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A Review of Perimplantitis and Lasers

Dr. Saurabh Gupta[1] Dr. Niva Mahapatra[2]
1,MDS, Oral and Maxillofacial Surgery, Axiss Dental Pvt Ltd, Bangalore
2,MDS, Oral and Maxillofacial Pathology, Axiss Dental Pvt Ltd, Bangalore

Abstract: *The main objective of this article is to review the current developments in the field of dental implants and the elimination of periimplant inflammations and infections with the aid of dental lasers. The term laser is just an abbreviation of Light Amplification by Stimulated Emission of Radiation. Lasers have been basically used in periodontal therapies like sub-gingival curettage and debridement, removing the granulation tissue while flap surgery is done, re-contouring of the osseous tissue and implant surgery. The maintenance of an implant is very important for efficient Osseo integration and a good prosthetic design. Any kind of bacterial inflammation and infection of the periimplant tissue calls for bone loss. Treatments like mechanical debridement, antibiotics and laser treatment have been recommended. Lasers play an important role in the dentist's office and in the maintenance of implants and to treat periimplantitis.*

I. Introduction

Now a days periimplant tissues have been subjected to treatment with the soft tissue lasers for the preparation of the osteotomy site and uncovering the submerged implants. The crown and abutment emergence profile can be shaped by the soft tissue lasers which play a key role in the esthetic zone helping in preserving the interdental papilla. Using lasers for such purposes has resulted in innovative practices for surgery which reduces patient's bleeding, pain, edema and scarring after the surgery to a great extent. With increased popularity of prosthesis supported by implants it has become important to provide for the maintenance of the regular implants. When there is lack of patient participation in the professional prophylaxis, inflammation of the periimplant is a common sight. Traditional practices cannot provide efficient debridement and decontamination of the sites as compared to the modern treatment modality with the soft tissue lasers. Lasers, ozone gas and photodynamic disinfection can result in bacterial decontamination. Many studies have shown that surface decontamination of the implant with CO2 or Er; YAG offer superior results relative to other methods (Peters, Tawse-Smith, & Leichter, 2012).

It has already been told that laser is just an abbreviation of light amplification by the stimulated emission of the radiation. Commonly used dental lasers for implants are diodes and carbon dioxide. The CO2 lasers give out energy which penetrates less than 0.1mm which is absorbed by the watery tissues and vaporizes the cells on surface of the tissues. Traditionally, carbon residue and char generally was a sterile dressing for any wound. New technologies like Ultra speed CO2 increases the accuracy of the surgery and boosts the healing process giving the patient excellent comfort. It is used mainly in oral soft tissue surgical therapies like excisions, gingivectomies, incisions, frenectomies and lesion removal. The invisible energy coming from CO2 lasers can be subjected to tissues with the help of the red aiming beam from neon and helium elements. The strength and type of laser must be selected for different dental procedures depending upon power and wavelength, pulsed or continuous mode, indirect or direct contact with the help of distinct tips. A laser light can be transmitted, absorbed, scattered or reflected within the tissues but transmitting and scattering may result in damage of the tissues which surround the targeted tissues. During the application of laser, the dentist must take care of the staffs and the patient's safety (Garg, 2007).

II. Biofilm

Dental plaques and pocket formation on the surface of the titanium implants is very common. It has been demonstrated by Lekholm, Holt and associates that the sub and supra gingival micro flora that is cultured from the titanium endosseous implants are the same as cultured from a natural tooth. In order to prevent periimplantitis it is important to examine the occurrence of periodontal pathogens after the implantation and after the prosthesis is placed. Equally important is the prevention of the formation of a bacterial biofilm on the surface of the implant (Catone & Alling, 1997).

The initial step for the development of an oral biofilm is the formation of a salivary pellicle consisting of host glycoproteins and proteins which serve as adhesion molecules for the bacteria. Streptococci are the primary colonizers which offer adhesion to Fusobacterium and Actinomyces. The chemical signals which are given out by the colonizing bacteria consist of cellular concentration which on reaching a critical point starts secreting exo-polysaccharides. A biofilm matrix is formed by these macromolecules which incorporate bacteria.

