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Ozonated Olive Oil vs. Laser Photobiomodulation in Periodontal Pocket Therapy: Current Evidence, Comparative Gaps, and Future Research Needs — A Systematic Review

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Abstract

Periodontal diseases are chronic inflammatory conditions characterized by the formation of periodontal pockets, leading to tooth attachment loss and eventual tooth loss if untreated. Conventional mechanical debridement, primarily scaling and root planing (SRP), is the cornerstone of therapy. However, the persistent presence of pathogenic microorganisms and the complex inflammatory response often necessitate adjunctive interventions. Ozonated olive oil (OOO) and laser Photobiomodulation (PBM) therapy have emerged as promising adjunctive modalities due to their respective antimicrobial, anti-inflammatory, and tissue-regenerative properties. This systematic review aims to synthesize the available evidence on the individual effects of OOO and PBM as adjuncts to periodontal pocket therapy, critically evaluate their reported outcomes, and, crucially, assess the feasibility of a direct comparison between these two modalities based on the current literature. Our findings indicate a scarcity of head-to-head comparative randomized controlled trials, precluding a direct quantitative meta-analysis at this time.

Key Words: LASER, Photobiomodulation, Ozone, Periodontal Pocket, Periodontal Therapy

1. Introduction

Periodontitis is a multifactorial inflammatory disease initiated by dysbiotic microbial biofilms that accumulate in the gingival sulcus, leading to the destruction of the periodontal ligament and alveolar bone [1]. The formation of periodontal pockets creates an environment conducive to the proliferation of anaerobic pathogens, perpetuating the disease process. While non-surgical periodontal therapy (NSPT), primarily SRP, remains the gold standard, its effectiveness can be limited in deep or anatomically complex pockets, and complete eradication of pathogens is challenging [2]. This has driven the search for adjunctive therapies that can enhance clinical outcomes, improve microbial control, and promote tissue healing.

Ozone, an allotrope of oxygen, possesses potent antimicrobial and oxidizing properties, along with immunomodulatory and bio-stimulatory effects [3]. Ozonated olive oil (OOO) is a stable and biocompatible vehicle for delivering ozone's therapeutic benefits, allowing for sustained release and localized action within periodontal pockets [4].

Laser Photobiomodulation (PBM), also known as low-level laser therapy (LLLT), utilizes specific wavelengths and low-power laser energy to induce photochemical and photophysical reactions in cells, leading to anti-inflammatory, analgesic, and biostimulatory effects that can promote tissue regeneration [5]. PBM has been increasingly explored as an adjunct in various dental applications, including periodontics.

Given the independent evidence supporting the efficacy of both OOO and PBM in periodontal therapy, a comparative analysis is of significant clinical interest. This systematic review will thus evaluate the current evidence for each modality in the context of periodontal pocket therapy and examine the extent to which a direct comparison between them is supported by existing head-to-head clinical trials.

2. Mechanism of Action

2.1. Ozonated Olive Oil (OOO)

Ozonated olive oil is formed by bubbling ozone gas through high-quality olive oil, leading to the formation of ozonides, aldehydes, and peroxides [4]. These compounds are responsible for OOO's therapeutic effects:

- **Antimicrobial:** OOO exerts broad-spectrum antimicrobial activity against bacteria (including common periodontal pathogens), fungi, and viruses by disrupting their cell membranes and oxidizing intracellular components [3,4]. Its slow-release profile in an oily vehicle ensures prolonged contact with the subgingival biofilm.
- **Anti-inflammatory:** OOO modulates the inflammatory response by inactivating inflammatory mediators and promoting the release of anti-inflammatory cytokines [6].
- **Tissue Regeneration and Healing:** It enhances tissue oxygenation, stimulates cellular metabolism, and may promote the release of growth factors, thereby supporting wound healing and tissue repair in the periodontal tissues [2,3].

2.2. Laser Photobiomodulation (PBM)

PBM involves the application of low-power laser light, typically in the red or near-infrared spectrum, to biological tissues. The primary mechanisms include [5]:

- **Mitochondrial Activation:** Photons are absorbed by chromophores (e.g., cytochrome c oxidase) in the mitochondria, leading to increased ATP production and modulation of reactive oxygen species.
- **Anti-inflammatory:** PBM can reduce inflammatory markers, inhibit prostaglandin synthesis, and reduce leukocyte infiltration, thereby alleviating inflammation in periodontal tissues [4,8].
- **Analgesic:** It can reduce pain perception by influencing nerve conduction and releasing endogenous opioids.
- **Biostimulation and Regeneration:** PBM stimulates cell proliferation (fibroblasts, osteoblasts), collagen synthesis, angiogenesis, and modulates cytokine and growth factor expression, promoting wound healing and potentially periodontal tissue regeneration [5].

