

Efficacy of Thalamotomy and Thalamic Deep Brain Stimulation for the Treatment of Head Tremor

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Objective : Stereotactic thalamic procedure is well known to be an effective treatment for disabling upper limb tremor of essential tremor. However, the effect of this procedure for head tremor, which is a midline symptom of that disease entity, has not been sufficiently established. The authors discuss the result of stereotactic thalamic operations for head tremor of their patients who suffered from essential tremor.

Methods : We evaluated 4 patients of essential tremor who had head tremor combined with both upper limb tremor. One patient underwent unilateral ventralis intermedialis thalamotomy, two patients had unilateral Vim deep brain stimulation (DBS) and one patient had unilateral Vim thalamotomy and contralateral DBS. Postoperative results of tremor were evaluated using our proposed scale.

Results : Contralateral upper limb tremors to surgical side were markedly resolved in all patients but there was no meaningful effect for head tremor in 3 patients who underwent unilateral thalamic surgery. In a patient having simultaneously unilateral thalamotomy and contralateral DBS, remarkable improvement of head tremor was observed.

Conclusion : Although it is difficult to evaluate the efficacy of thalamic surgery for axial symptom of essential tremor with a few cases, simultaneous unilateral thalamotomy and contralateral DBS would be expected to induce favorable outcomes for head tremor with significant economical advantages.

KEY WORDS : Deep brain stimulation · Essential tremor · Head tremor · Thalamotomy.

Introduction

Essential tremor, together with Parkinson's disease, is a representative movement disorder. Its main symptom is tremor without rigidity or bradykinesia that is different from Parkinson's disease, and appears as bilateral fashion especially during exercise. The tremor manifests primarily in the upper extremities, head and voice, and it does not respond to anti-parkinsonian medications⁷⁾. The therapeutics of essential tremor are the β -adrenergic blockers such as propranolol, etc. and primidone, but it is known to be effective less than 50% of patients, and the efficacy of the therapeutics decreases in

long-term administration in many patients⁹⁾. The surgical treatment of essential tremor is generally the approach to the ventralis intermedialis nucleus (Vim nucleus) of the thalamus as an anatomical target area similar to Parkinsonian tremor, and the stereotactic thalamotomy or deep brain stimulation (DBS) of the Vim nucleus can improve the essential tremor^{1,2,6,10,11)}. However, although such surgical treatments can improve the tremor of the upper extremities, their efficacy on the head tremor is not well established. We compared the improvement of the head tremor in 4 cases of essential tremor patients treated with the Vim thalamotomy or DBS, and also compared according to the unilateral and bilateral surgery.

Materials and Methods

On four bilateral essential tremor patients accompanying the head tremor, the thalamotomy of the Vim nucleus or DBS was performed. They were 3 males and 1 female, the range of their age was 45-69 years, and they had the symptom

• Received : August 17, 2004 • Accepted : November 15, 2004
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Table 1. Severity of tremor

Grade	Description
0	None (no tremor)
1	Mild tremor (tremor is occasional and does not interfere with social or professional activities)
2	Moderate tremor (tremor is constant and occasionally interferes with social or professional activities)
3	Severe tremor (tremor always interferes with social or professional activities and activities of daily living)

Table 2. Comparison of preoperative and postoperative limb tremor

Case	Preoperative ST	Postoperative ST
1 (Th)	3	1
2 (DBS)	3	1
3 (DBS)	3	1
4 (DBS+Th)	3	1 or 0

ST: severity of tremor, Th: unilateral thalamotomy, DBS: unilateral deep brain stimulation, DBS+Th: unilateral DBS+contralateral thalamotomy

Table 3. Comparison of preoperative and postoperative head tremor

Case	Preoperative ST	Postoperative ST
1 (Th)	2	1 or 2
2 (DBS)	2	1
3 (DBS)	3	1
4 (DBS+Th)	3	0 or 1

ST: severity of tremor, Th: unilateral thalamotomy, DBS: unilateral deep brain stimulation, DBS+Th: Unilateral DBS+contralateral thalamotomy

Table 4. Comparison of preoperative and postoperative voice tremor

Case	Preoperative ST	Postoperative ST
1 (Th)	3	1 or 2
2 (DBS)	3	1 or 2
4 (DBS+Th)	2	0 or 1

ST: severity of tremor, Th: unilateral thalamotomy, DBS: unilateral deep brain stimulation, DBS+Th: Unilateral DBS+contralateral thalamotomy

for 10~33years. All of them had been unresponsive to propranolol, primidone, and other drugs. One patient was treated by the unilateral Vim thalamotomy, 2 patients were treated by the unilateral deep brain stimulation, and 1 patient was treated by the simultaneous unilateral DBS and Vim thalamotomy on the opposite side. Using a Leksell G frame (Elekta, Inc., Sweden) placed on the patient's head, a brain magnetic resonance imaging (MRI) was performed to determine the anatomical target and the final target in the Vim nucleus for the thalamotomy as well as DBS was determined by performing macrostimulation. For deep brain stimulation, the electrode (lead model 3387; Medtronic, Inc, Minneapolis, MN, U.S.A.) was inserted into the final target, and an impulse generator (Solettra model 7426; Medtronic, Inc., U.S.A.) that was implanted in the subclavian area of the same side under general anesthesia, was connected with the electrode through a subcutaneous tunnel. There was no complications during or after surgery. The stimulus was switched off for the stimulation-off assessment and all three

patients showed preoperative degrees of limb and head tremors. The stimulation parameters included the following : rates 145 to 160Hz, pulse width 60 μ sec, amplitude 3.6 to 3.9V. The follow-up period was from 3 months to 5 years. The change of symptoms was analyzed by assessing the improvement of tremors on the upper extremities, the head, and the voice separately. For relative comparison, the degree of tremor was graded separately (Table 1).

Results

After surgery, in the upper extremity tremors of a patient treated with the unilateral Vim thalamotomy and 2 patients treated with the unilateral DBS, the tremors on the opposite sides were improved greatly as appeared only under a severe tense condition. In patients treated simultaneously with the unilateral DBS and the contralateral Vim thalamotomy, the tremor of both extremities was hard to detect even under a tense condition, and the difference between two sides was in evident (Table 2). The head tremor in 3 patients treated with the unilateral surgery was improved by 25~50% (tremor was not constant but remained with social or professional activities), with which patients were not as satisfactory as the improvement of the tremors of the upper extremities, and the difference between the Vim thalamotomy and the unilateral DBS treatment was not evident. However, in patients underwent the unilateral DBS and the contralateral thalamotomy, the head tremor was improved by over 75% (tremor was occasional and did not interfere with social or professional activities) (Table 3). In 3 patients who had the vocal tremor, 2 patients treated with the unilateral surgery showed the minimal improvement of the vocal tremor after surgery. In a patient treated with the bilateral surgery, about 20% improvement of the vocal tremor was detected (tremor became occasional but occurred under a any tense condition), which was not satisfactory to the patient (Table 4). Three patients underwent the unilateral surgery were under medication for the tremor of the upper extremities of the same side during the follow up and the recurrence of the tremor of the opposite side was not detected. In a patient underwent the bilateral surgery, without medications, the recurrence or the progression of the tremors of both upper extremities and head was not detected presently, over the 12-month follow-up time.

Discussion

In the stereotactic surgery for Parkinson's disease, the thalamus, the globus pallidus, or the subthalamic nucleus

is selected as the target according to the major symptom and the condition of the patient. For essential tremor of which symptom is only tremor, the thalamotomy or DBS of the thalamus has been performed³. For the surgical treatment of essential tremor, the effectiveness of the unilateral Vim thalamotomy for the extremity tremor has been well known^{6,22}, but its effect on the axial symptom such as the head and voice tremor has not been established. Together with the extremity tremor, the head tremor is a major symptom of essential tremor. It appears usually after the progression of the extremity tremor, and it may impede the daily life of patients as much as the extremity tremor³. On the other hand, as the risk for neurological complications of the bilateral thalamotomy such as cognitive dysfunction, speech disturbance, ambulation difficulty is high^{13,14,20}, the effectiveness of the bilateral thalamotomy on the axial symptom was not evaluated. The DBS of the Vim nucleus has been reported to be as effective as the thalamotomy for the extremity tremor¹⁹. In addition, it has been reported to reduce neurological complications and be more effective in comparison with the thalamotomy by adjusting parameters of the electrode^{1,4,10,11}. However, although the DBS of the unilateral Vim nucleus has been reported to be effective on the head tremor together with the improvement of the extremity tremor¹⁶, the evident improvement of the head tremor could not be expected according to the results of a multicenter study reported by Lim-ousin¹². This may be explained by that the axial symptom such as the head and voice tremor is induced by the bilateral side of the brain, and thus the unilateral surgery is not expected to be effective while bilateral surgery is anticipated to be effective^{5,21}. In contrast to the thalamotomy, the DBS is a non-destructive and reversible procedure and minimizes neurological side effects by adjusting the electrode parameters, which allows the bilateral surgery^{8,17}. Presently, in essential tremor, the head tremor has been reported to be improved by the DBS of the Vim nucleus^{3,15,18}.

Although the number of study population is small in our study, three patients underwent the unilateral Vim thalamotomy or DBS have good results in control of opposite extremity tremor, but the evident effect on the tremor of the head or voice was not detected. On the other hand, in a patient who underwent the unilateral DBS and the contralateral thalamotomy of the Vim nucleus, the tremor of the both upper extremities as well as the head tremor was improved to the patient's satisfaction.

Conclusion

For the treatment of the axial symptom of essential tremor, head tremor, the unilateral thalamotomy or DBS of the

Vim nucleus is hard to expect the effect according to various reports in the literature as well as our experience. In contrast, the bilateral DBS of the Vim nucleus has been reported to be effective in the axial symptom. Despite the limited experience of the authors' cases, good result was obtained by the unilateral DBS and the contralateral thalamotomy of the Vim nucleus. Although the evaluation of the effectiveness of such procedure requires more experiences and the analysis of the results, it may be meaningful not only for the outcome of surgery, but also for the financial burden of patients from the DBS.

• Acknowledgement

This study was financially supported by a clinical research grants from the Catholic Medical Center, Korea.

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