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COMPARING THE EFFECT OF DIODE LASER AND OZONE GEL IN POCKET DISINFECTION – A PILOT STUDY

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Objective: This pilot study strives to investigate the efficacy of diode laser and ozone gel in pocket disinfection as adjuncts to scaling and root planing (SRP) in patients with localized moderate periodontitis.

Background: Periodontitis is a common inflammatory disease affecting the tissue that supports the teeth. It is distinguished by periodontal attachment loss and alveolar bone degeneration. Standard non-surgical treatment involves SRP, but adjunctive therapies such as diode laser (photodynamic therapy, PACT) and ozone gel have been explored for enhanced antimicrobial effects.

Materials and Methods:A split-mouth, single-blind, randomized controlled experiment was implemented on 15 patients with localized moderate periodontitis. Each patient underwent SRP, followed by diode laser treatment (PACT) on one pocket and ozone gel on the other. Clinical parameters, including bleeding on probing (BOP), probing depth (PD), plaque index (PI), and clinical attachment level (CAL), were measured at baseline and one month post-treatment.

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Results: Both PACT and ozone groups showed significant reductions in BOP, PD, PI, and CAL after one month ($P<0.001$). At baseline, no significant differences were observed between the two groups. After one month, significant improvements in BOP were noted in the PACT group compared to the ozone group ($P<0.05$). Both groups demonstrated similar improvements in PD, PI, and CAL, with no statistically significant differences between them.

Conclusion: The study revealed that diode laser and ozone gel serve as effective adjuncts to SRP for minimizing periodontal inflammation and improving clinical metrics in patients with chronic periodontitis. However, diode laser therapy showed superior results in reducing bleeding on probing compared to ozone gel.

Clinical Significance: The data imply that implementing diode laser therapy into periodontal treatment procedures may give significant benefits in managing periodontal inflammation, notably in minimizing bleeding during probing. Further studies with larger sample sizes and longer follow-up periods are needed to confirm these findings and establish comprehensive clinical guidelines.

INTRODUCTION -

Periodontitis is a disease that affects the tooth supporting tissues and is characterized by loss of periodontal attachment including alveolar bone. The etiology of the disease is complicated, and bacterial deposits play a substantial role in the pathogenesis.[(2)] Chronic periodontitis is defined as an infectious condition that causes inflammation in the supporting tissues of the teeth, increasing attachment loss, and bone loss.[(3)] This description illustrates the primary clinical and etiological features of the disease: (1) microbial plaque accumulation (2) periodontal inflammation (3) loss of attachment and alveolar bone[(1)]. Key molecular pathways in the disease's pathophysiology have been identified, and these pathways ultimately result to the activation of host-derived proteinase, which facilitates the apical spread of the bacterial biofilm along the root surface, the loss of marginal periodontal ligament fibers, and the apical migration of junctional epithelium.

Clinical manifestations include supragingival and subgingival plaque accumulation, gingival inflammation, pocket formation, periodontal attachment loss, alveolar bone loss, and sporadic suppuration. The deposition of plaque on the surfaces of teeth and gingiva at the dentogingival junction is thought to be the main initiating factor in the development of gingivitis and chronic periodontitis[(2)]. Plaque associated with crevicular epithelial cells suggests that some species, such as S. oralis, S. intermedius, Parvimonas micra, P. gingivalis, Prevotella intermedia, Tanerella forsythia, and F. nucleatum, are more prominent. Scaling and root planing is a gold-standard non-surgical therapy that aims to smooth bacterially contaminated root surfaces and remove dental calculus and plaque[(3)].

