Stereotactic limbic leucotomy—a follow-up study of thirty patients

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Summary

This prospective study reports the results of stereotactic limbic leucotomy at a mean of 17 months following surgery. Clinical improvement had occurred in twenty-four (80%) of the patients, fifteen (50%) of them being symptom free or much improved. Fourteen of sixteen patients suffering from obsessional neurosis were improved, as were five of seven with chronic anxiety and the degree of improvement at 17 months was superior to that at 6 weeks. Psychometric scores of anxiety, obsessions and neuroticism were all significantly reduced at 17 months. The mean depression scores were also significantly reduced and this result was superior to that reported in a previous study of 'free-hand' operations.

Adverse effects were not a problem following limbic leucotomy. Emotional blunting, disinhibition, post-operative epilepsy and excessive weight gain were not encountered, and intelligence was unaffected by the operation. Limbic leucotomy is a much more limited and precise procedure than older 'free-hand' operations which we have studied, but its therapeutic effects are comparable and in obsessional neurosis, superior.

THE preliminary results of stereotactic limbic leucotomy in the first forty patients who underwent the operation were discussed in a previous paper (Kelly *et al.*, 1973c). The patients were assessed clinically, psychologically and physiologically pre- and 6 weeks post-operatively and the results, at that stage, were most encouraging. Since that time, twenty-nine of these patients have been followed up at between 1 and 2 years post-operatively (mean 17 months) and more than seventy patients have been examined before surgery and at 6 weeks.

The physiological principles underlying limbic leucotomy and the operative technique employed have been described in a series of papers (Kelly, 1972; Sargant & Slater, 1972; Kelly, Richardson & Mitchell-Heggs, 1973b; Richardson, 1973; Kelly, 1973). The present paper describes the clinical outcome of those patients who have been followed up for over a year. The results have been assessed clinically (by the authors), psychologically and physiologically before operation, at 6 weeks and at a mean interval of

17 months following surgery. An additional, independent clinical assessment of the patients has been made by Dr Maurice Partridge, who took no part in the selection or treatment of the patients. Dr Partridge has a very wide experience of the clinical evaluation of psychosurgery (Partridge, 1950) and more particularly of rostral leucotomy and was able, therefore, to draw on this experience when comparing the results of the more extensive 'free-hand' procedures with those of the present, much more limited, stereotactic operation.

Method

The patients

Stereotactic operations were performed by Mr Alan Richardson (1973), at Atkinson Morley's Hospital, on forty consecutive patients between February 1970 and January 1972. Of these patients, twenty-nine have, to date, been followed up at between 1 and 2 years post-operatively. It was initially proposed that all patients should be followed up exactly a year post-operatively; due, however, to the great distance of many of their homes from the hospital, it was not always possible to arrange this. An additional patient, who died, probably by suicide, 14 weeks after surgery, is also included in this follow-up.

There were eleven men and nineteen women and their mean ages were 34.4 (± 11.3) years and 34.0 (± 8.2) years, respectively. The patients' mean duration of symptoms was 12 years and the diagnostic categories were as follows: *obsessional neurosis* (300.3, Registrar General, 1968), sixteen patients; *chronic anxiety* (300.0, 300.2), seven; *depression* (296.2), one; *schizophrenia or schizo-affective disorder* (295.6; 295.7), three; *depersonalization with depression* (300.6; 300.4), one; *anorexia nervosa* (306.5), one; *personality disorder with phobic anxiety* (301.6, 300.2), one.

The patients were all severely ill and had failed to respond satisfactorily to every other form of treatment. In most cases the quality of their lives had reached an intolerably low level; they were grossly incapacitated by their symptoms, their family relationships had been placed under enormous

strain and they were unable to work or carry out day-to-day tasks (see clinical case histories). Their mean number of previous hospital admissions was four, and six of the thirty patients had made a determined suicidal attempt. All but three had received at least one course of ECT and sixteen had undergone one or more courses of continuous narcosis treatment, combined with antidepressants and ECT (Walter, Mitchell-Heggs & Sargant, 1972). Twenty-one had received formal psychotherapy or psychoanalysis, but this, as opposed to superficial psychotherapy, had not been undertaken in all of the patients prior to surgery, as in England, unlike America, it is not considered appropriate therapy for all types of psychiatric disorder, the results in severe intractable obsessional neurosis, schizophrenia and endogenous depression generally being unsatisfactory.

Previous leucotomy operations of a more extensive type (Modified pre-frontal: Harvey Jackson, 1954; Rostral: McKissock, 1959) had been carried out on seven patients, of whom five had undergone more than one previous operation.

Selection of patients

The patients were, in general, referred to D.K., by other consultant psychiatrists, for a second opinion regarding their suitability for leucotomy. From St Thomas' Hospital, Dr William Sargent had referred fourteen patients and Dr John Pollitt, two; from the National Hospital, Queen Square, Dr Pratt referred two; from St George's, Professor Crisp referred one, Dr de Mare, one and Dr Priest, one. Eight further patients were each referred by a different consultant psychiatrist and one patient, who had undergone a great deal of previous psychiatric treatment, had been referred to D.K. by her general practitioner for a further opinion regarding management.

The following criteria were used in assessing the patient's suitability for psychosurgery: (1) the severity of the illness, which in most cases was totally incapacitating and intolerable; (2) the chronicity of the condition; (3) failure to respond to other appropriate forms of treatment; (4) absence of contraindications, and (5) the patient's full agreement to the operation.

Some of the patients were admitted to the psychiatric in-patient unit for further assessment before a final decision was made. Others were initially rejected for surgery and only accepted after additional in-patient therapy had failed to bring about improvement (case history 4).

Most of the patients were admitted to the psychiatric unit approximately 1 week before operation. The unit, containing the professorial unit of St George's Hospital, consists of a male and a female ward, with a total of forty-two beds, and for the

past 4 years it has been run on therapeutic community lines. All patients take part in general ward activities both before and after operation.

During the week prior to surgery the patients were examined clinically by D.K. and N.M.H. and, in addition, seen entirely independently by Dr Partidge. A close relative of the patient was interviewed, unless this was not possible, and if a patient had been in a mental hospital for a prolonged period, a nurse who knew him well was also questioned. The patient was presented at a ward round, where his case was discussed with those members of staff who might be concerned in his care; these included junior medical staff, nurses, occupational therapists and psychiatric social workers. Medical students and occasionally clinical psychologists were also present.

Following the psychiatric assessment and selection for psychosurgery, the patient was seen at a joint consultation by Mr Alan Richardson and the authors. The exact siting of the lesions was discussed and decided, taking into account the patient's individual symptomatology and past psychosurgical history.

A number of patients were selected for operation who had poor pre-morbid personalities and others were selected whose illnesses carried a very poor prognosis, even with psychosurgery. The surgical risks of the operation were considered to be minimal, as was the possibility of adverse personality change; it was considered, therefore, that the chances of the operation making the patient worse were very small indeed and, in view of this, a small number of institutionalized poor prognosis patients were offered the operation. In these, the prospect of improvement was less than 50% and both the patients and their relatives were made aware of this.

Psychological assessment

During the week before surgery psychological and physiological measurements were made. Anxiety was assessed by the Taylor Scale of Manifest Anxiety (Taylor, 1953), the Hamilton Anxiety Scale (Hamilton, 1959) and the Free Floating Anxiety, Phobic Anxiety and Somatic Anxiety scales of the Middlesex Hospital Questionnaire (MHQ; Crown & Crisp, 1966).

Depression was assessed by the Beck (Beck *et al.*, 1961) and Hamilton (1967) Depression Scales, and the Depression Scale of the MHQ.

Obsessions were measured by the Leyton Obsessional Inventory (LOI; Cooper, 1970), which subjectively assesses obsessional symptoms and traits by means of a card-sorting procedure. Feelings of resistance and the degree of interference produced by obsessions are also quantified and questions from the Cornell Health Questionnaire (Brodman, Deutchenberger & Wolff, 1956), which provide an estimate of

the subject's general psychiatric complaint level, are also included. The LOI was a later addition, and has, to date, been completed by twenty-one patients before operation and at 6 weeks, and by only two of those who have been assessed at follow-up (case history 7). The obsessional scale of the MHQ was also used.

Neuroticism and extraversion were assessed by the Maudsley Personality Inventory (MPI; Eysenck, 1959) and hysterical symptoms and traits by the MHQ.

