

Visceral and Subcutaneous Fat at 3 Months Postpartum in Women With a History of Gestational Diabetes

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ABSTRACT

OBJECTIVE

To evaluate visceral and subcutaneous (SC) fat measures at 3 months postpartum in a population of women with recent gestational diabetes mellitus (GDM), compared to matched controls.

METHODS

Twenty-five women (14 GDM, 11 controls) who had all delivered a single live infant after 36 weeks of gestation were evaluated. Each woman had documentation of body habitus, a 2-hour 75-g oral glucose tolerance test (OGTT) and a computed tomography (CT) scan for fat areas.

RESULTS

Mean fasting blood glucose (FBG) was similar in women with GDM and controls, although FBG was higher in the former group. Women with GDM had an increased OGTT area under the curve (AUC) for glucose, while AUC for insulin was similar between groups. Measures of visceral and SC fat areas were similar between groups.

CONCLUSION

Women with previous GDM were insulin resistant at 3 months postpartum but had no differences in visceral and SC fat compared to body mass index (BMI) -matched controls.

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RÉSUMÉ

OBJECTIF

Mesurer les tissus adipeux viscéraux et sous-cutanés 3 mois après l'accouchement chez des femmes ayant présenté un diabète gestationnel (DG) et comparer les résultats à ceux obtenus chez des témoins appariés.

MÉTHODES

Vingt-cinq femmes ont été évaluées (14 ayant présenté un DG et 11 témoins). Toutes les femmes avaient eu un accouchement simple et donné naissance à un enfant vivant après une période de gestation de 36 semaines. Chez chaque femme, l'habitus corporel était documenté. Chacune a subi un test de tolérance au glucose par voie orale 2 heures après l'absorption de 75 g de glucose (TTGO – 75 g) et une tomographie par densitométrie pour mesurer les tissus adipeux.

RÉSULTATS

La glycémie moyenne à jeun était semblable chez les femmes ayant présenté un DG et chez les témoins, mais l'insulinémie à jeun était supérieure chez les femmes ayant présenté un DG. L'aire sous la courbe (ASC) de la glycémie produite par le TTGO était supérieure chez les femmes ayant présenté un DG, tandis que l'ASC de l'insulinémie était semblable dans les deux groupes. Les mesures de la masse adipeuse viscérale et sous-cutanée étaient semblables.

CONCLUSION

Chez les femmes ayant présenté un DG, il y avait une insulino-résistance 3 mois après l'accouchement, mais pas de différence pour ce qui est des mesures de la masse adipeuse viscérale et sous-cutanée par rapport aux témoins appariés selon l'indice de masse corporelle (IMC).

INTRODUCTION

Gestational diabetes mellitus (GDM) is a common and transient glucose intolerance of pregnancy, most often resolving at delivery (1). However, women with GDM remain at increased risk for postpartum abnormalities in insulin secretion and insulin action, as well as type 2 diabetes (1-4). In other populations, visceral fat mass has been shown to be a marker for insulin resistance and glucose intolerance (5-7). Adipose tissue distribution has not been evaluated in postpartum women, and it was considered possible that women with previous GDM would demonstrate increased visceral adiposity. Therefore, we assessed glucose tolerance and measures of fat area within a population of women with recent GDM and compared the results with those of body mass index (BMI) -matched controls.

METHODS

Fourteen women with a history of GDM (8) and 11 control women who all had delivered a live infant after 36 weeks of gestation were recruited from the practices of participating physicians. The protocol was approved by the Ethics Committee for Human Research, University of Western Ontario, London, Ontario, Canada, and informed consent was obtained from each volunteer. At 3 months postpartum, participants attended the Clinical Investigation Unit for documentation of the following: heart rate, blood pressure (BP), weight gain during pregnancy, infant birth weight, smoking history and current weight, height and waist-to-hip ratio.

