Stereotactic Targeting Precision in MR-Guided Focused Ultrasound: Anatomical Coordinates Analysis in Parkinson's Disease and Essential Tremor in Argentina

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Abstract

Introduction: Magnetic Resonance-guided focused ultrasound (MRgFUS) in functional neurosurgery is a non-invasive, incision-less alternative option which is being increasingly used for the treatment of medically refractory movement disorders. The therapeutic efficacy of MRgFUS for movement disorders depends on precise stereotactic targeting. While target selection is symptom-driven, understanding coordinates variability across targets, diagnoses, and hemispheres is essential for refining surgical planning.

Method: We prospectively analyzed 48 consecutive patients undergoing MRgFUS for movement disorders at our center in Argentina, between December 2024 and June 2025, using the AC-PC (Anterior Commissure-Posterior Commissure) coordinates system. Preoperative planning was based on 1 mm isotropic T1- and T2-weighted MRI. Coordinates were defined in X (lateral), Y (anterior-posterior), and Z (superior-inferior) dimensions relative to PC. VIM (ventral intermediate nucleus) targets were selected for tremor-dominant symptoms; NST (nucleus subthalamicus) targets were used for bradykinesia/rigidity. Coordinate data and AC-PC distances were prospectively recorded. ANOVA and t-tests compared coordinates distributions across targets, diagnoses, and hemispheres. Pearson correlation assessed anatomical-clinical associations ($p<0.05$ considered statistically significant). Patient consent was obtained to share this information.

Results: Complete stereotactic data were available for all 48 patients. Mean targeting coordinates were X=13.1 ± 4.5 mm, Y=7.2 ± 1.5 mm, and Z=1.1 ± 2.4 mm, with a mean AC-PC distance of 25.1 ± 1.4 mm. Within the VIM group, essential tremor and Parkinson's disease patients demonstrated similar targeting precision, though Y-coordinates differed significantly ($p<0.001$). X-coordinates did not differ by hemisphere ($p=0.935$). The mean objective improvement was 92.9% ± 7.5, while the mean subjective improvement was 91.5% ± 8.1 ($p=0.001$). No significant correlations were found between anatomical coordinates and clinical outcomes ($p>0.05$).

Discussion: The reported clinical outcomes from a single Argentinian center underscore the importance of meticulous preoperative surgical planning. MRgFUS stereotactic targeting demonstrates distinct coordinates profiles based on target type, diagnosis, and laterality, particularly in Y- and Z-axes. Despite this variability, consistent clinical outcomes suggest flexibility within anatomical bounds.

Conclusions: These findings support refined, anatomy-guided targeting to optimize individualized treatment planning.

References

1. Pineda-Pardo JA, Urso D, Martínez-Fernández R, Rodríguez-Rojas R, Del-Alamo M, Millar Vernetti P, et al. Transcranial Magnetic Resonance-Guided Focused Ultrasound Thalamotomy in Essential Tremor: A Comprehensive Lesion Characterization. Neurosurgery. 2020;87(2):256-265. doi: 10.1093/neuros/nyz395. PMID: 31574145.
2. Segar DJ, Lak AM, Lee S, Harary M, Chavakula V, Lauro P, et al. Lesion location and lesion creation affect outcomes after focused ultrasound thalamotomy. Brain. 2021;144(10):3089-3100. doi: 10.1093/brain/awab176. PMID: 34750621.
3. Arcadi A, Aviles-Olmos I, Gonzalez-Quarante LH, Gorospe A, Jiménez-Huete A, de la Corte MM, et al. Magnetic Resonance-Guided Focused Ultrasound (MRgFUS)-Thalamotomy for Essential Tremor: Lesion Location and Clinical Outcomes. Mov Disord. 2024;39(6):1015-1025. doi: 10.1002/mds.29801. Epub

2024 Apr 14. PMID: 38616324.

4. Zhang DY, Pearce JJ, Mazza J, Petrosyan E, Borghei A, Patel N, Sani S. Initiating a Magnetic Resonance-Guided Focused Ultrasound Program: Comprehensive Workflow and Lessons Learned from the Initial 116 Cases. Stereotact Funct Neurosurg. 2023;101(2):101-111. doi: 10.1159/000528925. Epub 2023 Mar 2. PMID: 36863325.
5. Yamamoto K, Sarica C, Loh A, Vetkas A, Samuel N, Milano V, et al. Magnetic resonance-guided focused ultrasound for the treatment of tremor. Expert Rev Neurother. 2022;22(10):849-861. doi: 10.1080/14737175.2022.2147826. Epub 2022 Dec 5. PMID: 36469578.
6. Gallay MN, Moser D, Federau C, Jeanmonod D. Radiological and Thermal Dose Correlations in Pallidothalamic Tractotomy With MRgFUS. Front Surg. 2019;6:28. doi: 10.3389/fsurg.2019.00028. PMID: 31157233; PMCID: PMC6533852.
7. Miller WK, Becker KN, Caras AJ, Mansour TR, Mays MT, Rashid M, Schwalb J. Magnetic resonance-guided focused ultrasound treatment for essential tremor shows sustained efficacy: a meta-analysis. Neurosurg Rev. 2022;45(1):533-544. doi: 10.1007/s10143-021-01562-w. Epub 2021 May 12. PMID: 33978922.