Validation of resting state fMRI with direct cortical stimulation

D. Zacà¹, S. Sarubbo²,³, M. Dallabona², G. Faraca², G. Pulcrano², F. Chioffi²,³, J. Jovicich¹.

¹CIMEC, University of Trento, Italy; ²Department of Neuroscience, Division of Neurosurgery, “S. Chiara” Hospital, Trento APSS, Italy; ³ Structural and Functional Connectivity Lab, Division of Neurosurgery, “S. Chiara” Hospital, Trento APSS, Italy;

Background: The support of task-based fMRI has been demonstrated for pre-surgical risk assessment and for planning of intraoperative mapping/monitoring¹. Pre-operative resting state (RS)-fMRI has been validated up to date for sensorimotor mapping by measuring the distance of the sensorimotor network from the eloquent sites emerged by intra-operative direct electrical stimulation (DES)². In this work we extended the validation of RS-fMRI to language and visual networks in a series of 6 patients submitted to awake surgery for resection of low-grade gliomas (4) and cavernous angiomas (2) in eloquent areas.

Methods: 3D anatomical T1-weighted (TR/TI/TE=10.6/450/4.2 ms, FA=12°, voxel size: 0.5x0.5x1 mm³) and 2D EPI BOLD RS-fMRI images (TR/TE=2600/45 ms, FA=87°, voxel size 4.0 mm³, 32 slices, 275 volumes) were pre-operatively acquired using a 1.5 T MR scanner on 6 patients scheduled for asleep-awake-asleep surgery with cortical-subcortical mapping. 2 6 positive (15 sensorimotor, 6 language, 5 visual) cortical sites were collected during cortical mapping with 0.7mm bipolar stimulation. RS-fMRI data were preprocessed using SPM 12. Following pre-processing for each patient sensorimotor, language and visual networks were selected among the independent components (IC) obtained running single-session Melodic (FSL) analysis by consensus between two authors who also thresholded each selected IC differently for each patient. The cortical sites demonstrated by DES were collected after surgery on the pre-operative T1-3D MRI by the same neurosurgeon (S.S.). For the best topographical location we matched the intra-operative pictures of the cortical mapping and the pictures of the cortical eloquent sites extracted by neuronavigation and captured before the resection. For each patient the shortest distance of each stimulation point from each network was measured in MNI space. We considered a shortest distance of 1 cm as the limit below which preoperative RS-fMRI networks accurately localize eloquent cortex.

Results: We found (Figure 1) that 80% of the motor stimulation points were within 1 cm of the nearest motor network. 83.3% of language stimulation points were in agreement with language networks and 100% of visual stimulation points were localized less than 1 cm from the visual activation network.

Conclusions: This work suggests a possible role of RS-fMRI in the pre-operative assessment of motor, language and visual networks, especially for pre-operative planning of surgical resections in patients not eligible for awake surgery with cortical-subcortical mapping.

References


Acknowledgements

This work has been funded by Fondazione Cassa di Risparmio di Trento e Rovereto