

## Role of Sonographic Measurement of Fetal Foot Length in Estimating Gestational Age: A Hospital Based Study in South Punjab

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### ABSTRACT

**Objective:** To highlight the importance of ultra-sonographic measurement of fetal foot length in determining fetal gestational age.

**Study Design:** Prospective comparative study.

**Place and Duration of Study:** Radiology Department Combined Military Hospital Bahawalpur from Jul to Dec 2020.

**Methodology:** Women referred from our obstetrics outpatient department for an antenatal ultrasound between 16 to 40 weeks were scrutinized through inclusion and exclusion criteria for selection in the study.

Record of their age, parity, gestational age by last menstrual period and sonographic measurement of fetal foot length were endorsed in a study proforma.

**Results:** A total of 153 patients were included in the study. The mean age of patients in our study was 28.64 years (mean  $\pm$  SD) (6.05), and the second parity was most frequent being 64 (41.8%). Pearson correlation coefficient (r) was 0.988 ( $p < 0.001$ ), which showed a powerful linear correlation between our two variables.

**Conclusion:** The results of our study show an excellent linear correlation between fetal foot length and gestational age by last menstrual period. Therefore, the fetal foot length measured by ultrasonography can be used confidently to determine gestational age.

**Keywords:** Fetal foot length, Gestational age, Ultra-sonographic age estimation.

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### INTRODUCTION

Appropriate pregnancy monitoring is always an extreme concern for patients and obstetricians. Good monitoring of pregnancy requires an accurate assessment of gestational age. Knowing the accurate gestational age is important for obstetricians to make timely obstetric decisions, interpret biochemical screening tests and counsel patients about the risk of fetal outcome in case of premature birth or termination of pregnancy.<sup>1</sup> Routinely, gestational age measurement is done by a variety of methods in the second and third trimesters like biparietal diameter (BPD), femur length (FL), head circumference (HC) and abdominal circumference (AC). However, sometimes all these measurement methods become unreliable due to other reasons like the variable head size in dolichocephaly or microcephaly, hydrocephalus, anencephaly, variable liver size and thickness of subcutaneous abdominal fat,

deeply engaged fetal head in late pregnancy and case of short limb skeletal dysplasias etc. In these circumstances, the need for some other reliable sonographic method is felt to determine the accurate gestational age of the pregnancy. This requirement can be full filled by sonographic measurement of fetal foot length.

The relationship between fetal foot growth pattern and advancing gestational age was first described by Streeter.<sup>1</sup> Cambell and colleagues also highlighted that the fetal foot length and fetal femur/foot length ratio are reliable indicators of assessing limb dysplasias and gestational age.<sup>2</sup> Unfortunately, there is no study available in our country to highlight the reliability of sonographic fetal foot length measurement in assessing gestational age, which gave us the initiative to do this prospective study in our geographic conditions.

The study aimed to highlight the fact that there is a constant linear relationship between fetal foot length and gestational age, which can serve as an important tool to assess the gestational age in routine or circum-

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tances when other traditional methods become unreliable, as mentioned above.

## METHODOLOGY

This prospective comparative study was carried out at the Radiology Department of Combined Military Hospital Bahawalpur Pakistan, a 400 bedded hospital in a southern district of Punjab. The duration of the study was from June to December 2020. The equipment used was a Cannon Color Doppler ultrasound machine, model 100G, with the curvilinear probe. The hospital ethical committee approved the study (Serial no. EC-21-2020). Raosoft sample size calculator was used for sample size calculation. We took the proportion of several antenatal OPD from our daily hospital OPD as a population proportion (16.9% in our case) with a 5% margin of error and 95% confidence level. Our sample size so calculated was 153. The sampling technique was non-probability consecutive sampling.

**Inclusion Criteria:** Patients included in the study were healthy women referred from Obstetrics OPD for antenatal ultrasound who were sure of their LMP, with no previous history of irregular menstruation and had uncomplicated pregnancies between 16 to 40 weeks.

**Exclusion Criteria:** Women unsure of their dates or having polyhydramnios/oligohydramnios or diabetes, multiple gestations, pregnancy-induced hypertension or preeclampsia, or any congenital fetal abnormality were excluded from the study.

Patients with obstetric OPD referred for ultrasound examination in the second and third trimesters (between 16 to 40 weeks) were scrutinized through the inclusion and exclusion criteria. Informed consent was taken from all included patients in the study before their ultrasound examination. In addition, the patients' age, date of last menstrual period and the number of their parity were noted. In addition to routine sonographic obstetrical evaluation and standard biometry, the fetal foot length in mm was specially measured. All related data was endorsed on proforma specially made for this study.

