Chapter

Presurgical Evaluation of Epilepsy Surgery

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Abstract

Drug-resistant epilepsy (DRE) is defined as failure of two adequate trials of appropriately chosen and administered antiepileptic drugs. Approximately about 30% of epilepsy patients are drug resistant. Accountable reasons to treatment failure including failure to recognize epilepsy syndrome, poor drug compliance, lifestyle factors, etc. In modern era of medicine, DRE patient should be encouraged to have early referral to tertiary epilepsy centre for presurgical evaluation. Comprehensive neurophysiology, structural neuroimaging, and neuropsychological and psychiatric assessment are regarded as essential elements. Invasive electroencephalography (EEG) monitoring in terms of subdural electrodes, depth electrodes, foramen ovale electrodes, and more advanced technique using stereoelectroencephalography (SEEG) are strong armamentarium for epilepsy surgeon. Epilepsy surgery in terms of resection, disconnection, or neuro-modulation should be recommended after a multi-disciplinary agreement.

Keywords: epilepsy surgery, drug resistant epilepsy, presurgical evaluation, anatomo-electro-clinical hypothesis

1. Introduction

Drug-resistant epilepsy (DRE) is defined as failure of two adequate trials of appropriately chosen and administered antiepileptic drugs. Approximately about 30% of epilepsy patients are drug resistant. Accountable reasons to treatment failure including failure to recognize epilepsy syndrome, poor drug compliance, lifestyle factors etc. In modern era of medicine, DRE patient should be encouraged to have early referral to tertiary epilepsy centre for presurgical evaluation. Comprehensive neurophysiology, structural neuroimaging, neuropsychological and psychiatric assessment are regarded as essential elements. Invasive electroencephalography (EEG) monitoring in terms of subdural electrodes, depth electrodes, foramen ovale electrodes, and more advanced technique using stereo-electroencephalography (SEEG) are strong armamentarium for epilepsy surgeon. Epilepsy surgery in terms of resection, disconnection or neuro-modulation should be recommended after a multi-disciplinary agreement.

2. Background and definition of drug-resistant epilepsy (DRE)

Patients with epilepsy whose seizures do not respond successfully to anti-epileptic drug (AED) therapy are considered to have drug-resistant epilepsy (DRE).

The prior equivalent term included medically intractable epilepsy or pharma-resistant epilepsy. This group of patient have the greatest burden of epilepsy related disabilities, and also added the significantly the healthcare resources expenses.

In 2010, a consensus proposal from task force of the International League Against Epilepsy (ILAE) commission on therapeutic strategies. A framework comprises two "hierarchical" levels is proposed for definition of drug-resistant epilepsy (DRE). Level 1 is categorization of outcome to a therapeutic intervention and level 2 is core definition of DRE based on how many "informative" trials of antiepileptic drugs (AEDs) resulted in a "treatment failure" outcome. The definition of DRE usually requires failure of two adequate trials of appropriately chosen and administered antiepileptic drugs (be it sequential monotherapy or combined polytherapy) [1]. It is also important to include the impact of seizure factors (frequency, severity, associated behavioural problem) on individual psychosocial wellbeing. Such impact will lead to the physicians' decision on drug options and the urgency of considering non-medical therapies.

Other important areas in the clinical assessment of DRE include the following.

2.1 The epidemiology

The prevalence of epilepsy patients aged 15 years or over in Chinese communities has been estimated at about 3–5.7 per 1000 [2], and about 40,000 Hong Kong people could be expected to have active epilepsy. The cumulative probability of a second attack at 1, 2, and 3 years was 30, 37 and 42% respectively. DRE comprised about one third of all epilepsy patients. A more recent study in 2008 showed the crude prevalence of active epilepsy and seizure disorder were estimated to be 3.94/1000. So the cases that should have under tertiary care for consideration of intensive work up will be around 1000 cases annually. There existed a treatment or referral gap of 20 years in the United States for this group of patient [3, 4]. It is foreseen that the local condition will be similar and an unmet need should call for more escalated awareness.

2.2 The pathogenesis

Prospective studies with chronic epilepsy patients suggested that 70–80% of patients retain their status as intractable versus in remission [5]. In other words, a minority, around 20% of initial intractable seizure cases will archive seizure freedom in long run and vice versa. Postulated mechanism leading to intractability includes glial proliferation and dendritic sprouting with synaptic recognition [6] in mesial temporal sclerosis. The concept of paroxysmal depolarization shift (PDS) is cellular events in which rapidly repetitive action potentials are not followed by the usual refractory period, thereby generating a prolonged membrane depolarization. Repetitive neuronal firing probably underlies the interictal and ictal unit and local field recording of high frequency oscillations (HFO).

Another compelling theory is the build-up of epileptic "neuronal network" (NN), via alternation in neuronal circuitry [7, 8]. A well-defined NN example is the limbic network with sequential propagation path via hippocampus, amygdala, lateral temporal neocortex and entorhinal cortex, medial thalamus and frontal inferior lobes. The interest on neuronal network analysis in epilepsy had gained strength with the use of high resolution recording techniques. Seizures start in a well-defined brain area and spread at great speed to connected brain area recruiting specific neuronal networks into typical oscillatory behaviour. Therefore, epilepsies should be considered as resulting from disturbed network interactions that implies "multi-targeted treatments" [9–13].

