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**ORIGINAL RESEARCH**
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# Treatment of recurrent minor aphthous stomatitis using diode laser (940 nm)

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## ABSTRACT

**Background:** The exact etiology of recurrent aphthous ulcers (RAUs) is unknown. The management of RAUs is not always straightforward. Ulcers in the mouth (recurrent aphthous stomatitis [RAS]) are very common and may vary in size from very small to very large.

**Objective:** To evaluate reduction in pain intensity and duration of pain relief, reduction in size of ulcer, and duration for healing of ulcer (healing time) in patients with RAS after application of Low-Level Light Amplification by Stimulated Emission of Radiation therapy (LLLT) comparing with topical Anginovag spray medication and control group.

**Materials and Methods:** A total of 21 individuals diagnosed as RAS were divided into three equal groups as follows: Group 1: Minor aphthous ulcer, which was treated by giving LLLT using Diode LASER; Group 2: Minor aphthous ulcer, which was treated by topical Anginovag spray medication.; Group 3: Minor aphthous ulcer, which was treated conservatively with motivation and follow-up.

**Results:** In this randomized, controlled, clinical study, LLLT using Diode LASER causes reduction in pain intensity due to RAUs, thereby reducing morbidity. There is also reduction in the diameter and healing time of the ulcer as compared to Anginovag spray medication and the control group.

**Conclusion:** Although various treatment modalities have been used and LLLT is not commonly used to treat aphthous ulcers, this study suggests that using LLLT would be a safe and effective treatment modality for RAUs patients.

**Keywords:** *diode laser (940 nm); recurrent minor aphthous stomatitis.; LASER . LLLT; RAUs*

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## INTRODUCTION

Recurrent aphthous ulcer (RAU) is a common ulcerative lesion found in the oral cavity. It is characterized by the appearance of single or multiple ulcerative lesions in the oral mucosa; typically painful, recurrent, small, round or ovoid with circumscribed margins and erythematous haloes. It is usually first observed in adolescence, but it is in adulthood that patients face periods of increased pain and discomfort. Manifestations of RAU impair feeding, swallowing, and speaking, thereby reducing a patient's self-image and quality of life.[1]

The causes of RAU are unknown, but are thought to be multifactorial with many triggers or precipitating factors. Among patient factors are genetic predisposition, local trauma, medications, allergy, hormonal changes, stress, and immunological abnormalities.[1]

RAU has three clinical presentations: minor aphthous ulcers, major aphthous ulcers, and herpetiform ulcers. As RAUs are of different sizes, from minor to major with different severity of symptoms, they take 10–14 days to heal.[1]

The treatment is palliative, as most existing therapies only reduce the symptoms and sometimes the duration of the lesion. corticosteroids, antiseptic drugs, and antibacterial drugs are used singly or in various combinations. Systemic medication is also used in severe cases or in those resistant to topical therapies such as steroids and immunosuppressive systemic agents.[1]

However, none of the conventional treatments has been shown to be effective in preventing or even decreasing the incidence of lesions.[1]

Studies have suggested that low-level laser therapy (LLLT) has the potential to treat aphthous ulcer and related lesions In addition to reducing the pain and discomfort, it stimulates the healing of ulcers.[1] Also, it has shown excellent results in the treatment and prevention of RAU.[2]

LLLT or cold laser is nondestructive energy that occurs at the periphery of the target tissue. LLLT was discovered incidentally in an attempt to treat cancerous cells with a ruby laser, and it was found that it did not kill tumor cells but accelerated wound healing. This phenomenon led to the concept of photobiomodulation.[3]

It has biostimulating effects, such as increase of cell metabolism and/or tissue regeneration, thereby accelerating healing of the tissue, anti-inflammatory effects on the targeting tissues and cells, as well as reduction of pain of various etiologies.[4]

The principle of biostimulation promoted by therapeutic lasers was introduced >20 years ago. It was first applied in dermatology, especially supplementing the repair process of skin wounds. Later, it was suggested that biostimulation could also be useful in accelerating the healing of wounds inside the oral cavity. Recurrent aphthous stomatitis (RAS) is one among the many that falls into the wide spectrum of clinical applications of a therapeutic laser.[5]

The primary goals of RAU therapy are relief from pain, reduction of ulcer duration, and restoration of normal function.[6]

## PATIENTS, MATERIALS AND METHODS

This clinical trial included a total of 21 patients with aphthous stomatitis, attending the Department of Oral and Maxillofacial Surgery, Al–imam Ali (peace upon him) hospital in Baghdad during a period of 6 months, from the time the patients were first examined. The studied drugs consisted of Anginovag in the form of Anginovg 10 mL solution aerosol (trade name is Anginovag manufactured by G Ferrrer international, S.A, Barcelona Spain).

### *Medical laser system*

The aiming beam is a visible laser diode, max 1 mW, 625 nm–670 nm, continuous or intermittent.

The laser used for patients was diode laser (commercial trade mark epic biolase), which emits a wavelength of 940 ± 10 nm, as seen in Figure 1.

