

PREFRONTAL LEUCOTOMY IN SCHIZOPHRENIA WITH REPORT OF 25 CASES

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IN view of the rather discouraging results and relapses with shock therapy with insulin (Sakel, 1934), with cardiazol (Meduna, 1937), with electrical convulsions (Cerletti and Bini), in the treatment of schizophrenia and other allied mental disorders, and in view of the hopeless ultimate prognosis of such cases, more drastic methods seem justified, where other methods of treatment are either unsuitable or have failed. It is from this viewpoint that the operation of *prefrontal leucotomy* first recommended and performed by Moniz in 1936 seems justified, and any improvement in the condition of the patient constitutes a progress in the treatment of mental diseases. The published results of U.S.A. and Great Britain, where the operation is rapidly gaining support, offer a hope of cure where the other accepted methods of treatment are unsuitable or have failed.

This operation was first performed at the Government Mental Hospital, Bangalore City, Mysore State, S. India, on 21st September, 1942, and this paper deals with the technique, experience and results of 25 cases operated on by us till October 1943. A detailed psychiatric analysis of this series is under publication, and this paper deals mainly with the surgical aspects.

Moniz's original technique has been modified by numerous workers, notably by Lyerley (1938), and by Freeman and Watts (1939) who use a lateral approach. The operation is based on the assumption that the frontal lobe is producing a disordered note in the smooth working of the 'intellectual' behaviour of the person, and that by isolating the frontal cortex from the rest of the brain, a 'release' of the other parts of the cerebral hemispheres occurs. This isolation is best attained by cutting the subcortical white matter as it lies in front of the anterior horn of the lateral ventricle. Moniz approached this area by trephine holes from the superior aspect of the skull, crushed the white matter with an expanding wire, and injected alcohol to make sure that most of the white matter had been interrupted. Freeman and Watts in 1939 modified the technique by approaching the frontal lobe from the lateral aspect of the skull; the white matter being severed by a nasal elevator. McGregor and Crumbie (1941) devised an instrument so adjusted as to cut a core of white matter $2\frac{1}{2}$ cm. in diameter.

Lyerley, using a lateral approach similar to that recommended by Freeman and Watts, turned down a flap of bone and exposed the brain. After the introduction of a brain speculum, the white matter is severed under direct vision. This open method is fundamentally sound, and is very attractive to all who hate a blind procedure; it has the disadvantage of being a very formidable operation. The Freeman-Watts technique, as followed by us, is simple and relatively safe. Both our experience and that of others following a similar procedure have indicated no serious disadvantages, and we do not feel justified in submitting our patients to the more severe Lyerley operation with its correspondingly increased risks.

In our series we have used the lateral approach as suggested by Freeman and Watts, and in the first ten cases used a Killian's nasal elevator to cut the white matter; in the later cases we used a modified McGregor and Crumbie leucotome.

Technique

The technique followed by us is practically similar to that recommended by Freeman and Watts. The pre-operative preparation consists of giving an ounce of castor oil as a cathartic on the day previous to the operation, followed by an enema on the morning of the operation. The head is completely shaved in men, but in women, only that portion of the scalp which is anterior to a line joining the two external acoustic meatus over the vortex. Premedication with one capsule of sodium amytal is given if the patients are very apprehensive or very violent. In the more quiet type of patient, no premedication is resorted to.

The patient is laid flat on the table with the head slightly raised on a pillow.

Anæsthesia.—Whilst many American workers have used local anæsthesia, we find it difficult to use local anæsthesia alone, especially in the agitated and violent type of patient. Various rectal and intravenous narcotics have been used in Great Britain and Europe, but our choice has been pure chloroform given by the open method both for induction and maintenance. We have noticed no ill-effects from this agent, provided that ordinary precautions are taken, and all the cases in this series have been operated upon under open chloroform anæsthesia.

After sterilizing the skin with tincture of iodine, towels are draped, and a point 3 cm. behind the curving lateral orbital margin and 5 cm. above the zygoma is marked on the skin. Lately, however, we have found that a point $2\frac{1}{2}$ cm. behind the anterior orbital margin and $5\frac{1}{2}$ cm. above the zygoma is more suitable, as with the measurements recommended by Freeman and Watts, we often found ourselves confronted with the anterior branch of the middle meningeal artery at the site of the trephine or burr hole. To facilitate easy measurements of the desired point, a localizing

plate (shown in figure 2) is used. The opening in the plate is situated 3 cm. from one edge and 5 cm. from the other edge. The shorter side lies on the zygoma and the longer against the orbital margin, and the hole corresponds to the site of the burr hole. After the point on the skin has been marked, an incision is made 4 cm. long, equally placed above and below the point, in the direction of the fibres of the temporalis muscle. The incision is entirely within the hair margin. The incision is deepened to the bone and, with a rugine, the muscle and the temporalis fascia covering it are detached from the bone and retracted firmly with a self-retaining mastoid retractor to give a wide exposure and a bloodless field. The coronal suture can occasionally be seen, but in our experience it is not often possible to identify the suture at this point, and consequently it is of little help. Where the suture could be identified, the burr hole was always placed anterior to it.

