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Review article

SURGICAL AND NON-SURGICAL LASER PRE-PROSTHETIC PERIODONTAL PREPARATION. LOW-LEVEL LASER THERAPY AND PHOTO-ACTIVATED DISINFECTION

Rada Kazakova
Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University – Plovdiv, Bulgaria.

ABSTRACT

Background: Clinical success and functional durability of indirect restorations depend on optimal dental health before the prosthetic treatment and the manipulation of the gingival tissues.

The **aim** of the current article is to review the surgical and non-surgical laser methods that can be applied as periodontal preparation in fixed prosthodontics.

Review results: Preprosthetic periodontal preparation includes conventional periodontal therapy (non-surgical) and periodontal resective (surgical) procedures - soft and hard tissue crown lengthening. The advantages of lasers in the latter are reduced bleeding, less postoperative discomfort and faster healing. Non-surgical preprosthetic preparation, on the other hand, aims at microorganisms' level reduction. The variety of protocols, which reduce the microbial number significantly, show photoactivated disinfection as adjunctive therapy in infection treatment, especially in patients with resistant microorganisms and anatomical complications.

Conclusion: Lasers can be applied as an alternative to the classic surgical and non-surgical means for periodontal procedures. Low-level laser therapy and photoactivated disinfection ensure faster bacteriolysis and affect the microorganisms locally, whereas systemic medicines influence the whole organism. Photodynamic therapy does not require maintaining high concentrations of the photosensitizer in the infected area, as it is when using antiseptics and antibiotics.

Keywords: low-level laser therapy, photoactivated disinfection, photobiomodulation, photodynamic therapy,

BACKGROUND

Clinical success and functional durability of indirect restorations depend on the careful and exact performance of a few consecutive procedures. One of the key ones is the manipulation of the gingival tissues and providing gingival esthetics. The aim during the process is to maintain the normal appearance of the healthy gingiva, and in order to achieve this, it is necessary to achieve optimal dental health before the treatment and minimal trauma during the procedure. Low-level laser therapy and photoactivated disinfection are adjunctive therapy to non-surgical periodontal treatment.

AIM

The aim of the current narrative review is to report the surgical and non-surgical laser methods that can be applied as periodontal preparation in fixed prosthodontics.

REVIEW RESULTS

Lasers and Surgical Preprosthetic Periodontal Preparation

Preprosthetic periodontal preparation includes conventional periodontal therapy and periodontal resective procedures. Removal of excessive gingival tissue for achieving better functional stability of the future restorations or a more harmonious smile line is often necessary in fixed prosthodontic cases. The reasons for the crown lengthening procedures are esthetic and reflect the growing popularity of the 'smile makeover' procedures, as well as the understanding of the dentists of preserving the biologic width. [1] This is a surgical procedure aiming at revealing a greater gingivo-incisal length of the tooth structure before the prosthetic restoration of the tooth, which involves predictable disclosure of a small amount of gingival tissue alone – soft tissue crown lengthening, or both gingival tissue and alveolar bone – osseous crown lengthening. Traditional osseous crown lengthening techniques usually include full-thickness flap elevation, ostectomy and osteoplasty to determine the new gingival level. [2]

Creating a 3 mm distance from the alveolar ridge to the margin of the future restoration results in stable periodontal tissue at that level. [3-4] The abovementioned distance was proved by Gargiulo et al. in 1961 and is based on the biologic width concept. [1] Surgical crown lengthening can be performed after finishing the initial hygienic phase.

The following indications for crown lengthening have been established:

• Altered passive eruption (APE).

• Deep subgingivally located finish line, at which the impression taking is difficult.

• Deep subgingival carious lesion.

• Root fracture in the cervical third.

• Root obturation in the cervical area.

• Achieving ferrule effect with short crowns. [5-7]

• Perforation of a parapulpal pin in the cervical third of the root.

• Insufficient retention of the artificial crown because of the reduced clinical crown length.

• Deep subgingival margin leading to an inflammatory reaction that cannot be controlled otherwise. [8-10]

• Odontoplasty in combination with resection or hemisection of a single root in advanced furcation lesions of multiple-root teeth.

• Heavily abraded dentition prior to the restoration.

