Electrochemical Oxygenation of Ischemic Tissue

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This presentation discloses new ideas and preliminary results on the development of a "metabolic prosthesis" for local oxygenation of ischemic tissue under physiological neutral conditions. We report for the first time the selective electrolysis of physiological saline by repetitively pulsed charge-limited electrolysis for the production of oxygen and suppression of free chlorine. For example, using 800 μA amplitude current pulses and <200 μsec pulse durations, we demonstrate prompt oxygen production and *delayed* chlorine production at the surface of a fused 0.85 mm diameter spherical platinum electrode. The data, interpreted in terms of the ionic structure of the electric double layer, suggest a strategy for in situ production of metabolic oxygen via a new class of "smart" prosthetic implants for dealing with ischemic disease such as diabetic retinopathy. We also present data indicating that drift of the local pH of the oxygenated environment can be eliminated using a feedback-controlled three electrode electrolysis system that chooses anode and cathode pair based on pH data provided by local microsensors.

All physiological fluids contain significant levels of Cl^-. Repetitively pulsed charge-limited electrolysis of this fluid may have application in the treatment of ischemic disease such as diabetic retinopathy via oxygenation of ischemic retinal tissue with minimal co-production of free chlorine. As reviewed by Ameri et al. (in M. S. Humayun et al., Eds., *Artificial Sight*, Springer, 2007), the surgical techniques for intraocular retinal electrode prosthetic implants have now been demonstrated. Of course, real-world physiological fluids are complex solutions that contain more than buffered Na^+ and Cl^-. For example, human aqueous and vitreous humors contain millimolar levels of lactate, glucose and ascorbate. Experiments presently underway indicate that these organic compounds alter the chlorine and oxygen yields, but do not change the basic results of this presentation. For example, the organic constituents, especially ascorbate, rapidly react with free chlorine so that the restriction on the 200 μsec pulse duration is lifted. At the same time, however, they compete, with varying degrees of success, for electrochemical oxidizing equivalents at the anode and lower the Faradaic efficiency of oxygen evolution. These are research issues of electrode materials, fabrication techniques, and kinetic strategies that will be the focus of future investigations.

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