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A SIMPLE TOOL FOR ASSESSMENT OF GESTATIONAL AGE IN NEWBORNS USING FOOT LENGTH

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ABSTRACT: BACKGROUND: Since decades attempts have been made to find a simple alternative method of gestational age assessment in newborns. It is important for the early identification and reference of preterm newborns from a rural setup where no proper medical facilities are available to a higher centre. **AIMS**: To construct standard reference intrauterine growth charts of foot length measurement for infants of 28-42 weeks gestational age and to study the correlation of foot length with gestational age. **SETTING & DESIGN**: It is an observational study conducted in a tertiary care hospital. **MATERIALS AND METHODS**: The study group included 1000 consecutively live born singleton infants of 28-42 weeks of gestation. Data were recorded for the foot length according to gestational age. Using MS Excel spread – sheet, the mean, standard deviation, 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles were calculated and percentile curves drawn. The correlation of foot length with gestational age was analyzed by applying correlation and regression analysis. Regression equation was derived to predict gestational age from foot length. Results: Foot length correlated very well with the gestational age with r = 0.93and regression equation obtained was: Y = 6.278 + 4.15X to predict gestational age(Y) from foot length(X). **CONCLUSION**: Foot length is a simple, quick and reliable anthropometric measurement to assess gestational age in neonates and can be used as a simple tool for identifying and referring high risk newborns by peripheral health workers in developing countries.
KEYWORDS: foot length, gestational age, newborn.

INTRODUCTION: An estimated 1million babies die globally every year because of prematurity, of which about 375,000 neonatal deaths due to prematurity and low birth weight occur in India alone.[1,2] Only about half of the newborns are weighed at birth and for a smaller proportion of them, the gestational age (GA) is known.[3]

Conventionally, GA is calculated by Naegele's formula and antenatal ultra-sonography (USG), or by using Ballard Scoring in neonates. In rural settings with low literacy levels, application of Naegele's formula and non-availability of antenatal USG check-up are limiting factors.[4,5] Application of ballard scoring requires the expertise of a pediatrician who may not be available in remote area.

Moreover, it cannot be used in asphyxiated neonates.

All these factors thus underline the importance of early identification and reference to higher centre of preterm babies at the rural setup, where most of the deliveries are conducted at home by untrained relatives and dais having no proper neonatal medical care facilities.[6,7]

Since decades, attempts have been made to find an alternative for gestational age assessment in newborns. These alternative measurements should be reliable, have a close correlation with gestational age, can be performed even by inexperienced medical personnel and have very little

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intra- and inter-observer variability.[8] Foot length is one such parameter which can be measured easily in preterm and sick neonates without disturbing the baby.

This study was performed to construct reference intrauterine growth charts for foot length measurement in newborns and to find a correlation of foot length with gestational age.

MATERIALS AND METHODS: This observational study was conducted from Oct2011-Sept2012 in a rural tertiary care teaching hospital. The study was approved by the Institutional Ethical Committee and written consent for participating neonates was taken from their parents/guardians. 1000 consecutively selected singleton live born babies of gestational age 28-42 weeks were included and formed the study group.

Exclusion criteria consisted of mothers not knowing date of last menstrual period (LMP), multiple births, gross congenital anomalies, chronic maternal disease/Obstetrical complications known to compromise fetal growth and gross discrepancy between gestational ages calculated by LMP & Ballard's score by >2 weeks.

Examination of newborns was done within 72 hours of birth. Assessment of gestational age was done as per LMP by Naegele's formula, i.e. addition of 9 months and 7 days to the first day of LMP and by Extended New Ballard Score.

Foot length was measured from the outermost point of the heel to the tip of the great toe or second toe whichever is longer, with a steel tape, after straightening the foot.

The collected data was tabulated according to sex and gestational age. Using MS Excel spread-sheet the mean, standard deviation, 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles were calculated and percentile curves drawn. The correlation of foot length with gestational age was analyzed by applying correlation and regression analysis. Regression equation was derived to predict gestational age from foot length.

RESULTS: Out of 1000 neonates, 435 (43.5%) were females and 565 (56.5%) were males. Their distribution with respect to GA is graphically represented in Fig 1. 365 (36.5%) were preterm babies bearing 28 wks to 36 wks 6 days of gestation and 635 (63.5%) were term babies (37-42 wks). The majority of the subjects were bearing 39 week gestation (19.8%) whereas the least(1.3%) were in the 42 week group. The mean, standard deviation and percentiles for foot length were tabulated with respect to GA as in Table 1.

