ORIGINAL ARTICLE

LASER DIODE APPLICATIONS IN PROSTHETIC DENTISTRY

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ABSTRACT

The future of dentistry is digital. Based on this premise, the supportive use of laser for gingival troughing is appropriate.
Laser diode in a continuous or pulsed mode was used as a possible instrument for soft tissue surgery and stimulation in the oral cavity. Dental procedures performed today with the laser are so effective that they should set a new standard of care. This article puts forward the state of the art of laser in prosthetic dentistry from a clinical point of view, based on the research that supports the indications described. Numerous studies in the literature have reported the benefits of laser use, and based on the laboratory and clinical evidence, application for the use of lasers in prosthetic dentistry is suggested. The clinician must be able to select the best laser for a certain procedure and also understand the biologic rationale for its use. The laser most widely used in prosthetic dentistry is the DIODE LASER.

Keywords: laser diode, soft tissue, dental procedures, prosthetic dentistry

INTRODUCTION

The unique characteristics of the diode lasers, including small size, high electrical efficiency and semiconductor reliability and longevity, have led to their widespread adoption in diverse therapeutic medical applications. Just as important, the unique ability to scale both the power and wavelength of diode lasers, together with the option of either free space or fiber delivery, enables manufacturers to offer products that are optimally suited to the needs of specific medical procedures. The end results are better outcomes, higher patient satisfaction, shorter treatment time, as well as shorter hospital stays, and reduced costs.

With dentistry in the high-tech era, we are fortunate to have many technological innovations to enhance treatment. No instrument is more representative of the term high-tech than the laser. Dental procedures performed today with the laser are so effective that they should set a new standard of care [1].

Laser is the acronym for "Light Amplification by stimulated emission of radiation". Lasers were developed and actually used in light shows and for other purposes. Today the laser is used in the scanners at the grocery store, in compact disc players, and as a pointer for lecturer and above all in medical and dental field. The image of the laser has changed significantly over the past several years.

The discovery of lasers and research into their applicability for dental use began in the 1960s. The first documented use of a laser in dentistry was published în 1985. Early efforts were limited to those soft tissue procedures that could be performed. In 1985, Myers & Myers modified an ophthalmic Nd: YAG laser for dental use [2].

The shorter wavelengths (500–1000 nm) are readily absorbed in pigmented tissue and blood elements. Argon is highly attenuated by hemoglobin. Diode and Nd:YAG has a high affinity for melanin and less interaction with hemoglobin. The wavelengths used in dentistry are in a range of 800-980 nm and are poorly absorbed in water, but highly absorbed in hemoglobin and other pigments [3,4].

The diode laser is a solid-state semiconductor laser which uses a combination of gallium, arsenide, aluminum, and indium (GaAlAs, InGaAs). Available wavelengths for dental use (placed at the near infrared portion of the invisible non-ionizing spectrum): 655 nm (a visible red diode); 800–830 nm (AlGaAs); 980 nm (InGaAs, GaAlAs). Fiberoptic cable is used in contact mode (for soft tissue surgery) and non-contact mode (for deeper coagulation). Emission mode is continuous wave and gated pulsed.

The pigment melanin which imparts color to skin is strongly absorbed by short wavelengths. Hemoglobin reflects red wavelengths imparting color to arterial blood. It is therefore strongly absorbed by blue and green wavelengths whereas venous blood containing less oxygen absorbs more red light and appears darker. Water has varying degrees of absorption of different

wavelengths [4-6].

Diode laser is excellent for soft tissue procedures as these do not interact with dental hard tissues. Poorly absorbed by tooth structure so that soft tissue surgery can be performed safely in close proximity to enamel, dentine and cementum. This laser systems as low laser therapy have also been used for biostimulation of osteoblasts around implants [7].

Laser diode may be used to perform most preprosthetic surgeries. Clinical application of Laser diode in FPDs are: soft tissue surgeries like cutting and coagulating gingiva and oral mucosa; soft tissue tuberosity reduction; treatment of unsupported soft tissues; hyperplazic tissue and stomatitis under the palate of a full or partial denture; curettage in gingival sulcus prior to tooth preparation to achieve good periodontal health and thus esthetics; LILT (low intensity laser treatment) tooth conditioning after tooth preparation in vitalized teeth [8].

