

Treatment Efficacy of Photobiomodulation for Moderate and Advanced Dementia or Alzheimer's Disease: Case Studies

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Abstract

Extensive research is ongoing in the use of Photobiomodulation (PBM, often referred to as low-level or cold laser therapy) to treat Alzheimer's disease as well as other debilitating diseases. The following case studies further confirm that PBM could be a breakthrough approach to limit the progression of insidious diseases. We present four cases, two with mild to moderate dementia and two with more advanced symptoms. Several publications have shown beneficial results, however, several weeks of daily treatments were necessary. The cases described here suggest that moderate and advanced dementia cases can be significantly improved with three or four eight-minute treatments over a 5 - 7-day period when using super-pulsing technology on Monday-Wednesday-Friday schedule (**Figure 1**). Gives a brief visual explanation of super-pulsing versus continuous wave technology.

Keywords

Photobiomodulation, Alzheimer's Disease, Dementia, Super-Pulsed Laser, Traumatic Brain Injury (TBI), Laser Diode, LED's, Continuous Wave

1. Introduction

In the scientific community there have been multifaceted efforts to find a remedy for Alzheimer's disease and dementia, which so far have consumed billions of US\$ in research costs [1]. However one non-pharmaceutical approach called Photobiomodulation (PBM) or low-level laser therapy (LLLT) has shown very promising results in some early stage clinical trials and in laboratory animal studies.

PBM involves the delivery of red and/or near-infrared light from a laser or a LED (light emitting diode) to a particular part of the body. PBM can in many circumstances provide physiological benefits lasting much longer than the duration of irradiation. PBM has been widely employed for reducing pain, inflammation, preventing tissue damage, and the stimulation of healing of wounds or other types of injuries [2]. Because PBM/LLLT does not involve any drugs or invasive modalities, it is remarkably free of side effects, and has been generally recognized as safe by the FDA.

One of the most impressive applications of PBM has been its use to treat a variety of brain disorders [3] [4]. These disorders have included acute [5] or chronic [6] [7] traumatic brain injury, acute stroke, [8] a variety of psychiatric disorders [9], Parkinson's disease [10] and Alzheimer's disease or dementia [11] [12].

The protocol described by Saltmarche *et al.* [13] for dementia patients included treatment with a combination of transcranial and intranasal LED devices, which are used daily at home for a 12-week period. We have obtained similar results with four eight-minute treatments delivered over a seven-day period.

The laser cited here is a high-powered super-pulsed laser with 5 - 905 nm (maximum 200 mW) and 4 - 660 nm (maximum 100 mw) diodes. Most other researchers use LEDs in their treatment. Laser diodes have stimulated emission which is collimated whereas LEDs have spontaneous emissions that are non-directional thereby having much lower output power. We have utilized this device for treatment in our clinical practice for over 17 years with no adverse effects reported by any patients or families. This system was originally FDA cleared for pain management and we initially treated chronic pain, orthopedic trauma, sports injury and arthritis. After treating hundreds of patients over the years with no adverse effects, we started treating simple headaches, migraines and concussions. After a short time, based on the patients reporting clinical benefits, it was concluded that the near infrared laser must be penetrating through the skull plate! Previously protocols for LED devices required the patient to wear helmet or similar device for half an hour every day for approximately 8 - 12 weeks. However, improvements have been made reducing the time to six minutes per day for 28 days. The patients we treated with the laser experienced significant improvement in 3 - 4 treatments in most cases.

Our first publication in 2012 described the efficacy of super-pulsed 905 nm low level laser therapy in the management of traumatic brain injury (TBI) in one case study [14]. Despite repeated efforts having been undertaken to present our findings to the Department of Defense or the National Football League, it fell on "deaf ears".

Our most recent papers described the clinical improvement in patients treated with our laser system for Post-traumatic Stress Disorder (PTSD) as well as for mild dementia [15] [16]. We have also recently obtained positive results in a case study of children and adults with attention deficit hyperactivity disorder (ADHD) [17].