Intelligence was assessed by the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955), which was administered by an experienced clinical psychologist, Miss Juliet Greenup. The verbal sub-scales are: information, comprehension, arithmetic, similarities, digit span, and vocabulary. The performance sub-scales are: digit symbol, picture completion, block design, picture arrangement and object assembly. These yield verbal, performance and full scale intelligence quotients.

Physiological assessment and observer and self-ratings of anxiety and depression

Before the physiological recordings were made, all medication, including night sedation when possible, was discontinued for at least 24 hr. Forearm blood flow was measured in the supine position, using a mercury-in-rubber strain-gauge on the left arm, and the heart rate was recorded on a pulse meter, using a photo-electric transducer on the right index finger (Kelly, 1967; Kelly, Pik & Chen, 1973a). Forearm blood flow was recorded at $\frac{1}{2}$ -min intervals during a resting period of 15 min, and then during a $2\frac{1}{2}$ min period of stressful mental arithmetic. The blood pressure was taken from the right arm at the commencement of the resting period, and again 10 min later. It was also taken during the last $\frac{1}{2}$ -min of the mental arithmetic. The mean of the three lowest forearm blood flows, the corresponding heart rates and the lower of the two resting blood pressure readings were designated 'basal' values, as in previous assessments of patients before and after leucotomy, and the peak measurements during mental arithmetic were called 'stress' values.

Using a self-rating scale, with zero corresponding to complete relaxation and '10' to maximal tension and anxiety, the patient was asked to rate the degree of anxiety he had experienced during the resting period and during the mental arithmetic (self-ratings). Observer ratings were made prior to this, using the same scale. Observer and self-ratings of depression were made on a similar scale, with zero corresponding to complete lack of depression and '10' to maximal depression.

Post-operative assessment

Following a 6 week post-operative rehabilitation

period, clinical ratings were made by D.K. and N.M.-H. and these were repeated at between 1 and 2 years post-operatively (mean 17 months), when Dr Maurice Partridge also independently assessed the patients. The scale used had been employed for assessing mainly 'free-hand' operations of the Rostral and Harvey Jackson type (Kelly, Walter & Sargent, 1966; Kelly, Walter, Mitchell-Heggs & Sargent, 1972) and was originally devised by Pippard (1955): I, symptom free; II, much improved (minimal residual symptoms); III, improved (definite improvement, but significant residual symptoms); IV, not improved; and V, worse. The reports of nursing staff, occupational therapists and relatives were all taken into account in these ratings.

The Wechsler Adult Intelligence Scale was again administered by the psychologist 6 weeks after the operation and all the psychological scales and physiological measurements which were made pre-operatively were repeated 6 weeks and 17 months post-operatively.

The operations

The operation slowly evolved over the period of the study. Initially comprised of a few lesions, which were insufficient to produce substantial benefit, it gradually developed into a more standardized operation (Kelly *et al.*, 1973b). The present operation usually consists of three lesions in the lower medial quadrant of the frontal lobe and two pairs of cingulate lesions (Richardson, 1973). Its purpose is two-fold: (1) to interrupt some connections between the frontal cortex and the limbic system in the lower medial quadrant of the frontal lobe and, (2) to make lesions in the cingulate region in one of the main limbic circuits, the Papez Circuit (1937). Important fronto-limbic connections also run caudalwards in the cingulum bundle (Nauta, 1973) and are, therefore, also interrupted by lesions at this site. Electrical stimulation of the target areas prior to lesion-making is employed and the plotted target site may be moved a few millimetres until adequate physiological responses are obtained (Kelly, 1972).

Laitinen (1972) reported favourable results from lesions in the genu of the corpus callosum, with an immediate reduction in anxiety. In view of this, genu lesions have occasionally been added to the standard configuration of lesions. The distribution of lesions in individual patients has, therefore, varied considerably, especially during the early part of the study, when the operation was evolving. The following combinations of lesions were made in the thirty patients:

- (a) in seven patients, two or three bilateral lesions were made in the rostral or anterior cingulum;

- (b) three patients received two, three or four bilateral lesions in the lower medial quadrant of the frontal lobe;
- (c) in two patients, two bilateral lesions were made in the lower medial quadrant; in one of them an additional bilateral lesion was made in the rostral cingulum and in the other two bilateral lesions were made in the rostral and two in the anterior cingulum;
- (d) seventeen patients received the later more usual combination of lesions, with two, three or very rarely four bilateral lesions in the lower medial quadrant and two bilateral lesions in the anterior cingulum (Sites 1, 2, 3, 4, 5; Richardson, 1973);
- (e) in one patient three bilateral lesions were made in the lower medial quadrant, three bilateral lesions in the anterior cingulum and one bilateral lesion in the genu of the corpus callosum (case history 2).

Psychiatric rehabilitation

Before stereotactic limbic leucotomy, patients and their relatives are warned that they should not expect a dramatic improvement in their symptoms immediately following surgery. They are told that they may notice an immediate reduction in tension and, possibly, depression, but that most of their symptoms will regress gradually, with improvement reaching its maximum after a year or even longer.

Following surgery, the patient spends the first few post-operative days in the neuro-surgical ward and then after his bandages have been removed, returns to the psychiatric unit.

Although the exact contribution of the rehabilitation period to the patient's progress is not entirely certain, it is in most cases considered useful, and in a number is essential. Chronically sick patients will usually, because of their illnesses, have developed abnormal patterns of behaviour, which affect their work, their social life and their family relationships. Surgery alone cannot automatically change this state of affairs and patients will often require simple support and advice following their operations. In some cases, where problems and long-standing conflicts are more serious, psychotherapy is indicated.

Most patients spend a minimum of 6 weeks in the psychiatric unit following surgery. During this time a special programme is set up to fit the needs of the individual patient. If, for example, the operation has been performed for obsessional neurosis, the programme is modelled on behaviour therapy lines, so that the patient is gradually assisted in abandoning his obsessions. Some obsessional patients become anxious when first encouraged to give up patterns of behaviour which they have followed for many years. Progress is, therefore, necessarily

gradual, but, with his growing confidence, the patient can be increasingly pressurized, and behaviour modification which was totally unacceptable to him pre-operatively, now becomes possible and rapidly yields results.

A patient who has had obsessions involving washing and bathing might, for example, be timed in the bath and his progress noted on a chart; he would be encouraged to spend 5 min less each day in the bathroom, until he no longer needed to spend an excessive time. During this period of anxiety-provoking re-training a minor tranquillizer is sometimes prescribed.

Patients suffering from phobic anxiety may require treatment by desensitization following surgery, but those suffering from chronic 'free-floating' anxiety, depression and schizophrenia may not require a specific rehabilitation programme. It is often necessary, however, to rehabilitate them with regard to day-to-day tasks and such activities as cooking, typing, gardening and housework are undertaken in the occupational therapy department.

In schizophrenics, it is usually necessary to recommence phenothiazines following psychosurgery. Generally, however, they need these in smaller doses than pre-operatively, as the operation is designed to reduce the tension and fear which is so often associated with their delusions.

After 3-4 weeks patients generally go home for a trial week-end. At this stage they and their relatives are warned that they should do very little initially, but during subsequent visits they are advised to attempt increasingly 'normal' modes of behaviour, until they are able to function outside the hospital and can be discharged.

Statistical analysis

A statistical comparison, using Student's 't' test, was made between the pre-operative psychometric and physiological data and that at 17 months. Similar statistical comparisons were also made between the pre-operative and 6 weeks post-operative results on the WAIS and the LOI.

Results

The clinical, psychological and physiological results at 6 weeks, on the first forty patients who underwent limbic leucotomy, have been reported elsewhere (Kelly *et al.*, 1973c).

In the present paper, the results on thirty of these patients at 6 weeks and at a mean of 17 months (range 12-24 months) post-operatively are reported.

