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Two Bolt MRI Guided Laser Ablation for Seizure Focus in the Lateral Position Utilizing Robotic Bolt Implantation

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Epidemiology Approximately 7-10% of adolescent epilepsy patients will have drug-refractory epilepsy[1, 2]. MRI-guided stereotactic laser ablation interstitial thermal therapy (MRgLITT) is a minimally-invasive surgical option, achieving seizure freedom in approximately 80% of all patients[3] while demonstrating safety and efficacy in pediatric and adolescent populations[4]. From a technical standpoint, this technique allows for the selective ablation of periventricular lesions not favorable to an open approach [5].

H&P Patient is a 25 year-old male with structural brain abnormalities and focal epilepsy with seizures starting at age 14 years. He has been refractory since age 19.

Imaging MRI revealed polymicrogyria (PMG) involving bilateral parieto-occipital regions. In addition, there were areas of gray matter heterotopia along the left lateral ventricle. MRI fingerprinting demonstrated higher T1 and T2 intensity in the L cortical malformations. DTI demonstrated a connection between the L PMG and lateral temporal lobe. SEEG revealed 2 GTC seizures and 1 focal unaware seizure from the L PMG.

Procedure Robotic Stereotactic Implantation of Two Laser Ports in the Lateral Position followed by MRI-guided Laser Ablation of L PMG.

Post-op Imaging Post-op CT demonstrates no acute hemorrhage. Post-op MRI demonstrates approximately 13ccs of L periventricular gray matter was ablated.

Surgical Outcomes and Follow-up Patient was discharged on POD 1 following steroid taper.

Keywords Stereotactic, minimally invasive, magnetic resonance thermal therapy, laser ablation, epilepsy

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Transcript

SLIDE 1 [TITLE]: 0:00-0:07
This is a case report of a two-lead MRI-guided laser ablation of a seizure focus in the lateral position.

SLIDE 2: 0:08-0:45
As an introduction, approximately 7-10% of adolescent epilepsy patients will have drug refractory epilepsy. For this population, MRI-guided stereotactic laser interstitial thermal therapy, or MRgLITT, is a minimally-invasive option. In the general population, approximately 80% of epilepsy patients will achieve seizure freedom following MRgLITT. This treatment modality demonstrates safety and efficacy in the pediatric and adolescent populations. For lesions not amenable to open approaches such as periventricular lesions, this approach can be used.

SLIDE 3: 0:46-1:01
The patient is a 25 year old right handed man with intellectual disability, structural brain abnormalities, and focal epilepsy with seizures since starting at 14. He was seizure free on oxacarbazepine from 16 to 19 years; however, he has been refractory since then.

SLIDE 4: 1:02-1:18
MRI revealed polymicrogyria involving the bilateral parieto-occipital regions. And, MR fingerprinting demonstrated that the nodules and cortical malformation on the left parieto-occipital area seem to have higher T1 and T2 signaling compared to the right side.

SLIDE 5: 1:19-1:26
This slide illustrates the areas of grey matter heterotopia involving the left lateral ventricle.

SLIDE 6: 1:27-1:42
Subsequent diffusion tensor imaging revealed that the left polymicrogyria and the left lateral temporal lobe share a common connection.

SLIDE 7: 1:43-1:55
SEEG shows that two GTCs and one focal unaware seizure originated from the left anterior emporobasal electrode.

SLIDE 8: 1:56-2:07
The plan therefore was to do a laser ablation of the left polymicrogyria with the outflow tract.

SLIDE 9: 2:08-2:47
This slide illustrates the overview of the key steps done at our institution. Following volumetric imaging and trajectory planning, we use the O-Arm to verify the trajectories and also measure the thickness of the skull. The operative setup is completed, followed by drilling and durotomy. And then the bone anchor is inserted. Of note, this case used two bone anchors for a two lead MRgLITT. After bone anchor insertion, the leads are inserted into the bone anchors and secured into place. Following that, the MRgLITT can begin after the patient is transported to MRI.

SLIDE 10: 2:48-2:57
This slide illustrates the o-arm setup and the patient in the lateral position. The O-arm parameters are in the bottom right portion of the slide

SLIDE 11: 2:58-3:12
The O-arm is then used to verify the trajectory. As seen here, a staple on the left side of the patient's head is used to test the trajectory of the robot.

SLIDE 12: 3:13-3:30
Following trajectory verification, the operative setup can begin. The patient's head is minimally shaved, the incisions are marked

on the scalp. The robot is then prepped and draped, and then guided to the appropriate trajectory.

SLIDE 13: 3:31-3:44
The first port is inserted into the trajectory corresponding to the left lateral polymicrogyria. A drill-stop distance of 96.9 was calculated based off of the O-arm and volumetric data.

SLIDE 14: 3:45-3:54
The second port was inserted into the left medial polymicrogyria, with a drill-stop distance of 102.5.

SLIDE 15: 3:55-4:04
Of note, to achieve a bolt distance of 15 mm, the bolt wings had to be shaved prior to insertion, with a final fixation distance of 50 mm from the scalp.

SLIDE 16: 4:05-4:10
After bolt insertion, the leads are then inserted into the bolts and then secured into place.

SLIDE 17: 4:12-4:22
The patient is then transported to MRI, and the MRI here demonstrates the lateral and medial leads placed into their respective targets.

SLIDE 18: 4:23-4:56
This slide illustrates the heat map as well as the final MRI map of the left lateral polymicrogyria laser ablation. Of note, the left lateral polymicrogyria was ablated in three sessions consisting of two minutes of laser pulsation. Between each session, the leads were advanced to the subsequent target, as seen here on the heat map.

SLIDE 19: 4:57-5:10
Similarly, the left medial polymicrogyria was ablated in three sessions of two minutes each, with the final map shown here.

SLIDE 20: 5:11-5:20
Post-operative scan demonstrates no acute hemorrhage as well as laser-related tissue changes along the left lateral ventricle.

SLIDE 21: 5:21-5:33
MRI confirms that approximately 13.8 ccs of tissue were ablated. The patient did well in the hospital and was discharged on post-op day one on some seizure meds following a steroid taper.

SLIDE 22: 5:34-6:15
Some key take home points for this case. MRgLITT allows for selective ablation of periventricular lesions. This case further demonstrates safety and efficacy of this treatment modality in the adolescent and pediatric epilepsy population. This is the first case to report MRgLITT done with two leads in the lateral position. Of note, a two port system was used to increase the amount of tissue ablated. In order to accomplish the appropriate distance between the two bolts, the bone anchors had to be shaved down in order to be placed next to one another.

SLIDE 23 [REFERENCES]: 6:16-6:21
And that concludes this case, thank you.

References

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Senior author. Statistical analysis: all authors

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