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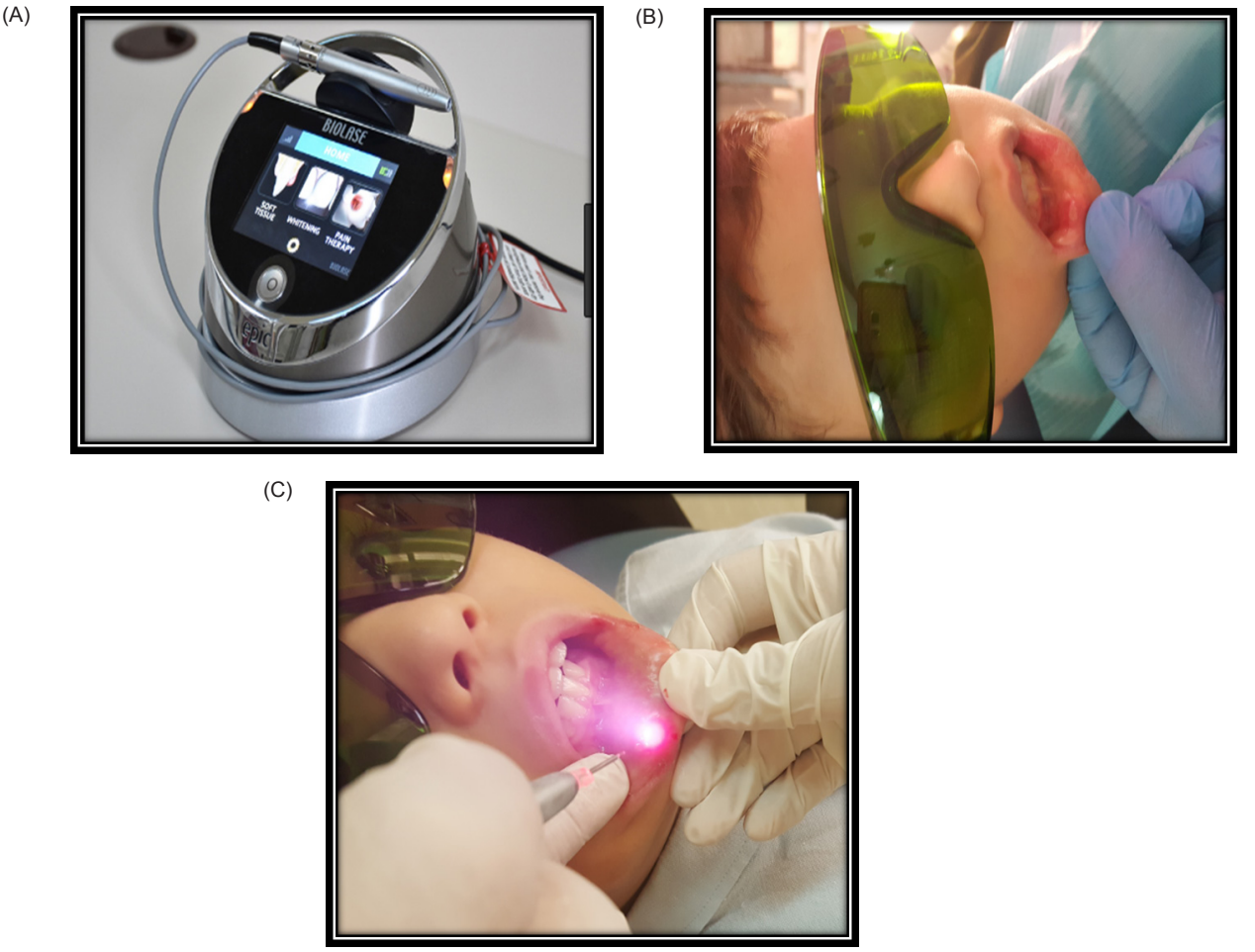


**FIGURE 1.** Gallium–aluminum–arsenide diode laser biolase epic.

## METHOD

***Laser group***

Seven patients treated by low-level laser therapy (LLLT) only.

- Patient set on the dental chair.
- Preoperative and postoperative photographs were taken.
- Goggle was put on the eyes of the patient; the surgeon and the staff also wore the specified goggle before using the laser.
- The LLLT was applied by using Gallium–Aluminum–Arsenide diode laser device (biolase trade mark epic, U.S.A), Figure 1.
- A power of 0.5W and wavelength of 940 nm for 3 minutes (180 seconds) in cw.
- Ulcer exposure for 45 seconds, then released for 15 seconds, and repeated twice for a total time of 180 seconds on each visit, with a gap of 3 days between each visit, and according to signs and symptoms of the patients.

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- About 2–3 mm distance between the tip of the laser fiber optic tube and the surface of the ulcer.
- Perpendicular, circular motion around the ulcer.
- All the patients have been recalled within 3 days and 6 days postoperatively to check the follow-up instructions, and to detect clinical signs and symptoms following the laser therapy, for evaluation of pain and size of the ulcer.

***Medication group***

Seven patients were treated with 10 mL aerosol solution (Anginovag spray) only. Patients received one spray on the ulcer, each 2–3 hours, as recommended by the manufacturer of the drug. All the patients were recalled within 3 days postoperatively to check the follow-up instructions, and to detect the clinical signs and symptoms following the medication, for evaluation of the pain and size of the ulcer.

***Control group***

Seven patients were treated conservatively with motivation and follow-up. All the patients were recalled within 3 days postoperatively to check the follow-up instructions, and to detect the clinical signs and symptoms following the conservative treatment, for evaluation of the pain and size of the ulcer.

***Methods of assessment***

*Healing period*

Both pain and diameter size of ulcer and the healing period were evaluated at the baseline, and 3 and 6 days posttreatment.

