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The Use of Diode and Erbium Lasers in Fixed Prosthesis Systematic Review

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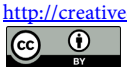

Abstract

Introduction: The integration of lasers in dental practice has experienced real extent thanks to the advantages and facilities they present. This technology has shown remarkable results namely in the surgery of soft tissues as well as hard tissues. In dentistry, and essentially in joint prostheses, the most lasers used are Diode laser and Erbium laser. These lasers facilitated interventions and optimizing treatment plans. Objective: The main purpose of our systematic review was to show the contribution of Erbium and Diode lasers in joint prostheses and to scientifically prove their usefulness. Materials and Methods: The collection of data from the scientific literature was carried out through a search on 2 research engines (PubMed and Science Direct), using the appropriate terms and keywords, over a period ranging from 2012 to 2022. The published articles responding to the inclusion criteria of our work were included. The writing of this systematic review followed the guidelines of PRISMA (Preferred Reporting Items for Systematic reviews and Meta Analysis) and the Guide of Cochrane Diagnostic Test Accuracy Protocol and Reviews. Results: 16 articles were considered as relevant documents to our research, in which 345 patients received a total of 553 prosthetic procedures. The results were divided into 4 parameters, according to the following clinical situations: Access to the cervical limit, coronary elongations, implant surgeries (2nd surgical procedure) and removal of fixed prostheses. Discussion: This systematic review is dedicated to the discussion of the results present in the studies included in our systematic review. Then, these results are compared with each other and with other publications to make a conclusive and definitive judgment on the various factors mentioned above.

Subject Areas

Dentistry

Keywords

Laser, Diode, Erbium, Fixed Prosthetic

1. Introduction

The term LASER is the acronym resulting from light amplification by stimulated emission of radiation, the device emits light and gathers it in a narrow beam.

History:

In 1917, Albert Einstein laid the foundations for the invention of the Laser by theorizing that photoelectric amplification could emit a single frequency, or stimulated emission.

Until 1959 that the term LASER was introduced to the public for the first time, in an article by a graduate student at Columbia University, Gordon Gould [1].

A laser that was generated from yttrium-aluminum-garnet crystals treated with neodymium was created in 1961; in 1962, the argon laser was developed, then the ruby laser became the first medical laser to be used in medicine in 1963 especially in ophthalmological medicine.

There are 4 types of lasers:

Solid lasers (including the Erbium family of lasers),

The gas lasers,

Dye lasers,

and finally semiconductor lasers including diode lasers.

The Erbium and Diode lasers are the two most used lasers in dentistry for periodontology, surgery, odontology, cosmetic dentistry, or prosthesis [2].

The Erbium laser family consists of 2 types of lasers mainly; Chromium-doped Erbium laser with a wavelength of 2780 nm AND yttrium-aluminium-garnet Erbium laser treated with neodymium, whose wavelength is 2940 nm [3].

These wavelengths have a high affinity for hydroxyapatite and are characterized by the highest absorption of water. Therefore, it is the laser of choice for the treatment of hard tissues of the tooth. In addition to this, these lasers can also be used for the ablation of soft tissues.

As for the Diode laser, all its wavelengths are absorbed mainly by the tissue pigment and hemoglobin. Conversely, they are poorly absorbed by hydroxyapatite and water in enamel.

The purpose of this research work is to show the contribution of Erbium and Diode lasers in fixed prosthesis.

2. Materials and Methods

This systematic review is carried out according to:

PRISMA criteria and the Cochrane Guide

The collection of scientific articles was carried out through a search on 2 databases.

PubMed and Science Direct

To facilitate the search, it was first necessary to identify the keywords then associate them thanks to Boolean operators in order to elaborate the search equations.

Search engines use these equations to find the right articles about it (See Figure 1).

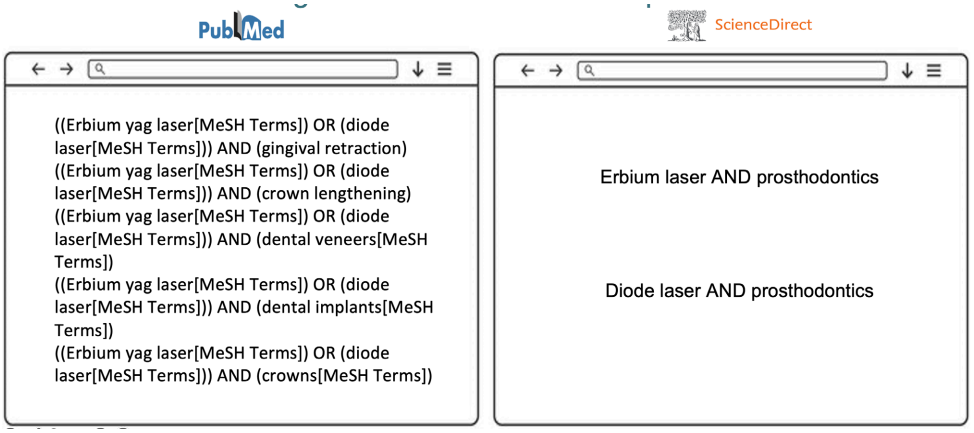

Figure 1. The Boolean operators equations.