2.3 Clinical course or trajectories and complications

In a recent study using incident cohort of drug resistant epilepsy, which adopt ILAE DRE criteria, there are different patterns of disease progression or trajectories observed [14]. The 30% proportion of patient eventually suffered from DRE was again observed. A long delay from disease onset to failure of second AED was also found. This finding might give insights to the pathogenesis as mentioned earlier.

The mortality and morbidity of DRE, is in general, believed to be higher than that of seizure free patients or patient with good seizure control [15–17]. Even in those that suffered from infrequent seizure, their daily life and subjective well-being are also jeopardized in various extents [18].

2.4 The classification

It is a common practice, among epileptologist, to subdivide the refractory epilepsy cases into temporal lobe epilepsy (TLE) and non-temporal lobe epilepsy (NTLE). The former also constitute two distinct groups, namely, mesial temporal lobe epilepsy (mTLE) and neocortical temporal lobe epilepsy (NeTLE), according to the clinical and radiological manifestations. Both mTLE and NTLE shared similar pathological substrates (**Table 1**) apart from the mesial temporal sclerosis only found in the former. The TLE patients usually present with complex partial seizures, with or without generalized seizure, depending on the neuronal network involved. Though a minority of these TLE will became seizure free after repeated drug trials [15], most of the patients will run a clinical course of refractory seizure attack, and indeed, they form the most well-known surgically remediable epilepsy syndrome [19].

For the non TLE cases, the clinical and radiological features are diverse and also depend on the underlying etiologies or pathological substrates. In general, the seizure semiology is less well defined and the MRI abnormalities are variable and they are challenging in the perspective of seizure focus localization. Usually concerted effort and multi modalities investigations (in phase 1 of presurgical evaluation) are required [20].

Pathological substrate	Mesial TLE	Neocortical TLE
Mesial temporal sclerosis	Most common	Not present
The others: present in both		
Neoplastic	High grade or low grade glioma	
Developmental	Focal cortical dysplasia	
Infective	Viral encephalitis	
Vascular	Cavernous angioma	
Migrational disorder	DNET, ganglioglioma	
Trauma	Encephalomalacia	

Table 1.
Temporal lobe epilepsy (TLE) pathology.

3. Approach to drug treatment failure

Before considering referral to tertiary centre for work up of DRE for surgical intervention, there are certain reasons of treatment failure that should be considered:

1. Failure to recognize a generalized epilepsy syndromes e.g. West's syndrome, Rasmussen's syndrome, autosomal dominant nocturnal frontal lobe epilepsy (ADNLE), early myoclonic encephalopathy (EME) etc.

2. Inappropriate choice of first line anti-epileptic drug (e.g. carbamazepine) that will aggravate seizures.

3. Poor drug compliance and lifestyle factors contributing to seizure recurrence.

These factors are often quoted as "pseudo-resistance" [21–23].

3.1 Guideline

There has been a number of regional and international consensus and guidelines related to comprehensive management of epilepsy surgery. In Hong Kong, the first guideline, *The Hong Kong Epilepsy Guideline 2009*, was published by the Hong Kong Epilepsy Society with the aim as a general guideline for the medical practitioner [24]. The Guideline included the following aspects:

1. Diagnosis, review, and referral

2. Patient education

3. Following a first seizure

4. Investigations

5. Classification

6. Principles of management

7. Pharmacological or AED management

8. Management of drug-resistant epilepsy

9. Side-effects of AEDs

10. Presurgical evaluation of drug-resistant epilepsy

11. Other forms of treatment

12. Prolonged seizures in the community

13. Treatment of status epilepticus

14. Perioperative management of seizure

15. Older people with epilepsy

16. Children and young people with epilepsy

The guidelines had the updated version in 2017–2018 and the whole guideline was divided into four sections addressing the following aspects including use of antiepileptic drugs, guideline on status epilepticus, drug resistant epilepsy, and woman and epilepsy [25].

3.2 Selection of eligible candidate

There is observation that the longer the delay between the onset of DRE and the surgery, the lower the chance of postoperative seizure freedom and improved psychosocial outcome [26]. So a timely referral is mandatory for quality care of such group of patients.

Anyhow, before recruiting the patient, the first step is to identify the appropriate candidate. Conceptually, the eligibility criteria will include the following:

1. Patient and patient's family understand and accept the surgical treatment and the potential risk

2. The seizure is disabling despite adequate and appropriate drug trial

3. The available imaging and neurophysiological data should be consistent with the possibility of a surgical remediable epileptic syndrome.

3.3 Presurgical evaluation

The first objective is to identify the epileptogenic zone, EZ by various invasive and non-invasive modalities of investigations. The more sophisticated or invasive approach will also depend on the clarity of structural identifiable pathologies in neuroimaging and the link with the clinical semiology.

The second objective, after screening of the potential epileptogenic zone, is to develop strategies to safeguard the lesion can be safely resected with no significant physical or cognitive sequelae.

