WORLD JOURNAL OF NEUROSCIENCE NOVEMBER 2012 **WJNS**
Published Online November 2012 http://www.Scirp.org/journal/wjnsl/

Efficacy of super-pulsed 905 nm Low Level Laser Therapy (LLLT) in the management of traumatic brain injury (TBI): A Case Study

William Stephan, M.D. per 1st Affiliation, Louis J. Banas, B.S., CLT per 1st Affiliation, Matthew Bennett, M.D. per 2nd Affiliation, Huseyin Tunceroglu, MSIV per 3rd Affiliation

1st Affiliation: William Stephan M.D., LLC, Buffalo, New York
2nd. Affiliation: University of Buffalo School of Medicine and Biomedical Sciences, Buffalo, New York
Email: huseyint@buffalo.edu

Received 04 September 2012.

1. INTRODUCTION

Traumatic brain injury (TBI) typically occurs when there is any sudden trauma to the skull that induces damage to the brain. There are many causes of TBIs, but unfortunately no documented cures. According to Faul et al., the annual incidence of TBI in the United States is approximately 1.7 million incidents, which account for 30.5% of injury related deaths[1]. The direct and indirect costs of TBI totaled an estimated 76.5 billion dollars in the United States in 2000 [2]. Traumatic brain injuries play a major role in the health care of our nation, especially in our armed forces, where the men and women serving our country are at a higher risk to suffer a TBI.

Treatment is centered on preventing future insult to the brain, but very little can be done to treat the already existing symptoms. These symptoms, as described by the National Institutes of Health, range from mild to severe and include: headaches, nausea, vomiting, confusion, and blurry vision**.** Current theory on alleviating the symptoms of TBIs is based on reducing inflammatory and oxidative stress and increasing perfusion to support metabolic needs [3]. A study by Naeser et al. looked at the use of Near Infra Red (NIR) light for the treatment of TBI, stroke, and neurodegenerative disease. Their results were very promising, showing that nightly treatments with NIR LED over a period of months to years improved cognitive abilities [4]. Furthermore, they showed that the use of NIR light increased ATP production, caused vasodilation, and improved perfusion. We believe that the superpulsed 905 nm LLLT system employed in this case study operates through similar mechanisms of action and to support our hypothesis we present a case report of a patient with a traumatic brain injury that was treated with the superpulsed 905 nm LLLT system two years after the injury occurred.

2. CASE REPORT

A 25 year old man with no pertinent past medical history presented as a new patient. His only complaint was chronic debilitating migraines since a traumatic brain injury which occurred in May of 2010. He was attacked and repeatedly hit over the head with a lead pipe, consequently requiring many sutures and leaving a scar on the brain as evidenced by the MRI performed subsequent to the incident. Since the attack, he has been experiencing excruciating migraines daily which he rates at ranging from 7/10 to 10/10 using a Visual Analog Scale (VAS) reference and physically describes them as: throbbing, squeezing sensations located primarily to the occipital region of his skull. He complains of being unable to have a peaceful night of sleep or to participate in play with his four children, the oldest being 9, due to the constant pain and agony he experiences.

After undergoing multiple previous treatment modalities, which included: medications, vitamin

supplements, and chiropractic massage therapies, all of which were unsuccessful at alleviating his symptoms, he had all but given up hope. Willing to try anything to rid himself of the chronic pain, he agreed to undergo LLLT treatment. Using a Theralase® superpulsed LLLT medical laser system equipped with a multiple probe handpiece (5 x 905 nm wavelength @ 0 to 100 mW average power per laser diode + 4 x 660 nm wavelength @ 25 mW average power per laser diode), he was given a total of five treatments delivered over a two week period, with the 905 nm laser diodes set to 50 mW average power. The LLLT was targeted to a total of four areas on the scalp for two and a half minutes each: midline occipital region just below the lamboidal suture, superior aspect of the nape to target the Circle of Willis and over the mastoid processes bilaterally. We selected 905nm wavelength based on a previous scientific study that demonstrated that the 905 nm superpulsed wavelength employed by the system was able to increase inducible Nitric Oxide Synthase (iNOS) expression by 700%, as compared to numerous other wavelengths that showed little or no effect [5]. iNOS has been well documented in numerous clinical studies to cause temporary vasodilation by signaling endothelial cells located in capillary walls to become flaccid and relax. Additional studies have shown that 810 nm and 665 nm wavelengths may also be effective, but those specific wavelengths are not able to produce as much iNOS expression, when compared to 905 nm superpulsed technology [6]. An average power for the superpulsed 905 nm laser diodes was initially chosen to be 50mW based on personal experience, but further clinical investigations may uncover more clinically effective average power settings.

