Original Research Article

Doppler ultrasound of umbilical artery in prediction of fetal outcome in pregnancy induced hypertension Sudanese population

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ABSTRACT

Background: Pregnancy induced hypertension is one of causes of fetal mortality and morbidity, there is few complete data about the most frequently altered Doppler parameters to predict fetal outcome in pregnancy induced hypertension in Sudanese pregnant women.
Methods: This is a cohort prospective study done in 206 pregnant women in second and third trimester presenting to antenatal clinic in Soba University Hospital Department of Obstetrics and Gynecology in the period from June 2008 to April 2013. The study aim was to assess the Doppler indices of umbilical artery in pregnancy induced hypertension for prediction of prenatal outcome; 105 pregnancy induced hypertension patients and 101 normotensives with normal pregnancy as control group included. Color Doppler of umbilical artery was done. Statistical analysis of data were done using SPSS, Receiver Operating Characteristic (ROC) curve analysis was performed and the Area Under the Curve (AUC) used to determine sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of umbilical artery Doppler indices to predict fetal outcome.
Results: The study determine that there was significant difference in Doppler indices in PIH and control group (p<0.01, the mean indices of umbilical artery is higher in PIH group compared with normal pregnancy group. High percentage of adverse fetal outcome had been reported in in Pregnancy Induced Hypertension group than in control. Systolic/Diastolic ratio was most accurate in predicting adverse outcome in pregnancy induced hypertension patients, followed by the pulastility index then the Resistive index (75%, 66% and 57% respectively).
Conclusions: This study concluded that pregnancy induced hypertension leads to higher Doppler indices of umbilical artery when compared with normal pregnancy. Doppler of the umbilical artery was useful to predict fetal wellbeing in PIH patients, high percentage of adverse fetal outcome had been reported in absent and reversed end diastolic flow velocity.

Keywords: Color doppler waveform, Pregnancy-induced hypertension, Pulastility index and resistance index, Systolic/Diastolic ratio, Umbilical artery,

INTRODUCTION

Hypertensive disorder complicating pregnancies are common and forms one daily triad along with hemorrhage and infection. Pregnancy Induced

Hypertension (PIH) is a form of high blood pressure in pregnancy and is the most common medical complication during pregnancy. It is the leading cause of maternal and fetal morbidity and mortality.[1,2] The most common complication of PIH is Intra Uterine Growth Retardation (IUGR), placental infarcts and abruptions. It is therefore desirable to know the accurate changes in uteroplacental and fetal circulation to predict perinatal outcome and help in the appropriate intervention.[1,2] Assuming that defective placental circulation results in adverse pregnancy outcome, Doppler ultrasonography has been used as a modality to evaluate placental circulation and fetal wellbeing for about three decades.[3] Doppler ultrasound enables a better understanding of the hemodynamic changes, therefore becomes one of the most important clinical tools for feto-maternal surveillance in high risk pregnancies. It can be credited with causing a significant decrease in perinatal mortality and morbidity.[3,4]

METHODS

This study was cohort prospective study carried out at khartoum state in Soba University Hospital at the department of Obstetrics and Gynecology, in the fetus unit and critical pregnancy in the period From June 2008 to April 2013 to predict the fetal outcome with Doppler indices of umbilical artery in PIH, the sampling includes 206 pregnant women (105 PIH patients and 101 normal pregnant women as control group). The two groups were compared according to fetal outcome through the Doppler parameters of the umbilical artery. Pregnancies with gestational age between 24 weeks to 36 weeks included in this study even if it had PIH or normotensive as control group, multiple gestations and congenital anomalies were excluded from the study. The preeclampsia patients were diagnosed if blood pressure ≥140/90 in pregnant women after 20th weeks of gestation with non proteinurea or with proteinurea more than 300 gm/24 hours. Doppler ultrasound of umbilical artery using VOLUSON 730 Expert Rev.[1] ultrasound machine done with multi-frequency curved liner array transducer (3.5-5 MHz), which has variable focal zone and frequency capability, used proper gain control 30 dB to improve the color resolution by reducing the frame rate and also used high wall motion filter to remove motion artifacts, Doppler indices of umbilical artery taken from free floating loop (Figure 1,2).

