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Original Article

The effect of blood glucose control on pregnancy outcomes in pregnant women with gestational diabetes mellitus

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Abstract: To investigate the effect of blood glucose control on pregnancy outcomes in pregnant women with gestational diabetes mellitus (GDM). A retrospective cohort study was conducted on a total of 150 pregnant women who underwent regular prenatal examination and delivered at our hospital from January 2013 to December 2016. Among these patients, there were 50 patients with suboptimal or uncontrolled blood glucose (designated as Group A), 50 matched patients with blood glucose controlled with in normal range (designated as Group B), and 50 matched healthy pregnant women (designated as Group C). The incidences of pregnancy complications and outcomes as well as neonatal birth condition and complications were collected and compared among three groups. The results showed the incidences of pregnancy-induced hypertension, polyhydramnios and preeclampsia as well as caesarean section were significantly higher in Group A than those in Group B (all $P<0.05$) and Group C (all $P<0.05$), while there were no statistical differences between Group B and Group C with respect to abovementioned results ($P>0.05$). The incidences of premature birth, low weight birth and macrosomia as well as neonatal hypoglycemia and respiratory distress syndrome were significantly higher in Group Ain comparison with those in Group B (all $P<0.05$); and Group C (all $P<0.05$); whereas no significant differences were found between Group B and Group C in terms of these parameters of neonatal birth condition and complications ($P>0.05$). In conclusion, strengthening of blood glucose control in pregnant women with GDM can improve pregnancy outcome, reduce pregnancy complications and neonatal complications.

Keywords: Gestational diabetes mellitus, blood glucose, pregnancy complications, pregnancy outcome, neonatal outcome

Introduction

Gestational diabetes mellitus (GDM) refers to diabetes mellitus diagnosed during pregnancy (including glucose intolerance or diabetes), which is the riskiest complication during pregnancy. Women with abnormal glucose metabolism or unidentified abnormal glucose metabolism before pregnancy are also designated as GDM patients [1]. The incidence of GDM is 1%-5% in China, which has obviously risen in recent years [2, 3]. GDM is also a high risk factor associated with type 2 diabetes. Statistically, pregnant women with GDM present a significantly higher risk of developing type 2 diabetes in the longterm [4, 5].

GDM is harmful to both maternal health and infant health. Pregnant women with GDM are more prone to developing pregnancy-induced hypertension syndrome, infection, excessive amniotic fluid, premature rupture of membranes, macrosomia etc. The incidences of neonatal asphyxia, hypoglycemia, respiratory distress syndrome, hyperbilirubinemia and other complications are higher in GDM women during perinatal period, which can lead to neonatal development disorders, and even death [6, 7]. Recent studies have also found that the early intervention of GDM may help improve the prognosis of pregnant women and fetuses, but the relationship between the ideal of gestational diabetes control and pregnancy outcomes is still unclear [8, 9].

In order toclarify the importance of optimal blood glucose control in pregnant women with GDM, the current study analyzed the clinical

Table 1. Clinical information in three groups

Group	Group A (n=50)	Group B (n=50)	Group C (n=50)	P
Age (range, year)	21-37	22-41	22-38	
Average age (year)	31.26±6.16	30.12±4.10	28.91±3.90	0.610
Gestation (range, week)	32-39	35-38	35-39	
Average gestation (week)	35.16±3.21	35.16±3.18	36.86±2.99	0.699
BMI (kg/m^2)	26.1±1.09	25.8±1.20	25.9±1.16	1.210
Diabetes history (month)	4.1±0.6	3.9±0.7	0	0.019
Fast blood sugar (mmol/L)	6.4±0.5	5.9±0.3	5.1±0.3	0.029
HbAi C (%)	6.6±0.3	6.0±0.3	5.3±0.2	0.043
Complication (n/%)	5/10.0	3/6.0	0	0.081

Table 2. The incidence of pregnancy complications during pregnancy in the three groups

Group	Pregnancy-induced hypertension (n/%)	Polyhydramnios (n/%)	Preeclampsia (n/%)
Group A (n=50)	14/28.0	12/24.0	13/26.0
Group B (n=50)	3/6.0[a]	2/4.0[b]	2/4.0[c]
Group C (n=50)	2/4.0[d]	2/4.0[e]	1/2.0[f]

Note: Compared with Group A, [a]P=0.003, [b]P=0.004, [c]P=0.002, [d]P=0.001, [e]P=0.004, [f]P=0.000.

data of 100 pregnant women with GDM (50 patients with suboptimal or uncontrolled blood glucose, and 50 patients with blood glucose controlled with in normal range) and 50 healthy pregnant women retrospectively. The pregnancy complications, pregnancy outcomes, neonatal birth outcomes and complications were compared among groups.

