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Fetal Weight and Head Circumference Estimated by Ultrasound for the Cervical Dilatation Progression Rate and Delivery Method

Abstract

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

Methods: In this prospective cohort study, all eligible individuals (٦٠ partcipants) were evaluated during the study period who were pregnant women with the gestational age of ٣٧ to ٤٢ weeks, referred to Mousavi Hospital in Zanjan in ٢٠١٩-٢٠٢٠ enrolled by the. The data collection instrument was a checklist to record clinical examination and ultrasound results, as well as reports on the labor and delivery processes. Finally, the data were entered in SPSS ٢٢ software and analyzed using descriptive statistics and the student t-test, Chi-square, and Mann-Whitney tests.

Results: According to the findings of this study, EFW and HC directly and significantly correlated with cesarean section and the unnatural progression or cessation of dilatation (P-value <٠,٠٥). Linear regression analysis revealed that EFW could be a predictor of the delivery type while HC can be considered as a predictor of the rate of dilatation progression.

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

Keywords: Estimated fetal weight, Head circumference, Delivery method, Dilatation, Ultrasound

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 ٣٧ to ٤٢ weeks of pregnancy and both the mother and neonate having good condition after delivery" (١). 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 delivery, the compatibility between the fetal HC and the mother's pelvis is a key factor. Prolonged labor in developing societies is typically due to cephalopelvic disproportion (CPD), which may lead to delayed labor, fatigue, and the rupture of the 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 ٨٪ of maternal deaths worldwide (٢, ٣). 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 (٤, ٥).

Fetal biometric evaluation is essential for assessing fetal growth and predicting perinatal outcomes (٦). Fetal HC is an important predictive factor for the labor process and directly affects the progression of childbirth (٧). Clinical studies have shown the efficacy of the ultrasound measuring of fetal HC (> ٣٧ cm) and EFW (> ٤,٥ kg) in predicting long-term delivery. According to studies, fetal HC is more advantageous than EFW (due to the inaccuracy of ultrasound weight estimation) in predicting labor progression and problems during delivery (٨).

Macrosomic complications have been established in obstetrics. Vintzileos *et al.*, 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 (٩).

Various factors can influence fetal biometric parameters during pregnancy. For example, the race is one of the most important variables affecting fetal biometric indices (١٠), so the standards defined for fetal biometric indices should be individually and specifically determined in each race. According to findings, 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 (١١, ١٢).

Lack of progress in labor due to CPD is among the reasons for urgent cesarean section, which is associated with increased maternal and fetal mobility (١٣). A study on random populations showed that high HC and abdominal circumference (AC) were among the reasons for emergency cesarean sections (١٤). Similar blinded studies have also reported that pre-labor ultrasound examinations can increase the rate of detecting large for gestational age (LGA) fetuses and reduce the adverse consequences of this condition (١٥, ١٦). 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 (١٧-١٩). 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. (٢٠). The present study aimed to investigate the value of ultrasound evaluation of EFW and fetal HC in predicting the labor process and delivery.

Methods

This was a prospective cohort study on mothers with term pregnancies (gestational age of ٣٧ to ٤٠ weeks and sixes days) referred to Ayatollah Mousavi Hospital of Zanjan during ٢٠١٩-٢٠٢٠ for delivery. All eligible individuals were evaluated during the study period. Inclusion criteria encompassed 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 for undergoing ultrasound, non-CPD emergency cesarean section, the detection of the 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 (i.e., 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.

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 ward under study. The researcher then explained the study's aims 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 (a gynecology resident) for parameters such as the 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 ١/٢(d١٢ + d٢٢) × ٢,٣٢٥/٢ formula; AC: The proximal-dorsal abdominal diameter at the gastric and the umbilicus vein levels using the d١ + d٢/٢ formula, and FL: From the greater trochanter proximal end to the distal metaphysis. Fetal weight was recorded in grams using the Hadlock III formula. The mother and labor progress were monitored during delivery, and related data were recorded in the checklist, including changes in descent (from normal >٢ cm/ hour in multiparous mothers and > ١ cm/hour in nulliparous women to complete ١٠ 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, the data were entered into SPSS V٢٢ software. For data analysis, descriptive statistics, including frequency distribution tables and graphs, were utilized, and comparisons between groups were performed by the Chi-squared (Pearson's x٢-test) test, student t-test . All the tests were conducted considering a significance level of P<٠,٠٥.

Results

In the present study, ٦٠ pregnant women in the age range of ١٥ to ٤٠ years were studied. The mean age of the mothers was ٢٥,٨٣ (٦,٧١) years, and the mean gestational age was ٣٨,٨٨ (٠,٩٤) weeks. The mean BMI of the participants was ٣٨,٨٨ (٠,٩٤) kg/m^{٢}. The mothers' pregnancy records have been shown in Table ١.

Table ١. The Participants' Pregnancy Records

Variables		Frequency (N=٦٠)	Percentage
Gravid	١	٣٣	٥٥,٠٪
	٢	١٨	٣٠,٠ %
	٣	٧	١١,٧٪
	٤	٢	٣,٣٪
Parity	Nulliparous	٣٣	٥٥,٠٪
	Primiparous	١٩	٣١,٧٪
	Multiparous	٨	١٣,٣٪
History of abortion		١	٣,٣٪

*Chi- squared

Rupture of amniotic membrane and labor pain were the causes of referral in ١٠ (١٦,٧٪) and ٥٠ (٦٣,٣٪) participants, respectively. In the ultrasound examination, the mean fetal HC was ٣٢,٩٧ ± ١,٣٨ cm, and the mean of EFW was ٣٣٤٣,٥٣ ± ٤٦٢,٤٩٢ grams. The means of birth weight and HC of the infants were ٣٢٤٢.١٧ ± ٦٠٧,٦٨ grams and ٣٥,٠٥ ± ١,٦٧ cm, respectively. The frequency of SGA was four (٦,٧٪), and LGA was observed in ١٥ cases (٢٥٪).

