# Noninvasive Seizure Alteration via Localized Electrical Stimulation

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It is established that epilepsy is the second most prevalent neurological disorder in the U.S., afflicting approximately 15 million Americans of all age groups. Present therapies are not suitable for emergencies. Our research focuses on the development of a non-invasive system, capable of detecting and terminating seizures rapidly. Towards this end, an electrode system for detecting seizure electrical activity and applying localized transcutaneous electrical stimulation (TES) was developed. The hypothesis was that if we could generate a focused, localized stimulation noninvasively, it would be possible to alter seizures. To test this hypothesis, the following methods were followed.

A computer model was developed, accounting for different conductivities of the scalp, skull, cerebral spinal fluid, and the brain. An electrode system consisting of a pair of concentric rings and a disc was modeled on the scalp surface. The potentials were calculated at points within the brain, induced by charging the electrode system. This model provided information regarding the magnitude of the electrical potential induced, which was necessary to gauge if the electrodes were capable of stimulating the nerve in question.

A practical experimental verification was achieved using a tank set-up. The set-up encompassed a tank, filled with a saline solution of known conductivity, to simulate the human intracellular space. The concentric ring electrodes were moved along the surface of the saltwater, at pre-determined depths from a recording electrode. Current pulses were applied to the rings and resulting potential waveforms observed.

Experiments were also conducted on rats. To induce seizures in the rats, an intracisternal rat penicillin model was used, developed for this research. The model was fast acting and long lasting, on average 14 minutes to seizure activity and one hour to cessation. Three sets of tri-polar concentric ring electrodes were placed on the scalp of seizing rats. Advanced EEG was recorded with the concentric ring electrodes and localized TES was applied through the same electrodes.

In conclusion, we observed that stimulation led to a decrease in frequency of the seizures. One significant note, applying TES didn't cause strong convulsions as conventional electroconvulsive therapy with earbar electrodes did. Further testing is necessary. These experiments give credence to our concept that these novel concentric ring electrodes can be used for non-invasive deep-brain stimulation to alter seizure activity.