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Clinical Efficiency of 980 Nm Diode Laser in the Treatment of Recurrent Aphthous Stomatitis

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ABSTRACT

Background and Objective: Recurrent aphthous stomatitis (RAS) is a common condition causing painful ulcers in the oral mucosa. This disorder affects around 25% of the population and disrupts vital functions. Despite its high prevalence, the exact cause remains unclear, leading researchers to explore factors like hormones, trauma, diet, stress, and tobacco use. Innovative approaches like low level diode laser therapy show promise in promoting tissue healing and pain reduction through biochemical reactions. The present study aims to assess the clinical effectiveness of a low-level diode laser in treating recurrent aphthous stomatitis.

Methods: This cross-sectional study was conducted on 15 patients with aphthous ulcers based on a pre- and post-intervention design for 6 months. QuickLase dual wavelength laser, set at 980 nm, was used for a single session per patient, including four 30-second applications with a 15-second interval. Data collection was done at specialized dental clinics, encompassing demographic details (measurement criteria), pain intensity through Visual Analog Scale (VAS), ulcer dimensions, functionality assessment, satisfaction scores, and edema presence. Observations were made pre-treatment and on Day 1, Day 3, and Day 7 post-treatment.

Findings: The average age of the patients was 30.4±10.6 years and 11 were male (73.3%) and 4 were female (26.7%). In this study, the investigation showed a significant reduction in pain scores, respectively before treatment and days 1, 3 and 7 after treatment (8.7±0.7, 5.9±1.8, 2.7±1.7 and 0.3±0.8) ($p<0.001$). The dimensions of the lesion and the presence of edema also decreased significantly over time ($p<0.001$), and patient satisfaction and performance improved significantly during the study.

Conclusion: The results of the study showed that low-level diode laser therapy can be used as an auxiliary approach in the treatment of recurrent aphthous stomatitis.

Keywords: *Aphthous Ulcer, Diode Laser, Biostimulation.*

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Introduction

Recurrent aphthous stomatitis (RAS), colloquially referred to as aphthous ulcers, represents the most prevalent ailment of the oral mucosa, affecting a substantial segment (approximately 25%) of the general population (1). This condition is typified by the recurrence of distressing, singular or multiple ulcers, characterized by margins displaying erythematous features (2). The deleterious effect of RAS on an individual's quality of life is evident, as it disrupts vital functions such as eating, speaking, and even oral hygiene, with the magnitude and quantity of the ulcers being contributory factors to this impact (3).

Notwithstanding its high incidence, the precise pathogenesis of (RAS) remains obscure, posing significant hurdles in formulating efficacious therapeutic approaches. Consequently, a multitude of factors are currently under scrutiny for their involvement in the ailment, including hormonal fluctuations, physical trauma, pharmaceutical agents, hypersensitivity to dietary constituents, insufficient nutritional status, psychological stress, and tobacco usage (4).

One emerging intervention in the field of oral medicine is the use of low-level diode laser therapy. Low-Level Laser Therapy (LLLT) is a non-invasive technique that has shown to be promising in stimulating the immune system, promoting tissue healing and reducing pain in various medical and dental applications (5-12). LLLT is a safe and non-invasive therapy with promising potential for various medical applications (13).

LLLT involves using a coherent and monochromatic laser beam with specific wavelength and power to penetrate tissues deeply. The laser's photons are absorbed by proteins, leading to various biochemical reactions that promote cell proliferation, tissue regeneration, and improved blood circulation. LLLT accelerates wound healing, collagen production, and epithelial cell differentiation while providing analgesic effects by reducing pain-related stimuli. Despite its diverse biological actions, the exact immunomodulatory mechanism remains unclear (14).

The present study aims to evaluate the clinical effectiveness of a low-level diode laser in the treatment of recurrent aphthous stomatitis. By investigating the impact of LLLT on the healing process, pain reduction, and potential recurrence of lesions, we seek to shed light on the role of this novel therapeutic modality in managing RAS.

Materials and methods

The present research is an evaluative one and constitutes a before-after (pre-post) interventional study conducted over a period of 6 months, from May 1 to November 1 2023. The ethical and scientific approval for the research was obtained from the scientific committee at the Institute of Laser for Postgraduate Studies, University of Baghdad (number: 1374 with project no.161 in 10/4/2023).