The fetal foot length was measured from skin posterior to calcaneum up to the tip of the longest toe (first or the second toe, whatever the case was) either in the planter or sagittal axis (whichever is easily visualizable and appears more correct). If fetal foot length was not visualized accurately, the patient was either re-examined after some time or on the next feasible appointment. Two consultant radiologists independen-

tly measured fetal foot length on ultrasound of selected patients to exclude bias factors.

The data of patient age, parity, and gestational age by LMP in weeks and sonographically measured fetal foot length in mm from all proformas. Statistical Package for Social Sciences (SPSS) version 20.0 was used for the data analysis. Gestational age by LMP was taken as an independent variable, whereas measured fetal foot length was the dependent variable for correlation. The *p*-value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

A total of 153 patients were included in the study. The age of the patients in our study ranged from 17 to 40 years, with a mean age of  $28.64 \pm 6.05$  years. The second parity was most frequent, 64 patients (41.8%), and the fifth parity was least common, which was 02 patients (1.3%). Most of our study patients were around 24 weeks of gestation (16 patients, 10.8%). The scatter dot graph (Figure-1) showed values close to the linear trend line highlighting a powerful correlation between gestational age by LMP and sonographically measured fetal foot length, with the Pearson correlation coefficient (*r*-value) being 0.988 with a *p*-value  $< 0.001$ .

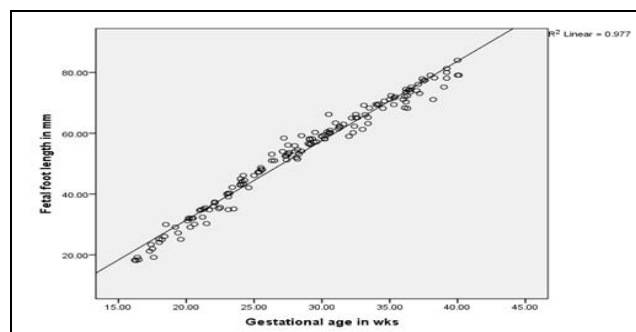


Figure-1: Scatter dot chart between gestational age and fetal foot length.

## DISCUSSION

Good regular monitoring of pregnancy for better fetal outcomes is the main focus of good obstetrics services globally. Estimation of correct gestational age is the cornerstone of fetal growth assessment and on which the time of delivery is decided. Unfortunately, clinical assessment of gestational age based on LMP and fundal height is unreliable.<sup>3</sup>

Nowadays, estimation of gestational age is more dependent on sonographic measurements of the fetus. Routine sonographic parameters like BPD, HC, AC and FL are used in the routine assessment of gesta-

tional age in the second and third trimesters. Almost all parameters show a linear increase with advancing gestational age. However, sometimes these parameters become unreliable in certain conditions, e.g., fetal hydrocephalus, microcephaly, fetal hydrops, and skeletal dysplasias. Moreover, all these routine sonographic predictors for fetal age show less reliability as pregnancy advances in the third trimester.<sup>4</sup> Therefore, as mentioned earlier, there was a need for some other sonographic parameters least affected by the conditions. Researchers have considered fetal foot length as a new reliable parameter for assessing gestational age. Fetal foot length shows a constant linear growth pattern with gestational age, making it a reliable tool for assessing gestational age assessment.<sup>5</sup>

Fetal foot length is an easy, quick and reliable method for estimating gestational age. It can be measured in either sagittal or planter view of the foot in the longest possible axis from skin posterior to calcaneum to the tip of the longest toe, the usual first or second toe. Nowadays, there is a software program/normograms chart in new ultrasound machines for converting foot length in mm to corresponding gestational age in weeks (Figure-2 & 3).

incentive for this study to see results on this topic in our local population, particularly in our south Punjab.

Our study found a constant linear relationship between fetal foot length and gestational age ( $R^2=0.9777, p<0.001$ ). There is a constant growth rate of the fetal foot with the progression of gestational age. Moreover, it is not affected by most of the fetal pathologies, which usually affect other sonographic parameters. As side information in our study, we also found that fetal foot length corresponds well with other fetal gestational parameters (like BPD, FL, HC, AC) in normal pregnancy (Figure-4).



Figure-4: Fetal foot measurement in 36 weeks fetus versus other sonographic parameters.

