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Detection of Fetal Malnutrition by CAN Score at Birth and its Comparison with other Methods of Determining Intrauterine Growth

VIKRAM SINGHAL, PRASHANT AGAL, NUTAN KAMATH*

ABSTRACT

**Background:** Fetal malnutrition (FM) and the terms ‘small for gestational age’ (SGA) and ‘intrauterine growth retardation’ (IUGR) are not synonymous, one may occur without the other. FM can be clinically assessed by using the Clinical Assessment of Nutritional Status (CAN) score. CAN score can assess the prevalence of FM among term newborns and is comparable to anthropometric criteria used to assess fetal growth. **Methodology:** A prospective cohort study was carried out at a tertiary referral hospital affiliated to a medical college, consisting of 200 singleton full-term neonates over a period of two months. In all neonates complete anthropometric assessment as per standard procedures and determination of weight for gestation was done. On the basis of Alexander and Associates intrauterine growth curves, newborns were classified into SGA and appropriate for gestational age (AGA). FM was assessed using CAN score as a standard and compared with weight for gestation age and Ponderal index (PI). **Results:** CAN score identified 17.5% (n = 35) malnourished neonates and 82.5% (n = 165) of babies as well-nourished by keeping the cut-off value of <25. Eight percent of AGA babies and 76.8% of SGA babies were found to be well-nourished on comparing weight for gestation age with CAN score. Sixteen (8%) babies were found to have FM using PI but applying CAN score only 10 babies were found to have FM. The sensitivity and specificity of weight for gestational age were found to 82.65% and 41.81%, respectively and that of PI 28.57% and 96.36%, respectively, when CAN score was taken as standard. **Conclusion:** This implies that CAN score can identify fetal malnourishment in those neonates, which are missed by other methods.

**Keywords:** CAN, anthropometry, fetal malnutrition

Fetal growth is a function of growth potential of the fetus, the availability of intrauterine nutrition and placental function. The net result of these factors is a wide distribution of birth size at any given gestational age and a wide variation in the state of nutrition at birth. The concept of fetal malnutrition (FM) was initially developed by Clifford and was defined by Scott and Usher as a clinical state of infants characterized by obvious intrauterine loss of failure to acquire normal amount of subcutaneous fat and muscle. FM and the terms ‘small for gestational age’ (SGA) and ‘intrauterine growth retardation’ (IUGR) are not synonymous, one may occur without the other.34 FM can be clinically assessed by using the Clinical Assessment of Nutritional Status (CAN) score.3 There are various other methods, which are used to determine nutritional status of newborns at birth like weight for gestational age, Ponderal index (PI) and mid arm/head circumference ratio. But each has its own drawbacks.36 Detection of FM at birth is thus useful for identifying those newborns who are at higher risk for metabolic complications associated with abnormal fetal growth.3 The aim of this study was detection of FM by CAN score of term neonates at birth and its comparison with other methods of determining intrauterine growth.

MATERIAL AND METHODS

A prospective cross-sectional study was carried out at a tertiary referral hospital affiliated to a medical college after taking the prior approval of the Institutional Ethics Committee. Two hundred singleton full-term neonates (38-42 weeks of gestation) whose hospital stay exceeded 24 hours of age were enrolled in the study after taking informed consent from the parents. Neonates
(both sexes), born as a result of multiple pregnancies and/or having major congenital malformations were excluded. The study was carried out over a period of two months. Before starting the study, the inter- and intra-observer variations of the CAN score were tested and found to be within acceptable limits (p > 0.05). Neonatal anthropometry measurements (weight, length, head circumference) were carried out between 24-48 hours of newborn age using standard guidelines and instruments. PI was calculated as weight (grams)/Length(cm) × 100; and values below 2.2 were taken as indicative of growth retardation. Infant's age was assessed by using New Ballard score and it was further correlated with last menstrual period (LMP) and ultrasonic measurements taken antenatally. If in disagreement for over two weeks, the clinical score was taken as the final gestational age (GA). All these data were recorded on the pre-designed form, for each baby. On the basis of normograms of the Alexander and associates intrauterine growth curves, newborns were classified as SGA and appropriate for gestational age (AGA). Infants, whose weights were below the 10th percentile for their GA, were classified as SGA, whereas those with birth weight between 10th-90th percentiles for their GA were designated as AGA babies.

CAN score has nine superficial readily detectable signs, which are rated from 1 (worst-severe FM) to 4 (best well-nourished). The highest possible score is 36 and lowest possible score is. A CAN score of ≤24 was taken as fatelly malnourished. CAN score is presented in Table 1.

Data were statistically analyzed with test of significance, calculated by chi-square test. Anthropometric measurements were expressed as percentiles. Sensitivity, specificity, positive and negative predictive values were also calculated, wherever required. A 'p' value of <0.05 was considered significant.

