IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 5 Ser.6 (May. 2023), PP 20-24
www.iosrjournals.org

Diabetic Retinopathy And Ocular Blood Flow: An Observational Study

Dr. Gariyashee Lahkar[1], Dr. J.J. Kuli[2], Dr. R.N. Gogoi[3], Dr. R.K.Gogoi[4], Dr. Amrita Das[5]

[1]Post Graduate Trainee,
[2]Professor and Head of the Department,
[3]Associate Professor, Department of Ophthalmology,
[4]Professor and Head of the Department, [5]Post Graduate Trainee, Department of Radiology, Assam Medical College and Hospital, Dibrugarh, Assam, India.

Abstract:
AIM: *To compare ocular blood flow parameters in Type 2 diabetic patients using the Color Doppler sonography and correlate it with the progression of Diabetic Retinopathy.*
METHODS: *120 diabetic patients, 27 of whom had no evidence of Diabetic Retinopathy and the rest had different grades of Retinopathy were assessed using Colour Doppler imaging to evaluate the ocular blood flow in the retrobulbar circulation at first presentation and after six months. Peak Systolic Velocity, End Diastolic Velocity and Resistive Index were recorded in the Ophthalmic Artery and the Central Retinal Artery.*
RESULTS: *The baseline resistive indices were higher than normal population. 13 patients developed progression in the last six months and showed significant increase in the Resistive Index of Ophthalmic Artery(p=0.0001) and the Central Retinal Artery(p=0.0006). End Diastolic Volume was also raised in the Central retinal artery (p=0.047).*
CONCLUSION: *The Retrobulbar Arterial Circulation appears to be progressively affected in all diabetics with DR. Significant changes in Resistivity Indices of Ophthalmic Artery and Central Retinal Artery along with altered flow velocity in Central Retinal Artery could be useful to predict individuals at higher risk for developing progression of Diabetic Retinopathy as well as also help in predicting the course of disease before clinical presentation.*
Keywords: *Retrobulbar arterial circulation, Diabetic retinopathy, Color Doppler imaging.*

Date of Submission: 06-05-2023 Date of Acceptance: 16-05-2023

I. Introduction:

Diabetic Retinopathy is a microvascular complications of Diabetes Mellitus, which has turned into a leading cause of preventable blindness in the present world with an increase in prevalence of the disease. In the past few years, hemodynamic alterations in the retina and choroid of diabetic patients have gathered a lot of attention, and several studies on the microvasculature of the retina have been utilized for a prompt diagnosis and treatment, which can eventually prevent blindness.

In Ophthalmology, Colour Doppler is a recent, non-invasive imaging method used to assess the orbital vasculature. The retrobulbar circulation is mainly made up by several branches of the Ophthalmic Artery, a branch of Internal Carotid Artery, which gets compromised in Diabetic retinopathy. Colour Doppler imaging enables qualitative and quantitative assessment of the Ophthalmic Artery (OA) and its branches and thus, proves to be a beneficial tool to assess patients with impaired blood flow and thereby and take early intervention.

II. Purpose of the Study:

This study intends to find the relationship between the retrobulbar circulation and its association with the clinical progression of Diabetic Retinopathy using Doppler parameters such as Peak Systolic Velocity (PSV), End-Diastolic Velocity (EDV), Resistive Index (RI), and Pulsatility Index (PI) measured in the Ophthalmic Artery and Central Retinal Artery.

III. Material and methods:

This was a hospital-based, observational study, where the progression of Diabetic Retinopathy was studied in 120 patients for a duration of one year, after being approved by the institutional review board.

120 diabetic patients, aging between 40-80 years of age, with or without signs of retinopathy on their first visit, who were willing to participate, were enrolled in the study. However, patients with metabolically unstable diabetes, any disease or anomaly of the eye which may affect blood flow velocity, such as ocular inflammation, systemic diseases like hypertension etc, cases with history of trauma or any intraocular surgery (excluding cataract surgeries) and those with significant media opacities precluding fundus examination were excluded from the study. Cases with proliferative diabetic retinopathy were not included due to difficulty in diagnosing further progression.

