




Evaluation of the accuracy of estimated fetal weight in pregnancies complicated by premature prelabour rupture of membranes (PPROM)

Doğum öncesi erken membran rüptürü (PPROM) ile komplike gebeliklerde tahmini fetal ağırlığın doğruluğunun değerlendirilmesi

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ABSTRACT

Aim: Premature prelabour rupture of membranes (PPROM) can affect ultrasound measurements of the fetus and therefore, estimated fetal weight (EFW) as there is a reduced amount of amniotic fluid. The aim of this study was to test the accuracy of EFW calculated with the Hadlock IV method in pregnancies complicated by PPRM by comparisons with birthweight.

Materials and Methods: A retrospective screening was made of the data of patients admitted with a diagnosis of early membrane rupture to Kayseri Training and Research Hospital between May 2018 and June 2020. Singleton pregnancies between 23⁺⁰-36⁺⁶ weeks with estimated fetal weight (EFW) measured by ultrasonography within 2 weeks before delivery was included in the study. The accuracy of the EFW was determined by the absolute percent difference between BW and EFW ($\text{abs}[\text{EFW}-\text{BWW}]/\text{BW}100$).

Results: A total of 137 patients were included in the study according to the sample size analysis. The mean difference between birthweight and EFW was 7,04% (0,04-44,5). The difference (min-max) between EFW and BW was 10,93% (0,11-34,6) when BMI was ≥ 30 kg/m² and 9,61% (0,79-34,6) in the presence of anhydramnios. And these were statistically significant, $p=0,001$ and $p=0,007$ respectively. However, the results for oligohydramnios, primiparity and breech presentation were not statistically significant ($p>0,05$).

Conclusion: In patients with PPRM, EFW measured by the Hadlock IV method can be estimated with a margin of error of 7,04%. This difference increases in obese women and anhydramnios and prediction becomes difficult.

Keywords: Premature prelabour rupture of membranes, Hadlock's formula, ultrasonography, estimated fetal weight.

Note: This study was presented as an oral presentation at the Izmir Democracy University 4th International Congress, which took place between 9-11 November 2022.

ÖZ

Amaç: Doğum öncesi erken membran rüptürü (PPROM), fetüsün ultrason ölçümlerini ve dolayısıyla amniyotik sıvı miktarında azalma nedeniyle tahmini fetal ağırlığı (EFW) etkileyebilir. Bu çalışmanın amacı PPRM ile komplike olan gebeliklerde Hadlock IV yöntemi ile hesaplanan EFW'nin doğruluğunu doğum ağırlığı ile karşılaştırarak test etmektir.

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Gereç ve Yöntem: Mayıs 2018- Haziran 2020 tarihleri arasında Kayseri Eğitim ve Araştırma Hastanesi'ne erken membran rüptürü tanısıyla başvuran hastaların verilerinin retrospektif taraması yapıldı. 23⁺⁰-36⁺⁶ hafta arası tekil gebelikler ile tahmini fetal ağırlık (EFW) doğumdan önceki 2 hafta içinde ultrasonografi ile ölçülenler çalışmaya dahil edildi. EFW'nin doğruluğu, doğum ağırlığı (BW) ile EFW (abs[EFW-BWW]/BW100) arasındaki mutlak yüzde farkla belirlendi.

Bulgular: Örneklem büyüklüğü analizine göre toplam 137 hasta çalışmaya dahil edildi. Doğum ağırlığı ile EFW arasındaki ortalama fark %7,04 (0,04-44,5) idi. EFW ve BW arasındaki fark (min-maks) BMI ≥ 30 kg/m² olduğunda %10,93 (0,11-34,6), anhidramnios varlığında %9,61 (0,79-34,6) idi. Bunlar istatistiksel olarak anlamlıydı; sırasıyla p=0,001 ve p=0,007. Ancak oligohidramniyoz, primiparite ve makat prezentasyon sonuçları istatistiksel olarak anlamlı değildi (p>0,05).

Sonuç: PPROM'lu hastalarda, Hadlock IV yöntemiyle ölçülen EFW, %7,04'lük bir hata payı ile tahmin edilebilmektedir. Obez kadınlarda ve anhidroamniyozda bu fark artmakta ve tahmin zorlaşmaktadır.

Anahtar Sözcükler: Doğum öncesi erken membran rüptürü, Hadlock formülü, ultrasonografi, tahmini fetal ağırlık.

