

Research Article

Correlation of foot length and gestational maturity in neonates

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ABSTRACT

Background: Accurate assessment of gestation maturity is not possible in all newborn infants specially when they are sick and need intensive care support. The aim was to study correlation of foot length (FL) with gestational age and other anthropometric measures at birth among preterm, term and post-term neonates.

Methods: Prospective observational study was done. 800 babies born at MGM Medical College Aurangabad from December 2012 to November 2014 were enrolled. FL at birth was measured from the center of the back of the heel to the tip of the big toe. Gestational assessment was done using modified Ballard's scoring on day one. Based on gestational age, babies were grouped as preterm, term and post term babies. All the three groups of babies were categorised into small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA) groups using lubchenco intrauterine growth curves. Linear regression analysis was done to investigate the relation of FL to gestational age, birth weight (BW), head circumference (HC) and crown heel length (CHL).

Results: There were 52.5% males and 47.5% females. Of the 800 newborns, preterm babies were 124 (15.5%), term babies were 604 (75.5%) and post-term babies were 72 (9%). The mean foot length was 7.42 cm with a range of 4.5-8.8 cm. Foot length correlated significantly ($p < 0.05$) with gestational age, birth weight, head circumference and crown heel length in preterm small for gestational age (SGA), preterm appropriate for gestational age (AGA), term Small for gestational age (SGA) and term appropriate for gestational age (AGA) groups. The correlation coefficient of foot length with gestational age was maximum in preterm AGA ($r=0.81$) and preterm SGA groups ($r=0.75$) followed by term SGA ($r=0.48$) and term AGA ($r=0.44$). Other groups had no correlation between foot length and gestational age. Post-term AGA and post-term SGA groups had correlation between foot length and birth weight.

Conclusions: Foot length correlated significantly with gestational age and other anthropometric parameters in preterm and term infants.

Keywords: Preterm babies, Foot length, Small for gestational age, Birth weight

INTRODUCTION

Accurate assessment of gestation maturity is not possible in all newborn infants specially when they are sick and need intensive care support. Anthropometric measures such as: birth weight, crown heel length and head circumference are the commonly used measures of growth in neonates, and they do correlate fairly with maturity. Weight measurements are significantly affected by changes in water, carbohydrate, fat, protein, and

mineral levels.¹ Although head circumference reflects brain growth, the effect of head sparing during malnutrition may result in an underestimation of growth.^{2,3} The foot of the newborn is usually readily accessible for measurement, even in incubators. It has been shown that foot length measurement is particularly valuable in premature babies who are so ill that conventional anthropometric measurements cannot be carried out due to the incubator and intensive care apparatus.⁴ Previous studies have demonstrated close positive correlation between foot length (FL) and

gestational maturity.^{4,5} The aim of this study was to study correlation of foot length and gestational age among preterm, term and post-term neonates.

METHODS

In this prospective study, physical data of 800 infants were collected and analyzed at MGM Medical College, Aurangabad - a tertiary neonatal unit of a teaching hospital, India. Study duration was from December 2012 to November 2014. Anthropometric measurements were done on all babies within 24 hours of life. Babies with congenital foot were excluded. Gestational assessment was done using modified Ballard's scoring on day one.⁶ Foot length was measured using sliding caliper with an accuracy of one tenth of a millimeter. Foot length was measured from posterior most prominence of foot to the tip of the longest toe of the right foot. Head circumference was measured using flexible, non-stretchable measuring tape. Crown heel length was measured using infantometer. Weight of the baby was measured using electronic weighing scale. The scale had an accuracy of ± 5 grams. Based on gestational age, babies were grouped as preterm, term and post term babies. All the three groups of babies were categorised into small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA) groups. This classification was done by using lubchenco intrauterine growth curves.⁷

Statistical analysis

The data was analyzed using SPSS for Windows (Version 22.0) software. The correlation between foot length and other parameters such as gestational age, birth weight, head circumference and crown heel length was analyzed by applying correlation and regression analysis. Correlation coefficient (r) values and R square (r^2) values were derived for the seven groups of babies who have undergone analysis. Scatter diagram was plotted to demonstrate the correlation between foot length and other anthropometric parameters.

