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Different surgical procedures in management of pharmacoresistant temporal lobe epilepsy: Review article

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Abstract
Surgery was proven to be a very successful intervention for Temporal Lobe Epilepsy (TLE) that resist medical treatment. Many surgical procedures have been employed to treat TLE all over the last decades, these surgical procedures are mainly resective surgeries aiming at excision of the epileptogenic cortex to achieve seizure freedom but they differ according to the extent of the resections from extensive resection as in standard Anterior Temporal Lobectomy to more limited resections as in Selective Amygdalohippocampectomy and neocortical lesionectomy.
Minimally Invasive stereotactic laser thermal ablation and stereotactic radiosurgery allow for selective destruction of the mesial temporal lobe structures as a substitute for surgical resection without harming nearby structures.
Neuromodulation technologies, which include responsive neural stimulations, stimulation of the vagus nerve, and deep brain stimulations can be used also as palliative options in some individuals with TLE who aren't candidate for resection or ablation but with lower rates of achieving complete seizure freedom.
The choice of the appropriate procedure should be individualized as not all these surgical procedures are suitable for all the patients. Comprehension of the rational, indications and limitations of each procedure is essential for epilepsy surgeon to choose the optimum procedure for each patient.

Keywords: Epilepsy surgery, temporal lobectomy, amygdalohippocampectomy, lesionectomy, ablation, neuromodulation

Introduction
Epilepsy is a prevalent and severe neurological disorder that impacts over 50 million individuals globally, resulting in increased rates of mortality and morbidity [1].
TLE is the most prevalent kind of focal epilepsy. A significant number of individuals suffering from this disease fail to attain satisfactory seizure management with the currently available anticonvulsant medications. Across the globe, surgery has progressively emerged as the preferred method of therapy for TLE that does not respond to medication [2]. Patients suffering from refractory epilepsy ought to be sent for presurgical assessment using radiological and electrophysiological investigations to determine the epileptogenic zone, that refers to the specific part of the brain cortex responsible for producing seizures. Removal of this zone will lead to the cessation of seizures [3].
There are different surgical techniques and approaches for surgical intervention of Drug Resistant TLE, most of them are of a resective purpose with aim to excise the epileptogenic zone, and preserve eloquent cortex intact. These procedures can be divided into anatomically standardized operations and tailored resections with altered boundaries of resection. These procedures vary also according to the extent of resection from extensive resection as in temporal lobectomy to more limited resection as in selective amygdalohippocampectomy and neocortical lesionectomy [4].
Recently more minimally invasive procedures for ablation of the epileptogenic zone by means of radiosurgery or laser gained popularity specially for treating hippocampal sclerosis, but long term outcome still need more studies [5].

Beside seizure freedom as the primary goal of all epileptic surgeries, preserving the function is another important goal to achieve, So Hippocampal transection is still a viable option for some cases of dominant Hippocampal sclerosis with preserved memory functions [6].

Neuromodulation is also a good palliative option that can be used in poorly lateralized temporal lobe epilepsy as bitemporal sclerosis and in cases where the eloquent cortex is included within the epileptogenic zone [7].

Temporal lobectomy

The phrase temporal lobectomy implies the complete excision of the temporal lobe. The phrases "anterior" or "anteromesial" temporal lobectomy are more suitable for describing the procedure frequently utilized by surgeons specializing in epilepsy [8].

The first implementation of the method was performing a surgical removal of the neocortex in the temporal region, while leaving the mesial temporal structures intact. Subsequently, Penfield *et al*. achieved improved outcomes by surgically removing the uncus and hippocampus in addition to the temporal neocortex [9].

Afterwards most of epilepsy surgery programs adopted the Classic anterior two-thirds temporal lobectomy with the median length of neocortical excision from the temporal tip of 5.5cm in the non-dominant temporal lobe and 4.5cm in the dominant lobe, with 3cm resection of hippocampus. The mesial and neocortical temporal structures may be excised at the same time, either in a single specimen or in two steps resection technique, where temporal neocortex is removed first. Subsequently, removal of the deep mesial structures [8].

