WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

SJIF Impact Factor: 3.458

ISSN: 2457-0400
Volume: 2.
Issue: 4.
Page N. 123-127
Year: 2018

Review Article www.wjahr.com

APPLICATIONS OF LASERS IN DENTAL IMPLANTOLOGY- A REVIEW

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Received date: 19 April 2018 **Revised date:** 10 May 2018 **Accepted date:** 31 May 2018

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ABSTRACT

Advances in the field of implant dentistry and in lasers have made it reach a higher level to deliver various treatment modalities in a better and successful way. The use of lasers in dental implantology includes preoperative, post operative and intra operative procedures. The use of lasers has various applications in implant dentistry such as in presurgical preparation, placement, second stage recovery and in the treatment of periimplantitis. Numerous studies have shown the capacity of laser wavelength and laser parameters successfully used in implantology. Thorough knowledge of properties of lasers, its characteristics and its mode of action is important for its beneficial use during clinical and surgical procedures. This article aims at giving a brief review of applications of lasers in clinical practice of implant dentistry.

KEYWORDS: Lasers, Implant, Periimplantitis, Ailing Implants.

INTRODUCTION

Dentistry has seen a significant expansion in the field of implantology and lasers which has proved to be beneficial in clinical procedures for practitioners. The first laser was built in 1960 by Theodore H. Maiman. A number of laser wavelengths have been brought into the field for various applications or procedures in implant surgery. Lasers were brought into medical practice in 1989 by Dr. William and Terry Myers. They modified ophthalmic Nd:YAG lasers for dental purpose. Even though the CO2, Nd YAG, diode, argon and holmium wavelengths are soft tissue lasers, the introduction of erbium family of wavelengths, which safely remove hard tissue have brought a big wave of development in laser application in dentistry.[1]

About lasers

Laser is an acronym for light amplification by stimulated emission of radiation. A laser can emit light through process of optical amplification based on stimulated emission of electromagnetic radiation. Laser light is monochrome (one special colour, in dental application that colour may be visible/ invisible). Three additional characters which laser light possess are collimation, coherency and efficiency. Several variants of dental lasers are in use with different wavelengths and this means they are better suited for different applications.

Diode Lasers: They are in the range between 810-1100nm. Romanos suggested that 980nm diodes are safer for titanium implants and 810nm diodes are considered to damage the implant surface. Hence 980nm diode lasers are considered to be useful in implant therapy. Low cost and small size are its advantages.

CO_2 lasers: Best surgical laser for soft tissue, for both cutting and haemostasis. New CO_2 lasers operate at 9300nm with features of strong absorption in both soft tissue and hard tissue.

Nd YAG lasers: It is used for soft tissue surgeries. It is effective in coagulation and haemostasis. But as their penetrating depth has a potential to damage, it is not useful in implant dentistry.

Er YAG lasers: Suitable for both hard and soft tissue. Procedure can be done without anesthesia. It can be used for bone cutting. It causes less thermal and mechanical trauma to the tissues. The procedure shows excellent healing.

Dental lasers have various applications in clinical as well as in laboratory procedures in implantology.

Lasers for Implant site preparation

Ideally, the soft tissue surrounding the implant should be prepared before starting an implant procedure. One of the most important uses of lasers in implantology is the removal of granulation tissue and disinfection of the surgical area after extraction.[2] Lasers found to have bactericidal effects can cause decontamination of surgical site and degranulation of extraction sockets. The erbium and diode lasers can disinfect and remove granulation tissue. The CO2 lasers can be applied for decontamination of bony surfaces and removal of soft tissue tags.[3]

Lasers for Mini implant placement

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.[4] Balk in et al proposed auto advanced technique by which a small opening could be placed into soft tissue and around 3mm into bone. These mini implants which are 1.8mm in diameter with self tapping thread, can be rotated slowly and auto advanced into soft cancellous bone.

Lasers for Flap incision and osteotomy

Usage of surgical blade for flap incision causes bleeding andobstructs the view and accessability to the surgical site. Dental lasers employed for this purpose have the advantage of hemostasis and keeps the visual field clean. Diode lasers, CO_2 lasers and erbium lasers are used for this purpose.[3]

Lasers can be used for the removal of bone without exerting pressure on the bone. This is an advantage of lasers during osteotomy, as conventional technique involves use of drills, handpieces and bone files which will increase patient's anxiety, pain and discomfort. Apart from this, usage of conventional methods may cause potential damage and post operative complications due to overheating. Improvements in laser technology allows accurate bone cutting.