RESULTS

This study included 800 neonates of which males were 52.5% and females were 47.5%. In the study group 203 babies (25.4%) were low birth weight babies, i.e. weight below 2.5 kg. 520 newborns (65%) had birth weight in the range of 2.5-3.5 kg. 77 newborns (9.6%) had birth weight > 3.5 kg. Maximum numbers of newborns were in 2.5-3.5 kg group. Males predominate over females in all groups. Of the total 800 newborns, term AGA, term SGA and term LGA were 509 (63.6%), 72 (9.0%) and 23 (2.9%) respectively. Preterm AGA and preterm SGA were 110 (13.7%) and 14 (1.8%), respectively. Post-term AGA, post-term SGA and post term LGA were 53 (6.6%), 16 (2.0%) and 3 (0.4%), respectively. Maximum numbers of newborns were in term AGA (63.6%) group. There were no newborns in preterm LGA group.

Of the 800 neonates studied, the mean foot length was 7.42 cm with a range of 4.5-8.8 cm and standard deviation of 0.57. The preterm AGA and SGA had a mean foot length of 6.7 and 6.16 cm respectively. The mean foot length for term AGA, SGA and LGA was 7.57, 7.04 and 8.04 cm respectively. The mean foot length for post-term AGA, SGA and LGA was 8.02, 7.57 and 8.27 cm respectively.

The gestational age of 800 babies studied was in the range of 26-42 weeks with a mean of 38 weeks. Classification of neonates according to their gestational age showed preterm 124 (15.5%), terms 604 (75.5%) and post-term 72 (9%). The maximum numbers of babies were in the term group. Out of the 800 neonates studied there were no newborns in preterm LGA group.

The minimum and maximum head circumference of preterm neonates was 21.5 cm and 36 cm respectively. The mean head circumference of preterm SGA was 27.42 cm and of preterm AGA was 30.17 cm. The minimum and maximum head circumference of term neonates was 27 cm and 36 cm, respectively. The mean head circumference was 31.38 cm, 33.01 cm and 34.14 cm for term SGA, term AGA and term LGA, respectively. The minimum and maximum head circumference of post-term neonates was 30 cm and 38 cm, respectively.

Pre-term babies had a maximum crown heel length of 49 cm and minimum of 32 cm. The mean crown heel length of pre-term SGA and pre-term AGA was 40.21 and 42.80 cm, respectively. Term babies had a maximum crown heel length of 52 cm and minimum of 38 cm. The mean crown heel length of term SGA, term AGA and term LGA was 44.83 cm, 47.11 cm and 48.52 cm respectively. Post-term babies had a maximum crown heel length of 52 cm and minimum of 42 cm. The mean crown heel length of post-term SGA, post-term AGA and post-term LGA was 45.87 cm, 48.36 cm and 48.00 cm, respectively.

From Figure 1, it could be observed that the foot length correlated significantly ($p < 0.05$) with gestational age, birth weight, head circumference and crown heel length in preterm AGA. Correlation coefficient (r -value) of all the parameters was highly positive. Maximum correlation was observed with gestational age ($r=0.810$) which indicates strong positive association between them. Similarly, foot length correlated fairly well with gestational age and other anthropometric parameter in preterm SGA group (Figure 2). Figure 3 shows correlation of foot length and other variables in term AGA group. Foot length correlated significantly with all the variables, maximum being with birth weight ($r=0.495$). There was no correlation between foot length and any of the parameters for term LGA and post term infants (Figure 4).

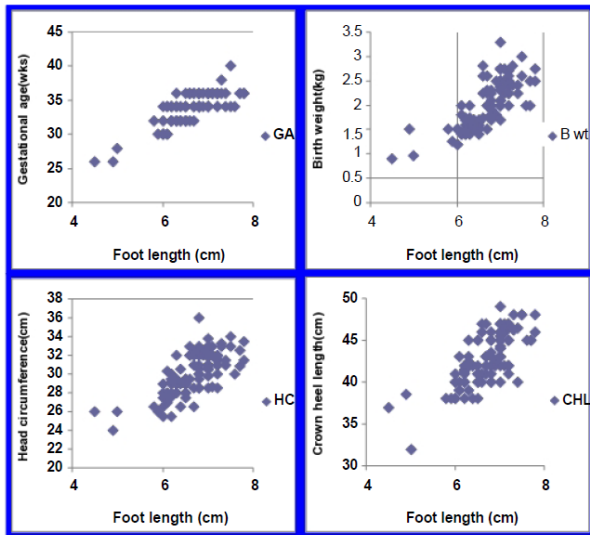


Figure 1: Scatter diagram for preterm SGA.