The keywords are:

Erbium Laser/Laser Diode/Gingival Retraction/Crown Lengthening/Dental Veneers/Prosthodontics/Dental Implants/Crowns.

To have more precise results, selection criteria were used. Included criteria articles were selected.

Our research included articles as a result.

Published from 2012 to 2022. Randomized controlled clinical trials and non-randomized clinical trials. Comparative and prospective clinical studies. - Case reports. AND - Systematic reviews.

And we excluded:

The *in vitro* studies, experiments carried on animals, articles used in other areas besides fixed prosthesis.

The search equations were optimized, but the bibliographic search still contained articles that did not answer the questions asked.

Sorting was therefore necessary to select only the relevant articles.

This sorting was done in 3 steps: selecting articles based on their title, then on summary, and finally on their full text.

When reading the articles, common data between the studies were retained, the following information was extracted:

Author, - Year of publication, - Country of study, -Type of study, - Number of patients, -Average age, -Number of acts, -Nature of the act, -Location of the act, -Type of laser used, AND finally the duration of the -Follow-up.

3. Results

The exhaustive search produced 1580 potentially relevant articles. After elimination of duplicates, screening on titles and abstracts, AND full text analysis, only 16 articles met the eligibility criteria. So, 16 items were included in our work (See Figure 2).

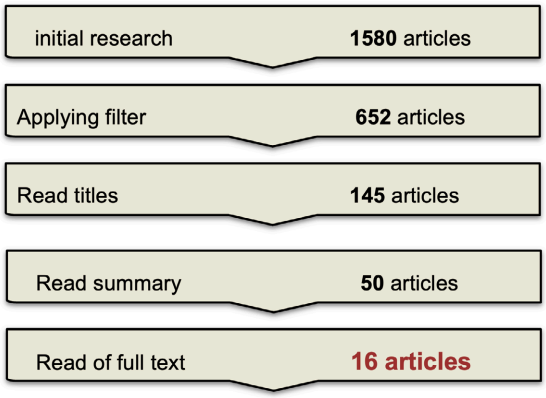

Figure 2. Flow diagram.

These included studies included: 6 case reports, 1 prospective study, 5 comparative studies, 2 randomized controlled trials and 2 systematic reviews.

These studies included more than 345 patients who received 553 prosthetic procedures:

Of which **Figure 3**:

270 implant surgeries;

64 coronary elongations;

180 access to cervical boundary;

39 dentures (including 19 crowns AND 20 veneers).

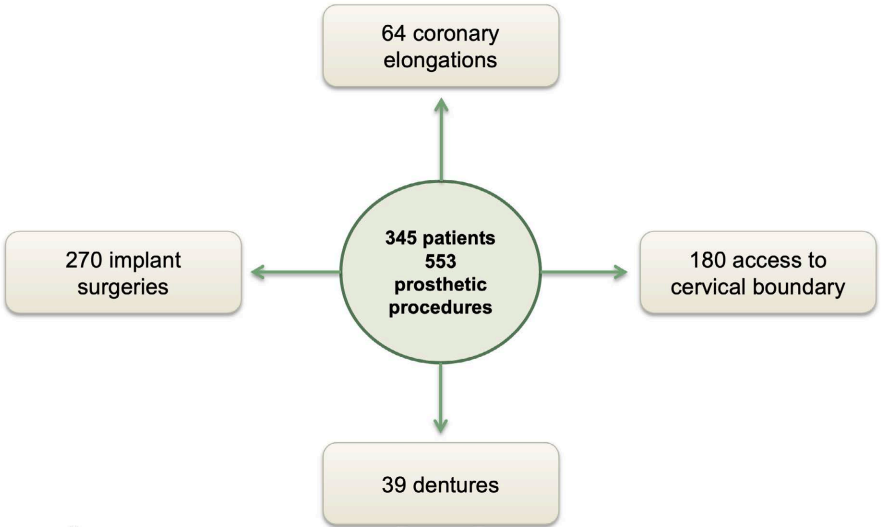

Figure 3. Distribution of articles.

We ranked our results according to 4 parameters:

- Access to the cervical limit, - Coronary elongation, - Implant surgery, - Removal of fixed prostheses.

