Original Research Article

Foot length as a screening tool for identification of preterm babies: a cross sectional study

Ananya S. L. Tenali[1], Ravi Kumar Tenali[2]*

Department of Pediatrics, [1]Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, [2]RICH Hospitals, Kasturidevi Nagar, Pogathota, Nellore, Andhra Pradesh, India

*Correspondence:
Dr. Ravi Kumar Tenali,
E-mail: ananyatenali@gmail.com

ABSTRACT

Background: India is one of the countries with the highest neonatal mortality, for which preterm birth is considered as major cause (43.7%). Therefore, early identification by a simple screening tool is important for prognostication and follow-up of new-born infants, especially preterm.

Methods: Cross-sectional study was conducted on 300 live newborns at Saveetha Hospital in Kanchipuram. Anthropometric measures such as birth weight, crown-heel length, head circumference, foot length were taken within 3 days of life and gestational age assessment was done by new Ballard scoring after calculation by Naegles formula. Neonates were grouped into preterm, term and post-term and also small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA). Minimum to maximum range of variables in each gestational range was calculated. The sensitivity and specificity of each variable was found using receiver operating curve. Parameter having the highest sensitivity and good specificity was considered as potential screening tool to identify high risk babies. SPSS Software version 17 for windows was used.

Results: The range of gestational age, length, foot length, birth weight and head circumference was 28-42 weeks, 35-53 cm, 5-8.8 cm, 0.8-4.7 kg and 22.8-54.3 cm respectively. Among all, maximum sensitivity at 37weeks gestational age was seen with foot length (80.57%) at a cut-off of 7.58 cm. A nomogram of foot length for each gestational age group (range of 2 weeks) was also derived.

Conclusions: It can be concluded that foot length has the potential to be considered as a screening tool to identify preterm neonates especially at a concentrated community level and is particularly useful in resource constraint countries.

Keywords: Anthropometric measures, Foot length, Neonatal mortality, Senitivity, Screening tool

INTRODUCTION

Neonatal mortality is defined as the probability of dying in the first month of life while the neonatal mortality rate (NMR) is the number of deaths among all live births during the first 28 days of life expressed per 1000 live births.[1,2] According to the WHO and maternal and child epidemiology estimation group (MCEE), 45% of under 5 deaths happen within neonatal period.[3] Globally, there is

47% decline in neonatal mortality from 1990–2015 which refers to a decrease from 36 to 19 neonatal deaths per 1000 live births. Even then, the decline in rate has been slower than that of post-neonatal under-five mortality, which is 58%. This pattern is seen in most low and middle-income countries including India.[1] Of the estimated 5.9 million child deaths in 2015, almost 1 million occurred in the first day of life and close to 2 million died in the first week.[4] As per united nations inter-agency group for child mortality estimation

(IGME), India is one of the countries with the highest number of neonatal deaths.[5] Globally, the main causes of neonatal deaths were complications related to preterm birth (35%) followed by intra-partum related complications (24%) and sepsis (15%).[4] In India also, complications due to preterm birth (43.7%) constituted the majority of neonatal deaths.[2] Preterm infants have a higher risk of morbidity. Complications like retinopathy of prematurity, anemia of prematurity, osteopenia of prematurity, necrotizing enterocolitis, intra ventricular hemorrhage; neuro-developmental disabilities ranging from cerebral palsy, mental retardation and sensory impairment to more subtle disorders, including language and learning problems, attention deficit hyperactivity disorder, behavioral and social-emotional difficulties are more common in premature infants.[6] Therefore preterm babies are considered as babies at risk. Neonatal morbidity can be reduced on a potential level by early identification of babies at risk at the community level particularly in peripheral medical centers. When early identification of high risk babies is done then, community level interventions including kangaroo mother care, immediate and frequent breastfeeding and active care seeking could reduce neonatal morbidity rates to large extent.[6,7]

Parameters such as birth weight, crown-heel length and head circumference are commonly used as predictors of growth and maturity in neonates. Anthropometric measurements like birth weight and length are significantly affected by changes in water, carbohydrate, fat, protein, and mineral levels. Though head circumference reflects brain growth, the effect of head sparing during malnutrition may result in an underestimation of growth restriction. It has also been stated that foot length is the least affected anthropometric measurement in intra uterine growth restricted babies.[8] So, the aim of the study was to assess if foot length of a neonate can be used as a screening tool for identification of preterm babies.

