The Benefits of Transcranial Laser Therapy

By Paul Schwen

Using Transcranial Laser Therapy (TLT) to Treat Traumatic Brain Injury (TBI), Concussion, Ischemic Stroke, Neurodegenerative Disorders (Alzheimer's, Parkinson's, Dementia), Neurotransmitter Disorders (Depression, Anxiety, Paranoia, Schizophrenia, Posttraumatic Stress Disorder)

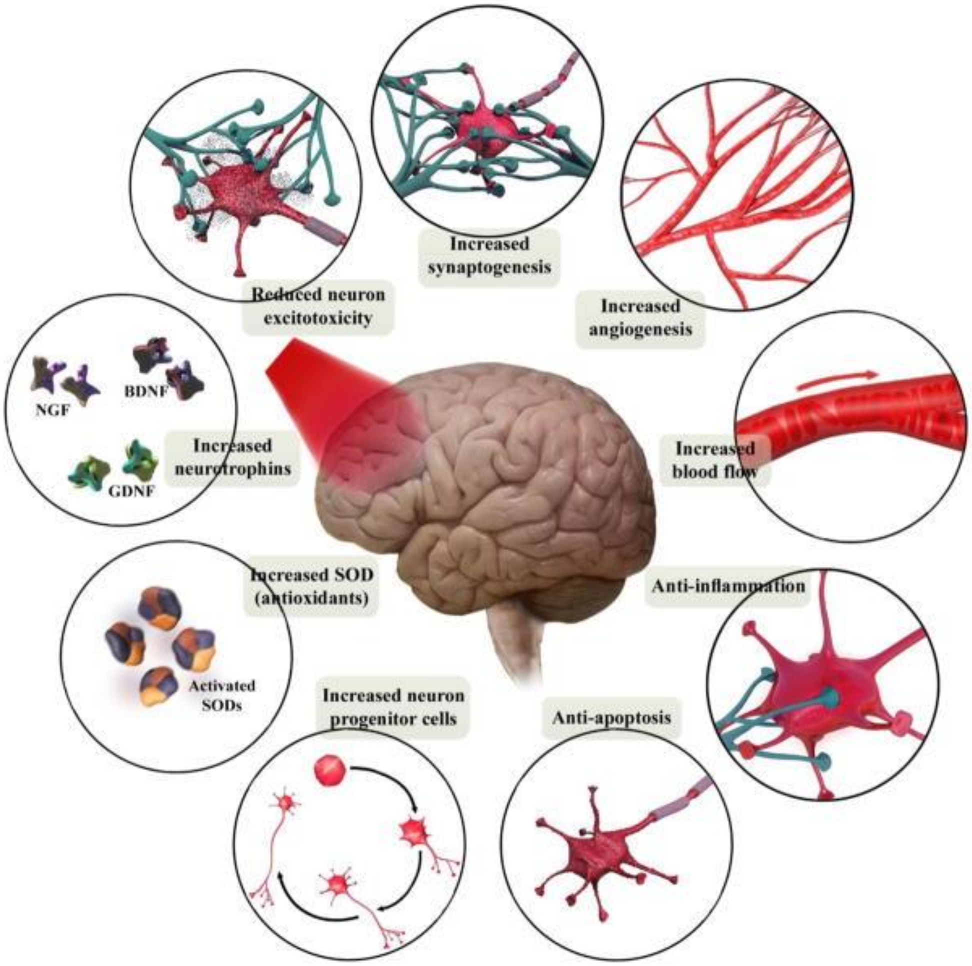
Traumatic brain injury (TBI) can include skull fracture, intracranial hemorrhage, elevated intracranial pressure, and/or cerebral contusion. Unlike stroke, the prevalence of which is tied with an increasing age of onset, TBI is much more common in younger populations. Not only does TBI have a large impact on the healthcare industry but also causes severe socioeconomic problems throughout the world. Every year in the United States, there are nearly 2 million head injuries resulting in 283,000 hospitalizations, 53,000 of which lead to death.1–3 Consequently, Americans living with TBI-related disabilities cost an estimated $56 billion yearly.4 In 2001, the World Health Organization (WHO) projected that within 5 years, motor vehicle accidents, one of the largest causes of TBI, would be ranked just behind ischemic heart disease and unipolar major depression as a cause of morbidity and mortality.

