SONOGRAPHIC ASSESSMENT OF FOETAL LIVER VOLUME CHANGES IN PREECLAMPSIA

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ABSTRACT

Introduction: The foetal liver serves as a central site for foeto-placental metabolism and vascular connection with the heart, and it is markedly influenced by intrauterine pathologies, rendering liver size assessment by ultrasonography essential for evaluating growth, nutrition, and maturation, and for early detection of microsomia and macrosomia.

Aim: This study aimed to assess foetal liver volume changes in pregnant participants with preeclampsia and to correlate foetal liver volume with the gestational age.

Material and methods: A case-controlled study involving 602 participants was conducted at Borno State Specialist Hospital. Purposive sampling method was adopted to recruit pre-eclamptic pregnant women, while non-pre-eclamptic pregnant women were selected using convenience sampling. The foetal biparietal diameter, femoral length, liver dimensions (antero-posterior, transverse, cephalocaudal), was measured with ultrasonic diagnostic software. Descriptive statistics and normality tests (Shapiro-Wilk) were performed. Mann-Whitney U tested differences in foetal liver volumes between two groups. Spearman's rho assessed correlations between foetal liver volume with gestational age. A p-value of less than 0.05 was considered statistically significant.

Results: Statistically significant reductions ($p < 0.001$) were observed in foetal liver volume of the pre-eclamptic participants compared to non-pre-eclamptic individuals. Strong positive statistically significant correlation existed between the foetal liver volume with gestational age.

Conclusion: **S**onography effectively identified a significant reduction of foetal liver volume in pregnancies complicated by pre-eclampsia.

Key words: Foetal, liver, Volume, pre-eclampsia.

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Obstetrics and Gynaecology. Purposive sampling was used to recruit pre-eclamptic pregnant women, while seemingly healthy pregnant women, matched with the pre-eclamptic group, were recruited using convenience sampling. Pregnant women in their 20 weeks and older diagnosed with pre-eclampsia by an obstetrician, with confirmed elevated blood pressure of ≥ 140/90 mmHg and proteinuria level of ≥ 300 mg or 1+ on urine dipstick, were included. Gestational age was confirmed in all cases by sonographic biometric analysis. Other inclusion criteria were singleton gestation, no maternal medical history of diabetes mellitus, and with evidence of foetal viability. An ethical clearance was obtained from the Human Research and Ethics Committee (HREC) of the Borno State Ministry of Health. All participants gave informed consent and joined the study voluntarily.

The patient lay in a supine position on the examination couch with the Sonographer sitting beside the examination couch. Adequate quantity of ultrasound gel was applied on the patient's abdomen. Ultrasound transducer was gently placed on the patient's abdomen, general scanning (in longitudinal, transverse, and oblique budge) of the pregnancy was done to assess the foetal viability and morphology[11]. The foetal biparietal diameter, and femoral length were use to determine the gestational age. The foetal liver was assessed when the foetus was at rest and there was no foetal respiratory movement.The liver was measured at a plane for measuring abdominal circumference in a frozen image of transverse and sagittal planes. The landmarks used to identify the correct section to measure the abdominal circumference, the umbilical portion of the left portal vein in the liver, or the bifurcation of the main portal vein into the right and left branches, with the foetal stomach as secondary landmark[11]. The liver was measured in three major dimensions; the antero-posterior length, transverse length, and cephalocaudal length (fig 1 and 2).

The foetal liver volume in this study was estimated with a formula (0.55 x antero-posterior length x transverse length x cephalo-caudal length)[8]. All the examination was performed using 3.5 MHz tranducer. The acquired data was categorised according to the maternal age, gestational age and apparently healthy and pre-eclamptic participants. Descriptive statistics were used to determine the mean, standard deviation, and the frequency of the distribution and the results were presented in tables and charts. The statistical analysis was carried out using IBM SPSS Statistics for Windows, Version 31.0. (IBM Corp. Released 2024. Armonk, NY.). A p-value of < 0.05 was used as the criterion of statistical significance.

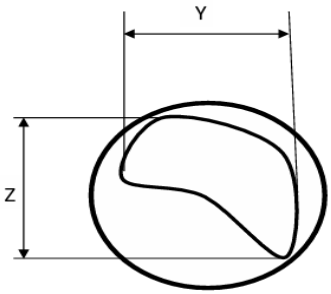

Fig. 1. Schematic presentation of foetal liver in transverse section.

Y= transverse length Z= antero-posterior length.

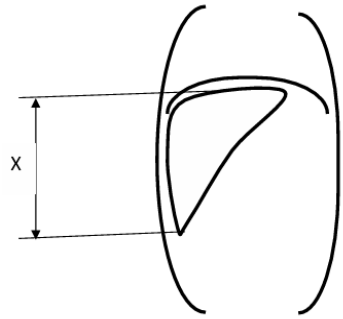

Fig. 2. Schematic presentation of foetal liver in sagittal section.

X= cephalocaudal length.

