UMBILICAL ARTERY DOPPLER VELOCIMETRYSTUDY ON PREDICTION OF ADVERSE PREGNANCY OUTCOMES AMONG HIGH RISK PREGNANT WOMEN WITH DIABETES MELLITUS AT AMINU KANO TEACHING HOSPITAL

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ABSTRACT

Background: Doppler velocimetry studies of pregnant women with diabetes mellitus can predict adverse pregnancy outcomes.

Objective: To identify pregnant women with diabetes mellitus for second trimester umbilical artery Doppler velocimetry to predict adverse pregnancy outcomes.

Methods: It was a prospective study among pregnant women with diabetes mellitus. The umbilical artery Doppler study was carried outin second trimester using 3.5 m Hz convex of the Mindry Digital Ultrasound Imaging System (Model DP-8800Plus; ShenzenMindray Biomed electronics, China).

Results: a total of 64 pregnant women with diabetes mellitus were recruited at the gestational age of 20 to 24 weeks. The mean age ± SD was 33.06±4.79. Only 24 (37.50%) of the women had gestational diabetes of which 16 (66.67%) had abnormal RI but no diastolic notch. Fourty women were identified with pre-gestational diabetes and Half of them had abnormal RI of which 4 had diastolic notches.

Conclusion: Diabetic pregnant women withhigh resistive indices following umbilical artery Doppler velocimetry were not associated with significant adverse pregnancy outcomes.

Keywords: Umbilical artery Doppler velocimetry, diabetes in pregnancy, adverse pregnancy outcomes.

INTRODUCTION

Diabetes mellitus is a common metabolic disorder as a result of a defect in insulin production, impaired insulin action or both.[1] Globally, about 28 million women of reproductive age are affected with this metabolic disorder.[2] Diabetes mellitus in pregnancy could be pre-gestational or gestational. In pre-gestational diabetes, its diagnosis pre-dates the pregnancy. Gestational diabetes mellitus is any degree of glucose intolerance with onset or first recognition during pregnancy.[3,4] Pregnancy complicated with either pre-gestational or gestational diabetes mellitus threatens the health or life of either the mother or the developing fetus or both and is considered high risk.[5,6]

Several studies have confirmed the diagnostic efficacy of Doppler velocimetry of the umbilical artery in high risk pregnancies, especially those complicated by pre-eclampsia and intra uterine growth restriction and subsequent development of adverse pregnancy outcomes.[7-11]

The usefulness of umbilical artery Doppler velocimetry in high risk pregnancies complicated by diabetes mellitus is controversial. Wong and colleagues [12] studied the use of umbilical artery

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Doppler velocimetry in the monitoring of pregnancy in women with pre-gestational diabetes. They concluded that the umbilical artery Doppler velocimetry is not a good predictor of adverse perinatal outcomes in diabetic pregnancies. Maulik et al[13] reported different findings. They reported that the use of umbilical arterial Doppler surveillance in pre-gestational diabetic pregnancies is indicated by the presence of maternal vasculopathy, fetal growth restriction or pre-eclampsia. Pietryga and colleagues[14] also revealed that placental Doppler velocimetry in gestational diabetes does not seem to be of clinical value for fetal surveillance in those pregnancies with the exception of those that are complicated by pre-eclampsia and/or intra uterine fetal growth restriction.

To our knowledge, no study on Doppler velocimetry for prediction of adverse pregnancy outcome on pregnancies complicated by diabetes mellitus was carried out in our region. We therefore, aimed to find out whether umbilical artery Doppler velocimetry findings would predict adverse perinatal outcomes among high risk diabetic pregnant women at Aminu Kano Teaching Hospital.

MATERIALS AND METHODS

It was a prospective study conducted at Aminu Kano Teaching Hospital between 1st August, , 2013 and 30th June, 2014 among pregnant women with diabetes mellitus. Ethical approval was obtained from the hospital ethical committee. Informed consents were obtained from the diabetic pregnant women. They were selected at 20-24 weeks of gestation for recruitment. The recruitment was by simple random sampling method (balloting).

