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RESEARCH ARTICLE
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MANAGEMENT OF ORAL LICHEN PLANUS BY THE APPLICATION OF CARBON DIOXIDE LASER: A SYSTEMATIC REVIEW

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Abstract:
The purpose of this review article was to determine whether carbon dioxide (CO_2) laser treatment is beneficial for oral lichen planus and to provide the most recent, comprehensive information that includes any new developments. This systematic review was completed from March 2022 to December 2023 at Udayan Dental College and Hospital, Rajshahi, Bangladesh. Search categories were specifically followed to databases like PubMed, PubMed Central, Cochrane, Medline, Embase, Cross Ref and in Google Scholar. Articles published between 2014 and 2023 were reviewed using MeSH (Medical Subject Headings) terms for example oral lichen planus, carbon dioxide laser, and oral premalignant condition. A total of 90 articles were selected to review, however following analysis, only ten articles met the predetermined inclusion and exclusion criteria. Among these publications, 2 retrospective studies, 1 prospective study, 2 clinical trials, 1 comparative study, 1 non-randomized controlled trial (NRCT), 1 scoping review, 1 single arm intervention study, and 1 case report were reviewed. This systematic study concludes the carbon dioxide laser is a very proficient tool for treating widespread lesions and is effective in the management of oral lichen planus. Recurrence frequency of the lesion was fewer after absorbed at a preliminary stage by the application of carbon dioxide laser.

Keywords: Carbon dioxide laser, Oral lichen planus, Oral mucocutaneous lesion.

Introduction:

The mucosa of the mouth is affected by oral lichen planus (OLP) which is a mucosal-type lichen planus. As a result, lesions that form in the oral mucosa are a chronic inflammatory condition with an autoimmune component and an unknown etiology [1,2]. Based on clinical appearance, OLP has recently been classified into three basic or elementary types: (i) reticular/hyperkeratotic, which is usually painless; (ii) erythematous/erosive (iii) and ulcerative. Both ulcerative and erythematous types can significantly lower the quality of life because they are typically symptomatic and accompanied by pain and a burning sensation. [3,4]. OLP lesion typically affect the dorsal and ventral surface of tongue as well as buccal mucous membranes inside the oral cavity [5]. OLP is classified as an oral potentially malignant condition (OPMD) declared by the World Health Organization (WHO) [6]. Oral lichen planus (OLP) is not a self-resolving condition due to presence of its cutaneous counterpart [7]. Globallyaround 0.98 percent of persons have OLP, with a higher frequency in those age is over 40.OLP often manifests ages ranging of 30 and 60, with middle-aged women making up the majority of patients [8,9]. Therefore, it is crucial to manage and treat OLP lesions. Since the origin of OLP is unknown, a variety of treatment approaches have been established but the major goal has been to manage pain as well as burning sensation and symptoms rather than treat the illness. Because of fewer side effects of topical steroids than systemic steroids, they have been regarded as the predominant treatment for OLP [10,11].

As intralesional corticosteroids deliver a high concentration of corticosteroids locally with limited systemic absorption, a recent comprehensive review found that they are an effective therapeutic option with fewer adverse effects than other topical corticosteroids. [12,13]. However, persistent topical corticosteroid therapy is required due to the chronic clinical features and high recurrence rate of OLP [14]. Several long-term side effects like secondary fungal infections, thinning of the oral mucosa, tingling or burning sensation, and cushingoid appearance could be the reasons. Additionally, some OLP patients do not respond to corticosteroids or are intolerant of them [12,15].It has been suggested that laser irradiation has anti-inflammatory properties. It has a thermal effect and reduces the chemotaxis of polymorphic nuclei present in pathogenic cells, which causes microbial cell wall breakdown, alteration in protein and eventually microbial cell destruction [16]. The basic laser treatments are neodymium-doped yttrium aluminum garnet (Nd: YAG) and Erbium-doped yttrium aluminum garnet (Er: YAG) laser (ERL) irradiation [17]. 1064 nm infrared Nd: YAG laser accelerates healing, improves local blood circulation, and immediately lowers discomfort and pain by permeating deeper structures into tissues.[18]. Hence, resulting new relevant treatment for OLP with less adverse effects is necessary [19].As CO_2 laser efficiently lowers indications and symptoms, it has been introduced as a promising therapy for OLP [20]. Furthermore, CO_2 laser reduces OLP's recurrence rate and malignant transformation [21].CO_2laser has been selected for the management of superficial oral mucosal lesions by photothermal excision or vaporization because of the optimal absorption of the CO_2 beam in oral soft tissues. An innovative option for treating big superficial lesions is vaporization. Many benefits come with using a CO_2 laser during surgery, such as less thermal damage to the supporting tissue and underlying structures, a bloodless surgical field, shorter recovery period, no need for dressings or sutures, minimal pain and edema following surgery, and invisible scarring even when secondary intention healing occurs[22]. CO_2 laser technology is used to treat problems that could become malignant [23].

