Published in final edited form as:

Parkinsonism Relat Disord. 2017 March ; 36: 100–102. doi:10.1016/j.parkreldis.2016.12.017.

Thalamic deep brain stimulation as rescue therapy for tremor following bilateral radiosurgery

Jonathan T. Butler,

Department of Neurology, Movement Disorder Division, Vanderbilt Medical Center-1161, 21st Avenue South/ Medical Center North A-0118, Nashville, TN 37232, USA

William Rodriguez,

Department of Engineering, Vanderbilt University-2301, Vanderbilt Place/ PMB 351826, Nashville, TN 37235-1826, USA

Srivatsan Pallavaram,

Department of Engineering, Vanderbilt University-2301, Vanderbilt Place/ PMB 351826, Nashville, TN 37235-1826, USA

Peter Konrad, and

Department of Neurosurgery, Vanderbilt Medical Center-1161, 21st Avenue South/D-4303 Medical Center North, Nashville, TN 37232, USA

Christopher M. Tolleson*

Department of Neurology, Movement Disorder Division, Vanderbilt Medical Center-1161, 21st Avenue South/ Medical Center North A-0118, Nashville, TN 37232, USA

Keywords

Deep brain stimulation Essential tremor Radiosurgery; Gamma knife Thalamus

1. Introduction

Deep brain stimulation (DBS) is a proven surgical intervention for the symptomatic treatment of essential tremor (ET) through stimulation of the thalamic ventral intermediate nucleus (VIM) [1]. We report a case of bilateral VIM DBS initiated 10 years after bilateral stereotactic thalamic gamma knife radiosurgery. DBS successfully lessened breakthrough of his progressive ET without leading to further disabling dysarthria.

*Corresponding author. christopher.tolleson@vanderbilt.edu (C.M.Tolleson).

Author roles

1.Research project: A. Conception, Organization, Execution-Dr Tolleson, Dr Butler, Mr Rodriguez, Dr Pallavaram and Dr Konrad; 2.Statistical Analysis: A. Design, B. Execution, C. Review and Critique-Not applicable; 3. Manuscript Preparation: A. Writing of the first draft-Dr Butler, Dr Tolleson, B. Review and Critique- Dr Tolleson, Dr Butler, Mr Rodriguez, Dr Pallavaram and Dr Konrad. All authors have approved the final version of the manuscript.

Disclosures

The other authors had no additional funding disclosures or conflicts of interest to report.

Supplementary video related to this article can be found at <http://dx.doi.org/10.1016/j.parkreldis.2016.12.017>.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.parkreldis.2016.12.017>.

1.1. Case report

This is a 71-year-old male without medical comorbidities who developed a bilateral upper extremity postural and action tremor insidiously at age 20. The tremor progressed in severity, leading him to ultimately seek neurologic care. Given a profound family history of tremor, he was diagnosed with ET. Various medications including propranolol and primidone initially controlled his tremor but ultimately lost effectiveness. He developed increasing difficulty with fine motor tasks such as eating, drinking and other activities of daily living (ADLs). Eventually, he underwent bilateral stereotactic gamma knife radiosurgery at age 60 at an outside institution with near complete tremor resolution. The patient did develop some mild post-procedural dysarthria. His tremor remained well controlled until age 69 whereupon it began progressing again, reaching the point he needed assistance with eating and dressing. He then presented to our institution. MRI imaging revealed bilateral spherical surgical lesions centered in the midsegment of the thalamus (Fig. 1). We felt he had remaining tremor circuitry to target with DBS in the region surrounding the lesions. The patient was presented at our multidisciplinary DBS conference and it was agreed to pursue bilateral thalamic DBS to expand the treatment area initially effective at controlling his tremor. A functional atlas which contains normalized patient data of efficacy and side effect potential from all prior VIM surgeries was morphed onto the patient's MRI, and utilized to create the surgical plan [2]. He underwent staged bilateral DBS surgery with microelectrode stimulation to map the region of interest. The patient had moderate tremor improvement intraoperatively. Final DBS electrodes (Medtronic #3387) were placed in locations optimizing tremor reduction and minimizing stimulation side effects (Fig. 1). A dual channel IPG (Medtronic Activa PC) was placed one week later.

Tremor ratings were performed pre and post DBS by a single blinded independent rater and videotaped. The patient underwent programming at 1, 3 and 6 months post implantation. We observed a 45% improvement in tremor compared to presurgical testing 6 months after surgery (Fahn, Tolosa, Marin Tremor Rating Scale 63/144 to 35/144). The left VIM was stimulated in a bipolar electrode configuration (2+/1-/0-, 4.5V, 120 ms pulse width, 130Hz) and the right VIM was stimulated with a monopolar configuration (C+/9-, 2.4V, 90 ms pulse width, 130Hz). The patient reported considerable tremor improvement. He regained the ability to eat and dress without assistance. He still had some difficulty with drinking and required a straw to complete the task without spilling. The least captured aspect of the tremor was the coarse end point of his action tremor when his hand neared a target. There was also some mild worsening in dysarthria with optimal DBS settings, requiring him to intermittently turn off stimulation when he needed to maximize speech production.

