Association of Umbilical Coiling Index in Normal And Complicated Pregnancies

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Abstract

Background: Umbilical cord index is the total number of coils divided by the total length of the umbilical cord in centimeters and an abnormal umbilical coiling index has been reported to be related to adverse fetal and pregnancy outcomes.
Objective: To compare and detect the association of the umbilical coiling index in normal and complicated pregnancies.
Patients and Method: This study was conducted in Sulaimania city in both Sulaimania Maternity Hospital and Soma Private Hospital from July 2012 to May 2013.A total number of 428 umbilical cords were examined, umbilical coiling index (UCI) was calculated by dividing the total number of coils by the umbilical cord length in centimeters. The outcomes measured were maternal age, intrauterine growth retardation, meconium staining, birth weight, apgar score,maternal diabetes mellitus and pregnancy induced hypertension. Hypocoiled cords were those having UCI less than 10^{th} centile, and hypercoiled cords those having UCI more than 90^{th} centile. Statistical analysis was done by chi square test, Fishers exact test and the t test where applicable.
Results: The mean UCI was 0.24±0.003 coils per one cm, hypocoiled cords were significantly associated with complicated pregnancies by pregnancy induced hypertension (PIH), gestational diabetes mellitus (GDM), and oligohydromnios (p value<0.05), while hypercoiled cords were associated with maternal age >35 years, (GDM), oligohydromnios, and polyhydromnios. Significant association detected regarding the cesarean section with hypercoiled cord, abnormal fetal heart AFH, meconium stained liquor (MSL), low Apgar score at 5 min. and low birth weight (LBW) were significantly associated with both hypo and hypercoiled cords (p-value <0.05).
Conclusions: Abnormal UCI is associated with several adverse antenatal , perinatal, and neonatal factors, and UCI is an indicator and marker for pregnancy and fetal outcomes.
Keywords: umbilical coiling index, hypocoiling cord, hypercoiling cord

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Introduction

Umbilical cord is vital to the development, well-being, and survival of the fetus, yet this is vulnerable to kinking, compressions, traction, and torsion which may affect the perinatal outcome[1]. The umbilical cord is protected by Wharton's jelly, amniotic fluid, helical patterns, and coiling of vessels[2]. Many characteristics of the human umbilical cord, a most mysterious and intriguing one, is the twisted or spiral course of its component blood vessels[1]. In 1954, umbilical coiling was first quantified by Edmonds who divided the total number of coils by the umbilical cord length in centimeters and called it "The Index of Twist". A coil is of 360-degree spiral course of umbilical vessels[3]. Umbilical coiling index (UCI) is defined as the total number of coils divided by the total length of the cord in centimeters[1]. A frequency distribution of umbilical cord index (UCI) was done by Rana et al.[4], they grouped the UCI as follows: <10th percentile—hypocoiled, a percentage of cords with coils that lie below 10%; 10th–90th percentile—normocoiled; >90th percentile—hypercoiled or those cords that have coils more than normal and lie above 90% of all, and the abnormal umbilical coiling index (UCI) has been reported to be related to adverse fetal outcomes [4,5].

Patients and Method

This study was conducted in Sulaimania city in both Sulaimania Maternity Hospital and Soma Private Hospital from July 2012 to May 2013, a total number of patients included in the study was 428 singleton pregnancies delivered in Sulaimani maternity teaching hospital and Soma private hospital. After separating the umbilical cord from the baby, the cord was tied and cut as close to the placenta as possible. The umbilical cord length was measured, including the length of the placental end of the cord and the umbilical stump on the baby (about 5 cm). 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.

The following maternal factors were recorded age, pregnancy induced hypertension (PIH), gestational diabetes mellitus (GDM), oligohydramnios, and polyhydramnios. Intrapartum factors like mode of delivery, fetal heart rate (FHR) abnormalities, meconium stained liquor (MSL), Neonatal factors like APGAR, and birth weight. At the end of sample collection, the mean UCI was calculated. On the basis of the latter, they were grouped as normocoiled group having UCI values between the 10th and 90th percentile of the mean UCI. Hypocoiled group was taken as having values less than the 10th percentile and hypercoiled group as having values more than 90th percentile of the mean.

The hypocoiled and hypercoiled groups were compared with the normocoiled group, and associations of the chosen parameters with UCI were studied. The statistical tests were the Chi-Square test and the Fisher's exact test. The values were entered and assessed with SPSS version 13.0 software and statistically analyzed, value of less than 0.05 was regarded as statistically significant.

Results

This study included evaluation of 428 umbilical cords of singleton newborns of mothers their ages ranged between 20-43 years; the mean length of the cords was found to be 53.28 (± 16.6) cms. The mean number of coils per umbilical cord was

found to be 11.36 with minimum 2 and maximum 38 coils. The mean UCI was 0.24±0.003 coils per cm (Table 1). Normocoiled cords were predominant in (360) 84.11% cases, while 42 (9.81%) cases were hypocoiled, and 26 (6.07%) cases were hypercoiled.

Table (1): Umbilical cord characteristics.

Mbilical cord	No. of cases	Minimum coiling	Maximum coiling	Mean of coils	SE	SD
Length (cm)	428	42	90	13.49	53.28±16.6	0.44
No. Of coil	428	2	38	11.36	0.17	5.39
UCI	428	0.06	0.62	0.24	0.003	0.09

Studying the antenatal and maternal factors including age, pregnancy induced hypertension (PIH), Diabetes mellitus, oligohydromnios, and polyhydromnios. Maternal age was found to have a significant association with hypercoiling as the p-value was 0.003 i.e < 0.05, pregnancy induced hypertension (PIH) was significantly associated with hypocoiling p-value < 0.05 but for diabetes mellitus, there was significant relation with the hypercoiling of the cord. Regarding the oligohydromnios, it was highly associated with hypocoiling whereas polyhydromniaos, was significantly associated with hypercoiling of the cord (Table 2).

Table (2): Distribution of three groups of UCI according to maternal factors**.**

	20–34 years	**>35 years**	**P-value**
Hypocoiled	25	13	0.061
Normocoiled	220	130	
Hypercoiled	32	8	0.003*
UCI	**Normal(N=376)**	**PIH (N=52)**	**p-value**
Hypocoiled	83 (22.07%)	16 (30.76%)	0.030
Normocoiled	206(54.78%)	32(61.53%)	
Hypercoiled	87 (23.13%)	4(7.69%)	0.273
UCI	**Normal (N=360)**	**Diabetic (N=68)**	**p-value**
Hypocoiled	97(26.94%)	24 (35.29%)	0.051
Normocoiled	215(6.94 %)	32(47.07%)	
Hypercoiled	48 (13.33%)	12(17.64%)	0.035*
UCI	**Normal (N=404)**	**Oligohydramnios (N=24)**	**p-value**
Hypocoiled	82(20.29%)	5 (20.83%)	0.013*
Normocoiled	252 (62.37%)	17 (70.83%)	
Hypercoiled	70(17.32%)	2 (8.33%)	0.015*
UCI	**Normal (N=397)**	**Polyhydromnios (N=31)**	**p-value**
Hypocoiled	83(20.9 %)	5 (16.12%)	0.076
Normocoiled	246(61.96 %)	20 (64.51%)	
Hypercoiled	68(17.12%)	6 (19.35%)	0.015*

Table 3 shows the distribution of frequencies of the three categories of the umbilical cords according to the studied intrapartum factors which were: mode of delivery, fetal heart rate (FHR), and meconium staining liquor (MSL). Among 77 cases who delivered by lower segmental caesarean section,19 umbilical cords showed hypercoiling so there was highly significant association between caesarean section deliveries (28.35%) and hypercoiling as p-value was (0.001).FHR abnormalities {prolonged decelerations and tachycardia were detected in 18 newborns and they were associated with both hypocoiling (27.77%) and hypercoiling (22.22%) which was highly significant (0.001).As far as MSL, both hypocoiled and hypercoiled cords were detected with meconium stained liquor (MSL) and the result was highly significant as the p-values of both were 0.020 and 0.001 respectively.

Table (3): Distribution frequencies of the three groups according to the intrapartum factors.

UCI	Normal vaginal delivery (N=351)	Caesarean section (N=77)	P value
Hypocoiled	52 (14.4%)	10 (14.92%)	0.060
Normocoiled	250 (71.22%)	48 (71.67%)	
Hypercoiled	49 (3.57%)	19 (28.35%)	0.001*
UCI	**Normal (N=410)**	**Abnormal FHR (N=18)**	**P value**
Hypocoiled	32 (72.08%)	5 (27.77%)	<0.001*
Normocoiled	337 (79.75%)	9 (13.43%)	
Hypercoiled	41 (10%)	4 (22.22%)	<0.001*
UCI	**Normal (N=320)**	**MSL (N=108)**	**P value**
Hypocoiled	65 (20.31%)	26 (24.07%)	0.020*
Normocoiled	202 (82.19%)	58 (53.7%)	
Hypercoiled	53 (16.56 %)	24 (22.22%)	<0.001*

From total 428 cases, 23 cases showed APGAR scores < 7at 5 min and among those 23, four (17.39%) had hypocoiling, 16 (69.56%) had normoocoiling, while 3(13.04%) cases showed hypercoiling pattern, these results are statistically significant as p-values were < 0.05. Low-birth weight (LBW) babies found to be significantly associated with both hypo and hypercoiling cases with p-values (0.011 and 0.001) respectively, and regarding the newborns admitted to the neonatal intensive care unit (NICU), there was no significant association with hypo or hypercoiling cords (Table 4).

Table (4): Distribution frequencies of the three groups according to the neonatal factors.

