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Original Article

Visual outcome of laser treatment in diabetic retinopathy

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Abstract
Objective: To determine the visual outcome of laser treatment in diabetic retinopathy.
Design: Prospective, non-comparative case series.
Materials and methods: A total of 80 eyes of 50 patients with diabetic retinopathy in different stages were photocoagulated using diode green laser. Focal laser only was given in 46 eyes and pan retinal photocoagulation only was given in 29 eyes while 3 eyes received focal laser and pan retinal photocoagulation. One eye was given grid laser only and one eye received both grid and focal laser. The best corrected visual acuity was noted and fundus examination was carried out prior to laser therapy and at the last follow-up and results were compared.
Results: Non- proliferative diabetic retinopathy was present in 76%. Following laser treatment, best corrected visual acuity improved in 52.50%, remained static in 35% and deteriorated in 12.5%. Maculopathy improved in 52%, remained static in 6% and deteriorated in 2% in right eyes while there was no maculopathy in 40% in right eyes. Similarly, maculopathy improved in 38% and remained same in 10% while 52% had no maculopathy in left eyes. After laser treatment, NVD (OD) regressed in 6% and remained unchanged in 4%. Similarly, NVE (OD) regressed in 18% and remained unchanged in 4% and NVE (OS) regressed in 18% and remained unchanged in 2% following laser therapy.
Conclusion: Timely and adequate laser treatment helps in saving the vision in patients with diabetic retinopathy.

Key words: Diabetic retinopathy, Diabetic maculopathy, Diode laser, Pan retinal photocoagulation, Visual outcome

Diabetic Retinopathy (DR) is an important cause of acquired visual loss in working age worldwide. With improvement of the modern medical facilities and surgical procedures the life expectancy of the diabetic patients has been increased, which is one of the factor for the development of advanced stages of diabetic retinopathy. The Salisbury Eye Evaluation Study showed that diabetic retinopathy was the third most important cause for visual impairment[4].

Approximately, 120 million people are estimated to have diabetes throughout the world. Currently 20% of the population 65 years or older have diabetes in the United States[1]. Data from the clinical trials shows that intensive glucose control may reduce the rate of moderate vision loss by as much 50% to 75% whereas blood pressure control may reduce the rate of moderate vision loss by as much as 47%[2,3].

The vision 2020 protocol projects diabetic retinopathy and glaucoma as the emerging causes of blindness in the developing countries. Provided the appropriate and timely intervention, the severe visual impairment associated with diabetic retinopathy can be largely prevented. Therefore, the major challenge to the health care providers today is the identification and education of patients with diabetes, and the enrollment of these patients in a life-long comprehensive ophthalmic management program in order to minimize visual morbidity.

Since current therapies are remarkably effective if DR is identified early and laser photocoagulation is applied at the early identification, accurate classification and timely treatment of retinopathy is necessary. Emphasis is also appropriately directed at ensuring compliant lifelong routine ophthalmologic follow-up of diabetic patients. This approach is critical in assuring optimal savings of sight and is currently supported by numerous initiatives such as the American Academy of Ophthalmology Diabetes 2000 program[5].

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Causes of registration for visual impairment due to diabetic eye disease were failure of laser treatment, rapidly progressive disease and poor patient attendance. However efficient and prompt laser therapy may reduce its incidence[6].

Materials and methods

It was a prospective study done in Nepal Eye Hospital from March 2004 through August 2005. Data pertaining to patient demographics, visual acuity, symptoms and signs, investigations, treatment modalities and the outcome following laser therapy were collected, processed and analyzed. Especially designed proforma was used for the study.

Patients visiting retina clinic of Nepal Eye Hospital with diabetic retinopathy requiring laser treatment were included in the study. Sample size was 50. Patients with diabetic retinopathy were evaluated clinically and categorized into proliferative and non proliferative diabetic retinopathy with its subdivisions.

