Innovations

Low Level Laser Therapy for Non-Surgical Management of Oral Mucosal Lesions: A Narrative Review

[1]Dr. Shahala B. B; [2]Dr. Nayantara Menon; [3]Dr. Deepak Daryani;
[4]Dr. Jiji V Unni; [5]Dr. Uthkal M.P

[1]PG Student; [2]PG Student; [3]Professor and PG guide; [4]Senior lecturer;
[5]Professor and head of department

[1,2] Department of Oral Medicine and Radiology, Malabar Dental College and Research Centre, Edappal, Malappuram, Kerala, India

[3,4,5] Department of Oral Medicine and Radiology, Malabar Dental College and Research Centre, Kerala University of Health Sciences, Thrissur Kerala, India

Corresponding Author: **Dr. Shahala B.B**

Abstract: *Over the past few decades, the use of laser technology has revolutionized dentistry in particular. Laser-based techniques have enhanced the precision, efficiency, and outcomes of both diagnostic and therapeutic interventions in various oral health conditions. Low-Level Laser Therapy (LLLT), also known as photobiomodulation therapy, has emerged as a promising non-invasive treatment modality in the management of various oral mucosal lesions. It harnesses the therapeutic effects of low-intensity laser light to stimulate cellular activity, promote tissue repair, and reduce inflammation and pain without causing thermal damage to tissues. Oral mucosal lesions, ranging from aphthous ulcers and oral lichen planus to mucositis and burning mouth syndrome, often present significant challenges in terms of symptom control and patient comfort. Traditional pharmacological approaches may offer relief but are often associated with side effects or incomplete efficacy. This article provides a narrative review about the use of Low-level laser therapy in non-surgical management of oral mucosal lesions.*

Key words*: Low level laser therapy, non-invasive, photo biomodulation, oral mucosal lesions, non -surgical management*

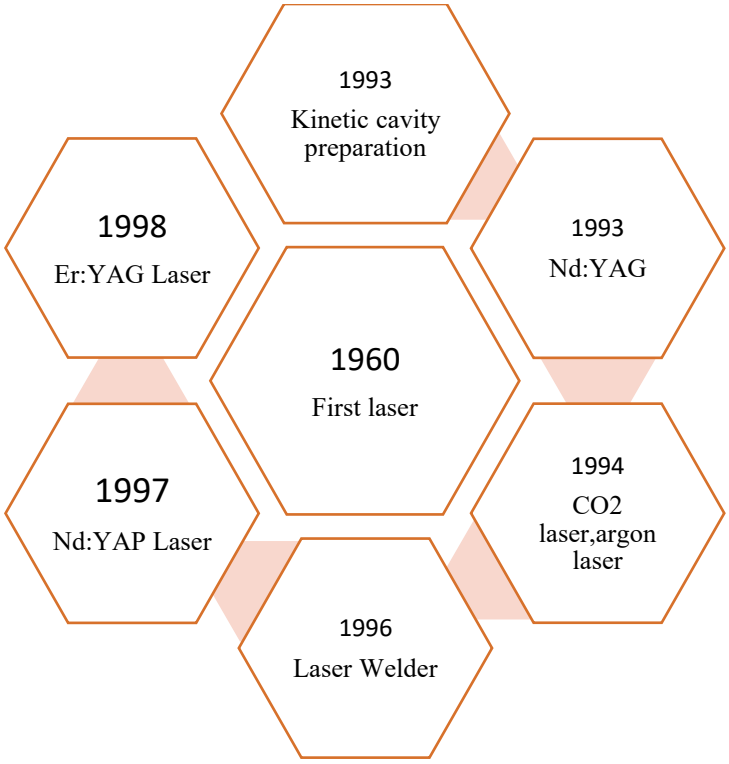
Introduction

LLLT provides a novel, evidence-based alternative by enhancing wound healing, modulating immune responses, and alleviating discomfort through its photochemical and photobiological effects. This article explores the role of LLLT in the non-surgical management of oral mucosal lesions, examining its

mechanisms of action, clinical applications, and benefits in improving patient outcomes.

