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Evidence Gaps and Future Directions for Low-Level LASER Therapy in Oral Sub Mucosal Fibrosis: A Scoping Review.

K. Ramalakshmi[1], B. Sathya Prabha[1], S. Elengkumaran[2]

1.Corresponding Author-Lecturer, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Porur, Chennai-116

2. Professor, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Porur, Chennai-116

3. Associate Professor, Department of Oral and Maxillofacial surgery, Sri Ramachandra Faculty of Dental Sciences

Sri Ramachandra Institute of Higher Education and Research, Porur, Chennai-116

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KEYWORDS

Oral submucous fibrosis, Photobiomodulation, Low-level laser therapy, mouth opening exercises

ABSTRACT:

Background:

Oral submucous fibrosis (OSMF) is a chronic, progressive, potentially sub-cancer disorder characterized by trismus, burning sensation, and mucosal rigidity. Low-level laser therapy (LLLT), also referred to as photobiomodulation, has emerged as a novel adjunctive modality in treating the OSMF. Primary focus of scoping study is mapping the body of evidence about the use of LLLTand to summarize the reported clinical outcomes.

Objective:

To map the existing evidence on the use of LLLT in the management of OSMF, identify research gaps, and suggest future directions for clinical application and research.

Methods:

Scoping review followed the PRISMA-ScR guidelines. Literature was systematically searched across Embase, PubMed, Web of Science, Scopus, Cochrane Library using keywords and Boolean terms regarding "oral submucous fibrosis" and "low-level laser therapy/photobiomodulation". Eligible studies encompassed observational studies, preclinical studies, randomized controlled trials, case reports, and systematic reviews. Data were charted for study characteristics, LLLT protocols, outcomes (mouth opening, burning sensation, pain, mucosal flexibility, quality of life), and safety. Thematic synthesis was used to map evidence and highlight gaps.

Results:

Evidence suggested LLLT improves mouth opening and burning sensation; yet, available studies are inadequate because of short-term follow-up, heterogeneous protocols, small sample sizes, and lack of standardized outcome measures.

Conclusion:

This review provided a comprehensive overview of the role of LLLT in OSMF, highlighted methodological and evidence gaps, and proposed future research directions, including standardized treatment protocols, long-term trials, and integration of patient-centered outcomes.

INTRODUCTION

Among the most prevalent "oral potentially malignant disorders" (OPMDs) that can cause significant morbidity is "oral submucous fibrosis" (OSMF). OSMF is a chronic, progressive, and irreversible disorder of collagen metabolism caused mainly by the prolonged habit of chewing areca nut and its commercial

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products.[1] It affects oral mucosa, in some cases, extends to pharynx and esophagus, resulting in functional impairment, mucosal rigidity, and an increased risk of malignant transformation.[2]

Among the etiologies listed in the literature are tobacco, areca nut, immunological problems, iron and zinc deficiencies, lime, chilies, and collagen disorders.[3,4]

The "World Health Organization" (WHO) reports that over 5 million people globally are affected by Oral Submucous Fibrosis (OSMF). The condition occurs predominantly in Asian populations, with India showing the highest rates. Over the past fifty years, its prevalence in India has increased dramatically—from 0.03% to 6.42%.Any age group may be affected; however, young to middle-agedindividuals are most commonly affected. [5,6]

The oral mucosa may experience burning, ulceration, discomfort, loss of pigmentation, blanching, a marble-like appearance, a gradual decrease in mouth opening, reduced tongue movement,and speech and deglutition problems are characteristic symptoms of OSMF. These symptoms have a debilitating effect on mouth opening, which has a major effect on QOL of the patients with OSMF.[7]

Various nonsurgical treatment modalities have been experimented with for OSMF, and no definitive treatment modality has been identified to date.

"LASER" refers to "Light Amplification by Stimulated Emission of Radiation." It works by stimulating lymphocytes, activating mast cells, enhancing mitochondrial "adenosine triphosphate (ATP)" production, and reducing pro-inflammatory cytokines through a process known as "photobiomodulation" (PBM). These actions contribute to its pain-relieving, anti-inflammatory, and anti-swelling effects. Additionally, lasers are non-invasive, cost-effective, and conveniently available as portable devices.[8]

These physiological effects of LLLT have a major impact on reducing the symptoms of OSMF. This study aims to map the existing literature, explore protocols, parameters, and highlight the evidence gap and research directions in this field.

