Comparative evaluation of low-level laser and CO₂ laser in treatment of patients with oral lichen planus


Abstract. A comparative evaluation of low-level laser and CO₂ laser therapies was performed, for the treatment of oral lichen planus (OLP). In a randomized open clinical trial, 28 patients with 57 lesions were randomly assigned to two groups. One group received CO₂ laser therapy, the other received low-level laser therapy (LLLT) for 5 sessions every other day. Participants were examined before the treatment, after 2 weeks, and at 1, 2 and 3 months, to assess the changes in sign and symptom scores. Improvements in size of lesions, in pain and clinical response scores were achieved in both groups. After 3 months, clinical response showed 100% and 85% partial to complete improvement in LLLT and CO₂ laser surgery, respectively. This demonstrates a quick and pronounced beneficial effect in controlling symptoms related to OLP. Both methods may be effective in the treatment of OLP, and can be used as alternative therapy alongside standard treatment modalities. The present study showed that LLLT displayed better results than CO₂ laser therapy as alternative or additional therapy, but further investigations in comparison with standard treatment modalities with a prolonged follow-up period will be necessary to confirm the efficacy of laser therapy in the treatment of OLP.

Keywords: oral lichen planus; laser CO₂; low level laser therapy.

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Oral lichen planus (OLP) is a common, chronic, immunological mucocutaneous disease that commonly involves the oral mucosa.1–3 This form is refractory to treatment.4 The most widely accepted treatment for OLP is topical corticosteroids that relieve the symptoms rather than cure the disease. The disadvantages of this treatment include candidiasis, thinning of the oral mucosa, patient compliance with the treatment, and discomfort during application.4,5 Alternative treatments include retinoid, cyclosporine, tacrolimus, and CO₂ laser surgery.4

Therapeutic laser treatment can be applied in many fields of dental research. Examples of successful clinical application of laser are CO₂ laser surgery in the oral cavity.6 An advantage of laser therapy is the sealing of blood vessels which reduces haemorrhaging during the operation. Post-operative oedema is reduced as lymphatic vessels are sealed, and pain related to the lesion is reduced or eliminated as nerve supplies are sealed. Laser decreases the possibility of cicatricial contractions. One of the most important benefits of laser
therapy is great patient compliance. It promotes tissue healing and reduces oedema, inflammation, and pain. In low-level laser therapy (LLLT), the ability to non-thermally and non-destructively change cell function is known as laser biostimulation and is the basis for the use of lasers. The advantages of this method are anti-inflammatory effects, acceleration of wound healing, analgesic effects, vasodilation and modulation of the immune system.5–8

In a clinical trial of 25 patients with OLP treated using diode laser (980 nm), 12% had recurrence.9 In a prospective cohort study, Cafaro et al. managed 13 unresponsive patients with OLP resistant to standard therapy using LLLT. They reported significant reductions in size and pain with no side effect.10

Regarding the chronic inflammatory nature of OLP, T-cell mediated autoimmune phenomena are thought to be involved in the pathogenesis of OLP.11 Therefore applying alternative methods such as LLLT, which aim to modulate inflammatory responses related to the disease, seems more reasonable and efficient than using methods such as CO2 laser surgery which deal with the symptoms.

CO2 laser surgery is still beneficial. It is thought that additional benefits can be achieved by simultaneously applying infra-red and red light in LLLT, to affect the surface and depth of the lesion. A method that is easier, less time consuming, and with a low recurrence rate might be more favourable than conventional therapies. The aim of this study was to compare the efficacy of LLLT with CO2 laser surgery in the treatment of OLP.

Materials and methods

The ethics committee of Tehran University of Medical Sciences, Iran, approved the study protocol. Informed consent was obtained from all participants.