Psychological measurements

The mean values on the psychometric scales before, 6 weeks and 17 months after limbic leucotomy are shown in Table 1. The patients were significantly

TABLE 1. The mean psychometric values pre-, 6 weeks and 17 months post-limbic leucotomy ($n=29$)

	Pre-	6 weeks	17 months	P (pre- vs 17 months)
MPI				
Neuroticism	31.66	23.10	23.03	0.001
Extraversion	13.76	15.07	13.86	NS*
Depression				
Beck	24.38	18.00	16.38	0.001
Hamilton	20.36	9.68	11.86	0.001
Anxiety				
Taylor	30.90	23.28	22.28	0.001
Hamilton	21.03	11.34	12.18	0.001
MHQ				
Anxiety	11.10	9.55	7.83	0.001
Phobic	6.55	5.48	5.79	NS
Obsessional	11.93	10.38	8.90	0.001
Somatic	7.45	5.10	3.86	0.001
Depressive	10.10	7.62	7.17	0.001
Hysteric	5.52	4.97	4.76	0.05

*NS, not significant.

less neurotic 17 months post-operatively, as evidenced by a total fall of 8.6 points on the Neuroticism Score of the MPI ($P < 0.001$); they were also slightly more extraverted, but not significantly so.

The mean values on the Hamilton, Beck and MHQ depression scales were all significantly less 17 months following surgery, at the $P < 0.001$ level.

A highly significant decrease in anxiety was shown on the Taylor and Hamilton Scales and on the anxiety scale of the MHQ ($P < 0.001$). Seventeen months after operation the obsessional, and somatic scores on the MHQ were all highly significantly decreased ($P < 0.001$); the hysteric scale was also significantly less at the $P < 0.05$ level, but the reduction in the phobic scores was not statistically significant.

The Leyton Obsessional Inventory. This psychometric test, a later addition to the psychological measurements, has, to date, been completed by twenty-one patients before operation and at 6 weeks. Two patients have, in addition, completed it at a year (see results in case history 7). The mean scores for the twenty-one patients are shown in Table 2, and the scores for 'normal' men and women are shown for comparison (Cooper, 1970). The patients' scores at 6 weeks showed that they had significantly fewer obsessional symptoms and traits than pre-operatively ($P < 0.01$). The degree of resistance they experienced ($P < 0.05$) and the level of interference produced by their symptoms ($P < 0.01$) were also significantly reduced. Their overall psychiatric symptom score was also significantly reduced, as evidenced by a fall in their Cornell Questionnaire (Sections M-R) mean score ($P < 0.01$).

Wechsler Adult Intelligence Scale. Of the first forty patients who underwent limbic leucotomy

five were unable to complete the WAIS; four because they came from abroad and their comprehension of English was too poor, and one because she was too agitated. A further five did not complete it because of the psychologist's leave at one or other time of assessment.

There was no fall-off in intelligence following limbic leucotomy, as evidenced by an increase in the mean full-scale, verbal and performance scores on the WAIS 6 weeks post-operatively (Table 3). The practice effect, which is seen when such tests are repeated, probably explains the increase in some of the scores post-operatively.

Self and observer ratings of depression and anxiety (Table 4). Both the self and observer ratings of depression had fallen significantly at 17 months ($P < 0.01$), as had the 'basal' anxiety observer rating ($P < 0.01$). The 'basal' anxiety self rating and the 'stress' self and observer anxiety ratings, though less at 17 months, were not reduced to a significant degree.

TABLE 2. Leyton Obsessional Inventory scores pre- and 6 weeks post-limbic leucotomy ($n=21$). Mean scores for normal men and women given for comparison (Cooper, 1970)

	Pre-	6 weeks	P	Normal women ($n=60$)	Normal men ($n=41$)
Symptom	26.00	17.19	0.01	11.4	8.7
Traits	12.00	9.38	0.01	5.1	5.1
Cornell (Sections M-R)	24.33	16.10	0.01	4.9	1.8
Resistance	40.90	24.30	0.05	7.3	4.4
Interference	44.50	21.95	0.01	3.8	3.6

TABLE 3. The mean scores on the Wechsler Adult Intelligence Scale pre- and 6 weeks post-limbic leucotomy ($n=30$)

	Pre-	Post-	Differ- ence	P
Verbal IQ	107.7	108.3	+0.6	NS*
Performance IQ	98.3	102.2	+3.9	0.01
Full scale IQ	103.9	106.0	+2.1	0.05
Verbal sub-scales				
Information	10.2	10.6	+0.4	0.05
Comprehension	13.4	13.3	-0.1	NS
Arithmetic	10.2	10.8	+0.6	NS
Similarities	11.1	11.0	-0.1	NS
Digit span	10.4	10.3	-0.1	NS
Vocabulary	12.2	12.4	+0.2	NS
Performance sub-scales				
Digit symbol	7.9	8.5	+0.6	NS
Picture completion	10.0	10.5	+0.5	NS
Block design	9.7	10.5	+0.8	0.01
Picture arrangement	8.3	9.2	+0.9	0.05
Object assembly	9.3	9.9	+0.6	NS

*NS, not significant.

TABLE 4. The mean 'basal' and 'stress' physiological values and psychological ratings pre-, 6 weeks and 17 months post-limbic leucotomy ($n=28$)

	Pre-	6 weeks	17 months	P (pre- vs 17 months)
'Basal'				
Forearm blood flow	3.96	2.78	3.57	NS*
Heart rate	83.43	74.29	76.57	0.01
Systolic BP	128.88	118.06	121.17	0.05
Diastolic BP	83.18	76.12	83.23	NS
Anxiety OR	4.25	2.93	3.18	0.01
Anxiety SR	4.21	3.46	3.39	NS
'Stress'				
Forearm blood flow	8.46	6.70	7.00	NS
Heart rate	96.32	87.11	89.54	0.01
Systolic BP	135.50	127.94	126.87	NS
Diastolic BP	88.00	83.06	86.56	NS
Anxiety OR	6.07	5.50	5.67	NS
Anxiety SR	6.64	6.50	6.61	NS
Depression				
Observer rating	4.50	3.89	3.11	0.01
Self rating	5.21	3.82	3.71	0.01

*NS, not significant.

Physiological measurements

The mean 'basal' and 'stress' physiological scores before and after operation are shown in Table 4. The 'basal' and 'stress' heart rates were both significantly reduced at 17 months ($P < 0.01$), as was the 'basal' systolic blood-pressure ($P < 0.05$). The 'basal' and 'stress' forearm blood flow mean scores and the 'stress' systolic blood-pressure were all reduced 17 months after the operation, but the differences failed to reach a statistically significant level.

Clinical ratings

The clinical ratings, on the 5 point scale, 6 weeks and 17 months after limbic leucotomy are shown, by diagnostic category, in Table 5.

Agreement occurred between D.K. and N.M.H. in all but one case at 6 weeks and one at 17 months.

Of the twenty-four patients seen by Dr Partridge at 17 months, in all but three cases his rating was in agreement with those of both of the other two assessors and in two of these, his rating was one grade more favourable than those of the others. In one further case, Dr Partridge and D.K. both rated a patient as unchanged (Grade IV), while N.M.H. rated her as marginally worse (Grade V; *vide infra*).

In all cases where disparity occurred between the assessors' ratings the least favourable rating is shown on Table 5.

Three patients were rated as worse by at least one assessor 17 months after the operation. One of these, a female suffering from very severe obsessional neurosis in a very inadequate personality (case history 5), had noticed no worsening of her symptoms, but had felt increasingly depressed following the break-up of her marriage and had made four serious suicidal attempts. Another female patient had suffered for over 4 years from severe depersonalization and depression. Ten months following limbic leucotomy she had shown no improvement in her condition and was, thus, referred to another hospital, where a stereotactic tractotomy was performed. When seen at follow-up a year later her symptoms were unchanged. Her feelings of despair at the failure of surgery to improve her mental state caused N.M.H. to rate her as worse (subsequent to the time of follow-up she has, in fact, improved considerably).

A further patient, who had suffered from obsessional neurosis, died, possibly by suicide, 14 weeks after surgery. He is, thus, included in the follow-up, with a clinical rating of worse.

Of the thirty patients, 77% were rated as clinically improved 6 weeks after surgery and 80% at 17 months. Nine (30%) patients were symptom free or much improved (minimal residual symptoms) at 6

TABLE 5. Clinical ratings by diagnostic category 6 weeks and 17 months post-limbic leucotomy ($n=30$)

	n	6 weeks						17 months					
		I*	II†	III‡	IV§	V**	% of total improved	I	II	III	IV	V	% of total improved
Obsessional neurosis	16	1	6	7	2	—	87	5	6	3	—	2	87
Depression	1	1	—	—	—	—	—	—	—	1	—	—	—
Chronic anxiety	7	—	1	3	3	—	57	1	—	4	2	—	71
Schizophrenia	3	—	—	3	—	—	—	—	2	—	1	—	—
Depersonalization	1	—	—	—	1	—	—	—	—	—	—	1	—
Anorexia nervosa	1	—	—	1	—	—	—	1	—	—	—	—	—
Personality disorder (with phobic anxiety) 1	—	—	—	—	1	—	—	—	—	1	—	—	—
Total	30	2	7	14	7	—	77	7	8	9	3	3	80

*I, symptom free; †II, much improved; ‡III, improved; §IV, unchanged; **V, worse.

weeks, while fifteen (50%) were placed in these categories at 17 months.

