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Evaluation the index of ophthalmic arteries in diabetic patients with retinopathy compared to diabetic patients without retinopathy using color Doppler ultrasound

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ABSTRACT

Diabetic retinopathy is the most common eye complication in diabetic patients that early detection of this complication is essential. The aim of this study was to evaluate ophthalmic artery index in diabetic retinopathy by Doppler ultrasound. . In this cross-sectional study, 64 patients were studied in 4 groups (healthy, diabetic without retinopathy, background retinopathy and proliferative retinopathy). Resistance index (RI) and Pulsatile Index (PI) were assessed by color Doppler ultrasound. The obtained data were analyzed by ANOVA and chi-square test and ROC curve. RI in diabetic patients with proliferative retinopathy has the highest mean (0.83) and the lowest mea was observed in healthy subjects (0.54) (P <0.001) as well as in PI, the highest rate was in diabetic patients with proliferative retinopathy (1.41) and the lowest was in healthy subjects (0.92) (P <0.001). The results of our study showed that the sensitivity, specificity, positive and negative predictive values and overall accuracy of RI and PI in diabetic patients with proliferative retinopathy in the best cut-off points (0.645 and 1.0175 respectively) were 100%.Ophthalmic artery index RI and PI was significantly increased in patients with diabetic retinopathy and the sensitivity and specificity for detection retinopathy was 100%. Color Doppler ultrasound method is more efficient for screening diabetic patients with retinopathy.

Keywords: Diabetes, Retinopathy, RI, PI

INTRODUCTION

Diabetic Retinopathy (DR) is a most common eye complication which seen in 30% of diabetic patients have some degree of retinopathy [1]. Despite extended research, initiation and progression mechanisms of DR still not clear, but vascular and hemodynamic alternations in eye play a critical role in DR individuals. On the other hand, the hemodynamic process role are not clearly defined [2], and in researchers reported inconsistency results about the hemodynamic factors. According to these results, blood flow in retrobulbar arteries can increase [3], decrease [4-14] or shown no changes [15]. Doppler ultrasound imaging is known one of the widely used techniques for evaluation of flew rate in vascular [1]. This imaging is reported as noninvasive, repeatability, spend a short time with no complication technique, while for funduscopy pupil dilatations required and the patients have to look a certain angle and the vision impaired as results of drugs effect for 4-6 hours [1]. Assessment of blood flew rate in ophthalmic artery, central retinal artery, posterior ciliary artery and central retinal vein with Doppler is technique with high ability in detection of early stage retinopathy in diabetic patients [1]. The aim of this study is to evaluation of eye arteries index among diabetic patients with or without retinopathy using the color Doppler sonography for quick detection and treatment, decrease complications and improve quality of life of patients.

MATERIALS AND METHODS

This study was descriptive-analytical study. The study population include diabetic patients without retinopathy, with background retinopathy, proliferative retinopathy and healthy individuals who come to ophthalmology clinics in Emam Khomeini hospitals in Ahvaz-Iran in 2015. According to the previous studies [10] standard deviation is 0.7 and given that 0.05 difference among resistance between a group clinically important and under consideration α=0.05 and β=0.2 sample size in each group is 16 and totally 64 individuals. Exclusion criteria from the study include: history of phaco surgery, trauma, inflammation, nondiabetic vascular disorders, pregnancy, breastfeeding, high blood pressure and hyperlipidemia. The selected patients referred for ultrasound. The physician has no idea about retinopathy before ultrasound performed. The ultrasound performed by expert sonographer and 7.5 MHz linear probe V10 Medison ultrasound in Emam Khomeini hospital. Fundoscopy were performed by ophthalmologist. Patients were in supine position and sterile gel was placed in closed eyelid [16]. Measurements include Peak Systolic Velocity (PSV), End Diastolic Velocity (EDV) in ophthalmic arteries, central retinal artery and posterior ciliary artery. According to the following formula Resistive Index (RI) and Pulsatile Index (PI) were measured [17, 18]: Resistive Index (RI) = PSV-EDV/PSV; Pulsatile Index (PI) = PSV-EDV/V mean; V mean=1/3(PSV-EDV) +EDV.

