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Preterm Erken Membran Rüptürü Olan İzole Oligohidramniyoz Olgularında Fetal Ağırlığın Tahmininde Manuel ve Otomatik Ölçümlerin Karşılaştırılması

Comparison of Manual versus Automated Measurement to Estimate Fetal Weight in Isolated Oligohydramnios with Preterm Prelabor Rupture of Membranes

Orhan ALTINBOĞA[1] Orcid ID:0000-0001-9992-8535
Hasan EROĞLU [2] Orcid ID:0000-0002-1180-5299
Seyit Ahmet EROL [1] Orcid ID:0000-0002-2494-4896
Betül YAKIŞTIRAN [1] Orcid ID:0000-0002-3993-4017
Emre BAŞER [3] Orcid ID:0000-0003-3828-9631
Aykan YÜCEL [1] Orcid ID:0000-0002-5888-692X

[1] Department of Perinatology, Ankara City Hospital, Ankara, Turkey

[2] Department of Perinatology, Etlik Zübeyde Hanım Women's Health Care, Training and Research Hospital, University of Health Sciences, Ankara, Turkey

[3] Department of Obstetrics and Gynecology, Faculty of Medicine, Bozok University, Yozgat, Turkey

ÖZ

Amaç: Üçüncü trimesterde tespit edilen izole oligohidramniyoz olgularında alternatif ölçüm yöntemlerinin gerçek (aktüel) doğum ağırlığını tahmin etmedeki etkilerinin değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Prospektif kohort çalışmamızda, 336/7 ve 366/7 gebelik haftaları arasında 78 gebe değerlendirildi. Rutin biyometrik ölçümler iki boyutlu (2D) ultrasonografi ile elde edildi. Manuel ölçümlerin yapıldığı bölümlere kaliperler yerleştirildi. Daha sonra aynı görüntü üzerinde ultrasonografi cihazı ile otomatik ölçüm alındı. Fetal ağırlık Hadlock II formülü kullanılarak hesaplandı.

Bulgular: Ortalama manuel ve otomatik tahmini fetal ağırlıklar (TFA) ve gerçek doğum ağırlıkları (aktüel DA) sırasıyla 2281,1 ± 326, 2371,5 ± 324 ve 2417,2 ± 353 idi. Manuel TFA, istatistiksel olarak anlamlı düzeyde hem gerçek (aktüel) DA'dan hem de otomatik TFA'dan daha düşüktü (sırasıyla p = 0.002, p = 0.001). Korelasyon analizinde, gerçek DA ile hem manuel TFA hem de otomatik TFA arasında anlamlı bir pozitif korelasyon bulundu (p <0,001). Bununla birlikte, bu ilişki manuel TFA ile karşılaştırıldığında otomatik TFA'da daha yüksekti (r = 0.858 vs r = 0.734).

Sonuç: Obstetrik uygulamada TFA'yı doğru tahmin edebilmek önem arz eder. Çalışmamızda, otomatik olarak elde edilen TFA'nın manuel olarak elde edilen TFA ile karşılaştırıldığında gerçek DA'ya daha yakın olduğunu gösterdik. Son zamanlarda teknolojinin en önemli konularından biri haline gelen yapay zeka, yakın gelecekte ultrasonografi cihazlarında kullanıldığında fetal ağırlığın tahmin edilmesinde bize daha fazla yardım sağlayabilir.

Anahtar Kelimeler: Fetal ultrasonografi, oligohidramniyoz, fetal ağırlık, doğum ağırlığı.

ABSTRACT

Objective: It was aimed to evaluate the effects of alternative measurement methods in estimating actual birth weight (actual BW) in third-trimester isolated oligohydramnios.

Materials and Method: In our study in prospective design, 78 pregnant women between 336/7and 366/7 weeks of gestation were evaluated. Routine biometric measurements were obtained through two-dimensional (2D) ultrasonography. Calipers were placed in the sections where the measurements were made for manual measurement. Then, automatic measurement was obtained by sonography device on the same image. Fetal weight was estimated using the Hadlock II formula.

Results: The mean manual and automated estimated fetal weights (EFWs) and actual birth weights (actual BWs) were 2281.1±326, 2371.5±324 and 2417.2±353, respectively. Manual EFW was lower than both actual BW and automated EFW at a statistically significant level (p = 0.002, p = 0.001, respectively). In correlation analysis, a significant positive correlation was found between actual BW and, both manual EFW and automated EFW (p <0.001). However, this relationship was higher in automated EFW when compared to manual EFW (r=0.858 vs r=0.734).

