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Full Length Article

Practical prognostic score for predicting the extent of resection and neurological outcome of gliomas in the sensorimotor area

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ABSTRACT

Objective: In this prospective study, we assessed the utility of a novel prognostic score (PS) in guiding the surgical strategy of patients with sensorimotor area gliomas.
Patients and methods: Form December 2012 to April 2016, we collected data from patients diagnosed with brain gliomas in the sensorimotor area. All the patients had intraoperatively confirmed contiguity or continuity with sensorimotor cortical and subcortical structures. Several clinical and radiological factors were analyzed to generate a PS for each patient (range 1–8). The end-points included the extent of resection (EOR) and neurological outcome (modified Rankin Score; mRS). We assessed the predictive power of the PS using different analyses. Crosstabs analyses and Fisher's exact test (Fet) were used to evaluate the possible predictive parameters, and for the classification of positive or negative outcomes for the chosen proxies; the significance threshold was set at $p < 0.05$.
Results: Using independent *t*-tests, we compared the mRS at different time points (pre, post, and at 6 months) for 2 subgroups from the total sample using a cut-off PS value of 4. For the EOR, a PS value of ≥ 5 was predictive of successful outcome, a value of 4 indicated an uncertain outcome, and a value of ≤ 3 predicted a worse outcome.
Conclusions: This PS value can be easily used in clinical settings to help predict the functional outcome and EOR in sensorimotor area tumors. Integration with information from fMRI, DTI, and TMS, along with MRI spectroscopy could further enhance the value of this PS.

1. Introduction

The surgical approach for gliomas in highly functional areas aims to achieve large surgical resection to improve oncological prognosis and functional preservation to maintain an optimal postoperative functional status [1]. This objective of wider resection is easily achievable in certain locations, but may be difficult at certain other sites, including an eloquent area or more generally critical area. Furthermore, an oncologically desirable resection always should be balanced with the need to preserve neurological function, in both high and low grade gliomas (HGGs and LGGs). Data from recent studies suggest that poor postoperative functional outcome negatively affects the quality of adjuvant therapies, and finally the global outcome [2–4]. Although clear evidence has been obtained regarding the factors predicting survival (age, tumor volume, preoperative neurological status, and location in eloquent areas) [5–13], information on reliable indices predicting functional outcome and EOR is scarce. Moreover, an eloquent location can hinder larger resection and is associated with a greater risk of postoperative deficits. Nevertheless, the availability of the direct mapping technique has helped overcome this limitation, and facilitates safe and large resection by exploiting interindividual variability and brain plasticity [14–18]. However, it would be useful to determine the specific patient characteristics that enhance the risk of new neurological deficits. In fact, the ultimate goal involves the ability to predict the risk of a specific neurologic deficit for a given lesion at a particular site in the brain [19]. In our previous retrospective study [20], we assessed the gliomas in eloquent areas to determine the clinical and neuroradiological parameters that predominantly affect the extent of resection (EOR) and immediate and late neurological outcome. We observed that factors related to the biology and morphology of the tumor, along with the clinical presentation, clearly helped define the operative risks in terms of the EOR and functional outcome. Based on this evidence, we