A total of 15 patients with a confirmed diagnosis of aphthous ulcer were enrolled in this study based on a convenience sampling method. Participant enrollment took place at Al-Mohmoudiyah, Al-Miamoon, and Al-Karamah specialized dental centers. Additionally, data were also collected at the Al-Emamain Al-Kadhmain medical city. Diagnosis of aphthous ulceration was established through comprehensive evaluation of clinical history and meticulous physical examination. The QuickLase dual wavelength laser dual-wavelength “810 and 980 nm” diode laser with fiber optics (FC 400 μm single file multimode) (England) was used in this study. Wavelength was set at 980 nm. Laser output power was set at 1 W, operating in continuous mode, with power density 5.9w/cm^2.

The data pertaining to each participant included demographic parameters, including age and gender. Evaluation of pain intensity was accomplished utilizing the Visual Analog Scale (VAS). Furthermore, the dimension of the aphthous ulcers was meticulously gauged in millimeters using a periodontal probe. Functionality was evaluated via a function score ranging from 0 to 100, demarcated as poor (0-25), fair (26-50), good (51-75), and excellent (76-100). Correspondingly, a satisfaction score, graded on a scale of 0 to 100, indicated overall contentment with the treatment. Additionally, the presence of edema surrounding the ulcers was assessed.

Observations were conducted pre-treatment and during subsequent post-treatment intervals, specifically on Day 1, Day 3, and Day 7.

Laser Treatment Procedure: Each patient underwent a single laser treatment session consisting of four 30-second applications, separated by a 15-second interval. The cumulative laser application time amounted to approximately 120 seconds for each participant. To ensure comprehensive coverage of the ulcer surface, the laser probe was maneuvered in sweeping circular motion. In cases of larger ulcers, particular attention was devoted to achieving optimal coverage.

Non-contact laser application: The distance between the laser probe's tip and the ulcer surface was meticulously maintained at 10 mm, augmented by the 15-second intervals and sweeping motion, employed to safeguard against potential overheating of oral tissues during the therapeutic intervention. Laser treatment for RAS is illustrated in figure 1.

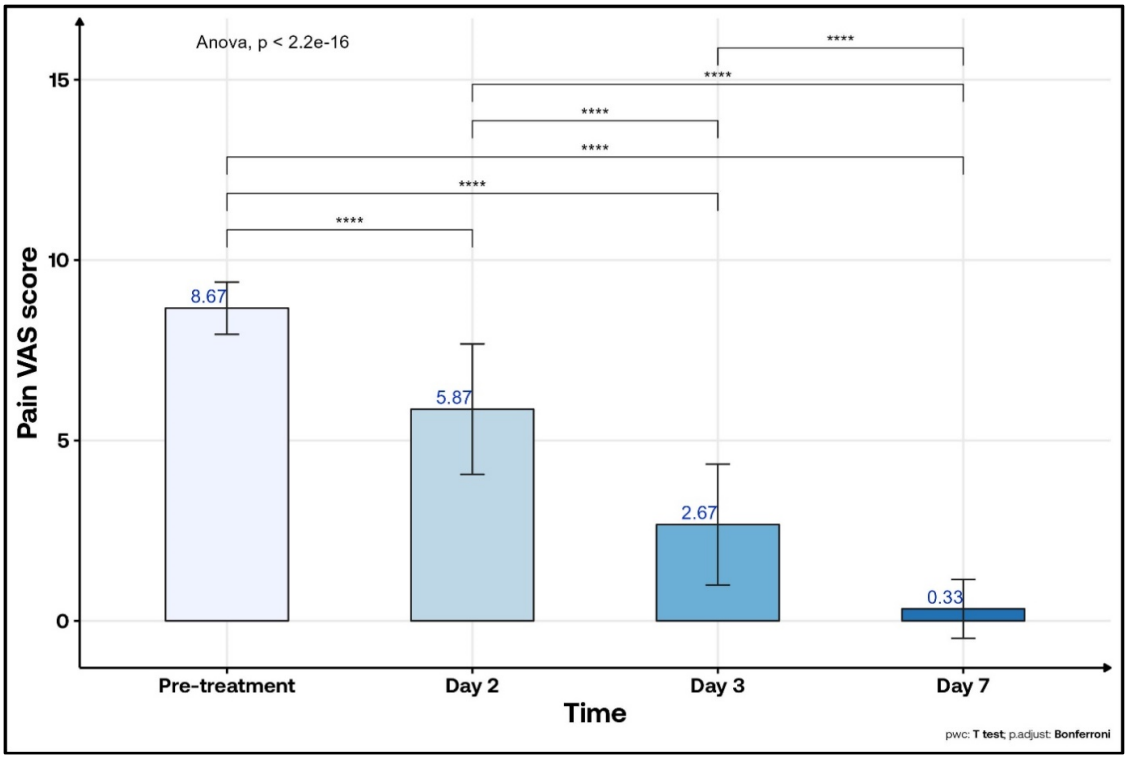

Figure 1. Post-hoc analysis of VAS score over time

Continuous variables were expressed as means and standard deviations. Categorical variables were expressed as frequency and percentages. Repeated Measure ANOVA, Cochran Q test, and Friedman's ANOVA tests were utilized to evaluate the difference in continuous and categorical variables over the

