Localized Transcutaneous Electrical Brain Stimulation Development

W. Besio[1], A. Nayak[1], K. Koka[1], J. Wei[1], M. Sahin[1], R. Patwardhan[2]
[1]*Department of Biomedical Engineering, Louisiana Tech University-Ruston, LA, USA*
[2]*Department of Neurosurgery, Louisiana State University-Shreveport, LA, USA*

Epilepsy medications are ineffective 30% of the time. Implantable devices are unsuitable in emergency situations. This research focuses on the development of an ambulatory system capable of the non-invasive detection and termination of seizures in emergencies. Towards this end, a concentric ring electrode system for detecting seizure electrical activity and applying localized transcranial electrical stimulation (TES) was developed. An evaluation has been performed to test the efficacy of the concentric ring electrode for brain stimulation. Computer models were developed to simulate the potential induced in the brain through inhomogeneous intermediate layers of known thickness and conductivities. This was followed by the development of a four-layered 'phantom head' model using agarose to test the electrodes and compare their characteristics with conventional electrodes. Ultimately, an intracisternal penicillin model was used to induce seizures in Sprague Dawley rats and stimulation was used to control the seizures. Computer simulations and agarose experiments reveal that our electrodes are capable of stimulating the brain in a highly localized fashion, as opposed to conventional disc electrodes. Animal experiments indicate that stimulation leads to a decrease in frequency of ictal spikes and convulsions. On average, the convulsions decreased from 26/min to less than 13/min. TES did not cause strong convulsions as electro-convulsive therapy with ear-bar electrodes did. The phantom model and simulations indicate that similar results can be expected on humans.