Comparison of diagnostic value of two-dimensional ultrasound and clinical examination in fetal weight estimation

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ABSTRACT

Background: Estimation of fetal weight during pregnancy plays an important role in prenatal and intrapartum care and is more important in pregnancies after 37 weeks to determine the type of delivery. The aim of this study was to compare and evaluate the accuracy and diagnostic value of two-dimensional ultrasound and clinical examination in estimating fetal weight and pregnancy outcomes.

Materials and Methods: This cross-sectional study was conducted on 300 pregnant women without abnormal fetuses and pregnancies after 37 weeks; mothers who had a normal delivery or cesarean section were evaluated by the available method. The weight of the fetus was estimated before and after delivery, using ultrasound and clinical examination. Newborns were classified into five groups based on their fetal weight. Analysis of collected data was performed with SPSS software.

Results: The mean age of the patients was 31 years and the mean weight of the neonates was 3450 g. At a weight of less than 3000 g, ultrasound and clinical evaluation were strongly correlated with the actual weight of the infant, but at weights of more than 3500 and 4000 g, weight estimation with ultrasound was highly accurate, and clinical examination had poor accuracy. In lower weights, square errors were fewer in both ultrasound and clinical examination, in comparison with higher weights. In higher weights, ultrasound is more reliable, and the diagnostic accuracy of clinical examination is reduced.

Conclusion: Estimation of fetal weight with prenatal ultrasound is highly accurate. Clinical examination is more accurate in determining the weight of small fetuses and does not pay much attention to the diagnosis of macrosomic fetuses and even leads to overestimation, while ultrasound is much more accurate in diagnosing fetal macrosomia.

Keywords: Clinical examination, fetal macrosomia, fetal weight estimation, two-dimensional ultrasound
delivery and fetal macrosomia are associated with a 3- to 5-fold increase in pelvic floor trauma.\(^\text{[1,6]}\) Pelvic floor trauma during vaginal delivery causes pelvic floor diseases such as urinary stress incontinence and pelvic organ prolapse.\(^\text{[6]}\) Therefore, with the help of ultrasound or clinical examination, many physicians can choose the best method of delivery and minimize the error rate.\(^\text{[1]}\)

In the United States, one-third of all deliveries were performed by cesarean section in 2009, which is a high rate.\(^\text{[8]}\) Since 1996, the prevalence of cesarean delivery in all age groups of mothers has increased by more than 50%.\(^\text{[9]}\) About half of which were related to primary cesarean section. Recent findings show that the Middle East has the highest rate of cesarean section in the world and the statistics are increasing, and it is important to provide diagnostic solutions to reduce cesarean section.\(^\text{[9]}\) Ultrasound is a simple and accessible method that uses the Hadlock formula and fetal biometric parameters including femur length, fetal head circumference, and abdominal circumference.\(^\text{[10,11]}\) If ultrasound is not available, fetal weight can be estimated by clinical examination and Leopold maneuvers, as well as by fundus height.

The aim of this study was to compare and evaluate the accuracy and diagnostic value of two-dimensional ultrasound and clinical examination in estimating fetal weight and pregnancy outcomes.

**Material and Methods**

**Study design**

The present study is a cross-sectional study, conducted on 300 pregnant mothers with singleton pregnancies without abnormal fetuses and pregnancies after 37 weeks (42–37), who referred to the gynecology department of Dr. Shariati Hospital for normal delivery or cesarean section, in 2018 and 2019. Mothers with abnormal fetuses, fetal breech, or transverse fetuses, patients who referred in the active phase and had dilatations greater than 4 cm, were excluded from the study.

**Inclusion and exclusion criteria**

Inclusion criteria included women in the age range of 18–42 years, singleton pregnancy, without chronic hypertension, and history of thrombophilia. Exclusion criteria included women with a history of chronic hypertension, smoking or drug abuse, overt or gestational diabetes, kidney disease, megaloblastic anemia, seizure, prior significant illness, personal or familial history of deep vein thrombosis, and/or vitamin deficiency, as well as those receiving any antifolate drugs (antiepileptics, methotrexate).

