**Objective:** To assess whether surgery to reduce or control epileptic seizures is safe and effective in patients known to have additional psychogenic seizures.

**Design:** We reviewed our computerized database of 1342 patients examined for epilepsy surgery and identified 13 patients with both epileptic and psychogenic seizures on whom postoperative outcome data were available. Data were gathered from the patients’ records. Mean postoperative follow-up was 56 months.

**Results:** Epilepsy surgery led to clinically relevant improvements in 11 of 13 patients. Seven patients became free of epileptic and psychogenic seizures, 2 patients became free of epileptic seizures but continued to have infrequent psychogenic seizures, 1 patient reported more than an 80% improvement in epileptic seizure frequency and an abolishment of psychogenic attacks, and in 1 patient nondisabling epileptic seizures persisted at lower frequency but psychogenic seizures stopped. In 2 of 13 patients, epilepsy surgery failed to produce notable improvements. Although 1 patient became free of epileptic attacks and the other had fewer than 3 epileptic seizures per year, the severity or frequency of psychogenic seizures and pseudo–status epilepticus increased postoperatively. One of these patients had a preoperative diagnosis of somatization disorder; in the other, pathological illness behavior had been noted.

**Conclusion:** A diagnosis of additional psychogenic seizures should not be considered an absolute contraindication to epilepsy surgery, although patients should undergo careful preoperative psychiatric evaluation.

Arch Neurol. 2002;59:82-86

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**RESULTS**

**PATIENTS**

Thirty-eight of 1342 patients who completed inpatient evaluation for epilepsy surgery had a mixture of epileptic and psychogenic seizures. Of these, 25 did not go on to have an operation: 10 had almost exclusively psychogenic seizures, 6 were thought to be inoperable, 5 did not want to go ahead with invasive EEG recordings deemed necessary by the neurologic team, 2 were thought to be good surgical candidates but decided against an operation, and 2 were still awaiting surgery.

Thirteen patients with additional psychogenic seizures did undergo epilepsy surgery (10 women and 3 men). The mean age at onset of unprovoked epileptic seizures in these patients was 10 years, and that of psychogenic seizures, 21 years (we were unable to determine the age at onset of psychogenic seizures in 4 cases). Even after discussion of the difference between epileptic and psychogenic attacks
PATIENTS AND METHODS

PATIENTS

We searched the computerized epilepsy surgery database for the period April 1, 1991, through December 31, 2000, for patients in whom an additional preoperative diagnosis of psychogenic seizures was recorded. Patient characteristics and seizure, medical, and psychiatric histories as well as details of diagnostic workup, surgical treatment, and follow-up were retrieved from the clinical records. The postsurgical follow-up program consisted of outpatient visits 3, 6, and 12 months after the operation and yearly after that. Patients who did not benefit from surgery were reexamined on an inpatient basis.

DIAGNOSES

In all patients, the diagnosis of epileptic seizures was confirmed during the preoperative workup by ictal video electroencephalogram (EEG) recordings, and in 7 with implanted electrodes. The technique used in the implantation of EEG electrodes has been described elsewhere. The diagnosis of psychogenic seizures was based on a combination of observations: a clearly situational character of events, typical semiologic features (gradual onset, waxing and waning of motor activity, side-to-side head movements, closed eyes, resistance to eye opening, maintained ictal pupillary reaction to light, ictal verbalization, ictal crying, pelvic thrusting, back arching, asynchronous limb movements, semipurposeful movements, prolonged atonia, responsiveness during apparent unconsciousness, and sudden postictal reorientation), the incompatibility of the semiologic features with recognized epileptic seizure patterns (including those seen in frontal lobe seizures), the absence of ictal EEG changes in surface or invasive recordings, normal postictal prolactin levels, or the induction of attacks with the suggestive injection of 0.9% sodium chloride during video EEG recording. In 12 patients, psychogenic seizures were documented at our center (spontaneous attacks on the ward were observed in 2 patients, during prolonged video EEG in 4, and during video EEG after suggestive injection in 6). In 1 patient, the diagnosis of psychogenic seizures was based on the documentation of non-epileptic attacks with video EEG at another hospital. All video recordings of psychogenic attacks were discussed with patients and previous seizure witnesses to ensure that the observed episodes were typical of habitual events. We confirmed the persistence of postoperative psychogenic seizures by ictal video EEG recording in patient 7, and the persistence of psychogenic as well as rare epileptic attacks in patient 5. In patients 1, 3, 4, and 12, the postoperative persistence of psychogenic or epileptic seizures was diagnosed by an experienced epileptologist at the time of routine follow-up on the basis of seizure descriptions from patients and relatives and our preoperative investigations.

