Deep-brain Stimulation as a treatment for Parkinson’s disease

Verónica Arcas Pliz Art Grau de Biología

Introduction:
The Deep-brain stimulation (DBS) is a surgical therapy for the treatment of Parkinson’s disease (PD) consisting in the implantation of one or more electrodes in a specific region of the brain. These electrodes attached to leads are connected to an impulse generator, a device that delivers an adjustable electrical current to brain tissue.

The objective of this research project is the explanation of the basis of the treatment along with its benefits and complications.

Pathophysiology of PD:
PD’s is a disease of the central nervous system and the early motor manifestations are usually due to the loss of dopaminergic cells in the substantia nigra pars compacta (SNc). This loss involves an increased activity in certain nuclei causing a decreased motor cortical activity. The basis of this procedure is to disrupt the abnormal neuronal activity to re-establish a more normal motor function.

Surgical technique:
The DBS device consists of three components that have to be implanted in a specific location. The electrodes are inserted in the brain and connected to a lead that extends to the outside of the skull, and connects with the third component which is the implantable pulse generator usually located in the infracranial area.

Target nuclei:
The most common targets for patients with PD are the subthalamic nucleus (STN), and the globus pallidus pars interna (GPi), which can be stimulated unilaterally or bilaterally. These intended target locations for the devices are used to treat the hallmark symptoms of rigidity, levodopa-induced dyskinesia, gait disorder, and tremor.

The central intermediate nucleus of the thalamus (VIM) is also being used as a target to treat essential tremor.

Limitations of medical Therapy for PD:
Medical treatment of early PD start when functional disability appears. Patients have a good initial response to medical therapy which is usually very effective in the early years of PD. This response to medication holds for about 5 years. With progression of the disease, medication-related complications develop in a majority of patients until surgical management is suggested.

Diagnosis of Parkinson disease

<table>
<thead>
<tr>
<th>Pharmacologic therapy</th>
<th>Non-pharmacologic therapy</th>
<th>Support services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue to monitor</td>
<td>Neurosurgical evaluation</td>
<td>Exercise</td>
</tr>
<tr>
<td>Levodopa against</td>
<td>Electrophysiology</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Dopamine agonist</td>
<td>Deep Brain stimulation</td>
<td></td>
</tr>
<tr>
<td>Add COMT inhibitor if not too</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unacceptable control with medical therapy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Complications:
DBS is not an entirely safe procedure yet, it involves many risks and complications that can be divided in 5 stages of the treatment:

Surgical complications:
This stage includes a variety of complications that may occur during the surgical intervention. This surgery can cause intracranial and extracranial hemorrhage, infections, displacement of the DBS leads, or suboptimal placement of the leads.

Hardware complications:
This type of complications take place after the surgery and include the migration of the leads, DBS lead failure or any other component of the system, skin erosion and pain over the hardware or infection.

Simulation-related complications:
These types of complications are related to problems during the stimulation in the process of the DBS programming. These kinds of complications are reversible with a simple adjustment of the stimulating amplitude.

Conclusions:
- DBS is restricted to patients that have developed motor fluctuations or dyskinesias but still have good cognitive capability.
- The treatment helps patients achieve a reduction of the dose of medication as well as motor fluctuations and an improvement of the symptoms.
- Improvement and complications depend on different factors: stage of the disease, targets of the neurostimulation and electrode position.
- DBS includes not just the implantation of the hardware but also a postoperative programming and maintenance.
- The actual effect of DBS is still unknown and has to be studied.

References: