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# ART OF LASERS IN PROSTHODONTICS – AN UPDATED REVIEW

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**ABSTRACT**

With dentistry in the high tech era, we are fortunate to have many technological innovations to enhance treatment, including intraoral video cameras, CAD-CAM units, RVGs and air-abrasive units. However, 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. Lasers were introduced into the field of clinical dentistry 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. At present, wide varieties of procedures are carried out using lasers. 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.

## INTRODUCTION

Laser dentistry can be a precise and effective way to perform many dental procedures. In this 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 American physicist [1]. The potential for laser dentistry to improve dental procedures rests in the dentist's ability to control power output and the duration of exposure on the tissue (whether gum or tooth structure), allowing for treatment of a highly specific area of focus without damaging surrounding tissues.

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As the applications for dental lasers expand, greater numbers of dentists will use the technology to provide patients with precision treatment that may minimize pain and recovery time.

Although the discovery of lasers and research into their applicability for dental use began in the 1960s, it was not until 1985 that the first documented use of a laser in dentistry was published. Early efforts were limited to those soft tissue procedures that could be performed using a straight optical lens/articulated arm delivery system. In 1985, Myers & Myers modified an ophthalmic Nd: YAG laser for dental use. Subsequent advances in laser research produced a hollow wave guide delivery system for Co2 lasers and a fiber optic delivery system for other wavelengths, making access to the entire oral cavity much easier [2].

The application of a laser to dental tissue was reported by Stern and Sognnaes [6] in 1964 and Goldman [7] et al. in 1965, describing the effects of ruby laser on

enamel and dentine. However, with the recent advances and developments of wide range of laser wavelengths and different delivery systems, researchers suggest that lasers could be applied for the dental treatments including restorative, periodontal and surgical treatments.

Several types of lasers [3] are available for used in dentistry based upon the wavelengths. The Er: YAG laser possesses the potential of replacing the drill, $CO_2$ laser can be used to perform gingivecotomy and to remove small tumors, argon laser is used in minor surgery, Nd: YAG is used in tissue retraction, endodontics and oral surgery and diode laser is effective for oral surgery and endodontic treatment. Nd: YAG laser helps to correct aesthetics flaws and is used mainly for soft tissue procedures.

The purpose of this article is to provide an overview of the current and possible future clinical applications of lasers in prosthetic dentistry. Prosthetic procedures for which conventional treatment cannot provide comparable results or are less effective are emphasized.

**Classification**

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 the other techniques** [4]

I. It is painless, bloodless that results in clean surgical field, 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.

**Disavantages of lasers**[4]

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

**A. Fixed prosthetics/esthetics**

i. Crown lengthening
ii. Soft tissue management around abutments
iii. Osseous crown lengthening
iv. Troughing
v. Formation of ovate pontic sites
vi. Altered passive eruption management
vii. Modification of soft tissue around laminates
viii. Bleaching

**B. Implantology**

i. Second stage uncovering
ii. Implant site preparation
iii. Peri-implantitis

**C. Removable prosthetics**

i. Tuberosity reduction
ii. Torus reduction
iii. Soft tissue modification
iv. Epulis fissurata
v. Denture stomatitis
vi. Residual ridge modification

**Fixed prosthetics/esthetics**

Lasers are used in fixed prosthodontics for crown lengthening, soft tissue management around abutments, osseous crown lengthening, troughing, Formation of ovate pontic sites, altered passive eruption management; modification of soft tissue around laminates, bleaching.

**Crown lengthening**

Clinical scenarios where crown lengthening procedures are indicated within esthetic zone require special consideration to achieve predictable esthetic results.

Crown lengthening procedures 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. Unesthetic gingival architecture.
h. Cosmetic enhancements

Lasers offer unparallel 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 electrosurgery, 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 [4].

**Soft tissue management around Abutment** [6]

Argon laser energy has peak absorption in hemoglobin, thus lending itself to providing excellent hemostasis and efficient coagulation and vaporization of oral tissues. These characteristics are beneficial for retraction and hemostasis 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 1.0 W, continuous wave delivery, 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.

**Modification of soft tissue around laminates** [6]**:**

The removal and recontouring 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 hemostasis and tissues weld the wound.

**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 [6].

**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 unesthetic and non self cleansing pontic design.

For favorable pontic design recontouring 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 perform with erbium family of lasers [6].

**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 [6].

**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 hemostatic agents. The results are predictable, efficient, minimize impingement of epithelial attachment, cause less bleeding during the subsequent impression, reduce postoperative problems, and reduce chair time [6]. 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.

