

Periodic Research

Measurements of foot as Determinants of Human Foetal Gestational Age



Mohd Arshad
Senior Resident,
Deptt. of Anatomy,
JNMC, AMU, Aligarh,



M. Salahuddin Ansari
Assistant Professor,
Deptt of Anatomy,
AIIMS, Rishikesh.

Farah Ghaus
Assistant Professor,
Deptt.of Anatomy,
JNMC, AMU, Aligarh,

S.M. Yunus
Professor & Chairman,
Deptt.of Anatomy,
JNMC, AMU, Aligarh,

Abstract

Determination of gestational age is important in civil and criminal cases. Though a reasonable assessment of gestational age can be made by measuring physical parameters such as crown-heel length, weight, morphological features organogenesis, development and ossification centres, an alternative parameter is desirable in some instances. This study was planned to establish a correlation between foetal foot parameters and gestational age. 30 formalin fixed human foetuses were obtained from Museum of Department of Anatomy, Jawaharlal Nehru Medical College, Aligarh. Foetuses were divided into five groups. (Group I :< 17wks), (Group II: 17-20wks), (Group III: 21-25wks), (Group IV: 26-30wks), (Group V : >30wks). Foot parameters i.e. length and breadth of foot, lengths of great toe and 2nd, 3rd, 4th, 5th toes, were measured using Vernier Callipers. It is concluded that except the length of great toe rest of parameters are reliably correlated with gestational age and thus can be used for determination of the same. This may serve as an important parameter in the medicolegal cases in which only foot or part of it is available for estimation of gestational age.

Keywords: Foetus, Foetal Foot, Gestational Age, Foetal Great Toe, Foetal Toes

Introduction

Infanticide is clearly distinguished from murder in UK (Infanticide Act of England 1938), especially if the infant is killed by the mother herself. India does not recognize infanticide as a separate crime, by a separate provision for it in the I.P.C. Gov't of UK considers infanticide as unlawful killing of infant under the age of one year (1). Indian Gov't considers 'Infanticide' as a general term used for child murder. 'Filicide' refers to cases in which the murderer is the parent of the victim (2). The law appears to assume a physiological basis for diminished responsibility in this context (3). In Indian law both murder and infanticide are punishable u/s 302 I.P.C.(4). In India, even slight latitude is not extended to the mother, although she might be suffering from some puerperal mental agony after child birth(5). Many studies(6,7,8,9,10), have been done earlier on determination of sex and stature by hand and foot length dimensions. Accurate foetal ultrasound measurements are one of the most important factors for high quality obstetrics health care. Commonly used foetal ultrasound measurements include: bi-parietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) (11). Aforementioned ultrasonic measurements are also quite precise but the quality of the measurements are user-dependent. But if these are done directly on the foetus it holds more accuracy and reliability.

Our study presents a direct method of foetal measurements that targets the accurate and robust detection of seven parameters i.e. length and breadth of foot, lengths of great toe, 2nd toe, 3rd toe, 4th toe and 5th toe.

Our approach has an upper hand over conventional ultrasonography, due to two reasons. First, our system is able to provide an accurate measurements and relative growth of different fetal foot parameters which were difficult to be done by other techniques. Second, the approach was designed to be absolutely manual, so that user does not need to provide any initial guess or approximation as by ultrasound method. Our data will provide a reference point for other methods of fetal foot measurement.

Material and Methods

30 formalin fixed human foetuses were obtained from Museum of Department of Anatomy, Jawaharlal Nehru Medical College Aligarh. Institutional ethics committee has no objection on doing research work on these foetuses. Foetuses were divided into five groups (I to V) as shown in Table 1.

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Groups	Gestational age (weeks of intrauterine life)	Number of foetuses
I	< 17 weeks	06
II	17-20 weeks	06
III	21-25 weeks	06
IV	26-30 weeks	06
V	>30 weeks	06

Following measurements were taken from human foetuses with the help of Vernier Callipers to nearest of millimetre.

1. length of foot.
2. Breadth of foot.
3. length of great toe.
4. Length of 2nd toe.
5. Length of 3rd toe.
6. Length of 4th toe.
7. Length of 5th toe.

Statistical Analysis

Each reading is taken three times and the mean of the same was considered to avoid human error. All the values are expressed as Mean ± S.D. Statistical significance was calculated by one way ANOVA followed by post hoc Dunnett's multiple comparison test. p < 0.05 was considered to be statistically significant. Graphs were plotted by considering mean values of measurements of different parameters and gestational age on y and x axes respectively, and patterns were analysed.

