UDC: 618.3+618.5:616.45-001/.3:616.12-007

PLACENTAL ELASTOGRAPHY IN THE DIAGNOSIS OF PLACENTAL DYSFUNCTION IN FETAL GROWTH RESTRICTION

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Abstract. *The aim of the study was to evaluate the diagnostic significance of placental elastography in pregnant women with fetal growth restriction (FGR) and to compare elastographic parameters with Doppler markers of placental dysfunction.*

A total of 56 pregnant women at 28–36 weeks of gestation were examined: 34 patients with FGR and 22 with physiological pregnancy. All patients underwent fetometry, Doppler assessment of uterine arteries, umbilical artery, and fetal middle cerebral artery, calculation of the cerebroplacental ratio (CPR), and transabdominal shear-wave elastography of the placenta.

Keywords: *placenta, elastography, shear-wave elastography, fetal growth restriction, Doppler, placental dysfunction*

Introduction. Fetal growth restriction (FGR) remains one of the leading causes of perinatal morbidity and mortality. According to international studies, FGR occurs in 5–10% of all pregnancies, and perinatal mortality risk increases by 4–8 times compared to normally developing fetuses.

In most cases, FGR is associated with placental dysfunction caused by impaired placentation, inadequate spiral artery remodeling, and chronic placental hypoperfusion.

Conventional ultrasound diagnostics of FGR includes fetometry and Doppler assessment of the maternal–placental–fetal circulation. The most informative indices are resistance index (RI), pulsatility index (PI), and cerebroplacental ratio (CPR). However, these methods mainly reflect hemodynamic changes occurring at later stages and poorly characterize structural and biomechanical properties of placental tissue.

In recent years, ultrasound elastography has gained increasing attention as a non-invasive method for assessing tissue mechanical properties. Shear-wave elastography (SWE) enables quantitative measurement of tissue stiffness (kPa) and allows in vivo evaluation of the placenta.

Morphological studies demonstrate that placental dysfunction is associated with fibrosis, infarctions, microthrombosis, reduced vascularization, and altered villous architecture. These changes lead to increased placental stiffness measurable by elastography. Previous studies report mean placental stiffness of 27–32 kPa in FGR versus 14–18 kPa in normal pregnancy.

Thus, placental elastography represents a promising tool for early detection of placental dysfunction before significant Doppler abnormalities develop.

Aim of the study. To determine the diagnostic value of placental elastography in detecting placental dysfunction in FGR and to assess its relationship with uteroplacental and fetal blood flow parameters.

Materials and methods. A prospective comparative study included 56 pregnant women at 28–36 weeks of gestation: main group (FGR): 34 patients, control group: 22 patients. Inclusion criteria: estimated fetal weight <10th percentile, reduced abdominal circumference, doppler signs of placental insufficiency. Exclusion criteria: multiple pregnancy, congenital anomalies, chorioamnionitis, severe extragenital diseases.

All patients underwent: ultrasound examination, doppler study (uterine, umbilical, MCA), CPR calculation, SWE elastography (Emean, Emin, Emax, elasticity ratio). Measurements were performed in 3 placental regions. Statistical analysis included mean values, SD, odds ratio (OR), and 95% CI.

Results. The analysis of the clinical characteristics of the examined pregnant women showed that the groups were comparable in terms of the main demographic and obstetric parameters. The mean age of women in the group with fetal growth restriction (FGR) was 29.7 ± 5.1 years, whereas in the control group it was 28.9 ± 4.7 years, indicating no statistically significant differences between the groups (Table 1).

Table 1.

Clinical characteristics of pregnant women

Parameter	FGR (n=34)	Control (n=22)
Age (years)	29.7 ± 5.1	28.9 ± 4.7
Gestational age (weeks)	32.4 ± 2.1	32.8 ± 2.0
BMI (kg/m²)	26.1 ± 3.8	24.8 ± 3.1
Primigravida, n (%)	18 (52.9%)	10 (45.5%)
Hypertensive disorders, n (%)	9 (26.5%)	1 (4.5%)

The gestational age at the time of examination was also comparable between the groups: 32.4 ± 2.1 weeks in the FGR group and 32.8 ± 2.0 weeks in the control group. This allows for a correct comparison of the functional parameters of the fetoplacental system.

The mean pre-pregnancy body mass index was slightly higher in patients with FGR (26.1 ± 3.8 kg/m²) compared to the control group (24.8 ± 3.1 kg/m²), which may reflect a tendency toward a higher prevalence of metabolic risk factors among pregnant women with placental dysfunction.

The proportion of primigravida women in the FGR group was 52.9% (18 patients), whereas in the control group it was 45.5% (10 patients), indicating a comparable parity structure.