Spencer observed that A significant number of individuals who underwent exploration with depth electrodes exhibited seizure initiation in the hippocampus, The procedure developed is the combination of an anterior 1/3 lobectomy and amygdalohippocampectomy, A method involving the partial excision of the cortex, about 3 cm away from the Temporal pole with preserving the superior temporal gyrus is followed by extended hippocampal resection. The objective is to protect the functioning lateral temporal neocortex while allowing for the elimination of mesial components [10].

This procedure provides the best seizure freedom outcome but it has the disadvantages of large incision and craniotomy in addition of questionable neuropsychological effect of lateral neocortex resection [8].

Selective Amygdalohippocampectomy

Selective amygdalohippocampectomy is a set of surgical procedures that specifically target the removal of mesial components, such as the hippocampus, uncus, amygdala, and parahippocampal gyrus, without including the excision of neocortical tissue. This would constitute an unco-amygdalo-hippocampo-parahippocampectomy, however the original phrase is more practical and widely recognized.

These operations are recommended for individuals who have been identified by preoperative investigations as having clear evidence of seizure foci in the mesial temporal lobe and no involvement of the lateral temporal neocortex. This often includes instances with mesial temporal sclerosis.

Trans Sylvian selective amygdalohippocampectomy

The trans-sylvian technique was first developed by Yasargil and Wieser. It involves using microsurgery to widen the sylvian fissure in order to reach the hippocampus and amygdala without removing or retracting the lateral neocortex, however this procedure carry more technical difficulties with the risks of vasospasm of sylvian vessels and the damage of the temporal stem [11].

Trans cortical selective amygdalohippocampectomy

In 1958, Niemeyer introduced trans ventricular trans cortical selective amygdalo-hippocampectomy. He utilized this technique in individuals suspected of having mesial disease but with intact lateral temporal neocortex.

Niemeyer proposed a method including a surgical cut in the middle temporal gyrus, which allows for direct and uncomplicated entry to the lateral ventricle' temporal horn. The hippocampus, amygdala, and PHG were subsequently excised using the subpial dissection method [12].

Olivier later explained a version of this procedure including an incision in the Superior Temporal Gyrus (STG). This procedure involves the removal of the anterior 2 cm of the STG to get accessibility to the amygdala, that is eliminated as well. Additionally, the temporal horn opens up and the anterior 1-2 cm of the hippocampus are excised. The superior temporal sulcus has also been employed by Olivier and others, however it ought to be noticed that Olivier had subsequently returned to the original Niemeyer technique via the MTG, since he considered the STG method to be more tiresome and less acceptable [13].

Subtemporal selective amygdalohippocampectomy

Many surgeons have documented the use of subtemporal techniques and their variations. Hori *et al*. first introduced the sub-temporal method for amygdalohippocampectomy. Their method consisted of surgically cutting the tentorium to minimize the displacement of the temporal lobe, and removing the fusiform gyrus as a whole to gain entry to the temporal horn [14].

In 1989, Shimizu *et al*. outlined a method for reaching the mesial temporal structures by using a sub-temporal zygomatic technique. This included removing the zygomatic arch and gaining accessibility to the mesial components by a partial excision of the Inferior Temporal Gyrus.

Park *et al*. further detailed a sub-temporal transparahippocampal technique for amygdalohippocampectomy, which enables the conservation of the lateral temporal lobe and the fusiform gyrus [15].

