The Association between Birth Weight 4000g or Greater and Perinatal Outcome in Patients With and Without Gestational Diabetes Mellitus

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Abstract

Fetal macrosomia is associated with adverse perinatal outcomes. This includes stillbirth, neonatal mortality secondary to birth asphyxia, shoulder dystocia, birth injury, and meconium aspiration syndrome, and after birth, neonatal respiratory distress, hypoglycemia and hyperbilirubinemia.

The aim of this study was to evaluate the association between birth weight 4000g or greater and perinatal outcome in mothers with and without gestational diabetes.

This study was carried out on 100 neonates of either diabetic or non diabetic mothers who were delivered in 6th October and Benha University Hospitals and Ahmed Maher Teaching Hospital during the period from November 2011 to August 2012. The neonates had been divided into two groups to compare between perinatal outcome (birth injury i.e. shoulder dystocia, and brachial plexus injury, neonatal respiratory distress, hypoglycemia and hyperbilirubinemia).

The 1st group (patients) included 50 newborns with birth weight 4000g or more, while the 2nd group (control) included 50 newborns with birth weight less than 4000g.

In the present study maternal Body Mass Index (BMI) has significant effect on neonatal birth weight, where the mothers with higher BMI have higher incidence to have macrosomic babies, the mothers with history of a macrosomic baby have higher incidence to have macrosomic baby, and the multiparous mothers have higher incidence to have a macrosomic baby than primiparas. Gestational Diabetes Mellitus (GDM) is a risk factor for macrosomia and other neonatal complications.

In the macrosomic group, 34 out of 50 newborn (68%) had no complications while the other 16 (32%) had complications in the form of shoulder dystocia in 6%, jaundice in 10%, respiratory distress in 8%, hypoglycemia in 6%, and Erb's palsy in 2%, while in control, 41 out of 50 newborn (82%) had no complications and 9 (18%) had complications in the form of jaundice in 12%, respiratory distress in 4% and hypoglycemia in 2%.

In this study, we report that not only does birth weight of 4000 g or greater increase the prevalence of adverse perinatal outcomes such as hypoglycemia, RDS, shoulder dystocia and Erb's palsy, but also that GDM status increases this risk even further. When both birth weight of 4000g or greater and GDM are present, the effect estimates of these outcomes appear to be more than additive.

Key Words: Macrosomia – BMI (Body Mass Index) – GDM (Gestational Diabetes Mellitus).

Introduction

MACROSOMIA (birth weight or estimated fetal weight 4500g or greater than 4000g irrespective of gestational age) is associated with adverse perinatal outcome. These include stillbirth, neonatal mortality secondary to birth asphyxia, shoulder dystocia, birth injury and meconium aspiration syndrome and after birth neonatal respiratory distress, hypoglycemia and hyperbilirubinemia [1].

Whereas these associations have been reported, what is less clear is the causal relationship between increased birthweight and these outcomes and whether these relationships are modified by the presence of other risk factors. Do all macrosomic fetuses experience the same risks or does genetic predisposition toward greater birth weight or the intrauterine environment alter both the short- and long-term consequences of macrosomia? [2].

Although the majority of macrosomic babies are born to nondiabetic mothers, gestational diabetes mellitus (GDM) remains a well-established risk factor [3].

Multiple studies have shown that GDM by itself, even in the absence of macrosomia, predisposes a patient to an increased risk of undesirable perinatal outcomes. These include intrauterine fetal demise, neonatal death, shoulder dystocia and preeclampsia [4].
Although previous studies have attempted to address the question of adverse outcomes associated with either macrosomia or GDM, there is a paucity of data focusing on the effects of both together. In particular, because women with GDM are more likely to have macroscopic neonates because of intrauterine effects of hyperglycemia whereas women without GDM may have macroscopic neonates because of a genetic predisposition, the neonatal outcomes in these 2 settings may differ [5].

Maternal diabetes is only one of the factors associated with fetal overgrowth; most large for gestational age (LGA) infants are born to non-diabetic mothers. Several other conditions frequently associated with fetal overgrowth are maternal obesity, multiparity and previous delivery of an infant heavier than 4000g. A positive relationship has been found between maternal prepregnancy weight and neonatal weight-height index, in both diabetic and control subjects [6].

