Biophysical injury mechanisms in electrical shock trauma

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Abstract

Electrical shock trauma tends to produce a very complex pattern of injury, mainly because of the multiple modes of frequency-dependent tissue-field interactions. Historically, Joule heating was thought to be the only cause of electrical injuries to tissue by commercial-frequency electrical shocks. In the last 15 years, biomedical engineering research has improved the understanding of the underlying biophysical injury mechanisms. Besides thermal burns secondary to Joule heating, permeabilization of cell membranes and direct electroconformational denaturation of macromolecules such as proteins have also been identified as tissue-damage mechanisms. This review summarizes the physics of tissue injury caused by contact with commercial-frequency power lines, as well as exposure to lightning and radio frequency (RF), microwave, and ionizing radiation. In addition, we describe the anatomic patterns of the resultant tissue injury from these modes of electromagnetic exposures.