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Umbilical cord coiling abnormality as a predictor of maternal and fetal outcomes

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Abstract

Background: The umbilical cord forms connecting link between the fetus and placenta through which the fetal blood flows to and from the placenta. Its three blood vessels pass along the length of the cord in a coiled or helical fashion (spiral course). The aim of the study was to evaluate umbilical cord coiling abnormalities and determine its relationship with maternal and perinatal outcomes.

Material and methods: The study included 190 patients divided into 2 groups: L_1 – 95 patients with UC abnormalities and L_0 – 95 with normal UC. The umbilical cord index was measured after delivery of the adnexal complex, which was defined as the total number of coils divided by the total length of the cord in centimeters.

Results: The hypo- and hypercoiling umbilical cord suggests the high risk of fetal distress (p<0.0001), instrumental vaginal deliveries, the admission of the newborn in the neonatal intensive care (p<0.0001) and perinatal morbidity, which demanded a transfer to other medical facilities (p<0.05). UC torsion was associated with insufficiency of placental circulation, IUGR, fetal hypoxia and fetal mortality (p<0.05). The straight cord had significant correlation with maternal infections, antenatal mortality and preterm labor in anamnesis, placental insufficiency, IUGR and neonatal morbidity (p<0.05).

Conclusions: Umbilical coiling index was found to be an important predictor of adverse maternal and perinatal outcomes. To conclude, abnormal umbilical coiling index is associated with an increased rate of adverse antenatal and neonatal features. The association shows wide variations in the numerous studies done so far.

Key words: umbilical cord, coiling abnormality, straight cord, perinatal outcome.

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Introduction

Umbilical cord (UC) is a vital structure which acts as a conduit between the developing fetus and placenta [1]. It carries nutrients, oxygen and fluids necessary for the intrauterine life. This unique lifeline needs optimal protection which is provided by Wharton's jelly, amniotic fluid, helical patterns and coiling of the umbilical vessels [2, 3].

The origin of umbilical cord coiling is unknown. Hypotheses include fetal movements, active or passive torsion of the embryo, differential umbilical vascular growth rates, fetal hemodynamic forces, and the arrangements of muscular fibers in the umbilical arterial wall [4].

Of the many characteristics of the human umbilical cord, a most mysterious and intriguing one is the twisted or spiral course of its component blood vessels. Mathematically speaking, the vessels of the cord are wound as cylindrical helices, rather than spirals, but both terms are used interchangeably to avoid confusion [3]. The coiling of the umbilical vessels develops as early as 28 days after conception and is present in about 95% of fetuses by 9 weeks of conception. The helices may be seen by ultrasonographic examination as early as during the first trimester of pregnancy [5]. Many investigators have found that majority of the cords have a left-sided twist [6-8].

The total number of coils seen is between 0 and 40. The coiled umbilical cord perhaps of its elastic properties, is able to resist external forces that might compromise the umbilical vascular flow. Umbilical coiling appears to confer turgor to the umbilical unit, producing a cord that is strong, yet flexible [9]. *A coil* is of 360-degree spiral course of umbilical vessels. Umbilical cord index (UCI) is defined as the total number of coils divided by the total length of the cord in centimeters [10]. Although UCI can be calculated antenatally by ultrasonography, limited data is available as to its accuracy.

Thus, 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 [11]. Umbilical cord abnormalities are among the pathologies which are still not clarified for the factors in their etiologies, do not have sufficient data on their diagnosis and treatment but may lead to severe perinatal complications. The present study has been undertaken to compare the maternal and perinatal outcome with the abnormal coiling of the cord with respect to umbilical coiling index.

Material and methods

This prospective study was carried out in the Department of Obstetrics and Gynecology at the clinical base of Municipal Clinical Hospital No 1, *Nicolae Testemitsanu* State University of Medicine and Pharmacy. The study and the control groups included 95 patients each (with (L_1) or without (L_0) umbilical cord abnormalities), as determined by sample size calculations.