There is an increased incidence of LGA infants, not only in pregnant women who equal or exceed the threshold values defining gestational diabetes (GDM) on an oral glucose tolerance test (OGTT), but also among women exhibiting lower degrees of glucose intolerance [7].

Glucose crosses the placenta by facilitated diffusion; therefore, maternal hyperglycaemia imposes a carbohydrate surplus on the fetus. The fetus responds with increased secretion of insulin. Because insulin is an anabolic hormone, fetal hyperinsulinaemia stimulates protein, lipid and glycogen synthesis to cause macrosomia [8].

Accurate diagnosis of fetal macrosomia would permit fetuses to be delivered by cesarean section, thus obviating the complications of macrosomia. On the other hand, liberal cesarean section may expose the mother to unnecessary operative risks. Two methods exist to identify the newborn who weighs 4000g or more before birth, clinical evaluation and sonography [9].

The introduction of real-time ultrasonography has enabled the clinician to reproducibly and accurately measure fetal structures. As fetal weight cannot be measured directly, it must be estimated from other anatomic parameters and a variety of weight estimation functions have been derived based primarily on head, abdomen and limb measurements [10].

The initial examination of a newborn infant should be performed as soon as possible after delivery to detect abnormalities and to establish a baseline for subsequent examination. Infants should have temperature, pulse, respiratory rate, color, type of respiration or until stabilized, tone, activity, and level of consciousness monitored every 30 min after birth for 2 hr [11].

Examination of the newborn should include an evaluation of growth and an observation of behavior. The average term newborn weighs approximately 3.4kg (7.5 lb); boys are slightly heavier than girls are. The average length and head circumference are about 50cm (20 in) and 35cm (14 in), respectively, in term infants. Each newborn’s growth parameters should be plotted on growth curves specific for that infant’s gestational age to determine the appropriateness of size. The infant’s response to being examined may be useful in assessing its vigor, alertness, and tone [12].

Patients and Methods

This study was carried out on 100 neonates delivered for either diabetic or non diabetic mothers, in 6th October and Benha University Hospital and Ahmed Maher Teaching Hospital during the period from November 2011 to August 2012. The neonates had been divided into two groups: The first group (patients) included 50 newborn with birth weight 4000g or more while the second group (control) included 50 newborn with birth weight less than 4000g. The perinatal outcomes (shoulder dystocia, brachial plexus injury, neonatal respiratory distress, hypoglycemia and hyperbilirubinemia) had been compared between the two groups.

Inclusion criteria:
- Single pregnancy.
- Full term pregnancy.
- Medical care during pregnancy.
- Mothers screened for gestational diabetes mellitus (GDM).

Exclusion criteria:
- Multiple gestations.
- Prepregestational diabetes mellitus.
- Newborns with congenital anomalies.
- Newborns with noncephalic presentation.
- Cesarean delivery without a trial of normal labor.

Shoulder dystocia, brachial plexus injury, neonatal respiratory distress, hypoglycemia and hyperbilirubinemia were defined using standard definitions:

1- Shoulder dystocia was defined as a prolonged head-to-body delivery time and/or the use of obstetric maneuvers.
2- Brachial plexus injury was defined as short-term paralysis of the arm thought to be secondary to birth trauma as determined by the pediatricians and neonatologists.

3- Neonatal RDS was diagnosed by the presence of at least 2 of the following 3 criteria:
   • Evidence of respiratory compromise (tachypnea, retractions, and/or nasal flaring) shortly after delivery and a persistent oxygen requirement for >24 hours.
   • Administration of exogenous pulmonary surfactant, and/or
   • Radiographic evidence (atelectasis, air bronchograms and a diffuse reticulogranular infiltrate) of neonatal pulmonary hyaline membrane disease as diagnosed by an attending pediatric radiologist or neonatologist.

4- Hypoglycemia was defined as blood glucose <45mg/dL or plasma glucose less than 50mg/dL.

5- Hyperbilirubinemia was defined as T.S.B >5mg/dL.