The key etiological factor for the periimplantitis is the biofilms that are formed by the penetration of the implants through the gingiva (Khan, Sasaki, & Hirose, 2011).

Current studies show that contamination of the internal parts of the dental implants by penetration of bacteria along the abutment-implant interface can cause inflammation and malodor of the periimplant tissue. The implant and teeth micro flora has been proved to be similar in patients having partial edentulous. In such patients, implants are generally colonized by bacteria originating from the surface of the oral mucous membrane after implantation (Grade, Heuer, & Strempel, 2011).

Periimplantitis is an inflammatory process which affects the tissues surrounding the Osseo integrated implants which results in the loss of the supporting bones. This condition can also be referred to as a process where the advanced loss of bone around the implant exceeds the confines of bone resorption which can be tolerated after Osseo integration. These can be thus categorized as implant failures resulting from various reasons like etiological and chronological aspects resulting from pathogenic entities from abnormal biochemical balance, bacterial processes or a combination of both. Inflammation around the implants can be found in marginal mucosa known as perimucositis or can extend periapically as a result of horizontal and vertical bone loss referred to as periimplantitis (R, DKD, & CAM, 2011).

Perimucositis is a reversible process and results from bacterial plaque. Failure of the implants result from extended inflammatory changes in the periimplant tissues. Two major varieties of lesions in the periimplant pathology are reversible inflammatory reactions and progressive bone loss from the periimplants after Osseo integration. Accumulation of bacteria begins within the soft tissues mainly around the neck of the implant, penetrates the abutment implant connection and is left untreated can spread toward the apical resulting in horizontal and vertical bone loss accompanied by implant failure. Various in vivo and in vitro studies have been done which reveal that bacterial colonization of the periimplant sockets is similar to the periodontal ones (Quirynen, Soete, & Steenberghe, 2002).

Bacterial species like Bacteroides internedius, Bacteroides gingivalis and Actinobacillus actinomycetemcomitans are the ones responsible resulting in severe periodontitis and periimplantitis. Kalykakis et al and Ellen et al found that periimplant and periodontal microflora revealed similar tendencies at the time of progressive deterioration of the tooth structures. Becker et al stated that adequate amount of Bacteriodes intermedius; Aggregatibacter actinomycetemcomitans and Porphyromonas gingivalis were found at the implant failure sites. Jasenka Zivko-Babic et al had reported that F nucleatum and A. actinomycetemcomitans are the key periodontal pathogens in the patients having implants with supported restorations and sub-gingival microflora. Prevotella intermedia, Campylobacter rectus and Prevotella oralis were not found generally. In this particular study P. gingivalis, A. actinomycetemcomitans, T. forsynthesis and F. nucleatum were only found. Implant failure accompanied by retrograde periimplantitis can be the result of micro-fractures of bone resulting from premature loading of the implants, trauma, overloading and occlusal factors resulting in Osseo integration loss in the area surrounding the implants. The diagnosis can be done by measuring the soft tissues by way of automated/manual probes, suppuration, radiographs, swelling, calculus and bleeding and color changes while microbial monitoring is done.

In case of percutaneous implants, periimplant abutment crust, skin thickness, exudates, implant mobility and tissue reaction can be measured. The tissue inflammation of the periimplant abutment can be seen round the epithelial tissues of the percutaneous implant abutment which supports maxillofacial prosthesis. A zero grade reflects normal skin, grade 1 shows mild inflammation like non-tender, edema and slight redness, grade 2 shows moderate inflammation like mild tenderness, edema and redness and lastly grade 3 shows severe inflammation like severe pain, edema, marked redness and ulceration.

