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Comparison of umbilical coiling index in term pregnancies with and without fetal growth restriction

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Abstract

Aim: To investigate pregnancies with and without fetal growth restriction, giving birth after 37 weeks of gestation in terms of umbilical coiling index and neonatal outcomes.

Materials and Methods: Twenty-nine patients with fetal growth restriction and 46 patients who have normal pregnancy and delivered after the 37^{th} week of gestation were recruited in this study. The umbilical coiling index was measured by ultrasound, following the patients who were hospitalized for delivery.

Results: There were statistically significant differences between the groups regarding to umbilical artery pulsatility index, gestational age at delivery and birth weight of the newborn. The need for a cesarean section because of non-reassuring fetal condition was statistically significantly higher in the fetal growth restriction group. The mean antenatal umbilical coiling index in fetal growth restriction and control patients was 0.29±0.08 and 0.27±0.08, respectively and the difference was not statistically significant.

Conclusion: There was no statistically significant difference between the patients diagnosed with and without fetal growth restriction who delivered after the 37^{th} gestational week, regarding the umbilical coiling index and perinatal outcomes, except umbilical artery pulsatility index, gestational age at birth and birth weight of the newborn.

Introduction

Fetal growth restriction (FGR), is a pregnancy condition, that caused by the placental dysfunction, and the fetus cannot reach its biological growth potential. There are various factors underlying this condition [1, 2]. FGR is a risk factor for perinatal morbidity and mortality [3]. Furthermore, newborn is at risk, regarding to adverse long-term outcomes, such as neurocognitive developmental retardation [4] and cardiovascular and endocrine diseases in adulthood [5]. FGR affects approximately 5-10% of pregnancies [6].

The normal structure of an umbilical cord includes a helix of three blood vessels composed of two arteries and one vein. There is a mucoid connective tissue around these vessels called Wharton's jelly [7]. Umbilical cord provides the connection between fetus and mother and transfers nutrients and oxygen, but this transport might be affected by the coiling pattern of the cord. The length of the umbilical cord at term is 50-60 cm and there are about 10-11 coils between the fetal and placental insertions [8]. The coiled structure of the cord and the index of coiling were first defined by Edmonds in 1954 [9]. Although there is some hypothesis like fetal movements [9], different vascular growth rates [10] or hemodynamic forces [11], it is not clear why the cord has a spiral structure. Today, the index known as the umbilical coiling index (UCI) was first described by Strong et al. After delivery, the ratio of the total number of coils to the length of the umbilical cord is defined as UCI [12]. According to the results of a series of studies, the normal coiling index is accepted as one coil/5 cm [13-15]. Some studies reported that hypocoiled (undercoiled) or hypercoiled (overcoiled) umbilical cords are associated with fetal death, fetal distress during labor, and FGR [16]. Thrombosis in the umbilical cord vessels and/or constriction of the vessels might be the results of abnormal coiling, and this may be the cause of adverse perinatal outcomes [16]. However, some studies report no relationship between adverse perinatal outcomes and UCI [17, 18].

The aim of this study is to investigate pregnancies, giving birth after 37 weeks of gestation, with and without FGR, in terms of UCI and neonatal outcomes.

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Materials and Methods

Twenty-nine patients with FGR and, maternal age matched 46 patients with normal pregnancy, who delivered after the 37th week of gestation, at Inonu University Department of Obstetrics and Gynecology clinic, between June 2019 and June 2021, were enrolled in this study. This study was approved by Malatya Clinical Research Ethics Committee (Protocol number: 2019/68) and written consent was obtained from participants.

Fetal growth restriction was defined as an estimated body weight of fetus which is lower than 10 percentile and accompanied by intrauterine growth deceleration detected with routine perinatal examinations [19, 20]. The exclusion criteria were the presence of preeclampsia, gestational hypertension, chronic hypertension, gestational diabetes mellitus, type 1 or 2 diabetes mellitus, multifetal pregnancy, the single-artery structure of the umbilical cord, the patients who delivered before 37th gestational week, and inappropriate image of the umbilical cord for measurement of antenatal UCI (aUCI). The gestational ages of the patients were calculated according to the last menstrual period of the patients and correlated with the first-trimester crown-rump length (CRL) measurements. Only the first-trimester CRL measurements were used for the patients who did not remember the last menstrual period. Demographic characteristics, ultrasound findings and neonatal outcomes of patients were recorded.

When the patient was hospitalized for delivery, the UCI was measured by ultrasound. All sonographic measurements were performed by the same clinician and with a 4 C-D 2-5 MHz transabdominal transducer (Voluson E6 and Voluson P6 (GE Healthcare, Milwaukee, WI, USA)). To measure the length of one coil, the longitudinal image of the cord was used and from the inner edge to the outer edge of the arterial wall was measured. For the calculation of aUCI, "aUCI=1/distance in centimeters" formula was used. For coiling categorization, the 10th and 90th percentile of the aUCI was used, and the aUCI, that $<$ 10th, between 10-90th and $>$ 90th percentile was accepted as hypocoiled, normocoiled and hypercoiled, respectively [21].

Statistical methods

The data was analyzed using the Statistical Package for Social Sciences soft-ware 17.0 (SPSS, Inc., Chicago, IL). The normality of the distribution of variables was tested by using the Kolmogorov-Smirnov test. All data were referred to the median (interquartile range) and mean ± standard deviation (SD). Student's-t test was used for the variables which have a normal distribution and the Mann-Whitney-U test was used for the variables which do not have a normal distribution. To analyze the categorical data, a Chi-square test was used. A p-value < 0.05 was considered as statistically significant.

Results

The results of the demographic characteristics of patients, ultrasound findings and neonatal outcomes were shown in Table 1. There were statistically significant differences between gestational age at delivery and birth weight of the newborn. The mean umbilical artery pulsatility index (UAPI) was 0.97±0.29 and 0.82±0.14 in FGR and control groups, respectively, and the difference was statistically significant (p=0.013). The need for a cesarean section because of non-reassuring fetal condition was statistically significantly higher in the FGR group ($p < 0.005$). Nevertheless, there was no statistically significant difference, regarding to umbilical artery pH and neonatal intensive care unit (NICU) requirement of the newborn, between the groups. The non-progressive labor and cephalopelvic discordance as an indication for the cesarean section was not statistically significantly different between the groups.

The mean aUCI in FGR and control patients was 0.29±0.08 and 0.27±0.08, respectively, and the difference was not statistically significant (p=0.32). The 10th and 90th centiles for the aUCI were 0.19 coils/cm and 0.40 coils/cm, respectively (Table 2).

There was no statistically significant difference between the groups according to coiling categorization (p=0.73).

There was a positive correlation between UCI and UAPI (R=0.32, p=0.005), however there was no correlation between UCI and pH (R= -0.1, p=0.39). On the other hand, there was a negative correlation between UAPI and pH, in pregnant women with FGR (R= -0.36, p=0.05).

Discussion

There was no statistically significant difference between the patients diagnosed with and without FGR who delivered after the 37th gestational week, regarding to the UCI and perinatal outcomes, except UAPI, gestational age at birth and birth weight of the newborn, in this study.

There was no relationship between the groups, in terms of coiling categorization and no effect of coiling pattern to the neonatal outcomes, in the present study. Several studies indicate the relationship between the umbilical coiling pattern and adverse neonatal outcomes [22-25]. Some studies demonstrated that the coiling pattern of umbilical cord as hypo-, normo- or hyper- coiled, was associated with adverse neonatal outcomes [12, 15, 16, 26].

In the present study, there was no association between the aUCI and gestational age at delivery, and birth weight of the newborn. Rana et al., reported that hypercoiling is associated with premature delivery [15]. In contrast, de Laat et.al. [25] reported that hypocoiling is associated with preterm delivery. Because only the pregnancies that delivered after the 37th gestational week were included, this study cannot make inference about preterm delivery.

In this study there was no relationship between the presence of oligohydramnios and the aUCI, in the groups. In agreement with this study, Kalem et.al. [27] reported no relationship between UCI and oligohydramnios. On the other hand, Kashanian et al. [21] reported that the risk of oligohydramnios is higher with hypercoiled cords. Similarly, Mustafa and Said [28] reported that hypercoiling is associated with both oligo- and polyhydramnios. On the contrary, Sahoo, et al. [29] reported that oligohydramnios is associated with hypocoiling.

