

Review Article

Psychosurgery: Yesterday and Today

By P. K. BRIDGES and J. R. BARTLETT

Psychosurgery is a controversial subject, but probably more so than it need be when the essential issues are clarified. Much of the dissension appears to result from an inadequate understanding of the current position. A critical appraisal first requires a perspective deriving from an appreciation of the development of this mode of treatment, followed by consideration of contemporary operations and evidence supporting their use. A recent World Health Organization (1976) booklet, which will have unfortunate authority, defines psychosurgery as, 'the selective surgical removal or destruction . . . of nerve pathways . . . with a view to influencing behaviour'. This definition is incorrect because most modern psychosurgery is concerned with the treatment of severe and intractable affective illnesses without any intended effect on behaviour at all, although, of course, behaviour may alter where it is directly influenced by the illness. A better definition of contemporary psychosurgery is: the surgical treatment of certain psychiatric illnesses by means of localized lesions placed in specific cerebral sites. There have been several previous reviews (Greenblatt, 1950; Schurr, 1969, 1973; W. L. Rees, 1973; Kelly, 1976; Bridges, 1977) and more general aspects have been discussed by Valenstein (1973).

Pre-frontal Leucotomy

Burckhardt (1891) in Switzerland and Puusepp in 1910 (published 1937) in Russia carried out the earliest operations. Burckhardt's rationale was that 'if we could remove these exciting impulses from the brain mechanism, the patient might be transformed from a disturbed to a quiet dement' (translated by Valenstein, 1973). But the results were not encouraging, as both pro-

ponents realized. However, psychosurgery really began at the International Neurological Congress held in London in 1935 (Fulton, 1948). The distinguished neurophysiologist, John Fulton, with his colleague Jacobsen, reported on behavioural changes which were observed in two chimpanzees named Becky and Lucy following bilateral ablation of the frontal association areas. The paper led Egas Moniz of Lisbon to point out that if frontal lobe removal prevented the development of what was called 'experimental neurosis' in animals and eliminated their frustrational behaviour, as described in Fulton's paper, it should be feasible to relieve anxiety states in man by surgical means. Within a year he encouraged his neurosurgeon colleague Lima to begin operating; at first lesions were produced by the injection of alcohol and later a special leucotome was developed for the purpose. In all they carried out leucotomies on about 100 cases. In his book, Moniz (1936) presented case histories in detail, and the major side effects were described; it was clear that the best results were with patients suffering from agitated depression while cases of chronic schizophrenia were little improved. This early observation has continued to have validity. Moniz received the Nobel Prize for this work in 1949, shared with Walter Hess. It should be noted that psychosurgery appears to have been originally conceived with the aim of treating neurosis and emotional over-responsiveness by means of a blunting effect, for the report described the post-operative state of the chimpanzees as 'deprived of emotional expression'. In contrast, the literature concerning contemporary operations shows that with these selective techniques normal emotional responsiveness is preserved.

The almost immediate widespread application of psychosurgery was associated with the work of Freeman and Watts in the USA. Beginning in September 1936 they first followed the method of Moniz, but soon devised their own 'standard pre-frontal lobotomy'. (The term had been used by Moniz). A blunt knife was swept in a coronal plane through a temporal, that is, lateral burr hole on each side (Freeman and Watts, 1950). They advocated a precise point of entry with adjustment of the plane of section in relation to clinical requirements, more anterior for affective disorders and more posterior in cases of schizophrenia. The anterior lesions produced less alteration in the patients' behaviour, but the more posterior positions gave a greater chance of potentially serious side-effects, which included prolonged incontinence, convulsions and major personality change, involving disinhibition or inertia and withdrawal ('vegetable' states).

