Review Article

THE NEW ERA OF DENTAL TECHNOLOGY - DENTAL LEASER: A SYSTEMIC REVIEW

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ABSTRACT

Modern dentistry has been making our lives easier for a long time, due to technological advancements in almost every sector of science. Lasers in dentistry are getting more popular over time. The purpose of this systemic review is to point out applications of laser technology in the field of Fixed Prosthodontics. This study was a systemic review thorough electronic search of PubMed and Google scholar database was performed to find relevant articles. The inclusion criteria: observational Studies, experimental studies, and papers published within the time 2000 to 2020. Exclusion criteria were the papers published in languages other than English and are older than 2000. Papers with the application of laser in other fields of dentistry like orthodontics, periodontics, or even removable prosthodontics were excluded. Each field of dentistry is benefitting from the outcomes of lasers from simplest to complex tasks in both diagnostic and therapeutic ways. Whether it is just caries removal to laboratory procedures or assisting the complicated steps encountered during oral surgery, lasers are proving to be a helpful asset. In conclusion, the way lasers are working on both soft and hard tissues is at a high state of refinement. Still, a lot of developments are on their way to gaining more of the benefits and minimizing the risks factors associated with lasers. Till then it is the obligatory duty of the dental staff to handle this gadget with great care during its use. They should be used according to their specific use based on their wavelengths.

Key words: Laser, Fixed prosthodontics, Laser safety, Dental biomaterial.

Introduction

With the advancement of technology in almost every field of science, modern dentistry has also been making our lives easy for quite a time. The employment of lasers is one of the causes. In the field of medicine, lasers are employed either for treating or removing a precise piece of tissue. These focused sources of light works wonder not only for the doctor but the patients also as much better hemostasis can be achieved leading towards much efficient healing. Offering a less invasive procedure and equipment with no vibrations or sounds, lasers are considered as a painless conjunctive during dental treatments by the patients [1].

Lasers in dentistry are getting more popular with time. The very first laser in general dentistry was called “dLase 300” developed by Myers and Myers [2]. From the removal of simple caries to the photodynamic therapy for malignancies, lasers have been proven to be very helpful. Its application in fixed prosthodontics had introduced a whole new aspect of revolution in dentistry as people are getting more educated about fixed rehabilitation of their mouth. Patients prefer a more permanent yet less invasive and painless solution for replacing their teeth or any other lost oral cavity tissue [3-5]. Fortunately, lasers had proven to be a successful tool in providing this standard of care. Dental bridges, crowns, inlays, onlays, etc. all procedures are benefitting from this advanced technology aid.

Earlier uses of lasers were limited to soft tissues only but with the introduction of newer wavelengths, it becomes possible to use lasers for hard-tissue procedures too [6]. These new lasers not only impacted clinical situations but laboratory procedures were also improved a lot. Apart from being different for tissue applicability as hard and soft tissue lasers, other lasers are also used in dentistry. These can be classified based on the range of wavelength or lasing medium used such as gas, liquid, solid, or semiconductor lasers, etc. [7]. Lasers used most commonly in prosthodontics are Carbon Dioxide laser (CO_2), neodymium‑doped yttrium aluminum garnet (Nd: YAG), Erbium:yttrium-aluminum-garnet (Er: YAG) laser [8]. A vast number of revolutionary implementations of lasers are available in the field of health sciences [9]. This artificial intelligence had taken its place in the operation theatre for quite a time. Whether it is helping as an aid in the process of the surgery itself, or helping in diagnostic modalities, the laser had paved its way in the medical field. The purpose of this systemic review is to point out applications of laser technology in the field of Fixed Prosthodontics. These applications include direct and indirect utilities of laser in the form of either a lab procedure or prepping of the abutment teeth for luting of the fixed appliance.

Materials and Methods

A thorough electronic search of PubMed and Google Scholar databases was performed to find relevant articles. Keywords included are laser, fixed prosthodontics, laser safety, as well as a synonym of these.

The inclusion criteria were the papers published from 2000 to 2020 and in the English language. All the papers include clinical studies or systemic reviews including the implementation of laser in fixed prosthodontics in one way or the other. Both observational studies and experimental studies were involved for the review. The publications which have higher significance in the hierarchical pyramid were selected. Exclusion criteria were the papers published in languages other than English and are older than 2000. Papers with an application of laser in other fields of dentistry like orthodontics, periodontics, or even removable prosthodontics were excluded.

Results and Discussion

Laser is an shortening of 'Light Amplification by Stimulated Emission of Radiation'. The foundation for inventing lasers was laid by Albert Einstein in 1917 based on his theory that a single frequency could be emitted by photoelectric amplification [10]. The very first functioning laser was introduced by Theodore Maiman in the 1960s and was called the Ruby Laser [8, 10, 11]. Later on, different types of lasers were developed with a breakthrough in laser dentistry in the mid-1990s [8].

Mechanism of action of dental lasers

The light in the laser is monochromatic. Three types of delivery systems are mostly involved in delivering laser light from the source to the wanted tissue. These can be fiber-optic cable, hollow waveguide, or articulated arm [8]. Other control systems like focusing lenses or cooling systems are also an integral part of these delivering systems. Lasers are classified based on their different wavelengths as argon laser, diode laser, carbon dioxide laser, or other such types. The difference in these wavelengths is determined by the configuration of an active medium, which can be a gas, a crystal, or a solid-state semiconductor. The light energy generated by the laser can interact with the target tissue in basically four diverse ways. These ways can be Reflection, Transmission, Scattering, and Absorption. On being absorbed in the tissue, laser raises the temperature and produces a photochemical effect reliant on the water content of the target tissue.

In dentistry, the mechanism in which laser acts are through its absorption within the target tissue in chromophores. A chromophore is an absorber of light having a certain affinity for certain wavelengths of light. These include water, apatite minerals, and various pigmented substances like haemoglobin, melanin, etc. Better the absorption more will be the efficiency of the laser. Several other factors are also considered while determining the effects of lasers on the target tissue. These factors are different wavelength, pulsation energy, contact time, density of energy, and the physical and chemical composition of tissue.

Implementations of laser in fixed prosthesis

Digital impressions taking

While practicing fixed prosthodontics, an accurate impression of the structure to be rehabilitated is necessary for a successful diagnosis and treatment planning. Intraoral scanners (IOS) are proving to be an excellent tool in replacing conventional methods of taking an impression with trays and elastomeric materials. Most of these IOS emit a laser beam and detect its return. This is then produced into a three-dimensional series of images. These images capture a near to accurate geometry of the structure in observation including its soft and hard components [12].

Digital dental models made through these intraoral scanners allow the formation of a virtual configuration which in turn leads towards the manufacture of an improved fixed or even removable prosthesis. This is a great revolution in the diagnostic field. But like any other technology, this also has its drawbacks as it is difficult to scan deep or sub-gingival margin lines and the cases with excessive bleeding around prepared teeth [13].

Crown lengthening

Although crown lengthening with lasers is an arguable procedure due to several reasons it is still used by some dentists. It provides an accurate way for the shaping of the gingival margin [14-16]. While doing crown lengthening with lasers, the operator has more control over the procedure as compared to a conventional method. It is less complicated for the doctor and more comfortable for the patient. But due to doubtful post-healing gingival margin and risks of damaging the tooth pulp, most dentists prefer conventional flap surgeries [17].

Osseous crown lengthening can also be achieved by lasers. Erbium:yttrium-aluminum-garnet (Er: YAG) laser light is count as a better option for this purpose as it can be highly absorbed in water content and hydroxyapatite crystals of bone [14].

Management of soft tissues around the abutments

To construct an efficiently fixed prosthesis, the abutment's surroundings should have the correct amount and angulation of soft tissues. This in turn provides an excellent fit for the fixed prosthesis like crowns or bridges etc. Argon lasers with a 300 um fiber and a power setting of 1.0W are considered a good option for shaping the soft tissue around the abutment. This laser aids in hemostasis and coagulation along with the vaporization of oral tissues [18, 19]. Similarly, Argon lasers can also help in recontouring and removing remaining gingival tissues around the laminates [20].

Bleaching

A survey-based study from Saudi Arabia indicates that females and people with higher socioeconomic status are very much concerned about their smiles [21]. A huge part of cosmetics dentistry relies upon the whiter and brighter color of teeth desired by the patients. Diode lasers are employed

for bleaching the teeth resulting in an immediate change of color and less hypersensitivity [22, 23]. People tend to choose lighter shades for their fixed prostheses ignoring the original shade of their teeth. Hence bleaching plays a significant role even after the fixation of a fixed prosthesis for the remaining dentition.

Removal of veneers

Veneers are getting popular among patients day by day as they can improve the aesthetics in terms of not only the color but minor crowding too. Over time, veneers may require removal and replacement due to several causes like caries, chipped or fractured porcelain, and staining due to failure of the margin [24]. Conventional methods of removing a veneer with a handpiece are a risky method as the underlying tooth can be damaged and patients also disliked this method. Using Er: YAG laser is a safer and more efficient alternative for removing unwanted or failed veneers [25].

Formation of ovate pontic sites

Modern dentistry has introduced humanity to the possibility of regaining the lost oral structures with an aesthetic appearance of the natural ones. Various techniques have been employed for the restoration of even the soft tissues. Diode lasers are also used to shape the gingival profile of the pontic site [26, 27]. This lets the cervical third part of the pontic to combine with the surrounding tissues hence mimicking the natural appearance of a tooth emerging through the gums.

Gingival troughing

Accurate impression taking is the prerequisite for achieving an excellent fixed prosthesis. Similarly, for an accurate impression, to expouse the finish line of the prepared tooth. Finish lines are frequently placed at or just below the crest of the gingival margin. For this purpose, the gingival tissue must be exiled hence allowing the sub-gingival finish line to be recorded. In this way, the impression material can flow easily between the abutment and gingiva increasing the efficiency of the final impression [28]. Conventional methods used for this purpose include cord retraction, and the use of haemostatic materials.

