cerebral palsy or mongolism were blind with retrolental fibroplasia.

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LOCATION OF STEREOTACTIC LESIONS CONFIRMED AT NECROPSY

BY

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[WITH SPECIAL PLATE]

Owing to the generous co-operation of neurosurgeons and pathologists in seven different neurosurgical units, material from the central nervous system of 15 patients who had had stereotactic operations has been received.

This paper is concerned with the gross location of the lesion made in the brains of patients who had undergone stereotactic operations. It is the first of a series of papers reporting the results of anatomopathological studies based on this and similar material.

Material and Methods

The entire brain from 13 patients and part of the brain from two patients were available for examination. Thirteen patients had Parkinson's disease, one had Huntington's chorea, and one had severe hemichorea. In 10 patients (11 operations) the target for the lesion was the globus pallidus, and in five patients the thalamus. The lesions were produced by the injection of chemicals or by heat. The various methods and the number of patients treated by each method are shown in Table I.

TABLE I.—Methods of Making Lesions: 15 Patients (16 Sides)

Chemical Coagulation				Thermo-coagulation
Injection of Absolute Alcohol	Injection of Absolute Alcohol after Dilatation of Balloon (Cooper's Method)	Injection of Etopalin (Ethyl Cellulose, "Pantopaque," and Absolute Alcohol)	Injection of Etopalin Thickened with Kaolin	Diathermy (Leksell's Method)
4 patients (5 sides): Cases 4R and L, 5, 7, 11	3 patients: Cases 2, 6, 10	1 patient: Case 12	3 patients: Cases 3, 8, 9	4 patients: Cases 1, 13, 14, 15

TABLE II.—Four Patients in Whom Death was Not Due to Operation

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
2	M 57	Idiopathic Parkinsonism	Right	Cellulitis of face, paraphimosis, septicaemia, pneumonia	25 days
4*	M 34	Post-encephalitic Parkinsonism	Left	Decerebrate state following second stereotactic operation	12 months after first operation; 8 months after second operation
6	F 60	Idiopathic Parkinsonism	Right	Suicide	6 months
15	F 53	Idiopathic Parkinsonism	Left	Cardiac failure	10 months

* This patient is also included in Table IV.

The cause of death is obviously of great importance when considering the location of the stereotactic lesion, for we want to know whether it can be taken as representative of the lesions made in the brains of other patients who have not yet died. If the operation causes the death of the patient, there is a strong likelihood that the lesion is in some way different from those in other patients who did not die. On the basis of

TABLE III.—Six Patients in Whom Death was Indirectly Due to Operation

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
9	F 56	Idiopathic Parkinsonism	Left	Pulmonary embolism	8 days
12	M 48	? Parkinsonism	"	Pulmonary embolism	11 days
14	M 51	Idiopathic Parkinsonism	"	Pulmonary embolism; pyelonephritis; cystitis	2½ months
10	F 40	Huntington's chorea	Right	Basal meningitis; pneumonia	15 days
1	M 67	Parkinsonism after typhoid	"	Poor post-operative state—cachexia; pneumonia	3 months
13	M 55	Idiopathic Parkinsonism	"	Acute pulmonary oedema	12 hours

TABLE IV.—Six Patients in Whom Death was Directly Due to Operation

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
5	F 65	Idiopathic Parkinsonism	Right	Never recovered from injections of procaine into second globus pallidus. Pneumonia	20 days, after first injection
11	F 69	Uncontrollable hemichorea	"	Never recovered from operation; pneumonia	4 days
8	M 43	Post-encephalitic Parkinsonism	"	Hemiballismus; exhaustion	11 days
3	M 68	"	Left	Severe hemiparesis; pseudo-bulbar palsy	4½ months
4*	M 34	"	Right	Intracerebral haemorrhage occurring at operation; decerebrate state following operation	8 months
7	M 49	Parkinsonism	Left	Intracerebral haemorrhage following operation	7 days

* This case is also included in Table II.

the cause of death the patients have been divided into three groups: (1) those in whom death was unconnected with the operation; (2) those in whom death occurred as a direct result of the operation; and (3) those in whom death occurred as a result of having had an operation, but who might equally well have died from the same cause after some other kind of operation. The selection of patients for this last group is, however, rather arbitrary, for in some instances it is not easy to determine whether or not some particular feature of the stereotactic operation might have been a factor in the post-operative history. The cause of death is given in the patients in the three groups in Tables II, III, and IV, which include also the patients' sex, age, disease, and the period of survival after the operation.