History and Development of LLLT

The concept of lasers dates back to Albert Einstein's theory of stimulated emission, which laid the groundwork for the invention of the first laser in 1960 by Theodore Maiman. The introduction of lasers into the medical field began soon after, and in 1964, lasers were first applied in dentistry. Low-Level Laser Therapy (LLLT) was first introduced in 1967 by Endre Mester, a Hungarian physician, who observed that low-intensity laser light accelerated wound healing in laboratory animals. This discovery marked the foundation of photobiomodulation, sparking interest in the therapeutic potential of laser technology across various medical fields. Initially used in dermatology and pain management, LLLT soon found applications in dentistry and oral medicine, where it demonstrated remarkable benefits in promoting healing, reducing inflammation, and alleviating pain.[1]



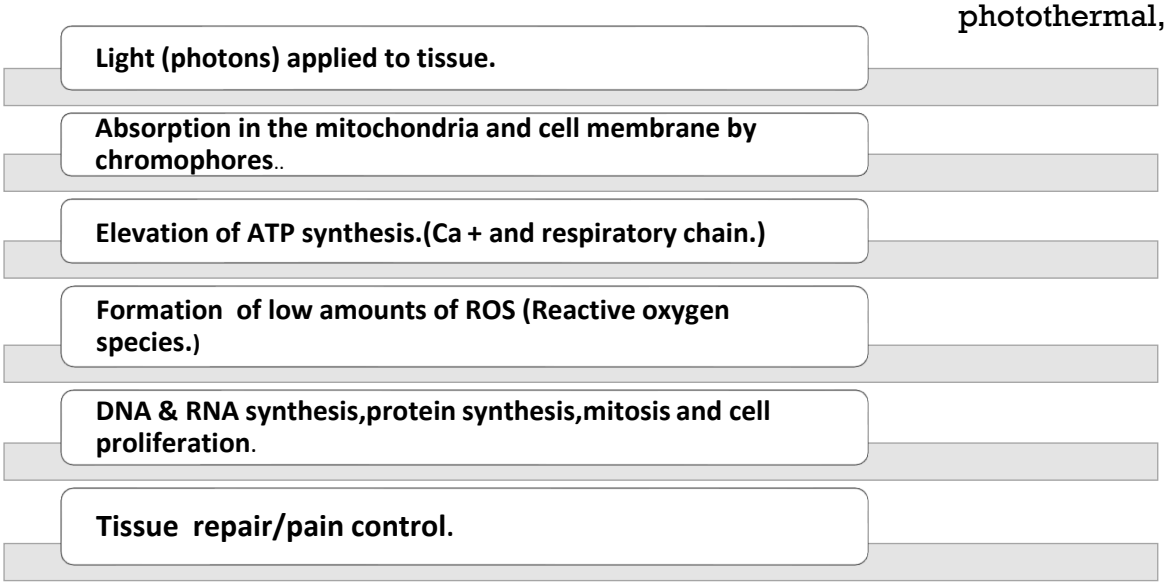
Types of LLLT

Category	Types	Description
Based on wavelength	Red light (600-700 nm)	Ideal for superficial tissue penetration;commonly used for wound healing ,oral mucosal lesions, and inflammation.
	Near -Infra red(700-1100 nm)	Penetrates deeper into tissues,used for muscle pain,joint disorders,and deep -seated lesions.
	Blue light (400-500 nm)	Effective for antimicrobial effects;used for managing infections and disinfecting lesions.
Based on Laser type	Diode laser	Most common type in LLLT; portable, affordable, and effective for a variety of conditions.
	Helium -Neon (hene)laser	Produces red light; used historically in LLLT but less Common due to advancements in diode technology.
	Other laser types	Includes Argon, Nd: YAG, and others, though these are less commonly used in LLLT due to their high intensity.
Based on Mode of delivery	Continuous wave lasers	Emits a steady laser beam; commonly used for uniform energy application.

	Pulsed wave lasers	Emits laser in short bursts or pulses; allows for controlled Energy delivery, often reducing tissue heating and enhancing therapeutic effects.
Based on power output	Low power (class 3B ,<500Mw)	Non-thermal and non-invasive; safe for photo biomodulation therapy without tissue damage.
	High power(class 4 ,>500 Mw)	Occasionally used in therapeutic applications but primarily for surgical and ablation purposes rather than traditional LLLT.
Based on therapeutic application	Pain management lasers	Used for reducing neuropathic or musculoskeletal pain ,including temporomandibular joint (TMJ) disorders.
	Wound healing lasers	Designed to promote tissue repair and reduce inflammation in oral and extra oral wounds.
	Antimicrobial lasers	Used in adjunctive periodontal therapy, endodontics and treatment of oral infections like candidiasis.
	Inflammation-modulating lasers	Specifically used for conditions like oral mucositis,oral lichen planus,and burning mouth syndrome by reducing cytokine activity and improving tissue regeneration.

