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Short Communication

The Use of Visible Light Lasers in Dentistry: Expanding Therapeutic Horizons through Photobiomodulation and Photodynamic Therapy

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Abstract

Visible light lasers encompassing violet, blue, green, yellow and red wavelengths are rapidly transforming modern dental therapeutics.

Their interactions with chromophores enable antimicrobial action, inflammation reduction and tissue regeneration.

This review summarizes mechanisms, applications and innovations in Photobiomodulation (PBM) and Photodynamic Therapy (PDT).

Keywords: Visible Light Lasers; Photobiomodulation; Photodynamic Therapy; Dental Lasers; Antimicrobial Therapy

Aim of the Study

To evaluate mechanisms, therapeutic applications and clinical outcomes of visible light lasers in dentistry, with emphasis on PBM and PDT.

Methodology

A narrative review of clinical trials, systematic reviews and foundational laser biology literature published between 2004-2024. Databases included PubMed, Scopus and Google Scholar.

Ten authoritative references were selected.

Introduction

Visible lasers (400-700 nm) activate chromophores including cytochrome c oxidase, flavins and porphyrins, producing biological effects supporting healing and microbial reduction [1-5]. Infrared lasers dominate traditional dentistry, but visible wavelengths now enable precision PBM and PDT applications [3,4].

Discussion

1. Biological Mechanisms and Wavelength Interactions

Visible wavelengths create distinct biological responses:

- Violet (~405 nm): Antimicrobial via porphyrin activation and ROS production [3]
- Blue (~445-470 nm): Antimicrobial and anti-inflammatory; effective in periodontal and endodontic PDT [9]
- Green (~520-540 nm): Hemoglobin absorption enhances hemostasis [8]
- Yellow (~577-590 nm): Stimulates mitochondrial function and improves perfusion [1]
- Red (~630-660 nm): Deep penetration; central to PBM, stimulating fibroblasts and cytokine modulation [5,10]

2. Applications in Photobiomodulation (PBM)

PBM supports wound healing, pain reduction, angiogenesis and tissue regeneration [1,5]. Evidence shows improved periodontal healing and reduced edema post-surgery [2,8].

3. Applications in Photodynamic Therapy (PDT)

PDT uses a photosensitizer activated by visible light to generate singlet oxygen, destroying pathogens. Effective in:

- Periodontitis and peri-implantitis [3,8]
- Endodontic disinfection of complex canal systems [4]
- Soft-tissue lesion decontamination [7]

PDT reduces antibiotic use and microbial resistance [6]

Results

Literature consistently shows:

- Significant bacterial reduction in periodontal and endodontic pockets [2,3]
- Faster wound healing and decreased pain [1,10]
- Enhanced fibroblast and collagen activity [5]
- Improved periodontal attachment levels with PDT adjunct therapy [3]
- Effective penetration into canal anatomy unreachable by irrigation [4]

Future Perspectives

Future systems will integrate multi-wavelength devices, AI-guided dosing, biomaterials and optical feedback technologies [6]. Personalized laser therapy protocols are expected in dentistry.

Conclusion

Visible light lasers are transforming dental therapeutics by integrating antimicrobial power, biostimulation and patient comfort. Strong evidence supports their expanding role in PBM and PDT. As precision dentistry advances, visible lasers will remain central to regenerative and minimally invasive care.

Conflict of Interest

It was declared any conflicts of interest that may have influenced the research, authorship or publication of the article.

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