Original Article

Iran J Pediatr
Mar 2012; Vol 21 (No 1), Pp: 70-76

Comparative Assessment of Fetal Malnutrition by Anthropometry and CAN Score

Mahalingam Soundarya*, MD; Achappa Basavaprabhu, MD; Kamila Raghuveera, MD; BS Baliga, MD, and BSV Shivanagaraja, MD

Department of Pediatrics, Kasturba Medical College,Manipal University, Mangalore, India

Received: *May 12, 2011*; Final Revision: *Jul 07, 2011*; Accepted: *Sep 25, 2011*

Abstract

Objectives: Fetal malnutrition (FM) implies soft tissue wasting at birth with significant postnatal consequences and morbidity, and is identified by clinical assessment (CAN score) and anthropometry. No previous studies have been done to study all these parameters and evolve a screening method. The aim of this study was identifying the incidence of FM using CAN score and compare the nutritional assessment with anthropometry and evolve a screening tool for rapid assessment of FM.

Methods: Prospective study in Government district maternity hospital. 300 term newborns were assessed by CAN score and anthropometry recorded. The newborns were classified as per weight for age. Ponderal index (PI), Body mass index (BMI) and midarm circumference/head circumference ratio (MAC/HC) calculated and compared to CAN Score for accuracy in identifying FM.

Findings: Incidence of FM was 24%. Newborns identified malnourished by PI, BMI, MAC/HC were evaluated by CAN score and significant number of them (31/78 in PI, 60/121 in BMI, 51/81 in MAC/HC) were found well nourished. Similarly those recognized as normal by PI, BMI, MAC/HC were malnourished by CAN score(25/222 in PI, 11/179 in BMI, 42/219 in MAC/HC) with statistical significance(0.0001). BMI had the highest sensitivity and 11 neonates with normal BMI had low CAN score ann 9 of them had normal PI also making a combination of BMI and PI a good indicator of normal nutrition.

Conclusion: FM is best identified by CAN Score. BMI is the best screening tool for malnutrition and when coupled with PI will identify most normally nourished newborns.

Iranian Journal of Pediatrics, Volume 22 (Number 1), Mar 2012, Pages: 70-76

Key Words: CAN Score; Fetal Malnutrition; Ponderal Index; Body Mass Index;

Introduction

Fetal malnutrition (FM) is a term coined by Scott and Usher in 1966 to describe infants who showed evidence of soft tissue wasting at birth irrespective of the specific etiology [1]. It is defined as failure to acquire adequate quantum of fat and muscle mass during intrauterine growth. The existing terminologies for describing intrauterine malnutrition include: small for gestational age (SGA), intrauterine growth restriction (IUGR) and placental insufficiency. None of these terminologies is actually synonymous with FM as none of these methods assess the subcutaneous fat accumulated nor are they population varied, instead are common for various populations

*** Corresponding Author;**
Address: Dept of Pediatrics, Kasturba Medical College Attavar, Mangalore – 575001, Karnataka
E-mail: soundarya29@gmail.com

despite their genetic and ethnic variations. Similarly 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. The importance of addressing this hidden problem of fetal malnutrition is emphasized because of the potentially serious sequelae of malnutrition on multiple organ systems with studies showing that 39% of fetally malnourished babies had intellectual and neurological handicaps [5,18]. The assessment of nutrition at birth has been made using various systems:

1. Anthropometry – weight, length, head and chest circumference.
2. Proportionality indices - Roher's 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 been used as a measure of adiposity in older individuals. It has also been described in newborns [14,17].
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 [2].

Perinatal problems and/or long term central nervous system sequelae are known to occur primarily in babies with FM whether appropriate for gestational age (AGA) or SGA and hence it is the need of the hour to promptly identify newborns with FM [5,18]. Features of malnutrition must be sought for, appropriately diagnosed and treated in every baby at risk. This anticipatory management of such infants at birth may decrease morbidity and improve the survival of such infants.

Aims and objectives:

1. To identify the incidence of fetal malnutrition by clinical assessment of nutritional status using CAN score.
2. To compare the assessment of nutritional status using CAN score to anthropometric indices and assess their accuracy in identifying fetal malnutrition.
3. To attempt at developing a screening tool in identifying fetal malnutrition using anthropometric indices.

Subject and Methods

This study was a prospective study undertaken at a Government district headquarters maternity hospital on 300 term singleton newborns born consecutively in the hospital.

