Using Estimated Fetal Weight From Ultrasonography at 18 to 22 Weeks to Predict Gestational Diabetes Mellitus and Newborn Macrosomia

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Abstract

Objectives: To determine if fetal macrosomia in the second trimester predicts the onset of gestational diabetes mellitus (GDM) or large for gestational age (LGA) birth weight.

Methods: We performed a case–control study using data from the Diabetes in Pregnancy Clinic in our tertiary care hospital. Cases were women with GDM requiring insulin (n = 65) or controlled with diet (n = 65). Control subjects were women who screened negative for GDM at 24 to 28 weeks' gestation (n = 131). Estimated fetal weight (EFW) was determined by ultrasound at 18 to 22 weeks.

Results: Estimated fetal weight that was one standard deviation (70 g) higher at 18 to 22 weeks was not associated with subsequent GDM (adjusted OR [aOR] 1.00, 95% confidence intervals 0.61 to 1.66), but was associated with a 231 g (95% CI 128 g to 334 g) increase in birth weight and increased odds of LGA (aOR 4.02, 95% CI 1.76 to 9.19) after adjusting for gestational age at the time of estimating fetal weight, maternal age, parity, BMI and GDM treatment.

Conclusion: EFW at 18 to 22 weeks did not predict the onset of GDM, but did predict LGA.

Résumé

Objectifs : Déterminer si la macrosomie fœtale constatée au deuxième trimestre permet de prédire l'apparition du diabète sucré gestationnel (DSG) ou la constatation d'une hypertrophie fœtale (HF).

Méthodes : Nous avons mené une étude cas-témoins au moyen de données issues de la *Diabetes in Pregnancy Clinic* de notre hôpital de soins tertiaires. Les cas étaient constitués de femmes présentant un DSG traité à l'insuline (n = 65) ou maîtrisé par le régime alimentaire (n = 65). Les témoins étaient constitués de femmes ayant obtenu des résultats négatifs au dépistage du DSG à 24-28 semaines de gestation (n = 131). Le poids fœtal estimé (PFE) a été déterminé par échographie à 18-22 semaines.

Résultats : Le poids fœtal estimé qui était plus élevé d'un écart-type (70 g) à 18-22 semaines n'a pas été associé à un DSG subséquent (RC corrigé [RCc], 1,00; IC à 95 %, 0,61 - 1,66), mais a été associé à une hausse de 231 g (IC à 95 %, 128 g - 334 g) du poids de naissance et à des risques accrus de constater une HF (RCc, 4,02; IC à 95 %, 1,76 - 9,19), à la suite de la neutralisation des effets de l'âge gestationnel au moment de l'estimation du poids fœtal, de l'âge maternel, de la parité, de l'IMC et du traitement contre le DSG.

Conclusion : Bien que le PFE à 18-22 semaines n'ait pas permis de prédire l'apparition du DSG, il a permis de prédire la constatation d'une HF.

Key Words: Gestational diabetes mellitus, ultrasound, estimated fetal weight, birth weight, macrosomia, large for gestational age birth weight

Competing Interests: None declared.

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INTRODUCTION

Gestational diabetes mellitus has short- and long-term sequelae for both mother and infant.[1] GDM increases the risk of fetal macrosomia, shoulder dystocia, and birth trauma.[2] Current practice is to screen for GDM at 24 to 28 weeks' gestation using a 50 g glucose challenge test and/or a 75 g glucose tolerance test.[3] Predicting the onset of GDM and macrosomia before this period may be advantageous, in that dietary modification, for example, can be instituted.[4] Few factors before 24 weeks' gestation are known to predict newborn macrosomia or maternal GDM,[5] and no studies have considered whether fetal weight in early pregnancy can predict the later onset of GDM. We assessed whether estimated fetal weight by ultrasound at 18 to 22 weeks' gestation can predict development of GDM, birth weight, and large for gestational age birth weight.

METHODS

We performed a case–control study at St. Michael's Hospital, an inner city tertiary care hospital in Toronto, Ontario, which performs approximately 3000 deliveries annually. The hospital's obstetrics program includes a multi-disciplinary Diabetes in Pregnancy Clinic. We included women whose antepartum care was provided at St Michael's Hospital and who delivered between January 1, 2008, and December 31, 2012. All women had a detailed anatomy ultrasound examination at 18 to 22 weeks' gestation, performed by an on-site certified sonographer. All women subsequently underwent a 50 g GCT at 24 to 28 weeks' gestation; those with a positive GCT (1-hour plasma glucose ≥ 7.8 mmol/L) underwent a 75 g GTT.[3] We excluded women with pre-gestational diabetes mellitus, multifetal pregnancy, use of oral corticosteroids, delivery before 32 weeks' gestation, or a major fetal anomaly. Cases were consecutive women with GDM treated with insulin (n = 65) or with diet modification (n = 65). All had dietary and lifestyle counselling. Control subjects were women who had a negative 50 g GCT (n = 131).