Not: Bu çalışma, 9-11 Kasım 2022 tarihleri arasında gerçekleşen İzmir Demokrasi Üniversitesi 4. Uluslararası Kongresi'nde sözlü sunum olarak sunulmuştur.

INTRODUCTION

Premature prelabour rupture of membranes (PPROM) is the opening of the amniotic membrane before the 37th gestational week and the loss of amniotic fluid through this opening (1, 2). Although seen in only 3% pregnancies, PPRM accounts for 20% of all perinatal mortality. It has been reported to be a complication of 140,000 pregnancies per year in the USA (1-3). Although the etiology of PPRM is multifactorial, the most important factor is subclinical infection. PPRM involves risks associated with primarily chorioamnionitis, cord prolapse, detached placenta, and anhydramnios, which require a prolonged hospital stay and antibiotic treatment (4).

With a reduced amount of amniotic fluid measured on fetal ultrasound, PPRM can affect the estimated fetal weight (EFW). In the measurement of EFW, there are several factors with an effect, such as maternal weight, skin structure, fetal position and the amount of amniotic fluid (5, 6). The Hadlock et al method is the most commonly used method in the calculation of EFW (7). There are very few studies in literature that have evaluated the accuracy of the Hadlock method in EFW measurement in cases with PPRM by comparison with the actual birthweight (8, 9).

The aim of this study was to compare the EFW with the actual birthweight in pregnancies complicated by PPRM to determine the accuracy of EFW calculated with the Hadlock IV method in such cases.

MATERIAL and METHOD

A retrospective screening was made of the data of patients with a diagnosis of early membrane rupture admitted to the Kayseri Training and Research Hospital between May 2018 and August 2020. Approval of the study was granted by the Hospital Ethics Committee (130/2020) and all procedures were in compliance with the Helsinki Declaration. Written informed consent for participation in the study was obtained from all the study subjects.

This study was presented as an oral presentation at the Izmir Democracy University 4th International Congress, which took place between 9-11 November 2022. A total of 137 subjects were included in the study to provide 90% power in a 95% confidence interval according to the sample calculation made using G-Power 3.1 program (8).

The patients included in the study were those with a singleton pregnancy with EFW value measured as 23⁺⁰-36⁺⁶ weeks on ultrasonography within 2 weeks before birth. Patients were excluded if they had fetal anomalies, multiple pregnancy or no EFW value measured within 2 weeks before birth. The diagnosis of early membrane rupture was made from the combination of patient history, physical examination, biochemical, microscopic and ultrasonographic findings.

The data related to maternal age, height, weight, BMI, ethnicity, gestational age, hypertension, diabetes, and chorioamnionitis were retrieved from the hospital data records system.

Ultrasonographic measurements were taken on a ClearVue 550 (Phillips, Holland) ultrasonography device using a C5-2 probe (2D convex 3-5 Mhz). The deepest pocket and amniotic fluid index were recorded in the ultrasound measurements. EFW was calculated using the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) measurements in the Hadlock IV formula of $\text{Log}_{10} \text{BW} = 1.3596 + 0.0064(\text{HC}) + 0.0424(\text{AC}) + 0.174(\text{FL}) + 0.00061(\text{BPD})(\text{AC}) - 0.00386(\text{AC})(\text{FL})$. All the measurements were taken by a single physician experienced in obstetric ultrasonography (ANA).

Oligohydramnios was defined as amniotic fluid index (AFI) <5th percentile for gestational age, or AFI <5cm and/or the deepest pocket <2cm. Anhydramnios was defined as the deepest pocket <1cm (3). We did not find any polyhydramnios cases with fetal ultrasonography measurements in the last two weeks, who developed premature membrane rupture and delivered at our center. Therefore, polyhydramnios cases, another cause of PROM, are not included in our sample size.

Preeclampsia was defined as blood pressure of 140 mm Hg systolic or higher or 90 mm Hg diastolic or higher occurring after 20 weeks of gestation in a woman with previously normal blood pressure and protein excretion of 0.3 g or higher in a 24-hour urine sample (10).

The diagnosis of Gestational Diabetes Mellitus (GDM) was defined as a blood glucose level of 200 mg or more in the 50-gram oral glucose tolerance test (OGTT) performed between the 24th and 28th weeks of pregnancy if diabetes is diagnosed in the first trimester or early second trimester with the standard diagnostic criteria of a hemoglobin A1C (HbA1C) of 6.5% or greater, a fasting plasma glucose of 126 mg/dL or greater, or a 2-hour glucose of 200 mg/dL or greater on a 75-g oral glucose tolerance test, it is considered pregestational diabetes (11).

As a result of the retrospective screening, a total of 1352 patients who developed membrane rupture between 23+0-36+6 weeks of gestation between May 2018-August 2020 were identified. It was determined that 567 of these patients did not give birth in this hospital. Of the 785 patients who gave birth in our hospital, 258 had multiple pregnancies and 148 had various degrees of fetal

anomalies. It was observed that the remaining 242 patients did not have fetal biometry measurements within two weeks before birth. The remaining 137 patients were included in the study.

The BMI threshold value of 30 kg/m² was determined based on the WHO obesity classification. This value was taken as basis because BMI > 30 kg/m² and above is considered obesity (12).

This accuracy was calculated as a percentage by subtracting BW from EFW and dividing this value by BW, and the formula $\text{abs}[\text{EFW}-\text{BW}] / \text{BW} \times 100$ was used.

The diagnosis in each case was made by the attending physician or the treatment team and not by a stated protocol.

Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS 25.0 software. Categorical variables were stated as number (n) and percentage (%) and continuous variables as mean \pm standard deviation (SD), or where appropriate, as median, minimum and maximum values. The McNemar test statistic was used in comparisons of categorical variables. In the comparison of antenatal and postnatal continuous measurements, variables conforming to normal distribution were compared using the independent groups t-test and those not showing normal distribution with the Wilcoxon test. A value of $p < 0,05$ was accepted as statistically significant in all the tests.

RESULTS

The demographic data and clinical characteristics of all the patients are shown in Table-1. The mean difference between EFW and birthweight was 7.04% (0.04-44.5). The difference (min-max) between EFW and BW was 10.93% (0.11-34.6) when BMI was ≥ 30 kg/m² and 9.61% (0.79-34.6) in the presence of anhydramnios. And these were statistically significant, $p=0,001$ and $p=0,007$ respectively. However, the results for oligohydramnios, primiparity and breech presentation were not statistically significant ($p > 0,05$) (Table-2). This value was found to be 3.3% in cases where ultrasonography measurements were made within ≤ 7 days.

Table-1. Demographic data and characteristics of patients.

	n	Values
Age (year) (n) (mean±SD)	137	26,1±6,1
Height (cm) (n) (mean±SD)	137	165,2±6,0
Weight (kg) (n) (mean±SD)	137	75,9±10,6
BMI (kg/m ²) (n) (mean±SD)	137	27,8±3,5
Gravida (n) [median (min-max)]	137	2(0-5)
Parity (n) [median (min-max)]	137	2(0-5)
APGAR 1. min. (n) (mean±SD)	137	6,9±1,7
APGAR 5. min. (n) (mean±SD)	137	8,4±1,5
Gestational week at PPRM (week) (n) (mean±SD)	137	31,2±2,4
Birth week (week) (n) (mean±SD)	137	32,5±2,5
EFW (n) (mean±SD)	137	1860,2±511,9
Birth weight (gram) (n) (mean±SD)	137	1997,1±515,7
Birth weight difference percentage [median (min-max)]	137	7.04 (0.04-44.5)
Nullipara (n, (%))	54	39,4
BMI≥30 kg/m ² (n, (%))	55	40,1
Type II DM (n, (%))	13	9,5
GDM (n, (%))	4	2,9
Preeclampsia (n, (%))	13	9,5
Oligohydramnios (n, (%))	22	16,1
Anhydramnios (n, (%))	26	19,0
Chorioamnionitis (n, (%))	6	4,4
Cesarean rate (n, (%))	43	31,4
Breech presentation (n, (%))	35	25,5
Ultrasonography date ≤7 days (n, (%))	69	50,4
Fetal sex (n, (%))		
Female	66	48,2
Male	71	51,8
Turkish (n, (%))	107	78,1
Syrian (n, (%))	30	21,9

BMI: Body mass index, PPRM: premature prelabour rupture of membranes, EFW: Estimated fetal weight, GDM: Gestational diabetes mellitus.

Table-2. Evaluation of the margin of error in birth weight according to various factors.