In 11 cases the formalin-fixed brain was sliced in the coronal plane, and in four cases in the horizontal plane, parallel to the optic tract. Many blocks from the basal ganglia and all relevant regions of the brain are being prepared and stained by a wide variety of methods.

Results and Observations

The brief clinical notes given here have been abstracted from the observations made by the neurosurgeon and/or neurologist concerned with each patient. As the purpose of the present paper is the presentation of the macroscopic findings in the first 15 brains examined, the structures involved in the lesion to only a very slight extent will not be enumerated.

The actual location of the lesions will be first described, and then the lesion will be considered in relation to the clinical result of the operation and to the cause of death.

The maximum extent of the lesion is shown diagrammatically in Text Figs. 1-3, and photographs of the actual lesions in representative cases are shown in Special Plate, Figs. 1-5. For ease of comparison the lesions are all shown in the coronal plane in Text Figs. 1-3, though in four cases the brain was sliced in the horizontal plane. Also, all the lesions are shown as if they were on the right side, whereas seven were in fact on the left. Tables V and VI summarize the degree of involvement of principal structures in the brain.

Location of Lesions

Target: Globus Pallidus (Text Figs. 1 and 2; Special Plate, Figs. 1-3; Table V)

In 11 operations (10 patients) the target was the globus pallidus. In two cases there was extensive intracerebral haemorrhage; in Case 4 (R) (Text Fig. 2) this occurred at operation, and in Case 7 (Text Fig. 2) it occurred the following day. In these two cases the precise localization of the stereotactic lesion is impossible to define, and accordingly these two cases will not be discussed.

In one case (Case 4 (L), Text Fig. 1; Special Plate, Fig. 1) the lesion is almost entirely limited to the ansa lenticularis, where it leaves the globus pallidus to pass round the anterior aspect of the posterior limb of the internal capsule. There is minimal damage to the globus pallidus and putamen. In another case (Case 15, Text Fig. 1; Special Plate, Fig. 2) the lesion is confined to the globus pallidus. In all the other cases the lesion involves the globus pallidus to some extent, but also spreads into neighbouring structures. The internal capsule is most commonly involved, some damage having occurred in all seven remaining cases, being

Fig. 1.—Diagrams showing site of lesion at level of its maximum extent in each case. Operative target: globus pallidus.

trivial in only one (Case 5, Text Fig. 2). In several of the cases the lesion is mainly capsular (Cases 1, 2, 3, and 6), with a variable degree of involvement of neighbouring structures. In Case 1 there are two lesions; the larger medial lesion is in the capsule, extending slightly into the thalamus, and the small lateral lesion is in the putamen and globus pallidus. In Case 2 (Text Fig. 1; Special Plate, Fig. 3) the lesion includes the lateral border of the thalamus and medial border of the globus pallidus; in Case 6 (Text Fig. 1) the lesion extends farther into both the thalamus and the globus pallidus, and includes the upper half of the subthalamic nucleus and adjoining zona incerta. In Case 3 (Text Fig. 2) the capsular lesion passes farther caudally and posteriorly than in any other case, extending to the level of the geniculate bodies. The lesion includes the medial border of the globus pallidus and putamen, and a small part of the upper poles of the zona incerta and

subthalamic nucleus. In Case 13 (Text Fig. 1) the main lesion is in the thalamus, the zona incerta, and the subthalamic nucleus. The adjoining medial part of the internal capsule is involved. Farther anteriorly this lesion, much reduced in size, extends into the globus pallidus, and there is a small lesion in the lateral part of the globus pallidus. In Case 14 (Text Fig. 1) the capsule and the globus pallidus are equally involved, with slight extension into the thalamus and putamen.

