REVIEW

Application of Lasers in Prosthodontics

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Abstract

In clinical dentistry lasers were introduced with the hope of overcoming some of the drawbacks posed by the conventional methods of dental procedures. Since its first experiment for dental application in the 1960s, the use of laser has increased rapidly in the last couple of decades. The specialty of Prosthodontics takes all concepts of dentistry and integrates effective comprehensive treatment planning. The practice will necessarily include a wide variety of patients seeking a diverse range of care. These include individuals who are highly fearful of dentistry and have long-term neglected care and those who have complex medical histories and require more specialized, advanced procedures. Some also have phobias and/or allergies to anesthetics. Lasers have become an integral part of treatment for these patients. The aim of this review is to describe the current and emerging applications for lasers in prosthetic dentistry. Used in conjunction with or as a replacement for traditional methods, it is observed that specific laser technologies are becoming an essential component of contemporary dental practice over a decade.

Key words- Lasers, Removable Prosthesis, Fixed Prosthesis, Implant Dentistry, Radiation

Introduction

In this modern era of high-tech devices, the dentist is being offered many sophisticated products designed to improve the quality of treatment rendered to patient. Already frequently used in the medical field, laser has begun to revolutionize dentistry. Laser is the acronym for "Light Amplification by stimulated emission of radiation" named by GORDON GOULD in 1957[1].The use of lasers in dentistry has increased over the past few years. The first laser was introduced into the fields of medicine and dentistry during the 1960s. Since then, this science has progressed rapidly. Because of their many advantages, lasers are indicated for a wide variety of procedures. Traditionally, lasers have been classified according to the physical construction of the laser (e.g., gas, liquid, solid state, or semiconductor diode), the type of medium which undergoes lasing (e.g., Erbium: Yttrium Aluminum Garnet (Er: YAG)) (Table 1). Once regarded as a complex technology with limited uses in clinical dentistry, there is a growing awareness of the usefulness of lasers in the armamentarium of the modern dental practice, where they can be used as an adjunct or alternative to traditional approaches. The purpose of this review is to provide an overview of various laser applications in Prosthodontics, and to discuss in more detail several key clinical applications which are attracting a high level of interest.

Different types of Lasers used in Dental Treatment[1] (Table 1)
Several types of lasers are available based on the wavelengths.
1. The Er: YAG laser possesses the potential of replacing the drill.
2. Co2 laser can be used to perform gingivecotomy and to remove small tumors.
3. Argon laser is used in minor surgery.
4. Nd: YAG is used in tissue retraction, endodontics and oral surgery.
5. The diode laser is effective for oral surgery and endodontic treatment. This laser helps to correct aesthetics flaws. It is used for soft tissue procedures.

Classification of Lasers

According to ANSI and OHSA standards Lasers are classified as:

Class I - These are low powered lasers that are safe to use. E.g. Laser beam pointer

Class II - Low powered visible lasers that are hazardous only when viewed directly for longer than 1000 seconds, e.g. He-Ne lasers

Class II b - Low powered visible lasers that are hazardous when viewed for more than 0.25 seconds.

Class III a - Medium powered lasers that are normally hazardous if viewed for less than 0.25 seconds without magnifying optics.

Class III b - Medium powered lasers that can be hazardous if viewed directly.

Class IV - These are high powered lasers (> 0.5 W) that produce ocular skin and fire hazards.

Advantages of Laser over other techniques[2]

I. It is painless, bloodless that results in clean surgical field, and fine incision with precision is possible.

II. There is no need for anesthesia if at all anesthesia has to be administered, then it needs to be used minimally only.

III. The risk of infection is reduced as a more sterilized environment is created as the laser kills bacteria.

IV. No postoperative discomfort, minimal pain and swelling, generally doesn't require medication.

V. Superior and faster healing, offers better patient compliance.

Disadvantages of Lasers[2]

I. Lasers cannot be used to remove defective crowns or silver fillings, or to prepare teeth for bridges.

II. Lasers can't be used on teeth with filling already in place.

III. Lasers don't completely eliminate the need for anesthesia.

IV. Lasers treatment is more expensive as the cost of the laser equipment itself is much higher.

Use of Lasers in Prosthetic Dentistry:

Lasers are now being used in a variety of procedures in prosthetic dentistry.

1. FIXED PROSTHESIS/ESTHETICS

A. Crown lengthening

Clinical scenarios where crown lengthening procedures are indicated within aesthetic zone require special consideration to achieve predictable aesthetic results. Crown lengthening procedures with the help of lasers are indicated in following conditions:

a. Caries at gingival margin
b. Cuspal fracture extending apical to the gingival margin
c. Endodontic perforations near alveolar crest.
d. Insufficient clinical crown length.
e. Difficulty in placement of finish line coronal to the biological width.
f. Need to develop a ferrule.
g. Unaesthetic gingival architecture.
h. Cosmetic enhancements.

Lasers offer unparalleled precision and operator control and may be beneficial for finely tracing incision lines and sculpting the desired gingival margin outline. All the other crown lengthening procedures has certain disadvantages as in surgical approach healing time is longer, post healing gingival margin position is unpredictable and patient compliance is poor as it needs use of anesthesia and scalpel for electro-surgery , the heat liberated has a deleterious effect on pulp and bone leading to pulpal death or bone necrosis. Orthodontic extrusion leads to vertical bone defect adjacent to extruded tooth and it also needs patient compliance[3].

B. Soft tissue management around abutments[4]

Argon laser energy has peak absorption in hemoglobin, thus lending itself to providing excellent haemostasis and efficient coagulation and vaporization of oral tissues. These characteristics are beneficial for retraction and haemostasis of the gingival tissue in preparation for an impression during a crown and bridge procedure. 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. Gingivoplasty may also be done using argon laser.

C. Modification of soft tissue around laminates[4]

The removal and re-contouring of gingival tissues around laminates can be easily accomplished with the argon laser. The laser can be used as a primary surgical instrument to remove excessive gingival tissue, whether diseased, secondary to drug therapy, or orthodontic treatment. The laser will remove tissue and provide haemostasis and tissues weld the wound.

D. Osseous crown lengthening

Like teeth mineralized matrix of bone consists mainly of hydroxyapatite. The water content and hydroxyapatite are responsible for the high absorption of the Er: YAG laser light in the bone. Er: YAG laser has very promising potential for bone ablation[4].

E. Formation of ovate pontic sites

There are many causes of unsuitable pontic site. Two of the most common causes are insufficient compression of alveolar plates after an extraction and non replacement of a fractured alveolar plate. Unsuitable pontic site results in unaesthetic and non self cleansing pontic design. For favorable pontic design re-contouring of soft and bony tissue may be needed. Soft tissue surgery may be performed with any of the soft tissue lasers and osseous surgery may be performed with erbium family of lasers.

F. Altered passive eruption management

Lasers can be used very efficaciously to manage passive eruption problems. When the patients have clinical

crowns that appear too short or when they have an uneven gingival line producing an uneven smile, excessive tissue can be easily and quickly removed without the need for blade incisions, flap reflection, or suturing[4].

G. Laser troughing

Lasers can be used to create a trough around a tooth before impression taking. This can entirely replace the need for retraction cord, electrocautery, and the use of haemostatic agents. The results are predictable, efficient, minimize impingement of epithelial attachment, cause less bleeding during the subsequent impression, reduce postoperative problems, and reduce chair time4. It alters the biological width of gingiva. Nd:YAG laser is used. It vaporizes the epithelium which is attached to the marginal finish lines, the epithelium getting vaporized is only a transient loss and it forms again. After laser troughing the impression is taken and sent to the lab for prosthetic work. The most important function of marginal finish line is to maintain the biological width, it acts as the termination point of tooth preparation, help in ease of fabrication, helps in taking a proper impression. In brittle teeth to maintain the biological width and finish line laser troughing plays an important role[5].

2. IMPLANTOLOGY

Dental lasers are used for a variety of procedures in implantology like implant recovery, implant site preparation and removal of diseased tissue around the implant.

A. *Implant recovery:* Following the placement of implant and its integration into the osseous substrate, the current method of treatment is to surgically uncover the implant, wait for the tissue to heal, and then proceed with impressions and fabrication of the restoration. The reason for the delay is to facilitate the impression-taking process. Uses of lasers can greatly expedite this procedure because the implant can be uncovered and impressions can be obtained at the same appointment[4]. All types of lasers can be used to expose dental implants. One advantage of use of lasers in implantology is that impressions can be taken immediately after second stage surgery because there is little blood contamination in the field due to the haemostatic effects of the lasers. There also is minimal tissue shrinkage after laser surgery, which assures that the tissue margins will remain at the same level after healing as they are immediately after surgery[6, 7].In addition the use of laser can eliminate the trauma to the tissues of flap reflection and suture placement.

B. *Implant site preparation*

Lasers can be used for the placement of mini implants especially in patients with potential bleeding problems, to provide essentially bloodless surgery in the bone[7].

C. Removal of diseased tissue around the implant

Lasers can be used to repair ailing implants by decontaminating their surfaces with laser energy. Diode, CO2 & Er:YAG lasers can be used for this purpose. Lasers can also be used to remove granulation tissue in case there is inflammation around an already osseointegrated implant[7, 8].

3. REMOVABLE PROSTHESIS

The successful construction of removable full and partial dentures mainly depends on the preoperative evaluation of the supporting hard and soft tissue structures and their proper preparation[9, 10]. Lasers may now be used to perform most pre-prosthetic surgeries. These procedures include hard and soft tissue tuberosity reduction, torus removal, and treatment of unsuitable residual ridges including undercut and irregularly resorbed ridges, treatment of unsupported soft tissues, and other hard and soft tissue abnormalities. Lasers also may be used to treat the problems of hyper plastic tissue and nicotinic stomatitis under the palate of a full or partial denture and ease the discomfort of epulis, denture stomatitis, and other problems associated with long term wear of ill-fitting dentures. Stability, retention, function, and aesthetics of removable prostheses may be enhanced by proper laser manipulation of the soft tissues and underlying osseous structure.

A. Treatment of unsuitable alveolar ridges

Alveolar resorption usually is uniform in vertical and lateral dimensions. On occasion, irregular resorption occurs in one of the dimensions, producing an unsuitable ridge. As the available denture bearing area is reduced, the load on the remaining tissue increases, which leads to an ill fitting prosthesis, with discomfort that is not alleviated by soft linings[11] to remove sharp bony projections and to smooth the residual ridge soft tissue lasers surgery to expose the bone may be performed with any number of soft tissue wavelengths (CO2, diode, Nd:YAG,) Hard tissue surgery may be performed with the erbium family of wavelengths.

B. Treatment of undercut alveolar ridges

There are many causes of undercut alveolar ridges. Two of the most common causes are dilated tooth sockets that result from insufficient compression of the alveolar plates after an extraction and non replacement of a fractured alveolar plate. Naturally occurring undercuts such as those found in the lower anterior alveolus or where a prominent pre-maxilla is present may be the cause of soft tissue trauma, ulceration, and pain when prosthesis is placed on such a ridge. Soft tissue surgery may be performed with any of the soft tissue lasers. Osseous surgery may be performed with the erbium family of lasers. During mastication, the upper denture oscillates, causing disproportionate resorption in the maxilla. The soft tissues are compressed, thus causing the denture to become increasingly unstable. Pain is not felt until the anterior nasal spine is nearly exposed and subject to trauma from the denture base. Unsupported maxillary alveolar soft tissues are bulkier than those in the lower jaw that tend to pro lapse in the lingual

direction. Traditional surgery consists of removing wedges of soft tissue from the alveolar crest until the wound edges are closed easily. Any of the soft tissue lasers are able to perform this procedure[12, 13].

C. Treatment of enlarged tuberosity

The most common reason for enlarged tuberosity usually is soft tissue hyperplasia and alveolar hyperplasia accompanying the over-eruption of unopposed maxillary molar teeth. The enlarge tuberosity may prevent the posterior extension of the upper and lower dentures, thereby reducing their efficiency for mastication and their stability. The bulk of the hyper plastic tuberosity may lie toward the palate. Surplus soft tissue should be excised, allowing room for the denture bases. The soft tissue reduction may be performed with any of the soft tissue lasers. If undercuts are present, then osseus reduction may be required. Erbium laser is the laser of choice for the osseus reduction[14, 15].

D. Surgical treatment of tori and exostoses

Prosthetic problems may arise if maxillary tori or exostoses are large or irregular in shape. Tori and exostoses are formed mainly of compact bone. They may cause ulceration of oral mucosa. These bony protuberances also may interfere with lingual bars or flanges of mandibular prostheses. Soft tissue lasers may be use to expose the exostoses and erbium lasers may be use for the osseous reduction. A smooth, rounded, midline torus normally does not create a prosthetic problem because the palatal acrylic may be relieved or cut away to avoid the torus.

E. Soft tissue lesions

Persistent trauma from a sharp denture flange or over compression of the posterior dam area may produce a fibrous tissue response. Hyper plastic fibrous tissue may be formed at the junction of the hard and soft palate as a reaction to constant trauma and irritation from the posterior dam area of the denture. The lesion may be excised with any of the soft tissue lasers and the tissue allowed re-epithelialized.

4. LASER APPLICATION IN DENTAL LABORATORY

There is a range of laboratory-based laser applications. Laser holographic imaging is a well established method for storing topographic information, such as crown preparations, occlusal tables, and facial forms. The use of two laser beams allows more complex surface detail to be mapped using Interferometry[16, 17], while conventional diffraction gratings and interference patterns are used to generate holograms and contour profiles[18-20]. Laser scanning of casts can be linked to computerized milling equipment for fabrication of restorations from porcelain and other materials. An alternative fabrication strategy is to sinter ceramic materials, to create a solid restoration from a powder of alumina or hydroxyapatite. The same approach can be used to form complex shapes from dental wax and other materials which can be sintered, such that these can then be used in conventional 'lost wax' casting. A variation on this theme is ultraviolet (helium-cadmium) laser-initiated polymerization of liquid resin in a chamber, to create surgical templates for implant surgery and major reconstructive oral surgery. These templates can be coupled with laser-based positioning systems for complex reconstructive and orthognathic surgical procedures.

Conclusion

Lasers have become a ray of hope in dentistry. When used effectively and ethically, lasers are an exceptional modality of treatment for many clinical conditions that dentists treat on a daily basis. But lasers has never been the "magic wand" that many people have hoped for. It has got its own limitations. If a clinician decides to use a laser for a dental procedure, he or she needs to fully understand the character of the wavelength being used, and the thermal implications & limitations of the optical energy. However, the future of the dental laser is bright with some of the newest ongoing research. From operative dentistry to periodontics, paediatrics and prosthetics to cosmetics and implantology, Lasers have made a tremendous impact on the delivery of dental care in the 21st century and will continue to do so as the technology continues to improve and evolve.

Table 1 Common Laser Types Used In Dentistry

Laser type	Construction	Wavelength (s)	Delivery system (s)
Argon	Gas laser	488, 515nm	Optical fiber
KTP	Solid state	532nm	Optical fiber
Helium - Neon	Gas laser	633nm	Optical fiber
Diode	Semiconductor	635, 670,810,980nm	Optical fiber
Nd:YAG	Solid state	1064nm	Optical fiber
Er,Cr:YSGG	Solid state	2780nm	Optical fiber

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