Birth weight difference %		P
BMI<30 (n=82) 5.01 (0.04-44.5)	BMI≥30 (n=55) 10.93 (0.11-34.6)	0,001*
Nulliparous (n=54) 7.30 (0.11-27.12)	Parous (n=83) 6.31 (0.04-44.5)	0.798*
Non-oligohydramnios (n=115) 6.90 (0.04-44.5)	Oligohydramnios (n=22) 7,64 (1,1-29,7)	0.464*
Non-anhydramnios (n=111) 5.56 (0.04-44.5)	Anhydramnios (n=26) 9.61 (0.79-34,6)	0,007*
Cephalic presentation (n=102) 6.15 (0.04-44.5)	Breech presentation (n=35) 7.57 (0.79-34,6)	0.134*

* Mann Whitney U Test

DISCUSSION

In this study, we investigated the accuracy of EFW measured with the Hadlock IV method according to birth weight in pregnancies complicated by PROM. We found that the margin of error increased statistically significantly in the presence of obesity, but the increase was not statistically significant in the presence of oligohydramnios, anhydramnios, nulliparity and breech presentation.

Accurate calculation of the estimated fetal weight is extremely important in determining the baby's survival risk, especially in premature births, and in determining the need for neonatal intensive care (NICU). Many formulas have been used so far to determine the estimated fetal weight. Guralp et al. found an $8.7 \pm 7.5\%$ margin of error in EFW measured by the Hadlock I method in preterm fetuses (13). Sheeana et al., in their study on 1220 fetuses, claimed that Hadlock 1 was more accurate than Hadlock 2 and reported a margin of error of 3.19% (14).

In a study conducted in France, 578 singleton pregnancies between 22-34 weeks were included and ultrasonography was performed within 2 days before birth. The Hadlock formula was compared with the INTERGROWTH formula, and it was reported that the Hadlock formula gave more accurate results (15).

EMR is one of the important causes of prematurity. Additionally, it may cause negative events such as chorioamnionitis, placenta abruption, and cord prolapse (1-4).

Aviram et al. state that 21 formulas, including Hadlock IV, give similar results in pregnancies complicated by PROM, and although the Ott formula gives the best performance, the difference can be neglected (16). Warshafsky et al. also investigated the accuracy of the Hadlock IV method in patients with PROM and showed that Hadlock IV provided an accurate EFW in PROM patients, regardless of fetal gender or amniotic fluid levels (17).

Esin et al., in their study with 234 PROM patients, found that the total median % error difference between EFW and birth weight was 11.7% of the birth weight and that the Hadlock formula used performed better with an overall median error difference of 10.5% (18). We used the Hadlock IV method in our study and concluded that the difference in birth weight was 7.04%. This

supports the studies on the accuracy of the method.

However, when the amount of amniotic fluid and other factors come into play, the results are contradictory. Duncan et al. It is stated that the accuracy of the hadlock formula in patients with PROM is affected by nulliparity, anhydramnios and the mother's BMI (8).

In another study, no effect of oligohydramnios on EFW accuracy was found (19). Karahanoğlu et al. (6), in their study with 1069 term isolated oligohydramnios and 182 term isolated polyhydramnios cases, show that EFW gives accurate results, although there is a possibility of overestimation for both polyhydramnios and oligohydramnios. Blitz et al. state that the amount of amniotic fluid affects the measurement, but BMI does not have such an effect (20).

In our study, the difference increased statistically significantly if the BMI was 30 kg/m² and above, while the difference increased in anhydramnios, oligohydramnios, nulliparity and breech presentation, but the results were not statistically significant.

In terms of the accuracy of the estimated fetal weight, when the ultrasonography is performed it is also important. Duncan et al. stated that the margin of error decreased significantly in ultrasonography performed 7 days or less after birth. In our study, 50.4% of the patients had ultrasound performed within the last 7 days and the margin of error in these patients was found to be 3.3%. This value is statistically significant ($p < 0,001$).

As a result, in pregnancies complicated by PPRM, the estimated fetal weight is 7.04% inaccurate compared to the birth weight. While there is a statistically significant increase in this rate in patients with BMI ≥ 30 kg/m², a non-statistically significant increase is observed in oligohydramnios, anhydramnios, nulliparity and breech presentation.

CONCLUSION

As a result, the most trusted and preferred method in the world for predicting birth weight is still the Hadlock IV method. It is observed that this method has a very low margin of error in the presence of PROM. However, in order to further reduce the margin of error in predicting birth weight, it is of great importance to prevent obesity during pregnancy and to record

measurements within 7 days before birth, and more extensive studies are needed to minimize the margin of error in EFW, especially in obese women.

Declaration of interest statement

The authors certify that they have NO affiliations with or involvement any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers'

bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Conflict of interest: The authors declare that they have no conflict of interest.

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