A STUDY OF CORRELATION OF FOOT LENGTH AND GESTATIONAL MATURITY IN NEONATES

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ABSTRACT

BACKGROUND
Gestational age estimation at birth can be done by clinical estimation through careful history of LMP, ultrasonic estimation of gestational age, date of first recorded foetal activity "quickening" first felt at approximately 16-18 weeks, Date of first recorded foetal heart sounds.

MATERIALS AND METHODS
A study sample of 800 live newborns were selected by simple random sampling technique born at GVR hospital and Government General Hospital, Kurnool from April 2015 to May 2016. Data was collected using standard proforma meeting the objectives of the study. a) Gestational age assessment was done using modified Bellard's score and b) Foot length was measured using sliding calipers which is having an accuracy of a millimeter. Following instruments are used: 1) Sliding calipers for measuring foot length, 2) Flexible, non-stretchable measuring tape for head circumference, 3) Infantometer for measuring crown heel length, 4) Electronic weighing scale for measuring weight.

RESULTS
The foot length of preterm neonates ranged from 4.5-7.8 cm with the mean foot length of 6.1571 cm and 6.6964 cm for preterm SGA and AGA, respectively. The foot length of term neonates ranged from 5.4-8.7 cm with a mean foot length of 7.0471 cm, 7.5703 cm, 8.0391 cm for term SGA, AGA, LGA respectively. The foot length for post term neonates ranged from 6.7-8.8 cm, with a mean foot length of 7.5688 cm, 8.0170 cm and 8.2667 cm for post term SGA, AGA and LGA, respectively. This shows that foot length increases as the gestational age increases.

CONCLUSION
Foot length can be correlated significantly with the gestational age, birth weight, head circumference and crown heel length.

KEYWORDS
Small for gestational age, Appropriate for gestational age, Large for gestational age, Birth weight, Foot length.

BACKGROUND
The most challenging part of the infant mortality is the large proportion of newborn deaths, contributing to an estimated 64% of all infant deaths, mostly in the first weeks of life. Major causes of neonatal mortality are diseases associated with preterm birth, low birth weight and lethal congenital abnormalities. Thus, birth weight is an important indicator of survival, future growth and overall development of child. It is associated with socio-economic, clinical, racial, hereditary, personal and geographical factors.

Low birth weight is associated with high neonatal morbidity and mortality due to susceptibility to adverse environmental influence, predilection to infections and difficulties in maintaining adequate nutrition. Low birth weight is also associated with post neonatal mortality and with infant and childhood morbidity. Neonates should be classified by gestational age as this is more meaningful than that based on birth weight. Small-for-gestational age infants are at high risk for poor postnatal growth. Birth weight and gestational age have traditionally been used as strong indicators for the risk of neonatal death. For any given weight, the shorter the gestational duration, the higher the neonatal mortality; for any given duration of gestation, the lower the birth weight, the higher the neonatal mortality. All these factors thus underlie the importance of early identification of low birth weight and preterm babies at the rural setup where no medical care facilities are available and early reference to higher centres. But the situation is made worse due to non-availability of resources in the form of

trained or expert health care staff and lack of basic facilities such as weighing machines.

Aims and Objectives
1. To study the correlation of foot length and gestational age among preterm, term and post-term neonates.
2. To Study whether foot length can be used as a proxy measurement to birth weight and gestational age assessment.

Inclusion Criteria
1. Preterm (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
1. Babies who were having skeletal deformities of foot.

MATERIALS AND METHODS

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RESULTS

This study included a total of 800 neonates of which males were 52.5% and females were 47.5%. In this study group 203 babies were low birth weight babies; 520 babies were normal birth weight and 77 newborns are birth weight >3.5 kg.
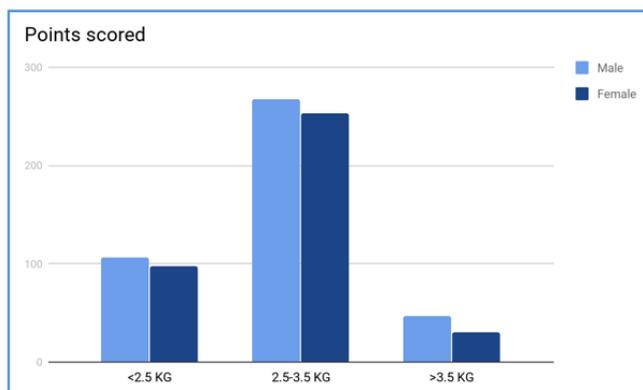
Graph 1. Bar Diagram Showing Number of Male and Female Newborns Included in the Present Study

