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Original Article

Fetal Parameters and Early Evidence of Fetal Macrosomia in Prepregnancy Diabetic Women

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Abstract

Background: Diabetes in pregnancy with macrosomia is an important risk factor for neonatal morbidity and mortality. Prediction of macrosomia is significantly improved by adding ultrasound to clinical findings. **Objective:** For earlier detection of macrosomia in prepregnancy diabetic mothers using fetal growth profile including biparietal diameter, femoral length, and also abdominal circumference (AC). **Patients and Methods:** A historical prospective cohort study was performed at National Endocrine and Diabetic Center in addition to the Obstetrics and Gynecology Department at Al-Yarmouk Hospital for 2 years, from September 2014 to 2016. A hundred and sixty pregnant women were enrolled in this study, 80 of them with a history of prepregnancy diabetes mellitus were taken as a patient group and the other 80 pregnant women with a compatible gestational age and without a history of diabetes mellitus were taken as a comparison group. Abdominal ultrasound was done for patients in both groups at 20, 28, and 36 weeks of gestation and then birth weight was measured for each. Results were compared between two groups. **Results:** The incident of macrosomia was 30% in patient group and 10% in comparison group. Regarding early prediction of macrosomia by ultrasound using biparietal diameter, femoral length, and AC, the results of the current study revealed that those macrosomic babies have higher femoral length, AC but not biparietal diameter in comparison with babies of average weight using ultrasound performed at 20-week gestation and repeated at 28 and 36 weeks. **Conclusion:** In diabetic mother, fetal macrosomia can be predicted by ultrasound during pregnancy as early as 20-week gestation.

Keywords: Fetal macrosomia, pregestational diabetes, singleton

Introduction

Birth weight is a key determinant of infant health, which appears to be influenced by a complex interaction of mother and fetal factors. These probably include maternal genetic, environmental, and lifestyle factors, in addition to fetal genetic study.[1]

The word "macrosomia" means a very large fetus or neonate, but there are no accurate criteria for macrosomia which is accepted by all obstetricians and researchers.[2] The American College of Obstetricians and Gynecologists (ACOG) defined macrosomia as birth weight more than 4000 g at any gestational age or birth weight more than the 90th percentile for weeks of gestation.[3]

Depending on the National Vital Statistics Report for US. Births in 2015, about 7% of newborns had birth weight more than 4000 g, 1% had birth weight more than 4500 g, and also 0.1% had birth weight more than 5000 g.[2]

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The incidence of macrosomia in pregnancies in diabetes was reported between 8% and 43%.[4]

Male infants have birth weight greater than female infants. They are generally about 150–200 g larger near term.[5]

Obese mothers have an independent and strong effect on fetal macrosomia.[6]

When normal-weight women compared to obese women, the infants of obese group had about twice the incidence of macrosomia compared to women with normal average weight.[7]

Maternal lipids' profile near delivery is also associated with fetal macrosomia and with an increased risk of neonatal and maternal injuries.[8]

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During pregnancy, hyperglycemia leads to the passage of higher amounts of glucose through the placental barrier and then fetal hyperinsulinemia and macrosomia,[9] which is associated with birth injury, respiratory distress, and neonatal hypoglycemia.[10]

Shoulder dystocia is one of the important obstetric emergencies facing the obstetrician and the possibility of brachial plexus injury or birth asphyxia. Although most of shoulder dystocias are unexpected and it might occur in a normal fetal weight, the relationship between macrosomia and shoulder dystocia is very clear.[11]

The accurate diagnosis of fetal macrosomia is by measuring birth weight postpartum, so it is confirmed only after delivery.[12]

Patients and Methods

This historical prospective cohort study was done at the National Endocrine and Diabetic Center in addition to the Obstetric and Gynecological Department at Al-Yarmouk Teaching Hospital for a period of 2 years from September 2014 to 2016.

A hundred and sixty pregnant women, age between 17 and 40 years, were participated in the study and prepregnancy body mass index between 18.5 and 30. Eighty of them with a history of prepregnancy diabetes mellitus (Type 1) were taken as cases and the other eighty pregnant women with a compatible gestational age and without a history of diabetes mellitus were taken as a comparison group.

Abdominal ultrasound was done for patients in both groups at 20, 28, and 36 weeks of gestation, and then birth weight was measured for each. Results were compared between two groups.

Regarding glycemic control, 75 women were kept on insulin therapy, while other five were only on diet control. All pregnant women had good glycemic control through all pregnancy based on multiple home profile blood sugar monitoring.

