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Original Article

Treatment Outcome of Subthreshold Micropulse Green Laser SMGL (532 nm) in Chronic Central Serous Chorioretinopathy

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ABSTRACT

Introduction: Subthreshold micropulse green laser (532nm) is effective for treatment of chronic CSCR with promising results.

Purpose: To assess the treatment outcome of a single session subthreshold micropulse green laser (SMGL) 532nm in chronic central serous chorioretinopathy (CSCR).

Methods: This was a prospective noncomparative consecutive case series. Eyes with chronic CSCR were treated with SMGL and evaluated at 1- and 3-months post laser. Best Corrected Visual Acuity (BCVA) and Central Macular Thickness (CMT), and Subretinal Fluid Height (SFR) following laser were evaluated.

Results: A total of 16 eyes of 13 patients with the diagnosis of chronic CSCR were enrolled in this study. The mean age of the patients was 45 years (range 31-60 years). All of the patients had a history of CSCR of more than 4 months duration (mean 7.9 months ± 3.01). The median baseline BCVA was 0.4 log MAR which improved to 0.25 log MAR. Of the 16 eyes, 1 eye had 3 lines of improvement (6.25%), 4 eyes had 2 lines of improvement (25%), and 3 eyes had 1 line of improvement (18.75%) and 8 eyes-maintained vision (50%). The mean SRF height pre and post laser was 191.813 µm and 54.93 µm, respectively (P<0.001). Similarly, the mean CMT pre and post laser was 328.18 µm and 242.87 µm, respectively (P<0.009). There was complete resolution of PED in 3 out of 5 eyes (60%).

Conclusion: Subthreshold micropulse green laser (532nm) is effective for treatment of chronic CSCR with promising results.

Keywords: CSCR, subthreshold, micro pulse, green laser, 532nm.

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INTRODUCTION

Central serous chorioretinopathy (CSCR) is characterized by idiopathic detachment of the neurosensory retina due to accumulation of serous fluid between the retinal pigment epithelium (RPE) and photoreceptor layers. The etiology and pathophysiology are varied. With the use of indocyanine green angiography, newly recognized subretinal abnormalities in CSCR include widespread hyperdynamic and hyperpermeable choroidal circulation with localized area of choroidal nonperfusion. The disease can present in acute or chronic form. Acute CSCR is generally self-limited with spontaneous regression, and it causes minimal sequelae. About 33–50% of cases can have recurrences with long term persistence (longer than six months) of subretinal fluid (SRF) leading to atrophy of the RPE, cystoid retinal degeneration, choroidal neovascularization, and permanent vision impairment (Piccolino et al, 2005; wang et al, 2002). The definition of duration of chronic CSCR is inconsistent ranging from 3 to 6 months as described in various studies (Chen et al, 2008; Lanzetta et al, 2008; Malik et al, 2015; Yadav et al, 2015). We have used 3 months in our study.

Management of chronic CSCR includes risk factor modification like discontinuation of steroids and smoking (Levy et al, 2005), medical treatment (carbonic anhydrase inhibitors) Pikkel et al. 2002, Conventional focal laser (Burumcek et al, 1997), photodynamic therapy (PDT) Bae et al, 2011, Ozmert et al, 2009, and intravitreal injection of vascular endothelial growth factor inhibitors (Lim et al, 2010). The conventional focal laser can cause central or paracentral scotomas, contrast sensitivity loss and accidental foveal damage, retinal distortion or choroidal neovasularization (Khosla et al, 1997). It has been reported that PDT with verteporfin induces the resorption of SRF by reducing choroidal vascular hyperpermeability (Alkin et al, 2014; Silva et al, 2013). However, it has the potential for serious side effects, such as choroidal ischemia, RPE atrophy, subretinal gliosis or fibrosis and iatrogenic choroidal neovascularization (Piccolino et al, 2003; Colucciello et al, 2006). To avoid these complications, newer PDT protocols, including half-dose (Chan et al, 2008;) and low-fluence (Reibaldi et al, 2009) applications, have been developed. Recently, micro pulse laser (MPL) photocoagulation is another possible treatment option for chronic CSCR (Ricci et al, 2009; Shivaprasad et al, 2010). The mechanism of action depends on targeting a train of ultrashort laser pulses at the particular tissue of interest. These repetitive bursts prevent damage to adjacent tissues from thermal effects, minimize total energy use, and provide time for tissue cooling between pulses (Shivaprasad et al, 2010). Multiple and overlapping spots with no visible clinical end point are delivered to the area of diseased RPE with the aim of inducing a biological response that promotes the recovery and restoration of the outer blood retinal barrier and ultimately, the resorption of the subretinal fluid. This technology can be paired with 810 nm, 532 nm or 577 nm lasers. The first studies on MPL for CSCR used an 810nm diode laser as the laser source (Ricci et al, 2009; Shivaprasad et al, 2010; Koss et al, 2012). Subthreshold micropulse yellow wavelength (577nm) laser (SMYL) is a newer technology that offers major advantages such as peak absorption of oxyhemoglobin, minimal xanthophyll absorption in the macula, and better penetration. The combined absorption by both melanin and oxyhemoglobin of 577 nm causes lesser scatter compared with 532nm or other yellow wavelengths, leading to energy

concentration to a smaller volume, allowing use of lower power and shorter pulse durations (Elhamid et al, 2015).

In underdeveloped countries like ours, the use of subthreshold micropulse green laser (SMGL) is affordable and easily available unlike SMYL which is costly. The use of green laser for chronic CSCR might be equally effective to yellow or diode laser. In this article, we report the use of SMGL for the treatment of chronic CSCR and its effect. We also intend to discuss the possible causes of no vision improvement in some of our cases based on OCT scans before laser treatment.

MATERIALS AND METHODS

This is a prospective noncomparative consecutive case series performed at Biratnagar Eye Hospital, Biratnagar, Nepal from May 1st 2019 to January 31st 2020. A total of 16 eyes of 13 patients were enrolled in this study. The research has been approved by the ethics committee and institutional board of Biratnagar Eye Hospital, Biratnagar, Nepal, and has adhered to the tenets of the Declaration of Helsinki. All patients had given written informed consent. The diagnosis of chronic CSCR is made based on clinical examination, optical coherence tomography (OCT), fundus fluorescein angiography (FA) and previous documentations suggesting the persistence of CSCR for more than 4 months. Inclusion criteria included adults more than 18 years old with visual impairment lasting at least 4 months or more; CSCR involving the fovea and documented by OCT; presence of single or multiple active angiographic leakage in baseline FA. Exclusion criteria included any patients with a history of comorbid ocular condition like age related macular degeneration, diabetic macular edema, advanced glaucoma, optic neuritis; prior history of anti VEGF use, laser or PDT therapies, intraocular surgery within the previous six months or contraindication for fluorescein dye.

All participants underwent a complete ophthalmic examination including BCVA testing, slit lamp biomicroscopy, intraocular pressure measurement and dilated fundus examination. Color fundus photography, fundus autofluorescence, fundus fluorescence angiography and OCT was performed at baseline using Topcon TRC 50EX Retinal camera and Zeiss Cirrus HD-OCT. SMGL treatment (Iridex IQ 532 Laser System) was performed using Low intensity (5% duty cycle); High-density (confluent spots); 0.2 seconds duration; 100µm spot size on the slit-lamp adaptor. The power was initially set to 100mW and titrated by 10mW to the minimum threshold value to cause a barely visible burn at far nasal periphery in normal pulse mode (micro pulse mode off), and then micro pulse mode was switched on and power was adjusted to double of that value over the area of focal and diffuse RPE leak. The power of the laser used ranged from 150 to 200mW. Area Centralis Volk lens was used for the laser treatment. All patients were followed up for 1 and 3 months and OCT was repeated on every visit. The morphologic results of the treatment were evaluated with OCT in terms of SRF height (sub foveal) and central macular thickness (CMT). SRF height was measured manually using calipers on the High Definition (HD)-OCT images between the outer segment of the photoreceptor layer and the apical face of the RPE layer. The primary outcome measure was change in BCVA, SRF height and CMT between baseline and at 3 months post laser. The secondary outcome measure was to study the demographic characteristics of the patients with chronic CSCR and to study different types of CSCR and OCT characteristics of the patients with no vision gain.

STATISTICAL ANALYSIS

SPSS software (version17.0) was used for statistical analysis. Visual acuity was converted to log MAR for analysis. The baseline and 3 months post laser SRF height, CMT and PED was analyzed using paired student's t-tests. A P-value of <0.05 was considered statistically significant.

RESULTS

A total of 16 eyes of 13 patients of chronic CSCR who completed 3 months of follow up post SMGL treatment were enrolled in this study. Eleven patients (84.61%) were male and two (15.38%) females. The mean age of the patients was 45 years (range 31-60 years). All of the patients had a history of CSCR of more than 4 months duration (mean duration 7.9 months ± 3.01). The median baseline BCVA was 0.4 log MAR. Of the 16 eyes, 6 eyes (37.5%) had an 'ink blot' pattern and 10 eyes (62.5%) had diffuse type of leakage on FFA. Turbid SRF was noticed in 4 eyes and baseline IS-OS disruption was seen in 7 eyes on HD-OCT. All patients underwent only one session of micro pulse laser and were followed up for 3 months.

The median BCVA improved to 0.25 log MAR. Of the 16 eyes, 1 eye had 3 lines of improvement (6.25%), 4 eyes had 2 lines of improvement (25%), and 3 eyes had 1 line of improvement (18.75%) and 8 eyes-maintained vision (50%). There was a statistically significant decrease in the mean SRF on OCT from baseline of 191.813 µm ± 127 to 54.93 µm ± 75 at 3 months follow up (P<0.001). There was complete resolution of SRF in 10 eyes (62.5%) (5 eyes each with ink blot and diffuse leakage). The mean CMT decreased from 328.18 µm ± 116 baseline to 242.87 µm ± 58 at 3 months follow up (P<0.009). Similarly, there was a decrease in the mean PED height from baseline 51.56 µm ± 84 to 23.93 µm ± 78 at 3 months follow up. There was complete resolution of PED in 3 out of 5 eyes (60%). RPE changes over the macula were seen in 3 eyes on HD-OCT scans and FAF. Table 1 summarizes the baseline and post later treatment measured parameters.

Table 1 Baseline and post later treatment measured parameters

	Baseline	At 3 months
Visual acuity (logMAR) Mean	0.518	0.478
Central macular thickness (µm) Mean (P<0.009)	328.18	242.87
Subretinal fluid height (µm) Mean (P<0.001)	191.81	54.93
Pigment epithelial detachment (µm) Mean	51.56	23.93

DISCUSSION

CSCR is a relatively common retinal disorder with its pathogenesis which had not yet been fully understood. An acute form of CSCR has a benign course which usually recedes spontaneously within a few months after the onset of symptoms and visual acuity is not usually significantly affected. The chronic form of CSCR is, however, a major therapeutic problem.

The most recent therapeutic armament for the treatment for chronic CSCR is subthreshold micropulse laser which has been intensively used since 2008. Although it is believed that in CSCR pathology lies in the choroid, rather than in the RPE, it is the RPE that transfers SRF to choroidal vessels. Subthreshold micropulse laser (SML) improves cell function, thus improving the pumping efficacy of RPE. Besides, the production of cytokines after stimulation by SML also probably reduces inflammatory processes accompanying that disease.

Our study demonstrated clinical improvement in visual acuity along with statistically significant decrease in SRF height and CMT with the use of SMGL in chronic CSCR (Figure 1-3).

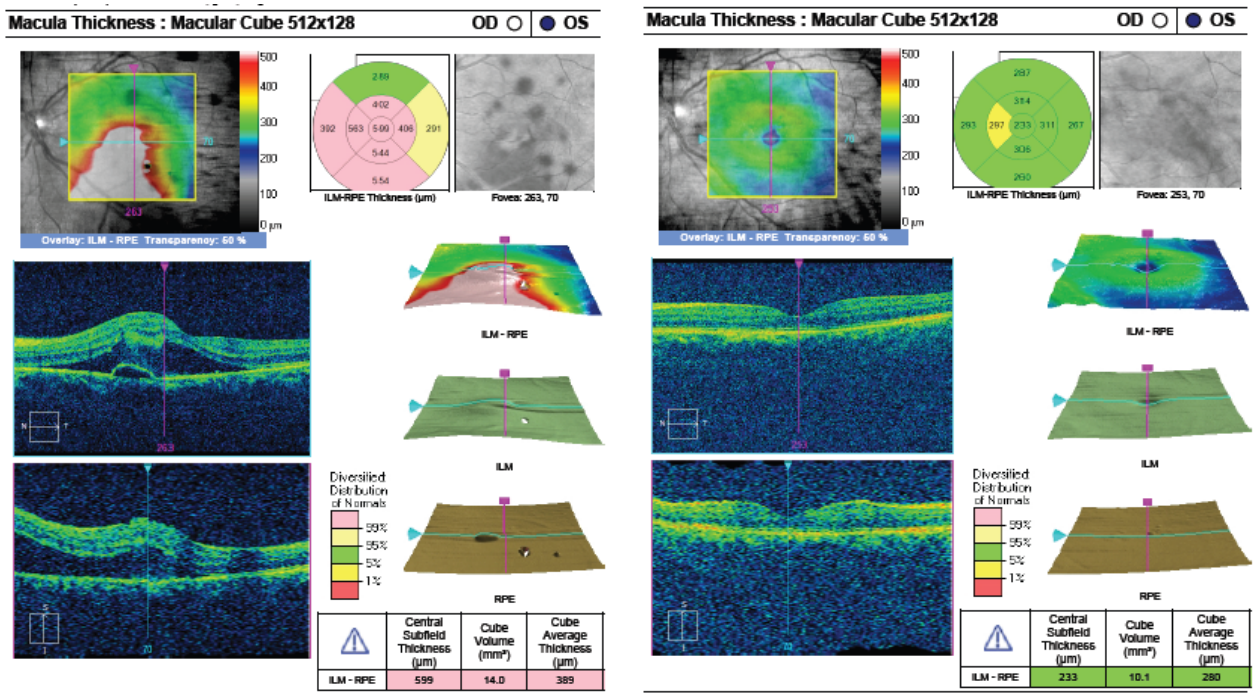

Figure 1 OCT macula of the patient with left eye CSCR pre and 3 months post laser treatment. Note the complete resolution of SRF and PED post laser (Top right).

Abbreviations: CSCR, central serous chorioretinopathy; OCT, optical coherence tomography; PED, pigment epithelial detachment.

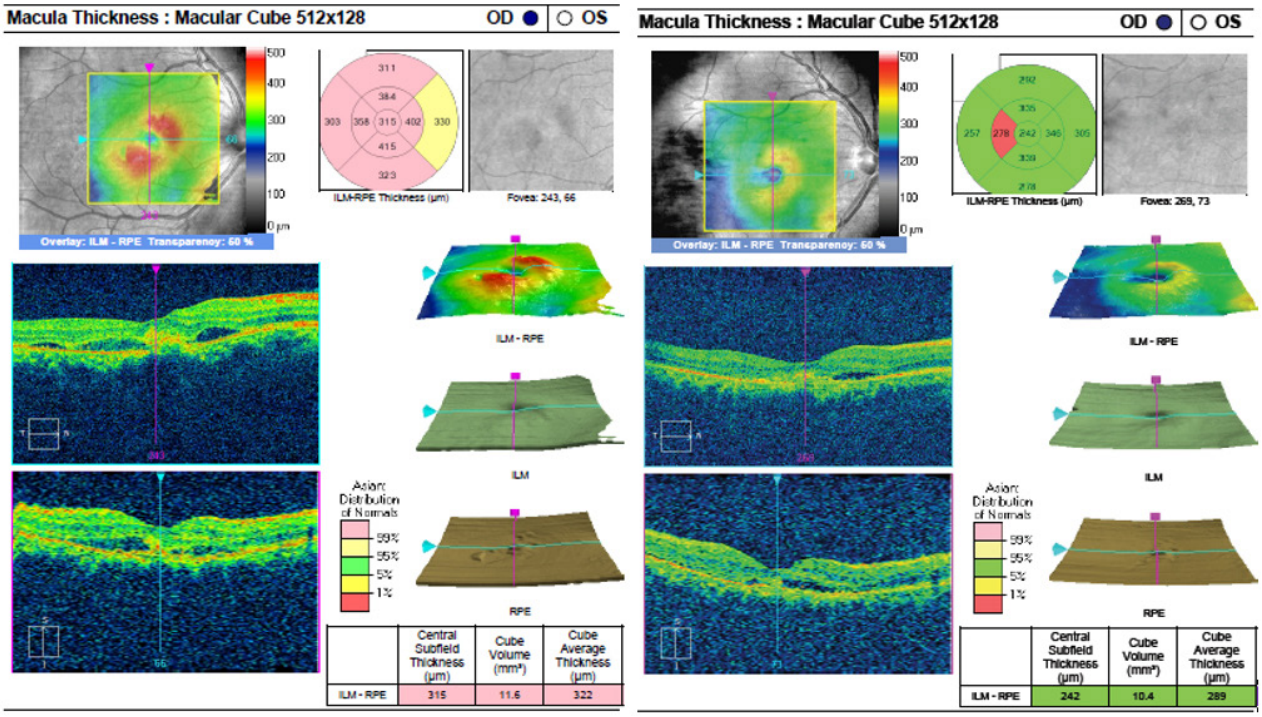

Figure 2 OCT of the patient with right eye CSCR pre and 3 months post laser. Note the significant reduction of SRF and PED but no complete resolution. In spite of disrupted IS-OS junction and persistent SRF, there was 2-line gain of vision.

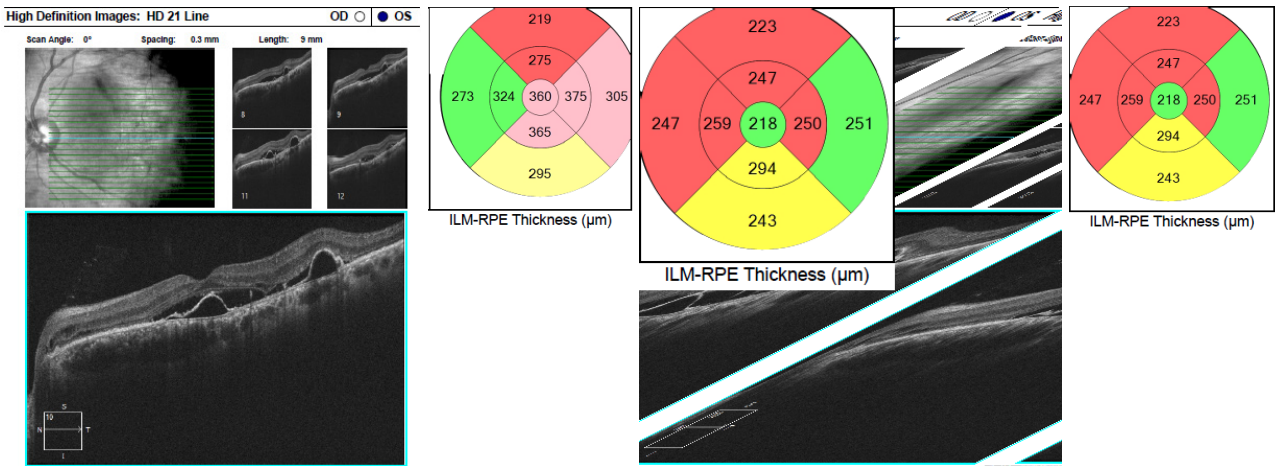

Figure 3 OCT of the patient with left eye CSCR pre and 3 months post laser. Note the complete resolution of SRF with decrease in PED height. There were 2 lines gain in vision post laser.

Various studies have been conducted to show improvement in vision and decrease in SRF and CMT using SML of different wavelengths for chronic CSCR. All of those studies including ours have used visual acuity and changes on OCT as parameters to evaluate the laser response.

In our study we found clinically significant improvement in visual acuity 3 months after a single session of laser. In 50% of the cases, we could see 1 to 3 lines vision gain and the rest 50% maintained vision. The median BCVA improved from baseline 0.4 log MAR to 0.25 log MAR.

A study conducted by Yadav et al (2015) using SMYL (577 nm) in the treatment of chronic CSCR, there was a median visual improvement of one line on Snellen's visual acuity chart. Of the 15 eyes, 2 eyes had 2 lines of improvement (13.3%); 4 eyes had 1 line improvement (27%) and 9 eyes-maintained vision (60%) which was comparable to our study. They had also performed microperimetry in 8 eyes of which 6 eyes (75%) showed an improvement in the threshold values post treatment.

Chen et al (2008) used a subthreshold micropulse diode laser to treat 26 eyes with chronic CSCR. There were 3 lines or more gain in visual acuity in 15 eyes (57.7%) and a gain of 1 and 3 lines in 6 eyes (23.1%). Similar to our study, Khatri et al[24] used SMGL in 13 eyes with chronic CSCR and followed up the patients for 5 months. There was improvement in mean BCVA from baseline 0.96 log MAR to 0.18 log MAR. Twelve eyes (92%) had vision gain of 3 lines with one (8%) case having a gain of 2.7 lines

Most of the studies have not given any possible cause for no vision gain in some of their cases. Eight eyes of our patients had no gain in visual acuity owing to the presence of combination of factors: IS-OS disruption in 7 eyes as seen in HD-OCT, presence of RPE atrophy in 3 eyes as seen in FAF, foveal thinning in 2 eyes and persistent PED in 2 eyes. One of the eyes (Figure 4) showed significant reduction of CMT from 546 to 196 μm and complete resolution of SRF from 398 to 0 μm, but there was no gain in visual acuity due to persistent large sub-macular PED (309 μm).

Our study determined disrupted IS-OS junction, presence of turbid subretinal fluid and RPE atrophy as HD-OCT based bad prognostic factors in those patients due to no gain in visual acuity despite significant decrease in SRF height and CMT.

In our study we found a statistically significant decrease in the mean SRF on OCT from baseline of 191.813 μm ± 127 to 54.93 μm ± 75 at 3 months follow up (136.37 μm mean decrease). There was complete resolution of SRF in 10 eyes (62.5%) (5 eyes each with ink blot and diffuse leakage). Most of the studies in literature have shown complete reduction of SRF ranging from 40 to 80% (Chen et al, 2008; Lanzetta et al, 2008; Malik et al, 2015; Yadav et al, 2015, Khatri et al, 2018) which is comparable to our study.

There was a mean decrease in SRF height from 232 to 49 μm, pre and post treatment respectively, showing a 79% average reduction in fluid height and 40 % complete resolution in study by Yadav et al, (2015). Similarly, there was complete resolution of SRF in 75% of the cases in a study by Lanzetta et al, (2008) and there was 71% complete resolution of SRF in a study by Ricci et al (2009) which was comparable to our study.

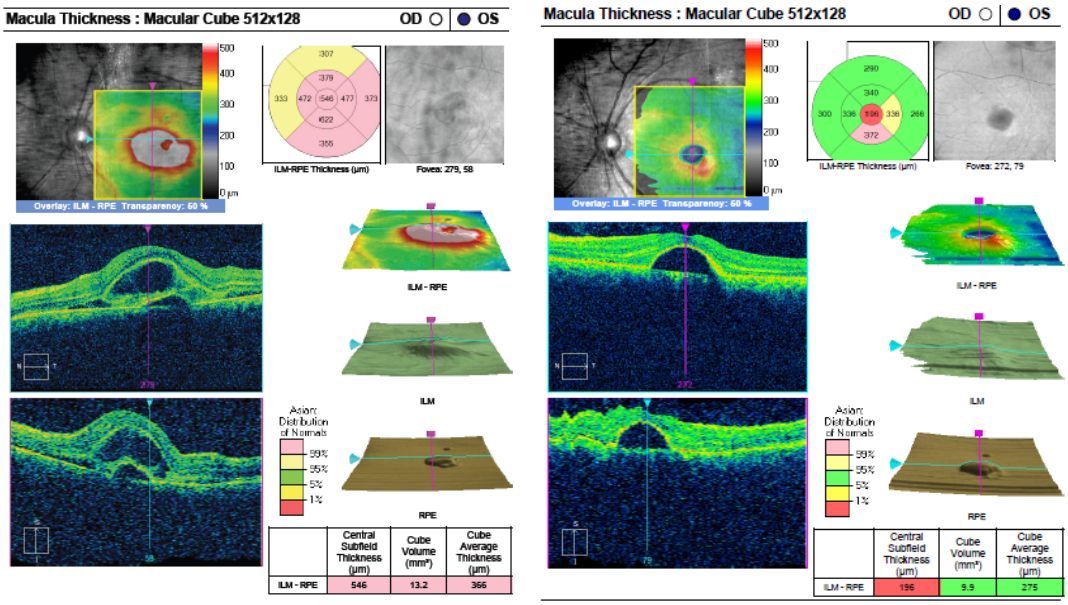

Figure 4 OCT macula of the patients with left eye CSCR pre and 3 months post laser. There was complete resolution of SRF with decrease of CMT from 546 µm to 196µm. However, there was persistent larger PED which led to no improvement of vision.

In our study, the majority of the cases had diffuse leakage patterns (10 eyes) in comparison to other studies in literature which had a higher proportion of focal leakages. Of the 10 eyes that showed complete resolution of SRF, 5 eyes had inkblot leakage and 5 eyes had diffuse leakage. Both types of leakage had good responses to treatment.

Chen et al (2008) reported that focal leaks without RPE atrophy responded better than those with diffuse leaks with RPE atrophy. In our study 3 eyes with RPE atrophy neither had complete resolution of SRF nor vision gain.

There was a mean decrease in CMT from 328.18 µm ± 116 baseline to 242.87 µm ± 58 (P<0.009) at 3 months follow up (85.31 µm mean decrease) in our study which was similar to mean 97 µm decrease in macular thickness in a study by Malik et al, (2008) and a mean decrease in CMT from baseline 503µm to 211µm in a study by Khatri et al (2018).

No studies in literature using yellow or diode micro pulse laser for chronic CSCR has discussed about the effect of micro pulse laser on PED, except for a study by Khatri et al[24] who had used SMGL and found that 2 patients had complete resolution of PED at 5 months post laser. Similarly in our study (Figure 5) we observed 3 out of 5 eyes had complete resolution of PED (60 %). This finding may indicate that green lasers might be effective in the treatment of chronic CSCR with PED.

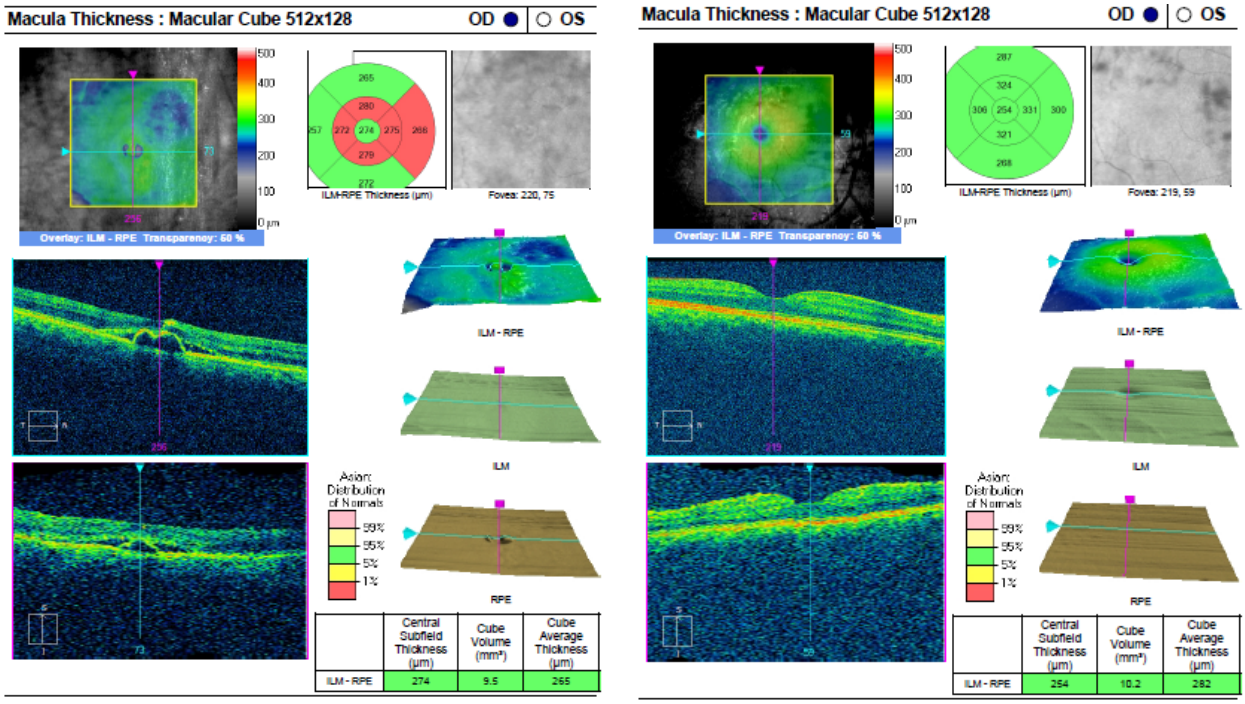

Figure 5 OCT macula of the patient with right eye CSCR pre and 3 months post laser. There was a complete resolution of PED and SRF.

Most of the studies had used 10-15 % duty cycle (Piccolino et al, 2005; Ricci et al, 2009; Koss et al, 2012; Elhamid et al, 2015; Khatri et al, 2018) but we used SMGL (532nm) with 5% duty cycle and low power setting (range 150 to 200mW).

Although we did not see complete resolution of SRF and gain of vision in all cases, our findings were encouraging in spite of short follow up.

This suggests that SMGL is a promising option for management of chronic CSCR, with statistically significant anatomical (resolution of SRF) and functional (improving BCVA) improvement in the treated eyes.

Limitations of our study were small sample size, shorter follow up period, the investigations done and follow up periods were not standardized and uniform, all patients did not undergo FFA on follow up to assess the response of the patients and microperimetry could not be done to assess the functional gain.

CONCLUSION

Subthreshold micropulse green laser (532nm) is effective for treatment of chronic CSCR with promising results. The results of the subthreshold micropulse green laser were comparable with diode and yellow SML laser. Our study showed faster decrease in SRF and CMT as early as 3 months post single session of laser and was able to determine disrupted IS-OS junction, presence of turbid fluid and RPE atrophy as OCT based bad prognostic factors for no vision gain in chronic CSCR.

Conflict of interest

The authors declare no conflict of interest.

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