It has been suggested that there were perhaps 50,000 operations carried out in North America; and Tooth and Newton (1961) reviewed over 10,000 cases operated on in Great Britain in the ten years from 1942. In the British review some two-thirds of the patients were schizophrenic and about one-quarter had affective illnesses. Of the former, 18 per cent did well, while as many as 50 per cent of those with affective illnesses were considerably improved or had recovered, thus confirming the earlier observations of Moniz. However, 3.1 per cent suffered effects on the personality so severe that discharge from hospital was not possible. Obviously there must have been a much higher proportion of other severe, but rather less profound, side effects. There was a rate of 'epilepsy persisting at the time of the survey or at death' of 1.3 per cent. Presumably, therefore, there was a higher incidence of fits of shorter duration. The death rate was 0.3 per cent. Enthusiasm for psychosurgery at this time appears to have tended to run away with itself, and finally Watts terminated his association with Freeman when the latter advocated a lesion produced through the roof of the orbit, performed immediately after two applications of unmodified electroconvulsive therapy to act as anaesthetic (Freeman, 1948; 1971).

Two points require emphasis. Firstly, these operations were observed from the beginning to be most effective in cases of depression, and this finding was subsequently confirmed. Secondly, surgery was used more often for schizophrenia. Presumably that was because the latter condition was a more grave therapeutic problem at the time; this illness was, of course, likely to be characterized both by severe behaviour disturbance and by considerable chronicity, which must have posed medical and nursing problems of a magnitude almost impossible to comprehend nowadays. For 18 per cent of schizophrenic patients to have done so well must have been a better response than had been achieved before, at a time when there were virtually no effective treatments for the condition. As the *Lancet* (1972) put it, 'such was the enormous pool of psychotic patients vegetating as chronic sick in the closed wards of mental hospitals, without effective drug control and without hope, that when it became possible to help them in any way, this new method was taken up with more enthusiasm than caution and with more technical skill than psychiatric and neurophysiological understanding. A wave of reaction followed and this was sustained by advances in drug therapy'. The introduction of chlorpromazine in the 1950s changed the therapeutic situation fundamentally.

So in historical context pre-frontal leucotomy was a better treatment than it now appears, but with the advent of effective medication it was superseded. As published reports show that subsequent modifications were both more effective and were likely to produce less severe side-effects we conclude that this drastic operation should have been abandoned some twenty years ago. In addition, with the availability of the major tranquillizers, schizophrenia ceased to be a primary indication for the subsequent modified psychosurgical procedures. There are fundamental lessons to be learnt from the rise and fall of prefrontal leucotomy, as has been emphasized by several writers (Templar, 1974; May, 1974; Robin, 1975) who all point out the inadequacy of objective assessment of the treatment, especially needed because of its potentially serious hazards. Freeman published long-term follow-up results as recently as 1971.

Bimedial Leucotomy and Orbital Undercutting

With this background, it is perhaps surprising that psychosurgical techniques were persisted with and were increasingly refined. The way forward was indicated by Fulton (1951) himself, who published a book which reviewed the anatomy of the various lesions in relation to their clinical results. There were a number of modifications of the standard operation, which led Turnbull (1969) to observe, probably unfairly, that 'no "standard" operation has ever been performed in so many ways'. There is also much evidence that, even when the same technique was used, the lesion could vary widely in size and site (Meyer and McLardy, 1949). From his analysis, taking into account the effects of variations, Fulton concluded: 'I believe that radical lobotomy as carried out by Freeman and Watts should be abandoned in favour of a more restricted lesion.' He went on to recommend electrocoagulation of the ventromedial quadrant of the frontal lobe. This was a statement of considerable vision, since a quarter of a century ago, it accurately described the most usual psychosurgical practice of today.

The aim was to produce a much more limited lesion than that advocated by Freeman and Watts. While there were other sites, as we shall describe, the most widely favoured techniques involved limitation of the lesion as far as possible to the ventromedial quadrant, as suggested by Fulton. Bimedial leucotomy (Greenblatt and Backover, 1950; Greenblatt and Solomon, 1952) approached this ventromedial segment from above with division of the white matter limited to a medial 2 cm of tissue on each side of the midline just rostral to the lateral ventricles. This operation was especially important because it was used quite consistently at the Maudsley Hospital over a number of years and the results have been reviewed in several papers. Post, Rees and Schurr (1968) followed up 52 patients for at least three years. They reported that 69 per cent were immediately relieved of their most severe symptoms and remained thus during the post-operative period, while only five failed to show benefit. But there were 'lasting and troublesome' or

'seriously disabling' effects in 21 per cent of the cases. Birley (1964) reported on the results with over 100 patients, with similar findings; 50 per cent of those with depression did well, as did as many as 75 per cent with obsessional neurosis. But there were 'disabling' effects on the personality in 6.5 per cent, and the rate of epilepsy was 1 per cent. Marks, Birley and Gelder (1966) reviewed the outcome of a group of patients with severe agoraphobia, most of whom had a bimedial leucotomy, and made comparisons with a retrospectively selected control group. The leucotomy patients did significantly better, and this was also found by Tan, Marks and Marset (1971) in a similarly designed investigation on patients with obsessional neurosis treated by the same operation.

Another important modification of the operation was the orbital undercut, conceived by Scoville (1949). This involved a rostral approach on each side of the midline in which the white matter of the ventromedial segment was divided by a horizontal cut. Knight (1964) suggested a similar technique, but with a more restricted lesion 2 cm wide on each side of the midline extending to a distance of 6 cm from the frontal pole. The refreshing characteristic of Knight's work was that he pursued a chosen operation for a sufficiently long period so that the results should be usefully studied, and his reviews were carried out by independent senior psychiatrists. Knight usually selected only those patients who were suitable for his chosen operation. The results for 320 patients who had his orbital undercut were reported on by Sykes and Tredgold (1964). Of those with depression, 69 per cent did well, with anxiety it was 44 per cent and with obsessional neurosis 30 per cent. But there remained troublesome effects on the personality in the case of 5 per cent, one or more fits occurred in 16 per cent, and five of the patients died.

So the more limited techniques which followed pre-frontal leucotomy produced therapeutic results that were better than those with the original operation, and mostly with less serious side effects, but the incidence of these remained disturbingly high nonetheless. Study of the reports cited will show that few cases of schizophrenia were included.

Stereotactic Subcaudate Tractotomy

The next development was entirely original for psychosurgery and involved a completely new concept. Knight (1965, 1969a, b) devised a method of producing a lesion of controlled size, accurately sited by stereotactic means, using an array of small ceramic rods, each 7 mm long and 1 mm in diameter, containing radioactive yttrium (^{90}Y), which has a half-life of some 62 hours. The array found most suitable consisted of two lines of three rods on each side. These produce a well localized lesion with a total size of about 22 mm \times 16 mm \times 6 mm, the site of which remains permanently detectable, as the rods are radio-opaque. Minimal trauma is caused during entry, as each rod is introduced separately through a cannula, the depth and direction of which are controlled by McCaul's stereotactic device using radiographic measurements. The target lies in the white matter beneath and partly anterior to the head of the caudate nucleus (Bartlett and Bridges, 1977). Newcombe (1975) has considered the shape and site and has described the pattern of radiation from yttrium, while Corsellis and Jack (1973) have produced convincing evidence of the much more accurate siting and limitation of the lesion with this operation compared to that found after orbital undercutting. Knight called his new operation bi-frontal stereotactic subcaudate tractotomy, a name intended to avoid the unhappy associations of the word leucotomy, while describing the characteristics of the technique.

The operation, which causes little disturbance to the patient, is carried out with full anaesthetic, and the head is not shaved. The procedure takes about 1½ hours and the patient is up and about on the third post-operative day. Anti-convulsants are not given postoperatively unless there is a history of epilepsy. Patients are admitted one week before operation and stay a minimum of two weeks afterwards, when a few return home, some are transferred back to the referring hospital and some remain longer for rehabilitation in the Unit. A number of patients show an immediate response, but in many cases there is a curiously slow improvement which takes several months. Routine physical treatments, including psychotropic

medication and electroconvulsive therapy can be instituted later if improvement is undesirably slow, and may accelerate the response. The clinical routine of the Geoffrey Knight Unit has been described by Bridges and Bartlett (1973).

