Original Article

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Measuring New Born Foot Length to Identify Small Babies in Need of Extra Care: a Cross-Sectional Hospital Based Study

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Abstract

Objective: The neonatal mortality rate (NMR) continues to remain quite high, one important cause being preterm deliveries. The main obstacle in the pathway towards decreasing NMR is identification of babies in need of extra care. To analyze the utility of newborn foot length as a proxy measure for birth weight and gestational age.

Methods: A cross-sectional study done in a hospital of eastern India with 351 babies during 4 months. Right foot length of each recorded using a plastic, stiff ruler.

Findings: 48.1% babies were preterm, 51.8% low birth weight (LBW) and 33.3% very low birth weight (VLBW). Foot length less than 7.75 cm has 92.3% sensitivity and 86.3% specificity for identification of preterm neonates. For identification of LBW babies (<2500 gm) a foot length less than 7.85cm has 100% sensitivity and 95.3% specificity. Foot length less than 6.85 cm has 100% sensitivity and 94.9% specifity for identification of VLBW babies (<1500 gm).

Conclusion: Foot length may be used in the identification of LBW and preterm babies who are in need of extra care.

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Key Words: Neonatal Mortality; Preterm; Low Birth Weight; Foot Length

Introduction

The proportion of child deaths that occur in the neonatal period is increasing. Every year over 4 million babies die in the first four weeks of life. Three-quarter of neonatal deaths occur in the first week, the highest risk of death is on the first day of life[1]. Globally, the main direct causes of neonatal death are estimated to be preterm birth (28%), severe infections (26%), and asphyxia (23%). Low birth weight (LBW) is an important indirect cause of death[1]. Preventing death in newborn babies has not been a focus of child survival or safe motherhood programs. While we neglect these challenges, 450 newborn children die every hour, mainly from preventable causes[1].

There are a number of reasons why our potential to reduce the burden of neonatal death is not currently realized on a large scale[2-4]. One problem is identification of babies at risk. A large number of all babies born in India are born at home and the majority of communities have no access to scales or other means by which to identify a baby as preterm, LBW in need of extra

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care.

Here we report a study on the use of newborn foot length to identify LBW and preterm babies and give the sensitivity and specificity estimates for different foot length cut-offs. The aim was to determine the utility of using foot length as a screening tool to identify LBW or preterm babies in need of extra care.

Subjects and Methods

A cross-sectional study was conducted from August to December 2011 in the maternity ward of a tertiary care hospital in Eastern India. The hospital is located in an urban area with around 70% patients being referred from various rural primary health centers, block primary health center and district level hospitals. 351 babies were included in the study. All babies born during the period were included excluding those with congenital anomaly, all sick newborns (birth asphyxia, meconium aspiration syndrome etc) and also extremely LBW babies. Large for date babies were also excluded from the study.

Gestational age of each newborn was calculated using new Ballard score. Right foot length of each baby was measured from the heel to the tip of great toe using a plastic stiff transparent ruler. All measurements and also gestational age assessment was repeated by 4 observers and inter-observer reliability compared. The observers were all doctors who were trained for 1 week prior to the start of data collection. All measurements were done from 12 to 24 hrs of birth after taking informed consent from the mother. Birth weight was measured using digital Salter scale. Babies were grouped as 1) preterm<37 weeks; 2) LBW <2.5 kg; 3) very low birth weight (VLBW) <1.5 kg. These babies were considered 'at risk' and in need of special care. The mode of delivery whether normal vaginal or cesarean section was also noted.

Data was entered in excel data sheet and analyzed using statistical software SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean±sd. Sensitivity and specificity of each foot length was calculated using non-parametric receiver operating curve[5]. Foot lengths having good sensitivity and also good specificity were considered as cut-offs for identification of 'at risk' babies. Inter-observer variation was calculated using kappa statistics. Kappa ratio was found to be 0.81. Ethical approval was taken from the institutional ethics committee.

Findings

Of 351 newborns included 169 (48.1%) were preterm (<37 weeks), 182 (51.8%) were LBW (<2.5 kg) and 117(33.3%) VLBW (<1.5 kg). One-hundred ninety newborns were males. There was no statistical difference between male and female foot lengths (P>0.05). Mean gestational age was 36.37 (±3.6) weeks, mean birth weight 2.09 (±0.81) kg and mean foot length was 7.33 (±1.16) cm. Out of 351 newborns, 241 (68.6%) babies were born by normal vaginal delivery while 110 (31.3%) by cesarean section. The objective was to find out a foot length having a very good sensitivity so as to assess the utility of using this anthropometric surrogate as a screening tool in identification of LBW and preterm babies. This screening method may help in providing live-saving home care or referral decisions to higher centers for babies in need of extra care. It may be particularly useful at the community level in low resource settings where most births occur at home, almost out of reach for clinical evaluation by a trained physician. Foot length less than 7.75 cm has 92.3% sensitivity and 86.3% specificity for preterm identification (Fig 1). For identification of

