Anthropometric indices and clinical assessment of nutrition score (CAN Score) in detection of fetal malnutrition at birth

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Abstract

Introduction: Low birth weight is commonly used criterion for identifying fetal malnutrition. But fetal malnutrition may be present at any birth weight and it is important to recognize it due to its high incidence of morbidity and mortality. Hence, CAN score has been introduced as the gold standard tool for identification of fetal malnutrition. **Objectives**: 1. To compare the assessment of nutritional status using anthropometric indices and CAN score and assess their accuracy. 2) To develop a screening tool in identifying fetal malnutrition using anthropometric indices. **Methods:** This prospective observational study included 349, term, live born, singleton newborns with no major congenital malformation. Nutritional status assessment was done on the basis of CAN score within 24 hours of birth. Ponderal Index (PI), Body Mass Index (BMI) and mid-arm to head circumference ratio was calculated and compared with CAN score. **Results:** Incidence of fetal malnutrition was 20.1%. Newborns identified as malnourished by PI, BMI, MAC/HC were compared with CAN score. BMI had the highest sensitivity (75.7, p<0.001) and combined with PI sensitivity increased to 89.1%. **Conclusion:** BMI is the best screening tool for malnutrition and coupled with PI makes it a good indicator of normal nutrition.

Key words: Fetal malnutrition, Ponderal index, BMI, CAN score

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Introduction

The term fetal malnutrition (FM) to describe infants who showed evidence of soft tissue wasting at birth irrespective of the specific etiology. It is defined as failure to acquire adequate quantum of fat and muscle mass during intrauterine growth [1]. There is no standard criteria to define fetal malnourishment or fetal malnutrition. Weight at birth has been the most common criterion adopted where the cut off levels of birth weight less than 2500 grams is indicative of fetal malnutrition. It does not identify fetal malnutrition which indicates a clinical state that may be present at any birth weight [2].

Newborns with malnutrition in late third trimester may have a birth weight of above 2.5 kg and are misdiagnosed as normal despite being malnourished. Intrauterine growth restriction (IUGR) refers to a condition in which a fetus is unable to achieve its genetically determined potential size. Small for

gestational age (SGA) is defined as growth at the 10th or less percentile for weight of all fetuses at that gestational age [3]. Not all fetuses that are SGA are pathologically growth restricted and, in fact, may be constitutionally small. Similarly, not all fetuses that have not met their genetic growth potential are in less than the 10th percentile for estimated fetal weight (EFW). None of these terminologies i.e. IUGR and SGA is actually synonymous with Fetal malnutrition as none of these methods assess the subcutaneous fat accumulated nor are they population varied. Also they are common for various populations despite their genetic and ethnic variation [4].

The assessment of nutrition at birth has been made using various methods:

1. Anthropometry– weight, length, head and chest circumference.

2. Proportionality indices - Ponderal Index (PI), head circumference to length ratio, chest circumference or

mid arm circumference and/or mid arm circumference to head circumference ratio (MAC/HC). Body Mass Index (BMI) has also been described in newborns [5].

3. Clinical Assessment of Nutrition (CAN) of the fetus and the score - CAN score is a scoring system based on nine 'superficial' readily detectable signs of malnutrition in the newborn baby [6].

Materials and Methods

Study place: This study was conducted in a tertiary level neonatal unit in Kolkata.

Study Population: All live born neonates delivered at the hospital were included in the study.

Study design: This was a prospective observational study conducted in a tertiary level neonatal unit in Kolkata, India, in the year 2016. Ethics clearance was taken from the institutional ethical committee.

Inclusion criterion was inborn live births between 34 to 42 completed weeks of gestation, clinically stable at birth, singleton newborns delivered consecutively in the hospital were selected.

Exclusion criteria

- Newborns with congenital anomalies

- Newborns <37 completed weeks gestation

- Multiple pregnancies

- Newborns requiring NICU care

-Newborns born to mothers with unreliable estimation of gestational age.

Gestational age was determined from the date of the last menstrual period (LMP) in concordance with clinical assessment by New Ballard's Scoring and first trimester ultrasonography [7].

The following parameters were recorded in all babies (weight was recorded at birth, length, mid arm circumference and head circumference were recorded within 24 hrs of life):

(i) Birth weight: Nude birth weight, measured to the nearest 10gms using electronic weighing scale.

