Closed-Loop Deep Brain Stimulation Is Superior in Ameliorating Parkinsonism

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Created 10/20/2011
By bergman October 20, 2011


Abstract:

Continuous high-frequency deep brain stimulation (DBS) is a widely used therapy for advanced Parkinson's disease (PD) management. However, the mechanisms underlying DBS effects remain enigmatic and are the subject of an ongoing debate. Here, we present and test a closed-loop stimulation strategy for PD in the 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) primate model of PD. Application of pallidal closed-loop stimulation leads to dissociation between changes in basal ganglia (BG) discharge rates and patterns, providing insights into PD pathophysiology. Furthermore, cortico-pallidal closed-loop stimulation has a significantly greater effect on akinesia and on cortical and pallidal discharge patterns than standard open-loop DBS and matched control stimulation paradigms. Thus, closed-loop DBS paradigms, by modulating pathological oscillatory activity rather than the discharge rate of the BG-cortical networks, may afford more effective management of advanced PD. Such strategies have the potential to be effective in additional brain disorders in which a pathological neuronal discharge pattern can be recognized.

Date Published:

2011/10/20

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