In this study, diabetes mellitus was taken as controlled when fasting blood sugar level was less than 120mg%. Similarly, patients were identified as hypertensives when the blood pressure was more than 140/90 millimeter of mercury irrespective of the age of the patient.

Informed consent was taken for fundus fluorescein angiography, for laser treatment and for enrollment in the present study.

Fundus fluorescein angiography (FFA) was done whenever indicated. In the present study, FFA was done in identifying subtle areas of neovascularisation or capillary non- perfusion, in doubtful cases of NVD/NVE, to study the status of macular perfusion and as a guide to laser treatment and as a means of evaluating the treatment during follow up.

Patients with indication for laser therapy were given diode pumped solid state green laser either pan retinal photocoagulation, focal or grid laser or in combination.

Indications for laser treatment of diabetic retinopathy in the present study were NVD irrespective of size and presence of preretinal haemorrhage, vitreous haemorrhage with NVD/NVE, neovascularisation of angle with or without proliferative retinopathy, neovascularisation of iris with retinal neovascularisation with or without vitreous or preretinal haemorrhage, diabetic maculopathy and clinically significant of macular edema.

Laser parameters in focal and grid laser therapy were as per Early Treatment Diabetic Retinopathy Study (ETDRS) and that in PRP were as per Diabetic Retinopathy Study (DRS). Patients were followed every 6 weeks through 18 weeks optic disc pallor, attenuation of blood vessels, regression of neovascularisation (NVD/NVE) and resolution of macular edema and taken as the signs of resolution of retinopathy. Following laser therapy, each patient was evaluated in terms of best-corrected visual acuity, regression of maculopathy, regression of NVD and regression of NVE.

Those patients having corneal diseases, inflammatory eye diseases, cataract causing visual acuity <6/18, optic neuropathy, cystoid macular edema and age related macular degeneration were excluded from the study. The limitations of the study were that the sample size was less, follow up period was short and patients visiting Nepal Eye Hospital were only included.

All demographic and clinical data were prospectively recorded on pre designed data collection sheet or proforma. The collected data were checked and coded manually and then entered into the computer. The numerical data obtained from the study were analyzed. Statistical analysis was performed with SPSS program (version10) and Epi-info program (version 6.04). Data were expressed in frequency, percentage, mean and standard deviation as applicable.

Results

Fifty-nine patients were enrolled in the study of which 9 were lost in the follow up. Therefore, only fifty patients completed the study. Out of the100 eyes of 50 patients, 80 eyes received laser treatment. Therefore, pre-laser analysis was done in 100 eyes while post laser parameters were analyzed only in 80 eyes receiving laser treatment.

All the fifty patients were of type II diabetes mellitus. Regarding the ethnic distribution of the enrolled patients, 58% were Newars followed by Bramhin (24%), Chhetri (10%) and Terai origin (6%).

The age of the patients varied from 36 to 74 years with mean of 54.57 years and 40% of the patients were of the age group 50-59 years. Males were involved more than females (58% vs. 42%). 74% of the patients were from Kathmandu valley while 26% were out of the valley. The duration of diabetes was <5 years in 20%, 5-10 years in 18%, 10-15 years in 18%, 15-20 years in 32% and >20 years in 12%. 60% of patients had the control of diabetes mellitus while

40% of patients had no control of diabetes mellitus. Regarding the treatment, 88% were on oral hypoglycaemic agents and 12% were on insulin. Regarding the associated risk factors, 52% had history of hypertension and were on treatment. Among them, blood pressure was controlled in 36% and uncontrolled in 16% with the medication. Only 6% of patients were on anticoagulants. 2% of patients had history of renal disease, 12% had history of smoking and 6% had history of drinking alcohol. None of the patients had history of glaucoma. One patient had prior laser treatment and three patients had undergone cataract extraction. Regarding the presenting symptoms, 92% presented with complaints of diminution of vision while 8% came for routine examination. 20% had history of floaters while 2% had history of flashes. Right eye vitreous of 90% was normal while 8% had vitreous haemorrhage and 2% had vitreous floaters. Left eye vitreous was normal in 98% while 2% had vitreous haemorrhage. Posterior vitreous detachment was present in only in 4% of cases.