OUTCOME

The frequency of postoperative epileptic and psychogenic seizures was gathered from patient records, including seizure charts. Postoperative seizure outcome was interpreted on the basis of the Engel classification. The Engel classification is often used to express epilepsy surgery outcome. Engel classes are based not only on epileptic seizure control but also on lifestyle after surgery. For the purposes of this study, psychogenic seizures were included in the tabulation. Classes I and II (no or fewer than 3 disabling seizures, respectively) are considered to denote surgical success. Class III represents limited improvement, and class IV, no significant improvement in terms of seizures or lifestyle.

PATIENTS

Eleven of 13 patients improved overall after epilepsy surgery. Seven became free of all epileptic and psychogenic seizures after surgery (patients 2, 6, 7, 9, 10, 11, and 13), although in 3 of these patients, anticonvulsant medication had to be adjusted before freedom from epileptic seizures was attained. Two patients (patients 3 and 12) reported seizure freedom for epileptic attacks with persistence of infrequent psychogenic seizures. Two patients (patients 1 and 4) became free of psychogenic seizures and experienced a worthwhile improvement of their epilepsy.

Two patients failed to benefit overall; whereas epileptic seizures were abolished by surgery in patient 8, she developed less frequent but more violent psychogenic seizures that could develop into pseudo-status epilepticus and precipitate admissions to her local hospital. This patient had a preoperative diagnosis of somatization disorder. Her medical history included an appendectomy, cholecystectomy, hysterectomy, episodic monocular double vision, globus syndrome, episodes of unexplained nondermatomal sensory loss, unexplained pyrexia, and palpitations. The other patient (patient 5) had

with the physician in charge (using video recordings where available), only 7 patients were able to distinguish between their 2 seizure types. Additional preoperative behavioral, psychological, or psychiatric problems were recorded in 10 patients (Table 1). Although 7 patients (patients 2 through 7 and 9) had had contact with a psychiatrist before their assessment for epilepsy surgery, none had received psychiatric treatment specifically directed toward the control of psychogenic seizures.

EPILEPSY SURGERY

The surgical techniques applied in this patient group have been described elsewhere. The epileptogenic lesions identified were hippocampal sclerosis (7 patients), cortical or glioneuronal dysplasia (3 patients), benign tumor (2 patients), and cerebral hemiatrophy (1 patient). Ten patients underwent temporal lobe operations (6 had selective amygdala-hippocampectomies), 7 on the right side. Two patients had extended extratemporal lesionectomies, 1 a functional hemispherectomy. The mean age at the time of epilepsy surgery was 29 years. Mean postoperative follow-up was 56 months (Table 2).
fewer than 3 epileptic seizures per year after surgery but continued to be badly disabled by her devastating psychogenic seizure disorder. She had spent a considerable part of her childhood in the hospital with relapsing nephrotic syndrome and complications of immunosuppression. Behavioral problems had been noted that a psychiatrist had characterized as pathological illness behavior. She had taken a deliberate drug overdose. She had a preoperative history of several episodes of "status epilepticus," which, retrospectively, were likely to have been pseudo–status epilepticus. Postoperatively, she developed a chronic factitious disorder. She had more than 20 admissions with pseudo–status epilepticus to hospitals all over Germany. On at least 10 occasions, pseudo–status epilepticus developed during train journeys, causing emergency stops.

