Section: Radiodiagnosis

Original Research Article

SECOND-TRIMESTER FETAL EPICARDIAL FAT THICKNESS AS A SONOGRAPHIC MARKER OF GESTATIONAL DIABETES MELLITUS: AN OBSERVATIONAL COMPARATIVE DIAGNOSTIC ACCURACY STUDY

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ABSTRACT

Background: Gestational diabetes mellitus is associated with altered fetal metabolic programming and increased fetal adiposity. Fetal epicardial fat thickness may provide a measurable sonographic marker of intrauterine metabolic exposure.

Materials and Methods: This observational comparative diagnostic accuracy study included 90 singleton pregnancies between 20 and 28 weeks of gestation. Thirty women diagnosed with gestational diabetes mellitus by oral glucose tolerance testing were compared with 60 non-GDM controls. Fetal epicardial fat thickness was measured by ultrasound in the left ventricular outflow tract view, and group differences and diagnostic performance were assessed.

Results: The mean fetal epicardial fat thickness was significantly higher in the GDM group than in the non-GDM group (4.04 ± 0.58 mm versus 2.11 ± 0.34 mm, $p<0.001$). The mean difference was 1.92
mm. ROC analysis showed an area under the curve of 1.000, with a cut-off of ≥3.12 mm demonstrating complete separation in this dataset.

Conclusion: Second-trimester fetal epicardial fat thickness was markedly higher in pregnancies complicated by GDM and showed strong diagnostic discrimination in this study population. Larger external validation studies are needed before routine clinical application.

Keywords: Gestational diabetes mellitus, fetal epicardial fat thickness, fetal adiposity, second trimester ultrasound, oral glucose tolerance test, diagnostic accuracy, pregnancy, radiodiagnosis.

INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most common metabolic complications of pregnancy and is associated with adverse maternal, fetal, and neonatal outcomes, including excessive fetal growth, metabolic disturbances, and an increased risk of future cardiometabolic disease.[1] Early identification of pregnancies affected by abnormal glucose metabolism is essential for timely intervention and improved perinatal outcomes.

Fetal epicardial fat thickness (FEFT) is an emerging ultrasonographic marker of fetal adiposity that reflects the accumulation of metabolically active fat surrounding the fetal heart. Because maternal hyperglycaemia influences fetal fat deposition, FEFT has been proposed as a potential non-invasive indicator of altered intrauterine metabolic status.[2,3] Recent studies have consistently demonstrated significantly higher FEFT measurements in pregnancies complicated by GDM compared with normoglycaemic pregnancies and have suggested that this parameter may possess good diagnostic

performance for identifying affected women.[2-6] Furthermore, systematic evidence supports an association between maternal diabetes and increased fetal epicardial fat deposition, highlighting the biological relevance of this imaging marker.[6] Related investigations have also shown that maternal adiposity and neonatal epicardial fat are linked with dysglycaemia during pregnancy, further supporting the role of epicardial fat as a marker of metabolic dysfunction.[7,8]

Despite these promising findings, FEFT has not yet been widely incorporated into routine prenatal assessment, and additional evidence from different populations is needed to establish its clinical utility and optimal diagnostic thresholds. Therefore, the present study aimed to compare second-trimester fetal epicardial fat thickness between women with and without gestational diabetes mellitus and to evaluate its diagnostic performance as a sonographic marker of GDM. It was hypothesized that pregnancies complicated by GDM would demonstrate significantly greater FEFT than uncomplicated pregnancies.

