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Photobiomodulation Therapy in Conservative Dentistry and Endodontics

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Abstract

The importance of using lasers is increasing in Conservative Dentistry and Endodontics. This is mainly due to its painless and non-invasive procedure. Pain is a common phenomenon that can have a significant effect on the quality of life of individuals. Low-power laser is one of the methods which reduces pain. In this review, we are focusing on Photo biomodulation (PBMT) therapy, which is a low-level light/laser therapy used in the field of Conservative Dentistry & Endodontics. It includes a wide range of electromagnetic wavelengths such as Broadband lights, Light Emitting Diodes, and Lasers. This therapeutic technique can be used in reducing postoperative pain after Endodontic Therapy, Endodontic surgery, Dentin Hypersensitivity, Bleaching, and also in Pulp Regeneration.

Keywords: Photobiomodulation, Laser, Dentinal hypersensitivity

Introduction

Theodore H Maiman in the year 1960 first produced laser (light amplification stimulated emission of radiation). Endre Mester in the late 1960s for therapeutic purposes-, developed a laser that helps in the biostimulation of wound healing. It can stimulate and suppress biological effects with analgesic, anti-inflammatory & wound healing effects. Photobiomodulation (PBMT) is a non- invasive, non-toxic cascade of biochemical reactions which affects on body's natural healing and ability. Light-emitting diodes, lasers & broadband light are non-ionizing forms of light sources utilized by photo biomodulation for producing photochemical & photophysical reactions in various tissues.

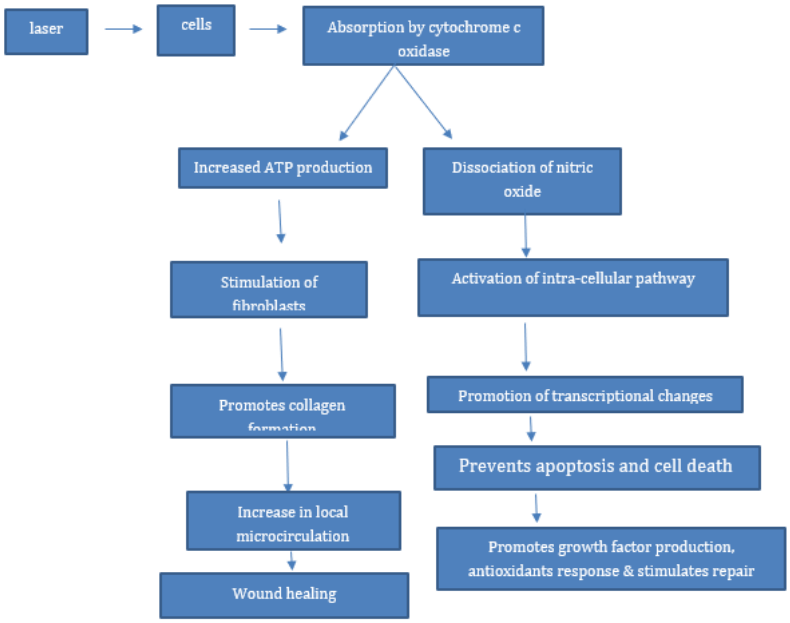
Methodology:

For data, a collection search was carried out online on various sites: Pubmed, Medline, Research Gate, and EBSCO. For search words and phrases - 'Photobiomodulation therapy, 'Low-level laser', 'Photobiomodulation therapy in Endodontics' and 'Photobiomodulation therapy in Conservative dentistry' were used in various combinations. The selected items comprised research and review articles. Among those articles, applications of PBMT in the field of Conservative Dentistry & Endodontics are considered.

Laser devices used for PBMT are much safer when compared with surgical lasers as they are smaller, compatible, handheld devices. PBMT is based on Arndt Schultz's law in which the Smaller range

stimulates biological response, the Medium range can impede & Massive range can destroy. The most commonly used lasers for PBMT are Aluminium-gallium-indium phosphide lasers & Gallium-aluminium-arsenide lasers. They are used mainly for pain management & palliative treatment.[1]

Mechanism of action:[2]



Considerations & technical parameters of PBMT[3]

Parameter	**Specifications**
Wavelength	600-1000nm
Waveform	Continuous, pulsed, modulated
Spectrum	Red to infrared region
Power density	Calculated by the laser output Power(MW)/beam area(cm2) 1mw/cm2 to 50mw/cm2 (average range)
Energy(expressed in joule as j)	Calculated by- mw(seconds)
Dose calculation(j/cm sq units)	Calculated by energy irradiated Area
Output power	1mw upto 500mw
Treatment interval	2-3 treatments per week for several weeks depending on the nature Of the application & chronicity of the disorder.

