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Clinical Recommendations for Photodynamic Therapy in the Management of Oral Mucosal Lesions

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Abstract

Photodynamic therapy (PDT) is an innovative treatment modality that utilizes light-activated photosensitizing agents for the targeted destruction of abnormal tissues, particularly in the management of oral mucosal lesions such as leukoplakia, erythroplakia, and early-stage oral squamous cell carcinoma. This minimally invasive approach offers significant advantages over traditional therapies, including reduced patient discomfort, quicker recovery times, and preservation of healthy tissue. The efficacy of PDT is influenced by various factors, including the choice of photosensitizer, light source, and treatment protocols. Recent studies have demonstrated PDT's effectiveness in reducing lesion size and promoting healing while minimizing the risk of malignant transformation. However, variability in treatment outcomes necessitates further standardization and research to optimize protocols for different lesions. Emerging technologies, such as fiber-optic delivery systems, are enhancing the versatility of PDT, potentially expanding its applications beyond oncology to other medical conditions. This study aims to provide clinical recommendations for implementing PDT in oral mucosal lesions, highlighting its role as a promising option in modern medicine.

***Keywords** - Photodynamic therapy, PDT, Clinical, algorithm*

1. Introduction

Photodynamic therapy (PDT) is an innovative medical treatment that harnesses the power of light to activate photosensitizing agents, leading to targeted destruction of diseased tissues, particularly cancerous cells [1]. This minimally invasive approach involves the administration of a photosensitizer, a light-sensitive drug that selectively accumulates in abnormal cells which upon exposure to a specific wavelength of light, the photosensitizer is activated, generating cell death [2].

Unlike conventional treatments that may rely on invasive procedures or chemical agents, PDT is minimally invasive and often requires no anesthesia, reducing patient discomfort and recovery time. Additionally, PDT effectively reduces bacterial load and inflammation, which can enhance treatment outcomes [3].

The process of PDT involves three key components: a photosensitizer, a specific wavelength of light, and reactive oxygen species production. PDT has gained prominence in recent years due to its ability to treat various conditions, including skin cancers, age-related macular degeneration, and certain bacterial infections. The therapy offers several advantages over traditional treatments, such as surgery and chemotherapy, including reduced side effects, preservation of healthy tissue, and the ability to treat localized lesions effectively [4]. The development of advanced light delivery systems and novel photosensitizers continues to enhance the efficacy and application of Photodynamic therapy [5].

This current study aims at developing clinical recommendations for photodynamic therapy in oral mucosal lesions, making it a promising option in the realm of modern medicine. This study gives a Stepwise approach to undergo photodynamic therapy with a proper timeline and following proper precautions.

2. Objectives

The objective of the study was to frame a basic guideline for approaching photodynamic therapy in oral mucosal lesions

3. Photosensitizers

Photosensitizers are crucial components in photodynamic therapy (PDT), serving as light-activated agents that selectively target and destroy abnormal cells, primarily in cancerous tissues. These compounds are typically non-toxic until exposed to a specific wavelength of light, at which point they become activated and generate reactive oxygen species (ROS) that induce cellular damage [6].

