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Protection of the retina by rapid diffusion of hydrogen: administration of hydrogen-loaded eye drops in retinal ischemia-reperfusion injury

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Abstract

Purpose: Retinal ischemia-reperfusion (I/R) injury by transient elevation of intraocular pressure (IOP) is known to induce neuronal damage through the generation of reactive oxygen species. Study results have indicated that molecular hydrogen (H(2)) is an efficient antioxidant gas that selectively reduces the hydroxyl radical (*OH) and suppresses oxidative stress-induced injury in several organs. This study was conducted to explore the neuroprotective effect of H(2)-loaded eye drops on retinal I/R injury.

Methods: Retinal ischemia was induced in rats by raising IOP for 60 minutes. H(2)-loaded eye drops were prepared by dissolving H(2) gas into a saline to saturated level and administered to the ocular surface continuously during the ischemia and/or reperfusion periods. One day after I/R injury, apoptotic cells in the retina were quantified, and oxidative stress was evaluated by markers such as 4-hydroxynonenal and 8-hydroxy-2-deoxyguanosine. Seven days after I/R injury, retinal damage was quantified by measuring the thickness of the retina.

Results: When H(2)-loaded eye drops were continuously administered, H(2) concentration in the vitreous body immediately increased and I/R-induced *OH level decreased. The drops reduced the number of retinal apoptotic and oxidative stress marker-positive cells and prevented retinal thinning with an accompanying activation of Müller glia, astrocytes, and microglia. The drops improved the recovery of retinal thickness by >70%.

Conclusions: H(2) has no known toxic effects on the human body. Thus, the results suggest that H(2)-loaded eye drops are a highly useful neuroprotective and antioxidative therapeutic treatment for acute retinal I/R injury.

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