Umbilical cord assessment was based on macroscopic examinations for length, diameter, color, insertion site, number of twists and vessels. Immediately after delivery, the umbilical cord was clamped at the fetal end and cut with scissors taking care not to milk the cord (as the latter might affect the umbilical cord index). The length of the cord from the fetal end to the placental insertion was measured with a tape (in centimeters). A coil was taken as one complete 360-degree spiral course of the umbilical vessels, and the total number of these complete vascular coils of the entire cord was determined. The generally accepted method of assessing the degree of the umbilical cord coiling is by calculation of the umbilical coiling index (UCI), defined as total number of complete vascular coiling per total length of cord in cm.

Umbilical cord abnormalities (UCA) included in the study were: normocoiled cord (1-3 coils per 10 cm), hypercoiled cord (more than 3 coils per 10 cm), torsion cord (more than 5 coils per 10 cm), hypocoiled cord (fewer than 1 coil per 10 cm), straight cord (the entire length of the umbilical cord shows no evidence of coiling).

The inclusion criteria in the research were: gestational age between 22^{+0}–41^{+6} weeks, spontaneous and singleton pregnancy, maternal age ≥ 18 years, research participation agreement. The exclusion criteria were: gestational age ≤ 21^{+6} weeks and ≥ 42^{+0} weeks, pregnancy, which occurred as a result of assisted reproduction technologies, multifetal gestation, congenital malformations of the fetus, decompensated somatic pathology of the patient, age of the patient ≤ 18 years, patients who refused voluntary participation in the research.

Clinical details obtained along with the cord specimens were: maternal age, gravidity and parity, gestational age, medical conditions complicating pregnancies, the status of the amniotic fluid, perinatal complications, anthropometric parameters of the newborn, APGAR score at 1 and 5 minutes as recorded by the obstetricians. All the mothers and babies were followed up till discharge.

Statistical analysis was performed using Statistical Package for Social Sciences for Windows (SPSS Version 23.0), Statistical Analysis System (SAS Version 9.4) and Microsoft Excel 2016. The significance was tested by using a Chi-square test, the Phi coefficient, the contingent coefficient, the Cramer V coefficient, and the Fisher's exact test. For all quantitative characteristics in the compared groups were evaluated the arithmetic means and mean-square (standard) errors of the mean, coefficient of variation, median, mode, and quartiles. *P* value of less than 0.05 was regarded as statistically significant.

Results and discussion

The age of the patients included in the control group (L_0) was between 19-37 years with the average of 27.86±4.36 years and in the study group (L_1) was between 19-40 years with an average of 29.09±4.84 years (fig. 1).

The rate of respondents living in the urban areas of the country was 87.37% (83) vs 82.11% (78) in the control and study groups respectively (p=0.31) (fig. 2). The analysis of the marital status in the study groups demonstrated 85.26% (81) married women in the L_0 vs 77.89% (74) in the L_1 (p=0.30) (fig. 3). Thus, according to the age criterion, living environment, marital status, the examined lots were homogeneous.

The birth weight in the control group (L_0) was 2460–4780 g (mean 3470.21±463.80 g); in the study group (L_1) – 1030-4760 g (mean 3198.11±673.68 g). The newborn length in the L_0 = 45-57 cm (52.37±1.99 cm) vs 34–58 cm (51.06±3.63 cm) in the L_1. APGAR score at 1 min L_0 = 7-10 points (8.66±0.69) vs L_1 = 0-9 points (7.46±1.65). APGAR score at 5 min L_0 = 8-10 points (9.13±0.67) vs L_1 = 0-10 points (8.01±1.7). The length of the umbilical cord in the L_0 ranged between 42-69 (55.6 ± 7.29) cm, but in the L_1 = 25-90 (56.46 ± 17.23) cm.

In the study group was determined hypocoiled cord – 35.79% (34), hypercoiled cord – 7.37% (7), torsion cord – 6.32% (6) and straight cord – 15.79% (15).

