Study of fetal malnutrition in full-term small for gestational age babies

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ABSTRACT

Introduction: Fetal malnutrition (FM) is a risk factor for increased neonatal morbidities and mortalities worldwide. Clinician's comes across the challenge to identify small for gestational age (SGA) babies whose health is endangered *in utero* due to a hostile intrauterine environment and to monitor and intervene appropriately. **Objectives:** This prospective observational study aimed to know the prevalence of FM and to study the occurrence of adverse perinatal events in term SGA babies. **Materials and Methods:** The study enrolled 903 term SGA neonates. Clinical assessment of nutrition (CAN) score was applied and anthropometric evaluation was carried out between 24 and 48 h of birth. Babies with adverse perinatal events were treated according to standard hospital protocol. **Results:** The prevalence of FM in the present study was 34.21% in term SGA babies. All anthropometric parameters such as birth weight, length, head circumference (HC), and ponderal index (PI) were significantly lower in SGA babies with FM as compared to those without FM. There was significantly higher occurrence of FM in SGA babies. Risk of FM was 3.17 times higher in SGA babies with length <3rd centile and risk 2.07 times higher when HC was <3rd centile. The risk of FM was 4.27 times higher when PI <2.2. When PI was compared to CAN score for FM, it had low sensitivity and specificity. **Conclusion:** CAN score is the better index for the detection of FM and for predicting high risk of perinatal morbidity in term SGA babies. Our study demonstrates that predicting malnutrition is more meaningful than birth weight alone.

Key words: *Clinical assessment of nutrition score, Fetal malnutrition, Ponderal index, Neonate*

Intrauterine growth restriction (IUGR) refers to a condition, in which a fetus is unable to achieve its genetically determined potential size. Not all fetuses that are small for gestational age (SGA) are pathologically growth restricted. About 40% are at high risk of potentially preventable perinatal death. Another 40% of these fetuses are constitutionally SGA but are healthy and do not need any intervention [1]. The remaining 20% of fetuses that are SGA are intrinsically small secondary to a chromosomal or environmental etiology. The clinician's challenge is to identify IUGR fetuses whose health is endangered *in utero* due to a hostile intrauterine environment and to monitor and intervene appropriately. This challenge also includes identifying small but healthy fetuses and avoiding iatrogenic harm to them or their mothers.

"Fetal malnutrition (FM)," a term coined by Scott and Usher [6], is defined as a failure to acquire adequate quantum of fat and muscle mass during intrauterine growth [4,5]. Assessment of nutritional status of fetus has been a major concern to many clinicians due to the potentially serious sequelae of malnutrition on multiple organ systems [2,3]. Fetal biometry has been used to identify malnourished fetuses as early as possible. In FM, the subcutaneous tissues and underlying muscles are diminished and the skin of arms, legs, elbows, knees, and interscapular regions is very loose. Babies with FM may have sequelae such as perinatal problems and long-term central nervous system [4]. Such babies should be promptly identified and anticipatory management at birth may decrease morbidity and improve the survival [4-6].

Fetal growth retardation is a risk factor for postnatal growth retardation, cardiovascular, and metabolic problems later on in life and adverse neurodevelopmental outcome [7,8]. However, prognosis differs among these term SGA babies, and a proportion of these neonates has a better outcome as compared to others. Any method to identify the "at-risk" newborn assumes importance as it helps to optimize the use of limited resources of the developing countries. Apart from this, the assessment of gestation and interpretation of growth curves requires training, limiting its use in rural areas. The present study is planned with the primary aim of estimating the prevalence of FM in term SGA babies and to study the occurrence of adverse perinatal events in term SGA babies with or without FM.

MATERIALS AND METHODS

The present prospective observational study was conducted in the neonatology unit of tertiary care institute at Government

Medical College, Nagpur, one of the largest tertiary care referral hospitals of central India. The study group consisted of 903 term SGA (weight <2.5 kg) neonates of gestational age (GA) >37 weeks born with normal vaginal delivery/lower segment cesarean section. Babies with major congenital malformations, premature babies (<37 weeks of GA), and weight >2.5 kg were excluded from the study. After obtaining written informed consent from parents, clinical assessment of nutrition (CAN) and anthropometric evaluation were carried out between 24 and 48 h of birth in all neonates. Institutional ethical clearance was obtained for the study.