While SRP can offer mechanical debridement by direct contact of both hard and soft tissue, the use of a light source such as a laser as an additional tool can offer a deeper penetration of the energy which may eradicate more pathogenes[(5)]. Photodynamic antimicrobial chemotherapy (PACT) is an alternative antibacterial, antiviral and antifungal treatment significantly useful against microbes that are resistant to drug[(4)].The rationale for this is that bacteria cannot evolve a defense mechanism against the cytotoxic

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effects of free radicals or singlet oxygen. Therefore, PACT can also affect the bacteria that are proliferating within the biofilms. Patients with periodontitis can benefit from the administration of low-intensity lasers and wavelength-specific, light-activated molecules that specifically target and eradicate microbial infections, thus alleviating disease symptoms(4). To achieve complete disinfection, photosensitive chemicals are often administered topically to the gingival sulcus area and then irradiated with a laser(6)(7). The bacterial photosensitivity is usually associated with the charge of the sensitizer. Neutral or anionic photosensitizers are said to bind to gram-positive bacteria effectively and to render them inactive. They do not, however, render gram-negative bacteria inactive upon illumination despite their partial binding to their outer membrane(4).In gram-positive species, the photosensitizer diffuses into sensitive regions trough a porous layer of lipoteichoic acid and peptidoglycans outside the cytoplasmic membrane. Gram-negative bacteria have an outer membrane that acts as both a functional and physical barrier separating the cell from its surroundings. The affinity of negatively charged photosensitizers for gram-negative bacteria can be increased by conjugating them with monoclonal antibodies that bind to cell-surface-specific antigens, utilizing membrane-active agents, or attaching the sensitizers to cationic molecules. PDT today presents a broad range of applications in odontology such as management of leukoplakia and pre-neoplastic lesions of the oral cavity(5), for the management of oral complications due to cancer therapy, for the treatment of dentinal hypersensitivity associated to exposed dentin and for the management of halitosis(8).

Ozone has been recognized as one of the best bactericidal, antiviral and antifungal agent.[9] In recent years, a number of therapeutic protocols have been developed with ozone to address dental infections associated with periodontal disease and to control infective microorganisms in dental plaque.[10]. The use of ozonated oils as an intra-canal dressing has been proposed for the treatment of gingivitis and periodontitis. It also lessens the noticeable odour from carious and infected dentin and acute necrotizing ulcerative gingivitis[11]. Ozone can be administered in a number of forms, including gaseous, water, oil, and gel. Ozone exhibits strong oxidative properties and strong antibacterial activity against oral infections. Bacterial cell wall lysis and bacterial cell content extravasation are caused by it. Additionally, it inactivates viruses by leaking into the nucleic acid core of the virus and causing damage to the core of the virus through the protein coat. Ozon has broad-spectrum antibacterial activity. Additionally, ozone appears to benefit the human body's biosynthesis, immunological system, and antihypoxic properties[12]. It enhances the amount of ribosomes and mitochondria in cells, activates the mechanism of protein synthesis, and enhances the metabolism of inflammatory tissues.Vasodilators such as nitric oxide are secreted by ozone, and this leads to the production of vascular endothelial growth factor, which in turn triggers angiogenesis.

MATERIALS AND METHOD

This study was a split mouth study, single blinded, randomized controlled trail. The sample comprised 15 adult patients including 7 females and 8 males who were referred to the department of periodontology at NIMS Dental College and Hospital, jaipur. The sample size was collected according to the data obtained from the previous study. The inclusion criteria consisted of patients older than 18 to 45 years of age with localized moderate periodontitis showing pocket depth of 4-6 mm and with at least 18 teeth present. Patients who received periodontal treatment in last 12 months preceding the

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study, those who consumed immuno-suppressants, antibiotics or anti- inflammatory drugs within the last 3 months and patients with systemic disorders that could affect the results and prognosis of periodontal treatment (such as diabetes mellitus) were excluded from trial. The excluded also include pregnant, patients having partial denture or with any grade of mobility , smokers and alcohol drinkers. The treatment protocol was explained to the patients, and they signed informed consent forms before entering the study.

