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Epilepsy after two different neurosurgical approaches to the treatment of ruptured intracranial aneurysm

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SYNOPSIS One-hundred-and-fifty-two patients who underwent surgery for intracranial aneurysm were studied to determine the incidence of postoperative epilepsy in relation to the site of the aneurysm and the type of surgical approach. The overall incidence of epilepsy was 22%. Of the 116 patients treated by the intracranial approach 27.5% developed epilepsy, in contrast with only 5% of the 36 patients who had carotid artery ligation in the neck. Epilepsy occurred most frequently (35%) with middle cerebral artery aneurysms, especially if moderate or severe operative trauma was sustained and there was postoperative dysphasia.

Rates of postoperative epilepsy among the survivors of ruptured intracranial aneurysm have varied widely —for example, Rose and Sarner (1965) reported that it occurred in less than 15% of their patients while Prior *et al.* (1973) found an incidence of 65%. Few studies have attempted to determine the factors which influence the incidence of postoperative epilepsy, in particular, whether the method of surgical treatment or other features are of importance. Thus, one of the main aims of the present investigation was to compare the occurrence and evolution of epilepsy after carotid artery ligation in the neck and after intracranial surgical procedures. Other factors studied included the site of the aneurysm and the presenting clinical features with a view to determining the relation if any with the incidence of epilepsy.

METHOD

There were 152 patients in the study, 62 males and 90 females, the survivors of aneurysm surgery between the years of 1945 and 1973. They had been followed up for one year to 22 years, with a mean of seven years. Thirty-three patients (22%) had an aneurysm on the anterior group of arteries—that is, the anterior communicating or anterior cerebral artery. Forty-nine (32%) had a middle cerebral artery aneurysm. In the remaining 70 patients (46%) the aneurysm was on the internal carotid, the posterior communicating or the basilar artery, the posterior group. There were 116 patients who had intracranial surgery and 36 patients who had internal carotid artery ligation, in the neck. The majority of patients who had the latter treatment were female. The age distribution of the two surgical groups was similar ranging from 15 to 55 years with a mean age of 40 years. To determine what factors were related to postoperative epilepsy, special attention was paid to clinical findings at the time of subarachnoid haemorrhage, those on admission to hospital and after surgery. Also diagnostic procedures and operative methods of treatment were considered, as well as untoward events occurring during surgery. With this in mind, operative damage such as partial frontal lobe resection and postoperative signs or symptoms were assessed separately into two categories, negligible to mild; or moderate to severe. Subsequently, these various assessments were related to the occurrence of seizures. A chi-square test, with the Yates correction, was used to determine whether there were differences in these features between the group of patients who developed epilepsy and those who did not.

RESULTS

OCCURRENCE OF EPILEPSY

Thirty-four (22%) of the 152 patients developed epilepsy. There were 116 patients who had intracranial treatment and 32 (27.5%) developed seizures. Thirty-six patients had carotid artery ligation in the neck and only two (5%) developed epilepsy. Eighteen (37%) of the 49 patients who underwent intracranial

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TABLE 1

TIME OF ONSET (MONTHS) OF FIRST FIT, AFTER INTRACRANIAL SURGERY, IN 34 PATIENTS WITH POSTOPERATIVE EPILEPSY

Aneurysm site	*Onset*				*Mean*	*Range*
	Less than 1 w	*Within 6 m*	*Within 12 m*	*After 12 m*		
Anterior group	1	1	2	5	15	>1–60
Middle cerebral	5	13	17	1	6	>1–29
Posterior group	0	3	4	5	29	4–98

surgery for middle cerebral artery aneurysm had fits. They occurred in seven (21%) of the 33 patients with an anteriorly placed aneurysm and in nine (13%) of the 70 patients with a posteriorly located aneurysm.

The latent period between operation and onset of seizures (Table 1) was on average 17 months for the patients who had intracranial surgery. For those with a middle cerebral aneurysm it was six months, range one to 29 months, and for the anterior group, it averaged 15 months, range one to 60 months. The longest latent period was observed in patients operated on for an aneurysm on the posterior group of arteries—namely, 29 months on average, range four to 98 months. The mean latency for the two patients who developed epilepsy after carotid artery ligation in the neck was 58 months.

Thirteen patients (38%) of those who developed epilepsy had generalised seizures. The remainder had various types of focal fits. Psychomotor symptoms occurred in four (22%) of the 18 patients with a middle cerebral artery aneurysm. Focal seizures which became secondarily generalised were seen in one-third of the patients who underwent surgery for an aneurysm on the anterior group.

The prescribing of anticonvulsants generally alleviated seizures though eight patients had one fit per year and two had seizures at least once a month. The prevalence of fits varied with the stage of the follow up (Table 2). Thus in the third postoperative year nine patients had their fits completely controlled, and 18 were having more than one seizure a year. In the eighth postoperative year 18 patients had their seizures controlled for at least one year with anticonvulsants and 14 did not.

