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Refining electrode placement in Deep Brain Stimulation: hemispheric asymmetries for stimulation response in Essential Tremor

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Deep Brain Stimulation (DBS) is a well-established treatment for symptoms of movement and psychiatric disorders. Its clinical efficacy relies on the positioning of the DBS electrodes in millimeter-sized anatomical targets. However, for many conditions, the optimal stimulation sites are still under discussion. In addition, few studies have highlighted the benefits of an asymmetrical placement of the electrodes between first and second implanted hemisphere. Thus, this study aims at identifying optimal and sub-optimal stimulation positions for tremor alleviation in Essential Tremor (ET) and compare them between hemispheres.

497 (277 left, 220 right hemisphere) intra-operative stimulation tests of 23 ET patients yielding tremor improvement were analysed. During the tests tremor improvement was classified as: “no improvement” (0%), “poor” (25%), “fair” (50%), “good” (75%), “excellent” (100%). Intermediate scores were also attributed if needed. Stimulation positions were marked on the patients’ electrode trajectories and transformed in a common anatomical space for cumulative analysis. The positions were labelled with 4 improvement categories: “low” ($0<impr.\leq25\%$), “medium” ($25\%<impr.\leq50\%$), “high” ($50\%<impr.\leq75\%$), “excellent” ($75\%<impr.\leq100\%$). Density-Based Spatial Clustering of Applications with Noise was applied to assess whether positions belonging to the same category would cluster in a specific anatomical area. Intra-hemispheric comparisons of cluster locations across different categories, as well as inter-hemispheric comparisons of clusters within the same category, were performed using Multivariate ANOVA followed by Tukey post-hoc testing.

The clustering algorithm identified seven clusters corresponding to improvement categories in the left hemisphere and four in the right. The centroids of the "excellent" clusters were located posterior-medial to the ventrointermediate nucleus of thalamus in the left hemisphere, and posterior-lateral in the right. In the left hemisphere, "excellent" clusters were significantly more medial and inferior compared to other clusters, whereas in the right hemisphere, they were positioned significantly more posteriorly. The "excellent" clusters in the left hemisphere were situated significantly more medially, posteriorly, and inferiorly compared to their counterparts in the right hemisphere. Additionally, clusters associated with "medium" and "high" improvement were also significantly more posterior in the left hemisphere relative to the right.

These findings demonstrate that stimulation sites associated with both optimal and suboptimal clinical improvement tend to cluster in anatomically distinct regions. Furthermore, the spatial distribution of improvement-related clusters differs between hemispheres. This emphasizes the importance of analyzing each hemisphere independently and suggests that such asymmetry should be considered during electrode implantation planning.

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Reference: #46102 Flash poster session2 Screen 1 (Thursday 25 September,15h-15h30)