Questionnaires were structured and pre-tested before they were administered. Socio-demographic characteristics and the history of current pregnancies were recorded on the questionnaires. The Doppler study was conducted using 3.5 m Hz convex of the Mindry Digital Ultrasound Imaging System (Model DP-8800Plus; ShenzenMindray Biomed electronics, China.)

The umbilical artery was identified by placing the transducer over the lower abdomen and by randomly directing it towards the uterine cavity to identify the umbilical cord using amniotic fluid acoustic window following application of the water soluble coupling gel. The angle between the ultrasound beam and the direction of the blood flow was adjusted to less than 35^0.

Spectral waveforms were examined by placing the pulsed- Doppler range gate within the vessel. The Doppler scale was adjusted such that the velocity measurement was done without aliasing. Recordings were accepted for analysis only after a clear, steady state was obtained for at least five consecutive pulsatile arterial waveforms. No waveforms were recorded during periods of fetal breathing, body movements, or cardiac arrhythmias. The Resistance Index (RI) of each umbilical artery was recorded.

The resistance index was considered abnormal if greater than 0.57. This value was in accordance with the RI considered abnormal in other studies[15]. At this time the presence of an early diastolic notch was also observed for. The systolic diastolic ratio was also recorded. The women were then divided into two groups: those with abnormal umbilical artery Doppler velocimetry (Group A) and those with normal velocimetry (Group B).

Other routine obstetric ultrasound parameters were also recorded to determine the fetal weight, gestational age, the state of amniotic fluid, placental localization among others.

They were followed up throughout pregnancy, delivery and early puerperium. Data on gestational age at delivery, Apgar scores at delivery, birth weight, intrauterine fetal death and early neonatal death were extracted among the two groups.

In this study, Low birth weight (LBW) was defined as a neonatal birth weight lower than 2,500 g and preterm labour was defined as delivery before 37 completed weeks of gestational age

Data were analyzed using SPSS version 17 computer software. X^2 test was used for categorical data. Where criteria for applying X^2 test were not met, Fishers' Exact Test was used and the P values less than 0.05 was considered to be statistically significant. Combination of receiver operating characteristic (ROC) curves' graphs were integrated with Stata, version 11, statistical software.

The predictive power of umbilical artery Doppler velocimetry for adverse pregnancy (fetal/neonatal) outcomes was expressed by sensitivity, specificity, positive predictive value, negative predictive value, relative risk with 95% confidence interval.

A graph of sensitivity against 1 – specificity, a receiver operating characteristic (ROC) curve was used.

RESULTS

During the study periods (1st august, 2013 to 30th June, 2014), a total of 64 pregnant women with diabetes mellitus were recruited at the gestational age of 20 to 24 weeks. The mean age ± SD was 33.06±4.79. Twenty eight (43.80%) aged 30 years and below while 36 (56.20%) were above 30 years.

Majority of the respondents were Hausas 52 (81.20%). Other tribes constituted 12 (18.80%)

Majority of the respondents were Muslim 60 (93.80%). Christianity constituted 4 (6.20%)

Most of the respondents attended tertiary level of education 36 (56.20%) and were home managers 48 (75.00%)

Table I: *Showing the Socio-Demographic Characteristics of the Respondents*

Feature	Frequency	Percentage (%)
Maternal age (Years)		
=30	28	43.80
>30	36	56.20
Total	64	100.00
Ethnic group		
Hausa	52	81.20
Others	12	18.80
Total	64	100.00
Marital status		
Married	64	100.00
Total	64	100.00
Religion		
Islam	60	93.80
Christianity	4	6.20
Total	64	100.00
Educational status		
Secondary	20	31.20
Tertiary	36	56.20
Qur'anic	8	12.50
Total	64	100.00
Occupation		
Home managers	48	75.00
Business	4	6.20
Professional/Executive	12	18.80
Total	64	100.00

Table II depicts diabetic pregnant women with normal (Group B) and abnormal (Group A) Doppler velocimetries. Only 24 (37.50%) of the women had gestational diabetes (GDM). Among them, 16 (66.67%) had abnormal RI but no diastolic notch. Fourty women were identified with non-gestational diabetes (NGDM). Half of them had abnormal RI of which four had diastolic notches.