Umbilical cord coiling abnormality was significantly associated with adverse maternal and perinatal outcome. Both hypo- and hypercoiling groups were found to be significantly associated with intrapartum fetal heart rate abnormalities which suggest the high risk of fetal distress (p<0.0001) and instrumental vaginal deliveries (vacuum extraction (p<0.0001). This is explained by the fact that coil-

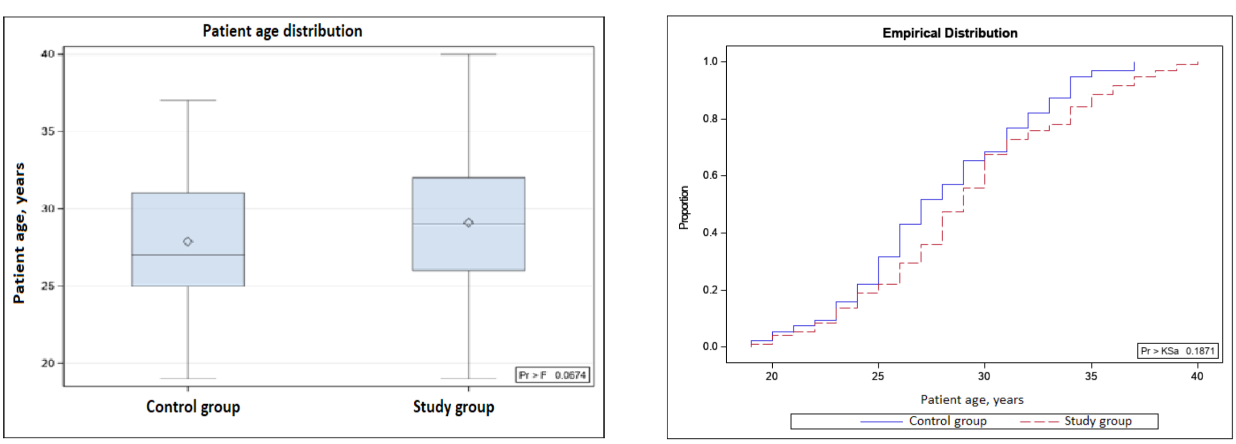

Fig. 1. Distribution of groups according to age criterion (years).

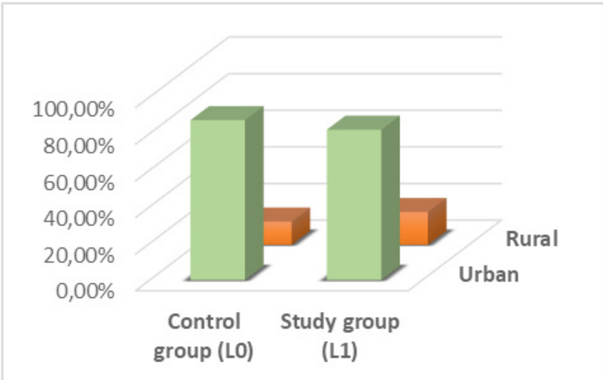

Fig. 2. Distribution of groups according to the living environment.

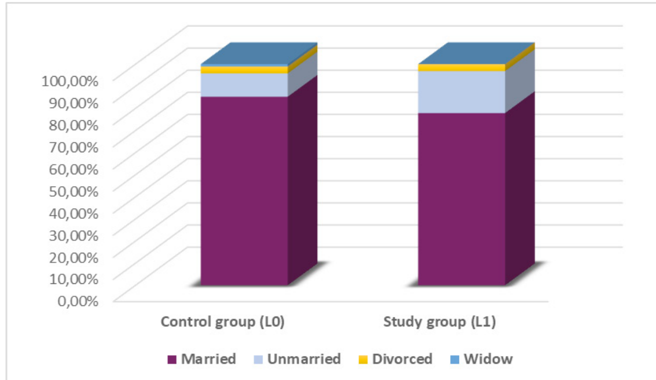

Fig. 3. Distribution of groups according to the marital status.

