Comparison of Parameters of Hand and Foot Growth with Gestational Age among Human Male and Female Foetuses - A Morph Metric Analysis

Mohd Arshad[1], Fazal-ur Rahman[2], Ali Amir[3], Kamil Khan[4]

ABSTRACT

Introduction: 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 of foetus and by noting morphological features, organ development and appearance of ossification centres, an alternative parameter is desirable in some instances. In this study we directly Comparison of Hand and Foot Growth with Gestational Age in Human male and female Foetuses.

Material and Methods: 60 formalin fixed human foetuses (25 male 35 female) were obtained from Museum of Department of Anatomy, Jawaharlal Nehru Medical College, and 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). We taking fourteen parameters in hand and foot i.e. length and breadth of the hand and lengths of all five fingers, Length and breadth of foot, length of all five toes, were measured using Vernier callipers.

Result: It was found during comparison of male and female hand and foot parameters that Breadth of hand in less than 17 weeks (p-0.047), Hand length during 17-20 weeks (p-0.029), Middle finger and ring finger during 17-20 weeks (p-0.006) and (p-0.014), Great toe during 17-20 weeks (p-0.011) was found to be statically significant.

Conclusion: It was concluded that breadth of hand, foetal hand length, middle finger and ring finger, great toe are significantly correlated with gestational age significantly ($p<0.05$) correlated with gestational age during comparison of male and female hand and foot parameters therefore these parameters could be utilized to estimate gestational age. It could be used in medico legal cases in where hand and foot parts are available or part of it is available for estimation of gestational age.

Keywords: Male Foetuses, Female Foetuses, Foetal Hand Parameters, Fetal Foot Parameters, Gestational Age,

INTRODUCTION

Accurate fetal ultrasound measurements are one of the most important factors for high quality obstetrics health care. Determination of gestational age is important in civil and criminal cases. Foetal age is usually estimated by measuring physical parameters such as crown-heel length and weight of foetus and by noting morphological features, organ development and appearance of ossification centres.[1,2,3] Other method for evaluation of age includes foetal biometric measurements by ultrasound. The parameter includes foetal crown-rump length, biparietal diameter, head circumference, abdominal circumference, femoral length, foot length and appearance of foetal heel ossification enters.[4,5,6,7] To determine gestational age in newborn, clinicians in industrialized countries rely on various prenatal and postnatal indicators such as first trimester ultrasound and last menstrual period[8] and neonatal data such as Dubowitz or Ballard scoring systems.[9,10] Study of literature suggests that fetal foot has a characteristic pattern of normal growth and the fetal foot shows gradual increase in length relative to the length of the embryo and could be used to estimate gestational age.[11,12] Though, a reasonable assessment of gestational age can be made by fore said method, an alternative parameter is desirable in some instances, especially in cases of severe hydrocephalus, anencephaly, short limb dysplasia, post-mortem destruction or in mutilated cases. Although manual measurement by specialists of BPD, HC, AC, and FL are also quite precise and hold more importance as they are done on aborted foetuses, of course the quality of the measurements are user-dependent and time consuming. But as these are done directly on the foetus holds more accuracy and reliability. Kumar et al[12] showed that the foetal hand and foot has a characteristic pattern of normal growth. These authors proposed that the foetal hand and foot length could be utilized to estimate gestational age.

In this paper we present a direct method of fetal measurements that targets the accurate and robust detection of different important parameters of fetal hand and foot that are difficult to measure by other techniques as ultrasound. This study also provide data for reference estimation of gestational age by comparing different parameters of hand and foot on gender (male and female) basis. 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.

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The only inputs to the system are the aborted foetuses and measuring instrument. The data can provide a reference point for other methods of fetal hand and foot measurement and determine the accuracy of them estimation of gestational age.

MATERIAL AND METHODS

60 formalin fixed human foetuses (25 Male and 35female) were obtained from Museum of Department of Anatomy Jawaharlal Nehru Medical College at Aligarh. Institutional ethics committee has no objection on doing research work on these female foetuses.

Groups	Gestational age (weeks of intrauterine life)	Number of foetuses = 60(25 male and 35 female)
I	< 17 weeks	12(5 male and 7 female)
II	17-20 weeks	12(3 male and 9 female)
III	21-25 weeks	12(4 male and 8 female)
IV	weeks	12(7 male and 5 female)
V	>30 weeks	12(6 male and 6 female)

Following measurements were taken with the help of vernier callipers to nearest of millimetre.

Parameters of hand- 1- Hand length 2. Breadth of hand. 3. Length of thumb 4. Length of index finger 5. Length of middle finger of 6. Length of the ring finger 7. Length of the little finger

Parameters of foot- 1- Foot length. 2 .Breadth of foot. 3. Great toe length. 4. Length of 2nd toe. 5. Length of 3rd toe. 6. Length of 4th toe. 7. Length of 5th toe.