As noted earlier, the degree of involvement of the capsule is least in Case 5. Here the threefold lesions are small, lying in the globus pallidus and the capsule, and crossing the ansa lenticularis to penetrate the optic tract.

Table V summarizes the extent of the lesion in all the cases examined in which the target was the globus pallidus.

TABLE V.—Target: Globus Pallidus. Location of Lesion in Ten Patients (11 Sides). (Brackets Indicate Minor Degree of Involvement)

Case No.	Globus Pallidus	Internal Capsule	Thalamus	Zona Incerta; Subthalamic Nucleus	Other Structures
4 (L)	+ (ansa lenticularis)				(Putamen)
15	+				
6	+	+	+	+	
2	(+)	+	(+)	(+) zona incerta	
14	+	+	(+)	(+)	(Putamen)
13	+	+	+	+	
5	+	+	+		Optic tract
1	(+)	+	(+)		(Putamen)
3	+	+	(+)	(+)	
4 (R)	Extensive haemorrhage				
7	"	"			

Target: Thalamus (Text Fig. 3; Special Plate, Figs. 4 and 5; Table VI)

In five cases the target was the thalamus. In one case (Case 11, Text Fig. 3) the lesion involves the striate body and not the thalamus. In the other four cases the lesion is within the general target area, though the detailed location varies from case to case. It is obvious that in any approach to the thalamus it is inevitable that some fibres of the internal capsule must be transected. But in most cases in which the main extent of the lesion lies within the thalamus itself the degree of involvement of the capsular fibres is not great. This is in contrast to some of the cases in which the target is the globus pallidus and in which the main axis of the lesion has been in the capsule.

In Case 9 (Text Fig. 3; Special Plate, Fig. 4) there is considerable involvement of the capsule in the medial two-thirds, at the level of the red nucleus. In this case much of the lateral and latero-ventral region of the thalamus is included in the lesion, which extends into the zona incerta and upper pole of the subthalamic nucleus. In the remaining three cases the involvement of the capsule is much less extensive. The area of destruction in the thalamus is least in Case 12 (Text Fig. 3; Special Plate, Fig. 5). In this case the lesion extends obliquely across the lateral thalamic mass to end cranial to the medial part of the pre-rubral field. The general location of the lesion is similar in Case 10 (Text Fig. 3), but the area destroyed is considerably more extensive. Not only the more medial half of the lateral thalamus but also the central and parafascicular thalamic nuclei are involved, and the lesion extends medially very close to the wall of the ventricle. In Case 8 (Text Fig. 3) the oval lesion involves the greater part of the lateral and latero-ventral thalamus at this level, impinging on

FIG. 2.—Diagrams showing site of lesion at level of its maximum extent in each case. Operative target: globus pallidus.

the lateral border of the central thalamic nuclei and including the fibre radiations immediately cranial to the red nucleus. The upper part of the zona incerta is also included in the lesion.

Table VI summarizes the extent of the lesion in the five cases in which the target was the thalamus.

TABLE VI.—Target: *Thalamus*. Location of Lesion in Five Patients (Parentheses Indicate Minor Degree of Involvement)

Case No.	Globus Pallidus	Internal Capsule	Thalamus	Zona Incerta; Subthalamic Nucleus	Other Structures
12 9		+	+	+ zona incerta (+) subthalamic nucleus	(+) caudate
8		(+)	+	+ zona incerta	+ capsule of red nucleus
10 11		(+) +	+		+ caudate putamen

Effects of Lesion and Cause of Death

Deaths Unrelated to Operation

The best material from which to evaluate the localization and results of the therapeutic lesion consists of patients who die from causes completely unrelated to the operation, and preferably after a sufficiently prolonged period so that the boundaries of the lesion can be clearly delimited. These conditions are satisfied in the four patients included in Table II. In Case 2 the period of survival is rather too short to determine the precise degree of involvement of structures on the periphery of the lesion, though the immediate post-operative reaction in the brain is over.