A detailed history including demographic parameters, onset and duration of diabetes, details of treatment were taken from each participant, followed by a thorough general examination to look for any systemic manifestations of Diabetes. Any other systemic illness was ruled out. A comprehensive ophthalmic examination followed, which included, slit lamp examination, IOP measurement and specific detailed fundus examination (under mydriasis), which was done under Direct and Indirect Ophthalmoscopy and Slit Lamp Biomicroscopy with +90D lens. Dilated fundus examination was done in all cases 5-15 minutes after instillation of mydriatic-cycloplegic eye drop (Tropicamide 0.8% and Phenylephrine 5% eye drops), and classified according to International Disease Severity Scale for DR proposed by Wilkinson[1]. The eye with severe retinopathy was selected and if retinopathy were equal in both eyes, the right eye was selected for further evaluation. Cases identified with fundus findings were further evaluated by a digital fundus camera using fundus photographs, including Fundus Fluorescein Angiography and OCT, whenever indicated. Baseline blood investigations were carried out like FBS, PPBS and HbA1c levels.

The patients underwent Colour Doppler imaging at their first visit. They were again followed up at 6 months. During the follow-up period, patients received treatment according to guidelines. At follow up, the patients were subjected to Doppler Imaging and the parameters were re-evaluated for any change arterial circulation parameters. The measured parameters included Peak Systolic Velocity (PSV), End Diastolic Velocity (EDV), Resistive Index (RI) and Pulsatile Index (PI) in Ophthalmic Artery and Central Retinal Artery. Three consecutive readings were taken to avoid any effect of the respiratory cycle upon the velocities. All patients were seen at 3 months, 6 months and 3 monthly thereafter with a minimum of 6 months follow up. The grading of DR, and color Doppler parameters of last visit were considered to look for progression of diabetic retinopathy. Any increase in grade of diabetic retinopathy from previous evaluation was considered as progression.

IV. Results:

The study included 70 (58.33%) males and 50 (41.67%) females. The age of patients ranged from 41 to 80 years (mean age 54.86 ± 9.49 years). The duration of diabetes ranged from 2 years to 35 years (mean 13.10 ± 6.75). 18 patients (15.00%) were on insulin treatment and 102 patients (85.00%) were on oral hypoglycemic agents (OHAs) only for control of diabetes. Systemic parameters were well controlled throughout the study period for all.

At the initial visit, 26 patients (21.67%) had no evidence of Diabetic Retinopathy, 19 (15.83%) had Mild NPDR, 52 (43.33%) had Moderate NPDR, 13 (10.83%) had Severe NPDR and 10 (8.33%) had Proliferative DR . Among the study group, 13 patients (10.83%) developed progression of Diabetes and 107 patients (89.17%) did not develop any progression during the study period. There is no definite pattern of change in the parameters but few of the changes were found to be significant. Among the study population, the mean CDI parameters in the Ophthalmic Artery when compared between the first and the last visits showed that the RIs of the patients had increased significantly (p-value: 0.0001) between the two visits. However, alterations in the PSV, EDV and PI were not significant. Among the study population, the mean CDI parameters in the Central Retinal Artery were compared between the first and the last visits where the EDV in the patients had decreased(p-value:0.0473) and RIs of the patients had increased significantly (p-value: 0.0006). However, alterations in the PSV and PI were not significant.

The differences in the color doppler parameters at both the visits have been summarised in the tables below:

Table 1: Differences in the color doppler parameters at first and last visit:

Ophthalmic Artery Parameters	At 1st Visit		At Follow Up		*p-value*
	Mean	*S.D.*	*Mean*	*S.D.*	
PSV (cm/s)	32.17	6.19	32.39	6.16	0.7867
EDV (cm/s)	6.54	1.54	6.42	1.45	0.5192
RI	0.77	0.05	0.80	0.05	0.0001
PI	1.73	0.25	1.77	0.25	0.2185
Central Retinal Artery Parameters	At 1st Visit		At Follow Up		*p-value*
	Mean	*S.D.*	*Mean*	*S.D.*	
PSV (cm/s)	11.85	2.65	11.97	2.63	0.7383
EDV (cm/s)	3.62	1.21	3.32	1.12	0.0473
RI	0.71	0.08	0.74	0.08	0.0006
PI	1.36	0.28	1.40	0.29	0.2555