In the present study, an increase in foot length was observed with an increase in gestational age i.e. from 5.45cms at 28 weeks to 8.12cms at 40 weeks followed by fall at 41 and 42 weeks (8.01 and 7.85cms respectively) as in fig 2. The value of correlation co-efficient (r) of foot length with gestational age calculated was 0.934 and regression equation to calculate gestational age from foot length was Y= 6.278+4.15X, where Y is the gestational age (in weeks) and X is the foot length (in cms) (fig. 3).

At a cut-off of 7cms, foot length has a sensitivity of 94.76%, specificity of 94.30%, positive predictive value of 81.55 % and a negative predictive value of 98.54% for the prediction of gestational age below 34 weeks.

DISCUSSION: This study was performed to find correlation of foot length with gestational age in neonates, so that foot length can be used as a proxy measurement for estimation of gestational age.

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We observed a close correlation with r = 0.934. Similar correlation of foot length with gestational age was seen by M Kabra et al [10] in 1989 with r = 0.94.

The values of foot length obtained show a progressive rise from 28 weeks onwards with a dip at 42 weeks noted. This is accounted by the fact that in the later gestational age growth slows down and a higher frequency of growth retardation is expected in the later weeks with consequently decreased foot length. The values of foot length obtained in this study correlated well with the other studies done by Merlob et al (1984)[9] and M Kabra et al (1989)[10] at each gestational ages.

Thus, we can calculate the gestational age from a known value of foot length using the regression equation Y = 6.278 + 4.15X. For e.g; for a foot length of 6cms the gestational age calculated will be 31, which is very close to the mean value of foot length obtained in the present study: 6.17 cm. However, this remains a crude method as the slope of rise is too slow, making a large number of lengths normal for a range of gestation. Yet for approximation in field studies or where time is prohibitive, this could be useful.

The proportion of cases in each gestational week (28-42) was not evenly divided. The largest section was formed by the 39 weeks (19.8%) while the extremes accounted for the smallest portions, namely 1.5% of 28 weeks, 1.4% of 29 weeks and 3% of 30 weeks and 1.3% of 42 weeks. The inherent paucity of premature deliveries and the predominance of moribund state in most of them during the first few days of life, precluding the handling required for measurement, are some of the difficulties in getting larger size of these groups.

The early identification of preterm babies is an important prerequisite of any initiative to reduce mortality. There are various measurements in newborns to assess growth, namely; birth weight, head circumference, crown heel length etc. In many developing countries including India, the equipment's required to measure them may not be available or the babies may be sick and minimum handling is mandated.

Assessment of the gestational age by Ballard's scoring is time consuming, observer dependent for neurological scoring, dependent on the condition of the neonate and requires expertise. In such cases foot length is a parameter which can be easily measured even in sick neonates by health personnel in rural areas. It requires less handling and negates observer bias.

CONCLUSION: Foot length is a simple, quick and reliable anthropometric measurement which can be used as an alternative tool for gestational age assessment. It can be easily measured by peripheral healthcare workers & traditional birth attendants and could be used effectively for identifying and referring high risk newborns. It may also serve as a useful tool for busy pediatricians in office practice.

