CME LECTURE

ANAESTHETIC CONSIDERATIONS IN EPILEPSY SURGERY

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pilepsy is the most common neurological disorder in adults and children. It is a major cause of serious public health problems and can interfere with educational opportunities, social relationships, employability and family dynamics. The approximate annual incidence rate is 40 – 70 per 100,000 in industrial countries and 100 – 190 per 100,000 in resource poor countries. Up to 5% of people experience non-febrile seizures at some period of their life (1). Most patients can be managed medically. However 30% of people with epilepsy do not have seizure control even with the best available medications.(2),(3) Some of these patients may benefit from epilepsy surgery. The complications include memory loss, speech and language impairment. Therefore it is essential to weigh the benefits and risks of surgery in this group of patients.

Medically intractable epilepsy

Definition – Failure to control epilepsy by first or second line drugs with two or more trials. Patients with refractory epilepsy have to be assessed by the multidisciplinary group which include neurologist, neurosurgeon, psychiatrist, neuropsychologist, neuroradiologist and anaesthetist.

These patients are subjected to extensive investigations in order to evaluate the type of epilepsy and to select the appropriate surgical option.

Electrophysiological Evaluation

EEG is a common non invasive method of evaluating epilepsy. However, it does not give precise anatomical localisation or lateralisation of seizure onset.

Video EEG monitoring with scalp electrodes is another non invasive technique where patient's symptoms can be correlated with EEG activity. This method is useful to detect temporal lobe epilepsy and habitual seizures. In order to obtain this information EEG recording may have to be carried out for several days to two weeks in the telemetry room. If required the anti epileptic medication doses are reduced to provoke seizures.

Intracranial Electro Corticogram(ECOG) is an invasive EEG monitoring using subdural grids/strips or depth electrodes. Depth electrodes are an excellent modality designed to study electrical discharges from deep grey matter.

Placement of these electrodes needs general anaesthesia. Once the electrodes are inserted, the patient can have a further period of telemetry. With this information, the seizure focus can be defined with greater accuracy and it is also possible to undertake functional mapping of the cortical areas studied.

During resective epilepsy surgery intraoperative ECOG helps to guide the resection.

Anatomical Evaluation

MRI is the gold standard technique and detects 70 – 80% of hippocampal sclerosis. It also identifies other structural abnormalities like cavernomas, low grade gliomas and cortical dysplasia that could cause epilepsy.

PET is another method used for cortical localisation and lateralisation of the seizure. It shows hypometabolic changes in 60 – 90% of patients with temporal lobe epilepsy.

Magnetic Resonance Spectroscopy is used in patients where the condition is not evident with MRI. It quantifies the chemicals in selected areas of brain based on difference in resonance frequency.

SPECT is a highly sensitive method which generates a tomographic image of the brain using a radio active isotope emitting a single photon to measure blood flow. Ictal spect is of great value.

Physiological Evaluation

Functional MRI is an expensive method which performs a functional cortical mapping by measuring cerebral perfusion and blood oxygen levels.

Wada Test is used to assess the lateralization of language and memory areas in order to avoid iatrogenic damage during surgical resection. It is done by injecting sodium amytal in to the carotid artery. This pharmacologically mimics the effects of surgical resection and has a temporary effect.

Neuropsychological Test

Assessment of memory, learning, IQ, attention and concentration, motor skills, verbal and non verbal language and language lateralization is achieved.

Preoperative anaesthetic evaluation

It is vital to focus on antiepileptic medication, side effects and other associated co-morbidities *(Table 1)*. Some epileptic patients may have associated co-morbid conditions (*Table 2)***.**

Preoperative evaluation should also include consideration of the type of surgery *(Table 3)*. It could be a surgery for placement of electrodes, resection or disconnection of a focus or a placement of a modulation device like vagus nerve stimulator.

Table 1

Organ system involvement from anti epileptic medication
Oral – gingival overgrowth, Steven Johnsons syndrome, xerostomia, glossitis, oral ulceration, loose teeth Acidosis Renal and liver damage Neutropenia, aplastic anaemia, thrombocytopenia Coagulation disorders

Table 2

Co-morbid conditions associated with epilepsy
Cerebral palsy Spina bifida, myelomeningocoele, sacrolumbar agenesis Tuberous sclerosis and neurofibromatosis with multiple organ dysfunction Associated renal anomalies, multiple endocrine neoplasia (MEN) type 1 & 2 Latex allergy

Table 3

Type of Surgery	**Anaesthesia**
Electrode placement Depths – **Burr Holes** Strips – **Burr holes or Mini-Craniotomy** Grids – **Mini-Craniotomy or Conventional Craniotomy**	*GA/ Awake *depth of GA as for any craniotomy *should reduce depth of anaesthesia when the electrode integrity is checked
Resection surgery -craniotomy Amygdalohippocampectomy Temporal lobectomy Topectomy Anatomical hemispherectomy	*GA/Awake *depth of GA as for any craniotomy *should reduce depth of anaesthesia if ECOG is used
Disconnections *-craniotomy* Corpus callosotomy Multiple subpial transection Functional Hemisperectomy	*GA/ Awake *depth of GA as for any other craniotomy
Placement of a seizure modulation device Vagus Nerve Stimulator **– *needs left neck and left pectoral region dissection***	*GA *for replacement of a battery LA with Sedation

Anaesthesia for epilepsy surgery

The choice of anaesthesia depends on two main requirements of the surgical team. First the need for intraoperative ECOG and second the intention to perform craniotomy either with general anaesthesia with tracheal intubation or with local anaesthesia and conscious sedation. Therefore it is vital to follow all the principles of neuroanaesthesia. Apart from this, it is very important that the anaesthetic depth stays sufficient enough to block the nociceptive afferent pathways without attenuating focal discharge. This is especially useful in ECOG guided surgery.

