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ASSOCIATION BETWEEN UMBILICAL COILING INDEX AND ADVERSE PERINATAL OUTCOME

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ABSTRACT **INTRODUCTION:** The coiling of component blood vessels is one of the most mysterious characteristics of the human umbilical cord. Umbilical coiling index (UCI) is defined as the total number of coils divided by the total length of the cord in centimeters. Most of the published studies categorize umbilical cords as hypocoiled, normocoiled and hypercoiled. The presence of hypocoiling and hypercoiling in cords has been associated with adverse perinatal outcomes. **AIM AND OBJECTIVES:** (i) To study association of UCI with perinatal outcome in normal as well as high risk pregnancies like PIH, GDM, eclampsia, previous LSCS and elderly mothers. (ii) To study association of UCI with mode of delivery, birth weight, Apgar score at 1 minute and 5 minutes, meconium staining, intrauterine growth restriction and neonatal intensive care unit admission. **METHODS:** Observational study was carried out in the Department of Obstetrics and Gynaecology and the Department of Pediatrics, AIMSR, Bathinda. Patients were selected consecutively as and when they presented to hospital applying inclusion and exclusion criteria. **RESULTS:** Out of 200 cases, normocoiling was seen in 135 patients (67.50%), hypocoiling in 42 patients (21%) and hypercoiling in 23 patients (11.50%). The mean UCI in our study was 0.164 ± 0.135. Hypocoiling is significantly associated with preeclampsia, low Apgar score at 1 minute and 5 minute, meconium stained liquor and increased NICU admissions while hypercoiling is associated with diabetes mellitus, increased LSCS and assisted vaginal deliveries, low Apgar score at 1 minute, meconium stained liquor, intrauterine growth restriction and increased NICU admissions. **CONCLUSION:** Both hypocoiling and hypercoiling has significant association with adverse fetal outcome. Therefore, detection of coiling index postnatally or antenatally can identify babies at risk and thus helps in further management.

KEYWORDS : Umbilical Coiling Index, Normocoiling, Hypocoiling, Hypercoiling, Perinatal Outcome

INTRODUCTION

The umbilical cord is composed of two arteries, one vein, tiny rudiments of the allantois, the omphalomesenteric ducts and the Wharton's jelly. The fetus is supplied with oxygenated, nutrient rich blood from the placenta through the umbilical vein and the fetal heart pumps low oxygen containing and nutrient depleted blood back to the placenta through umbilical arteries.[1]

The spiral or twisted course of component blood vessels is one of the most mysterious characteristics of the human umbilical cord . It is hypothesized that movements of fetus, embryo's torsion (active or passive), fetal hemodynamic forces, differential umbilical vascular growth rates, and arrangements of muscular fibers in the umbilical arterial wall may be responsible for this. This coiling seems to arise because the longer umbilical vein twists around the umbilical arteries.[1,2]

The cord vessels are vulnerable to torsion, traction, kinking or compressions and subsequently leading to blood flow interruption which may affect the perinatal outcome.[2] Coiling provides a protective effect to all these forces therefore, securing an unterrupted blood supply to the fetus allowing it to move and change position without any haemodynamic compromise.[3]

A coil is defined as a complete 360 degree spiral course of the umbilical vessels. Normal umbilical cord coiling has been calculated to be approximately 1 coil / 5 cms of the umbilical cord length or 0.2-0.24 coils/cm.[3] It is observed that the number of twists in first trimester of pregnancy is roughly the same as that seen at 37 completed weeks of gestation i.e. in term cords. The total number of coils seen varies between 0 and 40. The umbilical cord coiling may represent a long-term record of fetal well-being as lengthening of the cord occurs from the fetal end.[4]

Umbilical coiling index (UCI) is defined as the total number of coils divided by the total length of the cord in centimeters. Most of the published studies categorize umbilical cords as hypocoiled, normocoiled and hypercoiled. A frequency distribution of umbilical coiling index was done by Rana et al.[5]

They grouped the umbilical coiling index as follows:

- <10th percentile (< 0.07) hypocoiled
- 10th–90th percentile (0.07 - 0.3) normocoiled
- >90th percentile (> 0.3) hypercoiled

This difference in umbilical coiling can be used as a marker for identifying fetus at risk. Although umbilical coiling index can be calculated antenatally by ultrasonography, there is limited data available as to its accuracy. An association between the antenatal UCI and postnatal UCI is present. Our present study aims at calculating umbilical coiling index postnatally and identifying its relation with perinatal outcome in normal and high risk pregnancies.