According to the modified Engel classification, epilepsy surgery was considered successful in 9 of 13 patients with mixed (epileptic and psychogenic) seizure disorders, useful in 2 patients, and a failure in 2 patients (Table 3).

Up to 20% of patients referred to epilepsy surgery centers with presumed refractory epileptic seizures prove to have purely psychogenic seizure disorders. Between 1991 and 2000, we diagnosed psychogenic seizures in 233 patients admitted to our ward. In 10% to 30% of unselected patients, psychogenic seizures coexist with epilepsy. We found additional epileptic seizures in 50% (116/233) of our inpatients with psychogenic attacks. Patients with epilepsy who have additional psychogenic seizures are excluded from some epilepsy surgery programs. We believed that we should not bar patients with medically refractory epileptic seizure disorders from a proven, potentially curative form of treatment. However, epilepsy surgery was offered only to patients predominantly disabled by epileptic rather than psychogenic seizures, and patients were informed preoperatively that surgery was a recognized intervention only for epileptic seizures and not for psychogenic seizures.
In total, 38 (2.8%) of 1342 patients examined for epilepsy surgery and 13 (1.3%) of 1001 patients operated on at our center during the past decade were preoperatively known to have additional psychogenic seizures. There was a preponderance of women in the group of surgically treated patients with additional psychogenic seizures (76.9% vs 50.9% of all patients operated on). Right-sided surgery was also more common in this group than in our whole surgical cohort (76.9% vs 44.7%). The patients were representative of our whole group in terms of onset or severity of epilepsy and age at the time of surgery. An association of psychogenic seizures and other somatoform disorders with female sex and right-sided neurologic disease has been described in previous studies of patients with mixed seizure disorders. The high number of patients with additional psychogenic seizures (10 of 13) who had a recorded history of psychological, behavioral, or psychiatric problems does not necessarily mean that psychogenic seizures were clearly demonstrable, surgically amenable seizure onset zone. A diagnosis of additional psychogenic seizures adds a further dimension to this evaluation. The Engel epilepsy surgery outcome classification.

Psychogenic seizures could also disappear after epilepsy surgery. In all, 9 patients became free of psychogenic attacks, 4 with a latency of 2 to 18 months. Seven of 9 patients who became free of psychogenic seizures postoperatively were also free of epileptic attacks. However, the patient with the worst postoperative outcome in terms of epileptic seizures (patient 4) also achieved freedom from psychogenic seizures, and 3 of 4 patients who continued to have psychogenic seizures after surgery became free of disabling epileptic seizures. There was therefore no definite link between the postoperative outcome in terms of epileptic and psychogenic seizures.

That 7 of our patients became free of both seizure types does not necessarily mean that psychogenic seizures were also caused by focal, organic disease, which was cured by resection of the ictogenic part of the brain. Epilepsy surgery, whether or not successful, represents a significant life event, and the reasons for an improvement of psychogenic seizures could well be psychological. It has also been observed that psychogenic seizures can remit spontaneously after a patient has been confronted with the diagnosis (eg, during the presurgical workup). Whatever the mechanism of improvement, the duration of follow-up suggests that freedom from psychogenic seizures can be maintained long-term after epilepsy surgery. The relatively good outcome in terms of psychogenic seizure control in our patients who underwent epilepsy surgery is in contrast with the poor outcome described in a group of patients with conservatively treated mixed seizure disorders.