follow-up period. The satisfaction and function levels were recoded as (poor=1, fair=2, good=3, excellent=4), to allow the non-parametric Friedmans' ANOVA to test the difference over time. The difference between categorical variables was investigated using either the χ^2 test with Yates's correction or Fisher's exact test, depending on the context. A P-value less than 0.05 was considered statistically significant. Statistical analysis using Statistical Package for social Science (SPSS version 22, Chicago, IL) were utilized for data entry, analysis and visualization.

Results

In this medical research study, the investigators examined a cohort of 15 cases. The average age of the patients was 30.4 ± 10.6 years. There were 11 (73.3%) male and 4 (26.7%) female subjects.

This medical research included the analysis of various characteristics and outcomes across different time points, encompassing Pre-treatment, Day 1, Day 3, and Day 7. The findings revealed notable improvements in patients' conditions throughout the study duration. Pain, quantified using the Visual Analog Scale (VAS) score, displayed a substantial reduction, with statistically significant differences observed between time points ($p<0.001$). Moreover, the dimensions of the lesions, both in terms of length and width, exhibited significant decreases over time ($p<0.001$). Remarkably, the presence of edema diminished progressively as the study advanced ($p<0.001$). Patient satisfaction levels and functional outcomes exhibited remarkable enhancements, with varying proportions of patients expressing improved satisfaction and function at different levels (Table 1, Figures 1 and 2).

Table 1. The description of Pain score, lesion characteristics, patients' satisfaction and function levels during the follow-up period

Characteristics	Pre-treatment Mean±SD or Number(%)	Day 1 Mean±SD or Number(%)	Day 3 Mean±SD or Number(%)	Day 7 Mean±SD or Number(%)	p-value**
VAS* score	8.7±0.7	5.9±1.8	2.7±1.7	0.3±0.8	<0.001
Size of the lesion					
Length (mm)	4.3±1.7	3.5±1.3	2.8±1.2	1.3±0.7	<0.001
Width (mm)	4.4±1.7	3.8±1.8	2.4±1.3	1.2±0.9	
Presence of oedema	15(100)	4(26.7)	0(0.0)	0(0.0)	<0.001
Satisfaction					
Poor	14(93.3)	0(0)	0(0)	0(0)	<0.001
Fair	1(6.7)	4(26.7)	0(0)	0(0)	
Good	0(0)	11(73.3)	10(66.7)	3(20)	
Excellent	0(0)	0(0)	5(33.3)	12(80)	
Function					
Poor	15(100)	0(0)	0(0)	0(0)	<0.001
Fair	0(0)	4(26.7)	0(0)	0(0)	
Good	0(0)	11(73.3)	12(80)	2(13.3)	
Excellent	0(0)	0(0)	3(20)	13(86.7)	

*Visual Analogue Scale, **Repeated Measure ANOVA (Type III test); Cochran Q test; Friedman's ANOVA

