First-Trimester Abdominal Adipose Tissue Thickness to Predict Gestational Diabetes

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Abstract

Objective: To estimate the discriminative capacity of first-trimester subcutaneous (SATT), visceral (VATT), and total (TATT) adipose tissue thickness in predicting gestational diabetes mellitus (GDM), including that requiring insulin.

Methods: We prospectively recruited a cohort of 1048 nulliparous women. Ultrasound images were used to determine abdominal SATT, VATT, and TATT at 11 to 14 weeks' gestation. Multivariate logistic regression models were used to predict GDM, as well as insulin-requiring GDM. Model discrimination was expressed as area under the curve (AUC).

Results: SATT (AUC 0.66, 95% CI 0.59–0.73), VATT (AUC 0.65, 95% CI 0.58–0.73), and TATT (AUC 0.68, 95% CI 0.61–0.76) were each associated with subsequent GDM. The respective AUC values for insulin-requiring GDM were 0.70 (95% CI 0.61–0.79), 0.73 (95% CI 0.65–0.82), and 0.76 (95% CI 0.67–0.84). At a false-positive rate of 10%, the detection rate for insulin-requiring GDM was 19% for maternal age ≥35 years, 31% for a BMI ≥31.6 kg/m^2, and 31% for TATT ≥61 mm, increasing to 42% in the model comprising all three measures.

Conclusion: First-trimester ultrasound measurement of adipose tissue is associated with a higher chance of developing GDM, especially insulin-requiring GDM.

Résumé

Objectif : Estimer la capacité discriminative de l'épaisseur des tissus adipeux sous-cutané (TASC), viscéral (TAV) et total (TAT) au premier trimestre à prédire le diabète sucré gestationnel (DSG), qu'il soit insulinodépendant ou non.

Méthodologie : Nous avons recruté de façon prospective une cohorte de 1048 femmes nullipares. À l'aide d'images échographiques, nous avons déterminé l'épaisseur du TASC, du TAV et du TAT abdominaux entre la 11^e et la 14^e semaine de grossesse. Des modèles de régression logistique multivariée ont été utilisés pour prédire le DSG et le DSG insulinodépendant. La discrimination du modèle a été exprimée par l'aire sous la courbe (ASC).

Résultats : L'épaisseur du TASC (ASC : 0,66; IC à 95 % : 0,59–0,73), celle du TAV (ASC : 0,65; IC à 95 : 0,58–0,73) et celle du TAT (ASC : 0,68; IC à 95 % : 0,61–0,76) ont toutes été associées à un DSG subséquent. Les valeurs de l'ASC dans le cas du DSG insulinodépendant étaient respectivement de 0,70 (IC à 95 % : 0,61–0,79), de 0,73 (IC à 95 % : 0,65–0,82) et de 0,76 (IC à 95 % : 0,67–0,84). Le taux de détection du DSG insulinodépendant était de 19 % chez les femmes de 35 ans et plus, de 31 % chez celles ayant un IMC de 31,6 kg/m^2 et plus et de 31 % chez celles dont l'épaisseur du TAT était de 61 mm et plus, et était de 42 % selon le modèle tenant compte de ces trois mesures. Le taux de faux positifs était de 10 %.

Conclusion : L'épaisseur du tissu adipeux mesurée par échographie au premier trimestre peut permettre de détecter un risque accru de développer un DSG, en particulier un DSG insulinodépendant.

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Key Words: Pregnancy, gestational diabetes, insulin, ultrasound, adiposity

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INTRODUCTION

Gestational diabetes mellitus is a prevalent health problem associated with adverse perinatal outcomes.[1] Treatment of women diagnosed with GDM, by optimizing blood glucose concentrations, can reduce the risk of fetal overgrowth, the hypertensive disorders of pregnancy, and birth complications, including shoulder dystocia.[2,3]

Several approaches to GDM screening have their respective limits and benefits.[4–6] Most GDM screening approaches

are done at 24 to 28 weeks' gestation,[1,4] which can significantly delay the GDM diagnosis and treatment from its onset.[1] Early prediction of GDM, and especially GDM requiring insulin therapy, could improve the benefits of such therapy and other non-pharmaceutical approaches.[7]

Obesity, especially visceral abdominal fat accumulation, is associated with metabolic dysfunction, and constitutes a major risk factor for diabetes mellitus.[8] Ultrasonography is a reliable and safe method for the assessment of abdominal adiposity in pregnancy.[9,10] In the first trimester of pregnancy, sonographic evidence of abdominal adiposity is associated with insulin resistance, the metabolic syndrome, and GDM.[8,10–14] The role of first-trimester subcutaneous and visceral adipose tissue thickness in clinical practice has yet to be defined, including predicting more severe GDM requiring insulin therapy.[8,11,12]

Herein, we sought to estimate the value of first-trimester subcutaneous, visceral, and total adipose tissues thickness for the prediction of GDM and insulin-requiring GDM.