Treatment protocol

After filling complete medical and periodontal records, all patients received initial periodontal therapy consisting of full mouth supragingival and subgingival scaling using hand instruments and ultrasonic devices with frequency of 6000 Hz and constant water irrigation. After oral rinsing the quadrants were divided into two sides(left and right); one side was randomly selected as group I (SRP + PACT) and other side as group II (SRP + OZONE GEL). The group I and group II were determined randomly using a table of random numbers. The random allocation was concealed in sealed envelopes and was kept by an independent subject who was not involved in the study process.

The periodontal pocket of the teeth on the PACT side was irradiated using a gallium aluminium arsenide (GaAIAs) diode laser along with a 300 microns optical fiber delivery system after the pocket was filled with a photosensitizer tolidine blue reagent using a 2ml syringe. The laser was set at 75mW in continuous mode the fibre tip was initiated on a carbon paper and irradiated for 30s and this step is repeated for 3 times with a 10s interval. The other pocket site is selected and carefully isolated with cotton rolls and thoroughly dried and OZONIL gel is applied carefully subgingivally and interproximally using a 10ml syringe until excess gel is observed from gingival margins. Eventually patient rinsed his/her mouth with saline and was asked to refrain from chewing hard, sticky, sour and spicy foods for 24hrs to avoid pain and irritation, along with avoiding brushing near the gel treated site or using interdental aids.

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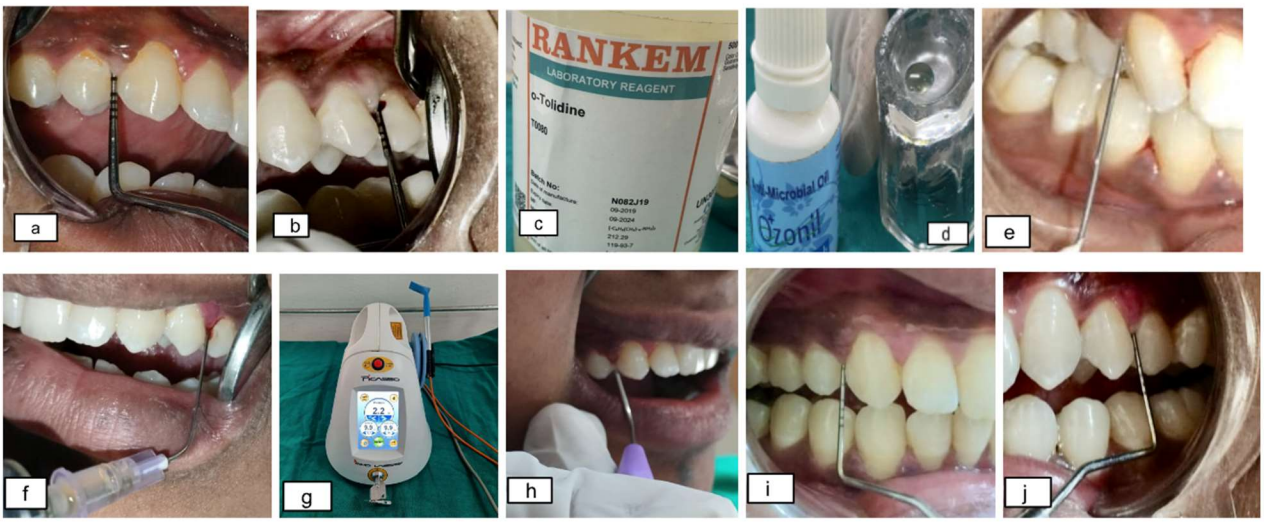

a) & b) pockets of 4 and 5mm seen i.r.t 13 and 24 c) toluidine blue regent d) ozonil gel e) & f) loading toluidine blue and ozone gel in 13 & 24 respectively g) & h) AMD 810 diode laser used for irradiation of the target site i) recall after 1 month

Clinical evaluation:

