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Original Research Article

Comparison of fetal growth assessment by conventional method and by using intergrowth 21st chart for detecting small for gestation fetuses

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ABSTRACT

Background: Low birthweight is a major contributor to neonatal morbidity and mortality. Conventionally, fetal growth is assessed by clinical palpation of fundal height (FH), which could have significant inter-observer variation. Routine ultrasound, though a reliable tool, is not cost-effective for low-resource settings. Symphysio-FH (SFH) measurement plotted on customized charts is another tool for monitoring fetal growth. The study aims to compare SFH measurement charted on intergrowth 21st international symphysis FH (SFH) graph charts with FH palpation as a method for detecting small for gestation age (SGA) fetuses.
Methods: This prospective observational analytic study was conducted on 500 pregnant women. SGA was suspected in case of a lag of ≥3 weeks in FH palpation or SFH plotted on intergrowth 21st charts falling below 10th centile. Birthweight of new-born was plotted on intergrowth 21st estimated foetal weight chart. Birthweight below 10th centile was classified as SGA.
Results: Out of 500 pregnancies, 13.2% new-borns were SGA. SFH measurement showed 99.5% specificity and 83.3% sensitivity compared to 98.6% specificity and 69.9% sensitivity by FH measurement for SGA detection. SFH measurement also had higher true positive (83.3% vs 69.6%), and true negative (97.5% vs 95.5%) value, and missed lesser cases (2.4% vs 4.5%) compared to FH palpation.
Conclusions: The study found SFH plotted on 21st intergrowth chart to be more sensitive and specific in detecting SGA new-borns compared to conventional FH palpation.

Keywords: Fetal growth restriction, Small for gestational age, Fundal height, Symphysio-fundal height, Intergrowth 21st project

INTRODUCTION

Low birthweight is one of the three important causes accounting for 78% of all neonatal deaths in India, neonatal infections and birth asphyxia being the other two.[1] Low birthweight can be consequent to pre-term birth, fetal growth restriction or a constitutionally small baby. Assessment of fetal growth for early diagnosis and timely intervention can reduce the adverse perinatal outcomes associated with growth restricted fetuses.

There are various methods for detection of SGA fetuses. Conventionally, it is done by clinical palpation of FH. Serial ultrasound scans in third trimester is another tool for early diagnosis of foetal growth disorders.[2] However, it is not cost-effective screening tool in low resource settings.

Serial measurement of SFH plotted on customized charts is considered a reliable objective tool for monitoring growth of a fetus.[3] The international SFH standards chart by intergrowth 21st project study created international standards to measure SFH as first level screening tool for foetal growth disturbance.[4] It also provides a graphical record of the changes in FH with the advancement of gestational age and is likely to minimize the subjective variation with the conventional method.

SGA being an important predictor of poor perinatal outcome, warrants studies to find a simple tool for low resource settings which is cost effective and accurate in early detection of growth restriction.

Hence, the current study was designed to compare the screening accuracy of clinical assessment of FH by palpation with SFH measurement charted on intergrowth 21st project standard charts for early detection of SGA fetuses.

METHODS

Study design

This prospective observational analytic study was conducted in the antenatal clinic and antenatal wards of department of obstetrics and gynaecology, Shrimati Sucheta Kriplani Hospital and Lady Hardinge Medical College, Delhi, India from November 2019 to October 2021.

Inclusion criteria

The study population comprised of 500 pregnant women with singleton pregnancy, with good dating based on regular menstrual cycles and confirmed date of last menstrual period based on foetal crown rump length on ultrasound between 9 to 13 weeks gestation. They were recruited at or beyond 28 weeks of gestation.

Exclusion criteria

Pregnant women with any factor affecting FH assessment such as multiple pregnancies, hydramnios, fibroid uterus, uterine malformation, abdominal mass, women with diabetes mellitus or malpresentation were excluded.

Materials

The test tools included: International SFH standards chart and international foetal growth standards estimated foetal weight chart.

Methodology

Ethical clearance was taken from the institutional ethics committee, Lady Hardinge Medical College and Associated Hospitals, New Delhi.

All women fulfilling selection criteria were recruited from antenatal clinic and antenatal wards of Lady Hardinge Medical College and Smt. Sucheta Kriplani Hospital in third trimester and serially followed up. Informed consent was obtained from all subjects.

FH was assessed by the conventional method of palpation by the primary investigator and recorded. For SFH measurement, a metric tape of non-elastic material was used and the measurement was recorded in centimetres as described in intergrowth 21st study.