Transcranial laser therapy (TLT), otherwise known as transcranial photomedicine TPM) or Transcranial Photobiomodulation (TPMB) is an effective, fast-growing approach to treating many different brain injuries and disorders. TLT is noninvasive and can be administered immediately after the onset of brain injury or diagnosis of brain disorder and is effective in long term treatment of brain injuries and disorders. The following benefits have been observed following transcranial laser therapy:

1. Neurogenesis (the ability of the brain to repair itself)
2. Synaptogenesis (encourage cells to form new synaptic connections)
3. Improved blood flow to neural tissues
4. Decrease in inflammation
5. Apoptotic cellular death inhibition
6. Neural tissue regeneration
7. Healing of lesions
8. Reduction in scar tissue
9. Enhanced recovery of cognitive function
10. Reduction in symptoms of neurodegenerative disorders
11. Reduction in symptoms of neurotransmitter disorders
12. Improved cerebral hemodynamics (the capacity of the brain to increase cerebral blood volume (CBV) to maintain a constant regional cerebral blood flow (rCBF) in the face of low cerebral perfusion pressure (CPP))
13. Reduction in migraine and cervicogenic headaches
14. No adverse side effects
15. Increase in memory, learning, overall neurological performance
16. Improvement in moods
17. Better, more productive sleep
18. Increased IQ

Brain Cells are Ideally Configured to Respond to Laser Therapy

Nerve cell function utilizes biochemical light pulses as a means of molecular signaling; as laser energy readily penetrates through the skull into cortical tissues, brain cells are ideally configured to respond to therapeutic light energy delivered via therapy laser application. The basic biochemical pathways activated by laser energy, i.e. increased adenosine-triphosphate (ATP) production, and signaling pathways activated by reactive oxygen species, nitric oxide release, and increased cyclic adenosine monophosphate (AMP) all work together to produce beneficial effects in brains when function has been compromised by ischemia, traumatic injury, or neurodegeneration.



Below are summaries of randomized, double blinded clinical research studies demonstrating the benefits of transcranial laser therapy:

Effectiveness and Safety of Transcranial Laser Therapy for Acute Ischemic Stroke
https://www.ahajournals.org/doi/pdf/10.1161/STROKEAHA.109.547547
Objective:
There is an urgent and unmet need for safer and more effective treatment for stroke, traumatic brain injury (TBI), and concussive injuries that could be quickly administered initially and for extended periods after stroke or injury onset. Currently there is a notable lack of therapeutic alternatives for what has become a global epidemic of brain injuries.

Transcranial laser therapy is a noninvasive technology that uses near infrared laser energy delivered transcranially to modulate biochemical changes within neural cells. The evidence of biochemical modulation caused by electromagnetic radiation has been proven many times over the years.[1]

1. *Karu T. Ten Lectures on Basic Science of Laser Phototherapy. Grangesberg, Sweden: Prima Books. ISBN 2007;978-91-976478-0-9.Google Scholar*

The concept of enhancing mitochondrial function in concussive injuries and or ischemic stroke is based on several lines of evidence suggesting that mitochondrial viability is critical to protect cells in the ischemic penumbra. Randomized, double-blind clinical research has shown that the net effect of the absorption of infrared energy includes increased adenosine triphosphate (ATP) formation, enhanced recovery, and inhibition of apoptosis.[2]

2. *Moskowitz M, Lo E. Neurogenesis and apoptotic cell death. Stroke. 2003; 34: 324–326*

Conclusion:
Given the evidence regarding the antiapoptotic effect of near infrared irradiation and the apparent extended time window of efficacy, during which apoptotic cell death could still be occurring in the penumbra, transcranial laser therapy acts in a neuroprotective fashion to stop cell death and restore cognitive function. Transcranial laser therapy also enhances recovery of function because there is evidence that lesion volume is not altered, but neurological function is restored.

Transcranial Laser Therapy (photomedicine) restores cognitive function and significantly reduces chronic migraine pain and cervicogenic headaches due to concussive injuries and TBI (Traumatic Brain Injury) caused by hockey injuries.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5180077/
Objective:
Ice hockey has been identified as the sport with the highest risk for concussions. On the ice, concussions result from a fall, being struck in the head by a hockey stick or puck, and from players colliding with the ice, each other, or the boards. Given the speed and brutality with which the game is played, it should come as no surprise that ice hockey has the highest rate of concussion incidence amongst contact sports. These injuries can be debilitating, resulting in chronic head pain and ongoing cognitive disabilities.

