RESULTS OF PREFRONTAL LEUCOTOMY IN THIRTY CASES OF MENTAL DISORDER.

By R. Ström-Olsen, M.D., B.Sc.Wales, D.P.M.,
Physician Superintendent, Runwell Hospital,
S. L. Last, M.D.Berlin, L.R.C.P.&S.E., D.P.M.,
Deputy Physician Superintendent, and
M. B. Brody, M.D.Sheff., D.P.M.,
Senior Resident Physician at the Hospital,

WITH OBSERVATIONS ON SURGICAL TECHNIQUE.

By G. C. Knight, F.R.C.S.,
Hon. Surgeon, West End Hospital for Nervous Diseases; Visiting Neurological Surgeon, Runwell Hospital.

The purpose of this paper is to present the results of treatment by prefrontal leucotomy in 30 cases of mental disorder. In view of the fact that this procedure is not only comparatively new, and uncertain in its ultimate effects, but is also after all a destructive operation, its trial was only felt to be justified, in the first instance at any rate, in a selected number of chronic patients with an apparently hopeless or very poor prognosis.

Indications.—Reports from the literature led us to believe that cases showing disturbed behaviour or chronic depression with or without agitation might benefit from leucotomy. In fact our cases do, broadly speaking, fall into these two categories. Thus seven cases of involutional melancholia, five each of paraphrenia and dementia paranoides, six of schizophrenia (other forms), four of epilepsy, two of chronic mania and one of psychopathic personality were selected. With the exception of the melancholias all except one of the remaining cases showed marked disturbance of behaviour, such as aggressiveness, violent outbursts, hostility, quarrelsomeness, abnormal irritability, destructiveness or negativism. In the paranoid psychoses most of these disturbances were based on hallucinatory experiences or due to delusions. In the schizophrenics they were mostly irrational or impulsive in nature, and as regards epilepsy, four of the most difficult and troublesome patients were chosen. Altogether this group represented the type of cases who required a great deal of nursing supervision, who were a constant source of trouble, often unemployable, and in many instances regarded as dangerous.

The seven involutional melancholias were selected on account of their chronicity, continued agitation or marked suicidal tendencies, necessitating continual nursing supervision both by day and by night. The selection of two chronic manias needs no elucidation, whilst the case of psychopathic personality presented the features of uncontrolled aggressiveness, lability, screaming bouts, temper tantrums and hysterical manifestations.

It may be added that other forms of treatment (e.g. shock therapies, prolonged narcosis, occupation, prolonged sedation, etc.) had failed to allay the symptoms in many of these patients, or had only produced at best a very short-lasting remission. In any case, with the exception perhaps of the involutional melancholias, the general characteristic of the group as a whole was chronicity, as will be seen from Tables I and II. Prefrontal leucotomy was therefore performed in these 30 patients without mortality, more as a palliative measure than with any hope of cure.

Type of operation.—In 9 cases the Crombie type of operation was performed, the leucotome with rotating blade as devised at Warlingham Park being used.

In 5 cases the technique advocated by Freeman was carried out.

https://doi.org/10.1192/bjp.89.375.165 Published online by Cambridge University Press

In the remaining 16 cases a combination of the Crombie and Freeman techniques was used.

Time observed after operation.—In accordance with findings of other workers results recorded too soon after operation are generally unreliable. This seems to be due (*a*) to the effect generally of a surgical operation, with its concomitants of special individual attention, changed environment, etc. (*b*) To the development of transitory symptoms due to the leucotomy, e.g. drowsiness, excessive lethargy, disorientation and mild confusion with amnesia, which would obscure the basic and permanent symptoms. The patients usually take two or three months to become stabilized and for the true clinical picture to emerge, but this time varies with each case and with type of operation. Of the present series 24 cases have been observed for six months or longer (up to 14 months), and the remaining six from one month to five and a half months, three of them for less then three months. These latter are all regarded as " not improved " so far. More experience is required before one may be dogmatic as to what length of time should elapse before the clinical condition becomes stabilized. Our results are put forward very much with this reservation.

Recording and assessment of effects of leucotomy.—We would like to stress that the effects of leucotomy can really only be satisfactorily recorded by presenting the clinical history of each case in detail, both before and after operation. Psychiatric material does not readily lend itself to framing results by tabulation, and this instance is no exception. As the space at our disposal does not allow of this, some form of tabulation has been necessary, though we append descriptions of four cases that were particularly instructive.

Tables I and II give a general survey of the results obtained, together with duration of psychosis, length of time observed after leucotomy, and type of operation. " Much improved " indicates a striking and complete relief of the worst symptoms which were taken as indications for treatment, and leading to disappearance of psychomotor unrest, easing of tension or depression and a consequent lessening of the need for supervision and greater freedom for the patient. " Improved " indicates partial relief of these symptoms to such an extent that they were no longer

TABLE I.—*Results of Prefrontal Leucotomy in* 30 *Cases of Mental Disorder.*

Case number.	Sex and age.	Duration of psychosis up to time of operation.	Time observed after leucotomy.	Type of operation.	Result.
Involutional melancholia, 7 cases.					
1	F. 54	6 years	14 months	Crombie	Not improved.
3	F. 53	2 ,,	13½ ,,	,,	,,
6	M. 57	3½ ,,	12½ ,,	,,	Much improved.
15	F. 60	3½ ,,	9 ,,	Freeman and Crombie	Improved.
16	F. 61	2½ ,,	8½ ,,	,, ,,	Not improved.
18	F. 62	4 ,,	7½ ,,	,, ,,	Slightly improved.
23	F. 47	3½ ,,	6 ,,	Freeman	Much improved.
Paraphrenia, 5 cases.					
2	F. 50	8 ,,	12 ,,	Crombie	Temporary improvement.
5	M. 46	6 ,,	13 ,,	,,	Much improved.
9	F. 64	11 ,,	11½ ,,	Freeman	Improved.
19	F. 60	14 ,,	7½ ,,	Freeman and Crombie	Not improved.
24	F. 51	2½ ,,	6 ,,	Freeman type ½ cm. further posteriorly	Deteriorated. *Died* 3½ months after leucotomy.
Dementia paranoides, 5 cases.					
7	F. 45	13 years	12½ ,,	Crombie	Slightly improved.
8	F. 43	5 ,,	12 ,,	,,	Improved.
21	F. 45	6 ,,	28 weeks	Freeman	,,
25	F. 42	10 ,,	5½ months	Freeman type, ½ in. more posterior and Crombie	,,
29	F. 39	8 ,,	7 weeks	Freeman and Crombie	Not improved.

TABLE II.

Case number.	Sex and age.	Duration of psychosis up to time of operation.	Time observed after leucotomy.	Type of operation.	Result.
Epilepsy (psychosis and oligophrenia), 4 cases.					
11	F. 38	7 years	10 months	Freeman and Crombie	Much improved.
12	F. 34	Congenital.	10 ,,	,, ,,	,, ,,
13	F. 43	18 years	9½ ,,	,, ,,	Improved.
14	M. 26	Congenital.	9 ,,	,, ,,	Much improved.
Other forms of schizophrenia, 6 cases (10 and 22 Catatonia).					
10	F. 26	10 years	10 months	Freeman and Crombie	Not improved.
22	F. 43	6 ,,	1 year	Freeman	Improved.
17	M. 36	10 ,,	8 months	Crombie	Not improved.
20	F. 41	24 ,,	7 ,,	Freeman and Crombie	Improved.
26	M. 29	6 ,,	6 ,,	,, ,,	Much improved.
27	F. 41	15 ,,	5 ,,	,, ,,	Improved.
Chronic mania, 2 cases.					
28	F. 45	7 years	3 ,,	,, ,,	Not improved.
30	F. 37	5 ,,	3 ,,	,, ,,	,, ,,
Psychopathic personality, 1 case.					
4	F. 26	Congenital.	13 ,,	Crombie	Slightly improved.

TABLE III.

	(a) Involl. melancholia, 7 cases.	(b) Paraphr. and demen. paranoid., 10 cases.	(c) Epilepsy, 4 cases.	(d) Schizophrenia, 6 cases.	(e) Chronic mania, 2 cases.	(f) Psychopathic Pers'y, 1 case.	(g) Total.
No longer depressed	3	..	..	..	..	..	3
Less depressed	1	..	..	..	..	..	1
Improvement in behaviour (i.e. no longer aggressive, violent or destructive)	..	7 (9) (1 temp.)	4 (4)	4 (6)	..	1 temp.	16 (2 temp.)
Loss of or marked diminution of agitation	4 (5)	..	..	..	..	..	4
Tension eased	..	4 (5)	..	..	..	1 temp.	5 (1 temp.)
Less irritable	..	..	4 (4)	2	..	..	6
Improved quality and output of work	4	1	3	4	..	1	13
Loss of initiative and spontaneity	2	9	1	..	2	..	14
Persistence of delusions and/or hallucinations	6 (6)	9	..	3 (3)	..	..	18
Developed volubility	(2 temp.)	..	1	..	..	..	3 (1 temp.)
No longer stuporose	..	..	..	2	..	..	2
Developed perseveration	5	3	..	2	..	..	10
,, retardation	..	3	..	3	1	..	7
,, emotional facility	5 (1 temp.)	7	3	4	..	..	19 (1 temp.)
,, euphoria	..	3	1	2	..	..	6
,, irritability and aggressiveness	4	..	..	..	..	(1 temp.)	5 (1 temp.)
Increased appetite	5	4	2	3	1	..	15
Loss of sphincter control	2 (1 temp.)	5 (3 temp.)	..	2 (1 temp.)	2 (1 temp.)	..	11 (6 temp.)
Developed epileptiform fits	..	1	..	..	..	..	1
Deteriorated and died	..	1	..	..	..	..	1

Temp. = temporary.

https://doi.org/10.1192/bjp.89.375.165 Published online by Cambridge University Press

such a disturbing influence in the ward or did not require the same amount of supervision, or where undesirable symptoms still remained but were of much less intensity. "Slight improvement" indicates amelioration in one or two symptoms (e.g. excitement or depression), but not of sufficient extent to change the clinical picture as a whole very much or to diminish the amount of supervision required.

Two distinct effects of leucotomy can easily be recognized: (*a*) the relief of undesirable symptoms, and (*b*) the production of new symptoms. These two groups of phenomena will combine so as to form the total resultant clinical picture. In Table III a number of the more striking symptoms have been analysed in each group of cases.

On the positive side there are the disappearance or lessening of depression in four out of seven melancholics, the improvement in conduct and behaviour of 16 of the remaining cases, and the improved quality and output of work (occupation therapy, farm work, etc.) in 13 cases, four of whom were consistently unemployable before leucotomy. Negative or undesirable results include loss of initiative and spontaneity, persistence of delusions or hallucinations, development of emotional facility or euphoria, of retardation, or perseveration, irritability and aggressiveness (in the melancholias) and volubility. The more physical sequelae included loss of sphincter control, development of voracious appetite, trophic disturbances such as greater predisposition to bed-sores and pressure-sores, and occurrence of epileptiform fits (one case only).

Some of these symptoms have been of a temporary character, and it may well be that others will gradually lessen as time goes on—our period of observation is as yet insufficient.

Table IV shows symptoms produced correlated with the types of operation. Our series is too small for too much significance to be attached to these figures. It is evidence *prima facie* however, that with the more extensive operation more symptoms are produced, e.g. mental symptoms which are very similar to those of the recognized organic psycho-syndrome, together with loss of sphincter control (permanent or temporary), voracious appetite and trophic disturbances. In Case 24 the Freeman technique was used, but the cut made further posteriorly. This patient subsequently displayed the features of an organic dementia, characterized by amnesia, confusion, marked euphoria with emotional facility and childishness. She became extremely noisy, restless and incontinent, and required frequent sedation. She eventually developed numerous bed-sores and died of exhaustion and toxaemia.

TABLE IV.

Type of operation.	Total number done.	Loss of initiative and spontaneity.	Developed retardation.	Developed emotional facility.	Developed euphoria.	Developed irritability and aggressiveness.	Increased appetite.	Loss of sphincter control.	Deteriorated and died.
C	9	4	1	3	..	2	5	..	..
C & F	15	8		10		3	7	6 (3 temp.)	..
			4		2				
F	4	1	..	4	2	..	3	3 (2 temp.)	..
F posterior	2	1	2	2	2	..	..	2 (1 temp.)	1

PSYCHOMETRIC INVESTIGATION.

It was hoped to test each patient before, six weeks and four months after operation with the following tests: Terman Vocabulary Test, the Revised Stanford Binet scale, the "Discrepancy Test" modification of Babcock's scale, Kohs' Blocks, Porteus Mazes, the Passalong Test, Progressive Matrices, and the Shipley-Hartford test. Practice effects were diminished where possible by applying forms L and M of the Stanford Binet and by reversing the designs and mazes at alternate sessions. Examinations will be continued at yearly intervals.

Only 14 patients out of 30 could be validly tested before operation and three of these could not be re-tested. One, our first case, became after treatment very suspicious of everything connected with the operation, including both tests and tester. The other two were the patients operated on with the Freeman technique ½ in. posteriorly. Both were too lethargic to test at either of the intended times. One of them has died. Whether cognitive potentialities have been irreparably

destroyed in the other cannot be decided until the lethargy has sufficiently diminished to permit valid testing.

The planned programme was effected in 11 patients. One, in whom the Freeman operation was performed, showed, six weeks later, a pronounced fall in the discrepancy test, a fourfold increase in the time consumed by the vocabulary test, an increase of from ¾ of an hour to over 2½ hours spent on the matrices, and a large fall in the number of items attempted in the Shipley-Hartford scale. These defects were also mainly attributable to lethargy and lack of spontaneity. At times she almost fell asleep over her task. Four months after the operation she attained her pre-operative level.

In five patients the combined Freeman-Crombie technique was used. Only one showed definite change, and she, curiously enough, was the only patient among those examined in this group whose EEG was apparently unaffected. Six weeks after the operation her Stanford Binet score declined from M.A. 18 to M.A. 12·7, her Porteus score fell from 14½ to 8½, although she spent treble the time on it, and her matrices score fell from 32 to 21. Four months after the operation her matrices score had returned to its initial level, but the other changes largely persisted. In addition, the time spent on her vocabulary test, previously slightly increased, was now doubled. Most of her loss appeared to be caused by extreme inhibition and vacillation, which inexplicably contrasts with the mild but unrestrained outbursts of irritability she often now displays. Sometimes, however, she seemed to struggle without result and forgot the problem before an answer came. She also exhibited defects in the quality of performance, including perseveration and signs of impaired conceptualization. On analysing the Stanford Binet items into the six groups suggested by Roe and Shakow (1) her additional failures six weeks after the operation were found almost exclusively, in order of severity, in " sustained associative thought," " conceptual thinking," and " immediate learning." Four months after operation the additional failures were halved in the first of these groups, but remained in the other two. Vocabulary, remotely learned material other than vocabulary, and immediate associative thought were unaffected by the operation.

In the remaining five patients the Crombie method alone was used. None showed defects, although two had abnormal EEG's. One considerably improved her scores in a fashion correlated with clinical improvement. The diminished suspicion of another was reflected by a fall in the time spent over the matrices from nearly five to one hour. Later his suspicion somewhat returned, and he spent two and a half hours on this test.

Four conclusions are to be derived from these investigations. Firstly, since so many patients cannot be validly tested before operation, an individual worker can accumulate little data. Therefore it is desirable that all investigators should use at least a uniform minimum battery of tests. Secondly, it is clearly necessary before interpreting results in purely cognitive terms to evaluate the effect of disorders such as lethargy, lack of spontaneity, and attitude of suspicion. Thus, a scale such as Wittman's for rating test reactions should be employed. Thirdly, different operative techniques appear to have different effects. The Freeman technique ½ in. posteriorly certainly produces lethargy, but our present material is insufficient to warrant generalization about its effect on cognition. The combined Freeman and Crombie technique sometimes produces lethargy, and in one case has left signs, four months after the operation, commonly found in demented patients. The Crombie operation alone does not seem to produce either marked lethargy or any cognitive defect, so that the Freeman element must be held responsible for this. Finally, no relation has appeared between test performance and abnormal EEG.

Electroencephalography.—Of seven cases on whom an operation of the Crombie type had been done and whose EEG was obtained, only three showed marked changes during the days following the operation. In the same way eight cases were examined who had the Freeman and Crombie operation and one whose operation was of the Freeman type, and of these only one (No. 18) *failed* to show changes. *EEG photos.*—No. 1 shows a normal record for comparison. Nos. 2, 3 and 4 show the changes in Case 25: (2) immediately following the operation random delta waves almost continually; (3) after about ten days long-fasting frequent bursts of high-voltage waves originating in the frontal region; (4) after about three weeks these became very much less frequent. This is the case which

had an epileptic fit, and records 3 and 4 are of the epileptic type. There has been only one other case so far who has shown anything comparable to this, and that is Case No. 26. He has not had an epileptic fit.

CASE 5.—Male, aged 46.
Diagnosis: Paraphrenia.
Duration of psychosis before leucotomy: 6 years or more.
Time observed after leucotomy: 13 months.

The history showed an insidious onset of the illness a couple of years prior to admission in November, 1937. There was a history of alcoholism from the age of 16 to 27. About twelve months before admission he started to express delusions openly, stating that he was subjected to persecution by the Post Office authorities by whom he was employed. On account of his delusions he got into trouble with the Post Office authorities, whom he accused of trying to hound him out of the service, and he stated that this plot against him had been going on for some considerable time. He was admitted in November, 1937, under certificate. He was suspicious and reserved in his attitude and very guarded in his replies to questions. In addition to the persecutory delusions he had auditory hallucinations, hearing voices giving him directions. Delusions of influence also began to appear, e.g. a few months after admission he believed that people were interfering with him at night. During his first admission his behaviour was fairly good and he managed to keep his delusions and hallucinations under reasonable control. On the application of his wife he was discharged relieved in June, 1938.

He was admitted for the second time under certificate in December, 1939. By this time the psychosis had developed considerably. He was now more suspicious and reserved, and his delusions were more numerous. Delusions against the Post Office authorities had been pressed into the background and now he expressed the delusion that his wife had been unfaithful because she was scared of some unknown persons, and that these persons had prevailed on her to have him certified. He thought that he was going to be held in hospital to be tortured every night, and that the medical staff were all against him. Hallucinations were not detectable at first, but these soon became apparent. The note in February, 1940, states that he complained of being sexually interfered with at night, and that he began complaining of voices which were saying obscene things to him. The hallucinations gradually became more pronounced, as a result of which he was frequently aggressive and violent towards other patients. By July, 1940, he had deteriorated. Auditory hallucinations were now very acute, and he had included his present environment in his persecutory delusions. He believed that he was being accused of filthy and abominable things by other patients, and that they were continually making references to him in obscene and vile terms, so much so that he complained to the medical officer that foul language was continually being directed at him, and he was afraid that unless he were away from the patients he would have to retaliate by striking them. His threatening attitude became more pronounced and his assaults on other patients more frequent. He was now tense and morose, but would still reveal his delusions and hallucinations to the M.O. at an interview. He was given a course of insulin therapy from December, 1940, to April, 1941, but without any improvement. As soon as he returned to his usual ward he became threatening, impulsive and violent, continually complaining of the foul language and false accusations that were being directed at him. "These remarks had an ugly and underhand meaning, purposing to make him a laughing stock of everybody." In February, 1942, his behaviour had still further deteriorated. He now maintained that he was being sexually interfered with at night, that people were systematically using filthy language to him and that he was being accused of the vilest crimes. "All these things put together," he said, "have such a paralysing effect on my life that they have undermined my physical health so that I am now quite unable to do anything, even to write letters to my wife." He stated that he dare not now tell the M.O. everything for fear of retribution. Violent attacks on other patients and on staff were frequent, and necessitated treatment in bed or continuous baths at various times. By the staff he was regarded as one of the most dangerous patients in the ward. This was his condition at the time when prefrontal leucotomy was performed on February 10, 1942.

During the first few days after the operation he was a little drowsy and very quiet. He would not talk very much and slept a great deal during the day. He ran a mild pyrexia for about 14 days after the operation. About a month after he was much improved physically. He smiled rather more than before, but did not talk (very much) spontaneously. He started becoming argumentative with the other patients, but if left alone would remain quiet and rather apathetic, at times smiling rather fatuously. On March 25 it was evident that his delusions were much the same as before, but as regards his hallucinations he said that he had hardly heard any foul language lately. Interviewed by the medical staff in April, 1942, he denied feeling better or different, and said that bad language was about the place all the time, but not as it was before. "They are not as forward as they were in their remarks to me," he said; "it is miles better than what it was." He was still in an observation ward. His behaviour, however, had been very good since the operation. There was no violence or aggressiveness, although at times he would adopt a threatening mien. On account of his good behaviour in the ward he was allowed grounds parole in May, 1942. He had become more solitary and apathetic and smiled much more fatuously. He would not employ himself, however, and his thought

content remained exactly the same. He remained well behaved, and was later transferred to a better ward and out of observation at night. He was not now regarded as dangerous.

At the interview in February, 1943, he smiled a good deal, more than he used to do, in a facile and fatuous manner. He was somewhat retarded. He continued to express the same delusions of interference and persecution, but stated: "It is not as bad as it was. They used to challenge me to fight. I was forced to fight. I have not been challenged now and have not had a fight with anyone for over twelve months." He keeps reiterating "It is not nearly so bad as it used to be," and uses perseveration. He is now much more facile, laughs and smiles more readily, and appears to be altogether more amenable. The Charge Nurse of the ward reports: "His behaviour is very good. He is now much more pleasant; he has never attacked any patients since he had the operation, and is much easier to deal with." He has little interest or initiative, however. He never plays games, writes letters or goes to any of the entertainments. His only occupations are to make his own bed, clean out his room and occasionally to read the newspaper.