The heat produced from the CO_2 laser blocks nerve endings, vaporizes and carbonizes tissue, seals lymphatic and blood vessels, and sterilizes wounds [5]. According to a recent systematic review and a few clinical trials, more rigorously defined inclusion criteria and trustworthy outcome measures are needed for randomized controlled trials contrasting CO_2 laser vaporization with a topical corticosteroid that is the conventional therapy technique [2,24-26]. The aim of this review is to summarize the progressions and systematically assess the efficiency of CO_2 laser therapy in the management of oral lichen planus to afford concepts for imminent medical conduct.

MATERIALS AND METHODS

Protocol and Focused Question

This review article was constructed using the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure [27] and according to the Population, Intervention, Comparison or Control and Outcome (PICO) principle. The focused question of interest was "what is the effectiveness of Carbon dioxide Laser on oral lichen planus (OLP) and clinical resolution in patients? "Pain reduction by visual analog scale (VAS) reported by the patient's self-assessment, dentist overall assessment were considered primary outcomes. The secondary outcomes were reduced size of lesion, the incidence of adverse effects associated of signs with the treatments and transformation of lesion to malignancy.

Information Sources and Search Strategy

This review work was prepared between March 2022 to December 2023 at Udayan Dental College and Hospital, Rajshahi, Bangladesh, Dhaka Dental College, Dhaka and Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. Searches were carried out in the PubMed, PubMed Central, Cochrane Library, Medline, Embase, CrossRef, Science Direct and lastly, a random search was too finished in Google Scholar databases by using key-words. The articles were investigated between the timeline 2014 to 2023. The following MeSH (Medical Subject Headings) keywords "Oral lichen planus, oral premalignant condition, CO_2 laser, carbon dioxide laser" were used for the search in the above databases.

As of the systematic search, a total of 90 papers were obtained from the above databases and the references to the above articles were also considered, if they were relevant to the review. Among the articles, 18 were also obtained from Google Scholar and back references.

Inclusion criteria: It included original articles, all clinical studies including Randomized controlled clinical trial (RCT), cohort studies, case-control studies, case reports, systematic reviews, and free articles.

Exclusion criteria: Review articles about CO_2 laser in treating OLP and oral leukoplakia, newsletters, letters to the editor, articles with non-structured abstracts, treatment of OLP and oral leukoplakia other than CO_2 lasers, and usage of CO_2 laser other than oral cavity.

Based on the above inclusion and exclusion criteria, the articles obtained were filtered. A total of 25 articles were relevant. On further analyzing the articles, due to the irrelevant content, 9 full articles and 1 structured abstract were finally selected and rest were excluded.

Eligibility Criteria

The systematic review evaluated only published studies pertinent to Poly cystic ovary syndrome (PICOS) query (Table 1).

