



# Ultrasound evaluation of fetal left ventricular Tei index in gestational hypertension and its correlation with the degree of placental hypoxia

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## ABSTRACT

**Objective:** To determine the fetal left ventricular Tei index level in gestational hypertension, and evaluate its correlation with the degree of placental hypoxia. **Methods:** A total of 98 pregnant women with gestational hypertension who gave birth in our hospital between May 2013 and May 2016 were selected as the gestational hypertension group and 50 normal pregnant women were selected as the normal pregnancy group. Before delivery, the color Doppler diasonograph was used to detect fetal left ventricular Tei index and umbilical blood flow parameters, enzyme-linked immunosorbent assay (ELISA) was used to detect the levels of hypoxia-related indexes and nerve injury indexes in umbilical venous blood after delivery of baby, and Pearson test was used to further evaluate the internal relations between fetal left ventricular Tei index and placental hypoxia degree. **Results:** Fetal left ventricular Tei index level of gestational hypertension group was higher than that of normal pregnancy group. Fetal ultrasonic umbilical blood flow parameters RI, PI and S/D levels of gestational hypertension group were higher than those of normal pregnancy group, ischemia hypoxia indexes HIF-1 $\alpha$  and HSP70 contents in umbilical venous blood were higher than those of normal pregnancy group while NO content was lower than that of normal pregnancy group, and nerve injury indexes NSE, S100B and MBP contents in umbilical venous blood were higher than those of normal pregnancy group. After Pearson test, fetal left ventricular Tei index in gestational hypertension was directly correlated with umbilical blood flow parameter levels as well as ischemia hypoxia index and nerve injury index contents in umbilical venous blood. **Conclusion:** Fetal left ventricular Tei index level in gestational hypertension is higher than that in normal fetus, and Tei index level is directly correlated with placental ischemia hypoxia degree.

## 1. Introduction

Gestational hypertension refer to the hypertension, proteinuria and so on occurring after 20 weeks of gestation, the blood pressure continues to rise and the albuminuria increases as the illness is aggravating, which seriously influence maternal and child safety[1,2]. Gestational hypertension is mainly characterized by systemic small artery spasm, it can reduce the uterine and placental blood

supply and lead to fetal hypoxia, and the early determination of fetal hypoxia degree is the key to choose the appropriate delivery time and protect the security of the fetal life. Tei index, also called cardiac work index, can objectively reflect the overall left ventricular function, its change is small in the adult, its sensitivity is high to the change in fetus and children < 3 years old, and it can be used as a reliable means to monitor fetal cardiac function[3,4]. In the study, the left ventricular Tei index of gestational hypertension fetus inspection in our hospital between May 2013 and May 2016 was detected, and its inner link to placental ischemia and anoxia was further evaluated in order to define the clinical value of the means for monitoring the illness in fetus with gestational hypertension disease and guiding the delivery time.

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## 2. Information and methods

### 2.1 General information

A total of 98 pregnant women with gestational hypertension were selected as gestational hypertension group, 50 normal pregnant women were selected as normal pregnancy group, and the research subjects and families signed informed consent. Inclusion criteria: (1)  $\leq 40$  years old; (2) with singleton pregnancy; (3) without history of gestational hypertension; (4) cooperating with all the checks. Exclusion criteria: (1) associated with gestational diabetes, gestational heart disease and other serious complications during pregnancy; (2) associated with intrauterine infectious diseases; (3) associated with fetal chromosomal abnormalities. Gestational hypertension group were 26-38 years old, the parity was 1-3 and  $(1.73 \pm 0.41)$  in average, and the body mass index was  $24-34 \text{ kg/m}^2$  and  $(27.31 \pm 4.52) \text{ kg/m}^2$  in average; normal pregnancy group were 24-36 years old, the parity was 1-3 and  $(1.68 \pm 0.39)$  in average, and the body mass index was  $23-34 \text{ kg/m}^2$  and  $(27.15 \pm 4.68) \text{ kg/m}^2$  in average. Two groups of pregnant women were not significantly different in the distribution of age, parity and BMI ( $P > 0.05$ ), and the hospital ethics committee approved the study.

