Int J Clin Exp Med 2020;13(8):5843-5847
www.ijcem.com /ISSN:1940-5901/IJCEM0113107

Original Article

Analysis of the correlation between fetal growth restriction and abnormal umbilical artery blood flow and the influencing factors on fetal growth

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Received April 22, 2020; Accepted June 13, 2020; Epub August 15, 2020; Published August 30, 2020

Abstract: Analysis of the correlation between fetal growth restriction (FGR) and abnormal umbilical artery blood flow and the influencing factors on fetal growth. A total of 120 pregnant women with FGR admitted to our hospital from January 2016 to January 2019 were selected as study subjects in the observation group, while 100 normal pregnant women were recruited into the control group. The ratio of the systolic peak value to diastolic peak value (S/D), resistance index (RI) and pulsatility index (PI) of umbilical artery blood flow in the two groups were observed, since the elevation of these indexes indicates oxygen deficit and various factors that cause FGR were analyzed. The factors with statistical significance were included in the multivariate logistic regression analysis to analyze the independent risk factors of FGR. The S/D, PI and RI of the observation group were higher than those of the control group, and the differences were statistically significant ($P<0.05$). The S/D of the observation group decreased with the advance of gestational weeks, and was higher than that of the control group; the results of univariate and multivariate logistic regression analysis found that anemia, oligohydramnios, placental abnormality and umbilical cord abnormality were independent risk factors for FGR. When a fetus in the uterus develops a growth restriction, his/her umbilical artery blood flow will show clear abnormalities, and the resistance to blood flow will increase significantly. The anemia, oligohydramnios, placental abnormality, umbilical cord abnormality and fetal membrane abnormalities are independent risk factors for FGR. Attention has to be paid to pregnant women with such conditions in clinical practice.

Keywords: Fetal growth restriction (FGR), abnormal umbilical artery blood flow, correlation, influencing factors

Introduction

FGR is a common high-risk pregnancy phenomenon found in Obstetrics [1]. This may cause more severe postnatal illness or fetal death [2]. A study claimed that the pathogenesis of FGR is relatively complex, and its treatment measures are relatively limited [3]. FGR mainly refers to when the difference between the fetal weight and the pregnant woman's gestational age does not meet the normal growth standards. Some studies have shown that the FGR has a certain correlation with abnormal umbilical artery blood flow [4]. However, other studies have shown that the abnormal umbilical artery blood flow leading to FGR in pregnant women is not the only factor leading to FGR [5, 6]. Therefore, a total of 120 pregnant women with FGR who were admitted to our hospital from January 2016 to January 2019 were enrolled in this study, aiming to investigate the relationship between the FGR and abnormal umbilical artery blood flow, as well as the influencing factors of FGR.

Materials and methods

General information

A total of 220 pregnant women who were admitted to our hospital for treatment from January 2016 to January 2019 were enrolled, 120 of whom with FGR were included in the observation group, and the other 100 healthy pregnant women were enrolled in the control group. The observation group aged ranged from 22 to 39 years, with an average age of (30.14±4.26) years and average gestational age of (33.1±0.4) weeks; while the control group aged ranged from 21 to 40 years, with an average age of (30.49±4.41), the gestational age was 30 to 37

Table 1. Abnormal indexes of umbilical artery blood flow of pregnant women in the observation group and control group ($\bar{x} \pm s$)

Group	n	S/D	RI	PI
Observation group	120	3.16±0.81	0.91±0.18	1.22±0.26
Control group	100	2.61±0.44	0.68±0.13	0.98±0.27
t value	-	6.082	10.667	6.699
P value	-	<0.001	<0.001	<0.001

weeks, with an average gestational age of (33.2±0.4) weeks. No significant difference was found with respect to the general data between the two groups ($P>0.05$).

Inclusion and exclusion criteria

Inclusion criteria: 1) Pregnant women who met the diagnostic criteria of FGR. 2) Pregnant women with complete delivery data. 3) Pregnant women with single pregnancy. 4) Pregnant women and their families who were informed of the study and signed the informed consent form. Exclusion criteria: 1) Pregnant women with multiple pregnancies and the fetuses were abnormal. 2) Pregnant women complicated with other diseases, such as hypertension, diabetes and heart disease, etc. 3) Fetuses had chromosomal abnormality. 4) Pregnant women and their families who did not agree to participate in the study and refused to sign the informed consent form. 5) If the pregnancy needed to be terminated in advance due to the pregnant women or the fetuses having abnormalities during the observation period.

