Temporal lobectomy in children with epilepsy

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The results of temporal lobectomy for medically refractory seizures are analyzed in 29 boys and 21 girls with a mean age of 15.8 years. The average age at onset of seizures was 7.5 years, and the time between onset and surgery averaged 8.3 years. Postoperatively, 27 patients (54%) were seizure-free, 12 patients (24%) had only occasional auras without loss of consciousness, five patients (10%) had fewer seizures, and six (12%) were unchanged. Therefore, 78% were essentially seizure-free and 88% benefited significantly from the operation. There was no significant change in the Wechsler Intelligence Scale scores before and after surgery; however, the shorter the time between seizure onset and surgery, the greater the likelihood of improvement in verbal and perceptual intelligence quotient. Social outcome was significantly improved, and a large percentage of patients were either in school or actively employed. Early consideration of temporal lobectomy in children with medically refractory seizures is recommended.

KEY WORDS • temporal lobectomy • lobectomy • epilepsy • temporal lobe seizures • Wechsler Intelligence Scale • outcome

Epilepsy is found in the general population in approximately six/1000 persons. About one-third of all epileptic patients suffer from temporal lobe seizures, and approximately one-half of these do not have good medical control. It is estimated that about 10% to 25% of all patients with temporal lobe epilepsy associated with complex partial seizures may be surgical candidates.

The first monograph on epilepsy and its treatment, "On The Sacred Disease" by Hippocrates, prescribed trephination on the side opposite to the focal seizure. Foerster and Penfield, in 1930, published their results with temporal lobectomy for posttraumatic seizures in 12 patients. With the development of clinical electroencephalography (EEG) in 1936, investigators such as Gibbs, et al., and Jasper and Kershman facilitated the first attempt at intraoperative EEG by Percival Bailey in 1947. Since then, the science of seizure surgery has developed through the pioneering work of many, including Penfield, et al., Green, et al., Morris, Falconer, et al., Walker, and Rasmussen. Certainly, it has been demonstrated that temporal lobectomy is a viable treatment for patients with temporal lobe seizures refractory to medical therapy.

Falconer first emphasized the importance of early surgery in medically refractory patients. Despite the proven therapeutic results in appropriately selected patients, there remains a reluctance to consider a surgical option. A debate still persists in terms of the indications for surgery and the timing of the operation. Relatively few series analyze the results of temporal lobectomy in the pediatric age group. Therefore, the purpose of this paper is to review the surgical results for the treatment of temporal lobe epilepsy in 50 children under the age of 18 years.

Clinical Material and Methods

Patient Population

Between the years 1970 and 1983, 50 patients under the age of 18 years underwent a temporal lobectomy for medically refractory seizures. The patient profile is presented in Table 1. Antecedent or causal factors included a history of febrile seizures in nine patients, meningitis in five, cranial trauma in seven, encephalitis in three, and maternal rubella in the first trimester in one.

Patients were evaluated postoperatively as outpatients by both the neurology and neurosurgery departments. Furthermore, all patients and families were sent a questionnaire pertaining to social, intellectual, and behavioral development (Table 2). Long-term outcome of seizure status was determined by the results of outpatient examinations and from the questionnaire. Fol-
TABLE 1
Preoperative profile of patient series

<table>
<thead>
<tr>
<th>Factor</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex (M:F)</td>
<td>29:21</td>
</tr>
<tr>
<td>age at onset (yrs)</td>
<td>mean 7.5</td>
</tr>
<tr>
<td></td>
<td>range 1-14</td>
</tr>
<tr>
<td>age at surgery (yrs)</td>
<td>mean 15.8</td>
</tr>
<tr>
<td></td>
<td>range 7-18</td>
</tr>
<tr>
<td>mean time between onset &amp; surgery (yrs)</td>
<td>8.3</td>
</tr>
<tr>
<td>seizure frequency (/mo)</td>
<td>1-4 5</td>
</tr>
<tr>
<td></td>
<td>5-10 10</td>
</tr>
<tr>
<td></td>
<td>11-20 15</td>
</tr>
<tr>
<td></td>
<td>20+ 20</td>
</tr>
<tr>
<td>lt temporal lobectomy</td>
<td>23</td>
</tr>
<tr>
<td>rt temporal lobectomy</td>
<td>27</td>
</tr>
</tbody>
</table>

low-up examinations were performed 4 or more years after surgery in 22 patients. The mean follow-up period for the entire group was 4.5 years (range 0.6 to 10 years).

