Surgical treatment of epilepsy resistant to medical therapy

Epilepsy is a chronic brain disorder characterized by the spontaneous occurrence of seizures, the clinical characteristics of which depend on the regions of the brain involved at the beginning of, during and after the ictal event. The prevalence of epilepsy in UK ranges between 0.5 and 1% and of these about 20% are considered to be refractory to pharmacotherapy.

Surgery should be considered if seizures remain intractable after a reasonable trial of anticonvulsant medication. Clinical judgment is necessary to determine in the individual patient what 'medically refractory' is, in terms of frequency and severity of seizures, and how these impact on the patient's quality of life.

HISTORICAL DEVELOPMENT OF SURGICAL TREATMENTS

The modern era of surgical treatment for epilepsy began in 1886 when Horsley described the localized resection of two cerebrocortical scars and one brain tumour in three patients with seizures (Horsley, 1886). Subsequently, a variety of other surgical procedures have been introduced, including hemispherectomy in 1923 by Dandy, corpus callosotomy in 1940 by Van Wagenen, temporal lobectomy by Penfield and Flanigin in 1950 and more recently the subpial trans-section by Morrell in 1989.

During the past decade in the UK, interest in the surgical treatment for medically intractable epilepsy has increased exponentially among the neurological and neurosurgical specialties. However, epilepsy surgery requires a team approach to what is a complex and chronic problem. The key is a multidisciplinary presurgical assessment with psychological, psychiatric, surgical and radiological input, with the epileptologist (neurologist) as the coordinator.

Simply removing a seizure focus by surgery in a patient who may have longstanding psychological and social problems as a result of the chronic disorder is not sufficient treatment; epilepsy surgery should be done within a comprehensive epilepsy centre staffed to treat patients and deal with their physical and psychological rehabilitation.

SELECTION OF CANDIDATES

A reliable presurgical evaluation helps to select the candidates for epilepsy surgery by providing localizing information about the epileptogenic focus, defined electrically, morphologically and functionally. A variety of non-invasive tests, as well as invasive studies (sodium amytal test and epidural, subdural or depth electrode monitoring), are used. Magnetic resonance imaging (MRI) plus videotelemetry are by far the most important non-invasive tests; the former to detect structural abnormalities, the latter to define the electroclinical seizure.

Other neuroimaging modalities such as positron emission tomography (PET), single photon emission computed tomography (SPECT) and magnetoencephalography (MEG) are also useful on occasion, however, these imaging techniques should be considered as clinical research tools at present. Neuropsychological and psychiatric assessment are also very important parts of the presurgical evaluation; not only can these specialities help to localize the parts of the brain being affected by the seizure, they are also crucial in assessing the risk to memory or of a psychiatric reaction following surgery.

DIFFERENT SURGICAL PROCEDURES

The most common and by far the most effective surgical procedure for epilepsy continues to be the resection of localized epileptogenic brain tissue (either a foreign tissue lesion, i.e. tumour of vascular anomaly, or hippocampal sclerosis). Because most of the medical resistant epilepsies have a temporal origin, an anterior temporal lobe resection is the most common surgical procedure for epilepsy. The operation involves the removal of the anterior two-thirds of the lateral temporal lobe (4–6 cm) and crucially the removal of the mesial temporal structure (most importantly the hippocampus).

More selective resections of the amygdala and hippocampus have developed for mainly the same indications but to avoid the possible psychometric disadvantages of the larger resection. With wholly concordant information from the clinical appearance of the seizure (ictal semiology), electroencephalogram recordings, brain imaging and neuropsychology studies, the result of temporal lobe epilepsy surgery is good, with a long-term seizure control outcome expected in 70–80% of cases (Engel, 1996).

A more recent and potentially attractive way of treating mesial temporal lobe epilepsy is ablation of the mesial temporal structures using radiosurgery. However, only a handful of patients with mesial temporal epilepsy are treated this way. Randomized controlled studies and long-term follow-up are needed to evaluate the antiepileptic effect of radiosurgery (Regis et al, 1995).

Frontal and occipital lobectomies do not play a major role in modern epilepsy surgery and have been mainly replaced by resections of the extra-

temporal epileptogenic lesions with or without surrounding brain tissue as guided by the electrocorticography (peroperative electroencephalography).

Other surgical procedures which are used less frequently in some highly selected cases are corpus callosotomy, hemispherectomy and multiple subpial trans-section. Callosotomy (dividing the corpus callosum) is based on the principle of disrupting the propagation of generalized seizures. It is considered in intractable epilepsy (particularly 'drop attacks') where no epileptic focus can be localized. Following this palliative procedure, approximately 50% of the patients show some improvement in their seizures, although the beneficial effect tends to decline in the long term.

Hemispherectomy is reserved for those cases with widespread unilateral and usually progressive brain disease causing intractable partial epilepsy. Hemispherectomies are virtually always performed only in children, where the brain is still developing, and where important functions have been shown, in the presurgical work-up, to have already relocated. Multiple subpial trans-section is an attractive addition to epilepsy surgery. This procedure aims at abolishing epileptogenic activity within vital functioning cortex without destroying its function. By disrupting only the lateral interneural connections, the pathways to subcortical structures are preserved. This procedure has found a small but distinct place in the epilepsy surgery armamentarium for those cases in which an extra-temporal epileptogenic lesion lies within an eloquent area (a part of the brain which serves important clinical functions, e.g. the motor strip).

Intermittent stimulation of the vagus nerve in the neck is emerging as a novel but important adjunct treatment used to reduce the frequency and severity of seizures in selected cases of partial onset seizures and primary generalized epilepsy, where resective surgery is not possible (Amar et al, 1998). In this role it is proving a useful palliative alternative; there are no risks associated with an intracranial operation, although side-effects from the stimulation itself do occur (e.g. hoarseness of voice).

KEY POINTS

- Intractable epilepsy remains a significant health-care problem in the UK.
- Epilepsy surgery is often highly effective but still probably under-used.
- Temporal lobe resections are the mainstay of surgical treatment of epilepsies.
- Callosotomy is now only rarely used.
- Hemispherectomy has a well-defined role in some childhood epilepsies.
- Vagus nerve stimulation is sometimes useful in cases not suitable for resective surgery.
- Radiosurgery is a novel treatment modality whose long-term efficacy needs to be proven.

CONCLUSION

The indication for surgery for epilepsy is primarily medical intractability. Modern surgical treatment options are varied. Each case assessment needs to be highly individualized within epilepsy surgery centres with the capabilities of performing all the presurgical tests that are required and the different types of surgery which may be indicated. HM

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Amar A, Heck C, Levy M et al (1998) An institutional experience with cervical vagus stimulator for medical intractable epilepsy. *Neurosurgery* **43:** 1265–75
Engel J (1996) Surgery for seizures. *N Engl J Med* **334:** 647–52
Horsley V (1886) Brain surgery. *Br Med J* **ii:** 670–5
Penfield W, Flanigin H (1950) Surgical therapy of temporal lobe seizures. *Arch Neurol Psychiat (Chicago)* **64:** 491
Regis J, Paragut J, Rey M et al (1995) First selective amygdalohippocampal radiosurgery for mesial temporal lobe epilepsy. *Stereoctact Funct Neurosurg* **64:** 193–201