Am J Transl Res 2022;14(6):4042-4049
www.ajtr.org /ISSN:1943-8141/AJTR0133152

Original Article

Systematic evaluation of cell-free insulin DNA levels in early blood glucose testing as a predictor of postpartum hypertension in pregnant women with gestational diabetes mellitus

Yuanyuan Zhang[1], Chunhua Li[2], Rui Lin[3], Yan Feng[2], Fang Zhang[2], Guangxia Zhang[1]

[1]Department of Obstetrics and Gynecology, Shandong Provincial Hospital Affiliated to Shandong First Medical University, Jinan 250021, Shandong, China; [2]Department of Surgery and Anesthesiology, Dongchangfu District Maternal and Child Health Care Hospital, Liaocheng 252004, Shandong, China; [3]Department of Obstetrics and Gynecology, Liaocheng Maternal and Child Health Hospital, Liaocheng 252004, Shandong, China

Received March 15, 2021; Accepted January 23, 2022; Epub June 15, 2022; Published June 30, 2022

Abstract: Objective: To investigate the perinatal outcome of postpartum hypertension in pregnant women with gestational diabetes (GDM). Methods: A total of 100 puerperae who gave birth in our hospital from March 2018 to January 2020 were retrospectively analyzed. Among them, 50 patients were puerperae with postpartum hypertension (experimental group), and 50 puerperae had normal postpartum blood pressure (control group). Before delivery, fasting, postprandial and bedtime blood glucose, glycosylated hemoglobin, and urine glucose were compared between the two groups. Results: Before delivery, the experimental group observed significantly higher fasting, postprandial, and bedtime blood glucose, glycosylated hemoglobin, and urine glucose than the control group ($P<0.05$). A notable decline in natural delivery rate was witnessed in the experimental group ($P<0.05$). The two groups presented no significant differences in neonatal outcomes, neonatal blood glucose and blood pressure, maternal blood pressure at 30 weeks and 34 weeks of pregnancy, and blood lipid levels during pregnancy ($P>0.05$). Conclusion: Postpartum hypertension in pregnant women with GDM results in a low probability of natural birth and it has a slight impact on the fetus.

Keywords: Blood glucose test, gestational diabetes mellitus, postpartum hypertension, insulin level

Introduction

Gestational diabetes mellitus (GDM) is defined as a specific disease in pregnant women who present with high blood glucose at different stages of pregnancy. Compared to type II diabetes mellitus (DM) patients, the abnormality of blood glucose only occurs during pregnancy. The mechanism behind GDM is related to hormonal changes during pregnancy, which results in the release of glucose into the systemic circulation after the incomplete metabolism of daily glucose intake, elevating plasma glucose levels, and increasing blood viscosity [1-3]. In addition to a higher risk of obstructive diseases such as cardiovascular disease and stroke, poor glycemic control in GDM patients is also detrimental to the parturients, fetus, and delivery outcome as well [4-6]. Consequently, GDM patients may suffer higher risks of hemorrhage, fetal asphyxia, and cesarean section. Moreover, DM patients invariably present with unstable blood pressure and lipid levels [7-9]. In order to evaluate the risk of postpartum hypertension in GDM patients, we analyzed the predicting value of cell-free DNA level in early blood glucose testing before delivery, and our study involves both patients with and without postpartum hypertension as the experimental group and the control group respectively. Before delivery, fasting, postprandial and bedtime blood glucose, glycosylated hemoglobin, urine glucose, delivery mode, neonatal outcome, neonatal immune function, neonatal blood glucose, and blood pressure, maternal blood pressure at 30 weeks and 34 weeks of gestation, and at delivery, along with blood lipid levels during pregnancy were compared

Table 1. Demographic Comparison ($\bar{x} \pm s$)

Groups	Experimental Group (n=50)	Control Group (n=50)	X^2/t	P
Age (year-old)	28.10±4.33	27.55±4.29	0.64	0.52
Height (cm)	163.39±8.87	162.88±8.24	0.30	0.77
Weight (kg)	68.62±4.39	69.05±4.55	0.48	0.63
Gestational Age (week)	37.67±1.30	37.41±1.42	0.95	0.34
Smoking (year)	1.96±0.33	2.00±0.36	0.58	0.56
Alcohol (year)	4.22±1.05	4.30±1.02	0.39	0.70
Primipara (cases)	33	30	0.39	0.53
Multipara (cases)	17	20		
Education				
Elementary school and less	5	7	0.38	0.54
Middle School	11	10	0.06	0.81
High School and above	34	33	0.05	0.83

between the two groups. This research is unique in the sense of exploring perinatal outcomes of postpartum hypertension in pregnant women with GDM, to further avoid adverse postpartum complications. The study was conducted as follows.

