Study on the Application of GE-E10 Ultrasound Equipment to Estimate Fetus Weight and Compare Its Accuracy With Birth Weight

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Research article

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Abstract

Background: To explore the application of GE-E10 four-dimensional color ultrasound equipment for estimation of fetus weight and compare its accuracy with birth weight.

Methods: A total of 160 singleton and full-term pregnant women who delivered successfully in our department of obstetrics and gynecology from March 2017 to October 2019 were randomly selected as the study objects. The fetus weight was estimated by using clinically used two-parameter formula and GE-E10 four-dimensional color ultrasound multi-parameter. The accuracy of the two methods in estimating fetal weight was compared and analyzed.

Results: The 160 puerpera enrolled: average age (23.64±6.12) years, average gestational weeks (38.56±2.34), average gravidity (2.35±1.02) times. The accuracy of GE-E10 multi-parameter ultrasound in estimating fetal weight and birth weight was 92.50% (148/160), which was significantly higher than that estimated by two-parameter formula: 72.50% (116/160), (P<0.05). The area under the ROC curve of fetus weight estimated by GE-E10 multi-parameter ultrasound was 0.842 (0.024-0.768), which is higher than that estimated by two-parameter formula was 0.717 (0.103-0.832), (P<0.05).

Conclusion: The accuracy of GE-E10 four-dimensional color ultrasound equipment in estimation of fetus weight is high and effective, which can be used for estimating fetal macrosomia effectively and providing guidance and reference for delivery of puerpera.

Background

Fetal birth weight is the most sensitive indicator concerning growth, development and health for newborns. The accurate estimation of fetal birth weight is of great guiding significance to whether a mother can successfully complete vaginal delivery, whether a mother with a small pelvis can have a vaginal trial, and how to choose solutions during stasis of stages of labor [1]. The exploration of the best method for accurate prediction of fetal weight has been one of the focuses of clinical studies in obstetrics all the time [2]. In medical calculation, fetal weight is generally calculated by measuring fetal biparietal diameter, femoral length, fundal height, abdominal circumference and other indicators through imageological examination. However, the value obtained is only the evaluation with certain error, rather than absolute accuracy, and cannot be deemed to be the actual fetal weight at birth [3]. In order to improve the accuracy of fetal weight estimation, many experts and scholars at home and abroad have carried out relevant studies, from the earliest single parameter measurement and evaluation to joint parameters, from two-dimensional ultrasound to three-dimensional ultrasonic measurement, and found that it is more accurate to directly observe fetal growth and development in uterus and measure its physiological parameters to estimate birth weight [4].

The commonly used two-parameter formula in clinical practice is to obtain the estimated value by multiplying fundal height and abdominal circumference plus 200g. It is generally believed that a fetus with weight of 3000-3500g is conducive to natural birth, while a fetus more than 4000g shall be regarded

as fetal macrosomia, which may increase the risk of maternal delivery. There are some difficulties in natural birth, so cesarean section should be taken into consideration [5]. The estimation value by two-parameter formula is easily affected by maternal obesity and thinness. Some studies believe that abdominal circumference index has relatively little significance in predicting fetal weight, but fundal height is not easily affected by other factors, which is an important maternal parameter for predicting fetal weight [6]. As one of the main examination methods in obstetrics and gynecology, ultrasound was firstly applied to estimate fetal weight by single index, which was easy to operate and not accurate. Subsequently, multiple parameters were usually used to estimate fetal weight in clinical practice, such as fetal biparietal diameter, abdominal circumference, head circumference, femoral lengthand etc., which improved the accuracy of fetal weight prediction to some extent [7]. With the continuous improvement of modern medical technologies, the application of four-dimensional color ultrasound in obstetric examination has been gradually popularized, maintaining the advantages of higher image definition and more accurate diagnosis of fetal malformation, and more accurate results can also be obtained from measurement of the above indicators. Therefore, multiple parameters of GE-E10 four-dimensional color ultrasound equipment are used for fetal weight estimation, and its application efficacy and clinical value are explored in this study. Details are as follows.

Methods

General Data

A total of 160 singleton and full-term pregnant women who delivered successfully in our department of obstetrics and gynecology from March 2017 to October 2019 were randomly selected as the study objects. Inclusion criteria: between the ages of 18-40 years; between 37-42 weeks of gestation; no complications of pregnancy; fetal health without malformation; voluntarily sign the informed consent to cooperate in examinations. Exclusion criteria: aged under 18 years or elderly parturient women over 40 years; complications during pregnancy; prenatal examination clearly indicated fetal malformation; puerperal with incomplete clinical data. The self-comparison was used in the study, the details of puerpera are shown in Table 1 and this study has been approved by the Ethics Committee of the Affiliated Hospital of North Sichuan Medical College.