28 patients with OLP (21 females and 7 males) were selected from those referred to the Department of Oral Medicine, Faculty of Dentistry, Tehran University of Medical Sciences between March 2009 and September 2010. Inclusion criteria were a clinical and histopathological diagnosis of OLP based on ‘a modified definition of the World Health Organization (WHO)’.12 Using this modified definition, the patients were clinically diagnosed with lichen planus owing to the presence of bilateral lesions and the presence of reticular lesions elsewhere in the oral cavity, and histopathologically diagnosed by the presence of well defined band-like zones of inflammatory infiltration confined to the superficial part of the connective tissue, consisting mainly of mature lymphocytes and vacuolar alteration of the basal layer of the epithelium. Patients demonstrating histological signs of dysplasia, lichenoid drug reactions, drug consumption in the past month, pregnancy or any localized or systemic disease were eliminated or asked to discontinue their treatment for a minimum of 1 month before entering the investigation, as were patients receiving immunosuppressive or immune-modulatory treatments, or any systemic or local drugs. Patients with lesions adjacent to an amalgam filling were excluded from the study sample.

The patients were evaluated by an oral medicine specialist for demographics, medical history, presence of pain and discomfort, duration of disease, type, size, and scores of the lesions, and these data were recorded.

This clinical trial was a balanced block open study. The patients were randomly assigned to two groups by separate pockets on which were written the name of a laser. Each pocket was read by enrolling a new patient to the study and the type of laser was determined. One group (n = 13 with 27 lesions) was given CO2 laser irradiation surgery (Deka, Italy, 10,600 nm, 3 W). The applied dose was determined from the results of a pilot study on 7 patients. The laser operation was carried out on an outpatient basis under local anaesthesia. The oral mucosa lesions were removed superficially with a defocused laser at about 3 W, and evaporation was continued until the sub-mucosal connective tissue was reached. For postoperative care, diphenhydramin syrup and an analgesic such as a non-steroidal anti-inflammatory drug (NSAID) were prescribed for 2 weeks.

The second group (n = 15 with 30 lesions) received LLLT using a diode laser (Mustang, Russia) with two probes, infra-red light (Ga–As, 890 nm, 0.3–0.5 J/cm2) and red light (633 nm, CW, 0.3–0.5 J/cm2). The selected dose was determined from a pilot study on 7 patients. Each patient received light exposure for 5 sessions every other day.

All participants, in both groups, were examined at baseline (before treatment), after 2 weeks and at 1, 2 and 3 months, to assess the effectiveness of treatment. During each appointment, the longest distance in centimetres from end to end of the reticular pattern, atrophic and erosive red area of the lesions was measured exactly with a scaled tongue blade, and digital photographs were taken.

Response rates were assessed clinically by three measures. First, a reduction in pain and discomfort (symptom). A visual analogue scale (VAS) was used to rank the severity of the patient’s symptom ranging from 0 (no pain) to 10 (extreme pain).14 Second, a reduction in the size of the lesions, determined by a scaled tongue blade.15,16 This was performed to compensate for the limitations of Thongprasom17 sign scoring, which determines only the measures of area ≥1 cm2 or <1 cm2. Third, a reduction in clinical response (sign). This was assessed by Thongprasom sign scoring as follows: 5 (white striae with erosive area ≥1 cm2), 4 (white striae with erosive area <1 cm2), 3 (white striae with atrophic area ≥1 cm2), 2 (white striae with atrophic area <1 cm2), 1 (mild white striae only), and 0 (no lesions, normal mucosa).13,18

Treatment outcomes were defined as changes in sign, symptom and size of the lesions between baseline and the last session. The symptomatic response, the clinical response and reduction of lesion size for each patient were calculated by subtracting each score from the initial score. Positive and negative values were considered as improvement and worsening, respectively.
**Statistical analysis**

The Mann–Whitney U-test was used for evaluation of clinical response scores and pain (VAS) changes compared to their baselines. The unpaired Student’s t-test was used for assessing the size reduction of the lesions. P values less than 0.05 were considered statistically significant.

