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Comparison between artificial intelligence and neurosurgeons in targeting the VIM for magnetic resonance-guided focused ultrasound thalamotomy.

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Background

Magnetic resonance-guided focused ultrasound (MRgFUS) thalamotomy has emerged as a compelling non-invasive alternative to deep brain stimulation (DBS) for treating essential tremor (ET). Optimal clinical outcomes depend on precise targeting of the VIM.

However, direct visualization of the VIM on conventional MRI is limited, often necessitating indirect targeting based on anatomical landmarks. RebrAIn's OptimMRI is a novel machine learning–based tool trained on a large database of ET patients successfully treated with radiosurgical thalamotomy and then designed to predict an optimal thalamic target.

Objective

To compare the target location predicted by RebrAIn's OptimMRI algorithm which has been traind on highly improved (CRST improvement >66%) patient treated with SRS to the lesions created using standard neurosurgical targeting in MRgFUS thalamotomy.

Methods

A retrospective analysis was conducted on 64 patients treated with MRgFUS thalamotomy at a single center. For each patient, coordinates for neurosurgeon-defined targets, ranging from one to three targets per patient (T1, T2, and T3), were recorded relative to the anterior commissure–posterior commissure (AC-PC) plane and compared to the "optimal" target coordinates predicited by RebrAIn. Additionally, post-procedural T2-weighted MR images were used to determine the lesion centroid (L1) coordinates which were also compared to the "optimal" target coordinates predicted by RebrAIn

Results

- Protocols of sonications and the obtained improvements.

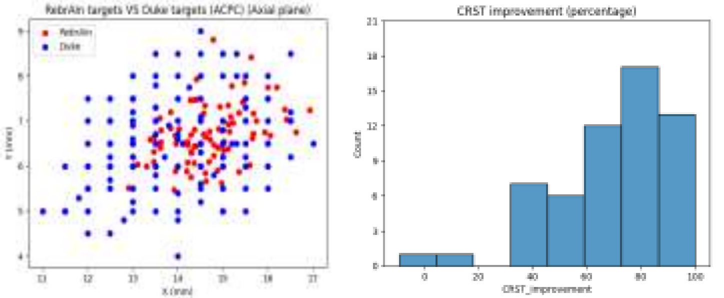

Figure 1 : Projection of the sonication and the Predicted coordinates in the Axial plane and the CRST improvement of the patients treated with 1, 2 or 3 sonication.

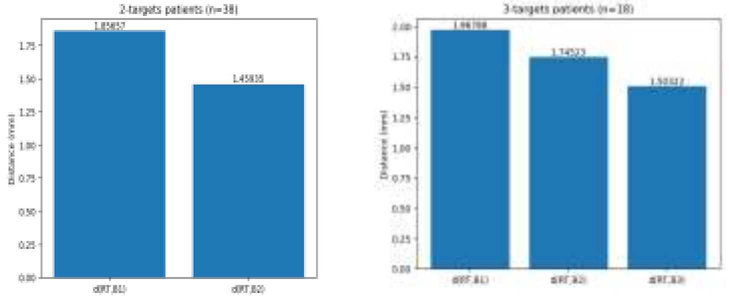

Figure 2: Evolution of distances between mean values of the theoretical 1st and 2nd sonications (left) or 1st , 2nd and 3rd sonication (right) and the Rebrain predicted target.

Lesion group Analysis

- Segmentation of the 64 lesions average
- Normalizing Postop images to MNI template
- Applying the normalization transformation to the lesion masks
- Summing the Masks to obtain the frequency
- Computing the lesion N-map
- Computing and Showing the sweet spot with the machine learning VIM-lesion Target (CE and FDA cleared).

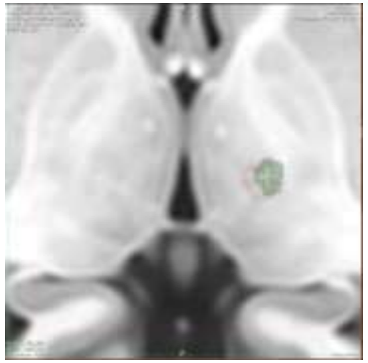

Figure 3: Group analysis of the MRgFUS (Duke, red) and SRS lesions used for the algorithm training (Green) and the Rberain AI target (White cross).

Conclusion

When multiple sonication were required to improve tremor control, the averaged coordinates aligned more closely with RebrAIn's prediction. Group analysis shows that the MRgFUS and SRS lesions are very close with slight differences in the lateral and posterior-anterior coordinates. Whether such differences are clinically meaningful in MRgFUS remains to be determined and is an area we are actively investigating. These findings provide preliminary evidence that the RebrAIn target may represent an optimal location for tremor suppression, highlighting its potential value in refining initial VIM targeting for MRgFUS and future use as a clinical tool.