Original Article

A study on visual outcome after laser photocoagulation in diabetic retinopathy cases

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ABSTRACT

Background: Diabetic retinopathy (DR) is one of the common causes of blindness in the world. Chronic hyperglycemia in diabetes causes progressive dysfunction of the retinal vasculature (microangiopathy) causing retinal hypoxia leading to expression of 'Vascular endothelial growth factor' (VEGF) and 'neovascularization'. Laser photocoagulation is used to convert hypoxic areas into anoxic areas thus decreasing chances of release of VEGF and hence neovascularization.

Aim: To study the visual outcome after laser retinal photocoagulation in DR cases.

Material and Methods: The study was carried out on 80 eyes of 44 patients presenting at Department of Ophthalmology, P. D. U. Govt. Medical College, Rajkot who had DR and underwent laser retinal photocoagulation during period of November 2012 to September 2014. All patients underwent assessment for visual acuity, anterior segment examination, posterior segment examination with +90 Dioptre lens and fundus fluorescein angiography. (FFA). Then laser retinal photocoagulation was done. After laser treatment, patients were assessed for best corrected visual acuity (BCVA) on 1week, 1 month, 3 months and 6 months and the results were analysed.

Results: 80% of the patients showed improvement in BCVA, 17.5% of the patient maintained same BCVA and 2.5% patients showed deterioration in BCVA which was statistically significant (paired t-test, $p<0.0001$).

Conclusion: Diabetic retinopathy causes significant dysfunction of retinal vasculature and hence retina, hampering vision. Timely treatment with laser retinal photocoagulation prevents further dysfunction and salvages involved retina causing statistically significant improvement in vision and quality of life.

Keywords: Diabetic Retinopathy, Visual Acuity, Laser retinal photocoagulation.

INTRODUCTION

Diabetic retinopathy remains one of the most common causes of blindness in India and the world. Diabetes progressively damages every system of the body. The nerves, retina and kidneys are the main organs affected by glucotoxicity as entry of glucose in these organs is insulin independent [1].

Chronic hyperglycaemia in diabetes causes progressive dysfunction of the retinal vasculature (microangiopathy) which causes retinal hypoxia leading to expression of 'Vascular endothelial growth factor'(VEGF) and 'neovascularization'; further leading to changes in the retina which is known as Diabetic Retinopathy (DR).

Mechanism of DR includes loss of pericytes, thickening of basement membrane leading to micro aneurysms& breakdown of blood retinal barrier further leading to oedema, hard exudates, dot and blot haemorrhages. Also there is non-perfusion of retina due to aggregation of platelets in capillaries. Compensation occurs in form of shunt vessels also known as 'Intraretinal microvascular abnormalities' (IRMA) & expression of 'Vascular endothelial growth factor' (VEGF) leading to neovascularization. Macular oedema and vitreous haemorrhage if occurs can lead to severe visual impairment [2,3]. Laser photocoagulation is used to convert the hypoxic areas into anoxic areas thus decreasing chances of release of VEGF & hence neovascularization and thus visual impairment.

The Diabetic Retinopathy Study (DRS) and the Early Treatment Diabetic Retinopathy Study (ETDRS) conclusively proved that timely laser photocoagulation of diabetic retinopathy can reduce severe visual loss by 95%.

The vast majority of diabetic individuals who lose vision do so, not because of an inability to treat their disease, but rather due to a delay in seeking medical attention. Successful management of diabetic retinopathy by a combination of glucose control, laser therapy, and vitrectomy represents one of the most striking achievements of modern ophthalmology [4]. And improvement in visual acuity leads to improvement in quality of life. Thus, visual outcome after laser photocoagulation improves living of the patient.

The objectives with which this study was carried out were to assess risk factors for development and progression of DR, to study visual outcome after laser retinal photocoagulation in DR cases and to assess factors affecting visual outcome after laser photocoagulation.

MATERIAL AND METHODS

Sample size: A prospective interventional study was carried out on 80 eyes of 44 patients at G. T. Sheth Ophthalmic Hospital, Department of Ophthalmology, P. D. U. Govt. Medical College, Rajkot. All the patients were in age group from 40-81 years, selected by non-probability convenient sampling method. This study involved 45 eyes of 23 males and 35 eyes of 21 females. The study period extended from November 2012 to September 2014.

Ethical clearance: The study was done after obtaining permission from Institutional Ethical Committee.

Inclusion criteria: All diabetic patients presenting at O.P.D. of G. T. Sheth Ophthalmic hospital, Department of Ophthalmology, P. D. U. Govt. Medical College, Rajkot, diagnosed to have diabetic retinopathy and subjected to laser retinal photocoagulation, were included in the study.

Exclusion criteria: Patients having pre-existing ocular morbidities like corneal disease, glaucoma, inflammatory eye disease, optic neuropathy, cystoid macular oedema & age related macular degeneration. Patients having advanced diabetic eye disease including vitreous haemorrhage, tractional retinal detachment, tractional retinoschisis and neovascular glaucoma and patients with previous history of laser treatment were also excluded from study.

Method: Detailed history elicitation of all the patients was done with special emphasis on history of diabetes - type of diabetes, diabetic age, age of onset of diabetes, treatment of diabetes if taking and in what form – oral hypoglycaemic drugs or injectable insulin. History of any systemic complication due to diabetes was noted. History of any co-existing systemic illnesses like hypertension, asthma, ischemic heart disease, etc. was elicited. Biochemical investigations - fasting blood sugar (FBS), post-prandial blood sugar (PPBS), serum creatinine, blood urea, total serum cholesterol, serum triglycerides were done.Patient's visual acuity and best corrected visual acuity (BCVA) were recorded with each eye separately, using well illuminated Snellen's visual acuity chart with patient sitting at distance of 6 meters. Patient's anterior segment examination was done with the help of slit lamp bio microscope. Patient's posterior segment-dilated fundus was examined using direct ophthalmoscope, also slit lamp bio-microscopy was done with +90 D condensing lens for assessment of diabetic retinopathy and indirect ophthalmoscopy was also done. Blood Pressure (BP) was recorded. Intra Ocular Pressure (IOP) measurement was done with Goldmann's Applanation tonometer. Physician Reference was done for assessment of diabetes and for fitness for doing Fundus Fluorescein Angiography (FFA). Pupils of both eyes of the patient were dilated with 0.8% Tropicamide + 5% Phenylephrine eye drops instilled thrice at interval of 10 minutes.

Red free and colour fundus photographs were taken with fundus photography camera. FFA was done in all patients to delineate the area & extent of damage of DR. DR was then classified according to ETDRS classification into Non Proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic Retinopathy (PDR). Patient is then given date and time for coming to hospital for laser photocoagulation.

Then, when patient comes, pupils of both eyes are dilated as mentioned above. Topically 4% lignocaine eye drops were instilled in both eyes three times at interval of 2 minutes. Patient is made to sit on table in front of slit lamp mounted with Nd:YAG (Neodymium: Yttrium Aluminium Garnett) double frequency laser (532 nm). Then, with the help of wide field laser contact lens or focal laser contact lens, patients are treated with laser pan-retinal photocoagulation with or without 'Grid' or 'Focal'

Photocoagulation. Laser parameters used are shown in **Table 1**.

Table 1: Laser parameters used in PRP (Pan Retinal Photocoagulation), Grid and Focal laser

Laser parameters	Spot size (microns)	Duration (m sec)	Power (m Watt)	Count (no.)
PRP	100-200	100-300	100-600	1200-2000
Grid	100	100	100-300	70-100
Focal	50-100	100	100-150	20-50

PRP is done in 3 sessions – in 1st session, inferior quadrant PRP is done followed by superior quadrant in 2nd session and nasal and temporal quadrants in 3rd session with an interval of 1 week between each session.Then, a drop of Ciprofloxacin (0.3%) eye drops is instilled in both eyes. Patient is asked to put Flurbiprofen (0.3%) eye drops 4 times a day in both eyes and called for follow up after 1 week.

Patient is called for follow ups on 1 week, 1 month, 3 months and 6 months. During these follow ups, patient's visual acuity, best corrected visual acuity (BCVA) and IOP are measured and dilated fundus examination is done to monitor regression of DR changes and improvement in visual acuity.Visual acuity is defined as 'Improved' when BCVA improved by 1 line or more & 'Decreased' when BCVA decrease by 1 line or more &'Stable' if no change in BCVA.These measurements are recorded and compared.

