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Recent advancement in Epilepsy Surgery

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Epilepsy surgery has evolved from a limited, high-risk intervention to a sophisticated, multifaceted option for patients with drug resistant epilepsy (DRE). The journey of this field highlights the growing ability of neurosurgeons to target specific areas within the brain to achieve meaningful outcomes, offering new hope for patients who were once thought untreatable. With new advancements, particularly in deep brain stimulation (DBS)/ lesioning and stereoelectroencephalography (SEEG), epilepsy surgery now stands at the forefront of precision and innovation.

Historically, epilepsy surgery was confined to patients with clear anatomical lesions that could be easily identified, such as tumors or malformations. Techniques like the anterior temporal lobectomy (ATL) had successful results but understanding about epileptogenesis was still limited. Early approaches were often restricted to excising large areas of brain tissue. However, over the past two decades, epilepsy surgery has embraced remarkable innovations, allowing neurosurgeons to target epileptogenic zones with far greater accuracy, even in complex or MRI-negative cases.

One of the most significant advancements has been the use of SEEG for mapping seizure networks in three dimensions. SEEG enables precise identification of epileptogenic regions that might be located deep within the brain or involve multiple areas. This technique has been revolutionary for MRI-negative epilepsy, where structural abnormalities are not visible on conventional imaging.[1] Combined with functional imaging modalities like PET and fMRI, SEEG has enabled neurosurgeons to operate with unprecedented accuracy, minimizing postoperative deficits and maximizing seizure control.

Another transformative development in epilepsy surgery is the use of DBS, especially targeting specific thalamic nuclei. While DBS was initially developed for movement disorders, its application in epilepsy has expanded rapidly. Radiofrequency ablation or what is commonly known as lesioning is a great substitute for DBS with similar results in long term follow-up. The anterior nucleus of the thalamus (ANT) has been a primary target for DBS/lesioning in patients with DRE, showing promising results in reducing seizure frequency.[2] Recent research and clinical applications have also explored the central median nucleus (CMN) of the thalamus, particularly for patients with generalized or multifocal seizures. Targeting the CMN appears to disrupt seizure networks, offering benefits for patients who may not respond as well to ANT alone.[3]

The concept of multiple thalamic target DBS/lesioning is an exciting new frontier. By targeting both the ANT and CMN, or potentially other thalamic nuclei in a coordinated approach, we may achieve even greater seizure control for complex epilepsy cases. These strategies leverage the thalamus's role as a key relay center in seizure propagation, allowing neurosurgeons to modulate multiple pathways within the brain's epileptogenic network. Although these approaches are still being refined, preliminary results suggest that multiple thalamic target could represent a new paradigm for patients with multifocal or generalized epilepsy who have not found relief through traditional surgical or DBS approaches.[4]

While DBS/lesioning and SEEG represent some of the most advanced interventions, neuromodulation therapies, including vagus nerve stimulation (VNS) and responsive neurostimulation (RNS), also play crucial roles. These therapies provide viable options for patients with multifocal epilepsy or for whom resective surgery is not feasible due to involvement of eloquent areas. By modulating brain activity and intervening before seizures fully manifest, these devices can significantly reduce seizure frequency and improve quality of life. Laser interstitial thermal therapy (LITT) is another key development in epilepsy surgery, especially in recent years. It's a minimally invasive technique that uses laser energy to ablate seizure foci with precision, and it's been particularly useful for treating mesial temporal lobe epilepsy (MTLE) and focal lesions in deep or difficult-to-access brain regions

Despite these advances, epilepsy surgery remains underutilized. Many patients who could benefit from these interventions do not receive timely referrals, often due to misconceptions that surgery is a last-resort option. This highlights an urgent need for increased education and awareness among healthcare providers and the public about the benefits and safety of epilepsy surgery. Timely intervention can make a profound difference in long-term outcomes, particularly in cases where early surgical intervention may halt disease progression.

Looking to the future, epilepsy surgery is poised to benefit from

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emerging technologies such as artificial intelligence (AI) and big data. Machine learning algorithms capable of processing vast neurophysiological datasets may soon help predict seizure foci with greater precision, personalizing treatments for individual patients.[5] Additionally, advancements in robotics and molecular therapies hold promise for refining surgical precision even further.

In conclusion, epilepsy surgery has reached a new era of precision and potential. By combining SEEG, DBS/lesioning with multi-target thalamic approaches, and other neuromodulation techniques, the field is redefining the possibilities for patients with refractory epilepsy. As these technologies continue to evolve, the epilepsy surgery community remains committed to pushing the boundaries, offering new hope to patients who live with the debilitating effects of epilepsy. The journey has been remarkable, and the future holds even greater promise.

References

1. Bartolomei F, Lagarde S, Wendling F, McGonigal A, Jirsa V, Guye M, et al. Defining epileptogenic networks: Contribution of SEEG and signal analysis. Epilepsia 2017;58:1131–47. https://doi.org/10.1111/epi.13791.
2. Salanova V, Witt T, Worth R, Henry TR, Gross RE, Nazzaro JM, et al. Long-term efficacy and safety of thalamic stimulation for drug-resistant partial epilepsy. Neurology 2015;84:1017–25. https://doi.org/10.1212/WNL.0000000000001334.
3. Dalic LJ, Warren AEL, Bulluss KJ, Thevathasan W, Roten A, Churilov L, et al. DBS of Thalamic Centromedian Nucleus for Lennox–Gastaut Syndrome (ESTEL Trial). Ann Neurol 2022;91:253–67. https://doi.org/10.1002/ana.26280.
4. Yang AI, Isbaine F, Alwaki A, Gross RE. Multitarget deep brain stimulation for epilepsy. J Neurosurg 2024;140:210–7. https://doi.org/10.3171/2023.5.JNS23982.
5. Alkhaldi M, Abu Joudeh L, Ahmed YB, Husari KS. Artificial intelligence and telemedicine in epilepsy and EEG: A narrative review. Seizure - Eur J Epilepsy 2024;121:204–10. https://doi.org/10.1016/j.seizure.2024.08.024.