Original Research Article

Evaluation of ocular hemodynamic alterations in patients with diabetes mellitus using colour doppler imaging

Adarsh K M[1], Hadi Hassan[2*], Devadas Acharya[3], Ravichandra G[4]

[1]Assistant Professor, [2]Postgraduate, [3,4]Professor, Department of Radio diagnosis, Yenepoya Medical college, Mangalore, Karnataka, INDIA.
Email: drhdh31@gmail.com

Abstract

Background: To study ocular blood flow velocity in the ophthalmic artery (OA) and central retinal artery (CRA) in patients with Type 2diabetes. **Materials and methods:** This was a cross-sectional study conducted at Yenepoya Medical College, Derlakatte, Mangalore. The retrobulbar circulation in 35 patients with Type 2 diabetic patients was compared with age-matched 35 non-diabetic patients. Linear transducer (9MHz) of Voluson E8 GE machine was used for performing Color Doppler imaging. **Results:** The peak systemic velocities and EDVs of CRA in the diabetic group were lower than those of normal subjects. The resistivity index (RI) of CRA was 0.78 in diabetic group and 0.70 in control group, and that of the OA was 0.79 in diabetic group and 0.72 in control group which was statistically significant. **Conclusion:** The study showed reduced blood flow velocity and increased RI in Type 2 diabetic patients as comparedto normal healthy individuals.

Key Word: Color Doppler imaging, ocular hemodynamics, resistivity index, Type 2 diabetesmellitus

***Address for Correspondence:**
Dr. Hadi Hassan, Postgraduate, Department of radiology, Yenepoya Medical College, Derlakatte, Mangalore, 575018, INDIA.
Email: drhdh31@gmail.com

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INTRODUCTION

Orbital circulation has been assessed by colour Doppler imaging for more than last 20 years. Ophthalmic artery and central retinal artery are the commonly used vessels for the assessment. Doppler velocimetry of orbital vessels has been proposed to be a useful tool for investigation of pathologic ophthalmic conditions (diabetic retinopathy, glaucoma) and hypertensive pregnant women (preeclampsia) and also as an aid to estimate intracranial circulation. It is a non-invasive technique, relatively easy to perform and not expensive. It is also a reliable technique. Previous studies which assessed reliability of Doppler velocimetry have found a good inter-observer reproducibility in the Doppler parameters.[1] Diabetes mellitus are commonly associated with abnormalities in the orbital circulation.[2,3] It seems that colour Doppler imaging of retinal arteries may be helpful in detecting the flow changes, even before retinal vasculopathy become visible on ophthalmoscopic examination. Diabetic Retinopathy affects the microvasculature of the eye causing alteration of the same.[2] Diabetes, with and without retinopathy, is often associated with hemodynamic alterations in ocular blood flow. Significant circulatory alterations are found in the ophthalmic artery in diabetic patients suggesting hemodynamic dysfunction. Colour Doppler Imaging showed alteration in the flow parameters of ophthalmic artery and central retinal artery in patients with diabetes.[1] Resistive index was significantly increased in diabetics as compared to controls.[2] The recent advances in non-invasive imaging techniques such as Color Doppler imaging (CDI) have improved clinical evaluation of ocular hemodynamic circulation. It is a useful tool when standard diagnostic procedures are difficult in the

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presence of cataract or hazy media.[4] The ophthalmic artery (OA), central retinal artery (CRA) and central retinal vein (CRV), posterior ciliary arteries (PCAs), and the superior ophthalmic vein can be easily identified using CDI. The circulatory parameters recorded include peak systolic velocity (PSV), end-diastolic velocity (EDV), and mean velocity (MV), the resistivity index (RI) and the pulsatility index. The purpose of this study was to measure blood flow velocity
in the OA, CRA, and PCA in patients with Type 2 diabetes and compare the results with age-matched normal control subjects