Maturity	AGA		SGA		LGA		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Term	509	63.6	72	9.0	23	2.9	604	75.5
Preterm	110	13.7	14	1.8	0	0	124	15.5
Post-term	53	6.6	16	2.0	3	0.4	72	9.0
Total	**672**	**83.9**	**102**	**12.8**	**26**	**3.3**	**800**	**100**

Table 1. Showing Distribution of Babies according to their Maturity and Weight-for-Gestational Age

Maturity	No. of Subjects	Range	Mean
Preterm SGA	14	4.7-7.1	6.1571
Preterm AGA	110	4.5-7.8	6.6964
Term SGA	72	5.4-8.0	7.0417
Term AGA	509	6.7-8.7	7.5703
Term LGA	23	7.3-8.6	8.0391
Post-term SGA	16	6.7-8.3	7.5688
Post-term AGA	53	7.2-8.7	8.0170
Post-term LGA	3	7.8-8.8	8.2667
Total	**800**	**4.5-8.8**	**7.4235**

Table 2. Descriptive Statistics of Foot Length for Different Groups of Babies

Maturity	No. of Subjects	Range	Mean
Preterm SGA	14	28-38	34.4286
Preterm AGA	110	26-40	34.1455
Term SGA	72	36-40	38.6667
Term AGA	509	36-40	38.9194
Term LGA	23	38-40	39.2174
Post-term SGA	16	42-42	42.0000
Post-term AGA	53	42-42	42.0000
Post-term LGA	3	42-42	42.0000
Total	**800**	**26-42**	**38.4475**

Table 3. Descriptive Statistics of Gestational Age for Different Age Group Of Babies

From the above two tables it can be concluded that the foot length increases as gestational age increases. The foot length of preterm neonates ranged from 4.5-7.8 cm with the mean foot length of 6.1571 cm and 6.6964 cm for preterm SGA and AGA, respectively. The foot length of term neonates ranged from 5.4-8.7 cm with a mean foot length of 7.0471 cm, 7.5703 cm, 8.0391 cm for term SGA, AGA, LGA respectively. The foot length for post term neonates ranged from 6.7-8.8 cm, with a mean foot length of 7.5688 cm, 8.0170 cm and 8.2667 cm for post term SGA, AGA and LGA, respectively. This shows that foot length increases as the gestational age increases.

DISCUSSION

The findings of our study can be comparable to Kulkarni et al. study which showed mean foot length of preterm neonates ranged from 4.6 cm to 6.89 cm and the men foot length of term neonates ranged from 6.99 cm to 7.58 cm. Gohil JR et al. study showed the mean foot length of preterms as 6.56 ± 0.43 cm, term SGA as 7.13 ± 0.26 cm and of term AGA as 7.6 ± 0.33 cm which is comparable with the present study. Shambhu Sharan shah et al. study showed the mean foot length in preterms as 7.18 ± 0.57 cm and terms as 8.0 ± 0.28 cm which are slightly higher than

ours. parameters such as a chest and arm circumference and length of baby and its correlation with birth weight were analysed in a study done by Nikorn Dusitsin[1] this study was done to find an alternative to birth weight measurement so that it can be used at primary health care level in developing countries like India where majority of births are conducted at home and the measurement of birth weight is very difficult due to non-availability of weighing machine. Fazhul Huque and Zakir Hussain[2] in 1991 found cut offs for chest circumference (30.14 cm) thing circumference (14.56) and a mid-arm circumference of 8.9 cm which corresponded well with birth weight of 2.5 kg and homemade measuring tape has been devised based on mid arm circumference to detect birth weights with cut off values for 2500 g, 2000 g to 2500 g and 2000 g in different shades of colour for illiterate attendants. Sharma JN et al[3] concluded that gestational age had a good correlation with birth weight and crown heel length. They also concluded that birth weight had a good correlation with mid arm circumference and chest circumference. They have suggested these measurements as an alternative to birth weight and gestational age assessment. Bhatia BD et al[4] concluded that there is a good correlation between arm circumference and birth weight. Dubowitz LMS et al[5] in 1970 described ''clinical assessment of gestational age in the newborn infant''. Ballard JL et al.[6] described a simplified score of foetal maturation of newly born infants'' and in 1991 published ''New Ballard score'' expanded to include extremely premature infants. Neela et.in 1991 described usefulness of calf circumference at a measure for screening low birth weight infants. De-Vaquera MV et al[7] in 1983 published their study on relationship between arm circumference at birth and early morality. Bhargava SK et al[8] in 1985 described mid-arm and chest circumference at birth as predictors of low birth weight and neonatal mortality in the community. Bhat et.al In 1995 studied efficiency of various anthropometric measurement in determining low birth babies and found calf circumference as the most effective alternative. One of the anthropometric parameter which has fascinated researchers since decades is foot length. Many studies have been done regarding the correlation between foot length, gestational age and birth weight. These studies have been done antenatally by ultrasonographic measurements and postnatally through direct measurement Transvaginal sonography was done by Kustermann et.al to measure foetal anthropometric parameters and find the correlation between these parameters and gestational age, among crown rump length biparietal diameter head circumference and abdominal circumference, crown rump length was found to have best correlation to gestational age. Piatt LD et al in their study described that the ultrasonic measurements of foetal foot length gave a reliable assessment of anatomical foetal or neonatal foot length and was highly correlated to the gestational age of the foetus. Kumar GP et al have reported that gestational age of the foetus can be estimated from hand and foot length. They found that the period of gestation in weeks can be obtained from foot length by b3, 4863 and adding 8.8649. Hem WM et al correlated foetal