RELATIONSHIPS BETWEEN CLINICAL FEATURES AND EPILEPSY

The main clinical findings within 24 hours of the subarachnoid haemorrhage, or on admission to hospital (Table 3) included seizures in five patients all of whom subsequently developed postoperative epilepsy. However, the association between post-

TABLE 2

PREVALENCE OF ACTIVE CASES OF EPILEPSY (MORE THAN ONE FIT PER YEAR) AT GIVEN TIME AFTER SURGERY FOR INTRACRANIAL ANEURYSM

No.	*Years since operation (no.)*							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Active cases of epilepsy	15	18	18	17	17	15	14	14
Patients who had fits controlled for at least 1 yr	—	7	9	11	13	19	18	18

TABLE 3

CLINICAL FINDINGS IN 152 PATIENTS WHO UNDERWENT SURGERY FOR INTRACRANIAL ANEURYSM

	Epilepsy rate			
	Anterior group	*Middle cerebral*	*Posterior group*	*Totals*
Number of patients	7/26	18/31	9/61	34/118
Premonitory features				
Bouts of severe headache in previous month	4/13	8/15	5/30	17/58
Ptosis for previous 5 m	0/0	4/8	1/7	5/15
Findings within 24 h of presenting SAH or on admission to hospital				
Loss of consciousness	3/7	8/16	1/25	12/48
Duration of unconsciousness:				
1–18 h	2/1	2/5	1/8	5/14
Coma	0/0	2/5	1/6	3/11
Confusion or inaccessibility	4/9	5/6	0/2	9/17
Blood pressure exceeding 140 mmHg, systolic and 100 mmHg, diastolic	1/5	2/2	1/7	4/14
Hemiparesis or hemiplegia	3/15	5/7	3/11	11/33
Dysphasia or aphasia	0/0	6/11	2/16	8/27
Papilloedema	3/13	1/3	2/14	6/30
III or VI nerve palsy	0/1	4/7	1/9	6/17
Preoperative seizures	2/2	2/2	0/2	5/6
Negligible to mild findings	3/14	13/20	7/56	23/90
Moderate to severe findings	4/12	5/11	2/5	11/28

operative epilepsy and other preoperative features such as bouts of severe headache preceding the main subarachnoid haemorrhage, unconsciousness within 24 hours of presenting subarachnoid haemorrhage or on admission to hospital (Table 3) did not reach statistical significance. Nor did the findings of vascular spasm or haematoma noted on contrast radiography (Table 4) occur significantly more often among patients who subsequently developed epilepsy.

On the other hand, complications remarked upon by the neurosurgeon at the time of operation often correlated with the occurrence of epilepsy (Table 5). Thus, cortical damage usually to the frontotemporal regions, as well as brain swelling, was noted in a significantly greater proportion ($P > 0.02$) of patients who subsequently developed epilepsy than those who did not. There was, in addition, a tendency, which did not reach statistical significance, for those who had lobectomies or intracranial haematoma to have seizures. Patients who underwent surgery for an aneurysm of the anterior groups of arteries and who developed dementia or other psychiatric disturbance postoperatively were significantly more likely to develop seizures than those who did not ($P > 0.05$). Patients who were operated on for middle cerebral artery aneurysm and who developed aphasia or dysphasia were similarly significantly ($P > 0.05$) more likely to develop fits. For those with a posteriorly located aneurysm and in whom hemiplegia or hemiparesis occurred, there was a significant association ($P < 0.05$) with epilepsy.

TABLE 4

DIAGNOSTIC PROCEDURES, FINDINGS, AND METHODS OF SURGICAL TREATMENT OF 152 CASES OF INTRACRANIAL ANEURYSM

	Epilepsy rate			
	Anterior group	*Middle cerebral*	*Posterior group*	*Totals*
Number of patients				
Preoperative	7/26	18/31	9/61	34/118
Angiograms				
Large (2.5–6 cm) aneurysm	5/9	7/13	5/29	17/51
Multiple aneurysm:				
2–4 aneurysms	1/2	2/6	3/9	3/17
Vascular spasm	2/7	6/8	3/20	11/35
Intracranial haematoma	2/1	3/13	2/5	7/19
Postoperative angiograms				
Aneurysm occluded	2/8	5/3	4/25	11/36
Partial or no occlusion of aneurysm	2/9	2/4	2/13	6/26
CSF pressure greater than 200 mm H_2O	3/6	2/7	1/7	6/20
Surgical procedures				
Carotid artery ligation in neck	0/2	1/7	1/25	*2/34
Intracranial				
Clipping	4/17	13/16	4/28	*21/61
Wrapping	2/4	3/4	1/4	6/12
Other	1/5	3/6	3/9	7/20

* Significant at the level of 0.05.

TABLE 5

TREATMENT FOR INTRACRANIAL ANEURYSM IN 152 PATIENTS: COMPLICATIONS AND OUTCOME

	Epilepsy rate			
	Anterior group	*Middle cerebral*	*Posterior group*	*Totals*
Number of patients	7/26	18/31	9/61	34/118
Operative procedures				
Cortical trauma	3/11	*9/5*	2/9	*14/25*
Partial lobectomy	6/19	6/14	2/5	14/38
Brain swelling	4/6	8/7	1/8	*13/21*
Postoperative sequelae				
Negligible or mild	2/8	*9/26*	5/48	16/82
Moderate or severe	2/1	*9/5*	4/13	18/36
Protracted drowsiness	2/5	4/7	2/7	8/19
Psychiatric/and/or dementia	*4/3*	2/5	3/14	9/22
Hemiparesis or hemiplegia	4/16	8/7	*5/11*	17/34
Dysphasia or aphasia	1/6	*8/4	2/11	11/21

* Significant at the level of 0.05.

