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MICROPULSE LASER THERAPY IN CENTRAL SEROUS CHORIORETINOPATHY: ANATOMICAL AND FUNCTIONAL OUTCOMES

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Central serous chorioretinopathy (CSCR) is a chorioretinal disorder caused by dysfunction of the retinal pigment epithelium, characterized by the accumulation of subretinal fluid in the macular region, leading to decreased central visual acuity, metamorphopsia, and central scotoma. Diagnosis is based on clinical examination, best-corrected visual acuity (BCVA) assessment, optical coherence tomography (OCT) of the macula, and fluorescein angiography. Therapeutic options include observation, pharmacological therapy, photodynamic therapy, anti-VEGF therapy, conventional laser photocoagulation, and subthreshold micropulse laser therapy. In this retrospective study, 16 patients with CSCR were treated exclusively with subthreshold micropulse

laser therapy. All patients underwent treatment using the same protocol, including prior laser titration in the retinal periphery and application of a 5% duty cycle. Follow-up examinations were performed at 15, 30, 90, and 180 days, with evaluation of BCVA and OCT parameters. Mean central macular thickness (CMT) decreased significantly from 421.5 ± 112.3 µm to 234.6 ± 18.9 µm at 6 months ($p < 0.001$), with complete resolution of subretinal fluid observed in all patients. Concurrently, significant functional improvement was noted, with mean BCVA increasing from 0.68 ± 0.12 to 1.0 ($p < 0.001$). These results indicate that micropulse laser therapy is an effective, safe, and reliable treatment modality for central serous chorioretinopathy, providing substantial anatomical and functional improvement with stable outcomes throughout the follow-up period.

Keywords: central serous chorioretinopathy, central macular thickness, micropulse laser therapy, subretinal fluid

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MIKROPULSNA LASERSKA TERAPIJA KOD CENTRALNE SEROZNE HORIORETINOPATIJE: ANATOMSKE I FUNKCIONALNE PROMENE

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Centralna serozna horioretinopatija (CSCR) predstavlja horioretinalno oboljenje koje nastaje usled disfunkcije retinalnog pigmentnog epitela i karakteriše se nakupljanjem subretinalne tečnosti u predelu makule, što dovodi do smanjenja centralne vidne oštrine, pojave metamorfopsija i centralnog skotoma. Dijagnoza se postavlja na osnovu kliničkog pregleda, merenja najbolje korigovane vidne oštrine (BCVA), nalaza optičke koherentne tomografije (OCT) makule i fluoresceinske angiografije. Terapijski pristupi uključuju posmatranje, farmakološku terapiju, fotodinamsku terapiju, anti-VEGF terapiju, konvencionalnu lasersku fotokoagulaciju i mikropulsnu lasersku terapiju. U ovoj retrospektivnoj studiji analizirano je 16 pacijenata sa CSCR lečenih isključivo subthreshold mikropulsnim laserom. Svim pacijentima je terapija sprovedena

istim protokolom, uz prethodnu titraciju lasera na periferiji retine i primenu duty cycle od 5%. Praćenje je vršeno nakon 15, 30, 90 i 180 dana, uz procenu BCVA i OCT parametara. Prosečna centralna debljina makule (CMT) smanjena je sa 421,5 ± 112,3 μm na 234,6 ± 18,9 μm nakon 6 meseci ($p < 0,001$), uz potpuno povlačenje subretinalne tečnosti kod svih pacijenata. Istovremeno je zabeleženo značajno funkcionalno poboljšanje, sa porastom prosečne BCVA sa 0,68 ± 0,12 na 1,0 ($p < 0,001$). Dobijeni rezultati ukazuju da mikropulsna laserska terapija predstavlja efikasan, bezbedan i pouzdan terapijski modalitet u lečenju centralne serozne horioretinopatije, sa izraženim anatomskim i funkcionalnim poboljšanjem i stabilnim rezultatima tokom perioda praćenja.

