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Effects of Long Bones on Fetal Weight Estimation

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Abstract

Objectives: An accurate estimation of fetal weight will help predict the macrosomic fetuses and determine the mode of delivery which reduce perinatal morbidity and mortality. In congenital abnormalities such as absence of femur and lower extremity agenesis, femur length can not be measured, or in patients with isolated femoral shortening, the calculation of estimated fetal weight can be misleading. So, in our study, we investigated the efficacy of the use of long bones in the calculation of estimated fetal weight in Turkish society.

Material and Method: This retrospective study was conducted in Turgut Ozal University Hospital, Department of Obstetrics and Gynecology, among 400 healthy singleton pregnant women whose gestational ages were confirmed by the first trimester ultrasound and patients who had undergone a targeted ultrasonography in the 20th-22nd gestational weeks. Biparietal diameter, head circumference, abdominal circumference, femur length, humerus length, tibia length and ulna length were measured for each patient through detailed ultrasonography examinations.

Results: In linear regression analysis for estimating fetal weight, bipariatal diameter, femur length, abdominal circumference, and tibia length were found to be more effective ($p<0.001$, $p<0.001$, $p<0.001$ and $p=0.010$, respectively). In the linear regression analysis including only the long bones, we have observed femur length, tibia length, and ulna length to be more effective ($p<0.001$, $p<0.001$ and $p=0.014$, respectively). Correlation analyses of long bones have revealed that all bones were highly correlated with each other ($p<0.001$ for each).

Conclusion: In cases when FL, one of the most important parameters in TFA measurement, cannot be measured, tibia and ulna lenghts may be considered as alternatives. There is need for multicenter studies carried out with more patients to be able to develop different ideas on the matter.

Key Words: Estimated Fetal Weight; Femur Length; Long Bones.

Uzun Kemiklerin Tahmini Fetal Ağırlık Üzerine Etkisi

Özet

Amaç: Fetal ağırlığın doğru tahmini, makrozomik fetusların öngörülebilmesini, doğum şeklinin belirlenebilmesini ve perinatal morbidite ve mortalitenin azalmasını sağlar. Femur yokluğu, alt extremite agenezisi gibi konjenital anomalilerde, femur uzunluğu ölçülemez, izole femur kısalığı olanlarda tahmini fetal ağırlığı hesaplaması yanıltıcı olabilir. Bu yüzden çalışmamızda Türk toplumunda tahmini fetal ağırlık hesaplamasında uzun kemiklerin kullanımının etkinliğini araştırdık.

Gereç ve Yöntem: Bu retrospektif çalışma Turgut Özal Üniversitesi Tıp Fakültesi Hastanesi Kadın Hastalıkları ve Doğum Anabilim Dalına başvuran, gebelik yaşı ilk trimester ultrasonografi ile doğrulanan ve 20-22. haftalarda detaylı ultrasonografisini yaptıran, 400 sağlıklı tekil gebe üzerinde yapıldı. Detaylı ultrasonografi sırasında biparietal çap, kafa çevresi, karın çevresi, femur uzunluğu, humerus uzunluğu, tibia uzunluğu ve ulna uzunluğu ölçüldü.

Bulgular: Fetal ağırlığı tahmin etmek amacıyla yapılan lineer regresyon analizinde bipariatal çap, femur uzunluğu, karın çevresi ve tibia uzunluklarının daha etkili olduğu tesbit edildi (sırasıyla; $p<0.001$, $p<0.001$, $p<0.001$ ve $p=0.010$). Sadece uzun kemiklerin dâhil edildiği lineer regresyon analizinde fetal ağırlığı tahmin etmede femur uzunluğu, tibia uzunluğu ve ulna uzunluğunun daha etkili olduğu görüldü (sırasıyla; $p<0.001$, $p<0.001$ ve $p=0.014$). Uzun kemiklerin kendi içindeki korelasyon analizinde tüm kemiklerin birbirleriyle yüksek oranda korele olduğu bulundu (tümü için; $p<0.001$)

Sonuç: Tahmini fetal ağırlık hesaplanmalarının önemli parametrelerinden olan femur uzunluğunun ölçülemediği durumlarda tibia uzunluğu ve ulna uzunluğunun ölçümü alternatif olabilir. Hasta sayısının fazla olduğu çok merkezli çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Tahmini Fetal Ağırlık; Femur Uzunluğu; Uzun Kemikler.

INTRODUCTION

The rate of being exposed to perinatal complications is higher in abnormally developing fetuses compared to fetuses with normal development (1). To this end, knowledge of fetal weight helps us in the prevention of perinatal complications. To ensure proper management of these fetuses fetal weight estimation should be made as accurately as possible. There are various formulas used in fetal weight estimations. These formulas use different combinations of different biometric parameters. The closest estimations of birth weight in the Turkish population are reported to be achieved by Hadlock 1 and 2 formulas (2). Obstetricians still work on new formulas to increase the accuracy of estimated fetal weight (EFW).

