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Placental volume in twin and triplet pregnancies measured by three-dimensional ultrasound at 11 + 0 to 13 + 6 weeks of gestation

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KEYWORDS: 3D ultrasound; first trimester; placental volume; triplet pregnancy; twin pregnancy

ABSTRACT

Objective *To compare the placental volume at 11 + 0 to 13 + 6 weeks' gestation between singleton and multiple pregnancies and to examine the possible effect of chorionicity on placental volume.*

Methods *The placental volume was measured by three-dimensional (3D) ultrasound using the Virtual Organ Computer-aided AnaLysis (VOCAL) technique in 290 consecutive twin and 37 triplet pregnancies at 11 + 0 to 13 + 6 weeks of gestation. For the comparison of twin, triplet and singleton placental volumes each measurement was expressed as a multiple of the median (MoM) for singletons, previously established from the study of 417 normal fetuses at 11 + 0 to 13 + 6 weeks of gestation.*

Results *Median twin and triplet placental volumes were 1.66 and 2.28 MoM for singletons, respectively. In twins the placental volumes increased significantly with gestation from a median of 83.6 mL (5th and 95th centiles: 56.0 mL and 124.9 mL) at 11 + 0 weeks to 149.3 mL (5th and 95th centiles: 100.0 mL and 223.1 mL) at 13 + 6 weeks. The median MoM in monochorionic twins was not significantly different from that in dichorionic twins with fused placentas or dichorionic twins with separate placentas. In triplets the placental volumes increased significantly with gestation from a median of 114.9 mL (5th and 95th centiles: 77.6 mL and 170.1 mL) at 11 weeks to 217.9 mL (5th and 95th centiles: 147.2 mL and 322.5 mL) at 13 + 6 weeks. There were no significant differences in total placental volume between monochorionic and dichorionic triplets, monochorionic and trichorionic triplets, or dichorionic and trichorionic triplets.*

Conclusions *Placental volume in multiple pregnancies does not depend on chorionicity, and the rate of placental growth between 11 and 13 + 6 weeks is not significantly different between singletons, twins and triplets. Moreover, for a given gestational age the placental volume corresponding to each fetus in twins and triplets is 83% and 76%, respectively, of the placental volume in singletons. Copyright © 2006 ISUOG. Published by John Wiley & Sons, Ltd.*

INTRODUCTION

There is increasing evidence to support an association between first-trimester placentation and subsequent pregnancy outcome[1]. One of the methods of assessing placentation is three-dimensional (3D) ultrasound measurement of placental volume[2,3]. In a study of 417 cases at 11 + 0 to 13 + 6 weeks' gestation we reported that in singletons the median placental volume increases exponentially with gestation from 51 mL at 11 weeks to 91 mL at 13 + 6 weeks.[3] Hafner *et al*. reported that there is a significant association between placental volume at 16–23 weeks and birth weight[4].

The rates of several pregnancy complications, including pre-eclampsia, fetal growth restriction and preterm delivery, are substantially higher in twin and triplet pregnancies than in singletons, and these complications are higher in monochorionic placentations[5].

The aim of this study was to compare the placental volume at 11 + 0 to 13 + 6 weeks' gestation between singleton and multiple pregnancies and to examine the possible effect of chorionicity on placental volume.

METHODS

The placental volume was measured using 3D ultrasonography in 290 twin and 37 triplet pregnancies at 11 + 0

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to 13 + 6 (median 12 + 5) weeks of gestation scanned in our center during a 22-month period (December 2003 to September 2005). The gestation was calculated from the first day of the last menstrual period in those women with regular menstrual cycles of 26–30 days in duration and from the day of the embryo transfer in those who had *in-vitro* fertilization. In all cases two-dimensioanl (2D) ultrasound examination demonstrated that all fetuses were alive and that they did not have any obvious major defects. Chorionicity was determined by examination of the base of the intertwin membrane in twins and the ipsilon zone in triplets[6,7].