Each reading was taken three times and the mean of the same was considered to avoid human error. By using ANOVA test, the variations between all adjacent groups are found statistically significant. Graphs were plotted by considering mean values of measurements of different parameters and gestational age on y and x axes respectively.

RESULTS

It is very clear from figure 1 that the growth of length of hand in female fetuses is more or less steady throughout except it is maximum between IV and V group whereas in male fetuses growth is constant between I and II group and then more or less steady. It implies that determination of fetal age using length of hand is more easy and significant in female. In figure 2 the breadth of hand shows steady growth but minimum growth in between I and II group in both male and female fetuses. Similarly in figure 3 the length of thumb

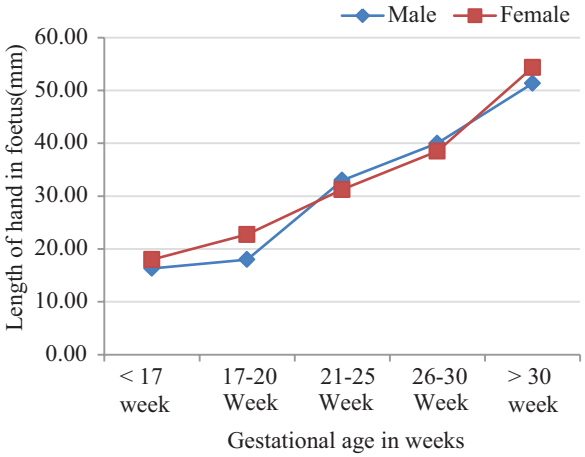


Figure-1: Showing Comparison of length of hand in male and female foetuses.

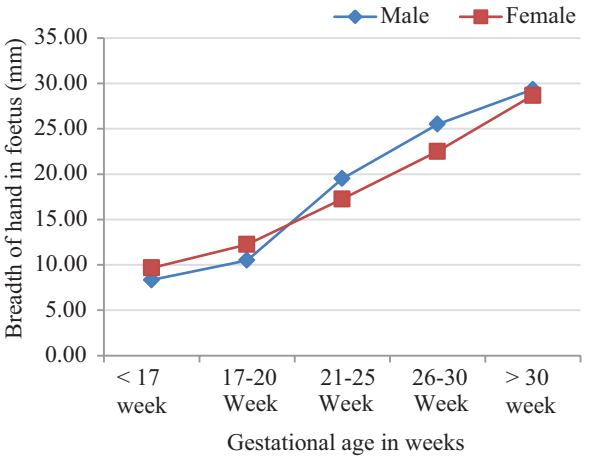


Figure-2: Showing comparison of length of hand in male and female foetuses.

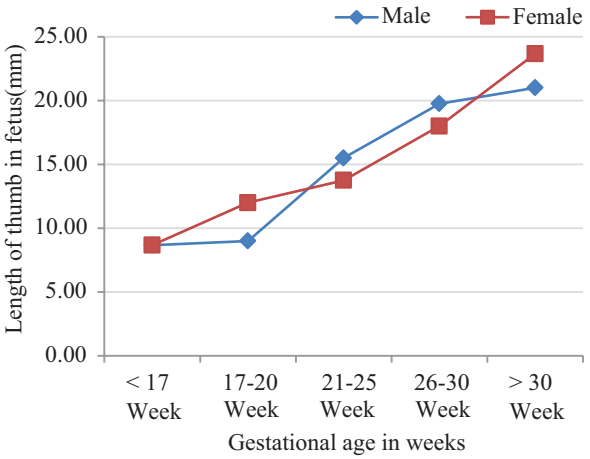


Figure-3: Showing comparison of length of thumb in male and female foetuses.