**Results**

The study sample consisted of 28 patients suffering from OLP (7 males, 21 females) with a mean age of 50.7 years, and a total of 57 lesions. 30 lesions were treated with LLLT and 27 lesions were treated with CO₂ laser surgery. The LLLT group consisted of 4 males and 11 females, the CO₂ laser group consisted of 3 males and 10 females. The buccal mucosa was the most common site for OLP (48%), followed by the gingiva (33%) and tongue (19%).

There was no significant difference in the mean baseline lesion (before treatment) size between LLLT (mean ± SEM; 3.2 ± 0.2 cm) and CO₂ laser surgery (3.1 ± 0.2 cm). The unpaired Student’s t-test showed that the lesion size reduction was significantly higher in LLLT than CO₂ laser surgery in all the follow-up stages (P < 0.05); Fig. 1).

The median (min, max) clinical response scores at baseline were 5 (2, 5) in both CO₂ laser surgery treated and LLLT patients. The clinical response (sign) improved during follow-up in both groups. Approximately 85% of the CO₂ laser surgery group experienced partial to complete clinical improvement, but 15% had no response. In the LLLT group, 100% demonstrated partial to complete improvement (Figs. 2 and 3). There was a significant difference in clinical response between the two groups. Improvements in clinical signs were significantly higher in the LLLT group in all follow-up stages (P < 0.05; Table 1).

Median (min, max) pain scores at baseline were 2 (0.5, 7) and 2 (0, 7) in the CO₂ and LLLT groups, respectively. Improvement in pain scores was achieved in both groups. A significant difference in symptomatic response was observed between the two study groups (P < 0.05). Amelioration in symptomatic response (pain) was significantly higher in the LLLT group in all follow-up stages (Table 2).

**Discussion**

OLP is a common chronic immunological disease the treatment of which remains a challenge for clinicians. There is no definitive treatment for OLP. Corticosteroids are the most widely accepted treatment for OLP, which relieve symptoms rather than curing the disease.

Although the cause is not well-known, T-cell mediated autoimmune phenomena are thought to be involved in the pathogenesis of OLP.⁷ Thus, applying alternative methods that aim to modulate inflammatory responses related to the disease seems reasonable and efficient.

One of the principal goals in dentistry is to provide painless treatment for the patient. Therapeutic laser treatment, also

**Table 1.** Lesion improvement as a percent of clinical response in CO₂ laser surgery and LLLT compared to the initial score in patients suffering from OLP.

<table>
<thead>
<tr>
<th>Clinical response</th>
<th>Follow-up sessions</th>
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<tbody>
<tr>
<td></td>
<td>2 weeks</td>
</tr>
<tr>
<td></td>
<td>CO₂</td>
</tr>
<tr>
<td>−2 (2 degrees worsening) (%)</td>
<td>7</td>
</tr>
<tr>
<td>0 (no change) (%)</td>
<td>63</td>
</tr>
<tr>
<td>1 (degree improvement) (%)</td>
<td>4</td>
</tr>
<tr>
<td>2 (2 degree improvement) (%)</td>
<td>15</td>
</tr>
<tr>
<td>3 (3 degree improvement) (%)</td>
<td>11</td>
</tr>
<tr>
<td>4 (4 degree improvement) (%)</td>
<td>0</td>
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<tr>
<td>5 (5 degree improvement) (%)</td>
<td>0</td>
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</table>
referred to as LLLT, offers numerous benefits. Along with the primary benefit of being non-surgical, it promotes tissue healing and reduces oedema, inflammation and pain. It can provide a non-invasive, sterile and painless treatment. The principle of using LLLT is to supply direct biostimulative light energy to the body’s cells.

Some advantages of LLLT are acceleration of wound healing, anti-inflammatory effects, increase in cellular metabolism, modulation of the immune system, vasodilatation and analgesic effects, and amelioration of morphine withdrawal. The ability to non-thermally and non-destructively change cell function is known as laser biostimulation and is the basis for the current use of lasers in a number of medical fields.