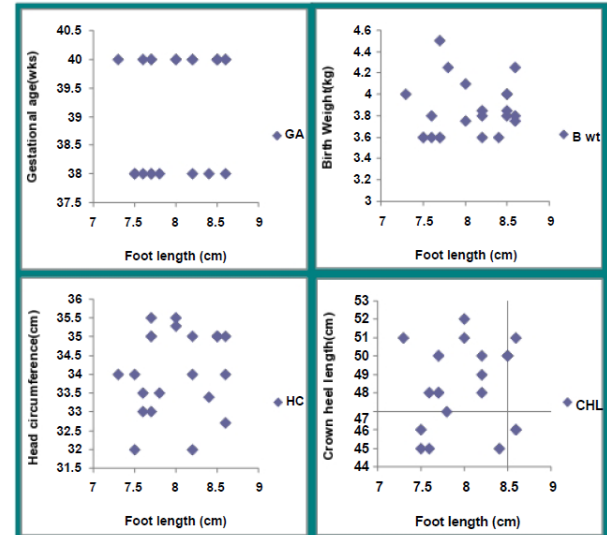


Figure 4: Scatter diagram for term LGA.

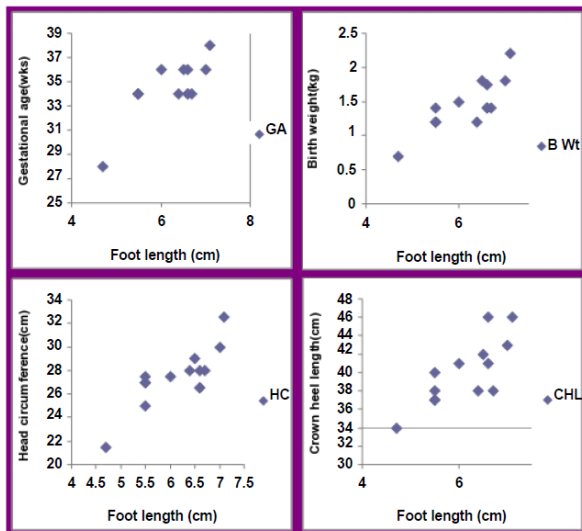


Figure 2: Scatter diagram for preterm AGA.

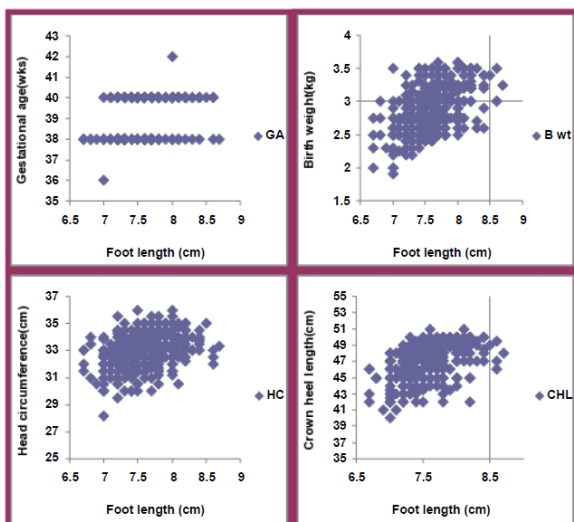


Figure 3: Scatter diagram for term AGA.