Table II: *High Risk Pregnancies with Normal and Abnormal Doppler Velocimetry*

High risk pregnancy	Group A (abnormal Doppler)		Group B (normal Doppler)		Total	Percentage
	RI (=0.58)	+DN	RI (<0.58)	-DN	Total	(%)
GDM	16	0	8	24	24	37.50
NGDM	20	4	20	36	40	62.50

Note: GDM, gestational diabetes; NGDM, non-gestational diabetes.

Table III depicts the diagnostic indices of Doppler velocimetry in patients with non-gestational diabetes (NGDM) for prediction of adverse pregnancy outcomes. Presence of high RI of at least 0.58 has a sensitivity, specificity, likelihood ratio, PPV, NPV and RR of 50.00%, 50.00%, 1.00, 20.00%, 80.00% and 1.00 respectively for prediction of preterm birth. There was no statistically significant difference between the two groups (P=1.00).

Occurrence of high RI of 0.58 also has a sensitivity, specificity, likelihood ratio, PPV, NPV and RR of 50.00%, 50.00%, 1.00, 20.00%, 80.00% and 1.00 respectively for predicting low Apgar scores. There was no statistically significant difference between the two groups (P=1.00).

Presence of high RI of 0.58 has a sensitivity, specificity, likelihood ratio, PPV, NPV and RR of 0.00%, 44.44%, 0.00, 80.00%, 0.00% and 0.00 respectively for predicting IUFD. There was no statistically significant difference of occurrence of IUFD between the two groups (P=0.106).

Similarly, high RI of 0.58 has a sensitivity, specificity, likelihood ratio, PPV, NPV and RR of 50.00%, 50.00%, 1.00, 20.00%, 80.00% and 1.00 respectively for predicting low birth weight. There was no statistically significant difference between the two groups (P=1.00).

**Table III** *Diagnostic Indices in Patients with Non Gestational Diabetes for Prediction of Adverse Pregnancy Outcomes*

Preterm birth						
Diagnostic indices	Sens %	Spec %	L-ratio	PPV	NPV	RR
RI= 0.58	50.00	50.00	1.00	20.00	80.00	1
		P= 1.00				
Low Apgar score						
Diagnostic indices	Sens %	Spec %	L-ratio	PPV %	NPV %	RR
RI= 0.58	50.00	50.00	1.00	20.00	80.00	1
		P= 1.00				
IUFD						
Diagnostic indices	Sens %	Spec %	L-ratio	PPV %	NPV %	RR
RI= 0.58	0.00	44.44	0.00	80.00	0.00	0
		P= 0.106				
Low birth weight						
Diagnostic indices	Sens %	Spec %	L-ratio	PPV %	NPV %	RR
RI= 0.58	50.00	50.00	1.00	20.00	80.00	1
		P=1.00				

Note: Sens, sensitivity; Spec, specificity; L-ratio, likelihood ratio; PPV, positive predictive value; NPV, negative predictive value; RR, relative risk

Figure 1 shows the combined ROC curves' graphs for NGDM to predict adverse pregnancy outcomes. The optimal cut-off point for predicting preterm birth, low birth weight and low Apgar scores were 0.725 with a sensitivity and specificity of 50.00% and 100.00% respectively (AUC=0.500, P=1.00, 95%CI=0.154-0.846).

The optimal cut-of for predicting IUFD was 0.000 with a sensitivity and specificity of 100.00% and 0.00% respectively (AUC=0.00, P=0.001, 95%CI=0.00-0.00).

