ORIGINAL RESEARCH

Photobiomodulation Effect of Low-level Laser Therapy as a Palliative Treatment of Symptomatic Geographic Tongue (A Double-blinded Randomized Clinical Trial)

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Abstract

Aim: To evaluate the effectiveness of photobiomodulation (PBM) of low-level laser therapy (LLLT) as a palliative treatment of symptomatic geographic tongue.

Materials and materials: This randomized double-blinded controlled clinical trial was performed on 50 patients with symptomatic geographic tongue (GT). Participants were allocated randomly into study and control groups. A 660-nm diode laser was applied on randomly selected patients of the study group ($n = 25$) over the complained site for 2 minutes with continuous laser beam application. For the control group ($n = 25$), no application of 660-nm diode laser was performed. None of the participants were aware if they received the LLLT or placebo treatment. Patients were assessed for the level of pain, burning sensation, and size of the lesion before starting LLLT "T0" and during recall visit "T1, T2, and T3."

Results: The study group showed a low level of pain, burning sensation, and better healing with statistically significant differences at T2 and T3 of the follow-up period, with a level of significance was set at $p < 0.05$.

Conclusion: Low-level laser therapy can be used to adequately relieve significant discomforts associated with GT and accelerate healing and restoring of the patient's quality of life.

Clinical significance: To develop a framework based on the results regarding the photobiomodulation effect of a 660-nm diode laser to relieve pain and burning sensation associated with symptomatic GT, which increases patients' perception toward the services provided to them.

Keywords: Geographic tongue, Low-level laser therapy, Photobiomodulation.

The Journal of Contemporary Dental Practice (2020): 10.5005/jp-journals-10024-2802

Introduction

Benign migratory glossitis is an inflammatory disorder of unknown etiology. It is characterized by a reduction in the number of papillae in the dorsum and the lateral border of the tongue, resulting in red, round patches with distinct white borders that give the dorsum surface of the tongue a map-like appearance. The lesions almost change their shape on a daily basis. Its prevalence has been reported to be 2–3% with equal distribution in both males and females and characterized by episodic exacerbation and remission periods.[1–3]

Benign migratory glossitis was studied under several terms: lingua geographica, geographic tongue (GT), erythema migrans, exfoliatio areata linguae, superficial migratory glossitis, lingual dystrophy, pityriases linguae, transitory benign plaques of the tongue, marginal exfoliative glossitis, and glossitis areata migrans.[4] Sapiro and Shklar also called it as stomatitis areta migrans. The term "migratory" is used to denote apparent migration due to simultaneous epithelial desquamation at one site and proliferation at another.[5]

Although the etiological factors for the development of GT remain unclear, several contributing factors such as emotional stress, vitamin deficiency, allergy, genetic factors, immune disorders, bacterial or fungal infection, and systemic diseases may contribute to its development.[1,2,6]

It presented in most cases, asymptomatically, but on some occasions, patients report pain or burning sensation, especially during the ingestion of spicy or acidic foods. These symptoms may compromise the quality of life, and so several treatment modalities had been proposed to minimize them.[6]

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How to cite this article: Saad I. Photobiomodulation Effect of Low-level Laser Therapy as a Palliative Treatment of Symptomatic Geographic Tongue (A Double-blinded Randomized Clinical Trial). J Contemp Dent Pract 2020;21(4):453–457.

Source of support: Nil

Conflict of interest: None

Some authors proposed oral hygiene maintenance, hydration, acetaminophen, and local anesthetic mouthwash solution. Others suggested using antihistamines, anxiolytics, corticosteroids, retinoic acids, and cyclosporine to reduce symptoms associated with GT.[7–10]

Abe et al.[11] successfully had treated a female patient with a painful GT with cyclosporine who failed to respond well to steroid therapy. Also, tacrolimus was proven successful in treating patients with autoimmune disease and GT, who were unable to respond to nonsteroidal anti-inflammatory drugs and vitamin B12.[12,13]

Photobiomodulation (PBM), likewise known also as low-level laser therapy (LLLT), uses the energy of light to initiate biological reactions from the cell. Also, it organizes the cell function and

significantly reduces inflammation through its anti-inflammatory action on the initial healing stages.[14,15]

The LLLT wavelength ranges from 600 to 1070 nm; however, lasers at 700–770 nm limit biochemical activity, although they are associated with higher penetration power.[16]

Blue light (400–480 nm) safely improves GT lesions by reducing the keratinocyte proliferative activity and modulating T-cell immune responses. On the other hand, red light (620–770 nm) can penetrate tissues about 6 mm, stimulate mitochondrial activity, and reduce local inflammation from macrophage modulation.[17,18]

This study aims to evaluate the effectiveness of using a 660-nm diode laser as a palliative treatment option for treating GT that accelerates healing and restoring the patient's quality of life.

