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Original Research Article

Foetal Foot Length Assessment and its Sonographic Correlation with Gestational Age

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Conflict of interest: Nil

Abstract:

Objectives: The present study was to assess the relationship between gestational age and foetal foot length and to derive a nomogram correlating gestational age(in weeks) with foetal foot length(in mm).

Methods: Ultrasound examinations were performed when the pregnant women were scanned in the supine position. FFL was measured from the skin edge overlying the calcaneus to the skin overlying the distal end of the longest toe (the first or second toe) on either the plantar/coronal or the sagittal view. In each foetus, the measurements of the two feet were averaged and a single value obtained for the purpose of statistical analysis.

Results: 3.67% of our pregnant women were of < 20 years, 70.33 % of our pregnant women were between 20 to 30 years, 25.67% % of our pregnant women were between 31 to 39years, 0.33% of our pregnant women were of >39 years. Strong significant linear statistical correlation was found between FFL and other parameters like HC, BPD, AC, FL with a p value of <0.001 and r values of 0.942, 0.959, 0.953 and 0.951 respectively.

Conclusions: A statistically significant relationship was seen between GA and FFL." and a strong significant linear statistical correlation was found between FFL and other reliable parameters like HC, BPD, AC, FL. Hence, FFL is an additional USG parameter along with other reliable parameters (HC, BPD, AC, FL) useful for the estimation of GA in 2nd and 3rd trimesters of pregnancy when other commonly utilized USG parameters are unreliable to predict GA like brachycephaly, dolichocephaly, achondroplasia etc."Foot length is more accurate in ascertaining period of gestation in 2nd trimester when compared to 3rd trimester.

Keywords: Gestational Age, Foetal Foot Length, Sonography.

Introduction

Appropriate pregnancy monitoring is always an extreme concern for patients and obstetricians. Good monitoring of pregnancy requires an accurate assessment of gestational age (GA) [1]. Accurate knowledge of GA may assist in appropriately counselling women who are at risk of a preterm delivery, about their neonatal outcomes and is also essential in the evaluation of foetal growth and planning interventions to prevent preterm births and related morbidities [2]. Accurate pregnancy dating is also important in the interpretation of biochemical serum screening test or for counselling patients regarding the option of pregnancy termination [1,2,3].

Several studies show association of foetal growth abnormalities with multiple short and long term complications. For example, pathologic Foetal growth restriction (FGR) (i.e., with suboptimal delivery of oxygen and nutrients to the foetus, resulting in less than expected growth) may cause cardiovascular remodelling and other developmental adaptations that protect the foetus in utero but also increases the risk of neonatal morbidity and long-term health consequences [4,5].

FGR is associated with stillbirth, prolonged neonatal hospitalization, feeding and respiratory difficulties, abnormal brain development, long term cardiovascular disease, developmental delay, and early mortality [6].

On the other hand, foetal macrosomia may lead to maladaptive endocrinology and cardiovascular responses. Large foetuses, especially those of diabetic mothers, have different body proportions, fat deposition, and metabolic profiles, resulting in increased risks of shoulder dystocia and neonatal hypoglycaemia [5,6].

In the long term, macrosomia or large-for-GA birth weight may confer increased risks of childhood obesity, insulin resistance, or overt diabetes, all of which contribute to poorer health [5,7].

Undetected foetal growth abnormalities may be associated with significant morbidity and mortality, so recognition of these problems to the earliest is of important. Without correct gestational dating, foetal growth complications are challenging to detect [8].

Clinical data such as menstrual cycle, uterine size are the initial parameters for GA estimation, but these parameters are not reliable for accurate GA estimation, errors in menstrual GA estimation have profound implications like unnecessary induction, dysfunctional labour and caesarean section and resultant neonatal and maternal morbidity. So accurate assessment of GA and evaluation of foetal growth is of paramount importance [9,10].

USG has emerged as a simple modality to assess the GA of foetuses because of its painless, non-invasive, non-ionizing, safe, portable, ease of access and relatively inexpensive nature [9,10,11]. Many pregnant women would not have these early ultrasound examinations in developing countries and majority of the time they report late in gestation. Thus, sonographic determination of GA is becoming increasingly important.

Multiple foetal anatomical measurements have been used in ultrasound for evaluation of gestation age. Ultrasound becomes one of the important tools for foetal growth evaluation during pregnancy. At present the most commonly used biometric parameters are HC (Head circumference), BPD (Biparietal diameter), FL (Femoral length) and AC (Abdominal circumference). No single foetal biometric parameter is known to be accurate in gestational age estimation. Inaccuracy can be reduced by addition of more anatomical parameters [12].

BPD measurements would overestimate or underestimate gestational age if the head is in unusual shape like, rounded (as in brachycephalic) or extremely elongated (as in dolichocephalic). AC measurements would overestimate or underestimate gestational age if there are differences in liver sizes and subcutaneous tissue width in macrocosmic and growth delayed foetuses [12]. FL measurements would overestimate or underestimate gestational age in conditions like Achondroplasia of the femur. In these circumstances, the need for some other reliable ultra-sonographic method is felt to determine the accurate gestational age of the pregnancy [12].

Foetal foot length (FFL) has a characteristic pattern of normal growth and is a reliable parameter for determining gestational age, especially when other parameters fail to accurately estimate foetal gestational age [12,13,14].

The objective of our present study was to focus on the fact that there is a constant linear relationship between FFL and GA, which can serve as an important tool for GA assessment when other traditional methods become unreliable, as mentioned above.

Material & Methods

Source of Data: Pregnant women undergoing antenatal scan with GA between 15-40 weeks and satisfying the inclusion criteria will be included in the study.

Equipment: Will be carried out in GE Voluson S10 using 2-5 MHz curvilinear probe.

Type of Study: Cross sectional study.

Duration of Study: 2 Years.

Sample Size: All the consecutive cases satisfying the inclusion and exclusion criteria during the study period will be included in the study.

Inclusion Criteria:

• Pregnant women with singleton pregnancies who will undergo antenatal scanning at GA between 15 to 40 weeks and are certain of their last menstrual period date.

• Pregnant women who have undergone a first trimester dating scan will be included in the study.

Exclusion Criteria:

• Patients with known complications of pregnancy like oligohydramnios, polyhydramnios, diabetes, hypertension, pre-eclampsia and multiple gestations, congenital anomalies were excluded from the study.

Methodology

Ultrasound examinations were performed when the pregnant women were scanned in the supine position. FFL was measured from the skin edge overlying the calcaneus to the skin overlying the distal end of the longest toe (the first or second toe) on either the plantar/coronal or the sagittal view. In each foetus, the measurements of the two feet were averaged and a single value obtained for the purpose of statistical analysis [24].

Statistical Analysis

Three Hundred Pregnant women undergoing antenatal scan with GA between 15-40 weeks and satisfying the inclusion criteria were selected for this study using convenience sampling method.

The data collected were tabulated in the Microsoft excel sheet. The normality of the data distribution was assessed for each and every parameter prior to any analysis. All the data were tabulated, compared and analyzed using software IBM SPSS Version 25. The categorical data were presented as number (percentage). The continuous data were expressed as either mean ± standard deviation. Appropriate statistical tests were applied for the assessment of the relationship between gestational age and foetal foot length and to derive a nomogram correlating gestational age in weeks with foetal foot length.

Observations & Results

The present study shown that 3.67% of our pregnant women were of < 20 years, 70.33 % of our pregnant women were between 20 to 30 years, 25.67% % of our pregnant women were between 31 to 39 years, 0.33% of our pregnant women were of >39 years.