The main justification for sub-temporal methods is that they preserve the temporal neocortex and avoid incisions in the temporal stem. Nevertheless, there are several disadvantages associated with this procedure, such as the retraction of the temporal lobe, harm to the basal veins, and the possible disruption of crucial basal temporal language regions. In addition, while the hippocampus may get sufficient exposure, exposing and excision of the amygdala and uncus are challenging with this surgical approach. It is advisable to restrict its use to lesion removal procedures in the posterior hippocampal/mesial temporal area [16]

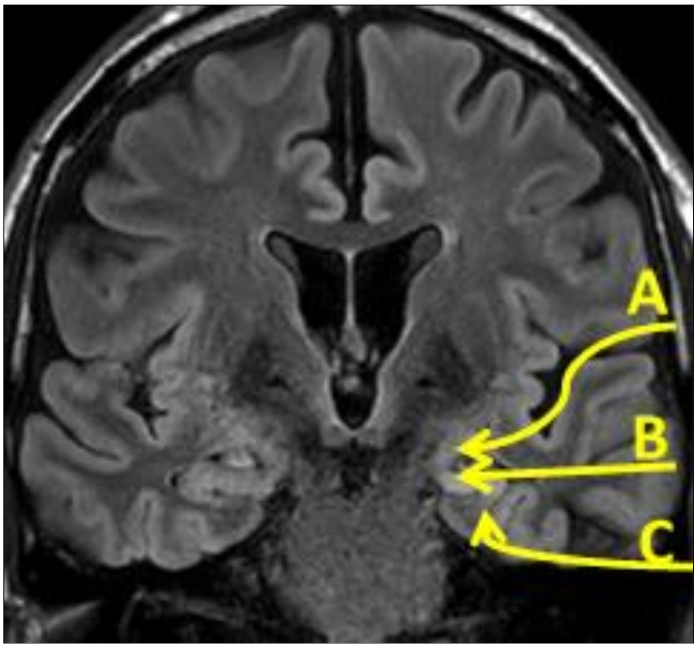

Fig 1: Selective Amygdalohippocampecomy, a) Trans sylvian approach, b) Trans cortical approach, c) Subtemporal approach

Neocortical resection (Lesionectomy)

The use of current MRI techniques has led to a rise in the diagnosis of minor lesions in the temporal lobe. It may consist of glial or glioneuronal malignancies, dysplasia in the cortex, or vascular abnormalities.

The primary approach in neocortical lesionectomy involves careful elimination of the grey matter in the specific area where epileptogenesis occurs, using an ultrasound aspirator set at a low suction and vibration level. The resection ought to be performed at the base of the sulcus, without going deeper, as removing the underlying white matter won't enhance control of seizures and may lead to harm of the underlying projection fibers. All vessels that cross the gyrus should be stripped of their surrounding tissue and meticulously preserved [17].

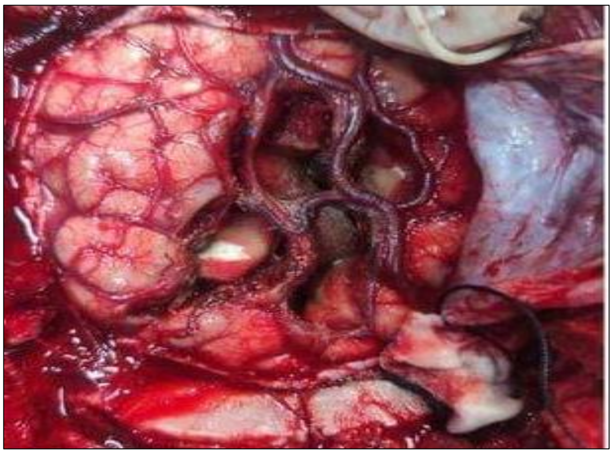

Fig 2: Subpial resection of neocortical FCD with preservation of by passing vessels

Some centers use an intraoperative electrocorticography to defining the margins of resection in neocrtical lesionectomy. Intraoperative ECoG is recorded by a diversity of grids and strips spanning a wide range from a 1x4, 1x8, 4x4, 8x8 etc. The dimensions of the electrodes within these arrays may range from 3 to 4 mm in diameter, the interelectrode distances is usually 1 mm.

Pre resection recordings are usually obtained from each position for about 10 to 20 minutes to define the borders of epileptogenic cortex while Post resection recordings help to ascertain the necessity of further resection expansion [18].

In the presence of dual pathology (Lateral neocortical lesion and hippocampal pathology) both pathologies should be excised for better seizure control.