(ii) Length: Length was measured to the nearest 0.1cm using an infantometer.

(iii) Head circumference: was taken as the largest circumference of the skull using a flexible non-stretchable tape to the nearest 0.1cm.

(iv) Mid Arm Circumference: Measured in the left arm, at a point midway between tip of the acromion and the olecranon process using a flexible non-stretchable tape to the nearest 0.1cm.

These measurements (birth weight and length) were then plotted on intrauterine growth charts for Indian babies to classify the newborns into appropriate for gestational age (AGA), SGA and large for gestational age (LGA) [3].

The following proportionality ratios were calculated

Ponderal index (PI):

It was calculated using the following formula

$PI = Weight (gms) \times 100/ Length (cms)^3$

Ponderal index < 2.2 gm/cm^3 was considered as an index of malnutrition [3].

Mid arm circumference/ head circumference Ratio (MAC/HC) with cut off value of 0.27 was used in this study to define malnutrition [8].

Body mass index (BMI) was calculated using the formula:

$BMI = Weight (Kg)/ Length (m)^2$

A cutoff value of $11.20 kg/m^2$ was considered as an index of malnutrition [4].

The same newborns were also assessed clinically between 24-48 hours on the basis of the superficial readily detectable signs of malnutrition in the newborn using the clinical assessment of nutrition (CAN) rating as described by Metcoff[5]. A score of <25 was used to define malnutrition (CAN score).

Each attribute was scored based on specific described criteria from 1 to 4; 1 being the maximum evidence of malnutrition and 4 being the evidence of good nutrition. The CAN score ranges between 9 as the lowest score and 36 as the highest score. Any score less than 25 is indicative of malnutrition.

In our study CAN score was the tool accepted as the gold standard for identification of fetal malnutrition[5] and proportionality ratios were compared with clinical assessment using CAN score to assess their effectiveness in identifying fetal malnutrition.

Data Analysis: For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS20.0.1 and GraphPad Prism version 5.

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Results

A total of 349 newborns were assessed and as per CAN score 70 were found to be malnourished with the incidence of 20.1% (table 1). There was no sex predisposition in the incidence of fetal malnutrition.

Table-1: Incidence of fetal malnutrition as per CAN score.

Can score	Frequency	Percent
Malnourished (<25)	70	20.1%
Well nourished (≥25)	279	79.9%
Total	**349**	**100%**

Incidence of malnourished babies is 20.1% as per CAN SCORE

Table-2: Comparison between Body Indices and CAN score.

	Malnourished	Well nourished	frequency	Chi square value	p-value
PI				127.99	
<2.2	36	6	42		<0.001
>2.2	34	273	307		<0.001
BMI				158.94	
<11.2	53	20	73		<0.001
>11.2	17	269	276		<0.001
MAC/HC				32.74	
<0.27	30	36	66		<0.001
>0.27	40	243	283		<0.001
SGA	30	36	66	115.76	<0.001

These newborns were classified based on PI, BMI, MAC/HC and these were found to be statistically significant

Table-3: Statistical details of the various anthropometric indices (in comparison to CAN score)

	PI	BMI	BMI or PI	MAC/HC
Sensitivity	51.4	75.7	89.1	42.9
Specificity	97.8	92.8	90.7	87.1
Positive predictive value	85.7	72.6	96.2	45.5
Negative predictive value	88.9	93.8	97.1	85.9

BMI had the highest sensitivity (75.7, $p<0.001$) and combined with PI sensitivity increased to 89.1%.

These newborns were classified based on Ponderal index and 12% (42) of the newborns were malnourished with PI <2.2. Among these after CAN score assessment, 06 were found clinically well nourished and of the remaining neonates with normal PI , 34 i.e. (11.1%) had significant malnutrition (Table 2). PI showed a 51.4% sensitivity with a positive predictive value of 60.2% and a negative predictive value of 88.7% (Table 3). On classifying the newborns based on BMI, 73(20.9%) newborns were found to be malnourished i.e. BMI<11.2. But when assessed by their CAN score, 20 of these newborns were well nourished. On the other hand among newborns with normal BMI 17 newborns (6%) had signs of malnutrition by CAN score. These were found to be statistically significant (Table 2).

