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Hydrogen-rich saline attenuates neuronal ischemia-reperfusion injury by protecting mitochondrial function in rats

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Abstract

Background: Hydrogen, a popular antioxidant gas, can selectively reduce cytotoxic oxygen radicals and has been found to protect against ischemia-reperfusion (I/R) injury of multiple organs. Acute neuronal death during I/R has been attributed to loss of mitochondrial permeability transition coupled with mitochondrial dysfunction. This study was designed to investigate the potential therapeutic effect of hydrogen-rich saline on neuronal mitochondrial injury from global cerebral I/R in rats.

Materials and methods: We used a four-vessel occlusion model of global cerebral ischemia and reperfusion, with Sprague-Dawley rats. The rats were divided randomly into six groups (n = 90): sham (group S), I/R (group I/R), normal saline (group NS), atractyloside (group A), hydrogen-rich saline (group H), and hydrogen-rich saline + atractyloside (group HA). In groups H and HA, intraperitoneal hydrogen-rich saline (5 mL/kg) was injected immediately after reperfusion, whereas the equal volume of NS was injected in the other four groups. In groups A and HA, atractyloside (15 μ L) was intracerebroventricularly injected 10 min before reperfusion, whereas groups NS and H received equal NS. The mitochondrial permeability transition pore opening and mitochondrial membrane potential were measured by spectrophotometry. Cytochrome c protein expression in the mitochondria and cytoplasm was detected by western blot. The hippocampus mitochondria ultrastructure was examined with transmission electron microscope. The histologic damage in hippocampus was assessed by hematoxylin and eosin staining.

Results: Hydrogen-rich saline treatment significantly improved the amount of surviving cells ($P < 0.05$). Furthermore, hydrogen-rich saline not only reduced tissue damage, the degree of mitochondrial swelling, and the loss of mitochondrial membrane potential but also preserved the mitochondrial cytochrome c content ($P < 0.05$).

Conclusions: Our study showed that hydrogen-rich saline was able to attenuate neuronal I/R injury, probably by protecting mitochondrial function in rats.

Keywords: Cytochrome c; Global cerebral ischemia-reperfusion; Hydrogen; Mitochondria; Neuroprotection; Permeability transition.

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