

Anodal Transcranial Direct Current Stimulation

Cerebrovascular reactivity (CVR) is a compensatory mechanism where blood vessels dilate in response to a vasodilatory stimulus and is a **biomarker** of vascular reserve and microvascular health. Impaired CVR indicates microvascular hemodynamic dysfunction, which is implicated in **traumatic brain injury** (TBI) and associated with long-term neurological deficiency. Recently we have shown that anodal **transcranial direct current stimulation** (tDCS) caused prolonged dilatation of cerebral arterioles that increased brain microvascular flow and tissue oxygenation in the traumatized mouse brain and was associated with neurologic improvement. Here we evaluate the effects of tDCS on impaired CVR and microvascular cerebral blood flow (mCBF) regulation after TBI. TBI was induced in mice by controlled cortical impact (CCI). Cortical microvascular tone, mCBF, and tissue oxygen supply (by nicotinamide adenine dinucleotide, NADH) were measured by two-photon laser scanning microscopy before and after anodal tDCS (0.1 mA/15 min). CVR and mCBF regulation were evaluated by measuring changes in arteriolar diameters and NADH during hypercapnia test before and after tDCS. Transient hypercapnia was induced by 60-s increase of CO₂ concentration in the inhalation mixture to 10%. As previously, anodal tDCS dilated arterioles which increased arteriolar blood flow volume that led to an increase in capillary flow velocity and the number of functioning capillaries, thereby improving tissue oxygenation in both traumatized and sham animals. In sham mice, transient hypercapnia caused transient dilatation of cerebral arterioles with constant NADH, reflecting intact CVR and mCBF regulation. In TBI animals, arteriolar dilatation response to hypercapnia was diminished while the NADH level increased (tissue oxygen supply decreased), reflecting impaired CVR and mCBF regulation. Anodal tDCS enhanced reactivity in parenchymal arterioles in both groups (especially in TBI mice) and restored CVR thereby prevented the reduction in tissue oxygen supply during hypercapnia. CVR has been shown to be related to nitric oxide elevation due to nitric oxide synthases activation, which can be sensitive to the electrical field induced by tDCS ¹⁾.

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Bragina OA, Semyachkina-Glushkovskaya OV, Nemoto EM, Bragin DE. Anodal Transcranial Direct Current Stimulation Improves Impaired Cerebrovascular Reactivity in Traumatized Mouse Brain. Adv Exp Med Biol. 2020;1232:47-53. doi: 10.1007/978-3-030-34461-0_7. PubMed PMID: 31893393.

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