Er:YAG lasers have been found to do precise bone cutting with minimal damage. Kesler et al in his study suggested the use of Er:YAG to be a safe option during osteotomy.[5]Er:YAG laser removes a fixed amount of material per pulse ,thus making accurate control of cutting possible and low average power provides holes comparable to those obtained using mechanical drills. Kesler et al suggested enhanced early healing by Er lasers compared to the use of burs.[6] This is because of higher level of platelet derived growth factor produced by erbium lasers compared to burs.[3,6]

Lasers during Uncovering at 2nd stage

Using scalpel for excision and incision causesbleeding, pain and discomfort for the patient during surgery. Hence while uncovering implant during 2nd stage surgery of submerged implants or surgical removal of hyperplastic periimplant tissue, lasers can be applied which help in reducing the discomfort to the patient.During the second stage or uncovering of implant, the use of Er:YAG laser is very effective and has advantages like sterilization, depolarization of nerves, analgesia, and hemostasis. Arnabat–domingnez et al suggested that the Er:yttrium-aluminium-garnium laser (Er:YAG) show successful results, except on implants placed in areas of esthetic considerations.[7]

CO_2 lasers are used for excision and vapourisation of different soft tissue tumours and periimplant hyperplasia. As the mode of application is continuous or super pulse, it helps in fast excision, coagulation and improved patient comfort. CO_2 laser also helps in decontamination of exposed implant surfaces. Hemostatic properties of CO_2 lasers are excellent. Hence they are mainly preferred for soft tissue. CO_2 laser energy gets reflected away from matallic surfaces thus reducing potential harmful effects on the implant surfaces. For osseous procedures CO_2 laser is not a good choice because it has the potential to cause thermal damage to bone.[4] Use of lasers can allow for taking impressions on the same day and it helps in abutment seating.

Nd:YAG and diode lasers should be used with special care because of the higher penetration depth and the possible damage to the bone in direct irradiation. Nd:YAG laser system has the potential to melt the surface and can even remove the surface layer from plasma-coated titanium implants, which makes the use of Nd:YAG lasers questionable in implant uncovering procedures or periimplant gingival peeling.[8]

Lasers for Lateral window sinus lift

In sinus lift procedure, graft material is placed between the bone and schneiderian membrane, where integrity of this membrane is important. CO2 and erbium lasers can be used to give an incision without hampering the bone integrity.[3]

Lasers In Perimplantitis

Bacterial infections and occlusal overload have been emphasized as the main etiological factors leading to implant failures. Periimplantitis is a multifactorial inflammatory process which leads to bone loss by affecting the hard and soft tissues around the implant. The infection seen in periimplant tissue is similar to the infection seen in periodontitis, and the bacteria most commonly involved are Porphyromonas Gingivalis species.[9,10,11,12,13] Many options are recommended for the treatment of periimplantitis, which include non-surgical methods of mechanical instrumentation and the use of antibacterial agents. Initial stages of the periimplantitis can be treated by the use of antimicrobial agents.[8,14,15,16] Whereas, the use of systemic antibiotics has not been effective due to the resistant strains of bacteria.[17,18] Other treatment options include apically positioned flaps to establish plaque control and polishing threads of implants, especially whenwide bony defects are present. Although Nd:YAG lasers significantly decrease bacteria, alterations to the implant structure occurs as well as significant increases in temperature. They resulted in melting, loss of porosity and other surface alterations even with the lowest settings. Hence Nd:YAG lasers and Ho:YAGlasers are unsuitable for peri-implantitis.[19] At a low-power setting,CO_2lasers are advantageous for periimplant procedures as they provide disinfection and significant bacterial reduction. They donot cause any alteration to the implant structure. The lasers help in the reduction of the bacteria P. Gingivalis specifically.

The most efficient and excellent use of the Er:YAG laser is in the treatment of peri-implantitis. Using the Er:YAG laser, promising results in the treatmentof periimplantitis have also been demonstrated histologically by Takasaki et al.[20] His study showed better results statistically and a tendency to produce a greater bone to-implant contact percentages (reosseointegration)when using the Er:YA laser compared with the curette group. Schwarz et al in his study has shown that Er:YAG lasers can be used for decontamination of dental implants effectively.[21] Er:YAG laser showed the removal of subgingival calculus from titanium implants without causing any thermal damage.[21]Er:YAG laser also has bactericidal properties at low energy densities and does not damage the implant surface.[22]

Lasers in ailing implants

In case of ailing implants, the use of laser energy has been proposed.CO_2, diode and Er:YAG lasers have been used for the purpose of decontamination of implant surfaces. Deppe et al suggested the use of laser decontamination in peri implant defects without damaging the surrounding tissues in the dog model. He also suggested that the use CO_2 lasers can lead to bone regeneration.[23] Whereas, Kreisler et al suggested that Nd:YAG and Ho:YAG lasers are not suitable for decontamination purpose of implant surfaces. GaAlAs lasers are considered safe where surface alterations of implant surfaces are concerned.[24]