Conclusion:
Transcranial Laser Therapy has proven effective in reducing and/or eliminating the symptoms of head pain and cognitive dysfunction due to concussive injuries.[3]

3. *Goodman D, Gaetz M, Meichenbaum D. Concussions in hockey: there is cause for concern. Medicine and Science in Sports and Exercise. 2001;22:2004–2009ontact sports.4,5*

Treating cognitive impairment with transcranial laser therapy
https://www.ncbi.nlm.nih.gov/pubmed/28219828
Objective:
This report examines the potential of laser therapy (photomedicine) to alter brain cell function and neurometabolic pathways using near infrared (NIR) wavelengths transcranially for the prevention and treatment of cognitive impairment. Boosting neurometabolic activity through non-invasive transcranial laser biostimulation of neuronal mitochondria is a valuable tool in preventing or delaying age-related cognitive decline that can lead to dementia, including its two major subtypes, Alzheimer's and vascular dementia.

Conclusion:
The technology to achieve significant improvement of cognitive dysfunction using transcranial laser therapy signals a new chapter in the treatment and prevention of neurocognitive disorders.

Transcranial laser stimulation improves human cerebral oxygenation
https://www.ncbi.nlm.nih.gov/pubmed/26817446
Objective:
Transcranial laser stimulation of the brain with near-infrared light is a novel form of non-invasive photobiomodulation or low-level laser therapy (TLT) that has shown therapeutic potential in a variety of neurological and psychological conditions. This study investigated how transcranial laser

stimulation influences cerebral hemodynamics and oxygenation in the human brain in vivo using functional near-infrared spectroscopy (fNIRS).

Results:
In both experiments, transcranial laser stimulation induced an increase of oxygenated hemoglobin concentration (Δ[HbO2]) and a decrease of deoxygenated hemoglobin concentration (Δ[Hb]) in both cerebral hemispheres. Improvements in cerebral oxygenation were indicated by a significant increase of differential hemoglobin concentration (Δ[HbD] = Δ[HbO2] - Δ[Hb]). These effects increased in a dose-dependent manner over time during laser stimulation and persisted after laser stimulation. The total hemoglobin concentration (Δ[HbT] = Δ[HbO2] + Δ[Hb]) remained nearly unchanged in most cases.

Conclusion:
Near-infrared laser stimulation applied transcranially can improve cerebral oxygenation.

Transcranial Low-Level Laser (Light) Therapy for Brain Injury
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5180077/
Objective:
A number of articles have shown Transcranial Laser Therapy (TLT) is effective at increasing memory, learning, and the overall neurological performance in animal models with TBI.

TLT has strong evidence for many beneficial effects on TBI and stroke in both animal models and human patients. Both acute stroke and acute TBI have a growing number of studies being published showing that TLT is an effective means of treating both. The many benefits of TLT are thought to be based on several different biological mechanisms. Near-infrared PBM (photobiomodulation) functions with improving mitochondrial energy production by stimulating the enzyme CCO and increasing ATP synthesis. Laser therapy can result in neuroprotection and help prevent the spread of brain cell death after injury as shown by the long-term development of smaller lesion areas in animals treated with TLT, when delivered at 4 hours post-TBI. Protection against toxins, increased cellular proliferation, and reduction in apoptosis and anti-inflammatory and antiedema effects also contribute to the mechanisms that underlie the beneficial effects of PBM. The most exciting process is that TLT stimulates both neurogenesis (the ability of the brain to repair itself) and synaptogenesis (encourage cells to form new synaptic connections). This could lead to the application of TLT as a treatment modality for neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease. Well-funded, controlled studies are necessary.

Cerebral Perfusion Enhancing Interventions: A New Strategy for the Prevention of Alzheimer Dementia
https://www.ncbi.nlm.nih.gov/pubmed/27324946

Objective:
Cardiovascular and cerebrovascular diseases are major risk factors in the development of cognitive impairment and Alzheimer's disease (AD). These cardio-cerebral disorders promote a variety of vascular risk factors which in the presence of advancing age are prone to markedly reduce cerebral perfusion and create a neuronal energy crisis. Long-term hypoperfusion of the brain evolves mainly from cardiac structural pathology and brain vascular insufficiency. Brain hypoperfusion in the elderly is strongly associated with the development of mild cognitive impairment (MCI) and both conditions are presumed to be precursors of Alzheimer dementia. A therapeutic target to prevent or treat MCI and consequently reduce the incidence of AD aims to elevate cerebral perfusion using novel pharmacological agents. As reviewed here, the experimental pharmaca include the use of Rho kinase

inhibitors, neurometabolic energy boosters, sirtuins and vascular growth factors. In addition, a compelling new technique in laser medicine called photobiomodulation is reviewed.

Conclusion:
Photobiomodulation is based on the use of transcranial laser therapy to stimulate mitochondrial energy production non-invasively in nerve cells. The use of photobiomodulation is an important tool in the treatment or prevention of cognitive decline that can lead to dementia.

