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Research Paper

The Sonographic Umbilical Cord Coiling in Late Second Trimester of Gestation and Perinatal Outcomes

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Abstract

Background: This study was conducted to determine whether or not the umbilical cord coiling index (UCI) during the late second trimester of gestation is associated with perinatal outcomes.

Methods: This was a retrospective study of 251 pregnancies in which a fetal anatomic survey with a recorded UCI was performed at 22-28 weeks gestation. The subjects were divided into normocoiled, hypocoiled, and hypercoiled groups and compared perinatal outcomes.

Results: Two hundred twenty-six patients were included. The incidence of preterm deliveries in hypocoiled group was 35%, which was significantly greater than the normocoiled groups (p=0.041). The incidence of neonates with low birth weights in the hypocoiled group was 36.4%, which was significantly greater than the normocoiled groups (p=0.044). In the hypocoiled group, 27.3% of newborns were admitted to the NICU which was significantly greater than the normocoiled and hypercoiled groups (p=0.041). After the adjustment by logistic regression analysis, only preterm delivery were significantly increased in hypocoiled group (OR=9.6, 95% CI=2.09-44.07).

Conclusion: The hyporcoiling of the umbilical cord during the late second trimester of pregnancy suggest that the risk for preterm delivery is high, consequently the delivery of low birthweight neonates is high, and the admission to the neonatal intensive care unit is increased.

Key words: perinatal outcome, ultrasonography, umbilical cord, umbilical cord coiling

INTRODUCTION

The umbilical cord is a very important structure connecting the placenta and the fetus. It consists of 3 blood vessels, and it has the characteristic of screw-shaped coils. The cause, role and mechanism of umbilical cord coiling have not been elucidated; nonetheless it has been shown that the coiling level is associated with adverse perinatal outcome such as intrauterine fetal death, intrauterine growth restriction and fetal distress during labor [1-4]. The umbilical cord coiling level can be objectively presented by the umbilical coiling index (UCI), which is the number of coils in the cord divided by the cord length in cm [2]. Such measurement is not feasible prior to birth, and thus the UCI is estimated by dividing the distance of one complete coiling (cm) by 1 presented by the method applying ultrasonography for antenatal evaluation [5]. Throughout the entire pregnancy, the total length of umbilical cord is in-

creased, and particularly, in the later period of pregnancy, the length of umbilical cord becomes longer every month by approximately 3 - 6 cm [6]. A tendency is that the UCI becomes smaller in the third trimester in comparison with the second trimester[7]. Nonetheless, the level of the lengthening of umbilical cord varies in each fetus, and thus the change of UCI is individual.

This study was conducted to determine whether or not the umbilical cord coiling index (UCI) during the late second trimester is associated with perinatal outcomes.

MATERIAL AND METHODS

This was a retrospective study of pregnancies among women who had a fetal anatomic survey with recorded umbilical cord coiling index during 22-28 weeks' gestation between January 2008 and June 2009, in the Department of Obstetrics, Catholic University Saint Vincent's Hospital. Multiple pregnancies fetuses with a single umbilical artery, and women who did not deliver at our hospital were excluded. Data were collected on maternal and neonatal characteristics. The study was approved by the hospital study medical ethics committee (nr. VC11RIS10009).

The measurement of the umbilical coiling index was that by the application of 3.5 MHz abdominal ultrasonography (ACCUVIX XQ-3D, Medison, Seoul, Korea). The umbilical cord floating in the amnionic fluid was measured according the method suggested by Degani et al. In two adjacent coils, the distance from the outer surface of the vascular wall to its next twist was measured and calculated (antenatal UCI = 1/distance in centimeters) [5]. On the time of measurement, the weight of fetus, the volume of amniotic fluid, the diameter of the cross-section of umbilical cord, and the umbilical artery resistant index were measured. All ultrasonographic measurements were performed by one investigator. Cases whose umbilical cord coiling index was lower than the 10th percentile were defined as the hypocoiled cord, cases whose umbilical index was between 10th percentile and 90th percentile were defined as the normocoiled cord, and cases higher than the 90th percentile were defined as the hypercoiled cord. The subjects were divided to the normal group, the hypocoiled group and the hypercoiled group. Clinical information was collected from the medical records. According to UCI groups, we compared clinical charecteristics and perinatal outcomes. Small for gestational age (SGA) was defined as a birth weight below the 10th percentile for gestational age at delivery. Preterm delivery was defined as delivery weeks < 37 gestation weeks. Low birth weight was defined as a birth weight less than 2,500 g. The rate of primary Cesarean section means that cesarean section rate in primipara or previous vaginal delivery women ((total cesarean section- repeat cesarean section/ total delivery – repeat cesarean section) * 100).

All statistical analysis was performed by the SAS version 8 (SAS institute Inc, Cary, USA). For the comparison the groups, one-way ANOVA (analysis of variances among groups) and the χ^2 test were applied. As Post Hoc tests, Bonferroni multiple comparison test and Fisher's exact test were applied. For the adjustment of maternal age, birth weight and gestational weeks at birth, logistic regression analysis was used. $p < 0.05$ was determined to be statistically significant.

RESULTS

251 pregnancies were checked UCI during study period. By exclusional criteria, total 226 pregnancies were included. The average gestational weeks was 24.76±1.22 weeks and maternal age was 32.9±4.41 years at time of ultrasound. The average delivery weeks was 38.21±1.92 weeks. The UCI of hypocoiled group that is lower than the 10th percentile was <0.27, the hypercoiled group that was higher than the 90th percentile was >0.64, and they were 20 patients and 24 patients, respectively. Fetal weight, the volume of amniotic fluid, the diameter of the cross-section of umbilical cord, and the umbilical artery resistant index were not significant association with UCI (Table 1).

When the perinatal outcomes according to the umbilical cord coiling index was evaluated, the average delivery week of the hypocoiled group was 36.8±2.34 weeks, and it was shorter than 38.3±1.82 weeks of the normocoiled group and 38.9±1.72 weeks of the hypercoiled group (p=0.02). Preterm delivery in the hypocoiled group was 36.4 %, and the higher incidence of preterm delivery than 7.7 % of the normocoiled group and 16.7 % of the hypercoiled group was shown, and the hypocoiled group showed a higher premature delivery rate than the normocoiled group (p=0.041). The rate of low birth weight neonates in the hypocoiled group was 36.4 %, the normocoiled group was 10 %, and the hypercoiled group was 20 %, and the incidence of low birth weight neonates in the hypocoiled cord was significantly higher than the normocoiled group (p=0.044). The incidence of SGA of the hypocoiled group was 20 %, the normocoiled group was 9.3%, and the hypercoiled group was 25%, it was not statistically significant between each group (p=0.421). The average birthweight of the hypocoiled cord group showed a tendency to be low, nevertheless, it was not statistically significant (p=0.103). The rate of primary Cesarean section did not show dif-

ferences between each group. The rate of emergency cesarean section that was performed during delivery did not show statistical differences between each group. Similarly, cases with the Apgar score below 7 points at 1 minute and cases with umbilical artery below pH 7.2 did not show statistical differences between each group. In regard to the outcomes of neonates, the rate of admission to the neonatal intensive care unit of the hypocoiled group was 27.3 %, and a statistically higher admission rate was shown in comparison with 6.8 % of the normocoiled cord and 0 % of the hypercoiled cord group (p=0.041) (Table 2). After the adjustment by logistic regression analysis, only preterm delivery were significantly increased in pregnant women who showed the hypocoiling (OR=9.6, 95% CI=2.09-44.07), low birthweight and admission to the intensive care unit were not statistically significant (Table 3).

Table 1. Maternal demographic characteristies and fetal sonographic characteristies according to UCI

Characteristics		Total population	Coiling subgroup			p-value
			Hypocoil	Normocoil	Hypercoil	
N(%)		226 (100)	20 (8.9)	182(80.5)	24 (10.6)	
Maternal age (year, %)		32.9±4.41 (4.39)	34.6±4.54 (5.33)	32.7±4.35 (4.28)	33.1±4.65 (4.6)	NS
Gestational weeks at sonography (week)		24.76±1.22	25.16±1.03	24.71±1.26	24.72±1.09	NS
Parity (N, %)	Parity =0	79	7 (36.8)	64 (35.6)	8 (32)	NS
	Parity >0	145	12 (63.1)	116 (64.4)	17 (68)	NS
cord diameter (cm)		1.36±0.21	1.32±0.21	1.37±0.21	1.306±0.22	NS
Umbilical artery resistant index		0.66±0.07	0.7±0.07	0.66±0.08	0.67±0.04	NS
Estimated fetal weight at sonography(gram)		737±163.35	742.45±48.49	733.62±169.80	761.4±125.33	NS
Amniotic fluid index		12.03±2.88	11.56±2.22	12.06±3.07	12.29±1.72	NS

Table 2. Perinatal outcomes of the study population by umbilical cord imdex

Characteristics (N,%)	Total population	Coiling subgroup			p-value
		Hypocoil	Normocoil	Hypercoil	
N(%)	226(100)	20 (8.9)	182 (80.5)	24 (10.6)	
Gestational weeks at Birth (weeks)	38.21±1.92	36.8±2.34[a]	38.30±1.82[b]	38.96±1.72[b]	0.02
IUGR	27(11.9)	4 (20)	17 (9.3)	6 (25)	NS
Preterm birth	26(11.5)	8(36.4)	14 (7.7)	4 (16.7)	0.041
A/S ≤ 7 in 1min	41(17.6)	6 (30)	31 (17)	4 (16.7)	NS
A cord gas ph ≤ 7.2	19(8.4)	2 (12.5)	14 (8)	3 (12.5)	NS
Primary c/s rate	35	2 (20)	29 (23.4)	4 (12.56)	NS
Birth weight(g, mean ± SD)	3102.34±583.50	2755.45±744.89	3149.78±564.07	3057±475.98	NS
Low birth weight	30(13.5)	8(36.4)	18(10)	4(20)	0.044
Breech presentation	17(7.5)	2(9.1)	13(7.1)	2(10)	NS
Congenital anomaly	16(7.2)	2(9.1)	14(7.8)	0(0)	NS
Emergency c/s	25(11.0)	3(15)	19(10.4)	3(12.5)	NS
NICU admission	18(8.3)	6(27.3)	12(6.8)	0(0)	0.041
Neonatal head circumference (cm, mean ± SD)	33.87±1.92	32.90±2.4	34.00±1.91	33.75±1.09	NS

Abbreviation: IUGR, intrauterine growth restriction; AS, apgar socre; NICU, neonatal intensive care unit; NS, $P > 0.05$.

