ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022

The Application of Photodynamic Treatment in Dental Specialties

Priyanka Aggarwal[1*], Amit Garg[2], Chetna Arora[3], Shubhra Malik[4], Rajiv Ahluwalia[5], Amit B Lall[6]

[1] Professor, Department of Periodontics & Oral Implantology, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

[2] Professor, Department of Periodontics & Oral Implantology, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

[3] Professor, Department of Conservative Dentistry and Endodontics, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

[4] Professor, Department of Conservative Dentistry and Endodontics, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

[5] Professor & HOD, Department of Orthodontics and Dentofacial Orthopedics, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

[6] Professor & HOD, Department of Oral & Maxillofacial Surgery, Santosh Dental College & Hospital, Santosh Deemed to be University, Ghaziabad, Delhi NCR, India

Email- [1]draggarwalpriyanka11@gmail.com

ABSTRACT:

Background: The development of science and technology in the medical field opens up opportunities for incorporating novel therapeutic approaches to address the problems posed by prevalent diseases. The growing usage of lasers in dentistry and medical is a reflection of the significant advancements in this technology over the past few decades. A. Mechanical periodontal debridement continues to be the gold standard for the nonsurgical treatment of periodontal disease. It is necessary to often maintain the mechanical periodontal treatment with different anti-infectious agents, such as antiseptics or antibiotics. The periodontal infections are further suppressed by antimicrobial drugs administered locally or systemically, which enhances the advantages of traditional mechanical therapy. The use of antimicrobials is restricted by the growth of resistant microbes and a change in the microbiota after prolonged use. This laid the groundwork for the development of photodynamic therapy and our current use of chemotherapy. For photodynamic antibacterial chemotherapy (PACT), the mouth cavity is particularly well-suited because of its relative accessibility to light. The terms photodynamic therapy, periodontal therapy, photosensitizer, wound healing, laser, and photo dentistry were used in the search to find original research publications, reviews, and case reports. Articles from PubMed and Google were retrieved from a chosen electronic database. In order to treat oral biofilms, a unique therapeutic strategy called photodynamic therapy is presented in this paper.

Keywords*:* Wound Healing, Photodynamic Therapy, Photosensitizer, Periodontal Treatment

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022**

INTRODUCTION:

The use of laser devices as an adjuvant in periodontal therapy has received more attention in recent years. High-power lasers are most frequently employed in periodontics. Calculus removal, osseous surgery, and soft-tissue management procedures like gingivectomy, gingival curettage, and melanin pigmentation reduction have all been done using CO2, Nd:YAG, and Er:YAG lasers.Numerous studies have demonstrated that laser phototherapy can effectively reduce side effects like surgical pain and post-treatment dental hypersensitivity while also reducing processes like inflammation, soft tissue and bone repair (LPT).Additionally, the so-called "antimicrobial photodynamic therapy" (aPDT), which combines low-power lasers with photosensitizers, can be used to lessen bacterial infection of periodontal pockets.Photodynamic antimicrobial chemotherapy (PACT) has a direct impact on extracellular molecules since the antimicrobial activity of photosensitizers is mediated by singlet oxygen, and the polysaccharides of an extracellular polymeric matrix are likewise vulnerable to photodamage. Some oxygen radicals are protected from by antioxidant enzymes like superoxide dismutase and catalase, however singlet oxygen is not one of them. An important benefit of PACT is its dual activity, which antibiotics do not exhibit.

The non-thermal killing of cells, bacteria, or chemicals is known as photodynamic treatment (PDT). In this, a photosensitizing agent is activated by light in the presence of oxygen. The production of hazardous oxygen species as a result of the photosensitizer's exposure to light causes localised photodamage and cell death. This reaction is cytotoxic and vasculotoxic in a clinical setting. Photosensitizers can be injected intravenously, taken orally, or used topically, depending on the type of substance.

