# Essential tremor case series

Clinical and radiological data from forty patients with medically-refractory essential tremor treated with unilateral tcMRgFUS thalamotomy were retrospectively analyzed. Treatment efficacy was assessed with Clinical Rating Scale for Tremor (CRST). Lesions were manually segmented on T1, T2, and susceptibility-weighted images, and 3-dimensional topographical analysis was then carried out. Statistical comparisons were performed using nonparametric statistics.

The greatest clinical improvement was correlated with a more inferior and posterior lesion, a bigger lesion volume, and percentage of the ventral intermediate nucleus covered by the lesion; whereas, the largest lesions accounted for the occurrence of gait imbalance. Furthermore, the volume of the lesion was significantly predicted by the number of sonications surpassing 52°C.

Pineda-Pardo et al. provided a comprehensive characterization of the thalamic tcMRgFUS lesion including radiological and topographical analysis. The results indicate that the location and volume of the lesion were significantly associated with the clinical outcome and that mid-temperatures may be responsible for the lesion size. This could serve ultimately to improve targeting and judgment and to optimize clinical outcome of tcMRgFUS thalamotomy [1)].

---

For three patients (five electrodes) diagnosed with essential tremor, Vorwerk et al. derived optimized multipolar stimulation configurations using an approach that is suitable for the application in clinical practice. To evaluate the automatically derived stimulation settings, they compared them to the results of the monopolar review.

They observed a good agreement between the findings of the monopolar review and the optimized stimulation configurations, with the algorithm assigning the maximal voltage in the optimized multipolar pattern to the contact that was found to lead to the best therapeutic effect in the clinical monopolar review in all cases. Additionally, our simulation results predict that the optimized stimulation settings lead to the activation of an equal or larger volume fraction of the target compared to the manually determined settings in all cases.

The results demonstrate the feasibility of an automatic determination of optimal DBS configurations and motivate a further evaluation of the applied optimization algorithm. [2)].

---

A cohort of 24 essential tremor patients before and 3 months after unilateral Transcranial magnetic resonance-guided focused ultrasound targeting at the posteroventral part of the VIM. Microstructural changes along the dentatorubrothalamic tract (DRTT) were quantified by means of probabilistic tractography, and later related to the clinical improvement of the patients at 3-months and at 1-year after the intervention. In addition the changes along two neighboring tracts, that is, the corticospinal tract and the medial lemniscus, were assessed, as well as the relation between these changes and the presence of side effects. Thalamic lesions produced local and distant alterations along the trajectory of the DRTT, and each correlated with clinical improvement. Regarding side effects, gait imbalance after thalamotomy was associated with greater impact on the DRTT, whereas the presence of paresthesias was significantly related to a higher overlap between the lesion and the medial lemniscus. This work represents the largest series describing the microstructural changes following transcranial MR-guided focused ultrasound thalamotomy in essential tremor. These results suggest

that clinical benefits are specific for the impact on the cerebello-thalamo-cortical pathway, thus reaffirming the potential of tractography to aid thalamotomy targeting [3)].

---

A total of 33 patients evaluated in Medtronic, Vasteras, Sweden,Medtronic, Eindhoven, the Netherlands. Department of Biomedical Engineering, Linköping University, Linköping, Unit of Functional and Stereotactic Neurosurgery, Department of Pharmacology and Clinical Neuroscience, Umeå University, Neurosurgery, Department of Clinical Neuroscience, Karolinska Institute, Stockholm, Sweden.(37 leads) treated with DBS were evaluated with the Essential Tremor Rating Assessment Scale (ETRS) 12 months after surgery. In addition, hand tremor and hand function (ETRS items 5/6 and 11-14) were evaluated for every contact during stimulation with best possible outcome without inducing side effects. Prediction of effective DBS electrode contacts was carried out in a retrospective leave-one-out manner based on probabilistic stimulation maps (PSMs), simulated stimulation fields, and a scoring function. Electrode contacts were ranked according to their likelihood of being included in the clinical setting. Ranked electrode contacts were compared to actual clinical settings.

