Comparison of fetal growth assessment by conventional method and by using Intergrowth 21 st chart for detection of small for gestational age foetuses: A prospective observational study among Indian population

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February 2, 2023

Abstract

Objectives: Primary objective was to compare screening accuracy of fetal growth assessment by conventional fundal height assessment by palpation with plotting of symphysio-fundal height (SFH) measurement on 21 st Intergrowth charts for detecting small for gestational age (SGA) foetuses. Secondary objective was to find an agreement between these two methods. **Design**: Prospective observational analytic study **Setting**: Lady Hardinge Medical College and associated hospitals, Delhi, India **Population**: Five hundred low risk pregnant women with singleton pregnancy, with reliable dates at [?]28 weeks from Antenatal Clinic of Lady Hardinge Medical College and associated hospitals from November 2019 to October 2021. **Outcome measures**: Assessment of fundal height in weeks by palpation and a lag of [?]3 weeks, suggested SGA fetus. SFH measured in centimetres and plotted on Intergrowth 21 st foetal growth charts. SFH of less than 10 th centile suggested SGA. Birthweight of new-born was plotted on Intergrowth 21 st Estimated Foetal Weight Chart. Birthweight of less than 10 th centile was classified as SGA. **Results**: Thirteen percent women delivered new-borns with birthweight below 10 th centile. Fundal height palpation had 98.6 % specificity and 69.9% sensitivity compared to 99.5% specificity and 83.3% sensitivity by SFH measurement for detecting SGA neonates. **Conclusions**: SFH measurement plotted on Intergrowth 21 st chart is more sensitive and specific for detecting SGA neonates compared to conventional fundal height palpation. Agreement between the methods measured by Cohen's Kappa Statistic was 0.804, indicating substantial agreement between the methods. SFH measurement is a more accurate and practical tool, for use in low resource settings.

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 small for gestational age (SGA) fetuses. Conventionally, it is done by clinical palpation of fundal height. The assessment is based on the relative position of the level of fundal height from an imaginary line passing through the upper border of the umbilicus dividing the abdomen into two parts. Serial ultrasound scans in the third trimester is another tool for early diagnosis of foetal growth disorders[2]. However, it is not a cost-effective screening tool in low resource settings.

Serial measurement of symphysio-fundal height plotted on customized charts is considered a reliable objective tool for monitoring growth of a fetus[3]. The International Symphysis Fundal Height Standards Chart by Intergrowth 21st Project study created international standards to measure symphysis fundal height as first level screening tool for foetal growth disturbance[4]. It also provides a graphical record of the changes in

fundal height with the advancement of gestational age and is likely to minimize the subjective variation with the conventional method.

Small for gestational age 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 fundal height by palpation with symphysio fundal height measurement charted on Intergrowth 21 Project standard charts for early detection of small for gestational age fetuses.

MATERIALS AND METHODS :

Study design and selection criteria: 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.

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.

Pregnant women with any factor affecting fundal height 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:

1. International Symphysis Fundal Height Standards C/hart: The international standard for symphysio fundal height measurement based on serial measurement by prospective longitudinal study from Foetal Growth Longitudinal Study of Intergrowth project[4].

2. International Foetal Growth Standards Estimated Foetal Weight Chart: The international foetal growth standards estimated foetal weight chart based on serial ultrasound assessment of foetal anthropometric measurements in pregnant women involved in Foetal Growth Longitudinal Study of 21st Intergrowth project[4].

Methodology : Ethical clearance was taken from the Institutional Ethical Committee. 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.

Fundal height (FH) was assessed by the conventional method of palpation by the primary investigator and recorded. For symphysio-fundal height (SFH) measurement, a metric tape of non-elastic material was used. With patient lying supine after voiding the bladder, the upper border of the symphysis pubis was marked, and the 0 cm marking of the metric tape was secured at this point. The tape was then passed in a straight line from the symphysis pubis over to the fundus of the uterus till a resistance was felt on the abdominal wall. The tape was sustained at this point on the fundus of uterus and the measurement was recorded in centimetres as described in Intergrowth 21st study.

Serial SFH measurements were taken during each follow up antenatal visit, and findings were plotted against gestational age in International Symphysis Fundal Height Graph. Any woman with suspected small for gestational age foetus was admitted and managed as per hospital protocol.

Small for gestational age 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 symphysio-fundal height was less than 10th percentile of the standard symphysio-fundal height 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 small for gestational age (SGA).

Sample size estimation: Taking expected proportion of small for gestational age detected by conventional method to be 10%, and proportion of small for gestational age 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

$n = (Z\alpha/2 + Z\beta)^2 * (p_1(1\text{-}p_1) + p_2\ (1\text{-}p_2))/\ (p_1\text{-}p_2)^2$

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 ($\varkappa$).

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 years ±3.7 years. Majority (81.4%) of women were below 30 years of age, and 0.6% were >35years. The average height of the subjects was 154.2±3.7 cm, with a minimum of 142 cm and a maximum of 166cm. 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. 10.4% (52 out of 500) women had caesarean birth.

Fetal Outcome : Of the 500 new-borns, 66 (13.2%) were small for gestational age 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).