This last procedure has two mechanisms. Direct electron transfer from the ions that produce photosensitizers occurs in type I reactions, as does the removal of an electron and/or hydrogen from a substrate molecule to produce free radicals. Rapid reactions between these radicals and oxygen produce extremely reactive oxygen species such superoxide, hydroxyl radicals, and hydrogen peroxide. Singlet oxygen, a highly reactive and electrically excited state of oxygen, is created through type II reactions. Typically, both methods contribute to the process.

Studies on the clinical indicators of periodontitis

In a study involving 30 patients, a comparison was done between sites treated with adjuvant PDT and sites treated with scaling and root planing (SRP) alone based on the clinical criterion bleeding on probing (BOP).Compared to SRP alone, photodynamic laser therapy resulted in a significant reduction of BOP. The decrease in BBOP persisted one week and one month after PDT. There was a distinct trend for the bleeding scores to rise one month after PDT, but at lower levels than the bleeding scores following SRP alone. [10] Twenty patients with untreated chronic periodontitis participated in a different trial. According to their findings, the baseline median values for relative attachment level (RAL), gingival recession,

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022**

and probing depth (PD) did not differ between the test group and control group. The authors concluded that in patients with chronic periodontitis, adjunctive PDT can improve the clinical outcomes of conventional subgingival debridement. Values for RAL, PD, sulcus fluid flow rate (SFFR) and BOP decreased significantly 3 months after treatment in the control group, with a greater impact on the sites treated with adjunctive PDT. [1]

Studies on the impact on oral bacteria

In a study, SRP was used to treat ten patients (aged between 40 and 50) who had active periodontal sites on a total of 253 teeth. According to the study's findings, PDT patients reported a bacterial reduction of 87.57%, which was the highest among all tested individual germs (P 0.05). At seven days, the overall results for all groups improved. Patients receiving PDT showed a notable reduction in bacterial count after one month, at 80.11% ($P > 0.05$), and after three months, at 91.37%. [2] Using a previously described in situ device, a study was done on a 7-day oral plaque biofilm developed on natural enamel surfaces in vivo. The study demonstrated that PDT significantly causes cell death and that the photosensitizer is absorbed into the biofilm's biomass. The treated biofilms also exhibit a distinct structure from the control samples, with no sign of channels and a less dense biomass, and are significantly thinner than the control samples. Transmission electron microscopy (TEM) images of the in vivo-formed plaque biofilms showed unequivocal evidence of significant bacterial damage, cytoplasmic vacuolation, and membrane damage after PDT. These outcomes unequivocally show the PDT's potential benefit in the control of oral biofilms. [3]

Research into how it affects periodontal health

The loss of periodontal tissue that can occur during therapy for periodontal disorders was shown to be significantly reduced when utilising PDT, according to research from So Paulo State University. Compared to other methods, such as SRP and antibiotic therapy, PDT caused the least amount of periodontal tissue damage in a rat population. PDT is also considerably less intrusive than other periodontal disease therapies. By reducing inflammation in the tissues around the teeth and improving dentin hypersensitivity, it can help tissues heal more quickly.

In a 2007 trial, Andersen et al. combined conventional SRP with PDT to treat chronic periodontitis; they found that after 6–12 weeks, there was a considerable decrease in pocket depth, increasing the efficacy of PDT. Additionally, there is a significant reduction in the amount of cementum that needs to be removed, which improves tissue regeneration without raising the risk of hypersensitivity. Additionally, patients with systemic illnesses (including cardiovascular disease, diabetes, and immunosuppression) and those who exhibit significant resistance to antibiotic medication benefit from PDT's antibacterial properties. [6]