PROBABILITIES OF DEVELOPING POSTOPERATIVE EPILEPSY

An attempt was made to determine the probability that epilepsy would occur on the basis of surgical complications, site of aneurysm, and postoperative neurological sequelae (Table 6). Patients with a middle cerebral artery aneurysm who sustained

TABLE 6

PROBABILITY OF DEVELOPING POSTOPERATIVE EPILEPSY; ACCORDING TO SITES OF ANEURYSMS, SURGICAL DIFFICULTIES, AND POSTOPERATIVE SEQUELAE: 152 PATIENTS WITH INTRACRANIAL ANEURYSM

	Anterior group	*Middle cerebral*	*Posterior group*
Operative difficulties			
Moderate or severe	0.25	0.56	0.16
Minor or negligible	0.19	0.30	0.12
Postoperative sequelae			
Dysphasia			
Moderate or severe	0.25	0.63	0.16
Negligible or mild	0.22	0.28	0.10
Other sequelae			
Moderate or severe	0.24	0.56	0.20
Negligible or mild	0.17	0.26	0.09

moderate or severe operative damage to the fronto-temporal cortical areas were more likely (probability 0.56) to develop postoperative epilepsy than those with minor postoperative difficulties (probability 0.30). Similarly, a patient with a severe dysphasia after surgery was found to be more likely (probability 0.63) to suffer from seizures than another who had no dysphasia (probability 0.28).

DISCUSSION

The incidence of postoperative epilepsy in the present series, 22%, is higher than that reported by others (Rose and Sarner, 1965; Storey, 1967) and it is about one-third of that found by Prior *et al.* (1973) in their study of EEG referrals. While sampling bias may well account for the relative excess of epileptics in the study of Prior *et al.* (1973), this is not the explanation for the greater incidence of epilepsy in the current investigation, as the patients were traced through the neurosurgical files. Perhaps the difference is due to the lengthy follow-up and surgical procedures employed for the patients in the present study. Thus, while most of those who underwent surgery in the study of Storey (1967) had ligation of the carotid artery in the neck, for the present series this was the case for only one out of five patients and this procedure we have shown to be associated with a significantly lower incidence of epilepsy than intracranial surgery. Should the proportion of patients having this type of treatment in the current series have been 50%, the resulting overall incidence of postoperative epilepsy data would have been about 14%.

It was unfortunate that, as this study was retrospective, it was not possible to match the patients by grade along the lines indicated by Hunt and Hess (1968). However, we had the advantage of a prolonged and well-defined follow-up which has not always been the case in other studies—for example, Rose and Sarner (1965). Another factor which probably diminishes the postoperative epilepsy rate in the patients reported by Rose and Sarner (1965) is the fact that they were prescribed anticonvulsants from the time of surgery. This was not done in the patients reported here.

Among the various factors which we found to be significantly associated with the development of postoperative epilepsy, the most outstanding are the severity and the site of brain damage. Thus, the present series shows that the shortest latent period for the development of fits and the highest incidence of postoperative seizures occurred in patients who sustained moderate or severe brain trauma close to an area of low seizure threshold (Andersen and Lømo, 1969)—namely, the regions supplied by the middle cerebral artery. Observations concerning the high epileptogenicity of this region were made by other authors, in cases of brain wounds (Russell and Whitty, 1952), cerebral abscesses (Legg *et al.*, 1973), and acoustic neuromas removed by the transtentorial approach (Cabral *et al.*, 1976). In this context it is of interest that a significant proportion of patients treated for ruptured aneurysms on the posterior cerebral or posterior communicating arteries had postoperative hemiplegia. Therefore, it is conceivable that, even in this group, a disturbance occurred which extended to encompass part of the territory supplied by the middle cerebral artery. Although lobectomies were more common among patients who developed epilepsy, they did not seem to play a significant role in the incidence of these seizures. This is in accordance with the low rate of fits (7%) in a series of uncomplicated lobotomies (Freeman, 1953), as well as with the common experience (Ward, 1975) that, for a successful surgical extirpation of a localised epileptogenic focus to occur, the operative trauma has to be minimal. Various authors (for example, Storey, 1967; Jennett, 1975) have shown that post-traumatic epilepsy is more likely to occur in the presence of an intracranial haematoma. Our results to some extent corroborate these findings but the effect of this complication on the incidence of postoperative epilepsy does not reach a significant level. The emphasis is, therefore, put on the surgical trauma in the genesis of the postoperative epilepsy studied here.

These findings suggest that anticonvulsants should perhaps be given routinely postoperatively to all these patients, a point currently under investigation in a prospective study.

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