Electron Paramagnetic Resonance Spectroscopic Evidence of Increased Free Radical Generation and Selective Damage to Skeletal Muscle Following Lightning Injury

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The present case study examined changes in peripheral markers of free radical metabolism and skeletal/myocardial muscle damage 30 h after a mountaineer had survived a lightning storm, having experienced contact with what was considered to be "upward leaders" at 4200 m. Sea-level control data were available between 3 and 8 weeks prior to the altitude sojourn for comparative purposes. Follow-up measurements were obtained for the same individual 3 weeks following the incident after simulated exposure to the combined stresses of inspiratory hypoxia and physical exercise. Venous blood was assayed for molecular markers of skeletal [myoglobin and total creatine phosphokinase (CPK)] and myocardial [cardiac troponin I (cTnI)] muscle damage. Ex-vivo spin trapping with alpha-phenyl-tert-butylnitrone (PBN) combined with electron paramagnetic resonance (EPR) spectroscopy was incorporated for the direct detection of free radicals. The relative increases [post-exposure/preexposure x 100 (%)] in the concentration of the PBN adduct, myoglobin, and CPK in the "lightning blood" were markedly greater than those observed following the simulation study (PBN: 276 vs. 129%; CPK: 1130 vs. 182%; myoglobin: 205 vs. 115%). In contrast, no changes were observed for cTnI. A marked decrease in the PBN adduct, myoglobin, and CPK was observed within 2 h of completing the simulation study, following oral administration of water and lipid-soluble antioxidant vitamins in normoxia. These findings are the first to document lightning-induced free radical generation and selective damage to skeletal muscle in a high altitude mountaineer. Furthermore, free radicals may contribute to the pathogenesis of lightning injury, and dietary supplementation with antioxidant vitamins may prove of some benefit against associated tissue damage.