Summary.—Marked improvement in behaviour. Thought content and hallucinosis unchanged. More retarded and more facile. Displays less initiative and spontaneity.

CASE 6.—Male, aged 57.

Diagnosis: Agitated involutional melancholia.

Duration of psychoses before leucotomy: Over 3 years.

Time observed after leucotomy: 13 months.

On admission he presented a picture of severe agitated melancholia. He was extremely apprehensive, restless and agitated, wringing his hands and reiterating, "You promised me you would spare my life. I will do anything: let me stay here all my life, so long as my children can come and see me," etc. He was very self-accusatory and blamed himself for his breakdown. On account of the previous history he was regarded as acutely suicidal. He continued to be extremely agitated and restless, also at times aggressive and actively suicidal, and was full of auto-accusatory ideas. He was continually begging to be allowed to stay in hospital. He continued in a similar condition in spite of two courses of prolonged narcosis, and did not improve. In June, 1939, he expressed the delusion that he was going to be taken away and chopped up, and his one fear was of leaving hospital. He continued to be very aggressive as well as suicidal, and had to have continuous bath treatment. In July, 1939, he began to cause a great deal of trouble, continually trying to break windows in order to escape. For the next two months he was alternately in the continuous bath or under prolonged narcosis. In November, 1939, he was still very depressed and continually begging not to be sent away, but at the same time impulsively violent, striking other patients and smashing windows. He was now becoming dangerous, suicidal and destructive, and was a great source of trouble in the ward. He was sustaining injuries almost daily, either through attempting to smash windows or trying to escape, and required constant nursing supervision the whole time. He also made several attempts at escape, although he kept reiterating that he did not want to leave hospital. He had gradually become one of the most troublesome patients in the ward, and it had become increasingly difficult to look after him, as one could not leave him even for a minute. This was his condition when prefrontal leucotomy was performed in February, 1942.

The post-operative course was fairly uneventful. He became very quiet, smiled and lost his agitation. About three weeks after operation spontaneously said that he wanted to go home. When interviewed by the medical staff in April, 1942, he said he was quieter and did not worry as much as he used to do. He admitted his violent and suicidal behaviour in the past, but said he felt better in that respect. He still heard voices at times, and said he felt depressed because he did not know what the doctors might do to him. He only wanted to do as he was told. Apparently greatly improved although he was still somewhat depressed, but showed in addition marked emotional facility. This condition has persisted. In February, 1943, he has maintained his improvement; he has been in a non-observation ward since August, 1942, and gives no trouble at all. When interviewed: What difference do you notice since the operation? "I feel very, very quiet, a kind of tame feeling. I do feel ever so much better." How do you feel in your spirits now? "I am contented. I feel quite happy. I am not worrying at all." (He then laughs.) "I want to stay here. I don't want to go out. I am quite happy here."

Objectively he appeared more facile and there was no sign of any depression or agitation, although he still expressed vague ideas of unworthiness and guilt regarding his past life. The Charge Nurse of the ward who had known him both before and after the operation reported: "He is a different man altogether. He is very quiet now. He will do ward work and will join in with games, particularly billiards and draughts, at which he is very good. He will also come and ask for jobs if he has nothing to do. He has one big worry. He is afraid of being sent home, and is afraid of being a nuisance as well."

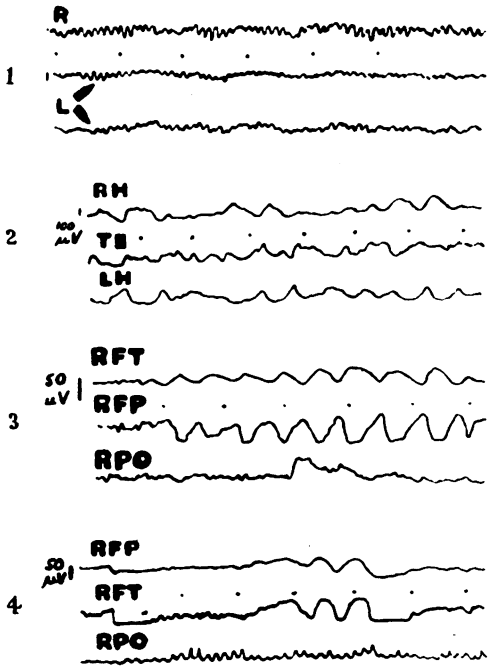
Summary.—Marked all-round improvement. Thought content essentially the same. Some increase in emotional facility. No objective signs of depression. Agitation and psychomotor unrest completely disappeared. A little more retarded in thought.

CASE 25.—Female, aged 42.

Diagnosis: Dementia paranoides.

Duration of psychosis before operation: 10½ years.
Time observed since leucotomy: 6 months.

The history showed an insidious onset over a course of seven years before admission, starting with ideas of reference and eventually delusions of persecution and influence. These were directed against the neighbours, whom she accused of listening to her conversation through the electric lights at night, of maligning her and alienating her husband from her. She kept these delusions fairly well under control for some years, but eventually, following a fight with a woman neighbour, she was summoned and bound over. Subsequently she became very abusive to the police and was admitted to hospital under certificate in August, 1938. She was dissociated and disconnected in her conversation, displayed various mannerisms, and incongruity of affect and thought content. She was hostile and abusive and expressed various delusions of persecution at the hands of her neighbours, whom she accused of being jealous of her. Various other bizarre delusions of influence and persecution were much in evidence. With the exception of



No. 1.—Normal record.
No. 2.—Case No. 25—one day after leucotomy.
No. 3.—Case No. 25—10 days after leucotomy.
No. 4.—Case No. 25—3 weeks after leucotomy.

a few months at home in 1939, when she left hospital against advice, she did not alter during the succeeding two years. Then she began to show deterioration, was extremely hostile and aggressive. She now included her present environment in her delusions and was particularly deluded against the staff. She expressed numerous delusions of influence as a result of which, she stated, she had been changed, and that the staff had taken advantage of her. She also had auditory hallucinations. As a result of the delusions and hallucinations she was frequently violent, e.g. she once knocked a nurse unconscious for ten minutes. From this time onwards she was very threatening and aggressive, frequently fighting with other patients as well as staff. She showed much intrapsychic ataxia. Emotional flattening was present, but her prevailing mood was one of sullen hostility. She was mostly very tense and suspicious. Thought content was unchanged. A few months prior to leucotomy she frequently became extremely noisy as well as aggressive and violent, causing a good deal of trouble, and requiring constant nursing supervision.

Prefrontal leucotomy was performed on September 21, 1942, using a modified Freeman technique ½ cm. further posteriorly, and also Crombie operation. For the first five days after the operation she remained very drowsy. She appeared somewhat confused and disorientated and did not seem to realize at first that she had had an operation. Even at this early stage she admitted that the voices were continually talking to her and that they still worried her. She said this with very little sign of affect. She appeared in fact apathetic and was retarded in her speech. Her habits had deteriorated. She was now incontinent of urine and faeces. A week

https://doi.org/10.1192/bjp.89.375.165 Published online by Cambridge University Press

after the operation she was not so sleepy but was lazy and lethargic. She seemed apathetic about everything, and was highly suggestible. She showed perseveration and was disorientated for time. She was still incontinent. A month after operation she seemed brighter; showed little spontaneity, though when stimulated did not appear to be so slow. Hallucinations and delusions of influence were still present, but she stated they did not worry her so much. She was still apathetic and quiet. Post-operative confusion seemed to be clearing up. She was still incontinent. Her condition remained practically unchanged for the next two months. On January 11, 1943, she had an epileptic fit. She had never had one previously, and presumably this fit was due to the leucotomy. There have been no other fits since.