All observations were made by a single observer in a warm well-lighted room. Weight was obtained using a digital scale with a capacity of 20 kg and sensitivity of ±5 g. The CAN score was obtained on the basis of superficial readily detectable signs of malnutrition in the newborn as described by Metcoff [4]. Each sign was rated 1 (worst, severe FM) to 4 (best, well nourished). The highest attainable score was 36 and the lowest was 9. FM was concluded in those with a CAN score of <25. Before starting the study, inter- and intra-observer variation of CAN score was tested and was found to be within the acceptable norms (p>0.05).

A cutoff value of the 10th centile was used to define SGA. A cutoff value for length used was 46.3 cm and for head circumference (HC) 32.1 cm. GA assessment was based on accurate recollection of date of the last menstrual period by the mother. When a doubt existed, findings from recent ultrasound examinations were taken into consideration and assessment of newborn using expanded new Ballard score was used to assign GA in completed weeks. HC was measured with a non-stretchable measuring tape just above the supraorbital prominence anteriorly and over the maximum occipital prominence posteriorly excluding the ears. Length was measured using an infantometer. A slight pressure was applied at the newborn's knees to ensure full extension of lower extremities. A value below the 3rd centile was taken as abnormal.

The hypothesis of this study was that nutritional status of term SGA babies is more important prognostically than birth weight. In this study, parallel analysis of the birth weight, ponderal index (PI), and nutritional status of term SGA babies was done to identify the method that provided the most useful prognostic information in terms of perinatal morbidity. Babies with adverse perinatal events were admitted in special care neonatal unit and were treated according to standard hospital protocol.

Demographic, anthropometric, and clinical parameters were presented as mean±SD. Categorical variables were expressed in actual numbers and percentages. Unpaired t-test was performed to compare mean birth weight, PI, length, and HC between well-nourished and FM groups. Categorical variables were compared by Chi-square statistics. Multivariate logistic regression analysis was performed to find the effect of length and PI. CAN score was expressed as continuous variables on neonatal morbidity. p<0.05 was considered as statistical significance. All tests were two sided. Statistical software STATA version 10.0 was used for statistical analysis.

RESULTS

In the present study, of the 903 term SGA neonates, 477 (52.8%) were male and 426 (47.2%) were female. Of all these, 309 (34.21%) were detected to have FM based on the CAN score of <25. Thus, the prevalence of FM in SGA babies was 34.21%. Of 309 babies with FM, 172 (55.66%) were male and 137 (44.33%) were female (p=0.218). All anthropometric parameters were significantly lower in malnourished term SGA babies except length. There was a significant difference in mean birth weight, HC, and PI (p=0.0000). The details are given in Table 1.

There was a significantly higher occurrence of FM (p<0.05) in term SGA babies with birth weight <1.5 kg, while in SGA babies with birth weight between 2.0 and 2.5 kg, a significantly larger number of babies were well nourished (p=0.0225). This observation suggests that term SGA babies with increasing birth weight tend to have lesser occurrence of FM. The details are given in Table 2.

When mean length of babies was used for comparison, there was no significant statistically difference. However, when length was considered in terms of being <3rd centile, a significant difference (p<0.0014) was found. Babies with birth length <3rd centile were found to be at 1.64 times higher risk for FM. Further, analysis of data showed that babies with HC <3rd centile were 2.07 times higher risk for FM than those with HC >3rd centile. Babies with PI <2.2 were 4.27 times higher risk for developing FM as compared to babies with PI ≥2.2 (p=0.0000). PI failed to detect FM in 91 babies with PI ≥2.2. When CAN score was compared with PI, it yielded following results: Sensitivity = 70.5%, specificity = 83.5%, positive predictive value = 68.9%, and negative predictive value = 84.5%. The details are given in Table 3.

Adverse perinatal events occurred in significantly high number in SGA babies with FM as shown in Table 4.

On multivariate analysis of the effect of length, PI, and CAN score on neonatal morbidity, CAN score proved to be highly significant variable (Table 5).

DISCUSSION

There are a very few studies available reporting FM in term SGA neonates. A large number of studies have reported FM in

Table 1: Anthropometric characteristic of intrauterine growth restriction population by CAN score

Parameters	CAN score		p value
	<25 SGA (Fetal malnutrition)	≥25 SGA	
Birth weight (kg)	1.82±0.35	2.07±0.27	0.000
Length (cm)	47.04±1.01	47.09±0.66	0.4175
Head circumference (cm)	32.14±0.84	32.61±0.62	0.000
Ponderal index	1.89±0.31	2.12±0.22	0.000

SGA: Small for gestational age, CAN: Clinical assessment of nutrition

Table 2: Comparison of anthropometric indicators of growth using CAN score

Birth weight (kg)	CAN score%		Chi-square	p value
	<25 SGA (Fetal malnutrition) (309)	≥25 (594) SGA		
<1.5 (55)	51 (92.72)	04 (7.2)	89.06	0.000
1.5–2.0 (455)	172 (37.80)	283 (62.19)	5.23	0.0225
2.0–2.5 (393)	86 (21.88)	307 (78.11)	47.68	0.000

SGA: Small for gestational age, CAN: Clinical assessment of nutrition

Table 3: Comparison of term SGA babies in terms of length and head circumference with CAN score

Parameters	CAN score (%)		Relative risk	95% confidence interval	p value
	<25 SGA (Fetal malnutrition)	≥25 SGA			
Length					
<3rd centile (139)	64 (46.04)	75 (53.95)	1.64	1.21–2.22	0.0014
>3rd centile (764)	245 (32.06)	519 (67.93)			
Head circumference					
<3rd centile (258)	134 (51.93)	124 (48.06)	2.07	1.69–2.54	0.0000
>3rd centile (645)	175 (27.13)	470 (72.86)			
Ponderal index					
<2.2	218 (70.55)	98 (16.49)			
≥2.2	91 (29.44)	496 (83.50)			
Total	309 (100)	594 (100)			

SGA: Small for gestational age, CAN: Clinical assessment of nutrition

Table 4: Adverse perinatal events in term SGA subgroup by CAN score

Adverse perinatal event	CAN<25 SGA (Fetal malnutrition) (%)	CAN≥25 SGA (%)	Relative risk	95% confidence interval	p value
Birth asphyxia	83 (26.86)	21 (3.53)	10.02	5.96–17.41	0.0000
Septicemia	74 (23.94)	9 (1.5)	20.46	9.97–47.12	0.0000
Hypoglycemia	46 (14.88)	8 (1.34)	12.81	5.86–31.54	0.0000
Hypocalcemia	41 (13.26)	8 (1.34)	11.20	5.08–27.98	0.0000
Hyperbilirubinemia	40 (12.94)	8 (1.01)	9.61	4.55–20.27	0.0000
Hypothermia	35 (11.32)	12 (2.0)	6.19	3.07–13.29	0.0000
Respiratory distress	28 (9.06)	03 (0.5)	19.62	5.96–101.42	0.0000

SGA: Small for gestational age, CAN: Clinical assessment of nutrition

Table 5: Multivariate logistic regression analysis of effect of length, ponderal index, and CAN score on overall neonatal morbidity

Final model	Odds ratio	95% confidence interval	p value
Length	2.24	1.33–3.76	0.002
Ponderal index	0.68	0.47–0.99	0.047
CAN score	0.61	0.56–0.66	0.000

CAN: Clinical assessment of nutrition

term appropriate for gestational age (AGA) babies. The present study showed that the prevalence of FM in term SGA neonates was 34.21%. Ezenwa and Ezeaka reported the prevalence of FM in preterm neonates to be 40% [10] and Almarzoki and Rana reported it to be 48.9% [11]. It is, however, higher than 26.59% documented from India by Kamath *et al.* [12]. There was a significant difference in mean birth weight, HC, and PI in SGA with FM (p=0.0000), SGA neonates with increasing birth weight have less FM. The body weight in relation to GA reflects only total body mass at the stated GA but does not reflect its distribution over the linear surface area. Infants with loose skin and clinical soft tissue wasting do not simply failed to grow but actually lost weight *in utero* [9].

