Transcranial Photobiomodulation Prevents Anxiety and Depression via Changing Serotonin and Nitric Oxide Levels in Brain of Depression Model Mice: A Study of Three Different Doses of 810nm Laser

Emad Eshaghi, MSc,[1,2] Saeed Sadigh-Eteghad, PhD,[1] Gisou Mohaddes, PhD,[1] and Seyed Hossein Rasta, PhD[1,2,3,4]_

[1]Neurosciences Research Center (NSRC), Tabriz University of Medical Sciences, Tabriz, Iran
[2]Department of Medical Physics, Tabriz University of Medical Sciences, Tabriz, Iran
[3]Department of Medical Bioengineering, Tabriz University of Medical Sciences, Tabriz, Iran
[4]School of Medical Sciences, University of Aberdeen, Aberdeen, United Kingdom

Objectives: The effectiveness of transcranial photobiomodulation (TPBM) in treating anxiety and depression disorders is a demonstrated and identified issue. However, the optimum therapeutic dose and the underlying mechanism of action are not fully understood. In this study, the therapeutic effects of three different near-infrared (NIR) doses on anxiety- and depression-like behaviors as well as cerebral levels of serotonin (5-HT) and nitric oxide (NO) were evaluated in a mouse model of chronic restraint stress (CRS).

Materials and Methods: CRS procedure (3 hours/day, over 3 weeks) was performed as a typical stress model to study anxiety and depression along with laser treatment (3 times/week, over 3 weeks), which began simultaneously with CRS. A NIR diode laser (810nm wavelength, 10 Hz) with the output power of 200mW and power density of 4.75 W/cm2 was implemented to deliver three different doses of 4, 8, and 16 J/cm2 to the cerebral cortex of mice. Behavioral experiments including open field, tail suspension, and elevated plus maze tests as well as serum cortisol levels were assessed to evaluate the anti-anxiety and antidepressive effects of NIR TPBM. The changes of 5-HT and NO levels in the prefrontal cortex (PFC) and hippocampus (Hipp) were assessed.
Results: CRS procedure induced anxiety- and depression like behaviors, increased serum cortisol levels, decreased 5-HT and increased NO levels in the PFC and Hipp areas. NIR TPBM improved behavioral results, decreased serum cortisol levels, increased 5-HT and decreased NO concentrations in the PFC and Hipp. A dose of 8 J/cm2 of NIR TPBM showed the maximum effects on behavioral and molecular results, while a decline was observed from the optimum effects at both lower (4 J/cm2) and higher (16 J/ cm2) doses.

Conclusion: Our results demonstrated that NIR TPBM had an anti-anxiety and anti-depressive effect in CRS mice, which is probably linked to increasing 5-HT and decreasing NO levels in the PFC and Hipp areas. Also, the maximum anti-anxiety and anti-depressive effect was produced at dose of 8 J/cm2.
Lasers Surg. Med.