The outcome after stereotactic tractotomy has been reviewed in several studies. The first 210 cases were investigated by Ström-Olsen and Carlisle (1971), the next 209 by Göktepe, Young and Bridges (1975). In both reports about 60 per cent of patients with depressive illnesses recovered (grade I—free of symptoms) or were very much improved (II—mild residual symptoms remain) in the case of anxiety the improvement rate was between 40 per cent and 60 per cent, while of those with obsessional neurosis 50 per cent did well. Some schizophrenic patients were included, but in no case was there marked clinical improvement, although there was a useful degree of amelioration in some cases. In the study by Göktepe *et al* (1975) some effect on the personality was reported by relatives for 7 per cent of the cases. Some of these changes were likely to have been for the better, such as increased assertiveness, but they were all invariably mild and in no case caused social difficulties. A degree of disinhibition was commonest with, for example, a tendency towards talkativeness or outspokenness, or there was an increase in smoking or eating habits. No emotional blunting was found. In the whole series of over 800 cases so far operated on there has been one death related to the operation which occurred some 34 days afterwards and was probably associated with accidental mis-siting of an yttrium rod (Knight, 1973).

Reference to the paper by Göktepe *et al* (1975) shows that the clinical assessment of outcome was well supported by objective data, such as the results of psychological tests taken at the time of the review and the treatment needs of the patients during comparable periods before and after operation. Perhaps most important was the reduction in the number of suicidal attempts after operation, compared to those during the same periods before. Among the 78 patients who did well, there was a total of five attempts up to the reviews 2½–4

years after operation, compared with as many as 33 during similar periods before. The five post-operative attempts occurred soon after operation, before improvement was experienced. Taking all 209 patients, they made a total of 64 suicidal attempts in the 2½–4 years pre-operative period, which gives some indication of the severity of disturbance of the patients accepted for psychosurgery. None of the clinical parameters changed post-operatively in the case of those who were assessed as improved (III—significant symptoms remain) or who were unchanged (IV). In no case was the patient's psychiatric state found to have been made worse (V). A comparative study of the results in depression and obsessional neurosis has been reported by Bridges *et al* (1973).

Limbic Leucotomy

Another development of stereotactic psychosurgery has been reported by Kelly, Richardson and Mitchell-Heggs (1973). Their operation is called limbic leucotomy and although the name is different the technique has very similar characteristics to those of tractotomy. The aim of limbic leucotomy is the stereotactic placement of lesions produced by cryogenic means (freezing) or by electrocoagulation into sites in the limbic system. The targets are selected by observing physiological changes resulting from electrical stimulation at the time of operation. There are two sites; one pair of lesions being located in the subcaudate area as in Knight's stereotactic tractotomy, while another pair are routinely placed in the cingulum bundle as well. The most recent report of this procedure is by Mitchell-Heggs *et al* (1976); their results are not easily compared with the findings after subcaudate tractotomy because significant benefit is reported for limbic leucotomy in terms of categories I, II and III, while all the studies on tractotomy consider definite response only with categories I and II. Mitchell-Heggs and her colleagues have suggested that in cases of obsessional neurosis added cingulate lesions produce better results than those in the subcaudate area alone, and they are also optimistic about their results with schizophrenia. But Bridges and Bartlett (1976) have shown evidence for disagreeing with these observations.

Mitchell-Heggs *et al* (1976) report that one patient of 100 operated on suffered a serious neurological complication, but that case had undergone an earlier leucotomy. No epilepsy has occurred in the series and no personality changes other than some outspokenness in a few cases.

The Contemporary Stereotactic Ventromedial Operations

Clinical aspects

The indications for both stereotactic tractotomy and limbic leucotomy are similar. Good results are obtained with depression which may be chronic or persistently recurrent and which does not respond adequately to other forms of treatment. In the case of depression, the operations have been placed in wider therapeutic context by Shaw (1977). Cases of anxiety do well, and this includes either chronic tension, recurrent states of anxiety or phobic anxiety states which, again, have not responded adequately to other treatments or persistently recur after only short periods of improvement. About half the cases with obsessional neurosis reach categories I and II with both operations, and this is a particularly good result bearing in mind how difficult this illness can be to treat by other means and how much incapacity can be caused. Although those using limbic leucotomy express optimism about their results with schizophrenia (Mitchell-Heggs *et al*, 1976), they have operated on few cases, and none of these reached category I. It is probably reasonable to say at this stage of our knowledge that schizophrenia is not a primary indication for contemporary psychosurgery, but the operation might help uncommon cases where there is associated intractable depression, anxiety or obsessional symptoms (Knight, 1973).