At the end of February, 1943, 5½ months after operation, when interviewed again she stated she felt much better. "I really think the operation on my head has had a lot to do with it. Friction is not so vivid really." She perseverates and repeats this sentence several times during the interrogation: "I feel much better; it certainly was very bad, but it is not so vivid now." "I have just got to carry on, put my worries aside and do the best I can." Objectively she appears very bright and contented and has entirely lost the morose and sullen expression, and her attitude is no longer suspicious. She smiles rather more fatuously than before, and emotional facility seems to be in evidence. She is more retarded and displays much less interest and initiative. The Sister of the ward reports: "She is very pleasant indeed. She is somewhat slow but will do odd jobs if asked. She writes sensible letters home." She is now no longer faulty in habits even without supervision, and gives very little trouble.

Summary.—Marked improvement in behaviour. Delusions and hallucinations much less prominent. Increased indifference of patient towards her own thought content, resulting in a calm attitude. She displays less initiative and interest, is more retarded, and emotionally more facile.

CASE 14.—Male, aged 27.

Diagnosis: Epileptic feeble-minded.

Time observed after operation: 9 months.

There was a history of onset of epilepsy in childhood. He was never employed, was backward at school and was most difficult to handle at home. He received out-patient treatment for many years and lived at home. He was admitted to hospital in February, 1942. His behaviour was extremely aggressive, and during the first week in hospital he was violent, striking at the nurses and the medical officer. He was irritable, suspicious and egocentric, and displayed the typical epileptic temperament. He was continually grumbling, was easily upset and would then strike out at any one. He proved a most uncontrolled patient, and after a time he showed himself one of the most difficult epileptics in the hospital. He had frequent outbursts of temper. He was childish and self-centred and very quarrelsome and argumentative, and would use obscene language without provocation. He frequently refused food to cause trouble for the nursing staff. There would be phases lasting a few days when he would be quieter and more controlled. After the first two months of his admission he had no more fits, which were apparently controlled by luminal and epanutin. His behaviour, however, remained very difficult. He required constant nursing supervision and was nursed in the disturbed ward.

Prefrontal leucotomy was carried out on June 2, 1942. During the first week after operation he had a mild pyrexia. He seemed apathetic, taking no interest at all, and was rather drowsy. He seemed very slow in response to questions and was particularly slow in eating his food, sometimes taking an hour and a half over a meal. Ten days after operation he seemed less drowsy. He was more pleasant and amenable, and showed no irritability. A month after operation he had maintained his improvement. He was now much more sociable. He had no outbursts of temper or violence, though at times he would still be argumentative and somewhat noisy. In September, 1942, at a medical conference he denied feeling any different after operation, but objectively he appeared steadier, more friendly and much less irritable. For three and a half months following leucotomy he had shown no aggressiveness and had not been threatening. The nurse accompanying the farm patients said he was much more stable and gave him a very good report. When he had worked on the farm before he had leucotomy he had threatened both the nurse and other patients with a spade, and had been difficult and cantankerous. In February, 1943, he still denied feeling different after the operation, but said he had not been excitable for a long time. He still displays the epileptic temperament, but appears much more chastened and is just a little querulous and self-centred. He is now in a better ward and enjoys the privilege of ground parole. The nursing staff who have known him before and after state that he is very much improved. He never strikes out now at anyone and is not regarded as dangerous. He works quite well on the farm and causes no trouble. He has a voracious appetite. He is much easier to handle.

Summary.—Marked improvement in behaviour. Somewhat more retarded. Irritability much less. Appears more contented and is a little facile.

Summary and conclusions.—On the basis of results of treatment by prefrontal leucotomy in 30 chronic cases of mental disorder it has been possible to substantiate that certain very disturbing mental symptoms may be alleviated in about half the total number treated. The question of the permanence of the relief of such symp-

toms must, as far as we are concerned, still remain *sub judice*, i.e. until a reasonable length of time has elapsed, after which any chance of relapse can be regarded as very remote. The *modus operandi* of such therapeutic effect will no doubt be the subject of much discussion and occasion many interesting hypotheses, both psychological and neurophysiological. It is not possible for us to put forward any working hypothesis, except that one may reasonably say that the important changes take place in the conative-affective sphere and not in the cognitive. In delusional, hallucinatory and tension states there appears to have arisen in those who responded well an indifference, even apathy, on the part of the patient towards his psychotic thought content, resulting in a calmer attitude and consequent abolition or lessening of psychomotor unrest and an improvement in behaviour. In the successfully treated depressive states the action is similar, viz. easing of tension with consequent loss of agitation and depression. It is reasonable to suppose that the relief of such unpleasant affective states and distressing conflicts is associated with the severance of the connection between the prefrontal area and the thalamus—but here histological confirmation is required. The thought content undergoes little change. In all the relevant cases except one the delusions and hallucinations persisted, though they often seemed less obtrusive and more shadowy than formerly.

TABLE V.—*Summary of Results in* 30 *Cases.*

Diagnosis.	Much improved.	Improved.	Slightly (or temp'ly) improved.	Not improved.	Deteriorated and died.	Total.
Involutional melancholia	2	1	1	3	0	7
Paraphrenia	1	1	1	1	1	5
Dementia paralytica	0	3	1	1	0	5
Schizophrenia (other types)	1	3	0	2	0	6
Epilepsy	3	1	0	0	0	4
Chronic mania	0	0	0	2	0	2
Psychopathic personality	0	0	1	0	0	1
Total	7	9	4	9	1	30

The final summarizing figures are given in Table V. After having studied the effect of prefrontal leucotomy in 30 chronic psychotics, our impression is that the best results are obtained in patients with severe disturbance of behaviour, such as excitement, aggressiveness, violence and destructiveness. The improvements achieved have been of practical importance. Patients with a disturbing influence have become quiet and easily manageable, thus obviating the need for the same close nursing supervision as formerly, and the output and quality of the patients' work has improved. In the involutional melancholias the results are a little disappointing. Patients showing tension and agitation seemed to derive the greatest benefit, whilst the chronic retarded depressive showed less change. We are of the opinion that prefrontal leucotomy is of benefit in the chronic type of psychotic patient described, but in view of the risk of producing undesirable new symptoms, both mental and physical, the operation should only be undertaken when all other methods of treatment have failed, and where it can reasonably be assumed that the chances of remission or recovery are very remote. In other words one must strike the happy mean between relief of distressing symptoms and sacrifice of frontal lobe.

OBSERVATIONS ON SURGICAL TECHNIQUE.

By G. C. KNIGHT, F.R.C.S.

