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Original Research Article

A PROSPECTIVE OBSERVATIONAL STUDY ON THIRD TRIMESTER ULTRASOUND PARAMETERS AND FETAL GROWTH PATHOLOGY SCORE IN THE DIAGNOSIS OF FETAL GROWTH RESTRICTION

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ABSTRACT

Background: Fetal growth restriction (FGR) is associated with increased perinatal morbidity and mortality. Third trimester ultrasound and composite indices like FGPS may improve identification of true growth abnormalities and associated outcomes. The aim is to evaluate the association and predictive utility of third trimester ultrasound fetal biometry parameters and the Fetal Growth Pathology Score (FGPS) in diagnosing FGR and assessing perinatal outcomes. **Materials and Methods:** This prospective observational study included 300 singleton pregnancies with reliable gestational age. Serial third trimester ultrasound assessments were performed at three visits (28–40 weeks). Fetal biometry (HC, AC, FL, EFW) was recorded and FGPS calculated. FGR was defined as birth weight <10th percentile. Categorical variables were analyzed using chi-square test, and predictive utility was assessed using PPV and NPV. **Result:** FGR was observed in 53.6% cases. Abnormality increased across visits, with AC showing highest abnormality (63.3%, 85.8%, 89.4%), followed by EFW (51%, 59.5%, 59.6%), HC (51%, 66.8%, 63.8%), and FL (36.7%, 48.1%, 51.1%). Abnormal outcomes were higher in LSCS (57.8%) and primigravida (53.5%). NICU admission was 32.3% and perinatal mortality 3.38% (p=0.028). Hypertension showed strong association with abnormal outcome (86.9%, p<0.001). EFW showed strongest association across visits (64.7%, 62.8%, 89.3%; p<0.001). FGPS showed PPV 56%, 53.7%, 63% and NPV 73.5%, 61.1%, 100%. **Conclusion:** Third trimester ultrasound parameters, particularly AC and EFW, along with FGPS, are useful in identifying FGR and associated perinatal outcomes.

INTRODUCTION

Fetal growth restriction (FGR) is a major concern in modern obstetrics due to its strong association with increased perinatal morbidity and mortality.[1-3] It represents a condition in which the foetus fails to achieve its genetically determined growth potential, often as a result of placental insufficiency, maternal comorbidities, or foetal factors.[4,5] FGR is associated with a wide spectrum of adverse outcomes, including preterm birth, low birth weight, neonatal intensive care unit (NICU) admission, and perinatal mortality.[2,3] In addition, it has long-term implications on neurodevelopment and metabolic health.[1] Therefore, early identification and appropriate monitoring of growth-restricted foetuses remain essential components of antenatal care.

Ultrasound examination plays a central role in the assessment of foetal growth.[1] Standard fetal biometric parameters such as head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated foetal weight (EFW) are routinely used to evaluate foetal size and growth patterns.[6] Among these, AC is particularly sensitive to nutritional and placental status, while EFW provides a composite measure reflecting overall foetal growth.[1,2] However, the interpretation of these parameters is often limited by biological variability and measurement-related differences, which may lead to challenges in distinguishing constitutionally small foetuses from those with true pathological growth restriction.[2]

To overcome these limitations, serial ultrasound assessments, particularly in the third trimester, have gained importance.[7] Repeated measurements allow clinicians to evaluate growth velocity and detect deviations from expected growth trajectories. This dynamic approach provides a more accurate

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understanding of foetal growth patterns compared to single time-point measurements. Despite this, overlap between small for gestational age (SGA) foetuses and those with FGR continues to complicate clinical decision-making, highlighting the need for more refined and individualised assessment tools.[1,3]
The Foetal Growth Pathology Score (FGPS) has been introduced as a novel parameter to address these challenges. It is derived from the negative pathological deviation of foetal biometric parameters from gestational age-specific percentiles.[7,8] By integrating deviations across multiple parameters and serial assessments, FGPS provides a cumulative measure of growth abnormality. This individualised scoring system offers the potential to improve differentiation between normal physiological variation and true growth restriction, thereby enhancing diagnostic accuracy.[8,9]
In addition to identifying FGR, it is equally important to understand how these ultrasound findings correlate with perinatal outcomes. Growth-restricted fetuses are at higher risk of complications such as operative delivery, birth asphyxia, and neonatal morbidity.2 Evaluating the predictive utility of ultrasound parameters and FGPS in relation to these outcomes can aid in risk stratification and guide timely clinical interventions.
This study aims to evaluate the role of third-trimester ultrasound parameters alongside FGPS in diagnosing FGR and assessing associated perinatal outcomes.

