Life is electricity. Living cells have a potential difference across their membranes, which can be changed by applying an electrical current. Therefore the functional activity of neurons and their connections inside circuits are subject to alterations by electrical stimulation. Deep Brain Stimulation (DBS) has been developed after the advancement in stereotactic neurosurgery. The first indication of DBS was applied to intractable pain almost half a century ago. In 1987, the discovery of DBS in movement disorders by the Grenoble team led by A.L. Benabid marked the start of this wide scale procedure. The initial idea was to decrease bilateral thalamotomy-induced morbidity in the treatment of tremors, thanks to the functional nature of DBS, which enables adjustment and reversibility of electrical parameters. Spatial adjustability was also possible with the development of quadripolar electrodes. The discovery at the origin of the antitremor effect of DBS was its dependence on the frequency of stimulation: no effect at 50 Hz, possible worsening at lower frequencies, improvement at higher frequencies with a plateau reached over 130 Hz. Changes in voltage influence the spatial spreading of current around the stimulation contact, whereas pulse width has minimal effect. From this discovery was born the concept of electrical neuromodulation of brain tissue. The high frequency effect, which mimics that of lesioning has been discovered for brain nuclei other than the thalamus, namely the globus pallidus (GP) and subthalamic nucleus (STN). These latter targets have been stimulated following the advancement in basal ganglia pathophysiology in the 90s, when it has been shown that the parkinsonian akinesia is associated with subthalamo-pallidal hyperactivity in animal models of Parkinson disease. Afterwards, the extension of the indications and stimulated targets stemmed from clinical observations of secondary effects of DBS in Parkinson disease, such as the antidyskinetic effect in the GPi or the beneficial effect of obsessive compulsive disorder in the STN. This sounded the start of DBS in various types of dyskinesias, mainly dystonia and psychosurgery.

So far, DBS is a therapy world-wide validated and regularly applied as the surgical procedure of choice for various types of tremors (parkinsonian, essential and symptomatic of a brain lesion) in the Vim thalamus or the subthalamic region, for the motor complications of levodopa-responsive Parkinson diseases in the STN or GPi and for primary dystonia in the GPi. The type of surgery by far the most frequently used is bilateral STN stimulation in Parkinson disease with about 50,000 operated patients. As any powerful therapy, the indications and patient management should
show a sense of tact and moderation. Twenty two years after daily use of DBS, I should confess the failure of the simplification procedures. DBS remains a sophisticated treatment that requires a multidisciplinary approach encompassing several expert partners. The neurosurgeon, possibly assisted by a neurophysiologist for cell recording, should be able to implant an electrode with a millimeter precision, and minimal risks. The neuroradiologist has to provide high definition images of the target without artefacts. The neuropsychologist, and/or the psychiatrist evaluate the mental and cognitive patient state, an invaluable help for surgery indication and postoperative follow-up. Above all, the neurologist should acquire a DBS competence to assist his colleagues in counselling surgery for a given patient, manage the patient before surgery to minimize surgery-induced complications (drugs, general health measures), assist the neurosurgeon in the research of the most suitable target (assessment of microstimulation-induced beneficial and adverse effects predictive of outcome), postoperatively set electrical parameters (recipes, coping with troubleshooting, combining DBS with drugs) and manage neurostimulation of educated patients in the long-term, when their symptoms may be a matter for stimulation defect. The success of DBS depends on the involvement of all competent partners who manage the patients, including general practitioners and nurses. DBS should be implemented in expert centers able to provide state of the art management of any candidate patient.

DBS enabled to confirm the network mode of function of the central nervous system, since the neuromodulation of a strategic area inside a loop alters the functioning of all the connected circuits to which this area is linked. How surprising was it for us to observe that stimulation of non motor NST parts in patients operated on for akinesia triggered laughing or crying. Thanks to the advancement of basic and clinical research, motor, cognitive, emotional and behavioral symptoms associated with neuropsychiatric disorders are now better understood. New therapeutic indication of DBS of various targets are about to occur. As an example, studies in progress deal with DBS of the STN and CM-Pf thalamic nucleus in dystonia of various origins, pendunculopontine nucleus area in gait disturbances, associative and limbic parts of the STN or nucleus accumbens in obsessive compulsive disorder, limbic part of the GPi in Tourette syndrome, hypothalamus in eating disorders and cluster headache, subgenual cingular cortex area and limbic striatum in depression and even fornix or basal nucleus of Meynert in amnestic Alzheimer disease…

Understanding the mechanism of DBS is of outmost importance and studies are ongoing in this field. The discovery of new modes of stimulation could improve its efficiency. Progress from nanotechnology will provide improved electrodes and more effective and comfortable ministimulators. The present electrical stimulation is rudimentary, mainly aimed at arresting abnormal neuronal discharges, and far
from the normal functioning of the human nervous system that should ideally be mimicked. In the long-term, the development of brain-computer interfaces will afford to decipher the discharge mode of a neuronal population and its behavioural correlates. Thus, new stimulation procedures delivering a sophisticated electrical message by one or several mini-electrodes could by applied in the dysfunctioning nervous system or the effector targets. Furthermore, implanted electrodes have also the interest of studying brain functioning either by microelectrode recording during surgery or local field potentials recording through chronic macroelectrodes during or after surgery.

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