Table 1: Eligibility Criteria for the Systematic Review

Domain	Inclusion Criteria	Exclusion criteria
Participants	Patients with symptomatic oral lichen planus, lesions and surgery in the oral cavity, such as oral leukoplakia, oral lichen planus, removal, oral premalignant lesion, oral malformations.	Treatment in other than oral cavity.
Intervention	The application of the CO_2 laser alone or in combination with other methods, active topical drugs and topical medications	Nonsurgical usage of the CO_2 laser in oral cavity.
Comparison	Other processes or not taking therapy at all	-
Outcome	Outcomes that measure the effectiveness of CO_2 laser surgery, such as bleeding, wound healing, pain, recurrence rate and other postoperative complications.	Studies that did not use the CO_2 laser.
Study design	Prospective, retrospective, clinical trials, non-randomized controlled trial, case reports, Single arm intervention study and comparative studies.	Systematic reviews with or without narrative reviews, short communications, letters to the editors and case series.

Screening and Selection of Studies

Screening of the titles and selection of abstracts for potential inclusion in the reviews as carried out independently by two reviewers. Studies were selected for full-text reading if: (i) the title, the

abstract, or both included search keywords and the information related to the eligibility criteria; (ii) relevant titles but the abstracts did not include information concerning the eligibility criteria; (iii) relevant titles but without abstracts. The full-text papers were read thoroughly to choose those that fulfilled the eligibility criteria.

Data Extraction or Assessment of Heterogeneity:

The following information used from the selected papers for data extraction:
(1) Study characteristics, such as first author and the publication year
(2) Study type and sample
(3) Study aim/objectives
(4) Study population: patients with symptomatic OLP, gender, age range
(5) CO_2 laser parameters (wavelength, radiation mode, power output and the focus type)
(6) Intervention and Comparison: other therapies, pain improvement (VAS) and others, follow up period, clinical resolution and adverse effects
(7) The Outcomes/Conclusion of the study

RESULTS

Selection of papers

Initially, the search identified 90 papers. 35 papers were excluded after screening the title and 30 were excluded after reading the abstract due to their irrelevant nature. 15 papers were excluded after full reading because the content did not meet the inclusion criteria of the study. The remaining 10 papers were selected for the systematic review and further analysis (Figure 1).

General Characteristics of Included Studies

Study design, evaluation period, sample size, medications, gender distribution, type of intervention and control of each study are summarized and demonstrated in Table 2. All the included studies were controlled clinical studies comparing the effect of CO_2 laser with another type of treatment. Among these, 2 were retrospective studies, 1 were prospective study, 2 clinical trials, 1 Comparative study, 1 was a Non-Randomized Controlled Trial (NRCT), 1 was a scoping review,1 was a single arm intervention study and1 was a case report.
Diagnoses of lichen planus were based on clinical and histopathological findings. The tongue was the most common sites of OLP. Table 2 displays the descriptive features of the studies.

