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Fetal Weight and Head Circumference Estimated by Ultrasound for Predicting Cervical Dilatation Progression Rate and mode of Delivery

Behnaz Molaei (MD)[1], Sahar Ghafoori (MD)[2], Golshan Manteghi (MD)[3], Shabnam Tofighi (PhD)[3*]

[1] Associated Professor, Perinatology Fellowship, Department of Obstetrics and Gynecology, Mousavi hospital, Zanjan university of Medical Sciences, Zanjan, Iran
[2] Medical Doctor, Department of Obstetrics and Gynecology, Mousavi Hospital, Zanjan University of Medical Sciences, Zanjan, Iran
[3] Assistant Professor, Department of Obstetrics and Gynecology, Mousavi Hospital, Zanjan University of Medical Sciences, Zanjan, Iran

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ABSTRACT

Background & aim: The relationship between fetal biometric indices and pregnancy outcomes has always been discussed. It seems that understanding the relationship between these indices and maternal and neonatal complications can be useful in the proper management of labor and delivery. This study was performed to determine the value of estimated fetal weight (EFW) and head circumference (HC) measured by ultrasound to predict the cervical dilatation rate and mode of delivery.

Methods: In this prospective cohort study, all eligible individuals (n=60) selected by convenience sampling were evaluated. The participants were pregnant women with the gestational age of 37 to 42 weeks referred to Mousavi Hospital in Zanjan in 2019-2020. Data collection tools included a checklist to record clinical examination and ultrasound results, as well as reports on the labor and delivery processes. Data were analyzed by SPSS software (version 22) and using descriptive statistics and the student t-test Chi-square test.

Results: EFW and HC were directly and significantly correlated with cesarean section and abnormal progression or cessation of dilatation (P<0.05). Linear regression analysis revealed that EFW could be a predictor of mode of delivery, while HC can be considered as a predictor of the rate of dilatation progression (p<0/05).

Conclusion: It seems that the sonographic estimation of EFW and HC prior to childbirth can be useful to predict mode of delivery and labor progression. However, it is suggested to conduct more comprehensive studies with larger sample size.

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Introduction

The World Health Organization defines natural childbirth as "a process that begins spontaneously and remains low-risk during labor from onset to birth, with the baby being born spontaneously in the vertex position at 37 to 42 weeks of pregnancy and both the mother and neonate are at good condition after delivery" (1). There are many factors that can affect the success of natural vaginal delivery, including estimated fetal weight (EFW) and fetal head circumference (HC). In fact, for a successful natural vaginal delivery, the compatibility between the fetal HC and the mother's pelvis is a key factor. In developing societies, prolonged labor is typically due to cephalopelvic disproportion (CPD), which may lead to delayed labor, fatigue, and rupture of uterine and vesicovaginal fistula. Prolonged labor is relatively common in the first pregnancy. The disproportion between fetal HC and the mother's pelvis is one of the causes of delayed labor and is responsible for 8% of maternal

* *Corresponding author*; Shabnam Tofighi, Assistant Professor, Department of Obstetrics and Gynecology, Mousavi Hospital, Zanjan University of Medical Sciences, Zanjan, Iran. Tel: 00989199120914; Email: mahsamoshiri00@gmail.com

deaths worldwide (2, 3). The fetus size is also a known risk factor for difficult labor. Fetal macrosomia increases the likelihood of shoulder dystocia, prolonged labor, and fetal distress (4, 5).

Fetal biometric evaluation is essential for assessing fetal growth and predicting perinatal outcomes (6). Fetal HC is an important predictive factor for labor process and directly affects the progression of childbirth (7). Leung et al. in their prospective study have shown the efficacy of ultrasound measuring of fetal HC > 37 cm and EFW > 4.5 kg in predicting long-term delivery. According to the studies, fetal HC is more advantageous than EFW (due to the inaccuracy of ultrasound weight estimation) in predicting labor progression and problems during delivery (8). Vintzileos et al. (1987) in their review study showed that fetal weight estimation by ultrasound is inaccurate, and fetal weight overestimation may encourage choosing of cesarean section for childbirth (9).