DISCUSSION

Current study demonstrated a significant degree of correlation between FL and BW, CHL and HC in term and preterm infants. In term LGA and post term infants, co-relation was poor. James et al demonstrated a positive linear correlation between FL and other indices of babies of gestational age 26-42 weeks.⁴ They concluded that birth weight and crown-heel length could be estimated from a measurement of FL. Gohil et al carried out a similar study with a larger sample.⁵ They found FL correlated well with birth weight, crown heel length, and head circumference. They suggested when it is difficult to weigh or measure the body length accurately, FL can serve as a useful measurement to assess a baby quickly in neonates nursed in incubators and receiving intensive care. This makes the measurement of FL in ill babies an important issue. FL has been proved useful in other clinical conditions.⁸⁻¹¹ Anderson et al reported relationship between FL and stature showed little change with increasing age from 1-18 years. The length from heel to toe maintained the same relationship with the length from heel to head at all ages (during which the foot was increasing in size).⁸ Mercer et al showed that ultrasonography measurement of fetal FL was useful in the assessment of gestational age.⁹ They concluded that fetal FL is a reliable parameter for use in the assessment of gestational age and is particularly useful when other parameters do not accurately predict gestational age for example, hydrocephalus, anencephaly, and short-limb dysplasia. Markowski et al also showed that FL was positively related to gestational age.¹⁰ Pospisilova-Zuzakora reported that fetal FL was related positively to fetal body length.¹¹ A study by Embleton et al showed that FL was the best predictor of naris-midtracheal length.¹² They concluded that FL is a reliable and reproducible predictor of nasotracheal tube length and is at least as accurate as the conventional weight based estimation. This method may be particularly valuable in

ill and unstable infants. The mechanisms that explain the role of FL in various clinical conditions are yet to be elucidated. As FL is a linear body measurement from the fetal period to adolescence, it may correlate closely with gestational age, body weight, body length, head circumference, or tracheal length. The foot was found to grow in synchrony with the body as a whole rather than with the lower extremity.

Several limitations in this study need to be specified: gestation assessment was done by new Ballard score, as obstetric dating was not available in all patients. There are chances of over or under estimation of gestation by this method especially in small for gestation and large for gestation infants. Number of infants was not equal in all gestational groups. There were no infants in preterm LGA group.

CONCLUSION

Foot length correlated significantly with gestational age and other anthropometric parameters like birth weight (BW), head circumference (HC) and crown heel length (CHL) in preterm and term infants.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Lucas A. Enteral nutrition. In: Tsang R, Lucas A, Uaay R, Zlotkin S, eds. Nutritional Needs of the Preterm Infant: Scientific Basis and Practical Guidelines. Baltimore:Williams and Wilkins. 1993:209-24.
2. Cooke RW, Lucas A, Yudkin PL, Pryse DJ. Head circumference as an index of brain weight in the fetus and newborn. Early Hum Dev. 1977;1:145-9.
3. Sparks JW, Ross JC, Cetin I. Intrauterine growth and nutrition. In: Polin RA, Fox WW, eds. Fetal and Neonatal Physiology. Philadelphia: WB Saunders;1992:267-90.
4. James DK, Dryburgh EH, Chiswick ML. Foot length a new and potentially useful measurement in the neonate. Arch Dis Child. 1979;54(3):226-30.
5. Gohil JR, Sosi M, Vani SN, Desai AB. Foot length measurement in the neonate. Indian J Pediatr. 1991;58:675-7.
6. Ballard JL, Novak KK, Driver M. A simplified score for assessment of fetal maturation of newly born infants. J Pediatr. 1979;95(5):769-74.
7. Lubchenco L, Hansman C, Dressler M, Boyd E. Intrauterine growth as estimated from live born birth weight data at 24 to 42 weeks of gestation. Pediatrics. 1963;32:793-800.
8. Anderson M, Blais M, Green WT. Growth of the normal foot during childhood and adolescence:length of the foot and interrelations of foot, stature, and lower extremity as seen in serial records of children between 1-18 years of age. Am J Phys Anthropol. 1956;14:287-308.
9. Mercer BM, Sklar S, Shariatmadar A, Gillieson MS, D'Alton ME. Fetal foot length as a predictor of gestational age. Am J Obstet Gynecol. 1987;156:350-5.
10. Markowski B, Lawler SD. Use of early fetal tissues obtained from suction termination of pregnancy. Lancet. 1977;1:186-8.
11. Pospisilova ZV. Determination of the body length of the fetus with the aid of the length of the sole of the foot. Biologia. 1962;17:49-52.
12. Embleton ND, Deshpande SA, Scott D, Wright C, Milligan DW. Foot length, an accurate predictor of nasotracheal tube length in neonates. Arch Dis Child Fetal Neonatal Ed. 2001;85:60-4.

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