Inclusion criteria

1. Normal glucose level
2. Singleton pregnancy
3. Viable fetus with the absence of identified fetal anomalies
4. Gestational age of equal or more than 20-week gestation
5. Body mass index before pregnancy (18.5–30).

Exclusion criteria

1. Maternal vascular disease including preexisting hypertension and antiphospholipid syndrome
2. Smoking, it has been associated with restricted fetal growth[13]
3. Liver disease which has been associated with chronic placental insufficiency[14]
4. Anemic patient associated with low birth weight[15]

Table 1: The demographic data

Criteria	Mean±SD		*P*
	Patient group (*n*=80)	Comparison group (*n*=80)	
Age	27.8±6.3	29.7±8.2	0.46
Gravida	3.3±1.7	3.8±2.2	0.34
Parity	3.2±1.2	3.1±1.3	0.64
BMI (prepregnancy)	25±4.2	24.7±6.3	0.38

SD: Standard deviation, BMI: Body mass index

Ethical approval was obtained from the Scientific Committee of Obstetrics and Gynecology in AL-Yarmouk Teaching Hospital.

Verbal consent was obtained for all women before enrolling them in this study.

To collect data, a full history was taken from all patients including demographic data and history of previous pregnancies, hypertension, macrosomic birth, and stillbirth, and also examination including vital signs and body mass index were done.

Only those with accurate date, with reliable last menstrual period and early ultrasound who fulfilled the inclusion criteria were included in the study.

Serial scans were performed at 20-, 28-, and 36-week gestation. Ultrasound machine type GE, Voluson, E6, convex probe 4C. Fetal parameters, including biparietal diameter (BPD), were measured from the outer edge of parietal bone near the probe to the inner edge of the other sides of parietal bone in thalamencephalon. Femur length (FL) was measured at the center of the two ends of the femur, and abdominal circumference (AC) was measured along the outer layer of the skin in the area including the spine, gastric vacuole, and umbilical vein using the elliptic function were recorded.

After delivery, clumping of umbilical cord and resuscitation of the newborn and measurement of birth weight using YRBB-20 scale were done; newborns over 4000 g birth weight were defined as macrosomic cases.

Statistical analysis

The data were expressed in means and standard deviation. *T*-test had been used to test the significance of difference between patients group and comparison groups. Statistical significance was considered whenever $P \leq 0.05$.

Results

A total of 160 pregnant women, aged between 17 and 40 years, were participated in the current study. Eighty women with prepregnancy diabetes mellitus considered as a patient group and eighty women with healthy uncomplicated pregnancy considered as a comparison group.

The data were expressed in means and standard deviation. *T*-test had been used to test the significance of difference

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between patients group and comparison group. A significant difference was considered at $P < 0.05$.

Table 1 shows the demographic data of both groups, there was no significant difference between the groups.

Table 2 shows a comparison by US findings at 20 weeks of gestation between patients and comparison groups.

Regarding femoral length, we found that patients group had a higher mean than comparison group which was statistically significant since $P = 0.002$.

Furthermore, AC mean was higher in patients group than in comparison group which also was statistically significant $P = 0.001$.

While the difference between BPD mean of patients group and comparison group was not statistically significant were $P = 0.131$.

Table 3 shows a comparison by US findings at 28 weeks of gestation between patients and comparison groups.

It was found that patients group had higher femoral length mean than comparison group which was statistically significant, $P = 0.001$.

Furthermore, AC mean was higher in patients group than in comparison group which also was statistically significant $P = 0.001$.

While the difference between BPD mean of patients group and comparison group was not statistically significant, $P = 0.103$.

Table 4 shows a comparison by US findings at 36 weeks of gestation between patients and comparison groups.

It was obvious that patients group had higher femoral length mean than comparison group which was statistically significant, $P = 0.001$

Furthermore, AC mean was higher in patients group than in comparison group which also was statistically significant, $P = 0.001$

While the difference between BPD mean of patients group and comparison group was not statistically significant, $P = 0.085$

Table 5 shows the comparison by birth weight between patients and comparison groups.

Patients group had higher birth weight than comparison group and this difference was statistically significant, $P = 0.001$.