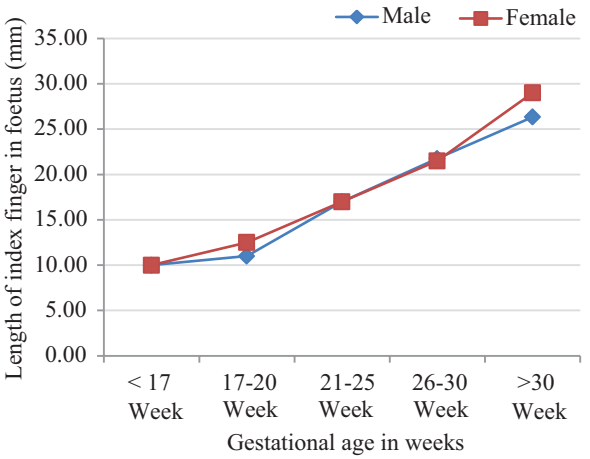
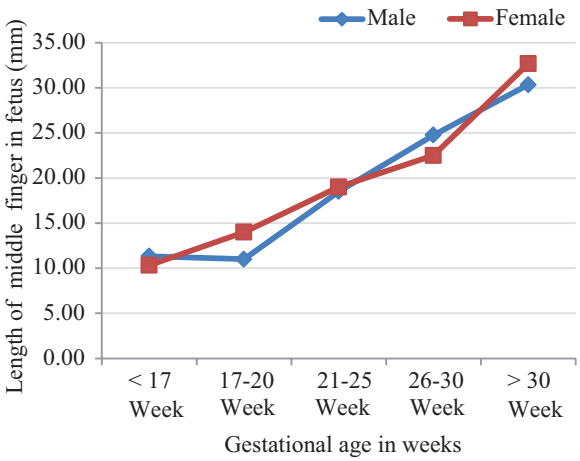
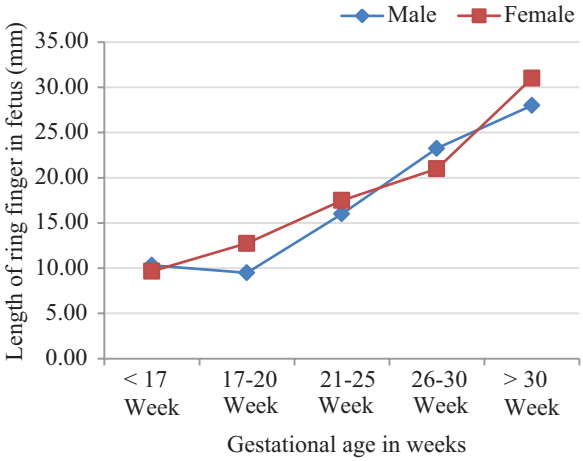


Figure-4: Showing comparison of length of index finger in male and female foetuses.



Finger-5: Showing comparison of length of middle finger of hand in male and female foetuses.



Finger-6: Showing comparison of length of ring finger of hand in male and female foetuses.

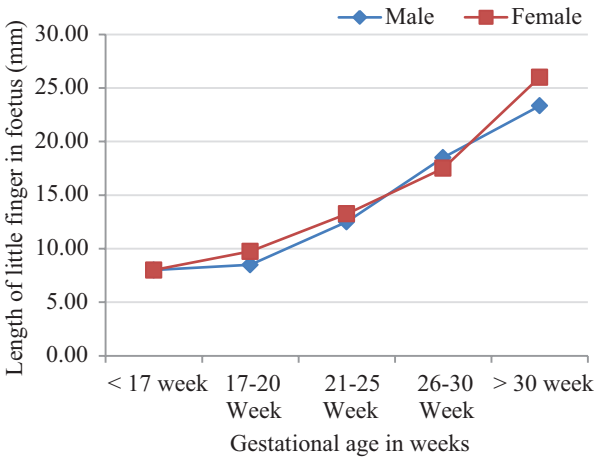


Figure-7: Showing comparison of length of little finger in male and female foetuses.

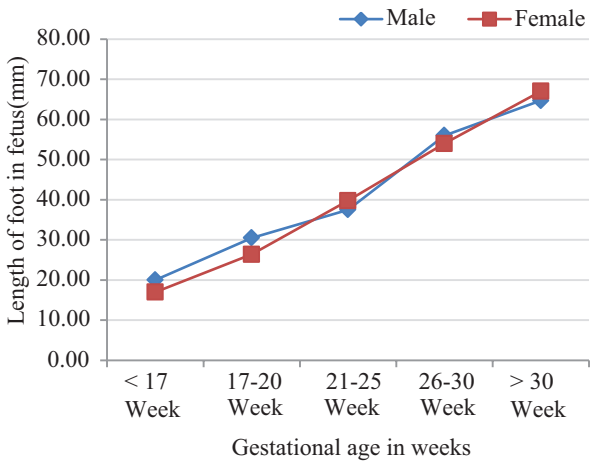


Figure-8: Showing comparison of length of foot in male and female foetuses.

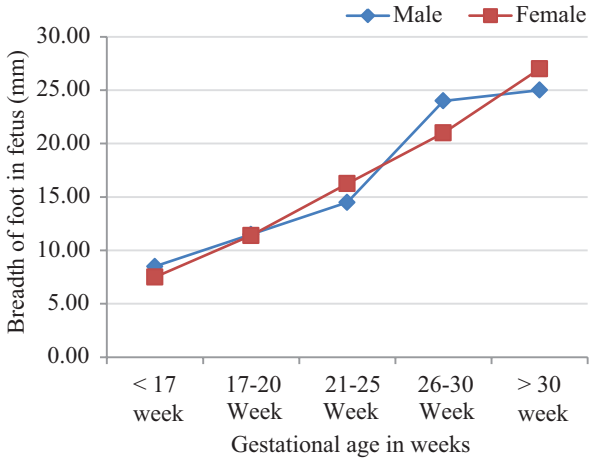


Figure-9: Showing comparison of breadth of foot in male and female foetuses.