Data analysis

The data have been analyzed using SPSS version 20 , Independent Samples T-test was used to compare mean flow velocity of normal pregnant women and PIH patients, cross tabulation using chi square test to compare the frequency of outcome in PIH patients and control group , Receiver Operating Characteristic (ROC) curve analysis was performed and the Area Under the Curve (AUC) used to determine sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value

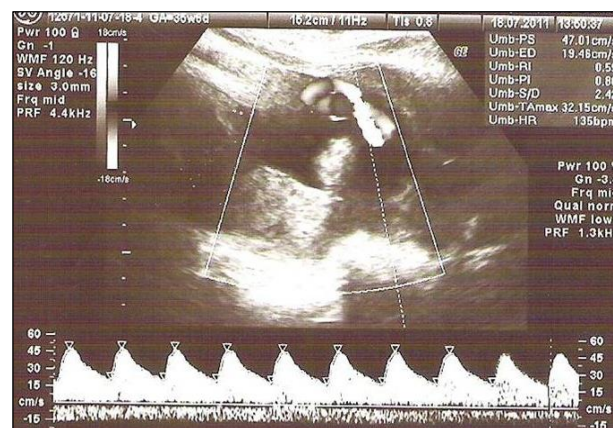(NPV) of umbilical artery Doppler indices to predict fetal outcome.

Figure 1: Normal colour doppler of the umbilical artery waveform at 35 wks (s\d ratio =2.42, ri =0.59 , pi = 0.86)

Figure 2: Colour Doppler of the umbilical artery waveform demonstrates absent end-diastolic frequencies in PIH patients.

RESULTS

The study determine that there was significant difference in Doppler indices in Pregnancy Induced Hypertension and control group (p<0.01, the mean indices of umbilical artery is higher compared with normal pregnancy, the different mean of S/D ratio was 0.40, the different in mean of RI was 0.06 and the different in mean of PI index was 0.16 shows in (Table 1). A low diastolic flow and higher indices characterized the pregnancies with abnormal outcomes.

The study found that the abnormal outcome is higher in PIH than in control group, in 105 PIH patients 60% had Cesarean section compare to 27% in control, 43% had IUGR compare to 5% in control group, while 10% IUD in PIH, 40% premature birth compare to 7% in control group, 17% had admission to neonatal care unit compare to 3% in control group, 16% morbidity and 14% mortality compare to 4% and 1% in control group

respectively, high percentage of adverse fetal outcome had been reported in absent and reversed end diastolic flow velocity in umbilical artery compared with group of present flow velocity (Table 2,3). The study found that in patients with PIH and presence of EDV when S/D ratio >3 the adverse outcome me is higher than in S/D ratio <3, and in all cases of RI >0.64 and PI >1 there is adverse fetal outcomes (Table 4-6). The umbilical artery indices could be used to rule-out adverse fetal outcome in patients with PIH more than confirming it, were shown clearly when the study used the ROC curve test to give the correlation between sensitivity and specificity.

Table 1: The mean of doppler indices in the normal pregnant women (no =101) and PIH patients with present flow (no=61).

The mean of indices	Normal n=101	Abnormal n=61	Mean difference	p value
S/D Ratio	2.3378	2.7387	0.40087	0.000
R. I	0.5591	0.6234	0.06433	0.000
P. I	0.8195	0.9833	0.16377	0.000

Table 2: Comparing the adverse outcome with groups of PIH patients.

