Taiwanese Journal of Obstetrics & Gynecology 57 (2018) 487–492

Contents lists available at ScienceDirect

Taiwanese Journal of Obstetrics & Gynecology

journal homepage: www.tjog-online.com

Original Article

Antenatal umbilical coiling index in gestational diabetes mellitus and non-gestational diabetes pregnancy☆

Laily Najafi [a], Mohammad E. Khamseh [a], Maryam Kashanian [b], Ladan Younesi [c], Azadeh Abedini [d], Ameneh Ebrahim Valojerdi [a], Zahra Amoei [d], Elmira Nouri Khashe Heiran [b], Abbas Ali Keshtkar [e], Mojtaba Malek [f *]

[a] Endocrine Research Center, Institute of Endocrinology and Metabolism, Iran University of Medical Sciences (IUMS), Tehran, 15937-16615 Iran
[b] Department of Obstetrics & Gynecology, Akbarabadi Teaching Hospital, Iran University of Medical Sciences (IUMS), Tehran, 1168743514 Iran
[c] Akbarabadi Teaching Hospital, Iran University of Medical Sciences (IUMS), Tehran, 1168743514 Iran
[d] Kamali Teaching Hospital, Alborz University of Medical Sciences, Karaj, 3134877179 Iran
[e] Department of Health Sciences Education Development, Tehran University of Medical Sciences, Tehran, 3439123900 Iran
[f] Research Center for Prevention of Cardiovascular Disease, Institute of Endocrinology and Metabolism, Iran University of Medical Sciences (IUMS), Tehran, 15937-16615 Iran

ARTICLE INFO

Article history:
Accepted 19 December 2017

Keywords:
Antenatal
Gestational diabetes mellitus
75-g oral glucose tolerance test
Ultrasonography
Umbilical coiling index

ABSTRACT

Objective: Umbilical cord abnormalities increase fetal morbidity and mortality. This study was designed to compare antenatal umbilical coiling index (aUCI) in gestational diabetes mellitus (GDM) and non-gestational diabetes mellitus (non-GDM) pregnancy, considering uncertainties about the best time to perform antenatal ultrasonography scan.

Materials and Methods: In this prospective study, 246 parturients were included, 123 with GDM and 123 with non-GDM pregnancy. Gestational diabetes was confirmed at 24–28 weeks of gestation (WG) using one-step strategy. An anatomical ultrasound survey of placenta and umbilical cord was performed at 18–23 as well as 37–41 weeks of gestational age.

Results: At 18–23 WG, the frequency distribution (10th, 90th percentiles, mean ± SD) of the aUCI in the GDM and non-GDM groups were (0.13,0.66,0.32 ± 0.19) and (0.18,0.74, 0.4 ± 0.31) respectively. These values were (0.12,0.4, 0.25 ± 0.11) in the GDM group at 37–41 WG and (0.17,0.43, 0.29 ± 0.11) in the non-GDM group. A significant relationship was detected between UCI value and GDM/non-GDM groups at both antenatal evaluations (18–23 WG; $P = 0.002$, 37–41WG; $P < 0.001$). A significant association at 18–23 WG was found between GDM/non-GDM groups and aUCI categorization (hypocoiling <10th, normocoiling 10th–90th and hypercoiling >90th) ($P = 0.001$). However, hypocoiling were significantly more frequent in GDM than non-GDM in both antenatal evaluations ($P < 0.001$, $P = 0.006$).

Conclusion: Antenatal UCI in pregnancy complicated by GDM were lower in comparison with non-GDM pregnancy. The most abnormal pattern of coiling in gestational diabetes was hypocoiling in both trimesters. In addition, 18–23 WG is the best time to perform ultrasound scan to detect aUCI and umbilical cord pattern.

Introduction

Life support, wellbeing and development of the fetus provides by the umbilical cord which is the major fetomaternal unit that allows gas and nutrient exchange [1].