The clinical measurements were contemplated before the treatment (baseline) and one months after therapy. Four clinical periodontal parameters were measured by a trained and calibrated examiner using a graduated periodontal probe. The subject who assessed the outcomes was not aware of the test and control sides. The periodontal indices evaluated in this study were as follows:

Bleeding on probing (BOP): To determine BOP, the periodontal probe was inserted approximately 2 mm into the gingival sulcus at the buccal and lingual sides of each tooth.
The probe was gradually slid from the distal to the mesial interproximal area. The presence of gingival bleeding was recorded at the distobuccal, mid buccal and mesiobuccal sites as well as the middle area of the lingual surface. Overall, BOP was registered as a yes/no response at 4 sites of every tooth. Finally, the number of sites where bleeding was present was divided by the total number of evaluated sites in the mouth and the result was multiplied by 100 to express the bleeding index as a percentage.

Probing depth (PD): PD is defined as the distance in mm between the free gingival margin and the bottom of the periodontal pocket. A periodontal probe was used to measure the depth of a sulcus or periodontal pocket. The periodontal probe was placed in the gingival
sulcus and entered as far as possible into the pocket parallel to the longitudinal axis of the tooth. The pocket depth was recorded in millimeters at four points of each dental element;
three points at the mesial, middle, and distal of the buccal surface and one point at the middle of the

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lingual/palatal surface.

Plaque index (PI): To determine PI, plaque detection tablets were used and all dental surfaces (except the occlusal surface) were examined for the presence of colored deposits at the dentogingival margin. The PI was calculated by dividing the number of plaque-containing surfaces by the total number of available surfaces (four surfaces per tooth) and multiplying the result by 100.

Clinical attachment level (CAL): CAL is determined by measuring the distance in millimetres from the cementoenamel junction (CEJ) to the bottom of the periodontal pocket using a periodontal probe. This criterion is a manifestation of the clinical adhesion loss of the periodontal fibers. CAL was measured at the same sites described for PD.

Results :
All the patients were followed up until the end of the study. Table presents the clinical parameters in the "SRP plus PACT" and "SRP plus ozone" groups at baseline and at 1 month after. In both groups, there was a significant decrease in BOP, PD, PI and the CAL over the period of the experiment (P<0.001).
At baseline, there was no significant difference in any of the clinical parameters between the two groups (P >0.05). Significant differences between the laser and ozone groups were found in terms of BOP at 1 month of intervention (P <0.05). Regarding the probing depth, plaque index, and clinical attachment level, the difference between the two groups was significant at 1 month after the treatment (P <0.05)
The bleeding on probing at baseline in SRP + laser group is 65.3 ± 0.27 while in SRP+ ozone group is 65.27 ± 0.13 (P < 0.001) while it was significantly reduced to 22.5 ± 0.17 and 31.61 ± 0.13 after 1 month respectively. (P < 0.001)

The clinical attachment loss at baseline in SRP + laser group is 4.98 ± 0.83 while in SRP+ ozone group is 5.15 ± 0.81 (P < 0.001) while it was significantly decreased to 4.37 ± 0.67 and 4.59 ± 0.72 after 1 month respectively. (P < 0.001).
The plaque index at baseline in SRP + laser group is 70.91 ± 0.18while in SRP+ ozone group is 71.52 ± 0.16 (P < 0.001) while it was significantly lowered to 46.83 ± 0.18 and 46.86 ± 0.16 after 1 month respectively. (P < 0.001)

The probing pocket depth at baseline in SRP + laser group is 4.71 ± 0.92 while in SRP+ ozone group is 4.88 ± 0.89 (P < 0.001) while it was significantly improved to 4.1 ± 0.76 and 4.34 ± 0.78 after 1 month respectively. (P < 0.001)