### 2.2 Left ventricular Tei index

Before delivery, the Philips color Doppler diasonograph HD5 was used for echocardiography examination of two groups of fetuses, four-chamber view, ventricular outflow tract view and coronary short-axis view were taken, the sampling volume was placed in the left and right ventricular outflow and inflow tract, and the blood flow spectrum was obtained. Left ventricular Tei index = (left heart isovolumetric contraction phase + left heart isovolumetric relaxation phase)/left ventricular ejection time, and three cardiac cycles were measured in a row to take the averaging.

### 2.3 Ultrasonic umbilical blood flow parameters

Before delivery, Voluson E8 four-dimensional color Doppler ultrasonic diagnosis system was used to evaluate fetal ultrasonic umbilical blood flow parameters of two groups of pregnant women. The probe was placed on fetal ventral umbilical artery to capture 5 consecutive end-systolic and end-diastolic blood flow rate without blood flow image interference, and the umbilical artery resistance index (RI), pulsatility index (PI) and peak arterial systolic blood flow velocity/end-diastolic blood flow velocity (S/D) were recorded.

### 2.4 Umbilical blood hypoxia-related indexes

After delivery of baby, hemostatic forceps were used to clip the fetal-side umbilical cord, umbilical venous blood was collected and centrifuged to get serum, and ELISA was used to determine the levels of hypoxia-related parameters hypoxia inducing factor-1  $\alpha$  (HIF-1  $\alpha$ ), nitric oxide (NO) and heat shock protein 70 (HSP70) as well as nerve injury indexes neuron-specific enolase (NSE), S100B protein (S100B) and myelin basic protein (MBP).

### 2.5 Statistical methods

Personnel who received professional statistical training were selected to input and calculate the data in the study, and statistical software was SPSS20.0. Tei index, umbilical artery flow parameters, umbilical venous blood indexes and other measurement data were in terms of mean  $\pm$  standard deviation, and comparison between two groups was by grouping t test.  $P < 0.05$  was the standard of statistical significance in differences between groups in the study.

## 3. Results

### 3.1 Left ventricular Tei index

Comparison of left ventricular Tei index between two groups of fetuses was as follows: mean fetal left ventricular Tei index value of gestational hypertension group was  $(0.53 \pm 0.07)$  and mean fetal left ventricular Tei index value of normal pregnancy group was  $(0.37 \pm 0.04)$ . Fetal left ventricular Tei index of gestational hypertension group was significantly higher than that of normal pregnancy group, and differences in fetal left ventricular Tei index were statistically significant between gestational hypertension group and normal pregnancy group ( $P < 0.05$ ).

### 3.2 Ultrasonic umbilical blood flow parameters

Comparison of ultrasonic umbilical blood flow parameters RI, PI and S/D levels between two groups of fetuses was as follows: fetal ultrasonic umbilical blood flow parameters RI, PI and S/D levels of gestational hypertension group were higher than those of normal pregnancy group. Differences in ultrasonic umbilical blood flow parameters RI, PI and S/D levels were statistically significant between two groups of pregnant women ( $P < 0.05$ ), shown in Table 1. Pearson test showed that fetal ultrasonic left ventricular Tei index level of gestational hypertension group was positively correlated with umbilical blood flow parameters RI, PI and S/D levels.

**Table 1.**

Comparison of ultrasonic umbilical blood flow parameter levels between two groups of pregnant women.

