

Pedunculopontine Nucleus Deep Brain Stimulation for Advanced Parkinson's Disease

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Introduction

Postural instability (PI) and freezing of gait (FOG), common in advanced Parkinson's disease (PD) respond poorly to dopaminergic therapy and deep brain stimulation (DBS) of subthalamic nucleus (STN), globus pallidus interna (GPi) and thalamus (Vim), sites used commonly to improve many motor dysfunctions of PD. Recent reports have identified pedunculopontine nucleus (PPN) as a promising DBS target to address PI/FOG in PD. Both motor and nonmotor benefits have been reported with PPN DBS, however acute but transient side effects, due to inadvertent stimulation of neighboring anatomical structures have also been documented.

Methods:

We performed a literature review to determine effects from PPN DBS, analyzing stimulation parameters and anatomical coordinates that were most effective.

Selection of patients:

1. Age of patient: <65 years (for benefit to be seen) and preferably not above 70 years of age (to minimize risk of side effects). 2. Disease duration and symptoms: Advanced PD cases, disease duration is >8-10 years and now has FOG and PI and refractory to dopaminergic therapy. 3. Tremor dominant PD and patients treated with DBS procedures in STN, GPI and VIM either alone or in combination with PPN were excluded from the analysis. 4. Primary focus of analysis is freezing of gait and secondary end point was postural instability.

Results Target:

Using AC-PC plane [Based on Zrinzo et al., 2008]: X: 6.4 mm lateral to midline Y: 3.5 mm posterior to posterior commissure Z: 11.4 mm caudal to PC in AC-PC plane

Using the floor of the fourth ventricle [Based on Ferraye et al., 2010] X: 6.3 mm lateral to midline D: 8.7 mm distance from floor of fourth ventricle H: 1.5 mm depth from pontomesencephalic line

Side effects:

The following side effects have been noted during or immediately after the surgery. 1) Paresthesias - due to inadvertent stimulation of medial lemniscus, spinothalamic tract 2) Oscillopsia, upper gaze palsy- due to inadvertent stimulation of different fascicles of the oculomotor nerve. 3) Urinary incontinence-

due to inadvertent stimulation of the pontine micturition center

The side effects have been reported as transient, however there are no longterm follow up of these side effects. Intra-operative monitoring of side effects such as paresthesias, oscillopsias can help in accurately identifying

target.



Stimulation parameters:

 Frequency settings between 20 Hz - 130 H, preferred range between 20 to 40 Hz (+/20 Hz). Higher frequency settings can cause dizziness, and can also worsen motor outcome.
 The voltage settings between 1.9 V - 4 V, kept 0.1 V below threshold for induction of side effects.
 Pulse width at 60 ms - 90 ms

4. Polarity: **Bipolar settings are preferred** over monopolar settings to minimize side effects.

Conclusions:

 Bilateral PPN DBS is more effective than unilateral PPN DBS
 The 3389 electrode is narrower than 3387 electrode type; hence with lesser scope for side effects.

3) It is preferable to target the posterior and not the anterior PPN, the caudal and not the rostral PPN.
4) Low frequency stimulation and voltages kept 0.1 V below threshold to induce side effects, result in best outcome.

References:

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