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ORIGINAL ARTICLE

Antenatal Ultrasound Assessment of Intrauterine Growth Restriction in Pregnant Women

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ABSTRACT

Background: Intrauterine growth restriction (IUGR) is a major contributor to perinatal morbidity and mortality, often resulting from placental insufficiency, maternal conditions, or fetal abnormalities. Antenatal ultrasound and Doppler studies are essential for early detection, enabling timely intervention to improve outcomes.

Objectives: To evaluate the role of antenatal ultrasound in the assessment of IUGR and to determine the association of abnormal umbilical artery Doppler findings with IUGR in pregnant women.

Study Design & Setting: This descriptive cross-sectional study was conducted at the Department of Obstetrics and Gynecology Nishtar Hospital Multan over a period of six months.

Methodology: A total of 150 pregnant women with singleton pregnancies, between 28–40 weeks of gestation, were included through consecutive sampling. Ultrasound was performed to record biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW). Doppler assessment of the umbilical artery was also conducted. IUGR was diagnosed when the EFW was below the 10th percentile for gestational age. Data were analyzed using SPSS, with p-values ≤0.05 considered statistically significant.

Results: The mean maternal age was 28.45 ± 6.61 years and mean gestational age was 33.67 ± 3.76 weeks. IUGR was present in 15 (10.0%) women. EFW was significantly lower in the IUGR group compared to the non-IUGR group (2030.7 ± 146.7 g vs. 2815.8 ± 381.5 g, p < 0.001). No statistically significant association was found between IUGR and abnormal umbilical artery Doppler findings (p = 0.817).

Conclusion: Antenatal ultrasound is a valuable tool for detecting IUGR, with EFW being the most sensitive parameter. Doppler assessment did not show a significant association with IUGR in this study.

Keywords: abdominal circumference, biparietal diameter, Doppler, estimated fetal weight, femur length, intrauterine growth restriction, ultrasound, umbilical artery

INTRODUCTION

Intrauterine growth restriction (IUGR) is a significant obstetric concern associated with increased risks of perinatal morbidity, mortality, and long-term neurodevelopmental impairment. It is defined as a condition in which a fetus fails to achieve its genetically determined growth potential, most commonly diagnosed when the estimated fetal weight is below the 10th percentile for gestational age.[1,2] IUGR can result from a wide spectrum of maternal, fetal, and placental factors, including hypertensive disorders of pregnancy, chronic maternal illnesses, congenital anomalies, chromosomal abnormalities, infections, and placental insufficiency.[3]

Globally, the incidence of IUGR varies between 5% and 10% in developed countries but can be as high as 25% in resource-limited settings, largely due to higher prevalence of malnutrition, anemia, and inadequate antenatal care.[4] IUGR is associated with increased risks of stillbirth, neonatal asphyxia, hypoglycemia, hypothermia, respiratory distress, and impaired immunity in the immediate postnatal period.[5] Furthermore, numerous studies have demonstrated the “fetal origins” hypothesis, suggesting that growth-restricted infants are predisposed to cardiovascular disease, type 2 diabetes, and hypertension in adulthood.[6]

Antenatal ultrasound plays a pivotal role in the detection, monitoring, and management of IUGR. It is the most accurate non-invasive tool for assessing fetal size, growth velocity, and well-being.[7] Conventional ultrasound parameters include biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW). Among these, AC is considered the most sensitive single biometric marker for detecting growth restriction, while serial growth assessments improve diagnostic accuracy by identifying deviations from the expected growth trajectory.[8,9]

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In addition to biometric measurements, Doppler velocimetry of the umbilical artery, middle cerebral artery, and ductus venosus provides valuable insight into fetal hemodynamics and placental function.[10] Abnormal Doppler findings, such as increased resistance in the umbilical artery or brain-sparing effect in the middle cerebral artery, are indicative of placental insufficiency and fetal hypoxia, aiding in risk stratification and timing of delivery.[10] Combining biometric evaluation with Doppler studies has been shown to improve the sensitivity and specificity of IUGR diagnosis compared to using biometric parameters alone.[11]

Timely diagnosis of IUGR is essential for optimizing perinatal outcomes. Once identified, careful surveillance, including frequent growth scans, Doppler assessments, and biophysical profiling, guides clinical decision-making regarding antenatal interventions and delivery timing. The challenge lies in differentiating constitutionally small but healthy fetuses from truly growth-restricted ones, as unnecessary interventions may increase maternal and fetal risks.