2. Discussion

Multiple interventional options exist for medically refractory ET including traditional thermoablative thalamotomy, DBS, stereotactic radiosurgery and high intensity focused ultrasound ablation [3]. Typically, ET follows a progressive course with worsening of postural and action tremor components. Despite initial response to DBS or thalamic lesional therapy, there can be symptom progression or reemergence. There are published case reports of utilizing thalamotomy after DBS as a rescue [4]. There is also published literature

referencing utilization of additional DBS leads to expand and further shape the stimulation field to capture additional tremor circuits and improve symptomatic control [5]. Upon review, this is the first known reported case of utilizing DBS as rescue therapy for ET after radiosurgery. DBS has been used as a rescue therapy for inadequate lesioning therapies in other indications [6–8]. Given a risk of permanently worsening dysarthria with further thalamic lesioning therapy, DBS has a notable advantage as rescue therapy, especially after bilateral lesioning therapy. It is a surgical option which theoretically does not permanently damage the tissue in the target area and has easily adjustable postsurgical outcomes due to the programmable electrodes. Our patient had some mild worsening in dysarthria but was able to turn the stimulation settings down or off as the situation required. This case report demonstrates that DBS used as rescue therapy after gamma knife surgery is a safe and at least moderately effective option without the risk of permanently worsened dysarthria.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Extraction of the patient's implant images and visualization in a normalized space with all data from prior VIM ET DBS surgeries was performed using the CranialVault atlas which is supported by NIH R01 EB006136 and NIH R01 NS095291.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. Dr Tolleson has done consulting work for Medtronic, Teva, and Acadia. Dr. Konrad is a founding member and stock holder, and Dr. Pallavaram is a stock holder, in Neurotargeting LLC that licenses the CRAVE software suite from Vanderbilt University that assisted with creating the functional atlas for this case.

References

- [1]. Vaillancourt DE, Sturman MM, Verhagen Metman L, Bakay RAE, Corcos DM, Deep brain stimulation of the VIM thalamic nucleus modifies several features of essential tremor, *Neurology* 61 (2003) 919e925.
- [2]. D'Haese PF, Pallavaram S, Li R, Remple MS, Kao C, Neimat JS, Konrad PE, Dawant BM, CranialVault and its CRAVE tools: a clinical computer assistance system for deep brain stimulation (DBS) therapy, *Med. Image Anal.* 16 (3) (2012) 744e753.
- [3]. Picillo M, Fasano A, Recent advances in essential tremor: surgical treatment, *Park. Relat. Disord.* 22 (Suppl 1) (2016) S171eS175.
- [4]. Bahgat D, Magill ST, Berk C, McCartney S, Burchiel KJ, Thalamotomy as a treatment option for tremor after ineffective deep brain stimulation, *Stereotact. Funct. Neurosurg.* 91 (2013) 18e23.
- [5]. Yu H, Hedera P, Fang H, Davis TL, Konrad PE, Confined stimulation using dual thalamic deep brain stimulation leads rescues refractory essential tremor: report of three cases, *Stereotact. Funct. Neurosurg.* 87 (2009) 309e313.
- [6]. Vergani F, Landi A, Antonini A, Sganzerla EP, Bilateral subthalamic deep brain stimulation in a patient with Parkinson's disease who had previously undergone thalamotomy and autologous adrenal grafting in the caudate nucleus: case report, *Neurosurgery* 59 (5) (2006). E1140. [PubMed: 17143205]
- [7]. Waln O, Jankovic J, Bilateral globus pallidus internus deep brain stimulation after bilateral pallidotomy in a patient with generalized early-onset primary dystonia, *Mov. Disord.* 28 (80) (2013) 1162e1163, 10.1002/mds.25456.
- [8]. Yamgoue Y, Pralong E, Levivier M, Bloch J, Deep brain stimulation of the ventroposteromedial (VPM) thalamus 10 Years after VPM thalamotomy to treat a recurrent facial pain, *Stereotact. Funct. Neurosurg.* 94 (2) (2016) 118e122, 10.1159/000444762.

Fig. 1.

The presented images include the post-operative axial image (top left), coronal image (top right), left sagittal image (bottom left), and right sagittal image (bottom right). In all images, the patient's postoperative CT is registered to the preoperative T1 MRI. Depicted images best capture the proximity of the electrode to the thalamotomy (axial reference frame: 4.5 mm superior to the mid-commissural point, coronal: level of contact 1 on the right brain and contact 2 on the left brain (3.9 mm posterior to the mid-commissural point), sagittal views: centered on the midpoint of the lead). Relative to the mid-commissural point, the mid-point

of the left lead was 14.7 mm lateral, 3.4 mm posterior and 4.5 mm superior (midpoint between cathodes: 13.5 lateral, 4.4 posterior, and 2.0 mm superior). The right lead midpoint was 20.8 mm lateral, 2.3 mm posterior and 9.9 mm superior (active contact: 20.2 lateral, 2.8 posterior and 8.4 mm superior). The gamma knife lesion midpoint on the left was 18.2 mm lateral, 5.2 mm posterior, and 4.3 mm superior relative to the mid-commissural point. On the right, the lesion midpoint was 16.7 mm lateral, 5.4 mm posterior, and 5.6 mm superior.

AC, anterior commissure; MP, mid-commissural point; PC, posterior commissure.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript