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Original article

Prediction of macrosomia by serial sonographic measurements of fetal soft-tissues and the liver in women with pregestational diabetes

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Abstract

Objectives. – This study aimed to determine whether antenatal ultrasound measurements of fetal soft-tissues and liver can predict macrosomia in women with pregestational diabetes.

Methods. – Fetal biometry, soft-tissue thickness (anterior abdominal wall [STAW], thigh [STT], upper arm [STA], scapular [STS]) and liver size were measured sonographically at 23, 28, 31 and 34 weeks of gestation. Large for gestational age (LGA) was defined as a birth weight greater than 90th percentile for gestational age on standard curves adjusted for maternal height and weight, parity and fetal gender. The area (± standard error) under receiver operating characteristic (AUROC) curves were also calculated.

Results. – A total of 29 pregnant women with pregestational diabetes were included, and a total of 663 measurements taken. Fifteen neonates were LGA. There was no significant difference in fetal soft-tissue thickness at 23, 28 and 31 weeks between the LGA and non-LGA neonates. In contrast, at 34 weeks, fetal soft-tissues were significantly thicker in LGA neonates ($P < 0.05$), but with no difference in liver surface area between the two groups. The specificity and sensitivity of 34-week ultrasonography to detect macrosomia was 78.6% and 66.7%, respectively, for abdominal circumference (AC), 71.4% and 93.3% for STT, 85.7% and 80.0% for STA, and 71.4% and 86.7% for STAW. No parameter was more powerful than the others. The best AUROC curves were found for AC (0.807), STT (0.821), STA (0.855) and STAW (0.821).

Conclusion. – Third-trimester sonographic measurements of fetal soft-tissue may help to detect macrosomia in pregnancies complicated by pregestational diabetes.

Keywords: Diabetes mellitus; Pregnancy; Ultrasonography; Macrosomia; Soft-tissues; Liver

Résumé

Détection de la macrosomie.

Objectif. – Évaluer, par un suivi longitudinal aux deuxième et troisième trimestres, la mesure des tissus mous et du foie comme marqueurs prédictifs de la macrosomie dans les grossesses de mères diabétiques.

Méthodes. – La biométrie fœtale, l'épaisseur des tissus mous (mur antérieur abdominal [STAW], cuisse [STT], bras [STA] et sous-scapulaire [STS]) ainsi que la surface du foie ont été mesurés par échographie à 23, 28, 31 et 34 SA. La macrosomie était définie comme un poids de naissance supérieur au 90e *percentile* des courbes personnalisées selon la taille et le poids de la mère, la parité, le sexe et l'âge gestationnel du fœtus. Les aires sous la courbe (ROC) ont été calculées pour chaque paramètre.

Résultats. – Vingt-neuf patientes suivies pour diabète prégestationnel ont été incluses. Six cent soixante-trois mesures ont été effectuées. Quinze nouveau-nés étaient macrosomes. Il n'y avait pas de différence significative entre les deux groupes pour l'épaisseur des tissus mous fœtaux à 23, 28 et 31 SA. En revanche, à 34 SA, la mesure des tissus mous fœtaux était significativement plus élevée chez les nouveau-nés macrosomes ($P < 0{,}05$). La surface du foie n'était pas significativement différente entre les deux groupes. La spécificité et la sensibilité de l'échographie de 34 SA était de 78,6 et 66,7 %, respectivement, pour la circonférence abdominale (AC), 71,4 et 93,3 % pour le STT, 85,7 et 80,0 % pour le STA, et 71,4 et 86,7 % pour le STAW. Les aires sous la courbe (AUC) étaient significatives pour l'AC (AUC = 0,807), le STT (AUC = 0,821), le STA (AUC = 0,855) et le STAW (AUC = 0,821).

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Conclusion. – Les mesures échographiques des tissus mous fœtaux au troisième trimestre apparaissent comme un outil supplémentaire pour la détection de la macrosomie chez les fœtus de mères suivies pour diabète prégestationnel.

Mots clés : Diabetes mellitus ; Grossesse ; Échographie ; Macrosomie ; Tissus mous ; Foie

1. Introduction

Macrosomia (defined as a birth weight greater than 4–4.5 kg) is three times more frequent in diabetic than in non-diabetic pregnancies [1,2]. Fetal complications of a diabetic pregnancy are the result of maternal hyperglycaemia rather than type of diabetes [3]. The increase in fetal weight is linked to organomegaly (especially of the liver) and fat deposition [4,5]. Macrosomia is associated with severe perinatal complications [6]. Shoulder dystocia is ten times more frequent in neonates weighing more than 4500 g with diabetic mothers and can lead to brachial plexus palsy [7]. It is therefore reasonable to attempt to detect macrosomia antenatally to reduce these risks.