Table.1: Gestational age distribution of pregnant women studied

Gestational age in (weeks)	No. of patients	%
Up to 18	35	12
18 to 22	95	31.6
22 to 26	23	7.6
26 to 32	59	19.66
32 to 36	71	23.66
36 to 40	17	5.48
Total	300	100%

12 % of our pregnant women were up to 18 weeks, 31.6 % of our pregnant women were between 18 to 22 weeks; followed by 7.6 % of our pregnant women were between 22 to 26, 19.66 % between 26 to 32 weeks, 23.66% of our pregnant women were between up to 32 to 36weeks of gestation, 5.48% of our pregnant women were between 36 to 40 weeks of gestation.

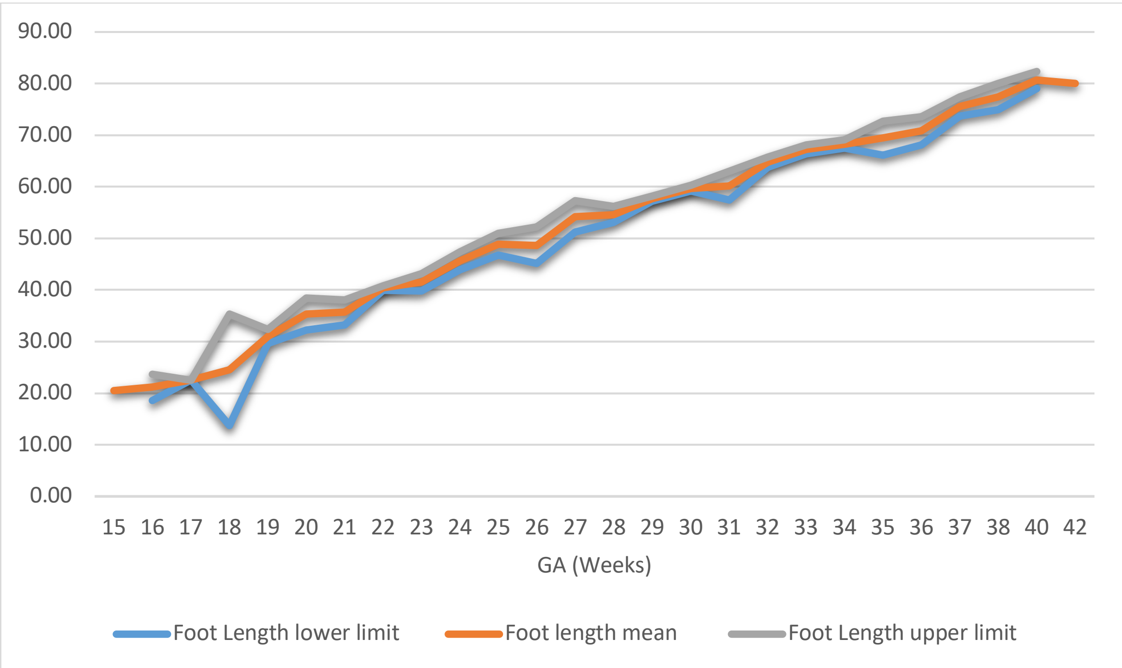

Figure1: Line diagram representing correlation between FFL and GA

Table 2: Correlation of CUA with other parameters (FFL, HC, BPD, AC, FL).

	r value	P value
Cumulative GA vs FFL	0.949	<0.001
Cumulative GA vs HC	0.942	<0.001
Cumulative GA vs BPD	0.946	<0.001
Cumulative GA vs AC	0.946	<0.001
Cumulative GA vs FL	0.953	<0.001

Strong significant linear statistical correlation was found between GA and FFL with a p value of <0.001 and r value of 0.949 %.

