Researchers from the Hebrew University will improve the outcome of Deep Brain Stimulation

Researchers from the Hebrew University report that analysis of patients? brain wave patterns can help improve the outcome of Deep Brain Stimulation, a novel type of treatment for Parkinson's disease, which works by implanting electrodes into the diseased brain area.

The researchers analyzed special brain waves to improve the pinpointing of the correct location for implantation of the electrodes. The analysis of these brain waves on a patient-by-patient basis can also give an indication on how successful various Parkinson's treatments will be for specific patients. The results of this study were recently published in the scientific journal *Brain*.

Deep Brain Stimulation (DBS) is a novel treatment for Parkinson's disease. In DBS, electrodes are implanted deep in the brain, and connected to an external pacemaker. These electrodes send electrical impulses to the brain, regulating malfunctioning brain activity and leading to a marked alleviation of the symptoms of Parkinson's disease. In this research, which was conducted in cooperation between ELSC and the Institute of Medical Research Israel-Canada of the Hebrew University - Hadassah Medical School, the scientists analyzed a specific type of deep brain wave pattern, called beta oscillations (ranging from 13 to 30 Hz), and related these to the efficacy of DBS treatment. In Parkinson's patients, these rapid rhythmic brain waves occur in a brain region called the sub-thalamic nucleus (STN), and have long been implicated in the disease, although a causal connection between the oscillations and the symptoms of Parkinson's remains unclear.

The sub-thalamic nucleus is located deep in the brain, and is the site of the DBS surgical treatment. Neurosurgeons use micro-electrode arrays to identify the location of the nucleus during surgery, passing through a neurosurgical trajectory to reach the desired location for implantation of the DBS macro-electrodes.

The group of scientists, spearheaded by PhD student **Adam Zaidel**, together with Alexander Spivak and Benjamin Grieb, and supervised by Prof. **Hagai Bergman** of ELSC and **Dr. Zvi Israel**, a neurosurgeon at the Hadassah Medical Center, analyzed beta oscillations during the surgical procedure of inserting DBS guiding electrodes into the brain. Specifically, they measured the length of the neurosurgical trajectory that actually showed beta oscillations, and correlated this length with the amount of improvement of symptoms after DBS and medication. They found a strong correlation; the longer the trajectory that showed oscillations, the more marked was the patients' improvement. The scientists further discovered that beta
Oscillations primarily occur in a certain region within the sub-thalamic nucleus, and that the ideal site for activation of the electrodes lies close to the center of this oscillatory region. These discoveries can aid neurosurgeons in choosing the best trajectory and location for the implantation of DBS electrodes. An additional analysis of the beta oscillations also showed that they may be used to indicate whether a patient will respond better to medication or to neurosurgery.

The length of the oscillatory region for three different patients. The x-axis shows the neurosurgical trajectory in mm, with the 0 indicating the center of the sub-thalamic nucleus. The red area in each graph shows particularly strong beta (13–30 Hz) oscillations. As can be seen from the graph, the patients differed in the length of the oscillatory region, with the patient in the top graph having the shortest, and the bottom patient having the longest oscillatory region.

The full research article

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