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Clinical parameters	**Baseline**		**After 1 month**	
	SRP + LASER	**SRP + OZONE**	**SRP + LASER**	**SRP + OZONE**
Bleeding on probing (BOP)	65.3 ± 0.27	65.27 ± 0.13	22.5 ± 0.17	31.61 ± 0.13
	P < 0.001		P < 0.001	
Clinical attachment level (mm ± SD)	4.98 ± 0.83	5.15 ± 0.81	4.37 ± 0.67	4.59 ± 0.72
	P < 0.001		P < 0.001	
Plaque index (Mean ± SD)	70.91 ± 0.18	71.52 ± 0.16	46.83 ± 0.18	46.86 ± 0.16
	P < 0.001		P < 0.001	
Periodontal probing depth (mm ± SD)	4.71 ± 0.92	4.88 ± 0.89	4.1 ± 0.76	4.34 ± 0.78
	P < 0.001		P < 0.001	

Discussion

The gold standard treatment for periodontal disorders is scaling and root planing along with concurrent use of antibiotics and/or antiseptics[(13)]. Different bacterial accumulations in the subgingival pockets cause periodontitis to start and worsen. Mechanical methods can be used to eradicate the subgingival microorganisms. The fundamental intent of periodontal therapy is to eliminate biofilm from the surface of the teeth.[(14)]. It is challenging to access the germs beneath the gingiva due to the intricate structure of the root and furcation regions. Because of this, it is impossible to completely eradicate bacterial germs using the mechanical method; instead, adjuvant therapies have been suggested to help remove plaque and bacteria[(15,16)]. One of the adjunctive treatments is the administration of antibiotics. It has been demonstrated that antibiotics either systemic or local are effective in the reduction of periodontal pathogens [(15,17)].

Periodontal therapy can be broken down into three approaches: surgical or non-surgical treatment for existing periodontitis, and preventive for non-formed periodontitis [(18)]. Surgical perio therapy is based on the principle of eliminating infected tissues and altering the surroundings to create the ideal conditions for the healing process while providing strict maintenance monitoring[19]. The non-surgical treatment was determined by the bacteriological results and the susceptible microorganisms to the antimicrobial medications administered[20]. The major goal of present study was to compare the efficacy of photodynamic therapy to ozone gel in pocket disinfection in addition to SRP. Intergroup and intragroup difference at the various times have been conducted in order to assess which chemical

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compound could be more beneficial for the treatment of periodontitis in addition to SRP. The null hypothesis of the study were that no significant intergroup and intragroup differences occur between the laser and ozone group.

In 1990, **Raab et al** suggested photodynamic antimicrobial chemotherapy, often known as photoradiation treatment, phototherapy, or photochemical therapy[21]. **Allison et al** identified aPDT as a medication and light-based therapy [22]
PACT comprises three components.:[6]

I. Lightsource

II. Photosensitizer

III. Free radical and singlet oxygen

The photosensitizer transitions from a low energy state to a highly energized triple state upon stimulation by its corresponding wavelength. The photosensitizer reacts with the medium's molecules and the oxygen in the tissues owing to the triple state's long half-life [23]. The singlet oxygen and free radicals are produced which lead to tissue damage [24]. The short half-life (0.04μs) and constrained effect radius (0.02μm) of the cytotoxic products are characteristic. O2 migration from the production site is limited, therefore the photosensitizer's localization and aggregation site determine the principal cell damage location. As a result PACT is perfect for local application without damage to cells further away [25].

Advantages of the use of aPDT in periodontal treatments [24]

1. Bacterial resistance to PACT is unlikely because singlet oxygen and free radicals interact with various cellular structures and in different metabolic processes.
2. PACT is a local, non-invasive approach that does not damage the tissues or microflora around the target territory.
3. PACT minimizes non-accessible bacteria in periodontal pockets in a short time, benefiting both the practitioner and the patient.
4. The risk of bacteremia is minimal after periodontal therapy with PACT.
5. There is no need for antibiotic prescription.
6. There is no prerequisite for local anesthetics, and microbial damage occurs in less than 60 seconds.