	Normal (N=405)	Low APGAR (N=23)	P-value
Hypocoiled	58 (14.32%)	4 (17.39%)	0.047*
Normocoiled	296 (73.08%)	16 (69.56%)	
Hypercoiled	51 (12.59%)	3 (13.04%)	0.014*
	Normal (N=330)	**LBW (N=98)**	**P-value**
Hypocoiled	32 (9.69%)	22 (22.44%)	0.011*
Normocoiled	286 (86.66%	58 (59.18%)	
Hypercoiled	12 (3.63%)	18 (18.36%)	0.001*
	Normal (413)	**NICU (15)**	**value**
Hypocoiled	53 (12.83%)	3 (20%)	0.48 NS
Normocoiled	325 (78.69%)	9 (60%)	
Hypercoiled	35 (8.47%)	3 (20%)	0.48 NS

Discussion

The total number of coils for any particular umbilical cord is believed to be established early in pregnancy[1,6], there are several studies done for explaining twisting of umbilical cord including those that explain it as a result of active or passive rotation of the fetus[3]. Our study was conducted to find out the relationship between UCI and various maternal and perinatal factors in normal and complicated pregnancies, the mean UCI in our study was similar to the study done by Chitra et al 2011 (Table 5)[5].

Table (5): Mean UCI in various studies.

Studies	UCI
Strong et al. [11]	**0.21 + 0.07**
Rana et al[4]	**0.19 + 0.1**
Ercal et al.([16])	**0.20 + 0.1**
Ezimokhai et al. [5,8]	**0.26 + 0.09**
de Laat et al. [15]	**0.17 + 0.009**
Chitra et al.[9]	**0.24 + 0.09**

A recent metanalysis showed the normal UCI to be 0.17± 0.009 completed spirals per cm[1], the direction of umbilical coils in our study was found to be predominantly anticlockwise. The anticlockwise coiling of umbilical cord was found in works of Chaurasia et al and Larco et al, they found in their study that the direction of coils was predominantly anticlockwise [2,7], the reason behind this direction remains unexplained, however the forceful paddling with fetal right arm as an already established handedness may be taken in consideration[8].Among the maternal factors, the age of 35 years in our study showed a significant association with hypocoiling and hypercoiling of the cord. This result is confirmed by results of study done by Ezimokhai et al [8] while our result disagreed by results of Chitra et al, as they found no significant association between cord coiling and maternal age [9].

The result of current study regarding pregnancy induced hypertension (PIH) revealed a significant association with hypocoiled cords, this was found by Chitra et al and Gupta et al too[9,10], although Larco and Strong et al had found that PIH might be related with normocoiling and this fact can be explained because of the elastic properties of the cord as it resists the external forces so that it can compromise the vascular flow and it can resist kinking and stretching, this might explain the significant association of hypocoiling and preeclampsia[7,11].We found that gestational diabetes mellitus (GDM)was significantly associated with hypercoiling of the cord, but it was found to be associated with both hypo and hypercoiling of the cord[5,9].

Kashanian et al. [13] found oligohydramnios to be significantly associated with both hypocoiled and hypercoiled, but in our study, oligohydramnios had a significant association with hypocoiled, whereas polyhydramnios had a significant association with hypercoiled, so our results were exactly similar to results of the study done by Gupta et al[10]. This can be explained by Edmond's hypothesis [3] which states that twist of the umbilical cord is a result of the rotary

movement imparted to the embryo, and hence more is the amount of liquor amnii, more is the rotary movement of the fetus and more will be the coiling. The converse will be true for oligohydramnios.

In our study meconium staining of the amniotic fluid was found to have a significant association with both hypocoiled and hypercoiled . Although Similar findings were noted in studies done by Ezimokhai et al.[8] and Kashanian et al [13]. Strong et al. studied 100 umbilical cords and found that meconium staining was associated with hypercoiled cords with the *p*- value of 0.03 which was highly significant but they did not offer a specific explanation for this observation[11,12].

Gupta et al.[10] studied 107 umbilical cords & found that in hypocoiling group, meconium staining was significantly higher than those with normal coiling group.

As it is well known that delivery by cesarean section (C.S) had both fetal and maternal indications so this supports our finding as we found the significant association of delivery by C.S with hypercoiled cord and this result is confirmed by result of Gupta et al[10] but disagreed by[4,10,12,13,15] as they found it's relation with hypocoiled cords. Abnormal fetal heart (AFH) in our study was associated with both hypo and hyper coiled cords. This was agreed by results of others [12,13,15,16] because all these researchers thought that both hypo and hypercoiled cords are prone to kinking and torsion making them less tolerant to stress of labour, while others found AFH had associated with hypocoiled cords[4,16]. We depended and concentrated on Apgar scores <7 at 5 min but not on the scores at 1 min because frequently a low scores at 1 min become near normal by 5 min[17] ,so we found low Apgar scores <7 at 5 min. in cases with hypo and hypercoiled cords and this is agreed by what was found in other studies[10,11,14], however in other study it was found to be associated with hypercoiling of the cord only[1]. Our study had showed babies weighing less than 2.5 kg to be associated with both hypo and hypercoiled cords, but this is disagreed with what was found by other researchers as they have found it in association with hypercoiled cords[4,15].

Conclusions

Abnormal UCI is associated with several adverse antenatal factors: maternal age; PIH, GDM , and Abnormal amniotic fluid volume, perinatal factors; mode of delivery, AFH, and MSL and neonatal factors; birthweight and Apgar scores.

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