A helix of three blood vessels (two arteries and one vein) is the major construction of the normal human umbilical cord which is protected by Wharton's jelly, amniotic fluid, helical patterns and coiling of the umbilical vessels [2–4]. Coiling is a unique and obvious feature of the human umbilical cord. The etiology, origin

Abbreviations: AUCI, Antenatal Umbilical Coiling Index; BMI, Body Mass Index; DM, Diabetes Mellitus; FBS, Fasting Blood Sugar; GDM, Gestational Diabetes Mellitus; UCI, Umbilical Coiling Index; WG, Weeks of gestation.

☆ **The place that study was performed:** Endocrine Research Center, Institute of Endocrinology & Metabolism and Akbarabadi hospital from Iran University of Medical Sciences (IUMS), Kamali hospital from Alborz University of Medical Sciences.

* Corresponding author. Firouzeh St., South Vali- Asr Ave., Vali- Asr Sq., Tehran, 15937-16615 Iran. Fax. +971 0098 21 88945173.
E-mail address: malekmoj@yahoo.com (M. Malek).

https://doi.org/10.1016/j.tjog.2018.04.033

and development of this coiling is still the subject of debate [2,5] and whether it represents a genetically or an acquired phenomenon [6].

Coiling of umbilical vessels develops as early as 28 days after conception and is present in about 95% of fetuses by 9th weeks of conception [5]. Currently the standard method used to quantify the degree of umbilical vascular coiling is the umbilical coiling index [7]; which was calculated by dividing the total number of complete vascular coils by the umbilical cord length in centimeters both sonographically or immediately after delivery [7]. A frequency distribution of umbilical coiling index (UCI) was categorized by the 10th and 90th percentiles; grouping the cords as <10th percentile hypocoiled, 10th −90th normocoiled and >90th percentile hypercoiled [8]. Degani et al. have described a technique for estimating the coiling index during ultrasound examination. They found that antenatal and postnatal measurements of UCI were highly correlated; some were positively correlated while some were negatively correlated [4]. Qin et al. showed that the sensitivity of second trimester ultrasound examination for predicting hypercoiling and hypocoiling at birth were low, however, these estimates do not accurately reflect the UCI at term [9]. The umbilical abnormalities (hypocoiling, hypercoiling and non-coiling) can lead to fetal morbidity and mortality [10].

Abnormal flow, constriction or thrombosis in the umbilical cord has been postulated as the possible etiologies of adverse prenatal outcomes in the presence of the UCI abnormalities [11]. These outcomes include respiratory distress, intrauterine growth restriction, and low apgar score seen with hypocoiling and hypercoiling of the umbilical cord [12]. The increment of perinatal mortality and morbidity in gestational diabetes mellitus (GDM) parturients may have a vascular etiology [13]. Coiling could protect the umbilical cord against external forces such as tension, torsion, compression, stretching or entanglement without any effect on the cord's elasticity [11]. The most prevalent pattern of coiling in pregnancies complicated by diabetes were non-coiling and hypercoiling [4,14,15]. Gestational diabetes mellitus was found to be an important risk factor for abnormal vascular coiling of the umbilical cord [14] and has a deleterious effect on umbilical vessels and the connective tissue component of “Wharton's jelly” [16].

Considering the impact of UCI on fetal outcomes and the uncertainties about the best time to perform antenatal ultrasonography scan, the aim of this longitudinal study was to perform serial antenatal ultrasound surveys to compare the umbilical coiling index in GDM and non-GDM pregnancy.

Materials and methods

This exposure based prospective study was performed between October 10th, 2014, and August 20th, 2016. The ethics committee of Iran University of medical sciences approved the study protocol (IR.IUMS.REC.1393 .24991) and the written informed consent was signed by all participants.

All 296 consecutive and unselected parturients at the 13th week of gestation were recruited into the study. Gestational age was determined (due to last menstrual period and 1st trimester ultrasound scan by crown-rump length (CRL)).

