



## Evaluation of Solid State 532 Nm Green Laser In Treatment of Diabetic Macular Edema

### KEYWORDS

Diabetic retinopathy, laser photocoagulation, clinically significant macular oedema

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**ABSTRACT** *Introduction:- Diabetic macular edema (DME) is the most frequent cause of vision loss related to diabetes mellitus. Laser photocoagulation is an established procedure to decrease the incidence of visual loss resulting from diabetes. Methods:- The present study was undertaken on 25 patients with diabetic macular edema visiting Outpatient Department of Regional Institute of Ophthalmology, Govt. Medical College, Amritsar (Punjab). Laser treatment was done using slit lamp laser delivery system using 532nm green laser. Results: - Solid state 532nm green laser tends to reduce visual deterioration in diabetic macular edema with 15 (44%) patients showed substantial visual improvement. Conclusion:- Clinically significant macular edema (CSME) solid state 532nm green laser photocoagulation is useful both for visual improvement and maintenance of good vision. The visual outcome after laser photocoagulation is inversely proportional to older age group, long duration of diabetes and those who are hypertensives.*

### INTRODUCTION

An estimated 346 million people are affected by diabetes worldwide in 2011, and the number of people with diabetes is expected to double from 2005 to 2030.<sup>1</sup> The hallmark of diabetes mellitus is hyperglycemia, and chronic hyperglycemia lies at the root of all complications of diabetes through its detrimental effects on blood vessels, leading to vascular dysfunction and eventually vascular occlusion.

A recent international study reported that diabetes control in individuals worsened with longer duration of the disease (9.9±5.5 years),<sup>2</sup> with neuropathy the most common complication (24.6 per cent) followed by cardiovascular complications (23.6 per cent), renal issues (21.1 per cent), retinopathy (16.6 per cent) and foot ulcers (5.5 per cent).<sup>3</sup>

The Wisconsin Epidemiologic Study of Diabetic Retinopathy found the 14-year incidence of DME in type I diabetics to be 26%.<sup>4</sup> Similarly the Diabetes Control and Complications Trial (DCCT) reported that 27% of type I diabetic patients develop DME within 9 years of onset.<sup>5</sup>

Diabetic retinopathy (DR) is the leading cause of vision loss of working-age adults<sup>6</sup> and diabetic macular edema (DME) is the most frequent cause of vision loss related to diabetes.

Clinically significant macular edema (CSME) is a form of DME that was precisely defined by the Early Treatment Diabetic Retinopathy Study (ETDRS).<sup>7</sup> CSME exists if any of the following criteria are met:

- § Any retinal thickening within 500 μm of the foveal center;
- § Hard exudates within 500 μm of the foveal center that are associated with adjacent retinal thickening (which may lie more than 500 μm from the foveal center);

- § An area of retinal thickening at least 1 disc area in size, any part of which is located within 1 disc area of the foveal center.

Fluorescein angiography (FA) is an essential tool in the diagnosis of Macular edema. FA not only highlights edema for easy visualization and treatment localization, but also creates a permanent record for future comparison. Furthermore it distinguishes and localizes areas of focal versus diffuse leakage, thereby guiding the placement of laser photocoagulation

The advantages of photocoagulation have been made clear by the ETDRS, in which laser photocoagulation was shown to halve the risk of doubling the visual angle, from 24% to 12% over 3 years.<sup>8</sup>

### AIMS AND OBJECTIVES

The aims of the present study were:

- 1) Visual outcome after "frequency-doubled solid-state 532-nm green laser" in exudative

### diabetic maculopathy.

- 2) To identify factors that predict visual outcome and post laser fundus changes after "frequency-doubled solid-state 532-nm green laser" in diabetic maculopathy.

### MATERIALS AND METHODS

A total of 25 patients with Diabetic macular edema visiting Outpatient Department of Regional Institute of Ophthalmology, Govt. Medical College, Amritsar (Punjab) were randomly selected and included in the study. Study was conducted after permission from Thesis and Ethical committee. Informed consent was taken from each patient.