Adverse out come	PIH group N=105	PIH with present EDV flow group N=61	PIH wit absent EDV flow velocity N=31	PIH with reversed EDV flow velocity N=13
Cesarean section rate	60%	27%	23%	10%
IUGR	43%	8.5%	24%	9.5%
IUD	10%	-	6.6%	2.8%
Premature birth	42%	8.5%	23%	9.5%
Admission to neonatal care unit	17%	2.9%	9.5%	4.8%
Morbidity	16%	3.8%	8.6%	3.8%
Mortality	14%	-	10.5%	3.5%

Table 3: Comparing the percentage of adverse outcome with PIH patients and normal group.

Fetal outcome	PIH group n=105	Normal group n=101
Cesarean section rate	60%	27%
IUGR	43%	5%
IUD	10%	0%
Premature birth	42%	7%
Admission to neonatal care unit	17%	3%
Morbidity	16%	4%
Mortality	14%	1%

Table 4: Cross tabulation shows the S/D ratio and fetal outcome in PIH with present of EDV.

S/d ratio	Fetal outcome		Total
	Normal outcome	Adverse outcome	
≤3	36	1	37
>3	14	10	24
Total	50	11	61

The test showed the area under the curve of the ROC (receiver operating characteristic) curve in the S/D ratio was 0.82 larger than the area of PI and RI indices, were 0.79 and 0.74 respectively (Figures 3, 4 and 5).

Fetal circulation plays an important role in monitoring fetal outcome and predicts adverse fetal outcome.
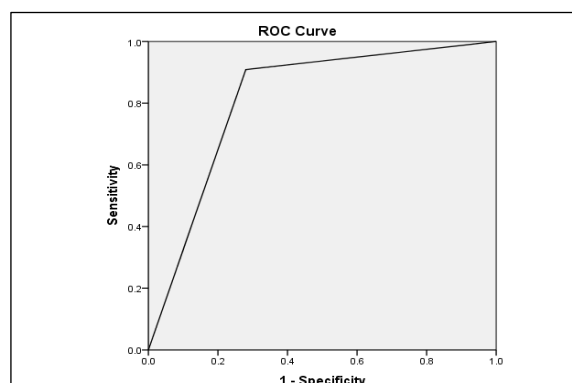

Figure 3: ROC curve showing the Specificity and sensitivity of the S/D ratio (Area under the curve 0.815).

Table 5: Cross tabulation between PI and fetal outcome.

PI	Fetal out come		Total
	Normal outcome	Adverse outcome	
≤1	29	0	29
>1	21	11	32
Total	50	11	61

According to, three cut-off values were considered for each of the indices, through the higher cut-offs (i.e. >3, >1 and >0.64 for S/D ratio, PI and RI, respectively) the study showed S/D ratio was most accurate in prediction of adverse outcome (75%) followed by the PI was (66%) and the RI index was (57%) in predicting adverse outcome in PIH patients (Table 7).
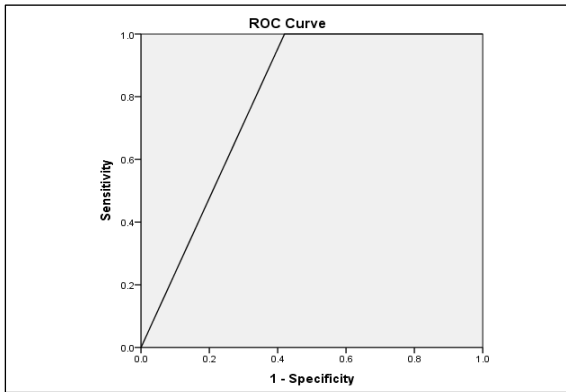
Table 6: Cross tabulation between RI and fetal outcome.