Both groups of the newborns (patient and control) were subjected to:
1- **Full history taking including:**
   • Personal history (infant data): Sex, name, date, place of birth, gestational age, birth weight.
   • Complaints.
   • Parents data: Father’s and Mother’s name, age, occupation, blood group and consanguinity.
   • Family history: Father's and mother's illness and history of previous pregnancies.
   • Present history: Onset, duration and course of the complaint.
   • Obstetrical history: Gravidity, parity, abortions living children, diseases and/or distress for medication during pregnancy, sings of fetal distress and method of delivery.
   • Full resuscitation data: (If required ), APGAR score at 1 and 5 minutes and meconium staining of the amniotic fluid.

2- **Complete clinical examination including:**
   • Assessment of gestational age using new Ballard Score and anthropometric measures.
   • Vital data: Pulse, temperature respiratory rate heart rate, voiding of urine and passage of stools.
   • Meticulous systemic examination: Head and neck, ENT, chest, heart CNS & reflexes, pelvis, skeletal system, skin and genitalia.

3- Laboratory investigations including:
   • Random blood sugar for all newborns.
   • Other essential tests according to the case e.g. serum bilirubin.

4- Radiological investigations:
   • Chest X-ray in cases of respiratory distress.

Antenataly, the mothers were subjected to:
1- **History & identification of risk factors including:**
   • Full personal and menstrual history.
   • Full obstetric history and history of macrosomic baby and weight gain during pregnancy.

2- **Body mass index:**
   • Body weight in kilogram/(Height in meter)$^2$.

3- Glycosylated hemoglobin (A1C).

4- **Antenatal estimation of fasting and postprandial (F&PP) blood glucose level:**
   • Early in pregnancy and at 28 weeks.

5- Serial ultrasound at 3rd trimester then every 4 weeks.

Ultrasonographic Prediction of Fetal Macrosomia:
1- **Abdominal Circumference (AC):**
   The plane in which the abdominal circumference is measured should be circular, including a short length of the umbilical vein and the stomach. In this case, the appropriate section should be obtained and displayed as centrally as possible with the minimum amount of outline beyond the edges of the screen. As the section is circular, the outline may be measured [13].

2- **Biparietal Diameter (BPD):**
   BPD is the width of cranium from parietal to parietal lobes. It is measured from a transverse plane through the skull at the level of the thalamus and cavum septi pellucidi, calculating the distance from the external surface of the cranial side near the transducer to the internal surface of the cranial side away from the transducer. It is most useful in the period of 10 to 28 weeks. The ability to measure BPD is related to the station of the presenting part. At a lower station (0 to +1), BPD is more difficult to measure [14].
3- Femur Length (FL):

The FL measured by ultrasound is the linear distance between the proximal and distal diaphyseal plates. It correlates with fetal length and in turn fetal age. Since the epiphyseal portions are cartilaginous, they cannot be as readily visualized. FL can be used at 12 weeks of gestation and later [15].

4- Estimated fetal weight formulas:

Although several methods appear to give similar results, yet, these involving HC, AC and FL are currently most appropriate and consistent [16].

Statistical analysis:

The Patient's data were compared between both study groups using the chi-square test and differences in continuous variables between the groups were analyzed using the two-sided \( t \)-tests. \( p \)-values <0.05 were considered significant.

Results

All results are illustrated in the following Tables and Figures.

Table (1): Mothers ages in patients and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age of the mothers</th>
<th>( t )-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Patients</td>
<td>19.000-36.000</td>
<td>27.260±4.309</td>
</tr>
<tr>
<td>Control</td>
<td>19.000-36.000</td>
<td>26.440±3.924</td>
</tr>
</tbody>
</table>

Table (2): Mothers BMI in macrosomic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mothers BMI (kg/m²)</th>
<th>( t )-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Macrosomic</td>
<td>23.000-30.800</td>
<td>27.304±1.816</td>
</tr>
<tr>
<td>Control</td>
<td>22.300-30.100</td>
<td>26.320±1.824</td>
</tr>
</tbody>
</table>

Table (3): FL by antenatal ultrasound at 37 week of macrosomic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>FL</th>
<th>( t )-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Macrosomic</td>
<td>72.400-79.900</td>
<td>75.620±1.690</td>
</tr>
<tr>
<td>Control</td>
<td>67.900-74.200</td>
<td>70.990±1.604</td>
</tr>
</tbody>
</table>

Table (4): BPD in macrosomic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>BPD</th>
<th>( t )-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Macrosomic</td>
<td>90.700-102.000</td>
<td>96.020±2.314</td>
</tr>
<tr>
<td>Control</td>
<td>91.000-98.300</td>
<td>93.956±1.484</td>
</tr>
</tbody>
</table>

Fig. (1): Mean of Mothers BMI in macrocosmic and control groups.

