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Research Article

Fetal Anterior Abdominal Wall Thickness as a Predictor of Fetal Macrosomia in Gestational Diabetes Mellitus: A Prospective Observational Study at Minia Maternity and Childhood University Hospital

Heba Hassan Ahmed[1], Dyaa Abdelmonem Ahmed[1], Ahmed Rabié Abdelrahim[1], and Mostafa Kamal AbdElhaseeb[1]

[1] Department of Obstetrics and Gynecology, Faculty of Medicine, Minia University, Minia, Egypt

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Abstract

Background: Gestational diabetes mellitus (GDM) is a prevalent pregnancy complication strongly associated with fetal macrosomia. Early detection of macrosomia is critical for optimal perinatal management. Fetal anterior abdominal wall thickness (FAAWT) has recently emerged as a promising ultrasonographic marker of fetal adiposity. **Objective:** To evaluate the role of FAAWT as a predictor of fetal macrosomia in pregnancies complicated by GDM. **Methods:** A prospective cohort study was conducted on 100 pregnant women with GDM between 36 and 39 weeks of gestation at Minia Maternity and Childhood University Hospital from January to December 2024. Standard fetal biometry and FAAWT were assessed via ultrasound. Statistical analysis included ROC curve analysis, Spearman correlation, and multivariate regression. **Results:** FAAWT showed a significant positive correlation with birth weight ($r = 0.236$, $p = 0.018$). FAAWT demonstrated a sensitivity of 91% and specificity of 54% for predicting macrosomia, with an AUC of 0.827 ($p < 0.001$). **Conclusion:** FAAWT is a valuable ultrasonographic parameter with high sensitivity for predicting fetal macrosomia in pregnancies complicated by GDM. Incorporating FAAWT into routine third-trimester assessments may improve detection of macrosomia and inform delivery planning.

Keywords: Gestational diabetes mellitus, Fetal macrosomia, Ultrasound, Fetal anterior abdominal wall thickness, Birth weight prediction

Introduction

"Gestational diabetes mellitus (GDM) is defined as glucose intolerance of variable severity with onset or first recognition during pregnancy. It is a common complication during pregnancy, with global prevalence rates ranging from 1% to 14% of all pregnancies, occurring in parallel with the global epidemic of obesity and its related metabolic disorders.(1) Pregnancy itself imposes a metabolic burden on women, accompanied by weight gain and insulin resistance, making them more susceptible to developing GDM.(2)

Key risk factors for developing gestational diabetes include obesity and excessive weight gain. Additionally, other factors play a significant role, such as a family history of diabetes and a history of gestational diabetes in previous pregnancies.(3) Notably, certain demographic characteristics increase the risk; for instance, studies in the United States have shown that women of African, Hispanic/Latina, Native American, and Pacific Islander descent have higher rates of GDM compared to White women. The risk of developing GDM also increases with advancing maternal age.(4)

Gestational diabetes leads to a range of complications affecting both maternal and fetal health. For the fetus, these complications include excessive birth weight (fetal macro-

somia), neonatal hypoglycemia, and an increased risk of respiratory problems. [5] Fetal macrosomia is a significant complication, defined as the birth of an infant weighing over 4000 grams, and its occurrence can be as high as 27% in pregnancies complicated by GDM. Macrosomia is associated with other potential complications such as difficult labor and birth injuries. [6]

Despite the increasing awareness of the risks and complications associated with gestational diabetes, accurate prediction of fetal macrosomia remains a challenge in clinical practice.[7] Traditional methods for assessing the risk of fetal macrosomia rely on maternal clinical factors and ultrasound estimations of fetal weight, which can be subject to variability and inaccuracies.[8] Therefore, there is a continuous need to explore and develop novel and reliable predictive tools that can assist clinicians in better identifying pregnancies at risk of fetal macrosomia, thereby enabling timely and appropriate interventions to improve pregnancy outcomes.[9]

This study aims to assess the diagnostic performance of FAAWT in predicting fetal macrosomia in GDM-complicated pregnancies at Minia Maternity and Childhood University Hospital. Accurate and early identification of risk factors and prediction of fetal macrosomia can contribute to improved management of pregnancies complicated by GDM and reduce potential complications for both mother and child."

