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The Current Role of Non-invasive Treatments in Traumatic Brain Injury

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Abstract

Due to the morbidity associated with traumatic brain injury (TBI), it is essential to have a rehabilitation plan, preferably multi-professional, to obtain the maximum degree of recovery of neurological and neuropsychological functions. Three types of non-invasive treatment techniques have been studied in patients with TBI and shown promising: Repetitive Transcranial Magnetic Stimulation (rTMS), the transcranial direct current stimulation (tDCS), and transcranial Led Therapy. The displayed data of this article implies that these non-invasive techniques can be used as an effective therapeutic approach to increase brain function in neurocognitive disorders and are a promising treatment for traumatic brain injury patients.

Introduction

Due to the morbidity associated with trauma, it is essential to have a rehabilitation plan, preferably multi-professional, to obtain the maximum degree of recovery of neurological and neuropsychological functions. Non-invasive brain stimulation modes allow researchers to study the activity of the human brain in real time, characterize the excitation balance and cortical inhibition, and finally to guide plastic changes [1]. Conventional rehabilitation strategies in patients with severe traumatic brain injury (TBI) obtained limited functional recovery. Justify the dual nature of the lesion, it means, the combination of focal and diffuse lesions makes the anatomic-clinical correlation challenging [2].

Three types of non-invasive treatment techniques have been studied in patients with TBI and shown promising: The Repetitive Transcranial Magnetic Stimulation (rTMS), the transcranial direct current stimulation (tDCS), and transcranial Led Therapy (TCLT). A single stimulation session has pro-cognitive effects in computerized neuropsychological tests, such as working memory, verbal fluency, reaction time, cognitive interference and sustained attention [3].

The rTMS for TBI is grounded on the perspective that induction changes in cortical excitability may lead to reorganization of a network responsible for an impaired cognitive function. This function can be compensated by mechanisms involving structural and functional changes in brain circuits [4] Studies have proven the improvement in some cognitive aspects after rTMS. The rTMS enhances positive neuroplastic changes that represents real improvement in the cognitive domains (like working memory), quality of life and in mood disorder [4].

The low-level laser therapy, when applied to the Central Nervous System (CNS) addressed to the aforementioned terminology includes lasers and LEDs type devices with power densities less than 100 mW/cm^2. Power density that order does not cause heating of biological tissues, producing only photochemical effects, which induce photobiomodulation which, in turn, has beneficial results, such as acceleration healing in skin wounds, improved recovery in ischemic damage in the heart and improves mitochondrial energy metabolism [5].

The metabolic changes caused by light energy occur both in superficial tissues, as in deep tissue [5]. Its action takes place primarily on cellular organelles (mitochondria and membrane) causing increase of adenosine triphosphate (ATP) and modifying the ionic transport. In this case, mobile photoreceptor sensitive to certain wavelengths that trigger chemical reactions in the short term, causes the acceleration of ATP synthesis (glycolysis and oxidative phosphorylation) and long-term transcription and DNA replication [6].

In humans the use of laser therapy has also started to be used with different focuses. A low-power laser therapy was used to verify the biostimulant effects of this therapy in tissue repair. It might be noted that after completion of the dental procedure patients undergoing therapy had vascular hyperemia increased local blood circulation, increased metabolism, collagen synthesis, stimulation produce endorphins, inhibiting nociceptor signals, which brought analgesic, anti- inflammation, tissue edema and reduction in healing effect [7]. On the other hand, when specifically applied to the CNS, They have also had their related results to those found in animal models and in clinical use. Results have been found in research on neurological recovery in acute ischemic stroke [8], in psychiatric disorders [9], neuro-degenerative diseases [10], in healthy people [11] and TBI victims [12].

The study of patients from the third month after the injury, in a research developed over 10 months had results suggesting that 45 minutes of exposure Transcranial LED Therapy for 4 weeks (the own patient's residence) could be a non-pharmacological treatment, safe, effective and cheap for the relief of symptoms of fatigue and daytime sleepiness in patients with TBI. Data pointing to a non-invasive treatment with important implications for rehabilitation of victims after the TBI [12].

It's also been suggested in other research [12]. TCLT found that increases the expression of growth factors in nerve cells, contributing to the regeneration of damaged brain tissue by the ECA. In this research, two cases of TBI victims, with a number of functional loss, and comorbidity framework involving Posttraumatic Stress Disorder

(PTSD), with serious consequences in their lives, and were subjected to systematic exposure TCLT, achieved remission of mood symptoms, PTSD, and recover their functionality, return to work and daily activities.

In one case, after 4 months of treatment with evening sessions (with gradually increased duration of 7 to 10 minutes) every day at home, the patient, considered unable to perform their work duties by medical skill, had gains related to attention, executive functions, memory, remission of symptoms related to PTSD, and returned to work full time as an executive consultant in an international business technology consulting [12].

TMS results in acute, transient changes in neuronal activity, secondary to shifts in the ionic equilibrium around the storage of charge directly from stimulation or cortical neurons. More lasting effects, otherwise, are considered to occur due to use-dependent mechanisms of plasticity, including synaptic modifications [13].

Brain excitability can be modulated by tDCS via the application of low-amplitude (0.5–2 mA) direct current through scalp electrodes. This current can lead to increased or even decreased neuronal excitability depending upon the polarity and spatial arrangement of the electrodes, through its effects on resting membrane potentials. Earlier reports demonstrated the capacity of tDCS to modulate motor cortical excitability. Short-term effects of tDCS occur probably via non-synaptic mechanisms by depolarization of resting membrane potentials [14]. Reports have demonstrated its utility in the facilitation of several cognitive domains, such as visuo-motor learning and implicit motor-learning [13].

The displayed data implies that these noninvasive techniques can be used as an effective therapeutic approach to increase brain function in neurocognitive disorders and are a promising treatment for traumatic brain injury patients, resizing the metabolic relation of cost/benefit of own energy consumption, keeping our day-to-day life

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