Fig. (2): Mean of FL by antenatal ultrasound at 37w of macrosomic & control groups.

Fig. (3): Mean BPD in macrosomic and control groups.
Table (5): AC in macrosomic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>AC Range</th>
<th>Mean±SD</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrosomic</td>
<td>339.600-371.000</td>
<td>356.044±6.482</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>310.000-336.000</td>
<td>321.048±5.702</td>
<td>28.665</td>
<td>&lt;0.001 *</td>
</tr>
</tbody>
</table>

Table (6): Estimated Fetal Weight (EFW) in macrosomic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>EFW Range</th>
<th>Mean±SD</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>3420.000-4103.000</td>
<td>3720.220±159.899</td>
<td>22.072</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Control</td>
<td>2720.000-3460.000</td>
<td>3023.080±155.918</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table (7): Mothers parity in macroscopic and control groups.

<table>
<thead>
<tr>
<th>Mothers parity</th>
<th>Groups</th>
<th>Patients</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>5</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>%</td>
<td>10.00</td>
<td>40.00</td>
<td>50.00</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>N</td>
<td>23</td>
<td>13</td>
<td>36</td>
</tr>
<tr>
<td>%</td>
<td>46.00</td>
<td>26</td>
<td>36.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>N</td>
<td>19</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>%</td>
<td>38.00</td>
<td>34.00</td>
<td>36.00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>N</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>%</td>
<td>6.00</td>
<td>0.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>N</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>%</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square $\chi^2$ 14.889

$p$-value $0.0019$

Fig. (10): Percentage of mothers parity in macroscopic and control groups.

Table (8): Maternal history of macroscopic baby in macroscopic and control groups.

<table>
<thead>
<tr>
<th>History of macroscopic baby</th>
<th>Groups</th>
<th>Patients</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>N</td>
<td>39</td>
<td>70.00</td>
<td>89</td>
</tr>
<tr>
<td>%</td>
<td>78.00</td>
<td>100.00</td>
<td>89.00</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>N</td>
<td>11</td>
<td>0.00</td>
<td>11</td>
</tr>
<tr>
<td>%</td>
<td>22.00</td>
<td>0.00</td>
<td>11.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>N</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>%</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square $\chi^2$ 12.360

$p$-value $0.001 *$

Fig. (11): Percentage of maternal history of macroscopic baby in macroscopic and control groups.

Table (9): Maternal GDM and birth injury in macroscopic group.

<table>
<thead>
<tr>
<th>G.D.M.</th>
<th>Birth injury</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>86.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Yes</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>6.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Chi-square $\chi^2$ 4.783

$p$-value $0.029 *$

Fig. (12): Percentage of maternal GDM and birth injury in macroscopic groups.

Table (10): Birth weight after delivery in macroscopic and control groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Birth weight</th>
<th>$t$-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>Mean $\pm$ SD</td>
<td>$t$</td>
</tr>
<tr>
<td>Patients</td>
<td>4080.000-4274.600</td>
<td>140.918</td>
</tr>
<tr>
<td>Control</td>
<td>2750.000-3139.380</td>
<td>196.555</td>
</tr>
</tbody>
</table>

Table (11): Relation between EFW and birth weight.

<table>
<thead>
<tr>
<th>EFW and Birth Weight</th>
<th>$r$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4500</td>
<td>0.469</td>
<td>0.001 *</td>
</tr>
</tbody>
</table>

Fig. (13): Mean of birth weight after delivery in macroscopic and control groups.
Table (12): Neonatal complications in macrosomic and control groups.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Groups</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients</td>
<td>Controls</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>34</td>
<td>41</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>68.00</td>
<td>82.00</td>
<td>75.00</td>
<td></td>
</tr>
<tr>
<td>Shoulder dystocia</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>6.00</td>
<td>0.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>N. jaundice</td>
<td>5</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>10.00</td>
<td>12.00</td>
<td>11.00</td>
<td></td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>8.00</td>
<td>4.00</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>6.00</td>
<td>2.00</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td>Erb's palsy</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>2.00</td>
<td>0.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square X² 6.744  
*p-value 0.345

Discussion

Macrosomia is defined as birth weight or estimated fetal weight greater than 4000g or 4500g irrespective of gestational age [1].