Patients and Methods

I- Study Design and Setting:
A prospective observational study conducted at Minia Maternity and Childhood University Hospital from January 2024 to December 2024.
II- Ethical Approval:
Approval was obtained from the Ethical Committee of the Department of Obstetrics and Gynecology, Faculty of Medicine, Minia University (No. 1143/04/2023).
III- Study Population and Inclusion Criteria:
- All pregnancies between 36 and 39 weeks of gestation with gestational diabetes which is diagnosed by ACOG and included after informed oral consent
-Timing of serial measurement is Performed at 36 weeks and before delivery.
IV- Exclusion Criteria:
- Uncertain gestational age.
- Fetal anomalies.
- Intrauterine growth restriction (IUGR).
V- Equipment:
- Ultrasound data were collected using standardized protocols with the Mindray Diagnostic Ultrasound System, model DC-N3 (Shenzhen Mindray Bio-Medical Electronics Co., Ltd., Shenzhen, China), equipped with a 1–5 MHz curvilinear transducer.
All ultrasound examinations were performed by a single operator.
VI- Ultrasound Technique:
- Standard fetal biometry including BPD, HC, AC, and FL was measured.
- FAAWT was measured 3 cm lateral to the insertion of the umbilical cord on the standard AC plane.
- EFW was calculated using Hadlock's formula.
-Macrosomia was defined as a fetal weight exceeding the 95th percentile or >2 standard deviations above the mean for gestational age
VII- Data Analysis:
Data were verified, coded, and analyzed using SPSS version 21. Continuous variables were presented as mean ± standard deviation; categorical variables as frequencies and percentages.

Results

The study included 100 women. Mean maternal age was 34.06 ± 3.2 years, and mean BMI was 32.4 ± 3.29 kg/m2.

Table (1): Distribution of fetal ultrasound parameters in the studied group at delivery

	Studied group N=100
BPD (cm) Mean ±SD	9.00 ±0.20
HC (cm) Mean ±SD	32.19 ±0.61
AC (cm) Mean ±SD	32.28 ±0.45
FL (cm) Mean ±SD	7.12 ±0.2
FAAWT (mm) Mean ±SD	5.74 ±0.76

SD: Standard deviation, BPD: Biparietal diameter, FL: Femur length,
AC: Abdominal circumference, EFW: Estimated fetal weight,
HC: Head circumference, FAAWT: Fetal anterior abdominal wall thickness.

This table shows that, the mean of BPD was 9.00 ±0.20 cm, the mean of HC was 32.19 ±0.61cm, the mean of AC was 32.28 ±0.45 cm, the mean of FL was 7.12 ±0.2 cm, and the mean of FAAWT was 5.74 ±0.76 mm.

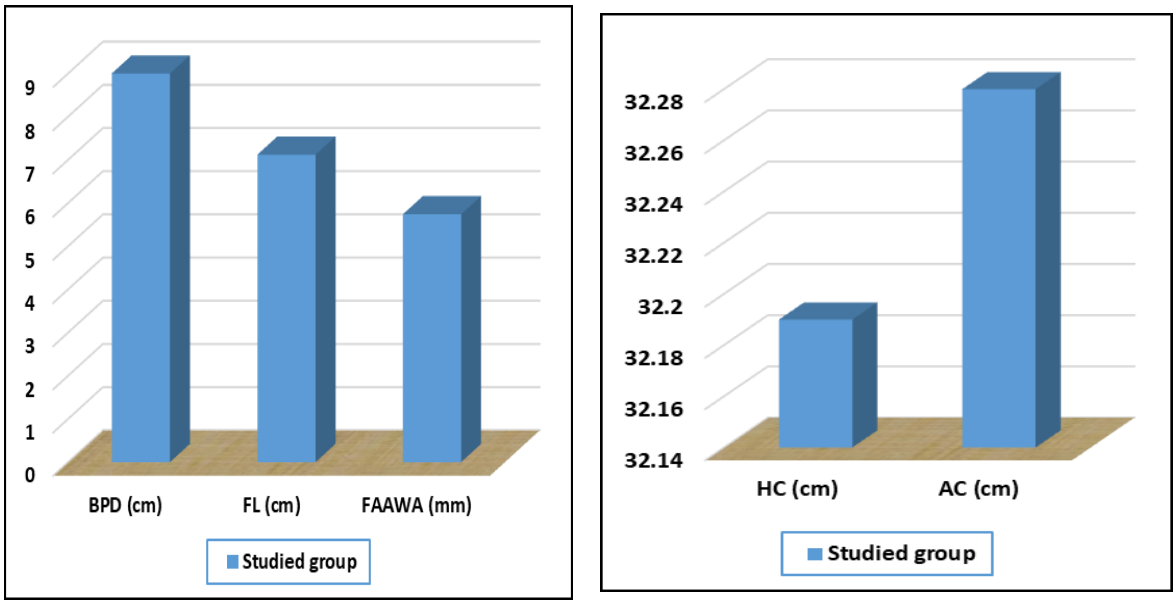

Figure (1): Distribution of fetal ultrasound parameters in the studied group.