The sample size was calculated by G power software (version 11), power = 90%, $\alpha = 5\%$, missing rate = 20% and the mean ± SD was used from Kurita's study [17].

Detailed history and physical examination were performed for all of the participants by an expert physician. Maternal sociodemographic, clinical, and obstetrical; ultrasound and laboratory parameters and anthropometric variables were extracted from the files and face to face interview in the first and the following prenatal visits by single trained observer. Standing height was measured using a stadiometer (Seca gmbh& co. kg. Germany) calibrated before each measurement, and weight was measured using a calibrated digital scale (Seca gmbh& co. kg. Germany). Body mass index (BMI) defined as weight in kg/height^2 (meters squared) was evaluated in the first trimester prenatal visit which was the best predictor of pre-pregnancy BMI [18]. Blood pressure was measured in a standard condition (sitting position, after 5 min of resting, and ceasing smoking, drinking tea or coffee, and eating food for at least half an hour).

Gestational diabetes defined according to the American Diabetes Association (ADA) criteria at 24–28 weeks of gestation (WG) using “one-step” 75-g oral glucose tolerance test (75-g OGTT) [13]. The non-GDM group was included the parturients who were not complicated by GDM. Preexistence of risk factors were included: maternal ethnicity, age, BMI, history of complicated pregnancy, glucosuria, and family history of diabetes [19].

In the first prenatal care visit we checked the fasting blood sugar (FBS) [19], and thyroid stimulating hormone (TSH) for all parturients before 24 WG, so if we detected abnormal FBS value (92–125 mg/dL), GDM diagnosis was confirmed [20]. In these with normal results; the75-g OGTT was performed for high risk group [19] in the first prenatal visit and for the others at 24–28 weeks of gestational age; so, if they had abnormal results they would be recruited in the GDM group and the others included in the non-GDM group. Blood glucose was measured by the Enzymatic Calorimeter method using a standard kit (EliTech kit) supplied by EliTech Group (France).

A fetal anatomical ultrasound survey (gray scale and color Doppler) of placenta and umbilical cord was performed once at 18–23 (appropriate time for evaluation of antenatal UCI (aUCI) in 2nd trimester [21]) and again at 37–41 weeks of gestational age or before delivery in preterm labor pain by one of two independent, trained, experienced, qualified and blinded ultrasonographers in each center. The Sonographic study was done by application of high resolution ultrasound equipment with color Doppler technology; Mindray DC7 unit equipped with 3.5 MHz curvilinear transducer (China).

For cord coiling assessment, the evaluation of the midsegment (free loop) of the umbilical cord by recordings of the longitudinal cord images was used [22]. The umbilical cord coiling is quantitatively assessed by the umbilical cord index (UCI).

Antenatal umbilical cord index (aUCI) was defined as reciprocal value of the distance between two consecutive umbilical coils. Umbilical cord coiling index was calculated as the number of completed coils per centimeter length of cord (aUCI = 1/distance in cm) [1,4,23]. The best images were obtained perpendicular to the cord. Hypocoiling and hypercoiling defined as; umbilical cords with UCI values <10th and >90th percentiles, respectively; so between 10th and 90th percentile, it was normocoiled, and where there are no coils it is described as non-coiled [7,11,14].

Single tone uncomplicated non-GDM pregnancy and pregnancy complicated by gestational diabetes, at gestational age of more than 13 weeks were included. Parturients with inadequate or incomplete antenatal, demographic, and sonographic information, multifetal pregnancy, overt diabetes, history of chronic hypertension, abortion, smoking or substance abuse, systemic disease, systemic medication use and history of any micro and macrovascular complications were excluded from our study.

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences (IBM SPSS statistics version 22) (IBM Crop., Armonk, NY, USA). Descriptive statistics methods were used for baseline characteristics (means ± SD and proportions (%), or median and