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Original Research Article

TO MEASURE FOOT LENGTH AND STUDY ITS CORRELATION WITH THE BIRTH WEIGHTOF THE BABIES

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Abstract

Background: To know the correlation between birth weight and foot length. To test the sensitivity and specificity of different cut off limits of foot length for the identification of low birth weight babies, viz,<2000gmand <2500gm. **Material and Methods:** Three hundred children were enrolled in the study. Birth weight was measured using electronic weighing scale of accuracy 10 grams within 24 hours of life. Foot length was measured by using vernier's caliper from right big toe to heel. Data was analyzed using SPSS. Different cut offs for foot length and their sensitivity, specificity to identify LBWbabies <2.5kg was analysed through ROC. **Results:** Foot length highly correlated with weight (P<0.001). A foot length of <8 cm, predicts a birth weight of <=2500gm, with a sensitivity of 33% and specificity of 99%. Foot length of <=7 cm, predicts a birth weight of <=2000 gm, with a sensitivity of 55% and specificity of 100%. **Conclusion:** Foot length is a reliable indicator for low birthweight. A positive correlation existed between foot length and birthweight(P<0.001). A cut off value of 8 cm of foot length for identification of low birth weight babies weighting <=2500 gm, and 7 cm of foot length identification of low birth weight babies <=2000 gm, with optimum sensitivity and specificity.

INTRODUCTION

Birth weight is one of the most reliable and sensitive predictor of thehealth and survival of new born in any community. "There is no indicator in human biology, which tells us so much about the past events and the future trajectory of the life as the weight of the infant at birth".

Babies with a birth weight of less than 2500 gm, irrespective of the period of their gestation are classified as low birth weight babies. But, in Indian population a birth weight of 2000gm is considered as appropriate criteria for defining low birthweight.[1]

About 30% of the babies in India are low birth weight, which constitutes 7to 10 million annually. Nearly 80% of the Neonatal deaths and 50% of infant deaths occur among the low birth weight neonates. Low birth weight is also a major determinant of malnutrition during infancy because, 40% of low birth weight babies are malnourished at the age of 1 year.[1] Low birth weight also increases risk of mortality due to the infections more than two to three times. Early identification and transfer of low birth weight babies, to higher centers, can avoid unnecessary neonatal deaths. So, there is a search for an alternate, non-invasive and inexpensive method to predict birth weight.

Anthropometric measurements, has been identified as a proxy measure for finding birth weight, during the first week of life. Our potential to connect new-borns to life saving interventions just took another step forward. We are beginning to have a robust body of evidence to promote simple, affordable and effective interventions for high-risk new-borns.

With the intention to develop a user-friendly low birth weight screening tool for use in communities where there are no scales, researchers in many studies tested how well the Foot length can predict whether the baby is low birth weight(<2500g) and in need of extra care. From such studies measuring Foot length could be used as a screening tool to identify and connect high risk babies born at home to extra care, but there would be some over-diagnosis. These studies were similar to previously reported from Asia, Uganda and Tanzania.

MATERIALS AND METHODS

Birth weight was measured using electronic weighing scale of accuracy 10grams within 24 hours of life. Foot length was measured by using vernier's

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caliper from right big toe to heel. Data was analyzed using SPSS.Different cut offs for Foot length and their sensitivity, specificity to identify LBWbabies <2.5kg was analysed through ROC.

METHOD OF MEASURING FOOT LENGTH

Foot length is measured by vernier's caliper in this study. For most measurements with a rules scale, it is desirable to estimate fraction of the smallest division on the scale. The common scale attachment that increase the accuracy of these estimates is the vernier scale. A caliper is an instrument with two jaws, straight or curved, used to determine the diameters of objects or the distances between two surfaces. A caliper with a vernier scale is called a vernier caliper.

The Vernier Principle. The vernier is an auxiliary scale, invented by Pierre Vernier in 1631, which has graduations that are of different length from those on the main scale but that bear a simple relation to them. The vernier scale has 10 divisions that correspond in length to 9 divisions on the main scale. Each vernier division is therefore shorter than a main-scale division by 1/10 of a main-scale division. The zero mark of the vernier scale coincides with the zero mark of the main scale. The first vernier division is 1/10 main-scale division short of a mark on the main scale, the second division in 2/10 short of the next mark on the main scale, and so on until the tenth vernier division is 10/10, or a whole division, short of a mark on the main scale. It therefore coincides with a mark on the main scale.