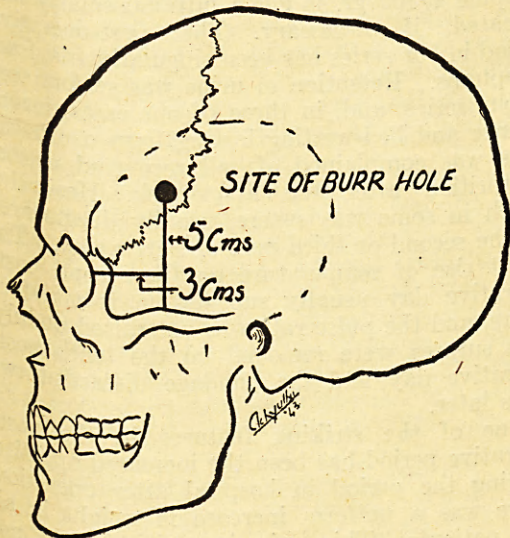


Fig. 1.—Showing site of burr hole.

In our first 9 cases, a trephine opening 2 cm. in diameter was made (the disc being replaced at the end of the operation), but in the later cases, a burr hole $\frac{3}{4}$ cm. in diameter was made with a Carr's burr. The bleeding from the diploë of the skull is stopped with cotton pledgets soaked in warm saline or in Horsley's wax. A similar opening is made on the opposite side. The head is now steadied, with the face looking vertically upwards towards the ceiling. The width of the brain from one dura to the opposite side is measured with a caliper. We have found very little variation in the width, the maximum in our series being 11.5 cm., the minimum 9.5 cm. and the average has been $10\frac{3}{4}$ cm. From this, the width of the white matter is estimated, and the stop on the instrument is arranged so as to adjust the depth to which the instrument is to be introduced without injuring the grey matter on the medial surface of the prefrontal cortex.

An avascular area of the dura is chosen, and a triradiate incision is made with a Von Grafe cataract knife after lifting the dura from the underlying brain with a dural hook, and the subarachnoid space is opened. A small quantity of cerebrospinal fluid usually escapes, though in some cases as much as 3 ounces of fluid was lost on each side. (This is of no consequence.) A needle with a stilette is introduced to the calculated depth in the direction of the opposite trephine opening, the stilette is withdrawn, and suction is applied with a syringe so as to make sure that the needle has not entered the anterior horn of the lateral ventricle. If cerebrospinal fluid is aspirated, the needle is withdrawn and reintroduced in a slightly more anterior direction; if no fluid is encountered, a Killian's blunt nasal elevator is introduced alongside the needle, to the calculated depth, and the needle is withdrawn. The elevator is now moved through an arc of 60° with the dura as the centre of the arc, and in the plane of the coronal suture. The elevator is withdrawn, and it is surprising how little bleeding follows this procedure. The slight amount of bleeding that usually occurs is easily controlled with warm saline irrigation.

A wet saline gauze pack is left in the wound, while the same procedure is repeated on the opposite side. The dura is difficult to suture on account of the small size of the burr hole, and is left unsutured; this is of no disadvantage. The wound is closed in layers without drainage.

This technique recommended by Freeman and Watts was followed by us in the first ten cases. In the later cases, the severing of the white matter was done with a modified McArthur and Crumbie leucotome.

This instrument consists of a rotating blade controlled by a screw device. Combined with it the instrument is made hollow so that suction can be applied to make sure that the instrument has not entered the anterior horn of the lateral ventricle, thereby dispensing with the passing of a needle to test the extent of the anterior horn of the lateral ventricle and so combining both manœuvres of testing and cutting in one.

We have found no difference either in the amount of hæmorrhage or in the after results by the different methods. The use of the McArthur and Crumbie leucotome simplifies the procedure. The instrument has an adjustable stop so as to control the depth to which the instrument could be introduced after estimating the width of the white matter so that the medial surface of the prefrontal cortex is not damaged. In our experience, the mark 4 on the leucotome usually answers the purpose well in most cases. The blade cuts a core $2\frac{1}{2}$ cm. in diameter, and the instrument is introduced in the same manner as the nasal elevator described above, the stop abutting against the dura, and the plane of movement of the blade corresponding to the plane of the coronal suture.