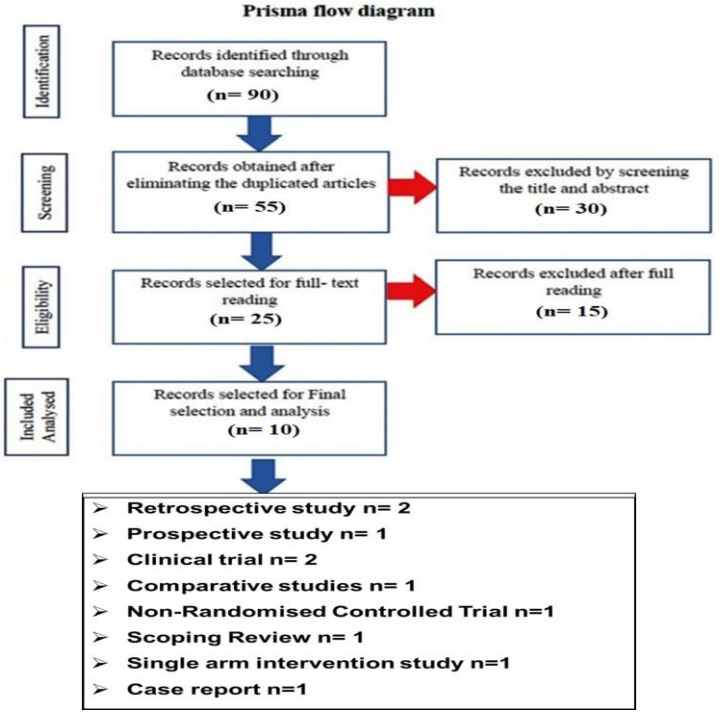

Figure 1: PRISMA flow diagram for research stages

Table 2: Experimental studies comprised in the existing study

Author	Study Type	Aim/objectives	Population	Intervention	Outcomes/Conclusion
Pakfetrat et al. 2014[28]	Clinical Trial	To investigate the efficacy of CO_2laser surgery for management of refractory erosive-atrophic oral lichen planus (OLP).	10 patients with 13 erosive-atrophic OLP resistant to standard therapy. Age range 35 to 64 years.	The severity of pain and discomfort was determined using a Visual Analogue Scale (VAS) score. Follow-up -1 month, 3 months	CO_2 laser surgery is effective for management of erosive-atrophic oral lichen planus (OLP).
Mozafari et al. 2015[29]	Non-Randomised Controlled Trial	To evaluating the therapeutic effects of CO_2 laser therapy on OLP	50 patients diagnosed with histopathologic OLP. Group 1: 25 patients, Group 2: 25 patients	Control group: retreated with local corticosteroid; Experimental group: treated with CO_2 laser, follow-up at one, three and six months after it, pain level was measured with VAS.	Radiation of CO_2 laser on OLP lesions that are resistant to local corticosteroid can reduce pain level and lesion size more than therapy with corticosteroid.
Huang et al. 2015[30]	Retrospective study	To evaluate the safety and advantages of using carbon dioxide (CO_2) laser	77 patients with OL, Group 1: 47 patients, Group 2: 30 patients	Group 1: treated with laser evaporation using Nd: YAG laser, Group 2: treated with CO_2 laser for excision, mean follow-up at 60 months.	22 patients with recurrence at follow-up. No significant difference between the groups
Mucke et al. 2015 [21]	Prospective study	To determination of the incidence of malignant transformation of OLP patients that were managed with a defocused CO_2laser	171 Patients Group 1- Symptomatic conservative treatment-103 patients Group II- Defocused CO_2laser-68 patients	CO_2laser surgery treatment was compared with conservative symptomatic management.	This study provides insight into the potential impact of the CO_2 laser in the management of patients with erosive OLP as well as malignant transformation to oral squamous cell carcinoma.
Cloitre et al.2018 [31]	Retrospective Study	To estimate the recurrence and the malignant transformation rates treated with CO_2 laser.	Out of 46 patients, 21 were excluded. 25 patients were included: 14 men and 11 women, 3 OLP was identified	Follow-up ranged from 12.3 to 50.7 months. Annual recurrence rate was 18.3%.	CO_2 laser vaporization has high recurrence rates, particularly those presenting hyperplasia.
Saibene et al. 2019[32]	Clinical Trial	To evaluate the outcomes of CO_2 laser surgery in the outpatient management of oral lesion.	78 patients (41 males and 37 females; age range 14-83 years.	All patients were prescribed to apply during the following 2 weeks two gels on the surgical site: a 0.5% chlorhexidine gel and amino acid and hyaluronate gel.	This work permitted to highlight strongly positive outcomes on outpatients' laser surgery for oral lesions treatment.
Matsumoto et al. 2019[20]	Single Arm Intervention study	To evaluate the efficacy of CO_2 laser therapy for oral lichen planus to conservative treatments.	16 patients with clinically and histologically diagnosed OLP.	irradiation compared with pre-irradiation scores. Follow-up-7 days, 1 month, 3 months, 6 months and 1 year	CO_2laser vaporization therapy was more efficient than conservative treatment.
Dalirsani and Seyyedi2021[33]	Case report	To perform laser therapy for OLP	8 patients, age range 30-77 years.	In some patients, mild keratotic lesions were observed in the follow-up sessions. Most patients were satisfied with treatment process and reported mild burning after treatment.	CO_2 laser could be employed for OLP lesions; however, some degrees of recurrence may occur.
Beulah et al. 2023[26]	Scoping Review	To determine the efficacy of carbon dioxide laser in treating OLP.	16 articles based on the preformed inclusion and exclusion criteria had been selected.	CO_2 laser therapy compared to patients who received analgesics and steroids.	Carbon dioxide laser was very efficient in treating larger size lesions. Recurrence rate of the lesions was very less when treated at an early stage.
Ibrahim et al. 2023[13]	Comparative study	To compare clinical efficacy and recurrence rates between CO_2 laser vaporization and intralesional triamcinolone injections in the management of OLP.	16 patients (10 female and 6 male; mean age of 44.8 ± 12.6 years) with bilateral symptomatic OLP lesions.	Comparison of variables between CO_2 group and triamcinolone acetonide (TA) group, follow up for 9 months.	CO_2 laser was more effective than triamcinolone acetonide (TA) after a single session with minimal side effects.