Fetal macrosomia has been associated with a range of maternal and perinatal complications. Macrosomic fetuses are more likely to experience adverse outcomes such as neonatal hypoglycemia, hypocalcemia, hyperbilirubinemia, polycythemia, shoulder dystocia, brachial plexus injury, clavicular fracture, birth asphyxia and neonatal mortality. Women delivering macrosomic fetuses are at an increased risk of cesarean section, vaginal and perineal trauma and post-partum haemorrhage [17].

Although the majority of macrosomic babies are born to non diabetic mothers, Gestational Diabetes Mellitus (GDM) remains a well-established risk factor [3].

Infants born to mothers with GDM have an increased risk for developing a range of adverse birth outcomes. However excessive fetal growth is the most common morbidity stemming from pregnancies complicated by GDM and occurs in 15%-45% of infants births to women with this condition during pregnancy [18].

In the present study the mothers age in both study groups ranged from 19 to 36 years which had no significant effect on birth weight; *p*-value= 0.322.

This agrees with the study from Nigeria, Ade sina reported that there were no significant differences in maternal age [19]. On the other hand, a study repoted by Oral et al., stated that maternal age over 35 years was a significant risk factor for macrosomic deliveries [20].

In the present study, the Body Mass Index (BMI) for the mothers of macrosomic group ranged from 23 to 30.8 with mean 27.304, while the BMI for the mothers of control group ranged from 22.3 to 30.1 with mean 26.32, with *p*-value=0.008. So mothers with higher BMI have higher incidence to have macrosomic baby.

This agrees with the study of Ehrenberg et al., done on 12,950 singleton births between January of 1997 and June of 2001. They found that pre pregnancy BMI and GDM were associated with LGA infants. The study noted that both obese and overweight women were more likely to deliver a LGA infant compared to women with a normal BMI [21].
Also Yogev et al., found that; obese women with normal glucose tolerance are also twice as likely to experience excessive fetal growth during pregnancy. Given the prevalence of obesity is much higher than GDM, obesity is likely to have a stronger influence on the development of excessive fetal growth [22].

In the present study, there is a significant relation between antenatal ultrasound measurements of Femur Length (FL), Biparietal Diameter (BPD) and Abdominal Circumference (AC) to estimate Fetal Weight in the last trimester, when these measures increase, Estimated Fetal Weight (EFW) increases and newborn body weight usually increases.

In the present study, the FL ranged from 72.4mm to 79.9mm in macrosomic neonates with mean 75.62mm, while in control group, FL ranged from 67.9mm to 74.2mm with mean 70.99mm; p-value=0.001.

This agrees with the study of Santolaya et al., who found that; the femur length is not affected by intrauterine growth abnormalities and that fetal subcutaneous tissue was greater in LGA fetuses. Also the fetal subcutaneous tissue/femur length ratio is a gestational age-independent parameter that has a greater sensitivity than the fetal abdominal circumference or estimated fetal weight formula for the intrapartum identification of large for gestational age fetuses [23].

However, Chauhan et al., who found that measurement of the femur length alone to estimate the birth weight in labor among females at term offers no advantage over the clinical estimate. Sonographic estimates would have to be based on two or more fetal measurements [24].

In the present study, the BPD in macrosomic neonates ranged from 90.7mm to 102mm with mean 96.02mm, while in control group, the BPD ranged from 91mm to 98.3mm with mean 93.956mm, p-value=0.001.

This agrees with the study performed by Al-Inany, who reported that; the biparietal diameter is most useful in the period of 10 to 28 weeks; later in pregnancy, it becomes a less reliable predictor of development. Biparietal diameter can be affected by variation in head shape; therefore it is best to use estimates based on the biparietal diameter in conjunction with other measures of fetal development [25].

In the present study, the AC in macrosomic neonates ranged from 339.6mm to 371mm with mean 356.044mm, and in control group, AC ranged from 310mm to 336mm with mean 321.048mm, p-value=0.001.

