by Chi-square test, Fischer's exact test and the t-test where ever applicable. **Results:** The mean UCI in our study was found to be 0.19 + 0.08. 82.7% of the cords were normocoiled whereas 8.6% cords were hypocoiled as well as hypercoiled each. UCI below 0.09 was hypocoiling and above 0.26 was hypercoiling. In this study we found that PIH, IUGR, intrapartum FHR abnormalities, MSAF, increased instrumental deliveries, low APGAR scores, NICU admission, low birth weight and ponderal index were significantly associated with hypocoiling (P<0.05). IUGR and NICU admission were significantly associated with hypercoiling too (P<0.05). **Conclusion:** Our study thus shows that abnormal umbilical coiling index is associated with adverse perinatal outcome.

Keywords: Umbilical Coiling Index (UCI), Perinatal Outcome

1. Introduction

The umbilical cord is the lifeline of fetus which supplies water, nutrients and oxygen. Its three blood vessels pass along the entire length of the cord in a coiled manner. Edmonds was the first to describe the quantification of the coiling of the cord[1]. He called it the 'index of the twist', which was the ratio or the number or twists to the length of the cord, giving positive and negative values to the twists when the direction of the twists turns from left to right, when sinistral turns counter balance dextralturns. Strong TH was the first to simplify this method[2]. He developed the "umbilical coiling index", which is the ratio of the twists to the length of the cord irrespective of the direction of the coils. An abnormal coiling index has been reported to be related to adverse fetal outcomes[3,4]. However at present enough data on UCI and its relationship with perinatal outcome is not available in India. This study is an attempt to find out the umbilical coiling index in Indian babies and the perinatal outcome.

2. Method

All fullterm singleton pregnant women in labor were included in the study. Mode of delivery could be vaginal or assisted vaginal. Those cases were excluded which had documented evidence of fetal anomalies/malpositions/ malpresentations, intra uterine fetal deaths, women not willing to give written informed consents, any pre diagnosed umbilical false or true knots, and those delivered by Ceasarean section. Placentae were delivered by controlled cordtraction following evidence of signs of placental separation. Placentae were carefully examined for completeness and for any abnormality. Length of the placental portion of umbilical cord was measured starting from placental end upto the cut end. Length of fetal portion of the umbilical cord was measured from the cut end upto the umbilicus of the baby. Total cord length was obtained by adding fetal portion length and placental portion length. Umbilical coiling pattern and number of complete coils were noted. The number of complete coils

*Author for Correspondence

or spirals were counted from the neonatal end towards the placental end of the cord and expressed percentimeter.A coilis defined as a complete 360 degree spiral courseof umbilical vessels around the Wharton's Jelly.

Umbilical Coiling Index (UCI) was calculated by dividing the total number of coils by the umbilical cord length in centimeters.

One hundred and eighty five umbilical cords were examined immediately after delivery by a single observer.

Perinatal outcome was assessed by presence of non-assuring fetal status in labour by NST, meconium staining of the amniotic fluid at the time of labour, mode of delivery, APGAR score at birth, 1 and 5 mins, birth weight, requirement of NICU admission, fresh still birth and ponderalindex. CTG was interpreted using the NICE (National Institute of Clinical Excellence 2014) guidelines of Electronic fetal heart rate monitoring and grouped into normal and abnormal CTG. The fetus was considered to have fetal distress when there was presence of meconium stained amniotic fluid (moderate/thick) and/oran abnormal CTG, or a low APGAR score at birth and 5 min.

Ponderal index was calculated by the formula: Ponderal index = [(Birth weight in grams)/(Crown heel Length in cm)^3] x 100

The centile values for UCI were calculated. Hypocoiling was considered with UCI less than the 10th percentile and hypercoiling was considered UCI greater than the 90th percentile. Statistical analysis was done by Chi-square test, Fischer's exact test and the t-test where applicable.

3. Results

We evaluated 185 cords at birth. The mean umbilical cord length was found to be 55.05 cm. Most (55.8%) of the cases did not have any risk factors. But among those with risk factors, the most common risk factor was anaemia found in 30 (15.1%) cases, pregnancy induced hypertension found in 23 (11.6%) cases followed by oligohydramnios in 9 (4.5%) and so on. 95.7% of the umbilical cords had a sinistral or left handed coiling, only 2.7% had dextral or right handed coiling and 1.6% had a mixed type of coiling.