The study was approved by the institutional ethics committee before commencement of the study.

Inclusion criterion was 300 term 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
- Those born to mothers with Gestational Diabetes mellitus
- 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 ultrasonography.

The following parameters were recorded in all babies (weight was recorded at birth, length, mid arm circumference and head circumference were recorded between 24 – 48 hrs of life): (i) Birth weight: Nude birth weight, measured to the nearest 10gms using electronic weighing scale. (ii) Crown to Heel Length: Length was measured to the nearest 0.1cm using an infantometer. (iii) Occipito-frontal 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 AGA, SGA and large for gestational age (LGA) [12], and the following proportionality ratios were calculated and compared with clinical assessment using CAN score to assess their effectiveness in identifying malnutrition.

Ponderal index(PI):

It was calculated using the following formula

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

Table 1: Incidence of fetal malnutrition

Parameter	Male (%)	Female (%)	Total (%)
Malnourished (CAN score<25)	33 (11)	39 (13)	72 (24)
Well nourished (CAN score>= 25)	110 (36.6)	118 (39.4)	228 (76)

Ponderal index of less than 2.2 gm/cm^3 was considered as an index of malnutrition [12].

Mid arm circumference/head circumference Ratio (MAC/HC): A cut off value of 0.27 was used in this study to define malnutrition [13].

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[14].

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[2]. 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 suggestive of malnutrition.

In our study CAN score was the tool accepted as the gold standard for identification of fetal malnutrition[2] and the relationship of the anthropometric indices was done in comparison to the gold standard ie CAN score.

For studying the relationship of anthropometrical attributes with CAN score, the observations were statistically analyzed using EPI INFO version 6 statistical package and Chi square test was performed. Sensitivity, specificity, positive and negative predictive values were calculated.

Findings

A total of 300 newborns were assessed with the incidence of fetal malnutrition being 24% as identified by CAN score. There was equal sex predisposition in the incidence of fetal malnutrition between male and female newborns (Table 1).

On classifying the newborns according to weight for age, 77% (231) were found to be AGA and 23% (69) were SGA. When these SGA neonates were assessed by CAN score, 23% (16) were found to be well nourished and 8.2% (19) of the AGA newborns were having clinical signs of malnutrition which was statistically significant (Table 2).

These newborns were also classified based on Ponderal index and 26% (78) of the newborns were malnourished. Upon CAN score assessment, 39.7% (31) were found clinically well nourished and of the remaining well nourished neonates with normal PI, 11.2% (25) had significant malnutrition (Table 2). PI showed a sensitivity and

Table 2: Comparison between Body Indices and CAN score

S. No	Body index	CAN score		Frequency	χ^2 test	*P* value
		Malnourished	Normal			
1	PI <2.2	47	31	78	75.9	0.0001
	>2.2	25	197	222		
2	BMI <11.2	61	60	121	77.5	0.0001
	>11.2	11	168	179		
3	MAC/HC <0.27	30	51	81	10.3	0.0001
	>0.27	42	177	219		
4	SGA	53	16	69	137	0.0001
	AGA+LGA	19	212	231		

PI: Ponderal index; BMI: Body Mass Index; SGA: Small for Gestational Age; AGA: Appropriate for Gestational Age; LGA: Large for Gestational Age

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

Statistical details	PI	BMI	PI+BMI	MAC/HC	CAN score*
Sensitivity	65.2	84.7	84.7	41.6	50
Specificity	86.4	73.6	72.8	77.6	93.8
Positive predictive value	60.2	50.4	49.5	37.0	84.7
Negative predictive value	88.7	93.8	93.7	80.8	73.3

* CAN score statistics have been extrapolated and in the present study CAN score has been taken as the standard for assessing fetal malnutrition [4]

PI: Ponderal index; BMI: Body Mass Index; MAC/HC: Mid arm circumference/head circumference Ratio

specificity of 65.2% and 86.4% respectively in detecting malnutrition in comparison to CAN score, 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, 40.3% (121) newborns were malnourished. But when assessed by their CAN score, 49.5% (60) of these newborns (BMI >11.2) were well nourished. On the other hand among newborns with normal BMI (59.7%, 179), 6% (11) 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 84.7% and specificity 73.6%; the positive and negative predictive values were 50.4% and 93.8% respectively (Table 3).

With regards to MAC/HC, 27% (81) newborns were found malnourished. Among these 81 newborns, a majority ie 62.9% (51) were identified as well nourished by CAN score and 19% (42) of well nourished newborns were clinically malnourished (Table 2). MAC/HC had a sensitivity of 41.6% and a specificity of 77.6%. The positive and negative predictive values were 37% and 80.8% 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 remained the same (84.7%, 72.8%, 49.5% and 93.7% respectively). Analysis was carried out with BMI which had exhibited a very high sensitivity as standard index against CAN score. Among the 179 well nourished newborns with BMI >11.2, 11 were clinically malnourished (CAN score <25) and the remaining 168 were normal. Further analysis of the PI in these 179 newborns showed that all the 168 with normal BMI, had also normal PI and 9 out of the 11 newborns with low BMI also had low PI implying that only 2 out of the total 300 newborns were misdiagnosed as malnourished when a combination of BMI and PI was applied (<1% underdiagnosis)(Fig. 1).

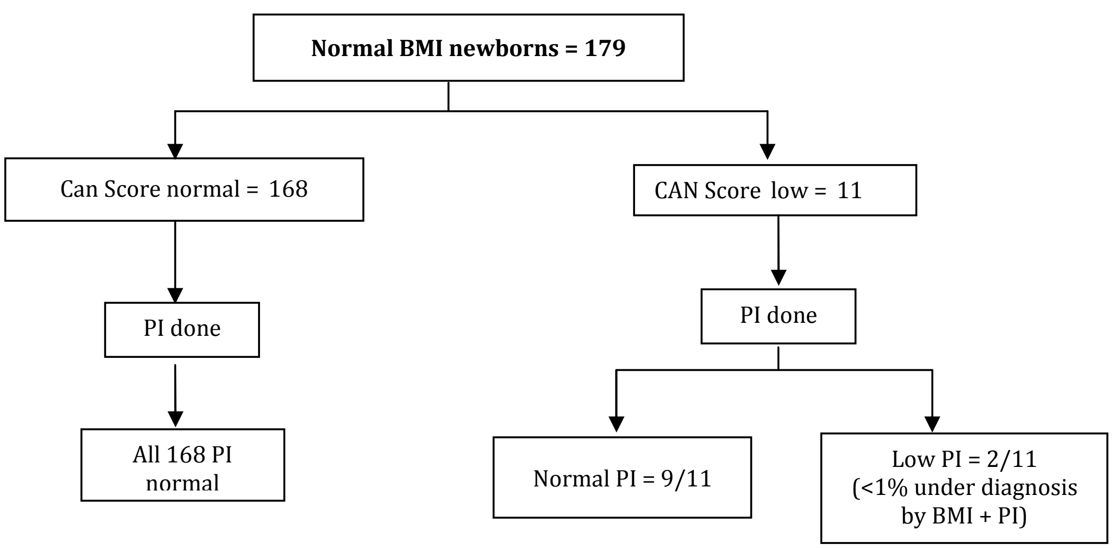

Fig.1: Analysis of combination of body mass index (BMI) and ponderal index (PI)

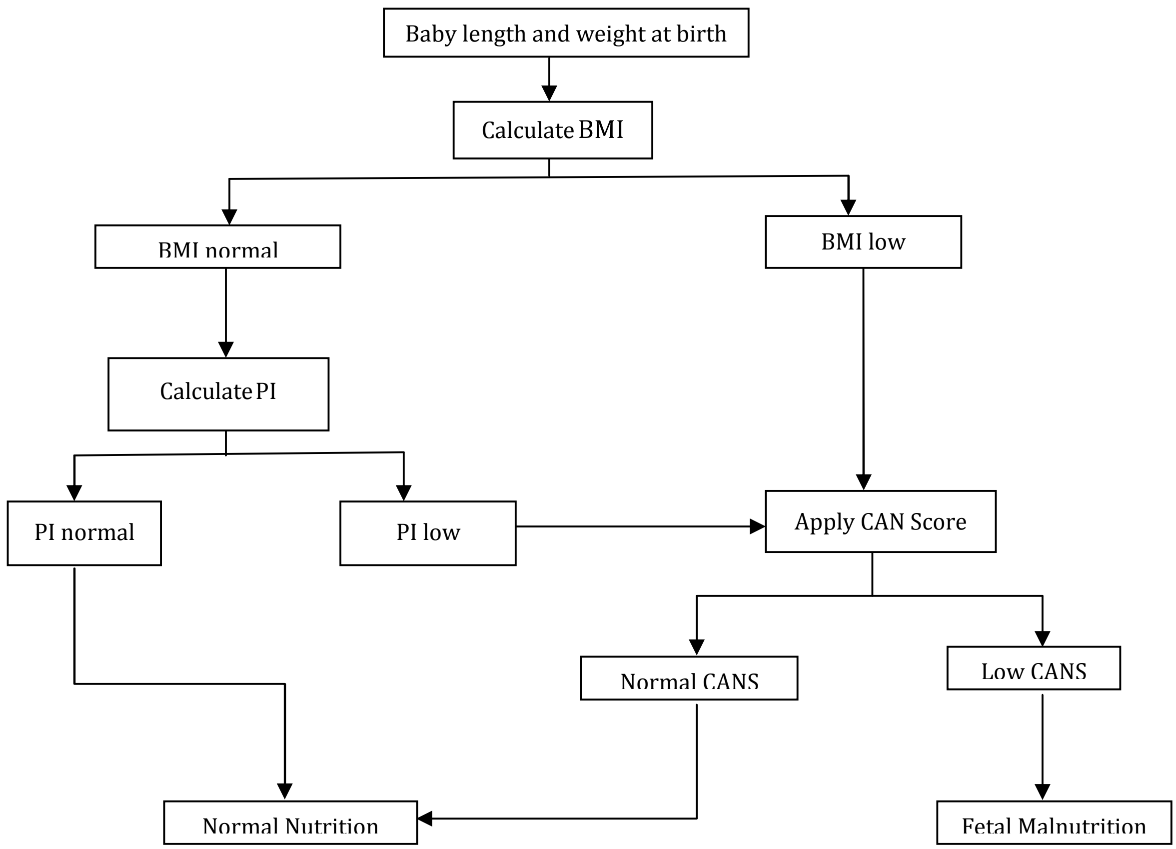

Fig. 2: Screening tool algorithm
BMI: body mass index; PI: ponderal index

Discussion

In developing countries low birth weight is a common clinical problem with long term implications on the growth, neurodevelopment and mortality and morbidity. 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 [15]. In our study the incidence of FM was 24%, more than values by Metcoff [2] (10.9%) and similar to Kumari [3] (27.4%) and Rao [4] (28%). When weight is used as a lone criterion, we found that many newborns with fetal malnutrition were mislabeled as well nourished and vice versa which is in concordance with studies done by Taylor [6].

Ponderal index is an index which relies on the principle that the length is spared at the expense of weight during acute malnutrition, however it does not take into account chronic malnutrition where as both weight and length are affected with their ratio being normal, hence such newborns who are malnourished will be misdiagnosed as normal. In our study PI exhibited a better specificity but poor sensitivity in identifying malnutrition. This is in concordance with other studies done by Osyande [7] and Adebami [16], but not with the study done by Georgieff [8] who found MAC/HC as a more accurate index.

On analysis of the relation of MAC/HC with CAN score, a very poor sensitivity was obtained with a fair specificity, the positive predictive value was also very low, hence making MAC/HC a very poor indicator in detecting fetal malnutrition. These observations are similar to those made by

Osyande [7] and Meadow [11] but lower values of statistics were reported by Mehta [10].

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.

The clinical tool (Fig. 2):

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.

The main importance of this screening tool lies in that in peripheral outreach centers where the availability of a qualified pediatrician is difficult and tedious, simple calculation of these indices by any auxillary health worker can help identify actual fetal malnutrition and thus refer these newborns for further evaluation and follow up at a higher center. This not only reduces the burden in the higher centers but also triages care to those who are truly malnourished.

Limitations: This study has a small sample size and hence larger multicentric studies are required to validate this screening tool for identifying fetal malnutrition.

Application of the study: Identification of fetal malnutrition which is a major problem has been so far hidden and unrecognized by the present anthropometric methods and is essential to adapt interventional methods to prevent the sequelae.

Our study simplifies this process by delineating those newborns who require CAN score and thereby accurately identifying fetal malnutrition which is of importance in developing countries where maximum newborns are delivered in outreach centers where qualified personnel are few.

Conclusion

The incidence of fetal malnutrition at birth is high and can be present irrespective of the normal anthropometric parameters for the newborn, and can be most accurately identified by CAN score that is time consuming and requires expertise.

