Cortical centres mapping by fMRI in patients with brain tumors

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The main aim of surgical treatment in patients with brain tumors is total resection of the pathology what correspond closely to the length of patient survival. To minimize the risk of postoperative, permanent neurological deficits, which are crucial for the quality of patients` life after surgery, reliable knowledge of the functional centers position is of the highest value. The presence of pathological tissue and perilesional oedema changes the topographical relations, which are different in every single patient. Neurosurgical treatment intended to preserve the cortex centers that subserve motor, sensory or language functions is possible only, when precise and credible determination of their position has been carried out at an earlier stage. CT scans and MRI images are often not sufficient providing only morphological information. Functional magnetic resonance imaging (fMRI) is a relatively new brain mapping technique which reflects changes in local blood flow and oxygen consumption caused by neural activation. This non-invasive, preoperative method enables the localization of the eloquent brain areas. However, as a every new clinical tool, value of fMRI must be validated in terms of sensitivity and accuracy. Intraoperative methods like intraoperative cortex stimulation (ICS) and somatosensory evoked potentials (SSEP) are the gold standard in brain mapping because of their reliability.

The aim of our study was to establish the effectiveness of fMRI technique in comparison with ICS and SSEP in planning the cortex centers-saving neurosurgical interventions.

Material and methods

33 patients with supratentorial brain tumors located in the vicinity of the central sulcus were included. They underwent conventional and functional MRI using the standard head coil in the 1,5 T scanner /Simens, Magnetom Vision/. SE (TR-588 ms, TE-15 ms, flip angle- 90, thich-3 mm, FOV 120) and EPI (TR-1,68 ms, TE-64 ms, flip angle- 90, thich-3 mm, FOV 120) techniques were used. All patients were asked to realized two tasks. For the first a researcher stroked the palm and digits of the hand opposite to the affected hemisphere. Performing simple, repetitive movements of the same hand was the second task. Ten series of eight images on 64x128 matrix were obtained for each task and data were analyzed with the use of Statistical Parametric Map 99 /Wellcome Dept of Cognitive Neurology, London, UK/. Statistically significant pixel locations, color-coded, were superimposed on corresponding T1 anatomical images. Then the spatial relations (direction and shortest distance) between the pathological mass and the closest activated region were determined. All patients underwent awaked surgery during which ICS and SSEP were carried out. The area of stimulation was divided into small fields and each of them were stimulated 3-4 times for reproducibility of results. The regions with positive response were marked for two kinds of stimulation separately. Both the spatial relationships as well as measurements of the distance between them and the tumor borders were determined.
Finally, detailed topographical locations of activated areas in the vicinity of the tumor were compared between fMRI and intraoperative techniques.

Fig.1

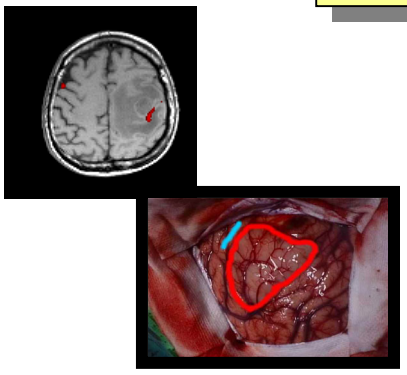

Fig.2

Results

There was a good agreement between both techniques in all patients who underwent ICS and/or SSEP. In 5 patients of high intraoperative risk e.g. massive oedema invasing mapping was not carried out. The distances between sites of activity defined by fMRI and surgical data ranged from 0 to 15mm in 24 patients ((96%). Only in one case (4%) this distance was bigger; for ICS –23 mm, for SSEP –19 mm. In 4 (14%) patients with no significant activity in rolandic area in fMRI, ICS did not produced any hand movement during operation. The size of activated regions found in fMRI examinations was always wider than the extent of positive response during surgery. The operation did not changed the neurological status in 21 of 33(63%) patients. 10 patients (30,3%) had preoperative deficits that were unchanged after surgery. New deficits were developed in 7 cases (21%); temporal in 6 cases, the permanent only in one. The surgical intervention reduced neurological deficits in 5 patients (15%).

Conclusions

1. The spatial correlation between fMRI and intraoperative methods for motor and sensory cortex centers is very high
2. fMRI combining functional and structural information available preoperatively allows to extensive tumor brain resection with lower morbidity and therefore is very helpful for planning cortex-saving neurosurgical interventions
3. Sensitivity of the fMRI technique increases significantly while using both motor and sensory paradigms in the same examination.

Fig.1 Sensory centers exam. a) fMRI b) SSEP
Fig.2 Motor centers exam a)fMRI b) ICS