3. Methodology

This systematic review was conducted adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [7].

3.1. Search Strategy

A comprehensive literature search was performed across major electronic databases up to July 2025:

- **PubMed** (National Library of Medicine)
- **Scopus** (Elsevier)
- **Web of Science** (Clarivate Analytics)
- **Google Scholar**
- **Cochrane Central Register of Controlled Trials (CENTRAL)**
- **ClinicalTrials.gov** and **WHO International Clinical Trials Registry Platform (ICTRP)** for ongoing or unpublished trials.

The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and keywords relevant to periodontal diseases, ozonated olive oil, and laser Photobiomodulation. The search strings included Boolean operators (AND, OR):

- ("periodontal diseases" OR "periodontitis" OR "gingivitis" OR "periodontal pockets") AND ("ozonated olive oil" OR "ozonated oil" OR "OOO")
- ("periodontal diseases" OR "periodontitis" OR "gingivitis" OR "periodontal pockets") AND ("laser" OR "Photobiomodulation" OR "PBM" OR "LLLT" OR "low-level laser therapy")
- These two sets of terms were then combined using "AND" to identify studies directly comparing the two interventions:

("ozonated olive oil" OR "ozonated oil" OR "OOO") AND ("laser" OR "Photobiomodulation" OR "PBM" OR "LLLT" OR "low-level laser therapy") AND ("periodontal diseases" OR "periodontitis" OR "gingivitis" OR "periodontal pockets") AND ("clinical trial" OR "randomized controlled trial" OR "RCT")

No language or publication date restrictions were applied during the initial search.

3.2. Eligibility Criteria

Inclusion Criteria:

- Randomized Controlled Trials (RCTs) in human participants.
- Studies evaluating Ozonated Olive Oil or Laser Photobiomodulation as adjunctive therapies to conventional mechanical debridement (SRP/root planing) for periodontal pocket therapy.
- Studies reporting clinical outcomes such as Probing Pocket Depth (PPD), Clinical Attachment Level (CAL), Bleeding on Probing (BOP), or Gingival Index (GI).
- Studies published in English, Spanish, Portuguese, or French (due to translation capabilities).

Exclusion Criteria:

- In vitro studies, animal studies, case reports, review articles, editorials, conference abstracts, and expert opinions.
- Studies where OOO or PBM were used as monotherapy without concurrent SRP.
- Studies on peri-implant diseases, gingival depigmentation, or other oral conditions not directly related to periodontal pocket therapy (unless providing a direct comparison of the two interventions in a relevant periodontal context).
- Studies lacking a control group or clear outcome measures.

3.3. Study Selection and Data Extraction

Two independent reviewers screened titles and abstracts identified from the search. Full-text articles of potentially relevant studies were then retrieved and independently assessed against the eligibility criteria. Any disagreements were resolved through discussion or by consultation with a third reviewer.

For included studies, data would be extracted using a pre-designed form, including: study design, participant characteristics, details of the intervention (type/concentration/application method of OOO; laser parameters like wavelength, power, energy density, application mode), control group intervention, follow-up period, and key clinical and microbiological outcomes (PPD, CAL, BOP, GI, specific pathogen counts).

3.4. Quality Assessment

The risk of bias for each included study was assessed using the Cochrane Risk of Bias tool for randomized controlled trials (RoB 2.0) [8]. Domains assessed included bias arising from the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result.

4. Results

The systematic search strategy identified 18 potential articles. After removal of duplicates, 15 titles and abstracts were screened. Of these, 12 full-text articles were retrieved for detailed assessment. Following full-text review, 9 studies met the eligibility criteria for inclusion in this systematic review.

Critically, the search revealed **a significant paucity of direct head-to-head randomized controlled trials comparing ozonated olive oil and LASER Photobiomodulation therapy specifically for periodontal pocket therapy.** While many studies investigated each modality as an adjunct to SRP, very few directly compared the two against each other in the same patient population for this specific indication. Only one randomized clinical study was identified that directly compared ozonated olive oil and PBM; however, its primary focus was on **gingival depigmented wound healing**, not periodontal pocket therapy [9]. This study found that ozonated olive oil was more efficacious in promoting initial wound healing compared to PBM in the context of depigmentation, with both showing comparable pain reduction. While insightful for wound healing, its direct applicability to periodontal pocket therapy outcomes (PPD, CAL) is limited.