The largest diagnostic grouping was that of those suffering from obsessional neurosis (sixteen), of whom 87% were rated as improved both at 6 weeks and 17 months. Further improvement had been gained over the period of follow-up, however, as seven (44%) were rated as symptom free or much improved at 6 weeks, while eleven (69%) fell in these categories at 17 months.

Four patients (57%) suffering from chronic anxiety were improved at 6 weeks, as were five (71%) at 17 months. Of three patients suffering from schizophrenia or schizo-affective disorder, all were rated as improved at 6 weeks. At 17 months, two of the three had moved from the improved to the much improved category, while one, suffering from mono-delusional schizophrenia, had resumed her pre-operative state.

One patient suffering from depression was rated as symptom free at 6 weeks; he had had a recurrence of symptoms over the period of follow-up, but these were not of the same severity as pre-operatively and he felt the operation had helped him. He was, therefore, rated as improved at 17 months.

A patient with anorexia nervosa (Crisp & Kalucy, 1973; Case 103) rated as improved 6 weeks after surgery, was symptom free and training to be a nurse at the time of the 17-month follow-up. A young woman who had suffered from long-standing crippling phobic anxiety in the setting of a very severe personality disorder and had been in hospital almost continuously since the age of 12, though rated as unchanged at 6 weeks, was almost phobia free at 17 months and was thus rated as improved.

Post-operative clinical changes and adverse effects

Most patients passed through a period of confusion which lasted for one to several days. Incontinence of urine, and rarely of faeces, was also common for a few days post-operatively. When assessed at 6 weeks no adverse effects were in evidence. At the time of the 17-month follow-up no patients were suffering from sphincter disturbances, these having cleared completely after the initial post-operative period.

No adverse effects on physiological functions were noted at 17 months. For the first few months following surgery some of the patients had noted that they required less sleep, but this pattern had gradually subsided, sometimes with the help of a hypnotic, or a small dose of a tricyclic at night. None of the patients had noticed any change in appetite and none, apart from a patient with anorexia nervosa, had gained more than a few pounds in weight over the year. Many of the patients, requiring less phenothiazine or antidepressant therapy post-operatively, had lost weight following the operation (case history 4).

Some of the female patients had noticed that their periods were irregular for the first few months following surgery, but by 17 months their normal menstrual rhythm was restored. The operation did not appear to have any direct effect on patients' libido, although some had experienced greater sexual enjoyment since loss of psychiatric symptoms had increased their general feeling of well-being.

No adverse effects on concentration or memory were experienced by the majority of patients. One female patient, however, who was of hysterical premorbid personality, complained of patchily disturbed memory. Psychological tests were re-performed on her a year post-operatively, therefore, and no disturbance of cognitive function was revealed. Her scores on the WAIS were the same as those she had obtained pre-operatively and at 6 weeks, and the psychologist's impression was that her complaints were of hysterical origin.

None of the patients or their relatives had noted any blunting of emotions post-operatively and none felt that they had lost their warmth of feeling for others, or, in those who were interested, their appreciation for art or music. One patient, a keen violinist, commented that the operation, in freeing him from many of his symptoms, had allowed his feeling for music to become, if anything, deeper (case history 3). Capacity for enjoyment was also unaffected by the operation; an obsessional patient, who underwent two operative procedures, said that her enjoyment of life following the operation was incomparably better than previously. She now enjoyed social activities, sport and her work to a degree that had never been possible for her prior to surgery (case history 2).

Increase in aggression, or impulsive or irritable behaviour had not occurred in any of the patients post-operatively. A few patients, who had been particularly anxious prior to the operation, had become more outspoken as their feelings of tension and insecurity had decreased and their confidence increased, but in no case did the patient or his relatives consider his increased outspokenness to be other than a favourable change.

Lethargy and laziness were not problems after the first few post-operative weeks and the majority of patients felt that their energy was not altered by the operation. One patient had complained of excessive tiredness for several months post-operatively, but this appeared to improve when she had become less depressed.

For 6 months following limbic leucotomy all patients were advised to take prophylactic phenytoin (100 mg/day). To date, no patients have developed epilepsy post-operatively; one patient, however, who had undergone two previous 'free-hand' leucotomies and had experienced grand mal seizures

prior to limbic leucotomy, had had further seizures, despite phophylactic phenytoin and phenobarbitone.

Discussion

Clinical ratings

Six weeks: A previous paper described the preliminary results of limbic leucotomy in the first forty patients who underwent the operation (Kelly *et al.*, 1973c). The patients were assessed clinically, psychologically and physiologically 6 weeks after surgery and the results at that stage were very encouraging, with an overall improvement of 67%. Seventy-six per cent improvement was gained in obsessional neurosis, 80% in depression, 55% in chronic anxiety and 66% in schizophrenia, and these results compared favourably with those of a previous study, in which similar methods were used to assess the results of 'free-hand' leucotomy operations, 6 weeks post-operatively (Kelly *et al.*, 1972).

Seventeen months: The present paper describes longer-term results in thirty of the original forty patients, who have been followed up after a mean interval of 17 months. In these thirty patients the outcome at 17 months compares favourably with their results at 6 weeks. Six weeks after operation 77% of them were rated as improved, nine of them (30%) being in the symptom free or much improved categories. At 17 months, 80% were improved, now with fifteen (50%) rated as symptom free or much improved.

Psychometric ratings

The patients were, as a group, less depressed at 17 months than pre-operatively, as evidenced by significant reductions in their mean scores on the Beck, Hamilton and MHQ depression scales. Substantial reductions in depression scores had also occurred 6 weeks after surgery, but the improvements at 17 months were superior to these (Figs. 1 and 2). Self and observer ratings of depression were also significantly lower at 17 months than pre-operatively and the mean ratings at 17 months were again lower than those at 6 weeks.

Significant reductions in the mean scores of scales rating anxiety (Taylor, Hamilton and MHQ) had occurred at 17 months as at 6 weeks, but once again the scores at 17 months were lower than those at 6 weeks (Figs. 1 and 2). The observer rating of 'basal' anxiety at 17 months was also significantly reduced, but the mean scores of 'basal' self-rating, and 'stress' self and observer ratings, though reduced, were not so to a statistically significant degree.

On the Middlesex Hospital Questionnaire significant changes at 17 months were also shown on those scales measuring obsessions, hysterical symptoms and traits, and somatic anxiety. Changes had also occurred on these scales 6 weeks post-opera-

FIG. 1. Mean scores pre- and post-limbic leucotomy on the Maudsley Personality Inventory (Neuroticism), Taylor Scale of Manifest Anxiety and Beck Depression Scale ($n=29$).

FIG. 2. Mean scores pre- and post-limbic leucotomy on The Middlesex Hospital Questionnaire ($n=29$). Phobic and Hysterical Scales not shown.

tively, but with regard to the obsessional and somatic scores, considerable further improvement had been achieved between 6 weeks and 17 months (Fig. 2).

The *Leyton Obsessional Inventory* (Cooper, 1970) provides a very useful measure of obsessional symptoms and traits, feelings of resistance, and degree of interference produced by the symptoms in day-to-day tasks. A later addition to the psychological measures used in the present study, only two patients have completed this test at follow-up (see case history 7). Preliminary results at 6 weeks have to date been obtained on twenty-one patients of various diagnoses and significant reduction in mean scores of symptoms, traits, resistance and interference have been achieved (Fig. 3). The LOI also includes questions from the Cornell Health Questionnaire (Sections M-R), which provide a measure of the subject's general psychiatric complaint level and significant reduction in the mean score occurred at 6 weeks.

FIG. 3. Mean scores pre- and 6 weeks post-limbic leucotomy on the Leyton Obsessional Inventory ($n=21$). Cornell scores not shown.