Treatment Modalities

Implants respond in a similar manner as natural teeth do to oral ecosystem and thus a proper schedule for maintaining the implants should be implemented with respect to lasers. Periimplantitis therapy is a nonsurgical phase including debridement mechanically with laser or ultrasonic devices either combined or alone with antiseptic or antibiotic agents and also a surgical procedure. Removing endotoxins and bacteria by help of mechanical depuration particularly in between the implant threads of rough surfaces is difficult.

It was noted by Fox and his colleagues that various surface alterations occurred after the titanium implants underwent debridement with the help of metal instruments made from either titanium alloy or stainless steel. Different metal instruments can easily contaminate the implant surface by altering the oxide layer making it open to corrosion. Disruption of the epithelial seal at the time of maintenance processes can result in permanent detachment as a result of plaque adherence to the rough surfaces. In order to get proper periimplant regeneration, efficient bacterial removal from the surface of the implant is very important. Using ultrasonic instruments and curettes can be damaging to the surface of the implant. Air powder instruments are abrasive and their applications are limited as they can result in emphysema when used for deep bony defects. They can modify the surface of the implants coated with HA in a negative manner. Chemical adjuvant bring about gingival irritation with local antibiotic and antiseptic therapy. Local antibiotic therapies with the tetracycline fibers around the failing implants have been found to not have any important therapeutic effects. Systemic antibiotic therapies have limitations in the sense of bacterial resistance and ineffectiveness of the dose applied. Meanwhile, the anti-bacterial role played by lasers has been well-established. In an in vitro study done on irrigation of the periimplant pockets particularly with toluidine blue and irradiation with a soft laser of 905 nm diode for a minute showed a substantial reduction in the rate of periodontopathogenic bacteria within the pockets (Beer & Beer, 2002)

III. Lasers

The most commonly used lasers in the dentistry industry are the Diode laser, Nd: YAG laser, CO_2 laser, Er:YAG laser and Er, Cr: YSGG. These lasers are basically used in procedures like sub-gingival debridement and curettage, removing granulation tissue when flap surgery is done, osseous re-contouring, management and maintenance of periimplantitis.

ND: YAG Lasers

ND: YAG lasers were used in both non-contact and contact mode and its effect on the titanium implant surface, non-hydroxyapatite and hydroxyapatite TPS types were calculated inclusive of the laser effects after the implants were contaminated with the spores of the bacteria Bacillus subtilis. When these lasers were used at o.3, 2.0, 3.o energy settings it resulted in melting of the surface, porosity loss and physical changes in the crystalline structure of the hydroxyapatite coating. Total sterilization of the implant surface was not seen. These lasers were found to be effective in the decontamination of the implant surface and altering them to a great extent. (Which study???) If the implant is to be completely sterilized it has to be sufficiently decontaminated which results in surface damage due to melting and crater formation on basis of the surface of the implant. As a result of temperature rise, the application of Nd: YAG laser in the contact mode for the treatment of hyperplastic mucositis, second stage surgery and periimplantitis is contraindicated. Melting, porosity loss, cracks, damage and dissolution of the sand blasted, sprayed with plasma and implant coated with HA was found after applying Nd: YAG laser in pulsed mode with high or low power settings. Damage of the implants coated with HA was extensive as manifested in cracks and dissolution. All the irradiated surfaces of the implants had layers like lava and alterations which looked like craters. The absorption of the Nd:YAG laser by the metal surface shows that there is great risk of damage to the implant while treating periimplant soft tissues (Garg & Garg, 2012).

Diode Lasers

Diode lasers which are of 810nm, 940nm and 980nm have less chances of damaging the root shaped retentive surface of the implant when a good coolant is used.GaA1As diode laser of 810nm at 1 to 1.5W used for 20 seconds to the maximum in a continuous wave mode reduces inflammation and bacterial contamination to a great extent and guided bone regeneration can be done effectively after this. The diode lasers are having characteristic of good coagulation properties just like Nd: YAG lasers which have good superficial tissue absorption capacities without even damaging the underlying tissues. Significant reduction of the pathogenic bacteria in the pockets of Prevotella intermedia, Actinobacillus actionomycetemcomitans and Porphyromonas gingivalis was found. It was found in in-vitro studies that diode lasers having a wavelength of 980 nm does not damage the titanium disc surface. Thus, it can be said that these lasers are most effective for the decontamination of the implant surface after the flap is elevated during the treatment of the periimplant bone defects.