RESULTS

A total of 602 pregnant women participated in this study, comprising 130 (21.6%) with pre-eclampsia and 472 (78.4%) apparently healthy individuals. The participants' ages ranged from 20 to 46 years, with a mean of 28.67 ± 5.94 years. Shapiro-Wilk tests were conducted to assess the normality of foetal liver volume distributions. The results indicated non-normal distributions ($p < 0.001$), suggesting the use of non-parametric statistical analyses.

Table 1 presents the distribution of pre-eclampsia status across maternal age groups. The results indicate a significant variation in participation rates. Specifically, the 26-28 age group had the highest participation (n = 113, 18.77%), whereas the 44-46 age group had the lowest participation (n = 2, 0.33%). The distribution of gestational age groups among participants with pre-eclampsia is presented in Table 2. The 32-34 gestational age group exhibited the highest frequency (24.92%, n = 149), while the 38-40 gestational age group showed the lowest frequency (5.64%, n = 34). A Mann-Whitney U test was used to compare the mean differences between the foetal liver volumes of the pregnancy complicated by pre-eclampsia with the apparently normal participants ($p < 0.001$).

Table 1: Distribution of maternal pre-eclampsia status with corresponding maternal age group.

Maternal age group	PreE status		
	PreE	Normal	Total
20-22	19 (3.16%)	92 (15.28 %)	111 (18.46%)
23-25	16 (2.66%)	76 (12.62%)	92 (15.27%)
26-28	17 (2.82)	96 (15.95%)	113 (18.77%)
29-31	25 (4.15%)	79 (13.12%)	104 (17.24%)
32-34	7 (1.17%)	42 (6.98%)	49 (8.15%)
35-37	30 (4.98%)	48 (7.97%)	78 (12.95%)
38-40	13 (2.16%)	30 (4.98%)	43 (7.14%)
41-43	3 (.5%)	7 (1.17%)	10 (1.67%)
44-46	0 (0%)	2 (.33%)	2 (.33%)
Total	130 (21.6%)	472 (78.4%)	602 (100)

PreE: pre-eclampsia

Table 2: The distribution of gestational age groups with maternal pre-eclamptic status.

	PreE status		
GA group	**PreE**	**Normal**	**Total**
20.00-22.86	24 (3.99%)	35 (5.81 %)	59 (9.8%)
23.00-25.86	13 (2.16%)	38 (6.28%)	51 (8.44%)
26.00-28.86	9 (1.5%)	79 (13.12%)	88 (14.62%)
29.00-31.68	31 (5.15%)	107 (17.77%)	138 (22.92%)
32.00-34.86	32 (5.31%)	117 (19.43%)	149 (24.74%)
35.00-37.86	19 (3.16 %)	64 (10.63%)	83 (13.79%)
38.00-40.86	2 (.33%)	32 (5.31%)	34 (5.64%)
Total	130 (21.6%)	472 (78.4%)	602 (100%)

PreE: pre-eclampsia

Table 3: Mean distribution of foetal liver volume according to their gestational age group with corresponding maternal pre-eclampsia status.

	PreE status	
	PreE	**Normal**
GA group (W+D)	Mean (cm^3) ± SD	Mean (cm^3) ± SD
20.00-22.86	5.69 ± .63	6.96 ± 1.83
23.00-25.86	9.00 ± 1.72	13.16 ± 2.97
26.00-28.86	17.04 ± .35	27.17 ± 3.77
29.00-31.86	27.74 ± .82	34.10 ± 1.74
32.00-34.86	41.54 ± .81	47.63 ± 2.31
35.00-37.86	52.20 ± 1.77	57.86 ± 1.82
38.00-40.86	60.00 ± 00	61.74 ± .42

PreE: Pre-eclampsia, **SD:** Standard Deviation, **GA:** Gestational Age, **W+D:** Weeks + Days