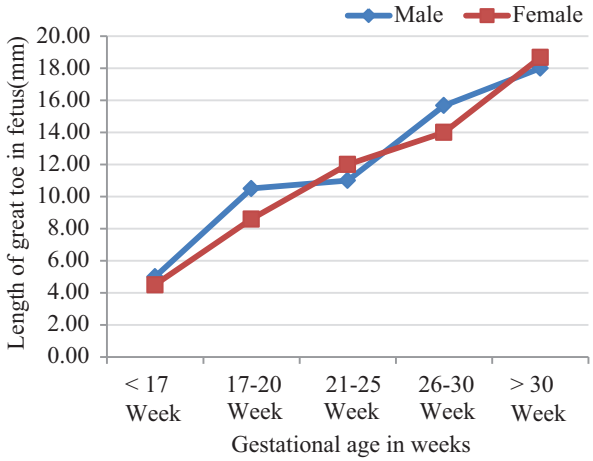


Figure-10: Showing comparison of length of great toe in male and female foetuses.

shows steady growth with gestational age in females while it is constant in male fetuses in I and II group and it increases rapidly during III group. Whereas the length of index finger shows constant growth as depicted by figure 4. In figure 5 depicts constant growth in length of middle finger of female fetuses except during V group where sudden growth is seen whereas no visible growth pattern seen during I and II group then constant increase in growth pattern is visible in male fetuses and also length of ring finger in figure 6 shows same pattern of growth as that of middle finger. Length of little finger in figure 7 shows same pattern of growth in male and female fetuses. Now if we compare the parameters of foot then in figure 8 depicts length of foot in foetuses shows steady growth throughout the gestation in both male and

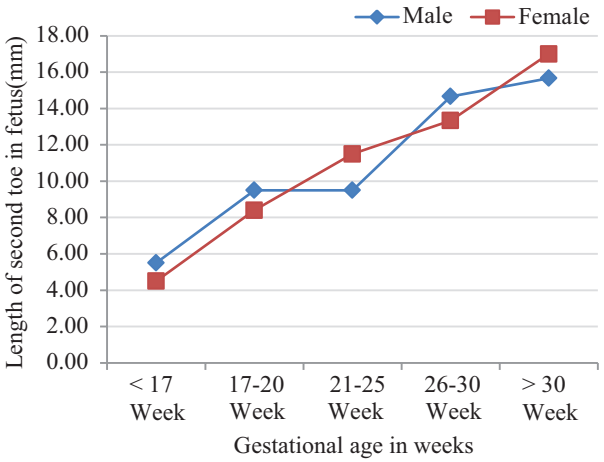


Figure-11: Showing comparison of length of hand in male and female foetuses.

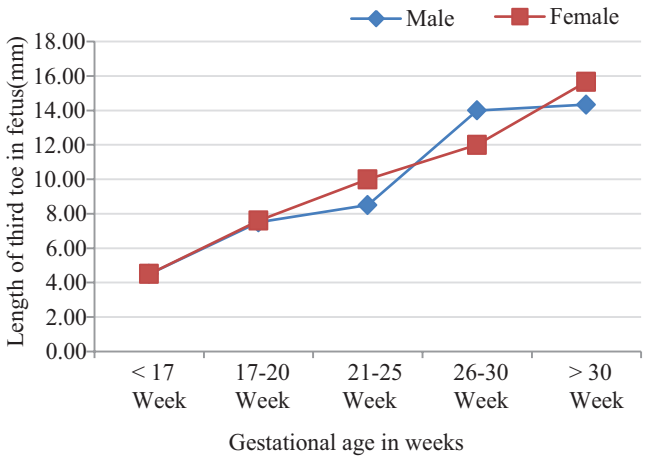


Figure-12: Showing comparison of length of third toe in male and female foetuses.

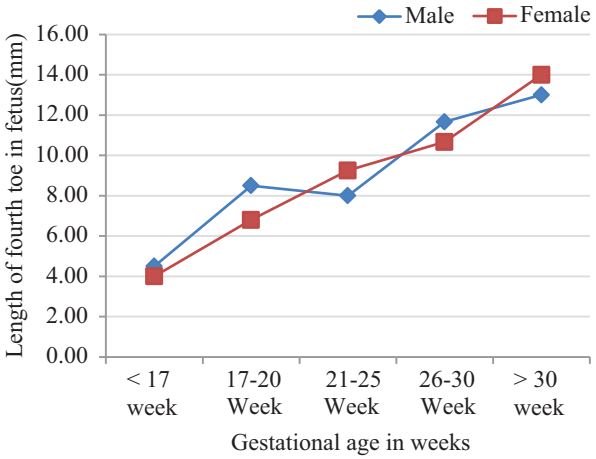


Figure-13: Showing comparison of length of forth toe in male and female foetuses.