Of these clinical studies, 3 studies targeted laser-assisted cervical boundary access techniques [4]-[6]. Then, 6 others focused on the contribution of lasers in coronary elongation [7]-[12].

4 studies demonstrated the use of laser in the second surgical time of implant placement [13]-[16], while 3 studies focused on the utility of lasers in the removal of dental crowns [17]-[19].

4. Discussion

4 clinical situations were highlighted:

Access to the cervical limit. Coronary elongation. Implant surgery (more specifically during the 2nd surgical procedure) and finally the removal of fixed prostheses. (especially crowns and veneers).

- Cervical boundary access technique:

Included studies from Xian *et al.* [14] and Unalan *et al.* [15] showed that the use of Erbium and Diode lasers resulted in less gum recession and less tissue alteration in the teeth involved. With better tissue healing when using the Erbium laser.

However, according to Stuffken *et al.* [16] as well as Melilli *et al.* [17], the retractor wire and the Diode laser had the same gingival retraction effect, and no difference was noted at the periodontal level [20]-[22].

We cannot prove the superiority of lasers over access to the cervical boundary; however, it remains a proven therapeutic option.

- Coronary elongation:

The case reports included in our review showed that the use of laser for coronary elongation was effective because it allowed faster healing, loss of attachment and minimal recession. It also ensured comfort for patients and postoperative follow-ups without pain. This favored the restorative treatment and reduced the delay time [23]-[25].

Compared to the conventional method, the use of lasers made it possible to have the best periodontal results, such as the absence of gingival recession and bone resorption in the treated teeth, in addition to the absence of pain and postoperative bleeding and the presence of minimal inflammation [26]-[29].

- Removal of fixed prostheses:

The studies of Morford & al. [30] Et de Kursoglu *et al.* [17] deduced that the use of the ERBIUM laser as a veneer removal tool, allowed a quick and easy intervention and without complications regarding the abutment tooth.

The review by Kellesarian & al. [14], showed that the binding forces of the assembly material used decreased with laser irradiation, thanks to the rays that vaporized its components, and therefore allowed safe removal compared to abutment teeth and prostheses.

According to Broome PJ [31], the thickness of the facet allowed to define the duration of irradiation by the laser; the facets at LESS than 1 mm thickness required a duration of 9 - 15 s, as for the lithium disilicate or zirconia prostheses that were thicker, required a duration of 15 - 30 s [32] [33].

The study by Rechmann & al. [34] demonstrated that the use of the Erbium YAG laser with water irrigation was effective in depositing ceramic crowns. Laser radiation penetrated the ceramic and degraded the components of the assembly

material [35] [36].

According to Gurney & al. [37]and Alikhasi & al. [38], a veneer removal by the Chromium-doped Erbium laser made it possible to perform a safe and secure procedure in relation to the pulp vitality of the abutment teeth.

Finally, the study by Morford & al. [39] was based on the use of the Erbium YAG laser; with which the removal of dental veneers was successfully and safely performed, but the duration of the procedure depended on the thickness and robustness of the prosthesis.

The use of Er:YAG and Er,Cr:YSGG lasers has proven effective for the removal of ceramic crowns and veneers. It is essential to respect the parameters of the lasers chosen to perform a safe intervention to the teeth concerned.

Therefore, the removal of the prostheses fixed by the laser allows to have promising results in terms of time and ease.

However, the success of the procedure was related to the types of crowns, the nature of the assembly material used, and the laser parameters chosen. This last factor played an essential role in preserving an adequate temperature for the pulp vitality and performing a safe intervention to the teeth concerned.

5. Conclusions

Access to the cervical margins of teeth using a diode laser still requires further systematic studies and systematic reviews to reach precise and evidence-based conclusions.

The use of diode and erbium lasers in crown lengthening procedures has been shown—through several clinical studies and systematic reviews—to enable minimally invasive, fast, and painless interventions, with minimal postoperative complications compared to conventional techniques.

In implant surgery, diode and erbium laser-assisted protocols have demonstrated, according to systematic reviews, a favorable impact on periodontal and peri-implant tissue healing, as well as improved patient comfort, compared with traditional mucosal flap methods.

The removal of fixed prostheses using the erbium laser has also proven effective, provided that the recommended parameters are strictly followed to preserve the underlying tooth structure. The duration and success of the procedure depend largely on the prosthesis thickness and the material used.

In conclusion, diode and erbium lasers represent significant progress in modern dentistry. Particularly in fixed prosthodontics, these laser systems have proven to be valuable in both soft and hard tissue procedures, leading to enhanced clinical outcomes. However, their application must follow specific criteria and recommendations to ensure safety and efficacy—an aspect that future systematic reviews should continue to clarify and standardize.

Conflicts of Interest

The authors declare no conflicts of interest.

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