2. Methods

The mechanism of action of PBM on the brain is due to specific wavelengths of photons (*i.e.* 660 nm. and 905 nm) illuminating the mitochondria. This process creates an uptake in the biochemical and cellular processes responsible for remarkable increase in cellular health. Various researchers reported: their findings in various journals: Mechanisms of action include: 1) Stimulation of mitochondria by photons and the consequent increase in cytochrome c oxidase activity and intracellular adenosine triphosphate (ATP) [18]. 2) Improvement in regional blood flow and oxygen delivery to the brain parenchyma by triggering nitric oxide (NO) production [19]. 3) Anti-inflammatory effects caused by changing the phenotype of the brain microglia from pro-inflammatory M1 to anti-inflammatory M2 [20]. This switch results from changing the mitochondrial metabolism from glycolysis towards oxidative phosphorylation by light absorption. It should be noted that M2 microglia can carry out phagocytosis, and could therefore dispose of beta-amyloid plaque in the brains of Alzheimer's patients [21] (Figure 1).

Super-pulsing can penetrate deeper in to the tissues with minimal thermal effect consequently reducing the amount of treatments needed utilizing LED's (Figure 2).

The patient was put in a supine position for the treatment (see Figure 3). No discomfort was reported by any patient. Moderate cases were given the Mini Mental State Exam, but advanced cases did not have the ability to respond.

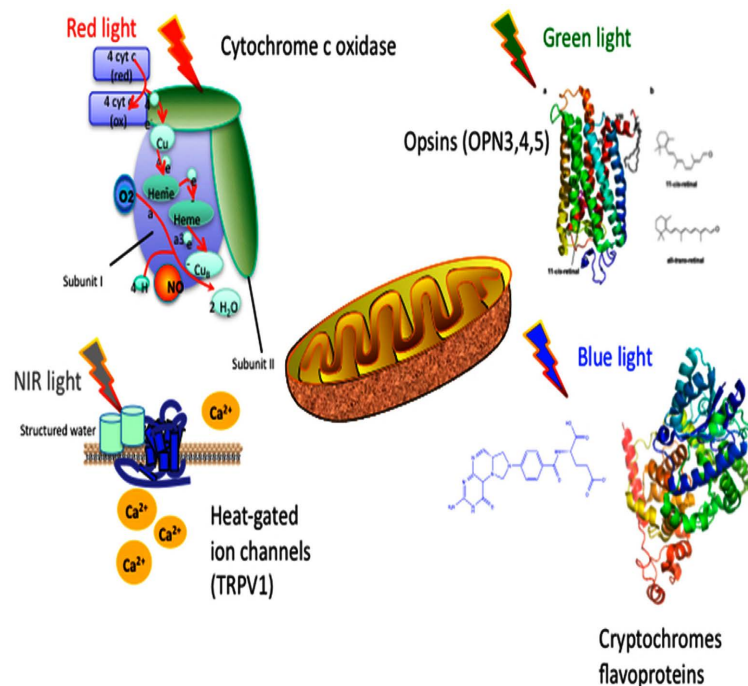
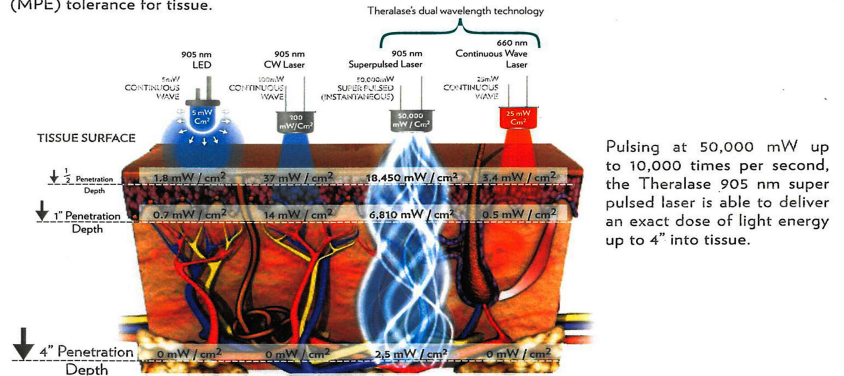


Figure 1. Proposed chromophores for PBM that can absorb different wavelengths of light. It should be noted that there is considerable overlap between the chromophores, and that the NIR absorbed by structured water is likely to be longer wavelength (>950 nm).