It may be postulated that standard prefrontal leucotomy could have exerted relatively specific effects on depressive illnesses by involving the cingulate and subcaudate areas, while the considerable extent of the lesion may have produced non-specific blunting and perhaps disinhibition effects and these could have been of value in some cases of schizophrenia. As Meyer and McLardy (1949)

pointed out of pre-frontal leucotomy, 'personality change and improvement seem to be positively correlated'. However, it should be repeated that the contemporary stereotactic operations do not produce affective blunting. It has been emphasized earlier that behaviour modification as a primary effect is not the intention with these operations.

Stereotactic tractotomy has in the past been carried out on a few alcoholic and drug-dependent patients with prominent depression or anxiety (Göktepe *et al*, 1975). Very few did well, and so these diagnoses would not now be considered for operation. The relief of pain of physical origin is not an indication for these stereotactic operations, although other sites may be of value for such cases (Sweet *et al*, 1977, Part IV).

Reports show that there is no detectable impairment of intelligence after the contemporary operations (Bridges, 1972; Bailey *et al*, 1973; Mitchell-Heggs *et al*, 1976). This sparing of cognitive function is also supported by the fact that very elderly patients do not react adversely to stereotactic tractotomy, which has been carried out with good results on several patients over 70 years old. Indeed, psychosurgery may be preferable in the elderly when so much confusion is produced by electroconvulsive therapy that it cannot be continued. Stereotactic tractotomy does not cause confusional states even in the very elderly, except sometimes for a limited period immediately after operation. The main clinical problem with regard to accepting the old is the possibility of severe cerebral atrophy being present, which may make it undesirable to operate for technical reasons. This can now be anticipated by means of computerized axial tomography.

The need for patients to have a stable personality in order for them to be accepted for the modern operations is of less importance than with earlier forms of psychosurgery, which were much more likely to exacerbate personality abnormalities, so that prefrontal leucotomy was usually restricted to those of 'good' pre-morbid personality. Marked antisocial traits remain a contraindication for contemporary operations, and if the illness is neurotic and arising directly from a personality disorder

operation is unlikely to be effective. Otherwise, the stability of those with relatively poor personalities can be improved if they are relieved of a superimposed major psychiatric illness.

The problem of the suitability of bipolar illnesses remains uncertain at the moment. Stereotactic tractotomy has been carried out with no subsequent complications in cases with a history of a few hypomanic attacks associated with many depressive episodes. But as one of the side effects is a tendency to disinhibition, and since very limited periods of hypomania have occurred post-operatively in rare cases, there is a theoretical possibility that in bipolar illnesses there could be a shift towards hypomania, although we know of no report of this having happened. Furthermore, open cingulotomies have been carried out for predominantly manic illnesses with success (Bailey *et al*, 1971). Thus, more experience with resistant bipolar illnesses is needed.

The post-operative care of patients is important but not complicated. In the immediate post-operative period there may be transient confusion, and lethargy is quite common. Patients remain with the units for at least two weeks, after which time neurosurgical complications are most unlikely. Anticonvulsant medication is not given routinely after stereotactic tractotomy, but phenytoin is recommended for six months after limbic leucotomy. Psychotropic medication is not reinstated unless there is a clear indication. Post-operative rehabilitation is of the utmost importance. The aims are to disrupt behaviour patterns established as a result of chronic illness, to help a return of confidence after long-term incapacity and to encourage the patient to fully realize restored potentials. In some cases improvement is slow, and during this period the patient requires support, with gradually increasing social stimulation. Behaviour therapy may need to be arranged for residual phobic and obsessional symptoms.

Conclusions

Three conclusions can be drawn from the reports on contemporary stereotactic psychosurgery which we have described. Firstly, the

ventromedial quadrant of the frontal lobe is a therapeutically useful target, and the results can be very good, especially bearing in mind that only intractable and quite desperate cases are accepted for psychosurgery. The marked reduction in suicidal behaviour noted post-operatively in one report is of considerable clinical importance. Secondly, this therapeutic success is obtained with an acceptable level of side-effects in relation to the seriousness of the illnesses being treated. It is probable that a small increase in the risk of producing one or more epileptic fits cannot be avoided completely with any intracranial operation, although this complication can be treated in the usual way with anticonvulsant medication. Finally, modern stereotactic techniques produce results that are as good, and often better, than the previous 'free-hand' cutting operations, and with significantly fewer side effects. So it is concluded that contemporary psychosurgery should only employ techniques involving stereotactically placed lesions of controlled size.

