



PHOTOBIMODULATION- ACCELERATING ORTHODONTIC TREATMENT

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ABSTRACT In Photobiomodulation (low level light therapy) the cellular biology is modified by exposure to light in the red or near infrared range (600 to 1000nm) using low energy lasers or LED's, which increases the rate of bone remodeling thus accelerating the orthodontic tooth movement without causing any side effects on the periodontium. The device used consists of a silicone mouthpiece, LED array and accelerometer. It can be used with any orthodontic treatment modality to increase the rate of tooth movement hence reducing the treatment time. Photobiomodulation causes accelerated tooth movement by increased bone remodeling. Hence it reduces the treatment time in orthodontic with lesser side effects as compared to other methods of accelerated orthodontics.

KEYWORDS : Orthodontics, Accelerated orthodontic treatment, Photobiomodulation, Low level light therapy

INTRODUCTION

Orthodontic treatment has evolved over time to improve the patient and clinicians experience by enhancing their smile during the course of treatment by allowing the patients to choose from a variety of brackets like ceramic, crystalline, lingual and so on. However these changes have been made only in terms of aesthetics. The longer duration of treatment time still remains one of the major drawbacks in orthodontics, causing most of the patients to dropout midway through the course or not opt for it altogether.¹

Conventionally, orthodontic treatment time may range anywhere between 12 to 48 months based on the amount and severity of malocclusion. Long treatment time predisposes patients to various problems such as dental caries, gingival recession and root resorption.¹ With an increasing number of adult patients visiting the orthodontic clinic, it became even more important to search for ways to accelerate tooth movement.

Many methods have been used to accelerate tooth movement. These include surgical methods such as corticotomy, piezosurgery etc. These methods are based on the principle that surgical irritation of bone initiates an inflammatory reaction which leads to formation of osteoclasts which in turn causes faster tooth movement.²

Although these methods have been found to be effective in increasing the rate of tooth movement, they have been associated with pain, patient discomfort, bleeding and other such unfavorable effects with the major disadvantage of being invasive in nature, they are not readily accepted by patients.

A recent advancement in this field is photobiomodulation. Unlike its predecessors, photobiomodulation is a non invasive procedure that has proven to accelerate tooth movement using light energy, hence reducing the treatment time.

DISCUSSION:

1) Photobiomodulation

When forces are applied to a tooth, they are transferred to the adjacent investing tissues. This causes a specific series of events to take place causing mechanical, chemical and cellular changes in these tissues which allow for structural alterations and contribute to tooth movement.¹

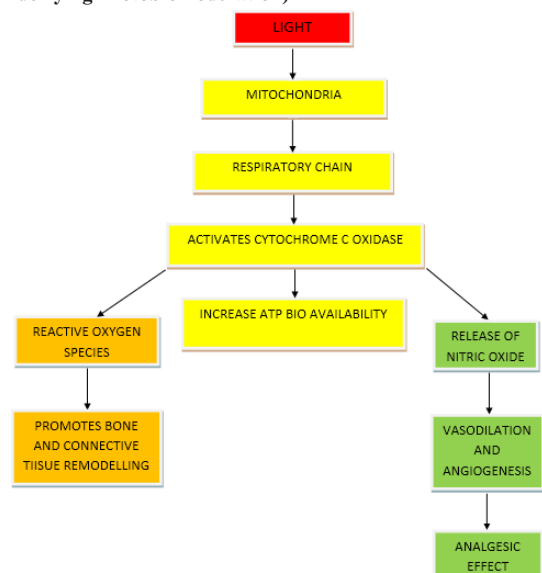
In Photobiomodulation (low level light therapy) the cellular biology is modified by exposure to light in the red or near infrared range (600 to 1000nm) using low energy lasers or LED's, which increases the rate of bone remodeling thus accelerating the orthodontic tooth movement without causing any side effects on the periodontium.

Mechanism Of Action:

Photobiomodulation acts on the mitochondria and is mainly mediated

by cytochrome C oxidase (CCO), the terminal enzyme of the respiratory chain.³ As CCO absorbs light in the near infrared range, photons excite wavelength specific chromophores to initiate signaling pathways. The activation of CCO directly increases adenosine triphosphate (ATP) production. Cytochrome C oxidase is known to dissociate from inhibitory nitric oxide, a free radical and an important signaling molecule to further increase ATP bio availability.⁴ When released, nitric oxide participates in biologic processes such as vasodilatation and angiogenesis to provide analgesic effects.⁵ Photobiomodulation has been shown to promote bone and connective tissue remodeling probably due to involvement of reactive oxygen species produced by mitochondria.⁶

Photobiomodulation has also been found to be functioning through an increased vascular activity which would also contribute to rapid turnover of the bone and is amenable to light.⁷ (**Figure.1. Mechanism Underlying Photobiomodulation**)



(**Fig 1. Mechanism Underlying Photobiomodulation**) Schematic diagram showing the absorption of red or near infrared light by specific cellular chromophores or photoreceptors located in the mitochondria. During this process in mitochondria, respiratory chain ATP production will increase and reactive oxygen species (ROS) are generated, Nitric oxide (NO) is released. These cytosolic responses may in turn induce transcriptional changes via activation of transcriptional factors (eg. NFkB & Ap1)

Procedure:

Photobiomodulation is an easy to carry out procedure which does not require a specific skill set and hence can be carried out by any individual. Also it is very comfortable to the patient as it is painless and does not require administration of local anesthesia.