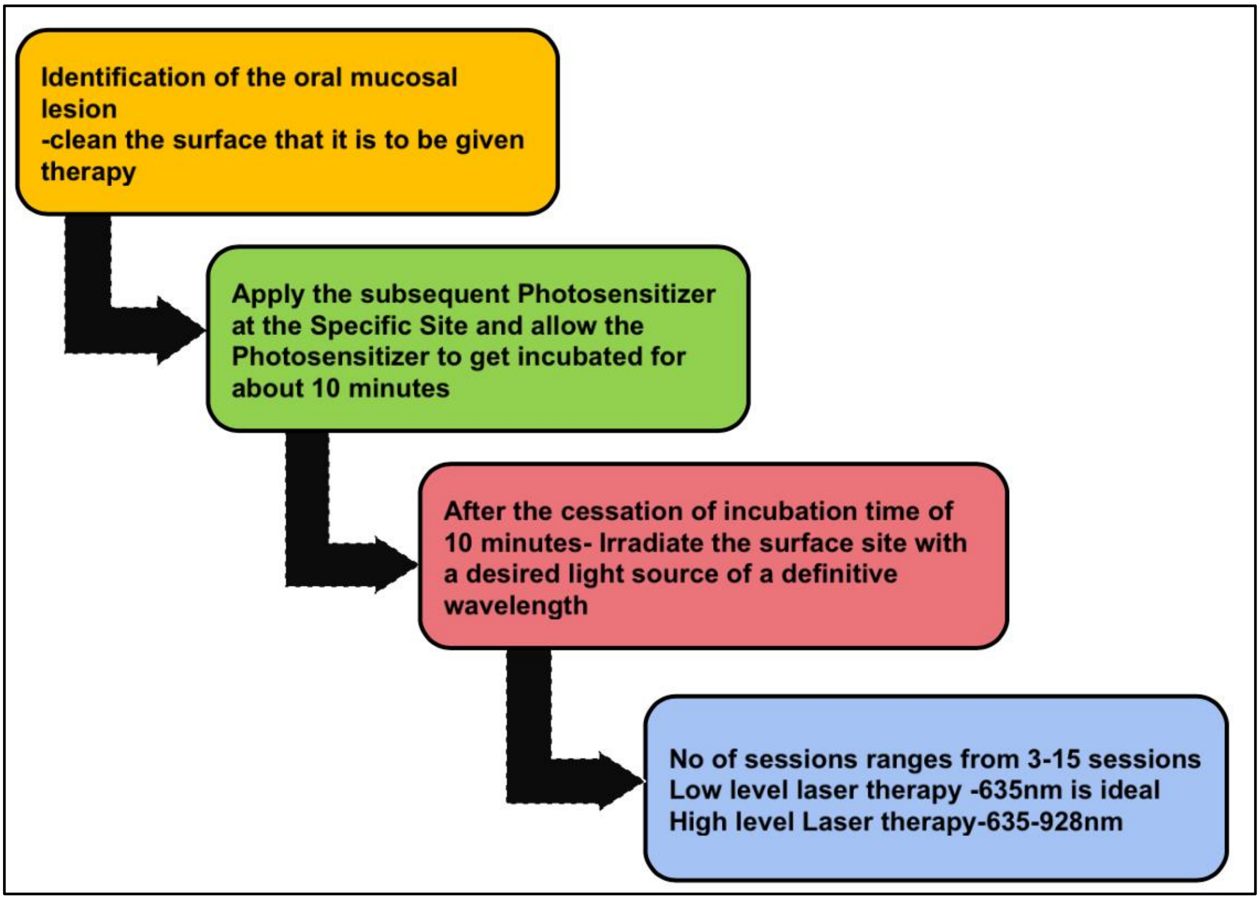
Photosensitizers can be categorized into various classes, including porphyrins, chlorins, and phthalocyanines, each with distinct absorption properties and mechanisms of action. The effectiveness of a photosensitizer depends on several factors, such as its ability to accumulate in tumor tissues, its light absorption spectrum, and the efficiency with which it produces ROS upon activation. Advances in the development of photosensitizers aim to enhance their specificity, reduce side effects, and improve their penetration depth within tissues. Ongoing research focuses on creating novel agents that can target specific cellular pathways or tumor microenvironments, further optimizing PDT's therapeutic potential and expanding its applications in treating a range of conditions beyond oncology, including dermatological and infectious diseases [7,8]

4. Light source

In photodynamic therapy (PDT), the light source is integral to the treatment's mechanism of action. Once the photosensitizer is localized in the target area, a light source, often a laser or a broad-spectrum light, is applied to the treatment site. The choice of light source is critical, as it must emit light at the precise wavelength that corresponds to the absorption spectrum of the photosensitizer [9]. This ensures maximum activation of the agent, leading to the production of reactive oxygen species (ROS) such as singlet oxygen. These ROS are highly reactive and can cause significant damage to cellular structures, leading to tumor cell death through mechanisms like apoptosis or necrosis [10, 11]

Moreover, the intensity and duration of light exposure can be tailored to optimize therapeutic outcomes. Advanced techniques, such as dosimetry, are employed to calculate the appropriate light dose required for effective treatment while minimizing damage to surrounding healthy tissues [12].

