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Application of Laser Technology in Fixed Prosthodontics

—A Review of the Literature

Al-Jallad Walid

Arab American University, Jenin, Palestine
Email: jallad1981@gmail.com

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Abstract

Introducing laser light in prosthetic dentistry opens a new era on the treatment modules with new impact in the quality of prosthodontics treatments, with hope of overcoming some of the drawbacks posed by the conventional methods of fixed prosthodontics procedures. Laser techniques cause less pain than traditional methods and eliminate the noise of instrumentals that some fearful patients who have long term neglected care and those have complex medical histories and required more specialized care, could use the advantage of laser in their treatment plan. The aim of the articles review is to highlight the current and emerging application of laser in fixed prosthodontics treatment to be used in conjunction or as replacement for traditional methods based on the research that support the indication described.

Keywords

Lasers, Fixed Prosthesis, Gingival Troughing, Esthetics, Crown Lengthening, Soft Tissue Management, Veneer Removal, Ovate Pontic

1. Introduction

The application of laser in medicine and dentistry go back to 1960 [1], since then the laser science has progressed rapidly and uses in field of dental science has been increased to overcome the drawbacks of conventional dental procedures [2]. Laser developed by Myers and Myers, it was recognized as the first laser designed specifically for general dentistry called the dLase 300 [3]. A Laser is an acronym for Light Amplification by Stimulated Emission of Radiation.

Laser has many advantages including less invasive more accurate and more precise procedure with less pain, faster healing, no direct soft and hard tissue contact, no vibration and more patients [4] [5], achieve immediate hemostasis and moisture control. Some patients have phobias and/or allergies to anesthetics. Lasers have become an integral part of treatment forthese patients.

Laser application has been introduced to every dental discipline including oral medicine, oral surgery, pediatric dentistry, operative and endodontic procedure, periodontal treatment, and implantology and prosthetic science [5] [68].

Manufactures have been introduced different laser products for dental application, the laser named according to their active medium, wave length, delivery system, emission mode, tissue absorption and clinical application [6] [7]. The active medium can be a gas (e.g. argon, carbon dioxide), a liquid like dyes or a solid state crystal rod e.g. Neodymium yttrium aluminum garnet (Nd:YAG), Erbium yttrium aluminum garnet (Er:YAG) or a semiconductor (diode laser).

The following lasers can be used in high powers, from a fraction of a watt to 25 watts or even more [8] [9] [10] [11] [66] [67].

1) The Erbium:YAG laser possesses the potential of replacing the drill. This laser is also used to alter pigmentation in the gingival tissues, providing the patient with pink gums. This laser is commonly used to prepare the patient for a cavity filling.

2) The Carbon Dioxide laser can be used to perform Gingivectomy and to remove small tumors. As a laser that does not require local anesthesia, it poses no discomfort for the patient and is practically a bloodless procedure.

3) The Argon laser is used in minor surgery. This gas laser releases blue-green light through a fiber optic cable to a handpiece or microscope.

4) The Nd:YAG is used in tissue retraction, endodontics and oral surgery. This laser usually does not require anesthesia. For procedures regarding the gingiva pockets, the dentist will insert the fiber between the gingiva and the tooth to sterilize and stimulate the tissue, causing the gingiva to adhere to the neck of tooth.

5) The diode laser—introduced in the late1990s—has been effective for oral surgery and endodontic treatment. This laser also helps treat oral cavity disease and corrects aesthetic flaws. As a compact laser, the diode is used for soft tissue procedures.

6) Low level lasers—less well-known—are smaller and less expensive. Sometimes referred to as “soft lasers” the therapy performed by these lasers is called “low level laser therapy.” Low level lasers improve blood circulation and regenerate tissues.

7) Holmium:YAG laser—This has been approved by the FDA to be used on the hard tissues of primary teeth.

The reader should consult other sources for specific information for current details about companies and their instruments.

2. Laser Application of Fixed Prosthodontics

2.1. Gingival Troughing

Achievement of accurate fixed dental prosthesis depends largely on accurate impression making, and one of the prerequisite for good impression is to record prepared abutment and gingival finish line of the restoration. For all impression procedures, the gingival tissue must be displaced to allow subgingival finish line to be registered [12]. This gingival retraction is a temporary displacement of the gingival tissue away from the prepared teeth [13]. Aim of the gingival retraction is to create the space to allow the impression material with sufficient thickness to flow in gingival sulcus [14] [15].

Traditionally different methods were applied for gingival retraction include mechanical retraction (using retraction cords), chemomechanical retraction (chemical used with retraction cord), matrix impression system [13], surgical retraction (laser, electrosurgery and rotary curettage).

Gingival retraction know as crown troughing is one of the newest procedures for preparation of the gingival tissue for fixed restoration impression, which replaces the conventional retraction methods. Laser troughing is predictable efficient, excellent hemostasis, relatively painless and minimizing postoperative problems, reduces chair time and sterilized sulcus [16] [17] [18].

Different lasers could be used including Neodymium: yttrium-aluminum-garnet (Nd-YAG) lasers, Erbium:yttrium-aluminum-garnet (Er:YAG), Diode laser, with all lasers have proved highly effective [18] [19].

2.2. Soft Tissue Management around Abutments/Laminates

Retraction of gingival tissue in preparation for an impression during crown and bridge fabrication, removal and/or recontouring of gingival tissue around laminates veneer can be easily accomplished using argon laser [20]. The lowest-wavelength lasers used for soft-tissue procedures in dentistry are the argon lasers [21], wave length of 514 nm is highly absorbed by red pigment structure (hemoglobin) making it extremely effective for soft tissue procedures Variety of fiber size (100, 200, 300 and 600) are available for precise cutting [22].

Argon laser with 300 um fiber, and a power setting of 1.0W, continuous wave delivery and the fiber is inserted into the sulcus in contact with the tissue. In a sweeping motion, the fiber is moved around the tooth. It is important to contact the fiber tip with the bleeding vessels. Provide suction and water spray in the field [23] [24].

Argon laser is safe surgical device since it has excellent control over depth penetration, excellent haemostasis to ensure clean dry operation filed, effective coagulation and vaporization of tissue [25].

2.3. Crown Lengthening

For more efficient functional and esthetics result in planning of restorative treatment, there are some clinical situations in which crown lengthening procedure is indicated, including 1) lack of sufficient length of a clinical crown to ensure a tooth preparation for fixed prosthodontics with retentive and resistance form; 2) preexisting dental caries or restorations in the vicinity of the free gingival margins that prevent preparation of finish lines for restorative margins coronal to the biologic width; 3) the need to develop a ferrule for pulpless teeth restored with posts 4) unaesthetic gingival architecture as a result of altered passive eruption [26] [27] [28].

Crown lengthening is a periodontal resective procedure, aimed at removing supporting periodontal structures to gain sound tooth structure above the alveolar crest level [29].

Understanding of biological width is mandatorily for utilization of crown lengthening procedure, Crown lengthening as describe by Cohen is sum of junctional epithelium and connective tissue attachments and its 2.04 mm average [30].

Planning of the restoration margin is important in restorative dentistry, when the margins of the prosthetics crown or bridge extended so much in the sulcus that dentist loses the access and vision where the margin is actually located. this lead to periodontal complication and eventually leading to prosthetic failure [31]. Violation of the biological width has periodontacl complications manifest as 1) Gingival recession and localized bone loss develop. This happens in cases where the labiobuccal bone is thin [32]. 2) Bone loss under the preparation margin that violated the biologic width [33]. 3) Clinical attachment loss. 4) Chronic progressive gingival inflammation around the restoration. 5) Bleeding on probing. 6) Pocket formation [34].

Several techniques have been proposed for clinical crown lengthening which includes External bevel gingivectomy, Internal bevel gingivectomy, apically displaced flap with or without resective osseous surgery, and surgical extrusion using periotome, Forced tooth eruption and Forced Tooth Eruption With Fibrotomy [34] [35] [36] [37].

Using laser for crown lengthening have many advantages; laser offer unparalleled precision and operator control,it can be held parallel to the long axis of the tooth to remove the bone immediately adjacent to cementum without damaging it, it cuts only in the tip which beneficial for finely tracing incision lines and sculpting the desired gingival margin outline [38]. Application of the laser in crown lengthening replaces conventional procedures to overcome the drawbacks of these procedures, surgical approach has long healing time, increase resorption of alveolar process, unpredictable gingival margin post-operatively, poor patients compliance, electro-surgery will generate heat that could be leading to pulp death or necrosis of bone. Orthodontic extrusion leads to vertical bone defect adjacent to extruded tooth and it also needs patient compliance [18] [39] [40].