RESULTS

In this study, 200 singleton term neonates were analyzed to detect FM. Mean birth weight of study population was 2.73 ± 0.35 kg and the mean length was 45.43 ± 2.02 cm. In our study, when nutritional status of newborns was detected by CAN score, 82.5% newborns were well-nourished but 17.5% newborns had malnutrition. When nutritional status of newborns was detected on the basis of weight for GA, we found that 62.5% babies were SGA, while 37.5% were AGA. When PI was used for detection of nutritional status in newborns, it was found that 92% newborns were well-nourished but 8% were malnourished (Fig. 1).

In our study, 35 of 200 term neonates, were malnourished in utero (FM). Thus, 96 out of 125 SGA babies were small but not malnourished and six out of 75 AGA were fully grown but were malnourished. Sixteen babies

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Table 1. The Nine signs for CAN Status in the Newborn

<table>
<thead>
<tr>
<th>Hair</th>
<th>Large amount, smooth, silky, easily groomed (4). Thinner, some straight, 'staring' hair (3). Still thinner, more straight, 'staring' hair which does not respond to brushing (2). Straight 'staring' hair with depigmented strip (flag sign) (1).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheeks</td>
<td>Progression from full buccal pads and round face (4); to significantly reduced buccal fat with narrow, flat face (1).</td>
</tr>
<tr>
<td>Neck and Chin</td>
<td>Double or triple chin fat fold, neck not evident (4); to thin chin. No fat fold, neck with loose, wrinkled skin, very evident (1).</td>
</tr>
<tr>
<td>Arms</td>
<td>Full, round, cannot elicit 'accordion' folds or lift folds of skin from elbow or tricep area (4); to a striking 'accordion' folding of lower arm, elicited when examiner's thumb and fingers of the left hand grasps the arm just below the elbow of the baby and thumb and fingers of the examiners right hand circling the wrist of the baby are moved towards each other; skin is loose and easily grasped and pulled away from the elbow.</td>
</tr>
<tr>
<td>Legs</td>
<td>Like arms.</td>
</tr>
<tr>
<td>Back</td>
<td>Difficult to grasp and lift skin in the interscapular area (4); to skin loose, easily lifted in a thin fold from the interscapular area (1).</td>
</tr>
<tr>
<td>Buttocks</td>
<td>Full round gluteal fat pads (4); to virtually no evident gluteal fat and skin of the buttocks and upper posterior high loose and deeply wrinkled (1).</td>
</tr>
<tr>
<td>Chest</td>
<td>Full, round, ribs not seen (4); to progressively prominence of the ribs with obvious loss of intercostal tissues (1).</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Full, round, no loose skin (4); to distended or scaphoid, but with very loose skin, easily lifted, wrinkled and 'accordion' folds demonstrable.</td>
</tr>
</tbody>
</table>
**Table 2. Distribution of SGA and FM Diagnoses in 200 Neonates and Comparison of CAN Score with PI**

<table>
<thead>
<tr>
<th>Weight for gestational age</th>
<th>CAN score</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FM</td>
<td>Nourished</td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGA</td>
<td>6 (8%)</td>
<td>69 (94%)</td>
<td>75 (37.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGA</td>
<td>29 (23.2%)</td>
<td>96 (76.8%)</td>
<td>125 (62.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>35 (17.5%)</td>
<td>165 (82.5%)</td>
<td>200 (100%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ponderal index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2.2</td>
<td>10 (62.5%)</td>
<td>6 (37.5%)</td>
<td>16 (8%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2.2</td>
<td>25 (13.5%)</td>
<td>159 (86.41%)</td>
<td>184 (92%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>35 (17.5%)</td>
<td>165 (82.5%)</td>
<td>200 (100%)</td>
<td></td>
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</tbody>
</table>

*<0.01 highly significant*

![Figure 1. Comparison of CAN score, weight for GA and PI.]

were found to have FM using PI but by applying CAN score only 10 babies were found to have FM. Out of the 184 babies found to be well nourished by using PI, 25 babies were found to be malnourished *in utero* by applying CAN score (Table 2). PI has low sensitivity in comparison to CAN score for diagnosis FM (Table 3). Also, using PI alone for diagnosing FM, some SGA babies may be misdiagnosed as FM and some AGA babies may be misdiagnosed as normal.

**DISCUSSION**

It is important to recognize babies with FM because of high incidence of neonatal morbidity and long-term sequelae-like metabolic syndrome. Depending on the period of gestation, when the malnutrition started, the clinical manifestations of FM vary. FM adversely affects body composition, including reduced muscle mass and protein content, organ structure and composition, bone, chemical composition and metabolic, and enzyme functions.

The perinatal problems and/or central nervous system sequelae, occurred primarily in fetally malnourished babies, whether AGA or SGA, but not those who were simply SGA but not malnourished was found in a study done by Hill et al. In *utero* growth restriction is not a uniform condition with respect to its severity and duration, the underlying pathogenesis and the developmental stage of the fetus at the time of its occurrence. If malnutrition happens early in the second trimester, length, head circumference and weight are significantly all reduced, whereas if length and head circumference are less affected but baby is small and underweight mostly the malnutrition happened in the beginning of the third trimester. If length and head circumference are within the normal range, and weight significantly less than the GA, an insufficient or unbalanced nutrient supply most likely occurred in the late third trimester.