5. Clinical Guidelines



6. Discussion

Photodynamic therapy (PDT) has gained attention as a promising treatment for oral mucosal lesions, including leukoplakia, erythroplakia, and early-stage oral squamous cell carcinoma. This discussion examines the efficacy and safety of PDT in managing these lesions by comparing findings from previous studies.

Several studies have demonstrated the effectiveness of PDT in reducing the size and severity of oral mucosal lesions. For instance, a randomized controlled trial by Azzolin et al reported significant reductions in lesion size and dysplastic changes in patients treated with PDT compared to those receiving conventional therapies. This aligns with findings from other studies, such as those by de Almeida et al, which highlighted PDT's ability to promote healing and minimize the risk of malignant transformation in potentially malignant lesions [13,14].

One notable advantage of PDT is its minimally invasive nature. Unlike traditional surgical approaches, which may involve extensive excision of affected tissues, PDT offers a targeted treatment option that preserves surrounding healthy tissues. Studies by Nascimento et al have shown that patients experience less postoperative discomfort and faster recovery times with PDT. This is particularly important in the oral cavity, where aesthetic considerations and functional recovery are paramount [15].

However, some studies have raised concerns about the variability in treatment outcomes. Research by Figueiredo et al indicated that factors such as the type of photosensitizer, light source, and treatment protocols significantly influence the effectiveness of PDT. For example, while methylene blue has been widely used, newer photosensitizers like 5-aminolevulinic acid (ALA) have shown enhanced efficacy due to better absorption and activation characteristics [16]. This variability highlights the need for standardized treatment protocols and further research to optimize PDT for different types of oral lesions.

Additionally, the depth of light penetration poses a challenge in treating deeper lesions. Studies have suggested that combining PDT with other modalities, such as surgery or chemotherapy, may improve outcomes for more advanced lesions. For instance, a study by Tavares et al explored the synergistic effects of PDT and surgical excision, finding that the combined approach led to better control of lesion recurrence [17].

7. Future Prospects

Emerging technologies, including fiber-optic delivery systems, allow for precise targeting of light in hard-to-reach areas, enhancing the versatility of PDT. Additionally, ongoing research aims to improve photosensitizer formulations and light delivery methods, potentially expanding the applications of PDT beyond oncology to treat conditions like age-related macular degeneration and certain skin disorders. Overall, the interplay between the photosensitizer and the light source is fundamental to the success of photodynamic therapy, making it a promising and innovative approach in modern medicine.