Conclusion: It is very important to estimate the EFW accurately in the practice of obstetrics. In our study, the automatically obtained EFW was found to be closer to the actual BW when compared to the manually obtained EFW. Artificial intelligence, which has recently become one of the most important subjects of technology, could provide us greater assistance in estimating fetal weight when used in sonography devices in the near future.

Key words: Fetal ultrasonography, oligohydramnios, fetal weight, birth weight.

Sorumlu Yazar/ Corresponding Author:
Orhan Altınboğa
Department of Perinatology, Ankara City Hospital, 06800 Bilkent, Ankara, Turkey
E-mail: orhanaltinboga@gmail.com

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INTRODUCTION

Fetal weight is of great importance for the neonatal period. It is known that LGA (large for gestational age) and SGA (small for gestational age) infants encounter various problems. For LGA infants these problems are often prolonged labor, difficult birth, postpartum polycythemia and hypoglycemia. Similarly, polycythemia and hypoglycemia could be observed in SGA babies; NEC (Necrotizing enterocolitis) and RDS (Respiratory distress syndrome) could also develop as frequent problems (1).

It is of great importance for all obstetricians to predict the estimated fetal weight (EFW) closest to actual birth weight (actual BW) in many terms (determination of delivery type, prediction of postpartum prognosis, potential need for pediatric consultation and medico-legal conditions). American College of Obstetricians and Gynecologists (ACOG) recommends elective C/S (cesarean section) to prevent complications related to shoulder dystocia in cases where EFW is greater than 4500 grams in pregnancies with diabetes complications, and where EFW is greater than 5000 in non-diabetic pregnancies (2).

There are many factors affecting EFW measurement. These could be listed as maternal weight, the resolution of USG device, placental localization and fetal position (3). There are many formulas used in the measurement of EFW. However, the most frequent measurement is the Hadlock formula, which includes the AC (abdominal circumference), FL (femur length), BPD (biparietal diameter), HC (head circumference) parameters (4). Decrased amniotic fluid causes blurred image and in that case operator have difficulty to asses the borders of fetal parts. Semi automated programs are aimed to resolve this problem by using complicated software.

One of the important factors affecting the accurate measurement of EFW is the AFI (amniotic fluid index) obtained by vertical measurement of the free amniotic pockets in the four quadrants of the uterus (5). The aim of the study was to reveal how EFW was affected by this change in pregnant women, where AFI was significantly reduced.

MATERIALS AND METHOD

This study was designed prospectively and was planned with the approval of the Ethics Committee in Etlik Zübeyde Hanım Women's Health Care, Training and Research Hospital, University of Health Sciences, Ankara, Turkey (Ethics Committee Decision Number: 2018/36). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained in writing from all pregnant women that were included in the study. Analysis was made on 78 pregnant patients, who were in 336/7-366/7weeks of gestation, were diagnosed with EMR (early membrane rupture= prelabor rupture of membranes), were measured as AFI < 50 mm and BMI (body mass index) below 30, had vertex presentation and posterior placental localization. EFW was calculated using the Hadlock II formula (4). In this formula, AC (abdominal circumference), BPD (biparietal diameter), HC (head circumference), FL (femur length) parameters were used.

For AC, the section was taken from the fetal abdomen at the level of liver and portal vein. For FL, the distance between femoral trochanter major and distal metaphyseal was measured. For BPD, the thalamus and the distance between parietal bones was measured from inside to outside from level of CSP (Cavum septum pellucidum). For HC, the thalamus and head circumference were measured from the CSP level.

In the study, AFI (amniotic fluid index) was calculated by measuring the four quadrants of the uterus vertically (5). AFI value was below 50 mm in all patients included in the study. All measurements were made by a single perinatologist using Voluson ™ E-6 (GE Medical systems, Zipf, Austria) to eliminate interobserver differences. EFW measurements were taken in two ways. After the BPD, FL, AC and HC sections were taken, calipers were placed and measured manually; and, these values were recorded. Then, the same sections were automatically measured with the program in the sonography device; and these were also recorded. These measurements were taken no more than 24 hours before delivery. The EFW values calculated manually and automatically were compared with the actual birth weights (actual BWs) measured in the postpartum delivery room.