The eye with severe retinopathy were selected and if retinopathy is equal in both eye, the right eye were selected for further evaluation. The signal localized from ophthalmic artery in upper part of intraocular region to optic nerve. Posterior ciliary artery were separated from ophthalmic artery and divided in some branches for blood supply. These branches is 0.2 mm and formed pial network [19]. Signals were localized from posterior ciliary artery. Despite multiple branches of posterior ciliary artery, only lateral branches were selected for evaluation.

Statistical analysis

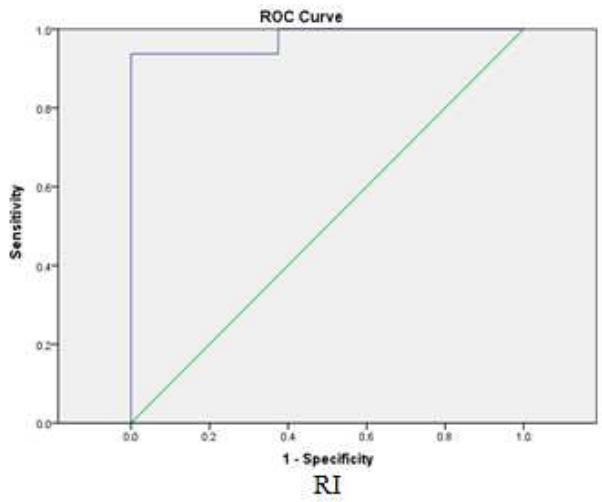
Demographic factors and clinical symptoms were recorded and entered in SPSS ver22 software. Statistical analysis were presented in descriptive and analytical section. All demographic and clinical factors of patients were reported according to the descriptive criteria. Tukey and Duncan tests were performed if ANOVA test assumptions established and if not Kruskal–Wallis nonparametric tests were performed. For determination sensitivity and specificity, ROC curve were used. All tests were evaluated in 5% error.

RESULTS

This study was performed in 2015 on 64 individuals, divided in for group include: diabetic patients without retinopathy, with background retinopathy, proliferative retinopathy and healthy individuals (in each group, n=16). Demographic variable include age (P=0.612) and gender (P=0.556) among groups were not significant. Among study groups, RI mean were high in proliferative retinopathy group (0.83) and after that background retinopathy (0.74), without retinopathy (0.69) and lowest mean were observed in healthy individuals (0.54) which statistically significant (P<0.001). Also, PI mean were high in proliferative retinopathy group, background retinopathy, without retinopathy and healthy individuals were 1.41, 1.26, 1.18 and 0.92 respectively which statistically significant (P<0.001) (Table.1). Area under the ROC curve for diabetic patients without retinopathy for RI was 0.977 and highest sensitivity and specificity in the cut-off point was 0.62 which sensitivity and specificity were equal to 93/8% and 100% respectively. Area under the ROC curve for PI was 0.938 and highest sensitivity and specificity in the cut-off point was 1.015 which sensitivity and specificity were equal to 93/8% and 100% respectively (Tables 2 and 3) (Fig. 1). Area under the ROC curve for detection of background retinopathy for RI was 0.984 and highest sensitivity and specificity in the cut-off point was 0.625 which sensitivity and specificity were equal to 93/8% and 100% respectively. Positive predictive value (PPV) and negative predictive value (NPV) in this method were 100% and 94.11% respectively. Area under the ROC curve for PI was 0.936 and highest sensitivity and specificity in the cut-off point was 1.04 which sensitivity and specificity were equal to 87.5% and 100% respectively. PPV and NPV in this method were 100% and 88.88% respectively (Tables 2 and 3) (Fig. 2). Area under the ROC curve for detection of proliferative retinopathy for RI and PI was 1 and highest sensitivity and specificity in the cut-off point were 0.645 for RI and 1.075 for PI which sensitivity and specificity were equal to 100%.PPV and NPV in this method were 100% (Table 2 and 3) (Fig. 2).