Methodology

Participants

The study was approved by local Ethical Committees and has got informed consent from participants. From January 2013 to December 2016, 50 patients with suboptimal or uncontrolled blood glucose were selected in this study (Group A). In the meantime, we selected 50 patients with GDM but controlled blood glucose with in normal range (designated as Group B: the blood glucose was controlled with in the normal range: fasting glucose <5.8 mmol/L, and 2 h postprandial glucose <6.7 mmol/L), and 50 healthy pregnant women (designated as Group C). All the subjects were at their first pregnancy, and had no history of diabetes before pregnancy orother chronic disease history before and during pregnancy.

Diabetes diagnosis

All the pregnant women underwent 75 g oral glucose tolerance test at the pregnancy of 24-28 weeks. The fasting blood glucose, 1 h postprandial glucose and 2 h postprandial glucose were measured. The normal standard is less than or equal to 5.1 mmol/L, 10.0 mmol/L and 8.5 mmol/L, respectively. The pregnant women were diagnosed as gestational diabetes when any blood glucose reached or exceeded the standard above [10].

Information collection

The participants' clinical data include baseline characteristics (age, BMI, blood pressure, gestation), diabetes patterns (diabetes history, the level of blood sugar and hemoglobin A1C (HbA1C)). Complications include ketosis, acidosis, etc., were collected.

Follow-up and outcome measures

The following outcome measures were observed in the three groups after enrollment until birth, including pregnancy complications (gestational hypertension, polyhydramnios, and preeclampsia), pregnancy outcomes (premature rupture of membranes, cesarean section, postpartum hemorrhage, and postpartum infection), neonatal birth condition (premature and low birth weight infants, and macrosomia) and neonatal complications (hypoglycemia, neonatal respiratory distress syndrome, neonatal infection, and myocardial damage).

Data analysis

SPSS21.0 was used for data analysis, and continuous data were expressed as mean and stand ard deviation. The difference was analyzed among the three groups by using ANOVA, and the inter-group difference was checked using post hoc Bonferroni test. Enumeration data were converted to percentage, and their

Table 3. The pregnancy outcomes in the three groups

Group	Premature rupture of membranes (n/%)	Cesarean section (n/%)	Postpartum hemorrhage (n/%)	Postpartum infection (n/%)
Group A (n=50)	1/2.0	29/58.0	1/2.0	2/4.0
Group B (n=50)	1/2.0	5/10.0[a]	0/0	1/2.0
Group C (n=50)	1/2.0	6/12.0[b]	0/0	0/0

Note: Compared with Group A, [a]P<0.000, [b]P<0.000.

Table 4. The conditions of neonatal birth in the three groups

Group	Premature birth (n/%)	Low weight birth (n/%)	Macrosomia (n/%)
Group A (n=50)	10/20.0	8/16.0	9/18.0
Group B (n=50)	2/4.0[a]	1/2.0[c]	2/4.0[e]
Group C (n=50)	2/4.0[b]	1/2.0[d]	2/4.0[f]

Note: Compared with Group A, [a]P=0.014, [b]P=0.014, [c]P=0.014, [d]P=0.014, [e]P=0.025, [f]P=0.025.

inter-group differences were analyzed by using partitioned Chi-square test (divided by three) between groups. P<0.05 was considered statistically significant.

Results

The clinical data of pregnant women in three groups

As shown in **Table 1**, there was no significant difference among the three groups regarding to age, gestation, BMI and the incidence of complication (including ketosis and acidosis). And there was no significant difference between Group A and Group B with respect to diabetes history (P=0.216), the levels of fast blood sugar (P=0.691) and HbA1C (P=0.399).

