Introduction

Epilepsy is a neurological disorder characterized by the susceptibility to epileptic seizures brought on by a chemical imbalance in the brain.\(^1\) Approximately one percent of the world population, over 50 million people worldwide, are affected by epilepsy.\(^2\) An average of 30% of the treated epileptic cases are unresponsive to the current anti-epileptic drugs and the drugs can cause side effects.\(^3\)

Seizures occur when too many neurons in the brain are stimulated or synchronized at once. Glutamate, a chemical in the brain, controls the excitability of these neurons and an overload of this chemical can stimulate the neurons to an epileptic seizure. Patients with epilepsy show a loss of GABA, a chemical inhibitor released from the hippocampal region of the brain and an increase of Glutamate.\(^4\) Anti-epilepsy medications aim to balance out these two chemicals, as well as several others in order to reduce the likelihood of a chemical imbalance resulting in an epileptic seizure.\(^5\) Current treatments for epilepsy include medication, surgery, and implantable electronic devices. All these methods come with risk and some have high rates of failure.\(^6\)

Research

Besio et al. have shown that noninvasive Trans Focal Electrical Stimulation (TFS)\(^3\) administered through tripolar concentric ring electrodes (TCRE) weakened the severity of behavioral and visual electrographic signals of epileptic status.\(^6\) The TCRE are positioned externally on the scalp surface.

![Electrode Placement](image)

**Figure 1 (Besio, W. G., et al. 2011)**

Electrode 1 is placed above the bregma and used for stimulation and recording. The other recording electrodes, 2 and 3, are placed behind the eyes close to the subcortical structures. Electrode r is for reference only.\(^3\) Figure 1 shows electrode placement and to the right is a TCRE.

Process

All animal protocol was approved by the University of Rhode Island IACUC. The TCRE are used to detect the seizure before it happens and then apply the TFS through electrode 1. They would then transmit 300Hz pulses for two minutes after seizure is detected and record the results for the next five minutes.\(^6\) All tests are recorded on video and the graphic representation of the data recorded by electrodes is aligned with the video for a full range of observations and hard data.

Advantages

The design of the TCREs has shown to significantly reduce signals from undesired sources. They isolate the signals from sources more effectively than conservative EEG recordings. The electrodes function externally and the noninvasive approach removes all the complications involved with surgery.

New Data

The main outcome of the research performed by Besio et al. (2011) showed the effectiveness of TFES in reducing highly synchronized neurons in the brain in the early stages of a seizure. They also noticed after the application of TFES the concentration of Glutamate decreased and the inhibitory GABAergic networks increased. The custom designed TCREs were successful in detecting seizures before they occurred and in transmitting TFES noninvasively.\(^3\) (Figure 2 in ppt. presentation.)

Resources