

**The Role of Umbilical Cord Thickness,  
Interventricular Septum Thickness and  
HbA1c Levels in the Prediction of Fetal  
Macrosomia in Patients with Gestational  
Diabetes Mellitus**

*Thesis*

Submitted for partial fulfillment of Master Degree  
in **Obstetrics and Gynecology**

*By*

**Noha Atteya Elsayed Mohamed Selim**

M.B.B.CH., 2006

Faculty of Medicine

Ain Shams University

*Under supervision of*

**Prof. Mohamed Sayed Ali Salem**

Professor of Obstetrics and Gynecology

Faculty of Medicine - Ain Shams University

**Dr. Rehab Mohamed Abdel Rahman Abdallah**

Lecturer of Obstetrics and Gynecology

Faculty of Medicine - Ain Shams University

**Faculty of Medicine  
Ain Shams University  
2015**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَقُلْ اَعْمَلُوا فَسَيَرَى اللَّهُ  
عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ

صدق الله العظيم

سورة التوبة آية (١٠٥)



## Acknowledgement

*First, thanks are all due to **Allah** for Blessing this work until it has reached its end, as a part of his generous help throughout our life.*

*My profound thanks and deep appreciation to **Prof. Mohamed Sayed Ali Salem**, Professor of Obstetrics and Gynecology, Faculty of Medicine - Ain Shams University, for his great support and advice, his valuable remarks that gave me the confidence and encouragement to fulfill this work,*

*I am deeply grateful to **Dr. Rehab Mohamed Abdel Rahman Abdallah**, Lecturer in Obstetrics and Gynecology, Faculty of Medicine - Ain Shams University for adding a lot to this work by her experience and for her keen supervision.*

*I am extremely sincere to **my family** who stood beside me throughout this work giving me their support.*

*Words fail to express my love, respect and appreciation to **my husband** for his unlimited help and support.*

---



*Noha Atteya Elsayed Mohamed Selim*

# List of Contents

	Page
Acknowledgment .....	--
List of Abbreviations .....	i
List of Figures .....	ii
List of Tables .....	v
Introduction and Aim of The Work .....	1
Review of Literature .....	5
<b>Chapter 1 : Gestational diabetes</b> .....	5
<b>Chapter 2 : Glycated hemoglobin</b> .....	33
<b>Chapter 3 : Fetal Macrosomia</b> .....	46
<b>Chapter 4 : Fetal Echocardiography</b> .....	52
Patients and Methods .....	69
Results .....	74
Discussion .....	96
Summary .....	103
References .....	106
Arabic Summary .....	--

## **List of Abbreviations**

ACCORD	: Action to Control Cardiovascular Risk in Diabetes
ACOG	: American college of obstetrician and gynecology.
ADA	: The American Diabetes Association
BMI	: Body mass index
DCCT	: Diabetes Control and Complications Trial
EASD	: European Association for the Study of Diabetes
GDM	: Gestational diabetes mellitus
HAPO	: Hyperglycemia and Adverse Pregnancy Outcome
HbA1	: hemoglobin A1
HGF	: Hepatocyte growth factor
HPLC	: High-performance liquid chromatography
IDF	: International Diabetes Federation
IFCC	: International Federation of Clinical Chemistry and Laboratory Medicine
IVS	: Interventricular septum
NGSP	: National Glycohemoglobin Standardization Program
OGTT	: Oral glucose tolerance test
PSL	: Prednisolone

## **List of Abbreviations** (Cont.)

RTK	: Receptor Tyrosine kinase
T2DM	: Type 2 diabetes mellitus
TNF	: Tumor necrosis factor
VADT	: Veterans Affairs Diabetes Trials
WHO	: World health organization

# List of Figures

<b>Fig.</b>	<b>Title</b>	<b>Page</b>
1	Universal blue circle symbol for diabetes.	5
2	Effect of insulin on glucose uptake and metabolism.	14
3	A kit with a glucose meter and diary used by a woman with gestational diabetes.	24
4	Standardized transverse scanning planes for fetal echocardiography include an evaluation of the 4-chamber view (1), arterial outflow tracts (2 and 3), and the 3-vessel and trachea view (4).	66
5	Sagittal views of the superior and inferior venae cavae (1), aortic arch (2), and ductal arch (3).	67
6	Low and high short-axis views of the fetal heart.	68
<b>Results</b>		
1	Mean umbilical cord, umbilical artery, and umbilical vein diameters in patients with GDM or normal controls.	83
2	Mean Wharton jelly area in patients with GDM or normal controls.	84
3	Mean IVS thickness in patients with GDM or normal controls.	85
4	Mean HbA1c level in patients with GDM or normal controls.	86
5	Incidence of fetal macrosomia in patients with GDM or normal controls.	87
6	Receiver-operating characteristic (ROC) curves for discrimination between patients with GDM and normal controls using various sonographic measures or HbA1c level.	88

## List of Figures (Cont.)

<b>Fig.</b>	<b>Title</b>	<b>Page</b>
7	Prevalence of GDM in patients with or without fetal macrosomia.	93
8	Mean umbilical cord, umbilical artery, and umbilical vein diameters in patients with or without fetal macrosomia.	95
9	Mean Wharton jelly area in patients with or without fetal macrosomia.	96
10	Mean IVS thickness in patients with or without fetal macrosomia.	97
11	Mean HbA1c level in patients with or without fetal macrosomias.	98
12	Receiver-operating characteristic (ROC) curves for discrimination between patients with or without fetal macrosomia using various sonographic measures or HbA1c level.	100