METHODS

The Arksey and O'Malley (2005) framework and PRISMA-ScR reporting requirements were followed in this review. The "Population, Concept, Context (PCC)" framework served as the basis for the inclusion criterion. O'Malley and Arksey proposed five stages: (1) determining the research question; (2) discovering relevant studies; (3) selecting studies; (4) charting the data; and (5) collating, summarising, and reporting the findings.

Population: Patients diagnosed with OSMF
Concept: Low-level laser therapy or photobiomodulation
Context: Clinical or research settings

Stage 1: Identifying the research question

What is the existing evidence on the effectiveness and safety of low-level laser therapy (LLLT) in the management of oral submucosal fibrosis (OSMF)?

Stage 2: identifying relevant studies

To locate relevant studies,a thorough search across databases has been carried out, like PubMed, Web of Science, Embase, Google Scholar,Cochrane Library, Scopus, from 2010 to 2025. The search strategy included the following keywords: OSMF, oral submucous fibrosis, low-level laser therapy (LLLT), photobiomodulation, mouth opening exercises

Stage 3: selecting studies

Inclusion criteria:

1. Study types: case control studies, cohort studies, quasi-experimental studies, case reports, randomized controlled trials.
2. Participants: studies including patients of any age or gender with diagnosis of OSMF.
3. Intervention: studies including use of low-level laser therapy alone or in combination with therapies.
4. Outcomes: studies reporting at least one clinical, functional, or subjective outcome such as: mouth opening, pain, histological improvement, or quality of life.
5. Language: studies published in English.

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Exclusion criteria:

1. Studies involving surgical Lasers
2. Studies where LLLT was not clearly defined or parameters not reported.
3. Animal or in vitro studies
4. Reviews, editorials, commentaries, or conference abstracts without full text.
5. Non English language papers.

No duplicate studies were found in the 15 articles that the search produced. Articles that clearly failed to fit the inclusion criteria were eliminated by the lead author after screening abstracts and titles. 9 articles in all were eliminatedsince they had usage of surgical LASER, focused only on medical and surgical management, and 1 study had used LLLT for erythema multiforme of oral mucosa. Following exclusion, only 6 articles werecounted in in research, which included clinical trials, retrospective studies, and studies that met inclusion criteria. In Figure 1, the study selection process is represented as a flowchart.