Pregnancy complications in the three groups

As shown in **Table 2**, during pregnancy, there were 14 cases (28.0%) with pregnancy-induced hypertension, 12 cases (24.0%) with polyhydramnios, and 13 cases (26.0%) with preeclampsia in Group A. In group B, there were 3 cases (6.0%) with pregnancy-induced hypertension, 2 cases (4.0%) with polyhydramnios, and 2 cases (4.0%) with preeclampsia. And in Group C, there were 2 cases (4.0%) with pregnancy-induced hypertension, 2 cases (4.0%) with polyhydramnios and 1 case (2.0%) with preeclampsia. The statistical analysis showed that there were significant differences among the three groups with respect to the incidence of pregnancy complications (P=0.009). The incidences of pregnancy-induced hypertension, polyhydramnios and preeclampsia complications were all significantly higher in Group A than those in Group Band Group C (all P< 0.01). However, no significant differences were found between Group B and Group C (P>0.05).

Delivery outcomes in the three groups

As shown in **Table 3**, in Group A, there was 1 case (2.0%) with premature rupture of membranes, 29 cases (58.0%) with cesarean section, 1 case (2.0%) with postpartum hemorrhage, and 2 cases (4.0%) with postpartum infection. In Group B, there was 1 case (2.0%) with premature rupture of membrane, 5 cases (10.0%) with cesarean section, 1 case (2.0%) with postpartum infection, and no case with postpartum hemorrhage. And in Group C, there was 1 case (2.0%) with premature rupture of membranes, 6 cases (12.0%) with cesarean section, and no case with postpartum hemorrhage and postpartum infection. The statistical results showed that the incidence of cesarean section in Group A was significantly higher than that of Group B and Group C (both P<0.000) while there was no significant difference between Group B and Group C (both P>0.05). In addition, there was no significant difference in the incidences of premature rupture of membranes, postpartum hemorrhage and postpartum infection among the three groups (all P>0.05).

Neonatal birth condition in the three groups

As shown in **Table 4**, there were 10 (20.0%) preterm infants, 8 (16.0%) low birth weight infants and 9 (18.0%) macrosomia in Group A. In Group B, there were 2 (4.0%) premature infants, 1 (2.0%) low weight infants, and 2 (4.0%) macrosomia. And in Group C, there were 2 (4.0%) premature infants, 1 (2.0%) low weight infants, and 2 (4.0%) macrosomia. The statistical results showed that the incidences of premature birth, low birth weight and macrosomia in Group A were all significantly higher than those in Group B and Group C (all P<0.05) while there were no significant differences between Group B and Group C (all P>0.05).

Table 5. The neonatal complications in the three groups

Group	Hypoglycemia (n/%)	Respiratory distress syndrome (n/%)	Infection (n/%)	Myocardial damage (n/%)
Group A (n=50)	11/22.0	8/16.0	4/8.0	2/4.0
Group B (n=50)	2/4.0[a]	2/4.0[c]	2/4.0	1/2.0
Group C (n=50)	3/6.0[b]	1/2.0[d]	3/6.0	0/0

Note: Compared with Group A, [a]P=0.007, [b]P=0.021, [c]P=0.046, [d]P=0.014.

Neonatal complications in the three groups

As shown in **Table 5**, there were 11 cases (22.0%) with neonatal hypoglycemia, 8 cases (16.0%) with respiratory distress syndrome, 4 cases (8.0%) with infection, and 2 cases (4.0%) with myocardial damage in Group A. In Group B, there were 2 cases (4.0%) with neonatal hypoglycemia, 2 cases (4.0%) with respiratory distress syndrome, 2 cases (4.0%) with infection, and 1 case (2.0%) with myocardial damage. And in Group C, there were 3 cases (6.0%) with neonatal hypoglycemia, 1 case (2.0%) with respiratory distress syndrome, 3 cases (6.0%) with infection, and no cases with myocardial damage. The statistical results showed thatthe incidences of neonatal hypoglycemia and respiratory distress syndrome in group A were significantly higher than those in group B and group C (all $P<0.05$). However, no significant difference was revealed between Group B and Group C (all $P>0.05$). In addition, there were no statistically significant differences in the incidences of neonatal infection and myocardial damage among the three groups (both $P>0.05$).