Mechanism of Action of Lasers

Understanding the mechanism of action of lasers is essential to comprehend their diverse applications in dentistry. The interaction of laser light with biological tissues varies based on the wavelength, power settings, and the type of tissue involved [2]. The effects of laser light on tissues can be categorized into photothermal,



photochemical, and photobiomodulatory interactions.

Photobiomodulation (PBM)

Photobiomodulation, or low-level laser therapy (LLLT), involves the use of low-energy lasers that interact with tissues at the cellular level without causing heat damage. The biological effects of LLLT include:

• Stimulation of Mitochondrial Activity: Increases ATP production, enhancing cellular metabolism.
• Anti-Inflammatory Response: Reduces inflammatory cytokines and modulates immune responses.
• Analgesia: Provides pain relief by modulating nerve activity and reducing inflammation.
• Wound Healing: Accelerates tissue repair and regeneration through fibroblast proliferation and collagen synthesis.This mechanism is particularly beneficial in managing chronic conditions like burning mouth syndrome and oral lichen planus.[2] The anti-inflammatory and analgesic properties of PBM make it a non-invasive alternative to pharmacological treatments.[14]

Cellular mechanisms of LLLT

Applications of Lasers

The versatility of laser technology allows it to be used for both diagnostic and therapeutic purposes across a wide range of oral health conditions. Below are some of the key applications of LLLT:

1. Management of Oral Mucosal Lesions

Oral mucosal lesions are common conditions that can range from benign ulcers to potentially malignant disorders. Laser therapy offers a minimally invasive solution for treating these lesions, promoting faster healing with minimal discomfort.

• **Recurrent Aphthous Stomatitis (Canker Sores):** Recurrent aphthous stomatitis (RAS) is one of the most prevalent oral mucosal conditions. Laser therapy is used to reduce the healing time and severity of ulcers by promoting tissue regeneration.[9] Studies have shown that patients treated with lasers experience immediate pain relief and a reduction in ulcer size within days of treatment. Low-level laser therapy is particularly effective in decreasing the frequency of ulcer recurrence.[8]

LLLT Parameters for RAS:

• Wavelength: 630-660 nm (red light)
• Power Output: 0.1–0.5 W
• Energy Density: 2–4 J/cm² per site
• Duration: 30–60 seconds per ulcer
• Sessions: 1–3 sessions per week, depending on the severity of ulcers
• Total Treatment Duration: 1–2 weeks, or until ulcers heal

•**Oral lichen planus (OLP):** OLP is a chronic inflammatory condition that affects the oral mucosa, often causing pain, burning sensations, and white striations. Laser therapy, particularly low-level lasers, helps reduce inflammation and modulate the immune response in OLP. Multiple clinical studies have demonstrated that patients treated with lasers experience significant reductions in symptoms compared to conventional treatments.[5][6][14]

LLLT Parameters for OLP:

• Wavelength: 630–980 nm (most effective between 630–660 nm for red and 810–980 nm for infrared)

• Power Output: 0.1–2 W, typically 0.5 W.
• Energy Density: 2–6 J/cm².
• Duration: 60–120 seconds per lesion.
• Sessions: 1–2 sessions per week for 4–6 weeks.
• Total Treatment Duration: 4–6 weeks, with potential for maintenance sessions as needed.

• **Herpes simplex virus (HSV):** Cold sores or oral herpes caused by the herpes simplex virus are painful and recurrent. Laser therapy, when applied during the prodromal stage, can reduce the duration and severity of outbreaks. Additionally, lasers have antiviral properties that help suppress viral activity in the affected tissues, reducing the frequency of recurrences .[7]
LLLT Parameters for HSV:

• Wavelength: 630–660 nm.
• Power Output: 0.1–0.5 W.
• Energy Density: 4–6 J/cm².
• Duration: 60–120 seconds per lesion.
• Sessions: 1–3 sessions during the outbreak (initiated at the prodromal stage for best results).
• Total Treatment Duration: Single session, but repeat treatment for subsequent outbreaks.