StatIstIcal analysIs

The statistical analysis was performed using SPSS (version 20 software, SPSS, Chicago, IL). Descriptive statistics were presented as mean, standard deviation, median, minimum value and maximum value. The data were expressed as mean ± SD and median (minimum-maximum). The distribution of the variable data was determined using visual (histograms, probability plots) and analytical methods (Kolmogrov Simirnov / Shapiro-Wilk's test). General Linear Model (GLM) - Repeated Measures test was used to evaluate the relationship between the variables of Manual EFW, automated EFW and actual BW. Bivariate correlations were investigated by Spearman's correlation analysis. Those with $p < 0.05$ was accepted as statistically significant. The effects of amniotic fluid volume on EFW were evaluated by systematic error and random error. Systematic error was defined as fixed one-way error (higher or lower). Random error was defined as two-way (higher and lower) fluctuations in the EFW. Systematic error was expressed as the mean percentage error (MPE). The percentage error was calculated using the following formula: (BW − EFW) 100/BW . Random error was defined as the standard deviation (SD) of the MPE. To evaluate the which measurement parameter effect the difference between the measurement techniques we use z score for the given gestational week. Z scores were measure for biparietal, head circumference and abdominal circumference and calculated as follows (50th percentile for given week -measured variable)/50th percentile for given week.

RESULTS

A total of 78 patients were enrolled in the study. All the patient has AFI lower than 50 mm. The mean age of the cases was 28.8±6.6. Their mean height was 161±5.1. Mean weights were found as 68.05±7.7. The mean BMI in our group was calculated as 25.9±2.8 (Table 1).

Table 1. Demographic data and estimated fetal weight models.

	Mean±SD	Median (min-max)
Age	28.8 ± 6.6	28 (17 - 42)
BMI	26 ± 2.8	26.1 (18.2 - 33.2)
Gestational week	33.8 ± 1.6	34 (27 - 36)
AFI	31.6 ± 12.2	34 (0 - 47)
Manual EFW	2281,1 ± 326	2239 (1719 - 3069)
Automated EFW	2371.5 ± 324.9	2328 (1870 - 3110)
Actual BW	2417.2 ± 353.9	2385 (1820 - 3220)

AFI; amniotic fluid index, BMI; body mass index, EFW; estimated fetal weight, BW; birth weight

Accuracy of measurement techniques were provided in Table 2. Systematic errors were 5.07±9.87 and 1.51±7.56 for manual and semi-automated measurements (p=0.037). Random error of manual measurement was 9.8 and random error of semi-automated measuramnet was 4.9 Z scores for BPD, FL and HC were not statistically different between the measurement techniques. However semi automated z score of AC was significantly lower than manual technique.

Table 2. Accuracy of measurement techniques.

	Manuel	Semi-automated	P value
Systematic error	5.07±9.87	1.51±7.56	0.037
Random error	9.8	4.9	0.008
Z score BPD	0.062±0.015	0.067±0.019	0.14
Z score AC	0.091±0.021	0.064±0.018	0.00
Z score FL	0.042±0.008	0.041±0.006	0.63
Z score HC	0.065±0.009	0.063±0.008	0.13

BPD; biparietal diameter, AC; abdominal circumference, FL; femur length, HC; head circumference

Table 3 presents the EFW values of the cases. Mean values of manual, automated and actual BW measurements were 2281.077, 2371.462 and 2417.205, respectively; and there was a statistically significant difference between the groups (p = 0.001). When we evaluated the groups within themselves, manual EFW mean values were found to be significantly lower than the mean values of both actual BW and automated EFW (p = 0.002, p = 0.001, respectively). However, no statistically significant difference was found between the mean values of actual BW and automated EFW (p = 0.127) (Table 4).

Table 3. Comparison of estimated fetal weight models.

	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	P
Manual EFW	2281.077	52.203	2175.397	2386.756	
Auto-mated EFW	2371.462	52.022	2266.148	2476.775	0.001
Actual BW	2417.205	56.676	2302.471	2531.939	

EFW; estimated fetal weight, BW; birth weight

Table 4. Comparison of manual EFW, automated EFW and actual BW measurements.

		Mean Difference	Std. Error	p	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Manual EFW	Automated EFW	-90,385*	24,146	0,001	-139,266	-41,503
	Actual BW	-136,128*	39,941	0,002	-216,984	-55,272
Automa-ted EFW	Manual EFW	90,385*	24,146	0,001	41,503	139,266
	Actual BW	-45,744	29,328	0,127	-105,116	13,629
Actual BW	Manual EFW	136,128*	39,941	0,002	55,272	216,984
	Automated EFW	45,744	29,328	0,127	-13,629	105,116

EFW; estimated fetal weight, BW; birth weight

The relationship between actual BW and both automated and manual EFW values was evaluated by correlation analysis (Figure 1 and Figure 2). Accordingly, there was a (statistically) significant correlation between actual BW and automated EFW (r = 0.893 & p <0.001) and manual EFW (r = 0.793 & p 0.001)

Figure 1. Automated EFW and actual BW scatter plot.

