

# The prognostic value of biometric data in placentation at the end of the first trimester

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## Abstract

The placenta has an important role in the further development of the pregnancy. In our study we followed up 300 monofetal pregnancies. **Objective.** The aim of our study was to develop methods for early diagnosis (first trimester) of high-risk pregnancies. **Methods.** We measured the ratio between gestational sac diameter and crown-rump length (GSD/CRL), placental volume and crown-rump length (PV/CRL), the ratio between the distance from the umbilical cord insertion site at the placenta and fundic edge of placentation and the distance between the umbilical cord insertion site at the placenta and cervical edge of placentation (F/C ratio). We measured also the impedance to flow in both uterine arteries at the end of the first trimester, average of the pulsatility index (PI). We used Chi-test for processing the data. **Results.** Pregnancies with a smaller amount of amniotic fluid (GSD/CRL ratio < 10<sup>th</sup> centile), with eccentric umbilical cord insertion at the placenta (F/C ratio < 0.33 or > 3) and with a smaller placental volume (PV/CRL ratio < 10<sup>th</sup> centile) at the end of the first trimester show a significantly higher risk for fetal malformation (OR=4.17; OR=12.09; OR=4.17, p<0.05) and second trimester spontaneous abortion (OR=4.94; OR=7.4; OR=9.89, p<0.05). Pregnancies with a larger placental volume (PV/CRL ratio > 90<sup>th</sup> centile) and with a smaller impedance to flow (PI values < 10<sup>th</sup> centile) at the end of the first trimester show a significantly higher risk for fetal macrosomia (OR=2.98; OR=2.98, p<0.05). **Conclusions.** Biometric data at the end of the first trimester could provide new information about the outcome of pregnancy. **Keywords:** amniotic fluid volume, placental volume, umbilical cord, high-risk pregnancy

## Introduction

We studied aspects of placentation at the end of the first trimester of pregnancy to evaluate the prognostic values of these biometric data. Prospective cohort studies revealed that some of placentation abnormalities can be detected since the late first trimester<sup>(1)</sup>. It is known good prenatal detection rates of velamentous umbilical cord insertion at 11-14 weeks of pregnancy. This allows closer follow-up of these pregnancies, which show that this anomaly is associated with some obstetrical pathology<sup>(2,3,4)</sup>. Moreover, placental volume was studied as a predictive factor in further development of pregnancies<sup>(5)</sup>.

The present study aims to investigate the aspects of placentation with ultrasound at the end of the first trimester of pregnancy, to evaluate the prognostic value of biometric data in placentation at the end of the first trimester and to develop methods for early diagnosis (first trimester) of high-risk pregnancies.

## Methods

First, we studied a number of 300 pregnant women at the end of the first trimester of pregnancy (11w-13w+6d), and followed up their pregnancy development until birth.

Second, we measured the following:

- Crown-rump length (CRL)
- Gestational sac diameter (GSD, simple average of diameters measured in three dimensions), location of the placenta, placental volume (PV)

- GSD/CRL ratio (amniotic fluid volume)
- PV/CRL ratio (placental quotient)
- The distance between the umbilical cord insertion at the placenta and the cranial (fundic) rim of the placenta (F)
- The distance between the umbilical cord insertion at the placenta and the caudal (cervical) rim of the placenta (C)
- F/C ratio. Umbilical cord insertion at the placenta was considered eccentric if F/C ratio was < 0.33 or > 3 (eccentricity of the placental cord insertion more than 50% of placental radius).

Placental volume we calculated as Figure 1 shows:

1. Spherical segment of one base (V):  $V = (3R^2 + H^2) \Pi * H / 6$  (see below),
  2. R-radius, H-height of spherical segment of one base,  $\Pi = 3.14$
  5.  $R = (F + C) / 2$
  6. H - maximum thickness of the placenta
  7. F - the distance between the umbilical cord insertion at the placenta and the cranial (fundic) rim of the placenta
  8. C - the distance between the umbilical cord insertion at the placenta and the caudal (cervical) rim of the placenta
  9. Placental volume:  $PV = [3(F + C)^2 + 4H^2] \Pi * H / 24$
- Uteroplacental circulation was studied using Duplex Color Doppler for pulsatility index (PI) bilateral

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Figure 1. Placental volume

in uterine arteries (simple average). The equipment used was General Electric S7, for abdominal probe.

Data were analyzed with Grubbs test and Kolmogorov-Smirnov test (for checking Gaussian distribution of values), then data were processed in EXCEL using Chi-square test.

## Results

At the end of the first trimester, crown-rump length median was 62 mm and 8.7 mm for standard deviation.