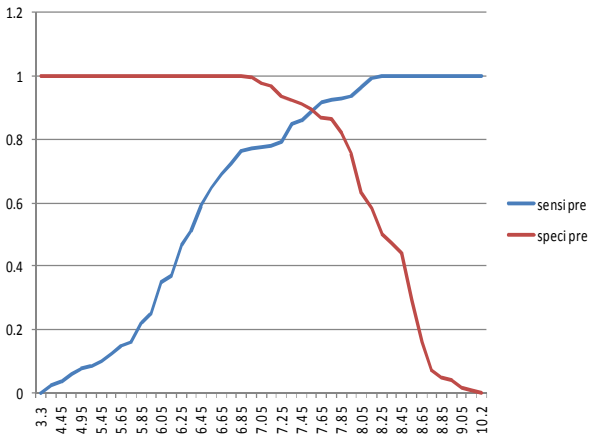

Fig. 1: Sensitivity and specificity values to identify preterm babies

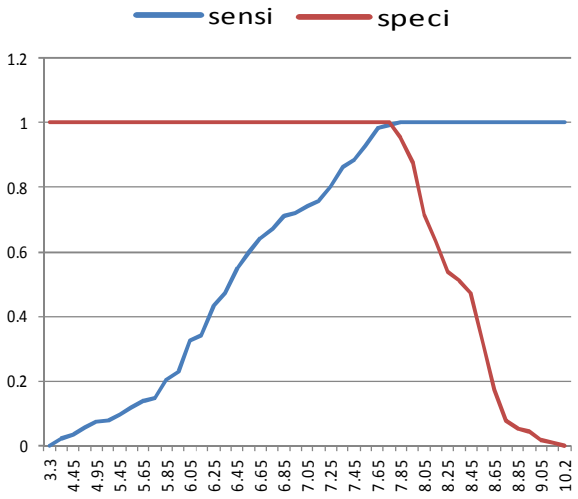

Fig. 2: Sensitivity and specificity values to identify low birth weight babies

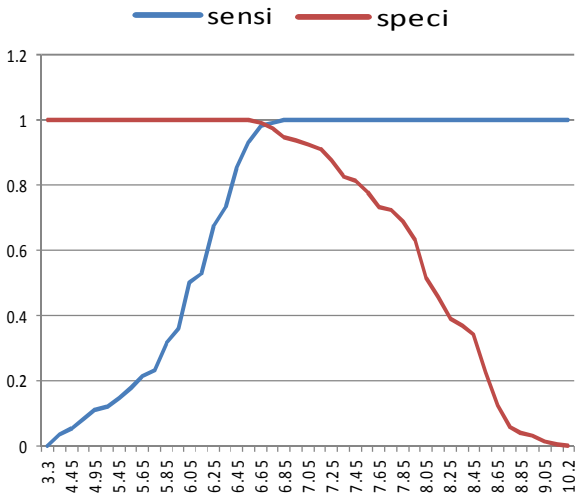

Fig. 3: Sensitivity and specificity values to identify very low birth weight babies

LBW babies (<2500 gm) a foot length less than 7.85 cm has 100% sensitivity and 95.3% specificity (Fig 2). Foot length less than 6.85 cm has 100% sensitivity and 94.9% specificity for identification of VLBW babies (<1500 gm) (Fig 3).

Correlations were calculated using Pearson correlation. Foot length and gestational age has a good positive linear correlation, coefficient being 0.869. Foot length and birth weight also has a good positive correlation, coefficient being 0.973 in preterm babies and 0.96 in term babies.

The sensitivity and specificity of two operational foot length cut-offs, <7 cm for VLBW babies and <8 cm for preterm or LBW babies were also calculated. Foot length <7 cm is 100% sensitive and 94% specific in VLBW identification whereas length <8 cm is 93.5% sensitive and 75.3% specific for preterm identification. Less than 8 cm foot length is also 100% sensitive and 87.6% specific for low birth identification.