RI	Fetal out come		Total
	Normal outcome	Adverse outcome	
≤0.64	24	0	24
>0.64	26	11	37
Total	50	11	61

Figure 4: ROC curve showing the specificity and sensitivity of PI (Area under the curve 0.795).
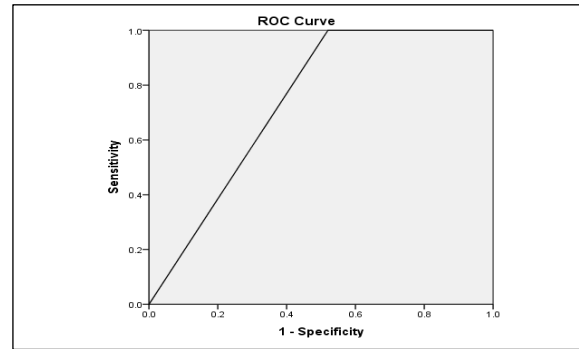

Figure 5: ROC curve showing the Specificity and sensitivity of RI (Area under the curve 0.740).

Table 7: The accuracy of the umbilical artery Doppler in predicting fetal outcome.

Indices	Sensitivity	Specificity	Positive predictive value (PPV)	Negative predictive value (NPV)	Accuracy predictive value
S/D Ratio	90%	72%	42%	97%	75%
RI	100%	48%	30%	100%	57%
PI	100%	50%	34%	100%	66%

DISCUSSION

The study population consisted of 105 PIH patients and 101 women with uneventful pregnancies as normal control group the study classified the PIH Patients into three groups according to Doppler flow velocity waveforms of the umbilical artery. First group consisted of (61 patients, 58%) with present end diastolic flow velocity waveforms, the second group consisted of (31 patients, 30%) with absent flow velocity, and the third Group consisted of (13 patients, 12%) with reversed end diastolic flow velocity .This study found that the flow velocity of the umbilical artery and the means of three indices were significantly higher to PIH patients with present flow velocity waveforms than the control group (the mean of S/D ratio for both groups were 2.74 and 2.34 respectively and the different of mean was 0.40), while the mean of RI were 0.62 and 0.56 respectively and the different of mean was 0.06. Finally (the mean of PI was 0.98 and 0.82 respectively, and the different of mean was 0.16), p <0.0 for all of indices as shown in (Table 1). This finding agrees with the study performed by Chen et al, who showed not only a higher pulsatility index in

preeclamptic patients but also a significantly greater PI in severe cases of preeclampsia.[5] Also this study agrees with the study carried out by Shahnaz Aali et al, that showed the umbilical artery PI and RI were significantly higher in preeclamptic patients (PI of 1.32±0.23 and RI of 0.77±0.09) when compared to the controls (0.97±0.18 and 0.64±0.08 for PI and RI, respectively) (p<0.001).[6] On the other hand Ozeren et al, could not find any difference in umbilical PI between normal pregnancies and preeclamptic patients without IUGR whereas, preeclampsia group with IUGR showed a significantly higher mean umbilical artery PI.[7]

The study revealed that the adverse fetal outcome includes is more in PIH than in control group cesarian section, IUGR, IUD, premature birth and admission to neonatal care unit with possible mortality and morbidity. Due to the diastolic flow decrease, then become absent, and later reverse the study found in 105 PIH patients 60% had Cesarian section, whereas 43% IUGR, 10% had IUD, while 40% premature birth and 17% admission to neonatal care unit. Also, the study found 16% morbidity and 14% mortality (Table 2). In patients with absent end

diastolic velocity group and reversed end diastolic velocity group there were higher rates of adverse fetal outcome when compared with the present flow velocity group, Cesarian section rate were 23%, 10% and 27% in three groups respectively, whereas IUGR was 24%, 9% and 8.5% respectively, while IUFD was 6.6%, 2.8% and 0% respectively. Also, premature babies were 23%, 9.5% and 8.5% respectively, admission to neonatal care unit were 9.5%, 4.8% and 2.9% respectively, morbidity was 8.6%, 3.8% and 3.8% respectively and finally mortality was 10.5%, 3.5% and 0% respectively (Table 3). This study findings agrees with study done by Bhatt CJ, et al, from India which found in patients with Absent End Diastolic Velocity (AEDV) and Reversed End Diastolic Velocity (REDV) perinatal mortality was 50% and 50% had IUGR babies.[8] Also the findings agree with study performed by Müller T et al, at University of Würzburg, Germany, he said that high perinatal morbidity and mortality rates have been reported in association with absent or reverse end-diastolic flow velocities in the umbilical artery.[9]