Each woman completed a 75-g oral glucose tolerance test (OGTT) after 3 days of ad lib carbohydrate intake. If menses had recurred, the 75-g OGTT was done during the follicular phase of the cycle. Baseline blood samples for blood glucose (BG) and insulin were obtained; 75 g of oral glucose was given over 10 minutes, and 4 blood samples were drawn through an indwelling intravenous (IV) line at 30, 60, 90 and 120 minutes. Impaired glucose tolerance (IGT) and diabetes were diagnosed using American Diabetes Association (ADA) guidelines (9).

Determination of subcutaneous and visceral fat by computed tomography scan

After a negative serum beta human chorionic gonadotropin finding, participants underwent computed tomography (CT) scanning for determination of visceral, subcutaneous (SC) and total body fat using a Picker PQ2000 scanner (Philips Medical Systems, Bothell, Washington, United States [US]). The methodology has been previously described elsewhere (10). Subjects were scanned in the supine position with arms above the head. CT scout radiograph determined the position of the following 3 scans: lower chest (T8-T9 level), abdomen (L4-L5 level) and mid-thigh (mid-distance between the knee joint and iliac crest).

Total fat area at each level was outlined using the computer cursor, and the area of adipose tissue within the highlighted

area was calculated. An attenuation interval for adipose tissue of -30 to -190 Hounsfield units (HU) was used (10-12). Deep abdominal fat area was measured by drawing a line using the computer cursor within the muscle wall, outlining the abdominal cavity. Abdominal SC fat area was calculated as the difference between total fat and deep abdominal fat areas.

Analyses

BG concentrations were determined by the glucose oxidase method (Synchron CX[®] 7 Delta Clinical System, Beckman Coulter, Irvine, California, US). The precision for BG was 2.0% within the assays and 3.0% between assays at a mean of 5.6 mmol/L. Serum insulin levels were assayed by microparticle enzyme immunoassay technology using the Abbott IMx system (Abbott Laboratories, Abbott Park, Illinois, US). The precision of insulin was 4.0% within and 4.7% between assays at a mean of 14.5 milliunits/L. The results of women with GDM and controls were assessed by student's t tests; results are reported as mean \pm standard error of the mean (SEM), with significance defined as $p < 0.05$.

RESULTS

Population characteristics

Twenty-five women (14 with recent GDM and 11 controls) participated in the study. Similar numbers of women in each group were breastfeeding (7 GDM, 6 controls), smoking (3 GDM, 2 controls) or using oral contraceptives (5 GDM, 4 controls). Women with GDM and controls were similar in age, peak weight at delivery, BMI, weight of infant and waist-to-hip ratio (Table 1). One participant with GDM was found to have diabetes on testing (fasting blood glucose [FBG] 7.3 mmol/L, 2-hour postprandial BG [PPG] 16.5 mmol/L), while 3 with GDM and 1 control had IGT (2-hour PPG > 7.8 mmol/L). Mean FBG was similar between groups, while fasting insulin was higher in the GDM group than in controls (87.2 ± 11.0 vs. 53.5 ± 11.0 pmol/L, respectively, $p < 0.05$). Women with GDM had an increased area under the curve (AUC) for glucose compared to controls (528 ± 119 vs. 210 ± 49 mmol/L \cdot minute, respectively, $p < 0.05$), while the AUC for insulin was similar between groups.

CT measurement of visceral fat area was similar between women with GDM and controls (87.1 ± 1.1 vs. 72.9 ± 6.2 cm², respectively, not significant [NS]), as were SC fat area (347.9 ± 36.0 vs. 397.2 ± 70.0 cm², respectively, NS) and the ratio of visceral to SC fat area (29 ± 4 vs. $22 \pm 3\%$, respectively, NS). When women with GDM and controls were considered together, visceral fat area was positively correlated with BMI ($r = 0.46$, $p < 0.05$) and the AUC for insulin ($r = 0.56$, $p < 0.01$). SC fat area was also positively correlated with BMI ($r = 0.87$, $p < 0.001$) and the AUC for insulin ($r = 0.52$, $p < 0.05$). Similar correlations were found in the control and GDM groups when considered separately.

