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FACTORS INFLUENCING ACCURACY OF FOETAL WEIGHT ESTIMATION BY ULTRASONOGRAPHY- A PROSPECTIVE STUDY

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Abstract

Aim: Factors influencing accuracy of foetal weight estimation by ultrasonography- A Prospective Study.

Methodology: Between January 2017 and December 2019, we studied 820 singleton pregnancies of mothers who attended our antenatal care unit in the Clinic for Obstetrics and Gynecology. We included only singleton pregnancies that were delivered within 14 days of the last sonographic scan and with a birth weight 1500 g. We excluded multiple pregnancies because of their different intrauterine growth pattern. Stillborn fetuses were also excluded. In this study we had no fetal malformations that presumably would have affected the preciseness of the biometry (i.e. gastroschisis, omphalocele, hydrocephalus).

Results: During the study period we analyzed 820 pregnancies between 23 and 42 weeks of gestational age (median 37+3), fetal birth weight ranging from 530 to 5,020 g (median 3,016 g) and maternal age ranged from 18 to 47 years (median 33 years). First we compared the accuracy of the 6 formulas. Estimations within a ±10% range of the actual birth weight varied from 54.7% (Hadlock I) to 63.5% (Hadlock II). The different size of the subgroups results from missing single parameters of the sonographic biometrical investigation. The analysis of impact of factors on the accuracy of sonographic fetal weight estimation was carried out with Hadlock II, thus including 767 fetuses and the highest percentage of estimations within the ±10% range of the actual weight. Only the time between estimation and delivery had a significant impact on the accuracy of the fetal weight estimation. Beside these results the impact of sonographic visibility on the precision of the fetal weight estimation was analyzed.

Conclusion: Fetal weight estimation is important to care for the pregnancy. It may influence the intenseness of monitoring and the time and mode of delivery. Pseudo-preciseness given by today's PACS should be carefully used, taking into consideration the limitations of the method and mainly the time interval between prenatal weight estimation and delivery.

Keywords: Pseudo-preciseness, PACS, Sonographic visibility, Fetal weight estimation, Hadlock I

Introduction

Assessment of fetal weight is a vital and universal part of ante- natal care, not only in the management of labor and delivery but often during the management of high risk pregnancies and growth monitoring [1]. Birth weight of an infant is the single most important determinant of newborn survival [1, 2]. Both low and excessive fetal weights at delivery are associated with an increased risk of newborn complications during labor and puerperium. The high perinatal morbidity and mortality associated with low birth weight are attributable to preterm delivery, intrauterine growth restriction, or both. For excessively large fetuses, the potential complications associated with vaginal delivery include shoulder dystocia, brachial plexus injury, bone injuries, and intrapartum asphyxia, while the maternal risks include birth canal and pelvic floor injuries, increased rate of operative vaginal and caesarean deliver- ies, and postpartum haemorrhage [3]. Limiting the potential complications associated with the birth of both small and excessively large fetuses requires that accurate estimation of fetal weight occurs before decision to deliver is made [4]. The two main methods for predicting birth weight in current obstetrics are clinical and ultrasonographic methods [5, 6]. Increasing attention is being paid to the accuracy of using various ultrasound measurements in estimating fetal weight. Multiple fetal parameters for prediction of fetal weight are employed. These are the biparietal diameter, head circumference, abdominal circumference, and femoral length. Ultrasound estimation of fetal weight, while being accurate to a degree, is associated with error depending on parameters measured and the equation used for estimation [7].

The aim of this study is to determine which method of fetal weight estimation is more accurate.

Methodology

Between January 2017 and December 2019, we studied 820 singleton pregnancies of mothers who attended our antenatal care unit in the Clinic for Obstetrics and Gynecology. We included only singleton pregnancies that were delivered within 14 days of the last sonographic scan and with a birth weight 1500 g. We excluded multiple pregnancies because of their different intrauterine growth pattern [5]. Stillborn fetuses were also excluded. In this study we had no fetal malformations that presumably would have affected the preciseness of the biometry (i.e. gastroschisis, omphalocele, hydrocephalus). The 820

pregnancies were divided into subgroups according to gestational age (weeks 22–24, 25–26, 27–28, 29–30, 31–32, 33–34, 35, 36, 37, 38, 39, 40, 41) and subgroups according to birth weight (500–1,000, 1,001–1,500, 1,501–2,000, 2,001–2,500, 2,501–3,000, 3,001–3,500, 3,501–4,000, 4,001–4,500, 14,501 g). We evaluated biparietal diameter (BPD), femur length (FL), circumference of the fetal head (HC) and abdominal circumference (AC) [6].

All calculations were carried out in absolute numbers (grams) and were transformed into the corresponding percentiles, to pro- vide better comparability between the different subgroups of birth weight [7].