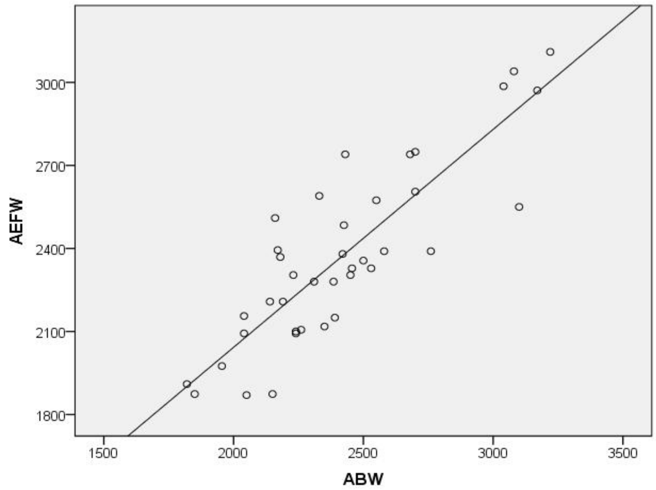
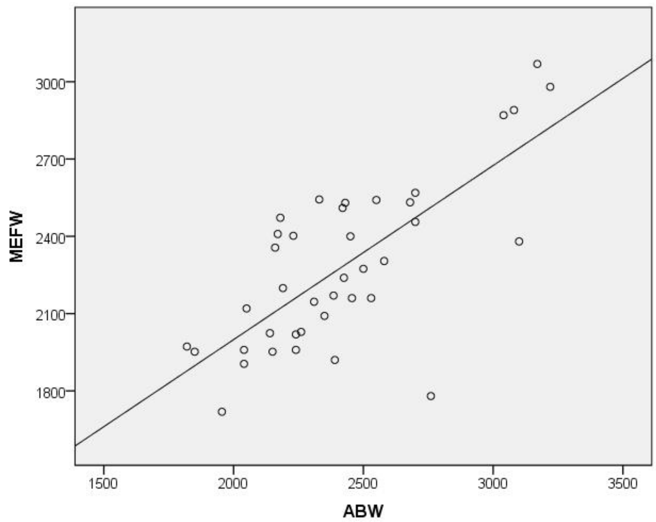


Figure 2. Manuel EFW and actual BW scatter plot.



DISCUSSION

The correct prediction of fetal weight is great importance to anyone interested in the obstetrics. Accurate estimated fetal weight measurement is extremely important in determination of delivery type, prediction of postpartum prognosis (in terms of SGA, IUGR) and the need for a pediatric consultation. The aim of the study was to see whether the erroneous calculations caused by the shadow effects of oligohydramnios in various measurements would be reduced, albeit relatively, through semi-automatic measurement by the device.

In our study, actual BW measurements were compared to manual and automated measurements performed in cases with oligohydramnios. Semi-automated soft ware more accurate than manuel technique. Moreover, it was observed that the manual measurements (manual EFW) resulted in significantly lower weight estimations in the patient group included in the study when compared to actual BW.

There are too many parameters affecting the accuracy of measurement in fetal weight estimation. These could be listed as the BMI, resolution of the device, fetal position, experience of the person performing the measurement, placental localization, and AFI (3, 6, 7).

One of the factors affecting the correct measurement of EFW is the formula that are used. Although there are too many formulas for these measurements in obstetrics, the Hadlock II is one of the most frequently used and accepted formulas. In our study, We used the Hadlock II formula for EFW evaluation (4).

There are also interesting studies conducted about the EFW prediction. For instance, several studies were conducted on the idea that fetal sex could be effective, and these studies had conflicting results. (7-9). The increase in BMI, which is another factor, hinders ultrasonographic evaluation significantly. Maternal adipose tissue, which increases with the increase in BMI, significantly reduces resolution of the area that is monitored. This causes the fetal anatomical evaluation to be performed suboptimally. (10, 11). All these factor effects the image quality and can be overcome by semiautomated programs which can assess the ultrasonoographic data more accurate than human eye.

In our study, only the patients with BMI <30 kg/m2, posterior placenta and vertex presentation were included in the study in order to reveal the effect of AFI. At the same time, four parameters (AC, FL, HC, BPD) were used in the Hadlock II formula to increase the accuracy of EFW. Thus, the effects on EFW were reduced. A total of 78 patients were evaluated in the study. Both manual EFW and automated EFW measurements of the same patients were calculated and compared to the actual birth weight. These groups were compared in terms of automated EFW, manual EFW and actual birth weight. When we look at the results of our study, the mean manual EFW was 2281±52, the mean automated EFW was 2371±52, and the mean actual BW was 2417±56. Both manual EFW values and automated EFW values were found to be within the expected ±15% error margin. However, it was observed that the automated EFW values were found to be significantly more accurate than the manual EFW with 1.5% error margin compared to an error margin of 5.7%, respectively. In addition, the mean value of the actual BW was determined to be significantly higher than the mean value of the manual EFW; and there was no statistically significant difference between actual BW and automated EFW.