Figure 1

Combined ROC graph for Non Gestational DM
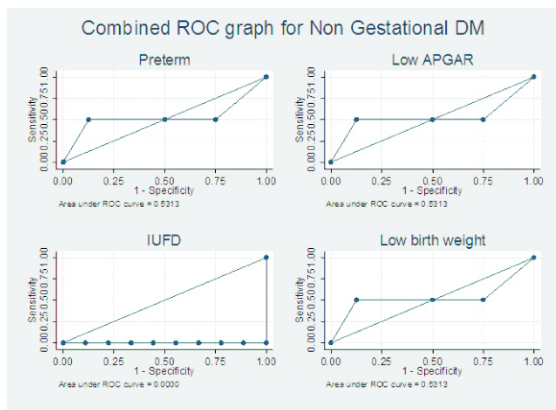
DISCUSSION

An appalling 66.67% of the high risk pregnant women with gestational diabetes were found to have high resistive indices. Reitter and colleagues[16] reported no difference of resistive index between pregnant women with well controlled gestational diabetes on insulin and healthy controlled pregnant women. This high figure of 66.67% could be due to poor control of blood glucose and other compounding variables. In addition, our Doppler study was at 20-24 weeks of gestation; Reitter's Doppler evaluation was at 35 weeks of gestation.[16]. For the 40 (62.50%) pre-gestational diabetes, half of them (50.00%) had abnormal resistive index of at least 0.58. Here, most of the diagnostic indices for prediction of adverse pregnancy outcomes were found to be average with the exception of intra-uterine fetal death (IUFD).

Table IV Diagnostic Indices in non-Gestational Diabetes

Studies	Outcomes	Sens%	Spec%	PPV%	NPV%	LR+
This study	Preterm birth/low birth weight/Apgar scores	50.00	50.00	20.00	80.00	1.00
	IUFD	0.00	44.44	80.00	0.00	0.00
Fadda[17]	C/S for FD	61.00	75.00	48.00	84.00	2.50
Landon[18]	IUGR, FD	100.00	89.00	51.00	100.00	9.70
Bracero[19]	Still birth	100.00	83.00	83.00	100.00	7.60
Grunewald[20]	C/S for FD	93.00	93.00	75.00	75.00	6.00
Bracero[21]	Composite	32.00	92.00	57.00	81.00	4.20

Note: C/S, Caesarean section; FD, fetal death; IUFD, Intra uterine fetal death; IUGR, intra uterine growth restriction.

These findings were lower than the figures reported in previous studies[17-21]. This could be attributed to different sample sizes and the adverse outcomes that were looked for in our study. The ROC analysis in this study also showed 0.725 as the optimum cut-off point for prediction of preterm birth, low Apgar scores and birth weight (AUC=0.500, P>0.05). Further study with a larger sample size is recommended to ascertain these findings. There was no area under the curve for IUFD.

CONCLUSION

Pregnant women with pre-gestational and gestational diabetes had high resistive indices following umbilical artery Doppler velocimetry. However, the predictive power of Doppler velocimetry for adverse perinatal outcomes is poor in our study.

REFERENCES

1. Glob Health Action 2014, 7:23987. Available at: http//:dx.doi.org/10.3402/gha.v7.23987

2. IDF (2003). Reproductive, maternal and child health. Brussels, Belgium: International Diabetes Federation

3. World Health Organization (2002). Laboratory diagnosis and monitoring of diabetes mellitus. Geneva: World Health Organization

4. World Health Organization (1999). Definition, Diagnosis and Classification of diabetes mellitus and its complications. Report of a WHO Consultations. Part 1: Diagnosis and Classification of diabetes mellitus. Geneva: World Health Organization.