The ultimate goal in presurgical evaluation is to identify the concept of "Six cortical zones" (**Figure 1**).

From pragmatic point of view, detailed interview of patient and patient's family and friends who can give detailed witness history and past background is mandatory. The interview should aim for recapitulating all relevant past history and probably risk factor or etiological factors. The latter will also give insights to prognosis of the epileptic disorder with respect to surgical treatment. A good example will be a case of post encephalitic epilepsy will render surgical intervention less successful [27].

There should be a multi-disciplinary team and the respective investigations should include neuroimaging, psychiatric, neuropsychological and electrophysiological assessment. A tertiary level or above epilepsy centre should have the available epilepsy surgery presurgical investigations of in two different levels:

- Level 1 investigations are compulsory to all epilepsy patients for better localization of epileptogenic zone by means of: (1) improvement of detection of structural lesion on MRI, (2) mapping the source of interictal epileptiform discharges, (3) detection of focal interictal brain dysfunction, and (4) detection of ictal focal brain hyperperfusion, and for assessment of risk of postoperative deficits by means of: (1) determination of hemisphere dominant for language, (2) prediction of risk of postoperative memory decline, (3) reduction of risk of visual field deficit, and (4) reduction of risk of motor deficit.

- Level 2 investigations are indicated for possible epilepsy surgery candidates with no formal conclusion about the localization or extension of epileptogenic zone. They are generally referring to those invasive monitoring tools.

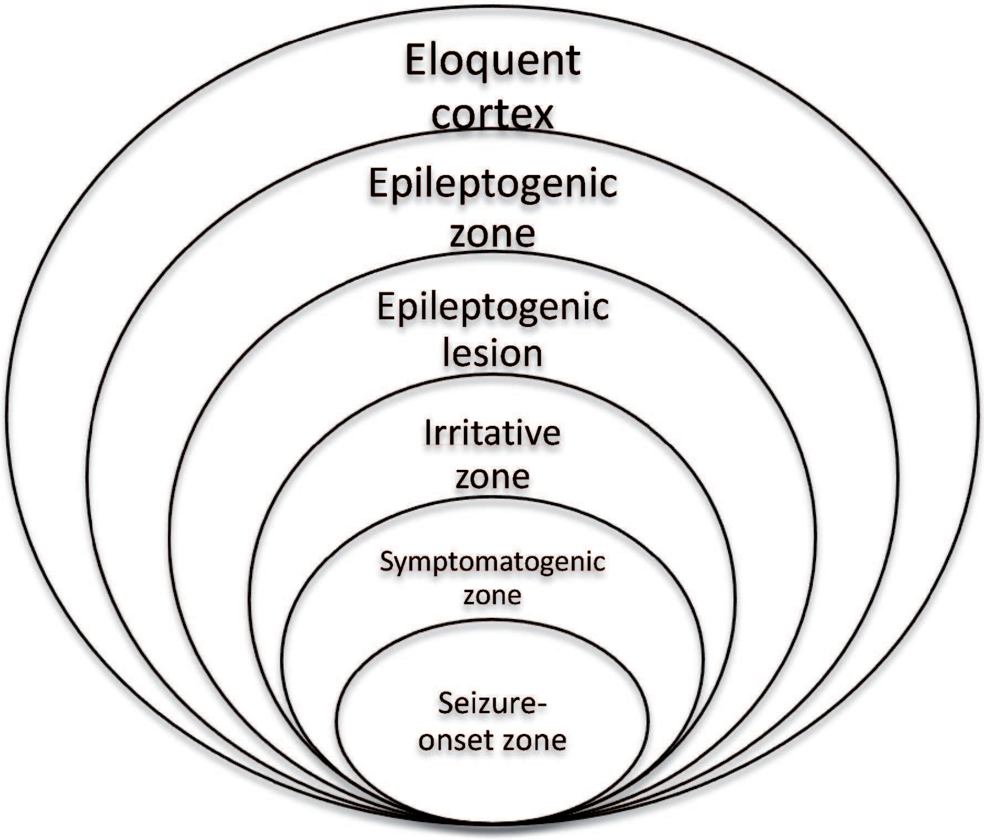

Figure 1.
Six cortical zones.

3.4 Neurophysiology

The neurophysiological evaluation includes interictal and ictal EEG sampling, which can be attained by non-invasive or invasive means in a long term recording manner.

The inter-ictal EEG will provide important hint to lateralization or localization of EZ. This is particularly true in cases of TLE solely unilateral anterior temporal spike is a strong predictor of post-operative seizure freedom [28]. Anyhow, it is not uncommon to have unilateral MTS with bitemporal interictal epileptiform discharges found [29]. Another interictal EEG pattern with good localizing value is short bursts of low-voltage, high frequency oscillations associated with focal cortical dysplasia [30].

Conceptually, the video EEG recording will capture the habitual seizures and the ictal EEG discharge and the lateralization and localization of the ictal onset zone can be deduced from analysis of adequate number of captured events.

After combined analysis of ictal and interictal EEG data, the irritative and ictal onset zones can be estimated [31].