Distribution of pathological cases in the studied population is presented in Table 1. Some of the fetal malformations found in our studied population are presented in Figures 2-8.

### GSD/CRL ratio (amniotic fluid volume)

For GSD/CRL values below the 10<sup>th</sup> centile (<1.04) prediction for fetal malformation, second trimester spontaneous abortion, premature birth, preeclampsia and small for gestational age newborns are presented in Table 2.

For GSD/CRL values above the 90<sup>th</sup> centile (>1.35) prediction for large for gestational age newborns (>4000g) are presented in Table 2.

Pregnancies with a smaller amount of amniotic fluid (GSD/CRL ratio <10<sup>th</sup> centile) at the end of the first trimester show a significantly higher risk for fetal malformation (OR=4.17, p<0.05) and second trimester spontaneous abortion (OR=4.94, p<0.05). This could not be applied for premature birth, preeclampsia (PE), small for gestational age (SGA) and large for gestational age (LGA) newborns.

### F/C ratio (eccentricity of umbilical cord insertion at the placenta)

For F/C ratio values <0.33 or >3 (eccentric umbilical cord insertion at the placenta), prediction for high-risk pregnancies are presented in Table 3.

Pregnancies with eccentric umbilical cord insertion at the placenta (F/C ratio <0.33 or >3) at the end of the first trimester show a significantly higher risk for fetal malformation (OR=12.09, p<0.05) and second trimester spontaneous abortion (OR=7.4, p<0.05). This could not be applied for premature birth, PE, SGA and LGA.

### PV/CRL ratio (placental quotient, cm<sup>2</sup>)

For PV/CRL values below the 10<sup>th</sup> centile (<4.7) and for values above the 90<sup>th</sup> centile (>11) prediction for high-risk pregnancies are presented in Table 4.

Table 1 Distribution of pathological cases in the studied population

	No.	Procent (%)
Fetal malformation <ul style="list-style-type: none"> <li>■ Hidrops fetalis (4)</li> <li>■ Exencephalia (2)</li> <li>■ Encephalocele occipitalis (1)</li> <li>■ Dandy Walker Sy (1)</li> <li>■ Chest and abdominal wall defect with ectopic heart (1)</li> <li>■ Artrogriposis congenitalis (1)</li> </ul>	10	3.33
Second trimester spontaneous abortion	6	2
Premature birth	16	5.33
Preeclampsia	8	2.67
Small for gestational age newborn (SGA)	8	2.67
Large for gestational age newborn (LGA)	22	7.33
Total	300	100

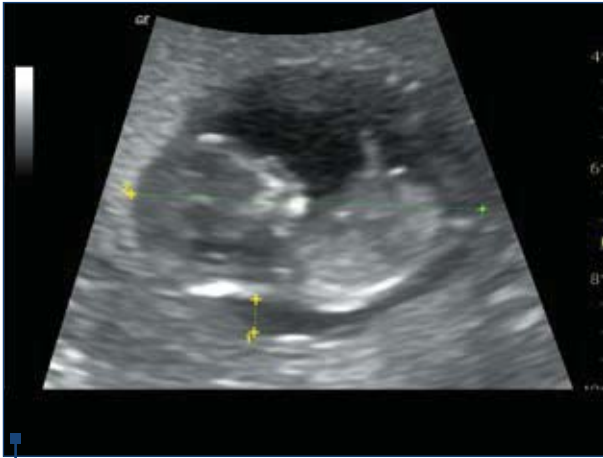


Figure 2. Hydrops fetalis (sagittal view, 12 weeks)



Figure 3. Hydrops fetalis (axial view, 12 weeks)



Figure 4. Exencephalia (coronal view, 12 weeks)



Figure 5. Exencephalia (sagittal view, 12 weeks)



Figure 6. Encephalocele occipitalis (sagittal view, 12 weeks)



Figure 7. Encephalocele occipitalis (axial view, 12 weeks)

Pregnancies with a smaller placental volume (PV/CRL ratio <10<sup>th</sup> centile) at the end of the first trimester show a significantly higher risk for fetal malformation (OR=4.17, p<0.05) and second tri-

mester spontaneous abortion (OR=9.89, p<0.05). This could not be applied for premature birth, PE and SGA. Pregnancies with a larger placental volume (PV/CRL ratio >90<sup>th</sup> centile) at the end of the first

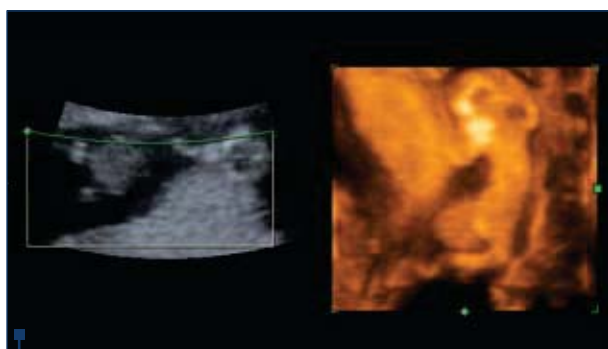


Figure 8. Chest and abdominal wall defect with ectopic heart (12 weeks)

trimester show a significantly higher risk for fetal macrosomia (OR=2.98,  $p < 0.05$ ).