Over the last few years, the use of ozone in medicine has significantly raised due to its recognized properties. Ozone reacts with numerous chemical compounds in two different and coexisting modes: direct molecular ozone reactions and free radical-mediated reactions[26]. The manner in which that ozone destroys bacteria could entail both of these strategies. There are several approaches to delivering ozone; however, it cannot be kept in water since it becomes exceedingly unstable and breaks down quickly through a complicated sequence of reactions[27,28]. Its lifespan, on the other hand, may be

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estimated in years when it dissolves in an oil base. When it integrates chemically with oil, generates long and intricate molecules[29]. Ozonated olive oil was subsequently chosen for this investigation rather than ozonated water because it was discovered that the oil application resulted in a prolonged stay in the oral cavity, sufficient medication permeation, excellent efficacy, and approval [30], on top of the possible advantages of omega-3 fatty acids found in olive oil as a host modulatory agent for the adjunctive treatment of periodontitis [31].

Given that ozone peroxidizes phospholipids, Ozone disintegrates the integrity of the envelope, which explains its potent antibacterial capabilities[32]. Furthermore, because ozone inhibits the NF-kappa B system, it has strong anti-inflammatory properties and can halt the activity of disease[33].In addition, ozone reacts with diverse chemical compounds in aqueous systems in two unique and simultaneous ways i.e directly through molecular ozone reactions and indirectly through free radical-mediated reactions. Both of these mechanisms may be involved in the destruction of bacteria by ozone[34].

In this study, both the PACT and ozone groups showed a significant decrease in the pocket depth (PD) and plaque index (PI) following the treatment. However, the difference between the two groups was small and not statistically significant. The pocket depth is generally between 1 and 3 mm in a healthy periodontium. Pockets deeper than 4 mm indicate periodontitis and cannot be efficiently cleaned. The PI is employed to estimate the status of oral hygiene by measuring the dental plaque located around the gingival margin.

Bleeding on probing (BOP) is a manifestation of inflammation. It is a very popular and commonly-used criterion to diagnose gingivitis and periodontitis and identify the sites at risk for periodontal breakdown. In the present study, a significant decrease in the BOP index was observed in both the ozone and the aPDT groups. For the ozone group, the reduction in BOP index was 52% after 1month of treatment respectively, whereas it was 66% in SRP + PACT group. The between-group comparison revealed that BOP was significantly lower in the quadrants that underwent SRP + PACT treatment, as compared to those that received SRP + ozone. This improvement may be attributed to decreased inflammation due to the eradication of periodontal pathogens and the elimination of the infected sulcular epithelium and granulation tissue from the periodontal pockets. The clinical attachment level (or loss, CAL) is another measurement of the extent of the periodontal support and refers to the pathological detachment of connective tissue from the cementum surface. CAL is a more accurate indicator of the periodontal support around a tooth than the probing depth alone. CAL is measured from an unchangeable point on the tooth surface, the CEJ. The outcome of the study revels that group treated with photodynamic therapy as adjunt to mechanical instrumentation of root surface (SRP) has significant impact on BOP when compared to the group treated with ozone gel. CAL on the other hand has small but significant improvement after the treatment in both SRP+ PACT and SRP + ozone group. However no significant difference was between the two groups at the assigned interval.

While PI and Probing depth has not shown any remarkable advantages when compared between photodynamic therapy and ozone therapy.

Conclusion: The study revealed that diode laser and ozone gel serve as effective adjuncts to SRP for minimising periodontal inflammation and improving clinical metrics in patients with chronic periodontitis. However, diode laser therapy showed superior results in reducing bleeding on probing

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http://magellanes.com/

compared to ozone gel.