MATERIALS AND METHODS

This was a prospective observational study conducted in the Department of Obstetrics and Gynaecology at PSG Institute of Medical Sciences and Research, Coimbatore, India. The study duration was 2 years. The study was approved by the Institutional Ethics Committee of PSG Institute of Medical Sciences and Research.

Inclusion & Exclusion Criteria
Pregnant women with singleton pregnancies, reliable gestational age determined based on the last menstrual period and/or confirmed by a first trimester dating scan, and those attending regular antenatal follow-up at the study institution were included in the study. Women with multifetal gestation, unreliable gestational age, presence of fetal anomalies, or diagnosed intrauterine infections were excluded from the study.
Methods: A total of 300 antenatal women meeting the eligibility criteria were included in the study. Eligible participants underwent third-trimester ultrasonography between 28 and 40 weeks of gestation, primarily between 28 and 34 weeks. Serial ultrasound assessments were performed at three visits during the third trimester. Fetal biometric parameters HC, AC, FL, and EFW were recorded and interpreted using gestational age-specific percentiles.
FGR was assessed using the FGPS, calculated from the negative pathological deviation (−%Devp) of each parameter, with values above the 5th percentile assigned zero deviation. A cumulative FGPS was derived from serial measurements and used, along with birth weight, to classify fetuses as true FGR or SGA. FGR was defined as birth weight below the 10th percentile for gestational age. Participants were followed until delivery for outcome assessment.
Statistical Analysis: Categorical variables were compared using chi-square test. Predictive utility was assessed using positive predictive value (PPV) and negative predictive value (NPV). A p-value <0.05 was considered statistically significant.

RESULTS

Among the study population, primigravida constituted 62% and multigravida 38%. Most women had normal BMI 52.7%, followed by overweight 22.3%, underweight 17%, and obese 7.9%. Neonatal gender distribution showed male 48% and female 52%. Majority of deliveries were term 74.3%, with preterm 25.7% [Table 1].

Table 1: Baseline Maternal and Pregnancy Characteristics

Variable	Category	n (%)
Parity	Primigravida	186 (62%)
	Multigravida	114 (38%)
BMI	Underweight	51 (17.0%)
	Normal	158 (52.7%)
	Overweight	67 (22.3%)
	Obese Grade 1	18 (6.0%)
	Obese Grade 2	4 (1.3%)
	Obese Grade 3	2 (0.6%)
Gender of Baby	Male	143 (48%)
	Female	157 (52%)
Gestational Age at Birth	Term	223 (74.3%)
	Preterm	77 (25.7%)

Table 2: Distribution of Ultrasound Parameters Across Visits

Parameter	Visit	Normal	Abnormal
		n (%)	
HC -%Devp	Visit 1	147 (49%)	153 (51%)
	Visit 2	96 (33.2%)	193 (66.8%)

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	Visit 3	17 (36.2%)	30 (63.8%)
AC -%Devp	Visit 1	110 (36.7%)	190 (63.3%)
	Visit 2	41 (14.2%)	248 (85.8%)
	Visit 3	5 (10.6%)	42 (89.4%)
FL -%Devp	Visit 1	190 (63.3%)	110 (36.7%)
	Visit 2	150 (51.9%)	139 (48.1%)
	Visit 3	23 (48.9%)	24 (51.1%)
EFW -%Devp	Visit 1	147 (49%)	153 (51%)
	Visit 2	117 (40.5%)	172 (59.5%)
	Visit 3	19 (40.4%)	28 (59.6%)

HC abnormality increased from 51% to 66.8% and 63.8%. AC showed the highest abnormality rising from 63.3% to 85.8% and 89.4%. FL abnormalities increased from 36.7% to 48.1% and 51.1%, while EFW abnormalities increased from 51% to 59.5% and 59.6%. [Table 2].

FGR was observed in 53.6%, with 46.3% normal babies. Birth weight distribution showed LBW 54.7%, VLBW 5%, and ELBW 1.3%. Abnormal outcomes were higher in LSCS 57.8% compared to vaginal deliveries 44.9%. Primigravida showed higher FGR 53.5% compared to multigravida 38.8%. BMI showed no significant association (p=0.642). NICU admissions were 32.3%, and perinatal mortality was 3.38% (p=0.028). Hypertension showed strong association with abnormal outcome 86.9% (p<0.001) [Table 3].