The mean birthweight of the new-borns was 2.78±0.30 kg, ranging from 1.72 kg to 4.0 kg. Of the women clinically suspected to have small for gestational age foetus, 78.8% (52 out of 66) had a birthweight less than 2.5 kg, while 2.8% (12 out of 434) women assessed to have normal foetal growth antenatally gave birth to a small for gestational age neonate (less than 2.5 kg). 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 small for gestational age new-borns were females, compared to 42.4% males. Perinatal complications were seen in 15.2% of small for gestational age neonates compared to 3.7% of AGA neonates (Fig. 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).

Of the total study population, 66/500 (13.3%) delivered new-borns with birthweight below 10th centile for the gestational age using International Foetal Growth Standards Estimated Foetal

Weight Charts.

On clinical examination, 52 (10.4%) women were suspected to have a small for gestational age fetus by fundal height palpation compared to 57 (11.4%) women by SFH measurement as charted on International Symphysis Fundal Height Standards.

Of the 57 women suspected with small for gestational age fetuses 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 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 fundal height 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 fundal height palpation method. SGA was missed in only 2.4% (11/443) of women by SFH measurement as compared to 4.5% (20/448) by fundal height palpation.

Significance measured by Chi-Square test gives a p-value of <0.001, indicating test results to be significant.

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 fetus are at higher risk of neonatal morbidity, stillbirth, and neonatal mortality compared to appropriate for gestational age fetus[6]. Antenatal identification of SGA fetus with structured surveillance of those identified, lowers the risk of adverse fetal 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.

The conventional method of FH palpation detected SGA foetus in 52/500 women (10.4%), of which, 46/52 pregnancies (69.6%) resulted in new-borns with birthweight below 10th centile (True Positive), and 6/52 (11.5%) were over diagnosed. SGA new-born was correctly ruled out in 95.5% (428/448) pregnancies, while 4.5% (20/448) were missed (Fig.2).

SFH measurement charted on Intergrowth 21st Project charts detected SGA foetus in 57/500 women (11.4%). Among these, 55/57 pregnancies (83.3%) had new-borns with birthweight below 10th centile (True Positive) and 2/57 pregnancies (3.5%) were over-diagnosed (False Positive). The method correctly ruled out small for gestational age neonate in 97.5% (432/443) pregnancies (True Negative) and missed 2.4% (11/443) cases (False Negative) (Fig.2).

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 small for gestational age 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 above the accepted cut off 2.5 kg for Indian standards. Remaining 3/10 cases with a birthweight below 2.5 kg (LBW) were babies born to mothers with a short 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 fundal height palpation, 5/10 cases had birthweight [?]2.5kg, which, though below 10th centile for the gestational age on Intergrowth 21st growth chart, is more than the accepted cut off 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 short 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 as normal in Indian context.

Clinically, FH palpation over-diagnosed SGA foetus in 6 cases, all of which had a birthweight above 2.5 kg. Four cases were over-diagnosed possibly due to engagement of foetal head in the last trimester with resultant decrease in estimated fundal height. One case was over-diagnosed 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 fundal height. One case had a birthweight falling just above 10^{th} centile for the gestational age (2.5 Kg at 37+5 weeks gestation) and could be due to subjective variation in assessment.

SFH measurement missed detection in 11 cases, of which 10 cases were also missed by the method of palpation.

Two cases were over-diagnosed on SFH measurement, one had a birthweight of 2.6 kg, and other case had a birthweight falling exactly on 10^{th} centile, and therefore was not included in small for gestational age as per the cut off value of below 10^{th} centile as per definition.

Symphysis fundal height 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 1)

Fundal height 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 ($p<0.001$). Preterm 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 fetus born small for gestation (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 $< 10^{th}$ centile but $>3^{rd}$centile on estimated foetal growth charts by 21^{st}Intergrowth.

Also, the International foetal growth standards estimated foetal weight charts by Intergrowth 21^{st} Project used as an outcome measure, have higher birthweight cut offs for the 10^{th}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. Also, the frequency of measurement, interval between measurements, and experience of the performer can further affect the study outcome.

CONCLUSION:

Symphysis fundal height measurement plotted on 21^{st}Intergrowth chart was found to be more sensitive and specific in detecting SGA new-borns compared to conventional fundal height palpation. The use of SFH measurement charts led to correct detection of additional cases, which were otherwise missed by palpation

and timely initiation of management of the same. Hence, this method seems to be more reliable compared to conventional FH palpation for assessment of foetal growth on antenatal visits for screening SGA foetuses and possibly 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 10^{th} centile on the 21^{st} Intergrowth chart with resultant overdiagnosis of SGA foetuses when applied to Indian population.

ACKNOWLEDGEMENT:

Disclosures: There is no conflict of interest among authors to declare.

Contribution to Authorship:

Millo Suka- Conducting the work, analysis of data, writing the manuscript.

Manju Puri- Concept, design and co-writing the manuscript.

Anuradha Singh- Co-designing, analysis of data, revising the manuscript.

Ethics Approval:

The study was conducted after clearance from the institutional ethics committee.

Clearance was obtained from- Institutional Ethics Committee, Lady Hardinge Medical College and Associated Hospitals, New Delhi

Dated- 28-10-2019

Reference number: LHMC/IEC/Thesis/2019/30

Funding: No funding received

Figure legend:

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

Figure 2: Comparison of Fundal Height palpation with SFH measurement on standard charts for detection of SGA neonates

Table 1: Comparison of diagnostic tests for fundal height palpation and SFH measurement in the detection of SGA neonates

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