Neurosurgery for psychiatric disorders

Daring must be an inborn trait. Egas Moniz, the neurologist who extrapolated from the abolition of experimental neurosis in two chimpanzees to the invention of a procedure to ablate pathways of the frontal lobes in mentally ill human beings, had already developed angiography and spent time in jail for opposition to the Portuguese monarchy. Such a man could write, in recording the results in the first 20 cases of frontal leucotomy, that the procedure was highly effective and “always safe”.2

But Moniz’s may have been daring whose time had come. Burckhardt, a Swiss psychiatrist, had operated on six patients some 40 years earlier.1 He had reasoned that destruction of the sites responsible for mental symptoms, such as the auditory centres in the case of hallucinations, or the tracts conducting their abnormal influences on other structures, would ameliorate mental disorder. A brief vogue of surgical intervention for general paresis of the insane had occurred at about the same time.4 But Moniz reported frontal leucotomy in 1936, a year before Klüver and Bucy6 described the emotional and behavioural changes due to temporal lobectomy and Papez8 published his “proposed mechanism of emotion”. Perhaps the time was ripe for a psychiatric treatment based on a theory of the cerebral mechanism of mental illness.

Indeed, Moniz devoted the bulk of his 1936 essay to an explication of his theory of cerebral function in mental disorders:7 He thought that “there are no cellular areas in the brain that are assigned specifically to a determined psychic manifestation”. Rather, mental functions, “even the simplest ones, originate from the activity of celluloconnective groups of different parts of the central nervous system”. In other words, a network model of higher functions—more modern in conception than the localisationist/associationist model of Burckhardt’s work—underlay Moniz’s surgical intervention. In normal conditions, the networks were flexibly elaborated under the control of internal and external necessities; in mental illness, they were fixed and required to be interrupted to relieve the patient of the fixed ideas that constituted mental disorder.

Several trends characterised the ensuing four decades of psychosurgery. Firstly, the population of patients operated on grew explosively, then collapsed. Only rough estimates are possible, but by 1954 more than 10,000 patients had undergone lobotomy in England and Wales and several times that number in the United States.11 The claim that violence might be due to surgically treatable brain disease led to fears that psychosurgery would be misused to address complex social problems, such as the urban violence of the 1960s in the United States.17 By the 1970s, only a few hundred operations were being done annually, and in subsequent years the number declined further.14 15

Secondly, over time the patient group seen as appropriate for surgery became narrower. Even in their earliest work, Freeman and Watts, the American popularisers of psychosurgery, recognised “a substratum, a common denominator of worry, apprehension, anxiety, insomnia and nervous tension” which marked the surgically treatable patient.16 Indeed, retrospective analysis of Moniz’s data shows that it was patients with depression who improved.4 Results of surgical intervention in the large group of chronically hospitalised patients with schizophrenia were disappointing in controlled studies, but controlled investigations of efficacy in anxiety disorders were more favourable.17 20

Studies done in the early era were limited by the methods of the time, with idiosyncratic ratings of efficacy and safety by unblinded examiners involved in the treatment and lacking confirmation of the site of injury (which was often not the intended site25). “The published literature in the field of psychosurgery was judged to be quite low in scientific merit”, concluded the reviewer in the 1977 report of the American National Commission studying psychosurgery.21 The decline of psychosurgery, however, can be attributed directly to the advent of psychopharmacological treatments for mental disorders, rather than to deficiencies in the evidence. Yet the number of patients refractory to currently available treatments, although incompletely delineated, is substantial.21 Thus reconsideration of the evidence for the safety and efficacy of ablative psychosurgery for psychiatric disorders is due. This is especially so in view of the third trend in psychosurgery—namely, that the anatomical target of the procedure grew smaller and was more precisely lesioned by improved surgical techniques.

At present most investigators use one of four neurosurgical procedures to treat psychiatric disorders, with reports of other lesions occasionally appearing.21 22 Each technique grew up in a centre which remained comfortable with it for historical reasons; few head to head comparisons of techniques are available, and differing methods of selecting patients and of gathering and presenting data make comparison of published reports difficult. All procedures employ bilateral lesions.

Cingulotomy entails MRI guided stereotactic thermocoagulation of the anterior cingulate gyrus and the cingulate bundle 20–25 mm posterior to the anterior tip of the lateral
ventricles and 7 mm from the midline. The lesion extends about 2 cm dorsally from the corpus callosum and is 8–10 mm in lateral diameter (fig 1).

Anterior capsulotomy is a lesion in the anterior one third of the internal capsule, 5 mm behind the tip of the frontal horns and 20 mm lateral to the midline, placed either by MRI guided stereotactic thermocoagulation or by radiosurgery (fig 2).

Stereotactic subcaudate tractotomy involves a lesion placed in the subcaudate white matter 5 mm anterior to the sella, 15 mm from the midline, and 10–11 mm above the planum.
sphenoidal. The British group at the Brook General Hospital has made this lesion by implanting two rows of five radioactive yttrium rods, but thermocoagulation is employed elsewhere.

Limbic leucotomy amounts to a combination of cingulotomy and a ventral lesion similar to that of subcaudate tractotomy (fig 3).

Newer techniques offer promise. The use of focused necrosing doses of $\gamma$-irradiation, termed radiosurgery, removes all perioperative risk, but the radiobiology of capsulotomy is incompletely understood and clinical experience is limited. Brain stimulation using implanted electrodes is undergoing expanded use for movement disorders, and the possibilities of physiological measurement and reversibility after intraoperative or postoperative assessment of benefit make this a worthwhile option to explore for psychiatric indications.

Studies reporting recent experience with surgery for psychiatric disorders do not completely correct the deficiencies of previous data. In the most recent reports on cingulotomy from the Massachusetts General Hospital, about a third of patients, mostly with obsessive-compulsive disorder, often with concurrent major depression, were considered improved and another quarter possibly improved. Fourteen of 31 consecutive patients had undergone a second procedure after the late failure of a first. Similarly, about a third of patients with depression or anxiety disorders, including obsessive-compulsive disorder, were found to benefit from subcaudate tractotomy. Anterior capsulotomy may show a somewhat higher success rate for anxiety disorders, including obsessive-compulsive disorder. None of the studies cited were controlled, nor were the evaluations blinded. Some investigators have argued that ethical problems preclude controlled trials of psychosurgery. However, the same argument could be made about any major surgical treatment, and especially in view of the unhappy history and controversial nature of surgical intervention for psychiatric illness, further controlled trials are urgently needed—as Birley suggested more than three decades ago. Mindus et al pointed out that the advent of radiosurgery allows sham procedures, which the necessity of placing burr holes precluded.

Safety has been even more controversial than efficacy. The perioperative morbidity of patients with stereotactic brain lesions is agreed to be minimal. Even the early, freehand, extensive operations were remarkably free of coarse neurological complications. Sensorimotor neurological signs did not appear, and language was undamaged. Motor control deficits could not be found; indeed, surgically treated schizophrenic patients may perform better than their unoperated counterparts. Even neuropsychological changes were subtle, variable, or absent. These findings must be interpreted in the context of the severe abnormalities seen in unoperated chronic schizophrenic patients. As Freeman and Watts commented, “A deteriorated schizophrenic looks and acts about the same with or without his frontal lobes”.

Nonetheless, in their earliest papers, Freeman and Watts—by contrast with Moniz—acknowledged an adverse effect of surgery: “Every patient probably loses something by this operation, some spontaneity, some sparkle, some flavor of the personality”. Early investigators lacked the neuropsychological tools to measure the consequences of frontal injury, and even today “sparkle” is hard to quantify. Further, the neurobehavioural sequelae of severe illness and extensive previous treatment make it hard to factor out an effect of surgery without careful attention to experimental design.

In recent studies of cingulotomy, neuropsychological data are not reported, so the investigators’ judgment that it is associated with “relatively mild, transient side effects and seems to be a safe procedure” must be considered somewhat impressionistic, although in accord with earlier, detailed studies of the procedure. The impression is supported by a single case study using sensitive attentional measures; this showed impairments in the immediate postoperative period which had resolved by eight month follow up. However, alterations in appreciation of pain and disruption of habituation of the orienting response have been recorded using measures outside the usual clinical battery. Presumably these changes do not represent clinically significant deficits. Vilkki used a projective test,