To obtain fetal weight estimations we relied on 6 widespread formulas: Hadlock I [8], Hadlock II [9], Hadlock III [9], Warsof [10], Merz [11] and Shepard [12]. With every formula we calcu- lated the percentage of fetuses, which were in a ±10% range of the actual birth weight and the mean deviation percentage from the actual birth weight in the stratified groups of weight and week of delivery.

As study goal we evaluated 9 important factors that influence the accuracy of prenatal weight estimation. All 9 influence factors were dichotomized and compared in pairs to calculate a possible significant difference in the accuracy of fetal weight estimation between the pairs.

To analyze the impact of visibility on the preciseness of fetal weight estimation, we pooled mothers with very poor imaging conditions caused by maternal obesity combined with little amnion fluid (maternal BMI 125.1 and AFI lower than normal, oligo or ahydramnion). These were compared with pregnancies presenting better imaging conditions (maternal BMI < 25 and normal amniotic fluid).

All scans were performed using curved array transducers with 4 or 5 MHz from the Acuson XP 128 or Acuson Seqoia 512TM platform.

Statistical analysis was performed using the Mann-Whitney U test. The absolute and the percentage standard deviation were calculated with Microsoft Office Excel 2000.

Results:

During the study period we analyzed 820 pregnancies between 23 and 42 weeks of gestational age (median 37+3), fetal birth weight ranging from 530 to 5,020 g (median 3,016 g) and maternal age ranged from 18 to 47 years (median 33 years).

First we compared the accuracy of the 6 formulas. Estimations within a ±10% range of the actual birth weight varied from 54.7% (Hadlock I) to 63.5% (Hadlock II). The different size of the subgroups results from missing single parameters of the sonographic biometrical investigation (table 1).

In order to select one of the 6 formulas for further evaluation of impact factors on the accuracy of the sonographic fetal weight estimation, we proved the comparability of the 6 sub collectives to exclude any formula bias. The referring results are shown in table 2.

Table 1: Formulas used for fetal weight estimation and percentages of estimation

Formulas used for fetal weight estimation	n	Estimation within range of actual weight
Hadlock I	769	54.7%
Hadlock II	767	63.5%
Hadlock III	671	61.6%
Warsof	818	58.6%
Merz	719	62.4%
Shepard	818	60.7%

Table 2: Factors of influence on the precision of the estimation

Influence factor	Dichotomy	n	Median percentage error signed percentage error
Time between estimation and	0–7 days	477	8.52±9.84
delivery (n = 767)	8–14 days	290	10.37±10.52
Expert vs. basic experienced	Expert	371	8.93±10.24
investigator (n = 752)	Basic experienced	381	9.51±11.22
Fetal gender (n = 767)	Male	382	9.42±10.67
	Female	385	9.01±10.77
Gestational age (n = 761)	<30 weeks	48	9.84±11.46
	≥30 weeks	713	9.16±10.67
Fetal weight (n = 767)	<2,000 g	98	10.12±12.29
	≥2,000 g	669	9.09±10.47

Maternal BMI (n = 767)	BMI <25	522	9.32±10.75
	BMI ≥25	245	8.87±10.39
Amniotic Fluid Index (n = 756)	Normal	590	8.96±10.48
	Oligohydramnion	166	9.97±11.34
Fetal presentation (n = 754)	Cephalic	598	9.01±10.67
	Other	156	9.98±10.74
Placenta location (n = 618)	Other	412	9.41±11.08
	Abdominal wall	206	9.01±10.17

The analysis of impact of factors on the accuracy of sonographic fetal weight estimation was carried out with Hadlock II, thus including 767 fetuses and the highest percentage of estimations within the ±10% range of the actual weight (table 1). Only the time between estimation and delivery had a significant impact on the accuracy of the fetal weight estimation (table 2). Beside these results the impact of sonographic visibility on the precision of the fetal weight estimation was analyzed.
We compared scans with good image quality (BMI <25, and AFI normal; n = 401) with scans limited by poor visibility (BMI >25.1, and AFI with lower than normal, oligo- or ahydramnion (AFI >90); n = 47). The difference of the mean percentage error between both groups was negligible. There was no difference in the accuracy of fetal weight estimation between both groups.

Discussion

Sonographic weight estimation is an important method in fetal monitoring. In the last 25 years, numerous formulas for intrauterine estimation of fetal weight have been published. All of them are based on defined sonographic parameters such as biparietal and frontooccipital diameter, head circumference, abdominal circumference and femur length. A wide variety of other diameters, circumferences and (with the advent of the 3D sonography) volumes have been evaluated in the hope of improving the predictive value of established calculations. Most of these new formulas have yet not been clinically established.

Analyzing different formulas for weight estimation (table 1) we studied the impact of 9 key factors that could potentially influence the accuracy of the fetal weight estimation. Hadlock II, as this formula had proven the highest accuracy in our study group, was mainly used.