All the subjects were serially followed up, and a minimum of 3 measurements of FH and SFH measurements were recorded during follow up antenatal visits. SFH findings were plotted against gestational age in international SFH graph. Any woman with suspected SGA foetus was admitted and managed as per hospital protocol.

Outcome measure

SGA was suspected if, there was a difference of more than 3 weeks in gestational age assessment by clinical palpation as compared to the calculated period of gestation.

The measured SFH was less than 10th percentile of the standard SFH for that gestational age.

All women were serially followed up with conventional assessment and SFH measurement on each visit till delivery.

The birthweight of new-borns was documented and charted on international foetal growth standards chart from intergrowth 21st Project. New-born weight less than 10th centile was considered as SGA.

Sample size estimation

Taking expected proportion of SGA detected by conventional method to be 10%, and that detected by SFH measurement to be 15% and a confidence interval of 95%, sample size was calculated using formula applied for comparison of two proportions $n=(Z\alpha/2+Z\beta)^2\times(p_1(1-p_1)+p_2(1-p_2))/(p_1-p_2)^2$

Sample size calculated was 683. For convenience, sample size of 500 was taken.

Statistical analysis

Data entry was done using Microsoft excel sheet and analysed. Diagnostic accuracy of conventional FH method and SFH measurement was compared by computing sensitivity, specificity, positive predictive value, negative predictive value of the two tests. The 95% confidence interval was calculated wherever applicable. Agreement between the two tests was calculated using Kappa statistic (κ).

RESULTS

Maternal characteristics

The age of the women enrolled in the study ranged from 18 years to 42 years, with mean age of 25.5±3.7 years. Majority (81.4%) of women were below 30 years of age, and 0.6% were >35 years. The average height of the subjects was 154.2±3.7 cm, with a minimum of 142 cm

and a maximum of 166 cm. Only 0.6% subjects were shorter than 145 cm.

Among the study subjects, 65.2% were multigravidae and, 34.8% were primigravida. There was an equal distribution of nulliparous (49.6%) and multiparous women (50.4%). Majority (71.4%) of the women had no prior history of abortions, 28.6% had at least one abortion of these 1.8% had history of 3 or more abortions.

According to Asian BMI cut off, 64.8% of women had a normal BMI, 28.6% were overweight, 6% were pre-obese and 0.6% were underweight. The average BMI was 22.4±1.53 kg/m^2(ranging from 17.7 kg/m^2 to 29.2 kg/m^2). As per Indian council of medical research (ICMR) classification of anaemia in pregnancy, 52.2% of women were anaemic, of which 41.8% had mild anaemia and 10.4% had moderate anaemia. Majority 89.60% (448 out of 500) had a normal vaginal delivery. The 10.4% (52 out of 500) women had caesarean birth.

Neonatal outcome

The mean birthweight of the new-borns was 2.78±0.30 kg, ranging from 1.72 kg to 4.0 kg. Of the 500 new-borns, 66 (13.2%) were SGA as defined by birthweight less than 10th centile on the international foetal growth standards estimated foetal weight chart and 434 (86.8%) were appropriate for gestational age (AGA). Of the SGA neonates 9.1% (6 out of 66) were born preterm, compared to 5.3% (23 out of 434) of AGA neonates.

In the study population, 57.6% of SGA new-borns were females, compared to 42.4% males. Perinatal complications were seen in 15.2% of SGA neonates compared to 3.7% of AGA neonates (Figure 1). A higher proportion of SGA new-borns (12.1%) required NICU admission as compared to 1.2% AGA neonates. The difference was statistically significant (p=0.001).