Lasers provide a expectable and competent way for creating this trough as it minimizes the impingement of epithelial attachment and reduces post-operative problems. Lasers that can be used for gingival troughing include Neodymium: yttrium-aluminum-garnet (Nd-YAG) lasers, Erbium:yttrium-aluminum-garnet (Er:YAG) and Diode laser, etc [1].

Treating dentinal hypersensitivity with lasers

Preparation of an abutment for fixed prosthesis can exacerbate dentine hypersensitivity as the exposed dentin with a rich supply of myelinated nerve endings can cause severe pain. The use of lasers for treating dentine hypersensitivity was first introduced in 1985. It is considered to be an interesting and controversial treatment option and several studies are being carried out to determine its advantages and disadvantages. Nd:YAG laser had proved to be very efficient in treating dentinal hypersensitivity without detrimental pulpal effects [8]. Mostly laser therapy is combined with topical desensitizing agents to increase the success of the treatment compared with either treatment alone.

Management of altered passive eruption

Inadequate passive eruption of teeth can hinder the aesthetics of a person due to the development of uneven margins of the gingiva. This altered smile not only affects the aesthetics but the confidence of the person is also shattered to a great extent. These uneven margins of the gingiva due to an altered passive eruption of teeth can be corrected by using lasers. Recontouring and removal of soft tissues from these margins by lasers will restore the aesthetics with minimal complications.

Laser Phototherapy

Preparing the soft tissues around the abutment for an accurate impression can cause inflammation signals in that tissue. This can be a problem while placing the prosthesis as the inflamed tissue will not relate to the prior impression taken for the prosthesis manufacturing. This laser promotes soft tissue remodeling ensuring that no inflammatory signs are existing in the respected tissue hence easing the final cementation process of fixed prosthesis.

Tooth Preparation

While preparation of an abutment for placement of a fixed prosthesis is being carried out with a high-speed handpiece, the tooth can endure several micro-fractures during this procedure [17]. To avoid this unwanted trauma to the teeth, lasers play an important role. The laser can also numb the tooth hence eliminating the need for anesthetic agents. Er:YAG laser used to preared the hard dental tissue [29, 30].

Laser safety and medico-legal considerations

Although a large number of lasers used for medical or dental purposes are simple to use, still a precautionary set of rules is necessary [31]. As the wavelengths of lasers are different as compared to normal light, it is advisable to not look directly at these. Protective eye wears that is wavelength-specific is recommended to be worn by not only the doctor but anyone in close vicinity [32]. CDRH and ANSI systems of classification had classified lasers according to their level of biological hazard [33, 34].

Class	Description
I	Very low risk. Non-harmfull producing laser.
IM	Safe except when seen through magnifying optics. Wavelength between 302.5 nm and 4000 nm.

II	Do not authorized human admittance to contact levels beyond the Class 2 AEL (Accessible Emission Limit) for wavelength between 400 nm and 700 nm. No known risk with 0.25 seconds (aversion response).
IIM	Hazardous when viewed through an optical instrument. Wavelength between 400 nm and 700 nm. No known harm with 0.25 seconds (aversion response) unless collecting optics are used.
IIIR	Safe with restricted beam viewing.Wavelength between 302.5 nm and 160 nm.
IIIB	Direct viewing is harmfull to the eyes. Normally safe if viewing diffuse reflections.
IV	Serious injury potential to eye and skin. Harmful effect under both intra beam and scater reflection seeing situations cause a fire hazards.

Laboratory rooms with lasers operating there should have warning bio-hazardous signs at their doors to avoid any accidental exposure. Lasers designed to cut or shape soft and hard tissues are strictly meant to be handled with extra care to limit injury to not only the patient but the doctor also. There should be a labeled Laser Safety Officer in each setup to manage the usage of leaser and care along with staff coordination and preparation [10].

The staff must get trained properly in using and handling lasers before using them on living beings [34]. Taking informed consent from a patient must be a part of the routine especially when the patient's soft or even hard tissues are planned to be altered.

Conclusion

Lasers in dentistry have come a long way in development to create ease not only for the doctor but the patient too. No doubt with the advent of lasers in dentistry, people are inclining more towards getting their dental treatment in time. The fear of some of the conventional ways of methods had been replaced by lasers [35]. Each field of dentistry is benefitting from the outcomes of lasers from simplest to complex tasks in both diagnostic and therapeutic ways. Whether it is just caries removal to laboratory procedures or assisting the complicated steps encountered during oral surgery, lasers are proving to be a helpful asset.

The way lasers are working on both soft and hard tissues is at a high state of refinement. Still, a lot of developments are on their way to gaining more of the benefits and minimizing the risks factors associated with lasers. Till then it is the obligatory duty of the dental staff to handle this gadget with great care during its use. They should be used according to their specific use based on their wavelengths. The future of lasers in prosthodontics seems to be promising and can replace more of the conventional methods in a way that can be beneficial for humanity. Rehabilitation of dental structures can be less painful and aesthetically more appealing with the proper use of lasers.

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