Invasive recording is indicated when there is a hypothesis of epileptogenic zone that is not fully supported by the non- invasive diagnostic modalities results. These difficult scenarios are especially found in the non-lesional cases [32, 33].

3.5 Structural neuroimaging

Magnetic resonance imaging (MRI) of brain constitutes the basic, yet the most important investigation of choice in presurgical evaluation. It is particularly true in some epileptic disorder like temporal lobe epilepsy, of which mesial temporal sclerosis is the pathological substrate, got its unique radiological-anatomical correlates:

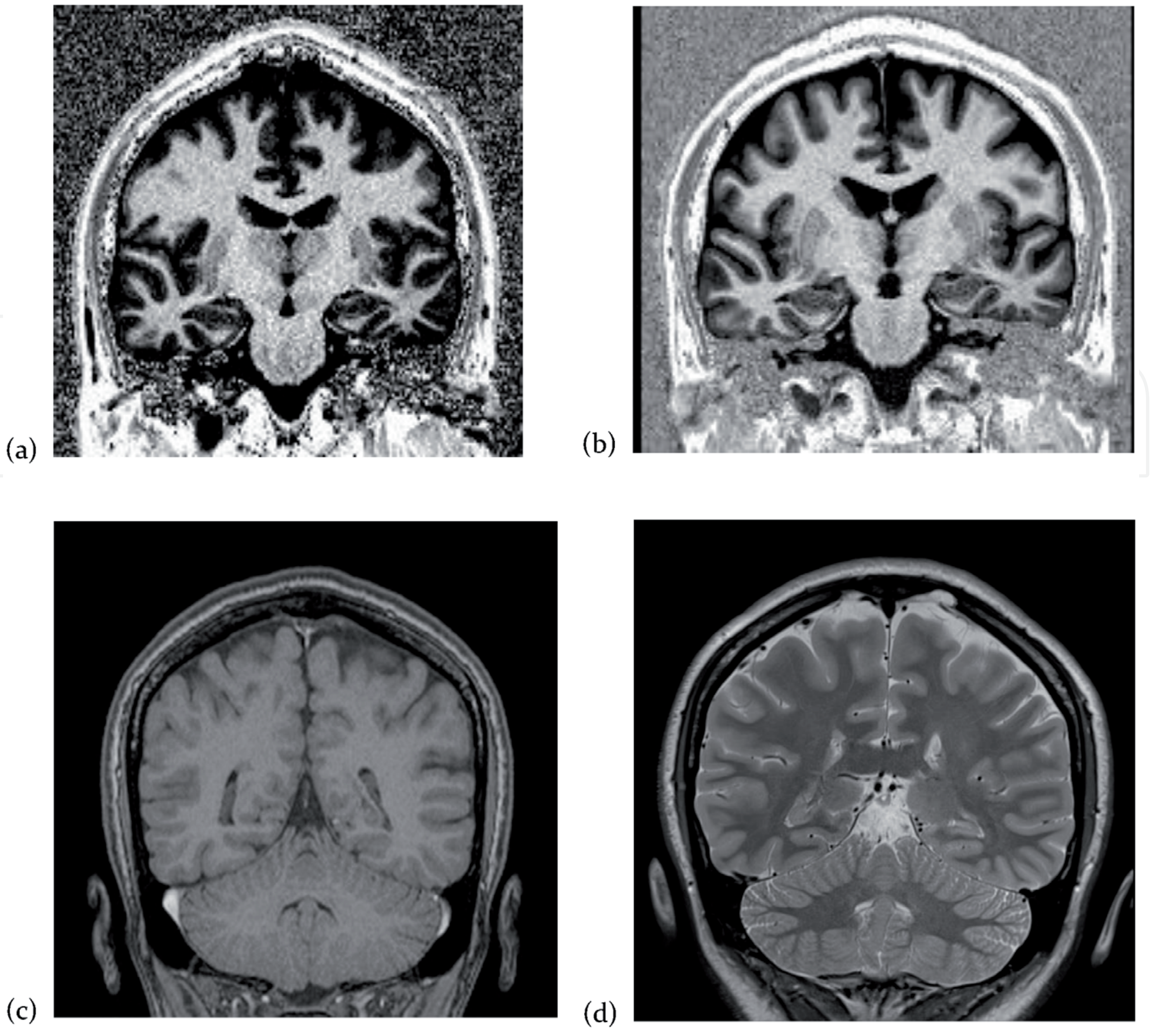

Figure 2.
Patient was regarded to be non-lesional epilepsy initially in 1.5 T MRI (a) and found to have cortical dysplasia in left temporal stem in 3 T MRI (b). Another epilepsy patient had very subtle lesion in right subependymal region in 1.5 T MRI (c) and confirmed to be subependymal heterotopia by 3 T MRI (d).

The MRI features of hippocampal sclerosis include (1) hippocampal atrophy on T1, (2) increased signal on T2-weighted images or fluid-attenuated inversion recovery (FLAIR) sequences, and (3) decreased signal on inversion recovery sequences [34, 35].

The detection of these abnormalities should be carried out with optimized imaging techniques, which include angulated coronal sections obtained perpendicular to the long axis of the hippocampal structures.

