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Color Doppler Ultrasonography in the Third Trimester of Pregnancy Significantly Reclassifies Fetal Growth Restriction in the Samrakshan Program of IRIA in India

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Introduction

The failure of a fetus to achieve its optimal growth potential is classified as fetal growth restriction (FGR). Small fetuses are a major risk for adverse perinatal outcomes including perinatal mortality, perinatal brain injury, and fetal distress compared to fetuses with normal growth.[1–5] FGR is considered as a fetus with an estimated fetal weight (EFW) less than 10th percentile. However, FGR also shows Doppler signs of hemodynamic redistribution as a fetal adaptation response to undernutrition or hypoxia and histological and biochemical signs of placental disease.[1] Small for gestational age (SGA) fetuses, on the other hand, are defined as constitutionally small fetuses without evidence for fetal adaptation to abnormal fetal environment and have perinatal outcomes similar to fetuses with normal growth.[1] Samrakshan, a national program of Indian Radiological and Imaging Association (IRIA), integrated trimester-specific Doppler studies with routine antenatal ultrasound assessments.[6] We present the results pertaining to the prevalence of FGR and SGA identified through the Samrakshan program.

Material and Methods

Fetal Doppler parameters of interest in the third trimester included mean uterine artery pulsatility index (PI), umbilical artery PI, the fetal middle cerebral artery (MCA) Doppler waveforms, and the cerebroplacental ratio (CPR). A transabdominal approach was used to assess the uterine artery Doppler indices and a mean uterine artery PI more than 95th percentile was considered abnormal.[7] Umbilical artery Doppler indices were assessed at a free loop cord and umbilical artery PI more than 95th centiles were considered abnormal.[8] MCA Doppler waveforms were measured to obtain peak systolic volume using auto trace or manual calipers with the pulsed wave Doppler gate placed at the proximal third of MCA close to its origin in the internal carotid artery.[8] The angle between direction of blood flow

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Table 1 Distribution of fetal growth restriction (FGR) and small for gestational age (SGA) fetuses by clinical staging in the screened population

Clinical staging	Diagnostic criteria	Prevalence (95% CI)
Stage 1 FGR	EFW < 3rd percentile Mean UtA PI > 95th percentile UA PI >95th percentile MCA <5th percentile CPR <5th percentile	465 (10.64%, 95% CI: 9.76, 11.58)
Stage 2 FGR	UA AEDV Reverse AoI	9 (0.21%, 95% CI: 0.11, 0.39)
Stage 3 FGR	UA REDV DV PI >95th percentile	19 (0.43%, 95% CI: 0.28. 0.68)
Stage 4 FGR	DV reverse a flow, fetal heart rate decelerations	5 (0.11%, 95% CI: 0.05, 0.27)
SGA	EFW 3rd to 10th percentile with normal Doppler study	386, (8.83%, 95% CI: 8.02, 9.71)
No FGR	EFW >10th percentile	3,488 (79.78%, 95%CI: 78.56, 80.94)

Abbreviations: AEDV, absent end diastolic velocity; AoI, aortic isthmus; CI, confidence intervals; CPR, cerebroplacental ratio; DV, ductus venosus; EFW, estimated fetal weight; MCA, middle cerebral artery; REDV, reversed end diastolic velocity; UtA, uterine artery; UA, umbilical artery.

and ultrasound beam was kept as close to zero as possible.[8] An MCA PI less than 5th centile was considered abnormal.[8] CPR was estimated by dividing the MCA Doppler indices by the umbilical artery Doppler indices.[1] A CPR PI less than 5th centile was considered abnormal for the Samrakshan program. Ductus venosus assessments and absent or reversed end diastolic velocity were assessed if mean uterine artery PI and/or CPR were abnormal. An abnormal Doppler study was defined as the presence of an abnormality in any one of the mean uterine artery PI, umbilical artery PI, MCA PI, or CPR.

