ABSTRACT

Objective: To look for and establish if there is any relationship between neonatal length, birth weight and gestational age and to try and arrive at a way for estimating neonatal length when only the birth weight and gestational age are known, in the term, appropriate for gestational age (AGA) newborns. Material and Methods: A cross sectional study of all the 380 singleton term babies (209 males; 171 females) with birth weights appropriate for gestational age (AGA), examined at the time of birth, born in the two year period, were the study subjects. The Exclusion criteria were: multiple pregnancy, intrauterine growth retardation and major structural or chromosomal anomalies. Stepwise linear regression analysis with gestational age (in days) and weight parameter (in kgs) was employed to yield the best-fit formula for predicting neonatal length (in cms) at birth. The relationship between the parameters was arrived at using linear regression analysis using the statistical software SPSS15 Results: We were able to establish a relationship between neonatal length, birth weight and gestational age & arrive at a mathematical derivation for estimating neonatal length for the other two parameters Conclusion: There is a relationship between the neonatal length, gestational age and birth weight which could be worked out in the form of a mathematical formulation. The new formula is relatively easy to use and needs no adjustment to centiles. It allows reliable length estimation in the term AGA newborns.

KEYWORDS: Estimated neonatal length, appropriate for gestational age (AGA), Intrauterine growth retardation.

INTRODUCTION

Growth is a process that starts with conception and ends at 15–16 years in girls and 17–19 years in boys. The periods of growth include intrauterine (9 months), infancy, prepubertal and puberty [1,2]. The growth is maximum in utero, where during a period of 9 months the fetus grows from one cell to about 50 cm at birth [3]. A newborn achieves ¼ th of his or her adult height during these 9 months of gestation. The hormones like growth hormone /insulin-like growth factor-1, and thyroid hormone are active only after birth and sex hormones only during puberty.
This implies that endocrine factors are unlikely to affect the birth length of the child [4]. The accurate measurement of neonatal length is of great importance and should be performed in every baby. The length should be plotted on infant growth charts according to gestational age [5]. Despite the fact that the range of variation of birth length is relatively small, it is necessary to establish whether the growth is adequate for age, and to observe the early postnatal growth velocity.

The Diagnostic and Prognostic Importance of Neonatal Length Measurements cannot therefore be undermined. The decision to conduct more than routine laboratory investigations in a newborn with subnormal length depends on the gestation and family history, physical examination and investigations. Accurate measurement of body length at birth is extremely helpful in the diagnosis of abnormal growth, in the growth follow-up, in the prognosis of final height, and in the consideration of possible therapeutic interventions [6]. But very often it is missed and thus when the child presents at a later age, birth length estimation could be vital in coming to a diagnosis. Hence, we felt the need to give importance to the estimation of the expected length of the babies at birth since in our own experience significant length discrepancies often occur if the infantometer is not used or is unavailable.[7]

**Objective** To look for and establish if there is any relationship between neonatal length, birth weight and gestational age and to try and arrive at a way for estimating neonatal length when only the birth weight and gestational age are known, in the term appropriate for gestational newborns.

### MATERIALS AND METHODS

In All the singleton live babies at term, who were appropriate for gestational age and whose mothers had no history of diabetes, hypertension, fetal growth restriction and other pregnancy complications, born at CMC (Christian Medical College, Ludhiana, Punjab) over a 2 year period in the Department of Obstetrics and Pediatric Medicine were the study subjects. Routine examination was performed for all of these babies. The actual birth weight was estimated using electronic weighing scales up to the nearest 10 grams and length was taken using an infantometer up to the nearest 1 cm. Measurements were taken by a single trained investigator. Infants with major structural or chromosomal anomalies were excluded. The duration of gestation was assessed based on first hand maternal history of the last menstrual period (LMP) and confirmed by first or second-trimester ultrasound, if there was any uncertainty about the gestational age. Based on the complete set of anthropometric data of 171 female and 209 male AGA Indian babies, a new predictive formula for expected neonatal length in the AGA babies was generated, separately for male and female neonates.