Table 1. Demographic and Doppler ultrasound variables frequency in study groups

Group variable		Proliferative retinopathy	Background retinopathy	Diabetic without retinopathy	Control	P-value
age		61.81±8.65	61.75±8.94	58.31±11.8	62±6.07	0.612
Gender	male	7 (43.8%)	9 (56.3%)	11 (68.8%)	9(56.3%)	0.566
	female	9(56.3%)	7(43.8%)	5(31.3%)	7(43.8%)	
RI		0.83±0.08	0.74±0.1	0.69±0.06	0.54±0.03	<0.001
PI		1.41±0.21	1.26±0.25	1.18±0.2	0.92±0.06	<0.001



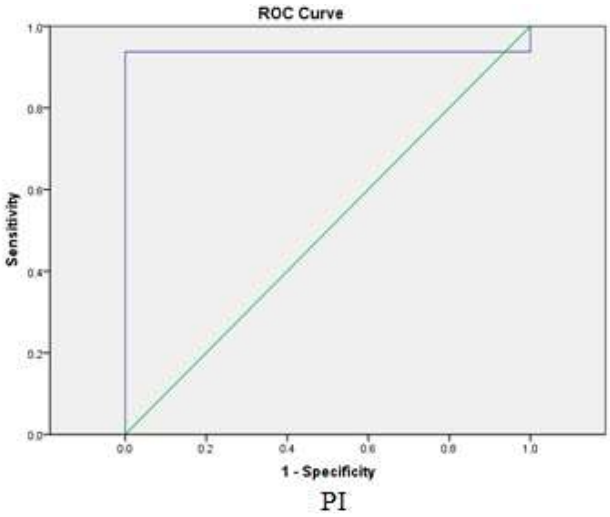


Figure 1. ROC curve in diabetic patients without retinopathy according to the RI and the PI

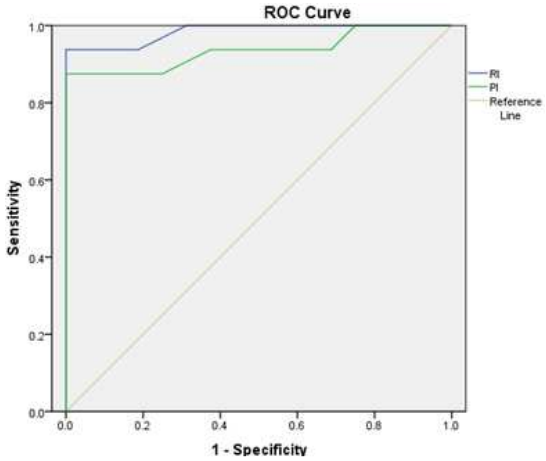


Figure 2. ROC curve in patients with background retinopathy according to the PI and RI

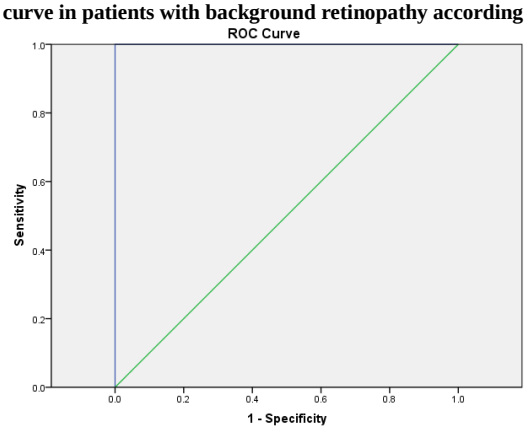


Figure 3. ROC curve in patients with proliferative retinopathy according to the PI and RI

Table 2. Area under the ROC curve in study group according to the RI and PI

group	variables	Area under curve	standard error	significance	Confidence interval	
					Low	High
Proliferative retinopathy	PI	1	0	<0.001	1	1
	RI	1	0	<0.001	1	1
Background retinopathy	PI	0.936	0.049	<0.001	0	1
	RI	0.977	0.025	<0.001	0	1
Diabetic without retinopathy	RI	0.977	0.025	<0.001	0	1
	PI	0.938	0.061	<0.001	0	1

Table 3. Sensitivity, Specificity, PPV and NPV according to the RI and PI in study group

Group	Variables	Sensitivity	Specificity	PPV	NPV	Positive probability	Negative probability	Overall Accuracy
Proliferative retinopathy	RI (cut off: 0.645)	100	100	100	100	-	-	100
	PI (cut off: 1.075	100	100	100	100	-	-	100
Background retinopathy	RI (cut off: 0.625)	93.8	100	100	94.11	-	0.062	96.87
	PI (cut off: 1.04	87.5	100	100	88.88	-	0.125	90.9
Diabetic without retinopathy	RI (cut off: 0.62)	93.8	100	100	94.11	-	0.062	96.87
	PI (cut off: 1.015	93.8	100	100	94.11		0.062	96.87

DISCUSSION

Results shown that mean of RI in proliferative retinopathy group is high (0.83) and in healthy group is low (0.54) which statically significant. Also PI measurement is high in proliferative retinopathy group (1.41) and low in healthy group (0.92) which statically significant. The results also shown that sensitivity, specificity, PPV and NPV for RI and PI in diabetic individuals with retinopathy in cut-off points (0.645 and 1.0175 respectively) equal to 100% and overall accuracy also 100%. Buzney and Feke (1994) evaluated 39 diabetic type I patients with retinopathy compared with 7 healthy individuals. According to the results, retrobulbular artery index in diabetic patients with retinopathy were significantly high (4). Our results is also shown that the high PI and RI values were observed in diabetic patients with proliferative retinopathy and background retinopathy. Karami et al., (2012) evaluated 125 individuals include 25 healthy, 74 diabetic without retinopathy and 24 with retinopathy and observed RI and PI of retrobulbular artery in diabetic retinopathy individuals were significantly high (20). Also in this study observed blood flew rate in end of diastole and systole peak in these patients were lower than other groups. After applying and remove confounding effects, observed only RI is significantly in these patients. Our results are in consistent with these findings. Atakashi et al (1998) evaluated 22 healthy and 52 diabetic patients. Resistance index of retrobulbular artery in diabetic patients were significantly high [21]. These findings are consistent with our results.

Baydar et al., evaluated ophthalmic artery Doppler in diabetic retinopathy and shown that RI of central retinal artery in control group is significantly higher than diabetic patients without retinopathy. Also they observed ophthalmic artery RI in diabetic patients without retinopathy is significantly higher than patients with non-proliferative retinopathy [22]. These results in contrast with our results, because in our research ophthalmic artery RI in proliferative retinopathy group is higher than background retinopathy, and in background retinopathy is higher than patients without retinopathy, and in these patients higher than healthy individuals. Theses difference may be due to different demographic variables and sample size or due to different in accuracy of measurement tools.

MacKinnon et al., (2000) evaluate ophthalmic artery Doppler in diabetic patients with retinopathy and shown that ophthalmic artery RI in proliferative retinopathy (0.81) and background retinopathy (0.81) is higher than healthy individuals (0.72) [23]. The results of these findings is in consistent with our results, but in our findings ophthalmic artery RI in background retinopathy group is significantly lower than proliferative retinopathy group which these difference may cause due to different sample size and demographic variables. D.Evans et al., evaluated ophthalmic artery Doppler in patients with retinopathy and observed hypoxic conditions cause significant alternations in flow rate of end diastolic and ophthalmic artery RI in healthy individuals, but in retinopathy patients these changes were not observed. Also they found RI in hypoxic conditions in healthy individuals are higher than diabetic retinopathy patients [24].

CONCLUSION

According to these results, it should be stated that RI and PI index of ophthalmic artery in diabetic retinopathy patients are increased significantly. Evaluation of sensitivity of RI and PI shown that these Doppler variables in 0.645 and 1.0175 cut-off points are sensitivity and specificity equal 100% and PPV and NPV is 100%. As a results we can purposed that Doppler is a useful method for screening patients with retinopathy.

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