Mesial Temporal Lobe Epilepsy (MTLE) Surgery

Mesial Temporal Lobe Epilepsy (MTLE) is one of the most common forms of **drug-resistant epilepsy**. It typically originates in the **mesial temporal structures** (e.g., hippocampus, amygdala, and parahippocampus) and is associated with **recurrent seizures** that significantly impair quality of life. Surgical intervention is often considered for patients who do not respond to medication and where the seizures severely affect daily functioning.

The main goal of surgery in MTLE is to remove or **disconnect** the brain regions responsible for the seizures, particularly the **hippocampus** and **amygdala**, which are commonly involved in this form of epilepsy. Surgical approaches to MTLE have evolved significantly over the years, with various techniques and procedures offering distinct advantages and limitations.

Types of Surgery for MTLE

1. **Anatomical Resection (Anterior Temporal Lobectomy)**

1. **Procedure**: The most traditional and widely used surgical approach for MTLE is **anterior temporal lobectomy**. This procedure typically involves the resection of the **hippocampus**, **amygdala**, and parts of the **entorhinal cortex**, which are thought to play a significant role in the generation of seizures.
2. **Indications**: It is most often recommended for patients with clear evidence of **mesial temporal sclerosis** (MTS) and a well-defined focus of seizure onset in the mesial temporal structures.
3. **Outcome**: Studies show that **70-80% of patients** experience significant reduction or complete cessation of seizures after anterior temporal lobectomy. Cognitive decline, however, can be a concern, especially regarding memory and language function, depending on the location of the resection.

2. **Laser Interstitial Thermal Therapy (LITT)**

1. **Procedure**: **MRI-guided laser interstitial thermal therapy (MRIgLITT)** is a minimally invasive alternative to traditional surgery. It uses laser energy to heat and ablate the targeted areas of the brain responsible for seizures. This is typically performed through a **small burr hole** and guided by real-time MRI.
2. **Indications**: It is primarily used for patients who are not candidates for traditional surgery due to medical or anatomical reasons, or those who wish to avoid more invasive procedures.
3. **Outcome**: MRIgLITT has shown promising results in treating MTLE, with seizure freedom rates similar to traditional surgical approaches in some cases. However, the long-term outcomes are still being studied. Cognitive outcomes tend to be better with LITT compared to anterior temporal lobectomy, but it may not be as effective in patients with extensive hippocampal sclerosis.

3. **Selective Amygdalohippocampectomy**

1. **Procedure**: This technique involves the resection of the **hippocampus** and **amygdala** while sparing other structures in the temporal lobe. This approach may be used in cases where seizures originate specifically from the hippocampus or amygdala and do not involve other

regions of the temporal lobe.
2. **Indications**: It is indicated in cases where **hippocampal sclerosis** or **amygdala involvement** is evident, but preservation of temporal lobe function is desirable, particularly in cases where the **non-dominant** hemisphere is involved.
3. **Outcome**: This approach can achieve high rates of seizure control, with fewer cognitive side effects than standard temporal lobectomy, especially when the **dominant** hemisphere is involved.

4. **Functional Hemispherectomy (Rare)**

1. **Procedure**: In extreme cases of drug-resistant epilepsy, **hemispherectomy** (removal of one hemisphere of the brain) may be considered. This is rare in MTLE but may be an option when epilepsy is severe and unilateral.
2. **Indications**: Typically used in cases of hemiplegia or severe, generalized epilepsy.
3. **Outcome**: While effective in reducing or eliminating seizures, hemispherectomy leads to significant functional impairments, especially in terms of motor and cognitive function.

Emerging Technologies in MTLE Surgery

1. **Minimally Invasive Approaches**

1. **Transorbital Laser Surgery**: As highlighted in the study by Valdiva et al. (2025), **transorbital MRIgLITT** is an emerging technique that may offer a less invasive alternative to traditional temporal lobe surgery. The **transorbital approach** involves targeting the mesial temporal structures through the **orbit**, sparing more tissue and potentially reducing complications such as cognitive deficits and infections. This approach may be particularly helpful in patients who are not ideal candidates for more invasive procedures.
2. **Neurostimulation**: In cases where resective surgery is not possible or effective, **neurostimulation devices**, such as the **vagus nerve stimulator (VNS)** or **responsive neurostimulation (RNS)**, are options. These devices stimulate the brain to prevent seizures or interrupt seizure activity when detected.

2. **MRI-guided Resection**

1. Advanced techniques like **intraoperative MRI (iMRI)** or **functional MRI (fMRI)** allow for better precision during surgery. These imaging tools guide the surgeon in real-time to avoid critical structures while maximizing seizure control. **Functional MRI** can also help delineate areas of the brain involved in language, motor, and other functions, assisting in planning the surgery to preserve as much cognitive function as possible.

Benefits and Risks of MTLE Surgery

Benefits: - **Seizure Freedom**: One of the primary goals of surgery is to reduce or eliminate seizures. Many patients experience **significant improvements**, with some achieving **seizure freedom**. - **Improved Quality of Life**: Surgical intervention can greatly improve quality of life for patients whose epilepsy is refractory to medical therapy, allowing for greater independence, better cognitive function, and reduced need for medications. - **Cognitive Preservation**: With advances in surgical techniques (e.g., laser ablation and minimally invasive approaches), the risk of cognitive decline has decreased in some cases, particularly concerning memory and language functions.

Risks: - **Cognitive Deficits**: Surgery on the temporal lobe, particularly the hippocampus, can result

in **memory impairment** and other cognitive difficulties. This risk is higher if the surgery involves the dominant hemisphere or critical regions of the brain involved in language or memory. - **Complications**: Like any surgical procedure, temporal lobe surgery carries risks of **infection**, **hemorrhage**, **stroke**, and **neurological deficits**. - **Recurrence of Seizures**: Not all patients become seizure-free after surgery, and some may experience **postoperative seizures** or require additional interventions. - **Emotional and Psychological Effects**: Surgery for epilepsy can have emotional and psychological impacts, as patients may feel anxiety, depression, or fear about the outcomes.

Conclusion

Surgery for **mesial temporal lobe epilepsy (MTLE)** is an established and highly effective treatment for those with **drug-resistant epilepsy**. Surgical options, including **anterior temporal lobectomy**, **MRIgLITT**, and **selective amygdalohippocampectomy**, provide promising outcomes in terms of seizure reduction and quality of life. Emerging techniques such as **minimally invasive transorbital laser surgery** and **neurostimulation** offer additional options, especially for patients who are not candidates for traditional resective surgeries. However, the risks of cognitive and emotional side effects, as well as the challenge of identifying optimal candidates, necessitate careful consideration and individualized treatment planning. As surgical techniques continue to evolve, more targeted and less invasive options are likely to emerge, further improving the prognosis for patients with MTLE.