Research Article

Sonographic Study of Fetal Body Measurements in Healthy and Diabetic Pregnant Mothers

Moustafa A. Mahmoud*, Hany H. Kamel and Shimaa A. M. Mahmoud***

* Department ofAnatomy, Faculty of medicine, Minia University, Minia, Egypt.

** Department of obstetrics and Gynecology, Faculty of medicine, Minia University,Minia, Egypt.

Abstract

***Purpose*:** to estimate the effect of maternal pregestational diabetes mellitus on the fetal growth in comparison to normal controlled pregnancies by using ultrasonography. ***Methods*:** This study was a cross sectional designed, done by sonographicmeasurement of fetal biometryin the third trimester of ١٠٠ pregnant women. Fifty of them were singleton foetuses without congenital anomalies of non- obese pregnant women with history of abnormal oral glucose challenge test (GCT) results (group ١), that group was compared with another fifty singleton foetuses without congenital anomalies of non- obese pregnant women with normal oral glucose challenge test (GCT) results (group ٢). ***Results*:** It was noticed that there are mild differences in fetal body measurements between the two groupswith respect to foetal fat body masswhich is represented by fetal abdominal wall thickness, all the measurements were slightly higher in group ١ than in group ٢ but not significant as most of cases which had been evaluated during our screening were controlled diabetic without marked foetal macrosomia. ***Conclusions*-**foetuses of diabetic mothers show accelerated rate of growth of fetal parameters and fetal internal organs than that of the normal populationespecially in the foetal abdominal circumference. Moreover, periconceptional glucose control appears to have a significant effect on fetal growth.

Key Words -Diabetes mellitus – Diabetes mellitus with pregnancy – Foetal biometry- Ultrasound- Ultrasound in pregnancy

Introduction

Diabetes mellitus is the most chronic medical condition affecting pregnancy outcomes. Pregnancy in women with type ١ or type ٢ diabetes mellitus is associated with high risk of congenital malformations, obstetric complications, and neonatal morbidity[١]. Several studies in different countries had confirmed that outcomes of pregnancy in women with both type ١ and type ٢ diabetes remain poor compared with healthy women without diabetes, and that outcome is frequently related to poor glycemic control in early pregnancy[١١].

It is also known that excess glucose metabolism by embryos in a hyperglycemic environment disturbs a complex network of biochemical pathways[٨]. Many studies have failed to demonstrate a consistent relationship between macrosomia and diabetic control[١٠]. Some researchers have proposed that such poor correlation might relate to differing recommendations for target blood glucose concentration or the gestational age at which tight control was achieved. Macrosomia occurs in a significant proportion of fetuses of pregnant women with type ١ diabetes, despite relatively good glycemic control.

With the advent of modern obstetric care, the incidence of congenital malformations has reduced, but large-for-gestational-age (LGA) babies and associated complications remain high. One might postulate that this is related to the varying recommendations for target blood glucose concentration[٦].

Nevertheless, maternal factors such as obesity and excessive weight gain in pregnancy might also contribute to the development of LGA neonates. Poor correlation between blood glucose concentration and birth weight might also be related to the gestational age at which tight control was achieved. These might account for

the conflicting results in many of the reported studies. Apart from diabetic control, maternal characteristics have also been shown to be associated with LGA babies[١٠]. Recently, growth acceleration among fetuses of diabetic mothers was reported to start at twenty- two weeks of gestation and to continue despite improvements in diabetic control. Such acceleration was determined by prevailing maternal glucose concentrations in the early trimesters[١٤].

However, it is unclear whether fetal growthspurt occurs even earlier than the late second trimester. It is still controversial whether fetal growth rate is determined by diabetic control in the first or second trimester. In the current study, we assessed the timing of fetal growth spurt in pre-existing diabetic pregnancies type ١ and its relationship with diabetic control in the third trimesters[٤].Motivating diabetic women to plan their pregnancies, to optimize glycaemic control is an established goal of the study. Recent advances in ultrasound measurements of fetal body composition with respect to lean and fat body mass make it possible to evaluate intrauterine fetal growth and abnormalities[١١].

The foundation for the use of ultrasound for the pregnant diabetic woman is early identification of congenital malformations and recognition of deviant fetal growth. In the case of fetal malformations, ultrasound technology will enhance well-timed options for the mother and, if needed, safer pregnancy termination[١٣].

In addition, ultrasound provides an instrument for evaluation of deviant fetal growth and fetal weight estimation for timely delivery. This editorial explores the means by which ultrasound can be helpful to the clinician managing a diabetic pregnancy. Longitudinal detection of fetal body composition distinguishes the effects on fetal growth by different maternal metabolic conditions[٤].