### INCLUSION CRITERIA

1. Age between 40 to 70 years irrespective of sex

2. Patients with diabetic maculopathy either pure exudative maculopathy or mixture of exudative and ischemic maculopathy

**EXCLUSION CRITERIA**

1. Proliferative Diabetic Retinopathy (PDR)
  2. Ocular diseases including glaucoma, uveitis, and mature cataract, Vitreous hemorrhage/retinal detachment
  3. Patient who have already received Intravitreal injections or Patients with past history of laser treatment for diabetic retinopathy
  4. Pure ischemic maculopathy
  5. Already vitrectomised eyes
- A detailed clinical examination of both the eyes was done as under
1. Visual acuity (VA) by ETDRS chart and best corrected visual acuity was noted.
  2. Slit lamp biomicroscopic examination of anterior segment was done. IOP measured.
  3. Fundus examination using Indirect ophthalmoscope with plus 20D lens and Slit lamp biomicroscopy with plus 78D lens.
  4. Fundus photography by using Topcon TRC-DX Fundus Camera with FA unit.
  5. Fundus fluorescein angiography done after taking informed consent.

Preparations of the patient for laser treatment involve informed consent, fully dilated pupils, and application of topical anesthesia (0.5% proparacaine hydrochloride ophthalmic solution) to the eye to be treated. The treatment was done using slit lamp laser delivery system with the help of Volk fundus lens and Quadraspheric Lens.

**Laser parameters used were**

For focal laser: Spot size: 50-100 µm, Duration: 50-100 ms, Power: 50-100 mw

Intensity: Whiten or darken microaneurysm

Number: to all leaking microaneurysm

For grid laser: Spot size: 50-200 µm, Duration: 50-100 ms, Power: 50-100 mw, Intensity: mild light burns,

Number: area of diffuse diabetic macular edema

Regular follow ups at 1 month interval done for a period of 3 months

**OBSERVATIONS:-**

**Age:-**

The age of the patients in this study varied between 42 years to 70 years.

Maximum cases 12 (48%) were from the age group 60-70 years, followed by 8 (32%) cases from age group 50-60 years. There were 5 (20%) cases from 40-50 years age group.

**SEX**

Out of 25 patients who were studied 16 (64%) patients were males and 9 (36%) were females

**Age in relation to visual outcome in study eyes:-**

Out of 34 study eyes 6 belonged to the 40-50 age group in which 4 (67%) eyes showed improvement of one or more line and in 2 (33%) the vision remained same.

11 belonged to the 50-60 group in which 5 (45%) showed improvement of one or more line, in 2 (18%) vision remained same and in 4 (36%) visual acuity became worse by one or more line.

17 belonged to 60-70 age group in which 6 (35%) eyes showed improvement in visual acuity for one or more line, in 10 (58%) the vision remained same and in 1 (7%) visual acuity became worse by one or more line

**TABLE 1: Showing age with visual prognosis after laser treatment**

Age group (year)	Eyes with improved visual acuity for one line or more	Eyes with same visual acuity	Eyes with visual acuity worse for one line or more	Total
41-50	4(67%)	2(33%)	0(0%)	6
51-60	5(45%)	2(18%)	4(36%)	11
61-70	6(35%)	10(58%)	1(7%)	17
Total	15(44%)	14(41%)	6(15%)	

**Visual outcome in relation to sex of the patient:**

Out of 19 male eyes 8 (42%) showed improvement in visual acuity for one or more lines, in 8 (42%) the Visual Acuity remained same and in 3 (16%) it became worse by one or more line.

Out 15 female eyes studied 7 (46%) showed improvement in visual acuity for one or more line, in 6 (40%) the visual acuity remained same and in 2 (14%) it became worse by one or more line.

**Table 2: showing sex of the patient and visual prognosis after laser treatment.**

Sex	No. of eyes with improved visual Acuity	No of eyes with same visual Acuity	No of eyes with worse visual Acuity	Total
Male	8(42%)	8(42%)	3(16%)	19
female	7(46%)	6(40%)	2(14%)	15
Total	15(44%)	14(41%)	6(15%)	

X<sup>2</sup>1.08; P >0.05 (NS)

**DURATION OF DIABETES:-**

Relation of duration of diabetes with visual prognosis after laser treatment

Out of 34 study eyes 11 were of patients with duration of diabetes less than 10 years in which 8 (73%) eyes showed improvement of one or more line and in 2 (18%) the vision remained same and in 1 (9%) the vision became worse by one or more line.

17 were of patients with duration of diabetes between 10-20 years in which 7 (41%) showed improvement of one or more line, in 8 (47%) vision remained same and in 2 (12%) visual acuity became worse by one or more line.

