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Association of Foot Length with Gestational Maturity and Anthropometric Parameters at Birth

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Abstract

Birth weight is one of the most important measures used for the assessment of the fetal development and health of the foetus both intrauterine life and after birth. Gestational age and birth weight are fundamental for assessing the intrauterine development and advancement and also to anticipate the troubles of extra-uterine adjustment. Hence the study was done with the aim to determine the correlation of foot length with anthropometric variables i.e. birth weight, gestational age, crown heel length and head circumference. The present observational study was done on 145 new bornbabies Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamil Nadu. Anthropometric evaluation was done on all babies within 72 hours of birth. Gestational age was calculated by New Ballard score. Birth weight (in kilograms) babies were weighed by weighing scales to the nearest 50 g. Foot length (in centimeter) was measured using sliding calipers. Head circumference (in centimeter) was measured using flexible, non-strechable fiber, measuring tape. Crown heel length (in centimeter) was measured using in fathometer. The data was analyzed using SPSS software version 23.0. P value less than 0.05 is considered significant. Females outnumbered the males. The mean birth weight of study participants were 2.62 kgs with gestational age of 28-42 weeks. The mean foot length of study participants was 7.59cms. Gestational age (r = 0.765), head circumference (0.789), crown heel length (r = 0.825) and birth weight(r = 0.845) found significant correlation with foot length. Among them birth weight found to have strong positive association with foot length. Foot length can be used with high accuracy to determine the gestational age in where are no facilities for fetal ultrasound antenatally available.

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Key Words

Foot length, Gestational age, Anthropometric parameters, Neonates

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INTRODUCTION

In India, most of our newborns are delivered at home by untaught or semi-trained birth attendants, relatives, or neighbors. Therefore, birth weight of these babies is not known. Only a small proportion of the population of India and other developing countries have an institutional delivery these babies are weighed at birth[1]. Neonatal period is a more susceptible period of life its death accounts for 60% of all infant mortality rate and 40% of all deaths of under-five children[2].

Global infant death rate is approximately 8 million/year, out of which 4 million deaths occur during the neonatal period. Most neonatal deaths that is, almost 75% occur in the early neonatal period and 25% during first 24h of life. Most of the neonatal deaths occur in developing countries. India contributes 20% of global birth and 25% of global neonatal death[3].

Birth weight (BW) is the single most important factor for the aftereffect of neonate. Approximately 80% of all neonate deaths are due to low birth weight (LBW) in both developed and flourishing countries. In India, 30% babies are LBW as against to about 5-7% in western countries and also is in second place in South Asia region[4].

Foot length assessment is an important fundamental for the fetal structural screening at all gestational ages. As it is a linear body measure, it can be closely related to gestational age, weight, length and perimeters[5].

The ideal maximum period to perform foot length measurement is still controversial. Some authors state that foot length maintains a strong correlation with weight from birth up to the fifth day after birth, being a good predictor for the evaluation of low birth[6-9]. However, a study revealed that newborn's feet significantly increase in length size during the first five days of life, implying that further research needs to be developed to determine the maximum period for this measure[10].

Considering that foot length is easy to apply since it has only one variable to be measured and is therefore less susceptive to errors that the material used for the measurement is easily found in any maternity or health service. This parameter should be more used by professionals such as nurses, pediatricians, neonatologists, members of the nursing team and pathologists who work in maternity and child areas[11].

The present study was conducted with the objective to study the association between foot length and gestational age another variables (birth weight, head circumference, crown heel length), among neonates and to consider whether foot length can be used as alternative to measurement to birth weight for gestational age assessment.

MATERIALS AND METHODS

This was an observational study was done on 145 new bornbabies chosen by convenient sampling born in Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamil Nadu during the study period 18 months who met the pre-defined criteria. The study was initiated after obtaining ethical clearance from the institutions ethical clearance committee. The sample was consisting of one group of total sample size 145 new born babies the scientific basis of sample size was decided based on the formula.

$$n = 4\sigma^{2}\frac{(Z_{a+}Z_{B})}{D^{2}}$$

Where, S1= standard deviation of foot length group = 2.32cm, S2= standard deviation of crown heel length = 2.54 cm, S2= 2= 5.90 cm, Za= Z value associated with alpha= 1.644, Zß= Z value associated with beta= 0.84, D = Precession= 1.
Total sample size = 145.

Selection Criteria: Anthropometric evaluation was done on all babies within 72 hours of birth. Babies of parents who gave consent for the study were included in the study. Babies with congenital deformities like congenital talipesequinovarus, congenital vertical talus, foot edema and other congenital anomalies were excluded.

Gestational age was calculated by enquiring into 1st day of mothers last menstrual period and subsequently confirmed by New Ballard score[12]. Birth weight (in kilograms) babies were weighed naked immediately after birth on lever actuated weighing scales to the nearest 50 g. Foot length (in centimeter) was measured using sliding calipers which is having an accuracy of an 1/10th of a millimeter. Head circumference (in centimeter) was measured using flexible, non-strechable fiber, measuring tape. Crown heel length (in centimeter) was measured using infantometerin which the infant was placed supine on it.

Statistical Analysis: The data was transferred to a Microsoft excel sheet 2007 for analysis. Data was analyzed for the statistical significance using intra-class correlation coefficient (r). Significance found by student t test. A $p<0.05$ was considered significant. The demographic data mean median mode and standard deviation measures were used for all other variables.

RESULTS AND DISCUSSIONS

The present study included 145 neonates of which females were 83 (87.2%) and males were 62 (42.8%). Table 1 presents anthropometric characteristics of study population. The mean gestational age of study

Table 1: Anthropometric variables of study population (n=145).

