

MRgFUS Planning with Elements Fibertracking

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Products

Elements Fibertracking, Elements Distortion Correction Cranial, Elements Trajectory Planning

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Clinical Background

Magnetic resonance-guided high-intensity focused ultrasound (MRgFUS) is FDA-approved for ablation of the ventral intermediate nucleus of the thalamus (VIM) to treat Essential Tremor (ET) and Parkinson's disease tremor. Despite its benefits, side effects such as numbness and paresthesia remain a primary limitation of MRgFUS. These may in part be attributable to indirect (landmark-based) targeting as the VIM cannot be delineated on standard MR imaging. Diffusion tensor imaging (DTI) is a promising technique to enable direct targeting as it can be used to determine both white matter tracts to target and those to avoid. Emerging evidence suggests that DTI-based targeting can decrease side effects during and after MRgFUS treatment. However, it has not yet been widely adopted in planning due to technical challenges and a lack of standardization.

Study Objectives

This study presents a novel method for DTI-based direct targeting using Brainlab Elements in conjunction with the ExAblate MRgFUS system (Insightec, Haifa, Israel) - the interface was enabled by the Elements component Import-Export. This approach is compared to standard indirect targeting and clinical outcomes are analyzed for 18 consecutive Essential Tremor patients up to three months post-op.

N = 18 patients, retrospective design

Results

• Clinical Outcomes:

- **Benefits:** Hand tremor improved by 84% at 1 month and 81% at 3 months
- **Side effects:** None of the patients experienced weakness, numbness, paresthesia, dysarthria or objective ataxia; 3 patients reported subjective imbalance, however, this was resolved in 1 month

- **Comparison to standard indirect targeting:** A statistically significant difference between the indirect and tract-based target was observed for both anterior and lateral coordinates ($p < 0.005$); Ø Euclidean distance $1.80 \text{ mm} \pm 0.88 \text{ mm}$

- **Procedural aspects:** Compared to literature reports on indirect targeting, fewer sonications were needed using this method (total number Ø 9.9 ± 1.7 per patient)

Summary

- DTI-based targeting with Brainlab Elements was **easy to implement into the clinical workflow**
- The method presented here accounts for **individual variability** with a statistically significant difference to the target otherwise determined in an indirect manner (based on landmarks)
- **An immediate tremor response** was observed in all patients during the procedure which can decrease the overall treatment time
- During and after treatment, **less sensory and motor side effects** were observed than those reported in literature for standard indirect targeting*

**Limitations: The small sample size and follow up time do not allow a generalization at this point*