The only difficulty we encountered in our study was not getting a good view for measuring fetal foot length due to fetal position. Therefore, we re-examined such patients again after some time on the same day or requested her to come on some other day if possible. If we could measure fetal length on the next appointment, we kept the patient in our study. Otherwise, the patient was excluded from the study.

Say that fetal foot length is a reliable predictor of fetal gestational age in our population, per previous studies, e.g. the research study of Mhaskar *et al.*<sup>6</sup> However, we found few studies on this topic in our region. One Nepalese study by Joshi and colleagues showed linear constant relation between sonographic foot length and gestational age ( $R=0.97$  and  $p<0.001$ ) and also a linear relationship between foot and femoral length ( $R=0.98$  and  $p<0.001$ ).<sup>7</sup> A study by Shah and colleagues also highlighted the same good linear relationship between sonographic fetal foot length and gestational age by LMP with correlation coefficient  $R=0.92$  ( $p<0.001$ ).<sup>8</sup> A study by Mital and colleagues compared sonographic fetal foot length and gestational age by LMP and footed femoral length ratio with excellent correlation coefficients ( $R=0.92$  and  $R=0.96$  respectively with  $p<0.001$ ).<sup>9</sup> Sharma and colleagues



Figure-2: Fetal foot measurement in 20 weeks fetus.



Figure-3: Fetal foot measurement in 17 weeks fetus.

This is a useful, reliable method for estimating gestational age, but unfortunately, we did not find any study in our country on this topic. Therefore, this is the

researched 100 formalin-fixed fetuses to correlate fetal foot length and gestational age by crown-rump length (CRL). Although this study was not by sonography, results showed a strong correlation between fetal foot length and gestational age by CRL, having an R-value of 0.986 with  $p < 0.001$ .<sup>10</sup> The R-value of this study was the same as that of our study.

We found a study of JPMC Karachi highlighting the postnatal measurement of foot length and its correlation with gestational age just after the baby's birth. However, this study was also not based on antenatal sonography, but still, the results show a good correlation between two variables with a correlation coefficient  $R = 0.817$  ( $p < 0.001$ )<sup>11</sup>. Similar research was done by Dr Narendra and colleagues on newborns within 48 hours of birth to see the correlation between foot length and gestational age. However their results are not very encouraging with  $r$ -value = 0.523,  $p < 0.000$ .<sup>12</sup>

Wong highlighted in a research the correlation between fetal foot length and gestational age in early pregnancy between 10-16 weeks.<sup>13</sup> The correlation coefficient of this study is  $R = 0.816$  which is less than our study probably. The sample size of Wong's study was small (47 patients), and the study was limited between 10-16 weeks. Singh and colleagues did a review study to find the most appropriate method to assess gestational age. They concluded that sonographic measurement of long fetal bones and fetal foot length is one of the sound parameters in estimating gestational age when LMP is not known.<sup>14</sup> A research on ultrasound of 300 patients by Hemraj and colleagues showed a strong linear correlation between fetal foot length and gestational age with an  $R^2$  value = 0.995,  $p < 0.0001$ . This result was even better than our study.<sup>15</sup>

Ebraheem and colleagues studied 100 pregnant women to correlate fetal foot length and femoral length on sonography with fetal gestational age and estimated fetal weight. They concluded that there is a strong correlation between fetal foot length, femoral length with gestational age and estimated fetal weight with  $R^2$  values of 0.87 and 0.92, respectively.<sup>16</sup> Dagnew and colleagues researched 205 newborns to see the correlation between foot length and gestational age. They found good correlation with  $r = 0.865$ ,  $p < 0.0005$ . This study was not antenatal sonography but still shows a good correlation.<sup>17</sup> Malik and colleagues did a study at Hail University Kingdom of Saudi Arabia to see the correlation of fetal foot length with gestational age. Their correlation coefficient was 0.828 with  $p <$

0.001.<sup>18</sup> The results of all these studies agree with our study's results and highlight the undebatable role of fetal foot length measurement in determining gestational age.

## CONCLUSION

Fetal foot length measurement is not part of our routine sonographic biometry in our country. The other routine sonographic parameters used in estimating fetal gestational age sometimes become unreliable in giving exact age due to one reason. The fetal foot length measurement can be used in these circumstances for determining fetal age. Moreover, fetal foot length measurement by sonography is an easy, reliable and quick method, so it should be part of routine practice with other parameters for gestational age determination.

**Conflict of Interest:** None.

## Author's Contribution

SFN: Main author, THB:, AAK:, MUA:, MJM:, MIA: Data analysis and proof reading.

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