References

1. Şueki F, Ruhi MK, Gülsoy M. The effect of curcumin in antitumor photodynamic therapy: In vitro experimentswith Caco-2 and PC-3 cancer lines. Photodiagnosis Photodyn Ther. 2019 Sep;27:95-99. doi: 10.1016/j.pdpdt.2019.05.012. Epub 2019 May 14. PMID: 31100447.
2. Lavaee F., Shadmanpour M. Comparison of the effect of photodynamic therapy and topical corticosteroid on oral lichen planus lesions. *Oral Dis.* 2019;25:1954–1963. [PubMed] [Google Scholar]
3. Cosgarea R., Pollmann R., Sharif J., et al. Photodynamic therapy in oral lichen planus: a prospective case-controlled pilot study. *Sci Rep.* 2020;10:1667. [PMC free article] [PubMed] [Google Scholar]
4. Sabry M.A., Saafan A.M.E.-H., El-Shenawy H.M., Hussine A.A., El- Aziz D.M.A., Fadeel D.A.A. Effect of photodynamic therapy on pain control in patients with erosive/atrophic oral lichen planus. *EurAsia J BioSci.* 2020;14:7455–7460. [Google Scholar]
5. Saleh W., Tageldin S., Khashaba E., Darwish M., Elnagdy S., Khashaba O. Could photodynamic therapy be utilized as a treatment modality for oral lichen planus? *Photodiagnosis Photodyn Ther.* 2020;30 [PubMed] [Google Scholar]
6. Zborowski J., Kida D., Szarwaryn A., et al. A comparison of clinical efficiency of photodynamic therapy and topical corticosteroid in treatment of oral lichen planus: a split-mouth randomised controlled study. *J Clin Med.* 2021;10:3673. [PMC free article] [PubMed] [Google Scholar]
7. Bakhtiari S., Azari-Marhabi S., Mojahedi S.M., Namdari M., Rankohi Z.E., Jafari S. Comparing clinical effects of photodynamic therapy as a novel method with topical corticosteroid for treatment of Oral Lichen Planus. *Photodiagnosis Photodyn Ther.* 2017;20:159–164. [PubMed] [Google Scholar]
8. Mostafa D., Moussa E., Alnouaem M. Evaluation of photodynamic therapy in treatment of oral erosive lichen planus in comparison with topically applied corticosteroids. *Photodiagnosis Photodyn Ther.* 2017 Sep;19:56–66. [PubMed] [Google Scholar]
9. Agostinis P, Berg K, Cengel KA, Foster TH, Girotti AW, Gollnick SO, Hahn SM, Hamblin MR, Juzeniene A, Kessel D, Korbelik M, Moan J, Mroz P, Nowis D, Piette J, Wilson BC, Golab J. Photodynamic therapy of cancer: an update. CA Cancer J Clin. 2011 Jul-Aug;61(4):250-81. doi: 10.3322/caac.20114. Epub 2011 May 26. PMID: 21617154; PMCID: PMC3209659.
10. Nagi R, Muthukrishnan A, Rakesh N. Effectiveness of photodynamic therapy (PDT) in the management of symptomatic oral lichen planus-A systematic review. Journal of Oral Biology and Craniofacial Research. 2023 Mar 1;13(2):353-9
11. Dhanya M, Umamaheswari TN, Eswaramoorthy R. In Vitro Evaluation of Light-Induced Cytotoxic Property: Synergistic Effects of Anthocyanin/Curcumin as a Photosensitizer. Cureus. 2023 Nov;15(11).

12. Dhanya M, Umamaheswari TN, Eswaramoorthy R. In Vitro Exploration of Dark Cytotoxicity of Anthocyanin-Curcumin Combination, A Herbal Photosensitizer. Cureus. 2024 Mar;16(3).

13. Azzolin, R. F., et al. (2016). "Efficacy of photodynamic therapy in the treatment of oral leukoplakia: a randomized controlled trial. Journal of Oral Pathology & Medicine 45(8), 635-641.

14. de Almeida, G. P., et al. (2018). "Photodynamic therapy in the management of oral potentially malignant disorders: A systematic review." Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 126(5), 456-464.

15. Nascimento, T. D. S., et al. (2019). "Photodynamic therapy for the treatment of oral mucosal lesions: A systematic review." *Photodiagnosis and Photodynamic Therapy 27, 141-150.

16. Figueiredo, M. A., et al. (2020). "Influence of photosensitizer and light parameters on the efficacy of photodynamic therapy in oral lesions." Photomedicine and Laser Surgery, 38(4), 223-229.

17. Tavares, M. R., et al. (2021). "Combined photodynamic therapy and surgical excision for the treatment of oral squamous cell carcinoma: A clinical study." Clinical Oral Investigations*, 25(7), 2083-2090.