

Nanosecond pulsed electric field ablation as an alternative or adjunct to surgery for treatment of cancer

Stephen J. Beebe and Xinhua Chen

Frank Reidy Research Center for Bioelectronics, Old Dominion University, USA

Surgery remains a fundamental means for cancer treatment and often offers some change for a cure. However, surgery is not always possible because of tumor proximity to blood vessels or ducts or when a patient is not healthy enough to undergo surgery. Application of nanosecond pulsed electric fields (nsPEFs) is a new approach to treat cancer using pulse power technology that was originally designed for military purposes. This novel approach deposits extremely short pulses of high power, low energy, electric fields into malignant tissues using electrodes to encompass tumors. Pre-clinical studies and beginning clinical trials show that treatments are effective and without local or systemic side effects, including absences of scarring. For internal tumors, electric fields are delivered by catheter electrodes and laparoscopy procedures.

Here we demonstrate efficacy for treatment of mouse melanoma (B16f10), mouse (Hepa-1-6 HCC) and rat (N1-S1 HCC) hepatocellular carcinoma. nsPEFs eliminate tumors by induction of caspase-dependent (apoptosis) and caspase-independent cell death mechanisms. Treatment also breaches small vessels, but spares larger vessels and ducts. nsPEF treatments also reduce angiogenesis. Microvascular density markers (CD-31, CD-35 and CD-105) are significantly decreased after treatment, reinforcing tumor cell demise. Furthermore, initial challenge studies show that mice are resistant to re-introduction of same tumor cells after treatment, suggesting that nsPEFs induces immunogenic cell death and possible host cell immune responses after treatment. nsPEF ablation of cancer targets three hallmarks of cancer (evasion of apoptosis and immune surveillance and angiogenesis maintenance) and provides effective alternative therapies for cancers in skin and internal organs.

Biography

Stephen J. Beebe completed his Ph.D. at the Medical College of Ohio (now the University of Toledo—College of Medical) and post-doctoral work at Vanderbilt University. He was a Fulbright Fellow in Oslo Norway. He is now a Professor at Old Dominion University and Eastern Virginia Medical School. He has published more than 100 manuscripts and serves on the editorial board for the Journal Nanomedicine and Biotherapeutic Discovery.

Xinhua Chen received her MD from Zhejiang University in Hangzhou, China. She received her PhD in Biological Sciences and did post-doctoral work in the Frank Reidy Research Center for Bioelectronics at Old Dominion University. She is presently an Attending Surgeon, in the Department of Hepatobiliary and Pancreatic Surgery at the First Affiliate Hospital of Zhejiang University

SBeebe@odu.edu