The biostimulation rule (Arndt–Schultz) notes that a low-grade dose of energy stimulates biologic processes and a high-grade dose of energy inhibits them. LLLT (photostimulation) involves the use of visible red and near-infrared light with tissue to stimulate and improve healing and reduce pain. The incident wave length determines the effects. Visible light is transmitted through the superficial cellular layers (e.g. the dermis, epidermis and the subcutaneous tissue). Light waves in the near infrared ranges potentially penetrate several millimetres and these wave lengths are used to stimulate deep cellular functions. Therefore, in this study, the authors applied two wavelengths, visible red (633 nm) and infra-red (890 nm), to treat OLP lesions. To the best of the authors’ knowledge, this paper reports the application of two low-level laser lights for the first time.

CO2 laser is one of the most efficient and beneficial lasers in dentistry. It is the established treatment (by evaporation) for superficial mucosal lesions. Some of its advantages are incision with no loss of blood, wound healing with little scarring and few recurrences. According to the authors’ results, a downward shift of the VAS score occurred in both laser groups at the end of the follow-up period, but it was more pronounced in LLLT. This finding is consistent with the authors’ proposed theory regarding the analgesic effect of LLLT based on biostimulation.

This study also showed a significant difference in the clinical response between the groups, which included a decrease in lesion size and transformation of erosive to atrophic or reticular forms; results were more pronounced in the LLLT than in the CO2 group. After 3 months, 35% of the patients showed 2 degrees of improvement, 31% 3 degrees, 19% 4 degrees and 15% 5 degrees of improvement with LLLT. So 100% of these patients demonstrated partial to complete improvement. In comparison, with CO2 laser surgery, 45% of the patients revealed 1–2 degrees of improvement, 18% 3 degrees and 22% 4 degrees of improvement. This demonstrates a quick and pronounced beneficial effect in controlling symptoms related to OLP. This is consistent with the effect of LLLT in improving healing. A few lesions showed complete responses with laser therapy. Considering the increased pre-malignant potential of erosive lesions compared with atrophic and reticular forms, the transition of the former to the latter types may be an important outcome of the current investigation.

Previously, the authors have used methylene blue mediated photodynamic therapy to treat OLP. In that study, 13 patients with 26 OLP lesions were enrolled. Patients were instructed to gargle a 5% methylene blue solution in water for 5 min. After 10 min, irradiation was performed by laser light 632 nm (120 J/cm2). Lesions were evaluated pre- and post-operatively, and at follow-up sessions for up to 12 weeks, for changes in sign and symptom (pain) scores, and size of lesions. Improvement in sign scores was achieved in 16 lesions. Eight lesions improved 2 degrees, 8 lesions improved 1 degree, and 10 lesions showed no reduction. That study was a before–after open trial, while the present study has been performed as a balanced block open study. In the present study, two laser lights were applied in order to affect both the surface and the depth of the lesions to boost the efficacy of the treatment. In addition to observing reduction in pain scores and size, the authors demonstrated significant improvement in clinical responses after 3 months.

Previously, the authors routinely treated OLP patients with corticosteroids. The main problem they observed was recurrence a short time after treatment (mean time, 1 month). Since the cause of OLP is unknown, it has no real cure. The authors searched for a procedure that, in addition to remitting signs and symptoms, increased the time before recurrence. Before starting treatment, the authors stipulate that patients must cooperate with them for at least 3 months after the end of therapy, otherwise they are excluded. This time was chosen following to the authors’ previous study. If local corticosteroid therapy had been used as a control in the present study, the results of the efficacy of laser therapy from this study could be more potent. In the present study, two laser lights were applied in order to affect the surface and the depth of the lesions to boost the efficacy of the treatment. In addition to observing reduction in pain scores and clinical responses, significant improvement in lesion size was demonstrated after 3 months.

In conclusion, this study showed that LLLT displayed better results than CO2 laser therapy as alternative or additional therapy, but further investigations in comparison with standard treatment modalities with a prolonged follow-up period will be necessary to confirm the efficacy of laser therapy in the treatment of OLP.

### Competing interests

None declared.
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Ethical approval
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