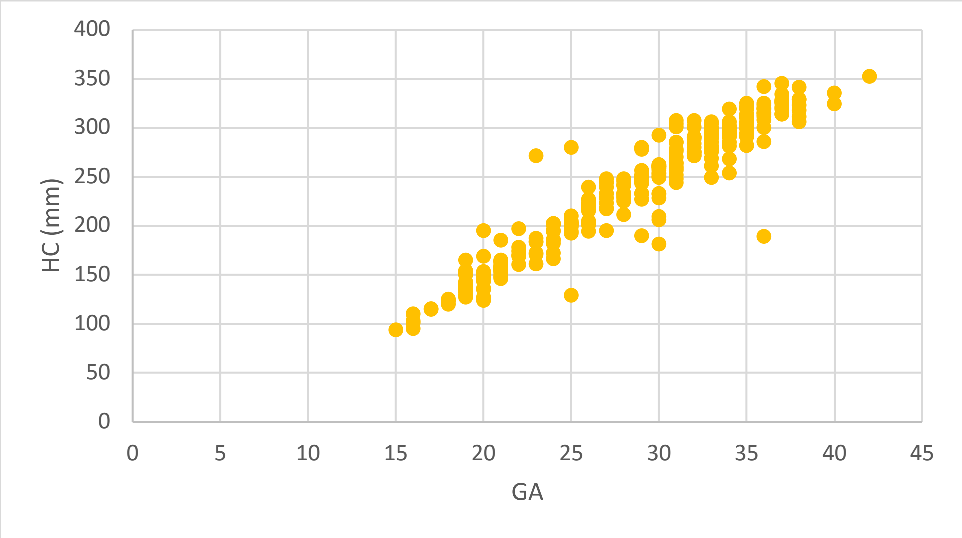

Figure 2: Line diagram representing correlation between HC and GA

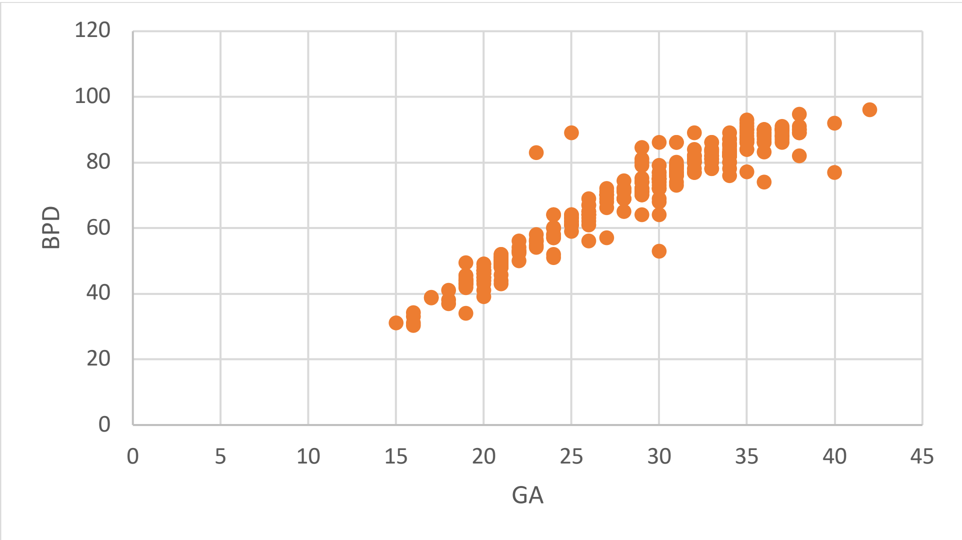

Figure 3: Line diagram representing correlation between BPD and GA

This scatter diagram shows that, BPD in millimetres taken along Y axis and GA taken along X axis showed a significant correlation of 0.946 with a significant p value of <0.001.