Immediately after the first treatment of only ten minutes in duration, the patient reported a 43% reduction in pain, reporting a VAS of 4/10 from a pre-treatment score of 7/10. He stated the throbbing and squeezing nature of his pain had immediately subsided and that all that was left was more of a dull achy pain. He continued with the treatments over the next week and with each new treatment his pain was further reduced. By the end of the course of 5 treatments, his pain had reduced by over 90% and all that remained was a minor ache that was barely even noticeable. Furthermore, he reported no side effects from the treatment except for a slight sensation of warmth over the area where the laser was placed. He was no longer experiencing constant pain; even his children noticed the difference saying that he looked happier. After two years, he was finally able to achieve a good night's rest.

3. DISCUSSION

Low Level Laser Therapy (LLLT) has been used in many acute and chronic conditions, but its effectiveness is yet to be fully documented by human clinical trials for migraine, stroke or TBI. Currently Dr. Michael Whalen, working at Massachusetts General Hospital, is conducting controlled studies using a low level laser with the hopes of bringing this new technology into the forefront of neuroscience and medicine. This case study gives one example of how LLLT can be used to treat chronic migraines, specifically those that are a result of traumatic brain injuries. LLLT has been shown to reduce pain and inflammation, create a state of vasodilation by activating the nitric oxide pathway and further even promote angiogenesis. The present theory is that by increasing blood flow to the brain, and subsequently, increasing oxygen delivery to the brain, the symptoms of a migraine can be mitigated. This case differs from previous studies performed using laser therapy to help patients with TBIs in that the type of laser and the settings used were unique. Specifically, unlike the LED light used by Naeser et al., the therapeutic laser we utilized only required five treatments over two weeks to be effective with immediate results after the first treatment.

It is currently unclear whether or not our patient will need maintenance therapy. He was interviewed at two weeks and *5 months post treatment, does carpentry work with his father* and remains symptom free. He is deeply appreciative of the care he was given and continues to enjoy family life which was impossible before LLLT. More research needs to be done, especially controlled double blind studies to further evaluate the full effectiveness and possible side effects of using LLLT in the treatment of TBIs and migraines, but the latest research has shown that LLLT is an extremely safe and effective technology for a wide range of neural and muscular skeletal conditions.

Note: Mr. Banas has successfully treated over 65 migraine patients not all of whom were victims of a TBI but except for a few instances gave the a patients life changing , significant relief.

REFERENCES

1. Faul M, X.L., Wald MM, Coronado VG, *Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths.* 2010.
2. Finkelstein E, C.P., Miller T and associates, *The Incidence and Economic Burden of Injuries in the United States.* Oxford University Press, 2006.
3. Sahni, T., et al., *Use of hyperbaric oxygen in traumatic brain injury: retrospective analysis of data of 20 patients treated at a tertiary care centre.* Br J Neurosurg, 2012. **26**(2): p. 202-7.
4. Naeser, M.A. and M.R. Hamblin, *Potential for transcranial laser or LED therapy to treat stroke, traumatic brain injury, and neurodegenerative disease.* Photomed Laser Surg, 2011. **29**(7): p. 443-6.
5. Moriyama, Y., et al., *In vivo effects of low level laser therapy on inducible nitric oxide synthase.* Lasers Surg Med, 2009. **41**(3): p. 227-31.
6. Wu, Q., et al., *Low-level laser therapy for closed-head traumatic brain injury in mice: effect of different wavelengths.* Lasers Surg Med, 2012. **44**(3): p. 218-26.