Ključne reči: centralna serozna horioretinopatija, centralna makularna debljina, mikropulsna laser terapija, subretinalna tečnost

INTRODUCTION

Central serous chorioretinopathy (CSCR) is a chorioretinal disorder characterized by serous detachment of the neurosensory retina caused by focal leakage through the retinal pigment epithelium. The condition predominantly presents with reduced visual acuity (VA), metamorphopsia, and central scotoma. Pathomorphologically, it is caused by increased vascular permeability of choroidal blood vessels and disruption of the RPE pump, which leads to the formation of subretinal fluid in the area of the macula. It occurs more often in middle-aged men who work in stressful jobs, then in people with hormonal imbalance, pregnant women or people with anomalous blood vessels such as telangiectasia(1). Although the prognosis of treatment is good, at the time of illness, people have a problem with general functioning, so it is important to respond in a timely manner with appropriate therapy. In the case of a transition to a chronic form, permanent damage to the RPE layer, choroidal neovascularization, and a permanent decrease in central visual acuity may occur (2).

Multimodal imaging plays a crucial role in the diagnosis and management of CSCR. Based on macular OCT findings, central macular thickness and the presence of subretinal fluid (SRF) are assessed, which is of great importance both for diagnostic purposes and for subsequent therapeutic follow-up. Fluorescein angiography (FA) findings identify the exact site of leakage, which is of crucial importance when evaluating the therapeutic suitability of micropulse laser treatment. Fluorescence angiography is of great importance when differentiating an acute from a chronic condition, as well as localizing the exact site of leakage, on the basis of which further laser therapy can be planned (3).

Several treatment modalities have been proposed for CSCR, including observation, pharmacological therapy, photodynamic therapy, conventional thermal laser photocoagulation, and intravitreal anti-vascular endothelial growth factor (anti-VEGF) injections. However, conventional laser treatment is limited by the risk of retinal scarring and permanent retinal damage (4). Pharmacological treatment options for central serous chorioretinopathy have also been investigated, aiming to modulate choroidal permeability and retinal pigment epithelium function. These include mineralocorticoid receptor antagonists, nonsteroidal anti-inflammatory drugs, carbonic anhydrase inhibitors (5,6). The simultaneous existence of CSCR and choroidal neovascularization is reserved for the application of antiVEGF therapy. Intravitreal injection of bevacizumab, afilbrecept or faricimab is of great importance both as monotherapy and as

adjuvant therapy with laser therapy. It shows a significant reduction of macular edema and the presence of subretinal fluid, which is confirmed by OCT (6).

Micropulse laser therapy has emerged as a promising alternative that delivers subthreshold energy in short repetitive pulses, allowing selective stimulation of the retinal pigment epithelium without inducing visible retinal burns. This technique minimizes tissue damage while promoting resorption of subretinal fluid and functional recovery (7). Every pulse has an “on and off” time frame called duty cycle (DC) allowing the tissues to cool before the following pulse. This makes it possible to carry out treatment close to the macula, even in some areas of the macula, which expands the therapeutic indications. Micropulse laser has been used in the treatment of CSCR, macular edema, swelling caused by venous retinal occlusions (8).

AIM OF THE STUDY

The aim of this study was to evaluate the anatomical and functional outcomes of micropulse laser therapy in patients with central serous chorioretinopathy by assessing changes in best-corrected visual acuity and subretinal fluid resolution over a six-month follow-up period.

MATERIAL AND METHODES

This retrospective observational case series included 16 patients diagnosed with central serous chorioretinopathy who were treated with micropulse laser therapy. Medical records were reviewed to evaluate anatomical and functional outcomes following treatment. A total of 16 patients (16 eyes) with clinically and imaging-confirmed central serous chorioretinopathy were included in the study. Inclusion criteria were decreased visual acuity associated with serous macular detachment, presence of subretinal fluid on optical coherence tomography, and active leakage identified on fluorescein angiography. Only patients with extrafoveal or parafoveal leakage suitable for micropulse laser treatment were enrolled. Patients with other retinal pathologies, previous retinal laser treatment, prior intravitreal therapy, or media opacities precluding adequate imaging were excluded from the study.