ER: YAG Lasers

Analysis of the Er: YAG lasers along with 540µm application tip for periimplantitis which was used at a 1.5mm distance from the surface of the implant with a pulse energy varying between 60-120mJ at 10pps with the bone block being placed in 37^{o}C water bath which stimulated diffusivity of the heat and in-vivo thermal conductivity showed that it is suitable for the decontamination of the different implant surfaces without leaving any adverse effects on the periimplant and implant bone (Grade, Heuer, & Strempel, 2011). While the testing was done, irradiation was done without and with cooling and the temperature of the cooling agent was 23.5^{o}C. The elevation of the temperature was higher in case of the implants coated with hydroxyapatite as compared to the other two titanium surfaces (Kreisler & Gotz, 2010).

It can be said that laser application can be a possible alternative treatment for the ailing implants. As per Schwarz et al, 2005, the combination of these lasers and mechanical chlorhexidine/ debridement isequally effective 6 months after the therapy in improvement of the Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL) but use of these lases reduces bleeding while probing. In a study, the efficiency of these lasers was found to be limited to 6 months for progressive periimplantitis lesions. It was also recommended that one course of laser treatment may not be sufficient for the achievement of a stable therapy and thus other measures like supplemental laser use or procedures for osseous regeneration may be needed. This study portrayed surface alterations and ineffective cleaning by the Key laser (Garg A. , 2007).

Carbon Dioxide Lasers

The CO2 lasers produce bactericidal effects but do not enhance the body temperature of the implants. In a study, a beam of CO2 laser with noncontact 4W setting was practiced to excise the hyperplastic tissue around the base of the sub-periosteal implant. A defocused CO2 beam was used for decontamination of the implant surface in case of periimplantitis for one minute after which filling of the bone defect was done immediately with BioOss and the resorbable membrane was placed. Another study which used a CO2 laser in continuous mode at low power output that of 2W was applied for 60 seconds from a 20 mm distance on titanium implants that were sand blasted. Significantly low level of bacteria was seen in Porphyromonas gingivalis. Another study revealed that a CO2 continuous laser irradiation of 6W does not affect the HA coated or plasma sprayed and sandblasted implant surface (Garg & Garg, 2012).

At a power setting of 2.5W no surface alterations were seen and excellent sterilization results were found. When the CO2 laser was used in the non-contact mode from a 5mm distance in both pulsed and continuous mode at 2.0, 4.0, 6.0 W powers setting, it showed no melting or alteration in any of the above mentioned implants. Ganz suggested that it is safe to use CO2 laser on titanium and HA coated screws with power setting lower than 2-4W in the continuous or pulsed mode. He also said that one could start with the continuous mode and then shift to pulse mode as it was more efficient in reducing the contact time between laser energy and implant surface. With this laser tissue necrosis is almost nil. CO2 lasers can easily be used for periimplant pathology, contouring the gingival tissue, controlling the mucosal abnormalities and treating the soft tissue complications (Peters, Tawse-Smith, & Leichter, 2012).

IV. Summary

Periimplantitis implants encompass conventional periodontal pathogens. Rough surfaces make it difficult to eliminate bacteria thus cleaning and sterilization of the implant surface is recommended. Ho: YAG and Nd: YAG lasers are not used for decontaminating implant surfaces. Power output is limited while using Er: YAG and CO2 laser to prevent damage. Er: YAG laser when operated at 60-120mj of pulse energy ensures substantial reduction of bacteria from hydroxyapatite coated, acid etched and plasma sprayed surfaces. GaA1A lasers are safe for surface alterations.

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