JNS

J Neurosurg 131:1339–1345, 2019

Neurosurgical Forum

LETTERS TO THE EDITOR

Resting-state functional MRI for functional neurosurgery: seeing the light?

TO THE EDITOR: We read with great interest the recent article by Lehner et al.[5] (Lehner KR, Yeagle EM, Argyelan M, et al: Validation of corpus callosotomy after laser interstitial thermal therapy: a multimodal approach. *J Neurosurg* [epub ahead of print November 16, 2018. DOI: 10.3171/2018.4.JNS172588]), discussing corpus callosotomy performed by laser interstitial thermal therapy (LITT) in a small cohort of 5 patients in the context of a multimodal approach. The authors additionally used resting-state functional MRI (rs-fMRI) to assess the outcome of this functional neurosurgery intervention. Whereas prior to LITT, brain activity showed robust interhemispheric functional connectivity, it was greatly reduced following callosotomy, with intrahemispheric functional connectivity being largely maintained.

Understanding how brain rewiring after functional neurosurgery procedures impacts brain activity is essential for our understanding and for future developments in this extraordinary and continuously expanding field. In that context, rs-fMRI is particularly useful given its ability to map various functional networks simultaneously with minimal cooperation required from the patient.

Boerwinkle et al.[1] have recently suggested that using rs-fMRI might improve outcomes of MRI-guided stereotactic laser ablation in the treatment of hypothalamic hamartomas. We have previously demonstrated how stereotactic radiosurgical thalamotomy (SRS-T) for drug-resistant essential tremor (ET) correlates with changes within large-scale brain networks (Fig. 1).[6–10] Comparison of pre- and post-interventional imaging allowed confirmation of

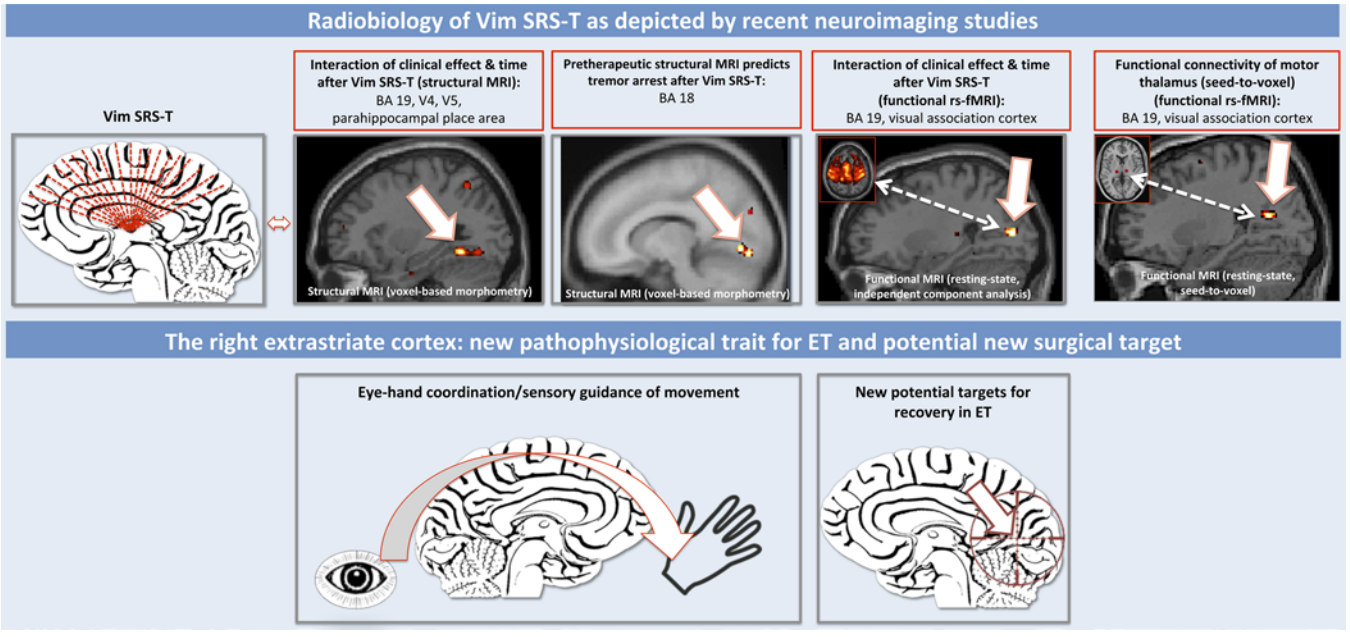

FIG. 1. Upper (*left to right*): Artistic representation of ventral intermediate nucleus (Vim) SRS-T; structural MRI alterations within Brodmann area (BA) 19 and also within BA 18, as depicted by structural (voxel-based morphometry) studies by our group; rs-fMRI changes, using different methodologies, such as independent component analysis and seed-to-voxel analysis. **Lower:** Artistic illustration (*left*) of the eye-hand coordination necessary for sensory guidance of movements, as a new concept for tremor generation in ET. Artistic illustration (*right*) suggesting the extrastriate cortex as a new potential target for the treatment of drug-resistant ET. Figure is available in color online only.

the role of the ventro-intermediate nucleus target in the tremor network.[7,8] Then, more surprisingly, a visually sensitive structural and functional network was shown to be involved in tremor generation and furthermore with arrest after the intervention, thus pointing toward potential new surgical targets for tremor such as the right extrastriate visual cortex.[6,7,9,10] We specifically coined the term "cerebello-thalamo-visuo-motor network"[7] to describe these observations.[2] In trigeminal neuralgia, Dou et al.[3] demonstrated how a specific measure of functional connectivity (e.g., regional homogeneity), would change in specific parts of the brain after percutaneous radiofrequency thermocoagulation. More recently, Fox elegantly discussed how relating symptoms with brain connectomics leads to lesion network mapping.[4]

In conclusion, an important use of rs-fMRI is its further application to interventional studies in the clinical realm, particularly in the functional neurosurgery domain. Whether this would allow us to "see the light" with respect to a better understanding of both the pre- and post-therapeutic state remains to be confirmed by future studies.