For the extratemporal substrates, MRI can also define hemimegalencephaly, schizencephaly, and focal subcortical heterotopia. Focal cortical dysplasia is the most common developmental pathology in children with extratemporal lobe seizures, and there is an international classification to define the underlying histopathology and foretell the outlook of surgical success [36].

3 T MRI system has better signal-to-noise ratio, spatial and tissue contrast resolution than a 1.5 T system. Studies have shown that for initially nonlesional cases scanned by 1.5 T system with standard MRI brain protocol, more than half had new findings after rescanned by 3 T MRI system with multichannel phased-array coils (**Figure 2**).

The recommended MRI epilepsy protocol includes:

1. Volume acquisition T1W sequence acquired in oblique coronal orientation, orthogonal to long axis of hippocampus, covers whole brain in 0.9–1 mm partition

2. Oblique coronal T2WTSE an T2W FLAIR sequences, orientated perpendicular to long axis of hippocampus, 2–3 mm slice thickness

3. Axial T2W or T2W FLAIR sequence of 3 mm slice thickness of whole brain

Diffusion tensor imaging (DTI) and tractography can be used for fiber tracking and noninvasive structural network mapping and is an optional imaging sequence to aid preoperative planning for surgical trajectory. Recent study reported identification of significant diffusion abnormalities of tract sections in ipsilateral dorsal fornix and contralateral parahippocampal white matter bundle in patients with poor postoperative seizure control. Though more studies are warranted to make conclusion, these results may help in understanding the mechanism of postoperative persistent seizure and may act as imaging prognosticator for operation outcome.

However, there are pathological substrates that go beyond the detection of MRI analysis. As a result, multi-modality imaging of the brain will come into play [37–39].

There are some functional neuroimaging modalities, namely PET, SPECT, fMRI and magnetoencephalography (MEG). Some of these scans can be co-registered with MRI to give more detailed structural-functional correlated imaging analysis. They will aid the localization of epileptogenic zone, and the sensitivity will largely depend on the epileptic syndrome. MEG helps to localize the epileptogenic zone and delineate the relationship between the suspected abnormality and the relevant regions in the brain. The placement of invasive electrodes can be guided by the MEG findings. A MEG-guided review of MRI may reveal subtle abnormalities and permit a precise surgical excision of the irritative zone. MEG is also indicated in patients with multiple intracerebral lesions, such as multiple cavernomas, in whom a sole epileptogenic lesion may be identified for lesionectomy [40–43].

With such information, the indication of further invasive studies will also be justified (**Figure 3**).

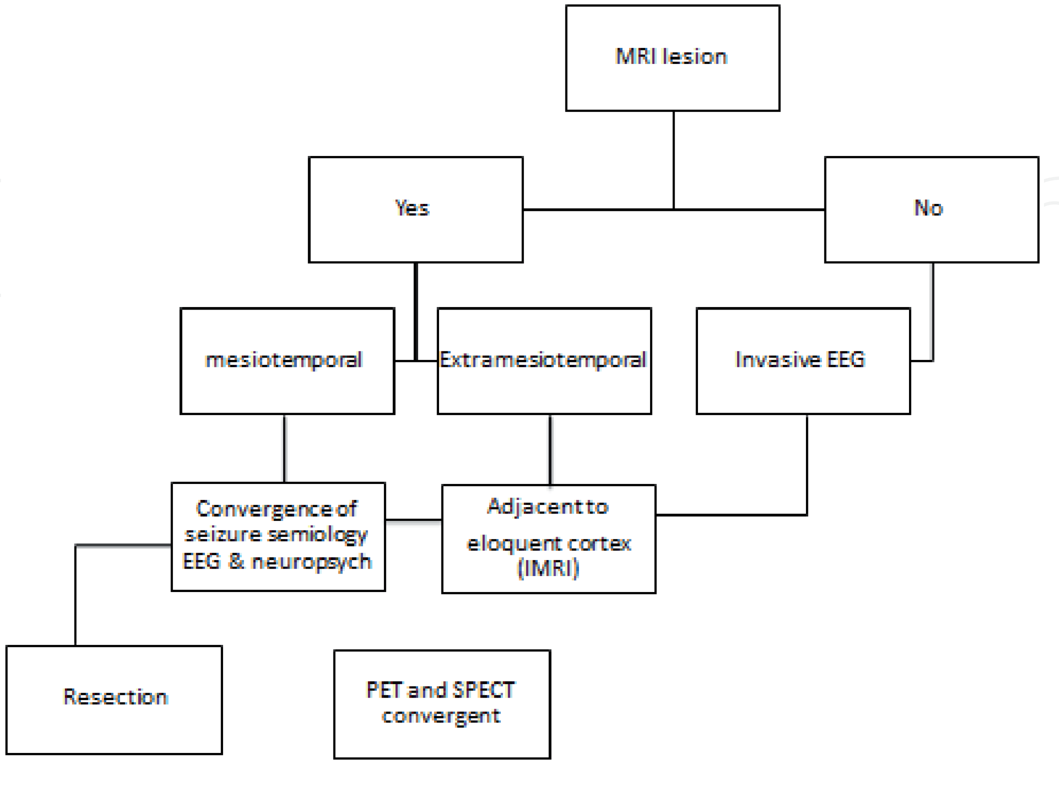

Figure 3.
Algorithm of workup of refractory epilepsy.