Table (2): Variable distribution between GDM women with and without macrosomia

	Macrosomia		P-value
	Absent	Present	
BPD (cm) Mean ±SD	8.9 ±0.19	9.00 ±0.23	0.98
HC (cm) Mean ±SD	32.18 ±0.58	32.22 ±0.75	0.81
AC (cm) Mean ±SD	32.22 ±0.4719	32.48 ±0.34	**0.02**
FL (cm) Mean ±SD	7.123 ±0.16	7.126 ±0.33	0.95
FAAWT (mm) Mean ±SD	5.569 ±0.71	6.415 ±0.58	**<0.001**
EFW (grams) Mean ±SD	3200.96 ±170.8	4213.15 ±131.14	**<0.001**

SD: Standard deviation, BPD: Biparietal diameter, FL: Femur length,
AC: Abdominal circumference, EFW: Estimated fetal weight,
HC: Head circumference, FAAWT: Fetal anterior abdominal wall thickness.

This table shows that, there was no statistically significant difference between studied groups regarding BPD, HC, and FL, there was statistically significant difference between studied groups regarding AC, FAAWT, and EFW.

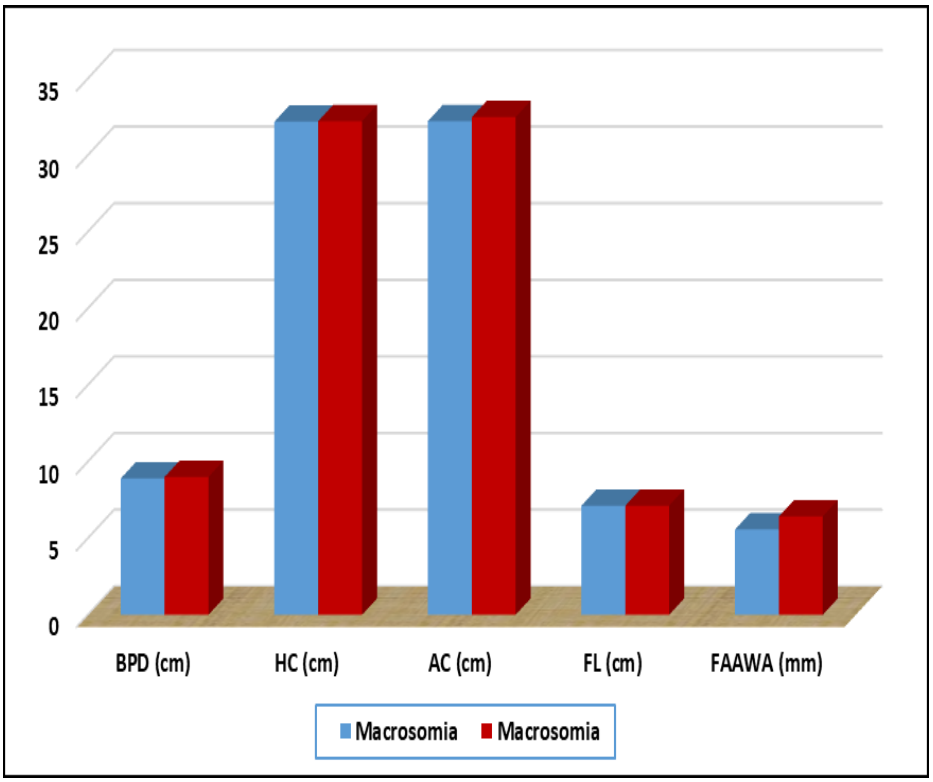

Figure (2): Variable distribution between GDM women with and without macrosomia

Table (3): Correlation of various fetal ultrasound parameters with birth weight at delivery

	Birth weight	
	r	**p-value**
BPD	0.113	0.265
HC	0.469**	**<0.001**
AC	0.406**	**<0.001**
FL	0.429**	**<0.001**
EFW	1.000**	**<0.001**
FAAWT	0.236*	**0.018**

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant, BPD: Biparietal diameter, FL: Femur length, AC: Abdominal circumference, EFW: Estimated fetal weight, HC: Head circumference, FAAWT: Fetal anterior abdominal wall thickness.