Only the time interval between weight estimation and delivery had a statistically significant impact on the accuracy of the study results. Of 63 studies published on factors that may influence the sonographic accuracy, 8 provided no data about the time interval between sonographic estimation and delivery. Of the remaining 55 studies, only 9 reported results of the impact of different time intervals. 5 of the 9 support our conclusion [13–14], 3 of the remaining 4 report contradictory results [15–17]. Benacerraf et al. [18] reported that there is no impact on the accuracy of the weight estimation caused by the time between investigation and delivery. The estimations were taken no more than 7 days before delivery and therefore cannot be compared to the results of our own study.

We can state that the accuracy of fetal weight estimation in our study is not influenced by the experience of the investigator. 6 studies paid attention to this question: 3 of them concluded that experience of the investigator has no impact [19, 20] and 3 stated that experience has an impact on the preciseness of the estimation [19, 20].

In our study the accuracy of fetal weight estimation was not influenced by the sex of the fetus. The fact that males have about 3% more birth weight at term than females [20] was discussed together with the question of the accuracy of fetal weight estimation in only two further studies: Mills et al. [21], investigating preterm pregnancies (weeks 23–29), had the same result as we state here, and Honarvar et al. [22] reported a similar result investigating preterm pregnancies between weeks 24 and 34. There was no statistically significant difference of the birth weight between males and females though females had about 46 g more average birth weight.

In our results we have seen no impact on the accuracy of fetal weight estimation when we compare lower gestational weeks with higher weeks. There are only two other studies analyzing the impact of gestational age on the accuracy of fetal weight estimation. Both conclude that gestational age has an impact on the estimation [2, 22].

Also we have seen no impact on the preciseness of the estimations when we compare the groups with lower and higher fetal birth weight using Hadlock II formula. To the best of our knowledge only Benacerraf et al. [18] published a study targeting the question if the accuracy of fetal weight estimation is influenced by the birth weight. As in our own study, Benacerraf reports no remarkable difference in the accuracy of fetal weight estimations in the different groups of birth weight. This study is remarkable because the design shows similar key characteristics as our own study: A large series of 1,301 women with single pregnancies, investigated in a defined time slot (1 week) before delivery in one institution was the base for the question if birth weight can

be estimated with a certain safety and if the accuracy of the estimation is influenced by factors like amniotic fluid and the number of days between estimation and delivery.

A few studies state that different formulas for different classes of gestational weeks or different classes of fetal weight have differing accuracies or have the tendency to over/underestimate the actual weight. The concerning results are inhomogeneous and inconsistent [2, 10, 12, 19]. To our best knowledge it is not possible to draw a consistent conclusion on which formula is definitively the best in which subgroup.

In our study we had no impact of the BMI on the accuracy of the fetal weight estimation. Furthermore, we cannot prove any influence of the amniotic fluid index on the accuracy of the estimations. The majority of the concerning studies state the same result [18].

The results of fetal weight estimation in our study are not influenced by the presentation of the fetus. Almost all available studies excluded different to cephalic presentations. Three studies support our conclusion. Only the results of Chauhan et al. [23] came to the result that a cephalic presentation is linked to a higher accuracy of fetal weight estimation when compared with breech presentation within the ±10% range of the actual weight.

Finally we have to state that even very poor imaging conditions caused by high maternal BMI and low amniotic fluid does not influence the accuracy of fetal weight estimation in the investigated collective. The aim of answering this was the clinical experience that the babies of mothers with such restricted sight cannot be measured accurately because the traditional landmarks to set the caliper points cannot be visualized. There is no literature available that posed the same question.

Accuracy of fetal weight estimation is influenced by the fact that most of the studies that we have taken into consideration do not state if they have eliminated factors that may have influenced their results such us multiples, fetuses with skeletal dysplasia, intrauterine growth restriction, etc. Furthermore, stratification for gestational age and fetal weight is rarely given. Finally, some authors re- port their results with the ±10% range while others re- port the mean percentage error. Due to the facts mentioned above, complete comparability of different studies in the field of fetal weight estimation is rarely given. Being aware of this limitation we can state that our results concerning the accuracy of fetal weight estimation with 6 of the most widespread formulas are in accordance with previous reports in the literature.

Conclusion

The literature targeting different aspects (accuracy of formulas, influence factors) of sonographic fetal weight estimation is inhomogeneous concerning the reported results and interpretations. To our knowledge this is the first study to investigate all important factors of influence on fetal weight estimation in a single group of singleton pregnancies at a single hospital. Fetal weight estimation is important to care for the pregnancy. It may influence the intenseness of monitoring and the time and mode of delivery. Pseudo-preciseness given by today's PACS should be carefully used, taking into consideration the limitations of the method and mainly the time interval between prenatal weight estimation and delivery.

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