Case Report

Therapeutic Outcome of Deep Brain Stimulation: A Single Center Review

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Abstract

Background

Deep brain stimulation (DBS) is a well-established neuromodulation therapy. Electric stimulation of brain nuclei makes neural circuit activities appropriately.

Patients

Fourteen patients (8 males and 6 females) were introduced to DBS from 2008 to 2017 at a single neurosurgical hospital. DBS was applied to 7 cases of Parkinson's disease, 3 cases of dystonia, 3 cases of thalamic pain, and 1 case of essential tremor. The stimulation target was the subthalamic nuclei (6 cases of Parkinson's disease), globus pallidus interna (3 cases of dystonia), ventrointermediate nucleus (1 case of Parkinson's disease and 1 case of essential tremor), or internal capsule (3 cases of thalamic pain).

Methods

Therapeutic effect was estimated by the Unified Parkinson's Disease Rating Scale (UPDRS) Part III for Parkinson's disease, the Burke–Fahn–Marsden Dystonia Rating Scale (BFM-DRS) for dystonia, the Clinical Rating Scale for Tremor (CRST) for tremor, or the Visual Analog Scale (VAS) for pain.

Results

Movement disorder was improved by 79% (Parkinson's disease), 65% (dystonia), and 96% (tremor), respectively. Thalamic pain was reduced by 73%.

Conclusion

DBS can improve several movement disorders and reduce thalamic pain.

Keywords: Deep Brain Stimulation; Therapeutic Effect; Single Center Review

Introduction

Deep brain stimulation (DBS) has been recommended for medically refractory movement disorders [1-5]. Electric stimulation of brain nuclei at the subthalamus (STN) or globus pallidus interna (GPI) in basal ganglia for Parkinson's disease [2,3], GPI for dyskinesia [4], and ventrointermediate (Vim) nucleus in the thalamus for tremor [2] makes neural circuit activities appropriately. Movement disorders in Parkinson's disease vary among the each patient. STN stimulation likely reduce tremor, rigidity, and akinesia with lesser medication of levodopa based therapy. GPI stimulation easily improves dyskinesia without psychiatric symptom in Parkinson's disease. Further, GPI stimulation can keep body balance and gait stable in Parkinson's disease patients. Not only movement disorders, thalamic pain can be controlled by DBS against the internal capsule (IC). Several reports and randomized trials have revealed the effectiveness of DBS therapy. However, the introduction of DBS needs much initial investment and close inspection by the specialist for stereotactic and functional neurosurgery. The adaptation of DBS therapy is still under limitation of authorized functional neurosurgery centers. The author reports a single center retrospective review of DBS therapy, which has been started in the east Hokkaido area of Japan at the first time.

Patients and Methods

The author retrospectively reviewed the cases of fourteen patients (8 males of mean age 61.5 years and 6 females of mean age 68.5 years) who received DBS from 2008 to 2017 at a single neurosurgery center in Hokkaido Japan. DBS was introduced to 7 patients of Parkinson's disease (including 2 of tremor dominant), 3 patients of dystonia (1 patients of cervical dystonia and 2 patients of secondary dystonia), 3 patients of thalamic pain, and 1 patient of essential tremor. The stimulation target was the STN (6 cases of Parkinson's disease), GPI (3 cases of dystonia without Parkinson's disease), Vim nucleus (2 cases: 1 of tremor dominant Parkinson's disease and 1 of essential tremor) or IC (3 cases of thalamic pain from post hemorrhagic stroke). Patients of dystonia included 2 of secondary dystonia. One was post tumor resection against a right acoustic tumor, and the other was post hypoxia followed by drug abuse.

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The details of each patient are summarized in Table 1.

A DBS electrode (Medtronic) was implanted using the stereotactic procedure [6-8]. Target localization of the STN, GPi, Vim, or IC was based on the Schaltenbrand–Wahren atlas and direct visualization on the MRI image using surgical planning computer software (Frame Link, Medtronic). DBS electrode introduction to the target position was performed with the Leksell frame stereotactic system. The target was physiologically isolated by micro-electrophysiological recording. Further, Vim (for tremor patients) was confirmed with a tremor inducing test, which was performed under local anesthesia without a muscle relaxant. An internal pulse generator (Medtronic) was implanted at the subclavian subcutaneous pocket and was connected to the DBS electrode.