measurements, especially foetal foot length is the most accurate the source for the determination of foetal age, followed by the measurements of the biparietal diameter and the foetal weight. One hundred and four patients ranging from 13-21 weeks of gestation were studied sonographical prior to abortion. The sonographic foetal measurements taken after abortion. Goldstein 1 et al.in their study showed a significant correlation between foetal foot length and gestational age and between foetal foot length and femur length. Mercer BM et al showed ultrasonography measurement of foetal foot length and reliable parameter use in the assessment of gestational age especially when other parameters do not accurately predict gestational age as in conditions like hydrocephalus, anencephaly and short limb dysplasia. Mhaskar R et al in their study of foetuses in the age group 13-42 weeks gestation demonstrated a strong correlation between foot length and gestational age. Daga Ret al. have suggested foot length corresponding to 34 weeks gestational age as a cut-off point for identifying a newborn risk. Successful breastfeeding (i.e. coordinated sucking and swallowing) is possible in most newborns at 34 weeks gestation. However, the birth weight at which this is achieved is very difficult to determine. If a simple method of maturity assessment was available, gestational age, an appropriate cut-off point may become a logical choice for detecting a newborn at risk. Measurement of foot length from footprint for predicting gestational age is a simple and reliable method. Daga SR et al. have utilized foot length measurement in rural born newborn care in Ganjad primary health center, Dahanu, India. Anganwadi workers were trained to make a home visit on the day of birth of a baby and to assess the size of the baby from footprint. They referred babies with a foot length less than 6.5 cm to a PHC. Babies were foot length in the range 6.5-7 cm were observed in the home. Traditional birth attendants (TBAs) were also trained in this programme. Neonatal and perinatal mortality rates declined appreciably over 3 years so, foot length can be used as an alternative measurement for identifying low birth weight. Dighole RV et al in managing very -low-birth-weight (VLBW) babies in a rural area have taken help of the foot length as a substitute for the birth weight. Under a rural neonatal care programme, care of newborns was administered at home mainly by trained TBAs in area covered by the Ganjad primary health care. Foot length was used as substitute for birth weight to help identify VLBW babies needing hospital care. Hirve S.S et al in their study have used as a neonatal foot length as approximate measure for birth weight. They devised a tri-coloured foot tape intended for use at home by the neonatal caretaker or birth attendant. Interobserver reliability comparing a trained medical social worker and household member was high They have suggested foot tape measurement method to be a low-cost technology to identify low birth weight babies at home. Mathur et al in their study showed to heel length and birth weight in preterms and low birth babies. The body surface area for estimating drug does can be easily calculated from weight from weight and derived from foot length by regression hence, foot length proves to be a valuable

anthropometric measurement, especially for low birth weight and critically ill infants who require minimum handling. James DK et al showed a positive linear correlation between foot length and other indices of body size like occipitofrontal circumference, crown-rump and crown heel length, birth weight in SGA and AGA babies of all gestational ages. In premature babies the correlation between foot length and birth weight (r=0.95) and foot length and crown heel length as a valuable measurement in premature babies who are too ill for conventional anthropometric measurements.

CONCLUSION

Significant correlation was observed between foot length and gestational age in different groups of newborns. The correlation of foot length with gestational age was higher in preterm neonates than in term neonates. Term SGA babies showed higher correlation of foot length with birth weight.

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