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Shifting Paradigms and Modern Face of Temporal Lobe Epilepsy Surgery: Laser Interstitial Thermal Therapy

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Mini Review

About 30-40% of patients with epilepsy remain intractable to antiepileptic drugs with temporal lobe epilepsy being the most common cause of drug resistant seizures. Anterior Temporal Lobectomy (ATL) is considered to be the standard surgical treatment for mesial temporal lobe epilepsy with reported long-term seizure free rates of 60-80% [1,2]. Yet epilepsy surgery continues to be underutilized, where only estimated 2% of potential patients undergo surgery annually [3]. Reasons for limited patient acceptance of temporal lobectomy include fear of mortality and acquiring permanent cognitive or language deficits. There is a continuous evolution in the field of epilepsy surgery with the aim of limiting the amount of brain resection. This has led to developing less invasive surgical interventions for removal of the epileptic focus with minimal risk of complications.

MRI guided- stereotactic laser thermocoagulation, also named as Laser Interstitial Thermal Therapy (LiTT) is a relatively new minimally invasive stereotactic surgical technique which was initially approved for treatment of brain tumors, and over the course of last six years has gained wide acceptance for treatment of mesial temporal lobe epilepsy [4,5], cavernous malformation [6], periventricular nodular heterotopia [7], hypothalamic hamartoma [8] and focal cortical dysplasia [9]. The effect of LiTT is based on the thresholds for thermal tissue damage where temperatures of 42°C to 45°C for periods of 30 to 60 minutes inactivate key enzymes, resulting in cell death and temperature of >60°C can cause irreversible cell damage. Tissue charring and vaporization occur at temperatures of >100oC; once tissue becomes charred, laser light penetration decreases and it act only as focal source of heat, resulting in a suboptimal extent of tissue ablation [4]. Therefore, the aim of LiTT is to achieve the largest region of controlled tissue ablation through optimal light penetration into the brain tissue while limiting localized tissue charring through temperature control. Complication rate for LiTT in epilepsy surgery seems to be lower and reported complications include visual field deficit, catheter misplacement, incomplete ablation of target and intracranial hemorrhage [4].

At this point, evidence of LiTT efficacy comes from large number of case series with relatively short durations of follow-up. In case series by Donos et al, [10], where 43 patients underwent LiTT for mesial temporal lobe epilepsy and reported Engel class I outcome of 67% at mean follow up interval of 20.3 months. Whereas Gross et al, [11], reported lower rate of seizure freedom of 53% at 1 year follow up in 58 patients who received LiTT for mesial temporal lobe epilepsy. Overall seizure freedom rate with LiTT appears lower than, but comparable to standard temporal lobectomy. Youngerman et al, [12] reported similar rates of seizure freedom following LiTT in patients with MTS and SEEG-confirmed, non-MTS mesial temporal lobe epilepsy. Hence in carefully selected MRI-negative patients, in whom intracranial monitoring has localized the seizure onset zone to the mesial temporal structures, LiTT could provide a good alternative to standard ATL.

Considering the neurocognitive outcomes, Drane et al, [13], reported significant deteriorations in confrontative naming (verbal task) and/or recognition of famous faces for 32 out of 39 patients undergoing standard ATL or tailored respective surgeries of mesial temporal structures. In contrast, where none of 19 patient who underwent LiTT had any cognitive worsening. Similarly, Kang et al, [14] also reported preserved contextual verbal memory in patients undergoing LiTT. In contrast, Donos et al, [10] reported decline in verbal and narrative memory but not naming in patients undergoing LiTT in the dominant hemisphere. The lack of uniformity of neuropsychological evaluations across studies, makes it difficult to give a final judgement on long term neurocognitive outcomes. The ongoing SLATE (Stereotactic Laser Ablation for Temporal Lobe Epilepsy) study will be first study to apply validated measures of verbal memory using Rey Auditory Verbal learning test.

In summary, comparing the long-term outcomes with standard anterior temporal lobectomy, LiTT has been viewed inferior by about 10-20% but it's considered as good alternative to standard ATL for better post-surgery cognitive performance, especially for language dominant temporal resection. The other advantage of LiTT is lower risk of complications such as infections, bleeding or permanent neurological deficits, and shortened recovery time. Future prospective studies would help further to determine whether the optimization of LiTT will achieve the similar seizure freedom rates seen with ATL.

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