MATERIALS AND METHOD

This was a cross-sectional study conducted at Yenepoya Medical College, Derlakatte, Mangalore over a period of 3 months on 70 patients (35 diabetic patients and 35 healthy control patients). All participants will undergo ophthalmic artery and central retinal artery color Doppler imaging by the same radiologist. It will be performed using a high resolution linear array multi-frequency transducer L9Mhz on GE voluson E8. After explaining the procedure to the participant the scan will performed with the subject in supine position and eyes closed. The transducer will be positioned on the eyelids with a gel interface. Excessive pressure will be avoided during the scan. First the Optic nerve will be identified as a linear hypo echoic stripe posterior to the scleral surface. Central retinal artery can be identified next to central retinal vein as two parallel vascular structures within the hypo echoic stripe. The ophthalmic artery can be identified nasally and superior to the optic nerve approximately 10 mm from the posterior wall of the sclera. The flow velocity will be measured at the Arteries using a wall filter of 100 Hz and sample of 1 mm. Doppler insonation angle will be adjusted below 60°. If the ophthalmic artery is not detected within 3 minutes, the examination will be aborted. Pulse repetition frequency (PRF) will be 4340 Hz for the ophthalmic artery and 2441 Hz for the CRA. PSV (cm/s), EDV (cm/s) and RI (RI = PSV-EDV/PSV) will be determined from spectral waveform.

The patients were divided in to two groups:

Group 1(Diabetic patients)

Inclusion criteria:

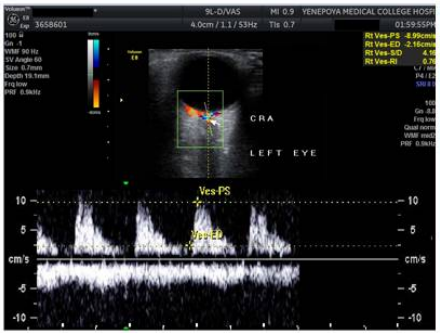
- All Adults with Type 2 Diabetes Mellitus will be included in the study.

Exclusion criteria:

Subjects with the following criteria will be excluded from the study:

- Children and elderly (as age may have effect on blood flow.)
- Patients with Type 1 Diabetes Mellitus.
- All those patients with history of DM for more than 20 years (as the probability of them without diabetic retinopathy is less even though may not be clinically detectable)

Group 2(Control group): This group comprises of healthy subjects. The control group were selected from relatives accompanying the patients or volunteers and will match for age and sex of the cases .Children and elderly will be excluded.



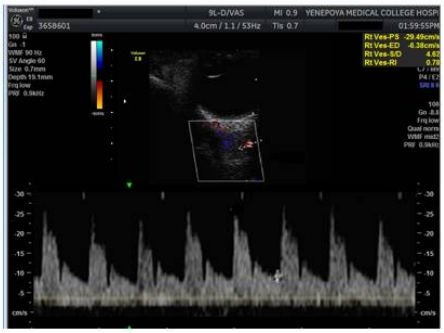


Figure 1 **Figure 2**

Figure 1and 2: Shows the waveform, PSV, EDV and RI of the CRA and OA respectively.

RESULTS

Table 1: Demographics

Parameters	Case control	Diabetics	Total
Number	35	35	70
Mean age in years	45.23 +/- 7.81	45.38 +/- 7.90	45.31 +/-7.80
Sex (male/female)	22/13	9/26	31/39

Table 2: Ophthalmic artery blood flow velocities (cm/s) and resistivity indices in normal subjects and diabetic patients.

Parameters	Case control	Diabetics	Total
No.of subject	35	35	70
PSV (mean+/-SD)	31.03 +/- 2.09	29.64 +/- 2.11	30.34 +/- 0.98
EDV(mean+/-SD)	8.66 +/- 0.78	6.40 +/- 0.70	7.53 +/- 1.60
RI(mean+/-SD)	0.72 +/- 0.03	.79 +/- 0.02	0.76 +/- 0.05

Table 3: Central retinal artery blood flow velocities (cm/s) and resistivity indices in normal subjects and diabetic patients

Parameters	Case control	Diabetics	Total
No.of subjects	35	35	70
PSV (mean+/-SD)	11.75 +/- 1.50	9.63 +/- 1.48	10.69 +/- 1.50
EDV(mean+/-SD)	3.44 +/- 0.58	2.17 +/- 0.29	2.82 +/- 0.92
RI(mean+/-SD)	0.70 +/- 0.05	0.78 +/- 0.03	0.74 +/- 0.06

Table 4: Below table represents the group comparison among normal and diabetes cases. Applying two independent sample t-test at 5% level of significance.