AIM AND OBJECTIVES

AIM: To study association between umbilical coiling index and perinatal outcome.

OBJECTIVES

1. To study association of UCI with perinatal outcome in normal as well as high risk pregnancies like PIH, GDM, eclampsia, previous LSCS and elderly mothers.
2. To study association of UCI with mode of delivery, birth weight, Apgar score at 1 minute and 5 minutes, meconium staining, intrauterine growth restriction and neonatal intensive care unit admission.

MATERIAL AND METHODS

Observational study was carried out in the Department of Obstetrics and Gynaecology and the Department of Pediatrics, AIMSR, Bathinda. Patients were selected consecutively as and when they presented to hospital applying inclusion and exclusion criteria. The umbilical cord was measured entirely, including the length of placental end of the cord and the umbilical stump of the baby. The number of the complete coils were counted from the neonatal end towards the

placental end of the cord. Umbilical coiling index was calculated. Chi-square test, Fischer's exact test and t-test were applied where applicable (under the supervision of statistician). Tests of significance were applied at 95% confidence interval (p value < 0.05).

RESULTS

Among the 200 patients studied, normocoiling was seen in 135 patients (67.50%), hypocoiling was seen in 42 patients (21%) and hypercoiling in 23 patients (11.50%). The mean UCI was 0.164 ± 0.135. The mean UCI in normocoiled patients was 0.148 ± 0.053, hypercoiled patients was 0.477 ± 0.126 and hypocoiled patients was 0.042 ± 0.013.

Preeclampsia was seen in 16 cases (8%) out of 200. Out of them, normocoiling was seen in 7 cases (3.50%), hypocoiling was also seen in 7 cases (3.50%) and hypercoiling was seen in 2 cases (1%). Eclampsia was seen in 10 cases (5%) out of 200. Out of them, normocoiling was seen in 4 cases (2%), hypocoiling was also seen in 4 cases (2%) and hypercoiling was seen in 2 cases (1%). Preeclampsia and eclampsia were significantly associated with hypocoiling (p-value 0.029) while they were not significantly associated with hypercoiling (p-value 0.052).

Table 1. Association of UCI and Preeclampsia-Eclampsia

UCI	Preeclampsia				Eclampsia				p-value
	Yes		No		Yes		No		
	No.	%	No.	%	No.	%	No.	%	
Hypocoiling	7	3.50	35	17.50	4	2.00	38	19.00	p_1 =
Normocoiling	7	3.50	128	64.00	4	2.00	131	65.50	0.029
Hypercoiling	2	1.00	21	10.50	2	1.00	21	10.50	p_2 =
Total	16	8.00	184	92.00	10	5.00	190	95.00	0.052

p_1 comparison between hypocoiling & normocoiling ; p_2 comparison between hypercoiling & normocoiling

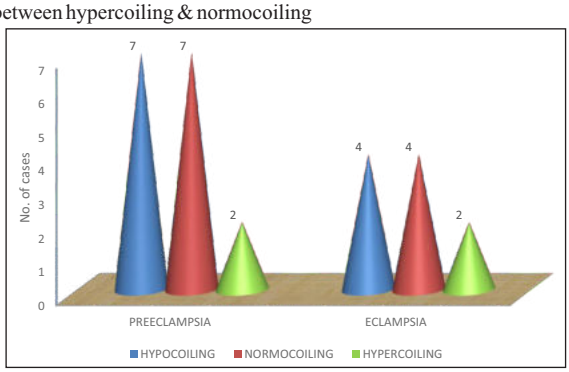

Figure 1. Association of UCI and Preeclampsia-Eclampsia

Diabetes mellitus was seen in 21 cases (10.50%) out of 200. Out of them, normocoiling was seen in 12 cases (6%), hypocoiling in 1 case (0.5%) and hypercoiling was seen in 8 cases (4%). Diabetes mellitus was significantly associated with hypercoiling (p-value 0.002) while it was not significantly associated with hypocoiling (p-value 0.139).