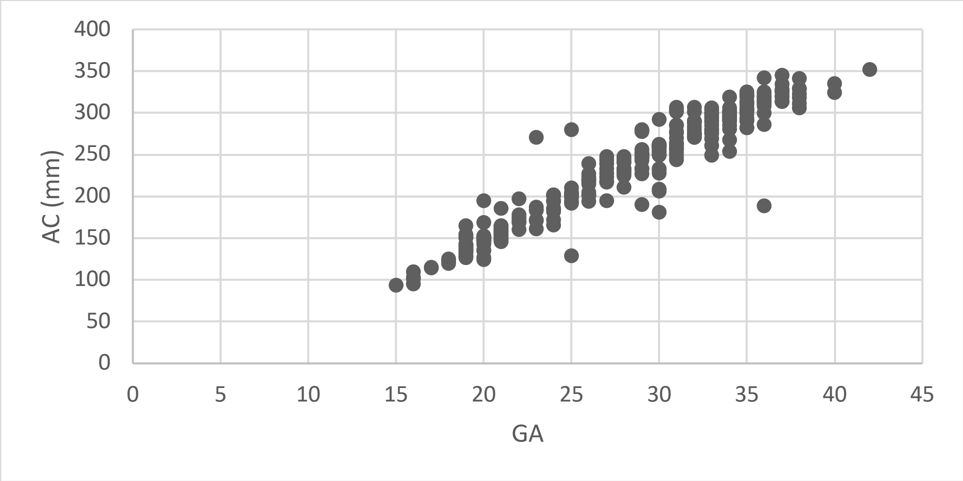

Figure 4: Line diagram representing correlation between AC and GA.

This scatter diagram shows that, AC in millimetres taken along Y axis and GA taken along X axis showed a significant correlation of 0.946 with a significant p value of <0.001.

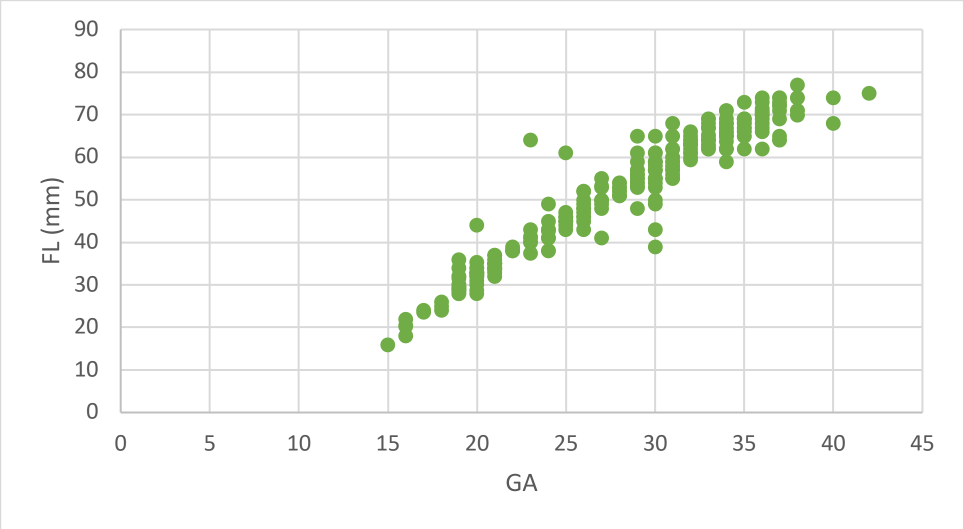

Figure5: Line diagram representing correlation between FL and GA

This scatter diagram shows that, FL in millimetres taken along Y axis and GA taken along X axis showed a significant correlation of 0.953 with a significant p value of <0.001.