AIM AND OBJECTIVES

The purpose of this article is to provide an overview of the current and possible future clinical applications of laser diode in prosthetic dentistry. Prosthetic procedures for which conventional treatment cannot provide comparable results or are less effective are emphasized. One of the aims of prosthetic rehabilitation is to achieve a harmonious result, but dentists often find themselves having to strike a balance between the subjective state of the single patient, which makes each case a case unto itself, and general rules of practice that instead give precise indications on the results that treatments should allow.

RESULTS

In our preprosthetic therapies we used a diode laser manufactured by DenMat United States (Figure 1), having the wavelength of 808 nm +/- 5 nm, with optical fiber with 400 micron diameter.

The SOL Laser unit is a dental soft-tissue laser surgical/debridement device. The SOL Laser may be used for a variety of soft-tissue, gingival modification, and sulcular therapy procedures. The SOL Laser is indicated for use in dental intraoral soft tissue general, oral maxilla-facial and cosmetic surgery including ablating, incising, excising, vaporizing and coagulation of soft tissues using a fiber optic delivery system. The SOL Diode Laser is attracted to melanin, hemoglobin and to some extent to water.

The laser, by definition, produces very precise incisions and at the same time exerts a variable haemostatic action (obviously depending on the type of laser used and the type of target tissue). Furthermore, the fact that diode lasers use optical fibers (with 300-400 micron diameters) to transmit energy makes them manageable and suitable for use in the clinic.

The diode laser is used at low power (1.5-3W) in order to avoid unnecessarily damaging or overheating the target tissue. Incisions made by a diode laser are wounds that heal by second intention, without the use of sutures and often without the support of antibiotic therapies, given the capacity of the laser beam to exert a decontaminating action.

Protocol for using the diode laser:

Laser treatments of soft tissues are carried out following infiltration of a local anaesthetic, sometimes with the addition of a vasoconstrictor in a concentration of 1:100,000/1:200,000.

An optical fiber with a 300/400 micron diameter is selected.

The optical fiber must be used in direct contact with the tissue to be remodelled or removed, and the operator should be careful to execute sufficiently rapid yet extremely precise movements that will allow him to make the necessary tissue incision while reducing to a minimum the contact between laser and tissue (i.e. the duration of the exposure and thus the risk of overheating).

The optical fiber must be absolutely stable during the cutting strokes and must also be cleaned scrupulously after almost every stroke, with physiological serum, in order to eliminate the tissue fragments that tend to adhere to it. The optical fiber is easily cleaned either with the laser turned off, using damp gauze, or with the laser running, by inserting it to a depth of 1-3 mm into a cotton roll and then removing it immediately.

Before being used on oral tissues the optical fiber must always be activated as follows: the laser machine is turned on and the fiber is trained on a dark background (articulation paper). This initiation causes the light energy to be absorbed by the burnt material on the tip, effectively making it a hot piece of quartz. The laser energy cuts indirectly by heating up the fiber optic tip. Diose lasers do not have enough peak power to efficiently cut tissue on their own without initiation.

The optical fiber must always be held perpendicularly to the tissue to be cut, unless the intention is to make a bevel cut in the tissue itself as a means of conserving more of the keratinised vestibular gingiva; in this case the optical fiber is held at an angle of 45 degrees in a vestibular-palatal or vestibular-lingual direction.

Remodelling does not need to be followed by antibiotic treatment to favour healing. The patient is simply advised to use a 0.25% chlorhexidine mouthwash, undiluted, for 7 days to keep the treated site clean and disinfected.