Materials And Methods –

Study participants were selected from a database consisting of patients undergoing obstetric sonographic examinationsin Suzan Mubarak University Hospital. This was a cross sectional study by sonographic examinations of ١٠٠ pregnant women in the third trimester. All subjects in this study were fulfilled according to; inclusion criteriaas pregnant women in the third trimester between (٣٠-٤٠) weeks of gestation, middle aged with singleton fetuses, fifty of them with a history of pregestational diabetes mellitus while the other fifty are normal. While exclusion criteriaof history of gestational diabetes mellitus, history of other chronic diseases as hypertension, pre-eclampsia, heart or renal diseases, thyrotoxicosis or fetuses of structural or chromosomal anomalies.

A ١-h ٥٠-g oral glucose challenge test was performed between ٢٤ and ٢٨ weeks of gestation to define the study groups: a value below ١٤٠ mg/dl was considered normal. Dating scans were performed before ١٤ weeks' gestation and serial scans were performed at ١٨, ٢٤, ٢٨, ٣٢ and ٣٦ weeks. Fetal parameters, including biparietal diameter, femur length, abdominal circumference, kidney length and liver span were recorded. The daily growth rates were calculated and compared with those in a low-risk (non-diabetic) population. All examinations were performed by the same sinologist using (Toshiba ultrasound model ٢٤٠ MHZ withCurved linear probe approx. ٣-٧ MHz).

Ultrasound Measurement technique we used was trans abdominal ultrasound involving scanning through patients' lower abdomen. The BPD is measured from the outer edge of the nearer parietal bone to the inner edge of the more distant parietal bone.The abdominal wall thickness is measured in an axial plane at the level of the junction of the umbilical vein with the left portal vein. The fluid-filled stomach had been seen on this plane. It was measured at the level of the abdominal circumference between the midaxillary lines. The measurements were taken from the inner to the outer aspect of the echogenic subcutaneous fat that surrounded the abdomen.The longest dimension of the femoral shaft is measured, liver length measured from the dome of the right hemidiaphragm to the tip of the right lobe. The renal length are Measured from the upper pole to lower pole.

Results

hundred pregnant women included in the study, fifty of them showed normal fetal growth (controlled group ٢) and the other fifty, forty seven of them with slightly increased non-significant fetal parameters while the other three showed fetal macrosomia which is defined as fetus at or above ٧٥th percentile. Table ١ presents a comparison of characteristics of the two groups. There was no evidence that these groups were different with regard to maternal demographic data. Table ٢show the basic statistics of fetal measurements in diabetic and normal pregnant women of the present study (mean value ± standard deviation and range).

It is noticed from data that the mean in all parameters in group one is slightly more than group two. This comparison was by using unpaired T-test. The p- value showed the highest level in measuring abdominal wall thickness, femur length, liver span, kidney length and the least value in biparietal diameter. P-value was our statistical evaluation for the comparison between the two groups, if the result of p value is less than ٠.٠٥, so it is significant but if statistically highly significant P value will be < ٠.٠٠١, so significant p value in the results of our study was P < ٠.٠٠١, the result will be significant (S) and if more than ٠.٠٥ it will be nonsignificant (NS). So, the significance only was in abdominal wall thickness which was greater in group one from the ٢٦th week to the end of preg-nancy. Macrosomia which is defined as <٢ standard deviation units (٩٧.٧٥٪), was found in ١٠–٢٧٪ of the diabetic groups.

It was noticed that there are mild difference between the two groups. With respect to fetal fat body mass, all the measurements were slightly higher in group ١ than in group ٢ but not significant but there is no doubt that there is difference especially in abdominal wall thickness which represents fat amount that has to be increased in fetuses of diabetic mothers.

Table (١): Maternal demographic Characteristics Stratified by Exposure

Variables	*Group ١ (n = ٥٠)*	*Group ٢ (n = ٥٠)*	*P value*
Maternal Age (years)	Mean ٢٨.٥ Range (٢٥- ٤١)	Mean ٢٣ Range (١٩- ٣٥)	**NS**
Maternal BMI	Mean ٢٧.٣ Range (٢١- ٢٩)	Mean ٢٢.١ Range (١٧- ٢٦.٨)	**NS**
١h GCT value (mg/ dl)	١٥٦.٣± ١٩.١	١١٢.٣± ١٩.٤	**S**
Parity	Mean ١ Range (٠-٣)	Mean ١ Range (٠- ٢)	**NS**
Occupation	Housewives ٣٧ Working ١٣	Housewives ٢٦ Working ٢٤	**NS**