In patients (2), the frequency of psychogenic seizures declined, there were several episodes of pseudo–status epilepticus after the operation. Epilepsy surgery can improve patients' lives only if candidates are examined carefully before surgery and if operative intervention is offered only to those who have a clearly demonstrable, surgically amenable seizure onset zone. A diagnosis of additional psychogenic seizures adds a further dimension to this evaluation. The "surgical fail-

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<th>Table 3. Outcome of Epilepsy Surgery</th>
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<td>Monthly Seizure Frequency, No.</td>
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<td>Mean</td>
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*Psychogenic seizures were included in the tabulation. See the "Outcome" subsection of the "Patients and Methods" section for details of our modification to the Engel epilepsy surgery outcome classification.
ures” in our series were caused by the persistence of their underlying psychological disorder, expressed by psychogenic seizures and pseudo-status epilepticus. This suggests that it is prudent to pay close attention to patients’ psychological status and to the cause of their psychogenic seizures before epilepsy surgery is undertaken. Our limited experience indicates that frequent or recurrent unexplained neurologic or medical symptoms and multiple operations may be a warning of poor surgical outcome, although less frequent or severe unexplained symptoms were also recorded in 2 of our patients who were successfully operated on. Other investigators have identified female sex, neurologic abnormality of the right or nondominant hemisphere, and seizure onset after puberty as risk factors for psychogenic seizures after epilepsy surgery. The inability of a patient to distinguish between psychogenic and epileptic attacks should not necessarily be a bar to surgery; although none of the patients who failed to improve overall could differentiate their epileptic from their psychogenic attacks, 3 of those patients who were successfully operated on could not distinguish their seizure types. In addition, frequent psychogenic seizures and a history of pseudo-status epilepticus do not seem to be reliable predictors of poor epilepsy surgery outcome.

Several potential limitations of our study deserve discussion. Patients examined for epilepsy surgery at our center represent a highly selected population; our results should thus be extrapolated with caution. In particular, the findings should not be interpreted as showing that epilepsy surgery is a treatment for psychogenic seizures. Furthermore, the retrospective nature of the study introduces potential bias. The selection of patients with mixed seizure disorders for surgery was not based on predefined rules, and our results may have been different if more of the 116 patients with both epileptic and psychogenic seizures studied on our ward had been operated on. In 2 patients, the preparative diagnosis of additional psychogenic seizures was not based on video EEG (the mode of investigation that comes closest to representing a gold standard in this setting) but on the observation of situational attacks that improved with verbal reassurance. Although attacks were observed by experienced clinicians, our diagnosis in these patients may have been incorrect. Likewise, we may have been wrong in the classification of persistent epileptic seizures in patients 1 and 4 and psychogenic seizures in patients 3 and 12 after surgery. In view of the low frequency of these postoperative events, the diagnosis was based on expert clinical assessment and preparative seizure documentation rather than direct seizure observation.

Despite these limitations, we feel justified in concluding that patients with disabling, refractory epileptic and additional psychogenic seizures should not be barred from epilepsy surgery, since this would deny a good outcome to some patients. However, both epileptic and psychogenic seizures should be clearly characterized before surgery. Although we have no proof of the efficacy of a preoperative psychiatric contact, patients with additional psychogenic seizures should be assessed by a psychiatrist before epilepsy surgery is undertaken so that psychological intervention can be considered, a clear psychiatric diagnosis formulated, and a prognosis recorded. Our findings should be confirmed in future prospective studies.

Accepted for publication September 7, 2001.

**Author Contributions:** Study concept and design (Drs Reuber, Kurthen, and Elger); acquisition of data (Drs Reuber and Fernández); analysis and interpretation of data (Drs Reuber, Kurthen, Fernández, and Schramm); drafting of the manuscript (Drs Reuber and Kurthen); critical revision of the manuscript for important intellectual content (Drs Reuber, Fernández, Schramm, and Elger); statistical expertise (Drs Reuber and Fernández); obtained funding (Drs Reuber, Schramm, and Elger); administrative, technical, and material support (Drs Reuber and Kurthen); study supervision (Drs Schramm and Elger).

This study was supported by the St James’ Trust for Nervous System Diseases and the Special Trustees of the General Infirmary at Leeds, Leeds, England (Dr Reuber), and grant SFB 400 from the Deutsche Forschungsgemeinschaft, Bonn, Germany (Drs Schramm and Elger).

We thank Peter J. Goulding, MD, FRCP, and Allan O. House, MD, FRCPsych, for their helpful comments.

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