Research Method

Fulfilled by the same senior ultrasound physician with over 5 years' work experience, the fetus weight was estimated by using clinically used two-parameter formula (fundal height and abdominal circumference) and GE-E10 four-dimensional color ultrasound multi-parameter (fetal biparietal diameter, head circumference, abdominal circumference and femur length) for all puerperal one week before delivery.

Two-parameter Formula

That is, the professional physician of obstetrics department will examine puerpera in terms of conventional measurement parameters: uterine height, abdominal circumference and abdominal wall

thickness; Each index was measured twice, with the mean value as the final result, and the estimated fetal weight was calculated as = uterine height × abdominal circumference +200g.

GE-E10 Four-dimensional Color ultrasound Multi-parameter

The equipment is American GE-E10 four-dimensional color ultrasound diagnostic device, with the probe frequency of 3.5 MHz. Ultrasound probes were used to continuously track the head, face, neck, chest, abdomen, spine, limb structure, placenta and amniotic fluid of the fetus, lengthways, horizontally and slantly. Detailed measurement parameters: fetal biparietal diameter, head circumference, abdominal circumference, length of femur and etc.; Each index was measured for three times, and the average value was taken as the final result. The data were through post-processing by relevant software of ultrasonic obstetrics to calculate the estimated fetal weight.

Evaluation Index

The puerperal were tracked till delivery, the birth weight of fetus was taken as the gold standard. The error was ±10g with the electronic newborn scale in the operating room. The accuracy of the two methods in estimating fetal weight and the coincidence rate in predicting macrosomia were compared and analyzed, and the calculated error ±200g was considered to be accurate or consistent. Macrosomia refers to the weight of a newborn being more than or equal to 4000g within 1 hour after birth. The ROC curve charts of the two estimation methods were drawn to evaluate their application efficacy (sensitivity and specificity).

Statistical Analysis

All data involving the study were analyzed and processed through the statistical software SPSS 20.0. The measurement data were expressed as mean ± standard deviation (' x±s). The counting data were expressed as a percentage (%), and Chi-square test was used between groups. $P<0.05$ was considered statistically significant.

Results

Analysis of General Data of Enrolled Puerpera

The 160 puerpera enrolled in the group: average age (23.64±6.12) years, average gestational weeks (38.56±2.34) and average gravidity (2.35±1.02) times. Data details are referred in Table 1.

Comparison of Accuracy of the Two Methods in Estimating Fetus Weight

The accuracy of GE-E10 multi-parameter ultrasound in estimating fetal weight and birth weight was 92.50% (148/160), significantly higher than that estimated by two-parameter formula: 72.50% (116/160), and the difference between groups was statistically significant ($P<0.05$); Data details are referred in Table 2 and Fig. 1.

Comparison of Coincidence Rate of Macrosomia by the Two Methods

There were 32 fetal macrosomia delivered by 160 puerpera, the coincidence rate of GE-E10 multi-parameter ultrasound was 84.38% (27/32), and that of two-parameter formula was 68.75% (22/32), the difference between both groups was statistically significant (P<0.05). Data details are referred in Table 3 and Fig. 1.

Comparison of Efficiency of Fetal Weight Estimation by the Two Methods

The ROC curve chart was prepared, with the two estimation methods as dependent variable, and the results show that the area under the curve of fetus weight estimated by GE-E10 multi-parameter ultrasound was 0.842 (0.024-0.768), that estimated by two-parameter formula was 0.717 (0.103-0.832), and the estimation efficiency of GE-E10 multi-parameter ultrasound was superior to two-parameter formula, indicating that the difference was statistically significant (P<0.05). Data details are referred in Fig. 2.

Discussion

Fetal weight is an important factor in determining the complexity of delivery and is critical for puerperal to select delivery mode and perinatal outcome. The accurate prenatal estimation of fetal birth weight through obstetric examinations will effectively improve the detection rate of macrosomia, thereby reducing the risk during delivery and occurrence of neonatal disability and death [8]. Macrosomia refers to the weight of a newborn being more than 4000g within one hour after birth. The prenatal diagnosis of macrosomia will provide guidance for medical staff to make correct treatment during delivery, thus reducing the incidence of maternal and infant obstetric complications [9]. In addition, the accurate estimation of a fetus whose birth weight is less than 2500g is also conducive to early prenatal diagnosis of intrauterine growth retardation and improvement of maternal and infant pregnancy outcomes [10]. At present, there are many clinical methods for estimating fetal weight at home and abroad, but the accuracy of different methods is quite different. Some scholars have found in their studies that the measurement of abdominal circumference before delivery has a high diagnostic value for predicting macrosomia [11]. However, it was found in the study of Dube C [12] that the accuracy of estimating fetal weight by single-parameter of abdominal circumference would be reduced due to the influence of multiple factors, such as fetal position, amniotic fluid and filling degree of fetal stomach bubble and etc. The uterine height and abdominal circumference are traditional indexes for fetal weight estimation, which are not easily affected by other factors. Therefore, they are considered as important maternal parameters for fetal weight estimation and macrosomia prediction.