Figure 1: A community volunteer in southern Tanzania using the foot length indicator printed onto her counselling card to determine whether this newborn baby requires counselling about extra care for small babies
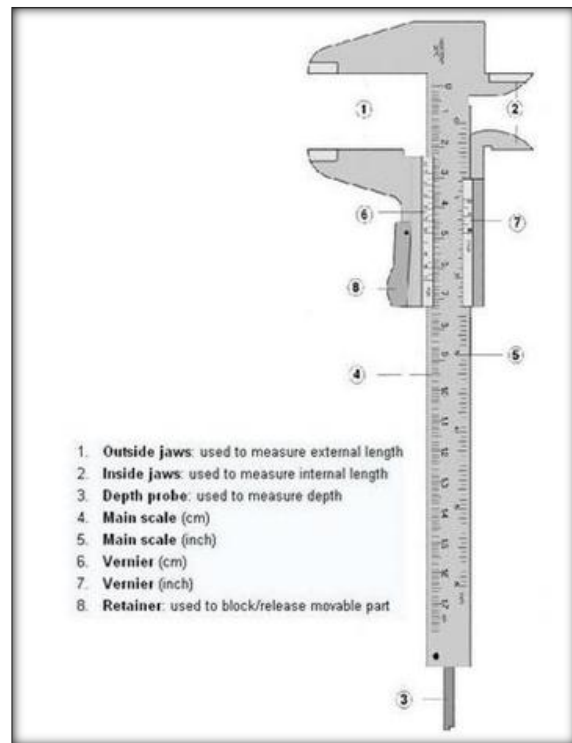

1. **Outside jaws**: used to measure external length
2. **Inside jaws**: used to measure internal length
3. **Depth probe**: used to measure depth
4. **Main scale** (cm)
5. **Main scale** (inch)
6. **Vernier** (cm)
7. **Vernier** (inch)
8. **Retainer**: used to block/release movable part

Figure 2: VERNIER CALIPER

Methodology

Study Place: The babies included in this study were the babies delivered at Raja Mirasudar Hospital, attached to the Thanjavur Medical College, Thanjavur.

Study Period: Study Period was over a period of 10months from October 2014 to July 2015.

Inclusion Criteria

Babies delivered at GRMH, attached to Thanjavur Medical College.

Exclusion Criteria

- Babies more than 24 hours of life.
- Babies with gross congenital anomalies of extremities.

Sample selection

By a random sampling,300 babies were included in this study by the above criteria.

Statistical analysis

Principles

Birth weight was the gold standard against which foot length was evaluated as a surrogate in this study to detect low birth weight.

Frequency, mean birth weight and foot length were calculated. All the values were tabulated. From the table, sensitivity and specificity, positive and negative predictive values, for various values of foot length, corresponding to birthweight of <2500 gms and <2000gms were calculated.

Simple regression between various mid arm circumferences and birth weights constructed and equation derived, to calculate the birth weight, if foot length is known.

Analysis

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All the values, birth weight in gm, foot length in cm were tabulated. In this study, cut-off point for low birth weight babies, of weights<2500,<2000gm,against various and foot length as < 7 cm, 7-8 cm, > 8 cm are evaluated.

From the above values, by using various statistical methods, the following were derived.

- Frequency–of birthweight and foot length
- Mean–of birth weight and foot length
- Simple and Multiple correlation–between various birth weight and foot length.
- Chi–square test–For testing the efficiency of hypothesis, birthweight (constant) and foot length (dependant variable).

REGRESSION

This is used to describe the dependence of one characteristic(y) upon the other characteristic(x). Both x and y, representing the value of two characteristics (a,bare constants are computed from the data).

Y=a+bx

If y is foot length, by using this formula, foot length for the given birth weight, can be calculated. If y is birth weight, birth weight for the given foot length, can be calculated.