But without mesial temporal sclerosis it should be individual decision determined by the pre-and intra-operative observations to apply tailored lesionectomy or to do standard anterior temporal lobectomy [19].

Minimally Invasive Ablation

The efficacy and safety of stereotactic radiosurgery in ablating mesial temporal components to improve seizures related to mesial temporal sclerosis (MTS) have been shown. However, the therapeutic benefits of radiosurgery aren't immediately apparent. The majority of individuals have a decrease in seizures within 9-12 months and attain total elimination of seizures within 18-24 months following radio-surgical therapy.

Laser interstitial thermal therapy can be also used with the aid of real time intraoperative MRI thermometry to target mesial temporal lobe structures with a very minimal effect on the surrounding structures.

However these procedures are attractive minimally invasive options for mTLE treatment but still better results of seizure freedom are achieved by resective surgery and long-term follow-up trials of these procedures are still lacking [5].

Hippocampal transection

This procedure is mostly recommended for patients who have severe left TLE that cannot be controlled, but have normal memory abilities before the surgery, and have a normal hippocampus as seen on MRI scans.

Although resective surgery improves seizure outcomes, there is still a risk of postoperative impairments in verbal memory. In order to tackle this issue, a novel approach was devised, using the principles of multiple subpial transection (MST) on the hippocampus. MST is a well-established surgical technique for managing epilepsy that originates from important parts of the brain, such as the motor or speech centers, while preserving the normal functioning of the cortex. By implementing MST in the hippocampus, it might potentially prevent the adverse consequence of verbal memory impairments following a left temporal lobectomy [6].

Neuromodulation

The purpose of all epileptic surgeries is to excise the epileptogenic focus to achieve seizure freedom, however many drug resistant temporal lobe epilepsy are not good candidate for curative surgeries for example bilateral mesial temporal sclerosis and epileptogenic focus involving speech centers in the temporal lobe.

Implantable stimulation devices can be used as a palliative option for those patients with the aim of reduction of seizures frequency and severity

Vagal nerve stimulation (VNS)

An implanted device generates periodic electrical stimulation to the left vagus nerve in the cervical region. This stimulation disrupts the synchronized impulses in the cerebral cortex, resulting in a reduction in the frequency of seizures. Individuals experiencing an aura may initiate the stimulator and perhaps terminate the seizure by passing a magnet across the device.

Recent controlled clinical research has shown that around 30% of patients saw a 50% reduction in seizures [7].

Responsive Neurostimulation (RNS)

Compared to scheduled or continuous stimulating, the RNS provides electrical stimulation based on real-time ECoG activities. The stimulation electrodes can be placed in both hippocampi in patients with bitemporal epilepsy [20].

Deep Brain Stimulation (DBS)

It is used for targeting the anterior thalamic nucleus, that's a key component of the limbic circuit and is believed to affect the threshold for seizures.

These treatments provide the potential for a non-resective, minimally invasive, modifiable in dosage, mostly reversible, and apparently secure intervention, but needs more studies to be widely approved [21].

Conclusion

Many Surgical procedures are available in managing of Drug Resistant TLE, each of which has its own indications and limitations.

The choice of the optimum procedure for every patient should be individualized according to patient's preoperative investigations and surgeon's experience to achieve effective and safe surgery.