17 were of patients with duration of diabetes between 20-30 years in which no eyes showed improvement in visual acuity for one or more line, in 4 (67%) the vision remained same and in 2 (33%) visual acuity became worse by one or more line.

**Table 3: showing relation of duration of diabetes with visual prognosis after laser treatment**

Duration of diabetes	No Of eyes with better visual acuity	No of eyes with same visual acuity	No of eyes with worse visual acuity	Total
<10yrs	8(73%)	2(18%)	1(9%)	11
10-20yrs	7(41%)	8(47%)	2(12%)	17
21-30yrs	0(0%)	4(67%)	2(33%)	6
Total	15(44%)	14(41%)	5(15%)	34

$\chi^2$  ' 8.97; P >0.05 (NS)

Duration of diabetes and post laser fundus findings:

Out of 34 study eyes 11 were of patients with duration of diabetes less than 10 years of which 3 (27%) showed complete resolution of exudates and edema around fovea and 8 (73%) showed incomplete resolution of exudates and edema around fovea

17 eyes were of patients with duration of diabetes between 10-20 years of which 3 (18%) showed complete resolution and 11 (18%) showed incomplete resolution and 3 (27%).

6 eyes were of patients with duration of diabetes between 20-30 years out of which all 4 (66%) showed incomplete resolution (33%).

**Table 4: showing duration of diabetes and post laser fundus changes**

Duration of diabetes	Complete resolution of exudates and edema around fovea	Incomplete resolution of exudates and edema around fovea	No resolution of exudates and edema	Total
<10yrs	3(27%)	8(73%)	0	11
10-20yrs	3(18%)	11(65%)	3(27%)	17
21-30yrs	0(0%)	4(66%)	2(33%)	6

$\chi^2$  ' 1.97; P >0.05 (NS)

**TYPE OF DIABETES AND VISUAL OUTCOME:-**

Out of 34 study eyes 6 (18%) were of patients with type 1 diabetes in which 3 (50%) showed improvement of one or more line, in 1 (16%) the visual acuity remained same and in another 2 (33%) vision became worse by one or more line.

28 (82%) eyes of patients with type 2 diabetes in which visual acuity improved by one or more line in 12 (42%), remained same in 13 (46%) and in 3 (11%) vision became worse.

**Table 5: showing type of diabetes and prognosis after treatment**

Type of diabetes	No. of eyes with improved post treatment visual acuity	No of eyes with same visual acuity	No of eyes with worse visual acuity	Total
Type 1	3(50%)	1(16%)	2(33%)	6(100%)
Type 2	12(42%)	13(46%)	3(11%)	28(100%)
	15(44%)	14(41%)	5(15%)	34(100%)

$\chi^2$  : 4.43; P >0.05 (NS)

**SYSTEMIC FACTORS:-**

**Visual outcome in relation with Hypertension:-**

Out of 25 patients 16 were hypertensive and 9 are non hypertensive

Out of 34 eyes treated 20 were of patients with hypertension of which 6 (30%) showed improvement in vision by one or more line, in 9 (45%) the vision remained same and in 5 (25%) the vision became worse by one or more line.

14 eyes belonged to patients with no hypertension in which 9 (64%) showed improvement in vision by one or more line and in 5 (36%) the vision remained same.

**Table 6: Visual outcome in relation with hypertension.**

Associated systemic illness	No of eyes with improvement post treatment	No of eyes with visual acuity same	No of eyes with visual acuity decreased post treatment	Total
Hypertensive	6(30%)	9(45%)	5(25%)	20(100%)
Non hypertensive	9(64%)	5(36%)	0	14(100%)

$\chi^2$  :4.14; P <0.05 (S)

**BEST CORRECTED VISUAL ACUITY (BCVA) OF THE STUDY EYES:-**

Out of 34 study eyes, 12 patients each had visual acuity of 6/18 and 6/24 and 5 patients each had visual acuity of 6/36 and 6/12

**Table 7: showing best corrected visual acuity in study eyes in patients with diabetic CSME.**

BCVA	Males	Females	Total	Percentage
6/36	3(9%)	2(6%)	5	15
6/24	6(18%)	6(18%)	12	35
6/18	7(20%)	5(15%)	12	35
6/12	3(9%)	2(6%)	5	15

$\chi^2$  ' 0.26; P >0.05 (NS)

**Visual acuity in relation to best corrected visual acuity**

Out of 34 study eyes 5 were with baseline BCVA 6/36, 4 (80%) with visual acuity same as pre treatment visual acuity and 1 (20%) with vision worse by one or more line on treatment.