Simple regression–Foot length (dependant variable), birthweight (constant variable).

CHARTS

Histogram and Scatter plot are drawn by using foot length as a dependant variable

RESULTS

INTERPRETATION OF STASTISTICAL ANALYSIS

In this tabular column birth weight of 2000 gm is used as a cut off, foot length of below and above 7 cm correlated against birth weight of below and above 2000gm. [Table 1]

P value < 0.001

If 7 cm of foot length is used as cut off value of 2000 grams of birth weight, the following values are derived.

- Sensitivity - 55%
- Specificity - 100%
- Positive predictive value - 100%
- Negative predictive value - 83%

In this tabular column birth weight of 2000 gm is used as a cut off, foot length of below and above 8 cm correlated against birth weight of below and above 2000gm. [Table 2]

P value < 0.001

If 8 cm of foot length is used as cut off value of 2000 grams of birth weight, the following values are derived.

- Sensitivity - 38%
- Specificity - 97%
- Positive predictive value - 80%
- Negative predictive value - 91%

The test of significance is 0.000 and it is highly significant. [Table 3]

In this tabular column birth weight of 2500 gm is used as a cut off, foot length of below and above 7 cm correlated against birth weight of below and above 2500gm.

P value < 0.001

If 7 cm of foot length is used as cut off value of 2500 grams of birth weight, the following values are derived.

- Sensitivity - 2%
- Specificity - 100%
- Positive predictive value- 100%
- Negative predictive value - 65%

In this tabular column birth weight of 2500 gm is used as a cut off, foot length of below and above 8 cm correlated against birth weight of below and above 2500gm. [Table 4]

P value < 0.001

If 8 cm of foot length is used as cut off value of 2500 grams of birth weight, the following values are derived.

- Sensitivity - 33%
- Specificity - 99%
- Positive predictive value- 97%
- Negative predictive value - 73%

The test of significance is 0.000 and it is highly significant. [Table 5]

Analysis of different cut off limits of foot length, with various sensitivity and specificity, for the identification of low birth weight babies<2500gm, given below.

P value < 0.001

In this study the best cut off limit of foot length is <8 cm for identification of babies weighing 2500 gm & less. [Table 6]
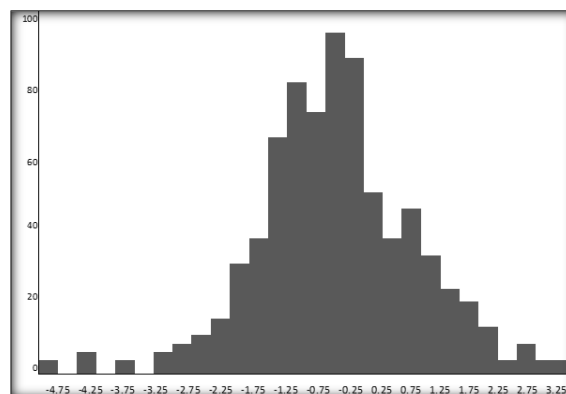
Analysis of different cut off limits of foot length for the identification of low birth weight babies <2000 gm, with various sensitivity and specificity as given below:

P value < 0.001

In this study the best cut off limit of foot length is <=7 cm for identification of babies weighing 2000 gm & less. [Table 7]

Figure 3: Regression Standardized Residual
The histogram confirm that the variable foot length follows a normal distribution

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Table 1: Frequency of birth weight

Birth weight(in grams)	Number of babies	Frequency
<2000	21	7%
<=2500	109	36%
>2500	190	64%

Table 2: Foot length (7 cm) vs Birth weight (2 kg)

	<=2000gm	> 2000gm	Total
FL <=7 cm	2 (a)	0(b)	2
FL > 7 cm	50(c)	248 (d)	298
	52	248	300

Table 3: Foot length (8 cm) vs Birth weight (2 kg)

	<=2000gm	> 2000gm	Total
FL <=8 cm	29 (a)	7(b)	36
FL > 8 cm	23(c)	241 (d)	264
	52	248	300

Table 4: Foot length (7 cm) vs Birth weight (2.5 kg)

	<=2500gm	> 2500gm	Total
FL <=7 cm	2 (a)	0(b)	2
FL > 7 cm	105(c)	193 (d)	298
	107	193	300

Table 5: Foot length (8 cm) vs Birth weight (2.5 kg)

	<=2500gm	> 2500gm	Total
FL <=8 cm	36 (a)	1(b)	37
FL > 8 cm	71(c)	192 (d)	263
	107	193	300

Table 6: ?

