ROLE OF MAGNETIC RESONANCE IMAGING FOR PREOPERATIVE EVALUATION OF PATIENTS WITH REFRACTORY EPILEPSY

ACF Hui 許志輝
JMK Lam 藍明權
YL Chan 陳宇亮
KM Au-Yeung 歐陽啟明
KS Wong 黃家聲
R Kay 祁理治
WS Poon 潘偉生

**Objective.** To investigate the magnetic resonance imaging characteristics of patients with refractory epilepsy and the relationship to progression to surgery.

**Design.** Prospective observational study.

**Setting.** University teaching hospital, Hong Kong.

**Patients.** Patients undergoing preoperative evaluation for epilepsy surgery.

**Main outcome measure.** Cranial magnetic resonance imaging findings, correlation with electroencephalographic results, and percentage of patients who were considered suitable candidates for surgery.

**Results.** Structural abnormalities associated with refractory epilepsy in 100 consecutive patients were mesial temporal sclerosis (30%), neocortical sclerosis (23%), vascular malformation (7%), neuronal migration disorders (7%), and tumours (5%). Normal brain scans were found for 28% of patients. Fourteen of 30 (46%) patients with medial temporal lobe lesions at magnetic resonance imaging were suitable candidates for surgery compared with 8/42 (19%) patients with extrahippocampal lesions (odds ratio=3.7; 95% confidence interval, 1.3-10.6; P<0.012).

**Conclusion.** Mesial temporal sclerosis was the most common pathology in patients with refractory epilepsy. At the Prince of Wales Hospital, for patients who have undergone a basic magnetic resonance imaging protocol and surface electroencephalography, the result of cranial magnetic resonance imaging is an important determinant for whether patients will undergo surgery.

---

**Key words:**
Epilepsy;
Magnetic resonance imaging;
Surgery

**Key words:**
癲癇症；
磁共振成像；
外科手術

**Hong Kong Med J 2003;9:20-4**

The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong:
Division of Neurology, Department of Medicine
ACF Hui, MRCP
KS Wong, MD, FRCP
R Kay, MD, FRCP

Division of Neurosurgery, Department of Surgery
JMK Lam, FRCS (Edin)
WS Poon, MD, FRCS (Glasg)

Department of Diagnostic Radiology and Organ Imaging
YL Chan, FRCR
KM Au-Yeung, FRCR

Correspondence to: Dr ACF Hui

---

**Introduction**

In Hong Kong, 20% of patients attending neurological clinics have pharmaco-resistant seizures but there is limited local information about epilepsy surgery. Apart from the physical effects of seizures, patients with refractory epilepsy may experience social isolation, lost educational opportunities, loss of independence, and discrimination in employment. Surgery is an established treatment for
patients with partial epilepsies refractory to drug treatment—approximately 60% of patients become free of seizures after surgery, with even higher success rates reported for certain subgroups.2,4

In addition to radiological abnormalities, the identification of a surgical candidate requires concordant clinical, psychological, and electroencephalographic (EEG) confirmation. Magnetic resonance imaging (MRI) allows preoperative targeting of the epileptogenic substrate.5,10 Magnetic resonance imaging is more sensitive than computed tomography (CT) in detecting structural abnormalities because of its superior soft tissue contrast multi-planar imaging capability and lack of beam hardening artefacts.11,12 While the mechanisms by which structural lesions induce seizures are unclear in most instances, MRI implicates a particular region as the source of seizures. The epileptogenic zone is most commonly located in the medial temporal lobe and the structures involved include the hippocampus, amygdala, dentate, and parahippocampal gyri. Although, historically, MRI protocols were designed to detect the presence of structural pathology in this region, lesions beyond these mesial structures can also give rise to refractory epilepsy. The objective of this study was to determine the MRI features in Chinese patients with refractory epilepsy undergoing assessment for surgical management. The association between the neuroradiological lesion and likelihood of the patient progressing to surgery was also studied.

Methods

Clinical information and brain MRI scans of patients referred to the epilepsy surgery programme of the Prince of Wales Hospital in Hong Kong—a regional centre that accepts referrals from other hospitals—were prospectively collected. Patients were considered potential candidates if they had refractory and disabling seizures despite adequate trials of two appropriate anti-epileptic drugs. International League Against Epilepsy classification of epilepsies and epileptic syndromes was used for determining the clinical diagnosis.13

The following exclusion criteria applied:
(1) presence of generalised epilepsy syndrome;
(2) presence of systemic illness such as neoplasm, or renal or liver failure;
(3) evidence of extrahippocampal lesions.

Magnetic resonance imaging lesions were divided into the following three categories:
(1) normal MRI;
(2) evidence of medial temporal lobe lesions; and
(3) evidence of extrahippocampal lesions.

Patients with extratemporal and lateral temporal neocortical MR abnormalities were included in the last group.7 The presence of MRI lesions were used to investigate the relationship between MRI abnormalities and eligibility for surgery. P values of less than 0.05 were considered statistically significant.

Results

One hundred consecutive adult patients (45 men, 55 women) underwent presurgical evaluation. The age range was 15 to 50 years (mean, 33 years). The diagnostic yield from MRI was 72%; scans were normal for 28 patients. Evidence of mesial temporal sclerosis was identified by one of two major MRI findings—hippocampal atrophy and increased signal intensity of the hippocampus on T2-weighted images. The most recent MRI studies for scrutinising these features using visual inspection have achieved sensitivities of 87% to 100%.14,15 Other secondary MR features include temporal horn dilatation, loss of hippocampal internal architecture, decreased hippocampal signal on T1-weighted images, poor parahippocampal grey-white matter definition, and loss of hippocampal interdigitations.

All patients had scalp EEGs, obtained using Nicolet BMSI (Nicolet Biomedical Inc, Madison, US) or Telefactor digital video-EEG (Telefactor, West Cohshohocken, US), and read by one of the authors. All patients with focal lesions at MRI went on to have video-EEG. Interictal or ictal epileptic discharges arising from the region with a lesion identified by MRI were regarded as concordant MRI and EEG evidence.

Patients who were considered suitable candidates went on to have functional brain assessment with the amylobarbitone (Wada) test before surgery. This involves injection of sodium amylobarbitone into the internal carotid artery, which inactivates the regions supplied by this vessel. Language representation and memory performance of the unaffected side of the brain can then be tested. The results were used to further establish lateralised temporal lobe dysfunction and to predict the likelihood of postoperative language or memory decline.

Magnetic resonance imaging lesions were summarised in Fig 6.
Electroencephalograms with surface electrodes were non-localising or non-lateralising for 50% of patients, concordant for 28%, multifocal for 16%, and discordant for 4%.

Twenty-two patients with concordant clinical, EEG, and MRI data were considered suitable for surgery; of these, 20 have been operated on and two have refused surgery. Using EEG information from scalp video-telemetry, 14/30 (47%) patients with MR evidence of medial temporal lobe lesions were regarded as candidates for surgery, whereas the figure was only 8/42 (19%) for those with extrahippocampal lesions (odds ratio=3.7; 95% confidence interval, 1.3-10.6; P<0.012). None of the patients (n=28) with normal MR scans were operated on.

Discussion

This series shows that mesial temporal lobe epilepsy (MTLE) is the most common form of epilepsy syndrome causing intractable seizures. The second most common finding was neocortical sclerosis and regions of encephalomalacia, which follows a number of insults to the central nervous system, including infarction, encephalitis, trauma, and inflammation. Low-grade tumours were found in six patients. Similar to results from other epilepsy centres, these consisted of low-grade lesions such as oligodendroglioma and dysembryoplastic neuroepithelial tumours. Tumours from oncological centres show a larger range of histological types with more aggressive grading.

Magnetic resonance imaging can identify structural anomalies that are associated with epilepsy. A radiological abnormality alone, however, may not represent the epileptogenic zone as it may be incidental and seizure onset...
Magnetic resonance imaging in patients with refractory epilepsy may arise from other areas. The EEG therefore remains essential for demonstrating electrically excitable tissue.\(^{16,17}\)

For patients with evidence of a lesion outside the temporal lobe or with diffuse pathology such as post-meningitic encephalomalacia, ictal scalp EEG recordings are often poorly localising. Candidates would require invasive EEG using subdural grids and/or depth electrodes. The more uncertain the source of epileptic activity, the more extensive coverage is required, which would lead to higher risk of complications (implantation of intracranial electrodes has a complication rate of 4\%).\(^{18-20}\)

In many Asian countries, the facilities and personnel required are not available for prolonged invasive EEG monitoring or functional imaging. Even with these additional investigations, the outcome after surgery is generally poorer compared with those patients with MTLE.\(^{21}\)

None of the patients with normal MRI were operated on. While this is, in part, a reflection of our hospital practice, it is commonly accepted that absence of a focal lesion renders the work-up more difficult and the prognosis for a good outcome is poorer. This does not imply that patients with a normal MRI should be automatically excluded from surgery, as alternative MRI techniques such as T2-reflexometry, MR volumetric studies and proton spectroscopy may uncover corroborating evidence. The optimum protocol includes an oblique coronal high resolution T2-weighted sequence, using 3-mm thin sections. To date, the imaging sequence should include oblique coronal high resolution T1-weighted volume data (spoiled gradient recalled echo acquisition with 1.5 mm partition size) through the whole brain, which allows reformatting in any plane, measurement of hippocampal volumes, and co-registration with functional data. A coronal fluid attenuated inversion recovery (FLAIR) sequence is also used to increase conspicuity of high T2 signal cortical lesions adjacent to the cerebrospinal fluid space. Quantitative assessment of the hippocampal volume have slightly increased sensitivity but the commonly used quantitative method is demanding and time-consuming,\(^{22,23}\) and is impractical for routine usage. Measurement of T2-relaxation time may also be quantified and this improves the sensitivity for hippocampal abnormalities.\(^{24}\)

With functional imaging techniques, interictal positron emission tomography may reveal potential epileptogenic areas but is not readily accessible; single photon emission CT is more widely available but requires ictal images. In many established centres, further presurgical assessment may be terminated for patients with normal high resolution MRI and non-localising electroclinical syndrome.

Since the presence of focal and, in particular, medial temporal lobe pathology increases the chances of progression to successful surgical treatment, high resolution
MRI should be performed early in the presurgical evaluation. This would reduce additional stress and inconvenience to patients and optimise the use of resources. Epilepsy centres, however, should not rely on the results of a single test as this would restrict access to surgery. The introduction of semi-invasive/intracranial EEG and more advanced imaging sequences would allow more patients with intractable seizures to benefit from surgery.

References


---

Announcement

Academy Fellows and Association Members are invited to submit original articles, case reports, pictorial medicine and medical practice papers for publication in the Journal.

The current acceptance rate is approximately 55 percent.

For further information, please refer to our website <http://www.hkmj.org.hk>.

Page charges have been abolished from 2003.