Constantin Tuleasca, MD, PhD[1–5]
Jean Régis, MD[6]
Elena Najdenovska, PhD[1]
Tatiana Witjas, MD[6]
Nadine Girard, MD[6,7]
Jean-Philippe Thiran, PhD[1–3]
Meritxell Bach Cuadra, PhD[1,3]
Marc Levivier, MD, PhD, IFAANS[1,2]
Dimitri Van De Ville, PhD[8,9]
[1]Lausanne University Hospital (CHUV), Lausanne, Switzerland
[2]Faculté de Biologie et de Médecine (FBM), Université de Lausanne (UNIL), Lausanne, Switzerland
[3]Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland
[4]Faculté de Médecine, Sorbonné Université, Paris, France
[5]Assistance Publique-Hôpitaux de Paris, Hôpitaux Universitaires Paris Sud, CHU Bicêtre, Le Kremlin-Bicêtre, France
[6]CHU Timone, Marseille, France
[7]Faculté de Médecine, Aix-Marseille University (UMU), Assistance Publique-Hôpitaux de Marseille (APHM), Marseille, France
[8]Faculty of Medicine, University of Geneva, Geneva, Switzerland
[9]Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

Acknowledgments

We wish to express our appreciation to Lausanne and Marseille University Hospitals.

The work was supported by the Swiss National Science Foundation (SNSF-205321-157040); the Centre d'Imagerie Bio-Médicale (CIBM) of the University of Lausanne (UNIL); the Swiss Federal Institute of Technology Lausanne (EPFL); the University of Geneva (UniGe); the Centre Hospitalier Universitaire Vaudois (CHUV); CHU Timone, Marseille, France; the Hôpitaux Universitaires de Genève (HUG); and the Leenaards and Jeantet Foundations.

References

1. Boerwinkle VL, Foldes ST, Torrisi SJ, Temkit H, Gaillard WD, Kerrigan JF, et al: Subcentimeter epilepsy surgery targets by resting state functional magnetic resonance imaging can improve outcomes in hypothalamic hamartoma. **Epilepsia 59:**2284–2295, 2018
2. Chiang VL, Chao ST, Tuleasca C, Foote MC, Lee CC, Mathieu D, et al: Proceedings of the 2018 next-generation Gamma Knife research meeting. **J Neurosurg 129 (Suppl 1):**5–9, 2018
3. Dou Z, Zhang X, Yang L, Wang W, Li N, Liu Z, et al: Alternation of regional homogeneity in trigeminal neuralgia after percutaneous radiofrequency thermocoagulation: a resting state fMRI study. **Medicine (Baltimore) 95:**e5193, 2016
4. Fox MD: Mapping symptoms to brain networks with the human connectome. **N Engl J Med 379:**2237–2245, 2018
5. Lehner KR, Yeagle EM, Argyelan M, Klimaj Z, Du V, Megevand P, et al: Validation of corpus callosotomy after laser interstitial thermal therapy: a multimodal approach. **J Neurosurg** [epub ahead of print November 16, 2018. DOI: 10.3171/2018.4.JNS172588]
6. Tuleasca C, Najdenovska E, Régis J, Witjas T, Girard N, Champoudry J, et al: Clinical response to Vim's thalamic stereotactic radiosurgery for essential tremor is associated with distinctive functional connectivity patterns. **Acta Neurochir (Wien) 160:**611–624, 2018
7. Tuleasca C, Najdenovska E, Régis J, Witjas T, Girard N, Champoudry J, et al: Pretherapeutic motor thalamus resting-state functional connectivity with visual areas predicts tremor arrest after thalamotomy for essential tremor: tracing the cerebello-thalamo-visuo-motor network. **World Neurosurg 117:**e438–e449, 2018
8. Tuleasca C, Najdenovska E, Régis J, Witjas T, Girard N, Champoudry J, et al: Ventrolateral motor thalamus abnormal connectivity in essential tremor before and after thalamotomy: a resting-state functional magnetic resonance imaging study. **World Neurosurg 113:**e453–e464, 2018
9. Tuleasca C, Régis J, Levivier M: Essential tremor. **N Engl J Med 379:**595–596, 2018
10. Tuleasca C, Régis J, Najdenovska E, Witjas T, Girard N, Thiran JP, et al: Visually-sensitive networks in essential tremor: evidence from structural and functional imaging. **Brain 141:**e47, 2018

Disclosures

The authors report no conflict of interest.

Correspondence

Constantin Tuleasca: constantin.tuleasca@gmail.com.

INCLUDE WHEN CITING
Published online May 17, 2019; DOI: 10.3171/2019.1.JNS1995.

Response

No response was received from the authors of the original article.

Heterogeneous hypothalamic adhesion among third ventricle craniopharyngiomas

TO THE EDITOR: We read with great interest the article by Forbes et al.[1] (Forbes JA, Ordóñez-Rubiano EG, Tomasiewicz HC, et al: Endonasal endoscopic transsphenoidal resection of intrinsic third ventricular craniopharyn-