The journal of
PROSTHETIC AND IMPLANT DENTISTRY
Official Publication of Indian Prosthodontic Society
Kerala State Branch

LASERS IN PROSTHODONTICS: AN OVERVIEW

*Khushboo Verma, **Ambika Shrivastav, **Siddharth Gupta, ***G.S. Chandu, * Vaibhav Jaiswal, *Jyoti Sarathe

*PG Student, **Professer, ***HOD & Professer, Department of Prosthodontics, Crown & Bridge and Implantology, Rishiraj College of Dental Sciences and Research Centre, Bhopal | Corresponding Author: Dr. Khushboo Verma, E-mail: thekhushbooverma0121@gmail.com

https://doi.org/10.55231/jpid.2023.v06.i03.04

Abstract:

Laser is an innovative tool in modern dental practice. LASER stands for 'Light Amplification by Stimulated Emissions of Radiation". In last 2 decades there have been an explosion of research studies in laser application. Advances in the use of laser device in prosthodontics have proven beneficial. Further laboratory and clinical experimentation may determine a significant place of laser in prosthodontics. The various application of Laser is convenient for both dentist and patient. This review article have described application of laser in field of prosthodontics in all aspect.

Key words: ***Dental Laser, Lasers application, complete denture, dental implants, low power Lasers.***

Introduction

Laser is an acronym which stands for "Light Amplification by Stimulated Emission of Radiation", which have been used in many fields.[1] Lasers have a wide spectrum of applications in the field of medicine and have replaced a scalpel to a reasonable extent all over the surgical field. It did not stop here but spread its wings to the oral cavity also and became a boon to dentists all around the globe.[2] The introduction of lasers in the field of prosthodontics has replaced many ordinary surgical and technical methods and has offered many sophisticated products designed to improve the quality of treatment rendered to a patient. Since the advent of laser application in dentistry, various cultivated products sketched to enhance the quality of treatment are being given to the patient. Hence, laser has begun to reform the field of dentistry.[3]

History:

Year	Name	Development
1917	Albert Einstein	On the quantum mechanics of electrons
1954	Charles and Townes	MASER
1958	Schawlow and Towes	LASER
1960	Theodore Maiman	1st working laser
1961	Ali Javan	He-Ne Laser

1961	Elies Snitzer	1st Neodymium Laser
1962	Bells Lab reported	YAG Laser
1964	Kumar Patel	Co_2 Laser
1964	Joseph and Richardson	Nd:YAG Laser
1966	Lankard and Soarokin	Ruby based Dye Laser
1971	Weichman and Johnson	1st used in endodontics
1980	Yamamoto and Sato	Nd:YAG Laser used in dental caries prevention
1989	Myers and Myers	Application of Laser in general dentistry
1990	Various laser	Diode,Nd:YAG, Er, Cr:YGG, Er:YAG,Co_2.

Various laser wavelengths used in dentistry:[4]

Laser	**wavelengths**	**uses in dentistry**
Argon	488 nm	Polymerization of the catalyst for curing composite resins.
Dual-wavelength Argon	488 nm and 514nm	Excellent control over depth of penetration makes this an extremely safe surgical device.
Diode	810 nm to 830nm	For soft tissue procedure providing for good hemostasis and effective cutting of tissue.
Diode	940nm, 980nm, 1064nm	Laser troughing and sterilization of endodontic canals.
Nd:YAG	1064 nm	Can penetrate quite deep into dental soft tissue. This laser is used primarily for soft tissue surgical procedures
Erbium (Er:YAGG)	2940nm	It is the safest wavelength available when working close to the pulp
CO_2 lasers	9300 nm 9600 nm10, 600 nm	hard tissue laser
Low Level Lasers.	785 nm 830 nm	These devices stimulate blood flow and increase cell activity resulting in pain relief, anti-inflammation, muscle relaxation and increased tissue healing.

Use of LASER in prosthodontics:

Uses of laser in dental removable prosthetics:[5]

1. Treatment of flabby ridges
2. Residual ridge modification
3. Tuberosity reduction
4. Torus reduction
5. Soft tissue modification
6. Epulis fissurata
7. Denture stomatitis
8. Vestibuloplasty
9. Sulcus deepening
10. Frenectomies
11. Osseoectomy during tooth/root extraction or ridge recontouring
12. Treatment of soft tissue and hard tissue undercuts.
13. Laser welding

Laser uses in field of complete denture:[6]

1. Prototyping and analyzing of occlusion by computer-aided designing (CAD) computer-aided manufacturing (CAM)

technology.

