

Original Article

Estimation of fetal weight by ultrasonic examination

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Abstract: Purpose: This study was to evaluate the accuracy and clinical application of a new technique in the fetal weight estimation by ultrasound. Methods: The fetal biparietal diameter (BPD), head circumference (HC) and femur length (FL) were measured by ultrasound examination within one week before delivery. Two different fetal abdominal sectors were measured for the assessment of abdominal circumference (AC). The fetal weight of 516 singleton fetuses was estimated according to above measurements and their actual birth weight was recorded after delivery. Results: There were no significant differences in the fetal AC or body weight evaluated before delivery and recorded after delivery. Conclusion: This new technique is more convenient and applicable for the evaluation of fetal AC as compared to standard method, and seems to be reliable and accurate for the assessment of fetal weight.

Keywords: Estimation of fetal weight, abdominal circumference, sector, ultrasonography

Introduction

The estimation of fetal weight by ultrasound is routinely used in clinical practice. Parameters used to estimate the birth weight are attractive to clinicians as they are important variables affecting perinatal mortality [1, 2]. Studies have revealed that estimation with multiple parameters may be more accurate as compared to that with a single parameter [3-7]. Fetal biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC) are essential parameters for the estimation of prenatal fetal weight, and of them, AC is a parameter with the highest sensitivity [8-16]. This study aimed to introduce a new technique for the AC measurement, which is easy and convenient to operate as compared to traditional methods, and also accurate in the estimation of fetal weight.

Materials and methods

Subjects

A total of 516 singleton fetuses with gestational age ranging from 31 to 41 weeks, who received examination by ultrasound and were born in our hospital, were recruited into present

study from January 2010 to February 2014. All pregnant women, including those with hypertension, gestational diabetes mellitus, first/non-first pregnancy and full-term/preterm delivery were examined within 7 days before delivery. Pregnant women with fetal malformation were excluded from this study. This study was approved by the Ethics Committee of our hospital.

Methods

Ultrasonography was performed using GE LOGIQ 9, GE LOGIQ E9 with a 3.5-MHz transducer. All the measurements were determined by trained and experienced physicians. Many ultrasound estimated fetal weight (EFW) formulae have been designed based on different fetal biometric parameters [17], almost all the EFW formulae either under or over estimated the birth weight in singleton pregnancies [18]. Since there is no particular formulae for EFW in Chinese population, Hadlock formulae was used as routine. BPD, HC and FL were measured according to standard protocol described in the *Ultrasound Medicine (Fourth Edition)* [19] (**Figures 1-3**). AC was measured with a new method which was different from the standard

Estimation of fetal weight by ultrasound

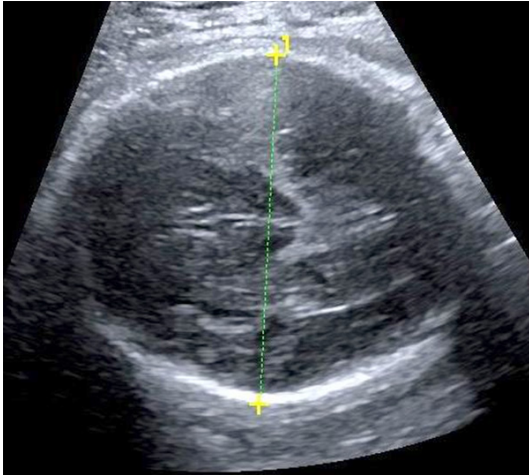


Figure 1. Measurement of biparietal diameter (BPD).

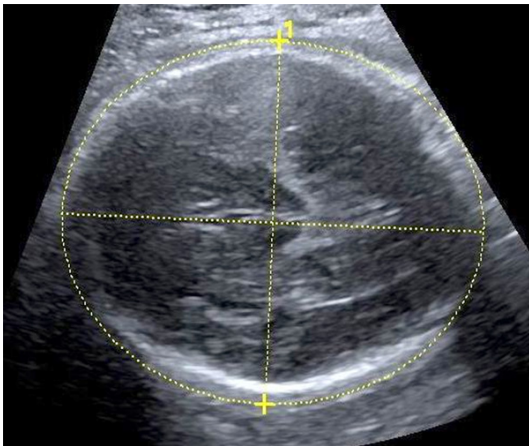


Figure 2. Measurement of head circumference (HC).

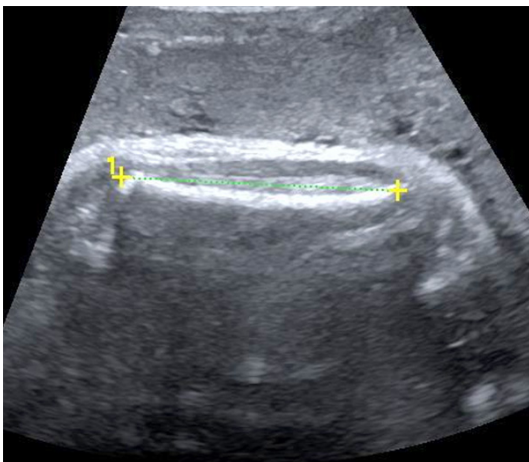


Figure 3. Measurement of femur length (FL).