Predictions made by the software tool showed that electrode contacts with rank 1 matched the clinically used contacts in 60% of the cases. Contacts with a rank of 1-2 and 1-3 matched the clinical contacts in 83 and 94% of the cases, respectively. Mean improvement of hand tremor and hand function was 79 ± 21% and 77 ± 22% for the clinically used and the predicted electrode contacts, respectively.

Effective electrode contacts can be predicted based on PSMs in patients treated with cZi DBS for ET. Predictions may in the future be used to reduce the number of clinical assessments that are carried out before a satisfying stimulation setting is defined [4)].

---

Fifty-two patients (30 male, 22 female; mean age 71.6 years, range 49-82) with right-sided ET benefited from left unilateral Vim RS in Marseille, France. Targeting was performed in a uniform manner, using 130 Gy and a single 4-mm collimator. Neurological (pretherapeutic and 1 year after) and neuroimaging (baseline) assessments were completed. Tremor score on the treated hand (TSTH) at 1 year after Vim RS was included in a statistical parametric mapping analysis of variance (ANOVA) model as a continuous variable with pretherapeutic neuroimaging data. Pretherapeutic gray matter density (GMD) was further correlated with TSTH improvement. No a priori hypothesis was used in the statistical model.

The only statistically significant region was right Brodmann area (BA) 18 (visual association area V2, $p = 0.05$, cluster size $Kc = 71$). Higher baseline GMD correlated with better TSTH improvement at 1 year after Vim RS (Spearman's rank correlation coefficient = 0.002).

Routine baseline structural neuroimaging predicts TSTH improvement 1 year after Vim RS. The relevant anatomical area is the right visual association cortex (BA 18, V2). The question whether visual areas should be included in the targeting remains open [5)].

1)
Pineda-Pardo JA, Urso D, Martínez-Fernández R, Rodríguez-Rojas R, Del-Alamo M, Millar Vernetti P, Máñez-Miró JU, Hernández-Fernández F, de Luis-Pastor E, Vela-Desojo L, Obeso JA. Transcranial Magnetic Resonance-Guided Focused Ultrasound Thalamotomy in Essential Tremor: A Comprehensive Lesion Characterization. Neurosurgery. 2019 Oct 1. pii: nyz395. doi: 10.1093/neuros/nyz395. [Epub ahead of print] PubMed PMID: 31574145.

2)
Vorwerk J, Brock A, Anderson DN, Rolston JD, Butson CR. A retrospective evaluation of automated optimization of deep brain stimulation parameters. J Neural Eng. 2019 Jul 25. doi: 10.1088/1741-2552/ab35b1. [Epub ahead of print] PubMed PMID: 31344689.
3)
Pineda-Pardo JA, Martínez-Fernández R, Rodríguez-Rojas R, Del-Alamo M, Hernández F, Foffani G, Dileone M, Máñez-Miró JU, De Luis-Pastor E, Vela L, Obeso JA. Microstructural changes of the dentato-rubro-thalamic tract after transcranial MR guided focused ultrasound ablation of the posteroventral VIM in essential tremor. Hum Brain Mapp. 2019 Mar 13. doi: 10.1002/hbm.24569. [Epub ahead of print] PubMed PMID: 30865338.
4)
Åström M, Samuelsson J, Roothans J, Fytagoridis A, Ryzhkov M, Nijlunsing R, Blomstedt P. Prediction of Electrode Contacts for Clinically Effective Deep Brain Stimulation in Essential Tremor. Stereotact Funct Neurosurg. 2018 Sep 28:1-8. doi: 10.1159/000492230. [Epub ahead of print] PubMed PMID: 30269142.
5)
Tuleasca C, Witjas T, Van de Ville D, Najdenovska E, Verger A, Girard N, Champoudry J, Thiran JP, Cuadra MB, Levivier M, Guedj E, Régis J. Right Brodmann area 18 predicts tremor arrest after Vim radiosurgery: a voxel-based morphometry study. Acta Neurochir (Wien). 2017 Nov 11. doi: 10.1007/s00701-017-3391-x. [Epub ahead of print] PubMed PMID: 29128955.