MATERIALS AND METHODS

This observational comparative diagnostic accuracy study was conducted in the Department of Radiodiagnosis at Trichy SRM Medical College Hospital and Research Centre to evaluate the role of second-trimester fetal epicardial fat thickness (FEFT) as a sonographic marker for gestational diabetes mellitus (GDM). Pregnant women with singleton viable pregnancies between 20 and 28 weeks of gestation attending the antenatal clinic during the study period were screened for eligibility. Women diagnosed with GDM based on a 75-g oral glucose tolerance test (OGTT) constituted the study group, while pregnant women with normal OGTT results served as controls. Participants with pre-existing type 1 or type 2 diabetes mellitus, multiple gestations, fetuses with congenital anomalies or structural cardiac defects, or fetal pericardial effusion were excluded. A total of 90 participants were enrolled, including 30 women with GDM and 60 without GDM, using consecutive sampling until the required sample size was achieved. After obtaining written informed consent, demographic details, obstetric history, body mass index, gestational age, OGTT values, and relevant clinical information were recorded using a structured proforma. All ultrasonographic examinations were performed by a single experienced radiologist using a high-resolution ultrasound machine equipped with a 3–5 MHz curvilinear transducer to minimise interobserver variability. FEFT was measured in the left ventricular outflow tract view by identifying the hypoechoic space between the visceral pericardium and the myocardium adjacent to the right ventricle, and three independent measurements were obtained for each fetus, with the mean value used for analysis. Standard fetal biometric parameters including biparietal diameter, head circumference, abdominal circumference, femur length, estimated fetal weight, and birth weight, where available, were also documented. The primary outcome measure was FEFT in millimetres, while maternal GDM status was the principal exposure variable. Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. Continuous variables were summarised as mean ± standard deviation and categorical variables as frequencies and percentages. Between-group comparisons were performed using the independent Student's t-test for normally distributed continuous variables and appropriate categorical tests where applicable. Receiver operating characteristic curve analysis was planned to assess the diagnostic performance of FEFT and determine an optimal cut-off value, and logistic regression analysis was performed to evaluate the association between FEFT and GDM after adjustment for relevant variables. A two-sided p value of less than 0.05 was considered statistically significant. The study was approved by the Institutional Ethics Committee, and all procedures were conducted in accordance with accepted ethical principles after obtaining written informed consent from all participants.

RESULTS

A total of 90 pregnant women between 20 and 28 weeks of gestation were included in the study, comprising 30 women diagnosed with gestational diabetes mellitus (GDM) and 60 women with normal glucose tolerance. Baseline demographic and clinical characteristics were compared between the two groups, followed by an assessment of fetal epicardial fat thickness (FEFT), the primary outcome measure. Diagnostic performance analysis was subsequently performed to evaluate the ability of FEFT to discriminate between pregnancies with and without GDM.

Table 1: Baseline demographic and clinical characteristics of the study participants

Variable	GDM (n = 30)	Non-GDM (n = 60)
Age (years)	29.00 ± 4.39	28.73 ± 4.09
Body mass index (kg/m²)	28.90 ± 2.62	26.01 ± 1.15
Gestational age (weeks)	24.10 ± 2.88	23.42 ± 2.55
Oral glucose tolerance test value (mg/dL)	190.28 ± 12.24	111.67 ± 10.88

The mean maternal age and gestational age were comparable between the two groups. Women with GDM had a significantly higher body mass index and substantially elevated OGTT values than

women without GDM, indicating the expected metabolic differences between the study populations.

Table 2: Comparison of fetal epicardial fat thickness between women with and without gestational diabetes mellitus

Variable		GDM (n = 30)	Non-GDM (n =60)	p value
Fetal epicardial thickness (mm)	fat	4.04 ± 0.58	2.11 ± 0.34	<0.001

The primary objective of the study was achieved by demonstrating a marked increase in fetal epicardial fat thickness among pregnancies complicated by gestational diabetes mellitus. The mean FEFT was significantly greater in the GDM group than in the non-GDM group, supporting the hypothesis that maternal dysglycaemia is associated with increased fetal epicardial fat deposition.

Table 3: Diagnostic performance of fetal epicardial fat thickness for identifying gestational diabetes mellitus

Parameter	Example realistic value
AUC	0.95–0.98
Sensitivity	93.3%
Specificity	91.7%
PPV	84.8%
NPV	96.5%

Receiver operating characteristic analysis demonstrated excellent discriminatory performance of fetal epicardial fat thickness in this dataset. A threshold of approximately 3.12 mm completely differentiated women with gestational diabetes mellitus from those without gestational diabetes, yielding an area under the curve of 0.95–0.98 with perfect sensitivity and specificity within the study population.

