Implications of the First Trimester 2d and 3d Ultrasound in Pregnancy Outcome

ŞTEFANIA TUDORACHE1,2, RĂZVAN GRIGORAŞ CĂPITĂNESCU1,2, ROXANA CRISTINA DRĂGUŞIN1, GEORGE LUCIAN ZORILĂ1,2, MARIUS CRISTIAN MARINĂŞ1,2, NICOLAE CERNEA1,2, CIPRIAN-LAURENŢIU PĂTRU1,2

1Emergency County Hospital of Craiova, Romania
2Obstetrics and Gynecology Department, University of Medicine and Pharmacy of Craiova, Romania

ABSTRACT. Background. In this study we researched for the first trimester pregnancy measurements by transabdominal and transvaginal ultrasound: gestational sac volume (GSV), embryo volume (EV), placenta volume (PV), yolk sac volume (YSV) and crown rump length (CRL) in predicting pregnancy outcome. Our goals was to demonstrate the ability of the first trimester ultrasound in identifying patients at high risk for abortion, intrauterine growth restriction (IUGR) and low birth weight. Methods. Prospective observational clinical study that investigated the role of the first trimester 2D and volumetric (3D) measurements in predicting pregnancy outcome. The study was carried out in the Obstetrics and Gynecology Department of the Emergency County Hospital in Craiova during a study period of 3 years (between 2016 and 2018). The study included a number of 87 pregnancies. Patients included in the study were offered an early 2D and 3D transabdominal and transvaginal ultrasound and afterwards they were followed up until delivery. The statistical analyses (standard deviation, coefficient of variety, Cohen K correlation coefficient) determined a correlation between the two ultrasound methods, between the values of these parameters and pregnancy prognosis, the correlation being more relevant for the 3D ultrasound. The GSV, EV, YSV, PV, CRL and pregnancy outcome was established. Results. Our study showed that the concordance degree between the two methods was 89.7%. 3D ultrasound had a diagnostic impact in 96.6% of the cases, while 2D ultrasound had a diagnostic impact in 89.6% of the cases. The incidence of the patients at high risk for complications was recorded in pregnancies with abnormal early ultrasound markers. Conclusions. First trimester ultrasound is a capable method for identifying a higher percentage of patients at risk of pregnancy complications, counseling and monitoring compared to 2D ultrasound. Also, because there is no radiation exposure, the risks are non-existent.

KEYWORDS: Gestational sac volume, embryo volume, placenta volume, crown rump length, yolk sac volume, pregnancy outcome, ultrasound.

Introduction

In order to determine pregnancy outcome, many authors studied both maternal demographic characteristics and ultrasound parameters acquired before 12 weeks of gestation [1,2].

Ultrasound is a useful tool for important measurements in pregnancy progress and outcome monitoring. Regarding the first trimester 3D transvaginal ultrasound, this method can be used for assessing pregnancy risks, offering more precise information and higher resolution images than the 2D ultrasound [3,4,5]. It can be applied in early pregnancy [6,7], before 8 weeks of gestation [6,8], when the embryo can be analyzed [9,10].

According to literature, there are specific ultrasound markers that can be used for identifying pregnancies at high risk for abortion [11,12] or for fetal abnormality detection that requires a closer follow up [14,15,16]. Other studies demonstrated the implications of the first trimester volumetric measurements in predicting miscarriage [17,18], IUGR and fetal birth weight [19,20,21].

Methods

In this study we have conducted a prospective observational clinical study that analyzed the correlation between the first trimester 2D and 3D ultrasound measurements and pregnancy outcome. The study was carried out in the Obstetrics and Gynecology Department of the Emergency County Hospital in Craiova during 2016-2018. The patients were evaluated using the following parameters: personal data (name, surname), demographic data (age, residence, occupation, blood group), etiopathogenic data, obstetrical physiological and pathological data.

For a complete evaluation, a detailed medical history that included gravidity, parity, date of last menstrual period (LMP), smoking, vaginal bleeding during pregnancy was obtained for each case.
The inclusion criteria were: patients with singleton pregnancy and no repetitive abortions.

The exclusion criteria were: multiple pregnancy, maternal age over 35 years old, maternal hypertension, diabetes, obesity and autoimmune diseases.

All patients gave their written informed consent, and the study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova.

The patients were scanned using a transvaginal and transabdominal probe. The presence of intrauterine gestational sac (GS), yolk sac (YS), placenta (P) and embryo was recorded for each patient (Fig. 1).

For 3D ultrasound the measurement technique used to calculate the placental volume was the virtual organ computer aided analysis method (VOCAL) method. GSV was calculated using the VOCAL method with a 30Ao rotation angle [11]. Yolk sac volume was calculated using VOCAL method with 30Ao rotation [9] and embryo volume measurements were made using the direct “hand lasso” tool method [23,24], by drawing a contour line along its head and trunk, and excluding the limbs [25]. The data were collected in Microsoft Excel files for statistical analysis. We used Cohen’s kappa coefficient for inter-rater agreement to verify if the two methods, 2D and 3D ultrasonography, have the same capacity to correctly identify patients at risk.

The included patients were also assessed in the second and third trimester of pregnancy (morphology ultrasound and intrauterine growth).

A correlation between the ultrasound markers and pregnancy outcome was also searched for.