Various factors can influence fetal biometric parameters during pregnancy. For example, the race is one of the most important variables affecting fetal biometric indices (10), so the standards defined for fetal biometric indices should be individually and specifically determined in each race. Chinese, Japanese, and particularly South Asian infants are much smaller than their respective gestational age, while North American and North African neonates are much larger than their Caucasian counterparts (11, 12).

Lack of labor progress due to CPD is one of the reasons for emergency cesarean section, which is associated with increased maternal and fetal mobility (13). A study on random populations showed that high head circumference (HC) and abdominal circumference (AC) were the reasons for emergency cesarean sections (14). Similar blinded studies have also reported that pre-labor ultrasound examinations can increase the rate of detecting large gestational age (LGA) fetuses and reduce the adverse consequences of this condition (15, 16). In addition to prenatal EFW, numerous studies have also examined fetal biometric parameters such as fetal head size. However, these retrospective studies are prone to intervention bias (17-19). The sonographic evaluation of fetal biometric parameters is not routinely performed in the third trimester of pregnancy, and the interpretation of clinical results is not universal. The sonographic assessment of the risk of non-progressive labor or emergency cesarean section after labor testing remains a controversial issue (20). The present study was performed aimed to investigate the value of ultrasound evaluation of EFW and fetal HC to predict the labor process and type of delivery.

Materials and Methods

This prospective cohort study was performed on 60 mothers with term pregnancies (gestational age of 37 to 40 weeks and 6 days) referred to Ayatollah Mousavi Hospital of Zanjan during 2019-2020 for delivery. All eligible individuals were selected by convenience sampling and were assessed. Inclusion criteria were term pregnancy, singleton pregnancy, cephalic presentation, no diabetes, and no contraindications to natural vaginal delivery. Also, exclusion criteria were the patient's non-cooperation and unwillingness to perform ultrasound, non-CPD emergency cesarean section, detection of unsuitable pelvis for a natural delivery at any stage of labor, and emergency cesarean section for any reason other than those related to fetal weight and fetal HC (lack of progress).

A researcher-made checklist was used to collect the required data, including demographic information, midwifery records, the results of vaginal examinations (dilatation and descent), clinical EFW, ultrasound EFW, fetal HC, type of delivery, and birth weight. The validity of the checklist was approved by ten faculty members of the obstetrics and gynecology department of the Zanjan University of Medical Sciences.

After approval by the Research Deputy of Zanjan University of Medical Sciences and the Research Ethics Committee of the university, the researcher received an introduction letter to refer to the hospital. Then, the researcher explained the aim of study and protocols to participants and assured them about the confidentiality of their information. After obtaining written consent from the participants, the researcher interviewed the mothers and examined them for the inclusion criteria. The mothers were also clinically examined by the

researcher (an Obstetrics and Gynecology resident) for appropriateness of the pelvis for delivery and the clinical estimation of fetal weight. Afterward, the mother underwent ultrasonography by a radiologist who was blinded to the study, and the following biometrics were measured:

BPD: The size of the fetus head from the outer edge of the proximal skull to the inner edge of the distal skull at the levels of the thalamus and the cavum septum pellucidum; HC: Occipitofrontal diameter, BPD: Calculated using the 1/2(d12 + d22) × 2.325/2 formula; AC: The proximal-dorsal abdominal diameter at the gastric and the umbilicus vein levels using the d1 + d2/2 formula, and FL: From the greater trochanter proximal end to the distal metaphysis. Fetal weight was recorded in grams using the Hadlock III formula (21). The mother and labor progress were monitored during delivery, and related data were recorded in the checklist, including changes in descent (from normal >2 cm/ hour in multiparous mothers and > 1 cm/hour in nulliparous women to complete 10 cm dilatation), labor cessation abnormalities (i.e., complete interruption of dilatation or descent defined as no changes in the cervix for two hours (i.e., dilatation stoppage) and no descent of the fetus for one hour (i.e., descent stoppage), and shoulder dystocia during labor.

