Review Article

Application of Lasers in Prosthodontics: A Review

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Abstract

LASERS has a wide range of action, and it is application in the field of prosthodontics have replaced scalpel to reasonable extend all over the surgical field and other conventional methods. An upcoming new technology replaces several shortcomings but by having its own risks and limitations. The aim of this article is to elaborate the application and uses of lasers in prosthodontics and the revolution by lasers in providing precise procedures to the patient.

Keywords: *Laser, Nd:YAG, photomechanical interaction*

Introduction

Laser is an acronym which stands for "Light Amplification by Stimulated Emission of Radiation", which have been used in many fields.

The use of Lasers in dentistry provides a new standard of care. The application and role of Lasers in prosthodontics in providing fixed dental prosthesis improves the standard of care for both the patients as well as the dentist due to its precise excision, a period of wound healing and their benefits of coagulation, which increases tissue response to provided surgeries. With a thorough knowledge of Lasers, their wavelength and target tissue interaction and better handling accurate care to the patients can be delivered.

Most commonly used Lasers in prosthodontics are CO_2, neodymium-doped yttrium aluminum garnet (Nd:YAG). The extensive development of mechanical cutting devices which are accompanied by sound and vibration makes patient fearsome which are overcome by the development of photomechanical interaction of Lasers-based dental devices

History

- Breakthrough in Laser dentistry came in the mid-1990s
- In 1956, Thomas Mailman exposed extracted tooth to prototype Ruby (694 mm) Laser, where transmission of Laser energy was found[1]
- In 1960, Goldman and Polanyi and Jako developed At, Nd:YAG, CO_2 lasers from general areas of surgery to oral cavity
- In late 1980s "selective thermolysis" where the pulsed-dye lasers have been introduced
- Lasers in dentistry have been on 1989, where the American Dental Lasers have been used commercially with Nd:YAG
- In mid-1990s, wavelengths were categorized diode laser-810-890 nm; Nd:YAG-1064 nm; CT: YSGG-2780 nm; Er:YAG-2940 mm; CO_2-10600 nm
- In 1989, Kuler and Hibst demonstrated the effectiveness of pulsed Er:YAG lasers (2780 nm)
- In 1997, laser armamentarium has been designed.

LASER production

Laser is formed by low convergence of beam of radiation with different wavelengths. They are in red-infrared spectra of light (NIR-Near Infrared).

The main component of LASERS is gain medium, reflector, and energy source.

The energy source provided externally stimulates the gain medium which is pumped up and emits photons which move back and forth between the reflector and energy is produced, and the exit path is provided in one of the reflectors resulting in Laser be production.

The biological tissue interaction with laser includes:[2]

- Reflection
- Scattering
- Absorption and
- Transmission.

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When absorption of tissue increases reflection and transmission decreases and are common with larger wavelength and their interference with water.

Laser with greater water absorption is Erbium lasers (Er:YAG, Er, Cr:YSGG).

In fixed prosthodontics accuracy of the treatment with minimal energy and correct wavelength provides success in the treatment. Uses and application of Lasers in prosthodontics include procedures such as:

- Crown lengthening
- Laser troughing
- Modification of soft tissues around laminates
- Management of soft tissues around abutment
- Osseous crown lengthening
- Altered passive eruption management
- Formation of oval pontic sites
- Removal of veneer
- Bleaching
- To treat dentinal hypersensitivity.

In implantology, their application in various procedures includes:

- Implant recovery
- Implant site preparation
- Removal of diseased tissue around the implant
- Soft-tissue lesions.

In removable prosthesis, their uses include:

- Treatment of enlarged tuberosity
- Surgical treatment of Tori and exostosis
- Treatment of alveolar ridge undercuts
- Treatment of unsuitable alveolar ridges
- Soft-tissue lesions.

Uses of LASERS in maxillofacial rehabilitation

It mainly provides a three-dimensional (3D) view and record for extraoral defects, and it also enhances the shape and convenience of preparation compared to conventional impression technique where soft-tissue distortion and patient discomfort or irritation can be minimized[3] This is also advantageous compared to 3D/optical computed tomography/magnetic resonance imaging where radiation exposure to the patients have been minimized.

Complete denture prosthesis

- Prototyping and analyzing of occlusion by computer-aided designing (CAD) computer-aided manufacturing (CAM) technology
- The analysis of the accuracy of impression by laser scanner.