2. The analysis of the accuracy of impression by laser scanner.

Use of laser in fixed prosthetics as follows:[5]

1. Coronary elongation
2. Soft tissue management around abutments
3. Soft tissue management around laminates.
4. Osseous crown lengthening
5. Formation of ovate pontic sites
6. Veneer removal
7. Root canal etching during direct fiber-reinforced composite restoration
8. Altered passive eruption management
9. Troughing
10. Bleaching
11. Tooth preparation for veneers and full coverage crowns and bridges
12. Removal of the carious lesion and faulty composite restorations before placement of final restorations.
13. Crown fractures at the gingival margins
14. Enamel and dentin Etching

Uses of laser in implantology:[7]

1. Preoperative frenectomy and tissue ablation
2. Preparation of surgical site
3. Decontamination and implant placement
4. Osteotomy
5. Uncovering of implant
6. Treatment of mucositis and peri-implantitis

The addition of treatment modalities in dental specialties: [8]

1. Laser holography Imagining
2. Selective laser sintering

Various application of laser in laboratories are:[9]

1. Laser titanium sintering
2. Laser ablation of titanium surfaces
3. Laser-assisted HA coating
4. Laser welding of titanium components of the prostheses.

Low-power lasers:

1. Effect of low-level laser on toothache
2. Effect of low-level laser on mucositis pain
3. Effect of low-level laser on myofacial pain
4. Effect of low-level laser on temporomandibular joint disorder pain
5. Effect of Low-level laser on trigeminal neuralgic pain

Uses of laser in dental removable prosthetics:

1. Residual ridge modification: Irregular resorption causes inappropriate ridge. To detach sharp bony projections and to smooth the residual ridge soft tissue lasers used (CO2, diode, Nd:YAG,) Hard tissue surgery may be produced with the erbium family of wavelengths.
2. Treatment of undercut alveolar ridges: There are many reasons of undercut alveolar ridges. Two of the most common reasons are dilated tooth sockets that result from inadequate compression of the alveolar plates after an extraction and non-replacement of a fractured alveolar plate. Soft tissue surgery may be produced with any of the soft tissue lasers. Osseous surgery may be produced with the erbium family of lasers.[10]
3. Treatment of enlarged tuberosity: Large tuberosity can be a challenge for a

prosthodontist in regarding the prosthetic rehabilitation. Literature suggests a clearance of minimum 5mm between the maxillary tuberosity and Mandibular mucosa. The bulk of the hyperplastic tuberosity may rest toward the palate. The soft tissue decrease may be accomplished with any of the soft tissue lasers.

4. Surgical treatment of tori and exostoses: 8% of the human population affected with equal prevalence in males and females from Mandibular torus.[11] Soft tissue lasers may be use to expose the exostoses and erbium lasers may be use for the osseous reduction.[12] Lasers have been a tool for uneventful healing of the tissue.

5. 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.

6. Epulis fissuratum reduction: CO2 lasers may be used in treatment of epulis fissatrum with much more satisfactory results than conventional scalpel [7-10].

7. Vestibuloplasty: The use of scalpel delays the continuation of treatment to a vast extent with the help of lasers the healing period has been reduced to a significant interval. Nickel has concluded the results of less post-operative pain in patients treated with lasers for vestibuloplasty.[13]

8. Laser welding: One of the modern methods of removable partial dentures defect repairs uses the pulsed laser with relative low average out power. This is known as a precise and rapid joining method, but its success depends on the control of many parameters.

9. Frenoctomy: Lasers such as CO2, Neodymium-doped yttrium aluminum garnet, Erbium-doped yttrium aluminum garnet, and diode have been used for frenectomy.

Laser uses in field of complete denture:

1. 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 software, formatted denture base plate under controlled numerical code. The denture base plate made of titanium is built up in later by layer.

2. Analyzing accuracy of impression by laser scanner: The laser scanner which has 3D-Digitizer without contacting the objects. Thus, a precise data are recorded and stored.

Use of laser in fixed prosthetics as follows:

1. Coronary elongation: All other coronary elongation methods have disadvantages in the surgical approach, the healing time is longer, the position of the gingival margin after healing is random and the postoperative outcomes are uncomfortable and painful for the patient.[14] Er: YAG lasers have a high potential for bone ablation due to the mineralized matrix of bone that contains water and hydroxyapatite (very high absorption rate).[15]

2. Soft tissue management around abutments: Argon laser ensures excellent hemostasis and well-regulated vaporization of oral tissues.

3. Modification of soft tissue around laminates: The removal and re-contouring of gingival tissues cover can be easily efficient with the

argon laser. The laser will detach tissue and supply hemostasis and tissues join the wound.

4. Osseous crown lengthening: Er: YAG laser has potential for bone ablation and helps in osseous crown lengthening.[16]

5. Formation of oval pontic sites: For a good design of the pontic sites, the use of lasers can be indicated for soft tissue and bone remodeling. Soft tissue surgery can be performed with argon and CO2 lasers and bone surgery can be performed with the Erbium laser family.

6. Removal of ceramic veneers: The use of lasers when removing veneers allows the practitioner to avoid cutting out the bonded elements, it also improves the patient's comfort and reduces the time in chair-side.[17]

7. Root canal etching during direct fiber-reinforced composite restoration: Er: YAG lasers cause thermomechanical ablation by micro explosions. The pressure interval during this process increases by causing micro-explosions in the inorganic structures leading to the opening of the dentine tubules.[18]

8. Laser troughing: Lasers can be used to produce a groove around a tooth before impression making. This can be prevent the requirement for retraction cord, electrocautery, and the use of hemostatic agents.[19]

9. Bleaching: Esthetics and smile are main situation in our modern society.. Diode lasers are used to bleach teeth without causing much tooth sensitivity and modification of the complexion of the tooth.