Studies on the possibility of anti-inflammatory

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022

Studies that looked at the inflammatory components of periodontal tissue revealed that individuals who had LPT in addition to traditional periodontal therapy had superior outcomes. [1, 8]When used following SRP, LPT has been shown to be effective in reducing inflammatory cells on histology, gingival inflammation, and metalloproteinase 8 (MMP-8) expression. [9]Ozawa et al. demonstrated that LPT considerably reduces the rise in plasminogen activity brought on by mechanical tensile strain in human periodontal ligament cells. [10]Latent collagenase, the enzyme that cleaves collagen fibres, can be activated by plasminogen activity. LPT also successfully prevents the formation of prostaglandin E2 (PGE2). According to research, LPT irradiation inhibits the synthesis of interleukin (IL)-1 and interferon (IFN), while stimulating the production of platelet-derived growth factor (PDGF) and transforming growth factor (TGF). The anti-inflammatory properties of LPT and its beneficial effects on wound healing may result from these modifications. [2]

The healing of wounds

A study found that at 3, 7, and 15 days following surgery, surface epithelization occurred considerably more quickly at sites receiving LPT (4 J/cm 2; = 588 nm) than at control sites. Additionally, full wound healing occurred more quickly (within 18–21 days) in LPT-treated sites compared to control sites (within 19-24 days). LPT may be advantageous in promoting periodontal healing following gingivectomy, scaling, root planing, and intrabony defect surgery, according to the findings from in vivo studies in particular. According to Stein et al., for the first 72 hours following irradiation, LPT has a biostimulatory impact on human osteoblast-like cells. [3] After 30 days of induced bone defect healing, histological investigations utilising animal experimental models have shown that LPT can cause an increase in collagen fibre deposition as well as in the number of well-organized bone trabeculae. [4] A biochemical assay was used to assess the effects of LPT on the bone healing process in surgically formed bone voids. The findings suggested that LPT affects calcium transport during the development of new bones. [5]

Management of pain and sensitivity as a result

LPT has been proposed as an alternate technique for managing postoperative pain. The therapeutic window for LPT's antiinflammatory effect overlaps with its capacity to enhance tissue healing, making it preferable to oral analgesics and nonsteroidal anti-inflammatory medications. According to some scientists, the lipid bilayers caused by LPT and the accompanying integral proteins of the nerve cell membrane may have taken on a more stable conformation, which may have contributed to the stabilisation of the membranes of nerve cells. [7] Several theories are put out to account for the reduction in pain with LPT in Dentinal Hypersensitivity (DH). The development of tertiary dentin and the decrease in sensory nerve activity are primarily responsible for the favourable outcomes. It is hypothesised that LPT mediates an analgesic effect due to the depolarization of C-fiber afferents, even if evidence on the neurophysiological mechanism is not yet conclusive.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022

Implantology photodynamic treatment

In implantology, laser PDT can be used to encourage osseointegration and stop peri-implantitis. Studies have demonstrated that laser photobiomodulation can be utilised to successfully increase the quality of the bone surrounding dental implants, enabling early prosthetic usage. [9] Researchers came to the conclusion that infrared laser photobiomodulation does speed up bone repair after their study's findings revealed substantial differences between the concentration of calcium hydroxyapatite in irradiated and control specimens. [9] With photobiomodulation, the proportion of bone fill and re-osseointegration also increased. [10]

Orthodontics

In a study, the authors sought to determine whether laser therapy may be as effective in treating individuals with facial structures that are prone to growth and developmental deviation as chin cups, face masks, and headgear. The hamsters were divided into three groups of three: Group A, the control group or group with normal development; Group B, the chin-cup group; and Group C, the laser group. In comparison to Group A, both groups B and C's lower jaw growth was slower during the course of the 7-month long study. These discoveries are significant because they raise the possibility of using lasers to alter how human facial structures grow and evolve in the future. [4] A study looked at how patients receiving treatment with fixed appliances perceived discomfort after receiving a single low-level laser therapy (LLLT) irradiation. In this single-blind trial, 76 patients (46 women and 30 men; mean age, 23.1 years) were divided into two groups. The findings demonstrated that the prevalence of pain perception at 6 and 30 h was decreased by LLLT immediately following multibanding. The authors came to the conclusion that LLLT might benefit orthodontic patients not just right away following multibanding but also for reducing pain during therapy. [5]