#### PI

For PI values above the 90<sup>th</sup> centile ( $> 2.17$ ) and for values below the 10<sup>th</sup> centile ( $< 0.48$ ) prediction for high-risk pregnancies are presented in Table 5.

Pregnancies with a lower impedance to flow in the uterine arteries (PI values below the 10<sup>th</sup> centile) at the end of the first trimester show a significantly higher risk for fetal macrosomia (OR=2.98,  $p < 0.05$ ). We couldn't find significant correlations between impedance to flow and fetal malformation, second trimester spontaneous abortion, premature birth, preeclampsia and/or small for gestational age newborns.

### Discussion

Small amount of amniotic fluid (oligoamnios) is well known as a poor prognostic factor in pregnancies. In similar cases with missed abortion in the first trimester, we could find flattened gestational sac. GSD/CRL ratio  $< 10^{\text{th}}$  centile at the end of the first trimester shows a significantly higher risk for fetal malformation (OR=4.17,  $p < 0.05$ ) and second trimester spontaneous abortion (OR=4.94,  $p < 0.05$ ).

First trimester spontaneous abortions often present genetic problems. These pregnancies show a weaker

**Table 2** Prognostic value of GSD/CRL ratio in placentation at the end of the first trimester

	OR	p	St	Sp	PPV	NPV
Fetal malformation *	4.17	$< 0.05$	30	90.7	10	97.41
Second trim. Sp Ab *	4.94	$< 0.05$	33.33	90.81	6.89	98.52
Premature birth *	0.61	ns	6.25	90.10	3.45	94.44
PE *	1.29	ns	12.5	90.07	3.33	97.41
SGA *	3.07	ns	25	90.2	3.33	98.88
LGA **	0.93	ns	9.10	90.28	6.89	92.62

Sp Ab - Spontaneous abortion after 13 week + 6 days; PE - preeclampsia; SGA - small for gestational age; LGA - large for gestational age; OR - odds ratio; St - sensitivity; Sp - specificity; PPV - positive predictive value; NPV - negative predictive value; ns - not significant statistically; \*For GSD/CRL values below the 10<sup>th</sup> centile ( $< 1.04$ ); \*\*For GSD/CRL values above the 90<sup>th</sup> centile ( $> 1.35$ )

**Table 3** Prognostic value of F/C ratio in placentation at the end of the first trimester

	OR	p	St	Sp	PPV	NPV
Fetal malformation	12.09	$< 0.05$	60	89	15.79	98.47
Second trim. Sp Ab	7.4	$< 0.05$	50	88.09	7.89	98.85
Premature birth	1.64	ns	18.75	87.67	7.89	95.03
PE	0.98	ns	12.5	87.32	2.63	97.32
SGA	2.33	ns	25	87.5	2.63	98.85
LGA	1.59	ns	18.18	87.77	10.52	93.12

Sp Ab - Spontaneous abortion after 13 week + 6 days; PE - preeclampsia; SGA - small for gestational age; LGA - large for gestational age; OR - odds ratio; St - sensitivity; Sp - specificity; PPV - positive predictive value; NPV - negative predictive value; ns - not significant statistically

**Table 4** Prognostic value of PV/CRL ratio in placentation at the end of the first trimester

	OR	p	St	Sp	PPV	NPV
Fetal malformation*	4.17	<0.05	30	90.67	10	97.41
Second trim. Sp Ab*	9.89	<0.05	50	90.81	10	98.89
Premature birth *	0.58	ns	6.25	89.79	3.33	94.44
PE *	1.25	ns	12.5	89.72	3.22	97.40
SGA *	3.07	ns	25	90.2	3.33	98.89
LGA **	2.98	<0.05	22.73	91	16.67	93.70

