ORIGINAL RESEARCH PAPER

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A STUDY OF CORRELATION OF FOOT LENGTH OF NEONATES WITH GESTATIONAL MATURITY

Dr. Rahul Gaur Post graduate student, Department of Anatomy, J.L.N. Medical College Ajmer,

Dr. Mahima Shrivastava Senior Professor, Department of Anatomy, J.L.N. Medical College Ajmer

Dr. Omprakesh Mali Post graduate student, Department of Anatomy, J.L.N. Medical College Ajmer

Dr. Mohini Binda* Post graduate student, Department of Anatomy, J.L.N. Medical College Ajmer
*Corresponding Author

ABSTRACT

Background: Since decades attempts have been made to find an alternative measurement for gestational age and birth weight estimation of newborns. Appropriate and timely care of a premature and low birth weight newborn is important but this is difficult in developing countries since most of the deliveries are conducted at home where adequate facilities to weigh a newborn does not exist. Foot length has been studied by various authors as proxy measurement which can be measured easily in sick and preterm newborns. This study was done to find correlation of foot length with gestational age and birth weight. **Methods:** It is a hospital-based prospective observational study, 350 newborns were included in the study. The New Ballard score was used to conduct the GA evaluation. Birth weight was measured using electronic weighing scale and foot length was measured using sliding caliper. Using the proper statistical procedures, a correlation between foot length, GA and birth weight was established. **Results:** Among 350 neonates studied. Males predominated over females (64% and 36%). 67% were term, 33% were preterm and 1% were post-term. The mean foot length was 7.171 cm with a range of 4.5-8.7 cm. In this study positive correlation between foot length and gestational age was found with the "r" value of 0.74. The study also showed a positive correlation between foot length and weight with the "r" value of 0.61. **Conclusions:** To conclude, the majority of the newborns in our study showed a strong association between foot length and gestational maturity as well as with birth weight. Foot length is a simple and reliable anthropometric measurement to assess gestational age and birth weight in preterm and term neonates especially who are sick. Foot length can be reliably measured by peripheral heath care workers and could be used effectively for identifying and referring high risk newborns.

INTRODUCTION:

Efforts have been taken since decades to develop an alternative method of estimating a newborn's birth weight and gestational age. To reduce neonatal mortality, it is crucial to provide preterm and low birth weight newborns with appropriate care as soon as possible. But in developing nations, where many births are still made in private homes in remote locations without proper facilities to measure gestational age and birth weight, this is challenging.

Not all newborn infants can have their gestational maturity accurately assessed, particularly if they are ill and require intensive care support. Commonly used anthropometric measurements of growth in newborns include birth weight, crown heel length, and head circumference. These measurements do have a good correlation with gestational maturity. Changes in the concentrations of water, carbohydrates, fat, protein, and minerals have a considerable impact on weight measurements.[1] The effect of head sparing during starvation may cause a growth estimate to be underestimated, even if head circumference indicates brain growth.[2,3]

Thus, all of these variables emphasise the significance of early detection of low birth weight and preterm babies in rural settings without access to medical care facilities and early referral to higher centres. However, the lack of resources in the form of skilled or knowledgeable medical personnel and the absence of essential amenities like weighing machines make the problem worse.[4]

In this study, an association between foot length with gestational age and birth weight were investigated.

MATERIAL AND METHOD:

350 Neonates admitted at J.L.N. Medical College And Associated Group of Hospitals, Ajmer. The study was conducted from November 2021 to November 2022.

Inclusion Criteria

Live newborns of different gestational ages within 5 days of birth.

1. Pre-term (Small-for-gestational age, Appropriate-for-gestational age, Large -for-gestational age)
2. Term (Small-for-gestational age, Appropriate-for-gestational age, Large-for- gestational age)
3. Post-term (Small-for-gestational age, Appropriate-for-gestational age, Large -for-gestational age)

Exclusion Criteria

Neonates having skeletal deformities of the foot.

B) Instruments used

1. Sliding calipers for measuring foot length.
2. Electronic weighing scale for measuring weight.

This was a cross sectional study and the data was collected using standard proforma meeting the objectives of the study.

Foot length was measured using sliding calipers having an accuracy of a millimeter. Foot length was measured from posterior most prominence of foot to the tip of the longest toe of the right foot. The length of foot was documented in centimeters.

Weight of the baby was measured using electronic weighing scale .All the dress of baby was removed before weighing.

