A CROSS SECTIONAL STUDY OF CORRELATION BETWEEN FOOT LENGTH AND GESTATIONAL AGE AMONG NEWBORNS IN A TERTIARY CARE CENTRE IN MANDYA

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ABSTRACT
Background: Accurate assessment of gestational age is not possible in sick newborns and those requiring intensive care. Knowing the gestational age is important for early identification of preterm and referral to higher centre for further care. Foot length can be easily measured, has better correlation with birth weight and it has been observed to be a good predictor of gestational age.

Methods: A cross-sectional study was conducted among 939 newborns, to determine correlation of foot length with gestational age and other anthropometric parameters such as birth weight, chest circumference and length

Results: The mean birthweight of the neonates was found to be 2.88 kg (SD $\pm$0.51). The mean head circumference was found to be 33.34 cm (SD $\pm$1.92). The mean chest circumference was found to be 35.01 cm (SD $\pm$1.93). The mean foot length was found to be 7.07 cm (SD $\pm$0.80). The mean gestational age of the neonates included in the study was 38.27 weeks (SD $\pm$1.74). A statistically significant positive correlation was observed between gestational age of neonates with anthropometric parameters like weight, head circumference, chest circumference and foot length.

Conclusions: Foot length is a low-cost, simple and feasible measurement, with potential to identify gestational age of infants. The foot length (independent variable) is strongly related with the period of gestation. As this method is simple, economical and accurate it can be used by primary health worker even in a rural setup.

Keywords: Anthropometric Parameters, Gestational Age, Foot Length, Birth Weight, Chest Circumference

Introduction:
Neonatal period is the first 28 days of life. AAP defines Gestational age as "time elapsed between last menstrual period and day of delivery".[1,2] Complications due to preterm birth constitute majority of neonatal deaths in India.[1,3] Preterm neonates are those with gestational age less than 37 completed weeks, term neonates are those with gestational age of 37 completed weeks to 41 weeks +6 days and post term neonate are with gestational age of 42 weeks or more.[1,4,5] Neonates are further categorized as Small for gestational age (SGA), Appropriate for gestational age (AGA) and Large for gestation age (LGA) using intrauterine growth curves and fenton's charts.[1,7] Those

with weight for gestational age < 10th percentile are considered as SGA and > 90th percentile are considered as LGA and those between 10th and 90th centile are considered AGA.[1,8]

Accurate assessment of gestational age is not possible in sick newborns and those requiring intensive care. Knowing the gestational age is important for early identification of preterm and referral to higher centre for further care. Anthropometric measurement like birth weight, length and head circumference are commonly used to measure growth in neonate and they correlate fairly with maturity. Parameters like weight and head circumference are affected by various factors. Weight is affected by carbohydrate, fat, protein and mineral levels.[6,9] Head circumference reflects brain growth and can be affected due to brain sparing effect and may result in under estimation.[10,11]

Foot length can be easily measured, has better correlation with birth weight and it has been observed to be a good predictor of gestational age. Foot length measurement can be done can in critically sick newborn. It is less prone for measurement error, so can be done even by a health care worker even at periphery level as it doesnot require any special training and equipment.[12] Hence this study has been done with objective to determine correlation of foot length with gestational age and other anthropometric parameters such as birth weight, chest circumference and length.

Methodology:

The present study was a hospital based cross sectional study, conducted on 939 newborn babies delivered at Mandya Institute of Medical Sciences a tertiary care hospital, over a period of 4 months from November 2022 to February 2023. All live newborns were included in the study. Newborns with congenital anomalies of lower limb, head and chest wall, those with skeletal dysplasia and chromosomal anomaly were excluded. Gestational age was assessed through modified Ballard's scoring within 24hrs of birth. Babies were weighed within one hour of delivery on digital weighing scale (recorded in grams). Foot length of right foot was measured by using a stiff transparent ruler within 24hrs of birth (from posterior most prominence of foot to the tip of longest toe), head circumference of newborn was measured by using non stretchable measuring tape (from occipital protuberance to supra-orbital ridge), chest circumference of newborn was measured (at the level of nipple), length was measured by using infantometer. Foot length, head circumference, chest circumference and length were recorded in centimeter.

Newborns were categorized as preterm, term, post term and further sub- categorized into SGA, AGA and LGA based on intrauterine growth charts.