Discussion

The importance of understanding the pathophysiology of fetal growth profiles which leads to macrosomia in diabetic pregnancies is that it might be helpful to design future preventive strategies.[16]

Many factors are related to increase birth weight including hereditary, weeks of gestation, diabetes, increase prepregnancy maternal weight, and also increase weight gain.[17]

Many and different studies have followed the development of macrosomic fetuses *in utero*.[16,18]

Table 2: Comparison between patients and comparison group at 20 weeks of gestation

Variable	At 20 weeks of gestation (mean±SD)		*t*-test for means	*P*
	Patients (*n*=80)	Comparison (*n*=80)		
BPD	41.53±1.005	41.76±0.91	1.517	0.131
FL	32.67±4.16	31.13±1.18	3.178	0.002
Abdominal circumference	13.85±0.73	13.05±1.02	5.666	0.001

FL: Femur length, SD: Standard deviation, BPD: Biparietal diameter

Table 3: Comparison between patients and comparison at 28 weeks of gestation

Variable	At 28 weeks of gestation (mean±SD)		*t*-test for means	*P*
	Patients (*n*=80)	Comparison (*n*=80)		
BPD	71.83±0.97	72.1±1.05	1.63	0.103
FL	64.63±1.4	61.58±1.21	14.65	0.001
Abdominal circumference	25.77±1.19	23.76±0.93	11.91	0.001

FL: Femur length, SD: Standard deviation, BPD: Biparietal diameter

Table 4: Comparison between patients and comparison group at 36 weeks of gestation

Variable	At 36 weeks of gestation (mean±SD)		*t*-test for means	*P*
	Patients (*n*=80)	Comparison (*n*=80)		
BPD	91.05±1.03	91.35±1.39	1.735	0.085
FL	73.73±1.88	69.17±0.91	19.52	0.001
Abdominal circumference	38.72±2.56	32.92±0.96	18.95	0.001

FL: Femur length, SD: Standard deviation, BPD: Biparietal diameter

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Table 5: Comparison between patients and comparison group by birth weight

	Mean		SD		*t*-test for means	*P*
	Patients (*n*=80)	Control (*n*=80)	Patients (*n*=80)	Comparison (*n*=80)		
Birth weight (kg)	4.14	3.36	0.304	0.33	15.4	0.001

SD: Standard deviation

The findings of the present study show that macrosomia can be predicted as early as 20 weeks of gestation since femoral length and AC (but not biparietal diameters) were significantly higher than uncomplicated pregnancy.

These results confirm the results obtained by Wong *et al*., who assess fetal growth in women with diabetes mellitus (Types 1 and 2) and observed that growth acceleration of fetuses in diabetic mothers (AC, femoral length, and even biparietal diameter) in the second and third trimesters had many differences in comparison with that of control group. Fetal growth acceleration continues until the end of pregnancy.[19]

Furthermore, another study for Wong *et al*., who monitored the beginning of growth acceleration among fetuses in pregestational diabetic pregnancies. Ultrasound scans were done every 4 weeks starting from 18 weeks and continue through all studies, and the end results showed that fetal growth acceleration in large for gestational age fetuses of diabetic mothers begins from 18 weeks of gestation.[20]

However, the finding of the current study showed partial agreement with those of Hammoud *et al*. who followed second and third trimester by ultrasound findings of fetal growth development in 77 pregnant women with Type 1 diabetes mellitus, 68 women with Type 2 diabetes mellitus, and in 99 women with gestational diabetes mellitus. Ultrasound measurements were done and 145 uncomplicated pregnancies also were enrolled as control group. Ultrasound examination included head circumference (HC), AC, femoral length, and HC/AC ratio. The results showed that only AC, but not FL, evolved differently in diabetic.[16]

Furthermore, results of Lampl and Jeanty revealed a significant increase in AC from 21-week gestation while femoral length again not affected.[21]

Lysikiewicz *et al*. followed thirty diabetic pregnant women with serial sonographic biometry from mid-pregnancy (26–30 weeks.) to term (38–40 weeks) pregnancy. Fetal AC and FL were above 50th percentile in diabetic patients during mid-pregnancy.[22]

The higher birth weight that observed in the newborns of diabetic mother in this study is similar to that of Shahnaz *et al*. were 37 pregnant women with diabetes and their fetuses compared to 29 uncomplicated pregnancies as control, biweekly abdominal ultrasound done and measurements of head, limb, and trunk dimensions, they concluded in their study that diabetes is a high-risk factor for fetal macrosomia.[4]

The current study had some limitations such as restriction in sample size, difficulties in follow-up, and as it mentioned before, the need of long time (around 2 years) to collect data.

The descriptions of disproportionate growth might help in future for prevention of macrosomia using the new developing technology of continuous blood sugar monitoring.

Conclusion

Macrosomia can be predicted by ultrasound as early as 20-week gestation.

We recommend that further studies to be done for detecting and compare the occurrence of neonatal complications among macrosomic babies in whom overgrowth started as early as second trimester and those whom growth acceleration started at the third trimester.

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Conflicts of interest

There are no conflicts of interest.

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