Finally, data were analyzed by SPSS software (version 22). For data analysis, descriptive statistics, including frequency distribution tables were utilized, and comparisons between the groups were performed by the Chi-square (Pearson's x2-test) test, t-test, and linear regression. P<0.05 was considered statistically significant.

Results

A total of 60 pregnant women in the age range of 15 to 40 years were studied. The mean age of the mothers was 25.83±6.71 years, and the mean gestational age was 38.88±0.94 weeks. The mean BMI of the participants was 38.88±0.94 kg/m^2. The mothers' pregnancy records have been shown in Table 1.

Rupture of amniotic membrane and labor pain were the causes of referral in 10 (16.7%) and 50 (63.3%) participants, respectively. In the ultrasound examination, the mean fetal HC was 32.97 ± 1.38 cm, and the mean of EFW was 3343.53 ± 462.492 grams. The means of birth weight and HC of the infants were 3242.17 ± 607.68 grams and 35.05 ± 1.67 cm, respectively. The SGA was observed in four cases (6.7%) and LGA in 15 (25%).

Table 1. The Participants' Pregnancy Records

Variables	Frequency (%)
Gravidity	
1	33 (55.0)
2	18 (30.0)
3	7 (11.7)
4	2 (3.3)
Parity	
Nulliparous	33 (55.0)
Primiparous	19 (31.7)
Multiparous	8 (13.3)
History of abortion	1 (3.3)

Based on data analysis, EFW had a significant relationship with dilatation progress and the type of delivery (P <0.05), so that a higher EFW was associated with a greater risk for abnormal progression or cessation of cervical dilatation and the need for cesarean section .Also, fetal HC was directly and significantly associated with the normal progression of dilatation and normal delivery (P <0.05) (Table 2).

There was significant association between HC and EFW and mode of delivery, so that increased HC or EFW is associated with higher probability of cesarean delivery (P=0.034) (Table3).

Based on Pearson correlation, the mean birth weight of the neonates was significantly correlated with EFW measured in ultrasound and clinical examinations (P=0.001). Therefore, the EFW measured by ultrasound or clinical examination predicted birth weight (Table 4).

No cases of shoulder dystocia were observed, so it was not possible to determine the predictive value of fetal biometric indices for this condition. Also, few neonates presented with a low Apgar score, and it was not applicable to assess the relationship between this parameter and fetal biometric indicators.

The analysis of linear regression showed that EFW and HC are the predictors of mode of delivery (P<0.05). In the comparison of the predictive power, the HC of fetus is a better predictor than its estimated weight.

Table 2. The relationship of HC and EFW with dilatation progression during labor

Feature	Normal dilatation progression	Abnormal progression or cessation of dilatation progression	P-value *
Mean head circumference (cm)	32.84±1.26	34.16±1.94	0.025
Mean estimated fetal weight (grams)	3302.44±458.44	3713±337.38	0.038

*t-test

Table 3. The relationship of HC and EFW with the Mode of delivery

Feature	NVD	CS	P-value *
Mean head circumference (cm)	323232.81±1.25	33.86±1.77	0.034
Mean estimated fetal weight (grams)	3290.82±466.37	3642.22±316.25	0.034

*t-test

Table 4. Comparison of sonographic and clinical estimation of fetal weight by birth weight

Feature	Mean (SD)	birth weight (grams) Mean (SD)	r	P-value*
Mean of sonographic fetal weight (grams)	3343.53(462.49)	607.68±3242.17	0.685	0.001
Mean of clinical estimated	3194.17(351.52)		0.635	0.001

* Pearson correlation

Table 5. The result of logistic regression predicting mode of delivery with EFW and HC

Features	Non-standard coefficients		Standard β	P-value
	β	Standard Error		
EFW	0.002	0.001	1.002	0.044
HC	0.666	0.316	1.946	0.035

Discussion

According to the findings of the present study, EFW and HC were significantly and directly associated with the need for cesarean section and the abnormal progression or cessation of dilatation. Linear regression analysis revealed that EFW could be a predictor of the type of delivery, while HC can be considered as a predictor of dilatation progression rate.

