



BACKGROUND

- ❖ Essential tremor (ET) is frequently associated with other co-morbid movement disorders such as spasmodic dysphonia (SD), writer's cramp and other focal dystonias^{1,2}.
- ❖ Ventral intermediate (ViM) thalamic deep brain stimulation (DBS) is a well established treatment for contralateral limb tremors³.
- ❖ There is now emerging evidence that voice tremors can also improve with both unilateral and bilateral thalamic stimulation^{4,5}.
- ❖ While patients with dystonia clearly benefit from pallidal stimulation⁶, thalamic stimulation may be preferred in cases of dystonic tremor⁷.
- ❖ There is limited data regarding the effects of thalamic stimulation on SD.
- ❖ We observed have 2 cases of unilateral thalamic stimulation, originally implanted for treatment of tremor, that incidentally improved each patients' SD.

CASE HISTORIES

Case 1: 59 year old left handed woman with ET and writer's cramp starting in her 20's was first evaluated at our center in 1995. Tremors were refractory to multiple therapies associated with persistent disability. After consensus approval, she underwent bilateral ViM DBS (3387 leads, Medtronic, Minneapolis, MN) placement in November 2007.

- Pre-operative Fahn-Tolosa-Marin (FTM) tremor rating scale (TRS) was 18.5 with normal phonation.
- During follow-up she discontinued right ViM stimulation due to stimulation induced side effects.
- In January 2012, left ViM IPG depletion revealed recurrent right hand tremors and new voice difficulties consistent with adductor spasmodic dysphonia.
- After IPG exchange her voice symptoms improved with re-initiation of left ViM stimulation (Video 1) to original settings (Table 1).
- For further characterization of voice symptoms stroboscopedaryngoscopy (SVL) was performed \geq 1hour off stimulation and after 5minutes on stimulation. (Table 2)
- Appropriate lead location of left ViM electrode was confirmed by MRI brain (Figure 1).

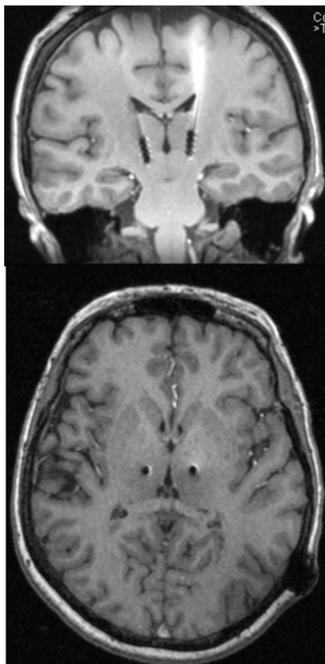


Figure 1: T1 coronal and axial images from case 1's MRI demonstrating optimal placement of left ViM. Suboptimal placement of right ViM lead likely accounts of intolerable stimulation related side effects which was later revised.

CASE HISTORIES

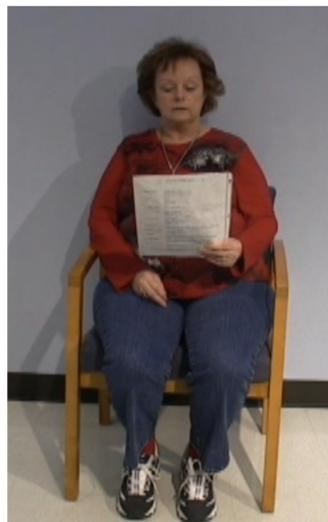
Case 2: 68 year old right handed woman with ET for > 20 years, spasmodic dysphonia, restless legs syndrome and migraines was first evaluated at our center in 1999. Her tremors were refractory to multiple therapies associated with persistent disability. After consensus approval, she underwent left ViM DBS (3387 leads, Medtronic, MN) placement in January 2011.

- FTM-TRS was 22 with evidence of spasmodic dysphonia pre-operatively.
- With optimization of her stimulation parameters (Table 1) she was noted to have near complete resolution of right hand tremors and marked improvement of SD (Video 2).
- Neuroimaging was not obtained due to sustained benefit from stimulation.
- ❖ For further characterization of voice symptoms SVL was performed \geq 1hour off stimulation and after 5minutes on stimulation. (Video 2)(Table 2).

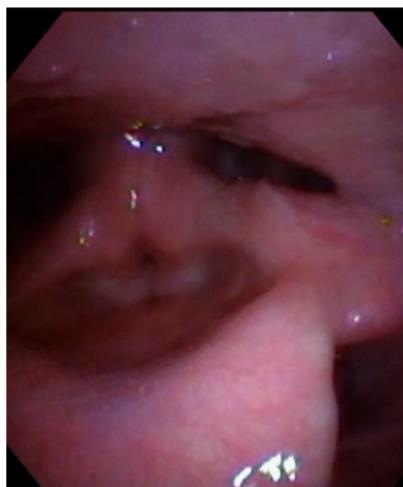
RESULTS, VIDEOS & TABLES

Table 1: Optimized DBS settings.