Discussion

With mortality in later childhood decreasing, the proportion of deaths that take place in the neonatal period has been rising. Majority of newborns who die are LBW including preterm babies, who have the greatest risk of death. Simple anthropometric alternatives to measuring birth weight have been investigated in various settings. Many studies have been conducted to investigate newborn foot length as a screening tool for small babies [5-11]. A study by James DK et al[6] in 1979 in Manchester with 123 babies showed that measurements of foot length are valuable in premature babies who are too ill for conventional anthropometric measurements to be made, and in whom such measurements cannot be carried out subsequently because of the incubator and intensive care apparatus. The study showed a more pronounced correlation between foot length and birth weight in preterm babies (r=0.95) than in term babies. Similar results were obtained in our study which showed a co-efficient of 0.97 for preterm babies and 0.96 for term babies in the positive linear correlation between foot length and birth weight. A hospital based study in Udaipur, India[7] found a foot length less than 7.2 cm to identify LBW babies (<2500 gm). We found foot length <7.25 cm has 80% sensitivity and 100% specificity in identification of LBW babies.

According to Daga SR et al[8], foot length of 6.5cm was found corresponding to a gestational age of 34 weeks. Among the 660 births they referred 20 neonates to hospital; 18 (90%) of them had a foot length of less than 6.5 cm. So, it shows that foot length, as a proxy for birth weight, helped to identify VLBW babies needing referral for hospital care. Daga et al have also reported their experience of The Rural Neonatal Care Project, in Danahu block in Maharastra, India. The

project had trained birth attendants as the main anchor for delivery of neonatal care. Foot length measurement from foot print was used as a substitute to birth weight as an indicator for referral. They found that neonatal and perinatal mortality rates declined appreciably over 3 years and the antenatal registration increased by 30%. So this study reveals that foot length measurement can be used as a surrogate to birth weight in newborns.

Hirve et al[9] in their study with 89 babies in Pune, India has devised a tri-colored foot tape for use at home by the neonatal caretaker i.e. mother or birth attendant. From regression analysis, foot lengths of 6.35 and 7.63cm were identified as the cut-off points corresponding to a birth weight of 1500 and 2500g respectively in their study. They found foot lengths less than 6.3 cm for VLBW babies with a sensitivity of 100% and specificity of 95.2%. We report in our study that foot length <6.85 cm has 100% sensitivity and 94.9% specificity for identification of VLBW babies.

The reliability of such foot tape is also high. Where there are the logistic constraints of care during delivery and the imperative need to identify LBW newborns, there is a felt need for low cost, easy to use, appropriate technology interventions. For this purpose, the foot length measurement by a stiff, transparent ruler is a simple technique that can be done even by a neonatal caretaker at home. In addition, a referral decision can also be taken from the measurement taken.

In the study by Mullany et al[10] in 2007, at Nepal, foot length measurements <6.9 cm were 88% sensitive and 86% specific for the identification of VLBW infants. They found chest circumference superior to foot length in classification of infants into birth weight categories. However, according to them for the identification of VLBW infants, foot length performed well, and may be preferable to chest circumference, as the former does not require removal of infant clothes.

A study in Taiwan[11] in 2009 with 256 retrospective data showed a significant correlation of foot length with birth weight but no foot length cut-off was suggested. Merchant et al[5] in Tanzania showed an 80% cut-off for both sensitivity and specificity to be desirable, is achieved for VLBW (<1500 g) at foot lengths <7.2 cm and <7.5 cm respectively, for LBW (<2500 g) at foot lengths <7.9 cm and <7.6 cm, and for prematurity (<37 weeks) at foot lengths <7.7 cm and <7.5 cm. If we assume a cut-off around 80% for both sensitivity and specificity then in our study it is achieved for VLBW at <6.45 cm and <7.45 cm respectively, for LBW at <7.25 cm and<7.95 cm, and for preterm babies at <7.25 cm and <7.85 cm respectively. The study by E. Nabiwemba et al[12] from Uganda has also demonstrated a good positive predictability of foot length for LBW and preterm babies in their setting.

In India, where health care services are poorly accessed, a low-cost, home based device to identify small babies could support community efforts to save newborn. This is the first study in eastern India and the first hospital based study in India towards this effort of using foot length as an anthropometric surrogate to identify small babies in need of extra care.

Our study had certain limitations. It was a hospital based study with a small sample size without any community follow-up and hence it may not be representative at the population level. Moreover, the foot lengths were all measured on day one of life. Whether any change occurred on subsequent measurements was not documented. This method of measuring foot length may be useful in specific areas where most of the deliveries are occurring at home. For neonates born at the hospital, direct measurement of weight and close observation are better ways for detecting need of extra care.

Conclusion

Hence, to conclude foot length may be used as an anthropometric surrogate to identify LBW and preterm babies who are in need of extra care. It is particularly useful in resource constraint countries with a high burden of neonatal mortality and where facility-based services for newborns are poorly accessed. Foot length may be used as a screening tool to identify small babies for live-saving home care or referral to higher centers for better management.

Acknowledgment

This study has been approved by the Institutional Ethics Committee, Medical College, Kolkata, India.

Conflict of Interest: None

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