The North American Survey of Placement and Adjustment Strategies for Deep Brain Stimulation

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Abstract

Background: Deep brain stimulation (DBS) is gaining wide acceptance as treatment for Parkinson's disease, essential tremor, and dystonia.

Methods: A forty-item questionnaire commissioned by the DBS Study Group was sent to 46 centers that have performed at least 25 DBS implantations. These centers were identified through the DBS Study Group, other profession societies, and with the assistance of Medtronic Corporation. The results were then tabulated and descriptive analyses were performed.

Results: Thirty-four of 46 centers (74%) responded (30 academic, 4 private practice), and have implanted 4,478 patients. The timing for bilaterally implanted patients varied, as 12 sites almost always implanted simultaneously whereas 13 sites almost never implanted simultaneously. Stereotactic frames included Leksell (17), CRW (15) and Compass (2). Post placement imaging was routinely performed by almost all centers and included MRI (21), CT (4), CT/MRI variably (5), and ventriculography (1). Two centers used more than one electrode per side. The 32 centers that used a single electrode averaged 2.3±1.4 passes per electrode [range: 1–18 passes]. Most centers used macro-recordings to confirm placement by assessing the intra-operatively clinical response (32), and to assess for adverse events (25) at high voltages, averaging 6.8±2.3 V [range: 4–10 V]. The initial activation averaged 18±12 days after electrode placement [average range: 11±10 to 28±18 days, absolute range: 1–90 days]. Most sites had multiple programmers; however the primary programmer was the neurologist's staff (14), the neurologist (12), the neurosurgeon's staff (6), the neurosurgeon (2), or a physiatrist (1). PD medications are automatically reduced on the day of initial activation by 11 centers, are variably reduced by 9 centers, and are not initially reduced by 15 centers. Eventually, 85.9% of patients have some dose reduction, and 48.8% have a greater than 50% reduction of PD medications.

Conclusions: Strategies regarding DBS placement and adjustment vary in North America.

Introduction

Deep Brain stimulation (DBS) is gaining wide acceptance as treatment for Parkinson's disease (PD), essential tremor (ET), and dystonia. Conceptionally, DBS improves symptoms by functionally inhibiting certain brain areas, although the exact cellular mechanisms are not known. Methodologies to optimize placement, optimize adjustment settings, and reduce complications vary at different DBS centers, and formal guidelines regarding technical issues do not exist. We therefore surveyed major DBS centers in North America regarding DBS placement and adjustment strategies. This is not meant to advocate any particular methodology, but rather meant to present the diversity of current DBS practices.

Methods

Centers known to participate in deep brain stimulator placement (Activa®, Medtronic Corporation) were contacted via e-mail and asked to complete a questionnaire regarding their surgical techniques, programming strategies and patient management practices. Forty-six sites were identified through a DBS Study Group database, other professional groups, and corroborated with purchasing records from Medtronic Cooperation. The top twenty purchasers of Activa units were all invited to participate. We required a minimum of 25 implanted patients for inclusion. The 40 question survey was written by W.O. and H.B. Clarifications were made via subsequent email or personal communication. The results were tabulated and descriptive statistics are presented.

Results

Participating Sites:

Surveys were returned by 34/46 (74%) of centers. One non-responder sited confidentiality concerns and the others offered no specific reason for non-participation. Four responders were in private practice and the rest were academic or academic affiliated.

Patients:

The respondents have implanted DBS into 4,478 patients (1,199 unilat VIM, 470 bilat VIM, 523 unilat STN, 1,810 bilat STN, 245 unilat GPi, 218 bilat GPi, and 13 in other locations). The timing for bilaterally implanted patients varied tremendously as 12 sites almost always implanted simultaneously (<90% of procedures) whereas 13 sites almost never implanted simultaneously (<10% of procedures), and the rest variable staged procedures. Overall 51% of bilateral procedures were simultaneous. When staged, the second side was implanted an average of 3.7±5.0 months [mean range: 1.8–10.8 months, absolute range: 0.5–48 months] after the first side.