In Fixed Prosthesis

Crown lengthening

For better esthetics and functional importance, adequate crown length is essential and is commonly indicated for tooth with:

- Caries at marginal gingiva level[4]
- Cuspal fracture that extends below the level of gingival Margin
- Insufficient clinical crown length
- To enhance esthetic value (i.e.,) in cosmetic use
- When placement of finish line is difficult.

The uses of Lasers provide precise control during surgery and enhance gingival outline. It also provides dry surgical field for better visualization, reduction in bacteria, faster healing with less chairside time.

Laser troughing

Laser minimizes most of the difficult works and makes everything easy and concise; thus, the use of retraction cord is decreased by creating a trough by Laser before taking impression.[5] It also seals the blood vessels thus providing coagulation and replaces and lessens the use of hemostatic agents and electrocuted.[6] Most commonly used lasers for creating troughed Nd:YAG, which minimizes epithelial attachment interference and also minimizes postoperative complications.

Modification of soft tissues around laminates

The use of argon laser helps in recontouring and removal of the remaining gingival tissues around laminates easier.[4]

Management of soft tissues around abutment

As argon laser is absorbed in hemoglobin, it enhances hemostasis, coagulation, and vapourize the oral tissues.[4]

Gingivectomy, gingivoplasty (i.e.,) removal and contouring of soft tissues around abutment tooth are best done using Ar Laser. The management of soft tissues around abutment provides better finish line, adequate crown length. Also enhances troughing and accurate impression can be made of which excellent results of the fixed prosthesis can be achieved.

Osseous crown lengthening

Tooth is made of hydroxyapatite crystals, which is a mineralized bone matrix.

Er:YAG laser absorbs water content of mineralized matrix content Thus, encouraging for bone ablation.[7]

Altered passive eruption management

Inadequate passive eruption results in the development of uneven margins of gingiva which imparts normal smile, and it also hinders the confidence of the individual in interaction.

This altered passive eruption of teeth with uneven margins can be managed using lasers which removes and recontours the soft tissues such as margins of gingiva with minimal complication thus enhancing esthetics.

Formation of ovate pontic site

Recontouring both hard and soft tissues provides and enhance the pontic design.[4]

Soft-tissue recontouring and removal are done using Er lasers. In osseointegrated implant placement, granulation tissue should be removed and is done using lasers.

Removal of veneer

Dislodgement of restoration without cutting is done by using Lasers. Laser energy passes through porcelain glass which is unaffected and is absorbed by water molecule at the adhesive. Debonding occurs between silane and resin without damaging the underlying tooth.[3] Lasers such as Er, Cr:YSGG are used for removal of unwanted or failed veneers.[7]

Bleaching

To improve esthetics and smile diode lasers are commonly used to improve the shade of the teeth without causing sensitivity and much alteration to the tooth complex.[3]

To treat dentinal hypersensitivity

Nd:YAG laser for the treatment of dentinal hypersensitivity.[8] Many lasers can induce thermal effect, if their parameters are used under controlled conditions, thermal damage to temperature sensitive pulpal tissues can be minimized.

Implantology

The use of LASERS in placement, recovery, and site preparation of implants further improves the standard of using both lasers and implants in combination.

Implant recovery

Laser usage in implant placement and their interaction with adjacent bony structures obtained surgically with a better healing process, and this also helps in impression making and fabrication of restoration in the same appointment.[7] This provides faster healing and reduces chairside time and also improves the tissue quality and minimize shrinkage of tissues after surgery thus an accurate restoration can be obtained.

Implant site preparation

Site preparation is an important procedure implant placement as a blood-filled site hinders normal visibility thus the site for placement can be altered resulting in damage to adjacent structures or decreases the strength of their integration with adjacent hard structures, i.e., osseointegration.[7] They are commonly used in patients with bleeding complications as they provide a bloodless field with adequate coagulation.

Removal of diseased tissue around the implant

The use of Lasers in the removal of granulation tissue over the osseointegrated surface of the implant in case of inflammation. Sterilization of implant surface can be done by using Laser energy. Diode, CO_2, Er:YAG lasers are commonly used for sterilizing implant surface[2] thus removing bacterial contamination and improving the success rate[9] Er:YAG Laser helps in removal of subgingival calculus From the surface of Ti Implant fixture without causing thermal damage.