RESULTS

In the present study, 80 eyes of 44 patients were studied during study period of 23 months. Baseline characteristics of them are shown in **Table 2**. Age distribution shows that highest incidence of Diabetic Retinopathy was found in age group of 51-60 years (50%) and least incidence was found in age group of 71-80 years (0%) and fewer incidences is found in age groups of < 41 years (2.5%) and > 80 years (2.5%). Sex distribution shows that 45 patients (56.25%) in this study were males and 35 (43.75%) were females.Distribution of eyes shows that both eyes showed equal incidence of involvement in Diabetic Retinopathy - 50% each. Co-existent hypertension is present in 41 patients (51.25%)of DR and absent in 39 patients (48.75%). This shows that more than 50% patients with diabetes who had co-existent hypertension developed DR. Thus, hypertension is one of the risk factors for the development of DR. Hyperlipidemia is found in 48 patients (60%) with DR and absent in 32 patients (40%). Thus, hyperlipidemia is also one of the risk factors for the development of DR.

Table 2: Baseline characteristics of patients included in the study

Characteristic	Number (%, n=80)
Age group (in complete years)	
<41	02 [02.50%]
41-50	14 [17.50%]
51-60	40 [50.00%]
61-70	22 [27.50%]
71-80	00 [00.00%]
>80	02 [02.50%]
Sex	
Male	45 [56.25%]
Female	35 [43.75%]
Eye with diabetic retinopathy	
Right eye	40 [50.00%]
Left eye	40 [50.00%]
Co-existent hypertension	
Present	41 [51.25%]
Absent	39 [48.75%]
Status of lipid profile	
Normal	32 [40.00%]
Hyperlipidemia	48 [60.00%]

Table 3 shows diabetic profile of the patients included in the study. According to the duration of diabetes,34 patients (42.50%) had diabetes for duration of < 5 years, 44 patients (55%) had diabetes for duration of 6-10 years and 2 patients (2.5%) of patients had diabetes for duration of 11-15 years. Thus, maximum patients with DR had diabetes for duration between 6-10 years. Mode of treatment shows that 22 patients (27.50%) were on treatment with insulin, 50 patients (62.50%) on oral hypoglycemic agents (OHA) and 8 patients (10%) were on treatment with both. Thus, all patients included in the study were under treatment, yet only 12 patients (15%) were having controlled diabetes and 68 patients (85%) were having uncontrolled diabetes. This shows that patients with uncontrolled glucose levels were more prone to develop DR. Thus, control of diabetes is one of the risk factors for development of DR. Distribution of patients according to the stage of DR shows that 36 patients (45%) had Non Proliferative Diabetic Retinopathy (NPDR) and 44 patients (55%) had Non Proliferative Diabetic Retinopathy (NPDR).

Table 3: Diabetic profile of the patients included in the study

Characteristic	Number (%, n=80)
Duration of diabetes (diabetic age)	
0-5	34 [42.50%]
6-10	44 [55.00%]
11-15	02 [02.50%]
Mode of treatment for diabetes	
Insulin	22 [27.50%]
Oral Hypoglycemic Agents (OHA)	50 [62.50%]
Both Insulin and OHA	08 [10.00%]
Status of diabetes control	
Controlled	12 [15.00%]
Uncontrolled	68 [85.00%]
Stage of diabetic retinopathy	
Non Proliferative Diabetic Retinopathy (NPDR)	36 [45.00%]
Proliferative Diabetic Retinopathy (PDR)	44 [55.00%]

Table 4 shows co-relation of stage of DR with duration and control of diabetes.

Co-relation with duration of diabetes: Out of 80 (100%) patients, 34 (42.5%) patients had duration of DM from 0-5 years, 44(55%) patients had duration of DM 6-10 years and 2 (2.5%) patients had duration of DM from 11-15 years. Out of 34 (42.5%) patients with duration of DM from 0-5 years, 18 patients (22.5%) had NPDR and16 patients (20.00%) had PDR. Out of 44 (55%) patients with duration of DM from 6-10 years, 18 patients (22.5%) had NPDR and26 patients (32.5%) had PDR. Out of 2 (2.5%) patients with duration of DM 11-15 years, none of the patient (0%) had NPDR and both the patients (2.5%) had PDR.

This shows that as the duration of diabetes increases, conversion from NPDR to PDR increases. Also, duration of diabetes is directly proportional to the severity of Diabetic Retinopathy.

Co-relation with control of diabetes: Out of 80 (100%) patients, 12 (15%) patients had controlled DM whereas 68 (85%) had uncontrolled DM. Out of 12 (15%) patients with controlled DM, 7 patients (8.75%) had NPDR and 5 (6.25%) had PDR. Whereas in 68 patients (85%) with uncontrolled DM, 29 (36.25%) patients had NPDR, whereas 39 (48.75%) patients had PDR.

