

Changes in visual acuity and contrast sensitivity following macular photocoagulation for clinically significant macular edema: Four month outcomes

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Abstract

Threshold severity of diabetic macular edema (DME) at which initiation of laser treatment is justified, was defined as 'clinically significant macular edema' (CSME) by ETDRS (Early treatment of diabetic retinopathy study). ETDRS showed that macular photocoagulation decreased persistent macular edema and risk of moderate visual loss by 50% in CSME. Benefit of treatment generally observed in 3-4 months.

Objectives: To estimate the improvement in visual acuity VA and contrast sensitivity CS at four months following macular photocoagulation, in a single arm of Type 2 diabetes patients diagnosed with CSME in a semi-urban population of South Kerala.

Methodology: It was a prospective study (Descriptive). 250 eyes of Type 2 diabetics with CSME were included. Focal/grid pattern macular photocoagulation, using frequency doubled Nd: YAG laser was administered to all participants. Improvement in VA was defined as gain by one line/more and decrease by more than two lines was considered as worsening. Any drop/gain in CS was considered significant. Analysed using SPSS 16.0.

Results: 148 eyes (59.2%) received focal and 102 eyes (40.8%) received grid pattern lasers. 242 eyes were included in final analysis. VA in 77 eyes (30.8%) was stable, improved by one line/more in 134 eyes (53.6%), decreased by <2 lines in 22 eyes (8.8%) and decreased by >2 lines in 9 eyes (3.6%). Paired sample t-test to compare VA and CS before and after therapy, showed significant improvement (p<0.001 and p<0.001 respectively).

Conclusion: VA as well as CS showed statistically significant improvement at 4 months following focal/ grid pattern of macular photocoagulation in CSME.

Keywords: Clinically significant macular edema, Diabetic Retinopathy, Photocoagulation.

Introduction

Diabetic macular edema (DME) can appear at any stage of diabetic retinopathy, except in early non-proliferative diabetic retinopathy (NPDR).^{1,2} It results from focal or diffuse leakage from retinal vasculature. Patients with centre-involved DME experience a gradual loss of visual acuity. The 'Early treatment of diabetic retinopathy study' (ETDRS) coined the term "clinically significant macular edema" (CSME) in order to define the threshold severity level of edema at which it is appropriate to initiate laser treatment.³

Macular photocoagulation is the established mode of treatment for CSME as defined by the ETDRS group.^{1,3,4} The most commonly used methods are focal, grid and modified grid. Focal treatment targets microaneurysms directly, whereas grid pattern lasers are used in cases with diffuse capillary leakage and capillary non perfusion.⁴⁻⁷ Modified grid is a combination of focal and grid methods.

The ETDRS showed that photocoagulation decreased persistent macular edema and the risk of moderate visual loss by 50%.³ Although several treatment options like intravitreal steroids and anti-VEGF agents have gained popularity in treatment of DR, laser photocoagulation still plays a vital role in management of DR and will continue to play a vital role over the next several years.⁸

Several clinical studies corroborate the findings of experimental work conducted on animal eyes to

observe the effect of macular laser treatment, that, initially there occurs a temporary increase in macular edema and temporary worsening of visual acuity post-treatment, which eventually subsides.⁹ It generally takes 3-4 months to observe the benefit of treatment.⁷

Visual acuity is routinely being used as the sole measure of visual function in clinical practice in such cases. The most commonly used chart for the same is the Snellen visual acuity chart. The high contrast seen in Snellen charts doesn't exist in our surroundings and hence, the difficulties encountered by patients in performing their daily activities does not come to light by measuring visual acuity alone. In the absence of high contrast visual acuity loss, contrast sensitivity (CS) becomes a useful tool in gauging the level of visual function.