Propofol is the commonly used induction agent and anaesthesia can be maintained with isoflurane with or without nitrous oxide or with remifentanil. There are controversies over the effect of nitrous oxide on the ECOG in patients with epilepsy. Recent studies show that nitrous oxide decreases the spike activity significantly therefore it is important to discontinue N_2O during ECOG monitoring[(4),(5)]. Another study says N_2O can be used[(6)]. On the other hand the remifentanil infusion enhances spike activity in the epileptogenic zone. Therefore it can be used during ECOG monitoring[(7)]. Sevoflurane has greater neuro excitatory properties than isoflurane, however, the wide spread irritative response to sevoflurane is not useful in localizing the epileptogenic area[(8)]. Therefore it may not be suitable for ECOG monitoring during surgery.

Antiepileptic medication interacting with anaesthesia

Patients who are on long term treatment with phenytoin and carbamazepine may have increased fentanyl requirements and may be resistant to non-depolarising relaxants secondary to hepatic enzyme induction[(9)]. Bolus injection of phenytoin may prolong neuromuscular block. All antiepileptic medication tends to decrease the MAC of volatile agents.

Table 4

Anaesthetic agents precipitating epilepsy
Enflurane, Sevoflurane
Methohexitone
Flumazenil
Tramadol
Etomidate
High dose opiates
Local anaesthetics – lowers toxic threshold

Postoperative considerations

Blood levels of antiepileptics are significantly altered by anaesthetic drugs due to changes in pharmacokinetics and pharmacodynamics. Carbamazepine levels tend to double after surgery and normalise in 7 – 10 days. Drug toxicity can be easily confused with intracranial complications and unexpected low levels can precipitate seizures thereby complicating recovery. It is crucial to monitor blood levels of antiepileptic agents and manage accordingly.

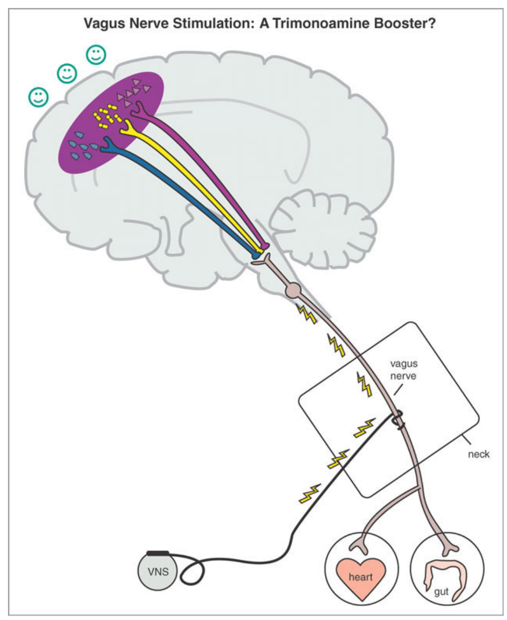
Management of epileptic patients for awake procedures

They may require sedation, analgesics, local anaesthetics and catheterisation. Anxiety, agitation, vomiting, seizures, pain and inability to lie still are some of the problems that can be encountered during surgery.

Indication for vagal nerve stimulators (VNS)

- In adults and children over 12yrs of age for medically refractory complex partial seizures
- Uncontrolled seizures despite two antiepileptic drug trials
- Compromised quality of life
- Intolerable side effects of antiepileptic medication
- Patients not suitable or not willing for surgical resection

Vagus nerve – Figure 1



80% of the fibres are afferent carrying both somatic and visceral impulses and the rest are parasympathetic efferents to the heart, lungs, the gastrointestinal tract and motor efferent fibres to pharynx and larynx[(10)].

Afferent sensory component of vagus nerve is Nodosa Ganglion (NG) and this in turn relay afferent impulses to Nucleaus of Tractus Solitarius (NTS). There are three major outflows from NTS.

- Autonomic feedback loops
- Direct projection to the reticular formation in the medulla
- Ascending projections to the parabrachial nucleus (PB) and locus ceruleus (LC)

PB and LC also have efferents to amygdala and striae terminalis.

Theoretical basis of VNS therapy

LC activation releases noradrenaline & serotonin which in turn modulate the seizure threshold. This occurs by releasing gaba amino butyric acid (GABA) or by inhibiting the release of glutamate in the regions with afferent connections to the LC.

Vagal nerve stimulator

This is a simple device with two electrodes anchored and looped around the mid-cervical portion of left vagus nerve. The pulse generator is implanted in the left infra clavicular region which consists of a magnet that causes on demand summation to abort or deintensify oncoming seizures.

The effectiveness of VNS increases with time. Bilateral or left cervical vagotomy is a contraindication for VNS placement. Left internal jugular cannulation and unipolar diathermy should not be carried out in patients with VNS. This should be turned off prior to MRI and rechecked post scan. It can be used in a CT scanner but may cause scatter due to interference. This should be deactivated prior to anaesthesia for surgery other than epilepsy surgery, due to the risk of cardiac arrest. Battery life is 6 – 8 years.

Table 5

Side effects of vagal nerve stimulation
Laryngeal irritation
Hoarseness
Cough
SOB in COPD
Change in voice quality
Bradycardia
Periodic apnoea
Cardiac arrest

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