Prefrontal leucotomy consists essentially of the division of the central core of white matter within the frontal lobes with a minimum disturbance of the cortex and subcortical tissues. It is an intervention based upon theoretical considerations, empirically designed to sever the connections of the frontal cortex, and especially, it is said, to interrupt the projections connecting the frontal regions with the thalamus and hypothalamus. Apart from this hypothetical design it is lacking in precise objective, for we have as yet no knowledge whether division of one set of fibres within the frontal lobe is of greater significance than another in producing the altered behaviour that is observed.

Almost certainly the operation should be performed bilaterally, but the necessity for this lacks absolute proof. The cortical plane of section is of primary importance. The site of election at present accepted is that the fibres should be divided at a point 3 cm. behind the outer angle of the eye, the division being effected in the plane of the coronal suture.

There is evidence from the published reports (2), and from our present series, that the total effect produced varies with the antero-posterior location of the cut. Incisions that are spaced further anteriorly than at the point described produce less change in behaviour and are less effective as a means of lowering tension, dementia and psychomotor activity. Those that are sited further posteriorly are attended with undesirable changes—loss of initiative and spontaneity, corresponding to the organic psychosyndrome and amounting in extreme cases to dementia. Since Moniz (3) introduced the method numerous modifications of technique have

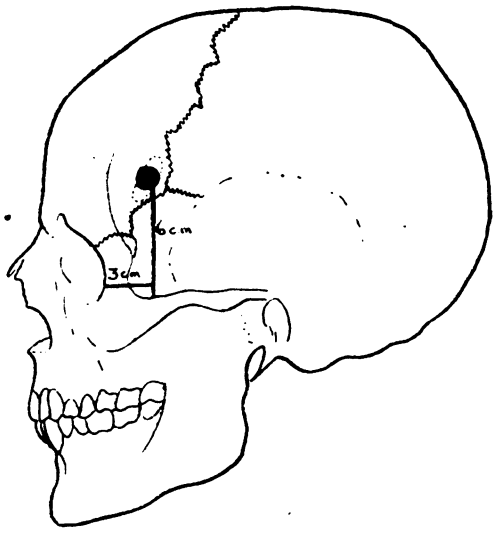


FIG. 1.—Illustrates the usual method of approach. A trephine hole is fashioned 3 cm. behind the outer angle of the eye and 6 cm. above the zygoma. This point is immediately anterior to the junction of the coronal and temporal sutures. The dotted line around the trephine hole indicates the upward and downward extension of this aperture, made for reasons of improved access in the course of operation.

been devised in order to secure division of the fibres. The multiplicity of the available measures suggests that there is no particular virtue in one method rather than another. Moniz approached the lobe by trephine openings situated 3 cm. from the mid-line, on the line of the coronal suture; in the first he destroyed the intrafrontal white matter by alcohol injections, later by the cutting of multiple cores of tissue within the frontal lobe formed by rotating by a loop of steel which expanded after insertion into the brain. Freeman and Watts (4) approached the lobe from the side at a point 3 cm. behind the outer canthus and 6 cm. above the zygoma, a cut being made in the coronal plane with a blunt knife, guarded against too deep an entry and turned through an arc with its centre at the surface. McGregor and Crombie (5) have devised an instrument with a rotating blade which cuts a circle 3 cm. in diameter. This instrument is introduced through a trephine hole situated at a point 3 cm. behind the eye and 5 cm. above the zygoma, a cut being made in this case also in the coronal plane with the instrument adjusted so that the blade shall lie in the centre of the lobe. Lyerly's (6) open method is fundamentally sound, and attractive to those who abhor the dangers of a blind procedure. By this method a small, rectangular osteoplastic flap is resected over the lobe and the fibres divided under direct vision. This is obviously a more formidable procedure than the simple closed methods outlined above.

TABLE VII.—*Results of Mental Tests in Prefrontal Leucotomy.*

Serial No. (operation).	Terman Vocab. M.A. (Time in mins.)			Stanford-Binet (1937-L) M.A. (Time in mins.)			Discrep. Test M.A. (Time in mins.)			Discrep. score.			Kohs M.A. (Time in mins.)			Porteus M.A. (Time in mins.)		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
2 (C.)	19 (20)	19 (13)	18 (10)	19–3 (105)	18–8 (100)	18–7 (90)	15 (20)	19 (16)	19–6 (18)	8	+1	+5	16–8 (35)	15–7 (35)	16–9 (28)	14½ (10)	15½ (7)	12½ (10)
4 (C.)	15 (6)	16 (5)	16 (4)	15–5 (130)	15–11 (115)	16–7 (130)	12–6 (18)	14–0 (18)	14–0 (15)	15	10	10	16–2 (30)	16–3 (28)	19–7 (25)	14½ (10)	14 (13)	12 (15)
5 (C.)	16 (13)	15 (12)	17 (10)	16–0 (165)	16–2 (110)	15–1 (120)	14–6 (20)	14–6 (30)	14–0 (20)	6	3	12	14–7 (25)	18–9 (28)	19–1 (20)	14 (10)	12½ (20)	16 (12)
7 (C.)	15 (8)	16 (18)	16 (10)	10–2 (150)	13–6 (100)	13–8 (105)	11–0 (20)	13–0 (18)	11–0 (25)	22	15	24	10–8 (35)	12–10 (20)	12–5 (30)	6½ (35)	11½ (15)	14½ (2)
8 (C.)	17 (15)	17 (10)	18 (12)	16–5 (145)	16–10 (115)	17–5 (100)	14–6 (20)	18–0 (20)	18–0 (18)	9	+1	0	12–9 (40)	14–3 (38)	14–5 (35)	12 (15)	14 (9)	15 (12)
11 (F. & C.)	15 (10)	15 (7)	15 (5)	15–9 (120)	14–10 (115)	16–6 (110)	10–9 (30)	10–0 (30)	12–6 (30)	27	35	15	11–5 (30)	10–3 (25)	14–0 (45)	11½ (17)	11 (20)	10½ (14)
12 (F. & C.)	11 (8)	11 (17)	12 (15)	10–6 (115)	11–0 (120)	10–10 (75)	9–3 (23)	10–9 (23)	11–0 (18)	21	14	9	12–4 (20)	11–5 (23)	11–10 (25)	13 (22)	12 (14)	13½ (15)
13 (F. & C.)	15 (10)	15 (8)	15 (15)	11–6 (130)	11–8 (110)	11–3 (120)	10–6 (23)	9–8 (25)	10–0 (17)	27	33	28	8–9 (25)	9–0 (20)	9–0 (18)	6½ (25)	8 (30)	8 (35)
14 (F. & C.)	12 (12)	12 (10)	11 (10)	12–6 (135)	11–6 (110)	13–8 (110)	12–0 (20)	11–6 (19)	13–0 (17)	0	6	+15	13–2 (26)	13–8 (35)	12–4 (32)	13 (16)	15½ (12)	12 (12)
18 (F. & C.)	17 (15)	17 (20)	17 (30)	18–0 (145)	12–7 (185)	13–7 (170)	13–0 (21)	12–6 (25)	11–0 (20)	15	19	25	11–7 (30)	11–0 (28)	10–8 (33)	14½ (15)	8½ (45)	11 (48)
21 (F.)	15 (5)	13 (23)	15 (12)	10–0 (115)	9–4 (130)	11–10 (135)	10–0 (17)	7–6 (30)	10–0 (22)	32	44	30	11–1 (30)	13–4 (40)	13–4 (23)	12 (12)	11 (15)	9 (15)