Table (٢): Basic statistics of fetal body measurements

Variables (Parameters)	**Group ١ (n = ٥٠)**		**Group ٢ (n = ٥٠)**		**Significance (P value)**
	Mean±SD	**Range**	**Mean±SD**	**Range**	
Bi-parietal diameter	٨. ٧٧٥±٠.٨٣٢	٧.٢- ٩.٧	٨.١٢٠±٠.٦٥١	٧- ٩.٢	٠.٦ **NS**
Abdominal Wall Thickness	٩.٦٦٤±١.٧٦٣	٧.٠٤-١٣	٧.١٣٧±٠.٨٤٣	٧- ١٠.٠٤	٠.٠٠٧ **S**
Femur Length	٨.٤٢٣±٠.٧٥٢	٧- ٩.٤	٧.٧٨٧±٠.٥٢٨	٧- ٩.٢	٠.٠٨ **NS**
Liver Span	٤.٧٨٥±٠.٦٩٥	٣.٦- ٥.٨	٤.٠٥٠±٠.٦٩٧	٣.٢- ٥.٦	٠.٥ **NS**
Kidney length	٣.٣٧٥±٠.٣٤٦	٢.٦- ٣.٨	٢.٤٧٠±٠.٣٠٦	٢- ٣.٢	٠.٢ **NS**

SD = Standard deviation. Data are presented as number (percent), mean ± SD, and median (interquartile range).

Discussion

Strict metabolic control has been shown to improve perinatal outcomes in pregnancies complicated by pregestational diabetes mellitus[٨]. In this study our target population was hundreds of pregnant non obese women in their third trimester; half of them normal and the others were complicated with pregestational diabetes mellitus to detect the differences in foetal growth between the normal pregnant women and diabetic ones and to know the effect of diabetes mellitus on foetal body measurements, and at the end we compared our results with previous studies.

We measured some foetal parameters as biparietal diameter, abdominal wall thickness, femur length, liver span and kidney length by ultrasonographay to detect these differences. This study showed that growth rates for biparietal diameter, femur length and foetal abdominal area among the foetuses of diabetic mothers were higher than those in the low-risk population from ٣٠ weeks' gestation onwards. These differences were clearer for foetal abdominal wall thickness measurements, followed by femur length and biparietal diameter. These findings were expected, as foetuses that are large for gestational age (macrosomic) are most accurately reflected by the size of the abdominal wall thickness. Biparietal diameter is the least affected foetal parameter among foetuses of women with diabetes mellitus because we found that biparietal diameter increases only in cases of complicated diabetes with foetal malformations as macro-cephaly or hydrocephalus.

Femur length is important for diagnosis of foetal dwarfism when femur length is at least ٢-٣ standard deviations below the mean.These results were expected because diabetic pregnant outcome has to be large foetus for gestational age but our results were that no great differences between the two groups because our cases already have history of diabetes mellitus before pregnancies and most of them have history of repeated abortions or foetal malformations, so they were coming to the hospital regularly for follow up then in the third trimester admitted to the hospital for control and termination of pregnancy most probably before the week ٣٨ of gestation [٤].This means that the cases taken were controlled cases of diabetes mellitus with foetuses large for gestational age but not macrosomic babies except five cases we observed that there was macrosomic foetuses with clear big foetal parameters because these five ladies were of very high glucose levels even with treatment i.e uncontrolled cases, so these ladies admitted to the hospital for early termination of pregnancy to prevent further foetal and maternal complications.

In previous studies, it was advised not to take an average size for femur length or biparietal diameter for dating because we can have foetus with average size head and longer or shorter than average femur length [٧].We measured also liver span and kidney length to estimate the effect of diabetes mellitus on the growth of organs. Our study showed that the mean of liver length in group one is slightly more than group two and increases also by the increase of gestational age but also not greater difference between the two groups as our cases were controlled.

This result also was expected because it is known that complicated diabetes mellitus affecting the growth of organs but not all macrosomic cases recorded foetal organ enlargement. The foetal liver length was the only measurement showing a significant increase among women with diabetes mellitus. This may be because the foetal liver growth is more sensitive and responsive to maternal glucose levels[١٢]. Another possibility for the results of liver measurements is that the major increase in liver size occurs early in pregnancy and therefore growth acceleration can be detected as early ١٨ weeks' gestation [٢]. Foetal liver enlargement was not associated with an increase in foetal abdominal circumference or estimated foetal weight; while liver enlargement was significantly related to maternal fasting glucose levels and not ٢- hour postprandial levels. Similarly, maternal fasting glucose level is associated with foetalmacrosomia in late pregnancy[٤]. Kidney length measurements results in both groups are nearly to be equal. In other studies normal kidney length which had measured from upper pole to the lower pole is increasing sligthly by gestational age as the normal reference data which is recorded for foetal kidney length in the third trimester of pregnancy were ٣.٥ to ٤.٥ cm[٥].It was reported that type-١- diabetes

mellitus may cause fetal growth retardation (small fetus for gestational age) but this complication occur mostly with complicated pregnancy with another vascular disease or chronic hypertention, so with exclusion of these disease, we also had no cases with growth restriction [٣].

After comparison this topic needs further research by using another more better methods of investigations as foetal three- dimensional ultrasound and follow up of maternal blood glucose level .In conclusion, we have constructed a new set of reference centiles for foetal biometric measurements and equations for dating of pregnancy for Egyptian singleton pregnancies. Our charts were very similar to those of the other studies. We believe that our charts are ready for clinical use.

Acknowledgments

This research project was supported by a grant from the 'Research Center for Female Scientific and Medical Colleges', Deanship of Scientific Research, Minia University

References

١. Alberti KG and Zimmet PZ, ١٩٩٨. Definition, diagnosis and classify-cation of diabetes mellitus and its complications. Part ١: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic Medicine ١٥: ٥٣٩ - ٥٥٣.

٢. Nasrat H, Abalkhail B, Fageeh W, Shabat A and el Zahrany F, ١٩٩٩. Anthropometric measurement of newborns of gestational diabetic mothers: does it indicate dispropor-tionate fetal growth.

٣. Pittas, AG and Greenberg AS, ٢٠٠٣. Contemporary Diagnosis and Management of Diabetes. Handbooks in Health Care Co, Newtown, PA.

٤. Rey E, Attie C, Bonin A, ١٩٩٩. The effects of first-trimester diabetes control on the incidence of macro-somia. Am J Obstet Gynecol ١٨١: ٢٠٢–٢٠٦

٥. Hohler CW, ١٩٨٤. Ultrasound estimation of gestational age. Clin Obstet Gynaecol; ٢٧(٢): ٣١٤-٢٦.

٦. Schwartz R and Teramo KA, ٢٠٠٠. Effects of diabetic pregnancy on the fetus and newborn. Semin Perinatal ٢٤: ١٢٠–١٣٥

٧. Stubbs SM, Leslie RD and John PN, ١٩٨١. Fetal macrosomia and maternal diabetic control in pregnancy. Br Med J (Clin Res Ed) ٢٨٢: ٤٣٩–٤٤٠

٨. Lei H and Wen SW, ١٩٩٨. Ultra sonographic examination of intrau-terine growth for multiple fetal dimensions in Chinese population. Central South Chinese fetal Growth study group. Am J ObstetGynecol; ١٧٥. ٩١٦-٢١.

٩. Verburg BO, Steegers EA, De Ridder M, et al.,. ٢٠٠٨. New charts for ultrasound dating of pregnancy and assessment of fetal growth: longitudinal data from a population-based cohort study. Ultrasound Obstet Gynecol. ٣١(٤):٣٨٨–٣٩٦

١٠. Zaidi S, ١٩٩١. Ultrasound examination in early pregnancy. In: Zaidi S. Ed Real-time Ultrasound in Obstetrics and Gynaecology: ٢nd ed. Twel Publishers, Karachi; ٢٣.

١١. Durnwald C, Huston-Presley L, Amini S and Catalano P, ٢٠٠٤. Evaluation of body composition of large-for-gestational-age infants of women with gestational diabetes mellitus compared with women with normal glucose tolerance levels. Am J ObstetGynecol; ١٩١: ٨٠٤– ٨٠٨.

١٢. Weindling AM, ٢٠٠٩. Offspring of diabetic pregnancy: Short-term out-comes. Fetal Neonatal Med,١٤, ١١١–١١٨.

١٣. Persson B and Hanson U, ١٩٩٦. Fetal size at birth in relation to quality of blood glucose control in pregnancies complicated by pregestational diabetes mellitus. Br J Obstet Gynaecol ١٠٣: ٤٢٧–٤٣٣

١٤. Schaefer-Graf UM, Heuer R and Kilavuz O, ٢٠٠٢. Maternal obesity not maternal glucose values correlates best with high rates of fetal macrosomia in pregnancies complicated by gestational diabetes. J Perinat Med; ٣٠: ٣١٣.