Methodology

In a prospective study (descriptive) conducted at Dr. SMCSI Medical College, between August 2015 - February 2017. Type 2 diabetics with diminution of vision subsequently attributed to CSME on clinical examination were studied. Those with media opacities and other retinal pathologies affecting vision were excluded. All subjects received focal or grid pattern macular photocoagulation using frequency doubled Nd: YAG Laser (Neodymium-doped yttrium aluminium garnet). Visual acuity (VA) and contrast sensitivity Function (CSF) were recorded using "Snellen's" chart

and “Mr. Happy” chart respectively, at baseline prior to laser therapy and at four months following therapy. VA was converted to log MAR equivalents for ease of analysis. Improvement in VA was defined as gain in VA by one line/more on the Snellen chart. Worsening of vision was defined as loss of more than two lines at four months. Any gain or loss in CSF was considered significant. Data was analysed using SPSS version 16.0.

Results

250 eyes of 144 patients were enrolled in the study 6 eyes were lost to follow-up and 2 patients with unilateral disease succumbed to myocardial infarction. 242 eyes were therefore included in the final analysis. 142 eyes (58.7%) received focal laser treatment and 100 eyes (41.3%) received grid pattern of laser treatment. Of these the 11 eyes with PDR and 12 eyes with very severe NPDR, first received treatment for the macular edema at the baseline visit and subsequently received PRP; in accordance with the ETDRS recommendations. The mean BCVA at baseline was 0.555±0.24 (Fig. 1). The mean BCVA at four months after laser treatment for CSME was 0.374±0.27 (Fig. 2). A paired sample t test was performed to compare the BCVA before and after laser treatment for CSME.

There was a significant improvement in BCVA at 4 months after laser therapy; p<0.001(Table 1). Of the 242 treated eyes, 77 eyes (31.8%) had stable vision, 134 eyes (55.4%) showed an improvement in BCVA by at least one line, 22 eyes (9.1%) showed worsening of BCVA by less than two lines, 9 eyes (3.7%) showed worsening of BCVA by greater than two lines (Fig. 3). Contrast sensitivity function was documented at baseline and four months after laser treatment, as CS score on a scale of 1 to 80; 1 being the least and 80 being the best CSF(Fig. 4). The mean CS score at baseline was 28.97±21.772 (Fig. 5). The mean CS score at the end of four months was 34.35±26.383 (Table 3). A paired sample t test was performed to compare the CS scores before and after laser treatment for CSME. There was a significant improvement in CS function at 4 months after laser therapy; p<0.001(Table 2). At the end of 4 months 207 eyes (85.53%) maintained stable CSF, 26 eyes (10.74%) showed an improvement in CSF and 9 eyes (3.71%) showed worsening of CSF (Fig. 6). At the end of four months, 5 eyes (2%) developed vitreous haemorrhage and 9 eyes (3.7%) progressed to PDR.

Table 1: paired sample t test showing a statistically significant improvement in BCVA after laser treatment

Pair	Mean difference after laser	SD	95% confidence interval		P value
Pre and Post Laser BCVA	0.1818	0.2834	0.1459284	0.2177080	p<0.001

Table 2: CS scoring system adopted in Mr. Happy contrast sensitivity test

Michelson Contrast	C S Score
100%	1
~25%	4
~10%	10
~5%	20
~1.25%	80

Table 3: paired sample t test showing a statistically significant improvement in CS scores after laser treatment

Pair	Mean difference after laser	SD	95% confidence interval		P value
Pre and Post Laser CS score	-5.380	19.756	-7.882	-2.879	p<0.001

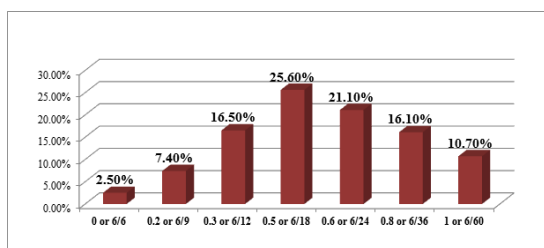


Fig. 1: distribution of eyes based on baseline BCVA

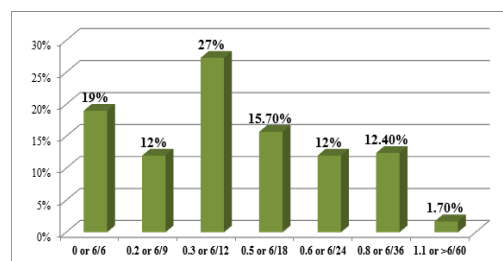


Fig. 2: Distribution of eyes based on BCVA four months following laser therapy

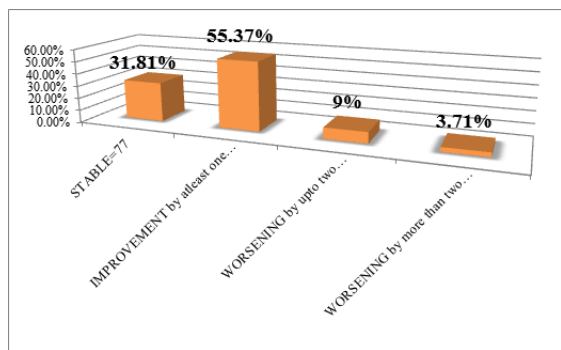


Fig. 3: Distribution of eyes based on visual outcome expressed as gain or loss of Snellens lines following laser treatment

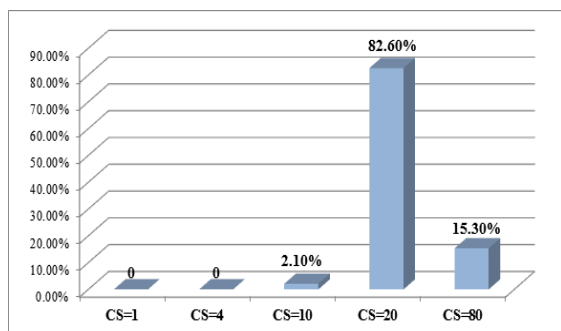


Fig. 4: Distribution of eyes based on CS scores at baseline

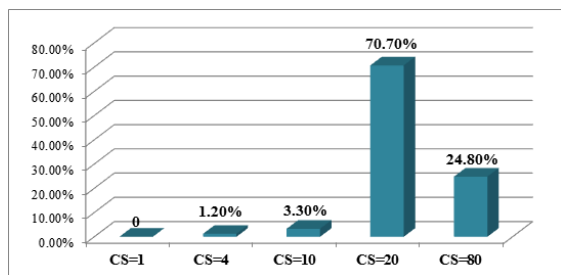


Fig. 5: Distribution of eyes based on CS scores at four months following laser treatment

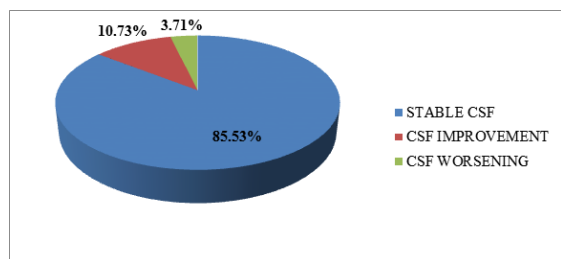


Fig. 6: Distribution of eyes based on CSF outcomes at four months after laser treatment

Discussion

Patz et al. (1973) and Cheng et al. (1975) in their studies reported that eyes treated with laser photocoagulation for macular edema were more likely to retain significantly better visual acuity compared to

those that were not treated.^{10,11} In 1986 (Washington D.C), Olk et al. observed the effect of modified grid argon laser photocoagulation on the visual acuity of 92 eyes with macular edema. They concluded that there was an improvement in BCVA in 32.9% of treated eyes at 12 months following laser therapy. Vision remained stable in 63.2% treated eyes and worsened in 3.9% of treated eyes at 12 months. They defined a gain or fall in visual acuity by two lines or more as improvement and worsening respectively.⁹

More recently, in 2014, Shah et al. (Gujarat) reported an improvement in BCVA in 38% eyes at 3 months following focal or grid laser treatment with frequency doubled Nd: YAG laser for CSME. 40% maintained stable vision and 23% were observed to have worsening of BCVA at the end of 3 months.¹² However, the gain in BCVA was not quantified in this study.

In the present study we found that there was an improvement in BCVA by a line or more in 134 (55.37%) of the 242 eyes studied. The improvement was found to be statistically significant ($p < 0.001$). BCVA remained stable in 77 eyes (31.81%). There was a fall in BCVA by up to two lines in 22 eyes (9%) and by more than two lines in 9 eyes (3.71%). Of the 31 eyes that experienced a fall in BCVA at 3 months, 9 eyes had received focal lasers and 22 eyes had received grid pattern of laser photocoagulation. It may also be noted that among the eyes with poor outcome 5 eyes had developed vitreous haemorrhage and 8 eyes had progressed to PDR at the follow-up visit at 3 months. In these eyes the fall in visual acuity may be attributed to these adverse events.

Hellstedt et al.¹³ and Midena et al.¹⁴ individually suggested that CS is a sensitive indicator of early changes in diabetic retinopathy. They found an improvement in CS at the last follow-up among patients receiving focal and grid laser therapy. Talwar et al. reported an improvement in CS and stabilization of VA following focal argon laser photocoagulation in 14 eyes with CSME. They also added that changes in VA and CS were independent of each other.¹⁵

Faravash et al.¹⁶ and Shah et al.¹² reported improvement in CS from baseline following focal laser photocoagulation with frequency doubled Nd: YAG laser. In the study by Faravash et al, CS was measured with an ascending limit technique from a non-seen grating contrast level up to the patient's threshold of recognition using 0.25 dB increments. The mean contrast sensitivity threshold was observed to have increased in all frequencies three months after laser treatment. The maximum rise was observed in the frequency of 6.4 cycles per degree (cpd). There was a statistically significant increase only in this frequency ($P = 0.041$). Shah et al. used the Pelli-Robson Chart (Clement Clarke International Ltd.; Columbus, OH.) to record CS. They reported a net improvement in the CS by 0.11 logCS units, which was statistically significant

($p=0.001$). In the study by Shah et al., CS improved from the baseline in 49.1% of the enrolled eyes and 61.5% of these had undergone focal laser for DME. In the present study, using the Mr. Happy test we observed that the mean CS score improved from 28.97 (S.D=21.772) at baseline to 34.35(S.D=26.383) at the end of 3 months after laser treatment. 26 eyes (10.74%) showed an improvement in CSF and 9 eyes (3.71%) showed worsening of CSF. 207 eyes (85.53%) retained stable CS scores. Of the eyes that showed an improvement in CS, 76.9% underwent focal lasers. It may therefore be assumed that focal lasers are more likely to be associated with better contrast sensitivity functions at 3 months.

Among the 9 eyes that experienced worsening of CS at 3 months; 3 eyes had severe NPDR, 2 eyes had very severe NPDR and 4 eyes had PDR at baseline evaluation. The 6 eyes with very severe NPDR and PDR received PRP at 2-3 weeks following initial laser treatment for CSME. Lövestam-Adrian et al. in their study on 20 eyes treated with PRP for PDR noted a loss in CS following PRP compared to the untreated eyes.¹⁷ The fact that these 9 eyes in our study eventually received PRP within the 3 month follow-up period could be considered a contributing factor towards the worsening of CS. However, 8.2% of the eyes that retained stable CS also received PRP within three months, but none of the eyes that showed an improvement in CS underwent PRP.

Conclusion

Our study demonstrates that laser treatment helps in improving VA as well as CS in eyes with CSME. Contrast sensitivity may be a more sensitive tool in picking up subtle changes in visual function in such patients and assessment of the same can be included in routine workup of patients with DME. The short duration of follow-up is a limitation of the study. A longer follow-up period will help better understand for how long the effect of treatment actually lasts. The use of optical coherence tomography (OCT) would have been a better objective indicator of the effect of treatment in restoring macular morphology and function.

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