Brain targets in surgery for Parkinson’s disease

Results of a survey of neurosurgeons

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Sixteen neurosurgeons were requested to define their preferred surgical target for treatment of parkinsonism. The scattergram thus obtained showed a great variability among surgeons. Although there was a concentration of targets in the ventrolateral (VL) nucleus of the thalamus, there was a separation by as much as 6 to 7 mm between targets. One surgeon placed the lesion in the subthalamic white matter below the VL nucleus, and two placed it outside the thalamus in the pallidothalamic pathways in Ford’s field. It is assumed that successful surgery interrupts the pallidothalamocortical pathways that transmit tremor and rigidity impulses, regardless of which part of the pathways is severed.

KEY WORDS • Parkinson’s disease • stereotaxic surgery • thalamotomy • pallidotomy

In spite of the great progress in the medical therapy of Parkinson’s disease during the last 15 years, surgical treatment is still indicated in selected cases. At the recent European Congress of Neurosurgery in Brussels, it became evident that many neurologists showed an increased interest in a surgical approach. At that Congress it was stressed that surgery should be considered when the tremor does not respond to drugs, when the patient cannot tolerate drugs, or when drugs cause severe involuntary movements. There was also discussion about whether surgery should be the first treatment when a relatively young patient develops a severe unilateral tremor.

Several clinical studies have shown that stereotaxic surgery may alleviate the tremor and rigidity in 80% to 93% of cases, and that this relief is of a long duration. The use of physiological methods, such as electrical stimulation and recording of spontaneous and evoked activity from the target area, are important in determining the final site for the destructive lesions. However, anatomical and radiological landmarks, such as the intercommissural line and the third ventricle, still constitute the starting point when identifying the target for probe placement.

The author surveyed 16 neurosurgeons to determine the brain region in which they presently introduce electrodes for stimulation and recording in order to establish the site for lesion placement. The results of the survey are presented in this paper.

Survey Method and Results

An empty map of the thalamic area complete with a millimeter scale was given to 16 stereotaxic neurosurgeons from four continents and 11 countries. Each surgeon was asked to mark his preferred choice of target for treatment of a patient with Parkinson’s disease who exhibited equally severe tremor and rigor. Additionally, they were asked to indicate the direction of the approach, the stereotaxic instrument used, and the method of producing the lesion. The neurosurgeons, in alphabetical order, were: a) G. Bertrand, Canada; b) G. Dieckmann, West Germany; c) P. Gildenberg, United States; d) J. Gybels, Belgium; e) E. Hitchcock, United Kingdom; f) F. Isamat, Spain; g) L. Laitinen, Sweden; h) R. Marino, Brazil; i) B. Meyerson, Sweden; j) H. Narabayashi, Japan; k) B. Nashold, United States; l) G. Ojemann, United States; m) R. Sédan, France; n) J. Siegfried, Switzerland; o) R. Tasker, Canada; and p) J. Waltz, United States.

Three surgeons used Todd-Wells instruments, two used the Leksell stereotaxic apparatus, and two used the Riechert-Mundinger instruments; the rest used their own guides. The occipital approach was used by Dr. Gybels; all other surgeons introduced the probe through a frontal burr hole. Fourteen produced the lesions with high-frequency electrocoagulation, one (Dr. Bertrand) used a loop leukotome, and another (Dr. Sédan) used either a leukotome or electrocoagulation. A lateral stylet
electrode was used by Dr. Dieckmann for production of lesions in Forel's field and the adjacent dentatothalamic fibers. Bipolar electrocoagulation was used by Dr. Meyerson; the others used monopolar electrodes.

The first-choice targets of the 16 neurosurgeons are shown in Fig. 1, which demonstrates a considerable variability from one surgeon to another. Using the atlas of Schaltenbrand and Wahren, the majority of surgeons try to introduce the probe in the ventrolateral (VL) nucleus, but the target points may lie as far as 6 to 7 mm from each other. Dr. Ojemann chooses a target in the zona incerta below the VL nucleus, whereas Drs. Dieckmann and Gildenberg introduce the electrode in the pallidofugal fibers of Forel's field, where, according to Dr. Dieckmann, some dentatothalamic fibers can also be reached.

Discussion

In 1959, Bravo and Cooper demonstrated that stereotaxic lesions in the VL nucleus of the thalamus effectively abolished the tremor and rigidity of their patients with Parkinson's disease. Lesions in the medial pallidum and the ansa lenticularis often resulted in good relief of rigidity, but the tremor was less likely to disappear. In 1960, Svennilson, et al., reported long-lasting remission of tremor in 82% of their pallidotomy patients and good relief of rigidity in 79%. Unfortunately, this remarkable paper was published in a Scandinavian psychiatric and neurological journal and did not reach many neurosurgical readers. Both Svennilson, et al., and Bravo and Cooper had observed that tremor often did not disappear immediately after pallidotomy but was gone by 3 months after the procedure. Rightly or wrongly, most neurosurgeons since then have aimed at placing their lesions in the VL nucleus of the thalamus (at the VOA, VOP, or VIM).

Brierley and Beck showed in 1959 that radiological landmarks, such as the intercommissural line and the posterior commissure, bore no constant relationship to the thalamic nucleus in the anteroposterior or vertical plane. They stressed that the future of stereotaxic surgery lay in the direction of development of physiological methods; these would permit the exploration of nuclei and fiber systems with minimal trauma so as to identify the target by physiological criteria. Since that article was first published, many neurosurgeons have chosen the final site for placement of the destructive lesions on the basis of physiological tests. The tests include electrical stimulation of the target area, transient cryogenic blocking of function around the probe tip, recording of spontaneous or evoked activity, or recording of electrical impedance of the target area.

Before conducting these investigations, the surgeon used radiological landmarks to introduce his probe as close as possible to the proposed final lesion site.

The present study does not provide information as to the effects and side-effects of surgery. Because only one of the 16 neurosurgeons interviewed reported that his results were not always good, it is probably justifiable to assume that the results obtained with these lesions, irrespective of the surgical target, are satisfactory. Earlier clinical studies have shown that surgical lesions in the medial pallidum, the pallidofugal fibers, or the VL are effective for the treatment of Parkinson's disease.
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nucleus of the thalamus abolish the tremor and rigidity in 80% to 93% of patients.\textsuperscript{3,7-9,12,14} It has not been documented that thalamic lesions are more effective than pallidotomy. One should remember that the long-lasting good effects of pallidotomy, as carried out by Lars Leksell, were assessed by neurologists,\textsuperscript{14} so those results may be more reliable than the results reported by neurosurgeons.\textsuperscript{3} The difference between the results of these two studies may be due to the fact that the surgical targets were different. Bravo and Cooper\textsuperscript{3} always tried to place their lesions above the intercommissural line, whereas the target of Leksell as reported by Svennilson, \textit{et al.},\textsuperscript{14} lay 3 mm below the intercommissural line.

Two neurosurgeons interviewed in the present study (Dr. Dieckmann and Dr. Gildenberg) still use the pallidothalamic pathways as their target, and a third (Dr. Ojemann) places the lesion in the fasciculus thalamicus in the zona incerta. All this raises the question of whether successful surgery for Parkinson's disease requires only interruption of the pallidothalamocortical pathways that transmit tremor and rigidity impulses toward the motor cortex, regardless of where these pathways are severed. Physiological tests help the surgeon to determine where the densest pathways of tremor and rigidity impulses lie. This assumption receives support from the postmortem neuroanatomical studies of Beck and Bignami\textsuperscript{2} and Larson, \textit{et al.}\textsuperscript{13} To test the validity of this hypothesis would require a multi-unit clinical study in which the effects of lesions lying in different parts of the pallidothalamic cortical pathway are assessed by independent neurologists.

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References


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