Material and methods

Demographics

A total of 100 puerperae who gave birth in our hospital from March 2018 to January 2020 were retrospectively analyzed. Among them, 50 patients were puerperae with postpartum hypertension (experimental group), and 50 puerperae had normal postpartum blood pressure (control group). The experimental group involved 50 cases with postpartum hypertension, and the control group involved 50 cases without postpartum hypertension. Patients' ages ranged from 22 to 34 years old in the experimental group and from 20 to 33 years old in the control group. There was no statistically significant difference in age, gestational age, and educational background between the two groups (P>0.05). This study strictly complied with the ethics committee certificate, (ethics certificate number: 2017-11-15) and the patients and their families signed an informed consent form. See **Table 1**.

Inclusion/exclusion criteria

Inclusion criteria

① No hypertension before pregnancy; ② Age above 18 when pregnant; ③ No other systemic disease; ④ No allergies, history of drug abuse, or other bad habits; ⑤ This study was approved by our medical ethics committee, and patients voluntarily participated in this study.

Exclusion criteria

① Twin pregnancy; ② Parturients older than 40-year-old; ③ Diagnosis of DM before pregnancy.

Methods

During pregnancy, parturients' fasting, 2 h postprandial, and bedtime blood glucose were monitored via peripheral finger stick. All patients were encouraged to keep an appropriate level of exercise, avoid being bed-bound, eat healthily and keep fit. Plasma levels of blood glucose, glycosylated hemoglobin, urine glucose, and blood lipid level were also monitored monthly. Morning and random blood pressure (systolic blood pressure (SBP) and diastolic blood pressure (DBP)) were monitored daily. Parturients were also encouraged to read, listen to music, and avoid smoking, drinking and crowds. Two ml fasting cubital venous blood was drawn for blood lipid testing and mid-morning urine testing was conducted for urine blood glucose.

A total of 20 ul $CD3^+$, $CD4^+$, $CD8^+$ tricolor monoclonal antibody was added to the absolute counting tube, 50 ul EDTA-K2 anticoagulated whole blood was added, and it was placed at room temperature for 15 minutes. Next, 450 ul of disposable hemolysin was then added and it was placed in the dark at room temperature

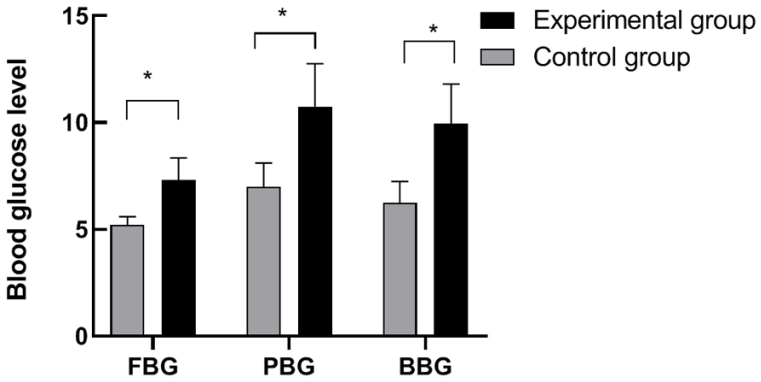

Figure 1. Comparison of fasting, postprandial, bedtime blood glucose before delivery between two groups. Note: From left to right, the horizontal axis represents fasting blood glucose (FBG), postprandial blood glucose (PBG), and bedtime blood glucose (BBG), the vertical axis represents blood glucose level. FBG in the experimental group was (7.31±1.04) mmol/L and in the control group was (5.21±0.38) mmol/L, t=13.41, *P<0.05, the result is statistically significant. PBG in the experimental group was (10.76±2.00) mmol/L and in the control group was (6.98±1.13) mmol/L, t=13.41, *P<0.05, the result is statistically significant. BBG in the experimental group was (9.96±1.85) mmol/L and in the control group was (6.23±1.01) mmol/L, t=13.41, *P<0.05, the result is statistically significant.

for 15 minutes. The $CD3^+$, $CD4^+$, $CD8^+$ cell counts were detected with the FACScalibur type flow cytometer produced by BD Company. The MULTISET software automatically analyzed and calculated the absolute cell counts and corresponding ratios of $CD3^+$, $CD4^+$, $CD8^+$.