3.6 Neuropsychological assessment

Conceptually, the principle of neuropsychological batteries of test lies on the functional neuroanatomy(**Table 2**). It is controversial to state the prediction of postoperative cognitive outcome should be based on the side that was to be resected or the side that would remain following surgery.

There is always a long debate between the usage of WADA test and fMRI in determination of language dominance. In majority of cases, fMRI can clearly lateralize the language localization. However, in cases having agitation or mental compromise, or there is bilateral activations in fMRI, WADA test should be considered as a definitive test (**Figure 4**). Anyhow, the lower the mental reserve and the higher the functional adequacy of the resected tissue will preclude the surgical feasibility [44, 45].

3.7 Psychiatric assessment

It is recommended that the presurgical evaluation should include a thorough psychiatric assessment [32]. There are several reasons:

1. The prevalence of psychiatric disorder is prevalent in epilepsy patients, and psychopathology is common in patients with TLE.

2. Appropriate assessment might help to anticipate acute anxiety, delusions, and the latter symptoms might be aggravated in some temporal epilepsy cases, in perioperative period

3. The life time history of psychiatric disorder was associated with worst post-surgical seizure outcome, though the existence of stable psychiatric disorder does not preclude epilepsy surgery.

The areas of assessment should include four domains, namely, behavioural, psychiatric, self-esteem profile and quality of life.

3.8 Invasive EEG studies

In general, the indications to consider invasive EEG monitoring are as the followings:

1. To define precisely the epileptogenic zone when non-invasive data are not concordant

2. To conclude the divergence of non-invasive data in different regions

3. To map eloquent cortical and subcortical function for resective surgery planning

	Cognitive function	**Remark**
Temporal lobe	Memory and language	Left side represents verbal memory Right side represents visual memory
Frontal lobe	Executive and behavior	
Posterior part	Perception and higher sensory	

Table 2.
Functional neuroanatomy.

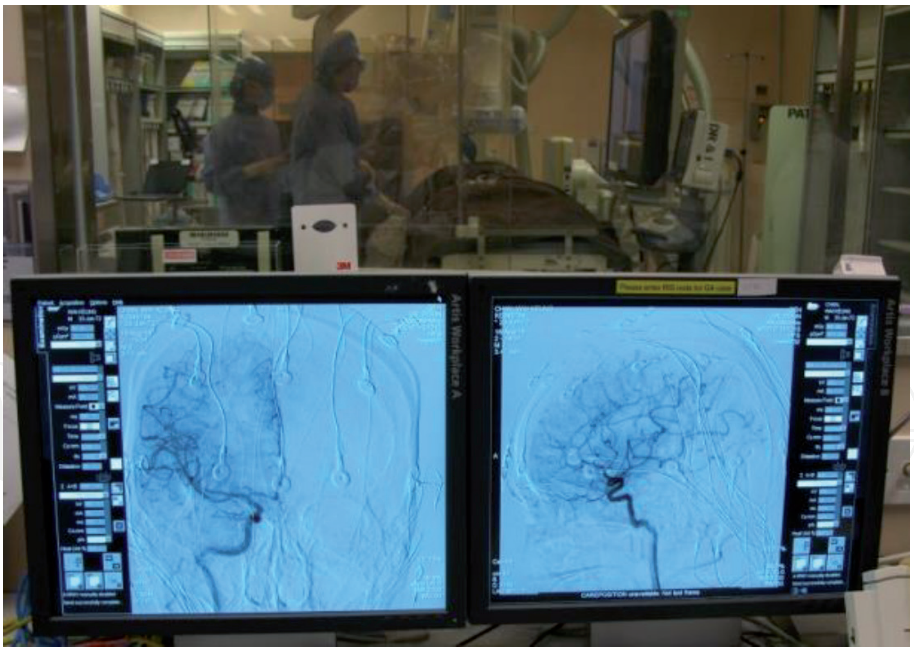

Figure 4.
Clinical photo showing the setup for WADA test.