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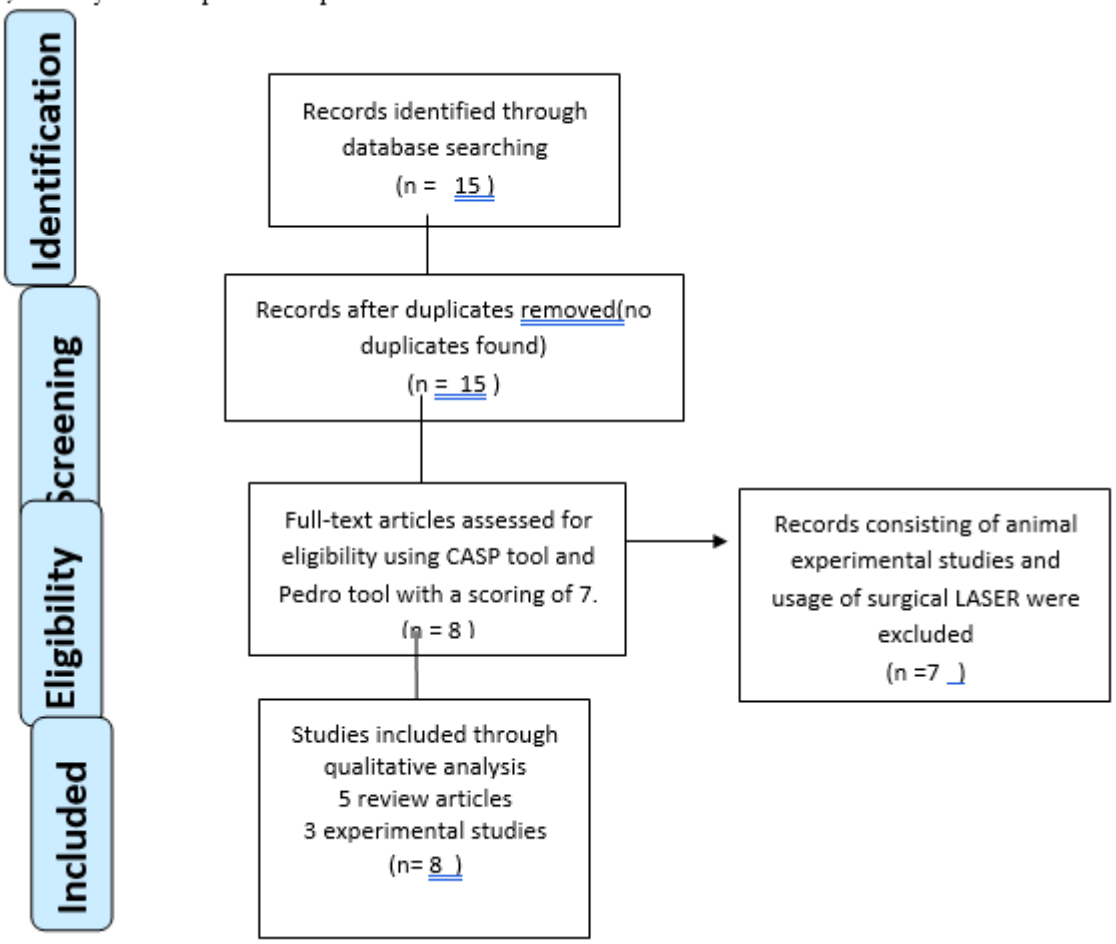

RESULTS:

Study Selection

A total of 15 records have been retrieved from electronic databases encompassing PubMed, Embase, Cochrane Library, Scopus, Web of Science. Following the screening of titles and abstracts, 7 studies were excluded as they primarily addressed surgical laser treatments, drug-based therapies, or other unrelated oral disorders. Ultimately, 8 studies met the inclusion criteria and were incorporated into qualitative analysis

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(Figure 1).One study provided sufficient quantitative data for analysis.

Characteristics of Included Studies

The included studies comprised quasi-experimental studies(n = 2), randomized controlled trials(n=2), and case series/retrospective studies (n=2). Sample sizes are 10 to 60 participants. All participants were clinically diagnosed with OSMF and received LLLT either alone or in combination with adjunctive therapies such as physiotherapy, intralesional injections, or antioxidants.

Laser Parameters and Treatment Protocols
There was notable heterogeneity in the LLLT parameters used across studies.
- Wavelengths: 630 nm to 980 nm
- Power output: 100 mW to 500 mW
- Energy density: 1–6 J/cm²
- Duration per session: 30 seconds to 3 minutes
- Treatment frequency: daily or alternate days
- Total duration: 2–8 weeks

Most studies employed diode lasers in continuous mode, applied intraorally over affected buccal mucosa.

Clinical Outcomes

All included studies demonstrated enhancement in mouth opening and burning sensation, with some reporting on pain, mucosal flexibility, quality of life, and histological changes.

- Mouth Opening: All six studies reported statistically significant improvement (mean increase 3–10 mm).
- Burning Sensation: Five studies demonstrated significant reduction in VAS scores for burning sensation.
- Pain and Mucosal Flexibility: Three studies showed notable pain reduction and enhanced mucosal elasticity.
- Quality of Life: Only one study included a validated QoL assessment, which showed improvement post-LLLT.
- Histological Changes: Limited data indicated decreased fibrosis and increased vascularity in post-treatment biopsies.

Safety and Adverse Effects

No major adverse effects were reported. Minor, transient erythema or warmth at the application site was occasionally noted, resolving without intervention.

Summary of Evidence and Gaps

Very few clinical trials are conducted in LLLT for oral submucosal fibrosis.