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PBMT in Dentistry: It has been used in various fields of dentistry for different procedures which includes Alveolitis, Anaesthetia, Pericoronitis, Hypersensitive dentin, Mucositis & TMJ disorders, etc.,

PBMT in Orthodontics :

During intraoral maxillary radiography and during taking impressions in orthodontics, PBMT helps in prevention of the gagging by placing the laser on the acupuncture point on the wrist. PBMT is also effective in reducing pain in the final stage of arch wire placement with numerous different bracket systems placed buccally & lingually in both the arches. After application of the laser pain control occurs by two mechanisms, by increased production of B-endorphin and in the peripheral nerves there is repression of nerve impulse conduction, then local pain impulse transmission gets impaired. During rapid maxillary palatal expansion PBMT helps in decreasing pain & increases the speed of tooth movement and bone deposition and also accelerates the bone remodeling process by stimulating osteoblastic and osteoclastic cell proliferation and function during orthodontic tooth movement.[4]

PBMT in Periodontics :

In periodontal disease PBMT can be used as an adjunctive as it can be used in oral hygiene treatments for periodontal pathologies. The symptoms and the periodontitis condition can be controlled with the use of LLLT. In conjunction with scaling, curettage, root planning, or surgical treatment as PBMT have an anti-inflammatory effect which slows or stops the deterioration of periodontal tissues and reduces the swelling to facilitate hygiene, accelerated healing and less post- op discomfort by stimulating human periodontal fibroblasts, reduced gingivitis index, pocket depth, plaque index, gingival fluid, and Metallo proteinase-8 levels and there are positive results after gingivectomies.[3] On periodontal health PBM is able to exert a beneficial action by normalizing the blood vessel permeability and cause vasodilatation and accelerates the healing process in damaged tissue is accelerated by bio-stimulation.[5]

PBMT in Implant dentistry :

There is an enhanced osteoblastic activity and improved bone neoformation along with mineralization because of increased alkaline phosphatase activity, after application of PBMT post operatively which shows a positive response clinically on osseointegration and in dental implant stability which was suggested by Sara Mahmoud Zayed and Ahmed Adel Abdel Hakim in their systematic review.[6]

PBMT in Local anesthesia :

The pain of local anaesthetia in the maxillary anterior region were reduced by application of diode laser found in a clinical trail conducted by sholeh ghabraei et al. as PBMT reduces the inflammation and pain by modifying the synthesis of prostaglandins and bradykinin, increases the drainage of lymph ,reduces tissue edema & histamine and prevents the release of mediators from the damaged tissues which are associated with pain, and also reduces the acetylcholine levels by increasing the acetylcholine esterase enzyme activity.[7]

PBMT in conservative dentistry:

Due to the significant effects on reduction of pain & inflammation, improvement of wound healing, and induction of the formation of dentin hard tissue. It is also used as an adjuvant technique in direct pulp capping. In endodontic surgery application of PBMT helps in pain & inflammation reduction, and the healing of soft and hard tissues. In pulpotomy, PBMT is one of the common protocols of laser therapy as it reduces inflammation and maintains pulp vitality & improves healing via increased collagen matrix, fibrosis, and formation of hard tissue barrier.[8] It reduces tooth sensitivity by tubal occlusion, changes the pain threshold of pulpal nerves, and stimulates reactive dentin. Laser light with irradiance over 300 mW/cm^2, when absorbed by the nociceptors, causes analgesia. Thus, it exerts an inhibitory effect on delta A and C-type nerve fibers, slowing conduction velocity, reducing the amplitude of compound action potential, and suppressing neurogenic inflammation. The efficacy of LLLT in reducing post-bleaching sensitivity could be attributed to the biomodulative, anti-inflammatory, and analgesic effects of low-power lasers. Laser therapy may restore the cell damage and accelerate the inflammatory process induced by HP byproducts in the pulp tissue and could also suppress the passage of neurosensory impulses. These effects possibly appear after several hours of laser radiation. The greater effectiveness of infrared versus red laser in reducing post-bleaching