• The need to improve the esthetic appearance of front teeth with short clinical crowns and a gingival (high) smile line. [9-16]

Lasers and Non-surgical Preprosthetic Preparation. Low-Level Laser Therapy and Photoactivated Disinfection

Everyday dental clinical manipulations aim at reducing the number of microorganisms. There is a number of protocols that notably diminish the microbial number, i.e., disinfection (PAD), or photodynamic therapy (PDT). The latter serve as adjunctive therapy in infection treatment, especially in patients with resistant microorganisms and anatomical complications.

High-intensity laser irradiations leads to temperature rise, protein denaturation and destruction of decontaminating microorganisms. [17] Such effects cannot be expected when applying low-level laser therapy (LLLT), or photobiomodulation (PBM), because it is unable to achieve such high temperatures. [18] Nevertheless, soft lasers exhibit proven antimicrobial properties. This effect is achieved by combining low-level lasers with photosensitizers, thus reactive oxygen species (ROS) are released. The latter lead to a destruction of cell membranes, mitochondria and deoxyribonucleic acid (DNA), therefore microbial reduction is inevitable.

The antimicrobial capacity of PAD and PBM is used for increasing the microbial reduction and pain levels in periodontal, restorative, endodontics, pediatric and implantology conventional therapy. [19-24] Viral inactivation and successful treatment of infections caused by the herpes simplex type I virus are proven. [25-27]

A combination of an adequate light source and a photosensitized targeted to the specific pathogen – PAD, is essential for effective bacterial infection elimination. Hence, photosensibilisation takes place in subgngival or superficial oral tissues. [28] The most frequently used source of photosensibilisation in dentistry is the low-level laser because it:

• Has a narrow spectral range, which allows more specific interactions with the photosensitizers.

• Can be connected to optical fibers.

• Does not lead to tissue temperature increase, as it is seen when using a polychromatic light. [28]

DISCUSSION

Lasers can be successfully applied in periodontal preprosthetic procedures. [8-10] The clinical advantages of laser application for the dentist, as well as for the patient, are reduced bleeding and less postoperative discomfort and oedema, compared to the conventional surgical techniques and electrosurgery. [9-16] Moreover, the clean operative field, due to the excellent hemostasis and moisture control, ensures more precision in the execution of the prosthetic procedure. The main advantage over all the instruments was water cooling, which made the manipulations gentler, the reactions after them (pain, redness and swelling) – more sluggish, and the healing – faster.

The use of light emitting diode (LED) light was also described in the literature. A few positively charged photosensitizers suitable for PDT, such as toluidine blue and poly-L-lysine-chlorine derivates. [29] The incubation period between the photosensitizing agent and the pathogens lasts within a few minutes, therefore it should be taken into consideration prior to the laser irradiation. [29]

Despite the numerous advantages of PAD, its major drawback is a lack of standardization and confirmed protocols. Clinicians have been researching the antiseptic properties of PDT, the ideal light source, the suitable photosensitizer for each bacterial species or target tissue, in addition to the appropriate light intensity and power settings. Protocols derived from this extensive in vivo and in vitro research demonstrated safety and superior clinical results, proving the safety of using PAD. [30, 31]

Feurstein et al. reported how blue light affected biofilm formation. The two main assumptions are about to be validated in vivo. The first conclusion was that when Streptococcus mutans was exposed to blue light, the new biofilm formation was affected, leading to increasing the number of destroyed bacteria. [31] The second one is that earlier research showed that blue light, connected with hydrogen peroxide, had a strong antibacterial effect on the biofilm. [31, 32, 33] A synergic effect between blue light and hydrogen peroxide exists. The phototoxic effect of Streptococcus mutans is mainly photochemical, with ROS. If such light is applied on an infected tooth, in a combination with hydrogen peroxide, it presents as an adjunctive minimally treatment.

CONCLUSION

Lasers can be applied as an alternative to the classic surgical and non-surgical means for periodontal procedures. They present with reduced bleeding and postoperative oedema, as well as faster healing. Low-level laser therapy and photoactivated have several advantages compared to the traditional antimicrobial agents. They ensure faster bacteriolysis and affect the microorganisms locally, whereas systemic medicines influence the whole organism. Photoactivated disinfection does not require maintaining high concentrations of the photosensitizer in the infected area, as it is when using antiseptics and antibiotics. Moreover, it does not damage or change the adjacent structures like periodontal or periapical tissues, even when a high concentration of the dye and the laser energy are applied.

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Address for correspondence:
Rada Kazakova
Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University – Plovdiv, Bulgaria
3 'Hristo Botev' Blvd
E-mail: rada.kazakova@mu-plovdiv.bg