Observation

The growth of length of foot in foetuses is steady growth throughout the gestation but it is maximum between III- IV groups. This indicates that determination of foetal age is possible from foot length but it is more authentic in groups III and IV (fig.1). In fig. 2 the breadth of foot also shows similar growth pattern. In fig. 3 the length of the great toe shows interesting pattern of growth. Growth is slowed down between groups II and III and last two ones, therefore gestational age will be significant only if it fall between groups I & II and III & IV. Length of 2nd, 3rd, 4th, 5th toes show constant and steady growth throughout the gestation (fig. 4, 5, 6 & 7 respectively). Therefore the lengths of lateral four toes are also relevant for determination of gestational age throughout foetal period.

Table 2. Length of Foot of Human Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	18.00 ± 3.16	-----	
II	27.00 ± 6.63	50	S
III	39.00 ± 4.47	44.44	S
IV	54.83 ± 5.34	40.57	S
V	65.833 ± 7.16	20.06	S

Table 3. Breadth of Foot of Human Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	7.8 ± 1.72	-----	
II	11.5 ± 1.64	47.43	NS
III	15.66 ± 1.96	36.17	S
IV	22.5 ± 3.08	43.67	S
V	26.00 ± 3.40	15.55	S

Table 4. Length of Great Toe of Human Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	4.46 ± 0.51	-----	
II	8.83 ± 0.75	97.98	S

III	11.66 ± 2.06	32.04	S
IV	17.16 ± 3.06	47.16	S
V	18.16 ± 3.12	5.82	S

Table 5. Length of 2nd Toe of Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	4.66 ± 0.71	-----	
II	8.16 ± 0.98	75.10	S
III	11.66 ± 10.83	42.89	S
IV	14.00 ± 2.19	20.06	S
V	16.33 ± 3.32	16.62	S

Table 6. Length of 3rd Toe of the Foetus

Group	Mean ± SD (mm)	Percent increase	P value < 0.05
I	4.5 ± 0.54	-----	
II	7.33 ± 0.81	62.88	S
III	9.50 ± 1.64	29.60	S
IV	13.00 ± 2.09	36.84	S
V	15.00 ± 2.82	15.38	S

Table 7. Length of the 4th Toe in Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	4.33 ± 0.51	-----	
II	7.00 ± 0.89	61.66	S
III	8.83 ± 1.32	26.14	S
IV	11.16 ± 1.47	26.38	S
V	13.50 ± 3.08	20.96	S

Table 8. Length of the 5th Toe in Foetus.

Group	Mean ± SD (mm)	Percent increase	p value <0.05
I	3.66 ± 0.51	-----	
II	6.16 ± 0.75	68.30	S
III	7.83 ± 1.47	27.11	S
IV	9.83 ± 0.98	25.54	S
V	11.66 ± 2.73	18.61	S

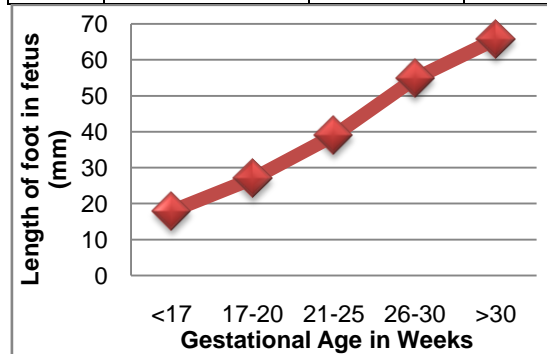


Fig.1- Length of Foot Versus Gestational Age Showing Steady Growth Throughout the Gestation But it is Maximum Between III- IV Groups

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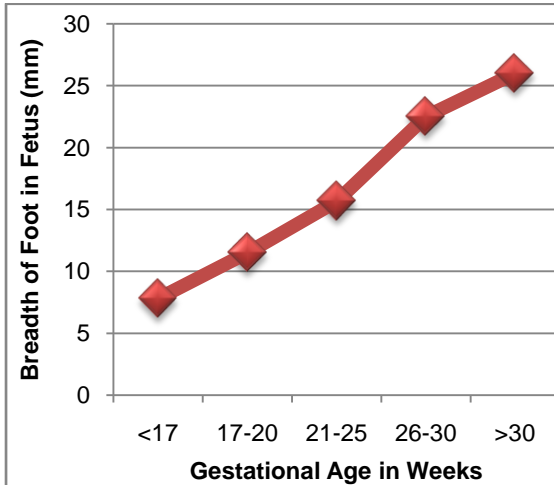


Fig.2- Breadth of Foot Versus Gestational Age Showing Steady Growth But It is Maximum B/W III-IV Groups.

