Low-intensity laser-assisted antimicrobial photodynamic therapy and intravascular laser irradiation of blood in oncology: systematic review and a brief report

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ABSTRACT

Oncological patients may present with difficult-to-resolve oral lesions that impair their quality of life, and laser therapy can help these patients. This study sought to present a systematic review of the use of intravascular laser irradiation of blood (ILIB) and antimicrobial photodynamic therapy (aPDT) for oncological patients. Furthermore, it provides a brief report on a patient with laryngeal cancer who experienced cytotoxic symptoms such as oral mucositis and oral candidiasis while receiving aPDT and ILIB. A systematic search of PubMed, Scopus, Embase, Cochrane, Lilacs, Web of Science, Scielo, and Gray Literature was conducted, with no year or language restrictions, for primary clinical studies that used ILIB and aPDT to treat oral manifestations in oncological patients. In the brief report, aPDT was administered within the first five days, and ILIB was used for persistent lesions and pain. The review included five clinical studies. They included case reports, retrospective studies, randomized clinical trials, and non-randomized clinical trials. ILIB therapy combined with aPDT has been shown to reduce pain and promote faster healing when compared to not using ILIB. In our brief clinical case, healing was accelerated while pain and infectious inflammatory processes were reduced in the oral cavity. This neutralization of oral toxicity by combining aPDT and ILIB improved overall health, resulting in rapid healing of the oral lesions. The combination of aPDT and ILIB may be an effective therapy for the rapid recovery of oral lesions among cancer patients. More research is needed to better understand the effects of ILIB in oncology patients.

Key words: cancer, laser therapy, low-intensity light therapy, intravascular laser irradiation of blood.
Introduction

Head and Neck Cancer (HNC) constitutes an important group of malignancies, with laryngeal cancer being a subset. Conventional treatment options include surgery, radiotherapy, and/or chemotherapy. Among these options, radiotherapy is predominantly favored, primarily because surgery is often deemed impractical due to anatomical limitations associated with certain types of head and neck cancer. Despite that, it can cause side effects that manifest in the oral cavity of these patients, which may interfere with their quality of life.

Oral Mucositis (OM), is a common side effect in patients with head and neck cancer undergoing radiotherapy, with or without concurrent chemotherapy. It manifests erythema, edema, and ulceration following radiation therapy or chemotherapy for cancer treatment. Once installed, OM presents symptoms such as pain, speech disorders, and odynophagia, thereby compromising patients' quality of life. Additionally, these patients are susceptible to developing oral candidiasis (OC), which can escalate into a fungal and opportunistic infection if left untreated and has a high incidence in patients undergoing head and neck radiotherapy (RT). Failure to diagnose and treat these oral complications can compromise the patient's systemic condition, necessitating discontinuation of cancer treatment or an undesirable hospitalization.

Antimicrobial Photodynamic Therapy (aPDT) has emerged as a promising approach. The typical parameters for low-intensity laser usage include a red laser diode emitting light at a wavelength of 660 nanometers in a precise and continuous manner. The beam has a diameter of 0.25 cm, a power output of 100 mW, and an irradiation time of 3 seconds per point. This setup generates a fluence of 1.2 J/cm² over the entire length of the lesion, with a uniform spacing of 1 cm between points. The antimicrobial effect of aPDT is based on the principle that visible light activates a non-toxic photosensitizer molecule, which generates reactive oxygen species that kill microorganisms through an oxidative burst. The increase of pathogens resistant to commonly used drugs in the general population underscores the urgent need for antimicrobial approaches capable of efficiently inactivating pathogens without inducing resistance.

Similarly, Intravascular Laser Irradiation of Blood (ILIB), currently performed transcutaneously and minimally invasive, has contributed to preventing the appearance of lesions in different regions of the body and can be used to treat various diseases. In addition to its analgesic effects, ILIB also demonstrates spasmyotics, and sedative properties. ILIB facilitates the absorption of red wavelength light by the blood, thereby increasing the person's metabolism through the stimulation of mitochondrial components. Furthermore, it influences the synthesis of the enzyme superoxide dismutase, the primary physiological protein regulating the body's oxidative system. Superoxide dismutase inhibits the action of reactive oxygen species (ROS) and protects cells by combating free radicals.

The literature describes the use of low-intensity laser therapy parameters targeting the radial or carotid artery using a 660-nanometer red laser with an optical power of 100 mW and continuous exposure for 10 minutes. Evidence in the literature portraying the use of ILIB for the treatment of OM and OC is scarce. Therefore, our objective is to present a systematic review addressing the critical question: Is ILIB an effective therapy for treating oral manifestations in oncological patients? Additionally, we provide a brief report of an oncological patient presenting with oral manifestations of OM and OC, where aPDT combined with ILIB was utilized to treat lesions in the oral cavity.

Materials and Methods

The methodology was defined following the PRISMA guidelines (Preferred Systematic Reviews and Meta-Analysis Report) and registered in the International Prospective Registry of Systematic Reviews (PROSPERO) under registration CRD42022351003. The case report followed the Declaration of Helsinki. The patient agreed and signed the Consent Form.

The literature search was conducted in 7 databases and gray literature. The review's question was: "Is ILIB an effective therapy for treating oral manifestations in oncological patients?" Additionally, we provide a brief report of an oncological patient presenting with oral manifestations of OM and OC, where aPDT combined with ILIB was utilized to treat lesions in the oral cavity.

Literature research

A search was performed in PubMed, Scopus, Embase, Cochrane, Lilacs, Web of Science, Scielo, and Gray Literature, as well as a manual search of the reference lists of the included studies, with no year or language restriction. The first phase established an investigation to de-