Variables	Mean	Std. deviation
Gestational age(weeks)	38.08	2.276
Foot length(cm)	7.598	0.4454
Head circumference(cm)	32.872	1.096
Length(cm)	47.738	1.639
Birth weight(kg)	2.627	0.4184

Table 2: Sex distribution of babies based on their birth weight.

Birth weight (kg)	Male		Female		Total	
	N	percentage	N	percentage	N	percentage
<2.5	28	19.31	25	17.24	53	36.55
2.5-3.5	34	23.44	58	40	92	63.44
Total	62	42.7	83	57.2	145	100

Table 3: Mean anthropometric characteristics of study population.

Maturity	N	Foot length		Gestational age		Birth weight		Head circumference		Mean length	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PretermSGA	7	6.642	0.4314	34.29	1.799	1.671	0.275	30.785	0.5669	44.857	0.8018
PretermAGA	19	7.157	0.6318	34.11	2.536	2.263	0.491	32.126	1.401	46.421	2.734
TermSGA	14	7.385	0.3109	38.71	0.994	2.346	0.277	32.142	0.9889	47.071	1.696
TermAGA	104	7.765	0.2207	38.93	0.988	2.79	0.246	33.231	0.7541	48.240	0.8949
PosttermAGA	1	8.2	-	42	-	3.25	-	34.5	-	50	-
Total	145	7.598	0.445	38.08	2.276	2.627	0.4184	32.872	1.096	47.738	1.639

Table 4: Correlation between foot length and anthropometric variables (n=145).

Variables	r	r2	p-value
Gestational age(weeks)	0.765	0.585	0.000*
Head circumference(cms)	0.789	0.622	0.000*
Crown heel length(cms)	0.825	0.680	0.000*
Birth weight(kg)	0.845	0.714	0.000*

participants were 38.08 with a SD of 2.276.The mean foot length of study participants were 7.59 with a SD of 0.445.The mean head circumference of study participants were 32.87 with a SD of 1.096.The mean crown heel length of study participants were 47.73 with a SD of 1.63.The distribution of birth weight in babies ranges from 0.9-3.5 kgs. The mean birth weight of study participants were 2.62 kgs with a SD of 0.418.

Table 2 presents the sex distribution of babies based on their birth range of 2.5-3.5 kg weight. 53 babies (36.55%) were low birth weight babies in which male babies are more (19.31%)92 newborns (63.44%) had birth weight in the range of 2.5-3.5 kg in which female babies are dominated (57.2%).

As given in Table 4, of the total 145 newborns, term AGA and term SGA were 104 (71.72%) and 14 (9.65%). Preterm AGA and preterm SGA were 19 (13.10%) and 7 (4.82%) respectively. Post-term AGA was 1 (0.68%). Maximum number of newborns was in Term AGA (76.55%) group. There were no newborns in post term SGA group. The mean foot length of the babies was 7.598cms. The mean gestational age was 38.08 weeks, mean birth weight was 2.627 kgs, head circumference was 32.872cms and mean length of the babies was 47.738cms.

Table 4 describes the correlation of various parameters with foot length of the babies. Maximum correlation was observed with gestational age (r = 0.765), head circumference (0.789), crown heel length (r = 0.825) and birth weight (r = 0.845) which indicates strong positive significant association ($p<0.05$) between foot length and the variables.

The present observational study was done on 145 newborn babies chosen by a purposive sampling technique in Sree Mookambika Institute of Medical Sciences, Kulasekharam. In our study we have chosen all consenting infants of the gestational age 28-42 weeks, irrespective of antenatal status and their mode of delivery. Only live singleton deliveries were chosen. The consent was taken antenatally from either parents.

Females (57.2%) outnumbered the males (42.7%). Similar observations were seen in the study of James[13] The mean gestational age of the babies in our study was 308.08 weeks. This was similar to the findings of Mital *et al,* Marchant *et al* Saroj[14-16]

In this study, number of children born with AGA was 124 and SGA was 21. Similar findings was noted in the study of Saroj[16]

The mean foot length of the babies in our study was 7.42cms. Similar findings was also done by Saroj et al and Srinivasa *et al* in which the mean foot lengths was 7.44 cms and 7.58 cms respectively[16,17].

The mean birth weight in our study was 2.62 kgs and the foot length in preterm SGA 6.642 cms, preterm AGA 7.157 cms, term SGA7.385 cms, term AGA7.765 cms, post term AGA 8.2cms. In a study by Gohli *et al,* the mean foot length of preterm was 6.56±0.43 cm, term SGA was 7.13±0.26 cms[18].

In the present study, the foot length was less than 7.2cmswith 89.3% sensitivity and 74.8% specificity for identification of LBW babies. This was in accordance with the findings of Mullany[19] Study by Hirve *et al* found foot lengths less than 6.3 cm for VLBW babies with a sensitivity of 100% and specificity of 95.2%[20]. In another study by Mukherjee, the observations revealed that foot length less than 7.75 cm has 92.3% sensitivity and 86.3% specificity for preterm

identification. For identification of LBW babies (<2500 gm) a foot length<7.85 cm has 100% sensitivity and 95.3% specificity and foot length<6.85 cm had 100% sensitivity and 94.9% specificity for identification of VLBW babies (<1500 gm)[21].

In our study it was observed that the foot length correlated significantly ($p<0.05$) with gestational age, head circumference, length and birth weight. Correlation coefficient (r-value) of all the parameters was positive. Maximum correlation was observed with birth weight ($r = 0.845$) which indicates strong positive association between them.

CONCLUSION

The findings of the study conclude that foot length can be used with high accuracy to determine the gestational age in where are no facilities for fetal ultrasound antenatally available. It can be safely done by anyone and does not need a formal training. This can be used as a parameter for early identification of high risk cases so that referrals can be done at the golden hour in turn reducing the chances of neonatal mortality.

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