Relationship Between MRI-Based Stereotactic Planning and Functional Localization via Microelectrode Recording in Subthalamic Nucleus Deep Brain Stimulation: A Case Series.

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Abstract

Introduction: Precise anatomical localization of the surgical target is essential in minimally invasive procedures such as subthalamic nucleus deep brain stimulation (STN-DBS). Correlating the stereotactic coordinates from preoperative MRI-based planning with intraoperative microelectrode recording (MER) findings helps achieve optimal functional localization without compromising clinical outcomes. This study not only reinforces existing scientific evidence but also aims to provide practical guidance for emerging surgical teams with limited resources or early-stage experience.

Method: A retrospective observational study was conducted on patients with advanced Parkinson's disease who underwent subthalamic nucleus deep brain stimulation (STN-DBS) between January and June 2025. Six consecutive patients were included, all of whom had undergone preoperative MRI-based stereotactic planning and intraoperative microelectrode recording (MER).

Result: The mean follow-up of this cohort was 18 months. The change in BNI was toward pain reduction in 21 of the 23 patients (91.3%), from BNI I to II with fewer cases toward IIIa or IIIb, while one remained the same (IV) and one worsened (IV to V). Initially patients reported severe pain with a mean VAS score of 10 (range 8-10). Early responses after SRS (7-30 days) showed a significant reduction in pain ($p<0.001$), as most patients' scores dropped to 4-6. At one year, these results were sustained ($p=0.065$). Patients with a 2-year follow-up maintained pain reduction from year 1 ($p=0.337$), with scores predominantly 0-1, except for patients 1 and 2. The most common side effect was non-bothersome facial hypoesthesia, emerging early and persisting in 13 patients (56.5%). Pain-free survival rate showed at 6 months 87% of patients were pain-free (BNI I-II), and the estimates at 12 and 24 months were 68% and 60%, respectively. Five people had previously undergone other non-pharmacological treatment; their response was parallel to those who received SRS as a first option ($p=0.921$).

Discussion: Six patients (four men and two women) with advanced Parkinson's disease who underwent STN-DBS were included. A total of 12 hemispheres were analyzed. A tendency was observed toward the need for more than one MER trajectory to achieve reliable functional localization of the STN. In most cases, two trajectories per hemisphere were required due to the absence of typical electrophysiological signals in the centrally planned trajectory. All patients presented elevated preoperative UPDRS-III scores, with evident subjective clinical improvement observed during postoperative follow-ups. However, quantitative postoperative data collection is still ongoing. Concordance analysis between the anatomically planned target (MRI-based) and the functionally determined target (MER), as well as the comparison between the location of the active contact(s) and the original planned coordinates, is currently in progress. Preliminary findings suggest that MRI-based planning did not always coincide with the optimal functional site determined intraoperatively through MER.

Conclusions: In this case series of six patients with advanced Parkinson's disease who underwent STN-DBS, multiple MER trajectories were required in most hemispheres to achieve accurate functional localization of the target. Preliminary data indicate that MRI-based anatomical planning does not always align with the intraoperatively determined optimal functional target. Ongoing concordance analysis and active contact comparison will provide further insight into the reliability and precision of each targeting method.

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