	Case 1	Case 2
Target	Left ViM	Left ViM
Polarity	C+1-	C+2-
Amplitude (V)	4.0 V	3.6V
Pulse Width (μ s)	90 μ s	90 μ s
Frequency (Hz)	145 Hz	150Hz



Video 1: In the 1st segment case 1's voice sample is shown in the "off state" \geq 1 hour after discontinuation of stimulation. In the 2nd segment her voice sample is shown 5 minutes after re-instating stimulation to optimal settings with marked improvement of her spasmodic dysphonia.



Video 2: In the 1st segment case 2's SVL is shown in the "off state" \geq 1 hour after discontinuation of stimulation. In the 2nd segment her SVL is shown 5minutes after re-instating stimulation to optimal settings with improvement of laryngeal spasm.

RESULTS, VIDEOS & TABLES (cont...)

Table 2: Stroboscopedaryngoscopy

	Case 1	Case 2
OFF DBS \geq 1hour	Arytenoid spasm on adduction and tension in the false vocal folds	Arytenoid spasm on adduction and tension in the false vocal folds
ON DBS 5 min	Subjective improvement of vocal spasms and subtle reduction in arytenoid spasms, decreased spasm in false vocal folds and improved sustained phonation	Decreased arytenoid spasm and decreased tension in the false folds with marked improvement in sustained phonation

DISCUSSION

- ❖ Our two cases demonstrate improvement of SD with unilateral thalamic stimulation confirmed by SVL.
 - There was no evidence of kinetic tremor in either case.
 - Kinetic tremor extends through the entire larynx and is not limited to the vocal folds suggestive of essential voice tremor⁴.
- ❖ SD is best managed with botulinum toxin injections to the vocal cords^{5,6}, however this treatment is temporary and can be limited by weakened voice caliber with breathy quality in which cases alternate therapies are needed.
- ❖ A single case of spasmodic dysphonia reported to improve with bilateral thalamic stimulation reported⁷. To our knowledge these are the first two cases of incidental SD reported in the literature that demonstrate improvement with unilateral thalamic stimulation.
- ❖ The ViM nucleus receives somatosensory input from the cerebellum which is implicated in the pathophysiology of ET⁸.
- ❖ Functional neuroimaging implicates cerebellar dysfunction in the pathophysiology of SD⁹. Thus it is possible that stimulation of the cerebellar efferent pathways to the thalamus may result in improvement in both spasmodic dysphonia and limb tremor in our patients.
- ❖ Bilateral stimulation is traditionally considered necessary to treat midline symptoms, yet in our cases unilateral stimulation yielded substantial improvement in voice in both patients.
- ❖ These observations support further investigation of the effects of unilateral thalamic stimulation for the treatment of SD refractory to botulinum toxin therapy.

REFERENCES

1. Lou JS, Jankovic J. Essential tremor: clinical correlates in 350 patients. *Neurology*. 1991;41(2 (Pt 1)):234-8.
2. Schweinfurth JM, Billante M, Courey MS. Risk factors and demographics in patients with spasmodic dysphonia. *Laryngoscope*. 2002;112(2):220-3.
3. Kumar K, Kelly M, Toth C. Deep brain stimulation of the ventral intermediate nucleus of the thalamus for control of tremors in Parkinson's disease and essential tremor. *Stereotact Funct Neurosurg*. 1999;72(1):47-61.
4. Sulica L, Louis ED. Clinical characteristics of essential voice tremor: A study of 34 cases. *Laryngoscope*. 2010;120:516-28.
5. Batla A, Stamelou M, Bhatia KP. Treatment of focal dystonia. *Curr Treat Options Neurol*. 2012;14(3):213-29.
6. Ludlow CL. Spasmodic dysphonia: a laryngeal control disorder specific to speech. *J Neurosci*. 2011;31(3):793-7.
7. Lyons M, Evidente V. Essential tremor and spasmodic dysphonia response to bilateral thalamic deep brain stimulation: review of experience and possible mechanism. Poster presentation. *Parkinsonism and Related Disorders*. 2009; 15S2: S29-199.
8. Pedrosa DJ, Reck C, Florin E, Pauls KA, Maarouf M, Wojtecki L, et al. Essential tremor and tremor in Parkinson's disease are associated with distinct 'tremor clusters' in the ventral thalamus. *Exp Neurol*. 2012;237(2):435-43.
9. Simonyan K, Ludlow CL. Abnormal structure-function relationship in spasmodic dysphonia. *Cereb Cortex*. 2012;22(2):417-25.