female. This indicates that fetal foot is the best indicator for estimating the gestational age of fetuses irrespective of the gender. In fig. 9 the breadth of foot in female fetuses shows steady growth whereas in male it is showing irregular pattern of growth so it is not a reliable parameter for estimating gestational age in male. Length of great, second, third, fourth toes in fig. 10,11,12,13 shows irregular pattern

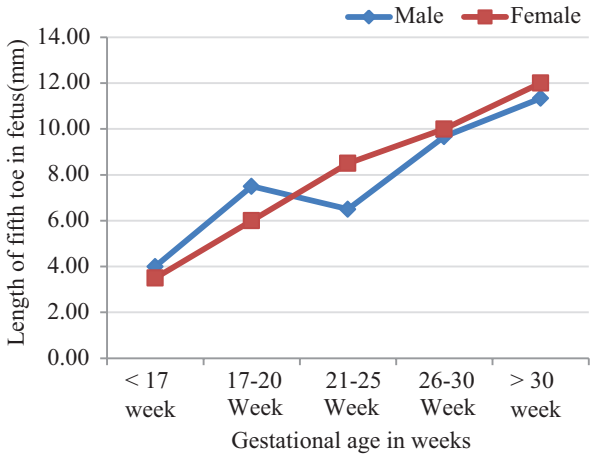


Figure-14: Showing comparison of length of fifth toe in male and female foetuses.

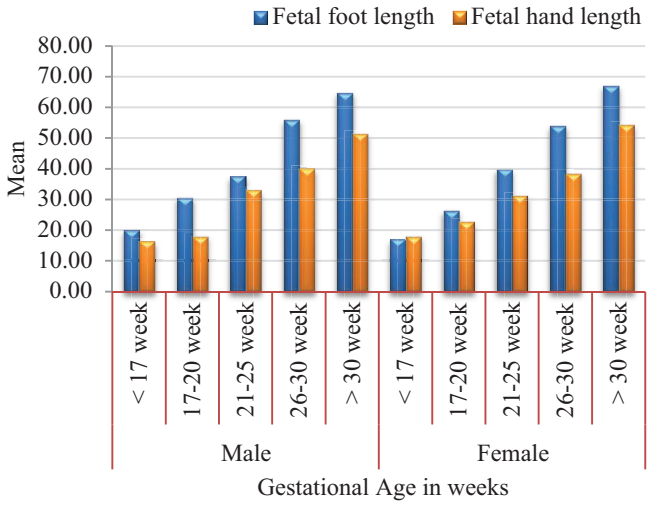


Figure-15: Shows the comparison between gender of fetal foot length and hand length

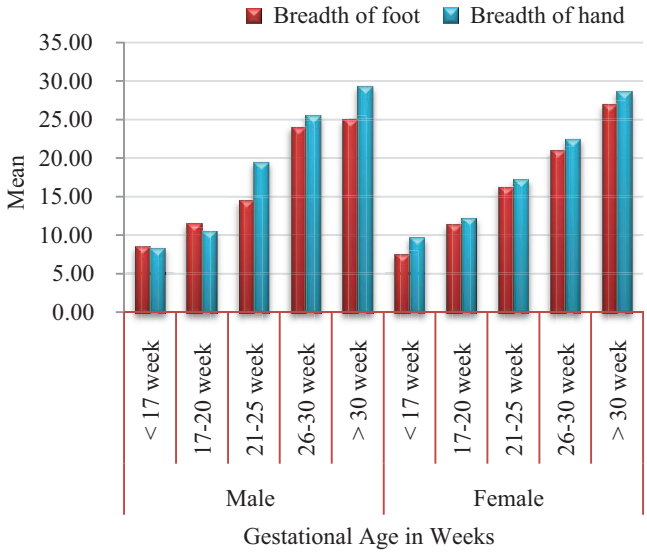


Figure-16: Shows comparison between gender of breadth of foot and hand at different gestational ages.

of growth in both genders. Therefore the lengths of medial four toes are irrelevant for determination of gestational age throughout foetal period in both gender, whereas length of

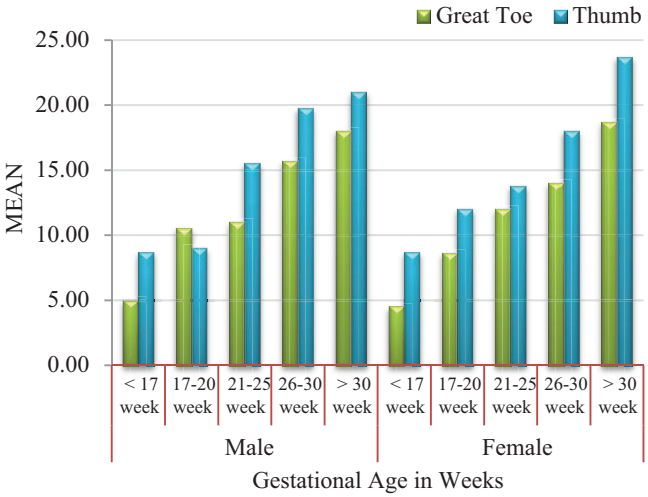


Figure-17: Shows comparison of gender between great toe of foot and thumb of hand at different gestational ages.