Summary of benefits of using CO_2 laser: There was a significant reduction in pain and lesion size in subsequent follow-up periods [28]. The healing following laser removal progressed well.

Summary of parameters using CO_2Laser of included studies

Follow-up periods: Seven studies stated follow-up period, which ranged from 7 days to 60 months. There was a significant reduction in pain and OLP lesion size in subsequent follow-up periods. Regular follow-up is required to reduce the size of the lesion. [33] The sign scores of the lesions were also significantly improved at follow-up periods. At the 3-month follow-up, the complete disappearance of the erosive/atrophic area was observed in 54% of the lesions [28]. There was a significant difference between the pain levels of the two groups in different follow-up periods [29]. Nine patients with 11 sites were treated with CO_2 laser vaporization, showed a significant reduction in pain and TSS score 1 year after irradiation [20]. The complications and recurrence were evaluated in the follow-up sessions [33]. During the 9-month follow-up, seven patients showed recurrence only on the TA side, five patients showed recurrence on both sides, and four patients did not show recurrence on either side. No one of the patients showed recurrence on the CO_2 side alone. The recurrence rate for a 9-month follow-up was 31.3% in the CO_2 group, and all the recurrent cases were asymptomatic; in the TA group, the recurrence rate was 75%, and most recurrent cases were associated with pain [13].

VAS and other scores: The patients were evaluated for a reduction in pain and clinical scores based on changes in the appearance and severity of the lesion. In this study, pain was measured by Visual Analogue Scale (VAS) score, Numerical rating scale (NRS) score, Thongprasom sign score (TSS) and reticular–erythematous–Ulcerative (REU) score. Lesion diameter also evaluated using CO_2 laser treatment. At the end of the follow-up period, 8 patients reported no pain and 2 patients exhibited downward shift of the VAS from score 3 to score 1[28]. There was no significant difference between the two groups in regard with their mean VAS and lesion diameter [29]. VAS score was 2.5 points after 24 hours and 0 points after 7 days of surgery [32]. It was used a different score for assessing pain. The Numerical rating scale (NRS) score and Thongprasom sign score (TSS) were statistically lower at 1 and 3 months (short-term) and 6 months and 1 year (mid-long-term) after irradiation than the preirradiation scores. By the CO_2laser treatment, the reticular–erythematous–Ulcerative (REU) score, Thongprasom sign scoring (TSS), visual analogue scale (VAS) scores and lesion diameter improved significantly [13,20].

CO2 laser over corticosteroids: The size of the lesion and pain level showed no changes in both the groups of corticosteroids and CO_2 laser. But at the end of the study, the efficiency level of laser therapy was higher than that of systemic corticosteroids. The size of the lesion and the pain level decreased in the case of CO_2 laser therapy [28].In another study, CO_2 laser vaporization was compared with topical corticosteroids in treating OLP lesions [29].

Mode of CO_2 lasers: Table 3 showed a great variation in the laser parameters used in the included studies. In all 10 papers, CO_2 laser was used with wavelengths ranging from 9600 nm to 10966 nm and power output ranging from 0.3-20 Watt. The CO_2 laser machine has 3 modes such as Continuous Wave (CW) defocused, CW scanner, and Super Pulse (SP) scanner [26]. Studies have proved that CW defocused mode was found effective in treating a premalignant lesion in recurrent cases and long-term follow-up was also found successful [21,26,31].

