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Novel cardiac microimpedance measurement strategies

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Gap junction uncoupling and interstitial fibrosis are commonly identified contributors to cardiac arrhythmia initiation and maintenance. Uncoupling slows conduction velocity and promotes dispersion of repolarization. Fibrosis limits lateral myocyte connectivity, which promotes nonuniform action potential propagation. While it is presumed that these changes occur because the intracellular and interstitial electrical impedances on the size scale of individual myocytes, i.e., the cardiac microimpedances are altered, direct measurements to confirm this presumption, are limited. Traditional approaches to making such measurements require multiple transmembrane potential recordings in close proximity to a stimulating electrode, which is technically challenging in heart preparations because vigorous contractions complicate controlled microelectrode impalements. We recently developed an approach, termed multisite stimulation, that allows directional intracellular and interstitial microimpedance measurements to be obtained without any intracellular access required. The approach involves stimulation and recording in 4-electrode configurations with individual electrodes sufficiently close to confine the supplied current to the interstitium. Using more widely spaced stimulating pairs or increased stimulation frequency, supplied current redistributes to the intracellular compartment. Implementation involves integrated use of microfabricated electrode systems to achieve the necessary precision for stimulation and recording, histologic reconstruction to resolve microstructural features of measurement regions, and membrane equation-based computer modeling for electrode system design and interpretation of recordings.

Biography

Andrew E. Pollard received the B.S., M.S., and Ph.D.degrees in Biomedical Engineering from Duke University, Durham, NC in 1983, 1985 and 1988, respectively. He is a Professor of Biomedical Engineering at the University of Alabama at Birmingham and a member of the Cardiac Rhythm Management Laboratory. Dr. Pollard's primary research interests are in the study of cardiac arrhythmias, with particular emphasis on numerical modeling and experimental mapping.

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