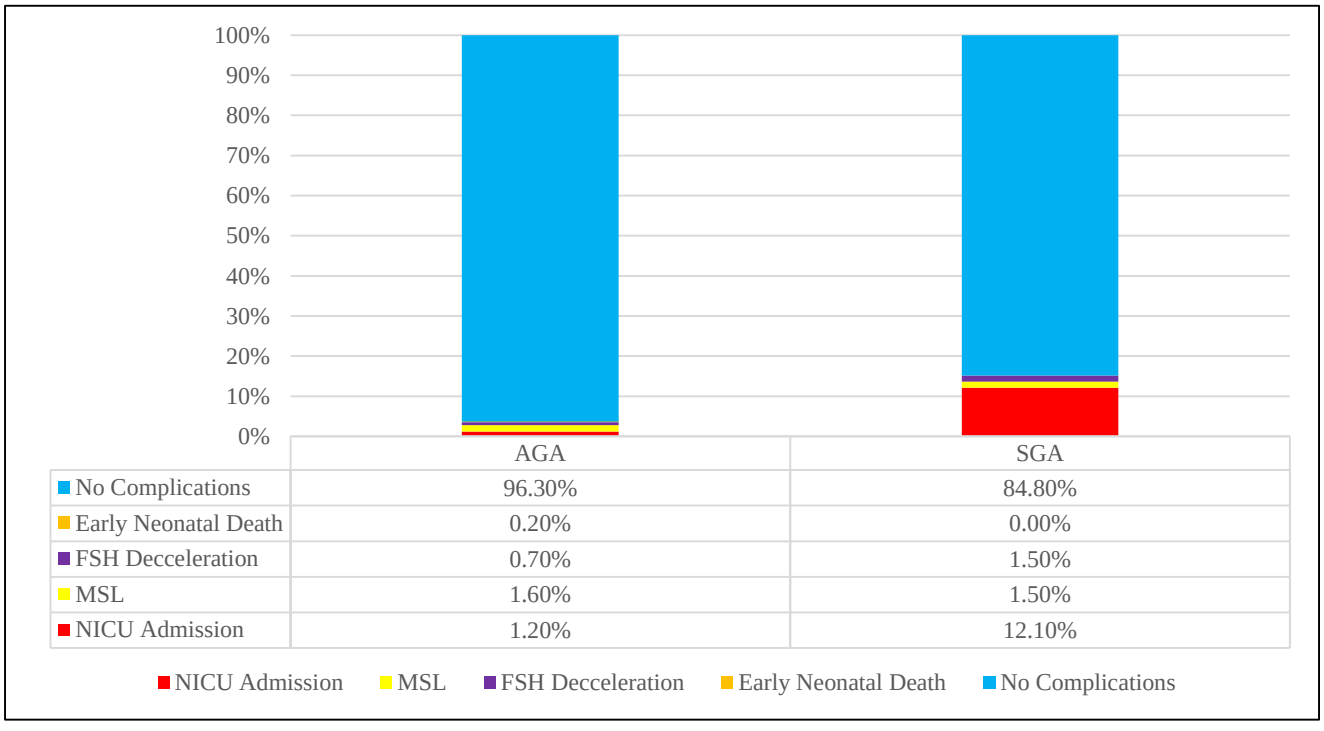
Suspected SGA based on FH palpation

On clinical examination, 52 out of 500 (10.4%) women were suspected to have a SGA neonate by the FH palpation.

Suspected SGA based on SFH measurement charted on standard charts

The 57 out of 500 (11.4%) women were suspected to have SGA neonate by SFH measurement as charted on international SFH standards.

Of the 57 women suspected with SGA newborn based on SFH measurement charted on standard charts, SGA was correctly detected in 96.5% (55/57) as compared to 88.5% (46/52) among the 52 women suspected to have SGA newborns by conventional FH palpation. SGA was over-diagnosed in 3.5% (2/57) by SFH measurement in comparison to 11.5% (6/52) by the conventional method of FH palpation. In women in whom normal growth was assessed by SFH measurement on standard charts, 97.5% (432/443) delivered AGA new-borns compared to 95.5% (428/448) with FH palpation method. SGA was missed in only 2.4% (11/443) of women by SFH measurement as compared to 4.5% (20/448) by FH palpation (Table 1). Significance measured by chi-square test gives a p<0.001, indicating test results to be significant.



	AGA	SGA
No Complications	96.30%	84.80%
Early Neonatal Death	0.20%	0.00%
FSH Decceleration	0.70%	1.50%
MSL	1.60%	1.50%
NICU Admission	1.20%	12.10%

Figure 1: Percentage distribution of perinatal complications among AGA and SGA neonates.

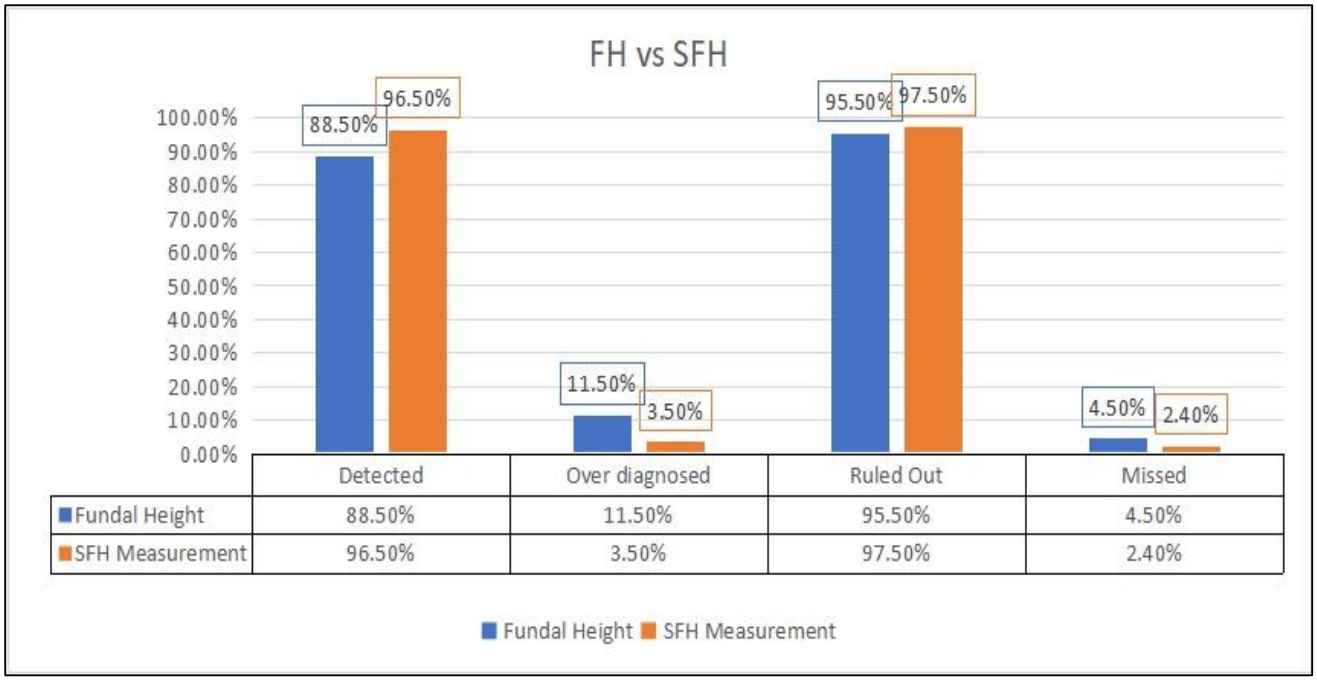


Figure 2: Comparison of FH palpation with SFH measurement on standard charts for detection of SGA fetus.

Table 1: Comparison of neonatal outcomes by the method of FH palpation and SFH measurement.

Methods	Positive (SGA suspected)	True positive (SGA detected)	False positive	Negative	True negative	False negative (missed)
SFH	57	55	2	443	432	11
FH	52	46	6	448	428	20

Table 2: Comparison of diagnostic tests for FH palpation and SFH measurement in detection of SGA fetus.

Statistics	Fundal height	SFH measurement
Sensitivity	69.70%	83.33%
Specificity	98.62%	99.54%
Positive likelihood ratio	50.41	180.83
Negative likelihood ratio	0.31	0.17
Positive predictive value	88.46%	96.49%
Negative predictive value	95.54%	97.52%
Accuracy	94.80%	97.40%

DISCUSSION

The number of infants born small for gestation is higher in low and middle-income countries, with prevalence being highest in South Asia.[5] Such neonates are at a higher risk of neonatal morbidity and mortality compared to AGA neonates.[6] Antenatal identification of SGA neonates with structured surveillance of those identified, lowers the risk of adverse fetal and neonatal outcomes.[7]

The outcome of the pregnancies, as measured by birthweight of new-born charted on international foetal growth standards chart from intergrowth 21st project showed that out of 500 pregnancies, 13.2% (66/500) resulted in new-borns with birthweight below 10th centile for the period of gestation.

Comparison of assessment by FH palpation and SFH measurement plotted on 21st intergrowth charts for detection of SGA

The method of FH palpation suspected SGA in 52 out of 500 pregnancies (10.4%), of which, 46 pregnancies (88.46%) resulted in new-borns with birthweight below 10th centile (True positive), and 6 out of 52 (11.5%) were false positive (over diagnosed). SGA was correctly ruled out in 95.5% (428/448) pregnancies (True negative), while 4.5% (20/448) were missed (False negative) (Figure 2).

SFH measurement charted on Intergrowth 21st project charts suspected SGA in 57 out of 500 pregnancies (11.4%). Among these, 55 pregnancies (96.49%) had new-borns with birthweight below 10th centile (True positive)

and 2 out of 57 pregnancies (3.5%) were false positive (over diagnosed). The method correctly ruled out SGA in 97.5% (432/443) pregnancies (True negative) and missed 2.4% (11/443) cases (False negative) (Figure 2).

Insights into the false negative and false positive results with the two methods

A total of 21 cases of SGA new-borns were missed during the study, of which 10 cases were missed solely on conventional FH palpation, 10 cases were missed by both the methods and one by only SFH measurement. Overall, FH palpation missed 20 cases of SGA new-born while SFH measurement missed 11 cases.