Laser applications in dental laboratory

Lasers are useful for depositing hydroxyapatite (HA) thin films on titanium implants. Pulsed laser deposition (PLD) has shown a method to produce pure, crystalline and adherent HA coatings. It showed no dissolution in a simulated body fluid.[25]

Laser applications in dental technology

Osseointegration of dental implants requiresa passive fit of the prosthesis. The elimination of the casting process would be the best way to obtain a passive fit. In cases of multiple implants, there would be a non passive fit due to the expansion and contraction during casting. This problem is solved by laser- welding which gives a passive fit. Reidy et al have reported the precision fit of the laser-welded framework to 1-piece casting.[26] Ortorp et al in his study concluded that the laser-welded framework was a possible option for edentulous mandible.[27] Whereas, a few reports have also suggested a higher tendency for fractures in laser-welded implant frameworks. A study conducted by Bergendal and Plamqvist showed more fractures of artificial teeth on titanium-welded frameworks.[28]

Lasers as hemostatic tool

Many patients who undergo implant surgery have a history of systemic conditions or long term anticoagulant therapy. Lasers have minimized the bleeding on the surgical site which gives good accessability and visibility for the dental surgeons. Lasers benefit the patients by fast and effective hemostasis. The best hemostatic effect of the lasers is associated primarily with the Nd:YAG and diode lasers and next with the CO_2. Er:YAG and Er,Cr:YSGG lasers have a lower hemostatic effect. In patients with bleeding disorders, after tooth extraction the effectiveness on bleeding has been shown with the bare fiber diode or Nd:YAG laser.Lasers,hence are considered helpful and effective during immediate implant placement.

Lasers and photodynamic therapy

Photodynamic therapy is the light-induced inactivation of cells, microorganisms, or molecules. Antimicrobial photodynamic therapy is a process of staining infectious bacteria with a photosensitizing dye, then a light of appropriate wavelength and intensity causes bacterial destruction. The science behind the photodynamic therapy and laser, is that the laser gets activated by photosensitive dye causing the singleton oxygen build up, thatcauses the oxidation of lipids and enzymes of the pathogenic bacteria, leaving the healthy cells unharmed.[8]

Studies by Meisel and Kocher have suggested the high bactericidal effects of photodynamic therapy.A definitive reduction of pathogenic bacteria around implants was noted in their in vitro studies.[29]A significant reduction in periodontal signs of inflammation has been shown in beagle dogs by the studies conducted by Sigusch et al.[30] The results from the study conducted by Dörtbudak et al indicated that photodynamic treatment reduced bacterial counts.[31]Giroldo et al showed a marked reduction in Candida when they used laser in combination with methylene blue.[32]

Lasers in wound healing

In a study by Luomanen et al, the wound-healing mechanisms using CO_2 and Nd:YAG laser application were evaluated and found that the best healing was observed in CO_2-laser treated wound sites.[33] Kaminer et al reported an increased bacteremia due to the scalpel and other methods of surgery, whereas no bacteremia was seen when using a CO_2 laser.[34] He concluded that low energy settings with Nd: YAG laser established normal wound healing without scar tissue formation and tissue discoloration compared with the scalpel incisions. And high energy settings with the Nd: YAG laser caused a higher amount of necrosis. The wound healing in the oral mucosa using a CO_2 showed similar effects.[35] The wound healing after laser irradiation isdelayed in contrast to scalpel incision healing.

Lasers in osseointegration

For the success of implants the most ideal goal to achieve is osseointegration. Osteoblast attachment to the surface of the titanium implants helps in new bone formation and better implant healing.

Lasers are being investigated for possibly improving osseointegration. The reason behind a better tissue response could be the enhanced adhesion of blood cells, the stabilization of the clot at the periimplant interface, which may fasten the healing process. Advantage of this is early implant loading and function.

Kesler et al have shown that use of laser has improved osseointegration around titanium implants when compared with traditional osteotomies.[5] Electron microscopic analysis of the osteoblastic attachment on titanium surfaces when irradiated by CO_2 or Er,Cr:YSGG laser demonstrated a good proliferation of osteoblasts as well as an attachment on different type of implant surfaces.[36] This may explain the possible reosseointegration after implant surface decontamination using these laser systems.

CONCLUSION

Combining lasers and implantology is considered to be a good practice which can be significantly beneficial for the patients and a better treatment delivery by the dental practitioners. Even though a lot of benefits areassociated with the use of lasers in implant procedures, there are risks of irradiation of implant surfaces and tissues. Therefore, a good knowledge of different lasers, training on laser technology and use is necessary to get excellent clinical treatment outcome and success.

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