10. Crown fractures at the gingival margins: Er: YAG or Er, Cr: YSGG lasers can be moved out to permit correct exposure of the fracture margin.[20]

11. Crown preparation: Crown preparation with lasers a debated topic still. Er, Cr: YSGG laser is used most commonly now. It uses hydrokinetic technology (laser-energized water to cut or ablate soft and hard tissue).

Uses of laser in implantology:

1. Implant recovery: The CO2 lasers and Er: YAG lasers are used with success while Nd: YAG laser is contraindicated as this causes temperature build up around the implants and also melting of the implant surface.[21] All types of lasers can be used to release dental implants. There is minimal tissue shrinkage after laser surgery, which tell that the tissue margins will continue at the same level after healing. In addition, the use of laser can detach the trauma to the tissues of flap reflection and suture placement.

2. Implant site preparation: Lasers can be used for the placement of mini implants generally in patients with potential bleeding problems, to give bloodless surgery in the bone.[16]

3. Removal of diseased tissue around the implant: Lasers can be used to restore implants by sterilizing their surfaces with laser energy. Diode, CO2 & Er: YAG lasers can be used for this reason. Lasers can be used to remove granulation tissue in case there is inflammation around an Osseointegrated implant.[22]

4. Treatment of peri-implantitis: Diode lasers, CO2 lasers and Er: YAG lasers have been used for the treatment of peri-implant diseases, due to their bactericidal effect and their technical simplicity.

5. Implant explantation: "Failed implants" can be removed by using Er, chromium: YSGG (Er, Cr: YSGG) laser which provides a minimally invasive technique instead of conventional methods of removal. The Er, Cr: YSGG laser has been demonstrated to effectively cut bone without burning, melting or altering the calcium: phosphorus ratio of the irradiated

bone.[21]

6. Laser welding of titanium components: Laser welding can be advocated in fabricating frameworks to obtain a passive fit of implant prostheses on multiple implants.

7. Computer-aided laser cured surgical template: Rapid prototyping techniques allow the production of physical models on the basis of virtual computational models. The rapid prototyping technologies that are currently in use are stereo lithography (SLA), inkjet-based system (3 dimensional printing), selective laser sintering (SLS), and fused deposition modelling. SLA uses an ultraviolet laser to "laser cure" cross-sections of a liquid resin and is the technique which is commonly being used for the generation of computer-generated surgical guides. SLS models are opaque, whereas SLA models are translucent. Fabrication of surgical templates using SLA have been proved to benefit from high precision by several well-documented researches.[21]

Use of laser in maxillofacial prosthesis:

1. Laser holography imagining: Laser surface digitizing tools can be used to obtain to pathologic data of the patient's deformity, the procedure is called as Laser Holography Imagining. Lasers help in creating a visually realistic prosthesis that shows illusion of normal appearances.[23] Lasers also overcome the drawbacks of three-dimensional computed tomography and magnetic resonance imaging reconstruction as the patient is not exposed to considerable radiation and any stress.

2. SLS (SELECTIVE LASER SINTERING): The SLS (Selective Laser Sintering) is a method of computer aided designing using mainly the laser. In this method models are generated directly from 3-D computer data then converted to STL files, which are then sliced in to thin layers (typically about 0.1 mm/0.004 inches) using the associated computer software.[24]

Various application of laser in laboratories are:

1. Laser titanium sintering: Direct laser metal sintering is a means by which it is possible to directly generate physical objects with defined structure and shape on the basis of virtual 3D model data. This technique offers the advantage of using titanium and its alloy as starting powders that are completely melted and fused in the laser focus resulting in a high mechanical strength.[25]

2. Laser ablation of titanium surfaces: Machined and Al2O3 blasted surfaces of screw shaped Ti dental implants were irradiated by 30 ns pulses of Nd:glass laser at 1064 nm wavelength with 0.5–3 J pulse energy. The laser treatment increased the temperature of the Ti surface well above the melting temperature. The surface composition was the same as the bulk titanium without any segregation.[26]

3. Laser-assisted HA coating: Lasers have been used for deposition of HA thin films on titanium implants pulsed laser deposition has proven to be a promising method to produce pure, crystalline and adherent HA coatings which show no dissolution in a simulated body fluid.[24]

4. Laser welding of titanium components of the prostheses: Laser welding is one of the very recent yet versatile techniques used in dentistry, which is capable of manufacturing good quality weld joints with remarkable consistency.[27]

Conclusion

The 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 a daily basis. However, laser has never been the "magic wand" that many people have hoped for. It has got its own limitations. Never the less, the future of dental laser is bright with some of the newest

ongoing researches. The use of different laser in prosthodontics has made it possible to redefine the principles of soft and hard tissue management around dental and implant abutments, offering the practitioner the possibility of performing multiple procedures in complete comfort and with great predictability of results. However, the dentist's responsibility requires him to choose the right laser, the right wavelength and the lowest amount of energy to achieve the desirable results.

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