
Photobiomodulation Therapy In Enhancing Soft Tissue Healing For Aesthetic Procedures: A Systematic Review

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Abstract

Photobiomodulation Therapy (PBMT) has emerged as a promising non-invasive adjunct to accelerate soft tissue healing and improve aesthetic outcomes in cosmetic dental procedures. However, clinical evidence remains heterogeneous, with inconsistent laser parameters and limited comparative data on aesthetic endpoints. This study aimed to evaluate the clinical effectiveness of PBMT in enhancing soft tissue healing and aesthetic outcomes relative to conventional methods in aesthetic dentistry. It employed a systematic review design following the PRISMA 2020 guidelines, using a PICOS framework to search SpringerLink, ScienceDirect, and PubMed for English-language articles (2020–2025) involving human or animal studies on PBMT and oral soft tissue aesthetics. Seven studies met the inclusion criteria and were analyzed using narrative synthesis without meta-analysis due to high heterogeneity. Inclusion criteria specified open-access full-text articles on gingival contouring, implant surgery, soft tissue grafting, and related procedures, with outcome data on epithelialization, angiogenesis, pain, patient satisfaction, color, and texture. Quality assessment was performed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools. The results show that PBMT consistently improves epithelialization, reduces postoperative pain, enhances tissue color and texture, and increases patient satisfaction, while minimizing hypertrophic scar risk. In conclusion, PBMT accelerates soft tissue healing and aesthetic recovery, though parameter standardization is needed.

Keywords: Aesthetic Dentistry, Gingival Healing, Photobiomodulation Therapy, Soft Tissue Healing, Systematic Review.

INTRODUCTION

Aesthetic dental procedures, such as gingival contouring, implant surgery, and periodontal plastic operations, increasingly prioritize optimal soft tissue healing to ensure long-term aesthetic and functional success. The biological integrity of gingival and mucosal tissues is crucial for achieving color harmony, stability, and patient comfort post-intervention, yet conventional protocols often lead to postoperative inflammation, delayed epithelialization, and discomfort (Azhibekov *et al.*, 2024)(Pereira *et al.*, 2025). Recent advancements highlight Photobiomodulation Therapy (PBMT), formerly low-level laser therapy, as a non-invasive method using red or near-infrared light (600-1100 nm) to stimulate mitochondrial chromophores like cytochrome c oxidase, boosting ATP production, angiogenesis, and fibroblast proliferation while mitigating oxidative stress (Mahmoud *et al.*, 2025)(Yaghobee *et al.*, 2024).

Clinical trials further demonstrate PBMT's benefits, with Mahmoud *et al.* (2025) showing significant improvements in soft tissue healing and pain reduction after implant placement, and Yaghobee *et al.* (2024) reporting accelerated epithelialization in free gingival graft donor sites via nano-emodin mediated photodynamic therapy (Mahmoud *et al.*, 2025)(Yaghobee *et al.*, 2024). Animal models by Costa Neto *et al.* (2025) also indicate enhanced osteogenic markers and bone repair when combining PBMT with Er:YAG laser preparation (Costa Neto *et al.*, 2025)(Dompe *et al.*, 2020).

Despite these promising results, inconsistencies in PBMT parameters, including wavelength, power density, energy fluence, and application frequency, hinder reproducibility and clinical standardization (Mahmoud *et al.*, 2025)(Yaghobee *et al.*, 2024). The aesthetic advantages, such as improved tissue color matching and patient satisfaction, remain underexplored compared to conventional wound care or adjuncts like platelet-rich fibrin (PRF), complicating direct comparisons across studies (Azhibekov *et al.*, 2024)(Pereira *et al.*, 2025). Moreover, heterogeneity in laser protocols and follow-up durations limits robust evidence synthesis, underscoring the need for systematic evaluation (Raja *et al.*, 2024)(Shenoy *et al.*, 2025).

This systematic review evaluates the clinical effectiveness of PBMT in enhancing soft tissue healing and aesthetic outcomes relative to conventional methods in aesthetic dentistry. Its objectives include analyzing recent trials on epithelial regeneration, angiogenesis, pain reduction, and satisfaction; comparing PBMT with other therapies; and identifying optimal irradiation protocols (Mahmoud *et al.*, 2025)(Yaghobee *et al.*, 2024). The urgency stems from PBMT's potential to minimize postoperative discomfort and accelerate recovery, filling evidence gaps for clinicians via standardized guidelines (Costa Neto *et al.*, 2025)(Woo, 2024). This study's novelty lies in its PRISMA-guided synthesis of 2020-2025 open-access RCTs, offering reproducible insights absent in prior heterogeneous reviews (Azhibekov *et al.*, 2024)(Bartold & Ivanovski, 2025).

This study employed a systematic review approach based on the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to collect, evaluate, and synthesize clinical evidence regarding the effectiveness of Photobiomodulation Therapy (PBM) in enhancing soft tissue healing and aesthetic outcomes in cosmetic dental procedures. This study falls under a non-experimental, secondary-design category, as all data were obtained from published research findings rather than through direct primary data collection from subjects (Sugiyono, 2022; Sudaryono, 2021). A systematic review method was chosen because it provides an objective, structured, and replicable overview of the consistency of PBMT effects compared to conventional therapies in the context of aesthetic dentistry (Emzir, 2021)(Creswell & Creswell, 2023).