Data analysis:

All the data thus collected were entered in Microsoft excel sheet. The data was analyzed using Open epi software 3.01. Frequency and percentage were calculated. The correlation between foot length and other parameters such as gestational age, birth weight, head- circumference, chest circumference and length were analyzed using correlation and regression analysis. Scatter diagram was used to see the correlation of foot length with gestational age and other anthropometric parameters.

Results:

Of the 939 neonates included in study 470 were male neonates and 469 were female neonates. 589 were delivered by LSCS and 346 by normal vaginal delivery (table 1).

TABLE 1: Gender of the neonates and mode of delivery (n= 939)

GENERAL CHARACTERISTICS		FREQUENCY (n= 939)	PERCENTAGE (%)
GENDER	**BOY**	470	50.1
	GIRL	469	49.9
MODE OF DELIVERY	**LSCS**	589	62.8

ND	346	36.9
AVD	4	0.3

The mean birthweight of the neonates was found to be 2.88 kg (SD $\pm$0.51). The mean head circumference was found to be 33.34 cm (SD $\pm$1.92). The mean chest circumference was found to be 35.01 cm (SD $\pm$1.93). The mean foot length was found to be 7.07 cm (SD $\pm$0.80). The mean gestational age of the neonates included in the study was 38.27 weeks (SD $\pm$1.74) (Table 2).

TABLE 2: Anthropometric measurements of Neonates (n= 939)

Anthropometric measurements	MEAN	Standard deviation (SD)
Birth weight (kg)	2.88	0.51
HC (cm)	33.34	1.92
CC (cm)	35.01	1.93
Foot length (cm)	7.07	0.80
Gestational age (weeks)	38.27	1.74

A positive correlation was observed between gestational age of neonates with anthropometric parameters like weight, head circumference, chest circumference and foot length. This correlation was found to be significant statistically (Table 3, Figure 1).

Table 3: Correlation of anthropometric measurements with gestational age

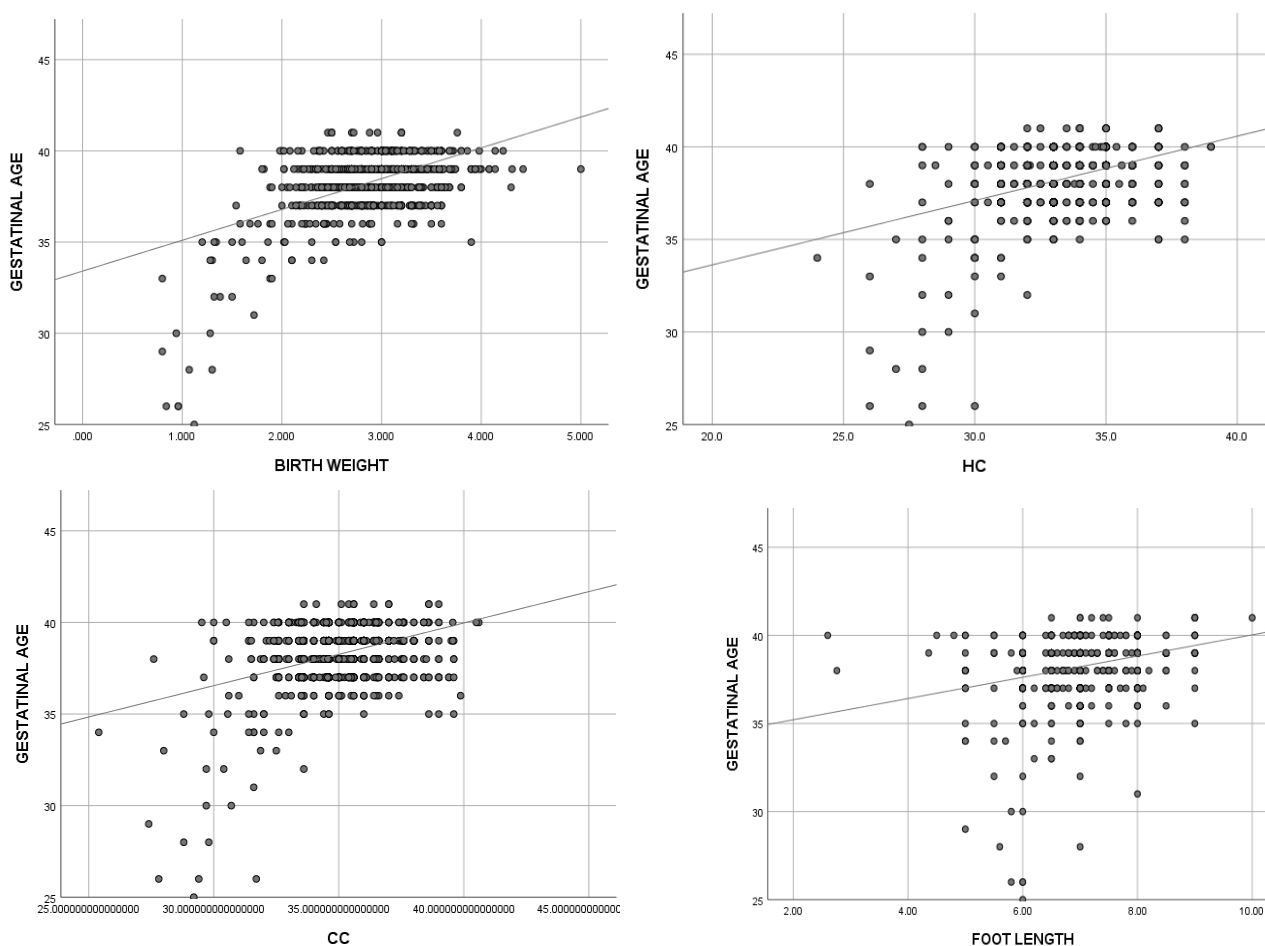| Anthropometric parameter		Gestational age
Birth weight	**Pearson Correlation**	0.497
	Sig. (2-tailed)	< 0.001
HC	**Pearson Correlation**	0.375
	Sig. (2-tailed)	< 0.001
CC	**Pearson Correlation**	0.371
	Sig. (2-tailed)	< 0.001
Foot length	**Pearson Correlation**	0.280
	Sig. (2-tailed)	< 0.001

