Seizing The Seizures

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Abstract
To combat seizures and other debilitating brain disorders, researchers at Neurapace have created a device to fight these events. It can sense and react to seizures immediately because it is fitted within the skull. Electrodes are affixed to areas of the brain that sense a seizure-like pattern and then stimulate the brain accordingly or dispense the correct medication. Since patients have the Neurapace device implanted, it will record data about their specific type of seizures, so the device can be updated to better aid the patients.

Our actions and thoughts are dictated by our brain and when something goes awry, we feel the consequences. A seizure is a neurological disorder caused by a sudden surge of disorganized electrical activity among neurons and can cause the brain to malfunction. This sudden storm of activity can cause someone to be unable to move until the episode is over. To decrease the amount of seizures in a person, researchers are trying to stimulate the brain in a way that combats the seizure. Brain stimulation has proven to be effective in reducing seizures (Anderson, 2008, p. 1). To stimulate the brain, electrodes are either placed outside or inside the brain. The latter is classified as invasive and can be very tricky because patients need to be stimulated manually. However, scientists have created a device to combat the problem of manual stimulation by upgrading the hardware of the brain.

Previous methods of combating seizures have involved deep brain stimulation of the vagal nerve, cerebellar cortex, and the centromedian nucleus of the thalamus. Other areas that have been tested are the dentate nucleus, the anterior nucleus of the thalamus, the caudate nucleus, the subthalamic nucleus, the hippocampus, and even the cortical surface. Patients have electrodes surgically implanted that monitor their brain for seizures to learn more about them and the areas of the brain that are affected. These electrodes are then used to stimulate the brain to quell the seizures. Neurapace and its researchers used this information to design a device that would both monitor and stimulate the brain to combat a seizure without outside interference, combining past deep brain stimulation techniques in a hands-free manner.

The Neurapace device is what scientists call, “responsive stimulation” (Anderson, 2008, p. 1). This is a way to combat seizures as soon as they happen without any exterior help. The device itself is one inch in width and two inches in length. It is equipped with programming containing seizure-sensing algorithms and can be updated with time. Therefore, they can manipulate these algorithms to better serve the patient. Once these algorithms sense seizure-like patterns, they stimulate the brain through various electrodes to combat the seizure, recording the events so the data can be later used to properly update the device.

To test this device, researchers had seven patients agree to have the device implanted into their brains. Out of these patients, four were used to develop a proper technique to implant the device. The other three patients were randomly placed in one of two groups: one group with the device turned off and the other group with the other device turned on. There were also specific requirements to be accepted into the study. For example, the patients needed to have, “at least two anti-seizure medications previously failed” and, “... an average of four seizures per 28 days for three consecutive days” (Anderson, 2008, p. 3). Clearly, implementing the Neurapace device is an invasive technique and should be a last effort to quell seizures. The patients that were chosen had a variety of seizure types, ranging from frontal lobe epilepsy to focal motor control. They would come in every two weeks after implantation to report any discomfort or changes in seizures. The changes in seizures were very promising. All cases decreased the seizure amount by an average of 60%. From the reports, the researchers also updated the devices to cater to the specific seizures of the patient, utilizing data that was collected from the device. Even though these results are very promising, more research must be done in the future to determine if the device is safe including conducting more surgeries to assess the safety of the procedure find how it may go wrong. Although researchers have yet to have a procedure go wrong, when one does go wrong, they need to know what the implications may be.

Figure 1. The NeuroPace device, size relative to a US quarter, before implantation.

Figure 2. Frameless stereotactic techniques are used for depth electrode implantation.
Specifically, in this study, one patient had a 75% reduction in seizures. Her seizures began when she was five. Her seizures would occur for one to two days a month, but during those one to two days, seizures occurred two to three times for 30 to 60 seconds at a time. Before the implantation, 11 medications had failed and the seizures were barely being controlled (Anderson, 2008, p. 4). After the device was implanted, the seizures were reduced immediately. Despite the reduction in seizures, some problems with the device arose. For instance, there was a skull defect from the surgery that gave the patient chronic headaches. This, however, was solved by an artificial replacement of the skull. Although the problem was fixed, it shows how sensitive the operation is. However, this patient’s case did show potential in the device’s ability to combat seizures. The results from this study were very promising for responsive stimulation. The reduction in seizures was significant and the side effects were few. Since the tested population was very small in size, the technique is not yet viable. As these devices are tested, more data will be collected which will allow for more seizure-sensing algorithms to be developed, creating a library of seizure patterns and appropriate responses to stop the seizures before their effects are noticed. At the same time, researchers can delve into creating a safer way to insert the device and apply it to combat other neurological disorders, such as migraines and motor dysfunction. There is a lot of potential in responsive stimulation as it may lead to a hands-free way to fight neurological diseases, leading to a myriad of possibilities.

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References