A 3D volume of the uterus was acquired by transabdominal ultrasonography (RAB 4-8L probe, Voluson 730 Expert, GE Medical Systems, Milwaukee, WI, USA). The sweep angle was set at 85° with the aim that the probe was perpendicular to the placental plate. The Virtual Organ Computer-aided AnaLysis (VOCAL) technique was then used to obtain a sequence of 12 sections of the placenta, each after a 15° rotation from the previous one. In each of the 12 planes the contour of the placenta or both placentas was drawn manually, taking care to exclude the uterine wall, which at this gestation is usually thickened under the placenta, because of either hypertrophy or contraction (Voluson 730 Expert Operation Manual, GE Medical Systems). The machine calculates a volume from the areas highlighted in each of the 12 planes, and when the calculation is finished the computed reconstruction of the organ is displayed together with the volume. Every measurement was done off-line after the scan by the same operator.

Statistical analysis

Linear regression analysis was used to determine the significance of the association between twin placental volume and gestational age (GA) in days and crown–rump length (CRL) of the largest fetus. The Shapiro–Wilks' *W*-test demonstrated that the data were not normally distributed and therefore they were log-transformed to achieve a normal distribution. The median, 5^{th} and 95^{th} centiles were initially calculated in the log-transformed data, and the corresponding values in mL were obtained by the exponential of the log-transformed data.

For the comparison of twin and triplet placental volumes with singletons, each measurement was expressed as a multiple of the median (MoM) for singletons, previously established from the study of 417 normal fetuses at 11 to 13 + 6 weeks of gestation[3]. The Mann–Whitney *U*-test was used to determine the significance of differences in the MoMs between the twins, triplets and singletons and between monochorionic twins and dichorionic twins with fused and separated placentas and between triplet pregnancies of different chorionicity.

Linear regression analysis was used to determine the significance of association between values of twin and triplet placental volume, expressed in MoM values for singletons, with gestational age and CRL of the larger fetus, respectively. The analyses were performed with SPSS 11.5 (Chicago, IL, USA) and Excel for Windows 2000 (Microsoft Corp., Redmond, WA, USA), and $P < 0.05$ was considered to be statistically significant.

RESULTS

In the twin pregnancies the median maternal age was 33 (range, 18–48) years, the median maternal body mass index (BMI) was 23.7 (range, 17.5–39.7) and the median gestation was 12 + 5 weeks. There were 80 monochorionic pregnancies, 111 dichorionic with fused placentas and 99 dichorionic with two separate placentas. In the triplet pregnancies the median maternal age was 35 (range, 25–50) years, the median maternal BMI was 22.5 (range, 18.6–34.9) and the median gestation was 11 + 6 weeks. There were 20 trichorionic triamniotic triplets, 12 dichorionic triamniotic and five monochorionic triamniotic. The placental volumes were successfully measured in all cases.

In the twin pregnancies the median MoM was 1.66 and this was significantly higher than in singleton pregnancies ($P < 0.001$). There was no significant association between MoM values with either gestational age ($r = 0.017$, $P = 0.777$) or CRL of the larger fetus ($r = 0.051$, $P = 0.382$). The median MoM in monochorionic twins (1.64 MoM) was not significantly different from that in dichorionic twins with fused placentas (1.64 MoM, $P = 0.523$) or dichorionic twins with separate placentas (1.71 MoM, $P = 0.179$).

In the triplet pregnancies, the median MoM was 2.28 and this was significantly higher than in singleton pregnancies ($P < 0.001$) and twin pregnancies ($P < 0.001$). There was no significant association between MoM values with either gestational age ($r = 0.074$, $P = 0.663$) or CRL of the largest fetus ($r = 0.095$, $P = 0.576$). There were no significant differences between monochorionic and dichorionic triplets ($P = 0.460$), monochorionic and trichorionic triplets ($P = 0.135$), or dichorionic and trichorionic triplets ($P = 0.330$).

