An Analysis of Glucose Levels in Normal Pregnancy and Pregnancy Complicated by Gestational Diabetes Mellitus

Usha Thachappilly[1], Vijayalakshmy R. S.[2], Sreedevi N. S.[3], Vijayalakshmy Moorkkattukara Thekkoot[4], Shajee Sivasankaran Nair[5], Sajith Vilambil[6], Sajeevan Kundila Chandran[7]

[1]Associate Professor, Department of Physiology, Government Medical College, Thrissur, Kerala, India. [2]Former Professor and Head, Department of Physiology, Government Medical College, Calicut, Kerala, India. [3]Professor and Head, Department of Obstetrics and Gynaecology, Pushpagiri Medical College, Thiruvalla, Kerala, India. [4]Professor and Head, Department of Physiology, Government Medical College, Thrissur, Kerala, India. [5]Associate Professor, Department of Biochemistry, Government Medical College, Thrissur, Kerala, India. [6]Associate Professor, Department of Transfusion Medicine, Government Medical College, Thrissur, Kerala, India. [7]Additional Professor, Department of Biochemistry, Government Medical College, Thrissur, Kerala, India.

ABSTRACT

BACKGROUND

Effective diagnosis and treatment of DM can reduce hyperglycemia related adverse pregnancy outcomes. We wanted to analyse glucose levels in normal pregnancy and pregnancy complicated by GDM.

METHODS

This is a case-control study conducted in the Department of Obstetrics and Gynaecology, Institute of Maternal and Child Health, Medical College, Calicut. A total of 200 subjects was divided into two groups comprising 150 controls (healthy pregnant women with no history of GDM) and 50 cases (pregnant women with GDM). All statistical data were analysed using SPSS software version 16. Continuous variables were expressed as mean ± standard deviation. Qualitative data was expressed as percentage. Independent t test was used for comparing quantitative data between two groups.

RESULTS

The mean age of normal pregnant study subjects was 23.76 years. The mean duration from last delivery was 1.37 years among normal pregnant mothers. Among the normal pregnant group, majority had no history of abortion. Mean Systolic Blood Pressure (BP) of normal pregnant category was 113.17 mmHg. Mean diastolic BP was 73.13 mmHg. The mean height and weight in normal pregnant group was 1.56 m and 57.33 Kg respectively. The average BMI was 23.42 among normal pregnant mothers. The mean age of GDM study subjects was 26.24 years. The mean duration from last delivery was 1.74 years among GDM mothers. In the GDM group, majority had no history of abortion. Mean systolic BP of GDM category was 122.04 mmHg. Mean diastolic BP was 79.76 mmHg and ranged between 70 - 100 mmHg. The mean value of blood glucose in women with GDM was 147.86 mg/dL and that in normal pregnant women was 103.59 mg/dL. The result was statistically significant.

CONCLUSIONS

Glucose tolerance is significantly reduced in GDM. Screening for GDM and adequate control measures help in detecting women with even minimal abnormality of glucose metabolism which may otherwise be undetected and progress to diabetes.

KEYWORDS

Glucose tolerance, Gestational diabetes, Blood glucose, Pregnancy

Corresponding Author:
Dr. Shajee Sivasankaran Nair,
Associate Professor,
Department of Biochemistry,
Government Medical College,
Thrissur- 680596, Kerala, India.
E-mail: drno2007@gmail.com

DOI: 10.18410/jebmh/2020/322

How to Cite This Article:
Usha T, Vijayalakshmy RS, Sreedevi NS, et al. An analysis of glucose levels in normal pregnancy and pregnancy complicated by gestational diabetes mellitus. J Evid Based Med Healthc 2020; 7(31), 1531-1535. DOI: 10.18410/jebmh/2020/322

Submission 08-06-2020,
Peer Review 12-06-2020,
Acceptance 03-07-2020,
Published 30-07-2020.