Thus, lesser the control of diabetes, more is the severity of DR. Control of DM is inversely proportional to severity of DR.

Table 4: Co-relation of stage of Diabetic Retinopathy with duration and control of diabetes

Characteristic with which stage of DR is co related	Numbers with NPDR	Numbers with PDR
Duration of diabetes [no. of patients, (%, n=80)]		
0-5 years [34(42.5%)]	18(22.5%)	16(20%)
6-10 years [44(55%)]	18(22.5%)	26(32.5%)
11-15 years [2(2.5%)]	00(0%)	02(2.5%)
Status of diabetes control[no. of patients, (%, n=80)]		
Controlled [12 (15%)]	07 (8.75%)	05(6.25%)
Uncontrolled [68 (85%)]	29(36.25%)	39(48.75%)

Table 5: Visual outcome after Laser Photocoagulation

Improvement in BCVA by lines		Number of patients (%, n=80)	
Deterioration in BCVA	-1 line	02 [02.50%]	
Static BCVA	0 line	14 [17.50%]	
Improvement in BCVA	1 line	40 [50.00%]	Total = 64 [80.00%]
	2 lines	21 [26.25%]	
	3 lines	01 [01.25%]	
	4 lines	02 [02.50%]	

*BCVA – Best Corrected Visual Acuity

Table 5 shows visual outcome after laser photocoagulation. Out of 80 patients, 40 patients (50%) showed improvement in best corrected visual acuity (BCVA) by 1 line, 21 patients (26.25%) showed improvement in BCVA by 2 lines, 1 patient (1.25%) showed improvement in BCVA by 3 lines, 2 patients (2.5%) showed improvement in BCVA by 4 lines, 14 patients (17.5%) showed no change in BCVA, 2 patients (2.5%) showed deterioration in BCVA by 1 line. Thus, 80% of the patients showed improvement in BCVA by ≥ 1 line, 17.5% of the patients maintained same BCVA and 2.5% patients showed deterioration in BCVA. This improvement in number of lines of BCVA is statistically significant (paired t-test, $p<0.01$).

Table 6 shows that, Comparison with duration: Out of 80 (100%) patients, 34 (42.5%) patients had duration of DM from 0-5 years, 44 (55%) patients had duration of DM 6-10 years and 2 (2.5%) patients had duration of DM from 11-15 years. Out of 34 (42.5%) patients with duration of DM from 0-5 years, 28 patients (35%) showed improvement in BCVA, 6 patients (7.5%) maintained same visual acuity and no patient (0%) showed deterioration. Out of 44 (55%) patients with

duration of DM from 6-10 years, 35 patients (43.75%) showed improvement in BCVA, 8 patients (10%) maintained same visual acuity and 1 patient (1.25%) showed deterioration. And,out of 2 (2.5%) patients with duration of DM 11-15 years, 1 patient (1.25%) showed improvement in BCVA, and 1 patient (1.25%) showed deterioration.

Table 6: **Comparison of visual outcome with duration, control and stage of diabetes**

Characteristic with which visual outcome is compared	Number of patients with		
	Improvement in BCVA (%, n=64)	Static BCVA (%, n=14)	Deterioration in BCVA (%, n=2)
Diabetic age [no. of patients, (%, n=80)]			
0-5 years [34(42.5%)]	28 (35%)	06 (7.5%)	00 (0%)
6-10 years [44(55%)]	35 (43.75%)	08 (10%)	01 (1.25%)
11-15 years [2(2.5%)]	01 (1.25%)	00 (0%)	01 (1.25%)
Status of diabetes control [no. of patients, (%)]			
Controlled [12 (15%)]	12 (15%)	00 (0%)	00 (0%)
Uncontrolled [68 (85%)]	52 (65%)	14 (17.5%)	02 (2.5%)
Stage of diabetic retinopathy [no. of patients, (%, n=80)]			
NPDR [36 (45%)]	33 (41.25%)	03 (3.75%)	00 (0%)
PDR [44 (55%)]	31 (38.75%)	11 (13.75%)	02 (2.5%)

Thus, there is inverse relationship between the duration of DM and visual outcome after laser photocoagulation.

Comparison with control of diabetes: Out of 80 (100%) patients, 12 (15%) patients had controlled DM whereas 68 (85%) had uncontrolled DM. Out of 12 (15%) patients with controlled DM, all 12 (15%) patients showed visual improvement and no (0%) patient showed visual deterioration, whereas out of 68(85%) patients with uncontrolled DM, 52 (65%) patients showed visual improvement, 14 (17.5%) patients showed static vision and 2 patients (2.5%) showed visual deterioration. Thus, there is direct relationship between the control of DM and visual outcome after laser photocoagulation.