Regarding the maculopathy, 35 right eyes and 26 left eyes had maculopathy. In the right eye, 58% had CSME, 6% had focal maculopathy and 6% had ischemic maculopathy. In the left eye, 38% had CSME,2% had diffuse maculopathy, 8% had focal maculopathy and 4% had ischemic maculopathy. Fundus fluorescein angiography was done in 18% of eyes. Eighty eyes of fifty patients were given laser therapy of which 44 were right eyes and 36 were left eyes.

Fig 2 shows the frequency of types of laser treatment given. Only Grid laser was given in 1 eye. Grid and focal laser was given in 1 eye. Focal laser only was given in 46 eyes and pan retinal photocoagulation only was given in 29 eyes while focal laser and panretinal photocoagulation was given in 3 eyes. Involvement of right eye only was 28%, left eye only was 12% and the involvement of both eyes was 60%. The eye which had grid laser, BCVA improved while the eye which had grid and focal laser, BCVA remained static.

Following focal laser, BCVA improved in 20 eyes, remained static in 22 eyes and reduced in 4 eyes. After pan retinal photocoagulation, BCVA improved in 19 eyes, remained static in 4 eyes and reduced in 6 eyes. Similarly, after focal laser and pan retinal photocoagulation, BCVA improved in 2 eyes, remained static in 1 eye with no deterioration.

Following laser treatment, best corrected visual acuity improved in 52.50%, remained static in 35% and deteriorated in 12.5%. Visual outcome improved in 52 % i.e., p value =0.038 and $\chi 2 = 6.53$ which is statistically significant.

Table 5 showed that maculopathy improved in 45%, remained static in 8% and unimproved in 1% there was no maculopathy in 46%. After laser treatment, NVD (OD) regressed in 6% and remained unchanged in 2% while NVD (OS) regressed in 6% and remained unchanged in 4%. Similarly, NVE (OD) regressed in 18% and remained unchanged in 4% and NVE (OS) regressed in 6% and unchanged in 2% following laser therapy.

Table 6 showed that pre laser visual acuity was in the group 6/6-6/18 in 51 eyes, 6/24-6/60 in 24 eyes and <6/60 in 5 eyes. Post laser visual acuity was 6/6- 6/18 in 57 eyes, 6/24-6/60 in 20 eyes and <6/60 in 3 eyes.

Best corrected visual acuity improved in 32 eyes where blood sugar level was controlled and improved in only 10 eyes where blood sugar level was not controlled. BCVA deteriorated in 4 eyes with controlled blood sugar level while it deteriorated in 6 eyes with uncontrolled blood sugar level.
BCVA improved in 23 eyes where blood pressure was normal while it improved in 8 eyes in hypertensive patients where blood pressure was controlled with drug and it improved in 11 eyes in hypertensive patients where blood pressure was uncontrolled with drug.

Following therapy, complications were seen in 5 right eyes and 5 left eyes. Recurrent vitreous haemorrhage was present in 6 eyes, partial tractional retinal detachment in 2 eyes, epiretinal membrane in 2 eyes. Follow up period varied from minimum of 4 weeks to maximum of 68 weeks with mean of 16.22 weeks.
Regarding the laboratory investigations like haemoglobin%, serum lipid profile and renal function tests, the results were within normal levels.