This table shows that, there was positive significant correlation between Birth weight and HC, AC, FL, EFW and FAAWT, while there was no significant correlation between birth weight and BPD.

Table (4): univariate regression analysis for prediction of macrosomia by various fetal ultrasonography parameters.

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
BPD	4.722	4.212	0.113	1.121	0.265	-3.636	13.081
HC	32.913	6.257	0.469	5.26	**0.001**	20.497	45.33
AC	29.372	6.679	0.406	4.397	**0.001**	16.117	42.628
FL	134.921	28.715	0.429	4.699	**0.001**	77.938	191.904
EFW	1.004	0.001	1	775.415	**0.001**	1.002	1.007
FAAWT	79.651	33.065	0.236	2.409	**0.018**	14.035	145.267

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant, BPD: Biparietal diameter, FL: Femur length, AC: Abdominal circumference, EFW: Estimated fetal weight, HC: Head circumference, FAAWT: Fetal anterior abdominal wall thickness.

This table shows that, according to univariate analysis, HC, AC, FL, EFW and FAAWT were significant predictors for macrosomia.

Table (5): Multivariate Regression Analysis for prediction of macrosomia by various fetal ultrasonography parameters.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
BPD	45.853	130.69	0.018	0.351	0.726	-213.671	305.378
HC	19.974	43.222	0.024	0.462	0.645	-65.856	105.805
AC	5.11	58.416	0.005	0.087	0.93	-110.893	121.113
FL	77.686	126.778	0.031	0.613	0.542	-174.07	329.442
FAAWT	-18.377	38.626	-0.027	-0.476	0.635	-95.081	58.328
EFW	1.031	0.066	0.882	15.545	**<0.001**	0.899	1.162

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant, BPD: Biparietal diameter, FL: Femur length, AC: Abdominal circumference, EFW: Estimated fetal weight, HC: Head circumference, FAAWT: Fetal anterior abdominal wall thickness.

This table shows that, according to multivariate analysis EFW was a significant predictor for macrosomia.

Table (6): ROC analysis for fetal ultrasonography parameters to predict macrosomia.

Test Result Variable(s)	Area	Sensitivity	Specificity	Std. Errora	Asymptotic Sig.b	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
HC	0.526	52%	54%	0.075	0.719	0.379	0.673
AC	0.672	81%	52%	0.06	**0.016**	0.554	0.79
FL	0.489	52%	41%	0.092	0.879	0.31	0.669
FAAWT	0.827	91%	54%	0.046	**<0.001**	0.736	0.918

This table shows that, HC had sensitivity of 52% and specificity of 54% with no significance for the prediction of macrosomia, AC had sensitivity of 81% and specificity of 52% with significance for the prediction of macrosomia, FL had sensitivity of 81% and specificity of 52% with no significance for the prediction of macrosomia, and FAAWT had sensitivity of 91% and specificity of 54% with significance for the prediction of macrosomia.

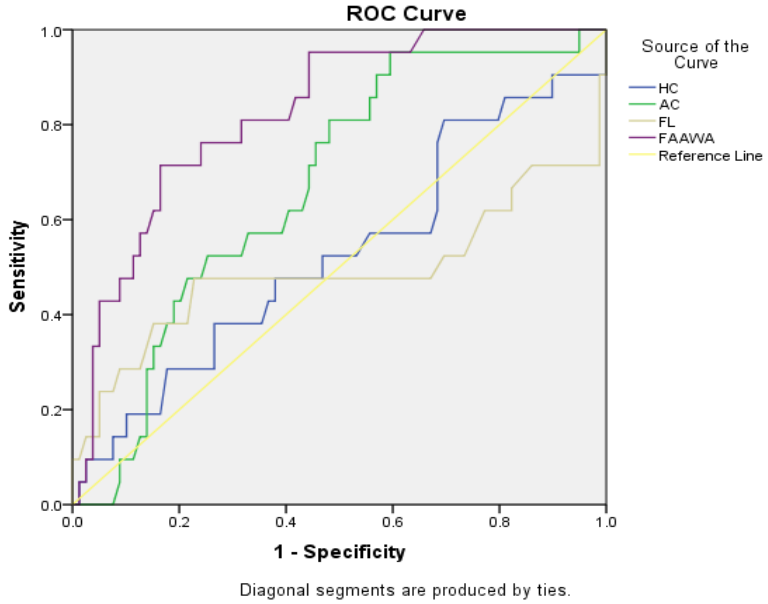

Figure (3): ROC curve for fetal ultrasonography parameters to predict macrosomia.