After the wound has been sutured in layers without drainage, the wound is dressed and

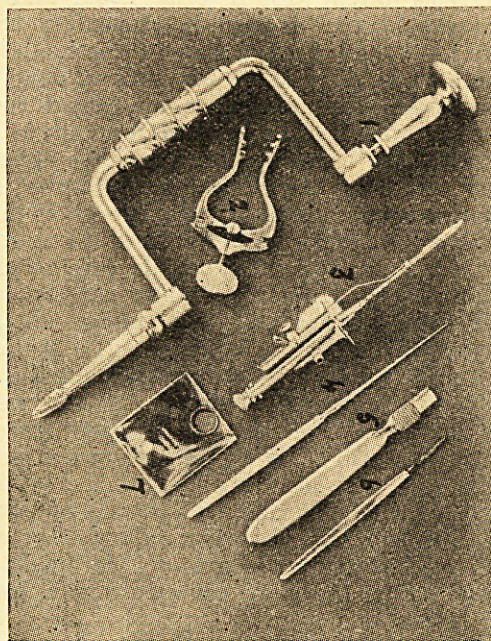


Fig. 2.—Showing the special instruments used.—

1. Burr.
2. Retractor.
3. Leucotome.
4. Dural hook.
5. Rugine.
6. Cataract knife.
7. Localizing plate.

bandaged, and the patient is returned to the wards. After he has regained consciousness, he is supported in bed with a back rest, and fluids are given freely by mouth.

Certain changes in the condition of the patient are noted as the white matter is cut with the leucotome. When the blade is rotated nearly completely, the respiration, which has been up to now regular, suddenly becomes irregular both in rhythm and depth. Often short gasps are followed by a long sighing type of respiration. In some, the respiration has become very shallow and occasionally stopped. These disturbances of respiration occur suddenly as most of the fibres of the frontal lobe are cut. Where respiration has failed, artificial respiration for a few minutes has always brought the respiration back to normal rhythm and depth. Sectioning the white matter on the opposite side has produced a second similar disturbance, but usually less marked.

Simultaneously with the respiratory disturbances, the pulse becomes irregular, for a few beats and sometimes becomes thready and imperceptible. In no case of our series has the heart completely stopped beating, and the cardiovascular changes are very transient and are probably secondary to the respiratory

embarrassment; they recover earlier than the respiratory changes.

The sudden change when the white matter is sectioned in a patient whose breathing is regular, and a similar change seen, when the opposite prefrontal white matter is cut, strongly suggest that some controlling influence from the prefrontal cortex to the respiratory centre either directly or through the medium of other centres has been suddenly interrupted, thereby throwing the respiratory centre 'out of gear' momentarily. During the period of readjustment, the respirations become irregular. The cardiovascular irregularity is probably caused by an irregular overflow of impulses from the respiratory to the cardiovascular centre in the neighbourhood.

Little or no post-operative attention is necessary. Patients are seldom restless but some are drowsy. Where they tend to be restless, or complain of severe headache, morphia $\frac{1}{4}$ gr. with atropine $\frac{1}{100}$ gr. is given intramuscularly and repeated if necessary. The post-operative period in our series has been singularly free from symptoms. Retention of urine was seldom seen in our series, and, in three of our cases, incontinence and bed-wetting lasting from one to six days was complained of; all recovered normal micturition after the first week. Headache, which in some was severe, usually disappeared by the second or third post-operative day. The slight rise of temperature on the second post-operative day usually subsides in twenty-four hours, and the pulse rate was not raised unduly. The sutures were removed on the tenth post-operative day and the bandage discarded two days later.

One of the striking features in the post-operative period has been the increased appetite. During the period in hospital after operation, there was a uniform increase in weight in all the patients. This gain in weight could not have been ascribed to any special diet, rest, or nursing, as such increase was not observed after cardiazol or insulin shock therapy, even though in the post-shock therapy period, the care of the patients, diet and nursing were practically the same as during the post-operative period. On the psychological side, in many, if not all, there is a profound change, even from the day of the operation. Patients who were violent are subdued, the bellicose are more modest; they have lost their hallucinations, take a more intelligent interest in the surroundings and in conversation, the voices that used to talk to them are no longer heard, and the patients appeared to be calm and placid. This improvement has been progressive and maintained.