**Method description and data collection**

Prior to ultrasound, after emptying the mother's bladder, fetal weight was estimated by a gynecologist from the abdomen by two-handed examination. The mother was in the supine position, and after straightening her legs, her abdomen was placed between her hands from the top of the symphysis to the pedal between her hands. In patients with fat abdomen, the skin was gently stretched to access the fundus, and if the uterus was placed flat, there is the possibility that the fetus had been pulled around the mother's pelvis; therefore, the fetus should be slowly moved from the perimeter to the middle of the abdomen for estimation of the correct weight.

Fetal weight was estimated in the ultrasound room, and the method of estimating fetal weight was performed by a professor of perinatology using the Hadlock formula and fetal parameters of biparietal diameter and head circumference, femur length, and abdomen circumference. The physicians who performed clinical and ultrasound assessments were blind to each other.

Then, after normal delivery or cesarean section, the fetal weight was recorded in the neonatal ward immediately after birth (first hour after birth) and after initial cleaning and before breastfeeding or feeding of the infant by the neonatal nurse.

In this study, infant weighs less than 2500 g were considered in the FGR range, 2500–3999 g in the normal range, and weights more than 3999 g were considered fetal macrosomia. Data were collected in a preprepared checklist and analyzed at the end of the research. The study was registered in the Iranian Registry of Clinical Trials IR.TUMS.MEDICINE.REC.1397.536 after approval of the research and ethics committees at the university.

**Statistical analysis**

The collected information was descriptive (mean, standard deviation, and frequency distribution) and analyzed using pair t-test, C-2 test, and Pearson correlation coefficient. Statistical analysis of data was performed through SPSS 20 software. \(P\) values less than 5% were considered as a significant level.

**Results**

This study was conducted on 300 pregnant women without abnormal fetuses and pregnancies after 37 weeks, and 107 of which were primiparous women (35.6%) and 193 were multiparous women (64.3%) [Table 1]. The youngest patient was 18 years old and the oldest was 40 years old. The mean age was 31 years and the mean gestational age was 38 weeks; most patients were overweight, and only 21.1% had normal body mass index (BMI). The mean weight of the neonates was 3450 g.

As can be seen in Table 2, at a weight of less than 3000 g, ultrasound and clinical evaluation have a strong correlation with the actual weight of the baby \((P < 0.05)\), but at a weight of more than 3500 and more than 4000 g, this relationship is strong in ultrasound and high sonography accuracy \((P > 0.05)\).

The results of Table 3 demonstrated that the mean fetal weight was significantly lower in primipara pregnant women than in multipara patients \((P < 0.01)\).

It has been observed that maternal body mass and gestational age affect weight estimation in both methods, and the greater the gestational age and BMI, the deeper the effect. Linear regression
analysis shows that maternal BMI affects the accuracy of the results so that as maternal weight increases, the rate of diagnostic error increases in both methods. In obese mothers, the weight estimated by ultrasound is even lower than the weight estimated by clinical examination (P < 0.05). [Table 4].

According to the results of Table 5, the negative predictive value of the clinical examination is high, meaning that if the clinical examination shows that the fetus is not macrosomic, it can be trusted with a 73% probability of correctness, so if the clinical examination states that the fetus is not FGR, it is equally acceptable, while the opposite is not true, so its sensitivity and positive predictive value are low. On the other hand, the results on ultrasound show high sensitivity and specificity and a high positive and negative predictive value.