Reference-

1. Carranza clinical periodontology volume I [11th edition-pg.no. 207]
2. Albandar JM, Streckfus CF, Adesanya MR, Winn DM. Cigar pipe and cigarette smoking as risk factor for periodontal disease and tooth loss. *J Periodontol.* 2000;71:1874–81.
3. El Mobadder, M.; Nammour, S.; Namour, M.; Namour, A.; Grzech-Les´niak, K. Disinfection Potential of 980 nm Diode Laser and Hydrogen Peroxide (3%) in "Critical Probing Depths" Periodontal Pockets: Retrospective Study. *Life* 2022, *12*, 370.
4. Shalu Bathla Periodontics revisited [pg.no. 496-498]
5. Di stasio, D; Romano, A.; Gentile, C.; Lucchese,A.; Serpico, R.; Paparella, R.;Minervini, G.; Candotto, V.; Laino, L. Systemic and topical photodynamic therapy (PDT) on oral mucosa lesions: An overview. *J. Biol. Regul. Homeost. Agents* **2018**, 32,123-126.
6. Moslemi N, Heidari M, Bouraima SA. Antimicrobial photodynamic therapy as an adjunctive modality in the treatment of chronic periodontitis. J Lasers Med Sci. 2012;3(4): 141-6
7. Chan y, Lai CH. Bactericidal effects of different laser wavelengths on periodontopathic germs in photodynamic therapy. Lasers Med Sci. 2013;18(1):51-5
8. Motta, P.d.B.; Motta, L.J.; Campos, T.M.; Gonçalves, M.L.L.; Santos, E.M.; Martimbianco, A.L.C.; de Andrade, D.J.C.; Mesquita-Ferrari, R.A.; Fernandes, K.P.S.; Horliana, A.C.R.T.; et al. Effect of Photodynamic Therapy on Halitosis: A Systematic Review of Randomized Controlled Trials. *Sensors* **2022**, *22*, 469.
9. Smith, N.L.; Wilson, A.L.; Gandhi, J.; Vatsia, S.; Khan, S.A. Ozone therapy: An overview of pharmacodynamics, current research, and clinical utility. *Med. Gas. Res.* **2017**, *7*, 212–219.
10. Nagayoshi, M.; Fukuizumi, T.; Kitamura, C.; Yano, J.; Terashita, M.; Nishihara, T. Efficacy of ozone on survival and permeability of oral microorganisms. *Oral Microbiol. Immunol.* **2004**, *19*, 240–246.
11. Aerts, O.; Leysen, J.; Horst, N.; Lambert, J.; Goossens, A., Contact dermatitis caused by pharmaceutical ointments containing 'ozonated' olive oil. *Contact Dermat.* **2016**, *75*, 123–126.
12. Srikanth, A., Sathish, M. & Sri Harsha, A. V. Application of ozone in the treatment of periodontal disease. J. Pharm. Bioallied Sci. 5(Suppl 1), S89–S94 (2013).
13. Colombo M, Gallo S, Garofoli A, Poggio C, Arciola CR, Scribante A. Ozone gel in chronic periodontal disease: A randomized clinical trial on the anti-inflammatory effects of ozone application. Biology. 2021 Jul 6;10(7):625.
14. Mokhtari MR, Ahrari F, Dokouhaki S, Fallahrastegar A, Ghasemzadeh A. Effectiveness of an 810-nm diode laser in addition to non-surgical periodontal therapy in patients with chronic periodontitis: a randomized single-blind clinical trial. Journal of Lasers in Medical Sciences. 2021;12.
15. Smiley CJ, Tracy SL, Abt E, Michalowicz BS, John MT, Gunsolley J, Cobb CM, Rossmann J, Harrel SK, Forrest JL, Hujoel PP. Systematic review and meta-analysis on the nonsurgical treatmentof chronic periodontitis by means of scaling and root planing with or without adjuncts. The Journal of the American Dental Association. 2015 Jul 1;146(7):508-24.