Table 1. The demographic parameters, ultrasound findings and perinatal outcomes of the groups

	FGR (n=29) Median (interquartile range)	Control (n=46) Median (interquartile range)	p
Age (years) †	28.3±4.9	30.8±5.8	0.06
Gravida	2(1-4)	2.5(2-3.25)	0.75
Parity	1(0-2)	1(1-2)	0.35
Abortus	0(0-1)	0(0-1)	0.71
Live birth	1(0-2)	1(1-2)	0.27
Gestational age at delivery (week)	38(37-39)	39(39-39)	< 0.001*
Birth weight of newborn (gram) †	2475±291	3292±361	< 0.001*
pH	7.35(7.32-7.38)	7.34(7.32-7.36)	0.21
aUCI (coils/cm) †	0.29±0.08	0.27±0.08	0.32
UAPI	0.97±0.29	0.82±0.14	0.013*
Mode of delivery			1
NVD	1 (3.44%)	3 (6.52%)	
C/S	28 (96.56%)	43 (93.48%)	
Indication for cesarean			
Previous C/S	13 (44.82%)	30 (65.21%)	0.08
Non-reassuring fetal condition	9(31.03%)	3 (6.52%)	0.005*
Malpresentation	2 (6.87%)	0 (0%)	0.14
Non-progressive labor and CPD	4 (13.79%)	10 (21.73%)	0.54
Gender			0.51
Female	18 (62.06%)	25 (54.34%)	
Male	11 (37.94%)	21 (45.66%)	
Oligohydramnios			0.09
Yes	7 (24.13%)	4 (8.69%)	
No	22 (75.87%)	42 (91.31%)	
NICU recruitment			0.70
Yes	4 (13.79%)	4 (8.69%)	
No	25 (86.21%)	42 (91.31%)	

*Statistically significant

† Normally distributed variables according to Kolmogorov-Smirnov test (mean±SD) aUCI: Antenatal umbilical coiling index, C/S: Cesarean section, CPD: Cephalopelvic discordance, FGR: Fetal growth restriction, NVD: Normal vaginal delivery, NICU: Neonatal intensive care unit, UAPI: Umbilical artery pulsatility index

Table 2. The coiling categorization of groups

	FGR (n=29)	Control (n=46)	p
Hypocoiled (aUCI < 0.19 coils/cm)	3 (10.34%)	8 (17.40%)	0.56
Normocoiled (aUCI=0.19-0.40 coils/cm)	21 (72.42%)	33 (71.74%)	
Hypercoiled (aUCI > 0.40 coils/cm)	5 (17.24%)	5 (10.86%)	

aUCI: Antenatal umbilical coiling index, FGR: Fetal growth restriction

There was no relationship between the umbilical cord arterial pH levels and aUCI. Although de Laat et al. [30] reported that hypercoiling is associated with fetal acidosis, Kalem et al.[27] reported no association with coiling and fetal acidosis. Besides, similarly to Kalem et al. [27], there was no relationship between the UCI and neonatal intensive care requirement among groups in the present study.

In this study there was statistically significant difference regarding the non-reassuring fetal condition between the groups. Previous studies reported that hypercoiled UCI is associated with fetal distress [12, 15, 26]. Also Sahoo, et al. [29], reported that both hypercoiling and hypocoiling are associated with fetal distress, meconium-stained amniotic fluid, and assisted deliveries. Although, Degani et al. [14], reported that there was no correlation between UCI and UAPI in term fetuses, there was a positive correlation between UCI and UAPI in this study.

Conclusion

There was no statistically significant difference between the patients diagnosed with and without FGR, who delivered after the 37th gestational week, regarding the UCI and perinatal outcomes, except UAPI, gestational age at birth and birth weight of the newborn.

Study limitations

The low number of participants is a limitation of this study. Because of the low participant number, the number of patients according to hypo-, normo-, and hypercoiled were also low. Nevertheless, although there are some studies and meta-analysis about UCI and obstetric and/or neonatal outcomes, this study is the first case-control study that compares the term fetal growth restriction (FGR) cases and controls in terms of the association of aUCI and obstetric and neonatal outcomes.

Ethics approval

This study was approved by Malatya Clinical Research Ethics Committee (Protocol number: 2019/68)

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