The estimation of fetal weight by abdominal circumference and uterine height is a two-parameter formula method commonly used in clinic. The results are mainly affected by maternal obesity and thinness, and the accuracy of estimation will be limited. On this basis, it has been believed in more and more studies that the application combining multi-parameter and advanced ultrasonic technologies plays an important role in improving the accuracy of fetal weight estimation [13]. Ultrasound is a widely used imageological examination in obstetrics and gynecology, which maintains the advantages of

noninvasive, painless and simple operation, and assists physicians to observe the growth and development of fetus in utero directly. Meanwhile, it has high accuracy in measurement of multiple fetal physiological parameters. The American GE-E10 high-end four-dimensional color ultrasound equipment and system adopts excellent ergonomic design, resists the radiation problems in radiation, light wave, electromagnetic wave and other aspects, which have no impact on human health, so it is safe and reliable for maternal prenatal examination [14]. Compared with ordinary ultrasound images, four-dimensional color ultrasound outputs clearer images and has more abundant data, especially for the diagnosis of fetal congenital malformations. It is used to measure the accuracy of physiological parameters such as fetal double apical diameter, abdominal circumference, head circumference and femoral length, thus improving the accuracy of fetal weight estimation and diagnosis of macrosomia [15]. Fetal biparietal diameter and femoral length are bone markers, which are rarely affected by other factors when the measurement methods are grasped. The application combining GE-E10 ultrasound and multi-parameter comprehensive estimation of fetal weight will effectively correct the errors caused by maternal obesity, thinness and measurement methods to a large extent [16]. Equipped with corresponding obstetrics software, GE-E10 ultrasound device will directly display the physiological parameters of the fetus after scanning and measuring some meridians of fetus. The establishment of fetal weight estimation model will even display the fetal weight directly without tedious calculation [17].

In this study, GE-E10 multi-parameter ultrasound equipment was used to estimate the weight of 160 fetus, and the accuracy rate was up to 92.50% compared with the birth weight, which was significantly higher than that of conventional two-parameter formula (72.50%). This result indicates that the application of GE-E10 multi-parameter equipment can improve the accuracy of fetal weight estimation in an effective manner. After delivery, 32 of 160 fetuses were macrosomia, and the coincidence rate of macrosomia predicted by GE-E10 ultrasound one week before delivery reached 84.38%, far higher than that of 68.75% predicted by the two-parameter formula. It can be seen that the application of GE-E10 equipment can also improve the diagnosis accuracy of macrosomia. Through study and analysis on ROC curve, the comparison of the effectiveness of the two methods in predicting fetal weight showed that the area under the curve of GE-E10 ultrasound estimation was larger than that of the two-parameter formula, indicating that this method had good sensitivity and specificity for fetal weight estimation. It was found in the study of Zahra Laleh [18] that the closer the ultrasound was to the delivery date, the more accurate it was compared with the birth weight. The existing clinical formula for weight estimation is only applicable to the fetus delivered 3-4d after ultrasonic examination, and the estimation error will increase with the delay of delivery date. In practice, it’s also difficult for obstetricians to grasp the time of fetal delivery accurately, so it is not realistic to estimate weight 3-4d before fetal delivery. Therefore, special attention should be paid to the valid time when ultrasound is applied to estimate fetal weight.

Conclusion

Compared with birth weight, the application of GE-E10 four-dimensional multi-parameter color ultrasound equipment in estimation of fetus weight has high accuracy, favorable specificity and sensitivity, thus

maintaining certain effect on estimation of macrosomia, and providing guidance and reference for delivery of puerpera.

Abbreviations

Not applicable.

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.This study is approved by the Ethics Committee of the Affiliated Hospital of North Sichuan Medical College. All patients gave informed written consent to participate in the study.

Consent for publication

Not appilicable.

Availability of data and material

The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

None.