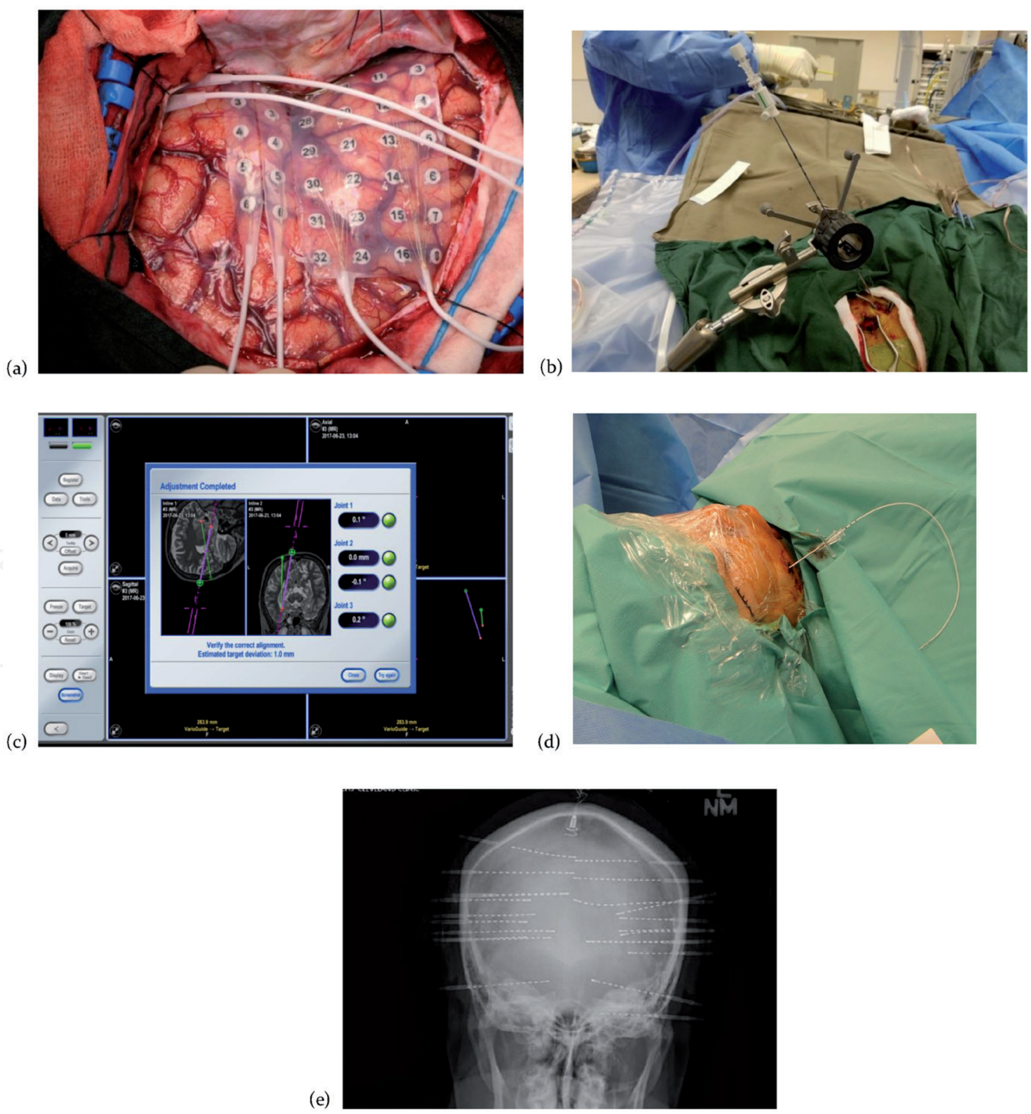

Figure 5.
Types of invasive EEG studies: (a) subdural strips and grids, (b) intracerebral depth electrodes, (c) insular depth electrodes insertion with neuro-navigation guidance, (d) foramen ovale electrodes, and (e) stereoelectroencephalography (SEEG).

4. To further validate the epileptogenic zone or provide information of prognostic value

5. To perform therapeutic treatment for active regions using thermocoagulation

Traditionally, modalities of invasive EEG monitoring include subdural electrodes, intracerebral depth electrodes, epidural peg electrodes and foramen ovale electrodes. A comprehensive review on risks and benefits in using subdural and depth electrodes showed that the related complications include epidural or subdural haemorrhage, intracerebral haemorrhage or contusion, meningitis, oedema around electrode, cerebral oedema, increased intracranial pressure etc. The overall complication rate ranges from 0.4% to 6.6%.

Stereoelectroencephalography (SEEG) is getting its popularity to enable precise recordings from deep cortical areas in bilateral and multiple lobes without subjecting the patients to have bilateral large craniotomies. The key and most important concept in considering SEEG is to test individualized *anatomo-electro-clinical hypothesis*. Based on clinical history, semiology, preoperative imaging and vEEG data, the findings of SEEG help the clinicians to understand the spatial and temporal dynamics of seizure i.e. where it starts, when and when it spreads. Study from Italian group showed that SEEG is a useful and relatively safe tool to localize the epileptogenic zone with procedure-related morbidity 5.6%. Other centres incorporate the neuro-robotic system in performing SEEG and showed comparable results. In general, SEEG had equivalent efficiency in determination of epileptogenic zone with lower operative morbidities and complications including CSF leak and intracranial haemorrhage, and better tolerance to patients. Current application of EEG recordings is not only limited to scalp EEG and intracranial EEG with subdural electrodes and depth electrodes (**Figure 5**) [46–49].

4. Epilepsy surgery for drug resistance epilepsy

The decision of surgical intervention is usually made in a consensus agreement among the discipline which carry out the investigation in a multi-disciplinary patient management conference in each epilepsy surgery centre. Basically it is a rational estimation of the precision of the epileptogenic zone (thus the success rate of seizure cure) and the risk benefit analysis of the potential post-operative risk.

