Stereotaxic thalamotomy—experiences from the levodopa era

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Abstract

After the introduction of levodopa drugs in the late 1960s, the number of thalamotomies fell dramatically world wide. However, as the Parkinsonian tremor proved rather resistant to levodopa treatment, the interest in this operation has been revived. During 1978–86, 51 stereotaxic thalamotomies were performed in 48 patients in our department. Thirty three of these patients had Parkinsonism, nine multiple sclerosis (MS) and the remaining six had various other involuntary movement disorders. The operation was most useful in the Parkinsonian group. Nearly 80% of these patients gained a substantial benefit in their daily lives. Patients with MS were all in advanced stages of the disease, and the operation was tried as a last resort. They had less benefit and more complications from operation than the other patients.

During the two decades after Spiegel and Wycis performed the first stereotaxic thalamotomies in 1947,¹ the operation was used frequently in the treatment of Parkinsonian tremor. When levodopa was introduced in the late 1960s, interest in thalamotomy declined dramatically throughout the world, and few such operations were performed subsequently.² It gradually became clear, however, that tremor was often unaffected by this type of medication. Tremor and, to some degree, rigidity had been the main indications for thalamotomy, and interest again focused on this operation.^{2,3}

Today nearly all Parkinsonian patients who have thalamotomy have been treated with levodopa drugs for some years, and there have been suggestions that this influences the outcome of the operation.⁴ Patients treated today are therefore not necessarily comparable to those in reports from the pre levodopa era.^{4,5-8} There are surprisingly few reports from the levodopa era on the effects of thalamotomy in Parkinson's disease; those available mainly concern the pure motor effects of the operation, or its complications,^{2,3,9-11} with one exception.¹² We have preferred to assess the total impact of the operation on the patient's daily activities, as evaluated by the referring neurologist.

This article presents our experiences with thalamotomy in patients with Parkinsonism, MS and various other movement disorders who we treated after the operation was revived in our department in 1978.

Patients and method

We reviewed all 48 patients who had stereotaxic thalamotomy during the period 1978–April 1986.

Forty five of these had a single unilateral operation, one patient had bilateral lesions (in two stages), and a unilateral operation was repeated in two patients because of a waning effect of the first operation. Thus, a total of 51 thalamotomies were performed on the 48 patients.

Thirty three of the patients had Parkinson's disease, nine suffered from advance multiple sclerosis, and six patients had various forms of involuntary movement disorders (hemiballism, cerebral palsy, posthemiplegic dystonia, tremor of unknown aetiology, intentional tremor after encephalitis/trauma and dystonia musculorum deformans). The patients with MS were mostly confined to a wheel-chair (7) or even bedridden (1); only one was still able to walk.

Tremor was the main indication for surgery in twenty six of the Parkinsonian patients, rigidity was predominant in two, and five patients were treated to alleviate both tremor and rigidity. All the patients with MS were operated on to alleviate pronounced and coarse intentional ataxia.

Just over half the operations were done in the dominant hemisphere (27/51 = 53%). However, this distribution was not even throughout the patient groups. Most of the patients with Parkinson's disease had symptoms that were more pronounced on one side, thus determining the side of operation. In this group, twenty one of the 34 operations (61.8%) were performed in the dominant hemisphere (the two reoperations, one on either side, not included). In the two other groups of patients, symptoms were more often bilateral. In these cases, the non-dominant side was usually preferred, to give the patient one steady hand, while keeping to a minimum the risk of severe complications.

We used a Leksell stereotaxic apparatus. The operation was performed under local anaesthesia in all except two cases (one child and one MS patient with an extreme ataxia had operation under general anaesthesia). The centre of the chosen target area for all groups

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Received 3 January 1989 and
in revised form 23 October
1989.