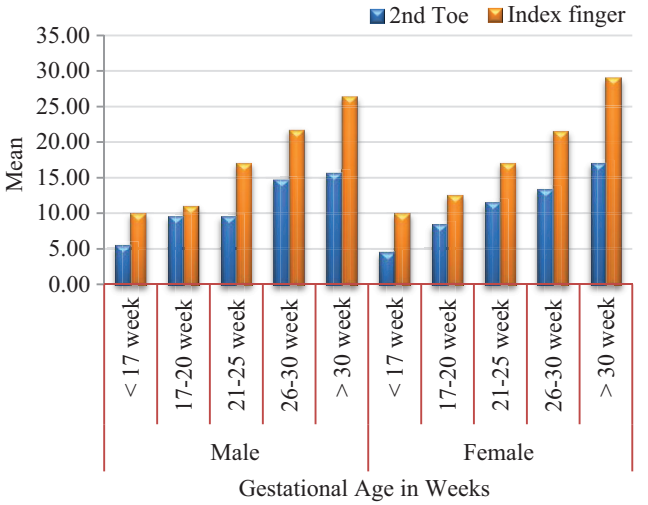


Figure-18: Shows comparison of gender between 2nd toe of foot and index finger of hand at different gestational ages.

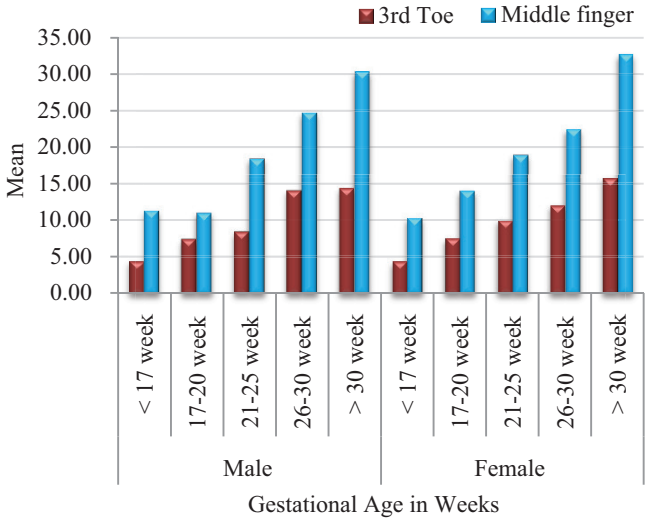


Figure-19: Shows comparison of gender between 3rd toe of foot and middle finger of hand at different gestational ages.

5th toe showing steady growth in female foetuses but in case of male it is irregular. We also did comparison between fetal hand and foot parameters to assess the difference in growth

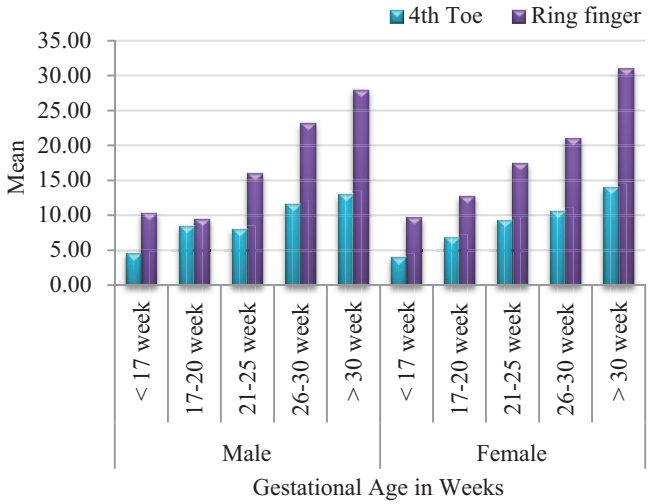


Figure-20: Shows comparison of gender between 4th toe of foot and ring finger of hand at different gestational ages.