References

1. De Boer HM, Mula M, Sander JW. The global burden and stigma of epilepsy. Epilepsy & behavior. 2008 May 1;12(4):540-6.
2. Wiebe S, Blume WT, Girvin JP, Eliasziw M. A randomized, controlled trial of surgery for temporal-lobe epilepsy. New England Journal of Medicine. 2001 Aug 2;345(5):311-318.
3. Jehi L. The epileptogenic zone: concept and definition. Epilepsy currents. 2018 Feb;18(1):12-16.
4. Anyanwu C, Motamedi GK. Diagnosis and surgical treatment of drug-resistant epilepsy. Brain sciences. 2018 Mar 21;8(4):49.
5. Chang EF, Englot DJ, Vadera S. Minimally invasive surgical approaches for temporal lobe epilepsy. Epilepsy & Behavior. 2015 Jun 1;47:24-33.
6. Shimizu H, Kawai K, Sunaga S, Sugano H, Yamada T. Hippocampal transection for treatment of left temporal lobe epilepsy with preservation of verbal memory. Journal of Clinical Neuroscience. 2006 Apr 1;13(3):322-328.
7. Alsaadi TM, Laxer KD, Barbaro NM, Marks Jr WJ, Garcia PA. Vagus nerve stimulation for the treatment of bilateral independent temporal lobe epilepsy. Epilepsia. 2001 Jul 7;42(7):954-956.
8. Wyler AR, Hermann BP, Somes G. Extent of medial temporal resection on outcome from anterior temporal lobectomy: a randomized prospective study. Neurosurgery. 1995 Nov 1;37(5):982-91.
9. Feindel W, Leblanc R, De Almeida AN. Epilepsy surgery: historical highlights 1909–2009. Epilepsia. 2009 Mar;50:131-51.
10. Spencer DD, Spencer SS, Mattson RH, Williamson PD, Novelly RA. Access to the posterior medial temporal lobe structures in the surgical treatment of temporal lobe epilepsy. Neurosurgery. 1984 Nov 1;15(5):667-71.
11. Schmeiser B, Wagner K, Schulze-Bonhage A, Elger CE, Steinhoff BJ, Wendling AS, *et al*. Transsylvian selective amygdalohippocampectomy for mesiotemporal epilepsy: Experience with 162 procedures. Neurosurgery. 2017 Mar 1;80(3):454-64.
12. Dos Santos AR, Mufarrej G, da Conceição PO, Cruz PL, Cavalcanti DD. Surgical Treatment of Mesial Temporal Lobe Epilepsy: Selective Amygdalohippocampectomy Using Niemey-er's Approach. Neurosurg Cases Rev. 2018, 1(006).
13. Olivier A. Transcortical selective amygdalohippocampectomy in temporal lobe epilepsy. Canadian Journal of Neurological Sciences. 2000 May;27(S1):S68-76.
14. Hori T, Tabuchi S, Kurosaki M, Kondo S, Takenobu A, Watanabe T. Subtemporal amygdalohippocampectomy for treating medically intractable temporal lobe epilepsy. Neurosurgery. 1993 Jul 1;33(1):50-7.
15. Park TS, Bourgeois BF, Silbergeld DL, Dodson WE. Subtemporal transparahippocampal amygdalohippocampectomy for surgical treatment of mesial temporal lobe epilepsy. Neurosurgical Focus. 1996 Oct 1;1(4):E2.
16. Little AS, Smith KA, Kirlin K, Baxter LC, Chung S, Maganti R, *et al*. Modifications to the subtemporal selective amygdalohippocampectomy using a minimal-access technique: seizure and neuropsychological outcomes. Journal of neurosurgery. 2009 Dec 1;111(6):1263-1274.
17. Smith MC, Whisler WW, Morrell F. Neurosurgery of epilepsy. In Seminars in Neurology © 1989 by Thieme Medical Publishers, Inc. 1989 Sep;9(03):231-248.
18. Kanazawa O, Blume WT, Girvin JP. Significance of spikes at temporal lobe electrocorticography. Epilepsia. 1996 Jan;37(1):50-5.
19. Zaghloul KA, Schramm J. Surgical management of glioneuronal tumors with drug-resistant epilepsy. Acta neurochirurgica. 2011 Aug;153:1551-1559.
20. Sun FT, Morrell MJ. The RNS System: responsive cortical stimulation for the treatment of refractory partial epilepsy. Expert review of medical devices. 2014 Nov 1;11(6):563-572.
21. Boon P, Vonck K, De Herdt V, Van Dycke A, Goethals M, Goossens L, *et al*. Deep brain stimulation in patients with refractory temporal lobe epilepsy. Epilepsia. 2007 Aug;48(8):1551-60.