2. Pain Management in Chronic Oral Conditions
Chronic oral pain conditions, such as burning mouth syndrome (BMS) and oral mucositis, present significant challenges for both patients and clinicians. Laser therapy offers a non-pharmacological alternative to pain management.

• **Burning mouth syndrome (BMS):** BMS is characterized by a persistent burning sensation in the mouth without an apparent cause. Low-level laser therapy has emerged as a promising treatment option, offering pain relief by modulating nerve function and reducing inflammation .[11] In clinical trials, patients receiving LLLT for BMS reported significant improvements in pain and discomfort, with long-lasting effects.[10]
LLLT Parameters for BMS:

• Wavelength: 630–810 nm (most commonly used wavelengths include 660 nm and 810 nm)
• Power Output: 0.1–0.5 W
• Energy Density: 2–5 J/cm²
• Duration: 60–120 seconds per affected area (e.g., tongue, palate)
• Sessions: 2–3 sessions per week for 4–6 weeks
• Total Treatment Duration: 4–6 weeks, with potential for periodic maintenance sessions

• **Oral mucositis:** Patients undergoing chemotherapy or radiation therapy for cancer are at high risk of developing oral mucositis, a painful inflammation of the oral mucosa. Low-level laser therapy has been shown to reduce the severity of mucositis, promote healing, and provide immediate pain relief . By stimulating

tissue repair and reducing inflammation, lasers enhance the quality of life for cancer patients suffering from this debilitating condition.[3]

- LLLT Parameters for Oral Mucositis:

• Wavelength: 630–660 nm (red light), or 810–980 nm (infrared)
• Power Output: 0.1–0.5 W
• Energy Density: 2–5 J/cm² per lesion
• Duration: 30–60 seconds per site
• Sessions: 1–2 sessions per week throughout cancer therapy, with post-treatment follow-up if needed.
• Total Treatment Duration: Until mucositis resolves, typically 2–4 weeks.

• **Trigeminal Neuralgia:** Laser therapy helps in pain reduction with a diode laser with wavelength of 660-980 nm was used widely for treatment of TN. Pain relief is because of the increase in serotonin and endorphin levels in combination with the decrease in prostaglandin E2 and bradykinin levels.[22,23]

LLLT Parameters for trigeminal neuralgia:

- Wave length: 780-1064 nm(near -infrared)
- Power output:30-200 mw .
- Energy Density: 4-10 J/cm^2 per point.
- Durations: 30seconds -1 minute per point
- Sessions: 2-3 times per week initially, then weekly for maintenance .
- Treatment points :along trigeminal branches (infraorbital, mental, mandibular foramen).

• **Post herpetic neuralgia:** Laser therapy can modulate inflammatory pain by reducing levels of biochemical markers (PGE2, mrnaCox 2, IL-1β, TNF-α), neutrophil cell influx, oxidative stress. Increase in pain threshold in nerve fibres helps in pain reduction of post herpetic neuralgia patients. He-Ne laser was effective in post-herpetic neuralgia patients.[21]

LLLT Parameters for post herpetic neuralgia:

- Wave length: 780-904 nm(near -infrared)
- Power output: 30-200 mw.
- Energy Density: 2-10J/cm^2 per point
- Durations: 30 seconds to 1 minute per point.
- Sessions: 2-3 times per week initially ,then as needed for maintenance.

- Treatment points: along affected dermatomes.

3. LLLT in tobacco cessation

Low -Level Laser Therapy (LLLT)has been explored as an aid for tobacco cessation by reducing withdrawal symptoms, managing cravings and promoting relaxation. Although more research is needed to standardize protocols, preliminary studies suggest that LLLT can influence neurotransmitters and endorphins levels, which may help alleviate the symptoms associated with quitting smoking.[20]

Mechanism of action:

- Endorphin release: LLLT is thought to stimulate the release of endorphins, which may reduce the stress and anxiety associated with nicotine withdrawal.
- Dopamine Regulation: LLLT may help modulate dopamine levels, which can be disrupted during nicotine withdrawal, reducing cravings.
- Acupuncture points: Similar to auricular (ear) acupuncture for smoking cessation, LLLT can stimulate acupuncture points on the ear and other body areas associated with addiction.