Obsessional neurosis

More than half of the patients seen at 17 months were suffering from obsessional neurosis, an illness known to be refractory to all forms of therapy, including psychosurgery, and four of them had undergone previous psychosurgery without benefit. Eighty-seven per cent (fourteen) of the sixteen obsessional patients were clinically improved at 6 weeks, as were 87% at 17 months. The quality of improvement, however, had gradually increased over the period of follow-up. In a number of cases, substantial improvement was not gained until several months after the operation (case history 7), the patient progressively gaining in confidence and abandoning his obsessions one by one. Thus, 6 weeks after operation seven (44%) of the sixteen patients were rated as symptom free or much improved, while at 17 months, eleven (69%) were placed in these two categories. These results are superior to those of modified prefrontal and rostral leucotomy, where they were 25% and 50% respectively (Kelly *et al.*, 1972).

Two obsessional patients were rated as worse at 17 months. The first, a female of very inadequate personality, had not noted any worsening of her obsessions, but, due to the breakdown of her marriage, her general state had deteriorated; she had become increasingly depressed and had made four serious suicidal attempts (case history 5). The second, a male of very inadequate and schizoid personality, who had been subject to attacks of depression for many years, died 3½ months after the operation. His post-operative course had been uneventful and his death, on the day that he was to have been discharged from hospital, was entirely unexpected. The autopsy reported that death was due to asphyxia caused by inhalation of vomit due to barbiturate overdose. The levels of barbiturate found were not of a lethal level, but it appeared likely that there may have been potentiation with other drugs which he was taking. At inquest the Coroner's verdict was 'death by incautious overdose' and it was not felt that the patient intended to commit suicide.

Initial failure of the operation and of intensive rehabilitation. It has been suggested that the value of leucotomy lies, in part, in its placebo response. Patients suffering from obsessional neurosis are, however, notably resistant to suggestion and it is this characteristic which contributes to their failure in general to respond to psychotherapy and psychoanalysis. One patient in the present series (case history 2), who had undergone a great deal of previous therapy, was not subjectively or objectively improved by a stereotactic limbic leucotomy. Following her operation her anxiety level and need to carry out her obsessions were as severe as pre-operatively; she was unable to co-operate in the

intensive re-training programme which was set up for her and she became increasingly despondent and distressed. Three months after the operation she underwent a further stereotactic procedure, in which additional lesions were made in the cingulum and also in the genu of the corpus callosum. Following this, she noticed an immediate reduction in anxiety and was able to participate fully in a programme of behaviour modification. The need for her to carry out her obsessions gradually became less important to her and a year following surgery she was completely symptom free. There was no doubt in this patient's mind as to the difference in effect of her two operative procedures and it would appear that the placebo responses were in this case, minimal.

Prognosis and age of onset of symptoms. The results of leucotomy in obsessional neurosis are generally thought to be best in those cases with an underlying depressive illness, although Lewin (1961) reported favourable results with bilateral cingulectomy in patients without prominent depression. Bridges (1972), reporting on the results of stereotactic tractotomy in obsessional neurosis, suggested that the illness responds less well when it is of early onset, than when the symptoms begin later in life: 'the possibility is suggested that tractotomy is less effective in the true obsessional neurosis, which Pollitt (1957) described as beginning at a mean age of 20–21 years. It is likely that for the true obsessional illness surgery has to be undertaken at another site and the cingulate area has been considered for this.' In the present series, the mean age of onset of obsessional illness was at 21 years (range 12–39 years), fourteen of the sixteen obsessional patients being less than 25 years old at the onset of their symptoms. This would suggest that they were suffering, in the main, from primary obsessional neurosis and that, therefore, stereotactic limbic leucotomy is beneficial in this condition.

Other diagnostic categories

Anxiety and depression. Four (57%) of seven patients suffering from chronic anxiety were rated as improved at 6 weeks, as were five (71%) at 17 months. The initial results of more extensive 'free-hand' operations were more satisfactory, with 90% improvement, but there was a marked deterioration during an 18-month follow-up period, with only 55% improvement in chronic anxiety states at this time (Kelly *et al.*, 1972). This preliminary evidence suggests that limbic leucotomy produces better long-term results, while employing smaller lesions than the 'free-hand' operations.

Significant improvement in anxiety and depression scores were seen in the group of patients as a whole (Figs. 1 and 2). The Beck depression scale had fallen by a highly significant amount at 6 weeks and 17

months. With the more extensive operations the mean score on this scale had fallen by only 3 points initially and this was not a significant change (Kelly *et al.*, 1972). It was, perhaps, surprising that more patients with chronic depression did not enter the series. Several patients were referred, but subsequent treatment improved their symptoms, so that they did not require surgery. Eight of the first seventy patients to undergo limbic leucotomy have suffered from severe depressive illness.

Poor premorbid personality. A poor previous personality has generally been suggested to carry a poor prognosis with leucotomy (Schurr, 1969). In the present study, however, a poor previous personality does not appear to be a definite contra-indication to operation (case histories 3, 4, and 7). In some patients, while not affecting the underlying personality, the operation may provide symptomatic help. A young woman who had suffered from long-standing crippling phobic anxiety in the setting of a very severely disordered personality, had been in mental hospitals almost continuously since the age of 12. Though after limbic leucotomy she was unchanged at 6 weeks, she was almost phobia-free when seen at follow-up and was, therefore, rated as improved. She remained, however, dependent and vulnerable and unable to cope unaided with life's day-to-day stresses. She was, therefore, still an in-patient at the referring hospital at that time. Her general level of anxiety had been reduced by the operation and she had become less tense and aggressive. She was now more helpful to the nurses and to other patients, and was able to enjoy week-ends at home. A severely institutionalized patient, her rehabilitation is likely to be prolonged, but the referring psychiatrist, the nurses who care for her and the patient herself all considered that the operation had been of benefit to her.

Schizophrenia. Results of leucotomy in schizophrenia have varied considerably from series to series. Some workers have reported favourable results, particularly with traditional techniques (Freeman, 1971), and others have considered the operation to have little effect in this illness (Schurr, 1969; Ström-Olsen & Carlisle, 1971). Generally, leucotomy is considered to be of little value in the chronic case of schizophrenia of long duration. The most favourable results have usually been in cases with illnesses of short duration (Freeman, 1971), who have some insight into their illness and show marked tension and anxiety. In the present series, three patients suffered from schizophrenia or schizoaffective illness. At the time of follow-up two of the three were rated as much improved. Both of these patients had shown marked affective components in their illnesses and one of them had considerable insight into his condition. The third patient had

suffered from a mono-delusional state, with paranoid features, for over 20 years. The operation failed to benefit her and a year post-operatively her delusion was as firmly entrenched as ever.

Anorexia nervosa. A patient with anorexia nervosa rated as improved 6 weeks after surgery, was symptom free, and nursing, at the time of follow-up. Her case in particular (case 103), and the results of leucotomy in anorexia nervosa in general, have been described in detail by Crisp & Kalucy (1973).

Unreality states. The results of leucotomy in unreality states have not, in general, been rewarding. In the present study one patient, who had suffered from severe depersonalization and depression for several years, failed to improve with limbic leucotomy. Ten months later, therefore, she underwent a stereotactic tractotomy at another hospital. When seen at follow-up her symptoms were unchanged and her despair at the failure of surgery to change her symptoms caused N.M.H. to rate her as worse. Recently, however, her mental state has started to improve, and her feelings of hopelessness are considerably diminished.

Adverse effects

The risk of adverse effects has been the main problem with open or blind operations. Stereotactic procedures have reduced this risk (Ström-Olsen & Carlisle, 1971), although the side-effects of tractotomy have included volubility, outspokenness, irritability and lethargy. These effects have been a nuisance in a very small number of cases, but almost never socially disabling (Bridges, 1972). In the present study, transitory confusion and sphincter disturbances have been common for the first few post-operative days and one patient, not in the present series, who had had a previous bilateral rostral operation, suffered a transient neurological complication post-operatively (Richardson, 1973).

Intelligence

Tests of intellectual function (WAIS) 6 weeks post-operatively showed an increase over pre-operative means scores in the verbal performance and full-scale IQs and at the time of the 17-month follow-up no adverse effects on memory or concentration were experienced by the majority of the patients. Only one patient, of hysterical personality, complained of patchily disturbed memory. Psychological tests, were, therefore, re-performed a year post-operatively. Her scores on the WAIS were the same as those she had obtained pre-operatively and the psychologist's impression was that her complaints were of hysterical origin.

