Robot-Assisted Placement of Depth Electrodes Along the Long Axis of the Amygdalohippocampal Complex

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Introduction

Classically, transoccipital hippocampal depth electrode implantation requires a stereotactic headframe and arc and the patient to be placed in a seated or prone position, which can be cumbersome to position and uncomfortable for the surgeon. Robotic intracranial devices are increasingly being utilized for stereotactic procedures such as stereolectroencephalography (SEEG) but commonly require patients be placed in head-neutral position to perform facial registration. Here we describe a novel robotic implantation technique where a stereotactic intracranial robot is used to place bilateral hippocampal depth electrodes in the lateral position.

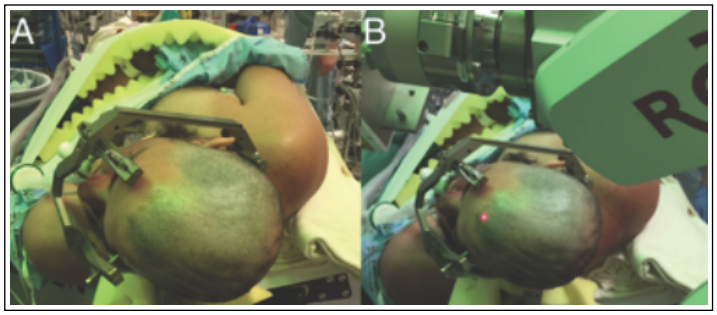
Methods

Four patients underwent SEEG depth electrode placement, which included placement of bilateral hippocampal depth electrodes. Each patient was positioned in the lateral position and registered to the robot with laser facial registration. Trajectories were planned with the robotic navigation software, which then identified the appropriate entry points and trajectories needed to reach the targets. After electrode implantation, target localization was confirmed using computed tomography (CT).

Table 1

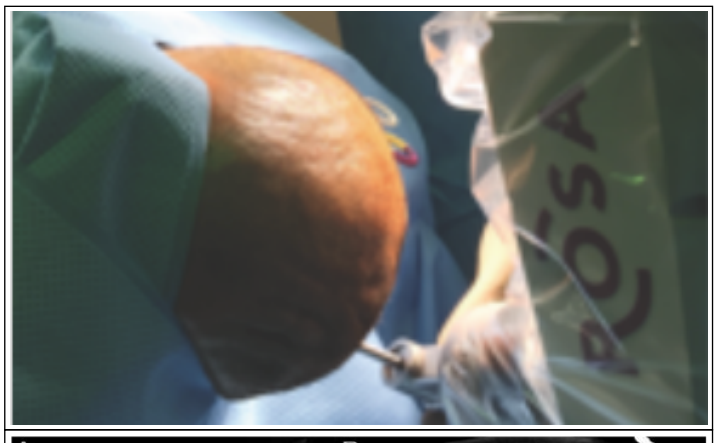
Patient	Age at procedure	Epilepsy onset	Refractory AEDs	Pre-Op VNS	Pre-Op MRI findings	Pre-Op video EEG findings
1	69	34	Lacosamide Levetiracetam Clonazapam	Yes (ineffective)	Nonlesional	Poor localization pattern; onset was suggestive of right hemisphere
2	47	16	Lacosamide Levetiracetam Phenytoin	Yes	Right mesial temporal sclerosis	Temporal intraictal epileptiform abnormalities with eletroclinical seizures; unclear laterality regarding onset
3	44	5	Lacosamide, Levetiracetam, Topiramate, Phenytoin, Valproate, Lamotrigine, Phenobarbital, Zonisamide, Pregabalin, Carbamazepine	Yes (ineffective)	Right sided cortical dysplasia	Bilateral independent seizures, but predominantly right hemispheric
4	50	NA	Levatiracetam Phenytoin	None	Possibly right mesial temporal atrophy	Epileptiform discharges in T2 region but also independent discharges in T1. Discharges are rarely bisynchonous

Pre-operative patient characteristics



Results

Electrodes targeting the amygdalohippocampal complex were accurate and there were no complications in this group. An average of seven electrodes were placed per patient. Ictal onset was localized for each patient. All patients subsequently underwent temporal lobectomy; at 6 months, 3 patients were seizures and the 4th had a significant reduction in seizures burden.



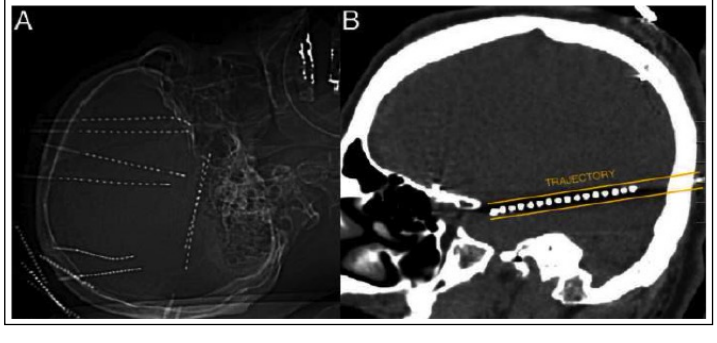


Table 2

Patient	SEEG localization	Number of Eletrodes	Resective treatment	Pathology	Complications	6 months post-op seizure outcome
1	Right hippocampus	6	Right temporal lobectomy	Hippocampus sclerosis	None	50% reduction in seizure burden
2	Right hippocampus	6	Right temporal lobectomy	Hippocampus sclerosis	None	Complete cesation of seizure
3	Right hippocampus	8	Right temporal lobectomy	Hippocampus sclerosis, cortical dysphasia	None	Complete cesation of seizure
4	Right hippocampus	8	Right temporal lobectomy	Hippocampus sclerosis	None	Complete cesation of seziure

Post-operative outcomes

Conclusions

We have developed the Robot-Assisted Lateral Transoccipital approach, which is an advantageous technique for placing bilateral amygdalohippocampal depth electrodes using robotic guidance. Benefits of this technique include fewer electrodes required per patient and ease of positioning compared with seated or prone positioning.

References

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