Gestational age assessment was done using modified Ballard's score[5]. Preterm, term, and post-term categories for babies were used

Small for gestational age (SGA), appropriate for gestational age (AGA), and large for gestational age (LGA) categories were used to classify all three groups of infants. Utilizing the intrauterine growth curve of Lubchenco, this classification was carried out.[6] The pre-term LGA group and post-term LGA group among the aforementioned groups were not examined since there were insufficient babies in this group to be statistically significant.

The data was analyzed statistically and correlation between foot length and other parameters such as gestational age and birth weight was analyzed.

RESULTS:

Significant correlation was observed between foot length and gestational age in different groups of newborns (preterm AGA, preterm SGA, term AGA and term SGA). Males predominated over females (64% and 36%). 233 (67%) were term, 115 (33%) were preterm and 2 (1%) were post-term. 278 (79%) were AGA, 67 (19%) were SGA and 5 (1%) were LGA.

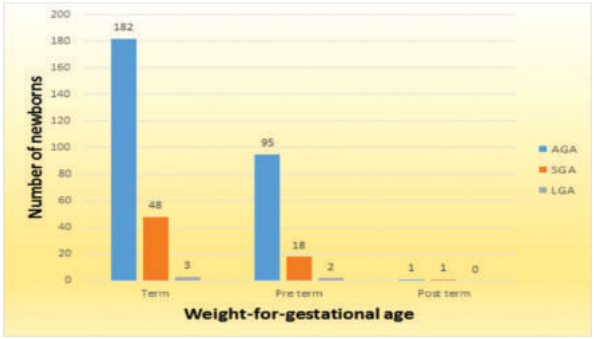

Figure 1: Distribution of babies according to their maturity and weight-for-gestational age

Figure 2: Demonstration of measurement of foot length using sliding caliper

Table 1. Descriptive statistics of the anthropometric variables of the study population

Variables	N	Mean	SD	Range
Foot length(cm)	350	7.17	0.80	4.5-8.7
Gestational age(weeks)	350	36.59	3.49	25-43
Birth weight(kg)	350	2.27	0.67	0.6-4.5

Table 2. Correlation between foot length and anthropometric variables

Anthropometric variables	Number of subjects	Correlation (r)	R-square (r2)	p-value
Gestational age (weeks)	350	0.748	0.560	0.000
Birth weight (kg)	350	0.614	0.377	0.000

The mean foot length was 7.17 cm with a standard deviation of 0.80. The mean gestational age was 36.59 weeks with a standard deviation of 3.49. Mean birth weight was 2.27 kg with a standard deviation of 0.67.

Foot length and Gestational age showed a positive correlation with a correlation coefficient of 0.74. Both AGA and SGA babies showed positive correlation of gestational age with foot length with correlation coefficient of 0.77 and 0.58 respectively.

Foot length and Birth weight also showed a positive correlation with a correlation coefficient of 0.61. Both AGA and SGA babies showed positive correlation of birth weight with foot length with correlation coefficient of 0.70 and 0.38 respectively.

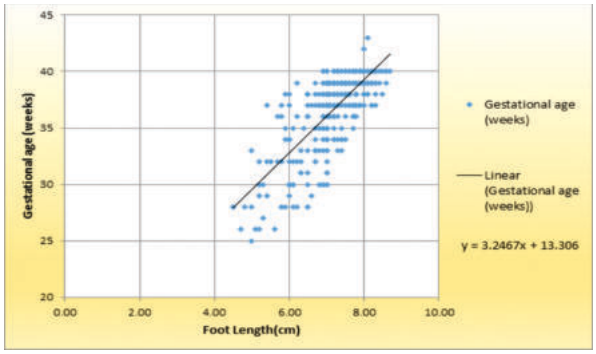

Figure 4: Simple linear regression function to determine the effect of gestational age on baby foot length.

DISCUSSION:

In present study, out of 350 students, 233 (67%) were term, 115 (33%) were preterm and 2 (1%) were post-term. This is comparable with other studies. Gohil JR et al.[7] study showed 10.4% preterm babies and 89.5% term babies. Kulkarni et al.[8] study showed 17.5% preterm and 82.4% term neonates. James et al.[9] study showed 76.4% term and 39.6% preterm neonates. Shambhu Sharan Shah et al.[10] study showed 92.9% term, 6.7% preterm and 0.4% post-term neonates. Majority of the studies have not analyzed anthropometric parameters in post-term neonates.

Among 350 neonates in present study, small for gestational age, appropriate for gestational age, and large for gestational age babies were 19%, 79% and 1% respectively. This is comparable to Shambu Sharan Shah et al.[10] study which showed 13.2% small for gestational age, 84.8% appropriate for gestational age and 2.1% large for gestational age babies. In the present study, in pre-term AGA neonates, foot length correlated significantly ($p < 0.05$) with gestational age and birth weight. Correlation coefficient (r-value) was highly positive for both gestational age and birth weight. Maximum correlation was observed with gestational age ($r = 0.627$) which indicates strong positive association between them, followed by birth weight ($r = 0.481$).