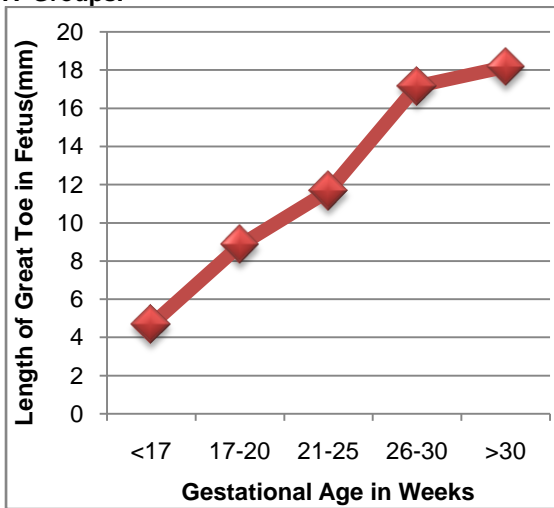


Fig. 3- Length of the Great Toe Versus Gestational Age Showing Variable Growth Throughout and It is Minimum in B/W IV-V Groups.

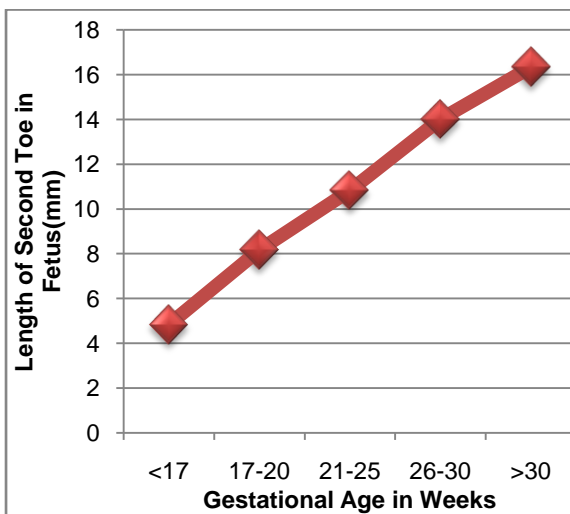


Fig. 4- Length of 2nd To Ersus Gestational Age Showing Constant Steady Growth Throughout the Gestation.

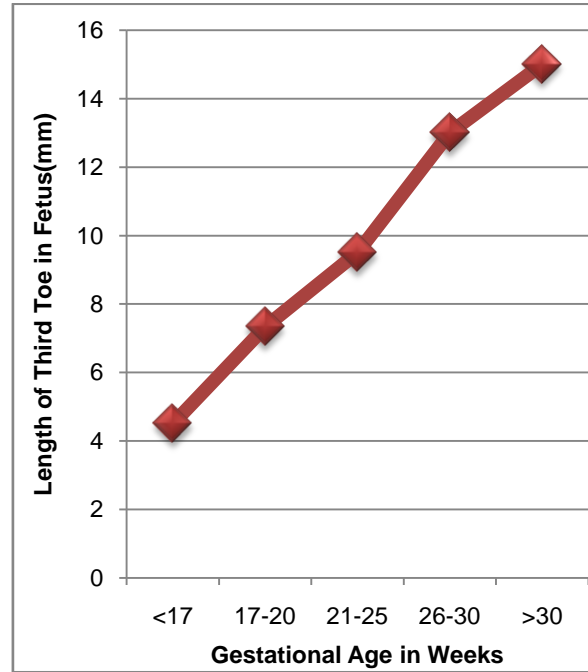


Fig. 5- Length of 3rd Toe is Versus Gestational Age Showing Steady Throughout the Whole Gestation.