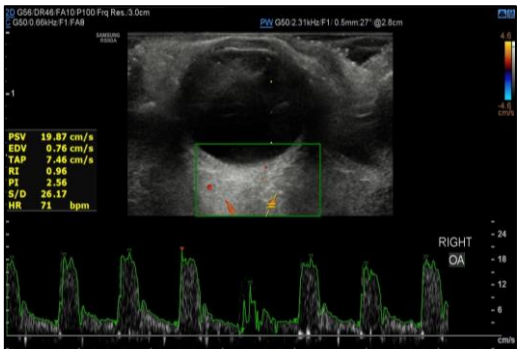

Figure 1: Colour Doppler Imaging: Ophthalmic Artery

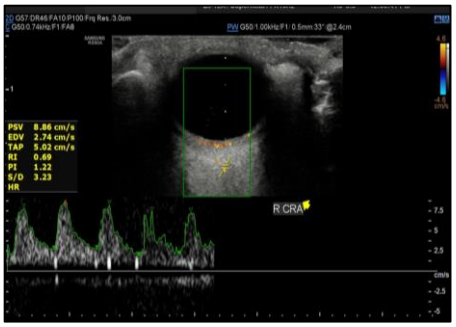

Figure 2: Colour Doppler Imaging: Central Retinal Artery

V. Discussion:

The present study was carried out to ascertain the predictive role of retrobulbar arterial circulation in the progression of NPDR as there is limited literature available regarding changes in retrobulbar circulation.

In the present study, 13 patients developed progression in the last six months. There are very few follow up studies in the field of Diabetic Retinopathy which includes study by Dimitrova G *et al*[2] in 2003 that showed 18 out of 35 patients developing progression at the end of 21 months. Similarly, Sood S *et al*[3] in 2013 found that 14 out of 50 showed progression during a period ranging from 6 months to 2 years. The discrepancy in the findings could be attributed to shorter follow up duration in our study compared to the rest of the studies.

Baseline resistive indices were higher than normal population and RI in both OA and CRA increased with increasing severity of the disease and the increase in the Resistive Index of Ophthalmic Artery(p=0.0001) found to be significant. Similar rise in RI s were also noticed in studies conducted by Sood S *et al*[3], Sullu Y *et al*[4] and Neudorfer M *et al*[5]. However, studies conducted by Dimitrova G *et al*[2], Mac Kinnon JR *et al*[6] showed no significant change in the Resitivity Indices.

Another Parameter which was affected was the End Diastolic Volume. It was found to be altered in the Central retinal artery (p=0.047). Reduction in mean EDV of both OA and CRA was also noted in studies conducted by Sullu Y *et al*[4] and Divya K *et al*[7].

Rest of the parameters were not found to be significantly altered during the study period. The several studies which have been conducted in this field and their findings have ben enumerated in the table below:

Table 2: Findings in different color doppler studies conducted in Diabetic patients:

STUDY	YEAR	FINDINGS
Basturk T *et al* [8]	**2012**	Significantly high RIs of OA, CRA
Mac Kinnon JR *et al*[6]	**2000**	Significant decrease in both PSV and EDV of CRA No significant alteration in RI in CRA
Karami M *et al*[9]	**2012**	Significant increase in RI in OA
Sullu Y *et al*[4]	**2005**	Reduction in mean EDV of both OA and CRA Increase in RI of both OA and CRA
Gračner T *et al*[10]	**2004**	Significant increase in PSV of OA
Divya K *et al*[7]	**2017**	Significantly reduction in EDV increase in RI of CRA
Baydar S *et al*[11]	**2007**	Significant increase in RIs of OA, CRA
Present Study	**2020**	Significant increase in RI in OA, CRA Significant decrease in EDV in CRA

Thus, Among the study population, the mean CDI parameters in the Ophthalmic Artery were compared between the first and the last visits where the RIs of the patients had increased significantly (p-value: 0.0001) between the two visits. However, alterations in the PSV, EDV and PI were not significant. Among the study population, the mean CDI parameters in the Central Retinal Artery were compared between the first and the last visits where the EDV in the patients had decreased(p-value:0.0473) and RIs of the patients had increased significantly (p-value: 0.0006). However, alterations in the PSV and PI were not significant.

Thus, Colour doppler imaging is useful in detecting significant changes in the blood parameters in the retrobulbar vessels and can be recommended to identify diabetic individuals at higher risk for developing severe DR, RI could be potentially useful for early diagnosis and follow-up of DR. This is especially useful in patients with opaque media where conventional methods are of little use. However, there is a need for large-scale studies to derive a cut off value in the Doppler indices to identify the Diabetics who are at risk of developing retinopathy and further progression.