The sensitivity of BMI in comparison to CAN score was 75.7% and specificity 92.8% the positive and negative predictive values were 72.6% and 93.8% respectively (Table 3). On classifying the newborns according to weight for age, 81% (283) were found to be AGA and 19% (66) were SGA. When these SGA neonates were assessed by CAN score, 54.5% (36) were found to be well nourished and 14.1% (40) of the AGA newborns were having clinical signs of malnutrition which was statistically significant.

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With regards to MAC/HC, 18.9% (66) newborns were found malnourished i.e. MAC/HC<0.27. Among these 66 newborns, a majority i.e. 54.5% (36) were identified as well nourished by CAN score and 14.1% (40) of well nourished newborns as per MAC/HC were clinically malnourished (Table 2). MAC/HC had a sensitivity of 42.9% and a specificity of 87.1%. The positive and negative predictive values were 45.5% and 85.9% respectively (Table 3). When the indices were combined (PI and BMI) and compared to CAN score, the net sensitivity, specificity, positive and negative predictive values were 89.1%, 90.7%, 96.2% and 97.1% respectively.

Discussion

In developing countries fetal malnutrition and low birth weight is a common clinical problem with long term implications on the growth, neurodevelopment and mortality and morbidity. But low birth weight is a not a reliable indicator of fetal malnutrition. This study aims to identify the incidence of fetal malnutrition, evaluate the different modes of assessment of malnutrition and develop a screening tool for assessment of nutritional status.

The existing indicators of nutritional status do not accurately assess the nutrition which is best assessed by the amount of subcutaneous fat accumulated in the in utero period. Therefore, a combination of clinical assessment with anthropometry is essential to identify most malnourished newborns [9]. In our study the incidence of FM was 20.1%, more than values by Metcoff [2] (10.9%) and almost similar to Adebami [10] (18.4%) and Saundarya et al [11] (24%). When weight is used as a lone criterion, we found that many newborns with fetal malnutrition were mislabeled.

Globally, only about half of the newborns are weighed at birth and about one-sixth of all newborns are low birth weight. In India birth weight was recorded only in 34.1% of live births and in west Bengal only in 43% of the babies, birth weight was recorded [12]. Many malnourished newborns remain undetected because they are either born at home or due to logistical problems like non-availability of a qualified pediatrician and are therefore deprived of the much needed care. Therefore, it is imperative to develop methodologies and tools, which are simple and sensitive for use at community level, and to screen malnourished babies. It is important to identify these high-risk babies early and give them adequate care needed for their survival.

These newborns can also have referred for further evaluation and follow up at a higher center. Deaths among these babies could be reduced with low cost interventions that focus on keeping the baby warm, maintain hygiene, breast feeding support, early identification and management of illness in the first days and weeks of life [13]. This not only reduces the burden in the higher centers but also triages care to those who are truly malnourished. PI (ponderal index) relies on the principle that length spared at the expense of weight during period of acute inflammation; weight and length velocities may be proportionately impaired so infants with chronic insult in utero may be misclassified by PI. In our study we found BMI had a high sensitivity but lower specificity compared to CAN score, suggesting that BMI is a sensitive indicator of fetal malnutrition.

Since a large number of newborns would be falsely identified as malnourished, further assessment of nutrition by CAN score in these newborns will distinguish the truly malnourished newborns by eliminating the newborns who were falsely diagnosed as malnourished by BMI.

Step 1. Assess BMI and PI. If BMI and/or PI is normal implies normal nutrition.

Step 2. If BMI is low, apply CAN score to identify true fetal malnutrition.

Limitations: This being a hospital-based study, the estimates of fetal malnourishment may not reflect what is in the community. At hospital the measurements were done by a single investigator which may not be the same at community level where multiple health workers are involved. In this study, we did not test the usefulness of these measures after day 1 in identifying fetal malnourishment. This would be critical because in some cases the CHWs do not visit the newborns on the first day.

What study adds? Applying CAN score is a time-consuming procedure and apart from it there is no single parameter to accurately differentiate between normal and malnourished newborns, hence combination of BMI and PI can be used to as a screening tool for detecting fetal malnutrition.

Contributors: AT conceptualized and designed the study, did data collection and analysis, drafted the initial manuscript. BS, DB contributed to the study design, data collection, analysis and interpretation, and also critically reviewed the manuscript. BS finalized the

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manuscript and shall act as the overall guarantor. The final version of the manuscript was approved by all authors

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