Patient Selection

Patients were considered potential surgical candidates when they fulfilled the following criteria. First, intensive and methodical treatment with anticonvulsant agents must be ineffective in controlling seizures despite adequate serum anticonvulsant levels. Second, a satisfactory unilateral temporal lobe epileptic focus must be identified. Our practice is to carefully withdraw anticonvulsant medications from patients under hospital supervision, so that the patient's typical seizure may be recorded by the use of prolonged video-EEG recording sessions. Intertical EEG's are also considered in this evaluation. We rarely resort to depth electrodes or other implanted recording arrays (subdural or epidural), as most candidates can be selected by the above techniques. Third, the general health of the patient must be otherwise satisfactory. When patients fulfilled these criteria, they were evaluated with a pneumoencephalogram prior to 1973, a contrast-enhanced computerized tomography (CT) scan after 1973, a carotid arteriogram including an Amytal (amobarbital) test if memory function was in question, and currently with magnetic resonance imaging.

Surgical Technique

The procedure was well described by Walker,44 and follows the principles of subpial resection of the superior temporal gyrus, hippocampus, and amygdala, as first advocated by Penfield and Flanigan.31 This is in some contrast to the en bloc procedure recommended by Falconer et al.7,8 The patient is anesthetized with isoflurane, fentanyl, and nitrous oxide, and an osteoplastic temporal bone flap with additional removal of the inferior temporal squamous portion to the floor of the middle fossa is utilized. After exposure of the cerebral cortex and identification of the Sylvian fissure and vein of Labbé, a cortical recording is made with 15- to 19-lead electrodes and three additional depth electrodes targeted at the amygdala and hippocampus. To enhance the intraoperative recording, the original anesthetic agents are reduced. Occasionally, electrical discharge is evoked by the use of the anesthetic agent enflurane or by brief stimulation from a depth electrode.

After the focus is identified, a formal temporal lobectomy is performed. The intraoperative EEG serves as a guide to the extent of the resection. As noted, the superior temporal gyrus, hippocampus, and amygdala are removed with microsurgical subpial resection, thereby decreasing the chances of injuring structures medially at the tentorium. A post-resection EEG is performed, and any additional epileptiform activity is attacked with subpial suction when possible. Generally, the extent of the resection measures 5 to 6 cm from the temporal pole, and the vein of Labbé is protected. The dura is closed with a homologous dural graft and perioperative Decadron (dexamethasone) is given.

Operative Results

Overall, 27 patients (54%) were without clinical seizures or auras and 12 patients (24%) had rare auras...
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without loss of consciousness. Five patients (10%) were improved but still had persistent seizures, and six patients (12%) were unchanged. Therefore, 78% of the patients were essentially seizure-free and a total of 88% benefited significantly from the operation. Twenty-four patients whose follow-up period was 5 years or greater had the following results: 10 (41.7%) were without clinical seizures or auras, eight (33.3%) had rare auras only, one (4.2%) was improved with fewer seizures, and five (20.8%) were unchanged. Therefore, the late follow-up data showed that 75.0% were essentially seizure-free. The increased percentage of those who were unchanged (20.8%) at late review as compared to the overall figure (12%) might be due to the fact that these patients were more likely to return for medical treatment and not be lost to follow-up review.

Among the 40 of a possible 50 patients who responded to our questionnaire, 36 considered that their overall condition had improved 75% to 100%, and 34 were either in school or successfully employed. Further subjective data from the questionnaire (notably Questions 8 and 9, Table 2) emphasized behavioral improvement in 36 patients. The five with no behavioral improvement were patients whose seizure frequency was unaltered by surgery. The 10 patients who did not respond to the questionnaire consisted of two patients who died from unrelated causes, two who were recorded as having persistent seizures at their last examination, and six who were known from previous communications to be seizure-free.