Table 1: Distribution of type of diabetic retinopathy (OU)

DR	Number	Percentage
NPDR	38	76.o
PDR	12	24.0
Total	**50**	**100.0**

Table 2: Distribution of severity of Non Proliferative Diabetic Retinopathy (NPDR, OU) among patients

Grades of NPDR	Number	Percentage
No NPDR	24	48.0
Mild to moderate NPDR	31	62.0
Moderate to Severe NPDR	27	54.0
Severe NPDR	11	22.0
Very Severe NPDR	7	14.0
Total	**50**	**100.0**

Table 3: Correlation of best corrected refraction with Focal Laser, PRP and Focal + PRP therapy (OU)

Best corrected	Focal Laser	PRP	Focal Laser & PRP
Improved	20	19	2
Static	22	4	1
Deteriorated	4	6	0
Total	**46**	**29**	**3**

Table 4: Visual Outcome among the patients with Laser Treatment (OU)

Vision	Number	Percentage
Improved	42	52.50
Static	28	35.0
Deteriorated	10	12.5
Total	**80**	**100.0**

Table 5: Status of diabetic maculopathy (OU) after laser therapy

Maculopathy	Number	Percentage
No maculopathy	46	46.0
Same	8	8.0
Improved	45	45.0
Deteriorated	1	1.0
Total	**100**	**100.0**

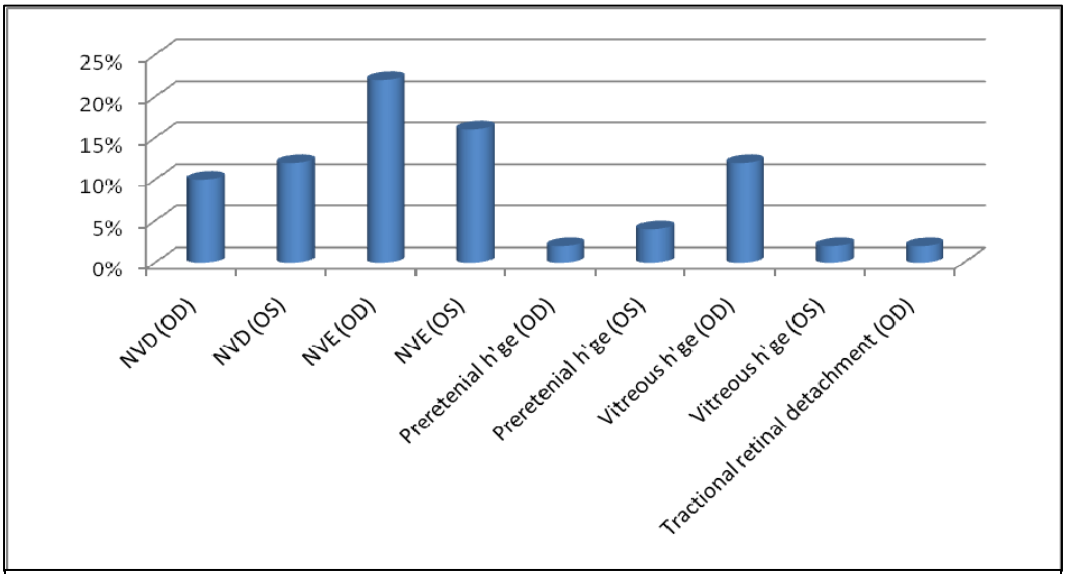
Table 6: Distribution of Pre-laser and Post-laser Grouped visual acuity (OU)

	Pre-laser		Post laser	
Grouped Visual Acuity	**Number**	**Percentage**	**Number**	**Percentage**
6/6- 6/18	51	63.75	57	71.25
6/24-6/60	24	30.0	20	25.0
<6/60	5	6.25	3	3.75
Total	**80**	**100**	80	100.0

Table 7: Correlation of best corrected refraction (OU) with status of diabetes mellitus

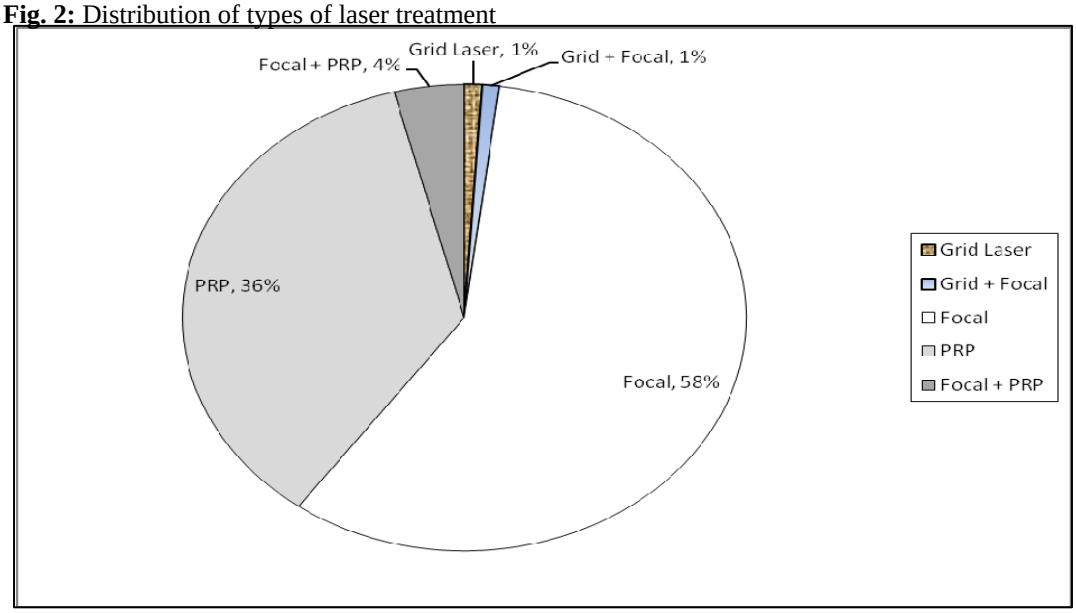
Diabetes Mellitus	Best corrected Refraction			Total
	Improved	Static	Deteriorated	
Controlled	32	13	4	49
Uncontrolled	10	15	6	31
Total	**42**	**28**	**10**	**80**

Fig 1: Distribution of NVD, NVE, Preretinal haemorrhage, Vitreous haemorrhage, Tractional retinal detachment



Among those with PDR, NVD (OD) was present in 10% and NVD (OS) was present in 12% and NVE (OD) was present in 22% and NVE (OS) was in 16%. Similarly preretinal haemorrhage was present in 2% (OD) an d4% (OS). Vitreous haemorrhage was present in 12% (OD) and 2% (OS). Similarly, tractional retinal detachment was present in 2% (OD).

Fig. 2: Distribution of types of laser treatment



Discussion

With changing lifestyle and more urbanization, diseases like diabetes and hypertension have become more common, leading to a greater prevalence of diabetic and hypertensive retinopathies in Nepal. Diabetic retinopathy accounted for 18% in the distribution of blindness with respect to the pattern of posterior segment diseases[7]. According to Singh DL and Bhattarai MD almost one fourth of the people 20 years and above in urban areas in Nepal showed diabetic tendency. Similarly, almost one third of people 40 years and above in urban areas in Nepal showed diabetic tendency and more than 10% of 20-39 years old women in urban areas in Nepal showed diabetic tendency[8]. Diabetes with or without retinopathy was the commonest cause (20.25%) for attendance in retina clinic followed by hypertension and venous occlusive disorders in Nepal Eye Hospital[9].

In the present study where 50 diabetic patients were analyzed, all were type II diabetes mellitus. The patients who were on insulin were the ones where blood sugar was not controlled with oral hypoglycaemic agents. This result is similar to the study done by R. Mohan et all on retinopathy in insulin dependent diabetes mellitus in South India[10]. The study states that IDDM is uncommon in India and at their centre IDDM constituted about 2% of the total diabetic population. In another study conducted by I.S. Jain, department of ophthalmology at PGI India[11] also found that NIDDM was about 10 times more prevalent than IDDM.

Regarding the ethnicity of the enrolled patients, 59% were Newars. This could be due to the fact that 74% of the patients were from the Kathmandu valley and the major residents of the Kathmandu valley are Newars. The maximum (40%) incidence of diabetic retinopathy requiring laser therapy was found in the age group 50-60 years. This does not coincide with the age group stated by Duke Elder[12].

