Ultrasound Prediction of Fetal Macrosomia in Diabetic Women and its Effect on the Route of Delivery and the Outcome of Pregnancy

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Abstract:

Objective: The purpose of this study is to review the maternal and neonatal outcome in pregnant diabetic women given a trial of labor and delivered macrosomic infants (>4000 grams) and to assess the accuracy of birth weight prediction by ultrasound examination at term.

Methods: One hundred and twenty-nine charts of pregnant diabetic women were reviewed, sixty eight women were given a trial of labor and delivered macrosomic fetuses (>4000 grams), fifty of them had vaginal delivery and the other eighteen had caesarean delivery. In the other group, 61 patients delivered by elective caesarean section, for 41 of them the indication was fetal macrosomia (>4000 grams) as estimated by ultrasound examination and in the other 20, it was due to clinical estimation of big baby.

Maternal and neonatal complications were reviewed in each group. Maternal complications included lacerations, hemorrhage and infection and the neonatal complications evaluated were shoulder dystocia and associated birth trauma, asphyxia, and mortality. The accuracy of ultrasound in estimating fetal weight was also evaluated.

Results: Sixty eight (52.7%) women attempted a trial of labor; 73.5% delivered vaginally and 26.5% had a caesarean delivery. All, except two, had macrosomic fetuses (>4000 grams). Only one woman, of those who delivered vaginally, had postpartum hemorrhage due to atonic uterus. The incidence of shoulder dystocia for infants weighing 4000-4499 grams was 6.3% and those infants had the same incidence (6.3%) of brachial plexus injury.

There was no perinatal asphyxia or perinatal mortality among those infants who were delivered vaginally. There were no maternal complications for women who had caesarean delivery after labor (18 patients) but there was perinatal asphyxia in two infants who were treated properly without any neurological sequelae. Elective caesarean delivery was performed in 47.3% of the study population. There were no neonatal complications or perinatal mortality in this group of patients and only one woman had wound infection.

The sonographic prediction of fetal weight was accurate in 52.4% of the cases. The overestimation was in 50.8% of the estimated fetal weights and 49.2% of them were underestimated when compared to actual birth weights.

Conclusions: Caution should be taken in the use of sonographic estimations of fetal weight to guide obstetric decisions concerning labor and delivery. Special consideration should be given to diabetic patients having fetuses with estimated fetal weights between 4000 and 4500 grams. Flexibility in the management of these patients is best, taking in consideration their previous obstetric performance and if the estimated fetal weight is closer to 4500 grams than to 4000 grams, it is perhaps, better to proceed to a primary caesarean delivery.

Introduction:

Antenatal detection of the macrosomic fetus could provide for optimal selection of timing and route of delivery in pregnancies complicated by diabetes mellitus. These women are prone to an increased rate of cephalopelvic disproportion and shoulder dystocia accompanied by traumatic birth injury, including nerve, bone and soft tissue damage, asphyxia and even death of their babies.

Shoulder dystocia may complicate up to 50% of vaginal deliveries of the infants of diabetic mothers with birth weights in the 4500 grams range(1). A more significant observation is that brachial plexus injury occurs 18 times more frequently following delivery when maternal diabetes is present(2). The difference in shoulder dystocia risk between diabetic and non-diabetic women is attributed to differences in the reason for the fetus being large.
In non-diabetic women, large fetal size is often genetically determined and fetal fat mass is distributed in a similar pattern to other appropriately grown, but smaller, fetuses. In contrast, the fetus of a diabetic woman may be exposed to high plasma glucose concentrations, leading to fetal hyperinsulinemia\(^3\). During fetal life, insulin is a potent growth factor and excess insulin results in organomegalay and excess fat deposition, primarily in the chest and abdomen\(^4\). This increased chest-head and shoulder-head size discrepancy seems a possible explanation for a higher risk for shoulder dystocia\(^5\). Sonographic estimation of fetal size at term is frequently used in the management of diabetic pregnancies.

