Role of 2D ultrasonography and Doppler in diagnosis of fetal complications in diabetic mothers.

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Abstract

Background: Objectives are antenatal fetal assessment in diabetic mother to detect congenital anomalies through evaluation of fetal biophysical profile using 2D US and Doppler study of umbilical artery and intracranial arteries for assessment of placental blood flow is our concern.

Method: The study includes 30 singleton diabetic pregnant women. It was conducted in Radiology Department of Mansoura University Hospital between June 2018 to Jan 2020. They were divided into high risk group and low risk group. 2D US study includes fetal biometry (Biparietal diameter, femur length and abdominal circumference). Doppler study includes (umbilical artery, middle cerebral artery and uterine artery).

Results: Cut-off point of umbilical artery RI is (0.67), PI is (1.12) and S/D ratio is (2.87). Cut-off point of MCA RI is (0.61), PI is (1.31) and S/D ratio is (2.92). Cut-off point of uterine artery RI is (0.61) and C/U ratio is (1.22). Major multisystemic congenital anomalies are seen in high risk group; otherwise low risk group is normal.

Conclusion: Conventional ultrasound has a role in assessment of fetal wellbeing and fetal growth rate. Doppler velocimetry examination adds significant data in management of complicated gestational DM associated with other medical disorders.

Introduction

Diabetes Mellitus is a major health problem, the incidence of gestational DM is 4% of all pregnancies, it is a major cause of perinatal morbidity and mortality, as well as maternal morbidity, and this incidence is largely attributed to socioeconomic development and changes in the life style of the community. However advances in the management of diabetes in pregnancy have been successful in reducing perinatal morbidity and mortality [1].

With the introduction of real-time ultrasound, it has become possible to evaluate fetal biophysical profile and modified biophysical profile.

Umbilical and intracranial arteries are the most common studied fetal vessels. The assessment of umbilical blood flow provides information of the blood perfusion of the fetoplacental unit.

The use of umbilical artery Doppler study in high-risk pregnancies especially Diabetes Mellitus has resulted in a decreased rate of death of the normally formed infants.

With increasing the use of Doppler ultrasound imaging in obstetrics, it becomes easy to assess the hemodynamic components of vascular impedance, follow up and management of complicated pregnancies. The study of the cerebral circulation is of great potential as the identification of cerebral vasodilatation secondary to hypoxia is of value for the identification and monitoring of fetus of diabetic mother.

Middle cerebral artery to umbilical artery resistive index ratio is a good predictor of neonatal outcome that reflect both umbilical-placental and cerebral vascular beds and can be used for identifying fetuses with increased placental and/or decreased cerebral resistance.

The aim of the study is to evaluate the role of 2D ultrasound and Doppler examinations in the assessment of fetal wellbeing in diabetic mothers [2].

Materials and Methods

This study is prospective, comparative and non randomized study.The study includes 30 singleton diabetic pregnant patients. It was conducted in Radiology Department in Mansoura University Hospital. TOSHIBA XARIO with colour flow imaging unit was used.

Cases are divided into 2 groups:

(A)High risk group is characterized by:

(1) Age > 25 y.

(2) Mild or marked obesity.

(3) Positive personal history of pre-gestational IDDM (Insulin Dependent Diabetes Mellitus) or glucose intolerance.

(4) Positive obstetric history of gestational and perinatal complication.

(5) Positive family history of DM.

(B) Low risk group is characterized by:

(1) Age < 25 y.

(2) Average body weight.

(3) Negative personal history of pre-gestational IDDM or glucose intolerance.

(4) Negative obstetric history of gestational andperinatal complication.

(5) Negative family history of DM.

The primary outcome includes maternal complications which included cesarean section, pre-eclampsia and pre-term labor and fetal complications which included abortion, intrauterine fetal death premature labor. The secondary outcome is that the cut-off point of umbilical artery RI is (0.67), PI is (1.12) and S/D ratio is (2.87). Cut-off point of MCA RI is (0.61), PI is (1.31) and S/D ratio is (2.92). Cut-off point of uterine artery is (0.61) and C/U ratio is (1.22).

We obtained consent from all patients before examination and to complete the data set we reviewed the standard antenatal sheets of all women included in the study, analyzed and compared the data collected on pre-gestational and gestational DM. The study is approved by local ethical committee of Faculty of Medicine, Mansoura University.