Accepted 10 November 1989

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of patients was placed 2 mm behind the mid-commissural plane, 3 mm above the intercommissural line and, most commonly, 14 mm from the midline. Two electrodes were used 6 mm apart. The inter-electrode plane was approximately parallel to the internal capsule, angled backwards 25–30° to the midline. With this target area and electrode orientation, stimulation and lesioning was assumed to affect the ventro-oral thalamic nuclei (vov and vop) and the reticular thalamic nucleus.¹³ The coordinates were calculated on the basis of intra-operative gas-encephalography. In the first patients, the active electrode tips were relatively large (length: 4 and 6 mm), but in the majority (25 of the Parkinsonian patients), a tip length of 2 mm was used. Before lesioning, the target area was screened for effect on tremor as well as unwanted side effects by electrical stimulation (50 Hz pulses from a constant current stimulator). Lesions were usually built up progressively by repeated lesions, gradually increasing temperature and heating time until the desired effect was achieved, while watching carefully for unwanted side effects. Throughout the operation, movements of the two index fingers were monitored by mechanoelectric transducers and recorded on a polygraph.

Nearly all patients were referred from neurological departments. Three to 89 months (median 24 months) after surgery, we sent a questionnaire to these departments, asking for an evaluation of the effect of the operation on the patient's daily activities and about possible side effects. The doctors were asked to use the following grades of outcome: Good; Moderate; Little; No effect; Worse.

Two of the Parkinsonian patients were dead at the time of the follow up, one from heart disease, the other probably from cerebral disease and old age. For the first, we received information about her condition before she died, for the other it was impossible to obtain reliable information. For the remaining 46 patients, we received adequate information about the effects of the surgery.

Results

Usefulness of the operation

Thirty three (68.8%) of the patients were

assessed to have had a good to moderate beneficial effect on their daily activities as a result of the operation. Twelve patients experienced only small or no gain, whereas three patients probably were worse after the operation. However, there were marked differences between the patient groups. There was a much better effect in the Parkinsonian patients than the other groups. The MS patients in particular seemed to gain little from the operation (table 1). This difference in outcome between the Parkinsonian patients and the MS group was highly significant ($p < 0.001$, chi-square).

On the usefulness of the operation, there was no significant difference between operations in the dominant and the non-dominant hemisphere in Parkinsonian patients. More than half (51.5%) of these patients were able to reduce their anti-Parkinsonian medication as a lasting effect of the surgery.

Unwanted side effects and complications

A total of 33 unwanted side effects were recorded in the 48 patients. More than half of these were minor and often transient, such as the very slight facial and arm paresis often seen shortly after surgery. In nine patients, 15 lasting side effects were so pronounced that we found it necessary to record them as complications (fig, table 2). In some of these cases, however, the patients, their relatives and the referring neurologists regarded these complications as relatively trivial and found the patients had gained from the operation. One of these complications was an extreme dysarthria following the second operation in the only patient who had bilateral lesions. Despite the severity of this complication, the patient herself regarded the operations as successful and does not regret the outcome, as the bilateral tremor, which had led to social isolation, disappeared. In the statistical analyses presented below, we have omitted this complication of the second

Table 1 The referring neurologists' evaluation of the effect of the operation on the patients' activities of daily living.

Beneficial effect of operation	Patient group					
	Parkinsonism		Multiple sclerosis		Miscellaneous*	
	No	%	No	%	No	%
Good	21	63.6	1	11.1	2	33.3
Moderate	5	15.2	3	33.3	1	16.7
Small	3	9.1	2	22.2	2	33.3
None	3	9.1	1	11.1	1	16.7
Worse	—	—	2	22.2	—	—
Lost to follow up	1**	3.0	—	—	—	—
Totals	33	100.0	9	99.9	6	100.0

*Includes hemiballism, posthemiplegic dystonia, intention tremor after encephalitis/trauma, unclassified tremor, dystonia musculorum deformans and cerebral palsy.

**Older patient with a marked mental change immediately after the operation. As we lack recent information, we have regarded this as a severe complication, and that three patients thus were worse after the operation.

Figure Thalatomies without (white columns) and with unwanted side effects in Parkinsonians. Hatched columns: minor negative side effects not leading to invalidity. Black columns: more severe side effects regarded as complications. More than one side effect could occur in one patient.

*: a severe dysarthria in the only patient with bilateral lesions.

Table 2 Unwanted side effects of, and complications to, the operation. Smaller effects, not yielding invalidity, in (). More pronounced complications, believed to add permanent invalidity, without (). More than one side effect could occur in each patient.

Unwanted effects	Patient group			Totals
	Parkinsonism	MS	Misc	
Mental changes	(4)	(2)	—	(6)
Hemiparesis	3	1	—	4
Dysphasia	(3)	(2)	(1)	(6)
Dysarthria	—	3	—	3
Subdural haematoma**	(4)	(1)	—	(5)
Totals	1	2	—	3
	(1)*	—	—	(1)
	2*	2	—	4
	—	1	—	1
	(12)	(5)	(1)	(18)
	6	9	—	15

*Transient dysarthria following the first operation in the dominant hemisphere, pronounced and lasting dysarthria following the second operation on the non-dominant side in the only patient with a bilateral lesion. Thus only one Parkinsonian patient had a lasting dysarthria after a unilateral lesion.

**Chronic SDH evacuated without permanent sequelae three weeks postoperatively.

Table 3 Number of surgical procedures with and without complications in patients with Parkinson's disease and multiple sclerosis. The second, contralateral procedure in the only patient with bilateral lesions is omitted

Patient group	Complication +	Complication -	Totals
MS	5	4	9
Parkinsonism	3	30	33
Totals	8	34	42

contralateral operation, and analysed only the results of the first unilateral procedure in the 33 Parkinsonian patients.

All our MS patients obtained an immediate reduction or even abolition of the intention tremor that had lead to the operation. However, compared to patients with Parkinson's disease, complications were far more common in patients with MS (table 3, $0.01 > p > 0.001$, chi-square), and the benefit from the operation was correspondingly smaller ($p < 0.001$ chi-square).

Except for the dysarthria following the bilateral operation already mentioned, complications in the Parkinsonian group occurred only in patients older than 66 years. (fig 1, $0.05 > p > 0.02$, chi-square). It is worth noting that all these complications occurred in patients whose operation was in the dominant hemisphere.

Discussion

It has been stated that "the results of unilateral thalamotomy are not so satisfactory in patients who have received levodopa therapy for a long period preoperatively".⁴ Nevertheless, based on other reports of patients operated upon after long term treatment with levodopa^{2,3,10-12,14} and our own experience, we conclude that stereotaxic thalamotomy still has a place in the treatment of drug-resistant Parkinsonian tremor and rigidity. The operation clearly had a positive impact on the daily lives of a vast majority of our Parkinsonian patients, most of whom reduced their medication after the operation. Although adverse effects of the

operation were seen, these were mostly mild, and did not lead to additional disability, except in the older patients that were lesioned in the dominant hemisphere.

On the other hand, our patients with MS gained less from the operation and had more complications than patients with Parkinson's disease. Our results are less encouraging than those of other authors,¹⁵⁻¹⁸ who all report substantial beneficial effects in the majority (73-95%) of patients with MS. Most of our patients were in advanced stages of the disease and clearly more affected than those of Speelman and van Manen.¹⁸ The condition of the patients of Arsalo *et al.*,¹⁷ who also reported good results, was similar to our patients. Thus differences in the preoperative neurological conditions alone cannot explain the difference between our results and those of previous authors.¹⁵⁻¹⁸ We believe this discrepancy is only apparent. Thus previous authors concentrated on the reduction or abolition of the involuntary movements and did not take into account the adverse side effects (which most of them did indeed report), in their final assessment of the results.

If we had considered only the effect on tremor, we too could report good results in patients with MS. In all our patients we obtained an immediate and marked reduction or even abolition of tremor, and this was sustained in five of the nine patients. However, reduction or disappearance of the tremor does not necessarily mean that the patient is better off. Many of our MS patients experienced postoperative adverse effects that counterbalanced the beneficial ones, and left the patient without any net gain from the operation, or even in a worse condition. We therefore found it more appropriate to report our results as the total effect of the operation in relation to the patients' daily lives, rather than as the isolated effect on motor skills. In our view, such assessments should preferably be performed independently; not, as in previous reports, by the operating neurosurgeon.