Surgical Methodology:

Stereotactic frames included Electa Leksell (17), Radionics CRW (15), and Compass system (2). Imaging for placement included: MRI only (21), MRI/CT fusion (11), and ventriculography (2). Several centers used specific MRI sequencing including FLAIR imaging. Post placement imaging was routinely performed by almost all centers and included MRI (21), CT (4), CT/MRI variably (5), and ventriculography (1).

Two centers used more than one electrode per side. The 32 centers that used a single electrode averaged 2.3±1.4 passes per electrode [range: 1–18 passes]. Thirty-three centers used micro-electrical recordings to assist with placement. Most centers used macro-recordings to confirm placement by assessing the intra-operatively clinical response (32), and assessed for adverse events (25) at high voltages, averaging 6.8±2.3 V [range: 4–10 V]. Intra-operative imaging was also used to confirmed placement: fluoroscopy (18), radiographs (3), and ventriculography (1).

Activation and Programming:

The initial activation occurred 18±12 days after electrode placement [average range: 11±10 to 28±18 days, absolute range: 1–90 days]. In patients with planned staged procedures, seven centers almost always waited for the second placement prior to any activation, whereas, 15 centers activated the first side prior to implanting the second electrode. Most sites had multiple programmers; however, the primary programmers were the neurologist's staff (14), the neurologist (12), the neurosurgeon's staff (6), the neurosurgeon (2), or a physiatrist (1).

Table 1. The Estimated Number of Adjustment Sessions

Time	Number of Adjustments	Mean Range Low	Mean Range High	Absolute Range Low	Absolute Range High
Month 1	1.8±1.2	1.0±0.8	3.4±2.4	0	12
Month 2-6	3.8±2.1	2.0±1.4	7.8±4.1	0	20
Month 6-12	2.2±0.8	1.0±0.8	6.0±4.3	0	20
Month 12-24	2.2±1.2	1.2±0.9	5.5±3.0	0	12

Results in mean ± sd; N = 34 Centers

Table 2. The Time Centers Spend on Adjustments

	Initial Programing *						Subsequent Programing *					
	0-15	16-30	31-60	61-90	91-120	>120	0-15	16-30	31-60	61-90	91-120	>120
VIM												
Uni	3	8	14	5	0	1	11	12	7	2	0	0
Bil	0	7	10	10	2	1	6	13	10	1	1	0
STN												
Uni	2	5	8	11	0	2	4	10	9	3	0	1
Bil	0	3	7	13	8	3	1	10	15	6	1	1
GPi												
Uni	2	4	8	8	0	1	7	6	7	3	0	0
Bil	1	3	4	10	6	2	5	6	9	5	1	0

*Time in minutes

Patient Assessments:

Twenty-seven centers use formal assessment protocols. Assessments of patients occurred post-operative at: month 1 (7), month 3 (18), month 6 (17), month 12 (22), month 24 (16), month 36 (14). Patients were programmed while "off" medications (19), "on" medications (1), or both "on" and "off" medications (15). Most centers asked patients to abstain from medications overnight prior to adjustments. All centers used clinical assessments taken from the Unified Parkinson's Disease Rating Scale (UPDRS) and three used additional electrophysiological assessments.

Medical Management:

PD medications are automatically reduced on the day of initial activation by 11 centers, are variably reduced by 9 centers, and are not initially reduced by 15 centers. Overall medications are automatically reduced in 48.9% of patients at their first visit. Eventually, 85.9% of patients have some dose reduction after surgery, and 48.8% have a greater than 50% reduction of PD medications.

Discussion

Our survey of 34 centers that perform DBS demonstrates variability in surgical techniques, programming and medical management. This survey is not meant to advocate any specific techniques but may serve as a resource for centers either developing or refining a DBS program.

There are several drawbacks to surveys of this kind. Although we are not reporting the results for any specific center, respondents may show some bias toward emphasizing results preserved as better. We specifically did not ask for an estimation of efficacy because this is difficult to do and may be inflated. The respondents were heavily weighted toward academic settings; however the majority of DBS is implanted in academic movement disorder programs. All respondents were asked to query records as needed to ensure accuracy; however this can not be guaranteed by the author, and it is suspected that the results of some centers were more meticulously recorded then others. Nevertheless, we feel that this affords a reasonably good report of DBS practice parameters within North America.

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