one described in the *Ultrasound Medicine* (Fourth Edition) [19]. In the standard abdominal

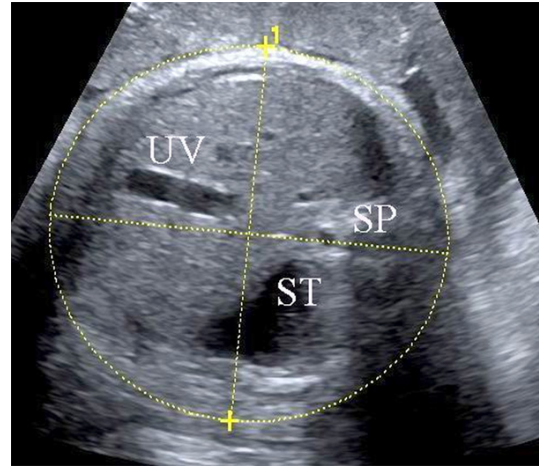


Figure 4. Standard abdominal sector and standard measurement of AC (AC1). SP: Spine, ST: Stomach, UV: Umbilical Vein.

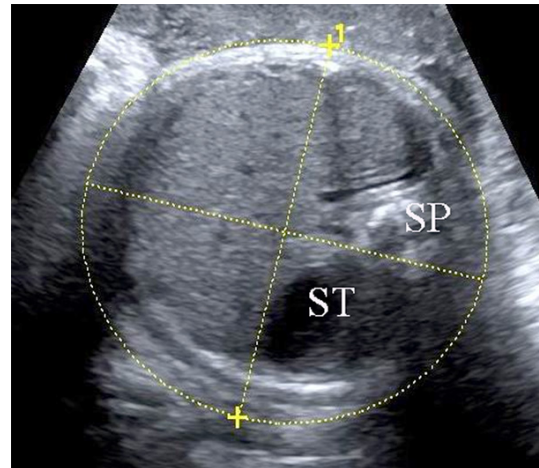


Figure 5. New technique and measurement of AC with the new technique (AC2). SP: Spine, ST: Stomach.

method, the liver, stomach, and umbilical part of hepatic portal vein with equal distance from the umbilical vein to two fetal abdominal side walls were measured, the sector should be perpendicular to the spine, and the length of umbilical vein should be about 1/3 anteroposterior diameter of fetus abdomen, the fetal skin should be included in the AC1 measurement (**Figure 4**; AC1). The new abdominal method only needs to show the maximum abdominal sector which is perpendicular to the spine and includes the stomach and liver, but the umbilical vein, heart and kidney are not necessarily included in this sector, the fetal skin should also be included in the AC2 measurement (**Figure 5**; AC2).

Estimation of fetal weight by ultrasound

Table 1. Absolute error of EFW2

Percentage	N	Occurrence (%)	Cumulative absolute error (g)
≤ 100	146	27.7	27.7
101~200	205	40.0	67.7
201~250	132	25.8	93.5
251~300	23	4.5	98.0
300	10	2.0	100.0

Table 2. Relative error of EFW2

Percentage	N	Occurrence (%)	Cumulative relative error (%)
≤ 5.0	288	55.5	55.5
5.1~10.0	185	36.1	91.6
10.1~15.0	25	4.9	96.5
≥ 15.1	18	3.5	100.0

All the above parameters were measured three times and then averages in cm were calculated. The fetal weight from two measurements estimated automatically according to the Hadlock formula was denoted as EFW1 and EFW2. The actual birth weight (ABW) was recorded within 10 min after birth with an electronic weight meter.

Statistical analysis

The absolute error (ABW-EFW) and relative error (absolute error/ABW × 100%) were calculated. Data were analyzed with Statistical Package for the Social Sciences (SPSS) version 17.0. A value of $P < 0.05$ was considered statistically significant.

Results

The absolute error and relative error of EFW2 are shown in **Tables 1** and **2**. The overall mean absolute error of ≤ 250 g was 93.5%, and the overall mean relative error of ≤ 5% and ≤ 10% was 55.5% and 91.6%, respectively.

As shown in **Table 3**, in Boys, the absolute error of ≤ 250 g was 87.0%, and the relative error of ≤ 5% and ≤ 10% was 54.3% and 88.8%, respectively. In Girls, the absolute error of ≤ 250 g was 90.9%, and the relative error of ≤ 5% and ≤ 10% was 55.1% and 89.3%, respectively. Chi-square (X^2) test showed there were no significant differences in these parameters between Boys and Girls ($P = 0.159, 0.87$ and 0.844 , respectively), which means the EFW based on a new

method was comparable between Boys and Girls.

The absolute error of ≤ 250 g, and the relative error of ≤ 5% and ≤ 10% were also similar among different weight groups ($P = 0.09, 0.17$ and 0.091 , respectively), which means that EFW based on the new method was comparable among different weight groups.

Moreover, U test showed there were marked differences in the ABW and EFW between boys and girls ($P = 0.0250$ and 0.0252 , respectively), which means ABW and EFW in boys are significantly different from those in girls, boy's weight is heavier than girl's. The body weight of boys was higher than that of girls.