Discussion

This study demonstrated that fetal anterior abdominal wall thickness (FAAWT) is significantly associated with fetal birth weight and may serve as a useful screening tool for predicting macrosomia in GDM pregnancies.[10] The study included 100 women, with a mean maternal age of 34.06 ± 3.2 years and a mean BMI of 32.4 ± 3.29 kg/m2.[11] All women in the study underwent delivery by Cesarean Section. Key findings revealed that the mean fasting glucose level was 129.61 ± 6.05 mg/dl, and the mean 2-hour postprandial glucose (PPG) level was 175.21 ± 5.95 mg/dl. At 36 weeks, the mean BPD was 8.95 ± 0.78 cm, the mean HC was 31.43 ± 3.21 cm, the mean AC was 31.58 ± 1.9 cm, the mean FL was 6.76 ± 0.66 cm, and the mean FAAWA was 5.07 ± 1.09 mm. Overall, the mean BPD was 9.00 ± 0.20 cm, the mean HC was 32.19 ± 0.61 cm, the mean AC was 32.28 ± 0.45 cm, the mean FL was 7.12 ± 0.2 cm, and the mean FAAWA was 5.74 ± 0.76 mm. The mean gestational age at birth was 36.74 ± 0.97 weeks, the mean birth weight was 3616.36 ± 520.1 grams, and the mean estimated fetal weight (EFW) was 3413.52 ± 445.13 grams. A significant positive correlation was found between FAAWT and birth weight ($r = 0.236$, $p = 0.018$).[12]

Univariate analysis identified FAAWT, HC, AC, FL, and EFW as significant predictors of macrosomia, while in multivariate regression, EFW remained the only independent predictor of macrosomia ($p < 0.001$).[13] the predictive power of FAAWT appears to be reduced in multivariate analysis when EFW is included. This may indicate collinearity or that EFW is a more dominant predictor. It Should discussed the potential interplay between the two variables in predicting macrosomia, FAAWT demonstrated a sensitivity of 91% and a specificity of 54% for predicting macrosomia (AUC = 0.827, $p < 0.001$), The high sensitivity of FAAWT observed in this study (91%) suggests it is a reliable screening tool for identifying at-risk fetuses. However, the moderate specificity (54%) of FAAWT implies that it can effectively identify most of macrosomic fetuses, it may over-predict macrosomia in some non-macrosomic pregnancies. Therefore, FAAWT should be considered as part of a multi-parameter assessment rather than as a standalone predictor. In particular, it could serve as an early screening tool that prompts further evaluation using Estimated Fetal Weight (EFW) and other parameters, and AC had sensitivity of 81% and a specificity of 52% with significance for the prediction of macrosomia ($p = 0.016$).[14] These findings contribute to the understanding of macrosomia in GDM pregnancies and highlight the potential utility of FAAWT in predicting birth outcomes.[15] However, the specificity of some measurements suggests that further investigation or additional risk factors should be considered for a comprehensive prediction of macrosomia.[16]

Limitations of the Study is:

1. Single-Center Study: The study was conducted at a single tertiary care hospital, which may limit the generalizability of the findings to other populations or healthcare settings with different demographics or clinical practices and we suggest that future multicenter studies be conducted to confirm our results.
2. Relatively Small Sample Size: Although the results were statistically significant, the modest sample size may affect the power of the study and the precision of estimates, especially in subgroup analyses, However, it was calculated based on similar previous studies to ensure sufficient statistical power and we suggest that future studies with larger cohorts be conducted to validate our findings.

Conclusion

Fetal anterior abdominal wall thickness measured by ultrasound is a sensitive parameter for predicting fetal macrosomia in pregnancies complicated by GDM. Its integration into routine third-trimester assessments may enhance the accuracy of prenatal weight estimations and optimize delivery planning to reduce perinatal complications.

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