Groups	n	RI	PI	S/D
Normal pregnancy group	50	0.63 $\pm$ 0.08	0.83 $\pm$ 0.09	2.09 $\pm$ 0.31
Gestational hypertension group	98	0.77 $\pm$ 0.09	1.31 $\pm$ 0.18	4.11 $\pm$ 0.46
T value		5.481	6.382	8.029
P value		<0.05	<0.05	<0.05

### 3.3 Umbilical blood hypoxia-related indexes

Comparison of umbilical venous blood hypoxia-related indexes HIF-1  $\alpha$  (pg/mL), NO ( $\mu\text{mol/L}$ ) and HSP70 (pg/mL) contents between two groups of fetuses was as follows: HIF-1  $\alpha$  and HSP70 contents in umbilical venous blood of gestational hypertension group were higher than those of normal pregnancy group while NO content was lower than that of normal pregnancy group. Differences in umbilical venous blood HIF-1  $\alpha$ , NO and HSP70 contents were statistically significant between two groups of fetuses ( $P < 0.05$ ), shown in Table 2. Pearson test showed that fetal ultrasonic left ventricular Tei index level of gestational hypertension group was positively correlated with hypoxia-related indexes HIF-1  $\alpha$  and HSP70 contents, and negatively correlated with NO content in umbilical venous blood.

**Table 2.**

Comparison of hypoxia-related index contents in umbilical vein between two groups

Groups	n	HIF-1 $\alpha$	NO	HSP70
Normal pregnancy group	50	19.62 $\pm$ 2.74	93.18 $\pm$ 10.29	13.46 $\pm$ 1.92
Gestational hypertension group	98	40.59 $\pm$ 5.37	86.63 $\pm$ 9.21	35.71 $\pm$ 5.35
T value		12.817	9.782	14.372
P value		<0.05	<0.05	<0.05

### 3.4 Umbilical blood nerve injury indexes

Comparison of umbilical venous blood nerve injury indexes NSE ( $\mu\text{mol/L}$ ), S100B (pg/mL) and MBP (ng/mL) contents between two groups of fetuses was as follows: NSE, S100B and MBP contents in umbilical venous blood of gestational hypertension group were higher than those of normal pregnancy group. Differences in umbilical venous blood NSE, S100B and MBP contents were statistically significant between two groups of fetuses ( $P < 0.05$ ), shown in Table 3. Pearson test showed that fetal ultrasonic left ventricular Tei index level of gestational hypertension group was positively correlated with nerve injury indexes NSE, S100B and MBP contents in umbilical venous blood.

**Table 3.**

Comparison of nerve injury index contents in umbilical vein between two groups.

Groups	n	NSE	S100B	MBP
Normal pregnancy group	50	18.94 $\pm$ 2.85	12.48 $\pm$ 1.94	1.46 $\pm$ 0.21
Gestational hypertension group	98	56.77 $\pm$ 7.19	41.77 $\pm$ 6.32	2.73 $\pm$ 0.41
T value		12.491	9.373	6.032
P value		<0.05	<0.05	<0.05

## 4. Discussion

Tei index is a sensitive index in evaluating infant left cardiac function, and its measurement method is simple and with good repetition, and Tei index increases as heart function declines[5]. At present, some scholars have proposed to use Tei index to evaluate the fetal cardiac function in patients with gestational hypertension,

and thus indirectly judge the gestational hypertension damage to the fetus[6]. In the study, Tei index before labor was first compared between the gestational hypertension group and normal pregnancy group, and it was found that fetal left ventricular Tei index of gestational hypertension group was significantly higher than that of normal pregnancy group, showing that maternal gestational hypertension change can cause fetal heart function damage. Studies have pointed out that the fetal heart function damage is one of the important performances of placental ischemia hypoxia, and the inner link between fetal left ventricular Tei index and placental ischemia hypoxia degree remains to be further discussed below.

