Light-tissue interaction of laser with neonatal rat brains

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Introduction

Neonatal anoxia is a major causa of neonatal deaths worldwide. The oxygen deprivation during birth can lead to incapacitating sequelae to surviving newborns, like the impairment of motor and cognitive functions [1]. The hippocampus is particularly sensible to such insults. The prefrontal cortex when hit by this insult, leads to disorders of attention-deficit/hyperactivity and learning disorders. Currently, the only available therapeutic solution for such insult is submitting neonates to hypothermia therapy [2].

Photobiomodulation therapy (PBM) consists of the application of light in a target injured tissue with the objective of promoting wound healing and reducing pain, inflammation and swelling [3]. Recent studies have shown its capabilities of reducing inflammation and having neuroprotective effects on the central nervous system, while also displaying promising results in the treatment of Parkinson, Alzheimer, stroke and traumatic brain injury [4].

Given the context, our research group aimed to investigate the light-tissue interaction using an animal model of neonate rat brains, by evaluating the light distribution, propagation and attenuation throughout the brain and also quantifying the amount of light that reaches the hippocampus and the pre-frontal cortex.

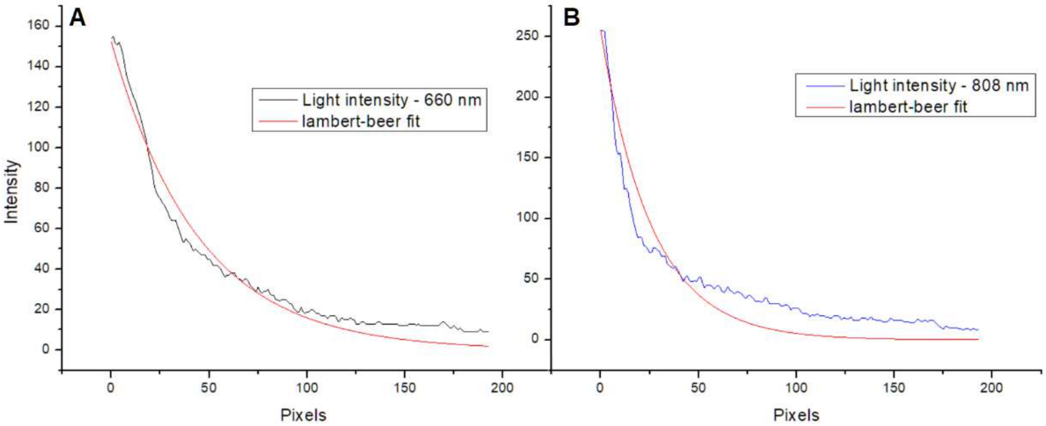
Materials and Methods

Neonate Wistar rat brains will be used to evaluate light distribution, being irradiated with a laser of 808 nm and 660 nm of wavelength in the bregma region. Images will be acquired perpendicular in relation to the target surface using an infrared sensible camera (Luca®, Andor Technology, North Ireland), later to be transformed into intensity matrices and the value of attenuation will be analyzed using a lambert-beer curve fitting. The tissue absorbance/ transmittance and reflectance will also be analyzed using a spectrophotometer (Cary 5000, Agilent Technologies, USA). The spectroscopic data will be collected for different regions of the brain. Preliminary test results for light attenuation were already obtained using adult Wistar rat brains. (CEUA: 8852240517).

Results and Discussion

Preliminary test images of irradiated adult rat brains at 808 and 660 nm were obtained and the 8-bit grayscale data were extracted using Python as intensity matrices. The following graphs were obtained in a straight line with the laser header direction, from the surface of the brain in the bregma region (dorsal) till the end of the tissue (ventral):

Figure 1: Plot of light intensity of different wavelengths of irradiation of an adult rat brain. The data was also fit into a lambert-beer function. Source: own work.



It is noticeable that the 808 nm wavelength (B) has a steeper curve, which may indicate a higher value of light attenuation. Further calculations with a more robust model of lambert-beer curve fitting will be added later on.

The spectroscopy data will be collected for different regions of the brain in transversal slices, following the same dorsal-ventral way of the light attenuation analysis. Despite having differences in grey and white matter concentrations, it is expected that the different regions don't deviate too much from one another in terms of light absorbance and reflectance.

Conclusions

Our study aims to help define an adequate methodology of light irradiation for future applications of photobiomodulation therapy in the brain.

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