Discussion

With the improvement of living standard and the emphasis on nutrition during pregnancy, the incidence of GDM is increasing gradually [2, 3]. Previous studies have shown that [8, 9] the strengthening of blood glucose monitoring and good control of pregnancy in diabetic women is important to improve maternal and neonatal outcomes.

Therefore, early diagnosis and active prevention and treatment of GDM are very important for reducing pregnancy and neonatal complications. The results of this study showed that the incidences of pregnancy-induced hypertension, polyhydramnios, preeclampsia, cesarean, premature infants, low birth weight, macrosomia, neonatal hypoglycemia, respiratory distress syndrome were significantly higher in GDM pregnant women without blood glucose control or with suboptimal blood glucose controlthan those GDM patients with ideal blood glucose control and healthy pregnant women. Nevertheless, there were no significant differences between GDM pregnant women with blood glucose control in the normal range and healthy pregnant women. The results of the current study were consistent with previous studies [11, 12], indicating that gestational diabetes can significantly increase the maternal and perinatal complications, and the control of blood glucose in the normal range can significantly reduce the incidence of these complications.

Reportedly, the abnormal glucose metabolism in pregnant women, whether hyperinsulinemia or insulin resistance, can thicken basement membrane of the capillary wall, resulting in pregnancy-induced hypertension, and the incidence of pregnancy-induced hypertension can reach over 50% especially in those patients with renal vascular disease [13]. In addition, elevated maternal blood glucose can pass through the placenta, resulting in elevated fetal blood glucose, which can further lead to increased fetal urine volume and excessive amniotic fluid, and ultimately lead to premature birth. There existed the dual effects of hyperinsulinemia and insulin resistance in pregnant women with gestational diabetes mellitus, and the pathogenesis of gestational diabetes was associated with pregnancy induced hypertension; gestational diabetes combined with preeclampsia is an important cause of preterm delivery [14-16]. In addition, hyperglycemia can stimulate and increase the secretion of fetal insulin, promote the fetal growth, resulting in weight gain and higherincidence of macrosomia in fetus [17]. Therefore, the incidences of cesarean section and neonatal emergency may increase significantly. For example, the hyperinsulinemia and hyperglycemia of the fetus can antagonize the adrenal cortex hormone in fetal, leading to the lack of lung type II active substance and delayed lung maturation, which can easily cause neonatal respiratory distress syndrome. This indicates the necessity of close monitoring of blood glucose during the maternal gestational week [18]. Furthermore, even though the new borns were delivered and es-

cape from the impact of maternal hyperglycemia, hyperinsulinemia itself still persists in the newborns, which may lead to hypoglycemia. And long-term hyperglycemia can promote the hyperplasia and hypertrophy of fetal islet cells. It was reported that the hypoglycemia caused by increased in sulin mostly occurs at the first 1 h to 2 h after birth, without obvious symptomsand sometimes undetected [19]. Consequently, severe neurological sequelae or even death can be developed if glucose was not supplemented timely. Therefore, the routine screening of blood glucose should be carried out in GDM patients during neonatal periods to prevent neonatal hypoglycemia, and reduce irreversible damage to the nervous system. And other precautionary measures suggested include maintaining normal body temperature and reducing energy consumption.

Furthermore, it was reported [11, 20] that the incidences of neonatal infection and myocardial damage were higher in pregnant women with GDM. Never the less, no significant differences were found among the three groups in this study, which may be due to the relatively small sample size. In addition, the follow-up investigation of pregnant women and newborns was not conducted. In the future study, it is of great necessity to enlarge the sample size and improve the experimental design so as to get more data with significant clinical value.

To conclude, GDM does great harm to maternal and neonatal, and the streng thening of blood glucose monitoring during pregnancy can significantly reduce the complications of maternal and neonatal, and improve the pregnancy outcomes.

Disclosure of conflict of interest

None.

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