All patients underwent a comprehensive ophthalmic examination at baseline and during follow-up visits. Best-corrected visual acuity (BCVA) was measured using a Snellen chart. Anterior segment examination and dilated fundus examination were performed using slit-lamp biomicroscopy with a non-contact fundus lens. Spectral-domain optical coherence tomography was performed using the Zeiss Cirrus 5000 OCT system (Carl Zeiss Meditec, Germany). OCT

imaging was used to assess macular morphology, central macular thickness, and the presence and extent of subretinal fluid. Color fundus photography and fluorescein angiography were performed using the Clarus 700 Ultra-Widefield Imaging System (Carl Zeiss Meditec, USA). Fluorescein angiography was used to identify the location and pattern of leakage and to guide laser treatment planning.

Micropulse laser treatment was performed using a 577 nm yellow laser system (Quantel Medical EasyRet, France). Treatment was applied in micropulse mode to areas of angiographically confirmed leakage, avoiding the foveal center. Laser settings were selected according to manufacturer recommendations and clinical judgment, aiming to deliver subthreshold energy without producing visible retinal burns previously treated on the peripheral parts of the retina to the bearly visible white spots, reduced by half energy and delivered in 5% duty cylce (DC) per area.

Following micropulse laser treatment, all patients received adjunctive topical therapy consisting of nonsteroidal anti-inflammatory drugs and topical carbonic anhydrase inhibitor (brinzolamide). Patients were examined at baseline, 15 days after treatment, 1 month, 3 months, and 6 months following micropulse laser therapy. At each follow-up visit, BCVA assessment and OCT imaging were performed to evaluate functional and anatomical outcomes. Data were collected and analyzed using Microsoft Excel. Descriptive statistics were used to summarize patient characteristics and clinical findings. Changes in visual acuity and OCT parameters during follow-up were evaluated by comparing post-treatment values with baseline measurements. Statistical significance was defined as a p-value < 0.05.

RESULTS

Sixteen eyes of sixteen patients were included in the statistical analysis. Central macular thickness (CMT) was measured at baseline and at 15 days, 30 days, 90 days, and 180 days after micropulse laser treatment.

Mean baseline CMT was 421.5 ± 112.3 µm. A progressive reduction in CMT was observed at all follow-up visits. At 15 days after treatment, mean CMT decreased to 327.6 ± 63.8 µm. Further reduction was noted at 30 days, with a mean CMT of 267.9 ± 35.2 µm. At 90 days, mean CMT was 238.3 ± 19.7 µm, and at the final follow-up visit at 180 days, mean CMT was 234.6 ± 18.9 µm, indicating sustained anatomical improvement. Paired comparisons between baseline and

each follow-up time point demonstrated a statistically significant reduction in CMT at 15 days, 30 days, 90 days, and 180 days (Wilcoxon signed-rank test, $p < 0.001$ for all comparisons) (Table 1).

Table 1: Changes in central macular thickness during follow-up

Patient	CMT baseline	15 days	30 days	90 dyas	180 days
1	646	438	272	226	220
2	352	220	224	224	218
3	641	400	305	262	235
4	408	357	318	228	227
5	292	281	255	221	219
6	474	348	268	238	235
7	343	291	267	224	225
8	330	291	235	232	230
9	591	442	340	289	287
10	372	338	261	260	259
11	349	228	222	220	221
12	388	335	310	228	227
13	470	345	265	239	230
14	335	280	220	218	218
15	375	333	266	255	255
16	378	315	259	248	247