BACKGROUND

Pregnancy is characterized by many metabolic adaptations which meet the energy needs of mother and developing foetus.[1] Fasting hypoglycaemia, postprandial hyperglycaemia and hyperinsulinemia are characteristic of normal pregnancy. A state of progressive insulin resistance which usually begins in the second trimester and progresses throughout the remainder of pregnancy occurs due to placental secretion of hormones such as progesterone, oestrogen, placental lactogen, prolactin and cortisol and ensures that the foetus has an adequate supply of glucose. This insulin resistance results in a compensatory increase in β cell response and hyperinsulinemia in normal pregnancy. Pregnancy can be regarded as a diabetogenic condition characterized by insulin resistance with a compensatory increase in β cell response and hyperinsulinemia.[2] GDM represents a cross section of young women with glucose intolerance and mechanisms that lead to chronic insulin resistance. This research was trying to compare glucose levels in both gestational diabetic and normal mothers.

Diabetes mellitus in pregnancy continues to be a relatively neglected problem and is not adequately recognized. Studies have revealed an increase in the prevalence of GDM with age, status of gravid and Body Mass Index (BMI). Weight gain and additional pregnancies independently increase the risk of developing diabetes. A knowledge of risk factors helps in identifying abnormal glucose tolerance that may be mild and asymptomatic. Most of those women with GDM would not be diagnosed to have abnormal glucose tolerance because majority have lower glucose levels and only some have glucose levels that would be diagnostic of diabetes outside pregnancy. Pregnancy, in essence, serves as a metabolic stress test that uncovers underlying insulin resistance and β cell dysfunction.[1]

GDM is detected through screening of pregnant women for clinical risk factors. It appears to result from the same broad spectrum of physiological and genetic abnormalities that characterize diabetes outside of pregnancy. GDM thus provides a unique opportunity to study the early pathogenesis of diabetes and develop interventions to prevent progression of the disease and this was one of the reasons for taking up this study. It was found that the degree of glucose intolerance during pregnancy was related to the risk of developing diabetes after pregnancy. Treatment of GDM reduces perinatal morbidity and maternal complications. Management of insulin resistance at this stage is associated with a reduction in the risk of diabetes and preservation of β cell function.[2]

We wanted to analyse glucose levels in normal pregnancy and pregnancy complicated by GDM.

METHODS

The study was conducted in the Department of Obstetrics and Gynaecology, Institute of Maternal and Child Health, Medical College, Calicut.

A total of 200 subjects were included in the study. The subjects were divided into two groups, comprising of controls and cases. Women with diabetes, hypertension and renal disease diagnosed before pregnancy were excluded from the study. The control group included 150 healthy pregnant women with no history of GDM. The cases included 50 pregnant women with GDM diagnosed by OGCT. For OGCT, they were given 50 gm of glucose in about 200 mL of water over 2 to 3 minutes. Exactly at 1 hour, 1 ml of blood is drawn from a forearm vein using a disposable syringe under aseptic precautions into a clean dry bottle containing oxalate. The blood glucose is determined by the Glucose Oxidase/Peroxidase method. (GOD/POD method) The study was conducted for a period of two years. The subjects were selected by random sampling method.

All statistical data were analysed using SPSS software version 16. Continuous variables were expressed as mean ± standard deviation. Qualitative data was expressed as percentage. Independent t test was used for comparing quantitative data between two groups.

RESULTS

The present study on GDM was conducted in a total of 200 subjects divided into two groups. One of the groups comprised of 50 women with GDM and the other included 150 normal pregnant controls.

The mean age of normal pregnant study subjects was 23.76 years. The category fell between 19 years and 30 years. The gravid status of normal pregnant mothers ranged from 1-5 and parity from 0-4. The mean duration from last delivery was 1.37 years among normal pregnant mothers. The normal pregnant group had a range of 0-3 abortions, while had no history of abortion.

Mean systolic BP of normal pregnant category was 113.17 mmHg and it ranged between 110-122 mmHg. Mean diastolic BP was 73.13 mmHg and it ranged between 70-84 mmHg. The mean height and weight of normal pregnant group was 1.56 m and 57.33 Kg respectively. The average BMI was 23.42 among normal pregnant mothers.

The mean age of GDM study subjects was 26.24 years. The category fell between 19 years and 31 years. The gravid status of GDM mothers ranged from 1-6 and parity from 0-5. The mean duration from last delivery was 1.74 years among GDM mothers. The GDM group had a range of 0-3 abortions, while majority had no history of abortion.

Mean systolic BP of GDM category was 122.04 mmHg and it ranged between 110-150 mmHg. Mean diastolic BP was 79.76 mmHg and it ranged between 70-100 mmHg. The mean height and weight of GDM group was 1.54 m and 64.24 Kg respectively. The average BMI was 26.98 among GDM mothers.

The mean value of blood glucose in women with GDM was 147.86 mg/dL and that in normal pregnant women was 103.59 mg/dL. The p value was< 0.001 (highly significant).

Blood Glucose (mg/dL)		
	GDM	Controls
Mean	147.86	103.59
SD	14.48	13.72
p value <0.001		

Table 1. Comparison of Blood Glucose in Women with GDM and Normal Pregnant Controls

DISCUSSION

In current study the mean value of blood glucose in women with GDM and normal pregnant women was compared. The blood glucose level in GDM category was significantly high.

Hyperinsulinemia of normal pregnancy is associated with several unique responses to glucose uptake. Serial glucose tolerance tests indicate a progressive decline in glucose tolerance with advancing gestation. During early pregnancy, glucose tolerance is normal or slightly improved and peripheral sensitivity to insulin and hepatic basal glucose production are normal. Insulin responses to oral glucose are also greater in the first trimester than before pregnancy. These observations are consistent with a 120% increase in the first phase of insulin response following IV glucose administration during 12 to 14 weeks gestation. The first phase response refers to the change in insulin concentration from 0 to 5 minutes after IV glucose. The rate of insulin release relative to the glucose concentration 5 to 60 minutes after IV glucose administration, referred to as the second phase of insulin response, is not significantly different from the non-pregnant state.[3] Longitudinal studies of glucose tolerance shows a progressive decline with advancing gestation. In late pregnancy, there are higher peaks of plasma glucose concentration, a delay in rise to the peak concentration and an increase in total area under the glucose tolerance curve compared with the non-pregnant state.[4] Pregnant women, however, maintain efficient glucose homeostasis with slightly lower preprandial and higher postprandial glucose concentration following mixed meals. Glucose levels change little when compared to large changes in insulin sensitivity because of compensatory hyperinsulinemia.[5] The glucose tolerance curve in pregnancy differs from that in the non-pregnant state as below.

Majority of women with GDM have β cell dysfunction occurring on a background of chronic insulin resistance. The mechanisms underlying insulin resistance of pregnancy are exaggerated in women with GDM.[6] A longitudinal study conducted by Xiang et al[7] in Latino women with GDM revealed an increased resistance to the effects of insulin on glucose clearance as well as suppression of glucose production and fatty acid levels. These women were found to have 6% higher glucose production, 9% lower glucose clearance and higher circulating FFA levels. Catalano et al[8,9] conducted the most detailed metabolic testing in pregnant women with GDM and observed a 22% reduction in insulin-mediated glucose uptake. Linda et al[7] observed a 65% reduction in insulin-stimulated glucose transport in GDM. Ward et al[10] and Ryan et al[11] also had observations consistent with the above findings. A longitudinal study[12] on insulin suppression in early pregnancy and late pregnancy in subjects with normal glucose tolerance and women with GDM concluded that the ability of insulin to suppress whole-body lipolysis which is reduced in normal pregnancy is further reduced in GDM. Increase in FFAs and hepatic glucose production has been documented in GDM in several studies.[13,14,15,16]