Based on data analysis, EFW had a significant relationship with dilatation progress and the type of delivery (P-value <٠,٠٥) 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-value <٠,٠٥). (Table ٢).

Table ٢. 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)	٣٢/٨۴ ± ١/٢۶	٣۴/١۶ ± ١/٩۴	٠/٠٢۵
Mean estimated fetal weight (grams)	٣٣٠٢/۴۴ ± ۴۵٨/۴۴	٣٧١٣/٣٣ ± ٣٣٧/٣٨	٠/٠٣٨

*; t-test

Table ٣. The Relationship of HC and EFW with the Type of Delivery in the Participants

Feature	NVD	CS	P-value *

Mean head circumference (cm)	۳۲/۸۱ ± ۱/۲۵	۳۳/۸۶ ± ۱/۷۷	۰/۰۳۴
Mean estimated fetal weight (grams)	۳۲۹۰/۸۲ ± ۴۶۶/۳۷	۳۶۴۲/۲۲ ± ۳۱۶/۲۵	۰/۰۳۴

*t-test

There were significant association between HC and EFW and the mode of delivery in such way that If the HC or EFW was bigger, the probability of cesarean delivery was higher.(table۳)

In the present study, the mean clinical EFW was ۳۱۹٤.۱۷ (۳٥۱,٥۲) grams while the mean EFW in ultrasonography was ۳۳٤۳.٥۳ (٤٦۲,٤۹) grams. The mean fetal HC was obtained ۳۲,۹۷ ± ۱,۳۸ cm in ultrasound examination. Based on Pearson correlation, the mean birth weight of the neonates significantly correlated with EFW measured in ultrasound (r = ۰,٦۸٥, P-value = ۰,۰۰۱) and clinical (r = ۰,٦۳٥, P-value = ۰,۰۰۱) examinations. Therefore, the EFW measured by ultrasound or clinical examination seemed to be able to predict birth weight.

In this study, 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.

Discussion

According to the findings of this 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.

The present study showed that with increasing HC and EFW, the risk of slowly or abnormally progressing dilatation and the likelihood of cesarean section also increase. Several studies have also reported results (٤, ١٢-١٤, ١٦) similar to ours with no contradictory findings.

According to the findings of this study, EFW was a strong predictor of the cesarean section but had no indication for predicting the dilatation progression rate. The results of numerous studies agreed with those of the present study (١٦, ٢٣-٢٥). In this study, EFW was revealed as a good predictor for the likelihood of the need for cesarean section. In a study by Pretscher *et al*., ١٢٣٩٦ pregnant women were assessed, revealing that EFW had no role in predicting the progression rate of dilatation and, therefore, labor (٢٤). In a retrospective multi-center study by Lipschuetz *et al*. in ٢٠١٨ (٢٦), it was noted that fetal HC above ٣٥ cm and EFW of higher than ٣٩٠٠ grams were potent predictors of abnormal progression of labor and the need for cesarean section. In the recent study, the predictive power of birth weight exceeded that of fetal HC (٢٦), 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. The recent study had a retrospective design on ١١٥٠٠ participants, in which ultrasound examination had been performed at least one week after delivery. In comparison, we performed ultrasonography at the time of admission for delivery.

In this study, HC was able to predict the dilatation progression rate during labor but not the need for cesarean section. A study by Pretscher *et al*. showed that HC could predict non-normally progressing dilatation and the need for midwifery interventions during labor. In the recent study, it was recommended not to make midwifery decisions during labor based on fetal biometric parameters (٢٤).

In their study, Mujugira *et al*. showed that HC above ٣٧ cm doubled the chances of cesarean section (٤). 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 ١٠٧٥٠ nulliparous mothers. Rabbi and colleagues described that an elevated HC could strongly predict the likelihood of cesarean section (٢٣). It seems that differences in participants' demographic features and studying ٢٠-٣٠-year-old nulliparous women by Rabei *et al*. can justify the difference observed in the dilatation progression rate. Also, Lipschuetz *et al*. showed that high HC could increase the likelihood of unplanned cesarean section (٢١). In addition, Sovio *et al*. reported that HC at the week ٣٦th of gestation, in association with other midwifery parameters, could predict emergency cesarean section (١٦). This discrepancy between the results can be explained by different sample sizes and the methodologies of the two studies.

In the present study, clinical EFW significantly correlated with the EFW measured by ultrasound. The results of a study by Alnakash & Shittu, as well as the study of Ganjouri *et al*.,

were in accordance with our observation (٢٤, ٢٧). However, Ugwu *et al*. reported that ultrasound EFW was far more accurate than its clinical equivalent (٢٨).

Overall, the findings of the present study and those of previous studies highlight that due to variable fetal biometric characteristics in different societies, each of these features 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.

Conclusion

In conclusion, EFW and fetal HC measured by ultrasound could predict the need for cesarean section and abnormal dilatation progression rate, respectively, in the studied population. Also, the significant correlation between the EFW obtained in ultrasound and birth weight indicated the accuracy of ultrasound measurements in this study. It is suggested to conduct 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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