Figure 1: Scatter Plot of Anthropometric parameters and gestational age of neonates
 Discussion:

Gestational age assessment of neonates at birth becomes important to detect preterm neonates who are at high risk of morbidity and mortality. Antenatal ultrasound scans serves as a baseline against which interval fetal growth can be evaluated throughout pregnancy and offers a noninvasive and accurate estimate of gestational age. To determine the gestational age weight, HC, length and chest circumference are used.[1,2] These conventional biometric parameters do, however, have some limitations (cranial malformations that affect the shape of the skull will affect the HC).[13,14] Present study focused on the role of   foot length measurements in assessment of gestational age.

In the present study, mean birthweight of neonates was 2.88 kg, mean head circumference was 33.34 cm, mean chest circumference was 35.01 cm, mean foot length was 7.07cm and mean gestational age was 38.27 weeks. Positive correlation with statistical significance was found between anthropometric parameters like birthweight, head circumference, Chest circumference, Foot length and the gestational age of the neonates. Foot length had a positive correlation with gestational age (r= 0.28) and this correlation was significant statistically (p= < 0.001).

Gavhane S et al in their study found that the mean foot length was 7.42 cm with a range of 4.5-8.8 cm and standard deviation of 0.57. The foot length correlated significantly (p <0.05) with gestational age, birth weight, head circumference and crown heel length.[15] Sharma V et al also observed that a linear relationship was present between foetal foot length and Gestational age (r=0.985, p<0.001).[16] Hemraj S et al in their study found a strong significant linear statistical correlation between sonographic gestational age and fetal foot length. [17]

Manjunatha B et al found that there was an increase of 4.11 gestational weeks for increase in 1 cm of foot length.[18] Tergestina M et al found that there is a positive correlation between foot

length and gestational age.[19] Folger LV et al in their meta-analysis concluded that Foot length is a simple proxy measure that can identify babies of low birthweight with high sensitivity.[20]

Wyk LV et al observed that the Foot length was shown to correlate well with Gestaional age, birth weight, length and head circumference. Gestational age assessment by Foot Length was found to be more accurate than the assessment Ballard score or LMP (p = 0.05, 95% CI −0.0005; 0.871).[21] Srivastava A et al found that Gestational age and foot length showed a positive correlation.[22] Dagnew N et al in their study observed a statistically significant strong positive correlation between gestational age and foot length (r = 0.865 and p<0.0005).[23]

In this study, foot length was found to be effective as other anthropometric parameters to help in assessment of gestational age. This method may be particularly valuable in ill and unstable infants for gestational age assessment.

Conclusion

Our study demonstrates that there is a statistically significant relationship between gestational age and neonate foot length. Foot length is a low-cost, simple and feasible measurement, with potential to identify gestational age of infants. The foot length (independent variable) is strongly related with the period of gestation. As this method is simple, economical and accurate it can be used by primary health worker even in a rural setup.

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