METHODS

This is a cross sectional study conducted from June 2016 to June 2017 at Saveetha Hospital, a tertiary care center in Kanchipuram where 80% patient flow is from surrounding rural health centers and primary health centers. 300 live born babies were included in this study excluding only neonates with chromosomal abnormalities like Down's syndrome or those with congenital anomalies affecting the head and lower limbs. Neonates with lower limb edema or foot asymmetries were also excluded. Gestational Age was calculated based on dates using Naegle's formula and confirmed by clinical Scoring. For this, New Ballard's scoring system was used.[9] By 3 days of life, anthropometric measurements were done for all the neonates. Birth weight was recorded using digital scale (CIBI) with ±500 mg accuracy. Foot length was measured in the right foot of all the neonates for the sake of uniformity using automated digital vernier calipers. Foot length was measured from posterior most prominence of the foot to the tip of the longest toe, using the paddle blades of the sliding calipers. Length of the neonate was measured with the help of infantometer. Birth weight, length, foot length was done on the 1st day of life. Head circumference was measured with the help of non-stretchable measuring tape on the 3rd day of life. After data collection, babies were categorized into preterm, term and post term based on gestational age assessment and were further grouped to small for gestational age (SGA), appropriate for gestational age (AGA), large for gestational age (LGA) using Lubchenco chart.[10] Data was entered in excel sheets and analyzed using SPSS Software version 17 for windows. Minimum to maximum range of variables in each gestational range was calculated. The sensitivity and specificity of each variable was calculated using receiver operating curve. Parameter having the highest sensitivity and good specificity was considered as the cut off to identify high risk babies.

RESULTS

Of the 300 babies, 38% were preterm and 29% were small for gestational age babies while there was no statistical significance in male and female distribution. In our study, the minimum to maximum range of variables in each gestational range was given in Table 1.

Table 1: Range of anthropometric variables in each gestational age group.

Gestational age range (weeks)	Length (cm)	Head circumference (cm)	Birth weight (kg)	Foot length (cm)
28-<30	35-37	22.8-26.1	0.8-1	5-5.5
30-<32	45.8-45.8	30.5-30.5	1.4-1.4	6-6
32-<34	43.8-46	29.6-32.2	1.1-1.6	6-6.8
34-<36	44-49	30.2-33.3	1.6-3.3	6-7.4
36-<38	37.5-49.5	29-46.5	1.2-3.1	6.2-7.58
38-<40	34.8-53	30-49.9	1.2-4.4	6.8-8.9
40-<42	46-53	32.5-54.3	2.3-4.7	7-8.8

The foot length range in our study population was 5-8.9 cm. In Preterm it was from 5-7.58 cm whereas in term the range was 6.8-8.9 cm and in post term babies it was 7-8.8 cm. To identify newborn of less than 37 completed weeks of gestation a receiver operating curve was done for all anthropometric measures against Ballard scoring. The first step was to identify the cut off value for each

anthropometric measure based on the value giving 80% sensitivity. Foot length had the highest sensitivity and specificity among all the other variables and the cut off value corresponding to 37 weeks of gestational age is 7.58 cm.

Once the cut off value was obtained ROC curve was plotted, for each anthropometric variable.

Table 2: Cut off value for each anthropometric measurement for 37 completed weeks.

