Functional magnetic resonance imaging indications

The ability of functional MRI (fMRI) to localize patient-specific eloquent areas has proved worthwhile in efforts to maximize resection while minimizing the risk of iatrogenic damage in patients with brain tumors. Although cortical reorganization has been described, the frequency of its occurrence and the factors that influence incidence are not well understood. Quinones et al. investigated changes in language lateralization between 2 fMRI studies in patients with brain tumors to elucidate factors contributing to cortical reorganization.

The authors analyzed 33 patients with brain tumors involving eloquent language areas who underwent 2 separate presurgical, language task-based fMRI examinations (fMRI1 and fMRI2). Pathology consisted of low-grade glioma (LGG) in 15, and high-grade glioma (HGG) in 18. The mean time interval between scans was 35 ± 38 months (mean ± SD). Regions of interest were drawn for Broca's area (BA) and the contralateral BA homolog. The laterality index (LI) was calculated and categorized as follows: > 0.2, left dominance; 0.2 to -0.2, codominance; and < -0.2, right dominance. Translocation of language function was defined as a shift across one of these thresholds between the 2 scans. Comparisons between the 2 groups, translocation of language function (reorganized group) versus no translocation (constant group), were performed using the Mann-Whitney U-test.

Nine (27%) of 33 patients demonstrated translocation of language function. Eight of 9 patients with translocation had tumor involvement of BA, compared to 5/24 patients without translocation ($p < 0.0001$). There was no difference in LI between the 2 groups at fMRI1. However, the reorganized group showed a decreased LI at fMRI2 compared to the constant group (-0.1 vs 0.53, $p < 0.01$). The reorganized cohort showed a significant difference between LI1 and LI2 (0.50 vs -0.1, $p < 0.0001$) whereas the constant cohort did not. A longer time interval was found in the reorganized group between fMRI1 and fMRI2 for patients with LGG (34 vs 107 months, $p < 0.002$). Additionally, the reorganized cohort had a greater proportion of local tumor invasion into eloquent areas at fMRI2 than the constant group. Aphasia was present following fMRI2 in 13/24 (54%) patients who did not exhibit translocation, compared to 2/9 (22%) patients who showed translocation.

Translocation of language function in patients with a brain tumor is associated with tumor involvement of BA, longer time intervals between scans, and is seen in both LGG and HGG. The reduced incidence of aphasia in the reorganized group raises the possibility that reorganization supports the conservation of language function. Therefore, longitudinal fMRI is useful because it may point to reorganization and could affect therapeutic planning for patients [1)].

In a study, Stopa et al. characterized the clinical use of fMRI by surveying neurosurgeons' use of and attitudes toward fMRI as a surgical planning tool in neurooncology patients.

A survey was developed to inquire about clinicians' use of and experiences with preoperative fMRI in the neurooncology patient population, including example case images. The survey was distributed to all neurosurgical departments with a residency program in the US.

After excluding incomplete surveys and responders that do not use fMRI (n = 11), 50 complete responses were included in the final analysis. Responders were predominantly from academic programs (88%), with 20 years or more in practice (40%), with the main area of practice in neurooncology (48%) and treating an adult population (90%). All 50 responders currently use fMRI in neurooncology patients, mostly for low- (94%) and high-grade glioma (82%). The leading decision factors for ordering fMRI were location of mass in dominant hemisphere, location in a functional area, motor symptoms, and aphasia. Across 10 cases, language fMRI yielded the highest interrater reliability agreement (Fleiss' kappa 0.437). The most common reasons for ordering fMRI were to identify language laterality, plan extent of resection, and discuss neurological risks with patients. Clinicians reported that fMRI results were not obtained when ordered a median 10% of the time and were suboptimal a median 27% of the time. Of responders, 70% reported that they had ever resected an fMRI-positive functional site, of whom 77% did so because the site was "cleared" by cortical stimulation. Responders reported disagreement between fMRI and awake surgery 30% of the time. Overall, 98% of responders reported that if results of fMRI and intraoperative mapping disagreed, they would rely on intraoperative mapping.

Although fMRI is increasingly being adopted as a practical preoperative planning tool for brain tumor resection, there remains a substantial degree of discrepancy with regard to its current use and presumed utility. There is a need for further research to evaluate the use of preoperative fMRI in neurooncology patients. As fMRI continues to gain prominence, it will be important for clinicians to collectively share best practices and develop guidelines for the use of fMRI in the preoperative planning phase of brain tumor patients [2)].

Mapping of language area

see Preoperative mapping of language area Functional MRI (fMRI) can assess language lateralization in brain tumor patients; however, this can be limited if the primary language area-Broca's area (BA)-is affected by the tumor.

Recent research indicates the value of including fMRI maps of attentional tasks along with traditional language-processing tasks in preoperative planning in patients undergoing neurosurgery procedures [3)].

Functional magnetic resonance imaging (fMRI) is a noninvasive and reliable tool for mapping eloquent cortex in patients prior to brain surgery. Ensuring intact perceptual and cognitive processing is a key goal for neurosurgeons, and recent research has indicated the value of including attentional network processing in pre-surgical fMRI in order to help preserve such abilities, including reading, after surgery.

The integration of anatomical and functional studies allows a safe functional resection of the brain tumors located in eloquent areas. Multimodal navigation allows integration and correlation among preoperative and intraoperative anatomical and functional data. Cortical motor functional areas are anatomically and functionally located preoperatively thanks to MR and functional magnetic resonance imaging and subcortical motor pathways with Diffusion tensor imaging and tractography. Intraoperative confirmation is done with cortical stimulation (CS) and N20 inversion wave for cortical structures and with subcortical stimulation (sCS) for subcortical pathways [4)].

1)

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2)

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3)

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4)

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