An overview of pre-surgical evaluation

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Abstract

The success of an epilepsy surgery program depends upon the early identification of potential surgical candidates and selecting from them, ideal candidates for surgery, who are destined to have a post-operative seizure-free outcome without any unacceptable neurological deficits. Since epilepsy surgery centers in resource-poor countries will lack the full range of state-of-the-art technologies usually available in resource-rich countries to perform pre-surgical evaluation, cost-effectively utilization of the locally available investigative facilities to select the surgical candidates becomes challenging. In the present era of rapid electronic communications and telemedicine, it has become possible for epilepsy surgery centers to pool their technological and human resources and to partner with centers nationally and internationally in implementing pre-surgical evaluation strategies.

Key Words

Epilepsy, pre-surgical evaluation, surgery

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Introduction

The epilepsy comprises a heterogeneous group of disorders clinically characterized by recurrent unprovoked seizures and electrically characterized by a sudden synchronized burst of electrical discharge emanating from a pool of neurons. The recurrent seizures that constitute epilepsy may be localized in origin or may be generalized. A majority of patients with localization-related (focal) epilepsies have a structurally and/or electrically identifiable lesion involving the cerebral cortex. Although a majority of patients with epilepsies are controlled by antiepileptic drugs (AEDs), nearly one-third of them continue to have recurrent seizures despite optimum AED therapy. A proportion of these patients with drug-resistant epilepsy (DRE) are candidates for epilepsy surgery. The objective of epilepsy surgery is not only to eliminate epileptic seizures without causing any neurological or cognitive deficits, but also to improve the quality-of-life and make an individual a productive member of the society.

Rationale of Pre-surgical Evaluation

The surgical candidacy of a patient with DRE is suspected based on the focal nature of the electro-clinical and neuroimaging data. However, not all spells in a patient with suspected DRE are epileptic and not all focal findings in such a patient are causally related to epileptic seizures. Therefore, the first step in the pre-surgical evaluation is to determine whether the habitual spells exhibited by a patient are indeed focal epileptic seizures and if they are, whether the lack of response to AED therapy in that patient is not because of noncompliance, inappropriate choice or inadequate dose of AEDs.[1,2] The second step is to localize the epileptogenic zone, which is defined as the region, the resection of which is necessary and sufficient to achieve seizure-freedom.[3] Although the anatomical extent of the epileptogenic zone cannot be directly established prior to surgery, it can be presumed with reasonable accuracy using a multimodality approach comprising clinical, electroencephalographic (EEG), structural and functional neuroimaging and neuropsychological evaluations [Table 1]. Although the presence of a well-defined lesion provides an important evidence for the localization of the epileptogenic zone, more often, the epileptogenic zone extends beyond the anatomical boundaries of the lesion and in certain instances, as in dual pathologies, may even be remote from the lesion. For example, the author and his colleagues have demonstrated that nearly one-third of patients with calcified neurocysticercosis lesions presenting with DRE can have an additional potentially epileptogenic lesion such as hippocampal sclerosis.[4] In such patients, to optimize post-operative seizure outcome, it is important to establish the causal relationship between one, other or both the substrates with regard to the origin of the epileptic seizures. Furthermore, when there are multiple lesions, as in tuberous sclerosis, the lesion that is causally related to the patient's seizures needs to be established before proceeding with surgery.[5] The third step is to delineate, if necessary, the spatial relationship between the presumed epileptogenic zone and eloquent cortical areas by functional

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Table 1: Pre-surgical evaluation modalities

Clinical evaluation
History: Seizure/spell semiology, AED therapy, compliance, psychosocial factors
Examination: Mimic facial paresis, visual field defects, other neurological deficits
Neuropsychological/speech evaluation
Neuropsychological testing
Speech/language testing
Intracarotid amobarbital (Wada) test
Psychosocial and psychiatric evaluations
Occupational evaluation
Structural imaging
MRI (≥1.5T), CT (to exclude calcification, if indicated)
Electrophysiological evaluation
Scalp/sphenoidal video-EEG monitoring
Invasive video-EEG monitoring
Intra/extra-operative electrocorticography/cortical stimulation and mapping
MEG
Functional imaging
Functional MRI
SPECT
PET
Co-registration strategies
SISCOM (SPECT plus structural MRI)
PET-structural MRI
EEG-fMRI (EEG plus fMRI)
Electrical source imaging (EEG plus structural MRI)
Magnetic source imaging (MEG plus structural MRI)

AED = Antiepileptic drug, CT = Computed tomography, MRI = Magnetic resonance imaging, EEG = Electroencephalographic, MEG = Magnetoencephalography, fMRI = Functional magnetic resonance imaging, PET = Positron emission tomography, SPECT = Single photon emission computed tomography,

mapping studies. The final step is to debate in a patient management conference whether and how the presumed epileptogenic zone can be completely resected without sacrificing the eloquent cortical areas.

Pragmatic Utilization of Pre-surgical Evaluation Technologies

The success of an epilepsy surgery program depends upon the early identification of potential surgical candidates and selecting from them, ideal candidates for surgery, who are destined to have a post-operative seizure-free outcome without any unacceptable neurological deficits.[6] Since epilepsy surgery centers in resource-poor countries will lack the full range of state-of-the-art technologies usually available in resource-rich countries to perform pre-surgical evaluation and surgery, the success of epilepsy surgery programs in a developing country like India will depend upon the ability of the team to select ideal surgical candidates using locally available technology and expertise without compromising on patient safety.[6,7] Knowing when not to operate because of the need for further investigations is as important as selecting which patient may benefit from surgery with the available facilities.