Therapeutic effect was estimated by the Unified Parkinson’s Disease Rating Scale Part III (UPDRS-III; ranged from 0 of no deficit to 108 points of full score) at the off period for Parkinson’s disease [9], the Burke–Fahn–Marsden Dystonia Rating Scale (BFM-DRS; ranged from 0 of no deficit to 120 points of full score) for dystonia [10], the Clinical Rating Scale for Tremor (CRST; ranged from 0 of no deficit to 184 points of full score) for tremor [11], or the Visual Analog Scale (VAS; ranged from 0 of no pain to 10 points of the worst pain) for pain. The therapeutic effect on tremor dominant Parkinson’s disease was estimated by the improvement of UPDRS-III score.

Results

Parkinson’s disease patients got an improvement of movement disorder of mean 79% (from 94% to 36%) in UPDRS-III score. The average improvement rate in Parkinson’s diseases patients except for the tremor dominant patients was 86%. Dystonia patients got an improvement of movement disorder by mean 65% (from 77% to 50%) in BFM-DRS score. Secondary dystonia patients got a 67% improvement (post acoustic tumor resection with hemi cerebellar injury) and a 77% improvement (post hyoxia dystonia at the lower extremities) in BFM-DRS score. Tremor was reduced by 96% in the CRST score in essential tremor. Thalamic pain was reduced by mean 73% (from 100% to 50%) in VAS score. Each result is summarized in Table 1. Patients’ background, diagnosis, duration of disorders, and treatments of DBS are described in Table 1.

Discussion

Parkinson’s disease related disorders are known to be regulated by STN or GPi stimulation [12,13]. The therapeutic efficiencies of DBS against STN or GPi are still under discussion. STN modulation has significant effects on the reduction in medication [14,15] and improvement of motor function during the off period [15]. In contrast, GPi modulation has significant effects on the relief from psychiatric symptoms [16]. STN-DBS against Parkinson’s disease was selected in this neurosurgical center. GPi-DBS was not applied to Parkinson’s disease patients. Every patient got excellent improvement in UPDRS-III score. Furthermore, all Parkinson’s disease patients could reduce their dopamine based medication. Levodopa administration dose was reduced in all Parkinson’s disease patients except tremor dominant cases. The mean reduction rate was 39% (from 67% to 20%) (Data not shown). Every patient got improvement of quality of daily activities with reduced medication (from their subjective interview, not objective scoring). These results were obtained by DBS therapy. Although the depression or other mental disorders are easy to be complicated with STN-DBS than GPi-DBS, no obvious mental complication was detected in STN-DBS against Parkinson’s disease. Because of small study size, it never asserts that STN-DBS does not cause psychiatry diseases.

Essential tremor and tremor dominant Parkinson’s disease is known to be controlled by Vim stimulation [17-20]. Tremor disappeared semi-completely (96% improvement in CRST) in essential tremor patients. Tremor dominant Parkinson’s disease patients got a 36% improvement in UPDRS-III. The gap between CRST and UPDRS-III was caused by the inclusion of tremor independent estimation items in UPDRS-III, which relatively diminished the improvement rate in tremor, dominant Parkinson’s disease.

Primary dystonia can be managed by GPi stimulation [21-24]. Not only a primary dystonia patient (number 2) but also both secondary dystonia patients (numbers 6 and 10) got a 50% or mean 72% improvement of movement disorder, respectively.

In addition to movement disorders, post stroke sensory disturbance can be refined by DBS against IC [25-27]. Subjective pain was reduced by mean 71% by IC-DBS. Although the pain scale was based on a subjective score, no patients experienced a greater pain by IC-DBS.

Conclusion

Despite the limitations of this small size review at a single neurosurgery center, the author concludes that DBS is useful for the management of movement disorders including Parkinson’s disease, dystonia, and tremor. Furthermore, not only primary dystonia but also secondary dystonia can be improved by DBS. In addition, thalamic pain can be reduced by DBS. This report provides further evidence for the usefulness of DBS.
Table 1. Summary of patients, details of therapy and outcomes.