Adebami *et al.* [13] reported that the mean weight, mid-arm circumference (MAC), and PI of babies with FM were significantly lower than those of babies without FM (p<0.0001). Although the mean HC and the length of the babies with FM were also lower, the differences were statistically significant. However, in the present study using growth standard alone, 41 (49.4%) of the 83 babies with FM would have been missed, PI would also have missed 51 (61.4%) of the babies with FM. If neonates are classified by birth weight alone, many growth retarded neonates are nutritionally normal and are not at increased perinatal risk. When birth length was assessed as a predictor for FM, it was found that birth length less than the 3rd centile proved to be a very significant predictor of FM. It also suggests that IUG ceases 4–6 weeks before delivery in these malnourished infants or progresses at a subnormal rate for a longer period at time. Járai *et al.* [14] investigated a mixed group of pre-term, term, and post-term SGA infants using different indices of body proportions and pointed to the significance of soft tissue wasting rather than low birth weight for diagnosis of FM.

Mehta *et al.* [15] reported that the cutoff CAN score of <25 separate 60% of the babies as well-nourished and 40% as malnourished. Weight for age and PI classified 70–75% of babies as well-nourished (AGA) and 25–30% as malnourished. Furthermore, MAC/HC classified nearly half the babies as well-nourished and half as malnourished. Deodhar and Jarad [16] reported FM in 19.6% of all term neonates (84.2%) of the SGA and 12.9% of AGA babies while Metcoff reported FM in 5.5% of AGA and 54% of SGA babies. A study by Waghmare *et al.* [17] reported that CAN score identifies overall 37.1% of babies as malnourished and 84.8% of SGA babies as malnourished. A study by Leeladhar *et al.* [18] reported FM in 8.3% of AGA 25/373 and (54.89%) 112/187 SGA babies. A study by Sankhyan *et al*. [9] reported FM in 4% of AGA and 57.1% of SGA babies, and overall occurrence of FM was 28% of all newborns. A study by Adebami *et al.* [13] studied total 442 term neonates and reported 18.8% of babies had FM. A study by Korkmaz *et al.* [19] reported that pre-term infants with GA between 28 and 34 of total 93 pre-term incidence of FM were 54.8% based on CAN score.

The combination of two parameters, weight and length to assess nutritional status, as well as to assess body proportion and nutritional status of neonates, compares superiority over single parameter like weight alone, making proportionality index as ideal choice for nutritional screening of newborns. A study by Sankhyan *et al.* [9] reported when CAN score was compared to standard, weight for gestation and MAC/HC had the highest sensitivity to identify malnourished neonates (92.5% and 90.5%).

The present study reported significantly high occurrence of adverse perinatal events in term SGA with FM as compared to term SGA normal babies. The most common was birth asphyxia followed by sepsis, hypoglycemia, hypocalcemia, hyperbilirubinemia, hypothermia, and respiratory distress. The difference between the two groups was significantly high. The previous studies [20-22], all based on the small sample size, support the differential morbidity pattern for the IUGR subgroups. The IUGR (low PI group) experienced a higher rates of meconium stained amniotic fluid, meconium aspiration, fetal distress, perinatal asphyxia, and low Apgar score and is at increased risk for intrapartum interventions [19].

Walther and Ramaekers [23] in their study reported that SGA infants had a higher incidence of asphyxia, hypoglycemia, and hypothermia in the neonatal period. When our data were analyzed to study the effects of various anthropometric parameters on neonatal morbidity, it showed that CAN score <25 appeared to have the highest correlation with the adverse perinatal outcome. SGA newborn infant with FM is high-risk newborn who is prone to short- and long-term complications of FM.

Assessment at birth for identifying FM will greatly impact the management of anticipated complications. The above observations imply that the current anthropometric criteria used to assess fetal nutrition have their shortcomings wherein lie the role for CAN status. Another advantage of CAN score is that it is independent of common confounding factors such as GA, race, stature and mother's weight, parity, and other factors known to influence weight [12]. The unavailability of antenatal sonographic fetal biometry which is a reliable tool in assessing high-risk fetuses in routine perinatal context is the major shortcoming of the study.

CONCLUSION

FM is common in SGA babies. CAN score is a simple, clinical index for identifying FM and may have the potential to predict neonatal morbidity associated with it, without the aid of any sophisticated equipment. Perinatal problems are known to occur in SGA babies with FM. There is a need for prompt identification of babies with FM. Anticipatory management of such newborns at birth may decrease morbidity and mortality and improve the survival of SGA babies.

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