Observational variables

Before delivery, fasting, postprandial and bedtime blood glucose, glycosylated hemoglobin, urine glucose, delivery mode, neonatal outcome, neonatal immune function, neonatal blood glucose, and blood pressure [Mean arterial pressure = (SBP+2×DBP)/3], maternal blood pressure at both 30 weeks and 34 weeks of gestation, and at delivery, along with blood lipid levels during pregnancy were compared between the two groups.

Fasting glucose within 3.9-6.1 mmol/L, and 2 h postprandial, bedtime glucose less than 8 mmol/L were considered as within a normal range [10-12].

Glycosylated hemoglobin, an indicator of a recent level of stable glycemic control, between 4.99%-6.79% was considered normal.

Urine glucose of zero was considered normal, symbols of "+, ++, +++" demonstrated the severity of positive urine glucose, the plus symbols, the more severe it is.

Immune function test variables: A higher level of patients' $CD3^+$, $CD4^+$, $CD8^+$ represented better immune function.

Blood lipid profile included triglycerides (TG), total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL).

Statistical analysis

Our statistical analysis used software was SPSS 20.0 and GraphPad Prism 7 (GraphPad Software, San Diego, USA) was used for graphic illustrations. Our study involved both quantitative data and categorical data, quantitative data were presented as ($\bar{x}$±s) using t-test, categorical data were presented as [n (%)], using chi-square. A *P*-value <0.05 was considered statistically significant.

Results

Comparison of fasting, postprandial, bedtime blood glucose before delivery between two groups

The fasting blood glucose (FBG), postprandial blood glucose (PBG), and bedtime blood glucose (BBG) in the experimental group were (7.31±1.04) mmol/L, (10.76±2.00) mmol/L, and (9.96±1.85) mmol/L respectively, and in the control group were (5.21±0.38) mmol/L, (6.98±1.13) mmol/L and (6.23±1.01) mmol/L (P<0.05). A remarkably higher outcome was observed in the experimental group. See **Figure 1**.

Comparison of glycosylated hemoglobin and urine glucose between two groups

When we compared the glycosylated hemoglobin and urine glucose between the two groups, the experimental group showed (8.20±0.61)% statistically significantly better results as compared to the control group (5.39±0.28)%; the number of positive cases of urine glucose was 41, which was significantly higher than 13 of the control group (P<0.05). See **Table 2**.

Table 2. Comparison of glycosylated hemoglobin and urine glucose between two groups

Groups	Glycosylated Hemoglobin (%)	Urine Glucose (Positive Cases)
Experimental Group (n=50)	8.20±0.61	41
Control Group (n=50)	5.39±0.28	13
X^2/t	29.60	31.56
P	<0.001	<0.001

Table 3. Comparison of delivery mode between two groups

Groups	Natural delivery	Cesarean section	Natural delivery rate(%)
Experimental Group (n=50)	21	29	42
Control Group (n=50)	40	10	80%
X^2			15.17
P			0.002

Table 4. Comparison of neonatal outcome between two groups

Groups	Neonatal asphyxia	Congenital diabetes mellitus	Healthy newborns
Experimental Group (n=50)	3 (6)	1 (2)	46 (92)
Control Group (n=50)	2 (4)	1 (2)	47 (94)
X^2			0.15
P			0.70

Comparison of delivery mode between two groups

The experimental group had 21 cases of natural delivery and 29 cases of cesarean section, with a natural delivery rate of 42%. The control group had 40 cases of natural delivery and 10 cases of cesarean section, with a natural delivery rate of 80%. A notable decline in nature delivery rate was witnessed in the experimental group (P<0.05). See **Table 3**.