# List of Tables

<b>Table</b>	<b>Title</b>	<b>Page</b>
1	WHO diabetes diagnostic criteria.	16
2	Tests for gestational diabetes.	17
3	Data in parentheses are 95% confidence intervals.	40
<b>Results</b>		
1	Characteristics of patients with GDM and normal controls	81
2	Outcome measures in patients with GDM and normal controls	82
3	Receiver-operating characteristic (ROC) curve analysis for discrimination between patients with GDM and normal controls using various sonographic measures or HbA1c level	88
4	Comparison of the receiver-operating characteristic (ROC) curves for discrimination between patients with GDM and normal controls using various sonographic measures or HbA1c level	90
5	Characteristics of patients with or without fetal macrosomia	92
6	Outcome measures in patients with or without fetal macrosomia	94
7	Receiver-operating characteristic (ROC) curve analysis for discrimination between patients with or without fetal macrosomia using various sonographic measures or HbA1c level	99

# Abstract

**Introduction:** Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. The prevalence may range from one to 14% of all pregnancy depending on population study and diagnostic test. Gestational diabetes mellitus is associated with an increased risk for adverse maternal as well as neonatal outcome.

**Aim of The Work:** The aim of this work is the prediction of fetal macrosomia by measuring: HbA1c level. ; Umbilical cord thickness; Interventricular septum thickness.

**Patients and Methods :** This prospective case-control study was carried out at Ain shams University maternity hospital between April 2015 and October 2015 on 80 patients. The patients were divided into two groups, 40 pregnant women as case group with gestational diabetes mellitus and 40 non-diabetic pregnant women as control group after being approved by the local hospital ethics and research committee.

GDM is associated with an increased risk of fetal macrosomia which has adverse maternal as well as neonatal outcomes, maternal complications such as postpartum heamorrhage, infections as well as third to fourth vaginal lacerations because of operative delivery due to macrosomia. Fetal macrsomia complicates 20-30% of pregnancies with (GDM).

Fetal complications like shoulder dystocia during delivery and brachial plexus injury. Both neonatal mortality and morbidity are higher in macrosomic fetuses compared with normal weight fetuses. Ceaserian section performed for fetal macrosomia are not rare at all, birth weight of the fetus is an important factor in determining the mode of delivery as the fetus is considered macrosomic if fetal weight is higher than or equal 4 kg.

**Keywords:** GDM : Gestational diabetes mellitus; HbA1:hemoglobin A1

---

## Introduction

The umbilical cord is responsible for materno-fetal blood flow. Normally, it is composed of two arteries permeated with venous blood and a vein that transports arterial blood, cushioned by a special type of mucous connective tissue known as Wharton's jelly and by remnants of the allantois (*Wang et al., 2004*).

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy (*Bener et al., 2011*).

The prevalence may range from one to 14% of all pregnancy depending on population study and diagnostic test (*Aslan et al., 2011*).

Gestational diabetes mellitus is associated with an increased risk for adverse maternal as well as neonatal outcome (*Ogonowski et al., 2011*).

Maternal hyperglycemia leads to fetal hyperglycemia, which stimulates pancreatic islet cells; and consequently fetal hyperinsulinemia. This state results in excessive fat tissue and total body size (*Zawiejska et al., 2008 and Stotland et al., 2004*), and the major reason for

---

poor perinatal outcome is accelerated fetal growth and macrosomia (*Khan et al., 2007*).

Fetal macrosomia complicates 20–30 % of pregnancies with gestational diabetes mellitus (GDM) (*de Onis et al., 2010*).

The birth of a macrosomic fetus has been associated with adverse outcomes for both mother and fetus. Shoulder dystocia during delivery and related permanent brachial plexus injury may be seen. Both neonatal mortality and morbidity are higher in macrosomic fetuses compared with normal weight fetuses (*Ghezzi et al., 2007*).

Maternal complications such as postpartum hemorrhage, infections, as well as third- or fourth-degree vaginal lacerations may occur because of operative delivery (*Ferber et al., 2010*).

Today, cesarean sections performed for fetal macrosomia are not rare at all. Birth weight of the fetus is an important factor in determining the mode of delivery, but pelvic assessment should not be ignored (*Hadlock et al., 2005*).

The presence of hyperglycemia influences biochemical transformation processes in the fetus (*Corrigan et al., 2009 and Langer et al., 2000*).

In addition, maternal diabetes induces placental genes related to chronic stress and inflammation, and recent data suggest the potential role of inflammation for embryopathy related to maternal diabetes (*Desoye et al., 1996*).

The myocardial tissue is the most likely structure affected by hyperglycemia. The ventricular free walls are less affected by hypertrophy compared with the interventricular septum (IVS) (*Gandhi et al., 1995*).

## Aim of The Work

The aim of this work is the prediction of fetal macrosomia by measuring:

1. HbA1c level.
2. Umbilical cord thickness.
3. Interventricular septum thickness.

## Gestational diabetes

### **Definition :**

**Gestational diabetes** (or **gestational diabetes mellitus, GDM**) is a condition in which women without previously diagnosed diabetes exhibit high blood glucose (blood sugar) levels during pregnancy (especially during their third trimester).



**Fig. (1):** Universal blue circle symbol for diabetes  
(Diabetes Blue Circle Symbol, 2006)

Gestational diabetes is caused when insulin receptors do not function properly. This is likely due to pregnancy-related factors such as the presence of human placental lactogen that interferes with susceptible insulin receptors. This in turn causes inappropriately elevated blood sugar levels (*Thomas et al., 2005*).

Gestational diabetes generally has few symptoms and it is most commonly diagnosed by screening during pregnancy. Diagnostic tests detect inappropriately high levels of glucose in blood samples. Gestational diabetes affects 3-10% of pregnancies, depending on the population studied (*Thomas et al., 2005*).