

ORIGINAL ARTICLE

The short term effect of grid laser photocoagulation in the management of diabetic macular edema

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ABSTRACT

BACKGROUND: Diabetic macular edema (DME) is one of the most common complication of diabetic retinopathy causing vision loss. Grid laser photocoagulation with or without intra vitreal drugs are the main stay of treatment for diabetic macular edemas with strict glycemic control. The study was done to evaluate the effectiveness of grid laser photocoagulation on DME. **MATERIALS AND METHODS:** A prospective, non randomized, consecutive, interventional study of 30 eyes of 20 patients with Type 2 diabetes mellitus having mild to moderate non proliferative diabetic retinopathy (NPDR) with macular edema who underwent grid laser photocoagulation was done over a period of 18 months. Patients were monitored at 1, 3 and 6 months. Visual acuity and change in foveal thickness were measured. **RESULTS:** There was a significant decrease in foveal thickness and improvement in visual acuity at 1 and 3 months. At 6 months, the decrease in foveal thickness and improvement in visual acuity was not statistically significant. **CONCLUSION:** The present study on grid laser photocoagulation and its effect on retinal thickness on diabetic macular edema shows that grid laser is beneficial in improving and maintaining the visual acuity and in reducing macular thickness but may not be sustained for 6 months in our study population.

Keywords: Diabetic macular edema, Grid laser photocoagulation, SD OCT

INTRODUCTION

The most common cause of visual loss in patients with diabetic retinopathy is macular edema. Untreated, 25 – 30% of patients with clinically significant macular edema exhibit a doubling of visual angle within 3yrs. In treated patients, the risk drops by 50%.^{1,2}The Wisconsin Epidemiologic study of Diabetic Retinopathy has clearly shown that the incidence of Diabetic Macular Edema (DME) is directly proportional to the severity of diabetic retinopathy.^{3,4}In eyes with mild Non Proliferative Diabetic Retinopathy (NPDR) 3% suffer from DME compared to 71% in proliferative diabetic retinopathy (PDR).

Diabetic macular edema: The terms for macular edema in diabetic patients currently used are:

1. Macular edema (ME); and (2) Clinically significant macular edema (CSME).

In Diabetes related Research Studies⁵, ME is characterized by retinal thickening or hard exudates within a 1 disk diameter (DD) from centre of the macula. (Fig 1).

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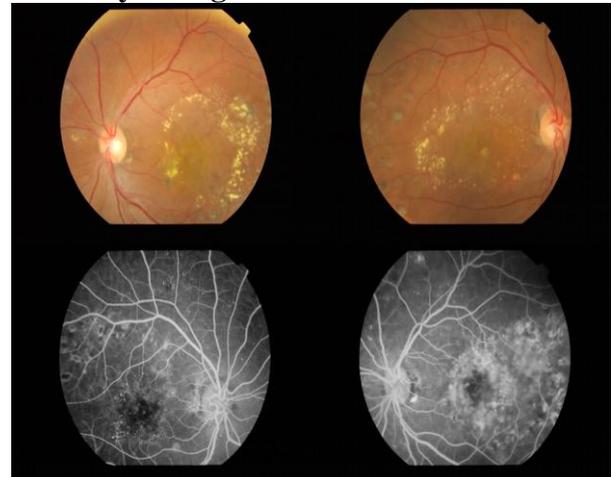
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The term *clinically significant macular edema* (CSME) is used if one of the following is present:

- Retinal edema located at or within 500 µm of the centre of the macula
- Hard exudates at or within 500 µm of the centre if associated with thickening of adjacent retina
- Zone or zones of retinal thickening 1 disk area in size (1500µm) or larger, part of which is within 1 disk diameter of the macular centre, characterized by the retinal thickening of the macular area visible under biomicroscopy.⁵