In congenital anomalies such as femoral absence and lower extremity agenesis, femur length (FL) cannot be measured, or, in cases with isolated femoral shortening, EFW calculations can be misleading. Therefore there is need for alternative formulas instead of the current options. In this study, it is our aim to investigate the

effectiveness of use of long bones in EFW estimations in Turkish society.

MATERIALS AND METHODS

This retrospective study was conducted among 400 healthy singleton pregnant women who presented at Turgut Ozal University, Faculty of Medical Hospital between January 2010 and June 2011. The patients' gestational ages were confirmed by the ultrasound performed in the first-trimester and they underwent detailed ultrasound examinations on the 20th-22nd weeks of their pregnancies. First we retrospectively evaluated the computerised data concerning age, gravida, parity, and gestational age of each patient. We excluded the patients with fetal anomalies, multiple pregnancies, systemic diseases such as hypertension and diabetes, and those with smoking history from the scope of the study.

The ultrasonography was performed by using (HD15 System; Philips Ultrasound, Bothell, Washington) 5-12-MHz linear-array transducer by the same radiologist. We collected the fetal biometric measurements according to the guidelines dictated by law and then recorded the values. We measured biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), FL, humerus length (HL), tibia length (TL), and ulna length (UL) during the detailed ultrasound. TF was calculated with Hadlock 2 formula by using BPD, HC, AC and FL parameters.

For the statistical analyses we analysed the obtained data by using SPSS statistical software package (SPSS 16.0; SPSS Inc., Chicago, IL, USA). The compatibility of the data to the normal distribution was graphically checked and ensured by using Shapiro-Wilk test only to find out that the data at hand did not comply with the normal distribution. The representation of continuous data was presented by using median values (minimum-maximum). To determine the factors that affect the identification of TFA, we used the Spearman correlation analysis and linear regression analysis by making use of backward:LR. P<0.05 value was considered statistically significant throughout the study.

RESULTS

The median age of the 400 patients included in the study was 30 (19-43) while the median values for gravida, parity, and gestational age were 2 (1-7), 1 (1-6), and 21 (18-24), respectively. The results of the demographic and ultrasound measurements are presented in Table 1. The correlation analysis showed that there was iki kez yazılmış was a very strong positive correlation between TFA and fetal ultrasonographic measurements (p <0.001) (Table 2). In the linear regression analysis, it was observed that BPD, FL, AC and TL were more effective in determining TFA (p<0.001, p<0.001, p<0.001, and p=0.010, respectively) (Table 3). The linear regression analysis concentrating on long bones only showed that FL, TL and UL were more effective in identifying TFA (p<0.001, p<0.001, and p=0.014, respectively) (Table 4). The analysis correlating long bones within themselves showed that all the bones were highly correlated with each other (for all values p<0.001) (Table 5).

Table 1. Demographic and ultrasound measurements (n=400)

	Median (Minumum-Maximum)		Median (Minumum-Maximum)
Age (years)	30 (19-43)	AC	166 (112-228)
Gravida	2 (1-7)	FL	35.30 (21-55)
Parity	1 (1-6)	Humerus	34 (20-48)
Gestational week	21 (18-24)	Tibia	31 (18-48)
BPD	50.70 (38-69)	Ulna	31.30 (19-46)
HC	192 (134-261)	TFA	420.50 (172-982)

Table 2. The correlation between TFA and fetal ultrasonographic measurements

		FL	HL	UL	TL	BPD
Weight	Rho	0.957	0.932	0.913	0.928	0.909
	p	**<0.001**	**0.001**	**<0.001**	**<0.001**	**<0.001**

Table 3. The linear regression analysis of the ultrasound parametres that are effective in predicting TFA

	B	p
Constant	-695.452	**<0.001**
BPD	3.544	**0.001**
HC	0.469	0.130
FL	10.166	**0.001**
AC	3.609	**0.001**
HL	-2.110	0.054
TL	2.800	**0.010**
UL	0.821	0.417

Abbreviations: BPD: biparietal diameter; HC: head circumference; FL: femur lenght; AC: abdominal circumference; HL: humerus length; TL: tibia length; UL: ulna length.P<0.05: statistically significant value

Table 4. The linear regression analysis concentrating on the effects of long bones only on TFA

	B	p
Constant	-567.778	**<0.001**
FL	15.083	**0.001**
HL	2.777	0.091
UL	3.582	**0.014**
TL	9.141	**0.001**

P<0.05: statistically significant value

Table 5. The correlation analysis of long bones.

		FL	HL	UL	TL
FL	Rho	1.000	0.927**	0.890**	0.917**
	P	.	<0.001	<0.001	<0.001
HL	Rho	0.927**	1.000	0.914**	0.915**
	P	<0.001	.	<0.001	<0.001
UL	Rho	0.890**	0.914**	1.000	0.898**
	P	<0.001	<0.001	.	<0.001
TL	Rho	0.917**	0.915**	0.898**	1.000
	P	<0.001	<0.001	<0.001	.