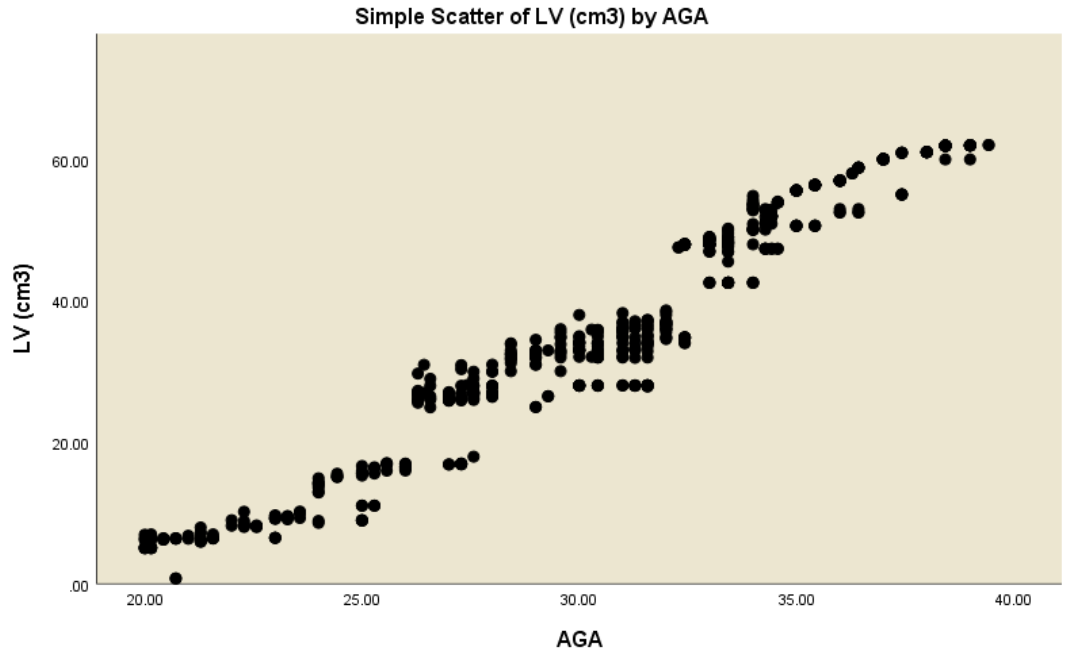

Fig. 1. simple scatter diagram of average gestational age (AGA) against foetal liver volume (LV).

DISCUSSION

Table 2 provides an age-stratified breakdown of pre-eclampsia prevalence, underscoring the importance of age as a factor in disease susceptibility. However, the observed age distribution is characterized by a slight preponderance of younger mothers, contrasted with a marked underrepresentation of older mothers (44-46 years), who comprised a mere 0.33% (n = 2) of the study sample. This finding aligns with established knowledge on age-related declines in fertility and pregnancy rates. The maternal age distribution in this study reveals a peak participation rate among women aged 26-28 years 18.77% (n = 113), with similar proportions observed among those aged 20-22 years 18.46% (n = 111) and 29-31 years 17.24% (n = 104). This finding is consistent with the National Population Commission's (2019) report, which identifies 20-29 years as the peak reproductive age range for Nigerian women.

The findings reveal fascinating patterns in the association between GA and pre-eclampsia. The overall pre-eclampsia prevalence was 21.6% (n = 130), with 78.4% (n = 472) of mothers having normal pregnancy outcomes. Notably, the results of this study diverge from those of previous studies, which was reported a prevalence rate of 4.51%[12], 16.7%[13], and 8.8%[14]. In contrast, the prevalence rate of pre-eclampsia in Northern Nigeria is remarkably high, accounting for approximately 40% of maternal mortality in the region[15]. Unfortunately, no specific percentage or exact prevalence rate for Northern Nigeria was found to compare with the finding of this study. Nonetheless, it is worth noting that PreE is a significant public health concern across Nigeria, affecting approximately 37,000 women annually[15].

A clear trend of increasing foetal liver volume with gestational age was observed in both pre-eclampsia and apparently healthy mothers. This finding is consistent with previous studies[8,16,17,18]. However, in every gestational age group, the mean foetal liver volume is consistently smaller in pregnancies complicated by PreE compared to those without PreE ($p < 0.001$). Furthermore, the data reveal a consistent disparity favouring the normal group in terms of foetal liver volume across all gestational age intervals. In the earliest gestational age group (20.00-22.86 weeks), the mean foetal liver volume for the PreE group was recorded at 5.69 ±0.63 cm^3, while the normal group exhibited a higher mean of 6.96 ±1.83 cm^3. This disparity in foetal liver volume becomes more pronounced in subsequent gestational age groups. For example, in the 23.00-25.86-week age group, the mean foetal liver volume is 9.00 ±1.72 cm^3 for the PreE group, compared to13.16 ±2.97 cm^3 for the normal group. The most significant differences are observed in the later gestational age brackets. At 38.00-40.86 weeks, the mean foetal liver volume for the PreE group was 60.00 ±0.00 cm^3, while the normal group showed a slightly higher mean of 61.74 ±0.42 cm^3. These findings suggest that maternal pre-eclampsia status significantly impacts foetal liver development, potentially influencing foetal growth and well-being. The observed differences in foetal liver volume across gestational age groups emphasize the importance of monitoring foetal growth in PreE pregnancies.

The study shows that maternal PreE has a clear impact on foetal liver development. Foetal liver volumes are consistently smaller at all gestational ages when compared to normal pregnancies. The rate of PreE observed in this study is 21.6%, which is significantly higher than previously reported rates in other areas. This highlights the serious public health issue it poses in the study population. These findings suggest that problems in foetal liver development may lead to negative foetal outcomes linked to PreE.

Integrate foetal liver volume into regular monitoring for PreE. Strengthen public health screening and interventions in areas with high prevalence. Pursue larger multi-centre studies to set standard reference values and evaluate long-term outcomes were recommended.

Conclusion: Sonography effectively identified a significant reduction of foetal liver volume in pregnancies complicated by pre-eclampsia.

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Competing Interest: The authors declare that there are no conflicts of interest related to this work.

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