Stereotaxic Anterior Cingulotomy for Neuropsychiatric Illness and Intractable Pain*

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In the 30 years since Egas Moniz published his first reports, thousands of patients have undergone frontal lobe surgery for mental illness. Recent reports indicate that about two-thirds of operated patients are benefited by frontal lobotomy, but serious side effects of operation have been noted in some of the unimproved group. There has been, therefore, a continuing search for a procedure which might be simpler, more effective, and safer.

We are reporting a series of 57 neuropsychiatric patients in whom bilateral radiofrequency lesions were placed stereotaxically in the anterior cingulum. We have witnessed an encouraging degree of improvement in psychiatric symptoms and no serious operative or postoperative complications. We have also performed cingulotomy to relieve the intractable pain of incurable cancer, but the 12 patients in this series are reported primarily in reference to the over-all surgical results and certain preliminary information obtained at autopsy relative to the size and anatomical placement of the lesions.

Rationale for Cingulotomy

Over the last 40 years, animal studies by neurophysiologists and neuroanatomists have disclosed an intimate working relationship between the frontal lobes and the limbic system, particularly in such states as fear, rage, sexual responses, passivity, aggression, and “pleasure.”

In 1937, Papez presented the hypothesis that there was a “reverberant” circuit from hippocampus to hippocampus into which impulses were delivered and from which they emanated, and that this “limbic system” was of prime importance for the mediation of inward emotional experience and outward emotional expression. Both visceral and somatic receptors might relay appropriate stimuli to the brain stem from which they would pass into the hypothalamus and its connections with the mamillary bodies, the anterior thalamic nuclei, and, via the anterior thalamic radiations, the cingulate region (Fig. 1). From the cingulum, impulses can be transmitted to the hippocampus, thence to the mamillary bodies via the fornix, the anterior thalamic nuclei via the tract of Vic D’Azyr, back to the cingulum, and finally closing the circuit at the hippocampus.

According to Papez, the cortex of the cingulate gyrus is the receptor site for those stimuli which set in operation inner emotional experiences. Propagation of this emotive process to the frontal cortex would, in his words, “add emotional coloring to the psychic process.” In reference to this relationship of the frontal lobes to the limbic lobe, MacLean states: “The medial forebrain bundle and its continuation as the cingulum may be considered to be to the limbic system what the internal capsule is to the outer convexity of the brain.”

Nauta has delineated certain of the connections between the limbic cortex and the brain stem by way of the central gray and the paramedian reticulum which, with the adjoining nucleus of Gudden, constitute the “limbic midbrain area.” From these areas, ascending connections are made with the hypothalamus and, through the medial forebrain bundle, with the amygdala and
septum from which fibers radiate to the limbic cortex of the temporal region.

Consideration of the possibility that interruption of the cingulate fibers might benefit the mentally ill resulted from the reported effects of cinguleotomy in experimental animals. Particularly in monkeys, it was noted that a state of "tameness and placidity" was observed postoperatively.

In 1947, at a meeting of the Society of British Neurological Surgeons, Fulton mentioned in discussion that "were it feasible, cinguleotomy in man would seem an appropriate place for limited leucotomy." As a result of this remark, Sir Hugh Cairns in 1948 began the operation of anterior cinguleotomy. In 1961, Lewin reviewed the results of 52 operations carried out by Cairns and his co-workers. In 1962, Foltz and White reported a series of 16 patients who had been subjected to stereotaxic cinguleotomy (or "cingulumotomy," the term they prefer) for the relief of intractable pain. Their observation that "patients who had anxiety and/or depression in one of various combinations had the best results from cingulumotomy" was the immediate stimulus for our study.

Material

During the period April 1, 1962 to July 1, 1966, 69 patients underwent 95 operations for bilateral stereotaxic cinguleotomy; 57 patients suffered from mental illness and 12 from in-

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**Fig. 1. Schema of the limbic system.** OB—olfactory bulb; LOT—lateral olfactory striae; INS—insula; UB—uncinate bundle; DB—diagonal band of broca; AMYG—amygdala; SCR—subcallosal radiations; HYP—hypothalamus; AT—anterior thalamus; MB—mammillary body; MTT—mammillothalamic trace (Vicq D’Azyr’s Tract); ATR—anterior thalamic radiations; ST—stria terminalis; HAB—habenula; MFB—medial forebrain bundle; SM—stria medullaris; HPT—habenulo-interpeduncular tract (fasciculus retroflexus of Meynert); IP—interpeduncular nucleus; LMA—limbic midbrain area of nauta; G—nucleus of Gudden; CG—central gray; CC—corpus callosum.