Table 3. Odds ratios for adverse outcomes in presence of hyocoiling or hypercoiling after maternal age, birth weight and gestational weeks at birth are adjusted by logistic regression

Clinical association	UCI	Odds ratio	95% CI	p-Value
Preterm birth	Normocoil	1	1	
	Hypocoil	9.6	2.09-44.07	0.017
	Hypercoil	2.96	0.52-16.73	0.416
Low birth weight	Normocoil	1	1	
	Hypocoil	1.18	0.15-9.22	0.871
	Hypercoil	2.96	0.52-16.73	0.302
NICU admission	Normocoil	1	1	
	Hypocoil	0.412	0.05-2.90	0.373
	Hypercoil	1.357	0.26-7.07	1

DISCUSSION

The role of umbilical cord coiling is not clear, nonetheless, it is thought to play a role of protecting the umbilical cord from external pressure such as tension, pressure, stretching or entanglement.[8, 9] Umbilical cord coiling is observed from 28 days after fertilization[10]. The mechanism by which physiological coiling occurs still, however, remains undetermined, with speculation that it may be related to early fetal activity and hemodynamic factors, or other anatomical issues such as the presence of Roach muscle.[11, 12]Several studies have reported that the abnormal postnatally checked UCI was associated with poor perinatal outcomes [1-4].

Studies on the association of the antenatal sonographic UCI with perinatal outcome are not abundant. In studies that were conducted on the early second - trimester of pregnancy (14 weeks -16 weeks), the hypocoiled cord was associated with fetal growth retardation, nonetheless, it was not associated with preterm birth, the low Apgar score, meconium stained amniotic fluid, and the abnormal findings of fetal heart rate monitoring [4]. In studies that were conducted on the mid-second trimester (18-23 weeks), it has been reported that both hypocoiled cord and hypercoiled cord were associated with fetal growth retardation, nonreassuring fetal status in labor, nonetheless, they were not associated with meconium stained amniotic fluid, interventional delivery, gestational age at birth, mode of delivery, and the low Apgar score [13]. In studies that were conducted on the third trimester, both hypocoiled cord and hypercoiled cord were associated with fetal growth retardation and interventional delivery, nevertheless, they were not associated with other perinatal outcomes [14]. In our studies that were conducted on the late second trimester (22-28 weeks), in the hypocoiled cord group, the average delivery week was low (p=0.02), and a high rate of preterm birth was shown (p=0.041). Because secondary results due to high rate of pretem birth was occurred, the rate of low birthweight neonates (less than 2,500 g) was increased, and admission to the neonatal intensive care was also increased (p=0.013). Nevertheless, they were not associated with other perinatal outcomes. It was shown that the hypercoiled cord was not associated with any adverse perinatal outcomes. In such manners, including our study, the results of already reported studies are different from each other. It may be due to that the UCI changes continuously in utero, and each investigator measured the UCI at different gestaional period. Study reporting that in some fetal growth retardation cases, the hypocoiled cord was detected by ultrasonography during the first trimester, however, the hypercoiled cord was shown after birth support this theory [15].

Studies determining the most effective time of the measurement of the UCI during pregnancy that reflects perinatal outcomes have not been conducted. However, during the first trimester of pregnancy, ultrasonographic examination of the umbilical cord is difficult, and thus errors in measurement may be big. In the third trimester of pregnancy, the volume of amniotic fluid is reduced, and thus the difference between the umbilical cord coiling and torsion is difficult to assess, and thus errors in measurement may be big. Therefore, in our study, the time of the measurement of the UCI, from 22 weeks to 28 weeks, which is the late second trimester of pregnancy was a suitable time.

The significant correlation of the UCI to fetal weight, the volume of amniotic fluid, the diameter of umbilical cord, and the umbilical artery resistant index was not observed. This is in agreement with the studies reported by Predanic et al. that the UCI is not associated with the thickness of umbilical cord or fetal weight [16]. Also this is in agreement with the study reported by Degani et al. that the UCI was not associated with the umbilical arterial Doppler index [5].

This implies that the cause of the association of the UCI with perinatal outcomes is another factor than hemodynamic factors such as the thickness of umbilical cord or blood Doppler waveforms.

In our study, it was suggested that in pregnant women who showed the hyporcoiling of the umbilical cord during the late second trimester of pregnancy, the risk for preterm delivery is increased, consequently the delivery of low birthweight neonates is high, and the admission to the neonatal intensive care unit is increased. But our study has small sample size and is a retrospective study. Larger prospective studies of the prognostic potential of UCI are required to confirm these findings.

Conflict of Interest

The authors have declared that no conflict of interest exists.

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