Treatment and diagnosis of oral lesions

Topical 5-ALA administration is a recent method for diagnosing oral lesions. The differentiation between malignant and nonmalignant lesions is made easier in 5-ALA-mediated photodynamic diagnostics by the difference in the fluorescence ratio between normal and premalignant/malignant tissue. 71 patients with clinically suspected oral leukoplakia were investigated at the Eastman Dental Institute for Oral Healthcare Sciences by the use of fluorescence in the diagnosis of oral leukoplakia. [6] The patients washed their mouths for 15 minutes with a 0.4% solution of 5-ALA three hours before the assessment. Due to the fact that 5-ALA administration causes the fluorescence intensity in malignant tissue to rapidly diminish, this very brief contact with the substance was helpful for diagnosis.

CONCLUSION:

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022**

Although the therapeutic potential of light-based treatments has long been understood, PDT's current growth is attributable to its encouraging outcomes and straightforward clinical approach. PDT is now used mostly in oncological therapy, although it will likely be used in other settings in the future. Due to the relatively recent development of portable and stable light sources, clinical PDT is still expanding. Pre-clinical research has demonstrated that photosensitizers are more hazardous to microbial species than they are to mammalian cells, and that prokaryotic cells experience illumination-based toxicity far sooner than eukaryotic cells. For the treatment of localised and superficial infections, including as mucosal and endodontic infections, periodontal diseases, caries, and peri-implantitis, which are the prospective targets, PACT appears to be the most effective. Because the target tissue is chosen by "marking" it with the photosensitizer and the therapy (laser energy) is active (directed) only on "marked" cells or tissues, the idea of photodynamic laser therapy is particularly appealing. Before researchers can move on with clinical trials and eventually clinical use, it is necessary to define the ideal therapy settings through the development of new photosensitizers, more effective light delivery devices, and additional animal studies

REFERENCE:

1. Ishikawa I, Sasaki KM, Aoki A, Watanabe H. Effects of Er YAG laser on periodontal therapy. J Int Acad Periodontol 2003;5:23-8. [PUBMED]
2. Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martin RA. Photoradiation in acute pain: A systematic review of possible mechanisms of action and clinical effects in randomize placebo-controlled trials. Photomed Laser Surg 2006;24:158-68.
3. Choi BK, Moon SY, Cha JH, Kim KW, Yoo YJ. ProstaglandinE(2) is a main mediator in receptor activator of nuclear factor-kappa ligand-dependent osteoclastogenesis induced by Porphyromonagingivalis, Treponemadenticola, and Treponemasocranskii. J Periodontol 2005;76:813-20. [PUBMED]
4. Groth EB. Treatment of dentin hypersensitivity with low power laser of GaAlAs. J Dent Res 74(3):794, Abstract 163,1995.
5. Chan Y, Lai Ch. Bactericidal effects of different laser wavelengths on periodontopathic germs in photodynamic therapy. Lasers Med Sci 2003;18:51-5.
6. Meisel P, Kocher T. Photodynamic therapy for periodontal diseases: State of the art. J Photochem Photobiol B 2005;79:159-70. [PUBMED]
7. Qadri T, Bohdanecka P, Tuner J, Miranda L, Altamash M, Gustafsson A, et al. The importance of coherence length in laser phototherapy of gingival inflammation: A pilot study. Lasers Med Sci 2007;22:245-51.
8. Pejcic A, Zivkvic V. Histological examination of gingival treated with low-level laser in periodontal therapy. J Oral Laser Appl 2007;71:37-43.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, S Iss 4 ,2022**

9. Ribeiro IW, SbranaMC, Esper LA, Almeida AL. Evaluation of the effect of the GaAlAs laser on subgingival scaling and root planing. Photomed Laser Surg 2008;26:387-91.

10. Ozawa Y, Shimizu N, Abiko Y. Low-energy diode laser irradiation reduced plasminogen activator activity in human periodontal ligament cells. Lasers Surg Med 1997;21:456-63.