***Assessment of pain***

Postoperative pain has been assessed by using the simple visual analog scale method. The patient was asked to describe pain intensity as follows:

0 = no pain
5 = moderate pain
10 = severe pain

***Visual analog scale (VAS)***

How to properly register pain perception on a 100 mm visual analog scale was explained to all patients. Beginning the day that the lesion appeared (D0) consecutively at the same time, every visit until the lesion completely disappeared. Aphthous lesion healing (ALH): The day that the lesion completely healed was registered on the chart, from the lesion intervention day, until a maximum of 6 days.

***Aphthous ulcers diameter measure (AUDM)***

A calibrated periodontal probe was used to measure the diameter of the ulcer, while the patients were placed in a comfortable sitting position. The probe is a long, tapered, rod-like tool that is calibrated in millimeters with a tip. Aphthous ulcers diameter measure (AUDM): It was taken from the first day it appeared, perpendicular to the widest point of lesion diameter and until the day before its total healing.

***Postoperative instructions***

The patients were given verbal instructions, including:

- Avoid taking hot, spicy, citrus, and hard foods for a few days.

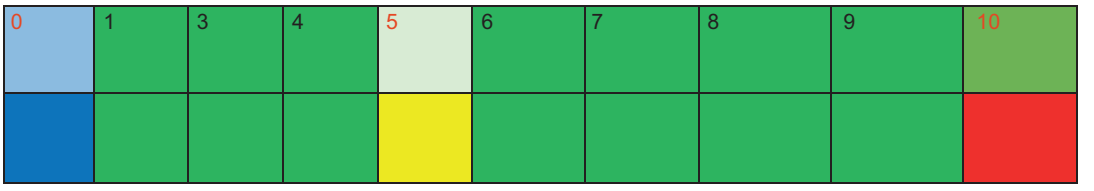


**FIGURE 2.** Visual analog scale method.

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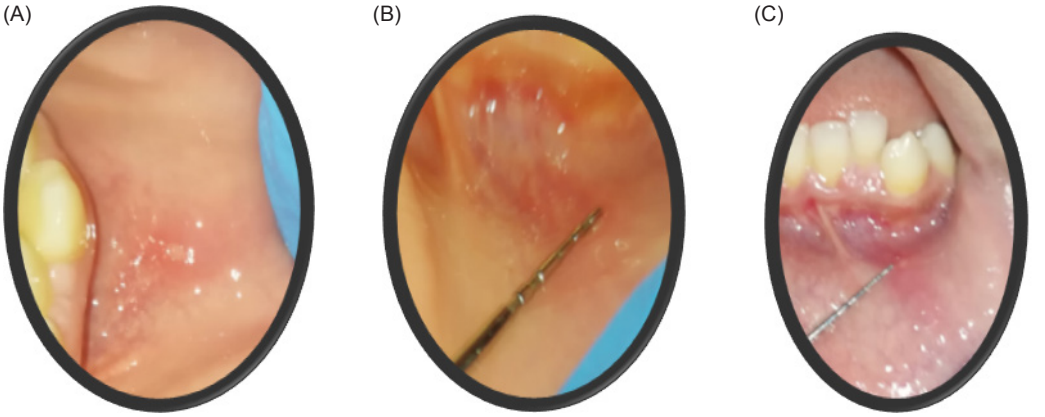


**FIGURE 3.** A calibrated periodontal probe was used to measure the diameter of the ulcer.

- Ensure meticulous oral hygiene is practiced.
- Ensure commitment to follow-up appointments on the exact dates.

## RESULTS

The study depended on comparison between three groups of patients:

a) Patients treated with low power laser therapy (LLLT) only.
b) Patients treated with Anginovag medication only.
c) Patients' control group (treated conservatively).

***Assessment of treatment results by three parameters as:***

**A. Healing time**

There was a significant reduction in the healing time of the ulcer on subsequent visits. Thus, the results of the present study suggest that there was a decrease in the healing time of the ulcer on subsequent visits, more so in Group 1, followed by Group 2, and last by Group 3.

**B. Size of the Ulcer**

There was a significant reduction in the size of the ulcer on subsequent visits. Thus, the results of the present study suggest that there was a decrease in the size of the ulcer on subsequent visits, more so in Group 1, followed by Group 2, and last by Group 3.

Figure 1 represents lesion at the treatment session, and complete healing of the same lesion without scar after 72 hours.

There was high reduction in the lesions' duration in the irradiated ulcers.

The effect of low-power lasers on conditions such as sores and ulcer wounds were studied, and it was concluded that laser therapy is effective at repairing tissue and controlling pain, although the outcomes may be influenced by the wavelength of the laser.