Table3: Mode of CO_2 laser parameters of included studies

Serial No.	Author	Wave length (nm)	Power output (Watt)	Consequence
1	Pakfetrat et al. (2014)	10600 nm slightly defocused	5 W	This study showed a significant relief in pain and discomfort after laser treatment.
2	Mozafari et al. (2015)	10600 nm	2 W	The study showed that laser therapy caused reduction in lesion size

				observed during the 6-month period.
3	Huang et al. (2015)	10600 nm	3.1 W	
4	Mucke et al. (2015)	Focal Length-125 mm Defocused beam-15	1 to 2-W	Continuous CO_2 laser treatment significantly reduced OLP lesions.
5	Cloitre et al.2018	10966 nm Focal Spot beam-4	10 to 20 W	After CO_2 laser vaporization noted minor complications.
6	Saibene et al. (2019)	9600, 10600 nm continuous and pulsed mode	4 W 6w	The CO_2 laser proved to be a painless surgery as most patients had low pain levels.
7	Matsumoto et al. (2019)	10600 nm Continuous wave Depth ~1-2 mm	3 W	The TS and NRS scores dropped dramatically after treatmentCO_2 laser.
8	Dalirsani and Seyyedi(2021)	10600 nm Continuous wave	4–7 watt	CO_2 laser accelerates wound healing.
9	Beulah et al. (2023)	10600 nm Continuous wave	0.3-20 W	CO_2 laser shows great efficacy in treating OLP.
10	Ibrahim et al. (2023)	10,600 nm continuous defocused mode	3 W; power density was 1527.8 W/cm2.	CO_2 laser vaporization effectively treat OLP lesions.

Recurrence rate of OLP treated with CO_2 laser: This article informed a range of 21%–44% for recurrence of lesions of oral lichen planus and leukoplakia, after CO_2 laser treatment. This wide range of reported recurrences could be related to various follow-up times and different types of lesions and different techniques for using CO_2 laser, which leads to various degree of destruction of the cells [21,31]. Mückeet al. 2015[21] reported a recurrence frequency of 38.2% for erosive lichen planus in a mean period of 42.7 months. CO_2 laser has implications in the management of patients with erosive OLP and has an effect on the recurrence rate of erosive OLP. Dalirsani and Seyyedi(2021) expressed CO_2 laser could be employed for OLP lesions; however, some degrees of recurrence may occur. Recurrence rate of the lesions was very less when treated at an early stage [26,33]. The efficacy of CO_2 laser with TA intralesional injection in managing OLP where decreased recurrence rates. This study also showed a lower recurrence rate and longer remission time within 9 months after treatment in the CO_2 group than in the TA group. Moreover, in contrast to those in the TA group, in which more than half of the recurrent lesions were painful, recurrent lesions in the CO_2 group were asymptomatic [13].

Comparison of CO_2 laser with other lasers: The total number of articles collected under this category was 2. The other lasers like Nd: YAG and LLLT laser were also found to be effective in treating OLP. The Nd: YAG laser shared many of the advantages of the CO_2 laser, but its unique feature was that it could be utilized in both a contact excision and non-contact coagulation mode. Lesions with a small surface area were most efficiently treated with Nd: YAG laser as it has a very precise contact mode of delivery. The recurrence rate of OLP when treated with Nd: YAG laser was also very less when compared to CO_2 laser [26]. LLLT has a property called laser bio modulation. It can change the cell function, non-thermally and non-destructively. It has additional benefits when compared to CO_2 laser by simultaneously applying infra-red and red light to affect the surface and depth of the lesion. It has a low recurrence rate and is easier and less time-consuming. The efficacy of CO_2 laser compared with TA intralesional injection where the CO_2 laser vaporization was more effective than TA intralesional injection in managing OLP [13, 20].

Main Outcomes

Pakfetrat et al. 2014[28] applied CO_2 laser in continuous-wave mode with medium output power to vaporize the epithelial layer of oral lichen planus (OLP). Their result indicated that the CO_2 laser surgery is an effective modality for management of erosive-atrophic oral lichen planus.