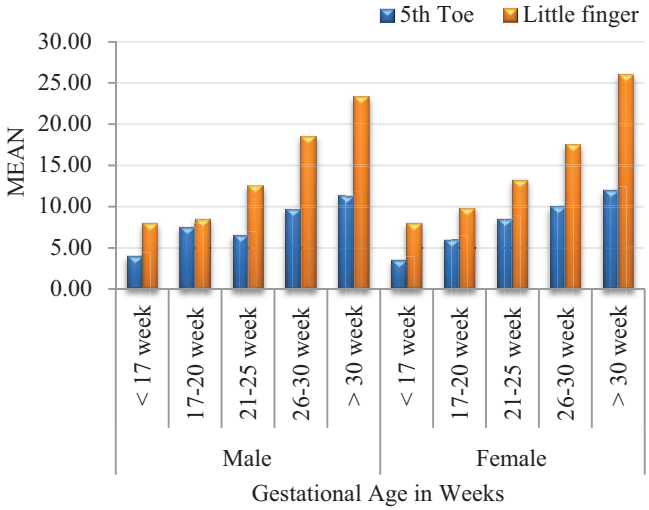


Figure-21: Shows comparison of gender between 5th toe of foot and little finger of hand at different gestational ages.

at different gestational ages. We found in figure 14 that fetal foot length is greater than fetal hand length except when the gestational age is less than 17 weeks in female fetuses. During comparison of breadth of hand and foot we found that breadth of hand is more than breadth of foot except during less than 20 weeks in case of male fetuses. While comparing in figure 16, the length of great toe is found to be less than length of thumb during all gestational age and all gender except during 17-20 weeks in male fetuses. Rest of the all four fingers length are greater than the lateral four toes.

DISCUSSION

Obstetricians have been using the foetal foot length to estimate gestational age. This method appears to be in agreement with other ultrasound parameters.[6,7] The period of gestation Streeter first evaluated the fetal foot for gestational age assessment in 1920.[11] In the present study we emphasised towards comparison between fetal hand and fetal foot parameters in males and females to assess the difference in growth at different gestational ages. It is found in present study that the growth of length of hand in female fetuses is more or less steady throughout except it is

Gestational age in weeks	Foetal hand length		Breadth of hand		Thumb		Index finger		Middle finger		Ring finger		Little finger	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
< 17 week	16.33 ± 2.52	18 ± 1	8.33 ± 0.58	9.67 ± 0.58	8.67 ± 1.53	8.67 ± 1.15	10 ± 1.73	10 ± 0	11.33 ± 2.08	10.33 ± 0.58	10.33 ± 2.08	9.67 ± 1.15	8 ± 2	8 ± 1
P-Value	0.346		0.047*		1.000		1.000		0.468		0.653		1.000	
17-20 week	18 ± 1.41	22.8 ± 1.7	10.5 ± 0.71	12.3 ± 1	9 ± 0	12 ± 2.7	11 ± 1.41	12.5 ± 0.6	11 ± 0	14 ± 0.8	9.5 ± 0.71	12.8 ± 1	8.5 ± 0.71	9.8 ± 0.5
P-Value	0.029*		0.088		0.214		0.116		0.006*		0.014*		0.061	
21-25 week	33 ± 4.24	31.3 ± 3.8	19.5 ± 0.71	17.3 ± 2.8	15.5 ± 0.71	13.8 ± 3	17 ± 1.41	17 ± 2.9	18.5 ± 2.12	19 ± 2.2	16 ± 1.41	17.5 ± 1.9	12.5 ± 2.12	13.3 ± 1.7
P-Value	0.631		0.342		0.482		1.000		0.802		0.391		0.659	
26-30 week	40 ± 6.9	38.5 ± 2.12	25.5 ± 5.9	22.5 ± 0.71	19.8 ± 3.1	18 ± 1.41	21.8 ± 2.8	21.5 ± 0.71	24.8 ± 3.8	22.5 ± 0.71	23.3 ± 3.6	21 ± 0	18.5 ± 3	17.5 ± 0.71
P-Value	0.790		0.537		0.506		0.910		0.474		0.451		0.682	
> 30 week	51.33 ± 3.79	54.33 ± 9.29	29.33 ± 3.79	28.67 ± 4.73	21 ± 2.65	23.67 ± 3.51	26.33 ± 3.21	29 ± 6.56	30.33 ± 2.08	32.67 ± 6.66	28 ± 1.73	31 ± 5.57	23.33 ± 1.53	26 ± 5.57
P-Value	0.632		0.858		0.353		0.561		0.593		0.423		0.469	
*Statistically significant														

Table-1: Showing Measurement of Different Parameters of Foetal Hand on Gender Basis.