Comparison of neonatal outcome between two groups

In the experimental group, there were 3 cases of neonatal asphyxia (6%), 1 case of congenital diabetes mellitus (2%), 46 cases of healthy newborns (92%). In the control group, there were 2 cases of neonatal asphyxia (4%), 1 case of congenital malformation (2%), 47 cases of healthy newborns (94%). No statistically significant difference was detected in neonatal asphyxia, congenital diabetes, and congenital malformations between groups (P>0.05). See **Table 4**.

Comparison of neonatal immune function between two groups

The neonatal levels of $CD3^+$, $CD4^+$, $CD8^+$ in the experimental group were (732.15±98.62) μl^{-1}, (319.89±76.22) μl^{-1} and (353.80±74.16) μl^{-1}, while those in the control group were (884.69±113.50) μl^{-1}, (501.48±89.99) μl^{-1} and (567.12±89.01) μl^{-1}. Worse performance of neonatal immune function was found in the experimental group in contrast to the control group (P<0.05). See **Figures 2**, **3**.

Comparison of neonatal blood glucose and mean arterial pressure between two groups

The neonatal blood glucose levels in the experimental group and the control group were (4.69±0.62) mmol/L and (4.66±0.65) mmol/L. The mean arterial pressure in the control group and the control group were (102.46±8.83) mmHg and (101.59±8.72). No evidence of significant differences in neonatal blood glucose and mean arterial pressure between the two groups was found (P>0.05). See **Table 5**.

Comparison of maternal blood pressure at 30 weeks, and 34 weeks of gestation, and at delivery between two groups

In **Figure 3**, the maternal blood pressure at 30 weeks in the experimental group was (113.69±7.38) mmHg and that of the control group was (112.56±7.51) mmHg. The maternal blood pressure at 34 weeks in the experimental group was (106.91±7.85) mmHg and of the control group was (106.12±7.46) mmHg. The maternal blood pressure at delivery in the experimental group was (118.50±8.00) mmHg and that of the control group was (116.32±7.69) mmHg. Maternal blood pressure at 30 weeks, and 34 weeks of gestation, and at delivery between two groups did not differ statistically (P>0.05).