Results

The results of 4,372 third trimester pregnant women from nine states screened in the Samrakshan program were analyzed. Three hundred and five (6.98%) fetuses had an EFW less than 3rd percentile, 579 (13.24%) had an EFW between the 3rd and 10th percentile, and 3,488 (79.78%) had an EFW more than 10th percentile. An abnormal Doppler study was identified in 1,024 (23.42%, 95% confidence interval [CI]: 22.19, 24.70) women. An abnormal Doppler study had a sensitivity of 73.1% (95% CI: 69.0, 76.9), specificity 81.1% (95% CI: 79.7, 82.4), positive likelihood ratio (LR+) of 3.86 (95% CI: 3.54,4.29), and odds ratio (OR) 11.6 (95% CI: 9.39, 14.4) for FGR. The LR+ and OR of the mean uterine artery PI. Umbilical artery PI, MCA PI, and CPR was 4.23 and 6.3, 4.94 and 5.89, 3.13 and 3.75, and 4.91 and 7.95, respectively for FGR. The sensitivity and specificity of the mean uterine artery PI, umbilical artery PI, MCA PI, and CPR were 39 and 90.8%, 19.3 and 96.1%, 22.7 and 92.7%, and 43.8 and 93.1%, respectively for FGR. ►**Table 1** presents the distribution of FGR by clinical staging[1] in the screened population. The overall prevalence of FGR and SGA in the screened population was 498 (11.39%) and 386 (8.83%), respectively. One in five (20.55%) of the screened population in Madhya Pradesh had FGR that may be due to the rural population covered by Samrakshan in this state (see ►**Table 2** for the state-wise distribution of FGR and SGA).

Discussion

Classifying fetuses based on an EFW less than 10th percentile will have resulted in 884 (20.22%) fetuses called as FGR in the screened population. The integration of Doppler assessments resulted in a significant reclassification of FGR from 20.22 to 11.39%. The remaining 8.83% of the 884 fetuses were now reclassified as SGA. This reclassification has important clinical

Table 2 Distribution of fetal growth restriction (FGR) and small for gestational age (SGA) fetuses by state

State	FGR	SGA
Jharkhand ($n = 56$)	7 (12.50%)	2 (3.57%)
Kerala ($n = 668$)	45 (6.74%)	44 (6.59%)
Madhya Pradesh ($n = 759$)	156 (20.55%)	49 (6.46%)
Maharashtra ($n = 1,446$)	147 (10.17%)	172 (11.89%)
Rajasthan ($n = 188$)	20 (10.86%)	16 (8.91%)
Tamil Nadu ($n = 220$)	8 (3.64%)	7 (3.18%)
Uttar Pradesh ($n = 1,025$)	108 (10.54%)	94 (9.17%)

Note: The data of Delhi and Pondicherry are not shown as they had only five participants each.

implications. The classification of FGR leads to intense monitoring of the mother and the fetus and adds significantly to the workload of the clinician and direct and indirect costs to the woman and family. These fetuses are more likely to be delivered through an operative method and late preterm to minimize risks for any adverse perinatal event. The reclassification as SGA translated to 8.83% of the fetuses previously classified as FGR and followed up like a normal growth fetus. This reduces the stress for the woman and family, reduces direct and indirect costs, and reduces workload for the clinician as these fetuses can be carried till term and delivered through normal modes. The clinical staging of FGR using Doppler and the reclassification to SGA is useful as it helps to determine the interval between follow up assessments and provides an objective pathway to decisions on mode and timing of childbirth.[1] The integration of Doppler can help reduce cesarean section rates, preterm birth rates, perinatal adverse events, and perinatal complications associated with operative childbirth. Clinical parameters like a drop in fetal growth velocity (a drop in abdominal circumference or EFW of >2 quartiles or >50 percentiles) can alert the clinician to the possibility of FGR.[9] However, longitudinal follow-ups are not a pragmatic reality in India, especially in rural populations, where access to the healthcare system is more often infrequent, with different providers at different periods or only at one point of time. A fetal Doppler assessment when the woman presents to the antenatal screen provides a viable alternative to longitudinal follow-up.

There are estimated 25 million childbirths in India annually and 67,385 childbirths every day in India.[10] The screened population is Samrakshan is not generalizable to the general population of India (as Samrakshan is an opportunistic screening program); however, we generalized the results from the program to the larger population to get a sense of what they mean in a clinical scenario. An estimated approximately 5 million fetuses will be classified as FGR in India every year based on a prevalence of 20.22% for FGR. If we integrate Doppler assessments and reclassify FGR, the magnitude reduces from 5 million to approximately 2.8 million FGR fetuses. Approximately 2.2 million fetuses are now reclassified from FGR to SGA and can be carried to term like normal growth fetuses. This significant reduction will have tremendous implications on the healthcare system of India, cesarean section rates, preterm birth rates, and perinatal mortality rates.

The preliminary analysis of Samrakshan data highlights the need for fetal radiologists in India to include fetal Doppler assessments and clinical staging of FGR in their routine practice.

Conflict of Interest
None declared.

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