**Discussion**

Assessing and estimating fetal weight before delivery is one of the prerequisites for pregnancy care in order to reduce maternal and fetal risks and complications. In this study, two-dimensional ultrasound was compared with clinical examination in estimating fetal weight in the third trimester of pregnancy. The weight of the fetus estimated by ultrasound and clinical examination corresponded to the actual weight of the infant after birth. This result was consistent with studies by Lee and Wu in 2020. [13,14]

Our study showed that in the weight range of 200–2499 and 2500–2999 g, clinical ultrasound and clinical estimation both had sufficient accuracy in estimation of fetal weight, but at higher weights, ultrasound was more accurate in estimating fetal weight. This indicates the high accuracy of fetal weight estimation by ultrasound, and this finding is consistent with the results of previous studies. [14-16]

In our study in lower weights, the square error is lower in both the methods of ultrasound and clinical examination, in comparison with higher weights; on the other hand, in higher weights, ultrasound is more reliable, and the diagnostic accuracy of clinical examination is reduced. It is important to note that in the estimation of higher weights, clinical examination is more unrealistic than the actual weight and the weight estimated by ultrasound, while the clinical examination is reliable in assessing the weight of smaller fetuses and its diagnostic accuracy is higher than ultrasound. These findings support the claim that fetal weight estimation with ultrasound can be highly accurate in diagnosing fetal macrosomia or growth retardation. This finding is consistent with the studies by Streicher et al. (2001) and Murphy et al. (2001) in examining the accuracy and precision of ultrasound and estimating the weight of infants in the range of 500–5000 g. [17,18] Findings from other studies also showed similar results. [19-20] Ultrasound is more accurate in diagnosing lower weights, although there was no significant difference between the weight estimated by ultrasound and the actual weight in

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**Table 1: Demographic data and parity**

| Parameters               | Mean ±, % (n=300) |
|-------------------------|-------------------|
| Age (year)              | 31.02±3.25        |
| BMI (kg)                | 26.96±4.10        |
| Gestational age (week)  | 38.18±1.31        |
| Normal BMI              | 21.1%             |
| Weight of the neonates (g) | 3450             |
| Parity group            |                   |
| Primipara               | 35.6%             |
| Multipara               | 64.3%             |

**Table 2: Range of fetal weight (g) in groups**

| Range of fetal weight (g) | US FEW | P | Clinical FEW | P | ABW |
|---------------------------|--------|---|--------------|---|-----|
| 2000-2499                 | 30 (10%) | 0.01 | 28 (9.3%) | 0.02 | 32 (10.6%) |
| 2500-2999                 | 35 (11.6%) | 0.03 | 34 (11.3%) | 0.02 | 32 (10.6%) |
| 3000-3499                 | 92 (30.6%) | 0.008 | 110 (36.6%) | 0.09 | 90 (30%) |
| 3500-3999                 | 101 (33.6%) | 0.02 | 68 (22.6%) | 0.11 | 106 (35.3%) |
| >4000                     | 42 (14.4%) | 0.01 | 60 (20%) | 0.23 | 49 (16.3%) |
| Total                     | 300 (100%) | - | 300 (100%) | - | 300 (100%) |

**Table 3: Comparison of mean fetal weights between parity groups**

| Parity Group | Mean fetal weight (g) ± SD | Comparison of mean weight between parity group | P |
|--------------|---------------------------|---------------------------------------------|---|
| Primipara    | 3100±50                   | Multipara Versus Primipara                   | 0.0001 |
| Multipara    | 3450±40                   |                                             |   |

**Table 4: Clinical examination in groups. Normal weight=18.5 < BMI <24.99. Overweight=25.0< BMI <29.99. Obesity class I=30.0 <BMI <34.9 obesity class II=35.0 <BMI <39.9**