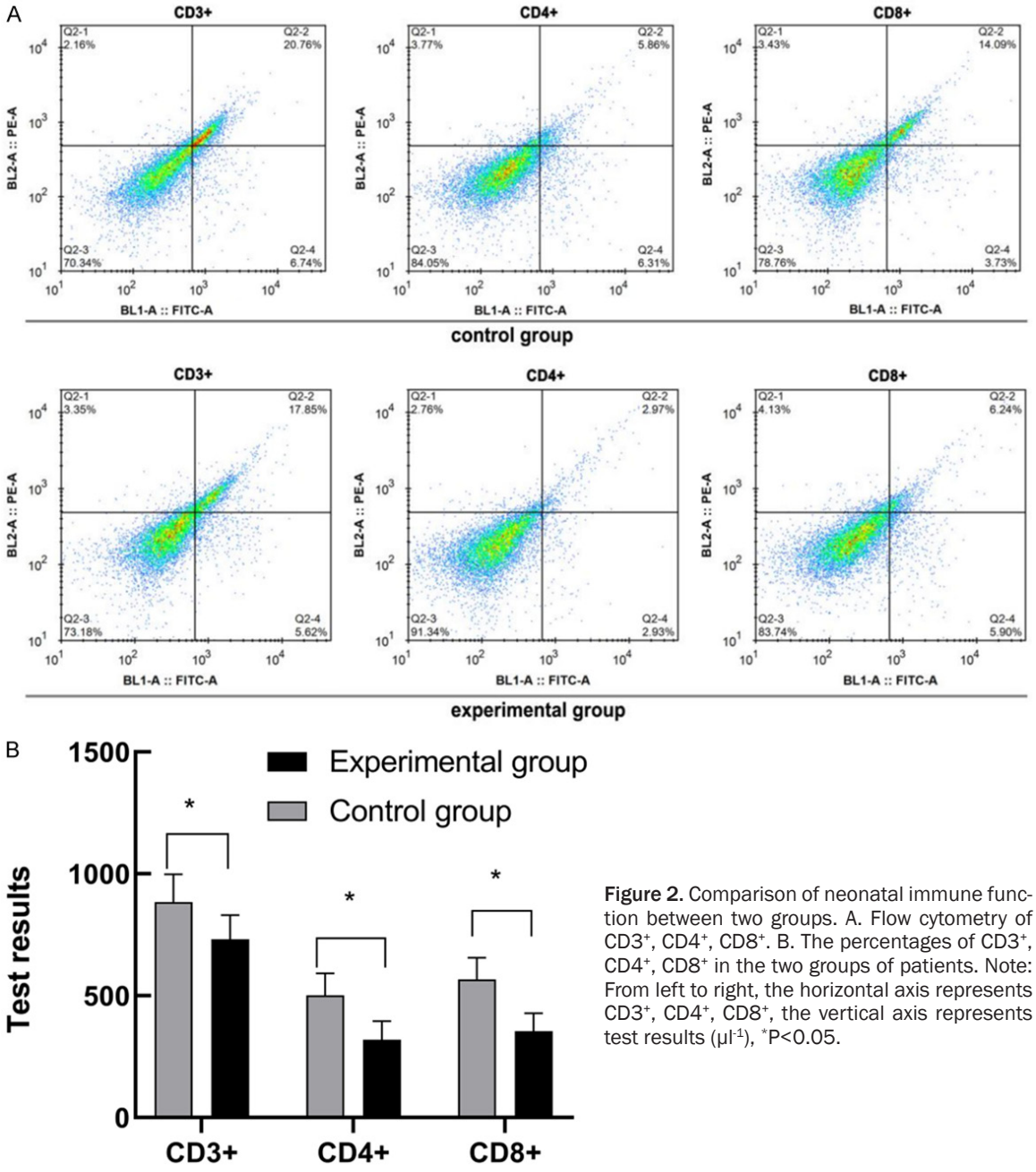

Figure 2. Comparison of neonatal immune function between two groups. A. Flow cytometry of $CD3^+$, $CD4^+$, $CD8^+$. B. The percentages of $CD3^+$, $CD4^+$, $CD8^+$ in the two groups of patients. Note: From left to right, the horizontal axis represents $CD3^+$, $CD4^+$, $CD8^+$, the vertical axis represents test results (μl^{-1}), $^*P<0.05$.

Comparison of blood lipid levels during pregnancy between the two groups

The levels of TC, TG, LDL, and HDL in the experimental group were (3.81±0.75) mmol/L, (0.92±0.08) mmol/L, (1.65±0.33) mmol/L, and (1.11±0.09) mmol/L; those in the control group were (3.84±0.77) mmol/L, (0.93±0.07) mmol/L, (1.69±0.39) mmol/L, and (1.10±0.10) mmol/L. The blood lipid levels during pregnancy were also similar between the two groups (P>0.05). See **Table 6**.

Discussion

GDM is a metabolic disease that occurs in pregnancy and as a result, a great number of parturients suffer an increased risk of endocrine disorders and hormonal disturbance. Inadequate insulin secretion or insulin resistance is secondary to excessive secretion, which are all causes of DM [13-15]. The potential danger of congenital fetal deformities by some drugs leaves the patient's with limited choices of medications; hence, nutrition, diet, and a