Most clinicians have looked to various logarithmic formulas for estimating fetal weight (EFW). Tamura et al\(^6\) demonstrated that differences by ultrasound at term in insulin-dependent women were as great as 900 gms in actual versus EFW. While a customized formula reduced the standard deviation of differences to 322 grams, this degree of potential error requires the obstetrician to utilize clinical judgment and percentile ranks of various sonographic parameters in addition to weight estimates when planning delivery of a suspected macrosomic fetus\(^7\). London along with others\(^7\) sought to identify fetal macrosomia, in particular enlarged asymmetric fetuses, by measuring the thickness of subcutaneous fat about the trunk and upper extremities.

Caesarean delivery essentially eliminates the serious adverse outcomes due to shoulder dystocia, but it has two primary drawbacks; first, the increase in maternal morbidity associated with caesarean delivery as compared to vaginal delivery, and second, the difficulty in accurately identifying fetal overgrowth antenatally. Death or permanent damage resulting from shoulder dystocia are both quite rare, as are also catastrophic maternal complications of caesarean delivery. The challenge for providers of obstetric care is to find the appropriate balance between fetal and maternal risk, between healthcare cost and personal cost, and to use the best tools to determine the optimal route of delivery\(^3\).

The purpose of this study was to review the maternal and neonatal outcome in pregnant diabetic women given a trial of labor and delivered macrosomic infants (≥4000 grams) and to assess the accuracy of birth weight prediction by ultrasound examination at term.

**Methods:**

A retrospective chart review was made of 129 pregnant diabetic women in the Women’s Hospital, Hamad Medical Corporation, Qatar. Medical records were abstracted for patient demographics, past obstetric history, estimated fetal weights, days from last ultrasound scan to delivery, exposure to induction of labor, delivery route, birth outcome, as well as maternal and perinatal complications. One hundred and one (78.3%) women were gestational diabetic patients who achieved control with diet only. Fourteen (10.9%) women were gestational diabetic patients treated with insulin and another fourteen (10.9%) women had pregestational diabetes and were treated with insulin during pregnancy.

Screening for diabetes during pregnancy by measurement of plasma glucose one hour after ingesting 50 grams of glucose is routine at the Women’s Hospital and at Health Centers. No special diet is necessary before the test. Usually the screening is between 24 and 28 weeks of gestation but for patients at high risk the screening is performed earlier (12 to 14 weeks) and if negative the test is repeated at 24 weeks and if again negative is repeated at 32 weeks. The patient might have gestational diabetes if the plasma glucose is ≥7.3 mmol/L (130 mg/dl) one hour after loading with 50 gram oral glucose; this is confirmed with a 3-hour glucose tolerance test (GTT) after ingesting 100 grams of glucose.

Patients whose one-hour screening test produced plasma glucose values >11 mmol/L (198 mg/dl) are considered gestational diabetics and do not need a 3-hour GTT. No screening test are used for patients with fasting plasma glucose level >7 mmol/L (126 mg/dl) or with random plasma glucose >11 mmol/L (198 mg/dl) as they are considered to be gestational diabetics. Patients with known pregestational diabetics are not screened.

All pregnant diabetic women are managed at the Women’s Hospital where there are two outpatient diabetic clinics operating for four days each week; one clinic run by a nutritionist and the other by an endocrinologist. Inpatients are managed by another nutritionist and endocrinologist.

The antenatal care visits for pregnant diabetic women are more frequent than in a normal pregnancy with more ultrasound scans and fetal surveillance with kick count, non-stress test and fetal echocardiogram and biophysical profile when needed. Fasting blood glucose and two hours post prandial are measured at every antenatal care visit.

Our protocol for pregnancy termination is to induce labor at 40 weeks for gestational diabetic women who are on diet control only and at 38 weeks for insulin-dependent diabetic patients. Induction of labour is performed by using prostaglandin E2 gel or tablets or by artificial rupture of membranes and syntocinon drips (synthetic oxytocin). Most of the obstetricians at Women’s Hospital perform elective caesarean section (CS) for women with estimated fetal weight (EFW) of 4000 grams or greater.