**C. Pain VAS score:**

Table 1 and Figure 4 show intra-group comparison of Pain VAS score at Day 0 – before and after treatment. There were immediate changes in the pain scores of the laser group just after diode laser application. The

**TABLE 1.** Intra-Group Comparison of the Diameter of the Ulcers.

| | Day 0 | Day 3 | Day 6 |
|---|---|---|---|
| Group 1 Laser | 4.00 mm | 2.00 mm | 0.00 mm |
| Group 2 Med. | 4.06 mm | 2.50 mm | 0.30 mm |
| Group 3 Cont. | 4.15 mm | 3.00 mm | 0.50 mm |

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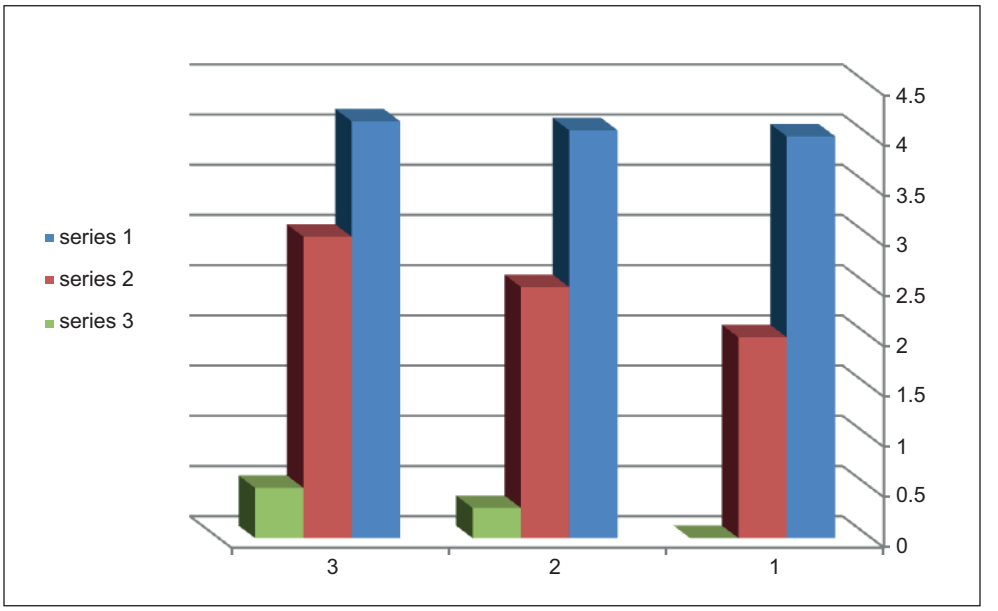


**FIGURE 4.** Intra-group size of the ulcers.

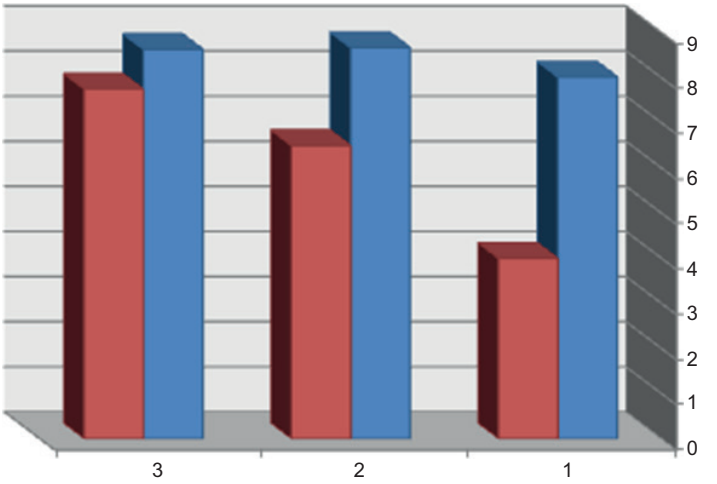


**FIGURE 5.** Pain VAS score at Day 0 – before and after treatment.

patient felt pain relief and decreased pain scores in a range of 6–8, and the mean reduction in the pain scores is as high as 6 on a scale of 1–10 in Table 2.

***Clinical observations***

1. Immediate pain relief
2. High patient acceptance
3. No harm to the surrounding tissue

TABLE 2. Intra-Group Comparison of Pain VAS Score.

| | **Day 0 Before treatment** | **Day 0 After treatment** |
|---|---|---|
| Group 1 | 8.02 | 4.00 |
| Group 2 | 8.67 | 6.50 |
| Group 3 | 8.63 | 7.75 |

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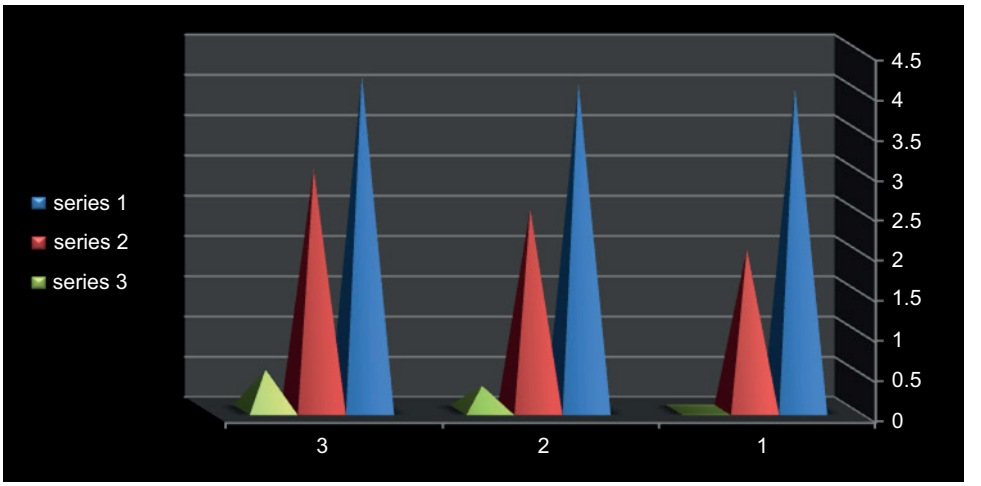