While the available evidence suggests LLLT is effective in improving mouth opening as well as reducing burning sensation in OSMF, interpretation is constrained by several methodological limitations:
- Small sample sizes and absence of robust control groups
- Variability in laser parameters and outcome measures
- Short-term follow-up durations
- Lack of standardized protocols and patient-centered outcome assessment

Table 1. Summary of Included Studies on Low-Level Laser Therapy in Oral Submucous Fibrosis

Author(s) & Year	Title	Journal / Source	Study Type	Sample Size / Participants	Intervention / Focus	Key Findings/ Results	Conclusion
Kesari Singh et al., 2017	"Role of Laser Biostimulation in Treatment of Oral Submucous Fibrosis: A Clinical Trial"	International Healthcare Research Journal	Clinical Trial	20 OSMF patients	Low-Level Laser Therapy (LLLT) – 3 cycles of 10 sec each per site	Significant improvement in mouth opening (p=0.02); reduction in burning sensation (p=0.03)	LLLT is an effective, painless, non-invasive treatment for OSMF.

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Chhabra et al., 2023	"Oral Submucous Fibrosis: A Review of the Current Concepts in Management"	Cureus	Review Article	—	Conservative, medical, surgical, and physiotherapy management	Comprehensive review of etiopathogenesis and therapeutic modalities, including micronutrient therapy, physiotherapy, antioxidants, and habit cessation	No curative treatment; early habit cessation, nutrition, and physiotherapy essential for management.
Gupta et al., 2015	"Oral Submucous Fibrosis – Current Concepts of Aetiology & its Management"	Journal of Applied Dental and Medical Sciences	Review Article	—	Etiology, staging, and management (medical & surgical)	OSMF is multifactorial; areca nut, nutritional deficiency, and autoimmunity implicated; medical & surgical interventions discussed	Early detection, lifestyle changes, and combination therapy recommended.
Papamanoli	"Low-level	Journal of	Review	—	Low-Level	LLLT	LLLT is a

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et al., 2022	Laser Therapy in the Oral Cavity: A Retrospection in the Future"	Cellular Signaling	Article		Laser Therapy (LLLT) mechanisms & applications	promotes cellular proliferation, collagen synthesis, and analgesia via photobiomodulation; reduces TNF-α, enhances healing	promising adjunct in oral and periodontal therapy; standardization needed.
Sukanya et al., 2022	"Determination of Effectiveness of Photobiomodulation in the Treatment of Oral Submucous Fibrosis"	Journal of Pharmacy and Bioallied Sciences	Clinical Trial	30 OSMF patients	LLLT (4 cycles, 15 s each, day 0–15, follow-up to 6 months)	Mean increase in mouth opening: 9.91 ± 3.34 mm (day 0–15), 14.29 ± 6.82 mm (6 months)	LLLT significantly improves mouth opening and is effective in OSMF management.
Patel & Patel, 2014	"Oral Submucous Fibrosis: Recent Modalities of Treatment"	International Journal of Medical Research and Review	Review Article	—	Drug therapy, surgical therapy, physiotherapy	Steroids, placental extract, hyaluronidase, lycopene, pentoxifylline, colchicine reviewed; surgical correction for severe trismus	OSMF remains incurable; combination of habit cessation, drugs, and surgery improves outcomes.
Saraswathi et al., 2022	"Laser: A Novel Method in the Management of Oral Soft Tissue	International Journal of Research and	Review Article	—	Use of lasers (CO_2, diode, Nd:YAG, Er:YAG) for oral lesions	LLLT and photobiomodulation accelerate wound	Lasers are minimally invasive, enhance healing, and effective for

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	Lesions"	Review				healing, reduce inflammation and pain in oral soft tissue lesions	soft tissue pathologies.
Senthilkumar et al., 2020	"Effectiveness of Ultrasound Therapy on Oral Submucous Fibrosis"	Indian Journal of Public Health Research & Development	Experimental Study	40 OSMF patients (Group A: exercise, Group B: ultrasound + exercise)	Ultrasound therapy with jaw exercises	Statistically significant improvement in mouth opening in ultrasound + exercise group	Ultrasound therapy effectively increases mouth opening and aids OSMF management.