The study found that in patients with PIH and presence of EDV when S/D ratio >3 the adverse outcome is higher than in S/D ratio <3, and in all cases of RI >0.64 and PI >1 there is adverse fetal outcomes (Table 4-6), which includes cesarean section, IUGR, IUFD, Premature birth, admission to the neonatal intensive care unit, fetal mortality and morbidity this results similar to the study done by Bhatt CJ, et.al from India, at 2003 which showed that S/D ratio of more than 3 in umbilical artery was considered to be abnormal and this correlates with the parameters of fetal outcome.[8] Also according to study done by Bibi Shahnaz et al, which found PI, the cut-off of ≥0.98 yielded the highest sensitivity and specificity. Also, RI of ≥0.64 acquired a sensitivity of 100% and specificity of 44% could be used to rule-out preeclampsia.[6]

Statistical analysis in this study showed that the umbilical artery RI and PI were the most sensitive (100%) in predicting fetal outcome than S/D ratio (90%). On the other hand in this study the Negative Predictive Value (NPV) was the highest for the three indices S/D ratio (97%), RI (100%) and PI (100%) (Table 7). However, the study done by Lakhkar BN, et .al, were showed among the umbilical indices, the PI had the highest sensitivity and specificity.[10] Also this study found that the S/D ratio was the highest specificity and positive predictive value with 72% and 42% respectively. But the specificity of RI and PI indices were least 48% and 50% respectively. Also, the positive predictive values for both RI and PI were least 30% and 34% respectively (Table 7). The umbilical artery indices could be used to rule-out adverse fetal outcome in patients with PIH more than confirming it, were shown clearly when the study used the ROC curve test to give the correlation between sensitivity and specificity. The test showed the area under the curve of the ROC (receiver operating characteristic) curve in the S/D ratio was 0.82 larger than the area of PI and RI indices, were 0.79 and 0.74 respectively (Figures 3, 4 and 5). Also, the study showed that the S/D ratio was most accurate (75%) in predicting fetal outcome followed by PI and RI (66% and 57%) respectively (Table 7). This indicates that the S/D ratio is the best indicator to predict fetal outcome and PI is the most accurate than the RI. This agrees with the study done by Bibi Shahnaz et al, who found that the PI, the cut-off of ≥0.98 yielded the highest sensitivity and specificity. Also, RI of ≥0.64 acquired a sensitivity of 100% and specificity of 44% could be used to rule-out preeclampsia.[6] Also the results of this study agrees with the study done by Todros T et al. His results showed the best accuracy was in predicting outcomes 1 and 4. The Positive predictive value increased strongly with higher cut-off curves while negative predictive value only decreased slightly, however the corresponding positive predictive values were 18% and 40% only.[11]

CONCLUSION

This study concluded that PIH leads to worsen placental insufficiently, which appears on the higher mean indices of umbilical artery to PIH patients when compared with normal pregnancy. A low diastolic flow and higher indices characterized the pregnancies with abnormal outcomes. The study concluded that Doppler of the umbilical artery was useful to predict fetal wellbeing in PIH patients, high percentage of adverse fetal outcome had been reported in absent and reversed end diastolic flow velocity in umbilical artery compared with group of present flow velocity. According to, three cut-off values were considered for each of the indices, through the higher cut-offs (i.e. >3, >1 and >0.64 for S/D ratio, PI and RI, respectively) the study showed S/D ratio was most accurate (75%) followed by the PI was (66%) and the RI index was (57%) in predicting adverse outcome in PIH patients. The study concluded that the umbilical artery S/D ratio, PI and RI are strong independent predictors in excluding adverse outcome in preeclampsia patients rather than confirming it.

Recommendations

The study recommended that Color Doppler examination used as screening tool in follow up of all cases of pregnancy induced hypertension.

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