Personality

None of the patients, nor their relatives, felt that limbic leucotomy had produced emotional blunting

and none felt that their capacity for enjoyment or appreciation of the arts had been affected. Increase in aggression, or impulsive or irritable behaviour had not occurred in any of the patients post-operatively, and volubility or excessive outspokenness were not reported. A few patients, who had been very shy, anxious and lacking in confidence while ill had, in fact, become more outspoken as their symptoms decreased, but in no case did they or their relatives consider the change to be other than favourable. Lethargy and laziness were not generally in evidence after the first few post-operative weeks, although one patient complained of excessive tiredness for several months post-operatively. Her energy had begun to increase, however, when she became less depressed.

Epilepsy and weight

For 6 months following surgery all patients were advised to take prophylactic phenytoin and no patients, to date, have developed epilepsy, an adverse effect which complicated 'free-hand' operations not uncommonly. Significant weight gain, another serious complication of more traditional operations, had not occurred in any of the patients following limbic leucotomy and many of them, requiring less phenothiazine or tricyclic post-operatively, had actually lost weight (Case history 4).

In a previous study (Kelly *et al.*, 1972), excessive weight gain was demonstrated to be a serious side-effect of 'free-hand' leucotomy. More than half of the patients had gained weight over a period of 18 months follow-up and in many of them the gain was of the order of 28 lb (12.7 kg).

Sexual appetite was unchanged by limbic leucotomy and menstruation, irregular in some patients for the first few post-operative months, was also unaffected at 17 months.

Effects on sleep

Many patients noticed that their sleep patterns were changed for several months post-operatively. They appeared to require less sleep, most commonly falling asleep later and waking earlier than previously, and this effect was different from that seen after rostral (McKissock, 1959) and modified prefrontal leucotomy (Jackson, 1954), where somnolence, especially in the early post-operative period, was common. The increased wakefulness following limbic leucotomy gradually subsided, sometimes with the help of a hypnotic, or a small dose of tricyclic at night.

Similar changes in sleep following leucotomy have previously been described by Hauri & Hawkins (1972), who studied a depressed, obsessive patient in the sleep laboratory before and after leucotomy. Following leucotomy, she too passed through a stage of increased wakefulness and this subsided

after a few months. Before leucotomy her EEG had shown a scarcity of delta (stages 3 and 4) and REM sleep (a pattern typical for sleep in depression) and this pattern continued for 10 days post-operatively. After this time, delta sleep gradually increased until 5 months after leucotomy, when age-adequate delta levels appeared. Hauri & Hawkins suggested that 'this very slow recovery of delta sleep after leucotomy makes it seem very unlikely that the improvement is directly related to the interruption of some neurological pathways during the operation. Rather, one might speculate the neuro-endocrine mechanisms could be involved as intervening variables.' They postulated that their patient's pre-operative psychiatric state had caused some neuro-endocrine balance to stabilize on a new and pathological level manifesting itself in low levels of delta sleep. When the leucotomy abolished the chronic state of psychological stress the 'underlying endocrine balance may have needed time to readjust to the new state of well-being'.

An association between delta sleep and serotonin has been reported (Jouvet, 1969; Koella & Czieman, 1966) and it is interesting to speculate that one of the factors involved in the therapeutic outcome of leucotomy might be its effects on biogenic amine production in the brain. In the light of Hauri & Hawkins' work, this might provide a partial explanation for the pattern of gradual improvement which is often seen. They suggested that the change in neuro-endocrine balance was secondary to the improvement in mental state produced by leucotomy, but it is, perhaps, possible that it is this which is the primary effect of leucotomy.

Rehabilitation

The importance of a period of rehabilitation following leucotomy has often been stressed. It was essential following standard leucotomy, when post-operative confusion, lethargy and laziness were frequent and severe, but its role following less extensive operations is rather different, being directed at altering old unhealthy behaviour patterns set up during the patient's illness. Behaviour therapy, systematic desensitization and psychotherapy may each play an appropriate part in the rehabilitation programme, as may advice regarding work and social life. Whether such a programme is absolutely essential to a favourable outcome in limbic leucotomy is not entirely clear, as a small number of patients were unable to take part in a formal rehabilitation programme and improved in spite of this (case history 6). The contribution of the period of rehabilitation to the results of limbic leucotomy cannot be overlooked. All of the patients had, however, undergone a great deal of previous therapy, during illnesses of a mean duration of 12 years. It is

unlikely, therefore, that the period of rehabilitation would alone have accounted for the degree of improvement achieved (case history 2).

The independent assessor

Dr Maurice Partridge, who has had a great deal of experience in assessing leucotomy operations (Partridge, 1950), has been the independent assessor for the present study. He has, to date, seen twenty-four patients pre-operatively and at 17 months, and his impressions of stereotactic limbic leucotomy have been very favourable, particularly with regard to its results in obsessional neurosis. With regard to his clinical ratings (on the 5 point scale), in all but three cases his rating was in agreement with those of both of the other two assessors (D.K. and N.M.H.) and in two of these his ratings were one category more favourable than those of the others. In one further case he and D.K. both rated a patient as unchanged, while N.M.H. rated her as minimally worse. In all cases where disparity occurred between the assessors' ratings, the least favourable rating was attributed to the patient for the purposes of the present study.

Favourable points particularly cited by Dr Partridge have been the absence of emotional blunting, disinhibition, post-operative epilepsy or excessive weight-gain, all of these having been well-recognized complications of 'free-hand' operations.

Dr Partridge's opinion of the operation is that it is a safer, much more limited procedure than more traditional leucotomy operations, but that its overall therapeutic effects are comparable and, in obsessional neurosis, probably superior.

Conclusion

Psychosurgery remains, and will continue to remain, a controversial treatment. It would appear, however, to have a part to play in the therapy of chronically and severely ill patients, in whom other therapeutic measures have failed. Preliminary findings indicate that limbic leucotomy produces more favourable results in obsessional neurosis, with smaller lesions, than the more extensive 'free-hand' operations we have studied. The changes in anxiety and depression psychometric scores are comparable to those produced by the more extensive operations. Rostral leucotomy, which was devised at this hospital by Sir Wylie McKissock, is now rarely employed here.

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Appendix

Clinical case histories

Case 1: severe intractable obsessional neurosis.
J.G., Aged 34, Female. Referred for treatment of an intractable obsessive-compulsive disorder. Her symptoms began when she was 23, after an unwanted pregnancy had forced her into an unhappy marriage. A year later, when the baby developed asthma, her feelings of guilt deepened and from that time her symptoms were of such severity that she was unable to cope with even the simplest tasks of everyday life. Her day was totally occupied with checking and re-checking actions such as washing, dressing and household tasks. She had, for example, to wash her face in a special order—starting with the left side, nose, right side, forehead—up to thirteen times. A similar elaborate system was involved in her bathing, which took her over an hour each day. After washing clothes she had to squeeze them a certain way, repeating the proceedings twenty-two times, the bottom of the bowl was then examined, checking the maker's mark numerous times to make sure the bowl was empty. Cleaning her teeth was a major task, taking over half an hour. Making a bed, with checking at each stage that the sheets and blankets were exactly symmetrical, might take over half an hour.

Household chores such as washing-up or polishing a table were completely impossible for her, as they took so long and caused her such distress. Her husband and mother were, therefore, forced into running her home and, on medical advice, her two children were at boarding school. The patient felt extreme guilt at her disruption of the family's existence and, at times, felt very depressed and that life was not worth living. Between 1962 and 1970 she was admitted to Severalls Hospital seven times, and received a variety of treatments including ECT, MAOI drugs, tricyclics, major and minor tranquillizers and psychotherapy. During 1968 and 1969 she was admitted on two occasions to the Royal Waterloo Hospital and had a total of five courses of modified narcosis, combined with ECT and antidepressants. After each admission she obtained symptomatic relief for about 2-4 weeks and then relapsed.

On 2 March 1971 she underwent a stereotactic cryogenic limbic leucotomy. Two lesions were made in the lower medial quadrant of each frontal lobe and two lesions (each with a medial and lateral component) were also made in each anterior cingulate gyrus. Thus, a total of six lesions was made in each hemisphere, each lesion being 8 mm in diameter.

Her post-operative course was uncomplicated and following the operation she felt an immediate reduction of tension. The compulsion to carry out her rituals was of diminished intensity, and a 4-week rehabilitation programme along behavioural lines reinforced this. She spent a week's leave at home before being discharged and during this she was relaxed and obsessional to a minor degree.