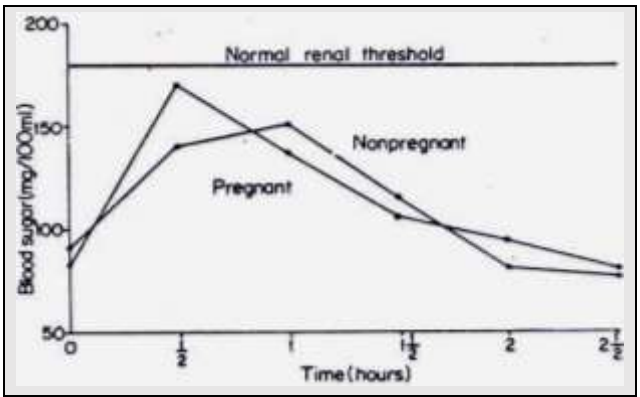

Figure 1. Glucose Tolerance Curve during Normal Pregnancy

A prospective study conducted by Homkoet al[17] found that women with GDM have 27% lower insulin sensitivity index and 40% more insulin resistance. A cross-sectional study[18] in Hispanic women with GDM has documented 63% and 70% lower insulin responses to oral and intravenous glucose respectively. Patients with GDM are insulin resistant and by third trimester have quite severe resistance approaching the degree of resistance in non-pregnant women with type 2 diabetes.[16,17] Insulin resistance, however, is not sufficient to cause diabetes unless the person has defective insulin secretion as well.[5] It has long been thought that GDM develops in women who cannot increase their insulin secretion when faced with increased insulin needs imposed by late pregnancy. However, several studies do not support this concept.[5] The increase occurs along an insulin-sensitivity curve which is about 50% lower (50% less insulin for any degree of insulin resistance) than that of normal pregnant women.[5] Osei et al[19] also reported similar findings in African American women with GDM. A longitudinal study conducted by Damm[20] in women with GDM revealed a state of relatively reduced insulin secretion to oral glucose compared to pregnant controls.

In present study glucose tolerance was compared in normal pregnancies and women with GDM. All subjects had a 50 gm 1-hour OGCT done at 24 to 28 weeks of gestation. OGCT is the most widely accepted screening test for detection of GDM. The mean plasma glucose in controls was found to be 103.59 mg/dL and that in GDM was 147.86 mg/dL. The difference was statistically highly significant with a p value of <0.001. Current recommendations from the ADA and ACOG accept a value of 130 mg/dL or 140 mg/dL for defining an abnormal initial screening test.[5,21] Using a value of 130 mg/dL or higher will increase the sensitivity of the test from 80 to 90% and decrease its specificity, compared with a value of 140 mg/dL. The lower screening level of 130 mg/dL identifies more patients with GDM at the cost of more false positive results. The light from more

studies in this aspect can help in formulation of newer guidelines, which can ultimately help in effective management of GDM.

The prevalence of diabetes in India is increasing at such alarming rates that every 5th diabetic in the world will likely be an Indian by the year 2030. Recent advances in the understanding of the link between GDM and type-2 diabetes can be used in clinical care aimed to prevent or delay development of diabetes in women with GDM and their offspring thereby decreasing the incidence and prevalence of diabetes in the population. Several researches have been conducted in this aspect. Angela et al has found there was no evidence of an effect of the intervention on measures of biochemistry or anthropometry; the effect on one health behaviour, diet adherence, was close to significance. Prevention programs must tackle the barriers to participation faced by this population; home-based interventions should be investigated. Strategies for promoting long-term health self-management need to be developed and tested.[22] Natalia et al concluded that lifestyle intervention was effective for the prevention of glucose disorders in women with prior GDM. Body weight gain and an unhealthy fat intake pattern were found to be the most predictive factors for the development of glucose disorders.[23]

CONCLUSIONS

Glucose tolerance is significantly reduced in GDM. Screening for GDM and adequate control measures help in detecting women with even minimal abnormality of glucose metabolism which may otherwise be undetected and progress to diabetes. This provides an opportunity to study early stages of glucose dysregulation thereby reducing foetal and neonatal complications as well as long term complications in mother and offspring.

Study was approved by Human Ethical Committee and Review Board of Institution. Study subjects were counselled separately about the study and a written consent was procured from them.
Financial or Other Competing Interests: None.

We thank Dr. Vijayalakshmy R, MD, Professor & Head (Retd.), Department of Physiology, Govt. Medical College, Calicut, for her scholarly guidance in the course of this work. We acknowledge Dr. N. S. Sreedevi, MD, DGO, Professor & Head (Retd.), Department of Obstetrics, Govt. Medical College, Calicut, for her unwavering support.

Financial or Other Competing Interests: None.