Ultrasonic fetal umbilical blood flow monitoring is a common noninvasive examination means for fetal umbilical arterial hemodynamics, and it intuitively reflects fetal-placental circulation resistance[7]. S/D ratio reflects the distal peripheral circulation impedance of target artery, S/D ratio increases at first in the case of fetal intrauterine hypoxia, it indirectly reflects the placental oxygen delivery situation, and the rising of S/D ratio is the direct sign of fetal intrauterine hypoxia[8,9]. RI and PI are also the main observation indexes of umbilical blood flow state, its level gradually declines along with the increase of gestational age under physiological condition, and the RI and PI levels increase when there are fetal intrauterine hypoxia and placenta vasoconstriction[10]. In the study, umbilical blood flow parameter levels were compared between gestational hypertension fetuses and normal fetuses, and it was found that fetal RI, PI and S/D levels of gestational hypertension group were higher than those of normal pregnancy group, it indicates that there is placental circulation disorder in gestational hypertension group, the correlation analysis showed that fetal left ventricular Tei index was positively correlated with RI, PI and S/D levels, and it further illustrates that fetal Tei index monitoring can indirectly reflect the extent of its placental circulation obstacle.

Detection of umbilical venous blood indexes after delivery of baby is the most reliable way to determine the degree of fetal ischemia hypoxia, HIF-1  $\alpha$  is the recognized placental hypoxia marker, hypoxia can induce the increase of its expression, and research has confirmed that HIF-1  $\alpha$  content increases in peripheral blood of pregnant women with gestational hypertension[11,12]. NO is the indicator with vasodilatation function, and the systemic small artery spasm caused by gestational hypertension can inhibit the vasodilatation effect of NO and cause the decrease of NO expression, which further increase the occurrence of fetal distress[13]. HSP70 is the newly proposed index that is closely related to placental ischemia hypoxia, the body reactively secretes HSP70 to protect target cells in the case of neonatal ischemia hypoxia, and the content of HSP70 increases in umbilical cord blood along with the increase of newborn hypoxia. In the study, the contents of the ischemia hypoxia-related parameters in umbilical venous blood were compared between compared two groups of fetuses, and it was found that HIF-1  $\alpha$  and HSP70 contents in umbilical venous blood of gestational hypertension group were higher than those of normal pregnancy group while NO content was

lower than that of normal pregnancy group, confirming that there is fetal placental ischemia hypoxia injury in gestational hypertension. And the correlation analysis showed that fetal ultrasonic left ventricular Tei index level of gestational hypertension group was positively correlated with the hypoxia-related indexes HIF-1  $\alpha$  and HSP70 contents, and negatively correlated with NO content in umbilical venous blood, indicating that fetal left ventricular Tei index is directly correlated with placental ischemia hypoxia injury, and monitoring fetal left ventricular Tei index can be used as a reliable means to determine the illness severity.

Fetal intrauterine chronic ischemia hypoxia can last until birth and lead to a variety of perinatal diseases, central nervous system is extremely sensitive to ischemia hypoxia, and severe placental circulation disorder and fetal hypoxia can lead to neonatal brain injury[14]. NSE, S100B and MBP are the indicators closely related to neural function damage, both NSE and S100B are nerve cell-specific, they can only be detected in the blood circulation in the case of nerve injury and blood brain barrier damage, and therefore, their contents are consistent with the hypoxic damage of nervous system[15]. MBP is the main protein of CNS myelin, it helps maintain the stability of myelin sheath structure and function, MBP expression increases reactively in the case of central nervous system function damage, it enters into the peripheral blood through the blood brain barrier, and it is a sensitive indicator of nerve injury. It was found in the study that NSE, S100B and MBP contents in umbilical venous blood of gestational hypertension group were higher than those of normal pregnancy group, it indicates that gestational hypertension can lead to fetal nerve function damage, the correlation study found that fetal ultrasonic left ventricular Tei index level of gestational hypertension group was positively correlated with nerve injury indexes NSE, S100B and MBP contents in umbilical venous blood, and it indicates that fetal Tei index can accurately judge the neural function damage, and lay a foundation for delivery time and the implementation of follow-up treatment after delivery.

To sum up, it can be concluded that left ventricular Tei index of gestational hypertension fetus was higher than that of normal fetus, and Tei index level is positively correlated with the degree of placental ischemia hypoxia. Fetal left ventricular Tei index is expected to become an important basis to judge the severity of gestational hypertension, and direct the timing of delivery and the follow-up treatment after delivery.

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