EARLY EXPERIENCES WITH ULTRASONIC IRRADIATION OF THE PALLIDOFOGAL AND NIGRAL COMPLEXES IN HYPERKINETIC AND HYPERTONIC DISORDERS*

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I. THE PROBLEM AND EARLY APPROACHES

In 1939 a series of surgical investigations directed at the basal ganglia in an effort to alleviate the hyperkinetic and hypertonic features of parkinsonism, chorea, athetosis and dystonia was initiated by the senior author39,40 of the present paper. Taken singly and in combination, the structures interrupted or extirpated in the pre-World War II series of 16 patients subjected to such operations included the caudate head, the ansa lenticularis, the anterior limb of the internal capsule, the oral third of the globus pallidus and the oral third of the putamen.41,42

The most encouraging clinical results were noted among the parkinsonian patients, several of whom obtained complete relief of tremor and marked reduction (but never complete abolition) of rigidity. Evaluation of the pre-war and early post-war series up to 1949—comprising the first 54 cases—indicated that the most effective surgical measures in the pallidofugal section”)43,44 and (b) section of the anterior limb of the internal capsule.6,7,34 Postoperative follow-up studies of these patients clearly established that it was possible to alleviate tremors without imposing paresis, dyspraxia, spasticity, hyperreflexia and other signs of so-called “pyramidal dysfunction” upon the patient. Such disabilities had been regularly encountered following the surgical procedures previously in use, namely, high cervical chordotony51–53 and motor and/or premotor cortical extirpation8–10,36,62 and were also present to a variable degree following the later developed operation of lateral midbrain crusotomy.5,63,64

None of the operations at the level of the spinal cord, midbrain crus, cortex or basal ganglia was directed specifically at the pathologic changes (whatever they may be) responsible for the hyperkinetic and hypertonic disorders. (In point of fact, the pathological data at present available do not permit unequivocal conclusions concerning the relationship between lesions

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at various sites in the brain and the clinical manifestations of the disorders under inquiry.\textsuperscript{50,48,46} On the contrary the aim of all such operations has been essentially that of interrupting, in some convenient region, a neural pathway (possibly forming a portion of a reverberating circuit), the integrity of which is conceived to be a necessary condition for the appearance of hyperkinesia and/or hypertonus.

Thus far, no procedure has been implemented for the relief of the so-called akinetic features of parkinsonism. Akinesia therefore constitutes a persisting problem that merits the serious attention of physiologists, pathologists and surgeons.

The pallidofugal operations proved technically difficult to perform with the conventional surgical measures available at the time of their inception and, as in other "physiological operations" (e.g., anterolateral chordotomy for intractable pain), the surgeon sometimes failed to interrupt or interrupt sufficiently the intended pathways. The result in such instances was less than satisfactory. Moreover, in some cases postoperative hemorrhages spread into the hypothalamus and pretectal regions, producing damage beyond the structures intended for surgical interruption or extirpation. Such accidents led to serious neurological deficits and, in some instances, to death. The risks entailed in implementing these operations were reflected in the mortality of approximately 14 per cent in the first 35 cases. Further experience did not bring the operative mortality below approximately 11 per cent. These considerations obviously marked the basal ganglionic and anterior capsular operations as too formidable to permit their recommendation for therapeutic purposes.\textsuperscript{48} Hence, at this stage (1949) their usefulness seemed largely limited to pathophysiologic inquiries into the neural mechanisms basic to hyperkinesia and hypertonus.

Finally, the effectiveness of such operations for the alleviation of tremor and rigidity, while seemingly established in one clinic, lacked confirmation from sources other than the original, chiefly because for a number of years the procedures were not undertaken by other workers.

II. CONFIRMATORY DATA AND RELATED DEVELOPMENTS

The development following World War II of human stereotactic instruments,\textsuperscript{1,35,38,47,59–61} comparable to the Horsley-Clarke apparatus used in animal experimentation during the second and third decades of the present century, and the parallel development of human brain coordinates\textsuperscript{48,50} which, however imperfect, made possible the first use of such stereotactic apparatus in clinical neurology, opened the way for a series of new neurosurgical experiments in America, Europe and Asia.\textsuperscript{12,31–33,48–50,64–68,69} These endeavors soon confirmed the earlier contention as to the vulnerability of tremors and rigidity as attacked through the pallido-pallidofugal complex and reiterated the point previously made that, in effecting relief of hyperkinesia and hypertonus, it was clearly feasible to avert clinical dysfunction of the "pyramidal tract."\textsuperscript{41,43,44} No less welcome was the fact that the use of such stereotactic