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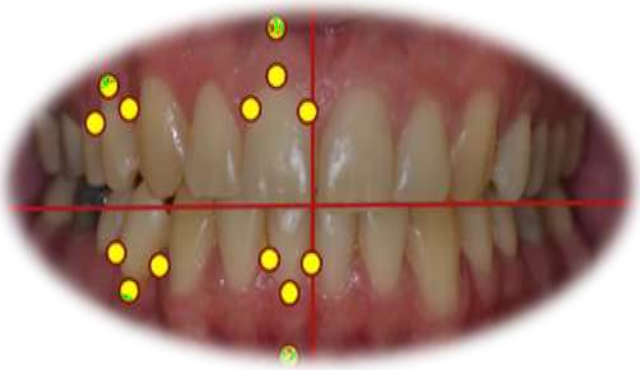
sensitivity could be related to the differences in the penetration depths of these wavelengths. It is believed that the red wavelength penetrates the tissue 8–10 mm, whereas the penetration depth of an 810-nm infrared laser is estimated to be 2–3 cm.[9,10]

Dental sensitivity after composite restorative treatment is among the common issues mainly caused by polymerization shrinkage. Although different treatments have been proposed to prevent these types of dental sensitivities, the ideal approach is still under study. The use of low-power lasers for deep restorations has been proposed in recently published articles aimed at evaluating its effect on postoperative sensitivity reduction.[8]

PBMT devices:

Twin flex II equipment

PBMT application points in post bleaching



PBMT treatment considerations[8,11,12]

Treatment	**Laser**	**Wavelength**	**Power**	**Energy density**	**Pulsed /Continues mode**	**Time and reputation**	**Optical fiber Or Spot Size diameter**	**Contact or Non-contact**	**Suggested Protocol**
Tooth hypersensitivity	GaAl As and	630nm, 660nm, 670nm,	1.5-500 mw	1.8-40 J/cm^2	9-30 Hz OrContinues	20-160s in each session	300 µm	Contact or Non-contact	**660nm, output power 200mW,**
	InGa AlP	685nm, 795nm, 810nm, 830nm, 980nm				per tooth, inthree-six sessions		Contact (5 mm)	**continuous mode, irradiation time60s,density 10.4J/cm^2,300 µm,fiber diameter, Non-contact (5mm), oscillating movements.**

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Tooth bleaching	Diode	780 nm or 810 nm	70-200 mw	12 J/cm^2	Continues	10-20 s	0.04 cm^2	Contact (middle of tooth crown and periapical region)	**810 nm, 200 mw, 12 J/cm^2, Continues, 20s (10s in each point), 0.04 cm^2 spotsize diameter,Contact (middleof toothcrown,and periapical region)**
Primary tooth pulpotomy	Diode	632nm or 660 nm	10 mw	2.5-4 J/cm^2	50–60 Hz frequency or continuou s	10 or 135 s	320 µm	Contact	**Diode 660 nm wavelength, 10 mW power output, 2.5 J/cm^2 energy density, 50–60 Hz frequency**
Endodontic anesthesia	Diode	980 nm	7.5 W/cm^2	15 J/cm^2	Continues	20 s			**980 nm, 7.5 W/cm^2, Continues mode, 20 s**
Post-Endodontic Pain Control	Diode	808 nm	100 mw	70 or 360 J/cm^2		80-100 s	600 µm or 0.0283 cm2	Contact	**Diode 808 nm, 100 mW power, and dose of 360 J/cm^2 for 100 seconds**
Post-Endodontic re- treatment Pain Control	Diode	808nm or 970±15 nm	100 or 500 mw	75-85.8 J/cm^2	10 Hz	30 or 80 s	200 µm	Non-contact (10 mm)	**970±15 nm, 500 mw, 85.8 J/cm^2, 10 Hz, 30 s, 200 µm, Non-contact (10 mm)**
Post operative pain after endodontic surgery	Ga AlAs	809nm	50 mw	7.5 J/cm^2	Continues	150 s	600 µm	Non-contact (10 mm)	**809nm, 50 mw, 7.5 J, Continues, 150 s, 600 µm, Non-contact**

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Conclusion:

There are different parameters of light that can influence the significant effects on the hypersensitivity of dentin or tooth. As the clinical trial studies are limited there is no specific protocol for radiation that can offer in other PBMT dental applications. There should be further clinical research in order to obtain much more clear results.

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