In Cases 4 (L) and 15 the lesions were confined to the ansa lenticularis and the globus pallidus respectively. In both cases the results were excellent. In Case 4 (L) there was almost total relief of tremor and rigidity contralateral to the lesion. A little more than four months after this operation the other side was operated on. Extensive intracerebral haemorrhage occurred at operation, and for the remaining eight months of his life the patient was decerebrate. The brain in this case was cut in the horizontal plane. The small lesion on the left side, shown in Special Plate, Fig. 1, was made by the injection of alcohol; it is essentially limited to the ansa lenticularis. The location of this lesion in the coronal plane is shown in Text Fig. 1.

In Case 15 the operation achieved a very good result. There was a lessening of rigidity in the right arm and leg, with an improvement in gait and a slight improvement in speech. The patient could write and type again after being unable to do so with her right hand for about eight years, and she could lead a more normal life; her condition continued to improve, and the intention was to operate soon on the other side, when she died. Her death was due to pericarditis and heart failure, the result of a cardiac infarct which had occurred years before the operation. The stereotactic lesion in the globus pallidus, shown in Special Plate, Fig. 2, had been produced by Leksell's method. It extends obliquely posteriorly and caudally from the level of the mammillary body to the level of the subthalamic nucleus. The medial segment of the pallidum is mainly involved.

In Cases 2 and 6 the results of the operation were considered to be moderately successful. The first patient (Case 2) was severely incapacitated from bilateral

Parkinsonism. As a result of the operation the tremor was abolished contralateral to the lesion and the rigidity was "much less." He had a left facial weakness and a slight weakness of the left wrist and fingers. His death was due to spreading infection from a sore on the face. The lesion was almost completely capsular in this case, with some involvement of the neighbouring pallidum and thalamus (Special Plate, Fig. 3). Case 6 was very similar to Case 2. This patient had bilateral Parkinsonism; she also had rheumatoid arthritis, and was very depressed by her increasing disablement and pain. As a result of the operation she had relief of tremor contralaterally and slight reduction in rigidity. There was a little weakness of the left face and arm. Though the patient and her doctor were satisfied that the operation was successful, the patient was disappointed as she considered that the other side was rapidly deteriorating. In depression over her considerable burden she committed suicide. The lesion, as in Case 2, was mainly

FIG. 3.—Diagrams showing site of lesion at level of its maximum extent in each case. Operative target: thalamus.

capsular, with lateral and medial extension into the pallidum and thalamus, and it also involved the zona incerta and subthalamic nucleus.

Deaths as Indirect Result of Operation

The next group of patients are those who are considered to have died as an indirect result of the operation. Of the six patients (Table III) forming this group, four (Cases 9, 12, 14, and 10) died from causes which could equally well have followed some other kind of operation. With regard to the other two patients, it is not known whether some essential feature of the operation contributed towards causing death. But as there is no evidence on this point, the lesions in the brains of all six of these patients are considered to be representative of the lesions in other patients who have not yet died.

In Case 9 the result of operation was satisfactory, tremor was relieved, and there was a decrease in tone and improvement in movement on the side contralateral to the operation. Eight days after operation the patient suddenly collapsed and died during physiotherapy. The cause of death was found to be a pulmonary embolism from a thrombosed iliac vein. The lesion, made by the injection of etopalin and kaolin, is in the intended target of the lateral thalamus, involving also the adjoining internal capsule and the zona incerta and subthalamic nucleus.

The next patient (Case 12) had bilateral Parkinsonism. The result of the operation was considered excellent in the relief of both tremor and rigidity. He also died suddenly during physiotherapy (at a different hospital from Case 9), death being due to a pulmonary embolism from a thrombosed pelvic vein. The lesion was made by two small injections of etopalin through an indwelling catheter, the first 11 days and the second eight days before death. The lesion extends across the thalamus, terminating cranial to the pre-rubral field.