5. Modder J, Fitzsimons J. CMACE/RCOG Joint guideline. Management of women with obesity in pregnancy. Centre for

Maternal and Child Enquiries (CMACE) and Royal College of Obstetricians and Gynaecologists (RCOG); 2010. Available from: http://www.rcog.org.uk/womens-health/clinicalgyidance/management-women-obesity-pregnancy[2013]

6. Moore T, Smith C. Diabetes mellitus and pregnancy. Medscape drugs, diseases and procedures reference; 2012. Available at :http://emedicine.medscape.com/article/127 547-overview [2013]

7. Krebs C, Macara LM, Leiser R, Bowman AW, Greer IA, Kingdom JC.Intra uterine growth restriction with absent end diastolic flow velocity in the umbilical artery is associated with mal-development of the placental terminal villous tree. Am J ObstetGynecol 1996; 175:1534-42

8. Nicolaides KH, Bilardo CM, Soothill PW, Campbell S. Absence of end diastolic frequencies in umbilical artery: a sign of fetal hypoxia and acidosis. Br Med J 1988; 297:1026-7

9. Bilardo CM, Nicolaides KH, Campbel S. Doppler measurements of fetal and utero-placental circulations: relationship with umbilical venous blood, gases measurement at cordocentesis. AM J ObstetGynecol 1990; 162:115-20.

10. Yoon BH, Remero R, Roh CR, Kim SH, Ager JW, Syn JW, et al.Relationship between the fetal biophysical profile score, umbilical artery Doppler velocimetry and fetal blood acid-base status determined by cordocentesis. Am J Obstet Gynecol. 1993; 169:1586-94

11. Giles WB, Trudinger JB, Baird PJ.Fetal umbilical artery flow velocity waveforms and placental resistance. Pathologic correlation. Br J ObstetGynaecol. 1985;

92:31-8

12. Wong SF, Chan FY, Cincotta RB, Mclntyre DH, Stone M. Use of umbilical artery Doppler velocimetry in the monitoring of pregnancy in women with pre-existing diabetes. Aust NZJ ObstetGynecol 2003; 43(4): 302-6

13. Maulik D, Lysikiewicz A, Sicuranza G. Umbilical arterial Doppler sonography for fetal surveillance in pregnancies complicated by pre-gestational diabetes mellitus. J MaternFetal Neonatal Med 2002; 12(6): 417-22

14. Pietryga M, Brazert J, Wender-Ozegowska E, Dubiel M, Gudmundsson S. Placental Doppler velocimetry in gestational diabetes mellitus. J Perinat Med 2006; 34(2): 108-10

15. Arduini D, Rizzo G, Romanini C, Mancuso S. Utero-placental blood flow velocity waveforms as predictors of pregnancy induced hypertension. *Eur J ObstetGynecolReprod Biol.* 1987; 26:335–41.

16. Reitter A, Hajduk B, Geka F, Buxmann H, Schlosser R, Loywen F. Doppler studies of gestational diabetes in the third trimester. Ultraschall Med 2011; 2:162-8

17. Fadda GM, Cherchi PL, D' Antona D, Ambrosini G, Marchesoni D, Capobianco G, etal. Umbilical arterypulsatility index in pregnancies complicated by insulin-dependent diabetes mellitus without hypertension GynecolObstet Invest2001;51:173–7

18. Landon MB, Gabbe SG, Bruner JPLudmir J. Doppler umbilical artery velocimetry in pregnancy complicated by insulin-dependent diabetes mellitus.ObstetGynecol 1989;73:961–5

19. Bracero L, Schulman H, Fleischer

A,Farmakides G, Rochelson B. Umbilical artery velocimetry in diabetes and pregnancy. ObstetGynecol 1986; 68:654–8

20. Grunewald C, Divon M, Lunell NO. Doppler velocimetry in last trimester pregnancy complicated by insulin-dependent diabetes mellitus. ActaObstetGynecolScand 1996;75:804–8

21. Bracero LA, Figueroa R, Byrne DW, Han HJ. Comparison of umbilical Doppler velocimetry, nonstress testing, and bio-physical profile in pregnancies complicated by diabetes.J Ultrasound Med 1996;15:301–8