Serial No. (operation).	Passalong M.A. (Time in mins.)			Shipley Vocab. M.A. (Items attempted.)			Shipley abstraction M.A. (Items attempted.)			Shipley Total M.A. (Concept. quot.)			Matrices score. (Time in mins.)		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
2 (C.)	13–10 (18)	15–10 (20)	18–0 (18)	18–2 (40)	18–6 (40)	18–6 (37)	16–5 (20)	17–3 (19)	21–0 (20)	17–7 (93)	18–0 (97)	19–6 (117)	48 (50)	51 (23)	51 (40)
4 (C.)	12–10 (18)	15–6 (20)	14–0 (15)	13–9 (26)	14–7 (30)	14–3 (37)	13–0 (12)	13–6 (13)	14–2 (14)	13–5 (93)	14–3 (91)	14–5 (98)	47 (185)	48 (190)	43 (105)
5 (C.)	14–2 (18)	15–0 (17)	13–8 (25)	17–0 (37)	13–9 (30)	16–2 (40)	13–6 (13)	14–2 (14)	14–2 (14)	15–7 (80)	14–3 (101)	15–5 (87)	43 (285)	44 (60)	44 (150)
7 (C.)	9–3 (20)	15–4 (23)	18–9 (15)	14–7 (24)	15–9 (31)	16–2 (40)	9–9 (9)	12–0 (18)	13–6 (20)	11–5 (66)	13–7 (75)	15–1 (83)	12 (35)	34 (30)	41 (40)
8 (C.)	8–3 (20)	9–8 (25)	14–6 (23)	17–4 (40)	16–2 (40)	17–4 (40)	13–6 (13)	14–2 (20)	14–2 (16)	15–7 (78)	15–5 (87)	17–4 (81)	40 (150)	47 (75)	35 (140)
11 (F. & C.)	12–0 (20)	10–0 (16)	11–6 (19)	16–6 (40)	15–5 (39)	15–1 (32)	12–5 (16)	13–6 (14)	12–5 (17)	14–5 (75)	14–7 (87)	13–7 (81)	41 (40)	39 (35)	43 (30)
12 (F. & C.)	10–4 (25)	17–0 (16)	16–2 (20)	11–1 (12)	<9–5 (26)	10–7 (21)	9–9 (7)	9–4 (8)	9–9 (9)	10–0 (90)	8–7 (*)	9–9 (*)	29 (45)	29 (45)	26 (30)
13 (F. & C.)	9–8 (18)	9–10 (12)	9–3 (18)	15–1 (40)	15–1 (40)	12–7 (29)	11–5 (20)	12–5 (20)	9–9 (18)	12–9 (73)	12–5 (72)	12–7 (58)	19 (75)	18 (50)	22 (70)
14 (F. & C.)	12–3 (20)	13–8 (18)	16–8 (17)	12–3 (27)	13–5 (40)	12–3 (36)	13–6 (20)	11–5 (20)	13–6 (20)	13–1 (109)	12–1 (85)	13–1 (109)	45 (90)	42 (55)	46 (50)
18 (F. & C.)	13–3 (15)	10–0 (15)	12–0 (14)	16–2 (29)	14–7 (27)	14–7 (40)	11–0 (14)	12–0 (13)	12–0 (11)	13–1 (67)	13–1 (80)	13–1 (80)	32 (50)	21 (75)	37 (90)
21 (F.)	15–4 (22)	14–3 (18)	16–10 (18)	15–1 (24)	9–5 (3)	12–3 (40)	10–5 (19)	9–9 (14)	9–9 (20)	12–1 (68)	9–4 (*)	10–6 (79)	17 (45)	19 (155)	32 (30)

Notes: C. = Crombie operation.
F. & C. = Combined Freeman and Crombie operation.
F. = Freeman operation.

1 = Before operation.
2 = 6 weeks after operation.
3 = 4 months after operation.

* = Unreliable.

Which of these methods will be selected is a question of individual surgical preference, and of secondary importance. The variations in technique are largely the results of an effort to avoid immediate or post-operative haemorrhage. That is the chief danger of this operation; a mortality arising from this cause is not unusual in the various published series. But haemorrhage can be avoided, in the closed methods, if certain simple precautions are taken. The dividing instrument must be blunt, and it must be used in such a way that it does not damage hidden vessels in the depths of the white matter, or those—including the anterior cerebral artery—which are situated upon the inner aspect of the frontal lobe. Cortical

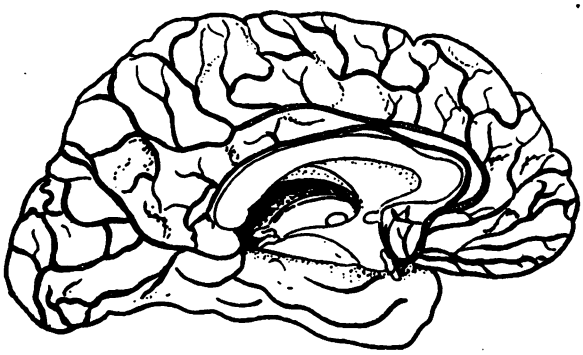


FIG. 2.—The anterior cerebral artery and its branches.

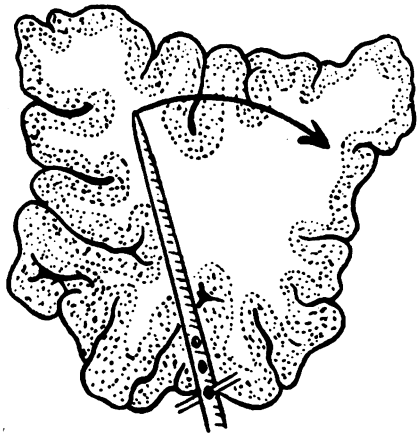


FIG. 3.—Illustrates a source of haemorrhage in frontal leucotomy. A leucotome that is passing safely through the white matter comes in contact with a vessel lying deeply within a sulcus on the inner aspect of the lobe.

vessels in this situation that lie in the depths of a sulcus may be in the line of traverse of a blade that is passing downwards through the white matter from above. The resistance of these vessels can be felt by experienced hands, and when encountered, the blunt instrument should be withdrawn and re-inserted at a slightly lower angle, so as to pass beyond the vessel before the section is completed.

Using this method we have so far operated upon 35 cases without a single post-operative haemorrhage or fatality.

Provided that this precaution is taken, it matters not one iota whether the division is effected by the open or closed method, or what particular instrument is used. Individual surgeons will continue to devise new measures that suit their individual prejudice, but advance will come more largely now from an interpretation of the clinical effect of sections of different amplitude and situation, rather than from the continued improvization of unimportant variations in technique. We lack

sufficient evidence on this point, and it appears to be the duty of the neurosurgeon, at this relatively early stage in the investigations, to produce this evidence; for in a destructive operation such as this, the question that still requires to be established is how little do we need to divide in order to produce the required effect.

In the present series an attempt has been made to establish any significant difference in effect produced by certain of the operations commonly employed, and as between sections fashioned at various planes.

Prefrontal leucotomy may be readily conducted under local anaesthesia, but since our cases have consisted of the most violent, aggressive and dangerous patients in the hospital, general anaesthesia has so far been employed in all without exception. In the first cases of the series we naturally selected the operation which appeared from published accounts to produce the desired effect with the least possible disturbance of tissue. Fibres were therefore divided by the Crombie rotating blade.