Thus, with these procedures it is now unnecessary for an illness which fails to respond to routine treatments to be left very long before operation is considered. Of course, the period of time will depend on the clinical characteristics of the individual case, but with an uncontrollably severe illness, especially where there is a high risk of suicide or severe anorexia is present, about one year or even less might be appropriate before assessment for psychosurgery.

Other Operation Sites

Cingulate operations have been used for some time, especially for cases of anxiety and of obsessional neurosis (Whitty *et al*, 1952; Lewin, 1961). Bailey *et al* (1971, 1973) carried out open anterior cingulotomies on 150 patients with manic-depressive and schizo-affective illnesses, anxiety and obsessional neuroses. There was an overall good response rate of 88 per cent, but there were major side effects including infections, two cases of status epilepticus and one death from cerebral haemorrhage.

It should be noted that these cingulate operations are described as appropriate for the same diagnoses for which ventromedial lesions are also indicated. However, from the published

results, the latter seem about as effective and also safer. There appears to be no evidence to suggest that the cingulum alone is a clinically more useful site than the frontal lobe ventromedial quadrant, although, as mentioned above, limbic leucotomy includes both and an enhanced therapeutic result is claimed (Mitchell-Heggs *et al*, 1976).

An unusual procedure has been described by Crow *et al* (1961) and by Crow (1973), whose technique involves the insertion into the frontal lobes of a sheath of 24 to 34 electrodes which reach to many sites and remain *in situ* for several months. Lesions are produced progressively in different areas as the patient's response is observed and psychotherapeutic exploration is pursued. In relation to the stereotactic operations and their apparent effectiveness, this seems a needlessly protracted and insufficiently selective method, especially now that there is so much experience available about the results to be obtained from specific and limited cerebral areas.

There have also been less frequently advocated target sites. The corpus callosum has been used by Laitinen (1972) for cases of anxiety and tension. Attempts have recently been made to correct abnormal sexuality by lesions in the hypothalamus (Roeder *et al*, 1972); this is of theoretical interest, but must be regarded as an undesirable development, both from the point of view of diagnostic indication and of the potentially more dangerous operation involved. Hypothalamotomy has also been advocated for obesity (Quaade, 1974), and thalamotomy has been carried out for the 'hyperresponsive syndrome' by Andy and Jurko (1972). Details about the many techniques and sites currently being tried for various indications are given by Sweet *et al* (1977).

Especially controversial is the attempt to control abnormal aggressiveness by means of amygdalotomy (Narabayashi *et al*, 1963; Heimburger, 1966; Vaernet and Madsen, 1970; Hitchcock and Cairns, 1973; Kiloh *et al*, 1974) and by posterior hypothalamotomy (Schvarcz *et al*, 1972). These operations have been used for severely disturbed subnormal patients and for those who exhibit pathological aggression or self-mutilating behaviour. It is from such

indications that the erroneously alleged intention of psychosurgery in general to modify behaviour has probably derived. In the case of amygdalotomy, it is true that behaviour is likely to be altered, but we consider this apparently effective operation to be justified only in the presence of a psychiatric diagnosis, or perhaps a neurological condition such as a temporal lobe abnormality, which is presumed to be the cause of the behaviour disturbance. The important question seems to be to ask whether the disturbed behaviour is a manifestation of an intractable illness or whether it is essentially unacceptable social conduct. The answers will not always be clear-cut, depending upon what is conceived as illness, so major ethical problems can arise. For example, there have been reports from the USA that amygdalotomy was offered to, and accepted by, a sexually violent, compulsorily detained psychopath, but was stopped by legal intervention (Boston University Law Review, 1974). Is this condition to be regarded as an illness?

There are definite ethical problems with the amygdala as a lesion site, but the controversy has tended to embrace the whole of psychosurgery indiscriminately, although the subcaudate target is appropriate in quite different clinical circumstances. So ethical debate needs boundaries, and the available evidence for and against the different operations should be considered separately and dispassionately. This would avoid the increasing outcry, most of it poorly informed, against all psychosurgery without differentiating indications, methods and results.

