

fMRI in Patients with Brain Tumors: Descriptive Serial Cases of Cognitive Function in Pre and Post Surgical Conditions

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Background: In recent years the application of fMRI in the clinical practice has grown rapidly. Today it is used to improve the planning of surgical interventions in patients with brain tumors in order to achieve a maximal tumor resection with minimal disruption and consequent function loss.

Objective: The aim of this study is to describe the cognitive function and fMRI activation in patients with brain tumors in pre and post-surgical conditions, and highlight the importance of fMRI in promoting neuropsychological positive changes after surgery.

Methods: Five patients with brain tumors in different regions and no previous craniotomy (see table1) were evaluated pre (one week before) and post-surgery (one week after). The evaluation consisted of the Karnofsky scale, neuropsychological tests (Cognistat, Rey-Osterrieth Figure, Wechsler Memory Scale) and fMRI studies. The specific fMRI paradigm was selected according to the location of the lesion (motor and/or language). All stimuli were presented in a block design using a GE 3.0T equipment, BOLD technique was used to get cerebral EPI images T2* weighted, 30 axial images with a matrix of 64x64 and 24cm FOV, TE of 40 milliseconds and TR of 3000ms. Anatomical images were correlated with high resolution T1 and SPGR images using Brain Voyager Qx software (Brain Innovation, Maastricht, NL), EPI images were aligned and movement corrected, and the activation map was obtained using a P<0.05. The results of the physical, cognitive and imaging evaluations were compared pre and post surgically.

Results:

Table 1. Patient characteristics. 5 patients with lesions in different brain regions, mean age 30.2, the Karnofsky evaluation remain the same pre and post surgically or improve in all cases.

Case no.	Age/sex	Tumor location	Diagnosis	Karnofsky Scale pre/pos %
1	26/Male	Frontal left	Meningioma	90/90
2	34/Male	Posterior fossa	Medulloblastoma	70/90
3	15/Male	Sellar tumor w/ caudal and dorsal affection to the hypothalamus, and 3 rd ventricle	Craneofaringioma	70/80
4	16/Female	Left intraventricular	Craneofaringioma	80/80
5	60/Female	Right fronto-parietal	Meningioma	80/80

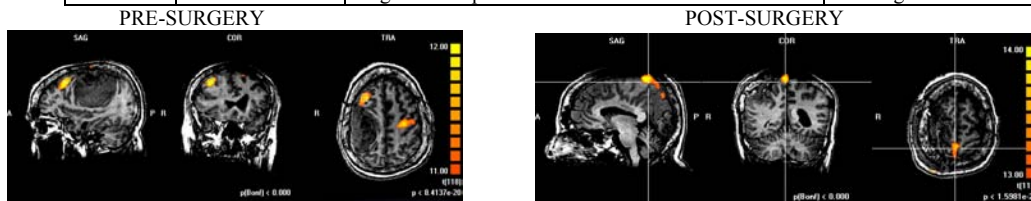


Figure-1. Case 5.
Pre: Precentral activity with rostral displacement due to meningioma
Post: Meningioma removal. Activity is localized in the precentral circumvolution.

The pre-surgical and post surgical fMRI studies showed activation in areas reported to be related to the specific task, but the functional activation was in different localizations before and after surgery (see fig-1). The pre-surgical fMRI condition showed less functional activity in eloquent areas near the lesion, and activation in surrounding areas in some cases. In other cases, the post-surgical fMRI condition showed activation correspondent to the areas reported to be involved in the task.

Table 2. Cognitive functioning and applied paradigms. According to our data all patients showed cognitive changes in one or more domains after surgery.

	Case1		Case2		Case3		Case4		Case5	
Neurosx. status	Pre	post	pre	post	pre	post	pre	post	pre	Post
Cognit. domain										
Orientation	N	N	N	N	N	Mo *	N	N	N	S*
Attention	N	N	Mo	N *	Mo	Mo	N	N	Mo	Mo
Comprehension	N	N	N	N	Mi	N*	N	N	Mi	Mo*
Repetition	N	N	N	N	N	N	N	N	S	Mi*
Denomination	N	N	N	N	N	N	N	N	N	N
Construction	N	N	N	N	N	Mo*	S	Mi*	S	Mi*
Memory	S	N*	S	S	Mo	N	N	N	S	Mi*
Calculus	N	N	Mo	N*	N	N	Mi	N*	S	Mi*
Analogical thinking	Mi	N*	S	N*	N	N	N	N	S	Mi*
Judgement tasks	Mo	N*	S	Mi*	Mo	S*	Mi	N*	N	N
fMRI paradigm	Language/ Motor, r hand		Motor, r hand/Language		Lang./ motor, r hand & r foot		Lang./ Sensori-motor bilateral		Sensorial/ Motor l hand	

N= Normal
 Mi= Mild
 Mo= Moderate
 S= Severe
 * changes were observed

C1 improved in memory, calculus, analogical thinking and social judgement. C2 improved in calculus, analogic thinking and judgment tasks. C3 had worse orientation, visuo-spatial and social judgement, and improved her verbal comprehension. C4 improved in construction, calculus and in judgement tasks.

C5 improved in orientation, verbal comprehension and repetition, construction, memory, calculus and analogic thinking.

Discussion:

It is remarkable that only one week posterior to the surgery the patients showed improvements in more than one cognitive domain. In the pre-surgical fMRI the activation according to the task was displaced by the lesion. With the tumor extracted, activation was found in a different cerebral location, probably due to the reorganization of the synaptic connections. Nevertheless it is necessary to re-evaluate the patients several months after surgery in order to obtain accurate information once the edema has been vanished.

It is important to understand the value and significance of the evaluation of both physical functionality and cognitive functions in order to understand the patient's recovery and to promote a better quality of life. This study highlights the effectiveness of utilizing fMRI techniques in order to achieve a better functional outcome of the neurosurgical patient.