Authors' contributions

MCZ and HGZ were guarantor of integrity of the entire study and they definited the intellectual content. MCZ also participated in study design, literature research, clinical studies, statistical analysis, manuscript preparation and manuscript review. HGZ carried out the study concepts. JC worked out the data

acquisition and she analysed the datas with YYG. HWZ editted the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1 Analysis of General Data of Enrolled Puerpera

Item	Scope	Median	Mean Value
Average age (years)	19-34	26.5	23.64±6.12
Gestational weeks (weeks)	38-41	39.8	38.56±2.34
Gravidity (times)	1-5	3	2.35±1.02

Table 2 Comparison of Accuracy of the Two Methods in Estimating Fetus Weight

Estimation Methods	Cases (n)	Number of Accurate Estimation (n)	Accuracy (%)
GE-E10 multi-parameter ultrasound	160	148	92.50
Two-parameter formula in clinical practice	160	116	72.50
x^2		13.853	
P		0.001	

Table 3 Comparison of Coincidence Rate of Macrosomia by the Two Methods

Estimation Methods	Cases (n)	Number of Estimated Macrosomia (n)	Coincidence Rate (%)
GE-E10 multi-parameter ultrasound	32	27	84.38
Two-parameter formula in clinical practice	32	22	68.75
x^2		6.808	
P		0.009	

Figures

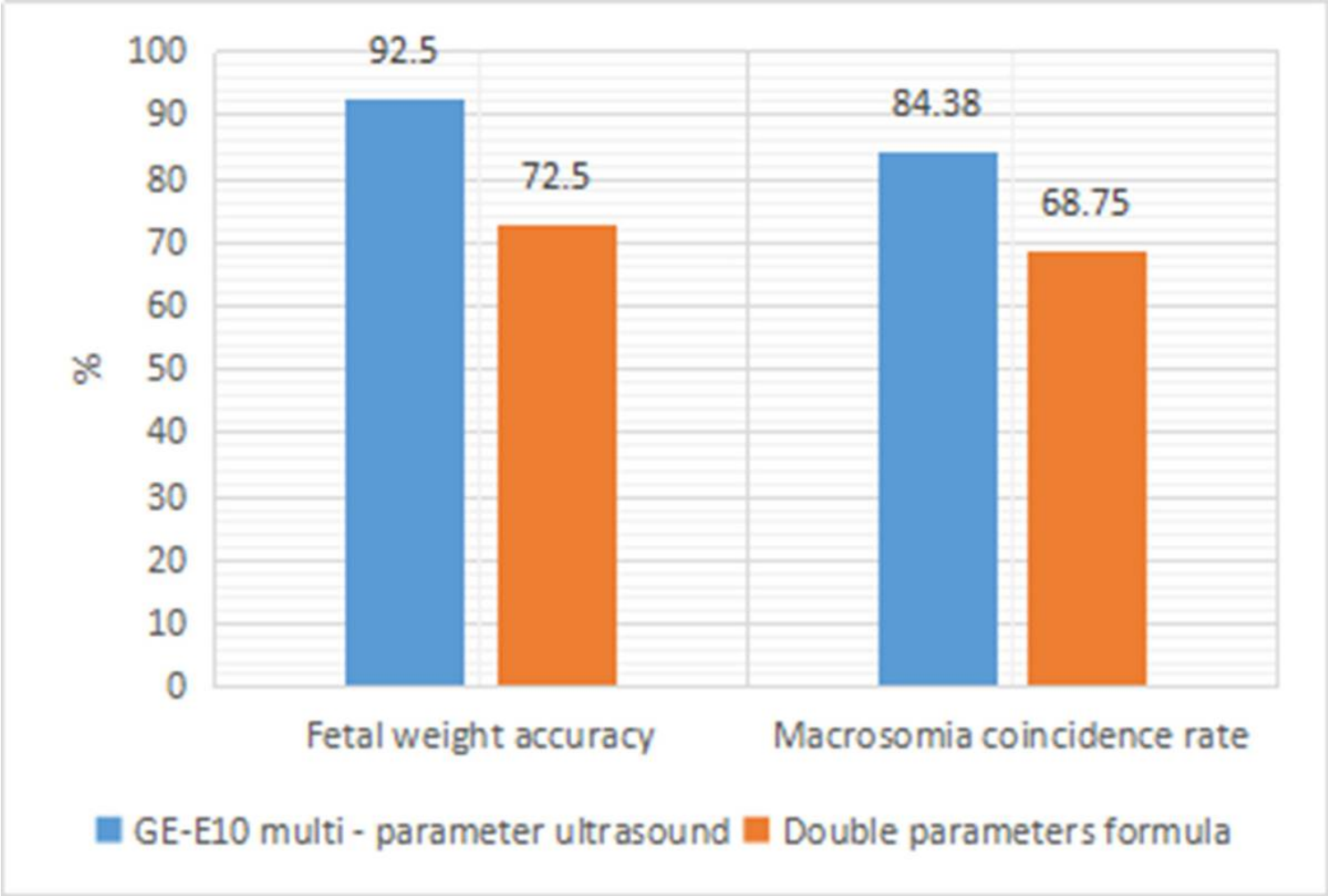

Figure 1

Accuracy Rate of Fetal Weight Estimation and Coincidence Rate of Macrosomia by the Two Methods.