Collected data: All the cases were subjected to the following:

1. History and clinical examination:

(a) Presence of Diabetes Mellitus.

(b) Parameters for calculation of fetal age (date of last normal menstrual period) and fetal wellbeing (perception of fetal movement and number per day, fetal body weight, fetal breathing movement and fetal tone).

(c) General clinical examination e.g.: blood pressure, edema and anemia.

2. Laboratory investigations:

Mean 2h post-prandial blood sugar in the third trimester was calculated for all patients after strict metabolic control using conventional insulin regimens and diet. This program was done for cases of conceptional DM and pre-conceptional IDDM.

3. Abdominal ultrasound (UD) and Doppler examination:

All patients were examined by both conventional and Color-Coded Doppler Imaging (CCDI) of the umbilical artery, middle cerebral artery and uterine artery. Ultra sonographic scan and Doppler study were performed using the commercially available machine (TOSHIBA XARIO) in the ultrasound unite of Radiology Department.

A. Conventional US: was performed for:

1) Fetal biometry: The fetal age estimation was calculated from the date of last normal menstrual period and confirmed by ultrasonographic examination using at least biparietal diameter (BPD) and femur length (FL).

2) Assessment of the amniotic fluid volume:

By measuring the amniotic fluid index (AFI) using the four quadrants technique, this was done by dividing the abdomen into 4 quadrants, and in each quadrant the maximum vertical diameter (MVD) of cord and limb free pocket was measured, finally the sum of four pockets was calculated. The presence of a single vertical pocket of amniotic fluid > 2 cm was considered evidence of adequate amount of amniotic fluid or more accurate AFI> 5 generally was considered to represent adequate volume of amniotic fluid.

3) Assessment of fetal anomalies:

By systematic examination of the fetal body systems by conventional ultrasound, we found that central nervous system (CNS), pulmonary and renal systems are the most affected systems by gestational Diabetes Mellitus.

B. Doppler examination:

1) Umbilical artery (UA):

The cord was located at the mid portion between fetal and placental insertion using real-time US. Then both the color box and sample volume were applied.

2) Middle cerebral artery (MCA):

To reach this level, plane for measuring the biparietal diameter, then the transducer was moved caudally until the heart shaped picture of the brain stem was seen. Using Doppler color flow, the MCAs can be seen running antero-laterally from their origin from the internal carotid artery to the lateral sulcus (Sylvain fissure).

3) Cerebral/umbilical ratio (C/U ratio):

It indicates the distribution of fetal blood flow.

4) Uterine artery resistive index (RI):

It indicates the uteroplacental circulation.

Results

The study includes 30 singleton pregnant diabetic mothers, age range from 20 to 40 years (mean = 30y) and gestational age range from 25 to 40 weeks (mean = 32.5 w). It includes 24 high risk cases and 6 low risk cases. All babies were delivered by cesarean section. All low risk patients had normal Doppler study, on the other side, high risk patients had variable Doppler findings (Tables 1-3) [3].

Table 1. *Obstetric history in high risk and low risk groups.*

Obstetric history	High risk group	Low risk group
IUFD	20.8 %	16.7 %
Neonatal death	20.8 %	-
Premature baby	12.5 %	-
Cesarean section	100 %	100 %
Antepartum hemorrhage	8.3 %	-
Congenital fetal anomalies	12.5 %	-

| Maternal pre-eclampsia | 12.5 % | - |
| Normal fetal outcome | 20.8 % | 16.7 % |

Table 2. *Doppler findings in high risk and low risk groups.*

Doppler findings (%)	High risk group	Low risk group
Umbilical artery: -Normal study. -Abnormal study.	50% 20.8%	100% -
MCA : -Normal study. -Abnormal study.	25% 4.2 %	100% -
Uterine artery RI: -Normal. -Abnormal.	87.5% 12.5%	100% -
C/U ratio: -Normal. -Abnormal.	62.5% 37.5%	100% -