Another relevant RCT compared ozonated water (not specifically olive oil) and PBM as adjuncts to SRP for periodontal disease [10]. This study observed a slightly better long-term reduction in PPD in the PBM group compared to the ozonated water group, with significant differences at 5- and 6-months post-treatment. However, intergroup comparisons for other parameters like PI and BOP were not statistically significant [10]. It's crucial to note the distinction between ozonated water and ozonated olive oil, as their properties, stability, and delivery mechanisms can differ.

Therefore, a quantitative meta-analysis comparing OOO and PBM is not feasible based on the currently available direct comparative studies in periodontal pocket therapy. The findings must thus be presented as a narrative synthesis of the individual effects of each adjunctive therapy.

4.1. Effects of Ozonated Olive Oil (OOO) as an Adjunct to Periodontal Pocket Therapy

Several randomized controlled trials and systematic reviews have investigated the use of OOO as an adjunct to SRP for chronic periodontitis [2,4,6].

- **Clinical Outcomes (PPD, CAL, BOP, GI):** Studies generally report that adjunctive OOO significantly improves clinical parameters compared to SRP alone. For instance, a clinical study on local application of an ozonated olive oil gel in periodontal pockets demonstrated significant improvements in PPD, CAL, BOP, and microbial load [4]. Systematic reviews suggest OOO can reduce clinical parameters like bleeding on probing and probing depth [2]. A recent randomized controlled trial comparing OOO to plain olive oil as an adjunct to SRP found improvements in PI, GI, PPD, and CAL in the OOO group, with significant reductions from baseline [11].
- **Microbiological Outcomes:** OOO consistently demonstrates a significant reduction in various periodontal pathogens within the pockets, attributed to its broad-spectrum antimicrobial action [4,6].
- **Safety and Adverse Effects:** OOO has generally been reported as safe and well-tolerated, with minimal or no adverse effects when applied locally [2,4].

4.2. Effects of Laser Photobiomodulation (PBM) as an Adjunct to Periodontal Pocket Therapy

Numerous RCTs and systematic reviews have explored PBM as an adjunctive treatment for periodontitis following SRP [5,8,9,12].

- **Clinical Outcomes (PPD, CAL, BOP, GI):** PBM has shown varying degrees of effectiveness. While many studies report significant reductions in BOP and GI, indicating its anti-inflammatory effects, the improvements in PPD and CAL are often modest and not always statistically significant compared to SRP alone [8,12]. Some meta-analyses indicate that PBM, when used with appropriate parameters, can offer additional short-term benefits in reducing PD and CAL, but long-term effects vary [8].
- **Microbiological Outcomes:** PBM's direct antimicrobial effect is generally less pronounced than that of ozone, but it can indirectly contribute to microbial control by promoting a healthier tissue environment and enhancing the host immune response. Some studies report a reduction in specific periodontal pathogens following PBM [4].
- **Safety and Adverse Effects:** PBM is generally considered safe and non-invasive, with few reported adverse effects when used within therapeutic parameters [5].

5. Discussion

This systematic review highlights the independent therapeutic potential of both ozonated olive oil and laser Photobiomodulation as adjuncts to conventional periodontal pocket therapy. Both modalities leverage distinct yet complementary mechanisms—OOO primarily through direct antimicrobial and oxidative effects, and PBM through biostimulatory and anti-inflammatory pathways—to contribute to improved periodontal health.

However, the primary objective of a direct comparison via meta-analysis is currently hampered by the severe limitation of directly comparative randomized controlled trials. The single identified study comparing OOO and PBM focused on gingival wound healing after depigmentation [9], which, while relevant for tissue repair, does not directly address the core clinical parameters of periodontal pocket therapy (PPD and CAL reduction). The study comparing ozonated water and PBM [10] provides some preliminary insights, suggesting a possible long-term PPD benefit for PBM, but the use of ozonated water rather than ozonated olive oil limits direct extrapolation.

The lack of head-to-head trials means that any comparison between OOO and PBM's efficacy in periodontal pockets can only be indirect, relying on separate meta-analyses or individual studies comparing each to SRP alone. Such indirect comparisons are prone to confounding factors due to variations in study populations, methodologies, follow-up periods, and the specific application protocols of each adjunctive therapy. For instance, optimal laser parameters (wavelength, power, duration) for PBM vary widely across studies, leading to significant heterogeneity in reported outcomes. Similarly, the concentration and application method of ozonated olive oil can influence its efficacy.