Data were abstracted from the standardized clinical assessment forms used in the hospital's Diabetes in Pregnancy Clinic. Maternal pre-pregnancy BMI and ethnicity were obtained from the antenatal record. EFW on ultrasound was derived using the Hadlock 3 formula.[6]

Three main associations were tested:

1. between EFW at 18 to 22 weeks and diagnosed GDM at 24 to 28 weeks;
2. between EFW at 18 to 22 weeks and birth weight; and
3. between EFW at 18 to 22 weeks and birth weight ≥ 90th percentile for sex and gestational age.

Multivariable logistic regression analysis was used to assess the association between each increase of 1-SD in EFW at 18 to 22 weeks' gestation and diagnosed GDM, contrasting all 130 GDM cases with 131 non-GDM control subjects. The model was adjusted for gestational age at assessment of EFW, fetal sex, maternal age, ethnicity (white vs. other), parity, and maternal pre-pregnancy BMI. Multivariable linear regression analysis was used to assess the relationship between each single SD (70 g) increase in EFW at 18 to 22 weeks and final birth weight, adjusted for the variables shown in the footnotes to Table 1. This analysis combined all cases and control subjects, and also stratified outcomes according to GDM status (cases with insulin-treated GDM, cases with diet-controlled GDM, and control subjects without GDM). Multivariable logistic regression analysis was used to assess the association between each SD increase in EFW at 18 to 22 weeks' gestation and the presence of LGA birth weight, adjusted for the variables shown in the footnotes to Table 2. Significance was set at a P value < 0.05. Data were analyzed using SAS version 9.4 (SAS Institute Inc., Cary NC).

Ethics approval for the study was obtained from the St Michael's Hospital Research Ethics Board.

RESULTS

A single SD (70 g) increase in EFW at 18 to 22 weeks was not associated with the development of GDM (aOR 1.00; 95% CI 0.61 to 1.66). Each 1-SD increase in EFW was associated with a 230.1 g higher birth weight (95% CI 128 g to 334 g) (Table 1). The association was significant among GDM cases managed with diet and among non-GDM control subjects, but not GDM cases on insulin (Table 1).

Among combined cases and control subjects, each 1-SD increase in EFW was significantly associated with having an LGA newborn (aOR 4.02; 95% CI 1.76 to 9.19) (Table 2). When information was stratified by cases and control subjects, the association remained significant only among control subjects (Table 2).

ABBREVIATIONS

aOR	adjusted odds ratio
EFW	estimated fetal weight
GCT	glucose challenge test
GDM	gestational diabetes mellitus
GTT	glucose tolerance test
SD	standard deviation

Table 1. Association between each 1-SD increase in estimated fetal weight at 18 to 22 weeks' gestation and birth weight (g)

Study outcome	Increase in birth weight in grams (95% CI) for each 1-SD unit (70 g) increase in EFW determined at 18 to 22 weeks' gestation	
Participants assessed	Gestational age adjusted model*	Fully adjusted model†
GDM cases and non-GDM control subjects combined	245.8 (143.5 to 348.1)	230.8 (128.2 to 333.5)
Stratified by case and control group status		
GDM cases on insulin	236.6 (33.5 to 439.8)	157.7 (−45.4 to 360.7)
GDM cases on diet	260.1 (76.0 to 444.3)	267.7 (85.5 to 449.9)
Non-GDM control subjects	206.5 (57.2 to 355.7)	198.7 (43.5 to 353.9)

*Using linear regression analysis, adjusted for gestational age at time of fetal ultrasound determination of EFW.

†Using linear regression analysis, adjusted for gestational age at time of fetal ultrasound, gestational age at delivery, infant sex, maternal age, ethnicity, parity, maternal BMI, and group status (insulin-treated GDM, diet-treated GDM, no GDM).

Table 2. Association between each 1-SD increase in estimated fetal weight at 18 to 22 weeks' gestation and or LGA birth weight above the 90th percentile

Study outcome	Odds ratio (95% CI) for LGA birth weight for each 1-SD unit (70 g) increase in EFW determined at 18 to 22 weeks' gestation	
Participants assessed	Gestational age adjusted model*	Fully adjusted model†
GDM cases and non-GDM control subjects combined	3.41 (1.64 to 7.50)	4.02 (1.76 to 9.19)
Stratified by case and control group status		
GDM cases on insulin	4.80 (1.14 to 26.1)	3.86 (0.59 to 25.10)
GDM cases on diet	1.40 (0.31 to 6.32)	2.11 (0.25 to 17.57)
Non-GDM control subjects	4.52 (1.55 to 16.5)	6.11 (1.51 to 24.67)

* Using logistic regression analysis, adjusted for gestational age at time of fetal ultrasound determination of EFW.