LLLT Parameters for tobacco cessation:

- Wave Length: 630-650 nm (visible red) or 810-830 (near-infrared).
- Power: 10-100 mw.
- Energy density: 1-4 J/cm^2 per point.
- Duration: 30-60 seconds per point.
- Treatment points:

A. Auricular points: Shen Men,Lung and point zero (ear points used in acupuncture for stress and addiction).
B. Body Points: LI 4 (Hegu) ,LI11, and PC 6 (acupuncture points on the hand, arm and wrist associated with stress relief and addiction management).

Advantages	**Limitation**
Minimally invasive	Cost
Enhanced control and precision during treatment	Limited Tissue Penetration
The bactericidal and antiviral properties of lasers help reduce the	Thermal Damage

risk of postoperative infections	
Immediate pain relief, which is beneficial for conditions like aphthous ulcers, BMS, and oral lichen planus.	Limited Evidence for Long-Term Efficacy
Promotes faster tissue regeneration and wound healing.	Safety Concerns: Eye Protection Smoke Production Operator Error

Future perspectives

The use of LLLT in oral lesions and conditions continues to expand as more research emerges regarding its benefits and applications. Innovations such as laser-assisted diagnostics, photodynamic therapy for cancer, and more advanced photo biomodulation techniques are expected to play a crucial role in the future of oral healthcare. As laser technology advances, it is likely to become even more integral in the prevention, diagnosis, and management of a wide range of oral diseases.

Conclusion

Laser technology has revolutionized dentistry, offering a versatile and effective approach for both diagnosing and treating various oral mucosal lesions. The ability to provide precise, minimally invasive treatments with reduced discomfort and faster healing times makes lasers a valuable tool in the management of oral conditions.

Low-Level Laser Therapy (LLLT) represents a significant advancement in the management of oral lesions in Oral Medicine, offering a non-invasive, painless, and effective therapeutic option. Each condition benefits from specific laser parameters tailored to its pathology, ensuring the best clinical outcomes with minimal side effects. Whether used for pain management, healing promotion, or lesion reduction, LLLT provides patients with a high level of comfort and rapid relief, supporting the growing role of lasers in modern oral healthcare practices.

As the field continues to evolve, lasers will undoubtedly remain at the forefront of innovation, enhancing the quality of care in oral healthcare practices worldwide.

References:

1. *Grande M, Facchini F, Moretti M, Larosa M, Leone M, Ziglioli F, Pozzoli GL, Frattini A. Storia del Laser nellaterapiadell'ipb[History of laser in BPH therapy]. Urologia. 2014 Jan-Mar;81 Suppl 23:S38-42.*
2. *Zecha JA, Raber-Durlacher JE, Nair RG, Epstein JB, Sonis ST, Elad S, Hamblin MR, Barasch A, Migliorati CA, Milstein DM, Genot MT, Lansaat L, van der Brink R, Arnabat-Dominguez J, van der Molen L, Jacobi I, van Diessen J, de Lange J,*

Smeele LE, Schubert MM, Bensadoun RJ. Low level laser therapy/photobiomodulation in the management of side effects of chemoradiation therapy in head and neck cancer: part 1: mechanisms of action, dosimetric, and safety considerations. Support Care Cancer. 2016 Jun;24(6):2781-92