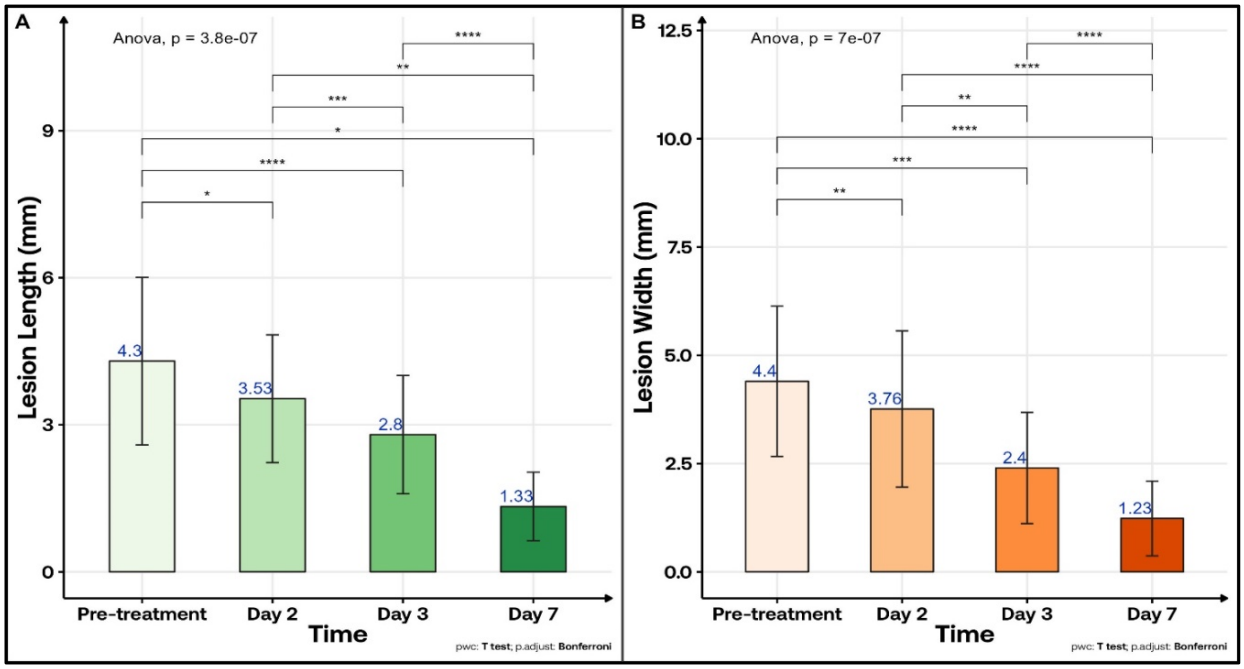

Figure 2. Post-hoc analysis of lesion length and width over time

Discussion and conclusion

This study involving the utilization of a low-level diode laser with a wavelength of 980nm, yielded significant advancements in patients' well-being throughout different time points.

Notable improvements were observed regarding reductions in pain intensity, dimensions of the lesions, and the presence of edema. Moreover, the study demonstrated enhanced levels of patient satisfaction and functional outcomes as supported by previous studies (15, 16). Likewise, Al-Alawe et al. (17) and Al-Wattar et al. (18) in their study showed obvious reduction in inflammatory cell infiltration and more epithelization in laser-treated wounds compared with control group. The findings presented in Hussein et al.'s study (19) underscore the advantages of utilizing the low-level diode laser over corticosteroid treatment. Statistical significance was demonstrated in favor of the laser group regarding pain reduction based on Visual Analog Scale (VAS) scores on day two and day seven. Furthermore, the laser group exhibited a notable reduction in lesion diameter, with no adverse effects in comparison to the corticosteroid-treated participants. This aligns with the outcomes of the present study, where substantial improvements in pain reduction, lesion dimensions, and edema were observed, reinforcing the therapeutic efficacy of the low-level diode laser for managing RAS. The work of Soliman et al. (20), De Souza et al. (21), Salman et al. (22), and Ghali et al. (23) collectively underscores the favorable effects of diode laser treatments. Soliman et al. (20) highlighted the remarkable improvements in healing time, pain reduction, and lesion size associated with diode laser treatment. De Souza et al. (21) reported pain reduction and lesion regression, supporting our study's outcomes. Ghali et al. (23) further substantiated these results, demonstrating pain reduction, ulcer diameter decrease, and shortened healing time when compared to control groups. LLLT employs distinct pain relief mechanisms. One approach is the adjustment of pain perception via endorphin and enkephalin release, altering nerve conduction. Another method involves increasing ATP synthesis in neuronal mitochondria, resulting in hyperpolarization that hinders pain signal initiation. This relies on red and near-infrared light absorption, activating mitochondrial components for electron transport and oxidative phosphorylation.

Consequently, this modulates cellular redox state, ATP provision, mitochondrial membrane potential, cytoplasmic pH, and nucleic acid production. The inhibition of prostaglandin E2 and interleukin-1 beta further aids pain mitigation by countering receptor sensitivity. These mechanisms collectively contribute to edema reduction and mitigation of inflammatory cascades (24, 25).

These positive results align with the anticipated therapeutic effects of low-level diode laser treatment, substantiating its potential in ameliorating the symptoms associated with recurrent aphthous stomatitis. In conclusion, the study revealed significant reductions in pain levels, dimensions of lesions, and edema presence over a span of seven days. Additionally, notable improvements in patient satisfaction and functional outcomes were observed. These findings suggest that the application of the low-level diode laser could be a valuable addition to the management of recurrent aphthous stomatitis.

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