Mozafari et al. 2015[29] designated that treatment with CO_2 laser is significantly more effective than corticosteroids.

Huang et al. 2015[30] used the carbon dioxide (CO_2) laser to treat oral lesions and stated its safety and benefits. Furthermore, they stated that CO_2 laser application reduced bleeding.

Mucke et al. 2015 [21] highlighted the latent effect of the CO_2 laser in the treatment of patients through erosive oral lichen planus.
Cloitre et al. 2018 [31] assessed the recurrence and the malignant transformation rates of oral potentially malignant disorders treated with CO_2 laser and found a high recurrence rate.
Saibene et al. 2019[32] confirmed that CO_2 laser as a valid option for treatment of oral lesions as vaporization or removal. They also allowed CO_2 laser surgery is effective for a wide range of oral lesions.

Matsumoto et al. 2019[20] evaluated the efficacy of CO_2 laser vaporization on refractory to conservative treatments for oral lichen planus (OLP). The NRS score and TSS were statistically lower after irradiation than the pre-irradiation scores. The CO_2 laser therapy showed adequate efficiency for oral lichen planus in their study.
Dalirsani and Seyyedi 2021[33] hypothesized that CO_2 laser can be employed to remove OLP lesions but some intervention is required to reduce the risk of malignant transformation.
Beulah et al. 2023 [26] illustrated the CO_2 laser treatment can be given as a first line of therapy even before the use of corticosteroids. Moreover, Carbon dioxide laser was very competent in treating larger size lesions.

Although CO_2 laser vaporization is considered a relatively aggressive and high-cost treatment, however, Ibrahim et al. 2023 [13] demonstrated that CO_2 laser was more effective than TA in the management of oral lichen planus and reduced the recurrence rate.

Risk of Bias
The results of the risk of bias analysis are displayed in Table 4. The information gathered for the risk of bias from 4 selected papers. Only 1 paper [32] was at moderate risk bias while the remaining 3 papers were at high-risk bias [13,20,28].

Table 4: Risk of Bias of the involved selected studies

Investigators	Sequence Generation	Allocation Concealment	Blinding of Study Participants and Personnel	All Patients Accounted for at the End of the Study	Clear Explanation of Withdrawals	Selective Reporting	Over Risk of Bias
Pakfetrat et al. (2014) 28	High	High	High	Moderate	Moderate	High	High
Saibene et al. (2019) 32	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Matsumoto et al. (2019) 20	High	High	High	High	Moderate	Moderate	High
Ibrahim et al. (2023) 13	Moderate	High	High	High	High	High	High

DISCUSSION:
For the management of oral lichen planus, CO_2 laser is currently a useful treatment protocol. The purpose of this systematic review was to confirm that the CO_2 laser is a successful treatment for oral lichen planus (OLP). This systematic review included clinical trials, retrospective, case reports, scoping reviews, prospective and comparative studies. As oral lichen planus is a long-lasting, provocative disease that is characterized by deterioration and delayed therapy, it has a long-lasting negative impact on the quality of life of the patients and sufferings for them. The distinct characteristics of the research were initiated from a refractory or new case of oral lichen planus (OLP), the size and duration of the lesion, the follow-up period, the mode of the CO_2 laser, the wavelength of the CO_2 laser, the length of time the of CO_2 laser was in contact with the tissue, and the brand of the laser machine [34]. Unlike cold-knife surgery, laser surgery does not physically damage tissue and provides immediate sterilization and increased visibility[35].