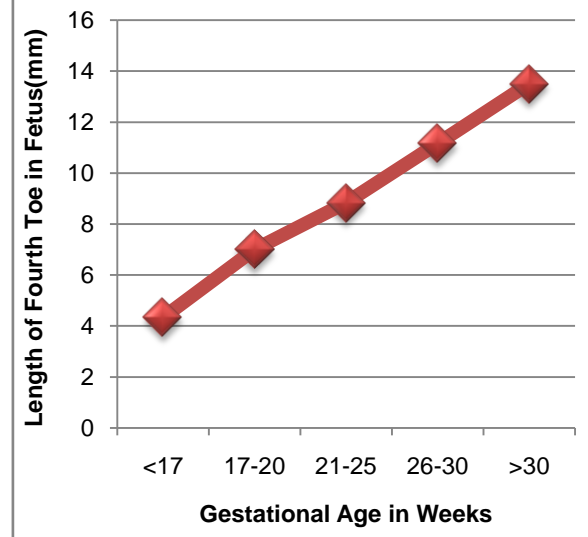


Fig. 6 -Length of 4th Toe Versus Gestational Age Showing A Constant Speed Growth Throughout the Gestation.

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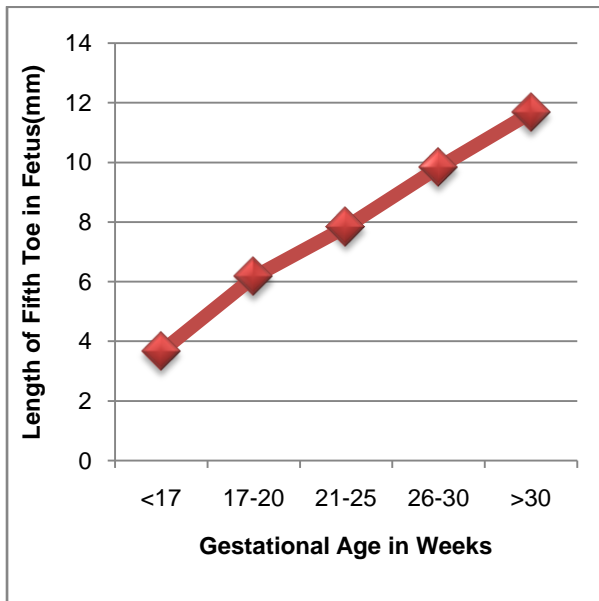


Fig.7-Length of 5th Toe Versus Gestational Age Showing Constant Increase in Growth in All Groups of Foetuses Throughout the Gestation.

Discussion

Most of the obstetricians depend on ultrasound for correct assessment of gestational age. Almost all foetal measurements change with gestational age (12). Accordingly several parameters are described in the literature to evaluate gestational age. But routinely we use MSD, CRL, BPD, HC, AC and FL. In normal situations, these parameters are adequate to reach the conclusion. However in cases of macrocephaly/hydrocephalus/ anencephaly, we obviously cannot use BPD and HC to assess GA. Similarly in short limb dwarfism, FL gives erroneous reading and so does AC in IUGR. Difficulty can arise even in normal term pregnancy when head is engaged and HC/ BPD cannot be correctly measured. Though rare events, aforementioned conditions can impose problems in calculating correct gestational age. Hence we have to look for other alternatives. In our experience, foetal foot length measurement is relatively simple technique and can be easily performed in normal day to day practice with good reliability. Shalev et al (13) tested the reliability of sonographic measurement of the foetal foot and found a good agreement in repeated measurements for and between the two planes. The present study demonstrated that there was a strong correlation between gestational age and fetal foot length and this parameter was not affected by gender, presence of maceration or gross congenital abnormality. In their Danish series of 30 infants with maceration, Maroun and Graem(14) found foot length to be a reliable predictor of gestational age. Our study is a non-invasive technique and does not need any special training to calculate gestational age. As the expenditure involved in this study is minimal it can be considered as an economical one and be used in rural areas by doctors with basic medical qualification. Another advantage of this study is that it is not lengthy and time consuming. This study can also be of help in cases where only fragmented remains of foetus are available, where other parameters like crown heel length, weight, etc. cannot be applied. In

most of the cases it is unlikely to have both feet destroyed .

Conclusion

Establishing precise duration of pregnancy is of paramount importance for a forensic pathologist. Except the length of great toes rest of parameters i.e. length and breadth of foot and lengths of lateral four toes are reliably correlated with gestational age and thus can be used for determination of the same. This will be of great help in the **medico legal** cases in which only foot or part of it is available for estimation of gestational age.

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