**FIGURE 6.** Significant reduction of pain score and ulcer diameter with the application of LLLT in group A.

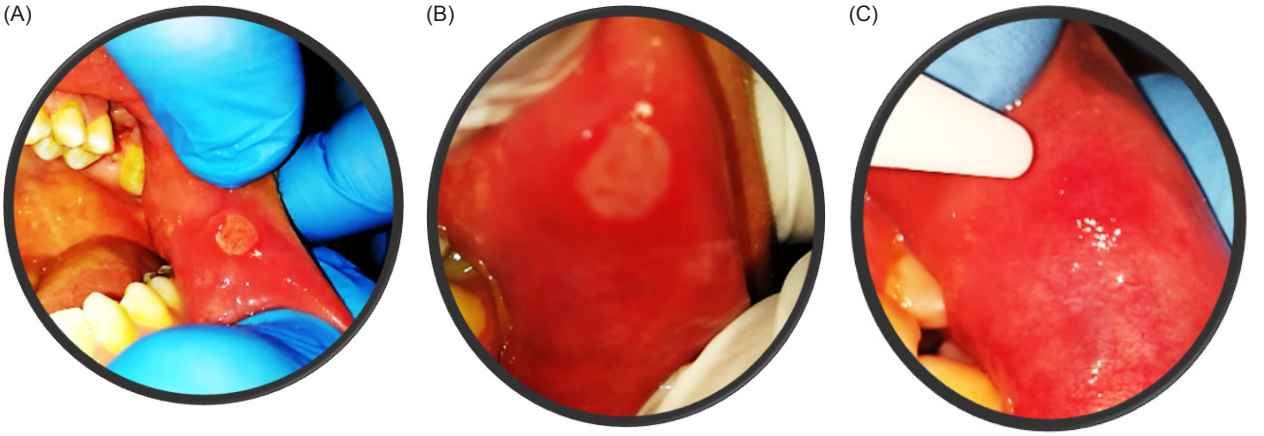


**FIGURE 7.** Patient with aphthous ulcer in the buccal mucosa of the left cheek. (A) Preoperative (laser group). (B) After 3 days. (C) After 6 days.

***Time taken***

The time taken for the treatment for the laser group ranged from 3 to 5 minutes, with an average of 4 minutes, where less time was needed for group medication and the control group.

## DISCUSSION

RAS is a common oral disorder affecting 5%–66% of examined adult patient groups. Although many exacerbating factors have been identified, the cause as yet remains unknown. The difficulty in establishing the exact nature of aphthous stomatitis is in part because of the nonspecific histopathologic features of the ulcers, and the lack of any reproducibly identifiable cause, endogenous or exogenous. And, the trigger of an episode of RAU is unknown.[7]

***Signs, symptoms, and discomfort for patients with RAU***

Although patients in most cases have spontaneous healing within 14 days, treatment is often

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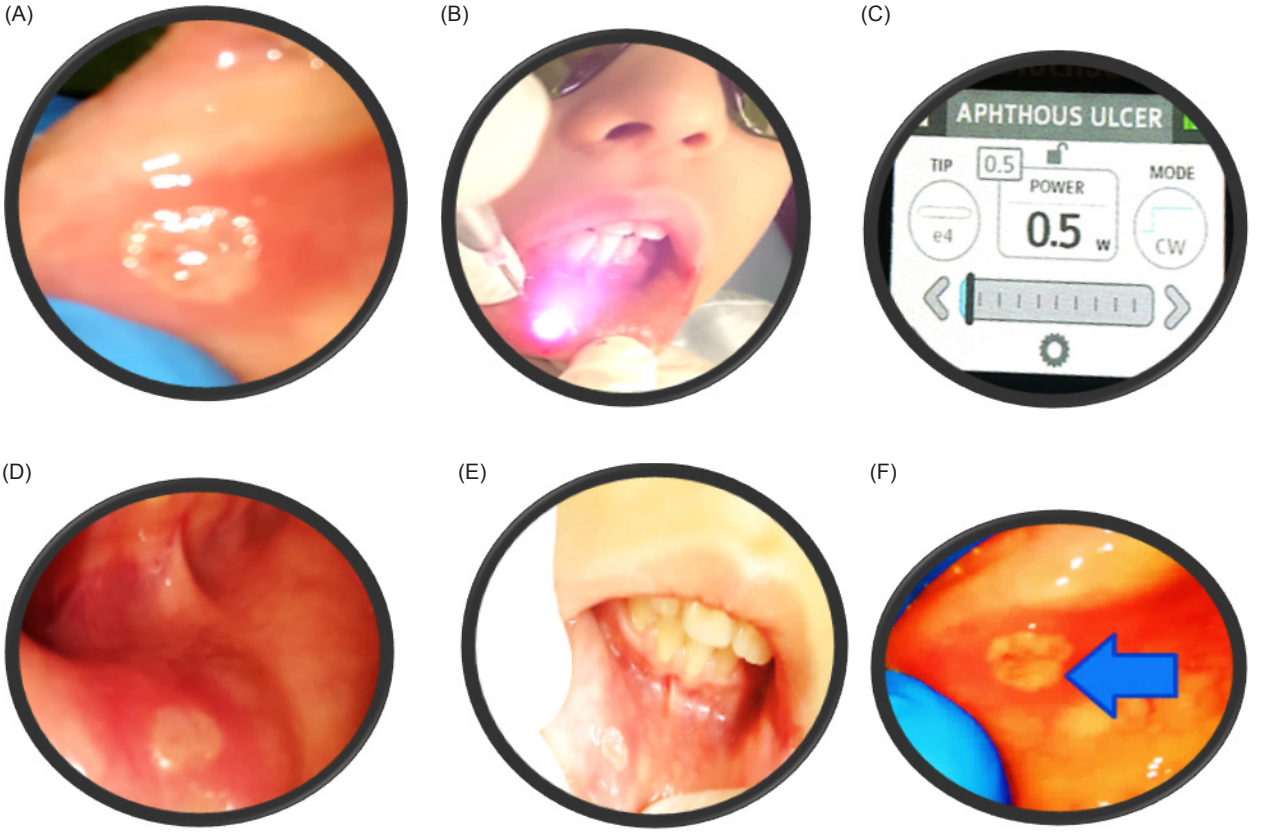