### RESULTS

Birth weights of male and female newborns were not significantly different from each other as also the birth length and gestational age in these AGA babies. [Table 1]

The New Formula Proposed For The Estimated Neonatal Length (ENL) Was As Follows:

- For males: \( \text{ENL} = 38.5 + 5 \times \text{Birth weight in kgs} - \frac{\text{gestational age in weeks}}{10} \)
- For females: \( \text{ENL} = 32.5 + 3 \times \text{Birth weight in kgs} + \frac{\text{gestational age in weeks}}{5} \)
Table 1: Birth weight, Birth length & Gestational age- Male versus Female neonates

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (in kgs)</td>
<td>2.87 ± 0.56</td>
<td>2.83 ± 0.56</td>
<td>0.136</td>
</tr>
<tr>
<td>Birth length (in cms)</td>
<td>48.75 ± 4.96</td>
<td>48.47 ± 3.61</td>
<td>0.216</td>
</tr>
<tr>
<td>Gestational age (in weeks)</td>
<td>38.52 ± 2.08</td>
<td>38.63 ± 2.28</td>
<td>0.30</td>
</tr>
</tbody>
</table>

The estimated lengths determined by our formulae were not significantly different from the actual lengths. (p=0.176 in case of boys and p=0.115 in case of girls). Overall estimated values of birth lengths were within ± 1.5cm of actual measurement at birth. The correlation of actual length with the ‘estimated length based on formula’ was highly significant amongst both males and females (p<0.01), the Pearson’s coefficient of correlation being 0.497 among males and 0.617 among females (figures 1 and 2).

Figure 1: Correlation of estimated length with actual length in male term AGA neonates

Figure 2: Correlation of estimated length with actual length in female term AGA neonates
DISCUSSION AND CONCLUSIONS

The relationship between gestational age, neonatal size and neonatal death is complex. To date, most authors have used birth weight as a proxy for neonatal size and have neglected to examine neonatal length because in the past neonatal length was often considered to be of little importance [8]. In addition, they have assumed that the size and gestational age were linearly related to neonatal death. Studies using multiple logistic regressions to examine the relationship between gestational age, neonatal size and neonatal death have shown that on its own, gestational age was nonlinearly associated with neonatal death. This nonlinearity disappeared with the addition of birth weight, crown heel length and head circumference. Recent studies in neonatal medicine have indicated that crown heel length is linearly associated with neonatal risk of mortality.

In a majority of deliveries in India though the birth weight and the gestational age are promptly recorded very little or no importance is given to recording the birth length, particularly because of unavailability of the appropriate equipment and/or technique. This serves as a barrier in evaluation of stature while plotting height in growth charts, when these children come to the attention of health system at a later age. This assumes special relevance with regard to the velocity of gain in stature of the child (e.g. for a child presenting with short stature, with known birth length, we can see the growth pattern by plotting the birth length in the percentile growth chart along with present length and check whether the growth is as per potential or not.) However due to the almost universal lack of this information (length at birth) in our setup (particularly in the rural background where conditions like malnutrition, infections etc which can impact the growth adversely are very prevalent) it becomes very difficult to monitor the velocity of growth. If a formula was available to give a good estimate of the birth length based on usually recorded antenatal/natal information, then it could serve as a means to help us in the growth assessment process. However no single formula can provide reliable estimations across the whole neonatal weight range as the coherence between birth weight and gestational age becomes extremely variable as, in case of asymmetrical SGA babies who are born with low weight but their length is normal because of defect in the intrauterine nutrition in the third trimester of pregnancy.

Further, no formulae so far have been designed specifically for the estimation of expected length even for term newborn. Theoretically, these formulae can improve length prediction and account for the growth pattern found in Indian AGA babies who form the largest pediatric group, since a majority of deliveries anywhere in the world including India belong to term AGA group.

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