The mean EFW and ABW were compared between girls and boys and among different weight groups (**Table 4**). As shown in **Table 4**, there were no significant differences in the EFWs and ABWs between boys and girls and among different weight groups.

The mean AC1 was 34.6 ± 0.44 cm and mean AC2 was 35.1 ± 0.22 cm, showing no marked difference between them ($P = 0.207$, t-test). This means there was no significant difference between AC1 and AC2.

Discussion

In the routine estimation of fetal weight with ultrasound, existing regression equation is used to estimate the fetal weight. Accurate estimation of fetal weight is extensively required by obstetrics doctors, which is particularly important when dealing with fetuses with growth restriction or macrosomia [13, 20-24]. Whether the fetus can be successfully delivered vaginally, whether the birth process should continue and whether vaginal delivery can be chosen for women with small pelvis, the accurate estimation of fetal weight plays an important role. Accurate information regarding fetal weight provides a basis for the clinical decision in many cases. Weight estimation in case of small for gestational age or macrosomia should be helpful for clinical procedures so as to effectively reduce the incidence of dystocia neonates [15, 25, 26] and minimize the perinatal morbidity and mortality [1, 2, 27, 28].

It has been reported that estimation of fetal weight according to multiple parameters is

Estimation of fetal weight by ultrasound

Table 3. ABW and EFW2 in different groups

Groups	N	ABW	EFW2	N	Percentage of $\leq 10\%$	N	Percentage of $\leq 5\%$	N	Percentage of ≤ 250 g
Boys	269	3424 \pm 491	418 \pm 500	239	88.8%	146	54.3%	234	87.0%
Girls	247	3330 \pm 458	3322 \pm 470	217	89.3%	134	55.1%	221	90.9%
2000-2500 g	18	2401 \pm 125	453 \pm 187	13	92.9%	11	78.6%	14	100%
2501-3000 g	75	2807 \pm 141	2860 \pm 160	70	93.3%	46	61.3%	71	94.7%
3001-3500 g	248	3256 \pm 128	3216 \pm 174	225	90.7%	143	57.7%	223	89.9%
3501-4000 g	132	3700 \pm 143	3726 \pm 189	115	87.1%	65	49.2%	118	89.4%
> 4000 g	43	4364 \pm 329	4350 \pm 304	32	74.4%	20	46.5%	35	81.4%

Table 4. Mean EFW and ABW in different groups

	Boys	Girls	2000~2500 g	2501~3000 g	3001~3500 g	3501~4000 g	> 4000 g
u	-0.2004	-0.2865	1.6640	1.5035	-1.2500	0.7273	-0.1702
P	0.841	0.775	0.096	0.133	0.211	0.467	0.865

much more accurate than that with a single parameter [3-7]. AC is particularly important [8-16]. Fetal weight increases in late pregnancy and is mainly related to fat accumulation and liver glycogen storage [29-31], which can be visualized by ultrasonography. Therefore, AC can preferably reflect the fetal weight, and is highly related to fetal birth weight [8-16]. This study focused on a new sector for the AC measurement that is more effective and easier to operate as compared to traditional sector.

Race, oligohydramnios, parity, smoking, and previous cesarean do not impact EFW accuracy [32], and BMI does not influence the measurements [18], but operator experience plays an important role in accurate fetal weight estimates [18]. The traditional abdominal sector used as a standard in practice relies more on examiner's skill, especially on the capture of the umbilical vein, which requires the length of umbilical vein be about one third of fetal abdominal anteroposterior diameter and with equal distance from the umbilical vein to two fetal abdominal side walls [19]. In practice, an inevitable factor that will impact the measurement of AC1 at this sector is fetal position. Fetal activity is relatively low in late pregnancy because of relatively fixed fetal position. For instance, when the fetus is in the occiput or sacral anterior position, the display of peritoneal structure is affected due to the lack of incident beams because they are blocked by the fetal spine in the front with increased bone structure calcification [33], that makes the umbilical vein stay in the spine shadows which

is hard to be show. However the new abdominal sector used in this study was rarely influenced by the fetal position, technical proficiency. It needs to show the maximum abdominal sector that is perpendicular to the spine and only need stomach, liver inside the sector, which is much easier and effective to operate properly, and our results showed that there was no significant difference in terms of accuracy between standard method and this new method.

According to our experience, the standard sector was for the first time used for the evaluation of fetal weight. When the standard sector is difficult to show, the new abdominal sector may provide a good alternative and also avoid persistent ultrasound examination for fetal weight estimation, which is not only good for the fetus but also reduce the exam duration dramatically. Especially while dealing with huge Chinese patient flow in daily work, a effective way with accurate results is significant and applicable for both patients and doctors.

In practice, these two methods are complementary in different situations. The new technique for AC estimation seems to be an efficient and accurate means for the estimation of fetal weight by ultrasound. It is important that repeated measurements (at least twice) are essential in both ways, to reduce measurement error and improve estimation accuracy.

Disclosure of conflict of interest

None.

Estimation of fetal weight by ultrasound

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Estimation of fetal weight by ultrasound

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