Table 3: Clinical Factors and Perinatal Outcomes

Variable	Category	Abnormal Outcome	Normal Outcome	P value
		n (%)		
Gestational Age (Visit 1%)	<32 weeks	50 (54.9%)	41 (45.1%)	—
	>32 weeks	98 (46.9%)	111 (53.1%)	
Birth Weight	Normal	117 (39%)	—	—
	Low Birth Weight	164 (54.7%)	—	
	Very Low	15 (5.0%)	—	
	Extremely Low	4 (1.3%)	—	
FGR Incidence	FGR	161 (53.6%)	—	—
	Normal	139 (46.3%)	—	
Delivery Type	Vaginal	89 (44.9%)	109 (55.1%)	—
	LSCS	59 (57.8%)	43 (42.2%)	
Parity vs Outcome	Primigravida	115 (53.5%)	100 (46.5%)	—
	Multigravida	33 (38.8%)	52 (61.2%)	
BMI vs Outcome	Underweight	25 (49.0%)	26 (51.0%)	0.642
	Normal	73 (46.2%)	85 (53.8%)	
	Overweight	37 (55.2%)	30 (44.8%)	
NICU Admission	Present	97 (32.3%)	—	—
	Absent	203 (67.7%)	—	
Perinatal Mortality	Yes	5 (3.38%)	0 (0%)	0.028
	No	143 (96.62%)	152 (100%)	
Hypertension	Yes	20 (86.9%)	3 (13.04%)	<0.001
	No	128 (46.21%)	149 (53.79%)	

All ultrasound parameters showed significant association with outcome. HC abnormal outcomes were 59.5%, 56.5%, and 80% (p<0.001) across visits. AC showed 55.8%, 51.6%, and 69% abnormal outcomes (p≤0.006). FL showed 74.5% and 62.6% abnormal outcomes in early visits (p<0.001) but was not significant in visit 3 (p=0.075). EFW showed the strongest association with 64.7%, 62.8%, and 89.3% abnormal outcomes (p<0.001) [Table 4].

Table 4: Ultrasound Parameters vs Outcome

Parameter	Visit	Negative	Positive	P value
		n (%)		
HC	Visit 1	91 (59.5%)	57 (38.8%)	<0.001
	Visit 2	109 (56.5%)	29 (30.2%)	<0.001
	Visit 3	24 (80.0%)	5 (29.4%)	0.001
AC	Visit 1	106 (55.8%)	42 (38.2%)	0.004
	Visit 2	128 (51.6%)	10 (24.4%)	0.001
	Visit 3	29 (69.0%)	0 (0%)	0.006
FL	Visit 1	82 (74.5%)	66 (34.7%)	<0.001
	Visit 2	87 (62.6%)	51 (34.0%)	<0.001
	Visit 3	18 (75.0%)	11 (47.8%)	0.075
EFW	Visit 1	99 (64.7%)	49 (33.3%)	<0.001
	Visit 2	108 (62.8%)	30 (25.6%)	<0.001
	Visit 3	25 (89.3%)	4 (21.1%)	<0.001

Positive = abnormal outcome; Negative = normal outcome

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FGPS showed moderate predictive performance with PPV 56%, 53.7%, and 63%, and NPV 73.5%, 61.1%, and 100%, showing improvement in later scans [Table 5].

Table 5: FGPS Predictive Values

Visit	PPV	NPV
	n (%)	
1	56%	73.5%
2	53.7%	61.1%
3	63%	100%

The most common growth pattern was A–A 52.3%, followed by A–N 37%, with fewer cases of N–N 9.3% and N–A 1.3% [Table 6].

Table 6: Growth Pattern Distribution

Pattern	n (%)
A-A	157 (52.3%)
A-N	111 (37%)
N-A	4 (1.3%)
N-N	28 (9.3%)

A–A: Abnormal–Abnormal; A–N: Abnormal–Normal; N–A: Normal–Abnormal; N–N: Normal–Normal

DISCUSSION

FGR is a major obstetric complication associated with increased perinatal morbidity and mortality, often linked to placental insufficiency and maternal factors. In this prospective observational study, third-trimester ultrasound biometry and the FGPS were used to assess growth abnormalities and their association with perinatal outcomes. The findings show significant associations with specific ultrasound parameters and serial patterns, with AC and EFW showing stronger associations, while FL showed lesser variability.

