Feasibility of Transcutaneous Electrical Stimulation for Controlling Epileptic Seizures

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Epilepsy is the second most prevalent neurological disorder in the U.S., afflicting approximately 15 million Americans of all age groups and approximately 1% of the world population. Antiepileptic drugs are ineffective up to 30% of the time and up to 50% of those receiving regular medications have major side effects. Surgical resection is an option for some patients, but it is also associated with serious complications. Electrical stimulation is becoming an accepted alternative treatment, but usually involves implantation of electronics. Here we report on the use of noninvasive electrical stimulation to control seizures in a rat model.

This research focuses on the feasibility of controlling seizures in a rat model with transcutaneous electrical stimulation (TES). TES was first verified with computer models, which simulate the potential induced in the rat brain through inhomogeneous intermediate layers of known thickness and conductivities. The computer models were followed by the development of a four-layered rat 'phantom head' model using agarose. An intracisternal penicillin model was used to induce seizures in Sprague Dawley rats and TES was applied to test its feasibility in controlling seizures. The onset of tonic-clonic seizures usually began within 2 minutes after penicillin injection and if unchecked, lasted up to 90 minutes with convulsions reaching over 50/min. After TES was applied, there was a significant decrease in convulsion activity (ANOVA, $p<0.006$). On average, the convulsions decreased from 37/min to less than 17/min as a result of stimulation.

We also developed computer simulations and phantom head models for humans, which indicated that similar results could be expected in humans. Thus, TES for seizure control warrants further investigation.