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Original Research Article

A Study to Assess Ocular Blood Flow by Colour Doppler Ultrasonography in Patients of Diabetic Retinopathy

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ABSTRACT

Introduction: Diabetes mellitus is on the increase and emerging as a major public health problem. The literature shows that there is an inverse correlation between the severity of diabetic retinopathy and blood flow velocity in ocular arteries. Resistive index is also significantly higher in diabetics with or without retinopathy than in normal subjects. The present study has been undertaken for measuring blood flow velocities in ophthalmic artery and central retinal artery in diabetic subjects.

Method: This study was conducted on 60 diabetic eyes and 20 non diabetic controls eyes. The values of blood flow velocity (cm/sec) obtain by colour Doppler imaging. Resistive Index (systolic velocity – diastolic velocity / systolic velocity) was calculated for ophthalmic and central retinal artery.

Results: In comparison from control group to Preproliferative & Proliferative Diabetic Retinopathy group in Ophthalmic Artery mean systolic & diastolic velocity decrease from 50.08 to 40.19 cm/sec (P value 0.04) & 19.86 to 10.31 cm/sec (P value 0.00) respectively. RI increase from 0.61 to 0.72 (P value 0.00). In Central Retinal Artery mean systolic & diastolic velocity decrease from 24.06 to 16.51 cm/sec (P value 0.00) & 8.12 to 4.56 cm/sec (P value 0.00) respectively. Resistive Index increase 0.64 to 0.69 (P value 0.25).

Conclusion: Ocular blood flow decrease with progression of diabetic retinopathy. Colour Doppler Imaging may become a valuable method to assess ocular blood flow in diabetic retinopathy and other ocular vascular disorders. This technique may be used when standard diagnostic procedures impossible because of hazy media.

Key Words: Diabetic Retinopathy, Colour Doppler Imaging, Blood Flow.

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INTRODUCTION

Diabetes mellitus is on the increase and seems to be emerging as a major public health problem for our country. It is a multisystem disorder, including cardiovascular disease, renal failure, peripheral neuropathy and retinopathy which may lead to blindness. The relationship of diabetes mellitus and retinopathy is most interesting.[1,2]

Initial lesions of diabetic retinopathy affect capillaries, small arterioles and venules. The earliest changes are retinal capillary bed obstructions and capillary dropout[3]. Progressive thickening of the basement membrane narrows the lumen of capillaries; microaneurysm, venous abnormalities, arteriovenous shunts and later neovascularisation develop. These changes of vessel morphology may disturb the retinal microcirculation. Furthermore, diabetes mellitus affects the blood rheology. Which reduce the retinal blood flow, if not compensated by regulatory means.

Because of serious consequence of diabetes mellitus in the eye, the investigations of retinal blood flow and its regulation in diabetic retinopathy is of primary importance, because it may lead to a better understanding of the microvascular pathophysiology of this disease. Furthermore the investigation may help in assessment of the effect of different mode of treatment and in the monitoring of disease progression.

Colour Doppler imaging (CDI) has made it possible to evaluate ocular blood flow under real time and physiological conditions. The literature shows that there is an inverse correlation between the severity of diabetic retinopathy and flow velocity.

This is a study to assess the influence of diabetes on ocular blood flow in patients of diabetic retinopathy in central retinal artery and ophthalmic artery and its assessment by CDI.

MATERIALS & METHODS

In our study 60 eyes of diabetic retinopathy and 20 controls were included. All subjects have history of DM for more than 10 years. Patients with history of hypertension, smoking and alcohol

consumption were excluded. Patient with h/o eye disease or eye trauma are also excluded. Intra Ocular Pressure (IOP) measurement done by applanation tonometer. Dilated Fundus examination of subjects done with slit lamp biomicroscopy using +90 Diopter lens. Diabetic subjects were divided into 3 groups according to stage of diabetic retinopathy. Healthy volunteers comprised the fourth group.

Group 1: Included patients having diabetes for more than 10 years but no diabetic retinopathy (NDR).

Group 2: Included patients with background diabetic retinopathy (BDR).

Group 3: Included patients with pre-proliferative and proliferative diabetic retinopathy (PrePDR & PDR).

Group 4: Included patients without diabetes and have a normal fundus (Control group).

All these patients were subjected to colour Doppler imaging of both eyes using 5-7.5 MHz linear phase array transducer. The same transducer was applied on the ipsilateral common carotid artery and blood flow velocity was seen to rule out any carotid disease. Only those patients in whom flow velocity was normal in carotid artery were taken into study.