Our study population comprised primigravida mothers with predominantly normal BMI; term deliveries were more frequent with balanced neonatal gender distribution. Similarly, Dasgupta et al. reported comparable maternal characteristics with primigravida 53.2%, mean BMI around 22.9 kg/m², and no significant differences in age (p=0.532) or BMI (p=0.605) between normal and abnormal ultrasound groups.[10]

In our study, serial scans showed increasing abnormality, most prominent in AC, followed by EFW and HC; FL showed relatively lesser deviation. Similarly, Deter et al. reported that among SGA fetuses, persistent growth patterns were predominantly observed as abnormal–abnormal (40%) and normal–normal (29%), with fewer discordant patterns (11%–21%), reflecting progressive third-trimester growth abnormalities with AC contributing prominently.[11] Similarly, Marchand et al. reported that AC demonstrated the highest predictive performance with sensitivity up to 90%–98% and specificity 91%–98%, whereas FL-based parameters showed lower diagnostic accuracy.[12] These align with our study as all highlight AC as a key parameter in detecting growth abnormalities, with consistent patterns across serial assessments and predictive performance measures.

In our study, FGR and low birth weight were frequently observed; abnormal outcomes were seen across delivery types and parity; no clear association with BMI, while hypertensive disorders were more commonly seen with adverse outcomes; NICU admissions and mortality were present. In comparison to Bonnevier et al., reported antenatal SGA detection was 34.3%–46.5% and preterm delivery 4.6%–5.3%. Perinatal mortality was lower in their study (0.33%–0.34%), with higher NICU admissions (32.3%). Emergency caesarean rates were 7.1%.[13] Similarly, Wang et al. reported SGA with FGR showing higher iatrogenic delivery rates (61.19% vs 41.01%), preterm delivery (27.54% vs 1.75%), and elective caesarean section (88.10% vs 67.44%), with NICU admissions of 29.85% vs 14.39%, foetal death 4.48% vs 2.88%, and lower neonatal resuscitation rates (2.24% vs 5.76%).[14] These align well with our study, highlighting the importance of third-trimester ultrasound in early detection of growth restriction, guiding timely intervention, optimising delivery decisions, and improving neonatal outcomes.

In our study, ultrasound parameters showed association with outcome across visits, with stronger and consistent patterns seen in EFW and AC, while FL showed variability. Similarly, Wang et al. showed significantly lower mean values of EFW (2227.9 vs 2903.0 g), AC (29.08 vs 33.86 cm), FL (6.23 vs 7.17 cm), HC (30.87 vs 33.06 cm), and BPD (7.98 vs 8.46 cm) in the FGR group (p<0.001), while placental thickness was not significant (p=0.251).[15] In comparison, White et al. reported moderate predictive performance for EFW (AUC 0.695) and higher accuracy for AC (AUC 0.789) in detecting growth restriction, with misclassification rates of 7.9%–10.7%, highlighting variability in predictive accuracy of growth parameters.[16] This aligns with our study as both evaluate ultrasound biometry for detecting FGR and predicting adverse perinatal outcomes and management decisions.

Our study showed variation in FGPS predictive performance across visits, with changes in both positive and NPV over serial assessments, alongside

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different growth trajectories, with a higher proportion showing persistent abnormal patterns and fewer cases showing normal or mixed patterns. In comparison, Hassan et al. reported that ISUOG criteria identified 100% of pregnancies at risk of adverse neonatal outcomes, with all cases meeting FGR criteria (EFW/AC <10th percentile) associated with composite adverse outcomes.[17] Similarly, Tuuli et al. reported lower sensitivity for early FGR (21.4%–37.2%) with specificity (83.4%–85.5%) and moderate predictive accuracy (AUC 0.70) for second-trimester assessment.[18] These are comparable to our study as all evaluate the prediction of growth restriction using ultrasound-based criteria and assess their ability to identify fetuses at risk of adverse neonatal outcomes across different time points.

The findings show consistent associations between third-trimester ultrasound parameters and fetal growth abnormalities, with serial assessments reflecting evolving growth patterns and variable predictive performance. The study's strengths include its prospective design, serial evaluations, and use of multiple biometric parameters with FGPS for comprehensive assessment. However, limitations include its single-centre setting, relatively small sample size, lack of Doppler assessment, and absence of long-term neonatal follow-up, which may limit complete evaluation of fetal compromise and outcome prediction.

CONCLUSION

Third-trimester ultrasound biometry, particularly AC and EFW, shows a significant association with FGR and adverse perinatal outcomes. Serial assessments improved detection of progressive growth abnormalities, while the FGPS provided an individualised approach to differentiate true FGR from constitutionally small fetuses. The findings support the use of combined serial biometry and FGPS to enhance diagnostic accuracy and aid in identifying at-risk pregnancies for appropriate clinical management.

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