In general, the outcome will be more favorable for lesional epileptic syndrome with concordance of investigation results and neuropsychological proof of "absence" of important cognitive function within the resected areas. On the contrary, the lack of concordance, the presence of important function in the pathological substrate will preclude the surgical feasibility. Besides the disease factor, there are also patient factors like seizure frequency, duration of illness, comorbidity that will govern the prognostication [50].

Conventionally, the operative outcome will be categorized in four classes according to Engel's classification [51] (**Table 3**).

Class I	Free of disabling seizures
Class II	Rare disabling seizures ("almost seizure-free")
Class III	Worthwhile improvement
Class IV	No worthwhile improvement

Table 3.
Engel's classification.

The rationale is to have complete resection of the epileptogenic zone. Broadly there are three types of epilepsy surgery

1. Curative, respective surgery in terms of resection surgery involves temporal lobe surgery and extratemporal lobe surgery. Among the different epileptic syndrome, the mesial temporal sclerosis usually has the most favorable seizure outcome: 70% of the patients have Engel's Class I [52, 53].

2. Palliative surgery in terms of disconnection surgery includes corpus callosotomy, hemispherectomy (anatomical/functional), hemispherotomy, multiple subpial transections. All these procedure are often performed in pediatric group of patients and they had been shown to have seizure reduction ranged from 40 to 50% [54].

3. Modulatory, in terms of deep brain stimulation (DBS), vague nerve stimulation (VNS), responsive neurostimulation (RNS) and gamma knife radiosurgery [55]

5. Long-term outcome after epilepsy surgery

Epilepsy surgery for temporal lobe epilepsy is usually recommended because of promising result. One study including 80 patients with temporal lobe epilepsy showed that the cumulative proportion of patients who were free of seizures impairing awareness was 58% in the surgical group and 8% in the medical group [56]. The Early Randomized Surgical Epilepsy Trial (ERSET) included 38 patients with mesial temporal lobe epilepsy and showed that zero of 23 participants in the medical group and 11 of 15 in the surgical group were seizure free during year 2 of follow-up [57]. Another study including more than 3000 patients from Germany concluded that the number of non-lesional patients and the need for intracranial recordings increased, and more than 50% of evaluated patients did not undergo surgery [58].

6. Treatment consideration for non-lesional epilepsy

There is always difficulty in identification of the epileptogenic zone in non-lesional neocortical epilepsy. Seizure free outcomes are about 55% for non-lesional temporal lobe epilepsy and 43% for non-lesional extratemporal lobe epilepsy patients. Concordance with two or more presurgical evaluations including interictal EEG, ictal EEG, FDG-PET, and ictal SPECT was significantly related to a seizure-free outcome. Another study showed that 38% of non-lesional epilepsy patients had an excellent outcome after resective epilepsy surgery after long-term intracranial EEG. In temporal lobe epilepsy with MRI negative and PET positive findings, surgery could achieve Class I surgical outcomes at postoperative 2 years in about 82% [59, 60].

7. Factors related to failure in epilepsy surgery

Failure of epilepsy surgery may be caused by wrong localization of the epileptogenic zone, very widespread epileptogenic zones and very limited resection of the suspected epileptogenic zone.

In patient after mesial temporal resection, seizure may arise from neocortical regions instead of from residual hippocampal structure. This may imply the existence of regional epileptogenicity. Hippocampus represents the area of cortex with the lowest threshold for seizure generation and the surrounding neocortical tissue also exhibiting epileptogenicity then becomes the site of ictal onset. About 25% of patients with seizure relapse after mesial temporal sclerosis may have seizure onset in the contralateral temporal region.

Extensive reevaluation of these patients is suggested for consideration of reoperation if epileptogenic focus can be localized.

8. Recent advance in epilepsy surgery

Minimally invasive intracranial endovascular EEG monitoring by means of nanowire and catheter and stent-electrode recordings is evolving [61]. High frequency Oscillations (HFOs) are believed as a potential marker for detection of epileptogenicity and predictive factor for epilepsy surgery outcome. However, a meta-analysis was able to show the significant but small relation between removal of HFO-generating brain region and outcome [62–64].

9. Conclusion

The prerequisite of seizure origin in a well circumscribed area of brain and the precision of localization of such epileptogenic zone by epilepsy work up make modern epilepsy surgery a promising treatment modality for refractory epilepsy.

The pre-operative assessment, which include multiple disciplines, however, should be focused on two important conceptual facets

1. Data concordance: the individual seizure pattern is ascribed to the hypothetical brain lesions, as suggested by neurophysiological and radiological data.

2. Functional reserve: the brain pathological region, if being resected, will not leave patient with significant morbidities

The advent of wide range of diagnostic tests and available surgical techniques has widened the applicability of surgical treatment. The success rate of these surgical interventions range from 10 to 20% of seizure reduction to more than 70% seizure freedom, depend on the different scenario.

In conclusion, epilepsy surgery for drug resistance epilepsy involves close collaboration and teamwork by multi-disciplinary specialties. Epilepsy surgery could be performed in different epilepsy centres. Patients should be referred early in their refractory disease course to a higher level epilepsy center for evaluation of the complex surgical options. Public education and promotion on management of refractory epilepsy by surgical treatments should be encouraged and lead by our local professional bodies and health organizations.

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