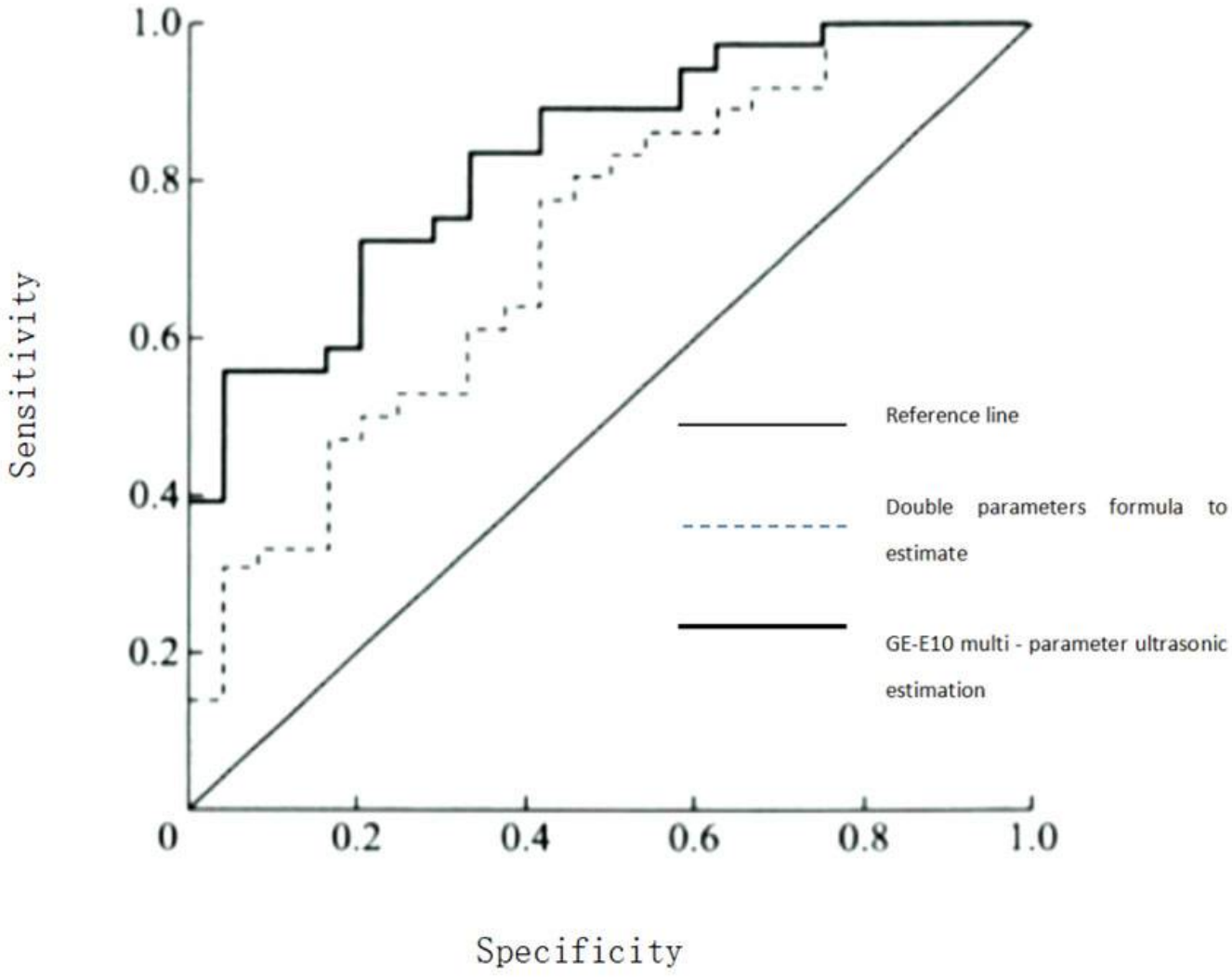

Figure 2

ROC Curve of Fetal Weight Estimation by the Two Methods.