In Case 14 the result of the operation was moderately satisfactory. There was a definite reduction in rigidity in the contralateral arm, less so in the leg, and a mild facial weakness. This patient had disturbances of micturition before the operation, and this was aggravated by the operation, normal functioning never being achieved. He died suddenly from a pulmonary embolism two and a half months after the operation, and was found to have severe cystitis and pyelonephritis. The stereotactic lesion had been made by Leksell's method, the target being the left pallidum. It lies in the internal capsule and the pallidum, extending into the putamen.

Case 10 was that of a patient with Huntington's chorea. After operation the involuntary movements contralateral to the lesion were greatly reduced, though present to some extent with purposeful movement. There was some weakness on that side. Nine days after the operation she developed pneumonia, and a few days later signs of meningitis. She died 15 days after the operation. The lesion had been made by Cooper's method. It lies within the intended target area, the right thalamus, extending obliquely across the thalamus to end between the red nucleus and the third ventricle.

Case 1 was an old man greatly incapacitated by bilateral Parkinsonism. After operation he was in an extremely poor state, and was described as being like the worst kind of "failed leucotomy." He did not seem

to be paralysed, but never moved; he was not mute, but scarcely ever spoke, and was completely apathetic. He would stop eating the food in his mouth and just sit staring before him. There is a possibility that a fall in blood-pressure recorded during the operation may have contributed to this state. He died of pneumonia three months after the operation. The lesion had been made by Leksell's method, the target being the right globus pallidus. It was known at operation that the temperature reached in the electrodes during heat coagulation was not as high as intended; the finding that there were two lesions instead of one was therefore not surprising. The larger medial lesion lies in the capsule, and the small lateral one extends between the putamen and pallidum.

The last patient in this group (Case 13) died 12 hours after the operation. The main complaints in this case were rigidity and weakness of all limbs. Immediately after the operation his condition was satisfactory; there was complete relief of rigidity of the right wrist, he was moving all limbs, and his grip was good. About eight hours after the operation his respiration became very rapid and shallow and he died because of acute pulmonary oedema. The lesion was made by Leksell's method, the target being the right globus pallidus. As in Case 1, there are two lesions. The larger, medial lesion extends through the internal capsule and the caudal and lateral part of the thalamus, including the zona incerta and most of the subthalamic nucleus; the small lateral lesion is in the outer segment of the pallidum.

Deaths Directly Due to Operation

The last group of patients (Table IV) are those in whom death could be said to be directly due to the operation. In Cases 4 and 7 the operation resulted in extensive intracerebral haemorrhage from which the patients never recovered. In both cases the lesion was made by the injection of alcohol, using the approach through the temporal lobe, the target being the globus pallidus. In Case 4 the vascular accident occurred at the time of operation; in Case 7 the patient recovered from the operation, but consciousness was impaired the following day and he deteriorated and became comatose, dying seven days after the operation.

In the next two cases (Nos. 5 and 11) there is no evidence in relation to the lesions to explain why the patients died. In Case 5 the target was the globus pallidus. Injections of alcohol were made into the right pallidum 20 and 16 days before death, and injections of procaine into the left pallidum 14 and 12 days before death. The first injection of alcohol reduced the rigidity in the arm for 24 hours only. The second injection had little effect on the rigidity, but caused a transient weakness of the contralateral limbs. Two days later 2% procaine was injected into the left globus pallidus. Because the patient appeared very drowsy no alcohol was injected. This procedure was repeated two days later, and again the patient's drowsiness prevented the injection of alcohol. She developed pneumonia and died 20 days after the first injection of alcohol and 12 days after the last injection of procaine. On the right side there are three needle tracts extending across the globus pallidus into the internal capsule, and in one instance into the optic tract. On the left side one needle tract has been seen, passing into the globus pallidus. No definite evidence why the patient responded so badly to the injections on the left have been found, but the

proximity of the tract to the hypothalamus may be of significance. Case 11 is that of a patient with uncontrollable hemichorea. Injection of alcohol into the contralateral (right) thalamus was attempted, but the patient, already in a poor state, never recovered completely from the operation and died from purulent bronchopneumonia four days later. The lesion is in the anterior part of the striate body, involving both the caudate nucleus and putamen, and the intervening fibres of the capsule.