Figure 1: SOL Portable Diode Laser

Figure 2: Interdental papillae herniated over the fracture lines

Figure 3: Intraoral appearance after papillectomy

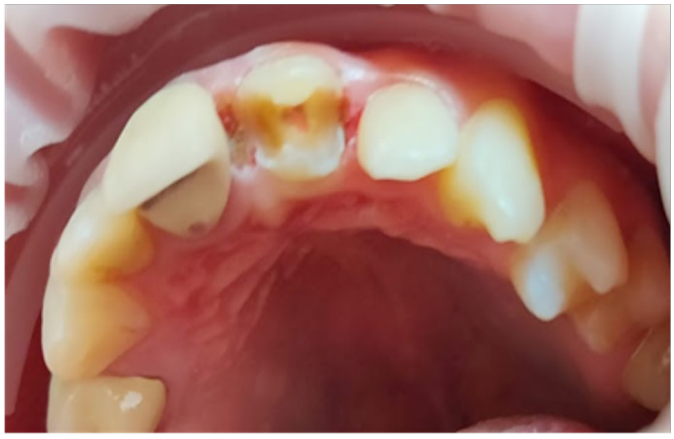

Figure 4: Intraoral appearance after removal of carious dentin

CLINICAL CASES:

1) REMODELLING THE GINGIVAL CONTOUR OF PILLAR TEETH

Often, we will encounter patients presenting with very irregularly shaped gums, a problem that can affect more or less extensive segments of the oral cavity.

In such situations, and particularly during the preparation of the pillar teeth and the application of the first, temporary restoration in resin, it is necessary to "adjust" the gingival tissue in order to confer a harmonious and symmetrical appearance not only on the tissue but also on the teeth, given that a tooth's length is determined by the line of the keratinised gum tissue around its neck.

The first case we want to present is of a young man who came to the medical office with a fractured central incisor. As shown in Figure 2, the interdental papillae are herniated over the fracture lines. From the medical history it is a devital tooth, with approximate massive obturations.

In order to be able to remove the decayed dental tissue we resort to remodeling the gingival contour with laser diode (Figure 3, 4). In this case, the mesial and distal papillae made it difficult to get an optimal impression. Now we can reconstruct the dental abutment under optimal conditions and perform the prosthetic treatment.

2) REMOVAL OF EXCESS GINGIVAL TISSUE AROUND ABUTMENTS

Many clinical situations are characterised by the presence of excess gingival tissue in contact with teeth that are to be the pillar teeth in a prosthetic rehabilitation.

An initial situation of this kind can be caused, among other things, by inflammation, accidental mechanical traumas, poor previous prosthetic restorations, drugs, or even a previous temporary prosthetic restoration if this was not carried out with due attention to the fundamental requisites of a "good" temporary restoration. In each of these cases, the operator has to remove the excess tissue without causing any damage to the surrounding structures and always tracing an ideal outline of the tissues that will remain.

Viewing the preparation margin is difficult, especially if it is in a subgingival location. This making gingival troughing necessary. The visualization of the preparation margin is a decisive factor for a perfect restoration in prosthetic dentistry.

The second case we want to present is of a woman who came to the medical office for complete

oral rehabilitation. The patient has a fixed prosthetic restoration incorrectly adapted, at the level of the maxillary premolars on the left hemiarch, accompanied by a gingival hypertrophy (Figure 5).

Figure 5: Gingival hypertrophy at the level of the abutments

Figure 6: Removal of gingival excess by laser diode

Figure 7: Appearance of the gum after gingivectomy

Figure 8: Temporary crowns made by Scutan method

After activating the laser, the tip of the fiber is moved gently over the tissue. The fiber should be kept parallel to the tooth to avoid unnecessary contact with the dental hard tissue and unintended irradiation of the bone (Figures 6, 7).

After gingivectomy, temporary crowns are made by Scutan method (Figure 8). After the healing of the gingival tissue, the prosthetic treatment is finalized.

3) LASER DIODE IN MOBILE DENTAL PROSTHODONTICS

Laser diode can be used as a adjuncts to removable prosthetic for many different procedures, including sulcular debridement. Soft tissue adhesions can be excised using diode lasers to improve re-epithelialization.