Rationale of operation

Moniz, in discussing the theory which led him to propose prefrontal leucotomy, considers that in normal people functional connections between the cortical cells are variable, giving various combinations of groupings. In certain mental

disorders, these groupings become fixed instead of being variable, and give rise to obsessions and delusions. He argued that, if these pathways are disconnected, the obsessions and delusions would disappear.

Experimental evidence on chimpanzees has shown that the removal of the frontal areas gives rise to some form of deficiency that has been termed 'intellectual'. Extirpation of the frontal lobe either as a result of accident (American crowbar case) or by deliberate surgery (Brickner's 1939 and Ackerley's 1935 cases) has shown slowness, deliberate activity, perseverance and freedom from anxiety on the part of the patient after the extirpation. Bianchi concluded that prefrontal lobe damage in monkeys tends to disaggregate the personality, and incapacitate the serializing and synthesizing groups of representations. Franz summarized the deficits in cats and monkeys in terms of deterioration of recently formed habits.

To quote Moniz: 'the idea was to operate upon the brains of patients, not directly upon the cell groups of the cortex or of other regions, but rather by interrupting the connecting fibres between the cells of the prefrontal area and other regions, that is to say, by sectioning the subcortical white matter'.

The frontal lobes form the latest stage in the evolution of the brain, but no definite conclusions as to their function have been arrived at so far. With refinement and specialization of the motor functions, the frontal lobes have attained a large size in anthropoids and a truly extraordinary size in man, in whom associational processes (figure 3) have reached a higher level. The superior longitudinal fasciculus is a bundle of great importance highly developed in the human brain.

Observations made of patients before and after frontal lobectomy by Ackerley for a tumor of the frontal lobe, and by Brickner (1939) who has performed it bilaterally, have suggested that the frontal lobe had a synthesizing function and enables us to become aware of an increasing number of simultaneous impressions. After removal of the frontal lobe, to quote Ackerley, 'we cannot but be impressed with the effortlessness with which the person is living'. According to Freeman and Watts (1939) the essential part of the prefrontal leucotomy is the division of connections between the frontal lobes and the thalamus.

Complications

Various complications of the operation have been mentioned by different authors. Many of these are transient, but some are of a permanent character. In our series, we have met with no serious complications, and none of a permanent

character. Hæmorrhage either at operation or soon after, is one of the most serious, and has been responsible for the majority of fatalities of the operation. Incontinence of urine, particularly bed-wetting during sleep, is fairly common, but most patients recover normal control in a few months. Various ocular changes have been mentioned. They include sluggish pupils, anisocoria, Argyll-Robertson pupils, myosis, ptosis, nystagmus, etc. We have noticed no such pupillary changes in our series. Somnolence for one to two days, mild pyrexia lasting four to five days are some of the mild post-operative phenomena observed. More severe, and producing mental deterioration, are epileptic convulsions, restlessness and violence, trismus and fibrillary contractions of the platysma and masseter muscles. These are of grave import and probably terminate fatally. Various degrees of residual paralysis, from aphasia to monoplegia and hemiplegia and sphincter disturbances associated with diarrhoea, have been reported in the literature. Though a formidable list of complications has been given, it is our impression that, excepting hæmorrhage, the other complications are either trivial or transient, and that the more serious ones are seldom seen; but no definite conclusion can be drawn from such a short series regarding the incidence of the various complications.

The hæmorrhage usually arises either from the main trunk of the anterior cerebral artery on the medial surface of the brain, or from one of its branches lodging in the sulci of the grey matter. The accompanying diagrams (figures 4 and 5) illustrate the source of hæmorrhage from a vessel lying deeply within a sulcus on the

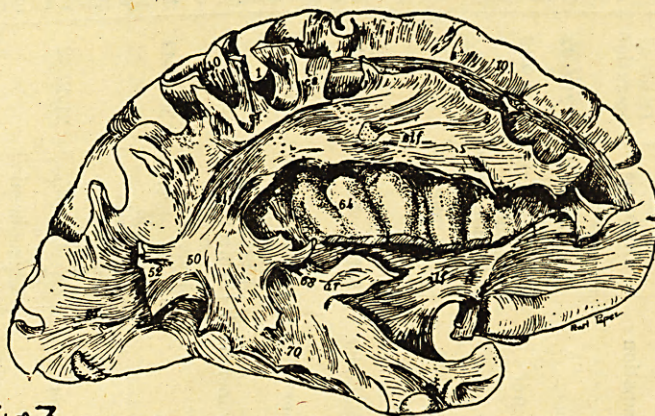


Fig 3. Association bundles in the human brain, x 4. slf, superior longitudinal fasciculus; ilf, inferior longitudinal fasciculus; or, optic radiations; ar, auditory radiations.