Table 2. Association of UCI and Diabetes Mellitus

UCI	Diabetes mellitus				Total		p-value
	Yes		No				
	no.	%	no.	%	no.	%	
Hypocoiled	1	0.50	41	20.50	42	21.00	p_1 0.139
Normocoiled	12	6.00	123	61.50	135	67.50	
Hypercoiled	8	4.00	15	7.50	23	11.50	p_2 0.002
Total	21	10.50	179	89.50	200	100.00	

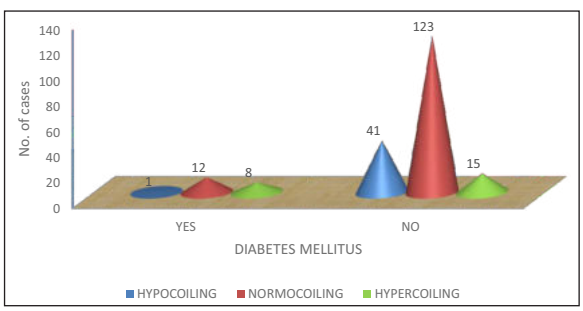

Figure 2. Association of UCI and Diabetes Mellitus

Out of 200 patients, total 28 cases (14%) were elderly. Out of them, normocoiling was seen in 18 cases (9%), hypocoiling was seen in 8 cases (4%) and hypercoiling in 2 cases (1%). Elderly age group was not significantly associated with either hypocoiling (p-value 0.248) or hypercoiling (p-value 0.414). Total 40 cases (20%) had previous LSCS. Out of them, normocoiling was seen in 30 cases (15%), hypocoiling was seen in 7 cases (3.50%) and hypercoiling was seen in 3 cases (1.50%). Previous LSCS was not significantly associated with either hypocoiling (p-value 0.295) or hypercoiling (p-value 0.241).

Out of 200 patients, normal vaginal delivery (NVD) was done in 115 cases (57.50%), LSCS done in 62 cases (31%) and assisted vaginal delivery (AVD) done in 23 cases (11.50%). Out of all NVD cases, 84 (42%) showed normocoiling, 26 (13%) showed hypocoiling and 5 (2.50%) showed hypercoiling. Out of all LSCS cases, 41 (20.5%) showed normocoiling, 14 (7%) showed hypocoiling and 7 (3.5%) showed hypercoiling. Out of all AVD cases, 10 (5%) showed normocoiling, 2(1%) showed hypocoiling and 11 (5.5%) showed hypercoiling. LSCS and AVD was significantly associated with hypercoiling (p-value 0.001) and not with hypocoiling (p-value 0.810).

Table 3. Association of UCI and Mode of Delivery

UCI	Mode of delivery						Total		p-value
	AVD		LSCS		NVD				
	no.	%	no.	%	no.	%	no.	%	
Hypocoiled	2	1.00	14	7.00	26	13.00	42	21.00	p_1
Normocoiled	10	5.00	41	20.50	84	42.00	135	67.50	0.810
Hypercoiled	11	5.50	7	3.50	5	2.50	23	11.50	p_2
Total	23	11.50	62	31.00	115	57.50	200	100.00	0.001

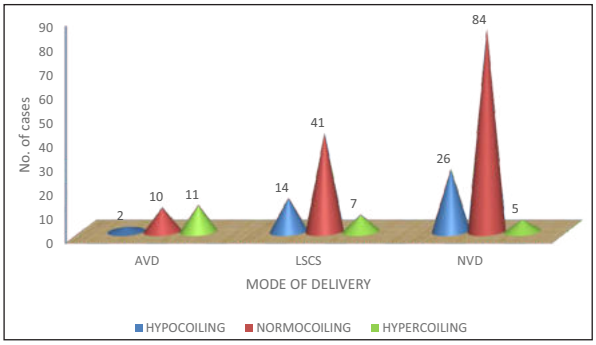

Figure 3. Association of UCI and Mode of Delivery

Out of 200 cases, 46 (23%) had Apgar score at 1 minute < 4 and 154 (77%) had Apgar score > 4. Out of 46 cases of low Apgar score at 1 minute, 11 (5.5%) showed normocoiling, 25 (12.50%) showed hypocoiling and 10 (5%) showed hypercoiling. Hypercoiling and hypocoiling both were significantly associated with low Apgar score at 1 minute (p-value 0.001 for both).