The third case we want to present is that of an elderly patient, totally edentulous. The patient has a sulcular adhesion in the maxillary prosthetic field (Figure 9), the presence of which can cause instability of the prosthetic structure and must be removed to increase the retention of the prosthesis (Figure 10).

RESULTS

The local anesthesia used before laser irradiation was minimal, and the patient's discomfort after surgery was limited and managed with mouthwash chlorhexidine. It was necessary only one laser session performed under contact anesthesia, followed by the formation of a small crust at the place of hyperplasia which was eliminated in a few days, being not necessary secondary care treatment. It was not necessary to administer postsurgery antiinflammatory or analgesic medication.

In the first two cases the gingivectomy procedure above pillar tooth is performed to help create ferrule effect on this preparation prior to fabrication of the definitive restoration. The patients does not noticed any discomfort and there was absolutely no bleeding.

In the third case no sutures were used, no bandages and the wounds were left to repair by second intention. After two weeks was observed an improved appearance of the lesion and scarring of the lesion without keloid aspects.

No postoperative pain was reported and no antibiotics were needed in any of the clinical cases.

DISCUSSIONS:

The successful use of the diode laser in soft tissue surgery is undisputed in literature [9]. Laser transmits energy to the cells causing warming, welding, coagulation, protein denaturation, drying, vaporization and carbonization.

Use of conventional double cord technique is time consuming and can damage the periodontium of the tooth. Electro surgery also has a disadvantage of delayed wound healing, bone recession etc. Lasers allow a clear vision of the gingival margin with minimum bleeding and reduces patient visits and are also highly acceptable to the patients [10].

Pulp irritation and inflammation may be caused

by aggression of tooth prep. LILT (low intensity laser treatment), with its antiinflammatory and biostimulating action are important adjuvant for better post op period after tooth prep, with less pain from pulp trauma. Diode lasers are used [11].

Enrico F. Gherlone and colleagues conducted a study to evaluate the tissue retraction and gingival healing using pulsed laser gingival retraction in comparison with the conventional mechanical or surgical techniques. This study showed that the laser technique was less aggressive to the periodontal tissues compared to the conventional ones, less gingival recession and less amount of bleeding from the sulcus. Also, laser technique showed hemostasis during impression making [12]. Laser proved to be superior to electrotome and retraction cords. The disadvantages of widening with retraction cords are bleeding and the tendency to recession and when using the electrotome, more recession occurred than when using laser [12].

Diode laser energy has peak absorption in hemoglobin, thus lending itself to providing excellent hemostasis and efficient coagulation and vaporization of oral tissues [13]. These characteristics are beneficial for retraction and hemostasis of the gingival tissue in preparation for an impression during a crown and bridge procedure [14].

Each device and each wavelength has specific advantages and disadvantages. It is important for the practician to understand these principles to take full advantage of the features of lasers and provide safe and effective treatment [15].

CONCLUSIONS

The introduction of lasers in the field of prosthetic dentistry has replaced many conventional surgical and technical procedures and is beginning to replace the dental handpiece. Today lasers have become an integral part of effective treatment planning.

Advances in the use of laser devices in prosthetic dentistry will continue. Further laboratory and clinical experimentation may determine a significant place for diode lasers in prosthodontics.

The laser has become a ray of hope in dentistry. When used efficaciously and ethically, lasers are an exceptional modality of treatment for many clinical conditions that dentists treat on a daily basis. However, laser has never been the "magic wand" that many people have hoped for. It has got its own limitations. However, the future of dental laser is bright with some of the newest ongoing researches.

An important advantage of laser treatments, assuming they are correctly performed, is their "atraumaticity" at the level of the oral soft tissues. As regards healing after laser treatment, many studies have clearly shown that laser wounds to the oral mucosa heal more slowly in the immediate post-operative period, but that healing is more effective in the medium and long term.

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To use diode lasers safely in a clinic, the practitioner should have precise knowledge of the characteristics and effects of these laser system and his applications as well as a full understanding of the conventional as well as surgical treatment procedures. Also the dentist should exercise appropriate caution during laser diode use.

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