SUPERPULSED 905 nm TECHNOLOGY PENETRATES UP TO 4" INTO TISSUE

SAFE AND EFFECTIVE

Theralase's superpulsed 905 nanometer (nm) near infrared and 660 nanometer (nm) visible red laser technology accelerates healing by reducing pain and inflammation while staying below the Maximal Permissible Exposure (MPE) tolerance for tissue.

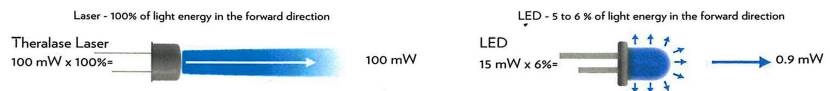


DUAL WAVELENGTH TECHNOLOGY

Theralase combines 660 nm visible red and 905 nm near infrared superpulsed lasers to allow superficial and deep penetration of laser energy of up to 4" into tissue activating all three known cellular pathways.

TRUE LASER DIODES VERSUS LEDs

True lasers are highly directional delivering 100% of the photons to the affected area versus only 5 to 6% with a LED; hence, much better treatment outcomes occur with true lasers versus LEDs.



SHORTER TREATMENT TIMES

The Theralase Multiple Probe utilizes 9 Lasers and is able to treat an area of 20cm² thus reducing treatment times by 90% in comparison to a single laser probe.

Pg.4

Figure 2. Theralase Inc., Toronto, Canada.



Figure 3. Dementia treatment being administered at home with portable system.

The laser contains five super-pulsed 905 nm diodes (200 nsec pulse duration) each with the ability to put out 200 mW average power, plus four 660 nm diodes each with the ability to put out 100 mW power. Patients were treated on a MWF schedule (*i.e.* three times) over a five-day period. Six areas were treated for three minutes each, four areas on the pre-frontal cortex and two areas on the mid-brain. Power settings were 100 mW for each of the 905 nm diodes and 75

mW for the 660 nm diodes. The energy delivered per site was 144 J, and the total energy delivered over six sites was 864 J (Figure 3).

Case 1: Moderate dementia

A 92-year-old female presented with memory loss, low energy and was becoming very argumentative, a trait not previously displayed. The first treatment was preceded by a short interview. She was very lucid and even had a sense of humor. After the treatment, we spoke to the daughter she lives with and said, “I don’t think we can help her as there seems to be nothing wrong with her.” The daughter requested we continue to administer additional treatments. Prior to the second treatment, the daughter informed the authors that the patient had asked her daughter for a hot fudge sundae, her favorite dessert that she had not asked for in three months! We administered four treatments and the following testimonial letter was written 3 months after the last treatment.

“Mr. Banas provided 4 treatments for my 94-year-old mother to assist her with beginning stage dementia. After the first treatment, I noticed she was not sleeping as much during the day. As the treatment progressed, I also noted she requested a hot fudge sundae, her favorite, which she has not done in more than a year. She also became more alert during the day; previously had been sleeping most of the day, getting up at my urging to drink ensure, water, and have a light meal of eggs, or toast and soup. While her memory short term is not different, she has more alertness, and interacts more with me as she had previous to her decline. Also noted, she wanted to go out to lunch, a favorite pastime which she had been loath to do lately. We prepared to go to lunch, as she is on oxygen 24/7 and uses a cane or walker to get around. I came to help her get her coat on and she had her lipstick out and was putting it on her lips. I asked about it and she said, since we’re going out I thought I should put some make up on but couldn’t find anything but lipstick. My mother had for years worn lipstick and would reapply it after having anything to eat or drink. Her lips were ‘addicted’ to lipstick! I was quite surprised and pleased to see her using it as this was something she stopped several years ago. She has also started to watch some of her old favorite television shows, another thing she had stopped. She is napping during the day, but more like long ago when she would get up and watch the news and have her coffee and breakfast, watch another show and then nap after lunch. Mr. Banas felt that the changes were a result of the increased blood flow from the light therapy treatments to her brain. I can’t argue with that as it was the only thing that changed and I did note several improvements. My mom is not argumentative at all and has always had a positive outlook to life, but these changes have improved her quality of life. Thank you!”