3. *Bensadoun RJ. Photobiomodulation or low-level laser therapy in the management of cancer therapy-induced mucositis, dermatitis and lymphedema. CurrOpin Oncol. 2018 Jul;30(4):226-232.*
4. *Nascimento RB, Neri BP, Moutinho MM, Fortuna T, Martins GB, Carrera M, Lima HR. Might photobiomodulation therapy interfere with the frequency of severe mucositis and oral candidiasis . A retrospective analysis in patients with head and neck carcinoma. Support Care Cancer. 2024 Jul 11;32(8):508.*
5. *García-Pola MJ, González-Álvarez L, Garcia-Martin JM. Treatment of oral lichen planus. Systematic review and therapeutic guide. Med Clin (Barc). 2017 Oct 23;149(8):351-362.*
6. *Mirza S, Rehman N, Alrahlah A, Alamri WR, Vohra F. Efficacy of photodynamic therapy or low level laser therapy against steroid therapy in the treatment of erosive-atrophic oral lichen planus. Photodiagnosis PhotodynTher. 2018 Mar;21:404-408.*
7. *Chen XP, Mata M, Fink DJ. Use of laser capture microdissection together with in situ hybridization and real-time PCR to study distribution of latent herpes simplex virus genomes in mouse trigeminal ganglia. Methods Mol Biol. 2005;293:285-93.*
8. *Suter VGA, Sjölund S, Bornstein MM. Effect of laser on pain relief and wound healing of recurrent aphthous stomatitis: a systematic review. Lasers Med Sci. 2017 May;32(4):953-963.*
9. *Rocca JP, Zhao M, Fornaini C, Tan L, Zhao Z, Merigo E. Effect of laser irradiation on aphthae pain management: A four different wavelengths comparison. J Photochem Photobiol B. 2018 Dec;189:1-4.*
10. *Tan HL, Smith JG, Hoffmann J, Renton T. A systematic review of treatment for patients with burning mouth syndrome. Cephalalgia. 2022 Feb;42(2):128-161.*
11. *De Moraes M, do Amaral Bezerra BA, da Rocha Neto PC, de Oliveira Soares AC, Pinto LP, de Lisboa Lopes Costa A. Randomized trials for the treatment of burning mouth syndrome: an evidence-based review of the literature. J Oral Pathol Med. 2012 Apr;41(4):281-7.*
12. *Kwiatkowski S, Knap B, Przystupski D, Saczko J, Kędzierska E, Knap-Czop K, Kotlińska J, Michel O, Kotowski K, Kulbacka J. Photodynamic therapy - mechanisms, photosensitizers and combinations. Biomed Pharmacother. 2018 Oct;106:1098-1107.*
13. *Merlin JPJ, Crous A, Abrahamse H. Combining Photodynamic Therapy and Targeted Drug Delivery Systems: Enhancing Mitochondrial Toxicity for Improved Cancer Outcomes. Int J Mol Sci. 2024 Oct 8;25(19):10796.*

14. *Panchal KG, Gupta E, Kumar A, Samir PV, Devika GS, Awasthi V, Singh R. Comparing the Effectiveness of Low-Level Laser Therapy and Topical Steroid Therapy Combination Regimen With Routine Topical Steroid Therapy in the Management of Oral Lichen Planus Symptomatic Patients. Cureus. 2023 Aug 25;15(8):e44100.*
15. *Berni, M.; Brancato, A.M.; Torriani, C.; Bina, V.; Annunziata, S.; Cornella, E.; Trucchi, M.; Jannelli, E.; Mosconi, M.; Gastaldi, G.; et al. The Role of Low-Level Laser Therapy in Bone Healing: Systematic Review. Int. J. Mol. Sci. 2023, 24, 7094.*
16. *Rola, P.; Włodarczak, S.; Lesiak, M.; Doroszko, A.; Włodarczak, A. Changes in Cell Biology under the Influence of Low-Level Laser Therapy. Photonics 2022, 9, 502.*
17. *Cotler HB, Chow RT, Hamblin MR, Carroll J. The Use of Low Level Laser Therapy (LLLT) For Musculoskeletal Pain. MOJ OrthopRheumatol. 2015;2(5):00068.*
18. *Avci P, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, Hamblin MR. Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring. Semin Cutan Med Surg. 2013 Mar;32(1):41-52.*
19. *Walsh LJ. The current status of low level laser therapy in dentistry. Part 1. Soft tissue applications. Aust Dent J. 1997 Aug;42(4):247-54.*
20. *Yavagal PC, L N. Efficacy of Laser Auricular Acupuncture for Smoking Cessation: A randomised controlled trial. Sultan Qaboos Univ Med J. 2021 May;21(2):e275-e281.*
21. *Mukhtar R, Fazal MU, Saleem M, Saleem S. Role of low-level laser therapy in post-herpetic neuralgia: a pilot study. Lasers Med Sci. 2020 Oct;35(8):1759-1764.*
22. *Falaki F, Nejat AH, Dalirsani Z. The Effect of Low-level Laser Therapy on Trigeminal Neuralgia: A Review of Literature. J Dent Res Dent Clin Dent Prospects. 2014 Winter;8(1):1-5.*
23. *Haghighat S, Rezazadeh F, Sedarat H, Tabesh A, Tayebi Khorami E, Aghasadeghi K. Efficacy of Laser Therapy in Trigeminal Neuralgia: a Systematic Review. J Dent (Shiraz). 2024 Mar 1;25(1):17-25.*