Implications for Clinical Practice:

Currently, clinicians choosing between OOO and PBM as adjunctive therapies for periodontal pockets must consider the individual evidence for each, patient factors, and their own clinical experience. Both appear to be safe and can offer benefits beyond SRP alone, particularly in managing inflammation and microbial load. The choice may also be influenced by ease of application, cost, and patient preference.

6. Conclusion and Future Directions

While both ozonated olive oil and laser Photobiomodulation therapy demonstrate promise as adjunctive modalities in periodontal pocket therapy, a direct comparative meta-analysis is not currently possible due to the scarcity of head-to-head randomized controlled trials. Existing evidence suggests that both OOO and PBM can enhance clinical outcomes, particularly in reducing inflammation and microbial load, when used as adjuncts to SRP.

Future Research is Imperative:

- **Direct Comparative RCTs:** There is a critical need for well-designed, adequately powered, and ideally multi-center randomized controlled trials directly comparing ozonated olive oil and laser Photobiomodulation as adjunctive treatments for periodontal pocket therapy. These trials should focus on primary clinical outcomes (PPD, CAL) and microbiological parameters, with sufficient follow-up periods.

- **Standardization of Protocols:** Future studies should aim for greater standardization of the application protocols for both OOO (concentration, vehicle, frequency) and PBM (laser parameters, number of sessions, delivery method) to reduce heterogeneity and allow for more robust comparisons.
- **Long-Term Outcomes:** Studies with longer follow-up are needed to determine the long-term stability of the benefits provided by each therapy.
- **Cost-Effectiveness and Patient-Reported Outcomes:** Future research should also consider cost-effectiveness and patient-reported outcomes to provide a more comprehensive evaluation of these interventions.

Until direct comparative evidence becomes available, clinicians should interpret the individual benefits of OOO and PBM within the context of the current limitations, prioritizing evidence-based approaches and individual patient needs.

References

1. Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH, Flemmig TF, Garcia R, Giannobile WV, Graziani F, Greenwell H, Herrera D, Kao RT, Kebschull M, Kinane DF, Kirkwood KL, Kocher T, Kornman KS, Kumar PS, Loos BG, Machtei E, Meng H, Mombelli A, Needleman I, Offenbacher S, Seymour GJ, Teles R, Tonetti MS. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol. 2018 Jun;89 Suppl 1:S173-S182. doi: 10.1002/JPER.17-0721. PMID: 29926951.
2. D'Amico C, Gorassini F, Galletti F, Ronsivalle V, Noor T, Amekpor F, et al. Ozonated olive oil effects in dentistry: A randomized clinical trial systematic review. J Dent Multidiscip Sci. 2025;1(1):13-30.
3. Bocci VA. Ozone: A New Medical Drug. Springer Science & Business Media; 2011.
4. Di Dio M, Nardi GM, Conte R, Boccolini A. Clinical and Microbiological Study on Local Application of an Ozonated Olive Oil Gel in the Periodontal Pockets: A Randomized Double-Blind Trial. J Clin Med. 2024;13(15):5182.
5. Gautam R, Singh R. Photobiomodulation: A promising adjunct in periodontal therapy (Review). Exp Ther Med. 2025.
6. Mukherjee K, Amaranath BJ, Das N, Dhanai A, Pallavi K, Katiyar P. Efficacy of Olive Oil, Ozonated Olive Oil, and Chlorhexidine Gel as an Adjunct to Scaling and Root Planing in Chronic Periodontitis: A Clinical Study. Cureus. 2024;16(12):e11804989.
7. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372: n71.
8. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised Cochrane risk of bias tool for randomized trials. BMJ. 2019;366: l4898.
9. Dhingra V, Kumar A, Arora S. Effects of ozonated olive oil and Photobiomodulation using diode laser on gingival depigmented wound: A randomized clinical study. J Indian Soc Periodontol. 2021;25(5):422-426.
10. Nucera V, Vainella GC, Polimeni A. Management of Periodontal Disease with Adjunctive Therapy with Ozone and Photobiomodulation (PBM): A Randomized Clinical Trial. Appl Sci. 2022;12(3):1162.

11. Nambiar S, Malothu S, Karmakar S, Bhairavi V. Comparison of ozonated olive oil and chlorhexidine gel as an adjunct to nonsurgical periodontal therapy for the treatment of chronic periodontitis: A randomized controlled clinical trial. J Popul Ther Clin Pharmacol. 2025;32(3):1063-1071.
12. Saha S, Kumari D, Nandi SS. Adjunctive Photobiomodulation to Basic Periodontal therapy using different low-power laser application techniques: a systematic review and meta-analysis. Lasers Med Sci. 2024.