Thirty-seven patients underwent Wechsler Intelligence Tests appropriate for their age, both preoperatively and postoperatively. Overall, there was no significant change in the preoperative versus postoperative scores for each of the following: full-scale intelligence quotient (IQ) was 91.6 versus 91.8; perceptual IQ 96.3 versus 96.3; verbal IQ 91.6 versus 91.4; and memory quotient 91.9 versus 90.5. These test results were further analyzed statistically in terms of side of lobectomy, length of resection, sex, age at surgery, and duration of seizures (time between seizure onset and surgery). Although the neuropsychological tests were not influenced by side of lobectomy or length of resection, the following associations were identified. Figure 1 demonstrates that the shorter the interval between seizure onset and surgery the greater the likelihood of postoperative improvement in the perceptual IQ. This was statistically significant to p < 0.02. Analysis of the verbal IQ yielded a similar result (Fig. 2) with p < 0.05 (Spearman’s nonparametric analysis). Neither the full-scale IQ nor the memory quotient was influenced by this variable. Interestingly, as depicted in Fig. 3, analysis of the memory quotient demonstrated that girls improved postoperatively with a mean difference of +4.9, while
boys worsened with a mean difference of $-3.5$ (p < 0.01). This was not attributable to side of resection, length of resection, age of patient, or duration of seizures.

Tumors were noted at the time of surgery in six patients: two were grade I astrocytomas, two grade I oligodendrogliomas, and two gangliogliomas. Three of these patients had entirely normal preoperative radiographic evaluations, including a contrast-enhanced CT scan and cerebral arteriogram.

Eight patients had early postoperative seizures. Four of these had episodes similar to their preoperative seizure; two of these had persistent late seizures. The other four patients had focal motor seizures related to acute foci following surgery, and only one had persistent seizures in the follow-up period. In 27 patients the post-resection EEG showed no residual epileptiform activity, and 23 (85%) of these patients remained seizure-free.

Complications included infected bone flaps requiring cranioplasty in two patients, transient rhinorrhea in one patient, and mild transient upper-extremity paresis in two patients, which resolved prior to discharge. In the first few postoperative days, four patients had minimal anomic dysphasia and one had expressive dysphasia. Except for one patient with residual expressive dysphasia, all language impairment resolved prior to discharge as assessed by staff speech pathologists. Twenty patients (40%) had the expected superior quadrantanopsia on visual field testing that subjectively was of no consequence.

### Discussion

Our surgical results compare favorably with those previously reported, as 78% of our group were seizure-free and 88% benefited to some degree from the operation. Vaernet reviewed 33 temporal lobectomy patients between the ages of 4 and 21 years, noting that postoperatively 61% were free of seizures and that 20% had a marked reduction in seizure frequency. He also commented that good prognostic factors included operation at an earlier age and a less than 4-year duration of seizures. Davidson and Falconer reviewed their results in 40 children aged 15 years or younger. In this group, 58% were seizure-free, 20% were almost seizure-free, and 12% were improved. Rasmussen reviewed 99 patients aged 15 years or younger, noting that 60% of the series had complete or nearly complete remission, 13% suffered only 10% as many seizures or less, and in 13% the attacks were reduced by one-half or more. Green and Pootrakul noted in their operative experience with 32 children that 81% were seizure-free or almost seizure-free. Therefore, overall there is a 60% to 80% surgical success rate in children with medically refractory temporal lobe seizures.

Falconer is credited with demonstrating that a reduction in seizures is associated with an improvement in both social interaction and behavior. This view has been reconfirmed by several authors. Vaernet noted that, of 30 patients with preoperative behavior difficul-

### Conclusions

In this series, temporal lobectomy provided a good result in 78% of the patients operated on for medically refractory seizures. There was improvement in social adjustment, with a high rate of employability and an objective demonstration of potential improvement in some components of the Wechsler Intelligence Scales with operation at an earlier age. Since the surgical
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benefits well outweighed the transient complications encountered, temporal lobectomy should be considered early in the treatment plans for children with medically refractory seizures.

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