REFERENCES

[1] Setji TL, Brown AJ, Feinglos MN. Gestational diabetes mellitus. Clinical Diabetes 2005;23(1):17-24.
[2] Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes. Diabetes Care 2002;25(10):1862-1868.
[3] Butte NF. Carbohydrate and lipid metabolism in pregnancy: normal compared with gestational diabetes mellitus. American Journal of Clinical Nutrition 2000;71(Suppl 5):1256S-1261S.
[4] Gillmer MDG. Diabetes in pregnancy. Oxford text book of Medicine. Vol. 2. 4th edn. 2003: p. 1752-1758.
[5] Buchanan TA, Xiang AH. Gestational diabetes mellitus. J Clin Invest 2005;115(3):485-491.
[6] Barbour LA, McCurdy CE, Hernandez TL, et al. Cellular mechanisms for insulin resistance in normal pregnancy and gestational diabetes. Diabetes Care 2007;30(Suppl 2):S112 –S119.
[7] Xiang AH, Peters RK, Trigo E, et al. Multiple metabolic defects during late pregnancy in women at high risk for type 2 diabetes. Diabetes 1999;48(4):848-854.
[8] Catalano PM, Tzybir ER, Wolfe RR, et al. Carbohydrate metabolism during pregnancy in control subjects and women with gestational diabetes. Am J Physiol Endocrinol Metab 1993;264(1 Pt 1):E60-E67.
[9] Catalano PM, Huston L, Amini SB, et al. Longitudinal changes in glucose metabolism during pregnancy in obese women with normal glucose tolerance and gestational diabetes mellitus. Am J Obstet & Gynecol 1999;180(4):903-916.
[10] Ward WK, Johnston CLW, Beard JC, et al. Abnormalities of islet β cell function, insulin action and fat distribution in women with a history of gestational diabetes: relation to obesity. J Clin Endocrinol Metab 1985;61(6):1039-1045.
[11] Ryan EA, Imes S, Liu D, et al. Defects in insulin secretion and action in women with a history of gestational diabetes. Diabetes 1995;44(5):506-512.
[12] Buchanan TA. Glucose metabolism during pregnancy: normal physiology and implications for diabetes mellitus. Isr J Med Sci 1991;27(8-9):432-441.
[13] Damm P, Handberg A, Kuhl C, et al. Insulin receptor binding and tyrosine kinase activity in skeletal muscle from normal pregnant women and women with gestational diabetes. Obstet & Gynecol 1993;82(2):251-259.
[14] Shao J, Catalano PM, Yamashita H, et al. Decreased insulin receptor tyrosine kinase activity and plasma cell membrane glycoprotein over expression in skeletal muscle from obese women with GDM: evidence for increased Serine/Threonine phosphorylation in pregnancy and GDM. Diabetes 2000;49(4):603-610.
[15] Buchanan TA, Metzger BE, Freinkel N, et al. Insulin sensitivity and β cell responsiveness to glucose during late pregnancy in lean and moderately obese women with normal glucose tolerance or mild gestational diabetes. Am J Obstet & Gynecol 1990;162(4):1008-1014.
[16] Catalano PM, Tzybir ED, Roman NM, et al. Longitudinal changes in insulin resistance in non-obese pregnant women. Am J Obstet & Gynecol 1991;65(6 Pt 1):1667-1672.

[17] Homko C, Sivan E, Chen X, et al. Insulin secretion during and after pregnancy in patients with gestational diabetes mellitus. The Journal of Clinical Endocrine and Metabolism 2001;86(2):568-573.

[18] Buchanan TA. Pancreatic β-cell defects in gestational diabetes: implications for the pathogenesis and prevention of type 2 diabetes. The J Clin Endocrin and Med 2001;86(3):989-993.

[19] Osei K, Gillard TR, Schuster DP. History of gestational diabetes leads to distinct metabolic alteration in non-diabetic African–American women with a parental history of type 2 diabetes. Diabetes Care 1998;21(8):1250-1257.

[20] Damm P. Gestational diabetes mellitus and subsequent development of overt diabetes mellitus. Dan Med Bull 1998;45(5):495-509.

[21] American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2004;27:S5-S10.

[22] O'Dea A, Tierney M, McGuire BE, et al. Can the onset of type 2 diabetes be delayed by a group-based lifestyle intervention in women with prediabetes following Gestational Diabetes Mellitus (GDM)? Findings from a randomized control mixed methods trial. J Diabetes Res 2015;2015:798460.

[23] Pérez-Ferre N, Valle LD, Torrejón MJ, et al. Diabetes mellitus and abnormal glucose tolerance development after gestational diabetes: a three-year, prospective, randomized, clinical-based, mediterranean lifestyle interventional study with parallel groups. Clin Nutr 2015;34(4):579-585.