Given the profound impact of IUGR on short- and long-term health outcomes, and the central role of ultrasound in its assessment, further research into its diagnostic accuracy, predictive value, and integration with clinical risk factors is warranted. This study aims to evaluate the role of antenatal ultrasound in the assessment of IUGR in pregnant women, with emphasis on its ability to detect growth abnormalities early and guide timely intervention.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in the Department of Obstetrics and Gynecology of Tertiary Care Hospital Nishtar-II, Multan from Jan 2023 to June 2023. A total of 150 pregnant women fulfilling the inclusion criteria were enrolled through non-probability consecutive sampling. The sample size of 150 was calculated using the WHO sample size calculator, taking an anticipated prevalence of intrauterine growth restriction of [e.g., 11%], a confidence level of 95%, and a margin of error of 5%.

Pregnant women aged 18–40 years with singleton pregnancies between 28 and 40 weeks of gestation, referred for routine or indicated ultrasound scans, were included. Gestational age was determined based on the first-trimester ultrasound or reliable last menstrual period. Women with multiple pregnancies, known fetal anomalies, uncertain gestational age, or maternal comorbidities that could affect fetal growth such as pregestational diabetes mellitus, chronic renal disease, or collagen vascular disorders were excluded. After obtaining informed written consent, all patients underwent a detailed antenatal ultrasound examination using a high-resolution ultrasound machine (Model: [Machine Name], Probe frequency: [e.g., 3.5–5 MHz]).[19] All ultrasounds were performed by a consultant radiologist or a senior sonologist with at least five years of experience. Standard fetal biometric measurements were obtained, including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). Estimated fetal weight (EFW) was calculated automatically by the machine using the Hadlock formula. IUGR was diagnosed when the EFW was below the 10th percentile for gestational age according to standardized fetal growth charts. In addition to biometric parameters, umbilical artery Doppler velocimetry was performed in all suspected cases of IUGR to assess placental resistance, with abnormal findings defined as a pulsatility index above the 95th percentile for gestational age or the presence of absent or reversed end-diastolic flow. Findings were documented on a predesigned proforma, including maternal demographic data, obstetric history, ultrasound results, and Doppler parameters.

All data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version [XX]. Quantitative variables such as maternal age, gestational age, and fetal biometric measurements were presented as mean ± standard deviation, while qualitative variables such as presence or absence of IUGR were presented as frequencies and percentages.

RESULTS

The demographic characteristics of the study participants are presented in Table 1. The mean maternal age was 28.45 ± 6.61 years, while the mean gestational age at the time of assessment was 33.67 ± 3.76 weeks. More than half of the women were multigravida (54.0%), whereas primigravida women comprised 46.0% of the sample. Urban residents constituted the majority (63.3%), with rural residents accounting for 36.7%. Regarding educational status, the largest proportion had completed secondary education (30.7%), followed by primary education (26.7%), graduate-level education (26.0%), and illiterate women (16.7%). In terms of body mass index (BMI) categories, most participants had a normal BMI (50.7%), with 30.0% being overweight, 10.7% obese, and 8.7% underweight.

The distribution of intrauterine growth restriction (IUGR) among the study participants is also shown in figure 1. A majority of women (90.00%) did not have IUGR, while 10.00% were diagnosed with the condition.

The mean biparietal diameter (BPD) was similar between the non-IUGR (84.8 ± 6.6 mm) and IUGR (85.2 ± 7.1 mm) groups (p = 0.840). Head circumference (HC) showed no statistically significant difference between non-IUGR (308.5 ± 16.4 mm) and IUGR (312.0 ± 14.4 mm) groups (p = 0.431). Abdominal circumference (AC) was 291.0 ± 21.2 mm in the non-IUGR group and 295.4 ± 24.0 mm in the IUGR group (p = 0.454). Similarly, femur length (FL) did not differ significantly between non-IUGR (70.4 ± 5.3 mm) and IUGR (69.5 ± 5.9 mm) groups (p = 0.528). In contrast, estimated fetal weight (EFW) was markedly lower in the IUGR group (2030.7 ± 146.7 g) compared to the non-IUGR group (2815.8 ± 381.5 g), with this difference being highly statistically significant (p < 0.001) presented in table 2.