(From "Comparative Neurology" by Papez.)

inner aspect of the frontal lobe, when the blade is rotated, and from the anterior cerebral artery on the medial surface of the brain.

The accompanying table shows the type of cases operated on and their clinical and post-operative histories.

TABLE

| Case | Sex | Age | Occupation | Diagnosis | Date of operation | Mental state before leucotomy | Previous treatment | Results of operation |
|------|-----|-----|------------------------|--|-------------------|---|---|--|
| 1 | M. | 27 | Farmer | Schizophrenia 7 years. | 21-9-42 | Noisy, violent, destructive with auditory hallucinations. | Cardiazol in 1940 with no effect. | Well behaved, quiet, recovered. |
| 2 | M. | 30 | Labourer | Schizophrenia paranoid duration more than 6 years. | 23-9-42 | Violent, boisterous, destructive with offensive habits. Auditory and visual hallucinations and disconnections. | Ammonium chloride and cardiazol with no benefit. | Easily manageable, quiet, but his delusions and disconnections persist. |
| 3 | M. | 35 | Cook | Schizophrenia 5 years. | 11-10-42 | Morbidly preoccupied, dull and depressed with spells of acute excitement. | Ammonium chloride and cardiazol without benefit. | Became bright and cheerful immediately after operation. Is able to attend to work where no special skill is required. |
| 4 | M. | 34 | Compounder | Schizophrenia | 12-10-42 | Hallucinations, delusions and disconnections with marked deterioration and vagrancy. | Ammonium chloride in 1941. Without benefit. | No improvement. |
| 5 | M. | 30 | Farmer | Schizophrenia paranoid 5 years. | 15-11-42 | Violent, boisterous with disconnections, automatisms, offensive habits and signs of deterioration. | <i>Nil</i> | No improvement. |
| 6 | M. | 35 | Petty merchant | Schizophrenia paranoid 4 years. | 16-11-42 | Mischievous and fixed delusions of grandeur. | <i>Nil</i> | Is quiet and manageable. |
| 7 | M. | 35 | Clerk | Schizophrenia paranoid (dementia præcox) 7 years. | 30-12-42 | Poor heredity. Brothers schizophrenics. Hallucinations, auditory visual delusions of grandeur and persecution, disconnections, automatisms. | Cardiazol and ammonium chloride in 1941 without benefit. | Is passive, has no initiative, is clean and obeys instructions mechanically. |
| 8 | M. | 30 | Labourer | Affective disorder c Schizophrenia features 5 years. | 31-12-42 | Poor heredity. Father psychotic. Patient violent, boisterous, offensive habits, auditory hallucinations with delusions of grandeur with spells of blankness and depression. | Ammonium chloride and insulin. No benefit. | Not violent, and is manageable. |
| 9 | M. | 32 | Clerk | Schizophrenia paranoid 7 years. | 28-1-43 | Bad heredity. Two sisters schizophrenics. Disconnected, filthy, deteriorated with meaningless laughter and excitement. | Cardiazol. No benefit. | Died of broncho-pneumonia on 2-3-43 after a perfectly normal convalescence. |
| 10 | M. | 26 | Cook | Schizophrenia paranoid 3 years. | 29-1-43 | Depressed, morbidity preoccupied, auditory and visual hallucinations, with spells of excitement, fleeting delusions. | Cardiazol and ammonium chloride without benefit. | Improvement almost immediately after operation. Worked in the hospital kitchen. Discharged, recovered on 7-8-43. |
| 11 | M. | .. | Clerk | Schizophrenia paranoid 6 years. | 26-2-43 | Disconnected meaningless talk, garrulity, delusions of grandeur, auditory hallucinations with signs of deterioration. | Cardiazol without benefit. | Overproductive and disconnected in talk, but otherwise harmless. |
| 12 | M. | 24 | Student (high school). | Schizophrenia paranoid 3 years. | 25-3-43 | Violent, assaultive, dirty in habits, delusions of persecution. Homicidal assaults. Visual and auditory hallucinations. | Ammonium chloride, insulin and cardiazol without benefit. | Consciousness clear and well oriented. Lost all initiative. General deterioration of intelligence. |
| 13 | F. | 25 | Housewife | Schizophrenia catatonic 3 years. | 26-3-43 | Morbid preoccupations, violent, meaningless excitement, offensive habits. Catatonic episodes. | Cardiazol and insulin without benefit. | Recovery spectacular from third day of operation. Improvement maintained. Looking after children and efficiently managing a difficult household. |