Sp Ab - Spontaneous abortion after 13 week + 6 days; PE - preeclampsia; SGA - small for gestational age; LGA - large for gestational age; OR- odds ratio; St - sensitivity; Sp - specificity; PPV - positive predictive value; NPV - negative predictive value; ns - not significant statistically; \*For PV/CRL values below the 10<sup>th</sup> centile (<4.7); \*\*For PV/CRL values above the 90<sup>th</sup> centile (>11)

**Table 5** Prognostic value of PI in placentation at the end of the first trimester

	OR	p	St	Sp	PPV	NPV
Fetal malformation *	1	ns	10	90	3.33	96.67
Second trim. Sp Ab *	1.83	ns	16.67	90.14	3.33	98.15
Premature birth *	0.56	ns	6.25	89.44	3.22	94.42
PE *	1.29	ns	12.5	90.07	3.33	97.41
SGA *	3.07	ns	25	90.2	3.33	98.89
LGA **	2.98	<0.05	22.73	91	16.67	93.7

Sp Ab - Spontaneous abortion after 13 week + 6 days; PE - preeclampsia; SGA - small for gestational age; LGA - large for gestational age; OR- odds ratio; St- sensitivity; Sp- specificity; PPV- positive predictive value; NPV- negative predictive value; ns- not significant statistically; \*For PI values above the 90<sup>th</sup> centile (>2.17); \*\*For PI values below the 10<sup>th</sup> centile (<0.48).

adhesion to the decidua, which manifest as miscarriage. Pregnancies with eccentric umbilical cord insertion at the placenta (F/C ratio <0.33 or >3) and a smaller placental volume (PV/CRL ratio <10<sup>th</sup> centile) at the end of the first trimester, show a significantly higher risk for fetal malformation (OR=12.09, p<0.05) and second trimester spontaneous abortion (OR=7.4, p<0.05).

We found only a weak non-significant correlation between PE and a smaller amount of amniotic fluid, smaller placental volume and a higher impedance to flow in the uterine arteries at the end of the first trimester. This can be caused by the small number of cases with severe preeclampsia in our study. Papageorghiou and Campbell<sup>(5)</sup> found that for a 10% false positive rate, placental volume measurement in the first trimester of pregnancy (11-14 weeks) reveals 20% of women that will develop early/severe preeclampsia requiring birth before 35 weeks. Placental volume and PV/CRL ratio are not influenced by age, number of previous pregnancies, body-mass index or smoking. Placentas of pregnant women with increased uterine artery resistance

in the second trimester of pregnancy, have a lower volume and PV/CRL ratio at 11-13 weeks<sup>(6,7)</sup>.

SGA presents a variety of aetiologies. Our study reveals a non-significant positive association between small for gestational age and smaller amount of amniotic fluid (GSD/CRL ratio <10<sup>th</sup> centile), eccentric umbilical cord insertion at the placenta (F/C ratio <0.33/>3), smaller placental volume (PV/CRL ratio <10<sup>th</sup> centile) and a higher impedance to flow in the uterine arteries (PI values above the 90<sup>th</sup> centile) at the end of the first trimester.

We noticed significant positive association between fetal LGA, larger placental volume (PV/CRL ratio >90<sup>th</sup> centile) and lower impedance to flow in the uterine arteries (PI values below the 10<sup>th</sup> centile) at the end of the first trimester (OR=2.98, OR=2.98, p<0.05).

We couldn't find significant correlations between impedance to flow and other pathologies, however there are some studies that reveal correlations between impedance to flow at the end of the first trimester and PE<sup>(8,9,10,11,12)</sup>, SGA<sup>(8,9,10)</sup>, abruptio placentae<sup>(2,10)</sup>, and intrauterine fetal death<sup>(9)</sup>.

## Conclusions

Pregnancies with a smaller amount of amniotic fluid at the end of the first trimester show a significantly higher risk for fetal malformation and second trimester spontaneous abortion. Moreover, pregnancies with eccentric umbilical cord insertion at the placenta (F/C ratio  $<0.33$  or  $>3$ ) at the end of the first trimester show a significantly higher risk for fetal malformation and second trimester spontaneous abortion.

The ones with a smaller placental volume at the end of the first trimester show a significantly higher risk for fetal malformation and second trimester spontaneous abortion, and the ones with a larger placental volume at the end of the first trimester show a significantly higher risk for fetal macrosomia.

In this study we showed also that pregnancies with a lower impedance to flow in the uterine arteries at the end of the first trimester show a significantly higher risk for fetal macrosomia. ■

### Figure legends

*H* - maximum thickness of the placenta

*F* - the distance between the umbilical cord insertion at the placenta and the cranial (fundal) rim of the placenta

*C* - the distance between the umbilical cord insertion at the placenta and the caudal (cervical) rim of the placenta

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