** statistically significant difference

DISCUSSION

The main goal of prenatal care is to reduce fetal and maternal morbidity and mortality. The way to reduce the risk of complications is to identify the issues at an early stage and plan prenatal and perinatal management accordingly. The accuracy of TFA measurement by ultrasonography is very important in this respect (3). Despite the known probability of errors in such methods, clinicians make decisions according to the measured results of TFA obtained with the help of USG.

The use of ultrasound in obstetrics began in 1962 with James Willocs's BPD measurement. In 1971, Campbell published the BPD nomograms (4). Since then, scientists have been studying every possible way to measure fetus-related structures that can be measured and publishing related nomograms. In time, advances in ultrasound devices and methods became an indispensable part of antenatal examinations which enabled more accurate measurements. This, in turn, provided a reduction in the margin of error in the calculation of TFA (5).

BPD, HC, AC, and FL are the most commonly measured parameters. Nomograms of other structures of the fetus have also been generated. These include bone structures such as humerus, tibia, ulna, sacrum, maxilla, and mandible along with other structures like cerebellum, cerebral ventricles, heart, kidneys, bladder, liver, feet, ears, etc. (6, 7). Among the long bones and due to its size and ease of measuring, FL is the most frequently used parameter. However, in cases with congenital anomalies such as femur absence and lower extremity agenesis, FL cannot be measured. Besides, even if it is measured, in patients with isolated femoral shortening for example, the measurements may mislead TFA calculation. Therefore there is need for alternative formulas that can be used instead. In occiput posterior position, which hinders BPD measurements, binocular distance is used. In infants with intrauterine growth retardation (IUGR), transcerebellar diameter measurement is preferred since it gives the actual age without being affected by the reasons causing IUGR (8).

In a study conducted in China, Qiu et al. (9) have found the AC and HL measurements to be more sensitive than the FL measurement. In another study carried out in Nigeria, Odita et al. (10) have found a strong linear relationship between the FL-TL and birth weight-gestational age pairs. It is true that genetic variations and geographic factors are effective on the fetus measures.Therefore it is quite natural to come across different biometric measurements in different societies.

Macrosomic fetuses are faced with a number of risks during labour or after delivery. Macrosomic fetuses cause elongation of the 1st and 2nd stages of birth, interventions in vaginal birth, emergency cesarean delivery, vaginal and perineal laceration, sphincter tears, and postpartum hemorrhage. More to the point, cephalopelvic disproportion is more common in macrosomic fetuses. Among the other fetal risks that may occur during birth, we may count shoulder dystocia, brachial plexus injury, bone injury, and the large number of patients being referred to neonatal intensive care units during the process (11). In the light of this information, it would be safe to state that the best way to decide the appropriate delivery mode in order to reduce perinatal morbidity is to make accurate estimates of fetal weight. Isolated femoral shortening of the baby may result in a higher margin of error in the calculation of TFA and this increases the risk of birth traumas. So, in order to make the correct prediction in isolated femoral shortening cases, other parameters could be preferred.

Throughout our study, we investigated the effects of other long bones on TFA. In our linear regression analysis, we observed that TL measurements are at least as effective as BPD, FL, and AC measurement. In the correlation analysis of long bones, we noticed a high

correlated. This makes us think that measuring other long bones instead of FL can actually be used in isolated femoral shortening cases.

Other possibilities where different parameters other than FL can be used in TFA calculation are baby's unsuitable position, maternal morbid obesity, and some other cases in which FL may not be observed well such as previous abdomen surgeries and all these conditions can mislead practitioners in weight estimations.

Accurate estimation of gestational age is very important in the assessment of fetal development, birth timing, and the management of preterm and postterm pregnancies. It is also important in the planning of invasive procedures such as chorionic villus sampling and genetic amniocentesis as well as in the interpretation of prenatal biochemical tests. Ideally gestational age should be confirmed by ultrasound in early pregnancy but there are many patients who do not know when their last menstrual period took place. Sometimes patients know about their last menstrual period but they may have irregular menstrual cycles while some other patients present for control only in the 2nd or even 3rd trimesters of pregnancies. Among routinely used parameters, FL was found to be successful in predicting fetal age in early second trimester. Jeanty et al. (12) state that FL measurements in second and third trimesters of pregnancy have a variability of 2,1 weeks while Hill et al. (13) claim that FL is the most reliable of all the individual parameters in the estimation of menstrual age. In cases when FL can not be observed well or cases with isolated femoral shortening and agenesis, practitioners may benefit from other long bones.

The risk of aneuploidy increase in patients with short femur. To confirm the diagnosis of isolated femoral shortening by using other long bones may prevent the increased risk of fetal aneuploidy resulting from the short femur.

CONCLUSION

The accurate estimation of fetal weight can help in predicting macrosomic fetuses, determining the mode of delivery, and reducing perinatal morbidity and mortality. In cases when FL, one of the most important parameters in TFA measurement, cannot be measured, TL and UL measurements may be considered as alternatives. Finally, it should be stated that there is need for multicenter studies carried out with more patients to be able to develop different ideas on the matter.

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