As there is no single parameter to accurately differentiate between normal and malnourished newborns, we hence looked at a combination of BMI and PI to identify maximum normal nutrition and would propose our screening tool for detecting fetal malnutrition (Fig 2) with the following interpretations.

Normal BMI and/or normal PI is a good indicator of normal fetal nutrition, therefore in these newborns there is no need to assess nutritional status by CAN score which is time consuming. Here the probability of identifying fetal malnutrition by CAN score, in the presence of normal PI and BMI, even if it is applied is <1%. BMI is a very sensitive index and those newborns identified malnourished by BMI should be screened further by CAN score to accurately identify fetal malnutrition.

Acknowledgment

We also wish to acknowledge the Manipal University Review Board for permitting us to conduct this study. We wish to acknowledge Dr Rathika D Shenoy, Associate Professor, Department of Pediatrics for her invaluable help with the manuscript preparation and statistics and Dr Unnikrishnan, Associate Professor, Department of Community Medicine for his technical help in the statistical analysis.

Conflict of Interest: None

References

1. Scott KK, Usher RH. Fetal malnutrition: Incidence, causes and effects. *Amer J Obstetr* 1966;94(7): 951-63.
2. Metcoff J. Clinical assessment of nutritional status at birth. Fetal malnutrition and SGA are not synonymous. *Pediatr Clin North Am* 1994;41(5): 875-90.
3. Kumari S, Jain S, Sethi GR, et al. A simple method of assessing for intrauterine growth retardation. *Ind J Pediatr* 1988;55(2):283-6.

4. Rao MR, Balakrishna N, Rao KV. Suitability of CAN SCORE for the assessment of the Nutritional Status of Newborns. *Ind J Paed* 1999;66(4):483-92.

5. Hill RM, Verniaud WM, Deter RL, et al. The effect of intrauterine malnutrition on the term infant: a 14 year prospective study. *Acta Pediatr Scand* 1984;73(4):482-7.

6. Taylor D, Nayak US. CAN score-Assessment of nutritional status of newborns. *J Obstetric Gynecol* 2002;52(1):76-8.

7. Eregie CO. Arm to Head ratio in the nutritional evaluation of newborn infants: a case report of an African population. *Ann Trop Ped* 1992;12(2): 195-202.

8. Georgieff MK, Sasanow SR. Nutritional assessment of the neonate. *Clin Perinatol* 1986; 13(1):73-89.

9. Nair RB, Elizabeth KE, Geetha S, et al. Mid Arm Circumference and Body Mass Index - the two important auxiologic parameters in neonates. *J Trop Pediatr* 2006;52(5):341-5.

10. Mehta S, Tandon A, Dua T, et al. Clinical assessment of nutritional status at birth. *Ind Pediatr* 1998;35(5):423-8.

11. Meadow NJ, Till J, Leaf A. Screening for IUGR using ratio of mid-arm circumference to head circumference. *Br Med J (Clin Res Ed)*. 1986;292 (6527):1039-40.

12. Mohan M, Prasad SR, Chellani HK, et al. Intrauterine growth curves in North Indian babies: weight, length, head circumference and Ponderal index. *Ind Pediatr* 1990;27(1):43-51.

13. Georgieff MK, Sasanow SR, Chockalingam UM, et al. A comparison of midarm circumference/head circumference ratio and Ponderal index for evaluation of mentally retarded infants after abnormal intrauterine growth. *Acta Pediatr Scand* 1988;77(2):214-9.

14. Brock RS, Falcao MC, Leone C. Body mass index values for newborns according to gestational age. *Nutr Hosp* 2008;23(5):487–92.

15. Sifianou P. Approaching the diagnosis of growth restricted neonates - a cohort study. *BMC Pregnancy Childbirth* 2010;10:6.

16. Adebami OJ, Owa JA. Comparison between CAN SCORE and other anthropometric indicators in fetal malnutrition. *Ind J Pediatr* 2008;75(5):439–42.

17. Fok TF, Hon KL, Ng PC, et al. Use of anthrop-metric indices to reveal nutritional status: normative data from 10,226 Chinese neonates. *Neonatology* 2009;95(1):23- 32

18. Adebami OJ, Owa JA, Oyedeji GA, et al. Prevalence and problems of foetal malnutrition in term babies at Wesley Guild Hospital, South Western Nigeria. *West Afr J Med* 2007;26(4):278–82.