The maximum number of coils was 33 and the minimum number was 0 found in 3 cords. The mean umbilical coiling index was 0.19, which was the 50th percentile. Hypocoiling was considered with UCI less than the 10th percentile (0.09) and hypercoiling was considered UCI greater than the 90th percentile (0.26). In this study we found that PIH, IUGR, intrapartum FHR abnormalities, MSAF, increased instrumental deliveries, low APGAR scores, NICU admission, low birth weight and ponderal index were significantly associated with hypocoiling. (P<0.05) (Table 1 and 2).

IUGR and NICU admission were significantly associated with hypercoiling too. (P<0.05).

Gravidity, Maternal Anaemia did not show significant associations with UCI.

4. Discussion

The umbilical cord and its vital blood vessels are one of the most vulnerable parts of the fetal anatomy and one of its distinctive features is its coiling pattern. The total number of coils for any particular cord is believed to be established early in pregnancy, and several studies have been done for explaining the twisting of the umbilical cord, including those that explain it as a result of active and passive rotation of the fetus. The role of this coiling is not clear but it is believed to be playing a role of protecting the umbilical cord from external forces such as tension, pressure, stretching or entanglement[5].

The mean UCI in our study was found to be 0.19 $\pm$ 0.08 which was similar to the mean found in various other studies, where it was found to be between 0.14 and 0.22[6–10].

In our study, 31.3% of hypocoiled cords were associated with PIH, compared to only 11.8% of normocoiled cords being associated with PIH, giving a significant p value of 0.046. In study done by Gupta S et al[6], 36.36 % of the hypocoiled cords were associated with PIH while only 9.3% of the normocoiled cords were associated with PIH, again giving a significant p value of <0.05.Similarly, 45.5% of hypocoiled cords in the study done by Tripathy S. were associated with PIH and only 17.3% of normocoiled cords were associated with PIH[8]. A significant p value of <0.05 was obtained.Similar significant results were obtained with the study done by Chitra T et al[7]. Our study did not show a significant association between hypercoiling and PIH (p = 0.22). But significant associations have been found in study done by Tripathy S et al, in which 50% of the hypercoiled cords were associated with PIH compared to only 17.3% of normocoiled cords[8]. Studies done by Gupta S et al and Chitra T et al also could not obtain significant results.

Our study showed a significant association between hypocoiling and IUGR. 68.75% of the babies with hypocoiled cords had IUGR compared to only 7.8% babies of normocoiled cords with IUGR. These results differed from those studies done by Gupta S et al and Agarwal S et al where both obtained non significant p values[6, 9].

Umbilical cord coiling prevents compression of the umbilical vessels, thus hypocoiling in the long run predisposes to decreased fetoplacental circulation thus resulting in intrauterine growth restriction.Significant results were obtained with hypercoiling and IUGR in concordance with study done by Agarwal S et al. 25% of the babies with hypercoiled cords had IUGR as compared to only 7.8% of normocoiled babies[9]. In the study done by Agarwal S et al, 80.8% of the babies with hypercoiled cords had IUGR compared to only 3.3% of the babies with normocoiled cords[9]. Hypercoiling by predisposing to increased kinking and torsion of the cord interferes with the fetoplacental circulation.

Fetal heart rate variations were found to be significantly associated with hypocoiling in our study. 37.5% of the babies with hypocoiled cords had an abnormal heart rate during labor. The p value in this instance was <0.001. In the study done by Chitra T et al, 18.8% of the babies with fetal distress in the form of intrapartum FHR abnormalities were hypocoiled whereas only 10.1% of the babies with normal intrapartum FHS were hypocoiled. Similar significant results were obtained by Rana J, Ebert GA, Kappy KA and our study[7,3]. Tripathy S. differed in having non significant p values when comparing hypocoiling and FHR abnormalities[8]. In our study, no significant association was seen between hypercoiling and intrapartumfetal distress, but this finding was not in concordance with other studies. Tripathy S et al also obtained non significant p values when comparing hypercoiling and FHR abnormalities[8].

In our study a significant association was found between meconium staining and hypocoiling., similar to that found in various other studies such as those done by Gupta S, Faridi MMA, Krishna J, Agarwal S, Purohit R &Jain G. 43.8% of the hypocoiled cords had meconium staining whereas only 14.4% of the normocoiled cords were associated with meconium staining of the amniotic fluid[6,9]. Hypercoiling was compared with normocoiling, the p value obtained was 0.7, not significant, in our study. These results were in concordance with other studies[6,8,9]. But Chitra s et al obtained significant p values when comparing hypercoiling with MSAF[7].