Technique.—The anterior half of the head is shaved as far back as a line passing vertically upwards from behind the ear. A spirit dressing is applied to the scalp on the night preceding operation. The patient lies on his back, his chin flexed upon his chest, the head being supported in a rest. A point on the vertex 14 cm. from the nasion indicates the superior extremity of the coronal suture. This point is marked. The situation of the trephine hole is marked upon the scalp by a rectangular template in which a hole has been cut 3 cm. from one edge and 6 cm. from another. This is applied so that it is in contact with the zygoma and outer margin of the orbit. The line of incision, 4 cm. long, extending in the plane of the coronal suture, is then infiltrated with one in a hundred thousand adrenalin in normal saline, injected into the sub-aponeurotic plane. The scalp is divided, the bleeding points secured, and a self-retaining retractor inserted. The temporal muscle is incised in the line of the incision and separated superiorly from the temporal crest, thus exposing the point of juncture of the coronal and temporal sutures. A trephine hole is fashioned with burrs, or hand-trephined, at the required situation bilaterally.

When both are formed, the brain width at this level is measured by a pelvimeter. Commonly, the width is constant at 10·5 cm., each frontal lobe being approximately 5¼ cm. thick. The Crombie leucotome is now adjusted so that the blade shall lie in the centre of the lobe; the stop that prevents too deep a penetration into the brain is set at 4¼ cm. A hollow ventricular needle is now passed into the brain substance and aspirated to ensure that the anterior horn of the ventricle will not be entered. The leucotome is inserted transversely across the head, care being taken that it does not project posteriorly or downwards. It is turned so that the blade will cut into the plane of the coronal suture, and now—either by a screw mechanism or by a wire pull, according to the variations in the individual model—the guarded blade is caused to rotate. The instrument is then withdrawn, but in a small proportion of cases it will be found that it fails to move easily. In these cases a vessel has been caught between the blade and shaft of the instrument and will be torn if any force is employed. If this resistance is encountered, the blade must be set back into its original position, and the instrument will then withdraw freely without haemorrhage.

This operation was performed initially in nine cases, but we noted that in two cases of paraphrenia there was a gradual return of hallucinations and irritability. Although the patient was greatly improved, the final picture was far less favourable than that observed in the immediate post-operative period. It seemed that in the immediate post-operative phase the effects of division of the central core of white matter were accentuated by oedema in the adjacent areas of the brain, and at this time there had been complete relief of all symptoms. As the post-operative oedema absorbed, the hallucinations appeared to return. We therefore considered that a greater section, which divided the fibres further out within the lobe that are not reached by the Crombie blade, might give a more favourable and lasting result. For this purpose we adopted the Freeman technique.

The initial steps of this method are precisely similar to those of the Crombie operation, but after the trephine hole has been fashioned, the opening requires to be enlarged with biting forceps upwards and downwards in the plane of the coronal suture, in order to allow rotation of the leucotome that is now introduced. The dura is opened, surface vessels coagulated or otherwise avoided, and a blunt leucotome inserted strictly transversely. Thus may too deep a penetration be guarded

against by means of a transverse bar that comes in contact with the skull; but with practice it is possible to guide the instrument in safety without this device, which may carry the point too far away from the side of the falx. The handle of the blade is depressed, carrying the point upwards within the lobe in the plane of the coronal suture. When the upper fibres of the lobe have been divided, the handle is raised almost vertically in order completely to transect the lowest fibres of the lobe. To give access to these it is essential that the incisions should have been extended somewhat upwards towards the convexity, to allow the handle to be sufficiently rotated. If any resistance is encountered during this traverse, it should be regarded as due to contact with a vessel, and the blade should be gently withdrawn a sufficient distance to avoid the block and then reinserted and the section continued.

Lately it has been our practice to make the Crombie section first, then complete the division of the peripheral fibres with a blunt leucotome. By this method one feels the arteries in the depths more readily, although the total effect of section is no different from that of the simple Freeman technique.

As a further experiment, we have, in two cases in which it appeared that the very maximum effect was needed, performed sections at a point half to one centimetre further back than the site of election. This posterior section is most harmful and should never be employed. It is attended by loss of initiative and spontaneity, by loss of sphincter control, by retardation and euphoria, and by a peculiar tendency to trophic ulceration of the skin. One patient so treated made a good recovery, but another deteriorated and died three months after operation—the only fatality in the series.

TABLE VI.—*Thirty-one Cases.*

Post-operative change.	Type of operation.			
	Crombie.	Crombie and Freeman.	Freeman.	Freeman posterior.
Improved behaviour	3 (2 temp.)	9	3	1
Improved quality and output	2	7	3	0
Loss of initiative and spontaneity	4	7	1	3
Developed volubility	0	1	2	0
,, perseveration	3	4	1	1
,, emotional facility	3	10	4	2
,, irritability and aggressiveness	2	3	0	0
,, increased appetite	5	7	3	0
,, loss of sphincter control	0	4 (2 temp.)	3 (1 temp.)	2 (1 temp.)
,, retardation	0	4	1	2
,, euphoria	0	2	1	2
,, trophic ulcers	0	0	0	2
Deteriorated and died	0	0	0	1
Abnormal EEG	3 out of 7	7 out of 8		—

When we attempt to evaluate the relative effect of the Crombie and Freeman operations, my impression has been that the results of the Freeman operation are more permanent. No case of temporary improvement has been observed; in fact, improvement following this operation tends to be progressive and to continue over a period of six months or more; but the procedure is more extensive, as evidenced by the occasional occurrence of loss of sphincter control, the occasional development of retardation and euphoria, and the abnormal electroencephalogram that is almost invariably observed (see Table). These features are not seen in the Crombie type of operation.

There is therefore some evidence of quantitative difference in effect, dependent upon the number of fibres that are sectioned. It may well be that we should deliberately select the operation of one or other type, grading our section according to the individual requirements of any given case. Loss of initiative and spontaneity, for example, represent a distinct improvement and a most welcome change in cases of chronic mania, but are features to be avoided in patients of high potentiality. I believe that the Freeman type of operation is the most efficient procedure to employ in cases of long-standing psychosis in whom the maximum effect is

desired; but that the more limited Crombie operation is less likely to produce harmful effects, and that this less serious measure should be employed in all cases of high potentiality, such as obsessional neurosis. Further experience may indicate that by still greater modification and reduction in the extent and situation of the cut—perhaps by confining the section to the lowest fibres of the lobe—it may be possible to remove obsessional symptoms without the least trace of reduction in the normal activities of the frontal lobe.

References.

(1) Roe A., and Shakow, D. (1942) *Ann. N.Y. Acad. Sci.*, **42**, 361.
(2) Freeman, W., and Watts, J. W.—*Psychosurgery.*
(3) Moniz, E. (1936), *Tentative opératoires dans le traitement de certaines psychoses.* Masson, Paris.
(4) Freeman, W., and Watts, J. W. (1937), "Frontal Lobotomy in the Treatment of Mental Disorders," *Southern Med. J.*, **30**, 22.
(5) McGregor, J. S., and Crombie, J. R. (1941), "Surgical Treatment of Mental Diseases," *Lancet.*
(6) Lyerly, J. G. (1939), "Transsection of the Deep Associated Fibres of the Prefrontal Lobes in Certain Mental Disorders," *Southern Surgeon*, **8**, 426–34.