Since there was a possibility that breastfeeding could have an effect on the measured outcomes, subgroups of lactating

vs. nonlactating women were compared. Unfortunately, these subgroups were not matched for BMI. Therefore, although no significant differences were found in any of the parameters measured, no firm conclusions may be drawn about the effects of lactation.

DISCUSSION

Women with a history of GDM had evidence of increased insulin resistance but demonstrated no significant differences in visceral or SC fat area at 3 months postpartum compared to matched controls.

Central body fat distribution and visceral fat mass have been shown to be risk factors for glucose intolerance in other populations (5-7). The women with GDM in this study did have evidence of increased insulin resistance, as fasting insulin levels were higher for similar BG levels and they had an increased AUC for glucose with the OGTT. These BG and insulin results are consistent with previously documented postpartum abnormalities in the setting of GDM (2-4).

Therefore, while women with GDM displayed the aforementioned, and not unexpected, abnormalities in insulin and BG parameters, they did not show any differences from controls in waist measurements, waist-to-hip ratios, visceral fat, SC fat or visceral:SC fat ratios.

Previous studies have assessed postpartum body habitus in either normal controls or women with GDM. Waist circumference and waist-to-hip ratios have been reported to be

associated with glucose intolerance during pregnancy (13), and a follow-up study in patients with GDM found that waist-to-hip ratios were similar in BMI-matched controls and women with GDM, although the time of assessment was up to 8 years postpartum (2). Another study of lean and obese women with a history of GDM reported increased waist-to-hip ratios only in obese women and not in lean women when compared to weight-matched controls (14). Other reports of postpartum body habitus have used skinfold thickness or underwater weighing, but these have been in women without GDM (15-17). Therefore, the present study is the first to directly measure postpartum fat area and distribution in a controlled manner.

It must be acknowledged that the sample size of the present study is not large, so analysis may have been affected by a type 2 statistical error; however, the sample size is similar to that of previous reports (2,14). If sufficient statistical power is presumed to be present in the current study, the lack of difference in fat outcomes between women with GDM and controls could suggest that regulation of postpartum fat distribution is different from that of the nonpregnant population. Therefore, both controls and women with GDM would have experienced similar effects after the conclusion of pregnancy. It is also possible that alterations in insulin resistance and fat accumulation do not occur simultaneously, so that the GDM population manifested abnormal glucose tolerance before a change in visceral fat distribution could be measured.

	GDM	Control	p value
Age (years)	30.8±1.4	29.2±1.6	0.4
Delivery weight (kg)	82.4±0.5	87.2±7.0	0.5
BMI (kg/m ²)	29.0±0.8	29.5±2.5	0.8
Waist-to-hip ratio	0.81±0.01	0.81±0.01	0.7
Infant weight (g)	3307±296	3494±148	0.6
FBG (mmol/L)	5.2±0.2	4.7±0.1	0.1
Fasting insulin (pmol/L)	87.2±11.0	53.5±11.0	0.04
Visceral fat (cm ²)	87.1±1.1	72.9±6.2	0.3
SC fat (cm ²)	347.9±36.0	397.2±70.0	0.5
Visceral:SC fat (%)	29±4	22±3	0.2
AUC glucose (mmol/L.min)	528±119	210±49	0.02
AUC insulin (pmol/L.min)	25 640±4620	25 700±2950	1.00

Results are mean±SEM

AUC = area under the curve based on the OGTT

BMI = body mass index

FBG = fasting blood glucose

GDM = gestational diabetes mellitus

OGTT = oral glucose tolerance test

SC = subcutaneous

SEM = standard error of the mean

Confirmation of this latter premise would only be possible with follow-up observations in this population.

In summary, we found that at 3 months postpartum, women with a history of GDM had evidence for insulin resistance but did not show significant differences in measures of fat area or distribution compared to controls.

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