According to Duke Elder, women are more liable to develop diabetes than men (3:2). They are also more likely to develop diabetic retinopathy. Studies have shown that females have a higher risk of developing diabetic retinopathy but proliferative retinopathy is more common in males[12]. However, in the present study, males were affected more than females (58% Vs 42%). The reason for the disparity in this result can be due to the fact that Nepalese women seldom seek medical assistance unless they are symptomatic and is why escape detection. However, males are more mobile and thus their hospital attendance is higher.

The present study shows a strong correlation of diabetic retinopathy with systemic hypertension. This result is similar to the study done by Knowler WC et all on 'Increased incidence of retinopathy in diabetes with elevated blood pressures; a six year follow up study in Pima Indians'[13]. According to Ballantyne and Lowenstein, hypertension was found in 50% of diabetics showing retinal changes[14]. Aarseth reported a similar increased incidence[15]. In this study also, 52% were hypertensives and blood pressure was controlled in 36% and uncontrolled in 16% with medication. In this study, best corrected visual acuity improved in more number of eyes with normal blood pressure than that with high blood pressure.

There have been few therapeutic innovations to prevent or significantly ameliorate diabetic retinopathy and at present emphasis is on achieving near-euglycaemia and avoiding or modulating known risk factors such as smoking, uncontrolled hypertension, hyperlipidemia and anaemia[16,17]. And some authority claim that any treatment to preserve full vision in diabetics must be instituted before capillary instability, incompetence and closure occur[18]. In our study, smoking was found in 12%, uncontrolled hypertension in 16%. However, hyperlipidemia and anemia is almost negligible.

In this study 24% of the patients had PDR while 76% had NPDR. The result is similar to the one quoted by Kanski JJ[19], Rizyal A[20] and Roy MS[21]. Regarding the distribution of diabetic patients in a study done by Karki DB et. all, 55% were NPDR with or without maculopathy and 29% were PDR while 16% had no retinopathy[9].

Diabetic maculopathy is the most common cause for visual impairment in diabetic patients, particularly those with type II diabetes mellitus[19]. Of the total 80 eyes in this series, 71 eyes had maculopathy. This could be due to the fact that all cases were of NIDDM and 92% presented with diminution of vision. The visual outcome following focal laser in diabetic maculopathy in the present study is better than that quoted in Clinical Ophthalmology by Jack J. Kanski[19]. In the study 'Risk factors influencing the treatment outcome in diabetic macular edema' by Gupta A et all, advanced age of the patient, large size of CSME and poor baseline visual acuity were found to be significantly associated with poorer outcome ($p<0.005$)[22]. The duration of diabetes mellitus in grouped years and the severity of diabetic retinopathy is not significant in this study.

The risk of severe visual loss (best corrected visual acuity 5/200 or worse at two consecutive visits 4 months apart) from PDR is approximately 40% after 6 years if not treated with laser pan retinal (scatter) photocoagulation (PRP)[22,23]. The risk of moderate visual loss (doubling of visual angle at two consecutive visits four months apart) from clinically significant macular edema (CSME) is approximately 33% after 3 years. Legal blindness (best corrected visual acuity of 20/200 or worse) has been estimated as 25 times more common in the diabetic population than those without the disease. Appropriate and timely laser photocoagulation can reduce the risk of severe visual loss by more than 95%. Similarly, the risk of severe visual loss from diabetic macular edema can be reduced by 50% with appropriate focal laser photocoagulation[5].

The best corrected visual acuity improved in more number of eyes with control of blood sugar level and it deteriorated in less number of eyes with controlled blood sugar level. This signifies the importance of good glycaemic control for better results following laser treatment. The United Kingdom prospective study has also confirmed that good glycaemic control of type II, non-insulin dependent diabetes mellitus is beneficial and delays the onset of retinopathy[24].