The study group have singleton pregnancies with no congenital anomalies, vertex presentation and having EFW and/or birth weight ≥4000 grams or having clinical estimation of
big babies by Leopold maneuver. The primary indication for elective CS was diabetes with macrosomia. All deliveries occurred between January 2001 and December, 2003.

Gestational age was calculated from the first day of the last reliable menstrual period and/or an ultrasonographic examination before 22 weeks. Late third trimester sonography was performed for fetal weight estimation for the study population by an expert ultrasonographer using a 3.5 MHZ curved - array transducer. The fetal weight was estimated by the Hadlock formula which incorporates head circumference, femur length and abdominal circumference in the regression equation. Our definition of a macrosomic fetus was an estimated fetal weight of > 4000 grams.

Our study population consisted of two groups, the first group, 68 patients, were given a trial of labor. Fifty of them delivered vaginally and 18 had an emergency CS. The second group 61 patients had elective CS, 41 of them due to an EFW > 4000 grams, and 20 patients had the elective caesarean section because of clinical estimation of big baby.

Primary outcome variables included the mode of delivery and incidence of neonatal and maternal complications. Antenatal prediction of macrosomia also was evaluated. Maternal complications evaluated were lacerations requiring repair, hemorrhage and infection. The neonatal complications evaluated were shoulder dystocia and associated birth trauma, asphyxia, and mortality. Birth trauma included Erb Palsy, Klumpke palsy and clavicular and humeral fractures.

Estimation of fetal weight were compared to actual birth weights of all infants delivering within 3 days of the ultrasound examination. The EFWs and birth weights were assigned to 500 grams intervals, and the correlation between these categories was calculated. The mean percent deviation of the birth weight from the EFW was calculated as follows: Percent deviation = (EFW - birth weight/EFW x 100).

**Results:**

We reviewed the maternal records of 129 pregnant diabetic women. Table 1 lists maternal characteristics. The mean maternal age was 34.1 ± 5.1 years. One hundred and three (79.8%) women were multiparous, 10.1% (13/129) were para I and 10.1% (13/129) were multipara. Fifty six (64/114) percent of the women were obese (90 kgs or more at the last prenatal visit). The maternal weight was not documented for 15 women. Fifty two (40.3%) of them had a previous macrosomic (> 4000 grams) infant and twenty five (19.4%) of them had a previous one caesarean section. The mean birth weight was 4191 ± 376 grams, the largest infant weighed 5342 grams. Sixty six percent (85/129) of the infants were males.

Table 1. Maternal Characteristics of the Study Population (129 women)

<table>
<thead>
<tr>
<th>Data</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>34.1 ± 5.1</td>
</tr>
<tr>
<td>Parity</td>
<td>4.1 ± 2.8</td>
</tr>
<tr>
<td>Gestational age at delivery (wk)</td>
<td>39.5 ± 1.4</td>
</tr>
<tr>
<td>Maternal weight at last prenatal visit (kg)</td>
<td>94 ± 17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity ≥ 90 kg</td>
<td>64/114</td>
<td>56.1</td>
</tr>
<tr>
<td>Gestational diabetic on diet</td>
<td>101</td>
<td>78.3</td>
</tr>
<tr>
<td>Gestational diabetic on Insulin</td>
<td>14</td>
<td>10.9</td>
</tr>
<tr>
<td>Pregestational diabetes</td>
<td>14</td>
<td>10.9</td>
</tr>
<tr>
<td>History of macrosomia</td>
<td>52</td>
<td>40.3</td>
</tr>
<tr>
<td>History of previous one CS</td>
<td>25</td>
<td>19.4</td>
</tr>
</tbody>
</table>

The analysis of our data were according to the route of delivery. 38.8% of the women had vaginal delivery and 14% had caesarean section after labor (emergency caesarean section). Elective caesarean section was performed for 61 women (47.3%), 31.8% because of EFW ≥ 4000 grams and 15.5% due to clinical estimation of big baby. Sixty-eight (52.7%) women attempted a trial of labour, fifty of them (73.5%) delivered vaginally and eighteen (26.5%) had an emergency caesarean section. The indication for caesarean section was failure to progress in nine patients and the other nine were due to big baby according to the clinical estimation of the attending obstetrician in labor room. In two cases of the latter, the indication was big baby and fetal distress. Forty five of the fifty women who delivered vaginally had an EFW less than 4000 grams ranging between 2575 and 3990 grams and the other five women had an EFW ranging between 4011 and 4329 grams.