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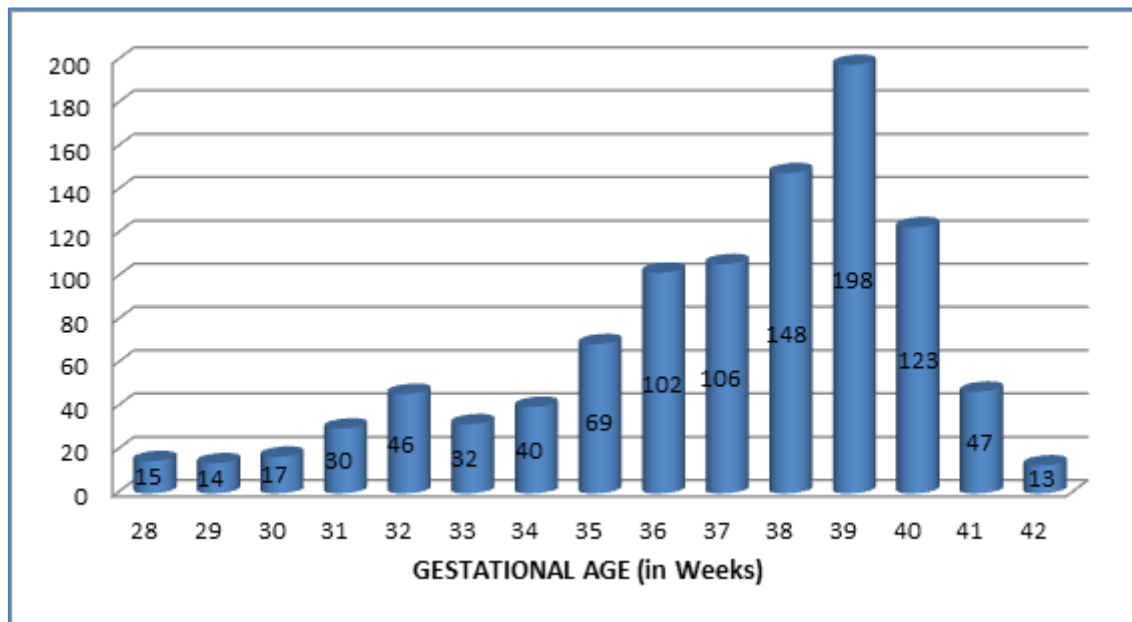
Fig. 1: Break-up of the study sample in each gestational age