Of the 10 cases missed by both methods, all had healthy babies. Seven cases (7/10) had a neonatal birthweight of 2.5 kg or above, which is acceptable for Indian standards. Remaining 3/10 cases with a birthweight below 2.5 kg (LBW) were babies born to mothers with a shorter height (two were 150 cm, and one 149 cm compared to mean height of 154.2 cm in the study population). All these three new-borns were healthy, possibly constitutionally small and were shifted to mothers' side.

Of the 10 cases missed only on FH palpation, 5/10 cases had birthweight ≥2.5kg, which, though below 10th centile for the gestational age on intergrowth 21st growth chart, is acceptable for Indian population. All these babies were born healthy. Remaining 5 cases had birthweight below 2.5 kg, 4 out of 5 were in mothers who had shorter maternal height (146 cm, 146 cm, 148 cm and 150 cm) compared to a mean height of 154.2 cm in study population. All these babies were born with normal APGAR score and shifted to mothers' side after birth and were possibly constitutionally small. One of the missed cases was a pre-term birth and required neonatal ICU admission.

One case of SGA new-born missed solely on SFH measurement, had a birthweight of 2.5 kg, acceptable in Indian context.

Clinically, FH palpation falsely suspected SGA in 6 cases, all of which had a birthweight above 2.5 kg. Four cases were false positive possibly due to engagement of foetal head in the last trimester with resultant decrease in estimated FH. One case was false positive for SGA in a woman with a tall height (165 cm) as compared to the average height of study population (154.2 cm). This could be due to increased length of maternal torso, leading to under-estimation of FH. One case had a birthweight falling just above 10th centile for the gestational age (2.5 Kg at 37+5 weeks gestation) and could be due to subjective variation in assessment.

Two cases were false positive for SGA by SFH measurement, of which one had a birthweight of 2.6 kg, and other case had a birthweight falling exactly on 10th centile, and therefore was not included in SGA as per the cut off value of below 10th centile as per definition.

SFH measurement used as a measure for detection of SGA new-born had a positive predictive value of 96.49% and a negative predictive value of 97.52%, a positive likelihood ratio of 180.3, a negative likelihood ratio of 0.17 and an accuracy of 97.4% (Table 2).

FH palpation for detection of SGA new-born had a positive predictive value of 88.46% and a negative predictive value of 95.54%, a positive likelihood ratio of 50.4 and a negative likelihood ratio of 0.31. The method had an accuracy of 94.8%. The agreement between the two methods for detecting SGA new-born as measured by Cohen's Kappa statistic showed a Kappa value=0.804, indicating a substantial agreement between the two methods for detection of SGA new-born.

In low-income countries, growth restriction has been found to be significantly associated with admission in special baby care unit.[8] Similar observations were made in the study with a higher proportion (12.1%) of total SGA neonates requiring Neonatal ICU admission compared to 1.2% of AGA neonates ($p<0.001$). Pre-term delivery was higher among SGA newborn (9.1%) than in AGA newborns (5.3%), and more perinatal complications were seen in SGA newborns (15.2%) compared to AGA newborns (3.7%).

The percentage of SGA newborn (13.2%) was comparable to the prevalence of SGA studied in Indian tertiary care hospital (13.6%).[9]

Strengths and limitations

The strength of the study lies in the application of customised growth charts developed from international standards involving geographically diverse regions including Indian population. The dating of pregnancy was good in the study population.

The main limitation of this study was a lack of ultrasound biometry and doppler correlation to compare the fulfilment of Delphi criteria for foetal growth restriction among those detected to be <10th centile but >3rd centile on estimated foetal growth charts by 21st intergrowth.

Also, the International foetal growth standards estimated foetal weight charts by Intergrowth 21st project used as an outcome measure, have higher birthweight cut offs for the 10th centile compared to that for Indian population, which could potentially lead to over-diagnosis of foetal growth restriction.

The measurements and palpation involved in the study are subject to variation according to the built of the mother, and other possible anatomical variations and can further affect the study outcome.

CONCLUSION

SFH measurement plotted on 21st intergrowth chart was found to be more sensitive and specific in detecting SGA new-borns compared to conventional FH palpation. It also led to correct detection of additional cases, which were otherwise missed on palpation. Also, it is a more cost and time effective tool compared to serial growth monitoring by ultrasonography in low resource settings.

However, this study observed a higher birth weight cut offs corresponding to the 10th centile on the 21st intergrowth chart with resultant overdiagnosis of SGA foetuses when applied to Indian population.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee LHMC/IEC/Thesis/2019/30

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