This coincides with the study of Smith et al., that included 3512 non diabetic women with a normally formed singleton fetus, an abdominal circumference measurement of the infant was measured within seven days of delivery. There was a linear relationship between abdominal circumference and birth weight [26]. In another retrospective study, the AC was very helpful in identifying potential macrosomic infants. If AC was <35cm, the risk of infant birth weights >4500g was <1%. If AC was >38cm, the risk was 37%, and more than 50% of these infants were identified [27].

In the present study, the Estimated Fetal Weight (EFW) in macrosomic neonates ranged from 3420g to 4103g with mean 3720.220g, while in control group it ranged from 2720.0g to 3460.0g with mean 3023.08, p-value=0.001.

This agrees with the study performed by Best and Pressman who reported that; ultrasound estimation of fetal weight is likely to be more accurate if longitudinal measurements and trends are taken into account rather than an individual measurement. Moreover, ultrasound fetal weight estimation is more accurate when performed at 34-37 weeks of gestation than at term, with an error in birth weight prediction of less than 15% in 91% of cases [28]. Also Chauhan et al., reported in their study that; in nondiabetic women, an ultrasound diagnosis of macrosomia is consistent with fetal outcomes in 15% to 79% of cases. In diabetic women, the ultrasound is consistent with fetal outcome in 44% to 81% of cases [29].

In the present study, 5 out of 50 mothers in macrosomic group were primigravida, 23 were second gravida, 19 were third gravida and 3 were fourth gravida, while in control group, 20 out of 50 mothers were primigravida, 13 were second gravida, 17 were third gravida and none of them were fourth gravida, p-value=0.0019.

This agrees with Bergman et al., who reported that; among the many factors that determine macrosomia, international studies have highlighted multiparity, pregestational overweight or obesity, prolonged gestation, excessive gestational weight gain and the occurrence of gestational diabetes as being the most important predictors [30,31]. Also Boulet et al., reported that parous women are 2-3 times more likely than nulliparous women to have macrosomic neonates [32].
In the present study, 39 out of 50 mothers in macrosomic group had no history of macrosomic baby and 11 of them had history of macrosomic baby, while in control group, all mothers had no history of macrosomic baby, \( p \)-value < 0.001.

This agrees with population based studies done by Walsh et al., who reported that parous women with previous delivery of a macrosomic neonate are 7-15 times more likely to deliver another macrosomic neonate in a subsequent pregnancy [33].

In the present study, 4 out of 50 neonates (8%) in macrosomic group had birth injury, 2 (4%) born to mothers with GDM and the other 2 (4%) born to non diabetic mothers, while in control group, no birth injury, \( p \)-value=0.029.

This agrees with Chu et al., who documented that; outcomes related to excessive fetal growth include shoulder dystocia, brachial plexus injuries, clavicle fractures, meconium aspiration, perinatal asphyxia, hypoglycemia and fetal death [34]. Also, Henriksen in 2008 reported that macrosomia is associated with a number of maternal and neonatal complications. There is increased an risk of cephalopelvic disproportion and shoulder dystocia in macrosomic deliveries that leads to traumatic birth injury and asphyxia. These risks are higher in infants of diabetic mothers than in infants of women without diabetes whose children have a similar birth weight [38].

In the present study, the birth weight after delivery ranged from 4080g to 4650g in macrosomic group with mean 4274.6g. While in control group, it ranged from 2750g to 3650g with mean 3139.38, \( p \)-value=0.001. There is a significant relation between estimated fetal weight (EFW) by ultrasound and the actual birth weights, \( r=0.469 \) and \( p \)-value=0.001.

This is similar to Sadeh-Mestechkin et al., who reported that; fetal weight can be estimated clinically and ultrasonographically [36]. Also Rhodes and Kenneth found that; ultrasound is helpful with a margin of error of 10-15%. This would be of value if performed after 38 weeks of gestation. This is because normal fetal growth is linear whereas macrosomic fetus has accelerated growth toward term [37].

In the present study, 34 out of 50 newborn (68%) in macrosomic group had no complications and 16 (32%) had complications in the form of: 3 (6%) had shoulder dystocia, 5 (10%) had jaundice, 4 (8%) had respiratory distress, 3 (6%) had hypoglycemia and one (2%) had Erb’s palsy. While in control group, 41 out of 50 newborn (82%) had no complications and 9 (18%) had complications in the form of: 6 (12%) had jaundice, 2 (4%) had respiratory distress and one (2%) had hypoglycemia, \( p \)-value=0.345.