| Parameters       | n (%) | Mean±SD | US/Accuracy (%) | Clinical/Accuracy (%) | All. Accuracy (%) | P  |
|------------------|-------|---------|-----------------|-----------------------|-------------------|----|
| Age              |       |         |                 |                       |                   |    |
| 18-30 years old | 128 (41) | 27.17±2.94 | 79 | 69 | 74 | 0.036 |
| Above 30 years old | 171 (59) | 35.84±7.25 | 21 | 31 | 26 | 0.268 |
| BMI              |       |         |                 |                       |                   |    |
| 37-39 week       | 134 (43) | 37.17±2.94 | 62 | 59 | 60.5 | 0.039 |
| 40-42 week       | 166 (56) | 40.84±0.82 | 38 | 41 | 39.5 | 0.182 |
| BMI              |       |         |                 |                       |                   |    |
| Normal weight    | 65 (21.6) | 22.5±7.19 | 42 | 36 | 39 | 0.039 |
| Overweight       | 112 (37.3) | 27.7±4.23 | 32 | 30 | 31 | 0.082 |
| Obesity class I  | 98 (32.6) | 32.2±5.11 | 16 | 23 | 19.5 | 0.119 |
| Obesity class II | 25 (8.3) | 36.5±2.84 | 10 | 13 | 11.5 | 0.182 |
macroscopic fetuses; also, other studies in this field confirmed this finding. A 2014 study by Goetzinger et al. compared the baby's actual weight and the weight estimated by clinical examination, which was performed by professors; this study found that professors made about 500 g of error in estimating weight, and the diagnostic accuracy did not increase despite the high experience.

In general, the results of this study showed that estimating fetal weight with prenatal ultrasound is highly accurate, and this method is also highly accurate in diagnosing fetal macrosomia and growth retardation. Clinical examination is also useful for estimation of lower weight, but it is not very accurate in estimation of heavier weights and even leads to overestimation, while ultrasound is very accurate in estimation of heavier weights.

One of the strengths of the study was the appropriate number of the study population. The practical finding is to rely on ultrasound results when assessing fetal weight in the normal range. On the other hand, estimation of the weight of macroscopic fetuses based on abdominal examination before delivery is usually exaggerated, while the estimation of fetal size using ultrasound is reliable.

**Conclusion**

Estimating fetal weight with prenatal ultrasound is highly accurate. Clinical examination is more accurate in determining the weight of smaller fetuses and does not pay much attention to the estimation of higher weights and even leads to overestimation, while ultrasound is much more accurate in diagnosing fetal macrosomia (fetal weights more than 4000 g). It is recommended that the effect of clinical examination and ultrasound imaging on fetal weight estimation be further evaluated in a multicenter study by examining the relationship between factors influencing the accuracy of estimation.

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**Conflicts of interest**

There are no conflicts of interest.

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**Table 5: Sensitivity, specificity, PPV, and NPV for each method**

| Method    | Sensitivity | Specificity | PPV   | NPV   |
|-----------|-------------|-------------|-------|-------|
| Ultrasound| 68.00       | 90.88       | 89.53 | 86.78 |
| Clinical  | 50.2        | 73.23       | 51.32 | 73.32 |
| P         | 0.04        | 0.03        | 0.03  | 0.04  |