Significantly more number of assisted deliveries (vacuum or forceps) were observed in the hypocoiled group as compared to the normocoiled group in our study (18.8% v/s 2.6%). Many authors have found a positive association between operative deliveries, especially for fetal distress and abnormal UCI[2,3]. Hypercoiling was not seen to be significantly associated with increased instrumental deliveries in any of the studies we compared with or our study (p = 0.4), which was in concordance with other studies.

In our study, the APGAR scores were low in the hypocoiled group at birth, 1 and 5 minutes. Similar results were seen in many studies[6–9]. Hypercoiled group did not show any association with low APGAR scores in our study which was opposite to those results obtained in the study done by Chitra T et al. But in Gupta s et al as well as in Tripathy S et al also did not obtain significant p values when comparing hypercoiling with APGAR scores[6, 8].

In our study, low birth weight was seen to be associated with hypocoiling with a significant p value of <0.01 in concordance with Chitra T et al. Where as opposite results were obtained in studies done by various authors[6,8,9]. Hypercoiling did not show significant association with low birth weight as seen in studies.

Another way of explaining adverse perinatal outcome in the form of NICU admission associated with abnormal UCI is by proving that there may be a window of optimal coiling. According to Reynolds, umbilical coiling contributes to the venous return of the fetus. The pulse pressure of the two umbilical arteries in the coiled cords generates a pumping mechanism with the umbilical vein which enhances the venous blood flow. Hence, more coiling leads to increased venous flow[11]. In our study, hypocoiling was significantly associated with NICU admission with a significant p value of 0.01. Similar result was obtained in the study done by Agarwal S et al[9]. Devaru D et al obtained no association of hypocoiling with NICU admissions[12]. On the other hand, when hypercoiling occurs, there is compression of the vein and increased turbulence in the arteries which as a result decreases both arterial and venous flow[10,13]. Increased NICU admission was also seen in babies having hypercoiled cords as seen in the study by Agarwal S et al[9]. Here Devaru D et al also found no association between hypercoiling and NICU admission[12].

Studies such as those done by Strong et al showed significant associations between hypocoiling and FSB but our study did not show similar findings.No studies showed significant associations between hypercoiling and FSB which was similar to the results found in our study, where the P value was 0.83.

UCI showed significant association with ponderal index in our study. The p value obtained in this group was 0.042. This is not consistent with the study done by Gupta S who obtained non significant association. Hypercoiling was not seen to be significantly associated with ponderal index in our or any other studies.

The incidence of cords without any coil was 1.6% which was lower than some other studies in Lacro RV et al[4] (5%), and in Rana J et al[3] (4.9%).

Table 1. Umbilical Coiling Index and maternal /neonatal /perinatal outcome factors

FACTOR	HYPOCOILED		P VALUE	NORMOCOILED		P VALUE	HYPERCOILED	
	n	%		n	%		n	%
PIH	5	31.3	0.046	18	11.8	0.22	0	0
IUGR	11	68.8	<0.001	12	7.8	0.048	4	25
FHR abnormalities	6	37.5	<0.001	6	3.9	0.51	1	6.3
MSAF	7	43.8	0.008	22	14.4	0.7	3	18.7
Mode of Delivery	3	18.8	0.02	4	2.6	0.4	8	4.3
Low birth weight	12	75	<0.01	19	12.4	0.31	4	25
NICU admission	8	57.1	<0.01	15	10.1	0.039	5	31.3
FSB	2	12.5	0.18	4	2.6	0.83	0	0

Table 2. Relationship between Umbilical Coiling Index and APGAR score and Ponderal index

FACTOR	VARIABLES	n	P VALUE	
Low APGAR score	Hypocoiled	16	<0.05	Hypo v/s Normo
	Normocoiled	153		
	Hypercoiled	16	>0.05	Hyper v/s Normo
Ponderal index	Hypocoiled	15	<0.05	Hypo v/s Normo
	Normocoiled	153		
	Hypercoiled	16	>0.05	Hyper v/s Normo

5. Conclusion

Our study thus shows that abnormal umbilical coiling index is associated with adverse perinatal outcome.

In addition studies by Predanic M et al have shown excellent correlation between antenatal and postnatal coiling index. With proper training on a reasonably good USG machine it is possible to measure coiling index in antenatal sonography scan with accuracy[14]. This finding then can be used as an antenatal, sonographic marker to predict women at risk of having adverse antenatal or perinatal outcomes.

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