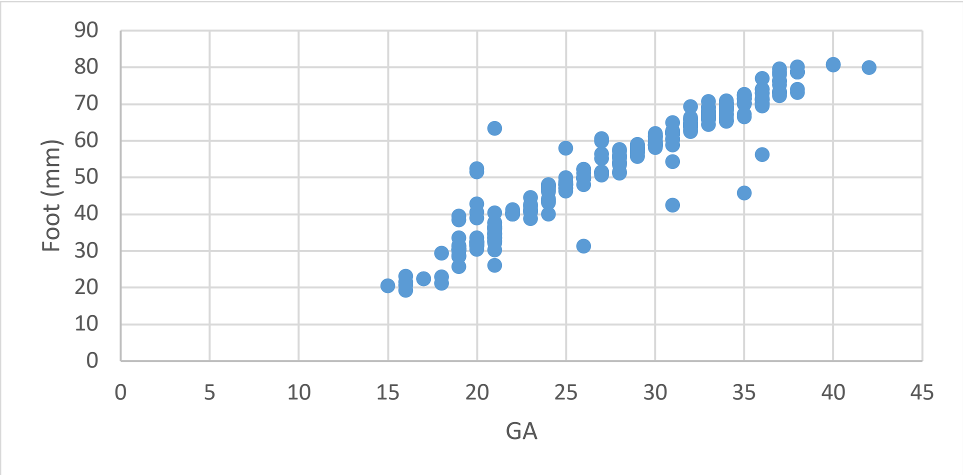

Fig.6: Line diagram representing correlation between FFL and GA

This scatter diagram shows that, HC in millimetres taken along Y axis and GA taken along X axis showed a significant correlation of 0.949 with a significant p value of <0.001.

Table.3: Correlation of CUA with FFL in 2nd and 3rd trimesters

	r value	P value
Cumulative GA vs FFL(2nd trimester)	0.885	<0.001
Cumulative GA vs FFL(3rd trimester)	0.749	<0.001

Strong significant linear statistical correlation was found between GA and FFL with a p value of <0.001 and r value of 0.885 % in 2nd trimester as compared to the 3rd trimester with a p value of <0.001 and r value of 0.749 %.

Table.4: Correlation of FFL with the routine USG parameters like HC, BPD, AC and. FL

		FFL (mm)
HC	Correlation	0.942
	P value	<0.001
BPD	Correlation	0.959
	P value	<0.001
AC	Correlation	0.953
	P value	<0.001
FL	Correlation	0.951
	P value	<0.001

Strong significant linear statistical correlation was found between FFL and other parameters like HC, BPD, AC,FL with a p value of <0.001 and r values of 0.942, 0.959, 0.953 and 0.951 respectively.

