Trigeminal Nerve Stimulation

Delayed cerebral ischemia (DCI) is the most consequential secondary insult after aneurysmal subarachnoid hemorrhage (SAH). It is a multifactorial process caused by a combination of large artery vasospasm and microcirculatory dysregulation. Despite numerous efforts, no effective therapeutic strategies are available to prevent DCI. The trigeminal nerve richly innervates cerebral blood vessels and releases a host of vasoactive agents upon stimulation. As such, electrical trigeminal nerve stimulation (TNS) has the capability of enhancing cerebral circulation.

Objective: To determine whether TNS can restore impaired cerebral macrocirculation and microcirculation in an experimental rat model of SAH.

Methods: The animals were randomly assigned to sham-operated, SAH-control, and SAH-TNS groups. SAH was induced by endovascular perforation on Day 0, followed by KCl-induced cortical spreading depolarization on day 1, and sample collection on day 2. TNS was delivered on day 1. Multiple end points were assessed including cerebral vasospasm, microvascular spasm, microthrombosis, calcitonin gene-related peptide and intercellular adhesion molecule-1 concentrations, degree of cerebral ischemia and apoptosis, and neurobehavioral outcomes.

Results: SAH resulted in significant vasoconstriction in both major cerebral vessels and cortical pial arterioles. Compared with the SAH-control group, TNS increased lumen diameters of the internal carotid artery, middle cerebral artery, and anterior cerebral artery, and decreased pial arteriolar wall thickness. Additionally, TNS increased cerebrospinal fluid calcitonin gene-related peptide levels, and decreased cortical intercellular adhesion molecule-1 expression, parenchymal microthrombi formation, ischemia-induced hypoxic injury, cellular apoptosis, and neurobehavioral deficits.

Conclusion: Our results suggest that TNS can enhance cerebral circulation at multiple levels, lessen the impact of cerebral ischemia, and ameliorate the consequences of DCI after SAH [1)].

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Shah KA, White TG, Powell K, Woo HH, Narayan RK, Li C. Trigeminal Nerve Stimulation Improves Cerebral Macrocirculation and Microcirculation After Subarachnoid Hemorrhage: An Exploratory Study. Neurosurgery. 2022 Feb 23. doi: 10.1227/NEU.0000000000001854. Epub ahead of print. PMID: 35188109.