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

16. Faveri M, Gursky LC, Feres M, Shibli JA, Salvador SL, De Figueiredo LC. Scaling and root planing and chlorhexidine mouthrinses in the treatment of chronic periodontitis: A randomized, placebo-controlled clinical trial. Journal of clinical periodontology. 2006 Nov;33(11):819-28.
17. Birang R, Shahaboui M, Kiani S, Shadmehr E, Naghsh N. Effect of nonsurgical periodontal treatment combined with diode laser or photodynamic therapy on chronic periodontitis: a randomized controlled split-mouth clinical trial. Journal of lasers in medical sciences. 2015;6(3):112.
18. Miliauskaite A, Selimovic D, Hannig M. Successful management of aggressive periodontitis by regenerative therapy: A 3-year follow-up case report. Journal of periodontology. 2007 Oct;78(10):2043-50.
19. Ramfjord SP, Cafesse RC, Morrison EC, Hill RW, Kerry GS, Appleberry EA. A comparative study of 4 types of periodontal treatment. 5 years observations. J Clin Periodontal. 1987;14:445e52.
20. Emingil G, Atilla G, Sorsa T, Luoto H, Kirilmaz L, Baylas H. The effect of adjunctive low-dose doxycycline therapy on clinical parameters and gingival crevicular fluid matrix metalloproteinase-8 levels in chronic periodontitis. Journal of periodontology. 2004 Jan;75(1):106-15.
21. Raab O. On the effect of fluorescent substances on infusoria. Z Biol. 1900;39:524-6.
22. Allison RR, Bagnato VS, Cuenca R, Downie GH, Sibata CH. The future of photodynamic therapy in oncology.
23. Ochsner M. Photophysical and photobiological processes in the photodynamic therapy of tumours. Journal of Photochemistry and Photobiology B: Biology. 1997 May 1;39(1):1-8.
24. Raghavendra M, Koregol A, Bhola S. Photodynamic therapy: a targeted therapy in periodontics. Australian dental journal. 2009 Sep;54:S102-9.
25. Moan J, Berg K. The photodegradation of porphyrins in cells can be used to estimate the lifetime of singlet oxygen. Photochemistry and photobiology. 1991 Apr;53(4):549-53.
26. Shoukheba MY, Ali SA. The effects of subgingival application of ozonated olive oil gel in patient with localized aggressive periodontitis. A clinical and bacteriological study. Tanta Dental Journal. 2014 Apr 1;11(1):63-73.
27. Hoigne J, Bader H. The role of hydroxyl radical reactions in ozonation processes in aqueous solutions. Water research. 1976 Jan 1;10(5):377-86.
28. Shin WT, Mirmiran A, Yiacoumi S, Tsouris C. Ozonation using microbubbles formed by electric fields. Separation and purification technology. 1999 May 3;15(3):271-82.
29. Cruz O, Menedez S, Martinez ME, Clavera T. Application of ozonized oil in the treatment of alveolitis. In2nd International Symposium on Ozone Applications Havana, Cuba 1997.
30. Jain N, Jain GK, Javed S, Iqbal Z, Talegaonkar S, Ahmad FJ, Khar RK. Recent approaches for the treatment of periodontitis. Drug discovery today. 2008 Nov 1;13(21-22):932-43.
31. Rosenstein ED, Kushner LJ, Kramer N, Kazandjian G. Pilot study of dietary fatty acid

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

supplementation in the treatment of adult periodontitis. Prostaglandins, leukotrienes and essential fatty acids. 2003 Mar 1;68(3):213-8.

32. Ünsal E, Walsh TF, Akkaya M. The effect of a single application of subgingival antimicrobial or mechanical therapy on the clinical parameters of juvenile periodontitis. Journal of Periodontology. 1995 Jan;66(1):47-51.

33. MI R GH, MI M ZB. Management of aggressive periodontitis using ozonated C. 2005;6(1):229-45.

34. Staehelin J, Hoigne J. Decomposition of ozone in water in the presence of org promoters and inhibitors of radical chain reactions. Environmental science & tech Dec;19(12):1206-13.