Comparison with stage: Out of 80 (100%) patients, 36 (45%) patients had NPDR, whereas 44 (55%) patients had PDR. Out of 36 (45%) NPDR patients, 33 (41.25%) patients showed visual improvement whereas 3 (3.75%) patients showed static BCVA and no (0%) patient had visual deterioration. And out of 44(55%) PDR patients, 31 (38.75%) patients showed visual improvement, 11 (13.75%) patients showed static BCVA and 2 (2.5%) patients showed deterioration of BCVA. Thus, visual outcome in patients with PDR is poor as compared to patients with NPDR. There is inverse relationship between severity of DR and visual outcome after laser photocoagulation.

DISCUSSION

With changing lifestyle and urbanisation, diseases like diabetes and hypertension are becoming more common, leading to greater prevalence of diabetic and hypertensive retinopathy. The age range in our study was between 40-81 years with mean age of 57.6 years. The highest incidence of DR in this study is in age group of 51-60 years (50%), which is consistent with study done by Rasmieh M. Al-Amer et al in which the highest incidence of DRwas found in the age group of 56-65 years (40%) [5]. Also, it is consistent with study done by Shreshtha et al in which also the maximum incidence of DR was found in 51-60 years (52%)[6]. In present study, 56.25% patients were males and 43.75% were females. This is consistent with study done by Shreshtha et al in which 53% were males and 47% were females [6]. However, it is not consistent with some other studies results of which state that women are more liable to develop diabetes than men (3:2). They are also more likely to develop DR. However, in the present study males were affected more than females. The reason can be the fact that Indian women seldom seek medical assistance unless they are symptomatic and that is why escaped detection and treatment.

In the present study, 51.25% of patients had co-existent hypertension. This shows that more than 50% patients with diabetes who had co-existent hypertension developed DR. Thus, hypertension is one of the risk factors for the development and progression of DR. This is in consistence with study done by Mathews DR et al in which 61.8% patients had co-existent hypertension [7]. Hyperlipidemia is found in 60% patients with DR in this study and is also one of the risk factors for the development and progression of DR. This is also shown in the study done by Van leiden HA et al in which hyperlipidemia is found in 50% patients with DR [8].

In current study, after laser photocoagulation, 80% of the patients showed improvement in BCVA by ≥ 1 line, 17.5% of the patient maintained same BCVA and

2.5% patients showed deterioration in BCVA. Improvement in number of lines of BCVA is statistically significant (paired t-test, $p < 0.01$). This is consistent with study done by Wilczyński M. in which vision improved in 70.34% patients [9].

Co-relation of DR with duration of DM in this shows that as the duration of diabetes increases, chances of development of DR are more and also chances of conversion from NPDR to PDR increases. Thus, duration of DM is directly proportional to development and progression of DR. This is also shown in the study done by Aiello et al and Salem M et al [10,11]. Plus, more the duration of DM, more the severity of DR and poorer the visual outcome after laser photocoagulation. Thus, there is inverse relationship between duration of DM and visual outcome after laser photocoagulation. This is in accordance with the study done by Mohan Rema et al [12].

Co-relation of control of DM with DR shows that patients with uncontrolled glucose levels are more likely to develop DR and severity of DR is also more. So, control of DM is one of the risk factors for the development and progression of DR. This is also shown by Abu El Asrar AM et al and El Haddad OA et al [13,14].Visual outcome after laser photocoagulation is better in patients with better control of DM. Thus, there is direct relationship between the control of DM and visual outcome after laser photocoagulation.

Co-relation of stage of DR with visual outcome shows that visual outcome in patients with PDR is poor as compared to patients with NPDR. There is inverse relationship between severity of DR and visual outcome after laser photocoagulation.

CONCLUSION

Diabetic retinopathy causes significant dysfunction of retinal vasculature and hence retina, hampering vision. Co-existent hypertension and hyperlipidemia are risk factors for development and progression of DR. Also, increased duration of DM and uncontrolled DM are risk factors. Timely treatment of DR with laser retinal photocoagulation prevents further dysfunction and salvages involved retina causing statistically significant improvement in vision and quality of life. There is inverse relationship between duration of DM and visual outcome after laser. Also, there is inverse relationship between severity of DR and visual outcome after laser whereas; there is direct relationship between good control of DM and visual outcome.

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