For the last two categories, weight, may be above the tenth percentile for GA. FM adversely affects body composition, including reduced muscle mass and protein content, organ structure and composition, bone, chemical composition and, metabolic and enzyme functions. FM is clinically characterized by obvious
intrauterine loss of subcutaneous fat and muscle. Weight, length and head circumference may or may not be affected.\textsuperscript{15} Irrespective of cause, fetuses with inadequate nutrition will not deposit fat as long as their basic metabolic needs are not met, whereas a baby with abundant subcutaneous fat cannot have suffered from in utero malnutrition. On the basis of this principle, the evaluation of fat deposits is an appropriate means for the distinction between IUGR and non-IUGR neonates. Neither SGA nor IUGR are synonymous with FM. The current anthropometric criteria used to assess fetal nutritional status of newborn, have their shortcomings.\textsuperscript{4,13,16} A simple, clinically applicable scoring system was developed by Metcalf\textsuperscript{4} to differentiate the malnourished from appropriate nourished babies irrespective of birth weight or clinical classification as IUGR, SGA, or AGA. This scoring system rated clinical evidences of malnutrition in term babies determined by inspection and hands on estimates of loss of subcutaneous tissue and muscle and is independent of common confounding factors which affect weight of the baby.\textsuperscript{4}

The CAN score is much simpler to learn and easy to do, particularly with the aid of cartoon illustrations of the signs and scores as described by Metcalf.\textsuperscript{4} Its major drawback is its subjective nature, like all other scoring methods used in the evaluation of neonates. The method could be used as a screening or confirmatory test.

In a study by Deodhar et al.\textsuperscript{20} FM was present in 19.6% babies (84.2% of the SGA, 12.9% of AGA babies) while Metcalf\textsuperscript{4} reported FM in 5.5% of AGA and 54% of SGA babies. This variability in the results may be because of type of growth charts used to differentiate AGA/SGA babies. Several fetal growth curves have been developed from various populations and geographic locations.\textsuperscript{17,18} In the study by Hill et al.,\textsuperscript{22} 32.6% of FM infants would have been misclassified as AGA, if only birth weights, lengths and head circumferences were considered for detection of growth retardation. In our study, using CAN score, 76.8% of SGA infants were not malnourished and 8% of AGA infants were fetally malnourished. Hill et al.\textsuperscript{22} have showed that 39% of later neurologic and intellectual handicaps occur predominantly in FM babies. This would have been missed if only a birth weight of less than the 10th percentile was used. Thus, apart from 23% of the SGA, 8% of the AGA malnourished babies are also at risk. Metcalf\textsuperscript{4} established. CAN score as a good indicator of FM. In a large sample of 1,382 term neonates, a simple brief CAN status revealed that 151 (10.9%) were FM, including 5.5% of 1,229 AGA and 83 (54%) of 153 SGA babies; nearly half 45.8% of the SGA infants were not malnourished in utero. Our data and previous reports\textsuperscript{4,13,16} suggest that using weight for gestation classification to identify malnourished neonates may not be entirely accurate, because it may identify many well-nourished neonates as SGA, or miss a proportion of malnourished AGA neonates.

To classify IUGR infants, PI has been used by various authors.\textsuperscript{19,20} PI 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. The other drawback of PI is that any error in calculating length is cubed in the calculation of the PI.\textsuperscript{2} In our study, 16 infants (8%) were found growth retarded according to PI (<2.2); out of these only 10 infants were fetally malnourished on using CAN score. When CAN score was compared with PI, it gave a sensitivity of 28.57% and a specificity of 96.36% in the present study. Haggarty et al.\textsuperscript{21} indicate that PI is a poor predictor of in utero growth retardation,\textsuperscript{5,21}

Deodhar et al.\textsuperscript{22} state that CAN score is a simple and rapid clinical scoring system for diagnosing FM. All AGA infants are not well-nourished and not all SGA babies are malnourished and those without FM have a better outcome and faster catch-up growth. In a developing country like India, CAN score can be used as a simple and effective tool to identify FM. The limitation of our study was small sample size and inability for long-term follow-up to assess development of these babies. Undoubtedly, further research is needed, using a greater range of confirmatory information. Search and evaluation of alternative indices or other simple indicators of growth restriction might also contribute to a more accurate identification of IUGR babies.

**CONCLUSION**

Our study concluded that SGA and IUGR are not synonymous with FM. CAN score, which is a simple clinical index for identifying FM, is a good indicator for the same in comparison to other methods of determining IUGR-like weight for gestational age and PI. This implies that CAN score can identify fetal malnourishment in those neonates, which are missed by other methods.

**REFERENCES**