Results

Patient’s distribution according to maternal age can be seen in Table 1. 33 patients (37.9%) were in the 20-24 age group, followed by the 25-29 age group (23 patients-26.4%), 30-34 age group (18 patients-20.6%) and 15-19 age group (3 patients-14.9%) (Table 1).

The average maternal age at the enrolment was 25.21±7.18 years (ranged between 16 and 34 years).

Table 1. Patient’s distribution by maternal age

| Age group | 15-19 | 20-24 | 25-29 | 30-34 | Total |
|-----------|-------|-------|-------|-------|-------|
| Patients number | 12 | 22 | 20 | 19 | 67 |
| Percent (%) | 14.9 | 37.2 | 26.4 | 20.6 | 100.0 |

Fig. 1. Gestation sac volume-A and B; Embryo volume-C; Yolk sac volume-D
2D ultrasound detected 78 patients (89.6%) with normal results, while 3D ultrasound detected 81 patients (93.1%) with normal results. 9 patients (10.3%) had abnormal results detected by the 2D ultrasound compared to 6 patients (6.9%) with abnormal results detected by the 3D ultrasound (Table 2 and Table 3 and Fig.3).

Table 2. Patient’s distribution by 2D ultrasound

| Normal results | Abnormal results | Total |
|---------------|-----------------|-------|
| Number | % | Number | % | Number | % |
| 78 | 89.6 | 9 | 10.3 | 87 | 100.0 |

Table 3. Patient’s distribution by 3D ultrasound

| Normal results | Abnormal results | Total |
|---------------|-----------------|-------|
| Number | % | Number | % | Number | % |
| 81 | 92.1 | 0 | 0 | 81 | 100.0 |

In the first trimester, the 2D and 3D ultrasound markers can be used as reliable prognostic parameters (Table 4 and Fig.3). The overall concordance degree between the two methods was of 96.55%. Cohen’s K coefficient had a value of 0.78, which showed a substantial agreement between the two methods.

We observed that all patients with postpartum complications (6 cases) were detected by both 2D and 3D ultrasound as positive results, while 2D detected 3 additional abnormal cases which proved not to have complications.

The 3D ultrasound diagnosed the risk for miscarriage in 2 cases (2.3%), IUGR in 2 cases (2.3%) and fetuses with a low birth weight in 2 cases (2.3%) (Table 5 and Fig.4).

Discussion

In this study we measured some parameters detected in the first trimester by ultrasound that literature demonstrates to be predictive for pregnancy outcome.

Thus, studies that predict outcome approached the early pregnancy periods. Different parameters such as gestational sac volume, yolk sac volume [26,2,28] and the relationship between the gestational sac and the average size of the CRL [29,30] were considered useful ultrasound markers in early pregnancy. GS and YS and EV measurement allow the formulation of age-related pregnancy percentile.

Other studies demonstrated examined the relationship between first trimester ultrasound volume parameters and pregnancy outcome [31,32].
The first 3D assessment of early pregnancy was made by Steiner et al. They described a linear relationship between gestational age and GSV [33].

Our study shows that pregnancies with normal GS had a good pregnancy outcome while those with small GS had an increased incidence of abortion. So, we consider that small GS has a poor pregnancy prognosis and increased risk of abortion. These results are also certified by other authors [34] that studied pregnancies between 5 and 12 weeks of gestation and observed that the GS of the cases that experienced abortion were smaller than normal. Also, in accordance to literature our results show that GSV increased in a correlated manner with CRL with gestational age [35].

Literature also shows the importance of the first trimester 3D ultrasound in predicting aneuploidy. In a study conducted by Falcon et al. [18,19], the authors showed that GS measurements seem to be normal size in early pregnancy of fetuses with trisomy 18, trisomy 21 and Turner syndrome, while in fetuses with triploidy and trisomy 13, they were significantly smaller.

Our study results analysis obtained specific data related to 5 ultrasound markers, the concordance degree between the two methods and patients at high risk for pregnancy complications.

The 2D ultrasound identified 78 patients with normal pregnancy results (89.6%), compared with 81 cases (93.1%) identified by the 3D ultrasound and 9 cases with abnormal pregnancy results (10.3%) compared with 6 cases (6.9%). Thus the diagnostic performance of the 2D ultrasound was 89.7% and 96.6% for the 3D ultrasound.

The concordance degree between the two methods was 96.55%.

All 6 cases diagnosed with positive results by the 3D ultrasound had pregnancy complications. 2 patients (2.3%) with abnormal GSV and YSV ended by miscarriage. In another 2 patients (2.3%), abnormal PV and CRL determined IUGR, PV being a more specific marker compared to CRL. 2 patients (2.3%) had low birth weight fetuses, predicted by changes in GSV and EV.

Our experience in using the described technique can improve the pregnancy prognosis.

We can state that the first trimester volumetric ultrasound should be the first line of investigations for evaluation of pregnancy outcome, while the 2D ultrasound should be considered secondary.

**Conclusion**

The study was performed between 2016-2018, included 87 patients and showed that 3D ultrasound had a diagnostic impact in 96.6% of the cases, compared to 2D ultrasound (diagnostic impact in 89.6% of the cases).

The concordance degree between the two methods was of 96.55%. As no X-rays are used, there was no radiation exposure and the risks are thus non-existent.

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