The accuracy of detecting macrosomia antenatally by estimating fetal weight (EFW) ranges from 15–79% compared with 40–52% for clinical estimations [8]. However, comparisons of 31 formulae for EFW showed that all were poor for the detection of macrosomia [9]. Hadlock et al. [10] found that head size, abdominal circumference (AC) and femur length were slightly superior to other measures for the detection of macrosomia. The mean absolute error in measurement was approximately 10%, or a 250–500 g difference compared with the expected value [11]. Jazayeri et al. [12] showed that an AC greater than 35 cm in the two weeks prior to delivery had a positive predictive value (PPV) of 93% for the detection of macrosomia. However, AC measurement was not superior to EFW and not sufficient on its own to predict macrosomia without taking other factors into account [13].

It is possible that macrosomia can be predicted by soft-tissue measurements. Deposition of fetal fat tissue takes place predominantly during the third trimester [14]. Close to term, 75% of body fat is found in subcutaneous tissue [15]. The macrosomic fetus has more marked development of this subcutaneous fat, particularly in cases with maternal diabetes [16]. Different sonographic parameters have been investigated as markers of fetal macrosomia, including measurements of fetal liver and soft-tissues, ratio of thigh subcutaneous tissue to femur length, and abdominal wall thickness, all of which are increased in diabetic pregnancies [17–24]. Buhling et al. [25] recently demonstrated a good correlation between these prenatal sonographic assessments and postnatal measurements. However, no study has evaluated the relevance of these markers longitudinally or established a standardized threshold value for each marker.

For this reason, the present study aimed to evaluate soft-tissue and liver measurements longitudinally through the second and third trimesters as predictive markers of macrosomia in women with pregestational diabetes.

2. Methods

This prospective study was approved by the ethics committee for research in gynaecology-obstetrics (CEROG) of the French College of Gynaecologists and Obstetricians, and was carried out in a level-III university maternity hospital between November 2010 and June 2011. Women with pregestational diabetes were followed through a multidisciplinary programme, and received their first and second trimester ultrasound evaluations *via* a referring physician who proposed their inclusion in the study. An informative letter was given to the selected patients to obtain their oral consent to participate. Ultrasonography was then performed during the fifth (US 1, 23 weeks), sixth (US 2, 28 weeks), seventh (US 3, 31 weeks) and eighth month (US 4, 34 weeks) of pregnancy. These times corresponded to the diabetic and obstetric follow-ups generally carried out in our department. All examinations were performed *via* the transabdominal route using a Voluson E8 Expert ultrasound system (GE Healthcare, Waukesha, WI, USA). Seven ultrasonographers were used for the study: one was the referring physician (P.D.) at our institution for diabetes patient management; while the other six were trained by him for best practices in taking the measurements. The first ten measurements were performed in the presence of the referring physician. An illustrated document in the ultrasound room could also be used to control the quality of their measurements. Twin pregnancies and patients who had undergone fewer than three of the four planned ultrasounds were excluded from the study.

At each ultrasound examination, fetal biometrics (biparietal diameter, head circumference, AC and femur length) and measurements of soft-tissue thickness and liver size were recorded. AC measurement was taken from a transverse section of the abdomen at the level of the umbilical vein complex. The percentiles used for EFW were derived from those described by Hadlock et al. [10], using the formula based on measurements of head circumference, biparietal diameter, femur length and AC. Anterior abdominal wall soft-tissue thickness (STAW) was measured on the usual AC section 2 cm laterally from the insertion of the umbilical cord. Calipers were carefully placed to measure the distance from the outermost skin edge to the innermost margin of the anterior abdominal wall. Soft-tissue measurements were also taken of the arm (STA), thigh (STT) and scapular area (STS). At these three sites, measurements of subcutaneous tissue thickness were obtained in duplicate at the midlevel of the femoral diaphysis as described elsewhere (Fig. 1) [22]. Measurement of liver surface area (LSA) was done on a transverse abdominal section. Reference points used for estimation of liver width were the external capsule of the liver and junction of the umbilical vein and, for liver length, a perpendicular axis between the outermost edges of the liver (Fig. 2). Quality of the