In twin pregnancies the total placental volume increased significantly with gestation from a median of 83.6 mL (5^{th} and 95^{th} centiles: 56.0 mL and 124.9 mL) at 11 weeks to 149.3 mL (5^{th} and 95^{th} centiles: 100.0 mL and 223.1 mL) at 13 + 6 weeks (Ln placental volume = $0.029 \times$ gestation in days + 2.193, Ln SD = 0.244, $r = 0.445$, $P < 0.001$; Figure 1). It also increased significantly with CRL of the larger twin, from a median of 78.7 mL (5^{th} and 95^{th} centiles: 54.2 mL and 114.1 mL) at a CRL of 45 mm to 165.0 mL (5^{th} and 95^{th} centiles: 113.8 mL and 239.3 mL) at a CRL of 84 mm (Ln placental volume = $0.019 \times$ CRL + 3.510, Ln SD = 0.226, $r = 0.559$, $P < 0.001$; Figure 1).

In triplet pregnancies the total placental volume increased significantly with gestation from a median of 114.9 mL (5^{th} and 95^{th} centiles: 77.6 mL and 170.1 mL) at 11 weeks to 217.9 mL (5^{th} and 95^{th} centiles: 147.2 mL and 322.5 mL) at 13 + 6 weeks (Ln placental volume = $0.032 \times$ gestation in days + 2.280, Ln SD = 0.238, $r = 0.575$, $P < 0.001$; Figure 2). It also