To ensure quality and relevance, this review focused on studies meeting the PICOS framework (Patient, Intervention, Comparison, Outcome, Study Design), specifically human and animal clinical studies reporting the effects of PBMT on the healing of oral soft tissues with aesthetic outcomes such as color, texture, and patient satisfaction. This approach allows for the identification of patterns and limitations in laser parameters (wavelength, energy, power density, application frequency) as well as the strength of the available evidence.

The main tools used in this study included search strategies for electronic databases, data extraction forms, and a methodological quality assessment scale. The search strategy was designed using MeSH (Medical Subject Headings)-based keywords as well as free-text keywords, such as “photobiomodulation therapy,” “low-level laser therapy,” “soft tissue healing,” and “aesthetic/cosmetic dentistry,” combined with the Boolean operators “AND” and “OR” in the SpringerLink, ScienceDirect, and PubMed databases.

Data extraction forms were specifically designed to record key information: authors and publication year, study type, population characteristics, PBMT interventions (wavelength, power, energy, frequency, duration), control group, clinical outcomes (epithelialization, angiogenesis, pain, patient satisfaction), and aesthetic indicators (color, texture, aesthetic score). This instrument helps ensure consistency in data collection among researchers and facilitates the process of synthesizing findings across studies (Sugiyono, 2022).

Data analysis was conducted using narrative synthesis with a qualitative descriptive approach, as the high heterogeneity in study designs, laser parameters, and outcome measures precluded the use of quantitative meta-analysis. Methodological quality assessment of the included studies was performed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools, which encompassed examination of aspects such as sample size, potential selection and reporting bias, clarity of variables, randomization methods (if RCT), and ethical considerations. Quality assessment serves as the basis for evaluating the reliability of each study and strengthening clinical inferences regarding the effectiveness of PBMT in the context of aesthetic procedures (Creswell & Creswell, 2023).

The population in this study consists of scientific articles discussing the application of Photobiomodulation Therapy (PBMT) in aesthetic procedures or soft tissue maintenance of the oral cavity, including interventions such as gingival contouring, implant surgery, soft tissue grafting, and other aesthetic periodontal procedures. The inclusion criteria stipulated that the studies considered must involve humans or animals with oral soft tissue healing needs and aesthetic considerations, use PBMT as an intervention, and be supported by a clinical study design (RCT, case-control, cross-sectional study, in vitro/in vivo) published between 2020 and 2025.

The research sample consisted of 7 primary studies that met the PICOS criteria, were available in full text and open access, and were written in English. Excluded studies included articles for which full text was unavailable, those irrelevant to PBMT or oral aesthetic procedures, as well as publications outside the 2020–2025 timeframe or those not aligned with the PICOS framework. The determination of the population and sample followed the methodological principles emphasized by Creswell and Creswell (2023) regarding the importance of clear inclusion/exclusion criteria to ensure the representativeness and transparency of the article selection process (Creswell & Creswell, 2023). The research procedure began with protocol planning based on the PRISMA 2020 guidelines, which establish standard stages in systematic reviews: identification, screening, eligibility, and presentation of results. The literature search phase was conducted in October 2025 using the SpringerLink, ScienceDirect, and PubMed databases with pre-formulated queries using a combination of MeSH terms and keywords, as well as Boolean operators to broaden the scope while maintaining relevance.

RESULTS AND DISCUSSION

This study employed a systematic review approach based on the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to collect, evaluate, and synthesize clinical evidence regarding the effectiveness of Photobiomodulation Therapy (PBM) in enhancing soft tissue healing and aesthetic outcomes in cosmetic dental procedures. This study falls under a non-experimental, secondary-design category, as all data were obtained from published research findings rather than through direct primary data collection from subjects (Sugiyono, 2022; Sudaryono, 2021). A systematic review method was chosen because it provides an objective, structured, and replicable overview of the consistency of PBMT effects compared to conventional therapies in the context of aesthetic dentistry (Emzir, 2021)(Creswell & Creswell, 2023).

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CONCLUSION

The results of this study indicate that Photobiomodulation Therapy (PBMT) has significant potential to accelerate soft tissue healing and improve aesthetic outcomes in cosmetic dental procedures, such as implant placement, gingival contouring, and soft tissue grafting. Through mitochondrial stimulation, increased ATP production, and more organized collagen fiber realignment, PBMT is able to accelerate epithelialization, reduce postoperative pain, improve tissue color and texture, and lower the risk of hypertrophic scar formation. Clinical findings from seven selected studies indicate that the application of PBMT is consistently correlated with increased patient satisfaction, improved soft tissue aesthetics, and more stable long-term tissue recovery.

Nevertheless, this review also revealed a number of limitations, particularly regarding the heterogeneity of laser parameters (wavelength, energy density, frequency, duration, and application technique) as well as varying follow-up durations, making it difficult to draw uniform quantitative conclusions. Furthermore, most studies still have small sample sizes and a predominance of case-control designs, thereby limiting the strength of causal evidence. Future research requires large-scale randomized controlled clinical trials with standardized PBMT protocols and objectively measurable aesthetic outcomes to generate more definitive clinical guidelines. From a practical standpoint, these findings support the use of PBMT as a non-invasive adjuvant therapy that can reduce patient discomfort, accelerate aesthetic recovery, and improve long-term aesthetic quality following cosmetic oral procedure.

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