Table 4. Association of UCI and Apgar score at 1 minute

UCI	Apgar score at 1 minute				Total		p-value
	<4		>4				
	no.	%	no.	%	no.	%	
Hypocoiled	25	12.50	17	8.50	42	21.00	p_1
Normocoiled	11	5.50	124	62.00	135	67.50	0.001
Hypercoiled	10	5.00	13	6.50	23	11.50	p_2
Total	46	23.00	154	77.00	200	100.00	0.001

Out of 200 cases, 28 (14%) had Apgar score at 5 minute < 7 and 172 (86%) had Apgar score > 7. Out of 28 cases of low Apgar score at 5 minute, 6 (3%) showed normocoiling, 20 (10%) showed hypocoiling and 2 (1%) showed hypercoiling. Low Apgar score at 5 minute was significantly associated with hypocoiling (p-value and not with hypercoiling (p-value 0.329).

Table 5. Association of UCI and Apgar score at 5 minute

UCI	Apgar score at 5 minute				Total		p-value
	<7		>7				
	no.	%	no.	%	no.	%	
Hypocoiled	20	10.00	22	11.00	42	21.00	p_1
Normocoiled	6	3.00	129	64.50	135	67.50	0.001
Hypercoiled	2	1.00	21	10.50	23	11.50	p_2
Total	28	14.00	172	86.00	200	100.00	0.329

Out of 200 cases, 43 (21.50%) had meconium stained liquor (MSL) and 157 (78.50%) had clear liquor. Out of 43 MSL cases, 14 (7%) had normocoiling, 22 (11%) had hypocoiling and 7 (3.50%) had hypercoiling. Both hypocoiling (p-value 0.001) and hypercoiling (p-value 0.016) were significantly associated with MSL but hypocoiling was more significantly associated.

Table 6. Association of UCI and Colour of Liquor

UCI	Colour of Liquor				Total		p-value
	Clear		MSL				
	no.	%	no.	%	no.	%	
Hypocoiled	20	10.00	22	11.00	42	21.00	p_1
Normocoiled	121	60.50	14	7.00	135	67.50	0.001
Hypercoiled	16	8.00	7	3.50	23	11.50	p_2
Total	157	78.50	43	21.50	200	100.00	0.016

Out of 200 cases, 12 (6%) were IUGR and 188 (94%) were normal. Out of IUGR cases, 4 (2%) showed normocoiling, 2(1%) hypocoiling and 6 (3%) hypercoiling. Hypercoiling was significantly associated with IUGR (p-value 0.001) while hypocoiling was not (p-value 0.437).

Table 7. Association of UCI and Intrauterine growth restriction (IUGR)

UCI	IUGR				Total		p-value
	Yes		No				
	No.	%	No.	%	No.	%	
Hypocoiled	2	1.00	40	20.00	42	21.00	p_1
Normocoiled	4	2.00	131	65.50	135	67.50	0.437
Hypercoiled	6	3.00	17	8.50	23	11.50	p_2
Total	12	6.00	188	94.00	200	100.00	0.001

Out of 200 cases, 43 (21.50%) were admitted in NICU and 157 (78.50%) were shifted to mother side. Out of NICU admissions, 13 (6.50%) showed normocoiling, 21 (10.50%) hypocoiling and 9 (4.50%) hypercoiling. Both hypocoiling and hypercoiling were associated with increased NICU admissions (p-value 0.001 for both).

Table 8. Association of UCI and NICU Admission

UCI	NICU admission				Total		p-value
	Yes		No				
	no.	%	no.	%	no.	%	
Hypocoiled	21	10.50	21	10.50	42	21.00	p_1
Normocoiled	13	6.50	122	61.00	135	67.50	0.001
Hypercoiled	9	4.50	14	7.00	23	11.50	p_2
Total	43	21.50	157	78.50	200	100.00	0.001

DISCUSSION

In our study, normocoiling was seen in 135 patients (67.50%), hypocoiling in 42 patients (21%) and hypercoiling in 23 patients (11.50%). In study done by Khan T et al. 161 patients (80.5%) had normocoiled umbilical cord, 19 patients (9.5%) had hypocoiled umbilical cord and 20 patients (10.0%) had hypercoiled umbilical cords.[6] In study conducted by Patil NS et al. 156 cords (78%) showed normal coiling, 23 (11.50%) showed hypocoiling, and 21 (10.50%) showed hypercoiling.[7] In study by Gaikwad P et al 82.7% of the cords were normocoiled whereas 8.6% cords were hypocoiled as well as hypercoiled each.[8]

The mean UCI in our study was 0.164 ± 0.135. In study done by Sarkate PS et al. the mean UCI was 0.268 ± 0.13.[9] In study conducted by Khan T et al the mean UCI was 0.19 + 0.1.[34] The mean UCI in study by Singh S et al was 0.2 ± 0.09.[6]