The mean gestational age at the time of ultrasound was 37.3 ± 2.2 weeks and the mean interval between the ultrasound examination and delivery was 17.2 ± 15.9 days.

All women who delivered vaginally had a birth weight infants of ≥ 4000 (range 4000-4560) grams and the mean gestational age at delivery was 39.7 ± 1.3 weeks. Only one of those fifty women who delivered vaginally had postpartum haemorrhage (> 500 ml blood loss) due to atonic uterus.

Shoulder dystocia occurred in four of the fifty women who delivered vaginally. Three of them had brachial plexus injury, left Erb's palsy, needed physiotherapy and the fourth one was not affected (Table 2). The incidence of shoulder dystocia for infants with birth weights between 4000-4499 was 6.3% (three in 48) and all those infants had brachial plexus injury. One of
the three infants had left fracture clavicle in addition to the left Erby's palsy. Apgar score < 7 at 1 minute was found in 4 of the fifty infants who were delivered vaginally, three of them had shoulder dystocia and left Erby's palsy. Apgar score < 7 at 5 minutes was in one of them.

The four infants, who had shoulder dystocia, were admitted to neonatal intensive care unit but there was no perinatal mortality among them.

Eleven of the eighteen women who had an emergency caesarean delivery had EFW < 4000 (2871-3874) grams and seven had EFW > 4000 (4075-4916) grams. The mean gestational age at ultrasound scan was 38.4 ± 2.3 weeks and the mean interval between the ultrasound and delivery was 10.4 ± 13.3 days. All women, except two, had birth weights ≥ 4000 (4055-4908) grams. The other two birth weights were 3590 and 3615 grams.

The mean gestational age at delivery for the eighteen women was 39.9 ± 1.3 weeks. There was no maternal complications among these women who had emergency CS.

Apgar score < 7 at one minute was found in two of the eighteen infants, and in one of them Apgar score was < 7 at 5 minutes. The two infants who had low Apgar score, were admitted to neonatal intensive care unit due to fetal asphyxia. The first infant had a birth weight of 4895 grams, stayed 33 days in NICU with a diagnosis of hydrops fetalis, severe lactic acidosis, acute renal failure and cardiomyopathy. The second infant was of birth weight 4845 grams, stayed 5 days in NICU with a diagnosis of meconium aspiration syndrome and obstructive cardiomyopathy. Both infants were treated properly and recovered.

Of the 68 women, given a trial of labor, 18 (26.5%) were induced and the remaining, 50 women, had a spontaneous labor. Induction of labor was by prostaglandin E2, tab/gel, in 12 cases and by artificial rupture of membranes and syntocinon drip in 6 cases. Fifteen of the induced women delivered vaginally and three women had emergency caesarean delivery, two of them for no progress and one for big baby.

The other group of the study population were 61 (47.3%) women delivered by elective CS. Forty one of them, the elective CS was performed because the estimated fetal weights by ultrasound were ≥ 4000 (4000-4789) grams. The mean gestational age at ultrasound was 39 ± 1.3 weeks and the mean interval between ultrasound scan and delivery was 2.2 ± 2.4 days.

Twenty eight of those 41 women gave a birth weight ≥ 4000 (4000-5232) grams and the other 13, the birth weight range was between 3520 and 3955 grams. The mean gestational age at delivery for the 41 women was 39.3 ± 1.3 days.

Twenty of 61 women had the elective CS because of clinical estimation of big baby, all of them had EFW < 4000 (2654-3995) grams. The mean gestational age at ultrasound was 37.7 ± 2.4 weeks and the mean interval between ultrasound and delivery was 11.5 ± 10.7 days. The birth weight was > 4000 (4130-5345) grams in 8 women and the other 12 had a birth weight ranging between 3344 and 3960 grams. The mean gestational age at delivery for the 20 women was 39.3 ± 1.7 weeks. Ten of these women (50%) had a history of previous CS.