Table 1

Maternal and perinatal factors of the umbilical cord coiling abnormalit

The evaluated characteristics	Chi-square test (χ^2)	*df*	*P value*	*Cramer's V*
Hypocoiled UC				
Insufficiency of placental circulation (IB, II)	40.93	9	<0.0001	0.27
Fetal bradicardia	51.09	6	<0.0001	0.37
Pathological CTG	53.95	6	<0.0001	0.4
Vacuum extraction	21.25	3	<0.0001	0.37
Fetal hypoxia	56.02	3	<0.0001	0.55
Pathological adaptation period	22.11	3	<0.0001	0.34
Neurological disorders of the newborn	9.31	3	0.02	0.34
Hypercoiled UC				
Harmful factors at work	9.71	3	0.02	0.3
Intrauterine infection (chorioamnionitis)	27.6	3	<0.0001	0.38
Fetal bradicardia	51.09	6	<0.0001	0.37
Induction of labor	10.27	3	0.01	0.25
Labor Weakness	40	9	<0.0001	0.3
Vacuum extraction	21.25	3	<0.0001	0.37
Pathological adaptation period	22.11	3	<0.0001	0.34
Neonatal morbidity	19.78	3	0.0002	0.32
Transfer to the second stage *or* other medical facilities	15.50/16.8	3	0.0014/0.0008	0.28/0.3
Torsion UC				
Antenatal mortality in anamnesis	30.82	3	<0.0001	0.4
Insufficiency of placental circulation (IA)	16.38	3	0.0009	0.3
IUGR	25.74	3	<0.0001	0.36
Fetal hypoxia	56.02	3	<0.0001	0.55
Stillbirth	9.47	3	0.02	0.22
Straight UC				
TORCH-infection (Mycoplasma, CMV)	42.4	24	0.01	0.27
Antenatal mortality in anamnesis	11.72	3	0.008	0.25
Preterm labor in anamnesis	8.24	3	0.04	0.2
Placental insufficiency (IB, II)	40.93	9	<0.0001	0.27
IUGR	8.04	3	0.04	0.31
Congenital pneumonia of the newborn	11.11	3	0.01	0.37

Note: UC – umbilical cord, CTG – cardiotocography, IUGR – Intrauterine growth restriction, CMV – Cytomegalovirus.

ing provides turgor and compression resistant properties to the cord which become compromised as the cord becomes hypocoiled [12].

In our study torsion and straight cords were found to be significantly associated with IUGR (p<0.0001 and 0.04). Ankita M. et al. and Agarwal S. et al. [5, 13] demonstrated a significant association between IUGR babies and hypercoiling cord (p=0.000 and p=0.0323). Ezimokhai et al. and Monique de Laat et al. obtained a similar result in their studies [14, 15]. However, Machin et al. [16] found IUGR to be associated with hypocoiling. They summarized that since adequate coiling prevents compression of the cord, hypocoiling in the long run results in reduced fetoplacental circulation, thus resulting in growth restriction.

Another interesting aspect to be analyzed is the admission of the newborn in the neonatal intensive care unit (NICU).

Dr. T. Shobha et al. [12] demonstrated that the newborn with hypocoiled and hypercoiled cords required NICU care, with strongly significant suggestive of correlation between the two groups (*p* value being 0.001 and 0.0136 respectively). We obtained a similar result that suggests strong correlation between hyper- and hypocoiled cords ($p<0.0001$).

In case of the torsion of umbilical cord, blood flow decreases below the critical level and this leads to fetal hypoxia, intrauterine growth restriction (IUGR) and fetal death ($p<0.05$). Akgün N. et al. and Yuce T. et al. confirm these results [17, 18].

No association was found between abnormal coiling and extragenital maternal diseases, pregnancy induced hypertension, oligo(poly)hydramnios, obstetric hemorrhage, premature rupture of membranes, meconium staining of liquor ($p>0.05$). Ezimokhai et al. [14] found hypercoiling to be associated with extremes of maternal age (< 20 and > 35 years). None of the other studies found age to be a significant factor [14].

The relation between UCI and various maternal/perinatal outcomes has been summarized in table 1. To conclude, abnormal umbilical coiling index is associated with several adverse antenatal and neonatal features.

Conclusions

1. The hypocoiling umbilical cord suggests the high risk of fetal distress ($p<0.0001$), instrumental vaginal deliveries (vacuum extraction), the admission of the newborn in the neonatal intensive care ($p<0.0001$) and neurological disorders of the newborn ($p=0.02$).

2. The hypercoiling umbilical cord was correlated with intrauterine infection (chorioamnionitis), labor weakness, fetal distress, pathological adaptation period, neonatal morbidity, which demanded a transfer to other medical facilities ($p<0.05$).