**Figure 3**: (A) Sagittal and (B) low axial MRI of acute limbic leucotomy lesions. The ventral lesions are similarly placed to those of subcaudate tractotomy.
the Holtzman inkblot technique, and disclosed reduced reduction in “imagination” after both cingulotomy and anterior capsulotomy; after capsulotomy perseveration increased.55 and Cumming et al found frontal deficits in a group of patients most of whom had undergone limbic leucotomy,55 and Nyman and Mindus found that half of a group of 10 patients who underwent anterior capsulotomy showed increased perseverative responding postoperatively.56 A careful, prospective neuropsychological study of subacute datectomy showed no adverse effects on cognition at six month follow up, although the finding that improvement of depression was correlated with reduced performance on some neuropsychological tests raises concern.57

Cognitive deficits may, however, be difficult to detect even when orbitofrontal brain injury has caused drastic alterations in personality.58 The contemporary procedures certainly cause less adverse effect on personality than the older, larger, freehand lesions; yet even with the former reduction in initiative and energy may be seen.59 On the other hand, favourable changes in personality may occur.60 Significant schizoid, antisocial, or histrionic personality disorders or traits are considered contraindications to surgery at some centres.28-31

Impairments, even if subtle, occasion no surprise after brain surgery; but how could surgical destruction of brain tissue produce an improvement in mental function? The renewed interest in the benefits of surgery for movement disorders lends plausibility to the idea that a malfunctioning network of inhibitory and facilitatory neurons can be rebalanced to improve brain functioning.62-64 Findings after epilepsy surgery led Penfield to the concept of “nociferous cortex”.65 Hermann and Seidenberg indeed recently showed that the improvement of executive cognitive functioning after temporal lobectomy confirms that adverse distant effects of hippocampal epilepsy are relieved by surgery.66 In the case of epilepsy the tissue removed is presumably abnormal, and the objections often raised to ablative neurosurgery for psychiatric disorders relate to surgical intervention in an anatomically normal brain. However, in the study just cited improvement in executive cognitive function was unrelated to the presence or absence of hippocampal pathology in the removed temporal lobe. An assertion that the brain of the patient with a severe treatment refractory mood or anxiety disorder is more normal than the histologically negative hippocampus of an epileptic patient is questionable at the least.

In fact, the cerebral substrate of the disorders under consideration is poorly understood. For obsessive-compulsive disorder, attention has focused on a loop involving the orbitofrontal cortex, limbic portions of the basal ganglia, and thalamic nuclei, which is proposed to be dysregulated in a reverberating fashion.67 This hypothesis calls to mind Moniz’s early allusion to “fixed” networks of the cir umambience of the frontal lobe and the anterior ventricular system.68 Recent evidence regarding depression has pointed to the cingulate gyrus and adjacent and related prefrontal areas.69 Data emerging from detailed neuropsychiatric studies of treatment-refractory patients being considered for surgery, or possibly electrophysiological studies undertaken during surgery, may lead to increased understanding of these disorders.

Certainly nothing in the available data justifies complacency about what must still be considered a “desperate cure”. Yet the patients are desperately ill and their lives severely impaired. Possibly even an intervention that risks subtle neuropsychological impairment or mild adverse personality change could be judged acceptable under such circumstances. But the ethical undertaking of neurosurgical intervention for psychiatric indications requires rigorous attention to psychiatric, surgical, and ethical and legal standards, as all the major groups working in the field have emphasised and as a Scottish Working Group has recently elucidated.92 Patients must be thoroughly evaluated psychiatrically by clinicians not part of the surgical team; all indicated non-surgical treatments must have been tried over an extended period. Patients must be able to give informed consent for the procedure and must do so without coercion, and appropriate psychiatric care subsequent to surgery must be assured. A capable surgical team must proceed only after neurodiagnostic as well as psychiatric assessment.

Psychosis should not be considered responsive to surgery. Anxiety disorders, notably obsessive-compulsive disorder, and depression constitute appropriate indications. Self mutilative behaviour in the context of Tourette’s syndrome may respond to surgery,71 although surgical approaches to Tourette’s syndrome itself have been disappointing.72 Ablative neurosurgery for violence is described at present only rarely73, whether it is in broader use than is published is hard to know. Especially rigorous ethical and legal safeguards must attend the use of surgery for this indication.

Any time for dawning in psychosurgery has passed. Scientific rigor and clinical prudence may transmute the excesses of an earlier day into a rarely used but irreplaceable procedure to relieve distress and save lives.

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