Theoretical Aspects

The contemporary operations appear to restore normal emotional modulation so that excessive swings of depression and extreme anxiety responses are eliminated and normal intensities of emotional experience are restored. The reason for what seems to be an almost specific effect, as suggested by the high recovery rates with some intractable psychiatric illnesses, resulting from a lesion in the ventromedial white matter of the frontal lobe, is not known. It remains unclear whether specific pinpointing of the site is important, as suggested by Kelly

(1972) and Kelly *et al* (1973), or whether the size of the lesion is critical within a selected cerebral region. Knight (1969a, 1969b, 1973) has considered some of the neuro-anatomical possibilities, showing how he was led to adopt the subcaudate area as the target for his operation.

In any case, the involvement of the limbic system is likely. Papez (1937) first suggested the importance of the old rhinencephalon in emotional experience almost at the same time as psychosurgery was initiated. There is a complex relationship between the frontal lobes and limbic structures, and Nauta (1971) has pointed out that there is reciprocity of communication so that the frontal lobe is at once a 'sensory' and an 'effector' mechanism. He also regards the frontal cortex as being the 'neocortical representative of the limbic system, because it is characterized so distinctly by its multiple associations with the limbic system, and in particular by its direct connections with the hypothalamus'. More specifically, in relation to psychosurgical lesions, Sweet (1973) has stressed the relevance of the thalamo-frontal radiation and quotes Ström-Olsen and Northfield (1955), who reported, from a post-mortem examination, bilateral degeneration of the medial part of the dorsomedial nucleus of the thalamus in a patient who had had an orbital undercut. This same retrograde degeneration was found after standard leucotomies by Freeman and Watts (1947). These findings recall the early observation of Moniz (1937) that 'the idea was to operate . . . not directly upon the cell groups of the cortex or of other regions, but rather by interrupting the connecting fibres between cells of the prefrontal area and other regions. . . . As a result of the interruption of the cylinder axes the cells of the pre-frontal area and of other regions of the brain connected with these would be affected secondarily'.

Livingston (1969) has described a 'great fronto-limbic-hypothalamic-midbrain behavioural axis' with two parallel circuits, both of which influence the autonomic and endocrine activity of the hypothalamus as well as the brain stem and reticular formation. Such associations offer theoretical support for the

possibilities of physiological, endocrinological and biochemical abnormalities in some psychiatric illnesses, reliable detection of which is increasingly becoming likely. So psychosurgery may add another research dimension to work on the metabolic aspects of psychiatric illnesses which could facilitate progress towards an understanding of the aetiology of pathological mood states. Certainly, unusual opportunities for investigations are offered (Bridges *et al*, 1975; Sepping *et al*, 1977), including the unique possibility of studying the ventricular CSF of psychiatric patients (Bridges *et al*, 1976).

Ethics and Controversy

While operations involving some sites in the brain remain of doubtful value, and some of the indications, especially with regard to anti-social behaviour, raise major ethical concern, the most commonly used procedures need not produce controversial ethical problems. These are the operations involving the subcaudate and cingulate areas which appear to be associated with good results and few side effects, and are nearly always carried out on patients able to give informed consent. Furthermore, the importance of such treatment is emphasized by the report by Guze and Robins (1970) showing that uncontrolled depression is associated with a risk of successful suicide of some 15 per cent, which suggests that it is reasonable to take known surgical risks when treating these illnesses. However, while psychosurgery appears to be of value on clinical grounds—and this itself has much validity—the problem remains that its effectiveness has not been conclusively demonstrated so far.

For all the benefit in some cases, there are many outstanding questions, and more attention should be given to considering these reasonably in the light of the quite considerable amount of data available, rather than rejecting all psychosurgery out of hand. There is at least one State in the USA where psychosurgery has been banned, and this has obtained in the Soviet Union for many years. Scientific challenge and the chance of clinical progress are rendered impossible by such rigid attitudes. Certainly the intemperate writings of Breggin (1972) clarify no issues. As Henry Miller (1972) has stated,

'Psychosurgery is certainly not a subject for denunciation or prohibition, but for the cool, continuous scientific consideration that should be applied to all problematical forms of treatment.' Furthermore, the opponents of surgical treatment in psychiatry rarely offer advice as how better to manage the desperate cases that come to operation. It is noteworthy that, after intensely hostile criticism in the USA in recent years, a National Commission has now reported favourably on psychosurgery (Culliton, 1976).