The device consists of a silicone mouthpiece which is to be placed between both the arches. The silicone mouthpiece has an attached LED array which emits infrared light at required wavelength (850 nm). The device has an accelerometer which helps to time the treatment session i.e. the time for which the teeth will be exposed to light. The light indicator shows when the treatment time is done. The device can then be removed from the oral cavity.

The device works on a battery which needs to be charged from time to time. The procedure needs to be done at regular intervals. The time interval between the appointments depends on the severity of malocclusion.

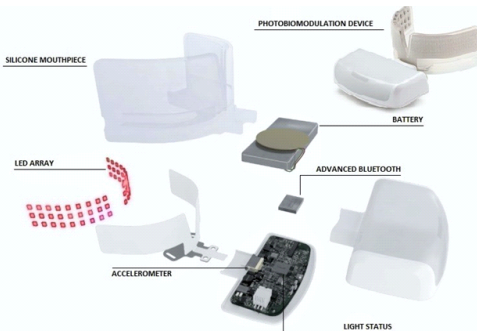
Photobiomodulation Device:

The device used in photobiomodulation consists of the following parts:

(Fig 2. Components of Photobiomodulation Device)

- 1. Silicone mouthpiece** – This is a soft, water proof, medical grade silicone mouthpiece. It is available as one size that fits all patients.
- 2. LED array** – This emits safe low level light in the range of 850 nm infrared wavelength.
- 3. Accelerometer** – This helps the device to time the treatment sessions. The treatment time is usually pre-set.
- 4. Battery** – It helps in wireless charging of the device.

Light status – This part of the device shows the treatment session progress and battery charge of the device.



(Fig 2. Components of Photobiomodulation Device)

Advantages:

Photobiomodulation or Low Level Light Therapy (LLLT) can be used alongside any orthodontic treatment to reduce the overall treatment time with the added benefit of being non invasive thus readily acceptable by patients.

Photobiomodulation causes vasodilatation and angiogenesis to provide a slight analgesic effect making the treatment more comfortable for the patients.⁵

The Photobiomodulation device is easy to understand and can be operated by any clinician. It does not require special expertise or skill set.

Disadvantages:

The use of this device requires the need of additional specialized equipment.

As this technique demands frequent application to achieve significant acceleration, more number of appointments would be required. Hence this therapy is suggested to only those patients that are willing to attend the practice multiple times and at short intervals.

1) Clinical Studies:

1- A multicentered clinical trial by Kau C.H. et al in 2013 performed

on 90 subjects (73 test subjects and 17 controls) demonstrated that photobiomodulation produced clinically significant changes in the rate of tooth movement as compared to the control group during the leveling and alignment phase of orthodontic treatment.⁷

2- A clinical trial by Cruz D.R. et al in 2004 performed on 11 patients with one upper quadrant receiving mechanical activation of canine teeth every 30 days (control group), while the other half received the same mechanical activation along with irradiation with a diode emitting light (study group) at 780nm, during 10seconds at 20 mW, 5 J/cm², on 4 days of each month, demonstrated that low intensity light therapy accelerates human tooth movement and can considerably shorten the treatment duration.⁸

3- The study by Genc G. et al in 2013 on 20 patients (14 girls, 6 boys) whose maxillary 1st premolars were extracted & canines were distalized. The mechanical retraction of maxillary lateral incisors was initiated, the left maxillary lateral incisors served as the control group, while the right maxillary lateral incisors along with mechanical retraction received low level light therapy at output power of 20mW & dose of 0.17 J/cm², on day 0, 3rd, 7th, 14th, 21st & 28th of initiation of retraction with a total of 10 doses five from buccal side and five from the palatal side, GCF samples were also collected at above mentioned days and the nitric oxide levels were analyzed which demonstrated that the application of low-level laser therapy, accelerates orthodontic tooth movement and do not show changes in the levels of nitric oxide in gingival crevicular fluid during orthodontic treatment.⁹

4- The study by Sousa N.V. et al in 2011 on 26 patients, where 13 patients underwent mechanical retraction of canines using NiTi spring of force 150g/side, served as the control group. The remaining 13 patients underwent mechanical retraction along with irradiation by diode laser at 780nm, 20mW, 10 seconds, 5J/cm² for 3 days each month for 4 successive months. The 3D casts and periapical radiographs of both the groups were compared which concluded that the Low-level light therapy shows accelerated orthodontic tooth movement, however do not show any significant difference in bone and root resorption.¹⁰

2) Future Scope:

With the treatment time being the major concern of many patients undergoing orthodontic treatment, the need for accelerating orthodontic treatment without invading surrounding structures is need of the hour. Photobiomodulation has proven to considerably accelerate tooth movement, reducing the time required for orthodontic treatment. It is non invasive and is readily acceptable to patients. However further studies, research and clinical trials are required to demonstrate its efficacy.

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