There have been many studies that aimed to reveal the effect of AFI, which is one of the parameters affecting EFW. Majority of these studies revealed that this effect is unclear; however it is believed to be due to the design of the studies and differences in clinical practice. (12). In one of these, this effect was investigated again; however, the effect of AFI could not be fully demonstrated in the results of the study since BMI information was lacking and only two measurement parameters were used (AC, FL) (13).

Amniotic fluid volume has significantly affect on the fetal weight measurement. Especially in oligohydramnios image quality is low and getting correct plane for measurement become more difficult. It was believed that this stemmed from the fact that dark areas (shadow effect) during sonography prevented the procedure to be performed optimally in pregnant women with severe oligohydramnios. This effect can be overcome by newly developed software programs. In our study we found that application of semi-automated software may decreases the EFW prediction error. We also found that most important parameter that causes incorrect measuremet is AC. Although FL and HC measured accurate, exponential effect of AC on EFW formulas is significant. In a recent study on pregnant women with isolated polyhydramnios, actual birth weight (aBW) was compared to the automated EFW and manual EFW. It was observed that automated EFW made more accurate estimations than manual EFW; however, no statistical significance was observed (14). In our study, it was observed that automated EFW estimated the actual birth weight more closely than manual EFW. The mean value of the actual BW was not found to be significantly higher than the mean value of the manual EFW; and, there was no statistically significant difference between the actual BW and automated EFW. It was believed that this stemmed from the fact that dark areas (shadow effect) during sonography prevented the procedure to be performed optimally in pregnant women with severe oligohydramnios. Presumably, when the device is in automated EFW settings, it can detect points that are difficult to display during manual measurements. It is believed that this is the reason why the difference between automated EFW and manual EFW occurred.

In a study on the effect of experience in EFW measurement, it was found that accurate EFW results could be obtained after at least 2 years of sonography training (15). In another study, the effect of the quality of the equipment used on EFW was investigated. When a good-quality ultrasound device was used, the standard deviation was (SD: 8.9), whereas this value was found to be (SD: 15) in measurements with low-quality equipment (16). When the results of our study were analyzed, it was observed that the margin of error was lower than the ± 15% margin of error in the literature. Possible causes of this situation were that the measurements were made by a single perinatologist, and that patients with BMI values below 30, with posterior placenta and vertex presentation were selected.

Recently, some new approaches have been tried for EFW. One of them is measuring the volume with 3D sonography and making fetal weight estimation. As a result, it was concluded that this new method of EFW made estimations closer to the actual birth weight (17).

One of the factors affecting the accuracy of EFW is ethnicity. This may be due to the fact that the traditionally used formulas are obtained from the groups with certain ethnicity, and the calculation of EFW with these formulas could give false results in other ethnic groups (18). Therefore, although it is ideal way to use the values of that ethnic group for each ethnic group, close ethnic groups could be evaluated with similar formulas since the ideal way would not be very practical (19).

While the low number of patients constituted the limitation of our study, the fact that the measurements were taken by a single perinatologist, EFW measurements were taken within 24 hours before delivery, BMI values were below 30, pregnant women with posterior placental localization were included in the study, and that the study was designed prospectively were the strengths of the study.

CONCLUSION

To conclude, accurate estimation of EFW is very important in obstetrics, as mentioned earlier. Despite many methods that have been made and proposed so far, we still do not have an ideal method. In addition to maternal and fetal causes, certain fetal conditions are known to affect EFW such as difficulty in determining the limits of AC during fetal movements and respiratory movements, and the inability to measure the head circumference of the engaged fetus properly due to molding (20, 21). Artificial intelligence, which has become one of the most important subjects of technology in the recent period, may soon improve further, be integrated into sonography devices, and help us more in estimating fetal weight by integrating it into sonography devices.

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Orhan Altınboğa: Protocol development, Data collection, Manuscript writing (orhanaltinboga@gmail.com)

Hasan Eroğlu: Data analyses (drhasaner@gmail.com)

Seyit Ahmet Erol: Data collection (gyn.aerol@gmail.com)

Betül Yakıştıran: Data collection (btlengin@gmail.com)

Emre Başer: Statistical Analysis (emrebasermd@gmail.com)

Aykan Yücel: Protocol development, Manucript editing (aykanyucel@gmail.com)

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