The selection of the pre-surgical evaluation modalities that are required to reliably localize the epileptogenic zone and to delineate its relationship to eloquent cortical areas in an individual patient with DRE can vary from simple and straightforward to highly complex multi-stage approach [Table 1]. Patients considered for focal resections such as those with mesial temporal lobe sclerosis and low-grade neoplasms and those with large hemispheric lesions considered for hemispherotomy could be selected for surgery by magnetic resonance imaging (MRI) and interictal and ictal EEG findings; many of them may not even require ictal video-EEG recordings. In contrast, patients with focal cortical dysplasias that are located close eloquent cortical regions and those with normal/indistinct MRI findings often require multiple non-invasive and invasive investigations. Epilepsy surgery centers in resource-poor regions should initially restrict their surgical candidates to patients with mesial temporal lobe epilepsy and those with circumscribed potentially epileptogenic lesions in whom the epileptogenic zone can be unquestionably localized by using locally available relatively inexpensive and non-invasive technologies and in whom excellent post-operative outcome can be guaranteed. In these regions, where more often the patients and their caregivers bear the cost of medical care, epilepsy surgery centers will have to evolve a cost-effective pre-surgical evaluation strategy by restricting the investigations to the minimum. The author and his colleagues have shown that judicious use of spenoidal electrode EEG recording in patients with suspected mesial temporal lobe epilepsy can obviate the need for invasive EEG monitoring in nearly one in five them.[8] Similarly, patients who require ictal single photon emission computed tomography (SPECT) can be carefully selected to optimize the utilization and yield of this test.[9] It is important for epilepsy surgery centers to regularly assess their capabilities and limitations and adopt a stepwise approach to increasing levels of complex pre-surgical evaluation and surgical treatment strategies [Table 2].[6]

In this era of rapid electronic communications and telemedicine, it is no longer necessary for an epilepsy surgery center to possess all the advanced technologies used in the pre-surgical evaluation by itself. The epilepsy surgery centers can pool their technological and human resources and partner with centers nationally or internationally to develop optimum usage of facilities to benefit their patients. For example, the R. Madhavan

Table 2: Classification of surgically remediable epilepsy syndromes according to the pre-surgical evaluation strategies

Can be selected by simple non-invasive strategies
Unilateral MTLE-HS
Circumscribed lesions not adjacent to eloquent cortical areas
Large unihemispheric lesions (considered for hemispherotomy)
Mutifocal epilepsies (considered for corpus callosotomy, VNS or DBS)
Hypothalamic hamartoma associated epilepsy syndrome
Require functional and/or invasive strategies
Bilateral MTLE-HS
Those with discordant clinical-EEG-MRI data
Circumscribed lesions adjacent to eloquent cortical areas
Focal epilepsies with normal or indistinct MRI findings

DBS = Deep brain stimulation, MRI = Magnetic resonance imaging, VNS = Vagus nerve stimulation, MTLE-HS = Mesial temporal lobe epilepsy with hippocampal sclerosis, EEG = Electroencephalographic

Nayar Center, Trivandrum, which has undertaken nearly 1500 epilepsy surgeries during the last 18 years, still does not possess 3T MRI, SPECT and positron emission tomography of its own, but routinely utilizes the services of other centers to get these investigations done. Similarly, an epilepsy center in Uganda, where no MRI facility is available in the whole country, utilized computed tomography and expertise from well-established epilepsy centers in the United States and Canada to select ideal candidates and to undertake epilepsy surgery in that severely resource-constrained country.[10]

References

1. Radhakrishnan K, Nayak SD, Kumar SP, Sarma PS. Profile of antiepileptic pharmacotherapy in a tertiary referral center in South India: A pharmacoepidemiologic and pharmacoeconomic study. Epilepsia 1999;40:179-85.
2. Vijai J, Cherian PJ, Stlaja PN, Anand A, Radhakrishnan K. Clinical characteristics of a South Indian cohort of juvenile myoclonic epilepsy probands. Seizure 2003;12:490-6.
3. Rosenow F, Lüders H. Presurgical evaluation of epilepsy. Brain 2001;124:1683-700.
4. Rathore C, Thomas B, Kesavadas C, Radhakrishnan K. Calcified neurocysticercosis lesions and hippocampal sclerosis: Potential dual pathology? Epilepsia 2012;53:e60-2.
5. Zhang K, Hu WH, Zhang C, Meng FG, Chen N, Zhang JG. Predictors of seizure freedom after surgical management of tuberous sclerosis complex: A systematic review and meta-analysis. Epilepsy Res 2013;105:377-83.
6. Sylaja PN, Radhakrishnan K. Problems and pitfalls in developing countries. Epilepsia 2003;44 Suppl 1:48-50.
7. Radhakrishnan K. Challenges in the management of epilepsy in resource-poor countries. Nat Rev Neurol 2009;5:323-30.
8. Cherian A, Radhakrishnan A, Parameswaran S, Varma R, Radhakrishnan K. Do sphenoidal electrodes aid in surgical decision making in drug resistant temporal lobe epilepsy? Clin Neurophysiol 2012;123:463-70.
9. Rathore C, Kesavadas C, Ajith J, Sasikala A, Sarma SP, Radhakrishnan K. Cost-effective utilization of single photon emission computed tomography (SPECT) in decision making for epilepsy surgery. Seizure 2011;20:107-14.
10. Boling W, Palade A, Wabulya A, Longoni N, Warf B, Nestor S, *et al*. Surgery for pharmacoresistant epilepsy in the developing world: A pilot study. Epilepsia 2009;50:1256-61.

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