**Bleaching**

Esthetics and smile has become important issues in modern society. Bleaching has become the common method for tooth whitening. Bleaching using diode lasers results in immediate shade change and less tooth sensitivity and is preferred among in office bleaching systems. In most cases results are obtained in a single sitting of about 45 minutes to an hour. Besides this laser energy is capable of inducing a decomposition reaction of the staining agent [6].

**Laser use in implant dentistry**

The scope of laser applications in implant dentistry is broad, and includes the manufacture of implants, pre prosthetic hard and soft tissue surgery, uncovering implants, correcting soft tissue, welding implant superstructure in the laboratory treating peri implantitis and disinfecting implant surfaces and finally, altering the response of hard and soft tissues through a process termed “Biostimulation”.

**Second Stage Surgery**

In relation to preparing tissues for implant placement Er:YAG and Er, Cr: YSGG lasers can be used to modify bone, as well as soft tissue. The middle infrared wavelength can be used for precise bone surgery. For example for creating windows before sinus lifts are undertaken with Nd: YAG and Ho: YAG lasers are not suitable for second stage implant surgery, because they can interact with Ti and damage the surface of theses fixtures. The middle infrared lasers with H2O mist spray are used for 2nd stage implant surgery. An ablative technique can

be used with these lasers for 2nd stage expect for in anterior areas, there is lack of keratinized gingival tissues [8].

**Microtexturing & Polishing**

Excimer laser are commonly used to treat implant surfaces, since these can achieve micro texturing and polishing. The highly polished surfaces favour the interaction of implants with soft tissues and they inhibit plaque accumulation .The patterned surface have been shown to result in significantly more bone to implant contact requiring greater peak removal torque values than if the surface has not been so modified [9].

**Impression**

One advantage of the use of lasers in implantology is that impression can be taken immediately after second stage surgery because there is a little blood contamination in the field due to the hemostatic effect of the lasers. There is also minimal tissue shrinkage [10].

**Laser Welding**

Laser welding is becoming a more popular procedure. It minimizes finishing and reduced time is major advantages for dental laboratory [11].

**Peri Impantitis**

One of the most interesting uses of lasers in implant dentistry is the possibility of salvaging ailing implant by decontaminating their surface with laser energy. A number of studies have examined lasers for treatment of peri implantitis. Er:Cr:YSGG and Er:YAG lasers have been used for debride calculus and other deposits from implant surface. Several studies have shown that bacterial reduction of greater than 98% can be achieved using only low level laser energies [9]. Low power lasers with photo sensitizers have also been used for treating peri implantitis. (PAD) The photo activated disinfection tech. which uses photosensitive dyes, such as toluidine blue, and diode laser has been shown to give rapid elimination of P.gingivalis, P.intermedia and A. Actinomycetemcomitans [10].

**Wound Healing**

The final area of interest is in relation to lasers which can achieve biostimulation. Biostimulation which shows its value in terms of accelerating wound healing and tissue maturation after injury. Not surpisingly, several studies have shown that low level laser treatment can accelerate the interaction of bone and implant in the immediate post placement period [11].

**Removable prosthetics**

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 [12,13]. 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 resorbed ridges, treatment of unsupported soft tissues, and other hard and soft tissue abnormalities. Lasers also may be used to treat the problems of hyperplastic tissue and nicotinic stomatitis under the palate of a full or partial denture and ease the discomfort of epulis, denture stomatitis, and other associated with long term wear of ill fitting dentures. Stability, retention, function, and esthetics of removable prostheses may be enhanced by proper laser manipulation of the soft tissues and underlying osseous structure.

**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 [14] 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.

**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 lower jaw that tend to prolapse 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 [15,16].

**Treatment of enlarged tuberosity**

The most common reason for enlarged tuberosities usually is soft tissue hyperplasia and alveolar

hyperplasia accompanying the over-eruption of unopposed maxillary molar teeth. The enlarge tuberosities may prevent the posterior extension of the upper and lower dentures, thereby reducing their efficiency for mastication and their stability. The bulk of the hyperplastic tuberosities 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 osseous reduction may be required. Erbium laser is the laser of choice for the osseous reduction [17,18].

**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.

**Soft tissue lesions**

Persistent trauma from a sharp denture flange or over compression of the posterior dam area may produce a fibrous tissue response. Hyperplastic 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 to re-epithelialize.

## CONCLUSION

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 daily basis. But laser 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, pediatrics and prosthetics to cosmetics and implantology, Lasers have made a tremendous impact on the delivery of dental care in the 21stcentury and will continue to do so as the technology continues to improve and evolve. However, the future of dental laser is bright with some of the newest ongoing researches.

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