**FIGURE 8.** Aphthous ulcer. (A) Preoperative (laser group). (B) Intraoperative ulcer with LLLT. (C) Laser dose parameter for recurrent aphthous ulcer (D) Aphthous ulcer after 3 days. (E) After 6 days with LLLT. (F) After 6 days with LLLT.

indicated to mainly control pain and to reduce the duration and severity of symptomatic outbreaks, especially during the periods of quiescence and exacerbation (period of increased pain and sensitivity) of RAS lesions. Pain usually reduces after 4–5 days, but during this period, it can cause discomfort to a patient during eating, swallowing, speaking, and wearing dental prostheses. Pain control is also very important in order to maintain patient physical and mental condition, further improving the effectiveness of the therapy. To date, it is widely accepted that the first-line therapy for patients with RAS is topical corticosteroid, even though the evidence of their efficiency is not overwhelming. Recently, laser as a new treatment modality has been introduced.[4]

***Laser group***

Reduction in the size of the ulcer on subsequent visits. This is in accordance with and Hadeel Salman et al.[6] who had observed significant decrease in the size of the lesions. The current study provides evidence that a single session of LLLT is effective in the management of RAS than conventional medical treatment, as the results showed significant reduction of pain score and ulcer diameter with the application of LLLT in group A than group B, C. These findings look similar to those of De Souza et al. As a result, a reduction of pain (75% of the patients) in the same session after laser treatment was demonstrated. Furthermore, a total regression of the lesion was achieved 4 days following laser

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irradiation (40% of the patients) compared to prolonged time (5–7 days) required to obtain the same results in the corticosteroid group. The authors concluded that under the conditions administered in the study, the GaAlP laser therapy can be safely used as the advanced RAS treatment technique in order to achieve immediate analgesia and faster healing of RAS lesions.[4]

On the other hand, healing was uneventful and all the patients experienced spontaneous reduction in pain recorded on VAS immediately after treatment. The lesion healed completely within 3–4 days. Follow-up for 1 year showed no recurrence of lesions in these patients[8]

The result was in agreement with a recently study, which stated that LLLT was suggested to be one of the important treatment modalities for wound repair processes and pain control.[9]

The result was also in agreement with De Souza et al.[10] who reported that LLLT InGaA1P diode laser can cause reduction in pain and a total regression of the lesion after days, and it was reported that low-level laser can decrease the healing time, pain intensity, and also the time of pain relief in patients with aphtae.[11]

The patients reported significantly less pain as well as less functional complications after LLLT therapy. Furthermore, they stated that they experienced faster healing compared with the usual medication therapy.[12]

## REDUCTION IN SIZE OF ULCER

There was significant reduction in the size of the ulcer on the subsequent visits, 3 and 6 days after the operation. This is in accordance with Muhannad A. Kashmoola (2005) and Hadeel Salman who had observed a significant decrease in the size of the lesion.[13] Thus, the results of the present study suggest that there was a decrease in the size of the ulcer on subsequent visits, more so in Group 1, followed by Group 2, and last by Group 3.

## HEALING TIME

Although aphthous heals itself in 10–14 days, the ulcer is still treated to reduce morbidity and healing time. On the other hand, clinical studies explained different mechanisms through which LLLT can accelerate wound healing. These mechanisms include local vasodilatation and increased blood flow, cellular biostimulation, in addition to analgesic and anti-inflammatory effects.[9]

On the other hand, differences between low-level laser therapy and triamcinolone acetonide kenalog on the healing of recurrent aphthous ulceration is that the laser light shows the activation of suppressor T-lymphocyte, which inhibits B-lymphocytes from antibody production and then decreases the production of histamine and kinins that are responsible for inflammation.[6]

Furthermore, a potential biostimulation of underlying and surrounding cells, increased collagen organization, and promoting of growth factors and cytokines in response to laser irradiation have been demonstrated.[4]

## REDUCTION IN PAIN INTENSITY

In the present study, reduction in the pain intensity, VAS score was evaluated in all the groups before and after treatment at day 0, 3 days, and 6 days. Moreover, researchers claimed that LLLT is effective in pain reduction and they provided some explanations such as: the role of LLLT in increasing the production of opioid peptides, decreasing the histamine release, reducing the prostaglandin and bradykinin production, increasing local circulation and oxygen supply, as well as blocking of the action potential generation in the primary afferent neuron.[9]