In present study, preeclampsia and eclampsia were significantly associated with hypocoiling (p-value 0.029) while they were not significantly associated with hypercoiling (p-value 0.052). The study by Ezimokhai M et al. showed preeclampsia was significantly associated with non-coiling (an extreme form of hypocoiled) (p< 0.001).[10] Hypertensive disorders were found to be significantly associated with hypocoiling (p value 0.030) in study done by Chitra T et al.[11] Gupta S et al found that in hypocoiled group pregnancy induced hypertension was significantly higher than in those with normocoiled group.[12]

In our present study, diabetes mellitus was significantly associated with hypercoiling (p-value 0.002) while it was not significantly associated with hypocoiling (p-value 0.139). Similar finding was seen in study by Chitra T et al where Diabetes mellitus had a statistically significant association with hypercoiling (p value 0.035).[11] Ezimokhai M et al. however, found significant association of GDM with both hypocoiled and hypercoiled.[10] Mustafa SJ et al. also found hypercoiled cords to be significantly associated with GDM (p value 0.035).[13]

In this study, elderly age group was not significantly associated with either hypocoiling (p-value 0.248) or hypercoiling (p-value 0.414). Ercal T et al also noted that there is no relationship between UCI and maternal age, gravidity or parity.[14] van Diik CC et al also observed there were no significant correlations of the UCI with maternal age.[15] In study done by Khan T et al. there was no significant association between maternal age and UCI.[6]

In our study, LSCS and AVD were significantly associated with hypercoiling (p-value 0.001) and not with hypocoiling (p-value 0.810). Similar observation was seen in study by Chitra T et al. where caesarean deliveries were found to have highly significant association with hypercoiled (p = 0.001).[11] Mustafa SJ et al. also had similar finding in their study showing significant association between caesarean section and hypercoiled cord (p value 0.001).[13] Wakpnjar J et al. also found that hypercoiling was associated emergency caesarean section.[16]

In present study, hypercoiling and hypocoiling both were significantly associated with low Apgar score at 1 minute (p-value 0.001 for both). Low APGAR score at 5 minute was significantly associated with hypocoiling (p-value 0.001) and not with hypercoiling (p-value 0.329). In study done by Chholak D et al. Apgar score <7 at 1 min and 5 min was found with hypocoiled cords.[17] Abdulrasul EA conducted a study and found that both hypocoiled and hypercoiled groups were significantly associated with low Apgar score at 5 minute.[18] In study by Patil NS et al. hypocoiled cords were significantly associated with Apgar score at 1 min of < 4 and at 5 min of < 7.[7] Rahi S et al. also observed significant association between hypocoiling cords and Apgar at 1 minute < 4 and Apgar score at 5 minutes < 7.[19]

In this study, both hypocoiling (p-value 0.001) and hypercoiling (p-value 0.016) were significantly associated with MSL. In study by Mustafa SJ et al. meconium staining of the amniotic fluid was found to have a significant association with both hypocoiled (p value 0.020) and hypercoiled cords (p value <0.001).[13] Significant association of both hypocoiling and hypercoiling with MSL was also observed in study by Ezimokhai M et al.[10]

In our present study, hypercoiling was significantly associated with IUGR (p-value 0.001) but not hypocoiling (p-value 0.437). Ezimokhai M et al.[10] and Devaru D et al.[20] found IUGR to be associated with hypercoiling.

In our study, both hypocoiling and hypercoiling were associated with increased NICU admissions (p-value 0.001 for both). Rahi S et al. found that the percentage of NICU admission was more (40%) in both hypocoiled and hypercoiled groups as compared to normocoiled group.[19] Similar findings of association of both hypocoiling and hypercoiling with NICU admission were seen in studies of Gaikwad P et al.[8], Wakpnjar J et al.[16]

SUMMARY AND CONCLUSION

Abnormal UCI is associated with several perinatal outcomes in normal as well as high risk pregnancies. Hypocoiling is significantly associated with preeclampsia, low Apgar score at 1 minute and 5 minute, meconium stained liquor and increased NICU admissions while hypercoiling is associated with diabetes mellitus, increased LSCS and assisted vaginal deliveries, low Apgar score at 1 minute, meconium stained liquor, intrauterine growth restriction and increased NICU admissions. Thus, both hypocoiling and hypercoiling has significant association with adverse fetal outcome. Therefore, detection of coiling index postnatally or antenatally can identify babies at risk and thus helps in further management.

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