Parameters	Group Statistics	Group	N	Mean	Std. Deviation	Significance
Age (In years)	AGE(YRS)	Normal	35	45.3714	7.90043	t=0.076
		Diabetes Cases	35	45.2286	7.80681	p=0.940
	(PSV(CM/SEC))	Normal	35	31.0329	2.08552	t=2.771
		Diabetes Cases	35	29.6420	2.11380	p=0.007
OPHTHALMIC ARTERY	EDV(CM/SEC)	Normal	35	8.6557	.77769	t=-0.854
		Diabetes Cases	35	21.8494	91.38006	p=0.396
	RI	Normal	35	.7200	.02787	t=-11.696
		Diabetes Cases	35	.7846	.01704	P<0.001*
	(PSV(CM/SEC))	Normal	35	11.7537	1.49486	t=5.983
		Diabetes Cases	35	9.6269	1.47950	p<0.001*
CENTRAL RETINAL ARTERY	EDV(CM/SEC)	Normal	35	3.4423	.58157	t=11.629
		Diabetes Cases	35	2.1669	.28780	p<0.001*
	RI	Normal	35	.7000	.05330	t=-7.642
		Diabetes Cases	35	.7783	.02885	p<0.001*

Note: * in the significance column represents significance difference the mean score among the groups.

There were 35 Type 2 diabetic and 35 normal subjects in our study groups. Of the 35 diabetic patients 9 were male and 26 females. Of the 35 healthy control individuals 22 were male and 13 females. Table 2 presents the PSV, EDV and RI of the ophthalmic artery in control and diabetic subjects. EDVs in diabetics were lower than those of control subjects ($P < 0.05$). The RI in patients with diabetes (0.79 ± 0.02) was greater ($P < 0.05$) than those in normal subjects (0.72 ± 0.03). The PSVs and EDVs in the diabetic group were significantly lower than those of normal subjects. Table 3 presents the PSV, EDV and RI of the central retinal artery in normal and diabetic patients. The PSVs and EDVs in the diabetic group were lower than those of normal subjects. The RI in patients with DR (0.78 ± 0.03) was greater than control group (0.70 ± 0.05).

DISCUSSION

CDI is a recent advance in ultrasonography which allows simultaneous two-dimensional imaging of structure and measurement of the blood flow with minimal discomfort and risk. Doppler spectral analysis allows quantitative assessment of blood flow velocity in the vessels. CDI is a useful tool for investigating the hemodynamic circulation in retro orbital vessels[5, 6]. In diabetic patients when fundus evaluation and fluorescein angiography are difficult due to hazy media (vitreous hemorrhage or cataract), CDI can be used to evaluate ocular blood flow. Retina derives its main blood supply from the CRA, which is a branch of the internal carotid artery[7, 8]. PCA also supplies a part of retina and optic nerve. The blood flow velocity in CRA is pulsatile like OA[9]. Many studies have been reported on ocular circulation in diabetic patients using a variety of methods. Decreased blood flow velocity has been detected in the retinal circulation of the

diabetic patients by blue light entoptic measurement: scanning laser ophthalmoscopy and bidirectional laser Doppler[10, 11, 12.]There are even some reports suggesting increased ocular blood flowin the diabetic retina. These blood flow variations are due to other factors such as duration and type of diabetes, anatomiclocation of measurement, metabolic control, systemic diseases, and use of antihypertensive agents. In our study of total 70 patients out of which 35 were diabetic and 35 healthy control individuals, we found EDVs of ophthalmic artery and central retinal artery indiabetic subjects were lower than those of normalsubjects. We also found that the RI of ophthalmic artery was greaterin diabetic patients as compared to normal individuals. These findings are comparable to the previous studies and show that hemodynamic disturbances in retrobulbar ocular circulation appear before clinical manifestations of diabetic retinopathy[6,13,14]. A study by Khandelwal *et al* also showed reduced blood flow velocity and increased RI in Type 2 diabetic patients as compared to normal healthy individuals. There are significant changes noted in retrobulbar flow in patients with diabetic retinopathy as compared to patients without retinopathy [15].

CONCLUSION

Although it was a study with a small sample size, our results suggest that it has a potential to provide useful information related to altered ocular blood flow in diabetic patients. This also suggests CDI may have prognostic value in identifying those at risk of developing sight threatening PDR.

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