<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Sex</th>
<th>Disorder</th>
<th>Duration</th>
<th>Side</th>
<th>Target</th>
<th>Complication</th>
<th>Pre DBS score</th>
<th>Post DBS score</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76</td>
<td>M</td>
<td>thalamic pain</td>
<td>1Y</td>
<td>Left</td>
<td>IC</td>
<td>None</td>
<td>VAS; 6</td>
<td>VAS; 0</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
<td>49</td>
<td>M</td>
<td>dystonia</td>
<td>5Y9M</td>
<td>bilateral</td>
<td>Gpi</td>
<td>None</td>
<td>BFM-DRS; 8</td>
<td>BFM-DRS; 4</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>F</td>
<td>thalamic pain</td>
<td>10Y</td>
<td>Right</td>
<td>IC</td>
<td>None</td>
<td>VAS; 6</td>
<td>VAS; 3</td>
<td>50%</td>
</tr>
<tr>
<td>4</td>
<td>77</td>
<td>F</td>
<td>thalamic pain</td>
<td>6Y</td>
<td>Right</td>
<td>IC</td>
<td>None</td>
<td>VAS; 8</td>
<td>VAS; 3</td>
<td>63%</td>
</tr>
<tr>
<td>5</td>
<td>71</td>
<td>F</td>
<td>Parkinson’s disease</td>
<td>15Y</td>
<td>bilateral</td>
<td>STN</td>
<td>None</td>
<td>UPDRS-III; 64</td>
<td>UPDRS-III; 4</td>
<td>94%</td>
</tr>
<tr>
<td>6</td>
<td>67</td>
<td>F</td>
<td>secondary dystonia (cerebellar injury)</td>
<td>11M</td>
<td>left</td>
<td>Gpi</td>
<td>None</td>
<td>BFM-DRS; 3</td>
<td>BFM-DRS; 1</td>
<td>67%</td>
</tr>
<tr>
<td>7</td>
<td>71</td>
<td>M</td>
<td>Parkinson’s disease (tremor)</td>
<td>13Y</td>
<td>bilateral</td>
<td>STN</td>
<td>None</td>
<td>UPDRS-III; 42</td>
<td>UPDRS-III; 6</td>
<td>86%</td>
</tr>
<tr>
<td>8</td>
<td>62</td>
<td>F</td>
<td>Parkinson’s disease</td>
<td>14Y</td>
<td>bilateral</td>
<td>STN</td>
<td>None</td>
<td>UPDRS-III; 46</td>
<td>UPDRS-III; 13</td>
<td>72%</td>
</tr>
<tr>
<td>9</td>
<td>58</td>
<td>M</td>
<td>Parkinson’s disease</td>
<td>22Y</td>
<td>bilateral</td>
<td>STN</td>
<td>None</td>
<td>UPDRS-III; 54</td>
<td>UPDRS-III; 5</td>
<td>91%</td>
</tr>
<tr>
<td>10</td>
<td>35</td>
<td>M</td>
<td>secondary dystonia (hypoxia)</td>
<td>7Y</td>
<td>bilateral</td>
<td>Gpi</td>
<td>None</td>
<td>BFM-DRS; 53</td>
<td>BFM-DRS; 12</td>
<td>77%</td>
</tr>
<tr>
<td>11</td>
<td>67</td>
<td>M</td>
<td>essential tremor</td>
<td>7Y</td>
<td>right</td>
<td>Vim</td>
<td>None</td>
<td>CRST; 23</td>
<td>CRST; 1</td>
<td>96%</td>
</tr>
<tr>
<td>12</td>
<td>72</td>
<td>M</td>
<td>Parkinson’s disease (tremor)</td>
<td>3Y7M</td>
<td>left</td>
<td>Vim</td>
<td>None</td>
<td>UPDRS-III; 28</td>
<td>UPDRS-III; 18</td>
<td>36%</td>
</tr>
<tr>
<td>13</td>
<td>64</td>
<td>M</td>
<td>Parkinson’s disease</td>
<td>17Y</td>
<td>bilateral</td>
<td>STN</td>
<td>None</td>
<td>UPDRS-III; 81</td>
<td>UPDRS-III; 15</td>
<td>81%</td>
</tr>
<tr>
<td>14</td>
<td>64</td>
<td>F</td>
<td>Parkinson’s disease</td>
<td>7Y2M</td>
<td>bilateral</td>
<td>STN</td>
<td>hemorrhage</td>
<td>UPDRS-III; 33</td>
<td>UPDRS-III; 3</td>
<td>91%</td>
</tr>
</tbody>
</table>

M (sex); male, F (sex); female, Y (duration); year, M (duration); month, IC; internal capsule, Gpi; globus pallidus interna, Vim; ventral intermediate, STN; subthalamic nuclei, VAS; visual analog scale, BFM-DRS; Burke-Fahn-Marsden Dystonia Rating Scale, UPDRS-III; unified Parkinson’s disease rating scale part III, CRST; clinical rating scale for tremor, NA; not available.
References