| | | | | | | | | |
|----|----|----|-----------------|------------------------------------|----------|--|--|--|
| 14 | F. | 30 | Housewife | 6 years. | 26-3-43 | Poor heredity. Mother and brother are manic depressives. Deteriorated. | Shock therapy of no benefit. | No improvement. |
| 15 | M. | 30 | Schoolmaster | Schizophrenia paranoid 3 years. | 22-5-43 | Overproductive disconnected talk, theatrical and grandiose behaviour with delusions of grandeur and spells of meaningless excitement. | Cardiazol without benefit. | Well behaved, talks sensibly, but still slightly overproductive. |
| 16 | F. | 33 | Housewife | Schizophrenia paranoid. | 23-5-43 | Intelligent, restless, noisy, disconnected and deteriorated. | Cardiazol and insulin without benefit. | Dull and depressed, is morbidly occupied and has lost all initiative. |
| 17 | F. | 30 | Housewife | Schizophrenia over 6 years. | 23-5-43 | Poor heredity. Father manic depressive, mother backward. Acute schizophrenic episodes all after child birth. Ligature of fallopian tubes 2 years ago. | Cardiazol with some improvement. It was followed by a breakdown. | No improvement, remains dull and depressed. |
| 18 | F. | 25 | Agriculturist | Schizophrenia simple 5 years. | 19-6-43 | Illiterate, dull and dazed, dirty habits, automatisms, childish behaviour with spells of meaningless excitement. | Ammonium chloride and cardiazol without benefit. | Quiet and co-operative. Reported to be attending to her household tasks without difficulty. Recovered. |
| 19 | M. | 32 | Student | Schizophrenia paranoid 7 years. | 21-6-43 | Restless, offensive habits, automatisms, with delusions of persecutions and spells of excitement. | Cardiazol without benefit. | Quiet, clean and inoffensive. Talks generally, rationally, but at times silly and childish. |
| 20 | M. | 35 | Engineer | Schizophrenia 4 years. | 21-6-43 | Restless, noisy, assaultive with delusions of grandeur and disconnections. | Ammonium chloride, cardiazol and insulin without benefit. | Quiet, well behaved, rational in ordinary conversation, grandiose ideas have disappeared. |
| 21 | F. | 31 | Housewife | Schizophrenia paranoid 4 years. | 23-7-43 | Honours graduate. Very intelligent. Restless, exhibitionist and theatrical with delusions of grandeur and fits of meaningless excitement. | Insulin and cardiazol without benefit. | Well behaved. Has gone back to her ordinary social and household duties. |
| 22 | M. | 28 | College student | Schizophrenia 6 years. | 24-7-43 | Restless and interfering. Fleeting delusions of grandeur and meaningless excitement. History of homicidal assaults against his wife and his father. | Ammonium chloride, insulin and cardiazol without benefit. | Pleasant, well behaved, and no fits of violence. Still under observation. |
| 23 | M. | 28 | Engineer | ? 3 years. | 17-9-43 | Asthenic, anxious, agitated with spells of acute panicky excitement, ideas of persecution and self-reproach, agitated depression. | Insulin and cardiazol without benefit. | Quiet, well behaved and seems to have recovered from his psychotic episode. |
| 24 | M. | 34 | Farmer | Schizophrenia simplex 6 years. | 18-9-43 | Restless, shouting and singing to himself, never violent or assaultive, fleeting delusions of grandeur, disconnections prominent. | .. | Friendly and co-operative. Works hard in the hospital kitchen. |
| 25 | M. | 22 | Student | Schizophrenia 3 years. | 22-10-43 | Poor heredity. Present attack is the third of three acute schizophrenic episodes characterized by intense restlessness, hilarity excitement e vandalism, auditory and visual hallucinations. | Insulin and cardiazol without benefit. | Spectacular improvement almost immediately after the operation. |

Mortality

One of the encouraging features of the published literature is the low mortality associated with this operation. Freeman in 31 cases

trolling hæmorrhage after leucotomy with the McGregor and Crumbie leucotome. No comparative figures of mortality in Indian patients could be obtained, as we are not aware of any

Summary of results

| Men | Women | Total number | Recovered | Improved | No change | Deteriorated | Mortality |
|-----|-------|--------------|-----------|----------|-----------|--------------|-----------|
| 19 | 6 | 25 | 7 | 6 | 10 | 2 | Nil |

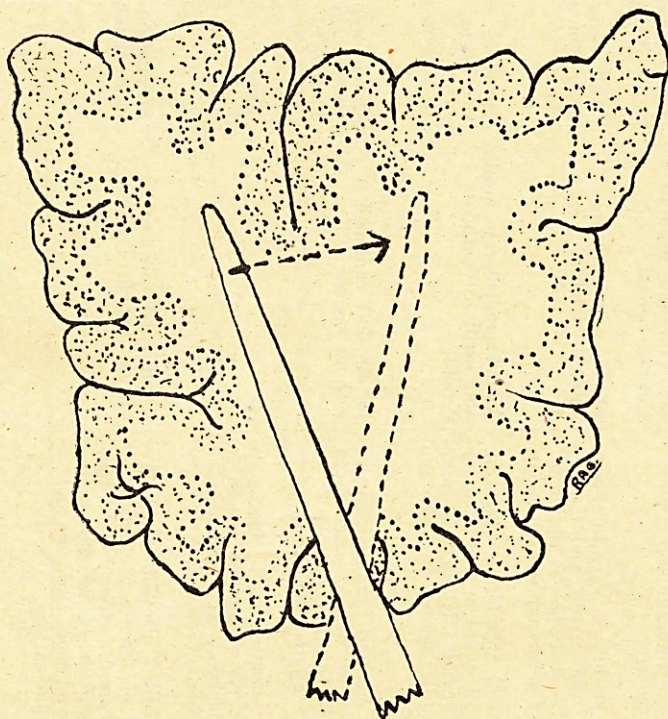


Fig. 4.—Showing the source of hæmorrhage from a vessel lying deeply in a sulcus.

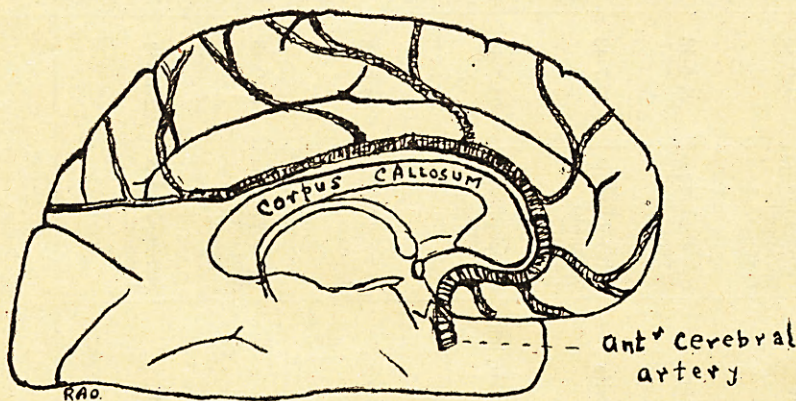


Fig. 5.—Diagrammatic representation of the anterior cerebral artery with branches.

had 3 deaths; Rizatti and Borgarello had no deaths in a series of 185 cases; Dax and Smith (1943) had 2 deaths in 50 cases. Most of the cases have died within three to four days of the operation, due to hæmorrhage. We have had no mortality so far in our series of 25 cases, although in three cases we had an anxious time in con-

published reports of similar work from any source in India.

We have classified those patients who are able to adjust themselves to their home surroundings, carry on their normal work as efficiently as could be expected of them, as 'recovered'; as 'improved' those who are friendly and co-operative, clean in their habits and able to look after themselves. In the two deteriorated cases it is difficult to state whether the operation had anything to do with the deterioration, or whether they would have deteriorated in any case. In this series the longest duration has been seven years and the shortest three years; this should only be taken as approximate, for in many cases the history is unreliable, or the patients and relatives might not have noticed slight symptoms of longer duration. In all these cases, however, the period of observation is too short to assess accurately the final results of the operation.

Selection of cases

All the cases in our series, consisting of 19 men and 6 women, were physically good operative risks, the youngest being 22 years and the oldest 35 years of age. In many of these cases, shock therapy had failed to give any relief. All of them had been ill for several years, and the majority of them were schizophrenics; in a few, schizophrenic syndromes had been superimposed on a primarily affective disorder. We have as yet formed no definite conclusions as to the most suitable type of case for leucotomy, but we feel that the chances of recovery are greater in the more 'intellectual' type of patient, though statistical proof for this is lacking.

When to operate on a patient is still a moot point. Although favourable results have been reported in cases of five to twelve years' duration, the general feeling has been tending towards earlier surgical treatment. We do not feel justified in dogmatizing as to the time most suitable for operation, in view of the fact that

at best, it is an operation of mutilation, in which a portion of the brain is completely isolated functionally from the rest of the brain. But in view of the progressive deterioration of the patient, it seems that the operation is justified when other less radical methods have been given a reasonable trial and found to have failed. When once it has been decided that other methods of treatment have failed, we feel strongly that earlier operation has undoubtedly a much better chance of success. We believe that prefrontal leucotomy is indicated when the mental disorder has failed to respond to other methods of treatment, and where the prospects of spontaneous recovery are remote.