Anthropometric variables	Cut off value	Sensitivity (%)	Specificity (%)
Birth weight (kg)	2.66	69.52	81.94
Head circumference (cm)	33.45	79.04	80.09
Length (cm)	47.7	69.04	81.01
Foot length (cm)	7.58	80.57	83.33

Area under curve for birth weight was 0.766, head circumference was 0.755, length was 0.714 and foot length was 0.798. We found that foot length had the maximum area under curve followed by birth weight. Therefore we infer that foot length has higher accuracy in predicting the gestational age of preterm babies. In this study the following normogram of neonatal foot length for each gestational age range was obtained.

Table 3: Normogram of foot length in our study.

Gestational age (weeks)	Foot length (cm)
28-<30	5-5.5
30<32	6-6.1
32-<34	6.1-6.8
34-<36	6-7.4
36-<38	6.2-8
38<40	6.8-8.9
40<42	7-8.8

Figure 1: ROC curve for anthropometric measurements.

DISCUSSION

Foot length increases along with gestational age. In our study the range of foot length in preterm babies was 5-8 cm. In the studies done by Kulkarni et al, Gohil et al, Shah et al and Rakkappan et al the foot length of preterm neonates was 4.6 to 6.89 cm, 6.13-6.99 cm, 6.61-7.75 cm and 5.51-6.37 cm respectively.[8,11,13] These studies showed a foot length range which is slightly lower than the values in the present study. This could be due to the fact that in the present study one Preterm baby was LGA with a foot length of 8 cm, which is a rarity. But in the study by Saroj et al the foot length range in preterms was 6.2-8.5 cm, the upper limit of which was similar to the present study which may be because in that study also there was one LGA baby with foot length of 8.5 cm.[14]

The foot length of term neonates in present study was 6.8 to 8.9 while in study by Kulkarni et al ranged from 6.99 cm to 7.58 cm which is lower range from the present study.[8] Rakkappan et al study showed foot length values of 6.4-8.3 cm which is nearly similar to present study.[13] This mild variation in values may be due to variation in the range of gestational age of the neonates enrolled in these studies.

In this study, foot length of 7.58 cm was found to be the cut-off point for identification of neonates with 37 completed weeks of GA (preterm). This finding is similar to that obtained by Daga et al and Kim et al study.[15,16] These studies showed that foot length of 7.47 cm and 7.5 cm serve as a reliable index of prematurity (37 completed weeks) respectively. Whereas Kumar et al, suggested 6.5 cm as a cut off point for identifying a newborn at risk (preterm).[17] This minor variation may be due small sample size. In this study, with mentioned cut off value, foot length had higher sensitivity and specificity in predicting Preterm gestation which was similar to various studies such as Saroj et al (<7.28 cm); Mathur et al (<7.2 cm); Merchant et al (<7.2 cm) and Mukherjee et al (<7.85 cm).[14,18-20] This is the first study done in Kanchipuram
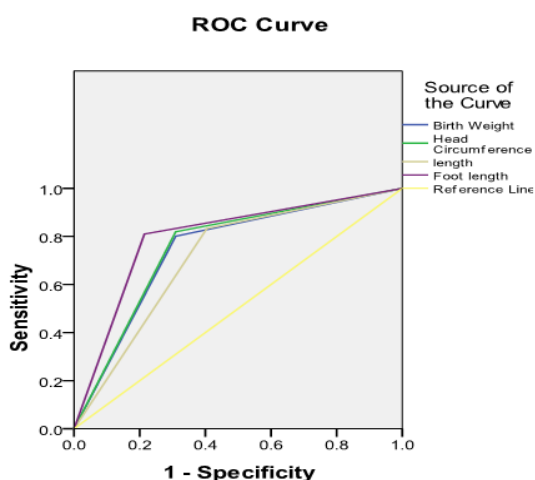
region on finding a reliable and simple screening tool to identify preterm babies. Nevertheless, some limitations like being a hospital based study in a concentrated population with limited sample size are present, so warrants further studies in wider population.

CONCLUSION

It can be concluded that foot length has the potential to be considered as a screening tool to identify preterm neonates especially at a concentrated community level and is particularly useful in resource constraint countries.

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