Figure 1: Fundus photograph showing clinically significant macular edema



Pathology: Diabetic macular edema results from retinal microvascular changes.^{6,7,8,9} Thickening of basement membrane and loss of pericytes, results in micro aneurysms which results in increased permeability and incompetence of the retinal vasculature. Hypoxia produced by this mechanism stimulates the production of vascular endothelial growth factor (VEGF). Studies suggests that the pathogenesis of diabetic macular edema is related to VEGF dependency, other inflammatory and angiogenic cytokines.¹⁰

Management of diabetic macular edema: The first line of treatment in DME is good glycemic control. The gold standard treatment of diabetic macular edema are focal and or grid laser, as defined by the ETDRS. Under ETDRS guidelines, laser photocoagulation is done when patients meet the criteria of clinically significant macular edema, even if visual acuity is not reduced.

Photocoagulation for diabetic macular edema:

Focal laser photocoagulation: According and to the ETDRS,^{1,2,11,12,13} DRS^{14,15} and other studies, for focal leakage, direct laser therapy using argon green,¹⁶ is applied to all leaking microaneurysms between 500 to 3000µm from the centre of macula.

Grid laser photocoagulation: For diffuse leakage, a grid pattern of laser photocoagulation using argon green is applied to an area more than 500µm from the centre of the macula and 500µm from the temporal margin of the optic disc.

Temporal 'c' photocoagulation: In this method, focal laser is applied like a continuous C pattern within the temporal arcade, 500µm from the centre of macula.

Evaluation of macular edema: Macular edema is diagnosed with the aid of +90D or +78D spherical hand held lens in association with slit lamp biomicroscope or indirect ophthalmoscope. Fluorescein angiography is an invasive qualitative test that facilitates the detection of vascular leakage. OCT^{17,18} is a noninvasive, noncontact imaging technique which produces cross-sectional images with millimetre penetration (approximately 2-3 mm in tissue) and micrometer scale axial and transverse resolution retina and optic nerve and also the anterior segment of the eye.

The Spectral domain technology (SD-OCT) replaces the moving parts found in conventional OCT instruments with a stationary spectrometer. The SD-OCT systems improves the detection of true outer retinal boundary and retinal layers, enables the detection and quantification of clinically relevant disease features.

Study design: A prospective, non-randomized, non-comparative, interventional study.

MATERIALS AND METHODS

This study comprised of thirty eyes of twenty patients with mild to moderate non proliferative diabetic retinopathy and macular edema who underwent grid laser photocoagulation.

This study was conducted for time span of 18 months at M.N eye hospital, Chennai. Ethical committee approval was taken prior to study.

Color Fundus photography, Fundus Fluorescein Angiography (FFA) and Spectral Domain Optical Coherence Tomography (SD OCT) were performed. Following grid laser photocoagulation, patients were reviewed at 1 month, 3 months and 6 months intervals to measure the change in foveal thickness and to document the change in visual acuity.

Patient selection:

Inclusion criteria: Patients with mild to moderate non proliferative diabetic retinopathy and macular edema were included in this study.

Exclusion criteria:

- Significant media opacities
- Patients with severe Non proliferative diabetic retinopathy
- Proliferative diabetic retinopathy
- Chronic renal failure
- History of glaucoma
- Other retinal and ocular diseases interfering with assessment of treatment results
- Previous laser photocoagulation
- Previous retinal or intraocular surgery

Procedure: Study was conducted over a period of one year from June 2015 to December 2016, according to the inclusion and exclusion criteria as mentioned above. With informed consent, all patients underwent a complete ophthalmological examination.

Colour fundus photography: Imagenet fundus images were captured at a stereo angle of 50

degrees using the Topcon™ fundus camera (TRC-NW8F).

Fundus fluorescein angiography: Fundus fluorescein angiography was done using the Topcon™ fundus camera (TRC-NW8F) after injecting 3ml of 20% fluorescein dye.

Optical coherence tomography: Spectral Domain OCT was done using NIDEK™ RS-3000 lite OCT reti scan machine.

Treatment procedure: Under topical anesthesia, grid laser photocoagulation was performed as an outpatient procedure. (Figure.2) Argon green laser 532 (Appasamy AMOGH PLUS) was used to produce a light grey retinal burn. The spots were 50 – 100 μm in size, one burn width apart placed in 3 rows 500 μm superior, temporal and inferior to the fovea. Each spot was produced by 100-200 mw exposure. All patients were treated by the same ophthalmologist. Patients were followed up at 1, 3 and 6 months when visual acuity was assessed and OCT repeated.

Figure 2: Fundus photograph showing grid laser photocoagulation



Statistical analysis: Statistical Analysis was done using SPSS 16.0 software (SPSS, Inc., Chicago,IL). The statistical analysis was performed by calculating the mean and standard deviation and compared using student’s t tests for paired samples and Chi square test Statistical significance was defined as $p < 0.05$.

RESULTS

This study comprised of 30 eyes of 20 patients with Type 2 diabetes mellitus having mild to moderate non proliferative diabetic retinopathy and macular edema who underwent grid laser photocoagulation over a period of one year between June 2015 to December 2016. There were 26 eyes for follow up at 1 month, 24 eyes at 3 months, and 25 eyes at 6 months.

The mean age of patients was 54.23 ± 11.32 years mean \pm SD (range 34 -74 years) (Fig.3). Of the 30 eyes, 24 eyes were male and 6 were females (Fig.4).

Fig 3: Age distribution in the study population

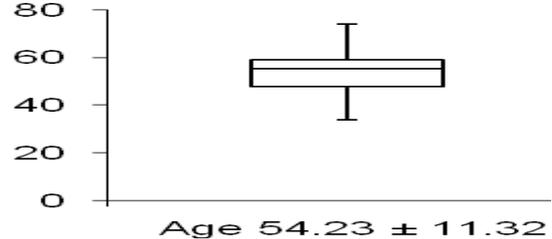
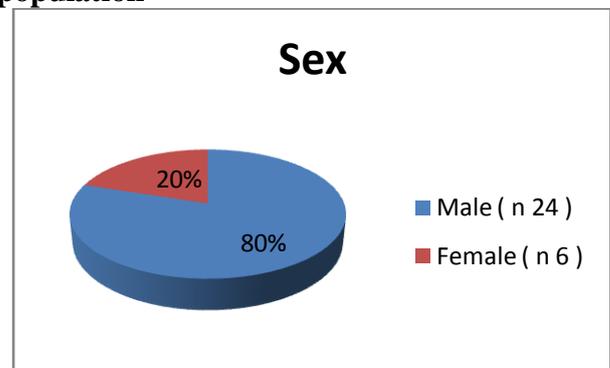


Figure 4: Sex distribution in the study population



FOVEAL THICKNESS OUTCOME:

1 Month follow up

At 1 month, 77% eyes showed decrease in foveal thickness, 8% eyes showed no change and 15% eyes showed increase.

3 Months follow up

At 3 months, 68% showed decrease in foveal thickness, 12% showed no change and 20% showed an increase.

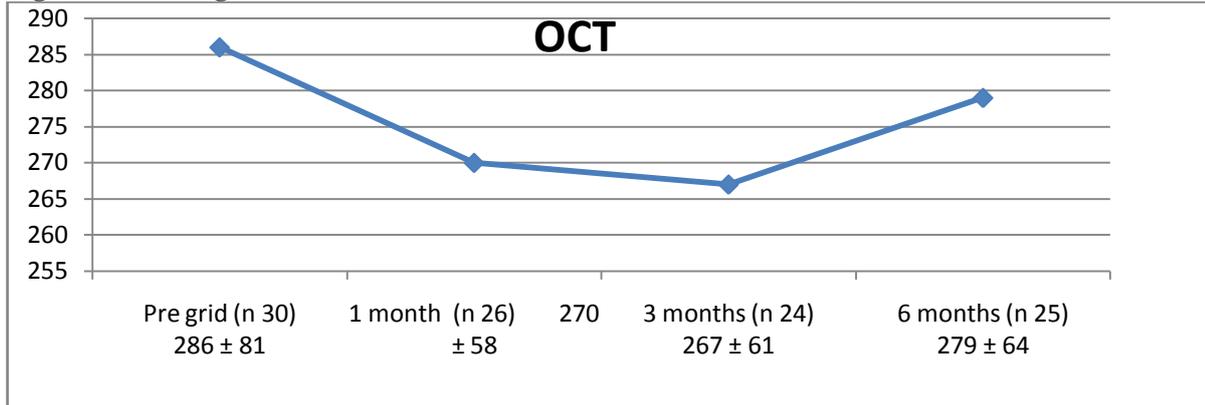
6 Months follow up

At 6 months, 52% eyes showed decrease in foveal thickness, 4% eyes showed no change and 44% eyes showed increase. The changes in foveal thickness for the various types of macular edema are depicted in Fig.5.

Table 1: Mean \pm Standard deviations and p values of foveal thickness

Duration	Foveal thickness	p value
Pre grid	$286 \pm 81 \mu\text{m}$	
Post grid – 1 month	$270 \pm 58 \mu\text{m}$	0.04
Post grid – 3 month	$267 \pm 61 \mu\text{m}$	0.05
Post grid - 6 month	$279 \pm 64 \mu\text{m}$	0.26

Figure 5: Changes in foveal thickness in microns (mean ± SD)]



Statistically, there was a significant decrease in foveal thickness at 1 and 3 months. However, at 6 months, the decrease in foveal thickness was not statistically significant.

VISUAL OUTCOME:

1 Month follow up

At 1 month, 54% eyes showed increase in visual acuity, 31% showed no change and 15% showed a decrease.

3 Months follow up:

At 3 months, 33.3 % eyes showed increased in visual acuity, 54.2 % showed no change and 12.5 % showed a decrease.

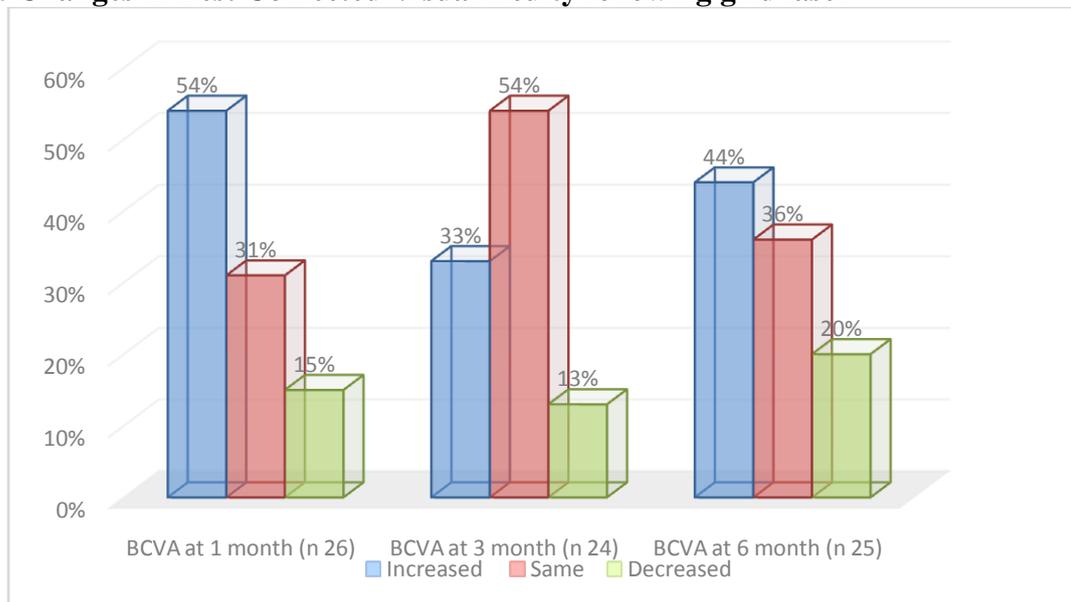
6 Months follow up:

At 6 months, 44 % eyes showed increased in visual acuity, 36 % showed no change and 20 % showed a decrease.

Table 2: Analysis of Visual acuity at 1 month, 3 months and 6 months

Visual acuity	1 month (n 26)	3 months (n 24)	6 months (n 25)
Increased	14 (54%)	8 (33.3%)	11 (44%)
Same	8 (31%)	13 (54.2%)	9 (36%)
Decreased	4 (15%)	3 (12.5%)	5 (20%)

Figure 6: Changes in Best Corrected Visual Acuity following grid laser



Statistically, there was a significant improvement in visual acuity at 1 and 3 months post grid laser photocoagulation, however at 6 months, although the visual acuity had improved it was not statistically significant.

DISCUSSION

Focal laser photocoagulation reduces the risk of moderate visual loss by 50% in patients with clinically significant macular edema (CSME). However, progressive visual loss occur in up to

25% of patients despite laser treatment and some eyes may be refractory to laser treatment.

In our study, post laser visual acuity had improved in 54% eyes and was maintained in 30.7% eyes at 1 month.

At 3 months, the improvement in visual acuity was seen in 33% eyes and visual acuity was stabilized in 54% eyes.

Visual acuity had improved in 44% eyes and was maintained in 36% eyes at 6 months. The change in visual acuity before and after laser treatment was statistically significant at 1 month (p 0.03) and 3 month (p 0.04) but it was not statistically significant at 6 months (p 0.10).

Our study showed that the foveal thickness had decreased in 77% eyes at 1 month; 68% eyes at 3 months and 52 % eyes at 6 month following grid laser photocoagulation.

Post laser retinal thickness at 6 month decreased in 60%, remained same in 4% and increased in 36%. On paired analysis however post laser retinal thickness was statistically significant only in the first month (p 0.04) and was not statistically significant at 3 month (p 0.05) and at 6 months (p 0.26).

Our study revealed a beneficial effect of grid laser photocoagulation in patients with non-proliferative diabetic retinopathy, where an improvement of visual acuity and decrease in foveal thickness following grid laser photocoagulation, but may not be sustained at 6 months or later in our population.

Several studies are done for correlating effect of grid laser photocoagulation on visual acuity and macular thickness. EDTRS study in 1985 showed that grid laser photocoagulation improves macular edema. It is considered one of the landmark study for diabetic retinopathy.

In studies done by Alvi R et al (2016), Lima Gomez V et al(2012), Qin B et al(2002) and Nawrocki J et al (1991) concluded that grid laser photocoagulation is effective in stabilizing / improving vision.^{19,20,21,22} However they did not consider macular thickness in their studies. Diabetic retinopathy clinical research network in 2009 studied 122 eyes for 16 weeks and 8 weekly thereafter and concluded that grid laser decreases the macular edema but does not resolve it.²³ Zaidi et al (2009) studied 101 eyes for 21 months and concluded that 65.3% patients

had positive visual out come. Control, duration and hypertension influenced visual outcome.²⁴ Degenring RF et al (2004) studied 41 eyes for 31.4+/- 19.6 weeks and concluded that in diffuse macular edema visual acuity decreased after grid laser photocoagulation.²⁵

Our study is limited by its small sample size, short follow up and inability to ensure good glycemic control in all patients prior to laser done in the varying socioeconomic background of our study population.

CONCLUSION

In conclusion the present study on grid laser photocoagulation and its effect on retinal thickness for diabetic macular edema shows that grid laser is beneficial in improving and maintaining the visual acuity and in reducing macular thickness but may not be sustained for 6 months in our study population.

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