The results are in accordance with the study conducted by Muhannad A. Kashmoola (2005), Hadeel Saman et al.[6], Khademi et al.,[14] De Souza et al.[10] who have concluded that 75% of the patients reported a reduction in pain in the same session after LASER treatment.[9]

It is well-known that LLLT causes immediate analgesia in various painful oral lesions. To date, there are several suggested mechanisms for pain reduction following LLLT application, such as effect in modulating key factors of inflammation, reduction of the prostaglandin E2 level, inhibition of cyclo-oxygenase, and/or lymphocyte metabolism that could lead to reducing of edema, and further reduction of inflammatory processes.[4]

It was shown that the release of endogenous pain relievers – endorphins and enkephalins – increases the production of serotonin and suppresses bradikinin activity. It has also been shown that laser therapy increases systemic microcirculation by nitric oxide synthesis, causing reduction in swelling and pain. Even though several potential mechanisms are proposed, the real underlying mechanism following laser therapy for pain reduction is yet to be determined. It is believed that not just one, but two or more coexisting mechanisms or their combination are responsible for the beneficial outcome of LLLT in achieving analgesia. Apart from the documented analgesic effect, LLLT is successfully applied for tissue healing, mainly due to successful hemostasis, sterilization, and anti-inflammatory effect.[4]

According to the results of our study, the clinical parameter of pain was reported by patients to be less at the sites treated with laser therapy than at the other control sites. This effect is in agreement with the results of another study in which 10 patients were treated with 940 nm GaAs laser.[3]

The results are in accordance with the study conducted by Sana Mirzaa.[10] We reported some preliminary data about LLLT for patients in which most of the patients reported an immediate pain relief after the first sitting, and all of them reported a complete resolution of symptoms at the end of the laser sessions, even if some lesions had only a partial clinical response.[15]

***Group 2 with medication***

Pain intensity was less as compared to the intensity before treatment. Moreover, topical corticosteroids, such as hydrocortisone, in the anaginovag spray are effective and have two modes of action.

- Anti-inflammatory action and specific blocking effect of T-lymphocyte epithelial cell interaction. On the other hand, the mechanism of action of topical corticosteroids results partly from vasoconstriction; the vasoconstrictions may be a direct or indirect effect exerted by the reduction of catecholamine, prostaglandin, or histamine levels at target cell sites.
- The anti-inflammatory effects of topical corticosteroids also may result from interference with the migration of polymorph nuclear leukocytes through the capillary walls and from decreased adherence of WBCs to the capillary endothelium. This drug also exerts anti-inflammatory effects by interfering with the function of lymphocytes and macrophages and by decreasing the action of lymphocytes. The topical glucocorticoids also decrease cell membrane permeability, impair the release of toxins or lysosomal enzymes, and inhibit the release or action of other chemical mediators during the inflammatory process. These mediators normally contribute to increase vascular permeability and subsequent changes including edema, leukocyte migration, and fibrin deposition.[6]

***Most steroids will provide short-term pain relief, and***

1. some have the problem of being prescription **medications**
2. being **costly** and
3. having the potential for significant **side effects** and systemic implications.[6]

***Group conservative treatment***

There was only slight reduction in pain intensity after 3 days and 6 days, and duration of pain was the shortest.

***Comprise with other studies***

This is in accordance with Muhannad A. Kashmoola (2005) and Hadeel Salman et al.[6] who

had observed a significant decrease in the size of the lesion. De Souza et al.[10] reported that LLLT InGaA1P diode laser can cause reduction in pain and a total regression of the lesion.[4]

***Parameter with same laser***

The clinical parameter of pain was reported by patients to be less at the sites treated with laser therapy than at the other control sites. This effect is in agreement with the results of another study in which 10 patients were treated with 940 nm GaAs laser.[3]

***Using of other laser***

In the literature, four types of lasers have been used to treat aphthous ulcers: **$CO_2$**, **Nd:YAG**, **diode**, and **GaAlAs**. Although all of them have succeeded in providing immediate pain relief to patients, **$CO_2$** lasers have the unique advantage of requiring a very short exposure time (5–10 s).[1]

Diode laser wavelength $\lambda$ = 810–980 nm approximate the absorption coefficient of soft tissue pigmentation (melanin, hemoglobin, and doxyhemoglobin). Therefore, the light energy from the diode is highly absorbed by the soft tissues and poorly absorbed by teeth and bone. A 940 nm laser can be used to coagulate, cut, or ablate soft tissue, in a contact mode for enhanced surgical precision and tactile feedback, or in a noncontact mode.[18]

Other studies in the literature used different ranges of power in their treatment of minor RAUs (60 mW and 0.5W). Furthermore, the studies differed in other respects as well: the authors used very similar wavelengths in their treatments: 809 nm and 810 nm. In their meta-analysis, Enwemeka et al. (2004) studied the effect of low-power lasers (<500 mW) on conditions such as sores and ulcer wounds and concluded that laser therapy is effective at repairing tissue and controlling pain, although the outcomes may be influenced by the wavelength of the laser.[19]

Some studies concerning acute pain also revealed that lasers operating at infrared wavelengths led to more effective pain reduction. Other studies in the literature that were using other laser wavelengths, including 633 nm, 670 nm, and 904 nm.

These studies did not find significant differences in their results. Strong evidence suggests that wavelength plays an important role in the final results of RAU treatment. Future studies are encouraged to test the influence of different wavelengths on pain control and reducing the sizes of RAUs. The laser parameters described by the authors were GaAlAs semiconductor laser with a wavelength of 809 nm, 60 mW, 1800 Hz, a duration of 80 seconds per treatment, and a dose of 6.3 J/cm$^2$.[19]

Other studies have been noted in the literature regarding duration of action, both after diode lasers at 0.5 W in NCC mode and application of benzocaine 20% gel. It was observed that diode laser at 0.5 W in ncc mode application had rapid onset of 1–2 minutes and duration of pain-free period after diode laser at 0.5w in ncc mode application was 40–50 minutes.[20]

In comparison with our study, the laser unit was set at an output power of 0.5W, wavelength of 810 nm, applied in NonContact, Continuous (NCC) mode with a distance of 2–3 mm between the LASER tip and ulcer surface. The LASER beam was applied in a continuous sweeping motion so as to cover the entire ulcer surface.[20]

In addition, different kinds of lasers were successfully used in studies for the treatment of RAS. The **GaAlAs** diode laser, **He-Ne** laser, **argon** laser, **InGaAlP** laser, **Nd:YAG** laser, **diode** 830 nm GaAs (904 nm), $CO_2$ diode laser were used in case reports and studies. For cases with aphthous-like lesions in Behçet syndrome, $CO_2$ laser and GaAs (904 nm) were used successfully. For cases with aphthous-like ulcer in AIDS (Acquired Immune Deficiency Syndrome) cases, diode 660 nm laser were used with good results.[21]

Although the assessed literature demonstrated significant analgesia and enhanced RAS tissue healing following laser therapy without any reported side effects, a reduction in the sensation of pain

**TABLE 3.** Effects of Low-Level Laser Therapy (LLLT) Treatment of Recurrent Aphthous Stomatitis (RAS).[4,10,13,16,17]

| Author and the year of the publication (reference) | Laser device (wave length, emission mode) | Laser parameters | Anaesthesia prior to irradiation | Oral gel prior to irradiation | Laser distance (between laser and RAS lesions | Laser application | Observation period and follow-up | Treatment outcome |
|---|---|---|---|---|---|---|---|---|
| Zand et al. 2009[5] | $CO_2$ laser (10.600 nm) continuous emission mode | Power: 1W Irradiation time: 5–10 s | No | Yes | 5–6 nm (circular motion) | Single | Before immediately after, and 4h, 8h, 12h, 24h, 48h, 72h and 96h after irradiation | Immediate pain releif |
| de Souza et al. 2010[6] | InGaAIP diode laser (670 nm) continuous emission mode | Power: 50mW Energy density: 3 J/cm$^2$ Irradiation time: 60 s | No | No | Touching the surface of RAS | Daily (once per day) on consecutive days | Before immediately after irradiation and every day up to 10 days | Immediate pain releif Enhanced healing |
| Zand et al. 2012[28] | $CO_2$ laser (10.600 nm) continuous emission mode | Power: 1W Irradiation time: 5–10 s | No | Yes | 5–6 nm (circular motion) | Single | Before immediately after irradiation, and every day until the resolution of signs | Enhanced healing |
| Prasad et al. 2013[29] | $CO_2$ laser (10.600 nm) continuous emission mode | Power: 0.7W Irradiation time: 5–8 s | No | Yes | 5–6 nm (spiral motion) | Single | Pain: Before immediately after and 24h after irradiation Healing: Before 3–4 days after irradiation and up to 14 days | Immediate pain releif Enhanced healing |

associated with aphthous ulcers using an Nd:YAG laser (2 W, 25 Hz, non-contact 50–60 seconds) is described by Blandowski et al. (2014). The result here was an almost immediate analgesic effect (24 h). Similar results were obtained by Brader (2008) in the application of an Nd:YAG laser, with comparable parameters. It can be assumed that the basic differences in the parameters of pulsed Nd:YAG and diode lasers with regard to wavelength, pulse output power, and duration are not relevant for treatment success as long as the average values for irradiance, average output power, and treatment duration concur (Table 3). Thus, treatment with the infrared diode laser at 970 nm and similar average parameters produce similarly successful results.[22]

In another study, the laser started with the tip at eccentricity 5-8 mm from the lesion and moved slowly toward the area and away from the lesion by 2-3 mm and moved continuously from the periphery of the lesion to the center.

The setting was initially put at 0.6 W CW for 30–45 seconds. A refractory period of 15–20 seconds between lasers was given to allow the tissue to cool down. A second and third pass with the laser was further applied to decrease the pain of the area on palpation. A second pass was done with the setting of 0.7 W CW W (pulsed) for 30–45 seconds, and a third and final pass was completed with 0.8 W CW for a similar period of time.[8]

Although various types of lasers have succeeded in providing immediate pain relief to patients, carbon dioxide ($CO_2$) lasers have the unique advantage of requiring a short exposure time (5–10 s).[1]

## CONCLUSION

- LLLT is more effective in producing great reduction in pain, ulcer size, and duration of the apthous ulcer when compared with symptomatic treatment.
- In view of the discoveries of the present study, it can be presumed that LLLT is a successful methodology for the treatment of aphthous ulcers. It gives immediate pain relief and patients become more comfortable in swallowing and eating.

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