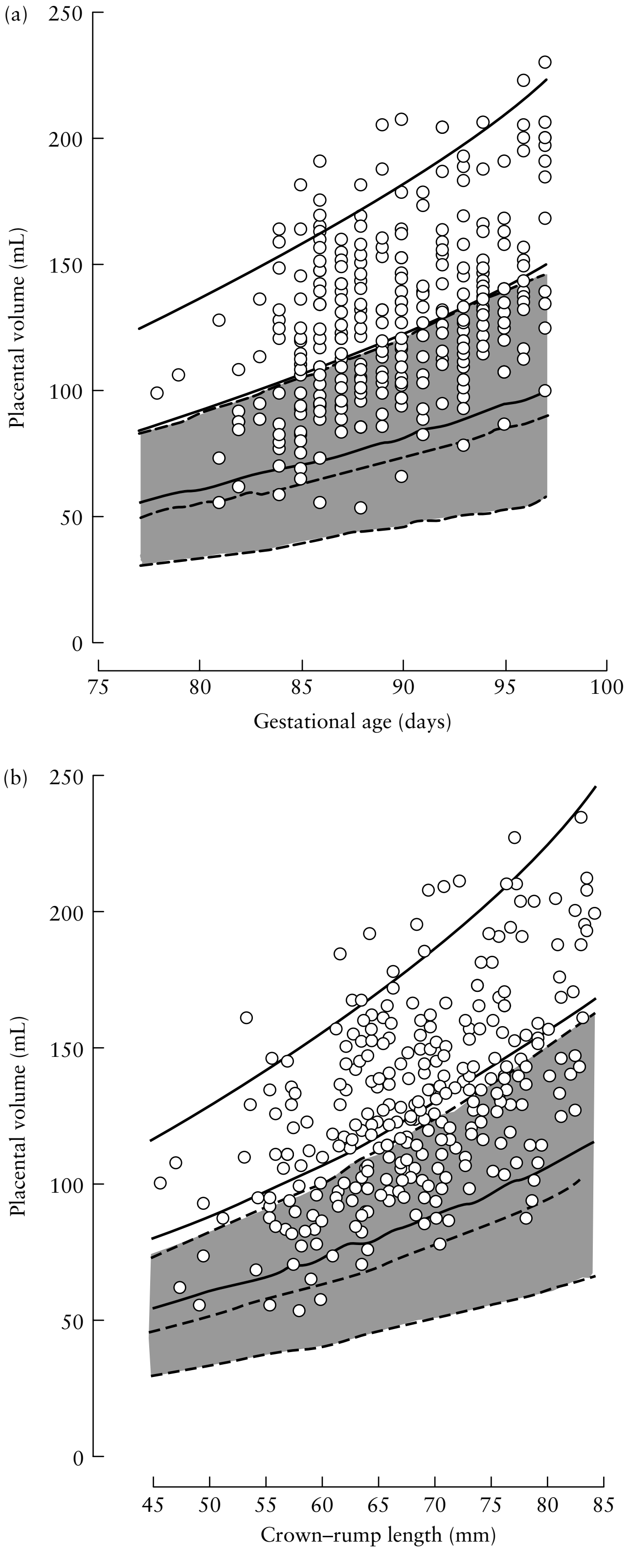

Figure 1 Reference range (median, 95th and 5th centiles, solid lines) of twin total placental volume with gestation (a) and crown–rump length (b) and their values (open circles) plotted on the appropriate reference range (median, 95th and 5th centiles, dashed lines) in singleton pregnancies.

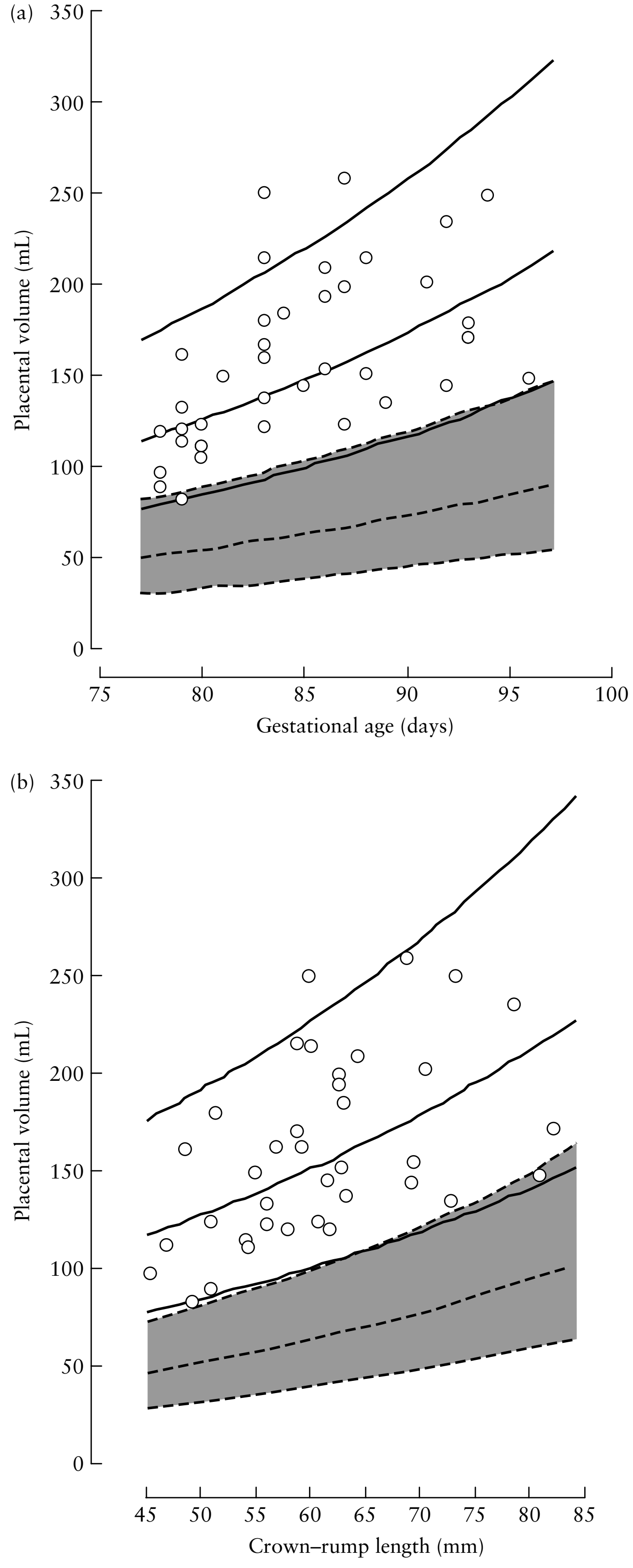

Figure 2 Reference range (median, 95th and 5th centiles, solid lines) of triplet total placental volume with gestation (a) and crown–rump length (b) and their values (open circles) plotted on the appropriate reference range (median, 95th and 5th centiles, dashed lines) in singleton pregnancies.

increased significantly with CRL of the biggest triplet, from a median of 117.2 mL (5th and 95th centiles: 78.1 mL and 176.0 mL) at a CRL of 45 mm to 227.5 mL (5th and 95th centiles: 151.5 mL and 341.5 mL) at a CRL of 84 mm (Ln placental volume = $0.017 \times \text{CRL} + 3.999$, Ln PSD = 0.247, $r = 0.531$, $P = 0.001$; Figure 2).

