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Review

Effect of photodynamic and laser therapy in the treatment of *peri*-implant mucositis: A systematic review

Abdulaziz M. Albaker, Aws S. ArRejaie, Mohammed Alrabiah, Tariq Abduljabbar*

Department of Prosthetic Dental Sciences, College of Dentistry, King Saud University, Riyadh, Saudi Arabia

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ABSTRACT

Background: The present study systematically reviewed the literature to investigate the effect of photodynamic therapy (PDT) or laser therapy (LT) in the management of *peri*-implant mucositis (*p*-iM).

Methods: The electronic databases were searched until October 2017. Outcome measures were bleeding on probing (BOP), plaque index (PI), or probing depth (PD). The addressed PICO question was: "Is PDT and LT effective in the management of *p*-iM?"

Results: A total of five studies included in the qualitative analysis, two of which had a low risk of bias. Three studies used PDT while two studies used LT. All studies reported a significant improvement in clinical *peri*-implant inflammatory parameters in *p*-iM. For PDT, one study demonstrated a significant reduction for PDT group as compared to manual debridement (MD), while one study indicated comparable outcomes when tested with probiotics at follow-up. One study used PDT alone and indicated significant improvements in *peri*-implant parameters at follow-up. However, in the studies using LT, one study demonstrated a significant improvement in *peri*-implant parameters as compared to scaling and root planing alone, while other study indicated comparable outcomes when compared with manual debridement/chlorhexidine group at follow-up.

Conclusion: This systematic review demonstrated inconclusive findings to show the effect of PDT or LT in the management of *p*-iM due to methodological heterogeneity such as non-standard control groups, laser parameters and short follow-up period. The results of this review should be considered preliminary and further, more robust, well-designed studies with long-term follow up and standardized comparators with laser parameters are warranted.

1. Introduction

The plaque-induced inflammation of the *peri*-implant, supracrestal soft tissues, named as *peri*-implant mucositis (*p*-iM), is a highly frequent clinical finding in patients rehabilitated with dental implants, with a weighted prevalence of 43% as reported in a recent systematic review [1]. *p*-iM is completely reversible following treatment [2,3], yet may advance into *peri*-implantitis if left untreated [4], with the irreversible loss of implant-supporting structures.

A variety of traditional therapy such as detoxification of implant surfaces and *peri*-implant tissues through mechanical curettage has been used for the treatment of *peri*-implant diseases [5,6]. However, previous studies [7,8] have reported that the combination of manual debridement (MD) and photodynamic therapy (PDT) or laser therapy (LT) is more beneficial than MD alone in the management of *peri*-implant diseases.

Photodynamic therapy (PDT) has gained popularity in dental science for the treatment of various oral diseases [9–18]. In PDT approach, a laser light of specific wavelength with photosensitizer application stimulates photosensitizer dye molecules. This causes changes in the dye molecule from ground singlet state to excited triplet state that oxidizes to form highly reactive and cytotoxic singlet oxygen resulting bacterial cell death [19]. On the other hand, laser therapy (LT) is depends on its anti-infective, anti-ablation, and bio-stimulatory effects [20]. Laser light produces well collimated, coherent, and monochromatic laser beam which causes excitation and accumulation of electromagnetic fields [21]. The advantages of LT include minimum antibiotic resistance, instant suppression of causative oral bacteria, and no systemic disturbance and negative effects on the healthy periodontal tissue [22].

Since the treatment of *peri*-implantitis may require surgical intervention and no universally acknowledged treatment guidelines have been established for the management of such disease, which remains a challenge for the clinician [23,24], the prevention and treatment of *p*-iM acquired growing importance. The present study systematically reviewed the literature to investigate the effect of photodynamic therapy

* Corresponding author.
E-mail address: academicksa1@gmail.com (T. Abduljabbar).

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(PDT) or laser therapy (LT) in the management of *peri*-implant mucositis (*p*-iM).

2. Materials and methods

2.1. Focused question

The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines was followed [25], and a focused question was developed. The addressed PICO question was: Is PDT and LT effective in the management of *p*-iM?"

2.2. Selection criteria

Two reviewers (AA and TA) independently screened and assessed the potential articles. Any difference between reviewers involving the inclusion of studies was solved through discussion. Studies that did not fulfill the inclusion criteria were excluded. The inclusion criteria of the present review followed the PICOS question: (**Population**) the patients in the included studies should be diagnosed with *p*-iM; (**Interventions**) the experimental group in the included studies should have allocated to non-surgical periodontal treatment with adjunctive PDT and LT; (**Comparisons**) compared to MD/SRP; (**Outcomes**) with outcome measures of interest were bleeding on probing (BOP), plaque index (PI), or probing depth (PD) with a minimum follow-up assessment at 6 weeks; and (**Study design**) the review was restricted to randomized clinical trials (RCTs) or retrospective controlled clinical trials published in the English language. Animal studies, in-vitro studies, opinion articles, letters to the editor, review articles, interviews, updates, abstract, and unpublished studies were excluded.