Conclusions

The encouraging results obtained in a short series of 25 cases with a poor prognosis make us hopeful of this useful method of treatment. While no theoretical support can be brought forward yet to justify the rationale of the operation, the favourable results obtained by us in India and by others abroad justify further investigations of the functions of the frontal lobe, and of methods of obtaining better insight into the pathological processes and the biochemical changes in these mental disorders. Numerous criticisms of this operation have been made, some on humanitarian grounds and some on the grounds that a more serious disorder has been inflicted on the patient than he is already suffering from. The modern concept of brain physiology and function is essentially dynamic, and we might agree with Golla (1943) that 'one need not be nervous in undertaking this procedure for fear of producing permanent mutilations in the brain'.

Summary

- (1) Bilateral prefrontal leucotomy has been performed on 25 patients at the Government Mental Hospital, Bangalore, Mysore State.
- (2) The technique followed by us is described.
- (3) Short case reports and results are tabulated.
- (4) The theoretical aspects of the operation and the justification of the operation are discussed.

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REFERENCES

- ACKERLEY, S. (1935) .. *Amer. J. Psychiat.*, **92**, 717.
 BRICKNER, R. M. (1939). *Arch. Neurol. and Psychiat.*, **41**, 580.
 DAX, E. C., and SMITH, J. *Mental Sci.*, **89**, 182.
 E. J. R. (1943).

- FREEMAN, W., and WATTS, J. W. (1939). *Yale J. Biol. and Med.*, **11**, 527.
 GOLLA, F. L. (1943) .. *J. Mental Sci.*, **89**, 189.
 LYERLEY, J. G. (1938) .. *J. Florida Med. Assoc.*, **25**, 203.
 MCGREGOR, J. S., and CRUMBIE, J. R. (1941). *Lancet*, *ii*, 7.
 MEDUNA, L. (1937) .. *Die Konvulsionstherapie der schizophrenie*. Halle.
 MONIZ, E. (1936) .. *Tentatives opératoires dans le traitement de certaines psychoses*. Paris.
 SAKEL, M. (1934) .. *Wiener med. Woch.*, **84**, 1211, 1265, 1299, 1326, 1353, 1383, 1401.

BIBLIOGRAPHY

- FLEMING, G. W. T. H., and MCKISSOCK, W. (1943). *Lancet*, *i*, 361.
 GOVINDASWAMY, M. V. (1939). *Ibid.*, *i*, 506.
 GRAY, H. (1929) .. *Textbook of Anatomy*. Longmans, Green & Co., London.
 HEBB, D. O., and PENFIELD, W. (1940). *Arch. Neurol. and Psychiat.*, **44**, 421.
 HUTTON, E. L. (1943) .. *Lancet*, *i*, 362.
 HUTTON, E. L., FLEMING, G. W. T. H., and FOX, F. E. (1941). *Ibid.*, *ii*, 3.
 JEFFERSON, G. (1937) .. *Proc. Roy. Soc. Med.*, **30**, 851.
 MCGREGOR, J. S., and CRUMBIE, J. R. (1942). *Lancet*, *i*, 654.
 MCKISSOCK, W. (1943). *J. Mental Sci.*, **89**, 194.
 NICHOLS, I. C., and HUNT, J. M. (1940). *Amer. J. Psychol.*, **96**, 1063.
 O'BRIEN, J. D. (1936). *J. Amer. Med. Assoc.*, **107**, 657.
 PAPEZ, J. W. (1929) .. *Comparative Neurology*. T. Y. Crowell Co., New York.
 PAVLOV, I. P. (1927) .. *Conditioned Reflexes*. Oxford University Press, London.
 REES, T. P. (1943) .. *J. Mental Sci.*, **89**, 161.
 SHEPLEY, W. H., and MCGREGOR, J. S. (1940). *Proc. Roy. Soc. Med.*, **33**, 267.
 STRECKER, E. A., PALMER, H. D., and GRANT, F. C. (1942). *Amer. J. Psychol.*, **98**, 524.
 STRÖM-OLSEN, R., LAST, S. L., BRODY, M. B., and KNIGHT, G. C. (1943). *J. Mental Sci.*, **89**, 165.
 WILLWAY, F. W. (1943). *Ibid.*, **89**, 192.
 WOLTMAN, H. W., SMITH, B. F., MOERSCH, F. P., and LOVE, J. G. (1941). *Proc. Staff Meet. Mayo Clinic*, **16**, 200.