DISCUSSION

This study has demonstrated firstly, that placental volumes of normal twin and triplet pregnancies increase with gestation; secondly, that there are no significant differences in placental volume between monochorionic and dichorionic twins or between monochorionic, dichorionic and trichorionic triplets; and thirdly, that the rate of placental growth between 11 + 0 and 13 + 6 weeks is not significantly different between singletons, twins and triplets. In addition we have shown that, for a given gestational age, the placental volume corresponding to each fetus in twins and triplets is 83% and 76%, respectively, of the placental volume in singletons.

Our findings are compatible with those of previous studies that reported on placental weights in multiple pregnancies. Bleker *et al.* observed that from about 24 weeks onwards placental weights of twin and triplet newborns are smaller than those of singletons and suggested that this might be owing to poor early placental development[8]. Pinar *et al.* reported that there is no difference in the mean placental weight between monochorionic and dichorionic twins[9]. Additionally, in twins the mean placental weight corresponding to each fetus, corrected for gestational age, is 85% and in triplets 75% of that in singletons[9,10].

Previous 3D ultrasound studies in singleton pregnancies have reported a significant association between placental volume measured at 14–26 weeks and birth weight, corrected for gestational age and infant sex[11–13]. In our study we did not examine the possible association between placental volume and birth weight in multiple pregnancies, because many of our pregnancies were ongoing. However, the observed differences in placental volume between singletons, twins and triplets are compatible with the reported birth weights of infants from such gestations. Thus, Alexander *et al.* reported that although the birth weight of singletons, twins and triplets is similar at 22–28 weeks, the birth weight at 32–37 weeks in twins is on average 84% and in triplets 77% of that in singletons[14].

Placentation in the first trimester of pregnancy may play a crucial role in determining the risk of subsequent late-pregnancy complications. Recent studies have suggested that trophoblast invasion of maternal tissues occurs as a continuous, progressive process during the first two trimesters of pregnancy, replacing the hypothesis of a first and second 'wave' of placentation[15]. That justifies the view that the pregnancy is a continuum, with serious late complications – such as growth restriction – having their origins in the very earliest weeks of gestation[1]. The relationship between first-trimester placentation and subsequent pregnancy outcome can be approached by Doppler assessment of uterine vascular resistance, the evaluation of circulating trophoblast derived proteins, and by placental volume measurement[1]. Women with a high uterine artery pulsatility index at 11–14 weeks have a markedly increased risk of hypertensive disorders and other adverse outcomes, such as fetal growth restriction and abruption[16–18]. Several studies have documented an association between low levels of first-trimester maternal serum pregnancy-associated plasma protein-A (PAPP-A) and subsequent development of pregnancy complications, including pre-eclampsia and fetal growth restriction[19–21]. Furthermore, there is an association between maternal serum concentration of PAPP-A and placental volume at 10–12 weeks of gestation[22]. First-trimester placental volume below the 10th centile (normalized to crown–rump length – placental quotient) is associated with an increased risk of pregnancy-induced hypertension and growth restriction[17].

It is well established that in both singleton and multiple pregnancies there is a correlation between placental weight at delivery and birth weight[23,24]. Our study indirectly reinforces this association, as we observed that the percentage of placental volume dedicated to each fetus in a multiple pregnancy is smaller than with singletons. In addition, we have established normal ranges for placental volumes in multiple pregnancies. The extent to which the measurement of placental volume in the first trimester will help to identify multiple pregnancies at high risk for adverse outcomes remains to be determined.

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