At the same time, a significantly higher incidence of hypertensive disorders of pregnancy was observed in the FGR group—26.5% (9 cases), compared to only 4.5% (1 case) in the control group. This confirms the close association between fetal growth restriction and placenta-mediated complications of pregnancy.

The analysis of Doppler parameters demonstrated pronounced disturbances in uteroplacental-fetal blood flow in pregnant women with FGR (Table 2).

In the FGR group, a significant increase in vascular resistance indices in the uterine arteries was observed. Thus, the uterine artery RI was 0.71 ± 0.06, which was significantly higher than in the control group (0.56 ± 0.05, $p<0.001$). A similar trend was noted for the uterine artery PI—1.42 ± 0.21 versus 0.92 ± 0.18, respectively ($p<0.001$). These findings reflect increased peripheral resistance in the uteroplacental circulation.

Table 2.

Doppler parameters

Parameter	FGR	Control	p
RI uterine arteries	0,71 ± 0,06	0,56 ± 0,05	<0,001
PI uterine arteries	1,42 ± 0,21	0,92 ± 0,18	<0,001
RI umbilical artery	0,69 ± 0,07	0,58 ± 0,05	<0,001
PI umbilical artery	1,36 ± 0,24	0,94 ± 0,19	<0,001
PI MCA	1,05 ± 0,22	1,58 ± 0,26	<0,001
CPR	0,87 ± 0,19	1,72 ± 0,28	<0,001
Grade I flow disturbance	9 (26,5)	0	-
Grade II	10 (29,4)	0	-
Grade III	4 (11,8)	0	-

A significant increase in resistance indices was also observed in the umbilical artery: RI was 0.69 ± 0.07 in the FGR group versus 0.58 ± 0.05 in the control group (p<0.001), and PI was 1.36 ± 0.24 versus 0.94 ± 0.19, respectively (p<0.001). The elevation of these parameters indicates impaired placental perfusion and increased vascular resistance within the placental circulation.

In contrast, a significant decrease in PI was observed in the fetal middle cerebral artery: 1.05 ± 0.22 in the FGR group compared to 1.58 ± 0.26 in the control group (p<0.001). This phenomenon reflects the development of the so-called "cerebral redistribution of blood flow" (brain-sparing effect), a compensatory mechanism aimed at maintaining perfusion of vital fetal organs.

The cerebroplacental ratio (CPR) was also significantly lower in patients with FGR—0.87 ± 0.19, whereas in the control group it was 1.72 ± 0.28 (p<0.001), confirming pronounced impairment of fetoplacental hemodynamics.

Table 3.

Placental Elastography Parameters

Parameter	FGR	Control	p
Emean (kPa)	29,8 ± 5,6	15,4 ± 3,1	<0,001
Emin (kPa)	21,6 ± 4,1	11,2 ± 2,4	<0,001
Emax (kPa)	36,7 ± 6,2	18,8 ± 3,5	<0,001
Elasticity ratio	2,14 ± 0,46	1,09 ± 0,21	<0,001
>25 kPa	20 (58,8)	3 (13,6)	0,001
20–25 kPa	9 (26,5)	4 (18,2)	-
<20 kPa	5 (14,7)	15 (68,2)	-

Analysis of the severity of blood flow disturbances showed that among pregnant women with FGR, grade I impairment was diagnosed in 26.5% (9 patients), grade II in 29.4% (10 patients), and grade III in 11.8% (4 patients). No pathological blood flow abnormalities were detected in the control group.

Thus, the obtained data indicate significant disturbances in uteroplacental and fetal hemodynamics in pregnant women with fetal growth restriction, confirming the leading role of placental dysfunction in the pathogenesis of this pregnancy complication.

In patients with FGR, a strong negative correlation between CPR and placental stiffness was identified: correlation analysis showed that higher placental stiffness was associated with a decrease in CPR. Clinically, this reflects the progression of placental insufficiency and centralization of fetal circulation.

Analysis of the threshold value of placental stiffness >25 kPa demonstrated a significant increase in the likelihood of FGR: OR = 9.05; 95% CI 2.24–36.55; p = 0.0009.

Placental elastography reflects both structural and functional changes. Increased stiffness is likely associated with ischemia, fibrosis, infarctions, and vascular alterations.

Combined use of Doppler and elastography improves diagnostic accuracy and risk stratification.

Conclusions. Placental stiffness is significantly higher in FGR. Doppler changes confirm severe placental dysfunction. Stiffness >25 kPa increases FGR risk 9-fold. Elastography is a valuable non-invasive diagnostic tool.

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