Materials and Methods

The current study involved 50 participants (28 females and 22 males) who were selected from the outpatient dental clinic of the College of Dentistry, Qassim University, and were clinically determined to have a symptomatic GT. All patients were provided with detailed information and a description of the investigation before signing the informed consent. The ethical committee of the College of Dentistry, Qassim University, provides ethical approval with code# ST/59/2019 before conducting the research.

The inclusion criteria were American Society of Anesthesiologists (ASA) class I patients with age ranged from 30 to 54 years, with a mean of 39.7 years, and the exclusion criteria included any patients with a history of using systemic or topical corticosteroids for at least 1 month before treatment. Also, those who were smokers, pregnant women, and with a noncontrolled systemic disease that may interfere with the application of LLLT were excluded.

Sample Size and Distribution

This research was a randomized, double-blinded, controlled clinical trial. A total of 50 adult participants were randomly allocated into two groups. The study group ($n = 25$) received a 660-nm diode laser and the control group ($n = 25$) did not receive a diode laser. The applications of LLLT were performed by the same investigator, while a different one performed the assessment.

Patient Assessment

History: Comprehensive history was collected from the selected participants, including demographic data; history of smoking; onset, duration, and the manifestation of the lesion; medical history; and history of medication and all previous therapies.

Lesion Analysis

Clinical examination of the lesion, distribution of the lesion, and the extension of the lesion were documented digitally as well, and the baseline data for comparing the results during the follow-up period were recorded (Figs 1 and 2).

Treatment Procedures

The laser applied in this study was an LLLT (SIRO Laser, Sirona Dental Systems GmbH, Bensheim, Germany). The research was blind for both participants and investigators. In the study group, the laser intensity was adjusted at 25 mW, with a wavelength of 660 nm. The MultiTip probe was used in the noncontact mode and set at a distance of about 1 cm from the tissue surface. The laser device was activated, and the diode blue light was applied with constant laser beam radiation for 120 seconds over the lesion. This procedure was repeated to cover all affected areas.

In the control group, the MultiTip probe was just placed over the affected area, but without any radiation activation. The investigator evaluated all participants using a visual analog scale (VAS)[19] for subjective evaluation at four periods as follows:

- Before the application of LLLT, T0
- 24 hours postsurgical, T1
- 7 days postoperatively, T2
- 30 days postoperatively, T3

The most severe and extensive lesion was identified and digitally photographed to be utilized as a reference point. The images were analyzed by visual analysis using clinical scoring (CS) for areas of atrophy following the application of LLLT.[20]

The resolution of pain and burning sensation was defined as a reduction in their severity. Following the complete response to treatment, the patients were followed up for 2 months for possible recurrence.

Statistical Analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) software (version 22). The VAS values were recorded before and after the application of LLLT. The Chi-square test was done to check the statistical significance. Results were considered significant if $p < 0.05$.

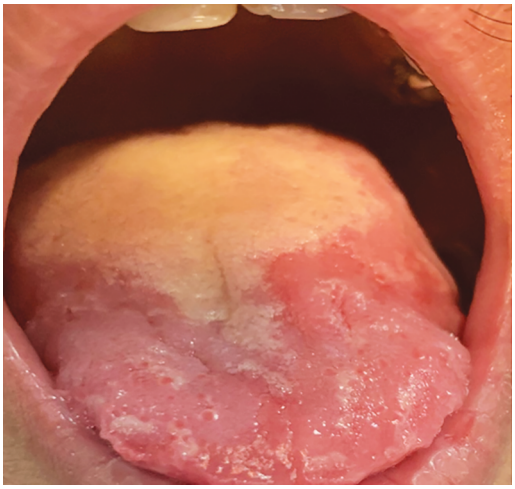

Fig. 1: Tongue lesion at T0

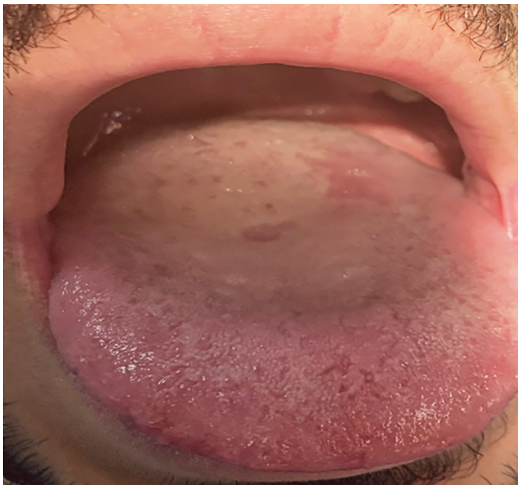

Fig. 2: Tongue lesion at T3

Results

A total of 50 patients participated in this study, including 22 males (44%) and 28 females (56%). A family history of the disease was reported in 23 participants (46%). Age ranged from 30 to 54 years, with a mean of 39.7 years ± 5.75 years. The duration of the lesion before treatment ranged from 1 to 16 months, with a mean of 9.10 ± 2.59 months (Table 1).

Tables 2 and 3 demonstrate the results for clinical status score (CS) and VAS score at T0, T1, T2, and T3. In the study group, LLLT resulted in a reduction of painful symptoms, the lesion size, and improved patient quality of life for 1 month. The improvement started to appear on the second day of application of LLLT. There were significant differences from baseline till the end of the follow-up period in terms of VAS and CS scores ($p > 0.05$).

All participants exhibit a high level of pain and burning sensation, but the study group shows better results after the application of LLLT with statistically significant differences at T1, T2, and T3 of the follow-up period. The level of significance was set at $p < 0.05$.

Table 1: Distribution of studied cases according to demographic data and lesion duration

	No.	*(%)*
Gender		
Male	22	44
Female	28	56
Age (years)		
Range	30.0–54.0	
Mean ± SD	39.70 ± 5.75	
Median	40.50	
Lesion duration (months)		
Range	1.0–16.0	
Mean ± SD	9.10 ± 2.59	
Median	10.4	

Table 2: Mean and standard deviation of CS in studied groups at baseline and after low-level laser therapy application

Studied group		*Study group*	*Control group*	*p value*
Mean ± SD	T0	7.6 ± 2.35	7.32 ± 2.41	–
	T1	6.9 ± 1.46	7.25 ± 2.03	$p < 0.001$**
	T2	2.81 ± 1.18	4.67 ± 1.98	$p < 0.000$***
	T3	0.91 ± 0.69	2.87 ± 1.02	$p < 0.000$***

**$p < 0.001$ moderate significance; ***$p < 0.000$ high significance

Table 3: Mean and standard deviation of VAS in the studied groups at baseline and after low-level laser therapy application

Studied group		*Study group*	*Control group*	*p value*
Mean ± SD	T0	9.40 ± 1.87	9.38 ± 1.54	–
	T1	5.14 ± 1.01	7.23 ± 1.87	$p < 0.001$***
	T2	3.07 ± 0.89	5.24 ± 1.34	$p < 0.001$***
	T3	0.97 ± 0.39	03.02 ± 1.01	$p < 0.001$***

**$p < 0.001$ moderate significance; ***$p < 0.000$ high significance

Discussion

Geographic tongue is a chronic immune-mediated oral lesion of unknown etiology. It affects 0.6 and 4.8% of the world population, with a slight preference for females. It is characterized by serpiginous white areas around the depapillated mucosa. Remission and reactivation in diverse locations originated the denomination benign migratory glossitis.[21–24]

In this study, in which the efficacy of LLLT was evaluated in 50 patients with symptomatic GT, 56% of the participants were female, and 44% were male, while 46% of the patients had a positive family history for the disease.

The same predilection was reported in previous investigations. This female prevalence was attributed to hormonal factors as a contributing factor for this gender predilection.[9,25,26]

Also, Vahedi et al.[9] reported a positive family history of the disease in 32% of the participants, which was lower than our obtained value.