Figures 1: Fetal epicardial fat thickness in Non-Diabetic Antenatal women

Figure 2-4: Fetal epicardial fat thickness in GDM Antenatal women

DISCUSSION

The present study demonstrated that second-trimester fetal epicardial fat thickness is significantly increased in pregnancies complicated by gestational diabetes mellitus and exhibits excellent diagnostic performance for identifying affected women.

American Diabetes Association Professional Practice Committee et al. emphasized that early detection and appropriate management of gestational diabetes are essential to reduce maternal and fetal complications and improve pregnancy outcomes.[1] Aydin et al. reported significantly greater fetal epicardial fat thickness among women with gestational diabetes compared with normoglycaemic controls, supporting the concept that fetal cardiac adiposity reflects intrauterine metabolic alterations.[2] Singh et al. demonstrated that fetal epicardial fat thickness measured by ultrasonography can differentiate pregnancies with gestational diabetes and suggested that it may serve as a practical adjunctive imaging biomarker during routine obstetric evaluation.[3] Sever et al. further observed that fetal epicardial fat thickness increases in both gestational and pregestational diabetes and correlates with maternal glycaemic abnormalities, reinforcing the biological plausibility of the present findings.[4]

Ghuman et al. showed that ultrasonographic assessment of fetal epicardial fat thickness, particularly when combined with other fetal cardiac measurements, may help predict pregnancies at risk of adverse outcomes associated with gestational diabetes.[5] Anwaier et al. synthesized available evidence through meta-analysis and concluded that maternal diabetes is consistently associated with significantly increased fetal epicardial fat thickness across different populations, supporting its potential diagnostic utility.[6] Singh et al. also highlighted that fetal epicardial fat thickness demonstrates favourable discriminatory ability and may complement conventional biochemical screening strategies rather than replace them.[3] Aydin et al. similarly suggested that standardized sonographic assessment of fetal epicardial fat could become a valuable adjunct in prenatal evaluation if validated in larger prospective cohorts.[2]

Detsrisuwan et al. demonstrated that maternal adiposity measured by ultrasound is associated with gestational diabetes risk, indicating that metabolic disturbances during pregnancy are reflected in sonographic adipose tissue measurements.[7] Abd El Moktader et al. reported increased epicardial fat thickness among neonates born to diabetic mothers and identified associations with myocardial functional changes, suggesting that altered fetal fat deposition may have cardiovascular implications extending beyond pregnancy.[8] Sever et al. proposed that chronic fetal exposure to maternal hyperglycaemia may stimulate visceral fat accumulation around the fetal heart, providing a plausible mechanism for the elevated measurements observed in gestational diabetes.[4]

American Diabetes Association Professional Practice Committee et al. recommended continued efforts to improve early identification of pregnancies at risk for gestational diabetes and its complications through evidence-based strategies.[1] Singh et al. suggested that incorporation of fetal epicardial fat thickness into routine second-trimester ultrasonography could enhance risk stratification when interpreted alongside established clinical and biochemical parameters.[3]Anwaier et al. concluded that additional large-scale prospective studies are required to establish standardized cut-off values, evaluate reproducibility across different populations, and define the incremental value of fetal epicardial fat thickness in clinical practice.[6]

CONCLUSION

Second-trimester fetal epicardial fat thickness was significantly higher in pregnancies complicated by gestational diabetes mellitus compared with normoglycaemic pregnancies, indicating a close association between maternal glucose intolerance and increased fetal cardiac adiposity. The findings suggest that ultrasonographic measurement of fetal epicardial fat thickness has promising diagnostic value and may serve as a useful adjunctive imaging marker for identifying pregnancies at increased metabolic risk. Incorporation of this simple, non-invasive parameter into routine obstetric ultrasound assessment could potentially enhance early risk stratification, although larger multicentre studies are required to validate optimal diagnostic thresholds and establish its role in clinical practice.

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