The stratification of intrauterine growth restriction (IUGR) by abnormal umbilical artery (UA) Doppler findings is shown in Table 3. Among women without IUGR, 85.9% had no abnormal UA Doppler findings, while 14.1% exhibited abnormal Doppler results. In the IUGR group, 80.0% had no abnormal UA Doppler findings, and 20.0% showed abnormal results. Overall, 85.3% of all participants had normal UA Doppler findings, while 14.7% demonstrated abnormalities. The association between IUGR and abnormal UA Doppler findings was not statistically significant (p = 0.817).

Table 1: Demographic characteristics of study participants (n = 150)

Variable	Category	n (%)
Maternal Age (years)	Mean±SD	28.45 ± 6.61
Gestational Age (weeks)	Mean±SD	33.67 ± 3.76
Parity	Multigravida	81 (54.0%)
	Primigravida	69 (46.0%)
Residence	Urban	95 (63.3%)
	Rural	55 (36.7%)
Education	Secondary	46 (30.7%)
	Primary	40 (26.7%)
	Graduate	39 (26.0%)
	Illiterate	25 (16.7%)
BMI Category	Normal	76 (50.7%)
	Overweight	45 (30.0%)
	Obese	16 (10.7%)
	Underweight	13 (8.7%)

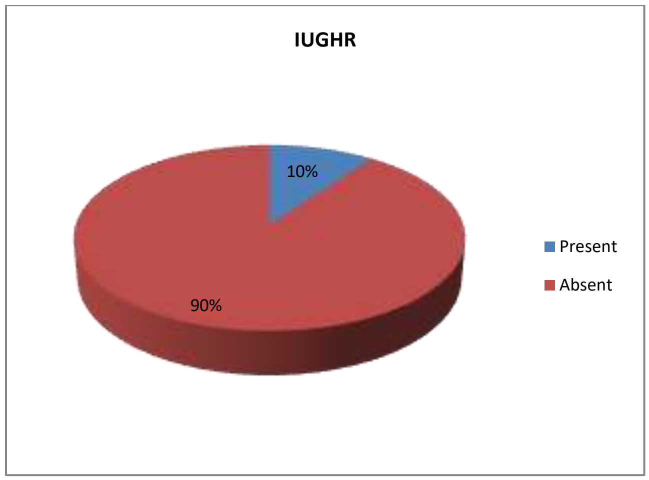

Figure 1: Frequency of IUGHR among pregnant women

Table 2: Comparison of fetal biometric measurements between IUGR and non-IUGR groups

Variable	No IUGR (Mean ± SD)	IUGR (Mean ± SD)	p-value
BPD (mm)	84.8 ± 6.6	85.2 ± 7.1	0.840
HC (mm)	308.5 ± 16.4	312.0 ± 14.4	0.431
AC (mm)	291.0 ± 21.2	295.4 ± 24.0	0.454
FL (mm)	70.4 ± 5.3	69.5 ± 5.9	0.528
EFW (g)	2815.8 ± 381.5	2030.7 ± 146.7	<0.001

Table 3: Stratification of IUGR by abnormal umbilical artery Doppler findings

IUGR Status	No Abnormal UA Doppler	Yes Abnormal UA Doppler	Total
No	116 (85.9)	19 (14.1)	135 (90.0)
Yes	12 (80.0)	3 (20.0)	15 (10.0)
Total	128 (85.3)	22 (14.7)	150 (100)
p-value = 0.817			

DISCUSSION

Intrauterine growth restriction (IUGR) is a significant cause of perinatal morbidity and mortality, resulting from impaired fetal growth due to placental, maternal, or fetal factors. Antenatal ultrasound is a reliable, non-invasive tool for detecting and monitoring IUGR, using parameters such as biparietal diameter, head circumference, abdominal circumference, femur length, and estimated fetal weight. Doppler velocimetry, particularly of the umbilical artery, provides additional insight into placental circulation and fetal well-being. Timely diagnosis of IUGR enables appropriate interventions to reduce adverse perinatal outcomes. In developing countries, limited resources make accurate, early detection even more crucial for reducing stillbirths and neonatal complications. This study aimed to assess the role of antenatal ultrasound and Doppler findings in identifying IUGR among pregnant women.