The values of blood flow velocity (in cm/sec) thus obtained were compared in different diabetic retinopathy groups and with the normal eyes of non-diabetic group and conclusions were drawn. Resistive index (systolic velocity – diastolic velocity / systolic velocity) was calculated for ophthalmic and central retinal artery.

Table 1: Range and Mean value of systolic and diastolic velocity in ophthalmic & Central retinal artery in different groups

Group	Ophthalmic Artery		Central Retinal Artery	
	Systolic	Diastolic	Systolic	Diastolic
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
I (NDR)	48.19 ± 15.68	17.54 ± 7.92	21.51 ± 3.68	7.56 ± 1.96
II (BDR)	40.44 ± 9.10	12.03 ± 3.24	21.40 ± 5.90	7.48 ± 2.63
III (PrePDR & PDR)	40.19 ± 19.14	10.31 ± 5.27	16.51 ± 8.03	4.56 ± 2.13
IV (Control)	50.08 ± 9.74	19.86 ± 7.06	24.06 ± 6.80	8.13 ± 2.01

Table 2: Mean Resistive Index in Ophthalmic and Central Retinal Artery.

Groups	Ophthalmic Artery RI	Central Retinal Artery RI
	Mean ± SD	Mean ± SD
I (NDR)	0.64 ± 0.10	0.64 ± 0.10
II (BDR)	0.69 ± 0.07	0.64 ± 0.09
III (PrePDR & PDR)	0.72 ± 0.09	0.69 ± 0.14
IV (Control)	0.61 ± 0.08	0.64 ± 0.09

Table 3: Comparison of parameters between group IV (Control) and group III (PrePDR & PDR) subjects with their P value

S.No.	Vessel	Parameters	Group IV	Group III	P value
1	Ophthalmic artery	Systolic Velocity (cm/sec)	50.08 ± 9.74	40.19 ± 19.14	0.04
		Diastolic Velocity (cm/sec)	19.86 ± 7.06	10.31 ± 5.27	0.00
		Resistive Index	0.61 ± 0.08	0.72 ± 0.09	0.00
2	Central retinal artery	Systolic Velocity (cm/sec)	24.06 ± 6.80	16.51 ± 8.03	0.00
		Diastolic Velocity (cm/sec)	8.13 ± 2.01	4.56 ± 2.13	0.00
		Resistive Index	0.64 ± 0.09	0.69 ± 0.14	0.25

Table 4: Comparison of parameters between group IV (Control) and group II (BDR) subjects with their P value

S.No.	Vessel	Parameters	Group IV	Group II	P value
1	Ophthalmic artery	Systolic Velocity (cm/sec)	50.08 ± 9.74	40.44 ± 9.10	0.002
		Diastolic Velocity (cm/sec)	19.86 ± 7.06	12.03 ± 3.24	0.00
		Resistive Index	0.61 ± 0.08	0.69 ± 0.07	0.001
2	Central retinal artery	Systolic Velocity (cm/sec)	24.06 ± 6.80	21.40 ± 5.90	0.19
		Diastolic Velocity (cm/sec)	8.13 ± 2.01	7.48 ± 2.63	0.39
		Resistive Index	0.64 ± 0.09	0.64 ± 0.09	0.86

Table 5: Comparison of parameters between group IV (Control) and group I (NDR) subjects with their p value

S.No.	Vessel	Parameters [Mean ± SD]	Group IV	Group I	P Value
1	Ophthalmic Artery	Systolic Velocity (cm/sec)	50.08 ± 9.74	48.19 ± 15.68	0.65
		Diastolic Velocity (cm/sec)	19.86 ± 7.06	17.54 ± 7.92	0.33
		Resistive Index	0.61 ± 0.08	0.64 ± 0.10	0.35
2	Central Retinal Artery	Systolic Velocity (cm/sec)	24.06 ± 6.80	21.51 ± 3.68	0.15
		Diastolic Velocity (cm/sec)	8.13 ± 2.01	7.56 ± 1.96	0.37
		Resistive Index	0.64 ± 0.09	0.64 ± 0.10	0.85

RESULTS

Total 60 eyes were divided into 3 groups according to the stage of diabetic retinopathy. Group 4 comprised of control eyes. Systolic and diastolic velocity found for each subject obtained. Mean value calculated for each group for ophthalmic artery & central retinal artery. (Table 1) Mean resistive index also calculated for each group. (Table 2) This table shows that Mean Resistive Index is increase progressively with progression of diabetic retinopathy in ophthalmic artery, while it is increase in only pre-proliferative and proliferative group in central retinal artery.