2.4. Osseous Crown Lengthening

Aesthetics crown lengthening in which osseous recontouring are performed to establish an ideal biological width in cases where the restoration margin placed close to the bone [41], the alveolar bone is reduce by ostectomy and osteoplasty, using rotary instrument and/or chisels to expose the required amount of tooth in scalloped fashion [42]. Using either a high speed or low speed handpiece with carbide or diamond burs carry the risk of damaging adjacent root surface, and there is a chance of bone damage as result of frictional heat generated [43].

Laser technology has many advantages over conventional methods; better visibility due to control bleeding, complete healing of bone defect within 56 days (as showed in animal studies) while the surgical crown lengthening procedure required of 3 - 6 month healing period, [44] [45] minimal thermal damage, result in lack of thermal side effects and painless procedure [46] less post operative discomfort, due to the micro-invasive technique and reduced inflammation [47].

Using Er:YAG laser on osseous crown lengthening has very promising potential for bone ablation, Er:YAG laser is highly absorbed due to water content of hydroxyapatite which isthe main content of the bone matrix [20], notable studies have been conducted on the Er Cr YSGG laser uses and its efficiency and safety in alveolar bone correction [40] [48].

2.5. Veneer Removal

Veneer restoration has been introduce in dentistry in order to improve aesthetics, as times go veneers may required removal or replacement for variety of reason such as caries, porcelain chipped or fractures, discoloration due to luting cement, marginal failure or leakage, or simply because the patient is unhappy with the esthetic outcome [49].

Conventionally all ceramic restorations are removed using high speed handpiece with diamond bur [50], removing veneers without damaging the underlying natural tooth can be both difficult and time consuming, even with magnification, since the iatrogenic damage to underlying structure with dentine exposed could result in drop in bond strength [51] [52].

Due to the drawbacks of conventional methods of removing veneer without damaging tooth structure and/or the veneer itself, research were looking for methods that could safely, predictably, and quickly debond porcelain restorations.

Erbium family laser [Er:CrYSGG] (erbium, chromium:yttrium scandium-galliumgarnet) and [Er:YAG] (erbium:yttriumaluminumgarnet) can be used to efficiently, safely, and predictably remove all unwanted or failed veneers [53] [54].

Different studies have been conducted to investigate the efficiency of Er:YAG laser in veneer debonding without damaging underlying tooth structure, they measure the energy and time necessary for debonding the veneers. In study conducted by Morford *et al.* [55], using 10 Hz, 133 mj 1.33 watts energy, laser tip held in position away 3 - 6 mm from veneer itself, he found that the time needed for complete porcelain veneer removal on average (113 ± 76 seconds). Other study conducted by Oztoprak and colleagues [56] using energy of 50 Hz, 100 mj 5 watts, with 2 mm laser tip away from porcelain veneers, the time required for debonding was 3 - 9 seconds [57] [58].

2.6. Formation of Ovate Pontic Sites

Replacement of missing teeth is commonly treated by fixed bridge work, in order to restore aesthetics and function demands by the patients, the practitioner should have a working knowledge of the available options for pontic design. Different factors have been address in order to chose the appropriate pontic design including size, shape, shade and position of thepontic, as well the emergence profile from the soft tissues [59].

In more aesthetics demands like anterior maxillae especially if there is high lip line [60], the ovate ponticis a design which creates the illusion of the tooth growing out of the gum and thereby, providing the best aesthetic outcome. In order for the ovate pontic to be successful, there must be sufficient height and width of alveolar ridge. Different technique has been reported in order to developed recipient site, including gingivoplasty which can be conducted by either the use of high-speed rotary instruments or electrosurgery [61]. Surgical augmentation of the pontic site with roll flaps and connective tissue grafts to enhance the emergence [62] [63]. Use of a long-term provisional restoration for 3 months, but there is little evidence for this [61] [64].

Laser has been used for creating a gingival profile of an ovate pontic, and had an advantage over conventional procedure of being minimally invasive, good healing tendency, minimal postoperative bleeding of the site, and in contact mode, it is ideal for gingival sculpting [65].

3. Conclusions

Laser in dental practice is a new technology replacing the short outcome of conventional methods which have its own disadvantage and limitation with level of risk. All the risks can increase in magnitude due to lack of knowledge about lasers. The responsibility of the clinician is to choose the correct laser wavelength for the procedure and use minimal power to achieve the desired result.

As this paper aimed to highlight the application of laser in fixed prosthodontics and compare to common conventional technique, which is effective and excellent method to be used in various applications ranging from soft tissues to hard tissues with high patient acceptance.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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