In the present study, post laser therapy, 57 eyes had BCVA in the group 6/6-6/18 as compared to 51 eyes prior to laser treatment. Similarly, 3 eyes had BCVA <6/60 after laser therapy as compared to 6 eyes with BCVA <6/60 pre laser therapy. In a study done by Degenring RF et al. regarding the clinical outcome of macular grid laser photocoagulation in the treatment of diabetic macular edema, mean visual acuity decreased in the whole population and especially in the subgroup with a baseline visual acuity of >or == 0.2 after macular grid laser photocoagulation[25]. However, we cannot come to any such conclusion as only two patients received grid laser photocoagulation. At the same time, maculopathy has improved in 52% (OD) and 38%(OS) following laser treatment. This could be due to the fact that patients mostly had clinically significant macular edema and only few had diffuse exudative maculopathy the prognosis of which is poorer.

National Diabetic Retinopathy laser treatment audit III. clinical outcomes. states that they had BCVA of 6/6 or better at follow up in 31.1%(132) of eyes and BCVA of 6/24 or worse in 16.7% (71) of eyes. Similarly, BCVA was <6/60 at follow up in 14 eyes[26].
In a study done by Mohan Rema et all, 73%(140) eyes with good visual acuity (6/9) at baseline maintained the same vision and 18.9% (10) eyes improved their vision. Of the 17 eyes with visual acuity ≤ 6/60 at baseline, 12 eyes maintained the same vision and the remaining 5 improved their vision. This was following the pan retinal photocoagulation at 1year follow up[28]. In the present study, after PRP in 29 eyes, BCVA improved in 19 eyes, remained static in 4 eyes and reduced in 6 eyes.

In the follow up study of 214 surviving patients enrolled originally in Early Treatment Diabetic Retinopathy Study, 42% had visual acuity of 20/20 or better and 84% had visual acuity of 20/40 or better in better eye. Compared with baseline, 20% had moderate vision loss (loss of 3 lines/more) in the better eye. Only 1 patient had visual acuity of 20/200 bilaterally[1].

Progression of the lens opacities, chronic macular edema, vitreous haemorrhage, macular traction and neovascular glaucoma was the main causes of visual loss in a study done by Dogu M et all in Kobe University School of Medicine in Japan[27]. However in this study, recurrent vitreous haemorrhage, partial tractional retinal detachment and epiretinal membrane were the complications observed post laser therapy with poorer visual outcome. Recurrent vitreous haemorrhage was observed in those eyes where the initial laser spot number was less than 1000 in five eyes while 1 eye had the initial number of laser spot more than 1000 spots. The National Diabetic Retinopathy Laser Treatment Audit III. Clinical Outcomes also states that regression of neovascularisation was associated with greater areas of retinal ablation at the initial treatment session[28].

Optimization of diabetic control, early correction of metabolic abnormalities in retinal vascular cells and pre-emptive strike to limit or reverse vascular occlusion, impaired retinal permeability and neovascularisation are the challenges for the future and given some success, it should be possible to significantly extend the functional life of the retinal circulation and guarantee a life-time of serviceable vision in most if not all diabetics[29].

Conclusion

Non proliferative diabetic retinopathy was present in 76% and proliferative diabetic retinopathy was present in 24% among the enrolled diabetic patients.

Following laser treatment, best corrected visual acuity improved in 52.50%, remained static in 35% and deteriorated in 12.5%. Visual outcome improved in 52i.e.i.e, p value=0.038 and χ^2= 6.53 which is statistically significant.

Maculopathy improved in 52%, remained static in 6% and deteriorated in 2% in right eyes while there was no maculopathy in 40% in right eyes. Similarly, maculopathy improved in 38% and remained same in 10% while 52% had no maculopathy in left eyes.

After laser treatment, NVD (OD) regressed in 6% and remained in 6% and deteriorated in 2% while NVD (OS) regressed in 6% and remained unchanged in 4%. Similarly, NVE (OD) regressed in 18% and remained unchanged in 4% and NVE (OS) regressed in 18% and remained unchanged in 2% following laser therapy.

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