Gestational age in weeks	Fetal foot length		Breadth of foot		Great Toe		2nd Toe		3rd Toe		4th Toe		5th Toe	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D
< 17 week	20 ± 2.82	17 ± 3.2	8.5 ± 2.12	7.5 ± 1.73	5 ± 0	4.5 ± 0.6	5.5 ± 0.71	4.5 ± 0.6	4.5 ± 0.71	4.5 ± 0.6	4.5 ± 0.71	4 ± 0	4 ± 0	3.5 ± 0.6
P-Value	0.324		0.564		0.312		0.132		1.000		0.178		0.312	
17-20 week	30.5 ± 0.71	26.4 ± 7.2	11.5 ± 0.71	11.4 ± 1.8	10.5 ± 0.71	8.6 ± 0.5	9.5 ± 0.71	8.4 ± 0.9	7.5 ± 0.71	7.6 ± 0.5	8.5 ± 0.71	6.8 ± 0.8	7.5 ± 0.71	6 ± 0.7
P-Value	0.48		0.945		0.011*		0.187		0.846		0.054		0.052	
21-25 week	37.5 ± 3.54	39.75 ± 5.2	14.5 ± 0.71	16.25 ± 2.2	11 ± 1.41	12 ± 2.4	9.5 ± 0.71	11.5 ± 1.3	8.5 ± 0.71	10 ± 1.8	8 ± 0	9.25 ± 1.5	6.5 ± 0.71	8.5 ± 1.3
P-Value	0.619		0.369		0.633		0.120		0.345		0.329		0.120	
26-30 week	56 ± 7.81	54 ± 3.6	24 ± 3.61	21 ± 2	15.67 ± 2.52	14 ± 1	14.67 ± 3.06	13.3 ± 1.2	14 ± 2	12 ± 2	11.67 ± 1.53	10.7 ± 1.52	9.67 ± 1.15	10 ± 1
P-Value	0.708		0.276		0.346		0.519		0.288		0.468		0.725	
> 30 week	64.67 ± 3.51	67 ± 10.6	25 ± 2.65	27 ± 4.4	18 ± 1	18.7 ± 4.72	15.67 ± 2.31	17 ± 4.6	14.33 ± 2.08	15.7 ± 3.8	13 ± 2	14 ± 4.35	11.33 ± 2.52	12 ± 3.5
P-Value	0.735		0.534		0.823		0.676		0.621		0.736		0.801	
*Statistically significant														

Table-2: Showing measurement of different parameters of foetal foot on gender basis.

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maximum between IV and V group whereas in male fetuses growth is constant between I and II group It implies that determination of fetal age using length of hand is more easy and significant in female. The result of our prospective study provides normative data on foetal hand growth throughout the gestation. The data of present study is in accordance with those of Kumar et al. In other hand if we compare the parameters of foot then length of foot in foetuses shows steady growth throughout the gestation in both male and female. This indicates that fetal foot is the best indicator for estimating the gestational age of fetuses irrespective of the gender. Hern's then elaborated a strong relationship between fetal foot and gestational age.[13] The period of gestation estimated by measurement of fetal foot length appears to be in agreement with other ultrasound parameters.[6,14] Patil SS et al. have demonstrated a statistically significant relationship between crown rump length and gestational age.[15] This study provides a normative data on fetal foot and hand growth throughout gestation. A statistically significant linear relationship is seen between foot length and hand length($p<0.0001$). This is in accordance to work done by Patil SS et al,Bardale R et al, Arshad M et al, Joshi K S et al, Hebbar S et al., Platt LD et al, Mital M et al and Manjunatha B et al.[14-21] As reported by Streeter, there is gradual increase in the length of foot relative to the length of the embryo.[11] Apart from estimation of gestational age, the utilities of foot length measurements have been shown by other studies. Pospisilova-Zuzakora used foot length to determine body length of fetus.[22] We also compare the parameters of hand to parameters of foot in both gender, we found that in less than 20 weeks some different growth pattern in hand length of female fetuses, breath of foot and length of great toe in case of male fetuses. The difference of this finding with other findings can be explained by variations in socioeconomic status, environmental and nutritional factors with reference to the findings of other studies.

CONCLUSION

In the present study, Determination of fetal age using length of hand is more easy and significant in female. This indicates that fetal foot is the best indicator for estimating the gestational age of fetuses irrespective of the gender. We conclude that fetal hand and foot lengths have been found to highly correlate with gestational age irrespective of the gender. Less than 20 weeks we found some different growth pattern in hand length of female fetuses, breathe of foot and length of great toe in case of male fetuses the utilization of foetal hand measurements will serve as a useful adjunct data for estimation of age in reliable manner. Moreover, its utility becomes apparent when other parameters of fetus cannot be utilized due to disease, deformity or destruction by injury or post-mortem process or mutilation. Usage of foot and hand length can serve as an adjunct data when other parameters of fetus like crown rump length, weight, etc. cannot be utilized either due to a disease, deformity or when fragmented specimens of fetus are available in forensic and pathological studies. All the other parameters used to assess the gestational age; this appears to be equally accurate.

The use of foot length and hand length in measurement of gestational age needs to be used more frequently in day to day working, so that the technique can be popularized more as its accuracy has already been reported by many workers. Therefore these parameters could be utilized to estimate gestational age. It is also use in the medico legal cases in male and female foetuses which only hand and foot or part of hand andfoot is available for estimation of gestational age.

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