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Effects of three hydrogen-rich liquids on hemorrhagic shock in rats

Zunmin Du [1], Haipeng Jia [2], Jing Liu [2], Xiaomin Zhao [3], Wei Xu [2]

Affiliations

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Abstract

Background: Hydrogen-rich saline provides a high concentration of hydrogen, which selectively reduces levels of hydroxyl radicals and alleviates acute oxidative stress in many models. We investigated the protective effects and mechanisms of three different hydrogen-rich liquid resuscitation preparations on lung injury-induced uncontrolled-hemorrhagic shock (UHS) in rats.

Materials and methods: A UHS rat model was prepared using the method of Capone et al. of arterial bleeding and tail amputation. Healthy male Wistar rats were randomly divided into seven groups (10 per group) to receive: sham treatment; Ringer solution; hydrogen-rich Ringer solution (H-Ringer solution); hydroxyethyl starch (HES); hydrogen-rich hydroxyethyl starch (H-HES); hypertonic saline/hydroxyethyl starch (HSH); and hydrogen-rich hypertonic saline/hydroxyethyl starch (H-HSH). At 72 h after successful resuscitation, lung tissue was Hematoxylin Eosin stained to score any pathologic changes. We also determined wet-to-dry (W/D) lung weight ratios and lung tissue concentrations of interleukin (IL)-6, tumor necrosis factor (TNF)-α, IL-10, malondialdehyde (MDA), and superoxide dismutase (SOD) and myeloperoxidase (MPO) activities.

Results: Compared with the non-H groups, polymorphonuclear neutrophil accumulation in alveoli in the H groups was significantly reduced (P value), and capillary leakage and wall edema were ameliorated. Compared with the sham group, pathologic pulmonary injury scores, W/D ratios, IL-6, TNF-α, IL-10, MDA concentrations, and MPO activity in the other groups were all increased, whereas SOD activity was decreased ($P < 0.01$). Comparing the H-Ringer, H-HES, and H-HSH groups respectively with the Ringer, HES, and HSH groups, pathologic pulmonary injury scores, W/D ratios, IL-6, TNF-α, MDA concentrations, and MPO activity were all reduced, whereas IL-10 concentrations and SOD activity were increased ($P < 0.01$).

Conclusions: Each hydrogen-rich liquid resuscitation preparation could protect the lung against acute injury secondary to UHS. These mechanisms may be associated with hydrogen inhibiting the release of pro-inflammatory cytokines, promoting anti-inflammatory cytokine release, and reducing oxidative damage.

Keywords: Hemorrhagic shock; Hydrogen; Inflammatory cytokines; Lung injury; Oxidative damage.

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