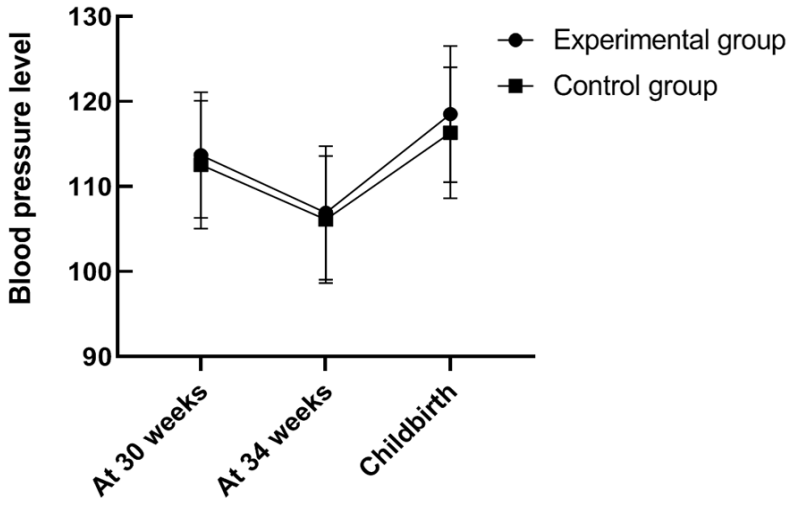

Figure 3. Comparison of maternal blood pressure at 30 weeks, 34 weeks of gestation, and at delivery between two groups. Note: From left to right, the horizontal axis represents 30 weeks of gestation, 34 weeks of gestation, at delivery, the vertical axis represents blood pressure level. The maternal blood pressure at 30 weeks of the experimental group was (113.69±7.38) mmHg and of the control group was (112.56±7.51) mmHg; the maternal blood pressure at 34 weeks of the experimental group was (106.91±7.85) mmHg and of the control group was (106.12±7.46) mmHg; the maternal blood pressure at delivery of the experimental group was (118.50±8.00) mmHg and of the control group was (116.32±7.69) mmHg, t=1.39, P=0.17. The result is not statistically significant.

Table 5. Comparison of neonatal blood glucose and mean arterial pressure between two groups ($\bar{x}$±s)

Groups	Mean arterial pressure (mmHg)	Blood Glucose (mmol/L)
Experimental Group (n=50)	102.46±8.83	4.69±0.62
Control Group (n=50)	101.59±8.72	4.66±0.65
T	0.50	0.24
P	0.62	0.81

Table 6. Comparison of blood lipid level during pregnancy between two groups ($\bar{x}$±s, mmol/L)

Groups	TC	TG	LDL	HDL
Experimental Group (n=50)	3.81±0.75	0.92±0.08	1.65±0.33	1.11±0.09
Control Group (n=50)	3.84±0.77	0.93±0.07	1.69±0.39	1.10±0.10
t	0.20	0.67	0.55	0.53
P	0.84	0.51	0.58	0.60

balanced lifestyle are more essential to treatment of GDM patients [16-18]. Body function and blood circulation are severely hindered by the invasion of glucose into the bloodstream after the incomplete metabolism of glucose in diabetes patients. When there is too much sugar in the blood, normal cellular function and activity will be impeded and blood viscosity will increase, resulting in high lipid levels in diabetes patients [19-21]. During systemic circulation, when the heart constricts and blood is pumped into the blood vessel, the blood pressure reaches its peak, which is called systolic pressure, and when the heart relaxes and blood returns to the heart from the major vessels, the blood pressure is at the lowest, which is called the diastolic pressure [22-24]. Blood pressure is associated with genetics, diet habits, blood viscosity, blood density, vessel elasticity as well as cardiac function. Therefore, DM patients are at a rising risk of hypertension. To evaluate the risk of postpartum hypertension in GDM patients, we analyzed the predicting value of cell-free DNA level in early blood glucose testing before delivery, and our study involved both patients with and without postpartum hypertension as the experimental group and the control group respectively. Before delivery, fasting, postprandial and bedtime blood glucose, glycosylated hemoglobin, urine glucose, delivery mode, neonatal outcome, neonatal immune function, neonatal blood glucose, and blood pressure, maternal blood pressure at 30 weeks, and at 34 weeks of gestation, and at delivery as well as blood lipid levels during pregnancy were compared between the two groups.

Our study showed that the fasting, postprandial, bedtime blood glucose, glycosylated hemo-

globin, urine glucose before delivery in the experimental group were significantly higher than the control group (P<0.05). High blood glucose will lead to a positive result of the urine glucose test which should be negative in normal cases. The results also demonstrated that blood glucose during pregnancy in parturients with postpartum hypertension in the experimental group was significantly higher than normal, which indicated that parturients with GDM posed increasing odds of postpartum hypertension compared to parturients without hypertension. There were significantly lower rates of natural delivery and worse neonatal immune function in the experimental group (P<0.05), as compared to the control group. With a higher risk of major bleeding and difficult delivery, measures should be taken to assist in delivery, and the increasing risk of neonatal infection or autoimmune dysfunction due to poor immune function in these neonates also requires proper attention. There were similar results in the neonatal outcome, neonatal blood glucose and blood pressure, maternal blood pressure at 30 weeks and 34 weeks gestation and at delivery, as well as blood lipid level during pregnancy (P>0.05). Our results demonstrated that despite the higher blood glucose and glycosylated hemoglobin level during pregnancy in parturients with postpartum hypertension in the experimental group, no major effects on neonatal outcome, neonatal blood glucose and blood pressure, maternal blood pressure, or lipid levels that were observed during pregnancy. Gestational blood pressure in the experimental group was slightly higher than the control group, but this difference was not obvious and was within a safe range, indicating that the parturients in the experimental group already presented signs of hypertension, and these signs became more obvious after delivery. Ning Jun et al. [25] revealed the close relationship between GDM, gestational hypertension, and gestational hyperlipidemia, which has been shown to have a certain predicting value. The results of their study were consistent with the results of our study, which consolidates the scientific value of our results. The limitation of this study lies in the absence of medium and long-term follow-up of postpartum GDM patients to confirm whether more postpartum complications will occur. In the future, the scope of the study will be expanded and the trial time will be extended.