There were no neonatal complications or perinatal mortality in the elective CS group (61 patients) and only one woman of them had wound infection.

The accuracy of the ultrasound in estimating fetal weight was assessed. Sixty three (48.8%) women delivered within 3 days after the ultrasound examination, with a mean of 1.3 ± 1.0 days. Thirty three (52.4%) of the EFWs were accurate when placed in 500 grams categories (Table 3). The mean percent deviation of the birth weight from EFW was -1.1 ± 8.3%. Thirty two of the EFWs (50.8%) exceeded the birth weight. The range of excess was between 8 and 730 grams. In three of them the excess was more than 500 grams.

Thirty one of the EFWs (49.2%) were less than the respective birth weights. The range of the difference was between 2 and 1007 grams. In five of them the difference was more than 500 grams.
Table 3: Correlation between estimated fetal weight and birth weight of infants delivering within 3 days of ultrasound examination

<table>
<thead>
<tr>
<th>Estimated Fetal Weight (gm)</th>
<th>Birth Weigh (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3500-3999 (N = 21)</td>
<td>3000-3499</td>
</tr>
<tr>
<td>4000-4499 (N = 33)</td>
<td>3500-3999</td>
</tr>
<tr>
<td>4500-4999 (N = 9)</td>
<td>4000-4499</td>
</tr>
<tr>
<td>5000-5499</td>
<td>4500-4999</td>
</tr>
</tbody>
</table>

* Accurate estimated fetal weight when correlated with birth weight

Discussion:

The diabetic woman carrying a macrosomic fetus and attempting vaginal delivery, is at highest risk for shoulder dystocia and this risk also increased with increasing birth weight.

Most of our obstetricians at Women’s Hospital prefer elective caesarean delivery in diabetic women having fetal macrosomia (≥4000 grams) in order to avoid shoulder dystocia with its possible consequences. The majority of their decisions were based on ultrasonographic estimates of fetal weight.

A major problem in the estimation of fetal weight with ultrasound near term is its high degree of inherent error. Mean errors in estimating fetal weight may approach 15% of actual birth weight, and as much as 25% in diabetic patients. Another factor in determining the accuracy of sonographic fetal weight prediction is the interval between the sonographic examination and the delivery date. Prophylactic caesarean delivery policies may subject some mothers of non-macrosomic fetuses to caesarean deliveries they would otherwise avoid, so we thought it is appropriate to investigate the influence of accurate ultrasound prediction of fetal macrosomia on delivery route and birth outcome.

The management of macrosomia in diabetic patients is controversial. Most authorities agree that primary CS is justified if the estimated fetal weight at the end of the pregnancy is 4500 grams or more. The controversy arises when the EFW is between 4000 and 4500 grams, some investigators advise caesarean delivery if the EFW is greater than 4000 grams. Others believe that the margin of error of sonographic weight estimates in patients at term and the relatively small number of fetal injuries, approximately 1 in 500 deliveries, when the fetus is between 4000 and 4500 grams do not justify caesarean delivery. In addition some, 50%-60%, of shoulder dystocias occur in infants weighing less than 4000 grams. Langer et al concluded that elective CS is strongly recommended for diabetic women with fetal weights ≥4250 grams due to increase incidence of shoulder dystocia at this EFW and this approach will eliminate 80% of the cases of shoulder dystocia with a minimal increase in the CS rate.

The antepartum risk factors for shoulder dystocia in our study population are: diabetes mellitus, multiparity, obesity, history of macrosomia as well as carrying a macrosomic fetus.

The majority of our patients had their diabetes well controlled and had regular antenatal care visits. We reviewed the outcome in fifty women who delivered vaginally and gave birth of ≥4000 grams. Most of these women had EFW < 4000 grams and the mean interval between ultrasound examination and delivery was 17.2 ± 15.9 days.