Best-corrected visual acuity (BCVA) was recorded at baseline and during all follow-up visits. For statistical analysis, Snellen visual acuity values were converted to logarithm of the minimum angle of resolution (logMAR). Mean baseline BCVA was 0.18 ± 0.08 logMAR. At 15 days after micropulse laser treatment, mean BCVA improved to 0.05 ± 0.04 logMAR. At 30 days, BCVA reached 0.00 logMAR in all patients and remained stable at 0.00 logMAR at both the 90-day and 180-day follow-up visits. Paired comparison demonstrated a statistically significant improvement in BCVA between baseline and 15 days, as well as between baseline and all subsequent follow-up visits (Wilcoxon signed-rank test, $p < 0.001$) (Table 2).

Table 2: Changes in best-corrected visual acuity during follow-up

Patient	BCVA baseline	15 days	30 days	90 dyas	180 days
1	0.5	0.8	1	1	1
2	0.7	1	1	1	1
3	0.5	0.8	1	1	1
4	0.8	0.9	1	1	1
5	0.9	1	1	1	1
6	0.7	0.9	1	1	1
7	0.8	1	1	1	1
8	0.7	0.8	1	1	1
9	0.5	0.8	1	1	1
10	0.6	0.9	1	1	1
11	0.7	1	1	1	1
12	0.7	0.8	1	1	1
13	0.6	0.9	1	1	1
14	0.8	1	1	1	1
15	0.7	0.9	1	1	1
16	0.6	0.8	1	1	1

DISSCUSION

The present retrospective case series demonstrated that micropulse laser therapy in patients with central serous chorioretinopathy resulted in significant and sustained anatomical and functional improvement. The statistical analysis confirmed a pronounced reduction in central macular thickness accompanied by complete resolution of subretinal fluid, as well as a marked improvement in best-corrected visual acuity during follow-up.

From an anatomical standpoint, the observed reduction in central macular thickness was both early and progressive. Mean CMT decreased significantly from baseline values of approximately 420 µm to nearly physiological levels by the third month of follow-up, with this reduction reaching strong statistical significance at all post-treatment time points ($p < 0.001$). The decreasing standard deviation over time further suggests a consistent anatomical response across the entire study population, reflecting a homogeneous treatment effect. Complete resolution of subretinal fluid was observed in all eyes by the third month and remained stable through the six-month follow-up period, indicating a durable therapeutic response. Zhou L. et al. in their study found that at 3 months, the complete resolution of subretinal fluid (SRF) in 577-nm SML group was 72.7, and after 6 months it was 85,5% which was lower than the result we found (9). Also Long

H. et al. found that reduction of CMT at 3th month was 312.94 ± 49.50 µm and at 6th was 291.38 ± 26.46 µm which was similar to our results (10).

Functional outcomes closely paralleled these anatomical improvements. Mean BCVA improved significantly from baseline, with statistical significance already evident at the 15-day follow-up ($p < 0.001$). By one month after treatment, all patients achieved a BCVA of 1.0, corresponding to a mean BCVA of 0.00 logMAR with no interindividual variability. This uniform functional recovery underscores the strong relationship between subretinal fluid resolution, normalization of macular morphology, and visual acuity improvement. Zhou L. et al. in their study found that the mean LogMAR BCVA significantly improved, and the mean central foveal thickness (CFT) significantly decreased in the SML group (9). Also, Long H. et al. showed significantly greater improvement in the BCVA (logMAR) compared to observation group at 1 month (0.20 ± 0.10 vs 0.30 ± 0.12, $P < 0.01$), 3 months (0.13 ± 0.06 vs 0.21 ± 0.06, $P < 0.01$) and 6 months (0.01 ± 0.06 vs 0.09 ± 0.66, $P < 0.01$) (10).

These results are in close agreement with previously published studies reporting significant reductions in subretinal fluid and central macular thickness following micropulse laser therapy, with corresponding improvements in visual acuity. Similar to our findings, other authors have demonstrated statistically significant anatomical and functional recovery.

The strong statistical significance observed in both anatomical and functional parameters supports the clinical relevance of micropulse laser therapy in the management of CSCR. The early reduction in CMT and SRF likely reflects improved retinal pigment epithelium pump function and enhanced choroidal fluid resorption induced by subthreshold laser stimulation, without causing visible retinal damage (11).

When compared with other treatment modalities, such as photodynamic therapy or intravitreal anti-VEGF injections, micropulse laser therapy offers a favorable balance between efficacy and safety. While anti-VEGF therapy may show benefit in selected cases, particularly in the presence of secondary choroidal neovascularization, its overall role in typical CSCR remains limited. In contrast, the statistically significant and consistent outcomes observed in the present study suggest that micropulse laser therapy can be considered a first-line treatment option in appropriately selected patients, particularly those with parafoveal leakage (12–14).

Clinically, the demonstrated statistically significant reduction in CMT and complete recovery of visual acuity highlight the practical value of micropulse laser therapy. Early intervention may prevent chronic retinal changes, photoreceptor damage, and long-term visual loss. The absence of recurrent subretinal fluid during the follow-up period further supports the stability of the therapeutic effect.

The present study has certain limitations, including its retrospective design, limited sample size, and lack of a control group. Nevertheless, the strong statistical significance of the observed outcomes, combined with their consistency across all patients, lends credibility to the findings. These results contribute to the growing body of evidence supporting micropulse laser therapy as an effective and tissue-sparing treatment for central serous chorioretinopathy.

Future studies should focus on larger prospective trials to further validate these findings, optimize laser parameters, and evaluate long-term outcomes. Additionally, comparative studies exploring micropulse laser therapy alone versus combined treatment strategies, including pharmacological therapy or anti-VEGF agents, may help refine individualized treatment approaches.

CONCLUSION

The results of this study demonstrate significant anatomical and functional improvement in patients with central serous chorioretinopathy treated with micropulse laser therapy. In acute, parafoveal forms of the disease, micropulse laser therapy may represent a method of choice, providing rapid and complete reduction of central macular thickness, full resolution of subretinal fluid, and complete recovery of best-corrected visual acuity.

The early normalization of macular morphology and visual function may reduce the risk of disease-related complications, while the sustained maintenance of achieved anatomical and functional outcomes throughout the follow-up period indicates a high degree of treatment reliability. Notably, complete recovery of visual acuity and normalization of central macular thickness were observed within the first month of follow-up, with no recurrence of subretinal fluid or additional complications detected during the six-month observation period, suggesting a low risk of disease recurrence.

Although the favorable outcomes observed in this study support the effectiveness of micropulse laser therapy, these results do not exclude other treatment modalities, including pharmacotherapy, conventional or photodynamic laser treatment, and intravitreal anti-VEGF

therapy. Depending on the clinical presentation, micropulse laser therapy may be applied either as a first-line treatment or as an adjuvant therapy in more complex or chronic cases.

Based on accurate diagnostic assessment and appropriate patient selection, micropulse laser therapy represents a safe, effective, and tissue-sparing therapeutic option and may be considered a treatment of choice in the management of central serous chorioretinopathy.

Literatura:

