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Deep Brain Stimulation Treatment of both Neurological and Psychiatric Disorders

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Abstract

Neurostimulation techniques have been around for many years, but have become a focus of research and therapy in recent years. Potential applications for brain and neurostimulation range from spinal cord stimulation to cochlear and bionic eye implantation, but there are significant differences in the clinical suitability of these different applications.

Keywords: Deep brain; Epilepsy; Technology; Pacemaker

Introduction

Electrical high-frequency deep brain stimulation (DBS) has been developed as an alternative treatment option for several neurological disorders. However, as surgical procedures, techniques, and safety measures have advanced, the use of DBS has expanded beyond therapeutic to research purposes. The exact mechanism of action is not yet fully understood, but the results of ongoing research and clinical studies are encouraging. DBS has been used to treat essential tremor since 1997, Parkinson's disease (PD) since 2002, and dystonia since 2003. It is also used to treat various conditions, including major depression. The therapeutic efficacy of DBS in PD is well established, but in other diseases such as epilepsy, the results are unclear and equivocal. This article is a brief review of the literature with a focus on Parkinson's disease, epilepsy, and obsessive-compulsive disorder (OCD).

Perhaps the ancient Romans and Greeks were the first to document the effects of electrical impulses on the nervous system. The same species was named by the Greek Narke for stunning its prey. Doctor Claudius. Scribonius Largus, AD 47, treated headaches with living rays. The same method was later used for hemorrhoids, gout, depression, and epilepsy. Avicenna (AD 980-1037) stated that the brain is not as homogeneous as was thought (Sharafkandi, 1997), but the observations and subsequent experiments of the German neurologist Edward Hitzig in 1864 provided a breakthrough opened. Anatomist Fritsch applied electrical impulses to the exposed cerebral cortex of dogs without anesthesia [1]. In 1874, shortly after the new era of brain stimulation began in Cincinnati, Bartholoff electrified a terminally ill patient whose scalp and skull had been eroded by basal cell carcinoma. These experiments worked well and induced contralateral movement. His current DBS device has quadrupolar electrodes that are typically inserted into the brain. Aligned extensions are passed behind the ear and an internal pulse generator is implanted on top of or inside the pectoral fascia [2]. Today's technology advances day by day, beyond imagination. Cochlear implants are already in use, and bionic eyes are making some progress as well. Potentially his DBS device could be programmed remotely over the phone or over the internet, much like a cardiac pacemaker.

Parkinson's disease

PD is the most common form of progressive neurodegenerative disease of the central nervous system (CNS). Approximately 10 million people have been diagnosed with PD worldwide, but this does not reflect the millions of cases that go undetected. A man is 1.5 times more likely than a woman to have PD. To compare the prevalence and incidence of PD in different regions of the world, as many factors are involved in the prevalence and incidence of PD, including gender, age, diagnostic criteria, and medical institutions It's getting very difficult. The early symptoms of PD are movement-related, with slow movements (bradykinesia), resting tremors, muscle stiffness, shuffling, and hunched posture resulting from the death of dopaminergic neurons in the substantia nigra pars compacta (SNpc). cause a midbrain region with the appearance of intracellular inclusions known as Lewy bodies (Vale, 2008). A variety of non-motor symptoms can occur in the late, sometimes early stages of Parkinson's disease, including autonomic, sensory, sleep, cognitive, psychiatric, and dementia [3]. The principle of neurostimulation is to restore the physiological function of a nerve or muscle through targeted and controlled electrical stimulation of the affected area. Deep brain stimulation (DBS) has been used in patients with late-stage Parkinson's disease to whom little or no pharmacological treatment is provided, and has indeed improved motor performance and, to some extent, cognition in Parkinson's disease patients without dementia.

In DBS, electrical stimulation pulses are continuously applied to specific brain regions at high frequency via chronically implanted electrodes. These leads with lead extensions and pulse generators are surgically implanted. Percutaneous programmers are also used to enable various treatment options [4]. The subthalamic nucleus (STN) and globus pallidus (GPi) are thought to be hyperactivated in Parkinson's disease and are the primary targets of DBS. However, the most common target of DBS is the STN, although the ventricular intermediate nuclei of the thalamus are also sometimes targeted. The mechanism of DBS is not fully understood but appears to rely on modulation of neuronal activity that nullifies and replaces aberrant patterns in the basal ganglia with less disruptive patterns [5]. DBS offers alternative treatments for severe PD. It is widely used and known to significantly improve symptoms of PD, including pain relief and cognitive impairment, but not PD-related dementia.