Moreover, the present study showed that increasing HC and EFW increased the risk of slowly or abnormally progressing dilatation and the likelihood of cesarean section. Similar results were reported in many studies (4, 12-14, 16).

According to the findings of the present study, EFW was a strong predictor of the cesarean section, but had no indication for predicting dilatation progression rate. Also, the results of some other studies showed that EFW is a good predictor for the likelihood of the need for cesarean section (16, 24-26).

The results of the present study indicated that EFW was correlated with the likelihood of the need for cesarean section. Ashrafganjooei et al. (2010) assessed 12396 pregnant women and revealed that EFW had no role in predicting the progression rate of dilatation and labor (25). In the retrospective multi-center study by Lipschuetz et al. in 2018, it was noted that fetal HC > 35 cm and EFW > 3900 grams were potent predictors of abnormal progression of labor and the need for cesarean section. Also, the predictive power of birth weight was higher than that of fetal HC (27), while in the present study, HC seemed to be a stronger predictor. The reasons for this discrepancy seem to be related to different methodologies and sample sizes of the two studies. They had a retrospective design on 11500 participants, in which ultrasound examination had been performed at least one week after delivery. In the present study, ultrasonography was performed at the time of admission for delivery.

In the present study, HC was able to predict the dilatation progression rate during labor but not the need for cesarean section. The study by

Ashrafganjooei et al. (2010) showed that HC could predict abnormal progression of dilatation and the need for midwifery interventions during labor. Moreover, it was recommended not to make midwifery decisions during labor based on fetal biometric parameters (25).

Mujugira et al. (2013) in their study showed that HC > 37 cm doubled the chances of cesarean section (4). It seems that the discrepancy between these results can be explained by different study designs, sample sizes, and inclusion criteria. The study of Mujugira et al. had a retrospective design and a sample size of 10750 nulliparous mothers. Rabei and et al. (2017) described that an elevated HC could strongly predict the likelihood of cesarean section (24). The difference observed in the dilatation progression rate can be justified by differences in participants' demographic features; Rabei et al. studied 20-30-year-old nulliparous women can justify. Also, Lipschuetz et al. (2015) showed that high HC could increase the likelihood of unplanned cesarean section (22). In addition, Sovio et al. (2018) reported that HC at the week 36th of gestation, in association with other midwifery parameters, could predict emergency cesarean section (16). This discrepancy between the results can be explained by different sample sizes and the methodologies used in the two studies.

In the present study, clinical EFW was significantly correlated with the EFW measured by ultrasound. Similar results were reported in the studies by Shittu et al. (2007) (28) and Ashrafganjooei et al. (2010) (25). However, Ugwu et al. (2014) reported that ultrasound EFW was far more accurate than its clinical equivalent (29).

Overall, the findings of the present study and previous studies highlighted that variable fetal biometric characteristics in different societies can be used to predict childbirth outcomes. For example, fetal HC can be utilized in some populations while EFW may be useful in others to predict the need for cesarean section, the dilatation progression rate, the likelihood of prolonged labor, and the duration of the active phase of labor.

One of the strength of the present study was the prospective design of the study. One of the limitation of this study was the small sample size which can affect the findings. Other weaknesses of this study was the convenience sampling, the random sampling is suggested for future studies. Also, assessment of the relationship between HC and EFW in macrocosmic pregnancies is suggested.

Conclusion

According to the results of the present study, EFW and fetal HC measured by ultrasound could predict the need for cesarean section and abnormal dilatation progression rate. Also, the significant correlation between the EFW by ultrasound and birth weight indicated the accuracy of ultrasound measurements in this study. It is suggested to conduct further studies with larger sample sizes in the future to obtain more accurate and generalizable results on the relationship of fetal biometric parameters with the type of delivery and labor progression.

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Conflicts of interest

Authors declared no conflicts of interest.

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