The following act as a concise summary of the benefits that come with using a CO_2 laser: Ablation of tissues with precision, particularly; since the additional benefits of magnification and fine beam control of the operational microscope and microscope manipulator are considered; negligible damage to the neighboring tissues when the power density of the laser decreases significantly after passing this threshold as a consequence of energy absorbed by the tissue at which it is targeted; improved sight of the crucial bloodless operative area is made possible by the instant hemostasis effect of sealing tiny vessels; increased regular tissue recovering by reducing factors (like the quantity of myofibroblasts within the wound and the amount of the collagen matrix established) which cause scar tissue and wound contraction and also interfere with the function of oral soft tissue; construction of a physiological covering over the surgical site to reduce post-operative pain and tissue swelling; lastly, effective excision and destruction of all aberrant mucosa to minimize disease recurrence locally[36,37].
Furthermore, compared to cold tools and anatomically based resections, the optimization of the broad excision accomplished leads to enhanced postoperative functional outcomes, including speech and swallowing.[3].There are options for laser and surgical treatment for OLP when conventional therapy is ineffective. Despite indications that CO_2 lasers are more successful and have fewer adverse effects than other treatment modalities, they are also the most expensive.[31]. A wide variation in the laser parameters used in the included studies. CO_2 laser with wave lengths ranging from 9600 nm to 10966 nm and power output ranging from 0.3-20 Watt was applied. Three modes are available for the CO_2 laser machine: defocused Continuous Wave (CW), CW scanner, and Super Pulse (SP) scanner. Research has demonstrated that in repeated occurrences, CW defocused mode was found to be useful in treating a premalignant lesion.

In the majority of studies, the CO_2 laser, either by itself or in combination with other therapy, proved beneficial in treating infections that necessitated oral surgery[5, 15, 39].
In previously conducted studies, low-power lasers with low range and different powers were reported with an improvement level of 25-85% while in the present study power of 2 W and improvement of 84% were recorded. In previous studies, low-power laser of 308 nm in the range of ultraviolet waves (UV-B) with penetration depth of 0.3 mm was used while in the present study 10600 nm laser in the range of infrared with depth of a few mm was used, which indicated favorable efficiency in improving injury and decreasing pain and inflammation in previous studies. Another advantage of the present study was utilization of CO_2 laser with wavelength of 10600 nm while in some studies excimer laser was utilized which is can create waves in the range of ultraviolent (UV-B) that are associated with carcinogenic risks and with an increase in the energy of the laser the patients will experience erythema and burning sensation in the laser place [40].

The results of our study lead us to determine that CO_2 laser is effective in oral surgery, although more randomized clinical trials are needed to compare the results of CO_2 laser surgery with other therapies, and multi-centered studies may improve the conclusion. The main goal of CO_2 laser treatment is to reduce the severity and recurrence rate of oral lichen planus and prevent malignant transformation.

LIMITATION AND SUGGESTION

Since utilization of laser in mouth, face and jaw is new and patients are not familiar enough with laser therapy, few patients are willing to conduct laser therapy for their oral diseases. Moreover, the problem of distance due to follow-up sessions was another limitation of the present study. The present study indicated that retreatment with corticosteroid and utilization of CO_2 laser for OLP patients who are resistant to local corticosteroid resulted in remarkable reduction of lesion size and pain acuity during a period of six months. However, efficiency of treatment with laser was remarkably higher than corticosteroid.
The treatment of CO_2 lasers has numerous limitations, as deliberated earlier. These limitations contain, in short-term: indeterminate recurrence rates in several circumstances, mainly in OLP;

fewer visual effects compared to other managements; increased epithelial heat wound, which involves appropriate watchfulness when exposing muscles near to the jawbone with this laser.
Moreover, there are compensations of using the CO_2 laser in surgery, with instant
Aeneous disinfection, enhanced revelation, less post-operative distress and muscle puffiness, effective removal, and abolition of all irregular OLP. The laser light practiced in the papers, we recommend utilizing a 10,600 nm wavelength and an average power of 1–8-win continuous mode, which produces brilliant results and less post-operative problems.

CONCLUSION

With respect to minimal side-effects and appropriate comfort level for the patients and physicians, CO_2 laser therapy could be suggested, especially for recalcitrant and extensive lesions, for which surgery has some difficulties. The main objective of this systematic review was to evaluate the efficacy of CO_2 in the treatment of characteristic oral lichen planus. Effectiveness of CO_2 is measured by numerous issues such as wavelength, power output, energy density, treatment duration, and the mode of operation. Upcoming experiments and supplementary study may support the role of CO_2 as an actual substitute selection in the treatment of oral lichen planus.

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