In conclusion, postpartum hypertension in pregnant women with GDM results in a low probability of natural birth and has a slight impact on the fetus.

Disclosure of conflict of interest

None.

Address correspondence to: Guangxia Zhang, Department of Obstetrics and Gynecology, Shandong Provincial Hospital Affiliated to Shandong First Medical University, Jinan 250021, Shandong, China. Tel: +86-133-4622-8030; E-mail: zhangguangxia123@yeah.net

References

[1] Karaçam Z and Çelİk D. The prevalence and risk factors of gestational diabetes mellitus in Turkey: a systematic review and meta-analysis. J Matern Fetal Neonatal Med 2021; 34: 1331-1341.

[2] Sapanont K, Sunsaneevithayakul P and Boriboonhirunsarn D. Relationship between ABO blood group and gestational diabetes mellitus. J Matern Fetal Neonatal Med 2021; 34: 1255-1259.

[3] Hu Q, Wang D, Yue D, Xu C, Hu B, Cheng P, Zhai Y, Mai H, Li P, Gong J, Zeng X, Jiang T, Mai D, Fu S, Guo L and Lin W. Association of ambient particle pollution with gestational diabetes mellitus and fasting blood glucose levels in pregnant women from two Chinese birth cohorts. Sci Total Environ 2021; 762: 143176.

[4] Chen WJ, Davis EM, Stoner JA, Robledo C, Goodman JR, Garwe T, Janitz AE, Xu C, Hwang J and Peck JD. Urinary total arsenic and arsenic methylation capacity in pregnancy and gestational diabetes mellitus: a case-control study. Chemosphere 2021; 271: 129828.

[5] Freathy RM, Hayes MG, Urbanek M, Lowe LP, Lee H, Ackerman C, Frayling TM, Cox NJ, Dunger DB, Dyer AR, Hattersley AT, Metzger BE and Lowe WL Jr; HAPO Study Cooperative Research Group. Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study: common genetic variants in GCK and TCF7L2 are associated with fasting and postchallenge glucose levels in pregnancy and with the new consensus definition of gestational diabetes mellitus from the International Association of Diabetes and Pregnancy Study Groups. Diabetes 2010; 59: 2682-2689.

[6] Kul Ş, Güvenç TS, Baycan ÖF, Çelik FB, Çalışkan Z, Çetin Güvenç R, Çiftçi FC and Caliskan M. Combined past preeclampsia and gestational diabetes is associated with a very high fre-