Since the primary etiology of GT is still unknown, a definitive cure does not exist, and the present treatments are aiming to alleviate the symptoms. Topical steroids, retinoic acid, cyclosporine, antihistamine, tacrolimus, and immune system regulators have been used in proposed treatment plans, yet they are neither specific nor curative. They modulate inflammatory and immunological responses, which is their primary mechanism of action.[13]

Current treatment options include topical analgesic, anesthetic agents, corticosteroids, antibiotics, multivitamins, cauterization, and a variety of combined therapies. Most of the treatments are associated with side effects or other disadvantages that make their usage clinically questionable.[2]

A challenge to patient management is to significantly stimulate the healing process and minimize patient discomfort, without side effects.[22]

Since LLLT modulates inflammatory responses with reduced edema and pain and increases cellular biostimulation,[27] as it was proved that LLLT improves the proliferation of epithelial cells and fibroblasts, stimulation of the lymphatic system, increased angiogenesis, and epithelization, all these reactions may consider LLLT as an alternative treatment for GT.[16]

Several limitations of using laser therapy had been reported and were attributed to its possible biostimulation response on benign and malignant cells. The chance of irradiating the gonads, threatening of eye and thyroid gland irradiation, cardiac pacemaker, epilepsy, pregnancy, local infection, hematological disease patients with a malignant tumor and photosensitive skin, or use of medication that causes photosensitivity considered as a contraindication for the use of laser therapy.[27]

In our study, LLLT was adjusted at 25 mW, with a wavelength of 660 nm. The laser probe was used in the noncontact mode and set at a distance of about 1 cm from the tissue surface. The results show a reduction in the severity of pain in both groups, particularly in the study group; complete pain resolution was noticed at the end of the follow-up period. In comparing the two groups, a significant pain reduction was observed at T1, T2, and T3 of the follow-up period.

These results agreed with a previous study conducted in 2009, which reported controlling the exacerbation of lesions of the GT by using the low-intensity lasers. These results can be explained by laser effects that increase cellular metabolism by stimulating mitochondrial activity and acting as analgesics, anti-inflammatory agents, and repairers of the tongue lesion.[28]

On the other hand, in 2017, another study reported using an 880-nm diode laser as a successful method for the treatment of migrant glossitis.[29]

In our study, a 660-nm visible blue diode laser with a lower penetration power is more suitable for tissue repair. On the other hand, the infrared diode laser with a longer wavelength has a greater capacity for penetration, with a higher indication only for analgesia.[28]

The result of the study revealed a better healing treatment in the study group in comparison to the control group, with statistically significant differences at T1, T2, and T3 of the follow-up period. The level of significance was set at $p < 0.05$.

The effects of LLLT on soft tissues are not attributed to heat. When LLLT is applied in an appropriate dose, photon's energy is converted into photochemical, photophysiological, and photobiological effects.[30] Such results include stimulation of lymphocyte, mast cell activation, and increased production of ATP. It also allows the proliferation of different cell types, such as fibroblasts and macrophages. All of these factors encourage anti-inflammatory effects and stimulatory effects, thus improving wound healing.[31]

Mast cell activation releases pro-inflammatory cytokines, which promote local leukocyte infiltration of tissues. Because mast cells play a crucial role in leukocyte activity, LLLT plays an essential role in modulating the activity of mast cells results in promoting wound healing in the oral cavity.[32]

Increased fibroblast proliferation, maturation, and locomotion were noted with the application of LLLT. There was also a decrease in prostaglandin E2 (PGE2) production and an increase in the development of the essential fibroblast growth factor.[33] Such effects can promote wound healing and reduce healing time.[34]

With respect to the benefit of LLLT as a variant from other topical therapy, LLLT is an easy therapeutic option highly accepted by skilled professionals and patients. Furthermore, the ability to promote immediate analgesia without side effects, exhibiting privilege clinical outcomes when compared to topical and systemic medications, makes LLLT one of the preferred treatment modalities for both clinicians and patients.[35]

Conclusion

Despite the fact that the GT is a transient injury, treatment is indicated in symptomatic cases. In this way, LLLT will be useful for symptomatic GT. Low-level laser therapy has likewise been regularly utilized to accelerate healing and relieve pain and inflammation in variant oral lesions. The noninvasive benefits, minimal side effects, and apparent benefits warrant exploration in GT treatment.

Consent

All authors declare that a written informed consent was obtained from the patients before conducting this research.

Ethical Approval

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee (Code#: ST/59/2019) and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Acknowledgment

The author would like to thank Suzan Salem for her participation in this study. The researcher would like to acknowledge the College of Dentistry, Qassim University, for its support in conduction of this study.

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