In preterm SGA neonates, foot length correlated significantly ($p < 0.05$) with both gestational age and birth weight. Correlation of foot length with gestational age is $r = 0.815$ and with birth weight is $r = 0.797$.

In the present study, in term AGA neonates, foot length correlated significantly ($p < 0.05$) with both gestational age and birth weight – gestational age ($r = 0.380$), birth weight ($r = 0.206$).

In term SGA babies also, the foot length correlated significantly ($p < 0.05$) with both gestational age and birth weight. Correlation coefficient (r-value) was positive for both gestational age and birth weight – gestational age ($r = 0.504$) and birth weight ($r = 0.543$).

James et al.[9] study showed that there was a positive linear correlation between foot length and other indices of body size (birth weight, head circumference, crown rump length

and crown heel length) in SGA and AGA babies of all gestational ages. However, in premature babies the correlation between foot length and birth weight (r = 0.95) and foot length and crown heel length (r = 0.96) was pronounced. In SGA babies, the correlation coefficient (r) of foot length with birth weight, head circumference, crown rump length and crown heel length were r = 0.91, 0.82, 0.89 and 0.88, respectively. In AGA babies the correlation coefficient (r) of foot length with birth weight, head circumference, crown rump length and crown heel length were 0.89, 0.90, 0.88 and 0.91, respectively.

Gohil JR et al.[7] study showed significant relationship between foot length and other body parameters (crown heel length, head circumference, birth weight) in preterm and term neonates. The highest correlation of foot length in term SGA and term AGA babies for foot length was with head circumference (r = 0.74 and 0.64 respectively) indicating that foot length and head circumference are affected in a similar fashion in term babies. In preterms, foot length correlated well with crown heel length, head circumference and birth weight (r = 0.92, 0.84 and 0.92 respectively).

The present study results were comparable to those of James et al.,[9] Gohil JR et al.[7] and Shambhu Sharan Shah et al.[10] In the present study, foot length correlated significantly with gestational age and birth weight in preterm SGA, preterm AGA, term SGA and term AGA babies. Preterm newborns' correlation coefficient values were significantly higher than those of term babies. In preterm babies, correlation of foot length was more with gestational age (r = 0.627 in preterm AGA and r = 0.815 in preterm SGA) and birth weight (r = 0.481 in preterm AGA and r = 0.797 in preterm SGA).

In term babies also, foot length correlated significantly ($p < 0.05$) with other anthropometric variables. The correlation of foot length to birth weight and crown heel length (r-value) in term babies is comparable to Gohil JR et al.[7] study. The correlation coefficient of head circumference in relation to foot length in term SGA babies is comparable with Shambhu Sharan Shah et al.[10] study.

CONCLUSION:

Significant correlation was observed between foot length and gestational age in different groups of newborns (preterm AGA, preterm SGA, term AGA and term SGA). Foot length also correlated with birth weight significantly. Foot length is an easy, rapid, and accurate anthropometric measurement that can be used as a proxy for birth weight and gestational age estimation, particularly in critically ill and preterm newborns receiving intensive care. It can be easily measured by medical practitioners and traditional birth attendants in the community.

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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. Pratinidhi AK, Shrotri AN, Shah U, Bodhani ND. Domiciliary care of low birth weight neonates. Indian Journal of Pediatrics 1986;53:87-92.
5. Ballard JL, Khoury JC, Wedig K, et al. New ballard score, expanded to include extremely premature infants. Journal of Paediatrics 1991;119:417-23.
6. Lubchenco LO, Hansman C and Boyd E. Intrauterine growth in length and head circumference as estimated from live births at gestational ages from 26 to 42 weeks, Pedaitrics 1966;37:403)
7. Gohil JR, Sosi M, Vani SN, Desai AB. Foot length measurement in the neonate. Indian Journal of Pediatrics 1991;58:675-7.
8. Kulkarni ML, Rajendran NK. Values for foot length in newborns. Indian Pediatrics 1992;29:507-9.
9. James DK, Dryburgh EH, Chiswick ML. Foot length – a new and potentially useful measurement in the neonate. Archives of Disease in Childhood 1979;54:226-30.
10. Shah SS, Shrestha PS, Gami FC. Detection of low birth weight newborns by footlength as a proxy measure of birth weight. Archives of Disease in Childhood 2005;90(Suppl 2):A9-A10.