12 each were with baseline BCVA 6/24 and 6/18, 6 (50%) each of which had improved vision by one or more line, 4 (33%) each with VA same as pre treatment Visual acuity and 2 (17%) each with VA worse by one or more line on treatment.

5 were baseline BCVA 3 (60%) of which had improvement with laser treatment and 2 had Visual acuity same as pre treatment.

Table 8: showing visual outcome in relation to best corrected visual acuity.

**FUNDUS FLUOROSCEIN ANGIOGRAPHY:-**

**Type of Leakage:**

Out of the 34 eyes studied 12 showed focal leakage in fundus fluoroscein angiography and 22 showed diffuse

leakage.

**Table 9: showing percentage of eyes with diabetic CSME having focal and diffuse leakage in FFA**

Type of Leakage	No of eyes	percentage
Focal	12	35
Diffuse	22	65

**LASER TREATMENT:-**

Out of 34 eyes 12(35%) treated with focal laser, of which 5(42%) showed visual improvement and 4(33%) showed same visual acuity as pre treatment and in 3(25%) the visual acuity became worse by one or more line.

22(65%) eyes were treated with grid laser out of which 10(45%) showed visual improvement, in another 10(45%) the visual acuity was same and in 2(10%) the vision became worse by one or more line.

**FOLLOW UP:-**

Best corrected visual acuity in study eyes (After 1 month of laser photocoagulation)

Out of 20 eyes treated by laser photocoagulation, 6(18%) had a definitive improvement by one line and 12(35%) had same visual acuity as that of pre laser photocoagulation. Remaining 16(47%) eyes had a decrease in visual acuity by one line.

**TABLE 10: Showing the changes in the best corrected visual acuity in study eyes after one month of laser photocoagulation**

Total eyes treated	Vision improved by one or more line		Vision unchanged		Vision worsened by one or more line	
	No	%age	No	%age	No	%age
34	6	18	12	35	16	47

Best corrected visual acuity in study eyes (After 2 month of laser photocoagulation)

Out of 34 eyes studied. 12 (35%) eyes showed definitive improvement in visual acuity by one or more line, in 14 (41%) eyes the vision remained same as in pre laser treatment and in 8 (24%) eyes vision worsened by one line or more

**Table 11: Showing the changes in best corrected visual acuity in study eyes after two months of laser photocoagulation**

Total eyes treated	Vision improved by one or more line		Vision unchanged		Vision worsened by one or more line	
	No	%age	No	%age	No	%age
34	12	35	14	41	8	24

Best corrected visual acuity in study eyes (After 3 month of laser photocoagulation)

Out of 34 eyes studied 15(44%) had definitive improvement of visual acuity by one or more line, 14(41%) had vision same as in pre laser treatment in 5 (15%) the vision worsened by one or more line.

**Table 12: Showing the changes in best corrected visual acuity in study eyes after three months of laser photocoagulation**

Total eyes treated	Vision improved by one or more line		Vision unchanged		Vision worsened by one or more line	
	No	%age	No	%age	No	%age
34	15	44	14	41	5	15

**POST LASER FUNDUS FINDINGS IN STUDIED EYES:-**

Out of 34 eyes treated 6 showed complete resolution of exudates and edema on fundus examination and 28 showed incomplete resolution of exudates and edema on fundus examination.

**Table 13:- Showing study eyes with post laser fundus findings**

Total eyes treated	Complete resolution of exudates and edema	Incomplete resolution of exudates and edema	No resolution of exudates and edema
34	6(18%)	23(67%)	5(15%)

**DISUSSION**

In the present study visual acuity improvement after laser photocoagulation is seen more in younger age group. Gupta A (1996) found poor outcome in 76% eyes in age more than 50yrs as compared to 24% in age less than 49 yrs in his study.<sup>9</sup> Browning DJ(1997) found co-relation between increasing age and visual outcome following laser to be significant (p=0.0179).<sup>10</sup>

