Oxidative stress and ischemic injuries in heat stroke.

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Abstract

When rats were exposed to high environmental temperature (e.g., 42 or 43 degrees C), hyperthermia, hypotension, and cerebral ischemia and damage occurred during heat stroke were associated with increased production of free radicals (specifically hydroxyl radicals and superoxide anions), higher lipid peroxidation, lower enzymatic antioxidant defenses, and higher enzymatic pro-oxidants in the brain of heat stroke-affected rats. Pretreatment with conventional hydroxyl radical scavengers (e.g., mannitol or alpha-tocopherol) prevented increased production of hydroxyl radicals, increased levels of lipid peroxidation, and ischemic neuronal damage in different brain structures attenuated with heat stroke and increased subsequent survival time. Heat shock preconditioning (a mild sublethal heat exposure for 15min) or regular, daily exercise for at least 3 weeks, in addition to inducing overproduction of heat shock protein 72 in multiple organs including brain, significantly attenuated the heat stroke-induced hyperthermia, hypotension, cerebral ischemia and damage, and overproduction of hydroxyl radicals and lipid peroxidation. The precise function of heat shock protein 72 are unknown, but there is considerable evidence that these proteins are essential for survival at both normal and elevated temperatures. They also play a critical role in the development of thermotolerance and protection from oxidative damage associated with cerebral ischemia and energy depletion during heat stroke. In addition, Shengmai San or magnolol (Chinese herbal medicines) or hypervolemic hemodilution (produced by intravenous infusion of 10% human albumin) is effective for prevention and repair of ischemic and oxidative damage in the brain during heat stroke. Thus, it appears that heat shock protein 72 preconditioning induced by prior heat shock or regular exercise training, as well as pretreatment with Shengmai San or magnolol is able to prevent the oxidative damage during heat stroke. On the other hand, hypervolemic hemodilution, Shengmai San, or magnolol is able to treat the oxidative damage after heat stroke onset.