1. Valls Pascual E, Martínez-Costa L, Santander F. Central serous chorioretinopathy and systemic corticosteroids in rheumatic diseases: report of three cases. BMC Musculoskelet Disord. 2015 Dec 5;16:378. doi: 10.1186/s12891-015-0843-4. PMID: 26638151; PMCID: PMC4670548.
2. Nicholson B, Noble J, Forooghian F, Meyerle C. Central serous 241 chorioretinopathy: update on pathophysiology and treatment. Surv Ophthalmol. 2013;58(2):103–26. doi: 10.1016/j.survophthal.2012.07.004.
3. Han J, Cho NS, Kim K, Kim ES, Kim DG, Kim JM, Yu SY. FUNDUS AUTOFLUORESCENCE PATTERNS IN CENTRAL SEROUS CHORIORETINOPATHY. Retina. 2020 Jul;40(7):1387-1394. doi: 10.1097/IAE.0000000000002580. PMID: 31157711; PMCID: PMC7302330.
4. Sartini F, Figus M, Nardi M, Casini G, Posarelli C. Non-resolving, recurrent and chronic central serous chorioretinopathy: available treatment options. Eye (Lond). 2019 Jul;33(7):1035-1043. doi: 10.1038/s41433-019-0381-7. Epub 2019 Mar 1. PMID: 30824822; PMCID: PMC6707196
5. Chin EK, Almeida DR, Roybal CN, et al. Oral mineralocorticoid antagonists for recalcitrant central serous chorioretinopathy. Clin Ophthalmol Auckl NZ. 2015;9:1449-1456. doi:10.2147/OPTH.S86778
6. Gemenetzi M, De Salvo G, Lotery AJ. Central serous chorioretinopathy: an update on pathogenesis and treatment. Eye Lond Engl. 2010;24(12):1743-1756. doi:10.1038/eye.2010.130
7. Bodea F, Bungau SG, Bogdan MA, Vesa CM, Radu A, Tarce AG, Purza AL, Tit DM, Bustea C, Radu AF. Micropulse Laser Therapy as an Integral Part of Eye Disease Management. Medicina (Kaunas). 2023 Jul 28;59(8):1388. doi: 10.3390/medicina59081388. PMID: 37629677; PMCID: PMC10456532
8. Scholz P., Altay L., Fauser S. A Review of Subthreshold Micropulse Laser for Treatment of Macular Disorders. Adv. Ther. 2017;34:1528–1555. doi: 10.1007/s12325-017-0559-y
9. Zhou L, Lai K, Jin L, Huang C, Xu F, Gong Y, Li L, Zhu Z, Lu L, Jin C. Subthreshold Micropulse Laser vs. Conventional Laser for Central Serous Chorioretinopathy: A Randomized Controlled Clinical Trial. Front Med (Lausanne). 2021 Jul 16;8:682264. doi: 10.3389/fmed.2021.682264. PMID: 34336888; PMCID: PMC8322653.

10. Long H, Liu M, Hu Q, Li X. 577 nm subthreshold micropulse laser treatment for acute central serous chorioretinopathy: a comparative study. BMC Ophthalmol. 2022 Mar 5;22(1):105. doi: 10.1186/s12886-022-02330-0. PMID: 35248003; PMCID: PMC8898420.
11. Scholz P, Altay L, Fauser S. A Review of Subthreshold Micropulse Laser for Treatment of Macular Disorders. Adv Ther. 2017 Jul;34(7):1528-1555. doi: 10.1007/s12325-017-0559-y. Epub 2017 May 24. PMID: 28540655; PMCID: PMC5504253.
12. Li X, Long H, Hu Q. Efficacy of subthreshold micropulse laser for chronic central serous chorioretinopathy: A meta-analysis. Photodiagnosis Photodyn Ther. 2022 Sep;39:102931. doi: 10.1016/j.pdpdt.2022.102931. Epub 2022 May 27. PMID: 35636735.
13. Lange CA, Qureshi R, Pauleikhoff L. Interventions for central serous chorioretinopathy: a network meta-analysis. Cochrane Database Syst Rev. 2025 Jun 16;6(6):CD011841. doi: 10.1002/14651858.CD011841.pub3. PMID: 40522203; PMCID: PMC12169103.
14. Schworm B, Luft N, Keidel LF, Hagenau F, Kern C, Herold T, Kortuem KU, Priglinger SG, Siedlecki J. Response of neovascular central serous chorioretinopathy to an extended upload of anti-VEGF agents. Graefes Arch Clin Exp Ophthalmol. 2020 May;258(5):1013-1021. doi: 10.1007/s00417-020-04623-w. Epub 2020 Feb 28. PMID: 32112141.