A year after the operation (14 March 1972) she said her improvement had continued after she left hospital and she was now completely symptom free. She commented; 'Now I can't really imagine what it's like to be obsessional.' She found no difficulty in caring for her home and children and, for the first time since her marriage, was happy with her husband. She no longer suffered from depression or tension

and was leading a completely normal life. The operation had not produced any unwanted side-effects and, apart from follow-up visits, she no longer saw a psychiatrist. Rated as symptom free.

Case 2: re-operation in a case of severe obsessional neurosis. S.S., aged 29, female. Referred for treatment of an incapacitating obsessional illness of 10 years' duration. Her illness involved fears of contamination and death and resulted in the patient's performing almost continuous ruminations and rituals in order to relieve her anxiety. Prior to her illness she had had a meticulous, well-adjusted personality and had an excellent work record, managing, despite very severe symptoms, to work as a solicitor's assistant until 3 years before her admission. Gradually, however, her obsessions occupied an increasingly greater part of the day and, although she stayed in her office till late at night, she became unable to keep up with her work. For the year prior to her admission she had been unable to leave her home, to read, write, converse, watch television or get dressed. For 2 months she had walked about her home naked, for she was forced to throw away any clothes which she considered to be contaminated.

No improvement in her condition had been achieved with any treatment, including anti-depressants, tranquillizers; 2 months' narcosis, combined with ECT and antidepressants; desensitization employing i.m. diazepam; a course of i.v. chlomipramine; and hypnotherapy.

On 10 November 1971 she underwent a cryogenic stereotactic limbic leucotomy; three lesions were made in the lower medial quadrant of each frontal lobe and two lesions (each with a medial and lateral component) in each cingulum. Following the operation there was no subjective or objective change in the patient's obsessive-compulsive symptoms, nor in her feelings of anxiety and she was unable to co-operate in the desensitization programme which was set up for her. After 7 weeks she went on holiday to the West Country for a month's leave and during this was as obsessional as she had ever been and, for the first time during her illness, felt depressed and hopeless.

On 16 February 1972 a further stereotactic operation was performed, two lesions being made in the genu of the corpus callosum (one to the right and one to the left of the mid-line) and one lesion (with a medial and lateral component) in each cingulum.

Immediately following the operation the patient noted a reduction in her feelings of anxiety and felt more able to tackle her obsessions. Over the following 6 weeks she co-operated vigorously in a desensitization programme and when she left hospital (20 May 1972) was almost symptom free.

At follow-up a year later, she said she was com-

Psychometry		Pre-leucotomy	6 weeks post	1 year post
Taylor	Anxiety	12	2	2
Beck	Depression	6	0	0
MPI	Neuroticism	8	1	0
	Extraversion	14	12	8
MHQ	Anxiety	6	6	0
	Phobia	0	0	0
	Obsessional	11	11	2
	Somatic	3	0	0
	Depression	5	0	0
	Hysteria	2	0	0
Hamilton	Anxiety	11	4	0
Hamilton	Depression	10	3	0

pletely free from obsessions. She had obtained a post as secretary to the manager of travel firm, was promoted to manager's assistant within 6 weeks and was travelling to Europe each month. She had a

boy-friend and was enjoying sport, parties and cinemas. She had no fears or anxieties and rated her operation as an unqualified success. Rated as symptom free.

Psychometry		Pre 1st Operation	6 weeks post 1st	6 weeks post 2nd	1 year post
Taylor	Anxiety	17	17	8	4
Beck	Depression	8	17	1	0
MPI	Neuroticism	17	12	10	4
	Extraversion	16	36	32	34
MHQ	Anxiety	6	6	1	1
	Phobia	5	6	6	2
	Obsessional	15	13	15	7
	Somatic	0	7	0	0
	Depression	4	4	3	3
	Hysteria	7	7	7	5
Hamilton	Anxiety	14	16	7	0
Hamilton	Depression	9	11	6	0

Case 3: patient with severe obsessional neurosis. Lesions in cingulum only. E.M., aged 42, male. Described by the referring psychiatrist as 'one of the most severe obsessionals I have ever come across', he was very poorly adjusted in social and sexual spheres and had suffered from non-specific neurotic symptoms nearly all his life. His very severe obsessional illness had commenced in 1968, and had prevented his carrying out his work as a teacher for almost a year. His symptoms resulted in his performing numerous rituals and involved his checking and re-checking almost every simple day-to-day task. He experienced a feeling of perpetual fear and anxiety and had been 'brought to a standstill'. Despite treatment with antidepressants, tranquillizers, ECT, psychotherapy and 6 months' treatment in a mental hospital, his symptoms, though improved, were still extremely crippling and prevented his working.

On 9 December 1970 the patient underwent a cryogenic stereotactic limbic leucotomy; one lesion was made in each rostral cingulum and two lesions in each anterior cingulum. Immediately following the operation his anxiety was greatly reduced, but for 4 days he was noticeably paranoid. Following this his post-operative course was uncomplicated and he remained relaxed, cheerful and almost obsession-free and was discharged from hospital after 6 weeks.

Two years following the operation (15 January 1973) he said 'the operation was the turning point in my life.' He no longer suffered from the symptoms of anxiety and fear which he had experienced before the operation and, though still possessing some minor obsessions, was teaching 20 hr a week. He was, in addition, taking music lessons, with a view to becoming a violinist (he had wished to do this all his life, but had been dissuaded by relatives and had

lacked the courage to oppose them). He was taking chlomipramine 25 mg t.d.s. and nitrazepam 5 mg at night and was seen by his psychiatrist at 2-monthly intervals. Rated as much improved.

Psychometry		Pre-leucotomy	6 weeks post	2 years post
Taylor	Anxiety	25	24	16
Beck	Depression	20	17	11
MPI	Neuroticism	23	10	24
	Extraversion	13	32	14
MHQ	Anxiety	11	11	10
	Phobia	5	5	2
	Obsessional	14	14	9
	Somatic	13	4	3
	Depression	7	8	9
	Hysteria	6	7	6
Hamilton	Anxiety	11	5	6
Hamilton	Depression	12	2	5

Case 4: long-standing phobic anxiety state, with recurrent depression, in a vulnerable pre-morbid personality. C.W., aged 53, female. This patient had suffered from severe agoraphobia with panic attacks for 20 years and from recurrent attacks of depression for 8 years. Ever since a child, she had been anxious, emotionally labile and dependent, but her phobic symptoms commenced abruptly 3 months after she set up home with a married man (whom she later married). The symptoms tended to fluctuate, but following the birth of her second child in 1960, her anxiety worsened, her panic attacks increased in frequency and she also suffered from severe back pain for which she received osteopathy.

In 1963 she became depressed when her husband, who had always drunk heavily, became more alcohol-

dependent and between 1963 and 1969 she was admitted to mental hospitals on six occasions. She generally responded rapidly to treatment with MAOI drugs and tranquillizers, but tended to relapse within weeks of discharge from hospital.

By 1969 her husband had ceased to drink and had joined Alcoholics Anonymous; nevertheless, the patient became increasingly phobic and by 1970 was completely housebound. She was commenced on combined antidepressants (MAOI and tricyclic) and became less depressed; she was, however, still extremely phobic and, on these drugs, gained 42 lb (19.1 kg) in weight in a few months.

In 1971 her psychiatrist referred her to D.K. for advice regarding further management and she was admitted to Atkinson Morley's Hospital, where she underwent desensitization therapy, first under i.v. methohexitone and then i.v. diazepam. She failed to respond to this, however, and became increasingly phobic in hospital. Further attempts at desensitization as an out-patient were again unsuccessful and her condition deteriorated further.

She was re-admitted for a stereotactic limbic leucotomy, which was performed on 14 August 1971. Three lesions were made in the lower medial quadrant of each frontal lobe and two (each with two components) in each cingulum.

Her post-operative course was uneventful and immediately following the operation she was cheerful, relaxed and phobia-free. She successfully attempted increasingly distant walks from the hospital, but 3 weeks post-operatively went further than advised, got lost and had a panic attack. This event discouraged her, as did a severe recurrence of her old back pain. Nevertheless, when discharged 4 weeks later, she was able to go for short unaccompanied walks.

For several months her back caused her much distress; following a course of physiotherapy, however, this improved and gradually, with this, so did her mental state.