Foot length in cm	8	9
Sensitivity	19%	33%
Specificity	100%	99%
Positive predictive value	100%	97%
Negative predictive value	65%	93%

Table 7: ?

Foot length in cm	7	8
Sensitivity	55%	4%
Specificity	100%	97%
Positive predictive value	100%	80%
Negative predictive value	83%	91%

DISCUSSION

The present study is an attempt, in evaluating the utility of foot length to detect the low birth weight in neonatal period by measuring the foot length and analyse its correlation with the birth weight. The study was conducted at the Post Natal Wards of the Raja Mirasudar Hospital, attached to Thanjavur Medical College Hospitals, Thanjavur. By random sampling with prescribed inclusive criteria, total of 300 babies within 24 hours of life, were screened over a period of 10 months. The incidence of low birth weight in this study is 36% with mean birth weight of 2711 gm.

In this study, various foot length values from 7 cm to 9 cm evaluated to predict birth weight of <20000 & 2500 gm.

In this study the best cut off limit of foot length is <=8 cm for identification of babies weighing <=2500 gm and <=7 cm for <2000 gm. The foot length value obtained by this study, coincides with the earlier study results.

Iranian journal of foot length (FL <7cm- <1.5 kg)
(FL <8cm-< 2.5 kg)
James DK et al (6)-1979 in Manchester.
Hirne et al, [9] Pune- India.
Mullany et a,[10]-2007,Nepal.
Taiwan,[11] in 2009(FL <7.2cm-<1.5 kg)
(FL<7.9cm-<2.5 kg)

However, the sensitivity, specificity, positive and negative predictive values are different.

In this study the best cut off limit of foot length is <=8 cm for identification of babies weighing 2500 gm and less. However, at this limit, there is a possibility of missing above 67% of low birth weight babies, as the sensitivity is 33%.

The specificity for this foot length is 99%, which means 1% of the referred has low birth weight requiring re-screening.

If the value is <=7 cm, specificity increased to 100%, which means 0% of the referred population needs re-screening, but, sensitivity of this value reduced to 2%, which means 98% of the low birth weight babies <2500 mg may be missed. Since the condition being screened is a life threatening one, it may not be desirable to miss as many low birth weight babies.

So, the best foot length cut off value for <=2500 gm weighing baby is <=8cm with a sensitivity of 33% and with a specificity of 99% and the positive predictive value of 97%, negative predictive value of 73%.

In this study the best cut off limit of foot length is <=7 cm for identification of babies weighing 2000 gm and less. However, at this limit there is a possibility of missing above 45% of low birth weight babies, as the sensitivity is 55%. The specificity for this foot length is 100%, which means 0% of the referred, has low birth weight requiring re-screening.

If the foot length is <=8 cm, specificity decreased to 97%, which means, only 3 % of the referred population needs re-screening, but sensitivity of this value reduced to 4% which means 96% of the low birth weight babies <2000 gm may be missed. Since the condition being screened is a life threatening one, it may not be desirable to miss as many low birth weight babies.

So, the best foot length cut off value for a baby weighing <=2000 gm is <=7 cm with a sensitivity of 55% & with a specificity of 100% and the positive predictive value of 100%, negative predictive value of 83%.

CONCLUSION

- Foot length is a reliable indicator for low birth weight.
- A positive correlation existed between foot length and birthweight(P<0.001).
- A cut off value of 8 cm of foot length for identification of low birth weight babies weighting <=2500 gm, and 7 cm of foot length for identification of low birth weight babies <=2000 gm, with optimum sensitivity and specificity.
- Measurement of newborn foot length for home births in resource poor settings has the potential to be used by birth attendants, community volunteers or parents as a screening tool to identify low birth weight or premature newborns in order that they can receive targeted interventions for improved survival.

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