†Using logistic regression analysis, adjusted for gestational age at time of fetal ultrasound, gestational age at delivery, infant sex, maternal age, ethnicity, parity, maternal BMI, and group status (insulin-treated GDM, diet-treated GDM, no GDM).

DISCUSSION

We found that EFW at 18 to 22 weeks' gestation did not predict a subsequent diagnosis of GDM, but was predictive of birth weight and LGA status.

A limitation of this study is that all women with GDM underwent dietary modification, with or without insulin treatment, which may have attenuated subsequent fetal growth. We used sonographic fetal biometry to estimate fetal weight, which has known limitations.[6] A strength of the study is that all of the women underwent both fetal sonography and GDM screening, the latter undertaken independent of knowledge of the former.

Overall, EFW at 18 to 22 weeks alone may be insufficient to determine subsequent maternal glucose tolerance. In line with our findings, a recent study found that EFW at 16 to 20 weeks' gestation was not associated with GTT values later in pregnancy, but was linearly associated with birthweight.[7] However, maternal GDM status or GDM-related therapy was not considered in that study. In our study, we found that EFW did not predict birth weight or LGA in women with GDM on insulin. Elevated maternal serum glucose is known to influence fetal growth trajectories. For example, in a study of pregnant women with GDM and type 1 and type 2 diabetes, EFW at 29 to 34 weeks was proportionate to birth weight percentile among mothers with well-controlled diabetes, but it underestimated birth weight percentile among those with poor glycemic control.[8]

We found that EFW at 18 to 22 weeks was not associated with LGA among women with GDM. One reason for this may be that excess fetal growth related to GDM occurs at a later developmental period. For example, EFW at 28 to 32 weeks' gestation has a strong negative predictive value for LGA status at birth.[9] Conversely, EFW did predict

both birth weight and LGA status among women without GDM, as noted by others.[7,10]

CONCLUSION

EFW at 18 to 22 weeks alone does not appear to be a reliable indicator of birth weight or LGA status among newborns of women with GDM. Clinicians should therefore obtain sonographic measurements in the third trimester of pregnancy, if indicated for clinical management.

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REFERENCES

1. Athukorala C, Crowther CA, Willson K. Australian Carbohydrate Intolerance Study in Pregnant Women (ACHOIS) Trial Group. Women with gestational diabetes mellitus in the ACHOIS trial: risk factors for shoulder dystocia. Aust N Z J Obstet Gynaecol 2007;47(1):37–41.
2. Christoffersson M, Rydhstroem H. Shoulder dystocia and brachial plexus injury: a population-based study. Gynecol Obstet Invest 2002;53(1):42–7.
3. Berger H, Crane J, Farine D, Armson A, De La Ronde S, Keenan-Lindsay L, et al. Screening for gestational diabetes mellitus. J Obstet Gynaecol Can 2002;24(11):894–912.
4. Ray JG, Berger H, Lipscombe LL, Sermer M. Gestational prediabetes: a new term for early prevention? Indian J Med Res 2010;132:251–5.
5. Schaefer-Graf UM, Kjos SL, Kilavuz O, Plagemann A, Brauer M, Dudenhausen JW, et al. Determinants of fetal growth at different periods of pregnancies complicated by gestational diabetes mellitus or impaired glucose tolerance. Diabetes Care 2003;26(1):193–8.
6. Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—a prospective study. Am J Obstet Gynecol 1985;151(3):333–7.
7. Parker M, Rifas-Shiman SL, Oken E, Belfort MB, Jaddoe VW, Gillman MW. Second trimester estimated fetal weight and fetal weight gain predict childhood obesity. J Pediatr 2012;161(5):864–70.
8. Ben-Haroush A, Chen R, Hadar E, Hod M, Yogev Y. Accuracy of a single fetal weight estimation at 29–34 weeks in diabetic pregnancies: can it predict large-for-gestational-age infants at term? Am J Obstet Gynecol 2007;197(5):497.e1–6.
9. Holcomb WL Jr, Mostello DJ, Gray DL. Abdominal circumference vs. estimated weight to predict large for gestational age birth weight in diabetic pregnancy. Clin Imaging 2000;24(1):1–7.
10. Pilalis A, Souka AP, Papastefanou I, Michalitsi V, Panagopoulos P, Chrelias C, et al. Third trimester ultrasound for the prediction of the large for gestational age fetus in low-risk population and evaluation of contingency strategies. Prenat Diagn 2012;32(9):846–53.