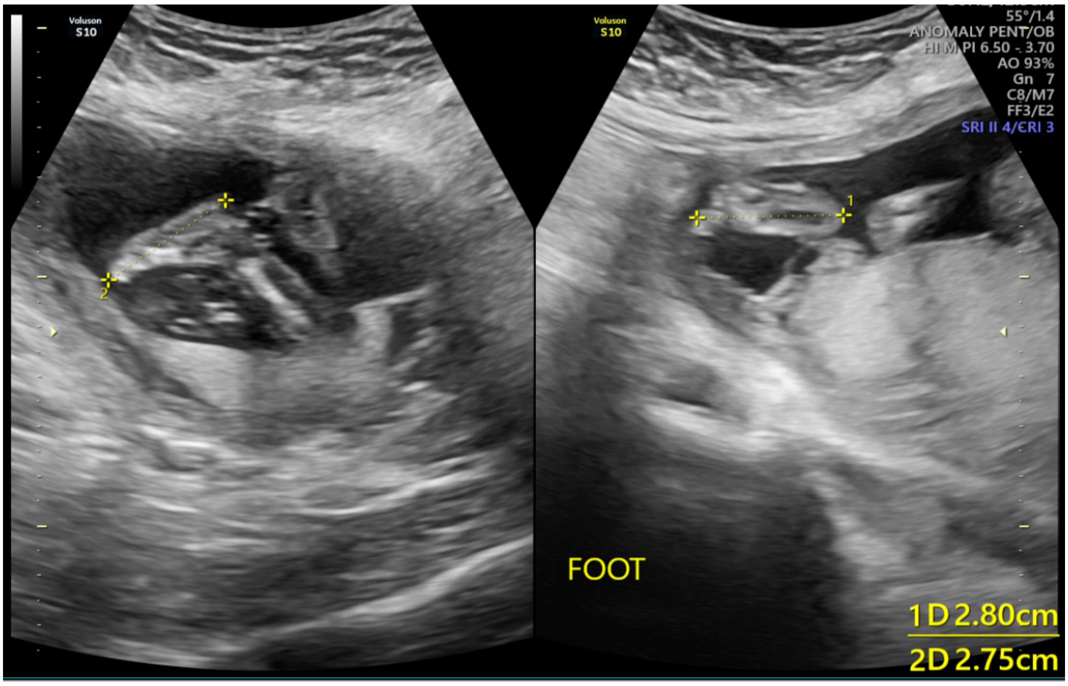

Figure 7: Shows Foetal foot measurement in sagittal and plantar view's in an 18 week old foetus

Discussions

From analysis of our study data with a sample size [n=300], FFL is reliable parameter in estimating the GA. FFL correlates with the other routine USG parameters like HC, BPD, AC and FL."

The correlation coefficient [r] of measured FFL with HC, BPD, FL, AC are 0.942, 0.959, 0.953, 0.951 respectively. Correlation of FFL with routine USG parameters are statistically significant with a p value of <0.001 in all of the above correlations."

"In our study FFL showed good correlation with GA with correlation coefficient 0.949 with p<0.001.

"In our study FFL shows better correlation with GA in 2nd trimester with a correlation coefficient [r] 0.885 and p value of <0.001 than in the 3rd trimester with correlation coefficient [r] 0.749 and p value of <0.001"

"Goldstein I et al. [15] found a significant correlation between FFL and GA (r = 0.9, p<0.0001) and between FFL and FL (r = 0.9, p <0.0001)."

"Pandey et al (2015) [16] found a significant correlation between FFL and GA with correlation coefficient [r] 0.960 and p<0.0001 and between FFL and FL (r=0.948, p<0.0001)."

"In our study correlation coefficient [r] between FFL and GA (r=0.949, p<0.001) and between FFL and FL (r= 0.951, p<0.001) was found to be similar."

Table-6 shows the comparison between the values of FFL of our study with previous studies done by Molly S et al. [17] Andrzej M et al. [18] Rajesh B et al. [19], Family Practice Notebook [20] and Mukta et al [21].

Our study suggests that the measurement of FFL with ultrasound gives a reliable GA estimation and FFL is highly correlated to the GA of the foetus.

"R. Mhaskar et al. [22] in 1989 demonstrated a strong correlation on comparison of linear regression of FFL versus GA with an r value of 0.84 (P < 0.001) which is comparatively much lesser than the present study showing r value of 0.949 (p<0.001)

Molly S. Chatterjee et al. [17] in 1994 similarly showed significant linear relationship between FFL and GA (r= 0.89, p<<0.0001)."

"Andrzej M et al. [23] in 2003 found value of the correlation between FFL and FL was 0.91 and between FL and GA was 0.94 which is close association with our study."

In conditions such as abnormal head shape (e.g. microcephaly, hydrocephalus & anencephaly), where BPD measurement is unreliable, FFL becomes a reliable alternate measuring parameter."

"In condition such as short limb dwarfism and other skeletal dysplasia's, where femur length is unreliable, FFL is a good predictor for GA along with other USG parameters."

Limitations

1. FFL can only be measured in a particular foetal position since foetus keeps moving always it takes time to take correct measurement.
2. However, accuracy of the study is limited due to smaller population, for better results the study is needed to be conducted in a larger population.

Conclusions

The present study concluded that the statistically significant relationship was seen between GA and FFL." And strong significant linear statistical correlation was found between FFL and other reliable parameters like HC, BPD, AC, FL. Hence, FFL is an additional USG parameter along with other reliable parameters (HC, BPD, AC, FL) useful for the estimation of GA in 2nd and 3rd trimesters of pregnancy when other commonly utilized USG parameters are unreliable to predict GA like brachycephaly, dolichocephaly, achondroplasia etc. Foot length is more accurate in ascertaining period of gestation in 2nd trimester when compared to 3rd trimester."

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