The next patient (Case 8) had an immediate excellent result after the injection of etopalin and kaolin into the right thalamus. Both tremor and rigidity were relieved. The next day he developed hemiballismus on the left side, and he died 11 days after the operation from pneumonia and exhaustion. The lesion extends over about two-thirds of the lateral and latero-ventral thalamic mass, right up to the red nucleus, and including the whole tegmental area and the zona incerta. The most cranial pole of the subthalamic nucleus may also be involved in the lesion.

The last patient (Case 3) was in a very poor state before the operation. He had advanced bilateral Parkinsonism, with some cerebral deterioration. After the injection of the left globus pallidus he had severe hemiparesis and pseudo-bulbar palsy. He survived in this poor state for four and a half months after the operation. The lesion was made by the injection of etopalin and kaolin; it lies mainly in the capsule, extending posteriorly to the level of the geniculate bodies.

Discussion

The 15 patients who form the material for this paper came from seven different neurosurgical units. They are the few patients who have died among a very large total series of patients operated on in these units, many with excellent results.

The first point to be answered from a series of brains in which stereotactic lesions were made is whether or not the lesion lies in the target area. This paper does not attempt to correlate with precision the surgeons' calculated target with the actual lesion found; its purpose is to show the gross location of lesions.

In 10 cases (11 sides) the target was the globus pallidus. Two of the cases can be excluded from further consideration, as the extensive haemorrhage which occurred obscures all evidence as to the accuracy of localization of the stereotactic lesion. Of the other nine lesions, two were accurately localized (Cases 4 (L) and 15) and limited to the target. In each of the other seven brains the lesion to some extent involves the globus pallidus, but only in addition to the neighbouring structures. The most striking feature of these lesions is the frequency of involvement of the internal capsule and the rarity with which this causes serious unwanted effects. In only one patient (Case 3), in whom the maximum involvement of the capsular fibres was at the level of the posterior part of the red nucleus—that is, farther posteriorly than in any of the other patients—was there serious paralysis. In three patients (Cases 14, 2, and 6) where there was considerable capsular damage at the level of the subthalamic nucleus there was only slight facial and upper-limb paresis. Another patient (Case 1) who had similar involvement of the capsule did not show any marked deficit of motor function, but he was difficult to assess owing to gross

mental changes. In two of the patients (Cases 5 and 13) there was involvement of the capsule without any deficit being noted, but in Case 13 death occurred too soon after operation for any really valid observations to have been made.

The subthalamic nucleus was considerably involved in the lesion in two patients (Cases 6 and 13) and slightly in two (Cases 3 and 14). In no patient in this group was any consequence of this involvement observed.

The next point to be considered is the therapeutic results of the operation, the target being the globus pallidus. The results were undoubtedly best in the two patients (Cases 4 and 15) in whom the lesions were confined to the globus pallidus or its outflow. In two other patients (Cases 2 and 6) the results were satisfactory, with relief of tremor and some reduction in rigidity. Whether these results were due to the capsular, the pallidal, or the thalamic lesion is not evident.

Of the five patients in whom the target was the thalamus, in one (Case 11) the lesion was completely outside the thalamus and in the other four mainly within the thalamus. In two of the patients (Cases 12 and 10) the lesion lies principally in the medial half of the lateral nuclear mass, and in the other two (Cases 9 and 8) in the lateral half. It is noteworthy that in the two patients (Cases 12 and 9) in whom the result of operation was satisfactory, and in whom death was not directly due to the operation, the area of common destruction is very small. In the patient (Case 8) in whom hemiballismus developed on the day after the operation the lesion is not grossly different from that of Case 9, except that the area involved extends more closely to the red nucleus. No feature of the lesion has been noted on gross examination to account for the occurrence of the hemiballismus. There is involvement of the subthalamic nucleus in another patient (Case 9) in whom hemiballismus did not occur. The only patient in this group with considerable damage to the internal capsule is Case 9. No clinical effects of this were observed.

The therapeutic result of operations on the basal ganglia for the relief of the tremor and rigidity of Parkinsonism is thought to be due probably to the destruction of the globus pallidus or its afferent fibres. Theoretically the lesion can therefore be made: (1) in the globus pallidus itself; (2) in the ansa lenticularis; (3) in the internal capsule involving the *système en peigne* of the pallidofugal fibres as they cross the capsule to reach the thalamus; (4) in the fields of Forel, including both the pallidal and the dentato-rubro-thalamic fibres; or (5) in the lateral nucleus of the thalamus, where many of these fibres terminate. This series of cases shows that lesions in each of these situations can in fact achieve the desired result without undue unwanted side-effects. It also shows that comparable lesions in other cases have not had the desired result.

On preliminary examination of the brains it is obvious that there is a variability in the degree of involvement of different nuclei in the primary disease process. In view of these differences from brain to brain, and in view of the varied site of the lesion, it would appear wise not to deduce too much in the living patient about the functional physiology of the structures presumably involved by the stereotactic lesion.

The cause of death in some of the patients merits further comment. In three, death was due to a pulmonary embolism; in two of these patients it occurred during

physiotherapy. Out of a total series of 15 patients this is an exceptionally high proportion to die because of this condition and under these circumstances. Whether the pulmonary embolism is related to the length of time taken at operation, or whether it may be connected with post-operative activity initiated after a very prolonged and markedly inactive pre-operative period, is not certain.

In the two patients in whom death was due to intracerebral haemorrhage it may be worth noting that the approach through the temporal lobe was used, and in both operations the method of coagulation was by the injection of alcohol. Two patients never recovered from the operation; in neither was the lesion large, nor was there any obvious reason why the patients did not recover.

Finally, in considering the operation as a factor contributing or leading to the death of the patient one point must be considered. In four patients (Cases 1, 3, 5, and 11) the pre-operative state was extremely poor, and as a result of increased experience with this type of operation it is doubtful whether such patients would now be accepted by the surgeons as reasonable operative risks.

Summary

The stereotactic lesions made by four different methods in 15 brains (16 sides) have been described in relation to their macroscopic location in the brain. In 13 cases the operation was performed for the relief of the tremor and rigidity of Parkinsonism, and in two cases to abolish the abnormal movements in Huntington's chorea and in hemichorea respectively. In 11 operations the target was the globus pallidus, and in five the thalamus. It has been found that there was a greater accuracy in placing the thalamic lesion than the pallidal lesion. The internal capsule was frequently involved, but it was rare for this to result in serious paralysis.

The location of the lesion is considered in relation to the clinical findings and to the cause of death. In six cases the results of operation were considered to be satisfactory; in two there was a little improvement; in two the immediate result, for a few hours, was satisfactory, then the patient deteriorated; and in six the result was bad. Good results were achieved with different lesions, both small and large, in widely scattered sites.

My most sincere thanks are given to all those neurosurgeons and neuropathologists who have so generously supplied this material. I also warmly thank Dr. E. A. Carmichael for his interest and the facilities he has provided. My thanks are due, and most heartily given, to Mr. K. L. Frampton for the photography, and to Miss Anne Ebborn for her technical work and help with the diagrams.