Case 2. Mild to moderate dementia

A former 84 year-old AFL professional football player was diagnosed with mild to moderate dementia five years previously. His wife had died before onset and his children were not proactive in an effort to help curb further onset (*i.e.* puzzles, games etc.) However, he was still very functional now but slow in responding to normal everyday day activities. Four treatments were administered

over an 8-day period.

The children reported that he no longer needed excessive daytime naps and his energy level was significantly increased. He would respond more quickly when asked a question. One of his close teammates came to visit after a one-year hiatus and he was not recognized immediately. However, the old teammate continued to engage his old friend about old times he did recall some stories. However, when the treatment was given a day prior to the Super Bowl, he could not remember the game was the next day even though it was mentioned twice during the session with him.

Case 3: Advanced dementia

This advanced case involved a 72-year-old man presented to us by his wife as a last resort. He had incontinence issues and could not follow directions. Using the standard protocols, we started to see remarkable results after the third treatment. For instance, when we told him to get up on the table he was able to do this properly without direction. In addition, when asked to open the goggle case and put the glasses on which he did with little effort, which he was not able to do previously. His incontinence issues were no longer a problem. Most encouragingly, after arriving for a treatment I walked out to greet them at the car to see how he would respond. He saw me coming and he turned to his wife and informed her, that I was coming out to greet them; this was tremendously gratifying.

Unfortunately, after the fourth treatment the family observed some adverse effects. He displayed excessive energy and some aggressive tendencies. He no longer would sleep through the night. At one point, in the middle of the night he got up and was rearranging furniture in the living room. His wife asked him what he was doing and he told her to “mind her own business!” We had to temporarily cut back on the treatments stopped treating the prefrontal cortex. As of this writing, this patient is still doing well and he has not had a maintenance treatment for 6 weeks. His wife is getting the sleep she needed. He controls his urinary issues but is wearing Depends for his defecation. He is apologetic to the wife for this issue.

Case 4: Advanced dementia

The 82-year-old mother of an alternative medicine physician asked me if I could help his mom. She had been diagnosed with dementia 7 years previously and was in need caretaker full time. Since I was only in the area for a short time, I told him I did not think I could help her unless perhaps there was an anger management problem. He reported there was and the issue had only manifested itself in the last year. He had the caretaker bring her to the clinic for a single treatment. Twenty minutes after the treatment, the caregiver and mother were in the recovery room. The mother was Cuban and could not speak English. I asked her 40-year-old niece if she had experienced anything from the single treatment expecting nothing of significance. To the surprise of both of us, upon seeing her right her right after the treatment “...she smiled and gave me a hug something she had not done for the 6 months we have been together!”

3. Conclusions

Published studies from multiple institutions are reporting significant benefits from photobiomodulation treatment in Alzheimer's disease or dementia. A group including Berman and Huang has described a helmet with 1100 LEDs emitting 1060 - 1080 nm light pulsed at 10 Hz with a 50% duty cycle [22]. PBM was administered for 6 minutes daily over 28 consecutive days in a pilot trial of 11 patients. A non-significant improvement was seen in the active compared to the placebo group with respect to MME and ADAS-Cog scores. The same group then went on to recruit a much larger group of fifty-seven patients [23]. Significant improvements were seen in the active group with respect to MMSE, Logical Memory Tests I and II, Trail Making Tests A and B, Boston Naming Test, and Auditory Verbal Learning Tests. A further analysis revealed no difference between the responses of male and female patients [24]. Additional case studies have reported the benefits in Alzheimer's disease patients using PBM alone [25] [26] [27] [28], or PBM combined with a ketogenic diet [29].

The rapidly increasing number of reports of the benefits of PBM for Alzheimer's disease and dementia suggest that this non-invasive, non-pharmaceutical, and safe treatment approach should be more widely adopted. Although LED helmets are attractive options, it is possible that higher-power super-pulsed lasers could provide improvements in a shorter period, and could be used by therapists as an in-office treatment. The growing amount of data concerning the cellular and molecular mechanisms of action provides a scientific basis for its wider adoption.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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