2.3. Search strategy

The authors (TA and AA) searched the electronic databases including MEDLINE via PubMed, Cochrane Central Register of Controlled Trials and Cochrane Oral Health Group Trials, EMBASE until October 2017. The literature search was conducted using the combinations of the following Medical Subject Heading (MeSH) and text words: ((laser therapy OR lasers OR photochemotherapy OR photosensitizing agents OR ablation) AND (*peri*-implant diseases OR *peri*-implant mucositis OR *peri*-implant). Manual searching of the following journals was performed from 1976 to 2017: *J Clin Periodontol, Int J Dent Hygiene, Photodiagn Photodyn Ther* and *Lasers Med Sci*. Additional relevant articles were searched manually from the reference lists of full text. Any differences about study selection were resolved through discussion.

2.4. Screening methods and data abstraction

Titles and abstracts of studies that fulfill the inclusion criteria were screened and assessed. Data were extracted from the included studies as per following parameters: author/country, study design (RCTs), subjects (sample size; mean and age range in years), inclusion of confounders, *peri*-implant diagnostic criteria, study groups, study outcome, and follow-ups. In addition, methodological quality and the characteristics of laser and photosensitizer were assessed.

2.5. Risk of bias in individual studies

The revised recommendations of the Consolidated Standards of Reporting Trials statement were followed for the assessment of methodological quality of the included RCTs [26]. To ascertain the validity of eligible randomized trials, the authors determined the risk of bias associated with concealment of allocation, randomization, blinding of outcome assessor, and blinding of patients in the studies. The Cochrane Handbook for Systematic Reviews of Interventions [27] was used to assess the possibility of bias in each study as follow: "high risk of bias" (high), "low risk of bias" (low) or "unclear" (?) for each of these sections. Overall, studies were considered as: (i) low risk of bias if all criteria were met (adequate randomization and allocation concealment; "yes" answer to all questions about the completeness of outcome data and blinding, and "no" answer to selective reporting and other sources of bias); (ii) unclear risk of bias if one or more criteria were partly met; or (iii) high risk of bias if one or more criteria were not met. The modified version of the Downs and Black checklist was used to assess the possibility of bias in non-RCTs [28]. Both the assessor discussed and resolved any disagreements.

2.6. Statistical analysis

No *meta*-analysis could be performed due to the methodological heterogeneity in the included studies, for example, study groups, laser/photosensitizer parameters, and a variation in the outcomes of *peri*-implant parameters. Therefore, the outcomes are reported as a narrative review.

3. Results

3.1. Study selection

Based on titles and abstracts search, initially 90 studies were identified. After removing duplicates (n = 2) and screening of abstracts, a total of 71 articles were not relevant to the objective of the review, hence excluded. Seventeen full-text studies were selected for screening of which, 12 studies were eliminated because they did not match the inclusion criteria. The final selection resulted in the inclusion of three studies [7,29,30] for PDT and two studies [8,31] for LT were included in the quality assessment. The inter-assessor agreement was good to excellent at initial screening and full-text eligibility ($k = 0.75$ and 0.95, respectively). All included studies [7,8,29–31] were conducted at either health care centers or a university hospital. Fig. 1 shows flow diagram of study selection process and results of the literature search according to PRISMA guidelines [25].

3.2. Characteristics of included studies

Among the five included studies [7,8,29–31], three [7,29,30] were categorized as RCTs, one case series [31] and one retrospective controlled clinical trial [8]. Trials originated from Saudi Arabia [7], Brazil [29], Italy [8,30], and Germany [31]. In all studies [7,8,29–31], the number of patients ranged between 20 and 54 with the mean age ranging from 52.2 to 57 years. The male to female ratio was 90/58 in all the included studies [7,8,29–31]. History of smoking was present in all the included studies [7,8,29–31]. The *peri*-implant diagnostic criteria varied among the studies. Three studies [7,29,30] included subjects with PD ≤ 4 mm, while one study [31] included patients with full mouth plaque scores $\leq 25\%$ and plaque index at the implant level < 1 and one study [8] included subjects with ≥ 1 site affected by mucositis and BOP. Out of five clinical studies, three studies [7,29,30] used PDT with MD [7], probiotics [29] and oral hygiene protocol [30] respectively, while two studies [8,31] used the LT with scaling and root planing (SRP) in the test group. In all studies [7,8,29–31], the follow-up period ranged between 6 and 136 weeks.

Risk of bias graph and summary are presented in Figs. 2 and 3, respectively. Out of five studies, only two studies [29,31] were considered as high-quality, while three studies [7,8,30] were regarded as low-quality (Table 1).

3.3. Laser and photochemotherapy related parameters

In PDT studies, one study used diode laser [7] while two studies [29,30] used LED lamp. The wavelengths of diode lasers used in the included PDT studies ranged from 630 nm to 660 nm. Power output and