Requirements for Spencer Wells artery forceps (straight and curved) with box joints are specified in a new British Standard (B.S. 3355:1961). It is specified that the instruments shall be made of stainless steel in a range of sizes of 5 inches (12.7 cm.), 6 inches (15 cm.), 7 inches (18 cm.), and 8 inches (20 cm.) nominal overall length. The standard is one of a series dealing with surgical forceps of various types. Copies may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London W.1. (Price 3s. each; postage extra to non-subscribers.)

PERSISTENT ACUTE VIRAL HEPATITIS

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[WITH SPECIAL PLATE]

Viral hepatitis is usually a benign, short-lived disease with recovery occurring within one to two months from the onset of symptoms. However, in some patients recovery is delayed well beyond this period. The purpose of this paper is to present our experience with the latter group of patients, and to emphasize that complete recovery eventually occurred in each case, despite the presence of active disease for as long as three years. The term "persistent acute viral hepatitis" is used to describe this group, as the histopathological picture was that of acute hepatitis despite the length of the illness.

We have encountered five patients with such an illness, all of whom were females aged between 19 and 47 years. Each patient had an onset compatible with viral hepatitis with initial mild jaundice. Outstanding symptoms were nausea, malaise, anorexia, pain in the right upper quadrant, and, less frequently, poorly localized abdominal pain. Hepatomegaly was present in four cases and splenomegaly in two cases. The biochemical pattern was that of hepatocellular disease, and it returned to normal in the intervals between attacks. Filter-paper electrophoresis of serum from these patients revealed transient mild increases in gamma-globulin level. L.E. cells could not be demonstrated. Aspiration liver biopsies revealed the changes of acute hepatitis with variable degrees of cellular necrosis and intralobular and periportal inflammation. The duration of the illness ranged from eight months to three years, despite prolonged periods of rest in bed and the provision of an adequate diet. Corticosteroids were given to each patient in an attempt to shorten the illness, but variable responses were obtained. The criteria for recovery were the disappearance of symptoms and signs, return of liver function tests to within the normal range, and normal liver biopsy findings. An illustrative case history is provided.

Case History (see Chart)

A 20-year-old female student began to complain of malaise and tiredness in April, 1958, and in the following week her urine darkened and she became jaundiced. Examination at this time also revealed tender enlargement of the liver, and viral hepatitis was diagnosed. She was treated with a high-protein diet and rest in bed, but she remained jaundiced and was seen by us in June, 1958. Abnormal physical findings persisted.

Investigation at this time revealed: Hb 15 g. per 100 ml.; white cell count 7,000 per c.mm. (polymorphonuclears 76%, lymphocytes 15%, monocytes 8%, eosinophils 1%); prothrombin index 100%. Serum bilirubin 2.5 mg. per 100 ml.; serum alkaline phosphatase 9 King-Armstrong units; thymol flocculation 2+ and zinc sulphate turbidity 11 units.

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MARION C. SMITH: LOCATION OF STEREOTACTIC LESIONS CONFIRMED AT NECROPSY

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 1.—Case 4 (left side). Horizontal plane. Lesion, produced by injection of absolute alcohol, in ansa lenticularis. Post-operative survival: 1 year.

FIG. 2.—Case 15 (left side). Coronal plane. Lesion, produced by Leksell's diathermy method, in globus pallidus. Post-operative survival: 10 months.

FIG. 3.—Case 2 (right side). Coronal plane. Lesion, produced by Cooper's balloon method, mainly in internal capsule. Post-operative survival: 3 weeks.

FIG. 4.—Case 9 (left side). Coronal plane. Lesion, produced by injection of etopalin and kaolin, mainly in lateral part of lateral thalamus, and in latero-ventral thalamus. Post-operative survival: 8 days.

FIG. 5.—Case 12 (left side). Coronal plane. Lesion, produced by two injections of etopalin, mainly in medial part of lateral thalamus. Post-operative survival: 11 and 8 days.

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FIG. 1.—Liver biopsy material from patient described, showing marked inflammatory changes three months after illness began. ($\times 50$.)

FIG. 2.—Liver biopsy material from patient described, two years after illness began. A few inflammatory cells remain. ($\times 50$.)