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GA	N	Mean	SD	Mean +2SD	Mean -2SD	Percentiles								
						3rd	5th	10th	25th	50th	75th	90th	95th	97th
28	15	5.453	0.263	5.979	4.927	5.10	5.18	5.20	5.25	5.50	5.55	5.82	5.91	5.94
29	14	5.705	0.291	6.287	5.123	5.16	5.27	5.38	5.50	5.82	6.00	6.23	6.45	6.60
30	17	5.963	0.171	6.305	5.621	5.70	5.76	5.79	5.80	6.00	6.12	6.20	6.24	6.29
31	30	6.179	0.147	6.473	5.885	5.99	6.10	6.21	6.45	6.70	6.88	6.0	6.51	6.58
32	46	6.279	0.196	6.671	5.887	6.21	6.00	6.07	6.12	6.31	6.42	6.51	6.66	6.76
33	32	6.509	0.272	7.053	5.965	6.18	6.20	6.21	6.31	6.52	6.81	6.88	6.94	7.12
34	40	6.801	0.213	7.226	6.374	6.50	6.52	6.59	6.70	6.81	7.12	7.14	7.17	7.19
35	69	6.882	0.229	7.340	6.424	6.30	6.43	6.57	6.80	7.00	7.08	7.11	7.16	7.20
36	102	7.171	0.257	7.685	6.657	6.32	6.76	6.90	7.12	7.21	7.32	7.50	7.61	7.62
37	106	7.532	0.282	8.096	6.968	7.106	7.20	7.23	7.41	7.50	7.71	7.80	8.01	8.08
38	148	7.677	0.240	8.157	7.197	7.20	7.21	7.40	7.51	7.72	7.80	8.02	8.04	8.10
39	198	7.833	0.218	8.269	7.397	7.40	7.51	7.59	7.72	7.81	8.01	8.10	8.10	8.20
40	123	8.128	0.199	8.526	7.730	7.80	7.91	7.96	8.01	8.12	8.20	8.41	8.50	8.52
41	47	8.014	0.300	8.614	7.414	7.50	7.53	7.61	7.80	8.10	8.21	8.40	8.46	8.50
42	13	7.854	0.789	9.432	6.276	6.22	6.70	7.51	7.70	8.10	8.30	8.38	8.48	8.53
Table 1: Mean, standard deviation and percentiles for foot length (cms)														
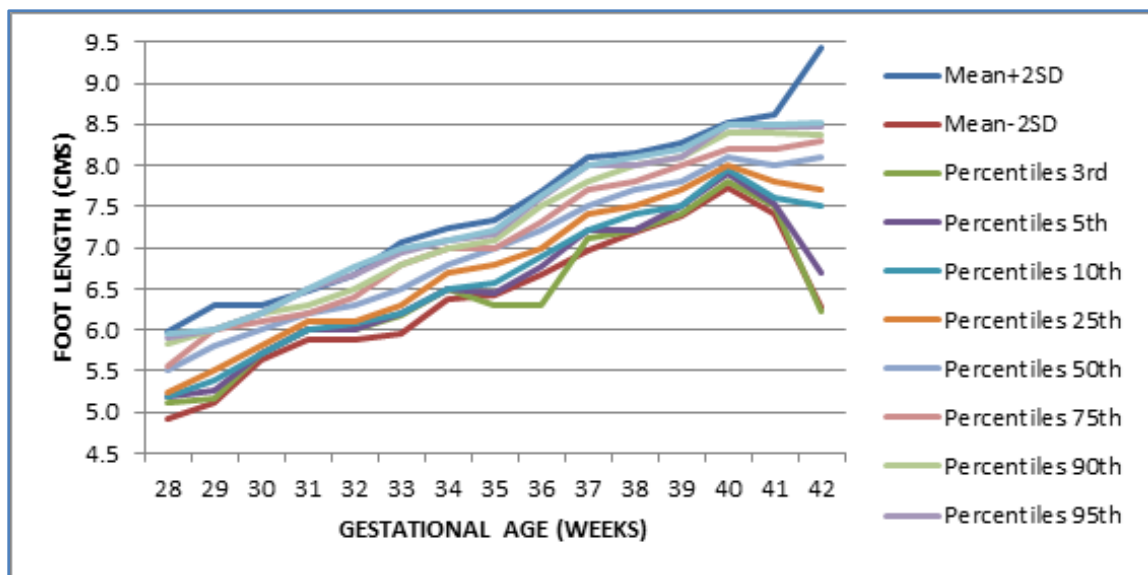
Fig. 2: Mean ± 2 SD and percentiles curves of foot length (cms)
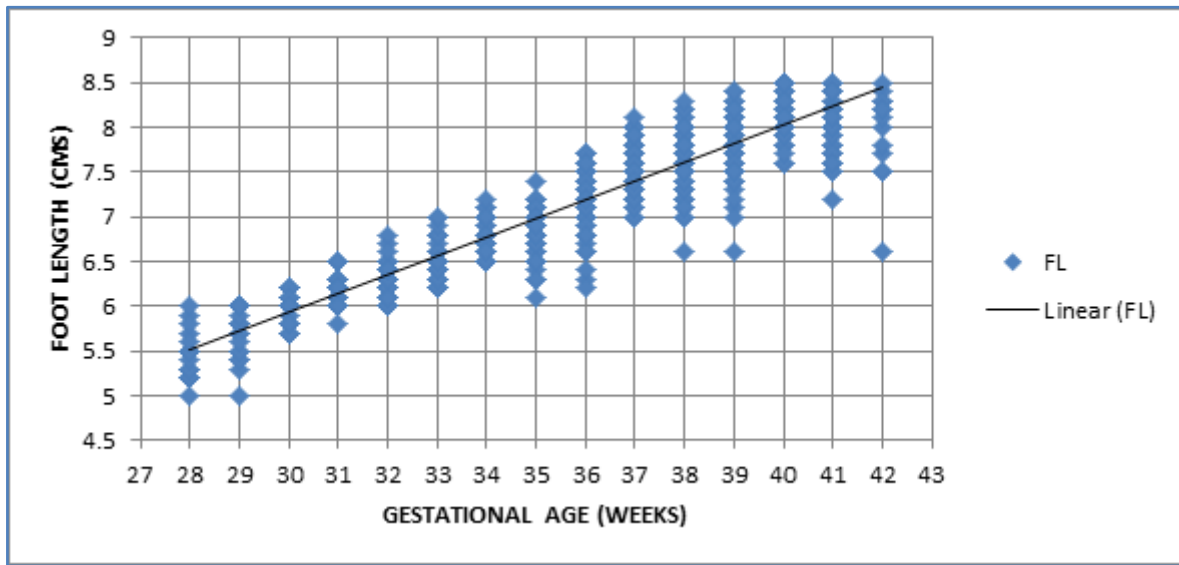
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Fig. 3: Correlation of foot length with gestational age

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