Duration of diabetes is found to be closely related to the BCVA after laser therapy in the present study and also shown by Tariq Q et al(2013) in a study.<sup>11</sup> It is apparent from the present study that non-hypertensives were better with laser photocoagulation. Keshav et al ( in his study found that among the patients with associated Hypertension 12 eyes (54.5% had stable visual acuity while 7 eyes (31.8%) had improvement in visual acuity and 3 eyes (13.6%) had worsening of visual acuity.<sup>12</sup>Prevalence of hypertension (61.9% [n=99], P <0.001) was significantly higher in the study group compared to controls by Rema M.<sup>8</sup> Gupta A (1996) showed 29.7 % with favorable outcome against 53.1% of eyes with unfavorable outcome in patients with hypertension.<sup>9</sup>In our study eyes with good BCVA are a bit better with laser photocoagulation. In Tariq Q et al (2013) study, 55% of the patients with baseline visual acuity between 6/6-6/18 shows improvement and 73.9% of the patients between 6/24 to 6/60 shows improvement after laser as compared to only 42.9% of patients with baseline visual acuity <6/60. Only 4.3% of patients with baseline visual acuity of 6/24 or 6/60 shows deterioration as compared to 14.3% of patients with baseline visual acuity of <6/60.<sup>11</sup>Romaniuk et al (2000) studied, 55% of the patients with baseline visual acuity between 6/6-6/18 shows improvement and 73.9% of the patients between 6/24 to 6/60 shows improvement after laser as compared to only 42.9% of patients with baseline visual acuity <6/60.<sup>13</sup>Out of 34 eyes studied 15(44%) had definitive improvement of visual acuity by one or more line, 14 (41%) had vision same as in pre laser treatment in 5 (15%) the vision worsened by one or more line. Tariq Q (2013) shows that laser photocoagulation is useful in improvement of vision in diabetic macular edema.<sup>11</sup> In a study by Keshav et al (2008) where the visual acuity status was compared with control of DM, it was found that in the controlled group, majority 39 eyes (59.1%) had stable outcome while 18 eyes (27.3%) of patients showed improvement in VA and 9 patients 13.6% of eyes of patients showed worsening of visual acuity.<sup>12</sup> In a study by Romanuik W.et al. (2000) it was seen that the stabilization occurred in about similar magnitude i.e. 51.3% and improvement in only 10% as against 27% in our study.<sup>13</sup>Shrestha S (2007) In the her study, after PRP in 29 eyes, BCVA improved in 19 eyes, remained static in 4 eyes and reduced in 6 eyes.<sup>14</sup> EDTRS study report no 2 1987 shows 16% eyes with vision improvement 77% with same vision and 7 % with vision deterioration.<sup>17</sup>

**SUMMARY AND CONCLUSION:-**

The present study was undertaken to study the role of solid state 532nm green laser in treatment of diabetic macular edema. There were 16(64%) males and 9(36%) females with no significant difference between sex and visual outcome post laser photocoagulation. Duration of diabetes between 7 to 24 years was taken and it was seen that subjects with chronic hyperglycemia for longer duration show less visual improvement. Out of 25 patients and 34 study eyes 28 (82%) belonged to NIDDM and 6(18%) belonged to IDDM. IDDM eyes seemed to fare better post laser due to lesser duration of diabetes and younger patients with better baseline BCVA. Post laser fundus finding followed the same trend as post laser visual acuity. Systemic hypertension was found in 16 patients 12 of which were males and 4 females. Ischemic heart disease was found in 2 of the male patients. Hypertension and visual prognosis were found to be inversely related. Out of 20 eyes treated by laser photocoagulation, 6(18%) had a definitive improvement by one line and 12(35%) had same visual acuity as that of pre laser photocoagulation. Remaining 16(47%) eyes had a decrease in visual acuity by one line after one month. Out of 34 eyes studied 12(35%) eyes showed definitive improvement in visual acuity by one or more line, in 14(41%) eyes the vision remained same as in pre laser treatment and in 8(24%) eyes vision worsened by one line or more after two months. Out of 34 eyes studied 15(44%) had definitive improvement of visual acuity by one or more line, 14(41%) had vision same as in pre laser treatment in 5 (15%) the vision worsened by one or more line after three months. From the results of this study it was evident that solid state 532nm green laser tends to reduce visual deterioration in diabetic macular edema and 15(44%) patients showed substantial visual improvement.

So corollary is that in clinically significant diabetic edema (CSME) solid state 532nm green laser photocoagulation is useful both for visual improvement and maintenance of good vision.

The visual outcome after laser photocoagulation is inversely proportional to older age group, long duration of diabetes and those who are hypertensives.

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