Epilepsy

Epilepsy is a diverse group of chronic neurological disorders

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associated with recurrent seizures. Epileptic seizures must be repeated at least 2 times or 1 seizure with brain changes that may increase the likelihood of future seizures. Excessive, abnormal, or hypersynchronous neural activity in the brain causes epileptic seizures. Worldwide he has more than 50 million people suffering from epilepsy, mostly in developing countries. About 70% of epileptic seizures can be controlled with medication, but for the remaining 30% medication helps little or nothing. Therefore, surgery or DBS can be considered [6]. Electrical stimulation of the vagus nerve (VNS) is used to treat patients with refractory epilepsy who are not amenable to surgery and who do not benefit from medication. The mechanism of action (MoA) of VNS in the treatment of seizure control is unclear. Vagal afferent synapses use excitatory neurotransmitters, inhibitory neurotransmitters, acetylcholine, and various neuropeptides. The majority of vagal afferent synapses are received by the nuclear sorus (NTS). NTS projects to other brainstem nuclei, such as the LC and Raphe Magnus, to regulate the release of norepinephrine and serotonin, respectively. These neurotransmitters ultimately affect the limbic, reticular, and autonomic centers of both hemispheres. Hypothetically, afferent vagal synapses attenuate seizure activity through modulation of neurotransmitters. The implanted device sends electrical impulses to the cervical spine. Intracranial and brainstem structures along the anatomical pathway from the point of stimulation to the cortex play important roles in VNS MoA. Includes locus coeruleus, thalamus, NTS, and limbic structures.

Obsessive Compulsive Disorder

OCD is an anxiety disorder, a brain and behavioral disorder characterized by thoughts, discomfort, fear, anxiety, and worry, leading to repetitive behaviors to reduce the associated anxiety. Or by a combination of such obsessions and compulsions. Repetitive behaviors include excessive washing and cleaning, domination, hoarding, and preoccupation with sexual, violent, or religious thoughts. Anyway, daily life, religious ceremonies and practices, and repetitive learning activities are not a constraint [7, 8]. OCD is characterized by the ventral-meso-prefrontal cortex (PFC), dorsal anterior cingulate cortex, orbitofrontal cortex (OFC), and associated cortico-striatal-thalamocortical (CSTC) circuits, including the basal ganglia and thalamus. It seems to be caused by an anomaly includes connectivity. OCD has a prevalence of 2% worldwide and approximately 20-40% of patients have persistent symptoms leading to chronic disability [9, 10]. Current treatments (selective serotonin reuptake inhibitors, cognitive-behavioral therapy, surgical excision, etc.) are effective, but approximately 10% of patients do not respond to these treatments. These patients are good candidates for DBS and can benefit from it [11].

The stimulation target is currently the STN, and the forelimbs of the internal capsule, the ventral capsule/striatum (VC/VS), and the inferior thalamic peduncle (ITP) are also targets for future research. Each site has strengths and weaknesses and requires more research and experimentation [12]. Stimulating the STN is a common and well-established procedure in the treatment of Parkinson's disease, thus reducing surgical complications. VC/VS stimulation, on the other hand, requires lower stimulation energy, resulting in longer battery life and thus fewer side effects from surgery [13]. The results of this treatment are promising. In two different studies, 4 of 6 patients showed a significant reduction in her Y-BOCS (Yale-Brown Obsessive Compulsive Scale) score, but more thorough studies are needed to determine its effectiveness significant research and clinical trials should be conducted and treatment safety [14, 15].

Other Brain Disorders

Other brain disorders that may benefit from DBS include: Tourette syndrome (also known as Tourette syndrome, Tourette disease, Gilles de la Tourette syndrome, GTS, or simply Tourette syndrome or TS) is an inherited neuropsychiatric disorder that begins in childhood. This neuropsychiatric disorder is characterized by multiple physical (motor) tics and at least one vocal (phonic) tic [16, 17]. However, this procedure is invasive and Tourette's disease is more common in the pediatric population, so it is only recommended for treatment-resistant cases.

Conclusion

Implantable neuromodulatory devices have proven to be highly beneficial to patients and their therapeutic applications are rapidly expanding. Numerous clinical cases and studies have confirmed its efficacy and potential in the treatment and treatment of brain diseases. The knowledge and experience gained have brought DBS to other fields of medicine, psychology and nutrition. Precise regulation of neurotransmission and downstream neurochemical cascades via both invasive DBS and non-invasive, such as transcranial magnetic stimulation, has proven to be a serious challenge for the future. Multiple methods of stimulation are facilitated by these devices and can target highly specific foci of the CNS. This can take the form of both inhibitory and/or excitatory effects.

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