3. The torsion of umbilical cord was associated with insufficiency of placental circulation, IUGR, fetal hypoxia and fetal mortality ($p<0.05$).

4. The straight cord had significant correlation with maternal infections, antenatal mortality and preterm labor in anamnesis, placental insufficiency, IUGR and neonatal morbidity ($p<0.05$).

References

1. Moshiri M, Zaidi SF, Robinson TJ., Bhargava P, et al. Comprehensive imaging review of abnormalities of the umbilical cord. RadioGraphics. 2014;34(1):179-96.
2. Gurusamy U, Thangavelu R, Venkataswamy C. Abnormalities of the umbilical cord: correlation with placental histology and perinatal outcome. Int J Res Med Sci. 2017;5:5009-16.
3. Chitra T, Sushanth YS, Raghavan S. Umbilical coiling index as a marker of perinatal outcome: an analytical study. Obstet Gynecol Int. 2012:213689. doi:10.1155/2012/213689.
4. Baergen RN. Umbilical cord pathology. Surg Pathol Clin. 2013;6(1):61-85.
5. Mittal A, Nanda S, Sen J. Antenatal umbilical coiling index as a predictor of perinatal outcome. Arch Gynecol Obstet. 2015;291(4):763-8. doi 10.1007/s00404-014-3456-5.
6. Patil NS, Kulkarni SR, Lohitashwa R. Umbilical cord coiling index and perinatal outcome. J Clin Diagn Res. 2013;7(8):1675-7.
7. Khong TY, Mooney EE, Ariel I, et al. Sampling and definitions of placental lesions: Amsterdam Placental Workshop Group Consensus Statement. Arch Pathol Lab Med. 2016;140(7):698-713.
8. Diwakar RK, Naik MM, Jindal MM. Umbilical cord coiling: case report and review of literature. BJR Case Rep. 2017;3(1):20150152.
9. Chholak D, Gupta P, Khajotia S. Study to evaluate association of umbilical coiling index and perinatal outcome. Int J reprod Contracept Obstet Gynecol. 2017;6(2):408-12.
10. Jessop FA, Lees CC, Pathak S, Hook CE, Sebire NJ. Umbilical cord coiling: clinical outcomes in an unselected population and systematic review. Virchows Arch. 2014;464(1):105-12.
11. Tripathy S. Umbilical Coiling Index and its relationship with perinatal outcomes. Indian J Neonatal Med Res. 2014;2(2):1-4.
12. Shobha T, Sharanya VS. Umbilical coiling index as a marker of perinatal outcome. Int J Sci Res. 2016;5(4):1951-5.
13. Agarwal S, Purohit RC, Jain G. Umbilical cord coiling index and perinatal outcome in normal and abnormal pregnancies. Sch J App Med Sci. 2014;2(1D):447-50.
14. Ezimokhai M, Rizk DE, Thomas L. Maternal risk factors for abnormal vascular coiling of the umbilical cord. Am J Perinatol. 2000;17(8):441-6.
15. de Laat MW, vander Meij JJ, Visser GH, Franx A, Nikkels PG. Hypercoiling of the umbilical cord and placental maturation defect: associated pathology? Pediatr Dev Pathol. 2007;10(4):293-9.
16. Machin GA, Ackerman J, Gilbert-Barness E. Abnormal umbilical cord coiling is associated with adverse perinatal outcome. Pediatr Dev Pathol. 2000;3:462-71.
17. Akgün N, Kösüs N, Kösüs A, Yardimci F. Umbilical cord stenosis and umbilical cord torsion developing in parallel: a case report. Perinat J. 2016;24(1):47-50.
18. Yuce T, Acar D, Kalafat E, Koç A. Umblical cord torsion: Case report. J Clin Obstet Gynecol. 2015;25(4):292-4. Turkish.

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Author's contributions

AA designed the trial and interpreted the data, drafted the first manuscript, revised and approved the final version of the manuscript.

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Ethics approval and consent to participate

The study protocol was approved by the Research Ethics Committee of *Nicolae Testemitsanu* State University of Medicine and Pharmacy of the Republic of Moldova (proceeding No 95/110, 21.06.2017). Written informed consent was obtained from all participants in the study.

Conflict of Interests

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