quency of coronary microvascular dysfunction. Microvasc Res 2021; 134: 104104.
[7] Plows JF, Stanley JL, Baker PN, Reynolds CM and Vickers MH. The pathophysiology of gestational diabetes mellitus. Int J Mol Sci 2018; 19: 3342.
[8] Yoffe L, Polsky A, Gilam A, Raff C, Mecacci F, Ognibene A, Crispi F, Gratacós E, Kanety H, Mazaki-Tovi S, Shomron N and Hod M. Early diagnosis of gestational diabetes mellitus using circulating microRNAs. Eur J Endocrinol 2019; 181: 565-577.
[9] de Gennaro G, Bianchi C, Aragona M, Battini L, Baronti W, Brocchi A, Del Prato S and Bertolotto A. Postpartum screening for type 2 diabetes mellitus in women with gestational diabetes: Is it really performed? Diabetes Res Clin Pract 2020; 166: 108309.
[10] Kohzuma T and Koga M. Lucica GA-L glycated albumin assay kit: a new diagnostic test for diabetes mellitus. Mol Diagn Ther 2010; 14: 49-51.
[11] Merrison H, Mangtani A and Quick T. The shifting demographics of birth-related brachial plexus injury: the impact of socio-economic status and ethnic groups. J Plast Reconstr Aesthet Surg 2021; 74: 560-568.
[12] Mahabady MK, Shamsi MM, Ranjbar R, Tabandeh MR and Khazaeel K. Quercetin improved histological structure and upregulated adiponectin and adiponectin receptors in the placenta of rats with gestational diabetes mellitus. Placenta 2021; 106: 49-57.
[13] Xu F, Yang S, Liu Y, Zheng X, Yang H, Zhang J, Ren Z and Yang J. Placental pathology and neonatal outcomes in pre-eclampsia with gestational diabetes mellitus. J Matern Fetal Neonatal Med 2021; 34: 1149-1154.
[14] Neven KY, Cox B, Cosemans C, Gyselaers W, Penders J, Plusquin M, Roels HA, Vrijens K, Ruttens A and Nawrot TS. Lower iodine storage in the placenta is associated with gestational diabetes mellitus. BMC Med 2021; 19: 47.
[15] Xu D, You J, Chen G, Su H, Zhang L, Cui L, Li Z, Huang G and Feng C. Changes of serum Zinc-α2-glycoprotein level and analysis of its related factors in gestational diabetes mellitus. J Diabetes Res 2021; 2021: 8879786.
[16] Timm A, Nielsen KK, Christensen U and Maindal HT. Healthcare professionals' perspectives on the cross-sectoral treatment pathway for women with gestational diabetes during and after pregnancy-A qualitative study. J Clin Med 2021; 10: 843.
[17] Herath MP, Beckett JM, Hills AP, Byrne NM and Ahuja KDK. Gestational diabetes mellitus and infant adiposity at birth: a systematic review and meta-analysis of therapeutic interventions. J Clin Med 2021; 10: 835.
[18] Mustafa M, Bogdanet D, Khattak A, Carmody LA, Kirwan B, Gaffney G, O'Shea PM and Dunne F. Early gestational diabetes mellitus (GDM) is associated with worse pregnancy outcomes compared with GDM diagnosed at 24-28 weeks gestation despite early treatment. QJM 2021; 114: 17-24.
[19] Liu J, Dai Q, Li W, Guo Y, Dai A, Wang Y, Deng M, Tang Z, She L, Chen X and Yang M. Association of vitamin D receptor gene polymorphisms with gestational diabetes mellitus-a case control study in Wuhan, China. BMC Pregnancy Childbirth 2021; 21: 142.
[20] Bounds FL, Rojjanasrirat W and Martin MA. Team-based approach to managing postpartum screening of women with gestational diabetes for type 2 diabetes. J Midwifery Womens Health 2021; 66: 101-107.
[21] Hu J, Ye Y, Lu A, Chen L, Mai Y, Huang G and Wang S. Pregnancy outcomes in patients with heart disease in China. Am J Cardiol 2020; 125: 1718-1724.
[22] Berian JR, Ban KA, Liu JB, Ko CY, Feldman LS and Thacker JK. Adherence to enhanced recovery protocols in NSQIP and association with colectomy outcomes. Ann Surg 2019; 269: 486-493.
[23] Hedrick TL, Thiele RH, Hassinger TE, Donovan J, Reines HD, Damico E Jr, Fogel S, Jones JE, Posadas J, Jones RS and Turrentine FE. Multicenter observational study examining the implementation of enhanced recovery within the virginia surgical quality collaborative in patients undergoing elective colectomy. J Am Coll Surg 2019; 229: 374-382.
[24] Morikawa M, Cho K, Yamada T, Yamada T, Akaishi R, Koyama T, Takeda M, Nishida R and Minakami H. Risk factors for postpartum hypertension in women with twin pregnancies. J Perinat Med 2011; 40: 115-120.
[25] Feller M, Snel M, Moutzouri E, Bauer DC, de Montmollin M, Aujesky D, Ford I, Gussekloo J, Kearney PM, Mooijaart S, Quinn T, Stott D, Westendorp R, Rodondi N and Dekkers OM. Association of thyroid hormone therapy with quality of life and thyroid-related symptoms in patients with subclinical hypothyroidism: a systematic review and meta-analysis. JAMA 2018; 320: 1349-1359.