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**References**

1. Agbozo F, Abubakari A, Der J, Jahn A. Prevalence of low birth weight, macrosomia and stillbirth and their relationship to associated maternal risk factors in Hohoe Municipality, Ghana. Midwifery 2016;40:200-6.
2. C AK, Basel PL, Singh S. Low birth weight and its associated risk factors: Health facility-based case-control study. PLoS One 2020;15:e0234907.
3. Perin J, Koffi AK, Kaler HD, Monchini J, Adewemimo A, Quinley J, et al. Using propensity scores to estimate the effectiveness of maternal and newborn interventions to reduce neonatal mortality in Nigeria. BMC Pregnancy & Childbirth 2020;20:534.
4. Valsky DV, Lipschuetz M, Bord A, Eldar I, Messing B, Hochner-Celnikier D, et al. Fetal head circumference and length of second stage of labor are risk factors for levator ani muscle injury, diagnosed by 3-dimensional transperineal ultrasound in primiparous women. Am J Obstet Gynecol 2009;201:91.e1-7.
5. Kandel KP, Kafle S. Risk factors associated with low birth weight among deliveries at Bharatpur Hospital. J Nepal Health Res Counc 2017;15:169-73.
6. Lukacz ES, Lawrence JM, Contreras R, Nager CW, Lub EK. Parity, mode of delivery, and pelvic floor disorders. Obstet Gynecol 2006;107:1253-60.
7. Konje JC, Ladipo OA. Nutrition and obstructed labor. Am J Clin Nutr 2000;72 (1 Suppl):2915-75.
8. AlQurashi MA. Impact of mode of delivery on the survival rate of very low birth weight infants: A single-center experience. Cureus 2020;12:e11918.
9. Menacker F, Hamilton BE. Recent trends in cesarean delivery in the United States. NCHS Data Brief 2010:1-8.
10. Chien P. Global rising rates of caesarean sections. BJOG 2021;128:781-2.
11. Dudink J, Jeanne Steggerda S, Horsch S. State-of-the-art neonatal cerebral ultrasound: technique and reporting. Pediatr Res 2020;87(Suppl 1):3-12.
12. Setrak H, Nogué E, Desenfants A, Prodhomme O, Filleron A, Nagot N, et al. Reference values for abdominal circumference in premature infants. Front Pediatr 2020;8:37.
13. Lee W, Mack LM, Sangi-Haghpeykar H, Gandhi R, Wu Q, Kang L, et al. Fetal weight estimation using automated fractional limb volume with 2-dimensional size parameters: A multicenter study. J Ultrasound Med 2020;39:1317-24.
14. Wu X, Niu Z, Xu Z, Jiang Y, Zhang Y, Meng H, et al. Fetal weight estimation by automated three-dimensional limb volume model in late third trimester compared to two-dimensional model: A cross-sectional prospective observational study. BMC Pregnancy Childbirth 2021;21:365.
15. Okafor CO, Okafor CI, Mbachu II, Obiomwu IC, Aronu ME. Correlation of ultrasonographic estimation of fetal weight with actual birth weight as seen in a private specialist hospital in South East Nigeria. Int J Reprod Med 2019;2019:Article ID 3693797, 4 pages.
16. Preyer O, Husslein H, Concin N, Ridder A, Musielak M, Pfeifer C, et al. Fetal weight estimation at term-Ultrasound versus clinical examination with Leopold’s manoeuvres: A prospective blinded observational study. BMC Pregnancy Childbirth 2019;19:122.
17. Kurmanavicius J, Streicher A, Wright EM, Wisser J, Müller R, Royston P, et al. Reference values of fetal peak
systolic blood flow velocity in the middle cerebral artery at 19-40 weeks of gestation. Ultrasound Obstet Gynecol 2001;17:50-3.

18. Venkat-Raman N, Murphy KW, Ghaus K, Teoh TG, Higham JM, Carvalho JS. Congenital absence of portal vein in the fetus: a case report. Ultrasound Obstet Gynecol 2001;17:71-5.

19. Hiwale SS, Misra H, Ulman S. Ultrasonography-based fetal weight estimation: Finding an appropriate model for an Indian population. J Med Ultrasound 2017;25:24-32.

20. Lee W, Mack LM, Gandhi R, Sangi-Haghpeykar H. Fetal weight estimation using automated fractional limb volume with 2-dimensional size parameters in diabetic pregnancies. J Ultrasound Med 2021;40:279-84.

21. Combs CA, Rosem B, Miodovnik M, Siddiqi TA. Sonographic EFW and macrosomia: Is there an optimum formula to predict diabetic fetal macrosomia? J Matern Fetal Med 2000;9:55-61.

22. Stubert J, Peschel A, Bolz M, Glass Ä, Gerber B. Accuracy of immediate antepartum ultrasound estimated fetal weight and its impact on mode of delivery and outcome-A cohort analysis. BMC Pregnancy Childbirth 2018;18:118.

23. Goetzinger KR, Odibo AO, Shanks AL, Roehl KA, Cahill AG. Clinical accuracy of estimated fetal weight in term pregnancies in a teaching hospital. J Matern Fetal Neonatal Med 2014;27:89-93.