This agrees with the study performed by Ju et al., who reported that; macrosomic fetuses are more likely to experience adverse outcomes such as shoulder dystocia, brachial plexus injury, clavicular fracture, birth asphyxia and neonatal mortality. Women delivering macrosomic fetuses are at an increased risk of cesarean section, vaginal and perineal trauma and post-partum haemorrhage [17].

In the present study, 4 out of 50 neonates (8%) in the macrosomic group had birth injury, all delivered normally, one (2%) had Erb’s palsy and the other 3 (6%) had shoulder dystocia. While in control group, no birth injury was detected, \( p \)-value=0.017.

This agrees with Nesbitt et al., who concluded that; the rates of shoulder dystocia increases linearly with infant birth weight and are highest among infants of mothers with diabetes. For example, the rate of shoulder dystocia is 34.8% for infants of diabetic mothers who weigh 4750 to 5000g at birth [38].This coincides also with Oral et al., who reported that brachial plexus palsy was 2.4% [20].

Also in a large study by Raio et al who studied neonates with birth weights >4500g. Shoulder dystocia and brachial plexus injuries occurred in about 10% and 3% of the newborns, respectively

In the present study, 5 out of 50 neonates (10%) in macrosomic group had neonatal jaundice while in control group, 6 out of 50 neonates (12%) had neonatal jaundice and all born to non diabetic mothers. The range of total serum bilirubin in macrosomic group was lower than control group, \( p \)-value=0.031.

This agrees with Tania et al., who found that; the prevalence of perinatal hyperbilirubinemia in patients without gestational diabetes and neonatal birth weight <4000g was 9.1% versus 7.6% in neonatal birth weight >4000g and the prevalence of perinatal hyperbilirubinemia in patients with gestational diabetes and neonatal and birth weight <4000g was 10.4 % versus 13.2% in neonatal birth weight >4000g [40].

In the present study, 4 out of 50 neonates (8%) in macrosomic group had respiratory distress; one of them born to mother with gestational diabetes
mellitus (GDM) and delivered by cesarean section after a trial of normal vaginal delivery, the other 3 born to normal mothers by normal vaginal delivery, while in control group, 2 out of 50 neonates (4%) had respiratory distress born to normal mothers by normal vaginal delivery, p-value=0.395.

This agrees with Tania et al., who found that; The prevalence of perinatal respiratory distress in patients without gestational diabetes and neonatal birth weight <4000g was 1.2% versus 1.7% in neonatal birth weight >4000g and prevalence of perinatal respiratory distress in patients with gestational diabetes and neonatal birth weight <4000g was 1.5% versus 4% in neonatal birth weight >4000g [40].

In the present study, 3 out of 50 neonates (6%) in macrosomic group had hypoglycemia, 2 of them born to mothers with gestational diabetes mellitus (GDM), while in control group, one neonate (2%) born to non diabetic mother had hypoglycemia.

This agrees with Tania et al., who concluded that; in non diabetic mothers, the incidence of neonatal hypoglycemia was 2-fold higher in the presence of birth weight of 4000g or greater compared with birth weight less than 4000g, and with the presence of both birth weight of 4000g or greater and GDM, the incidence of neonatal hypoglycemia was 2 times higher than in the group with GDM but birth weight less than 4000g [40], similar to our results. But Holtrop in 1993 reported that the rate of neonatal hypoglycemia was 10% in the macrosomia group [41].

Conclusion and Recommendations:

Antenatal ultrasound in last trimester is very important to expect fetal weight and macrosomia and to detect the optimal mode and timing of delivery to decrease the rate of birth injury and perinatal asphyxia.

Antenatal screening of GDM is very important as it is a risk factor for macrosomia and its related complications.

Our findings support that birth weight of 4000g or greater is associated with neonatal morbidity and the risks further increase in the setting of gestational diabetes. Such neonates should be screened by pediatricians for hypoglycemia and unrecognized Erb’s palsy. Hypoglycemia should be screened in 1st 24h of life at 1h, 2hs and 4hs after birth and then again until stabilization or satisfactory oral feeding starts and to start oral feeding as early as possible.

References