METHODS

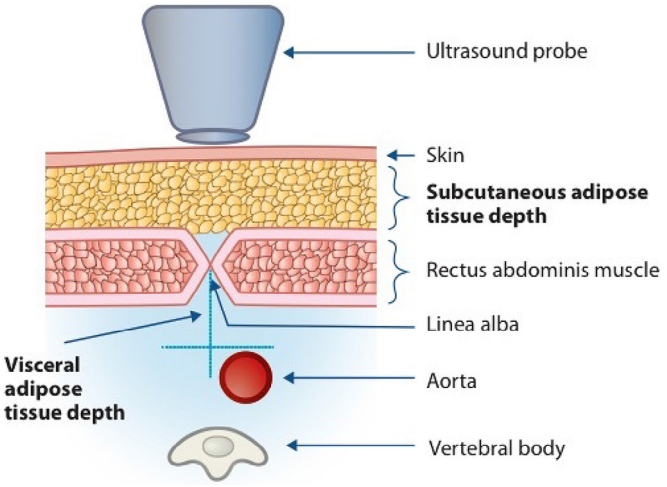
This was a planned sub-cohort study of a large prospective cohort study of pregnant women who were recruited in the first trimester whose goal was the early prediction of adverse pregnancy outcomes. Participants were recruited at the CHU de Québec between March 2011 and December 2014. Healthy nulliparous women, aged 18 years and older, and with a viable singleton pregnancy at $11^{0/7}$ to $14^{0/7}$ weeks, were eligible. Women with chronic hypertension, pre-pregnancy diabetes, or those with a fetal chromosomal anomaly or lethal malformation were excluded. Written informed consent was obtained from all participants, and the project was approved by the institutional ethics committee of the CHU de Québec. A questionnaire, including maternal medical characteristics, was completed by a research nurse, who also measured the height and weight of each participant at 11 to 14 weeks' gestation.

All participants underwent sonographic measurement of SATT and VATT at 11 to 14 weeks' gestation using a technique described previously and shown in Figure 1.[9,10]

ABBREVIATIONS

GDM	gestational diabetes mellitus
ROC	receiver operator characteristic
SATT	subcutaneous tissues thickness
TATT	total adipose tissues thickness
VATT	visceral tissues thickness

Figure 1. Ultrasound measurement of adipose tissue including subcutaneous and visceral adipose tissue.



Transabdominal ultrasound was completed using a RAB4-8-D/OB curvilinear Array probe in the 2–8 MHz frequency range (Voluson E8 Expert system, GE Healthcare Inc., Milwaukee, WI). Attention was paid to avoid undue pressure that could falsely compress the abdominal tissue. Images were also captured when the aorta was closest to the surface, at the end of maternal expiration. Measurements were done perpendicular to the aorta, about 2.5 cm above the umbilicus, at the level of the linea alba. Video recordings of adipose tissue thickness assessments were captured by a trained ultrasound technician blinded to the participant's medical history. SATT and VATT were subsequently measured on the stored video images by a second observer blinded to participants' characteristics. SATT was measured from the subcutaneous fat layer to the outer border of the rectus abdominus muscle, and VATT was measured from the inner border of the rectus abdominus to the anterior wall of the abdominal aorta (Figure 1). TATT was calculated as the addition of VATT and SATT. None of these measurements were disclosed to the study participants or their health care providers.

Medical charts were reviewed to obtain obstetrical outcomes. The primary outcomes of interest were GDM and insulin-requiring GDM. At our centre, screening for GDM was typically performed at 24 to 28 weeks' gestation using a non-fasting 1-hour 50-g glucose challenge test. A result <7.8 mmol/L was considered as screen negative, while a value ≥11.1 mmol/L defined a diagnosis of GDM. Those whose value was between 7.8 and 11.0 mmol/L underwent a 2-hour 75-g glucose tolerance test. GDM was diagnosed based on one abnormal glucose value, as follows: a fasting concentration ≥5.3 mmol/L, a 1-hour value ≥10.6 mmol/L, or a 2-hour value ≥9.0 mmol/L.[1,4] Women diagnosed with GDM

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