DISCUSSION:

Consumption of areca nuts is mostly associated with OSMF, a chronic, progressive, and potentially malignant illness that is exacerbated by environmental, immunologic, and dietary variables. A complex etiology and the lack of a conclusive treatment are highlighted by the combined evidence from the included research. With an emphasis on improving functional outcomes and stopping the course of the disease, management is still symptomatic, multimodal, and stage-specific.

Low-Level Laser Therapy (LLLT), another name for photobiomodulation, has emerged as a promising addition to the conservative management of OSMF. Following short-term LLLT treatment, several clinical investigations (Kesari Singh et al., 2017; Sukanya et al., 2022) showed statistically significant improvements in mouth opening and decreases in burning sensation. These results validate LLLT as a quick, painless, and non-invasive treatment that improves patient comfort and functional recovery.

Physiotherapeutic techniques including jaw-opening exercises and ultrasound therapy (Senthilkumar et al., 2020) have demonstrated positive benefits in enhancing mouth opening in addition to laser therapy. Mouth opening plus ultrasound produced better functional results than mouth opening exercises alone, highlighting the significance of integrating physical and biostimulatory techniques in the management of OSMF.

In earlier stages, conventional medical treatments including steroids, hyaluronidase, placental extracts, lycopene, pentoxifylline, and colchicine are still helpful (Patel & Patel, 2014; Gupta et al., 2015; Chhabra et al., 2023). Advanced cases with severe trismus are the only ones that can benefit from surgical procedures such fibrotic band removal and grafting. All authors emphasize, however, that these therapies primarily alleviate symptoms rather than addressing the underlying illness.

Despite encouraging outcomes, the examined literature still has a number of shortcomings. Study designs were diverse, follow-up times were brief, and sample sizes were small (usually 20–40 individuals). Direct comparison was challenging due to the considerable variation in treatment regimens, including laser wavelength, power density, and time. Long-term safety data and defined outcome measures are also missing. Future studies should concentrate on developing optimal protocols for LLLT, examining combination therapies (e.g., LLLT with pharmacologic or physiotherapeutic techniques), and understanding the molecular mechanisms underlying the reversal of fibrosis. To support meta-analyses and the creation of guidelines, standardized outcome measures—such as

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interincisal distance, pain/burning VAS, quality-of-life ratings, and histopathologic markers—should be regularly reported.

The incorporation of LLLT and physiotherapy-based modalities into the multidisciplinary management of OSMF is strongly supported by the current evidence base, despite its restricted scope. These procedures improve functional recovery, lessen pain and inflammation, and offer a non-invasive, safe substitute for conventional therapies. However, in order to produce evidence-based guidelines and prove their long-term efficacy, rigorous clinical trials and standardized methodologies are desperately needed.

Limitations

Small sample sizes, brief follow-up periods, and variation in treatment parameters and technique were the main limitations of the examined research.

Clinical Implications

The review's conclusions have significant implications for clinical practice. To improve mouth opening and lessen sensations like burning, LLLT can be used into the conservative treatment of mild-to-moderate OSMF. As fundamental therapies, physiotherapy, nutritional supplements, and habit cessation counseling should be given top priority by clinicians.

Research Gaps

To analyse the effectiveness and safety of LLLT, future research should concentrate on bigger, multicentric randomized controlled trials. It is necessary to have standardized treatment procedures that include wavelength, energy density, frequency, and duration of sessions. The molecular mechanisms of photobiomodulation and fibrosis reversal should be investigated further. To assess the outcomes' durability and possible risk reduction for malignant transformation, long-term follow-up is required.

Strengths of the Evidence

The reviewed evidence consistently shows that biostimulatory therapies like physiotherapy and LLLT can improve patient comfort and functional outcomes, despite certain limitations. The studies demonstrate the safety, usefulness, and promising therapeutic potential of LLLT. The search also showed limited researches in this field and paved a path for more researches with LLLT in OSMF.

Future Recommendations

1. Conduct randomized controlled trials with standardized treatment procedures that are well-designed and sufficiently powered.

2. Incorporate extended follow-up times to see durability of the improvement
4. Look for synergistic benefits in combination therapies (e.g., LLLT + pharmaceutical + physiotherapy).