VI. Conclusion:

Diabetic Retinopathy (DR) is one of the most common causes of preventable blindness in India. It affects the microvasculature of retina which if untreated, may lead to blindness. Therefore, early screening and effective intervention in early stages is of utmost importance. Although there has been lot of advancements in various diagnostic modalities, the hemodynamic changes in the retrobulbar circulation have not been studied extensively and remains as a significant but untouched area of study in the field of Diabetic Retinopathy.

In the present study, the utility of Colour Doppler Imaging has been employed to detect significant changes in the blood flow parameters of the retrobulbar vessels of Diabetic patients that changes with progression of the disease. The various blood flow parameters like PSV, EDV, RI and PI were measured in the Ophthalmic Artery and Central Retinal Artery, which were re-evaluated and compared after 6 months revealing significant changes in the RIs in both OA and CRA and altered EDV in CRA, thereby suggesting the role of blood flow parameters to be potentially useful in the early diagnosis and follow-up of DR.Thus, the findings of our study suggest that Colour Doppler Imaging has the potential to provide useful information regarding altered retrobulbar circulation even before the clinical appearance of Diabetic Retinopathy thereby enabling early diagnosis as well as early intervention.

However, the small sample size and short follow up period of our study limits the ability to assess the proper association. Furthermore, there is a need for large-scale studies to derive a cut off value in the Doppler indices to identify the Diabetics who are at risk of developing retinopathy. Also, longer follow up periods are essential to detect further association of alteration in blood flow and progression of Diabetic Retinopathy.

References:

[1]. Wilkinson CP, Ferris III FL, Klein RE, Lee PP, Agardh CD, Davis M, Dills D, Kampik A, Pararajasegaram R, Verdaguer JT, Group GD. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmology. 2003 Sep 1;110(9):1677-82.

[2]. Dimitrova G, Kato S, Yamashita H, Tamaki Y, Nagahara M, Fukushima H, et al. Relation between retrobulbar circulation and progression of diabetic retinopathy. British journal of ophthalmology. 2003 May 1;87(5):622-5.

[3]. Sood S, Narang S, Kocchhar S, Sarda S, Aggarwal S, Arya SK. Correlation of progression of diabetic retinopathy with the alterations in retrobulbar circulation. Nepalese Journal of Ophthalmology. 2013 Sep 23;5(2):147-53.

[4]. Sullu Y, Hamidova R, Beden U, Yakupov K, Canbaz S, Danaci M. Effects of pars plana vitrectomy on retrobulbar haemodynamics in diabetic retinopathy. Clinical & experimental ophthalmology. 2005 Jun;33(3):246-51.
[5]. Neudorfer M, Kessner R, Goldenberg D, Lavie A, Kessler A. Retrobulbar blood flow changes in eyes with diabetic retinopathy: a 10-year follow-up study. Clinical Ophthalmology (Auckland, NZ). 2014;8:2325.
[6]. MacKinnon JR, McKillop G, O'Brien C, Swa K, Butt Z, Nelson P. Colour Doppler imaging of the ocular circulation in diabetic retinopathy. Acta Ophthalmologica Scandinavica. 2000 Aug;78(4):386-9.
[7]. Divya K, Kanagaraju V, Devanand B, Jeevamala C, Raghuram A, Sundar D. Evaluation of retrobulbar circulation in type 2 diabetic patients using colour Doppler imaging. Indian journal of ophthalmology. 2020 Jun;68(6):1108.
[8]. Basturk T, Albayrak R, Ulas T, Akcay M, Unsal A, Toksoy M, et al. Evaluation of resistive index by colour Doppler imaging of orbital arteries in type II diabetes mellitus patients with microalbuminuria. Renal failure. 2012 Jul 1;34(6):708-12.
[9]. Karami M, Janghorbani M, Dehghani A, Khaksar K, Kaviani A. Orbital Doppler evaluation of blood flow velocities in patients with diabetic retinopathy. The review of diabetic studies: RDS. 2012;9(2-3):104.
[10]. Gračner T. Ocular blood flow velocity determined by colour Doppler imaging in diabetic retinopathy. Ophthalmologica. 2004;218(4):237-42.
[11]. Baydar S, Adapinar B, Kebapci N, Bal CE, Topbas S. Colour Doppler ultrasound evaluation of orbital vessels in diabetic retinopathy. Australasian radiology. 2007 Jun;51(3):230-5.