FGR diagnostic instrument and monitoring mode

All pregnant women were examined by color Doppler diasonograph (manufacturer: Jiangsu Jiahua Electronic Equipment Co., Ltd.) and the examination was completed by assigned staff. During the examination, the pregnant women assumed a supine position, or were lying on their side when necessary to keep their breathing stable. Routine examination was carried out for the fetuses in the womb of pregnant women, including biparietal diameter, head circumference, abdominal circumference, femur length and amniotic fluid, in order to evaluate the development of the fetuses in the uterus. CDFI was used to search for the umbilical cord. It was necessary to avoid the position close to the placenta and umbilical cord when searching, mainly finding the free part of umbilical cord approaching the fetus. The ratio of the systolic peak value to diastolic peak value (S/D), resistance index (RI) and pulsatility index (PI) of umbilical artery blood flow were measured.

Observation indexes

S/D, RI and PI of pregnant women were observed in the two groups. All clinical indexes of pregnant women were observed in two groups, and the indexes with statistical significance were included into the multivariate logistic regression template, so as to analyze the related influencing factors leading to FGR.

Statistical analysis

SPSS 22.0 software was used for statistical analysis. The enumeration data were expressed by (n, %) and the comparison was conducted by chi-square test; the measurement data were expressed as $\bar{x} \pm s$, and analyzed by independent sample t test. The clinical indexes with statistical significance were included in the logistic regression template, to analyze the influencing factors that result in FGR. $P<0.05$ was considered statistically significant.

Results

Abnormal indexes of umbilical artery blood flow of pregnant women in the two groups

The S/D, RI and PI of pregnant women in the observation group were significantly higher than those in the control group, and the differences were statistically significant ($P<0.05$) (**Table 1**).

Comparison of umbilical artery blood flow S/D of different time points between the two groups

The umbilical artery blood flow S/D of the control group was <3.0, while the S/D of the observation group decreased with the advance of gestational weeks, and was higher than that of the control group. The differences were statistically significant ($P<0.05$) (**Table 2**).

Analysis of influencing factors of pregnant women's clinical indexes in the two groups

The differences were significant in terms of anemia, oligohydramnios, placental abnormality, umbilical cord abnormality and other indexes between the two groups ($P<0.05$) (**Table 3**).

Table 2. Comparison of umbilical artery blood flow S/D of different time points between the two groups ($\bar{x} \pm s$)

Group	n	30~34 weeks	34~36 weeks	36~38 weeks	38~40 weeks	40~42 weeks
Control group	100	2.46±0.51	2.31±0.42	2.23±0.23	2.15±0.50	2.23±0.33
Observation group	120	4.55±1.32	4.42±0.89	3.26±0.55	3.06±0.65	3.11±0.51
t value		14.98	24.32	12.45	6.75	11.23
P value		<0.05	<0.05	<0.05	<0.05	<0.05

Table 3. Analysis results of influencing factors of each clinical index in the observation group and control group

Factor		Observation group (n=120)	Control group (n=100)	t/χ^2 value	*P* value
Age (years old)		30.14±4.26	30.49±4.41	0.597	0.551
Gestational weeks (weeks)		33.1±0.4	33.2±0.4	1.846	0.066
Eclampsia	Yes	12	5	1.912	0.167
	No	108	95		
Cholestasis	Yes	8	2	2.738	0.098
	No	112	98		
Pregnancy-induced hypertension	Yes	4	3	0.020	0.888
	No	116	97		
Anemia	Yes	22	6	7.470	0.006
	No	98	94		
Diabetes	Yes	15	21	2.880	0.090
	No	105	79		
Oligohydramnios	Yes	24	8	6.319	0.012
	No	96	92		
Placental abnormality	Yes	25	4	13.506	<0.001
	No	95	96		
Abnormality of umbilical cord	Yes	51	10	28.750	<0.001
	No	69	90		
Fetal membrane abnormality	Yes	44	32	0.525	0.469
	No	76	68		

Results of multivariate logistic regression analysis in pregnant women with FGR

The results of multivariate logistic regression analysis showed that anemia, oligohydramnios, placental abnormality and umbilical cord abnormality were independent risk factors for FGR (**Table 4**).

Discussion

With the development of gestational age in a normal pregnancy, the intrauterine placental villi develop and proliferate; the vascular lumen continuously expands and proliferates; the total cross-sectional area of the vascular lumen in the placenta increases significantly; the circulation resistance of the placenta decreases significantly and the blood flow of the umbilical artery is normal. However, the abnormal blood flow of the umbilical artery causes significant increase in placental circulatory resistance, which is mainly due to the fundamental changes in the diameter, number, and vasodilation of placental terminal vessels. When the umbilical artery blood flow is abnormal, ischemia and anoxia will occur in placental cells, and the blood vessel structure will change significantly, resulting in the disorder of energy transmission between the mother and the fetus, and affecting the growth, development and survival of the fetus. When abnormal umbilical artery blood flow occurs, the nutrition provided by the placenta is insufficient to support normal growth and development of the fetus, which can lead to FGR [7]. FGR is a common complication in the Obstetrics. It was found that the mortality of FGR is 6.39% [8, 9], indicating that the mortality rate of fetuses with growth restriction after birth is 4-6 times higher than that of newborns without growth restriction [10, 11]. In

Table 4. Results of multivariate logistic regression analysis in pregnant women with FGR

Factor	B	standard error	Wald	df	P	Exp (B)	95% confidence interval of Exp (B)	
							Lower limit	Upper limit
Anemia	1.874	0.499	14.132	1	<0.001	6.515	2.452	17.308
Oligohydramnios	-0.996	0.394	6.394	1	0.011	0.370	0.171	0.799
Placental abnormality	1.461	0.611	5.709	1	0.017	4.308	1.300	14.277
Abnormality of umbilical cord	1.375	0.465	8.748	1	0.003	3.954	1.590	9.833

addition, when compared with other normal fetuses without growth restriction, the physical and mental development of the fetuses with growth restriction in the later period will be relatively slow [12, 13]. Therefore, once FGR in the womb of pregnant women is found clinically, it is necessary to analyze the cause and actively treat it, so as to prevent a series of problems caused by the FGR after birth. This study mainly explored the relationship between the FGR and abnormal umbilical artery blood flow, and analyzed the influencing factors of FGR, in order to provide references for clinical diagnosis and treatment of FGR.

FGR to a certain extent affects the life of the fetus after birth, and it can also lead to the death of the fetus in the womb of the mother. Some studies revealed that the umbilical artery blood flow test can determine whether the fetus in the womb has growth restriction or not. The Doppler ultrasound of fetal umbilical artery can detect the umbilical artery blood flow and estimate the S/D, RI, PI and other indexes [14]. The umbilical artery blood flow will change when FGR occurs. FGR mainly manifest as the increased resistance of umbilical artery blood flow. In this paper, the RI of pregnant women in the observation group was significantly higher than that in the control group. While the S/D, PI and other umbilical artery blood flow indexes in the observation group were significantly higher than those in the control group, the S/D of the observation group decreased with the advance of gestational age, and was higher than that of the control group, demonstrating that the blood flow speed of pregnant women in the observation group is slow due to the elevated resistance of blood flow and it can result in the decrease of oxygen supply for the fetus and the FGR in the womb, which was consistent with the previous study results [14-16]. The results of univariate and multivariate analysis showed that anemia, oligohydramnios, placental abnormality, umbilical cord abnormality and fetal membrane abnormality were independent risk factors for FGR, because maternal anemia is likely to induce the stagnation of blood circulation between the placenta and fetus and slow down the energy materials imported from the mother to the fetus. This result is similar to other studies [16, 17]. Therefore, it easily leads to intrauterine FGR and maternal anemia. Oligohydramnios is also one of the factors that leads to FGR, which may be attributed to the fetus being affected by placental blood flow resistance. When the fetus has lack of oxygen, the blood circulation of the fetus itself needs to be redistributed. At this time, the blood supply to the brain and heart will increase significantly, while the blood supply to the kidney will decrease relatively, so the fetal urine will also reduce, and further result in little amniotic fluid. The placenta and umbilical cord are important organs of nutrition and gas exchange between the mother and the fetus. The development of the fetus is closely related to the placenta and umbilical cord. It is reported that abnormal placentas and umbilical cords can cause FGR [17, 18]. It is found that when the placenta and umbilical cord of pregnant women are abnormal, the umbilical artery blood flow will have clear abnormalities [19, 20].

To sum up, when FGR occurs, the umbilical artery blood flow will have clear abnormalities. The independent risk factors for FGR consist of anemia, oligohydramnios, abnormal placenta and an abnormal umbilical cord. In clinical practice, attention needs to be paid to pregnant women with such conditions, and early intervention measures should be taken to prevent the FGR.

However, due to the small sample size and short follow-up time in this study, there may be biased results. In future research, a larger sample size and longer follow-up time will be invested to provide more guidance for the treatment of such a disease.

Disclosure of conflict of interest

None.

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