There remains concern that patients may be compulsorily made to undergo surgery. So seriously is this taken by the staff of the Unit using limbic leucotomy that they will not accept patients who are the subject of an order under the Mental Health Act (1959) (Mitchell-Heggs *et al*, 1976). The Geoffrey Knight Unit has made it clear that they entirely endorse the need for free and informed consent by the patient, but they accept cases under a compulsory order solely to allow adequate control of possible suicidal behaviour before operation, to which the patient has freely agreed (Bridges and Bartlett, 1976). There will be problems when patients are unable, because of extreme illness, to give consent, most commonly severe states of depression when treatment is needed to save life. Ethical aspects have been soberly reviewed by the Boston University Law Review (1974).

The Present Position

The general characteristics of contemporary psychosurgery can now be summarized in Table I, and the indications are given in Table II. We advocate that, as psychosurgery is a rarely needed treatment, it is best carried out at a few specialized centres where society can monitor the work, where research is facilitated and experience accumulated, and where patients can form a self-supporting group. The units should be the responsibility of both a neurosurgeon and a psychiatrist in close association, and referral to a neurosurgeon alone does not now appear to be the best practice, although it seems to continue to be the American custom.

Certainly the patient's preference as to therapy is paramount and that of his clinical advisers will be very important. But we suggest that, on the basis of the clinical and experimental

TABLE I
Characteristics of contemporary psychosurgery

Indications are <i>depression, anxiety</i> and <i>obsessional neurosis</i> . Some cases of <i>schizophrenia</i> where the foregoing symptoms are prominent.
Main target area is the <i>ventromedial</i> segment of the frontal lobe. Also the <i>cingulum</i> and <i>amygdala</i> .
<i>Stereotactic</i> placement of the lesion.
Localized lesion produced in a <i>controlled</i> way. Current methods include radioactivity, electrocoagulation and cryogenic means.

TABLE II
Indications for modern stereotactic psychosurgery

<i>Subcaudate and cingulate operations:</i>	
<i>Depression:</i>	of endogenous or involuntal type, either chronic or persistently recurrent
<i>Anxiety:</i>	chronic or recurrent anxiety or tension, or phobic anxiety states
<i>Obsessional neurosis</i>	
Operation may be considered when these symptoms are severe or chronic and do not respond to other treatments, or respond inadequately, or when attacks of illness persistently recur.	
Less often, operations may be appropriate for patients with <i>schizophrenia</i> when tension, depression or obsessional symptoms are prominent.	
<i>Amygdalotomy:</i>	
Some cases where abnormal, severe and uncontrollable aggressiveness is associated with a psychiatric or neurological illness.	
<i>General aspects:</i>	
Patient's consent	
Appropriate type of illness	
Severity of illness	
Absence or inadequacy of response to all other treatments	
Absence of contra-indications (mainly prominent anti-social personality traits and some organic cerebral conditions)	

evidence available, the opposing aspects to be considered when psychosurgery is a possibility are not unduly complex. They are given in Table III, and the relative force of the arguments on each side will, of course, depend on the individual case. It is to be hoped that such

TABLE III
Risks to be taken into account when considering psychosurgery

Without operation	With operation
Fatal suicide (perhaps 15% in the case of depressive illnesses)	One or more fits (about 1%)
Continuing distress	General surgical risks
Functional impairment of personality resulting from chronic illness	Uncommon and mild effects on personality
Small risks from medication and ECT	

decisions will come to be unnecessary as psychopharmacology continues to advance to the point where illnesses that are now intractable will respond to future forms of medication, and psychosurgery will then no longer be needed. In the meantime some of the operations appear to have limited but uniquely important indications.

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P. K. Bridges, M.D., Ph.D., M.R.C.Psych., *Consultant Psychiatrist*,

J. R. Bartlett, F.R.C.S., *Consultant Neurosurgeon*,

Geoffrey Knight Psychosurgical Unit, South East Thames Regional Neurosurgical Centre, Brook General Hospital, Shooters Hill Road, London SE18 4LW

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