Laser therapy (TLT) reduces oxidative stress in primary cortical neurons
https://www.ncbi.nlm.nih.gov/pubmed/23281261
Objective:
Transcranial laser therapy (TLT) involves absorption of photons by mitochondria of cells leading to improvement in electron transport, increased mitochondrial membrane potential (MMP), and greater ATP production. Low levels of reactive oxygen species (ROS) are produced by TLT in normal cells that are beneficial. We exposed primary cultured murine cortical neurons to oxidative stressors: hydrogen peroxide, cobalt chloride and rotenone in the presence or absence of TLT (3 J/cm², CW, 810 nm wavelength laser, 20 mW/cm²). Cell viability was determined by Prestoblue™ assay. ROS in mitochondria was detected using Mito-sox, while ROS in cytoplasm was detected with CellRox™. MMP was measured with tetramethylrhodamine. In normal neurons TLT elevated MMP and increased ROS.

Conclusion:
In oxidatively-stressed cells TLT increased MMP but reduced high ROS levels and protected cultured cortical neurons from death. Although TLT increases ROS in normal neurons, it reduces ROS in oxidatively-stressed neurons. In both cases MMP is increased. These data may explain how TLT can reduce clinical oxidative stress in various lesions while increasing ROS in cells in vitro.

NEUROSCIENCE/ LASER THERAPY: Laser therapy boosts cognitive function following brain injury
https://www.bioopticsworld.com/articles/2011/05/neuroscience-low-level-laser-therapy-led-therapy-boosts-cognitive-function-following-brain-injury.html
Objective:
Research published in Photomedicine and Laser Surgery (doi:10.1089/pho.2010.2814) details case reports documenting improved cognitive function in chronic traumatic brain injury (TBI) patients treated with transcranial light-emitting diodes (LEDs), and concludes that controlled studies are warranted. The study reports the application of red and near-infrared LEDs, applied transcranially to forehead and scalp areas of patients.

Conclusion:
Patient 1 began the low-level laser therapy (TLT) seven years after closed-head TBI from a motor vehicle accident, at a time when her ability for sustained attention (computer work) was just 20 minutes. After eight weekly treatments (applied bilaterally for between 5 and 13 minutes), her sustained attention time increased to three hours. She has now performed nightly home treatments for five years. Patient 2 had a history of closed-head trauma (sports/military and recent fall), and magnetic resonance imaging showed frontoparietal atrophy. When she began the LED treatment, she had been on medical disability for five months. After four months of nightly LED treatments at home, she was able to discontinue medical disability and return to working full-time. Neuropsychological testing after nine months of LED treatment indicated significant improvement in executive function (inhibition, inhibition accuracy) and memory, as well as reduction in post-traumatic stress disorder. These patients' cognitive gains decreased if they stopped treatment for one to two weeks, and returned when treatment was restarted. The findings will provide a basis for future therapeutic use of phototherapy, according to Raymond J. Lanzafame, editor-in-chief of Photomedicine and Laser Surgery. "The development of novel therapies to restore function after neurologic injury, stroke, or disease is an increasingly important goal in medical research as a result of an increase in non-fatal traumatic wounds and the

increasing prevalence of dementias and other degenerative disorders in our aging population," he explains.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5803455/pdf/nihms911264.pdf

Photobiomodulation for Traumatic Brain Injury and Stroke

There is a notable lack of therapeutic alternatives for what is fast becoming a global epidemic of traumatic brain injury (TBI). Photobiomodulation (PBM) employs red or near-infrared (NIR) light (600-1100nm) to stimulate healing, protect tissue from dying, increase mitochondrial function, improve blood flow and tissue oxygenation. PBM can also act to reduce swelling, increase antioxidants, decrease inflammation, protect against apoptosis, and modulate microglial activation state. All these mechanisms of action strongly suggest that PBM delivered to the head should be beneficial in cases of both acute and chronic TBI; many studies have found positive effects on neurological function, learning and memory, and reduced inflammation and cell death, in the brain. There is evidence that PBM can help the brain to repair itself by stimulating neurogenesis, upregulating BDNF synthesis, and encouraging synaptogenesis. In healthy human volunteers PBM has been shown to increase regional cerebral blood flow, tissue oxygenation and improve memory, mood and cognitive function. Clinical studies have been conducted in patients suffering from the chronic effects of TBI. There have been reports of improvements in executive function, working memory, and improved sleep. Functional magnetic resonance imaging has shown modulation of activation in intrinsic brain networks likely to be damaged in TBI (default mode network and salience network).