The incidence of shoulder dystocia for infants with birth weights between 4000-4499 is 6.3%, a rate which is similar to the rate (6%) of shoulder dystocia in diabetic patients for infants weighing 4000-4499 grams in Delpapa and Mueller-Heubach study.

The incidence of brachial plexus injuries in our study is 6.3% which is similar to the incidence (6%) of brachial plexus injuries in McFarland et al study. Brachial plexus injuries occurred in three out of four cases of shoulder dystocia, two of them improved after physiotherapy treatment. The improvement was within 2 weeks for one infant and within 2 months for the other infant. The third infant was failed to be followed up as the patient left the country. Nocen et al reported that all, but one, of 28 brachial plexus injuries resolved by 6 month of age. There was no birth asphyxia among our shoulder dystocia cases. The purpose of preventing shoulder dystocia is to minimize persistent infant morbidity; however, either one or none of the four cases of shoulder dystocia in our study resulted in persistent morbidity.

Although our cases of shoulder dystocia were too few to determine the incidence of persistent infant morbidity, other studies have shown that the majority of cases of shoulder dystocia do not result in persistent birth injuries.

Sandmire and O’Halloin reported 73 cases of shoulder dystocia, of which two infants (2.7%) had persistent mild arm weakness.

However, Gordon et al reported a 5% (three of 59) incidence of permanent disability after 4 years of follow up in infants suffering brachial plexus injuries.

Sixty eight of 129 women in our study had the chance of trial of labour, all, except two, gave birth weights ≥4000 grams and fifty of them had vaginal delivery. According to those who believe that primary caesarean delivery is justified if the EFW was ≥4000 grams, that’s means the fifty women who delivered
vaginally should have CS and may be they had the opportunity of trial of labor because the EFW was < 4000 grams.

The fetal morbidity for the eighteen women who had caesarean delivery after labor was acceptable, two infants were admitted to neonatal intensive care unit with a diagnosis of perinatal asphyxia. For one of them the mother was presented late, the abdomen was huge, the cervix was fully dilated and cardiotocography showed decreased beat-to-beat variation and variable decelerations. The diagnosis for this infant was hydrops fetalis and cardiomyopathy. The second infant had meconium aspiration syndrome and cardiomyopathy. There was no neurological impact for both infants.

The other group of the study population (61 women) had primary CS section. In 41 of them, CS was performed because the EFW was ≥ 4000 grams, however, in 13 of them, the birth weight was less than 4000 grams. The mean interval between ultrasound examination and delivery for the 41 women was 2.2 ± 2.4 days.

Twenty women of the primary CS group had caesarean delivery because of clinical estimation of big babies, although, the EFW for all cases was less than 4000 grams and the mean interval between ultrasound scan and delivery was 11.5 ± 10.7 days.

Only 8 of the twenty women had birth weight ≥ 4000 grams. In addition, ten (50%) of those 20 women had a previous history of caesarean delivery which may indicate a bias in the decision-making regarding the mode of delivery being having scarred uterus.

Accurate prediction of macrosomia would be a significant step in reducing perinatal morbidity. However the mean errors in estimating fetal weight may approach 20% of actual birth weight in diabetic patients which translate into a large absolute value at term. The sonographic prediction in our patients was incorrect in 47.6% of the cases with the EFW both overestimating and underestimating the actual birth weight.

From our analysis, we conclude that caution should be taken in the use of sonographic estimations of fetal weight to guide obstetric decisions concerning labour and delivery. Also, special consideration should be given to diabetic patients having fetuses with EFWs between 4000 and 4500 grams, flexibility in the management of these patients is best taking in consideration their previous obstetric performance and if the EFW is closer to 4500 than to 4000 grams, it is perhaps, better to proceed to a primary caesarean delivery.

Those with EFW closer to 4000 grams can have a trial of labour. However, any abnormality such as protracted active phase or protracted descent, failure to descend, or secondary arrest of cervical dilation indicates the need for CS. No vacuum or forceps should be used in these patients. The obstetric team should be aware and prepared for the possibility of shoulder dystocia and should be well trained on appropriate management techniques.

References: