**Electrical Exploration of the Internal Capsule and Neighbouring Structures During Stereotaxic Procedures**

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The variability in position, shape and size of deep cerebral structures in relation to radiologically visible landmarks hardly needs to be stressed again and even the most careful plotting of a target point and the most precise instrumentation leave a margin of error which becomes more important as the target is situated farther away from the landmarks used to plot its position.

In an effort to compensate for or minimize this error in localization because of unpredictable anatomical variations, workers in the field of stereotaxic surgery have used various physiological methods to obtain a more precise identification of the deep structures involved in the projected lesion or of other neighbouring structures which it is desirable to avoid.

In our modest series of stereotaxic operations for the treatment of involuntary movements at the Montreal Neurological Institute, we have found such physiological exploration of the area in which we planned to make our lesions an extremely useful if not indispensable tool. In this presentation, we shall report on the results of this exploration in 26 procedures carried out on 22 patients.

**Material and Method**

Of the 22 patients, 15 were operated upon for various forms of parkinsonism, 1 for infantile hemiparesis with athetosis, 1 for multiple sclerosis with paraplegia and severe intention tremor of the arms and trunk, 2 for dystonia musculorum deformans, 2 for chorea, and 1 for multiple tics. In all cases we used the Leksell stereotaxic instrument and, except in 4 of the early cases in which the operation was done in one stage, the apparatus was slightly modified in such a way that the procedure could be carried out in two separate stages. The first one consisted in the application of the stereotaxic frame followed by double contrast ventriculography (Ethiodan* and air) to outline the anterior and posterior commissures of the 3rd ventricle. In the second stage, done a few days later under local anesthesia, the frame was reapplied and, after stimulation or recording in the target area, the operative lesion was carried out with a wire-loop leucotome of the type described by Bertrand.1 When fully extruded, the wire in our leucotome extends in an arc approximately 6 mm. in radius so that when the leucotome is rotated on its axis, it can be expected to make a lesion of approximately 0.9 cc., in the shape of a pear or inverted top.

In 25 of the 26 operations which form the basis of this presentation, the therapeutic lesion was carried out in the region of the nucleus ventralis lateralis of the thalamus or at the junction of this nucleus with nucleus ventralis posterior and in contact with the posterior limb of the internal capsule. In the remaining case, the lesion was aimed at the medial portion of the globus pallidus and the ansa lenticularis.

In these cases and in others, various methods of electrical stimulation and recording (straight multipolar electrodes, chronically implanted leads and more recently microelectrodes to record single-unit potentials) were used in an effort to identify

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* British Drug Houses.
better the structures we planned to destroy and others in their neighbourhood. In the group under study, however, we used mainly a curved searching electrode made of a spring wire insulated except at its tip and arranged in such a way that it can be pushed out laterally from the shaft along a slightly curved path to a distance 11 mm. from the axis of the shaft (we claim no originality for this instrument). Like the leucotome, the shaft is made of #16-gauge stainless-steel tubing but the insulated wire-electrode measures are slightly less than 1 mm. in diameter. The tip of this searching electrode can therefore explore in various directions to a distance 5 mm. beyond the reach of the leucotome wire (Fig. 1).

This monopolar electrode was used against an indifferent lead attached to the patient's ipsilateral leg which also served as ground lead for the cautery. Most of the stimulations were carried out with trains of square waves of 2 msec. in duration at a frequency of 60 per sec. and at amplitudes which seldom exceeded 4 V. With the searching electrode, the peak current was monitored at 0.3 mA. per V. Stimulations lasted between 1 and 5 sec.

After operation, an optical bench consisting of a zirconium arc as a source of light, a stand for the Leksell stereotaxic instrument and a transparent plastic screen were used to trace on paper the position of each point stimulated and of the assumed therapeutic lesion. Since the relative position of the source of light, the stereotaxic frame and the plastic screen on the optical bench were rigorously the same as those of the roentgenographic tube, frame and plate, at the time of operation the tracings obtained of the position of the electrode could easily be superimposed on the films outlining the ventricular system and obtained at the first stage of the operation. The coincidence of the tip of the shaft of the electrode, as outlined on this tracing with a small stainless-steel marker introduced at the end of the operation in the deepest portion of the lesion and visible on a set of anteroposterior and lateral films done before removing the frame, served as a control on the accuracy of the tracing procedure (Figs. 2 and 3).

From these tracings done in the anteroposterior and lateral projections, it was then easy to give each point stimulated along the path followed by the curved searching electrode its coordinates in the three planes of space. The planes of reference were the midsagittal vertical plane, the horizontal plane passing through the center of the anterior and posterior commissures and a coronal plane perpendicular to the other two and passing through a point halfway between the anterior and the posterior commissures. It is estimated that the accuracy of the coordinates plotted for each of the points stimulated should be within 2 mm. of the actual coordinates of that point in vivo.

**Results**

The effect of electrical stimulation, at the parameters used, on the tremor and rigidity of parkinsonism and on other types of involuntary movements was most unpredictable. Although tremor and rigidity were diminished frequently by the mere introduction of the shaft of the stimulating electrode at target, stimulating within the proposed lesion sometimes enhanced and sometimes decreased the tremor. And, indeed, restimulation of a point which had