Table 3 show comparison of systolic, diastolic velocity & resistive index between group IV & Group III. Significant changes were observed in systolic velocity (P Value <0.05), diastolic velocity (P Value <0.05), and resistive index (P Value <0.05) of ophthalmic artery. Changes in Systolic (P Value <0.05) and diastolic velocity (P Value <0.05) of central retinal artery was also significant. However, change in resistive index in central artery was not significant (P Value >0.05). Table 4 show Comparison between control group (group IV) and BDR group (group II). Significant changes were observed in ophthalmic artery systolic velocity (P Value <0.05), diastolic velocity (P Value <0.05) and resistive index (P Value <0.05), while central retinal artery showed no significant changes in blood flow velocities and resistive index (All P Values >0.05). Table 5 shows comparison of parameters in ophthalmic and central retinal artery between group IV and group I subjects. No significant changes were observed in any parameters of these groups (All P Values > 0.05)

DISCUSSION & CONCLUSION

In our study mean systolic and diastolic blood flow velocities in ophthalmic artery decreased progressively with progression of diabetic retinopathy (Table 1). All these values in diabetic subjects were lower than the values observed in normal subjects (group IV). The difference in blood flow values of group IV (Control) subjects with group II (BDR) and group III (PrePDR & PDR) was statistically significant (Table 3 & Table 4).

These findings in ophthalmic artery are consistent with Mendivial et al (1995)[4], who observed decreased blood flow in diabetic patients in comparison to normal subjects (systolic P <0.01, diastolic P <0.001). Similar reduction in blood flow velocities in diabetic was also observed by Juan et al (1986)[5] and Grunwald et al (1993).[6] However, Gobel et al (1995)[7] found no significant difference in blood flow velocity of normal subjects with either background retinopathy or proliferative retinopathy in ophthalmic artery. On the other hand Cunha vaz et al (1978)[8] observed marked increase in blood flow with progress of background retinopathy which decreases finally with proliferative retinopathy.

In our study mean systolic and diastolic blood flow velocities in central retinal artery decreased progressively with the progression of diabetic retinopathy (Table 1). All these values in diabetic subjects were lower than the values observed in normal subjects (group IV). The difference in blood flow values of group IV subjects with group III (PrePDR & PDR) subjects was statistically significant (Table 3). However, there was no significant difference in blood flow velocities of group I (NDR) and group II (BDR) subjects with group IV subjects (Table 4 & Table 5).

These findings of central retinal artery in our study are consistent with Gobel et al (1995)[7] who observed significantly lower (P<0.001) perfusion velocity in proliferative eyes than in control group. Similar reduction in blood flow velocity in central retinal artery was also observed by Mendivil et al (1995).[4]

In our study the resistive index of ophthalmic artery increased progressively with progression of diabetic retinopathy i.e. from group I to group III. In central retinal artery resistive index is high in group III in comparison to other groups (Table 2). The resistive index of ophthalmic artery in group IV (control group) subjects was significantly lower in comparison to group II (P<0.05) and group III (P<0.05) (Table 3 & Table 4). However, the resistive index of central retinal artery showed no statistically significant difference in any group (P >0.05).

The values of resistive index of ophthalmic artery in our study are in accordance with Tamaki et al (1993)[9], who also observed significantly higher resistive index in diabetics than in normal subjects. However, the values of resistive index of central retinal artery in our study are not consistent with Arai et al (1998)[10] who observed significantly higher resistive index in patients with diabetic retinopathy than that in normal subjects and in patients without diabetic retinopathy.

Thus in our study, there is significant reduction in ophthalmic artery blood flow velocity with the progression of background and proliferative diabetic retinopathy. The velocity in central retinal artery also reduced significantly with the progression of proliferative diabetic retinopathy.

Our study population was relatively small; therefore the accuracy of differentiating between patients with and without retinopathy was relatively low. A large series might have disclosed additional features related to usefulness of colour Doppler ultrasonography for distinguishing patients with diabetic retinopathy from those without diabetic retinopathy. Despite its limitations, colour Doppler imaging may become a valuable method to assess orbital blood flow in diabetic retinopathy and other ocular vascular disorders. This new technique may be used when standard diagnostic procedures, e.g. Fundus examination or fluorescein angiography, are impossible because of hazy media like cataract.

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