In conclusion, our results clearly show that stereotaxic thalamotomy can be of considerable help to the Parkinsonian patient with drug-resistant tremor or rigidity. We believe that the operation should be performed more commonly in these patients than is the case today. Patients with MS do not seem to benefit to the same extent. Reduction of tremor is not as consistent, the effect is often shortlasting, and complications are more frequent. Patients with MS should have an operation only if they are in a relatively stable, good neurological condition; if there are clinical or radiological signs of cerebral atrophy, thalamotomy has a very high risk.

- 1 Spiegel EA, Wycis HT. *Stereotaxic thalamotomy (Thalamotomy and related procedures)*, Part I. New York: Grune and Stratton, 1952.
- 2 Tasker RR, Siqueira J, Hawrylyshyn P, Organ LW. What happened to VIM thalamotomy for Parkinson's disease? *Appl Neurophysiol* 1983;46:68-83.
- 3 Manen J van, Speelman JD, Tans RJJ. Indications for surgical treatment of Parkinson's disease after levodopa therapy. *Clin Neurol Neurosurg* 1984;86:207-12.

- 4 Matsumoto K, Shichijo F, Fukami T. Long-term follow up review of cases of Parkinson's disease after unilateral or bilateral thalamotomy. *J Neurosurg* 1984;60:1033-44.
- 5 Cooper IS. Surgical treatment of Parkinsonism. *Ann Rev Med* 1965;309-30.
- 6 Gillingham FJ, Watson WS, Donaldson AA. The surgical treatment of Parkinsonism. *Br Med J* 1960;2:1395-402.
- 7 Van JM, Li C-L, Shapiro DY. A qualitative and quantitative evaluation of Parkinsonians three to six years following thalamotomy. *Confin Neurol* 1973;35:202-35.
- 8 Kelly PJ, Gillingham FJ. The long-term results of stereotaxic surgery and L-dopa therapy in patients with Parkinson's disease. A 10-year follow up study. *J Neurosurg* 1980;53:332-7.
- 9 Williams A, Calne DB. Treatment of Parkinsonism. In: Barbeau A, ed. *Disorders of movement*. Lancaster: MTP Press, 1981;171-90.
- 10 Broggi G, Giorgi C, Servello D. Stereotactic neurosurgery in the treatment of tremor. *Acta Neurochir* 1987; **Suppl** 39:73-6.
- 11 Frank F, Fabrizio AP, Frank-Ricci R, Gaist G. Stereotaxis and abnormal movements. *Acta Neurochir* 1987; **Suppl** 39:66-9.
- 12 Hitchcock E, Flint GA, Gutowski NJ. Thalamotomy for movement disorders: a critical appraisal. *Acta Neurochir* 1987; **Suppl** 39:61-5.
- 13 Schaltenbrand G, Wahren W. *Atlas for stereotaxy of the human brain*. Stuttgart: Georg Thieme, 1977.
- 14 Kelly PJ, Ahlskog JE, Goerss SJ, Daube JR, Duffy JR, Kall BA. Computer-assisted stereotactic ventralis lateralis thalamotomy with microelectrode recording control in patients with Parkinson's disease. *Mayo Clin Proceed* 1987;62:655-64.
- 15 Cooper IS. Neurosurgical alleviation of intention tremor of multiple sclerosis and cerebellar disease. *N Engl J Med* 1960;263:441-4.
- 16 Riechert T, Richter D. Stereotaktische Operationen zur Behandlung des Tremors der Multiplen Sklerose. *Schweiz Arch Neurol Neurochir Psychiatr* 1972;111:411-6.
- 17 Arsalo A, Hanninen A, Laitinen L. Functional surgery in the treatment of multiple sclerosis. *Ann Clin Res* 1973;5:74-9.
- 18 Speelman JD, Manen J van. Stereotactic thalamotomy for the relief of intention tremor of multiple sclerosis. *J Neurol Neurosurg Psychiatry* 1984;47:596-9.