Table 3. *Case processing summary using ROC curve in 30 cases of the study.*

Parameters	Cut-off point	Mean	Standard deviation	Standard error of measurements	95% Confidence Interval
Umbilical artery RI	0.67	0.67	0.15	0.12	0.47-0.84
Umbilical artery PI	1.12	1.33	0.56	0.11	0.29-0.74
Umbilical artery S/D ratio	2.87	2.62	0.89	0.13	0.38-0.85
MCA RI	0.61	0.67	0.11	0.14	0.24-0.71
MCA PI	1.31	1.47	0.54	0.12	0.31-0.63
MCA S/D ratio	2.92	2.89	0.96	0.12	0.27-0.81
Uterine artery RI	0.61	0.67	0.96	0.12	0.29-0.78
C/U ratio	1.22	1.21	0.41	0.11	0.19-0.64

Discussion

Diabetes Mellitus is one of the most common medical complications of pregnancy. A review of the literature over the last two decades indicates that the incidence of gestational DM varies from 0.15% to 12.3%. Between 0.2% and 0.3% of pregnancies occur in women with insulin dependent DM. The primary aim of the antepartum fetal surveillance is timely recognition of fetal compromise to enable appropriate intervention and to prevent further serious complications [4]. Low risk pregnancy is a pregnancy with negative medical history, gynecological history and good physical examination (Figures 1-2).
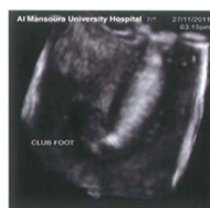

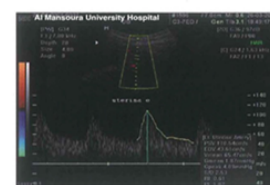Fig.(1, a) : 3D US of fetal lower limb shows club foot .
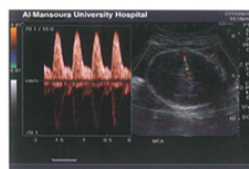
Fig.(1, b) :Normal uterine artery indices .
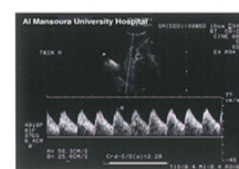
Fig.(1, c) :Normal MCA waveform .

Fig.(1, d) :Normal umbilical artery indices .

Figure 1. *1a: 3D US of fetal lower limb shows club foot; 1b: Normal uterine artery indices; 1c: Normal MCA waveform; 1d: Normal umbitical artery indices.*

That each fetal function evaluated in the fetal BPP had a different predictive value in indicating fetal hypoxia and they found that BPP scores of 4 and 6, an abnormal NST and decrease of AFV have higher positive predictive values than do fetal movement and fetal tone, with fetal breathing movements had an intermediate value. They concluded that not all abnormal BPP score are equal. The best perinatal outcome was following normal Doppler velocimetry and normal BPP. The worst perinatal outcome was following abnormal Doppler velocimetry and abnormal BPP. Abnormal Doppler velocimetry and normal BPP, normal Doppler velocimetry and abnormal BPP had intermediate perinatal outcome. The sensitivity of modified BPP is (52.8%), specificity is (36.6%), PPV is (39.6%) andNPV is (84.8%).

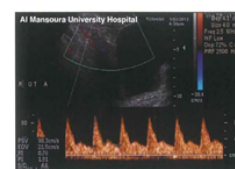Fig.(2, a) :Brain sparing effect in MCA .

Fig.(2, b) :High uterine artery Doppler indices .

Fig.(2, c) :2D US showing mild lemon shaped skull in microcephaly .

Fig.(2, d) :AREDV in umbilical artery waveform.

Figure 2. *2a:Brain sparing effect in MCA; 2b: High uterine artery Doppler indices; 2c:2d US showing mild lemon shaped skull in microcephaly; 2d:AREDV in umbitical artery waveform.*

In our study, Using ROC curve method, modified BPP is considered a poor test. We compared umbilical artery Doppler

results with modified BPP and it shows that: sensitivity is (100% and 66.7%), specificity is (88% and 60.9%), PPV is (83.3% and 80%) and NPV is (100% and 80%) respectively. So, Doppler study is more accurate than modified BPP [5].

Conclusion

Conventional US and Doppler derived vascular pattern have a role in the assessment of fetal wellbeing and fetal growth rate and hence management of adverse perinatal complications. Close antenatal fetal surveillance in pregnant diabetic mothers is recommended.

Acknowledgements

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