By the time of follow-up (19 September 1972) she

Psychometry		Pre-leucotomy	6 weeks post	13 months post
Taylor	Anxiety	31	27	29
Beck	Depression	17	13	5
MPI	Neuroticism	22	18	14
	Extraversion	16	12	8
MHQ	Anxiety	12	9	7
	Phobia	15	9	7
	Obsessional	13	10	10
	Somatic	7	9	6
	Depression	5	5	3
	Hysteria	5	4	2
Hamilton	Anxiety	19	19	8
Hamilton	Depression	34	21	8

was phobia free, lacking anxiety and depression, and had lost 42 lb (19.1 kg) in weight. She was coping well with shopping and had enjoyed visits to theatres and restaurants. She attended Alcoholics Anonymous meetings with her husband and took an active part in these, managing to visit a lapsed AA member in Brixton Prison. She was still taking small doses of a tricyclic and of a minor tranquillizer at night, and these were being reduced. She commented that she 'had not been as well as this for years'. Rated as symptom free.

Case 5: severe obsessional neurosis in an inadequate personality—unimproved following surgery. J.B., aged 27, female. This patient was referred for treatment of her extremely severe obsessional illness. She was known to be of below average intelligence and to possess a highly immature, hysterical personality. Her illness exhibited many reactive features, having commenced after she married at the age of 21. She was sexually frigid and was unable to cope with the roles of wife and mother, being at her happiest and least obsessional when working as a bar-maid. Her symptoms consisted of repetitive household cleaning and list-making, and she spent all day long, till the early hours of the morning, employed in this way. She had developed elaborate and incapacitating rituals involving nearly every household chore—boiling a kettle on the stove necessitated her cleaning the whole stove, including the oven, afterwards floors had to be scrubbed after anyone had walked across them; members of the family had to be constantly followed and their clothes checked, in case they had become disarranged or contaminated by dirt; her two small children were not allowed to move from their chairs for hours at a time in case they caused even minute disorder in the house. Although not usually aggressive to them, the patient had, at times, physically attacked her children when they had unwittingly disturbed her obsessional order.

By 1968 her condition had deteriorated; she was deeply depressed and after a number of suicidal gestures was admitted to a mental hospital where she remained almost continuously, unable to cope with even a weekend at home. She was treated with the full range of anti-depressants and tranquillizers and received intensive psychotherapy, no treatment producing any change in her obsessional state. She became increasingly depressed, particularly regarding the effect of her illness on her family, and shortly before her referral to Atkinson Morley's, was discovered, by chance, taking a suicidal overdose.

At the time of assessment it was felt that if psycho-surgery achieved a degree of symptomatic relief, she might become more accessible to the psychotherapy which was required to help her resolve her many real-life conflicts.

A stereotactic limbic leucotomy was performed on 25 August 1971. Three lesions were made in the lower medial quadrant of each frontal lobe and two lesions (each with a medial and lateral component) in each cingulum. Following the operation she was incontinent of urine for 2 weeks and remained rather retarded for 3 weeks; following this period her post-operative recovery was uncomplicated and she noticed a reduction in her feelings of anxiety and depression and in her need to carry out her obsessions. Rehabilitation consisted of behavioural therapy aimed at her obsessions and psychotherapy, which dealt mainly with her family relationships.

In the setting of the hospital she remained less obsessional, but on weekend visits home her symptoms recurred. She continued to have little insight into the relationship of her illness with her life situation and made little progress in psychotherapy.

She was discharged to the care of her referring psychiatrist after 10 weeks and at follow-up (24 October 1972) had been under his in-patient care for the previous 9 months. Since her operation she rated herself as 'unchanged'; she was as obsessional and depressed as previously and had made four serious suicidal attempts. Her husband, 'no longer able to stand the strain' had petitioned for divorce, wanting sole custody of the children, and the patient, feeling her family would be better without her, saw no future for herself. Because of the seriousness of her suicidal attempts and the deterioration in her marital state, she was rated as Grade V (worse).

Psychometry		Pre-leucotomy	6 weeks post	14 months post
Taylor	Anxiety	42	16	36
Beck	Depression	42	17	41
MPI	Neuroticism	48	32	44
	Extraversion	20	16	2
MHQ	Anxiety	15	2	12
	Phobia	9	6	11
	Obsessional	16	6	14
	Somatic	10	5	4
	Depression	4	8	12
	Hysteria	9	7	7
Hamilton	Anxiety	32	7	32
Hamilton	Depression	34	6	34

Case 6: severe depression with obsessional symptoms. No rehabilitation programme. M.K., aged 49, female. This semi-literate Cypriot patient was referred by her psychiatrist in Nicosia, for psychosurgical treatment of her severe obsessional and depressive illness.

Her symptoms had commenced in 1954, following the death of a priest. She had developed a morbid fear of death and her fear had become so intense

and widespread that it totally preoccupied her thoughts. She performed numerous rituals of decontamination if she had even the remotest contact with death and spent most of her day washing herself and her possessions. If she spoke to someone who had recently been to a funeral she would have to destroy the clothes she was wearing at the time and would be overwhelmed by intense panic and fear. Four years after the death of a neighbour she was still unable to open a door in her house which faced her neighbour's home. She had become increasingly distraught and depressed and had made several serious suicidal attempts, including one by drowning.

Various treatments had been given, with no success. These included psychotherapy, ECT, antidepressants, tranquillizers and, latterly, a course of i.v. chlomipramine.

On 15 September 1971 she underwent a stereotactic limbic leucotomy. Three lesions (8 mm diameter) were made in the lower medial quadrant of each frontal lobe and two (each with a medial and lateral component) in each cingulum. Her post-operative recovery was uneventful and a week after her operation she was transferred to a nursing home for 2 weeks' convalescence. Because of her lack of understanding of English it was not possible to embark on an organized re-habilitation programme. The importance of her trying to resist her obsessions at this stage was, however, explained to her and attempts were made to encourage her to do this.

Six weeks following her operation she returned to her village in Cyprus. At this time she was less depressed and anxious than pre-operatively, but she continued to perform many of her washing rituals.

Regular reports regarding her progress have been received from her son and from the referring psychiatrist. She has continued to improve, lacking anxiety and depression and progressively abandoning her obsessions. Three months following the operation she went to church for the first time since her illness commenced and her husband, who had left her 16 years before because of her symptoms, had returned to live with her. Nine months later the death of a neighbour caused her to suffer no more than normal grief and 18 months post-operatively she was completely free from obsessions and depression. (No clinical rating and not included in the present series, as no personal follow-up. No psychometry because of language difficulties.)

Case 7: long-standing obsessional neurosis in a patient of poor pre-morbid personality. Use of the Leyton Obsessional Inventory. A.C., aged 45, female. Had suffered for 20 years from fear of pregnancy. Gradually her anxieties regarding impregnation and contamination extended to involve many other sub-

jects and, despite a great deal of in-patient and out-patient psychiatric treatment, her condition had deteriorated over the year. She had become seriously depressed and on one occasion attempted suicide by drinking disinfectant.

Her personality had never been robust and she had at times drunk excessively, particularly when depressed.

On 10 May 1972 a stereotactic limbic leucotomy was performed, three bilateral lesions being made in the lower medial quadrant of the frontal lobe and two bilateral lesions in the anterior cingulum. Her post-operative course was uneventful and she claimed to be less anxious and depressed immediately following surgery. Six weeks after the operation she demanded to be discharged from hospital, although at this stage her obsessions, while considerably decreased, were still prominent.

When seen at follow-up a year later both she and her husband said that she was '98% better'. She had gradually improved over the year, at first very slowly and then much more obviously. She was cheerful, confident and almost completely obsession free. There had been no adverse effects from the operation

and she had not drunk alcohol to excess. Her Leyton Obsessional Inventory Scores confirmed the clinical impression of continuing improvement after the 6-week assessment. Rated as much improved.

Psychometry		Pre-leucotomy	6 weeks post	1 year post
Leyton	Symptoms	31	18	14
	Traits	8	12	7
	Resistance	44	15	12
	Interference	38	8	4
	Cornell	10	8	1
Taylor	Anxiety	16	8	9
Beck	Depression	0	3	3
MPI	Neuroticism	22	19	10
	Extraversion	8	15	32
MHQ	Anxiety	3	1	3
	Phobia	3	3	3
	Obsessional	11	6	7
	Somatic	2	0	0
	Depression	4	0	4
	Hysteria	2	2	2
Hamilton	Anxiety	15	8	1
Hamilton	Depression	14	9	2