5. To assess the viability of employing these modalities in environments with limited resources, including cost-effectiveness and implementation studies.
6. To lower areca nut intake and disease incidence, encourage patient education and community-level preventive measures.

Conclusion

The body of research highlights the potential of physiotherapy and LLLT as efficient, minimally invasive supplements in the multidisciplinary treatment of OSMF. Although they alleviate symptoms and enhance functional outcomes, more investigation is required for confirming their long-term effectiveness and standardization. For OSMF patients, including LLLT in treatment procedures may greatly improve their quality of life and prognosis.

REFERENCES

1. Varma S, Karambelkar MV, Suragimath G, Yavagal C, Mangalekar SB, Zope SA, et al. Optimizing the synergistic role of diode laser and drug therapies in the management of oral submucous fibrosis: a case report. Cureus. 2024;16(9):e70028. doi:10.7759/cureus.70028

2. Gupta M, Mishra P, Shrivastava K, Singh N, Singh P. Oral submucous fibrosis – current concepts of aetiology and its management. J Appl Dent Med Sci. 2015;1(1):28–39.

3. Papamanoli E, Kyriakidou K, Karoussis IK. Low-level laser therapy in the oral cavity: a retrospection in the future. J Cell Signal. 2022;3(2):96–104.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 2595-2603 | ISSN:2251-6727

4. Sukanya D, Upasana L, Deepak TA, Abhinethra MS, Choudary S. Determination of effectiveness of photobiomodulation in the treatment of oral submucous fibrosis. J Pharm Bioallied Sci. 2022;14(Suppl 1):S475–S479. doi:10.4103/jpbs.jpbs_673_21

5. Patel U, Patel V. Oral submucous fibrosis: recent modalities of treatment. Int J Med Res Rev. 2014;2(2):77–80.

6. Aparna TY, Pushpanjali M, Aruna P, Fathima PR, Vishal AJ, Mala D. Evaluation of the efficacy of laser biostimulation and intralesional triamcinolone acetonide in OSMF: a clinical study. J Indian Acad Oral Med Radiol. 2023;35(2):197–201. doi:10.4103/jiaomr.jiaomr_70_23

7. Gopal KS, Lankupalli AS, Priyadharshini S. Laser: a novel method in the management of oral soft tissue lesions. Int J Res Rev. 2022;9(3):323–330. doi:10.52403/ijrr.20220336

8. Gupta S, Jawanda MK. Laser as a promising non-invasive technique to treat oral submucous fibrosis: a systematic review of the literature. Saudi Dent J. 2021;33(7):413–423. doi:10.1016/j.sdentj.2020.11.005

9. Morais TML, Silva SMSD, Peralta FS, Kitakawa D, Nogueira MS, Carvalho LFCSC. Low-level laser therapy as an adjuvant in the treatment of erythema multiforme of the oral mucosa: a case report. Laser Ther. 2024;31(1):386. doi:10.4081/ltj.2024.386

10. Morais TML, Silva SMSD, Peralta FS, Kitakawa D, Nogueira MS, Carvalho LFCSC. Low-level laser therapy as an adjuvant in the treatment of erythema multiforme of the oral mucosa: a case report. Laser Ther. 2024;31(1):386. doi:10.4081/ltj.2024.386.

11. Gupta S, Jawanda MK. Oral submucous fibrosis: an overview of a challenging entity. Indian J Dermatol Venereol Leprol. 2021;87(6):768–777. doi:10.25259/IJDVL_371_20.

12. Senthilkumar S, Chitra S, Vijayaraghavan R, Hemaashree V, Subhavani P. Effectiveness of ultrasound therapy on oral submucosal fibrosis. Indian J Public Health Res Dev. 2020;11(3):320–324.

13. Tang J, Liu J, Zhou Z, Cui X, Tu H, Jia J, et al. Oral submucous fibrosis: pathogenesis and therapeutic approaches. Int J Oral Sci. 2025;17(8). doi:10.1038/s41368-024-00344-6.

14. Chaudhary Z, Verma M, Tandon S. Treatment of oral submucous fibrosis with ErCr:YSGG laser. Indian J Dent Res. 2011;22(3):472–474. doi:10.4103/0970-9290.87073.