In our cohort of 150 pregnant women (mean maternal age 28.45 ± 6.61 years; mean gestational age 33.67 ± 3.76 weeks), the prevalence of intrauterine growth restriction (IUGR) was 10.00% (15/150), closely mirroring Naeem et al. (2022), who reported mean maternal age 28.69 ± 4.46 years, mean gestational age 35.29 ± 2.50 weeks and an IUGR frequency of 10.3% among 87 third-trimester ultrasounds; like Naeem et al., our dataset shows that standard fetal biometry and composite metrics remain central to third-trimester assessment.[16] Across biometric comparisons, our IUGR versus non-IUGR means were broadly similar for BPD (85.2 ± 7.1 vs 84.8 ± 6.6 mm; p = 0.840), HC (312.0 ± 14.4 vs 308.5 ± 16.4 mm; p = 0.431), AC (295.4 ± 24.0 vs 291.0 ± 21.2 mm; p = 0.454) and FL (69.5 ± 5.9 vs 70.4 ± 5.3 mm; p = 0.528), while estimated fetal weight (EFW) was markedly lower in IUGR (2030.7 ± 146.7 g) than in non-IUGR (2815.8 ± 381.5 g; p < 0.001). This pattern—attenuated group differences for head parameters but a large, highly significant gap in EFW—aligns with the "head-sparing" physiology and supports Waseem et al. (2020)[18], who highlighted abdominal growth and composite measures as most informative for IUGR detection; although Waseem et al.[18] emphasized AC as the single most accurate marker, our AC difference did not reach significance (Δ 4.4 mm; p = 0.454), likely reflecting our modest IUGR sample (n = 15), wider gestational-age window (28–40 weeks) and variability in abdominal fat accretion late in gestation, whereas EFW, integrating multiple dimensions, captured the growth deficit robustly.[18] Mumtaz et al. (2025) demonstrated excellent agreement between trans-cerebellar diameter (TCD)-derived gestational age (35.53 ± 2.14 weeks) and dating ultrasound (35.60 ± 2.20 weeks) with a strong correlation (r = 0.954; p < 0.001); although we did not use TCD, their finding supports the reliability of head-sparing indices for gestational dating in growth-restricted fetuses and is concordant with our non-significant HC differences between groups (p = 0.431).[15] Our Doppler stratification showed abnormal umbilical artery (UA) indices in 14.7% overall (22/150) with no significant association with IUGR (abnormal UA in 20.0% of IUGR vs 14.1% of non-IUGR; p = 0.817). Naeem et al. considered Doppler, biometry and BPP collectively "helpful," and Rafique et al. (2021) reported placental thickness as a high-performing adjunct (sensitivity 86.30%, specificity 86.70%, PPV 75%, NPV 92%, diagnostic accuracy 86.40%), suggesting that in mixed-risk populations placental morphometrics may outperform isolated UA Doppler for screening; our null Doppler association may reflect early or milder placental disease, operator sampling differences, or limited power.[20] Compared with Aftab et al. (2022)—who found IUGR in 39.2% of women with pregnancy-induced hypertension (PIH) versus 10.8% in unexposed (RR = 3.6154; 95% CI 2.0658–6.3272; p < 0.05)—our overall prevalence (10.00%) tracks the unexposed risk, consistent with our unselected, general obstetric sample.[17] Finally, Amin et al. (2015) enriched for risk factors reported ultrasound-diagnosed IUGR in 39.63% and birthweight < 10th percentile in 25%, with 66.24% asymmetrical patterns; our lower IUGR frequency underscores how case-mix (risk-based vs routine screening) drives prevalence and performance metrics, and it highlights the value of incorporating risk stratification (e.g., PIH, low SFH, prior SGA) and adjunct markers (placental thickness, venous Doppler, cerebroplacental ratio) to enhance detection beyond standard biometry in routine practice.

The study utilized a standardized ultrasound protocol with Doppler assessment, enhancing the reliability of measurements. A relatively large sample size (150 patients) improved the statistical validity of results. Gestational age estimation relied partly on patient-reported last menstrual period, introducing possible recall bias. Long-term neonatal outcomes were not evaluated, limiting the scope of clinical impact assessment.

CONCLUSION

Antenatal ultrasound, combined with Doppler assessment, is an effective approach for detecting IUGR. Estimated fetal weight showed the most significant difference between IUGR and non-IUGR groups.

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