Removable Prosthesis

The success of the prosthesis being placed always depends on the vitality and order of the adjacent tissues in relation. An adequate pre-prosthetic surgery may enhance the success rate and also improves the satisfaction of the patients. Lasers are used in treating irregularly resorbed ridges, malformations, hyperplastic tissue thus both hard and soft tissues are being altered for a better functional constituent.

Treatment of unsuitable alveolar ridges

Normally resorption occurs as the age advances and due to loss of tooth structures. Both vertical and lateral ridges got resorbed simultaneously resulting in a uniform ridge. If there is any change in resorption or extraction or removal of teeth at different times, irregular gum massage, improper oral health-care results in the development of uneven ridges, sharp bony spicules or hyperplastic tissue that are unsuitable for denture placement.

Treatment of undercut alveolar ridge

Mild undercut may aid in retention of the denture prosthesis, but a severe undercut on both sides may impact both retention and stability of the denture. Undercut alveolar ridges are due to expansive tooth socket that are closed by compression and are done improperly. Most commonly natural undercuts are seen in lower anterior region or case of predominant premaxillary regions. Thus, undercut areas are to be treated surgically before prosthetic management.[6] Osseous surgery/hard tissue recontouring is done using Er family of Lasers, soft-tissue management is done using CO_2, diode and Nd:YAG lasers.[6]

Treatment of enlarged tuberosity

Unopposed maxillary molar teeth results in the development of hyperplastic tuberosity that may rest toward palate, along with hyperplastic soft tissues.[10] Prosthetic management in such cases may result in improper denture placement with poor retention and stability and are always accompanied by pain due to increase in load toward a particular area. Thus,

pre-prosthetic surgery should be done to manage the condition, advancement in the use of soft tissue and hard tissue lasers may enhance the prosthetic success rate because of better wound healing and at faster rate.

Surgical treatment of tori and exostosis

A large and irregular Tori and exostosis are most commonly formed by compact bone. Maxillary Tori are commonly seen in hard palate region whereas mandibular Tori are commonly located in the premolar region. Designing and fabrication of removable dental prosthesis covering the Tori and exostosis area often results in ulceration and severe pain. Thus, modifications in prosthesis were included in comparison to complete palate framework. The double palatal strap was used, but it also imparts retention of the prosthesis. Thus pre-prosthetic surgery which includes removal of bony exostosis or Tori may enhance the success rate. Thus, the use of hard tissue and soft-tissue lasers plays an important role in the removal of bony exostosis or Tori conditions. The use of Ar, XeCl, Nd:YAG lasers helps in removal of both hard and soft tissues.

Soft-tissue lesions

Any sharp margins of the denture or overcompensation of posterior dam area often results in the development of tissue response. The response may be ulcerative/degenerative, or in other cases, it may be hyperplastic. These hyperplastic soft-tissue growth can be excised using soft tissue lasers such as Nd:YAG, CO_2, diode lasers to enhance re-epithelization.

Complete Denture Prosthesis

Prototyping and computer-aided designing/computer-aided manufacturing technology

Rapid prototyping can automatically construct physical models of CAD data. It thus acts as a 3D printer which can help in accurate prosthesis fabrication. This technique used the rapid formation of complete titanium denture base by using CAD/CAM. Laser scanners, standard softwares, formatted denture base plate under controlled numerical code. The denture base plate made of titanium is built up in later by layer.

Analyzing accuracy of impression by laser scanner

A 3D-view is always better than a 2D model. The laser scanner which has 3D-Digitizer without contacting the objects. Thus, a precise data are recorded and stored. The software and the image of designing are related to the 3D-digitizer, and an accurate prosthesis can be fabricated. Landmarks on 3D models act as a guide in fabrication, tracks faster and provide a standardized prosthesis.

Conclusion

Laser has become a ray of hope in dentistry and its role in prosthodontics has increased the success rate of prosthesis and helps in restoring form, function and esthetics of the patients. Lasers when used efficiently and ethically, it provides excellent results with its own limitations. Thus, with newest ongoing researchers, the future of dental laser became bright in reforming many smiles. Laser forms a boon to many patients with bleeding disorders or allergies and also to the dentist in performing surgeries as it provides a pain free care. Besides being a "state-of-art" gadget, laser is extremely useful and patient-friendly piece of equipment for the dental professionals.

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Conflicts of interest

There are no conflicts of interest.

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