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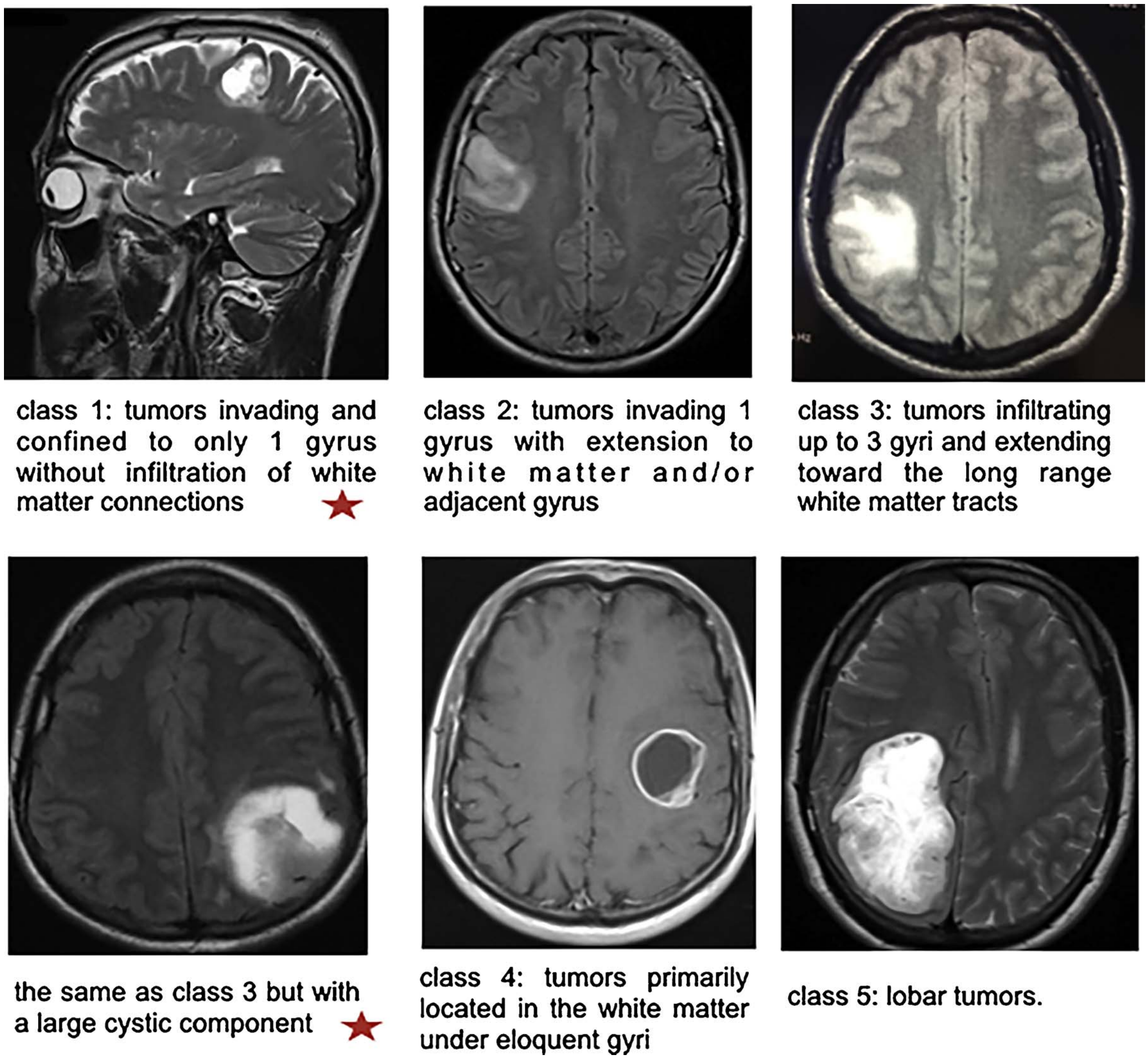

Fig. 1. MRI index of subcortical infiltration.The red star indicates that the tumors show a prominent cystic component. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1
Neuroradiological and clinical factors which are considered to calculate the prognostic score (PS).

+	sharp margins	yes [1]	no [0]
+	cyst	yes [1]	no [0]
+	seizures at onset	yes [1]	no [0]
−	MRI index > 2	yes [1]	no [0]
−	volume > 80cm3	yes [1]	no [0]
−	presumptive higher grade of malignancy	yes [1]	no [0]
−	paresis/dysesthesia	yes [1]	no [0]

identified factors with the best predictive power to create an in-house prognostic score (PS). We decided to apply this PS to only sensorimotor area gliomas, rather than language area gliomas, as these tumors are associated with less variable cortico-subcortical structures (i.e. primary motor cortex, premotor cortex, primary sensory areas, and cortico-spinal tract).

Here, we describe the results of our prospective study on this novel clinico-radiological PS that can help define the surgical strategy for patients with sensorimotor area gliomas.

2. Patients and methods

Form December 2012 to April 2016, we analyzed from a prospectively collected database of patients diagnosed with brain gliomas of the sensorimotor area. The inclusion criteria were as follows: the presence of suspected glioma infiltrating or in close vicinity to the precentral or postcentral gyri and cortico-spinal tract; availability of preoperative and follow-up clinical and neuroradiological data; and intraoperative confirmation of eloquence through intraoperative monitoring or cortico-subcortical electrical stimulation. The last criterion was vital to enhance the reliability of the PS. The positions of the sensory and motor areas were determined anatomically (axial T1 and T2) or through functional magnetic resonance imaging and diffusion tensor imaging (in cases where the precentral and postcentral gyri and CST were severely compressed or dislocated). When feasible, we follow a criteria of proposing awake surgery in patients with sensorimotor area tumors in order to obtain more detailed mapping, particularly in cases with important subcortical infiltration. However, intraoperative monitoring (IOM) in an asleep patient was chosen when the patient was unsuitable for awake surgery, and the tumor volume and subcortical infiltration were limited. Exclusion criteria were as follow: age under 18; patients with relapse/progression of a previously operated tumor.

The preoperative data used to calculate the PS included clinical and neuroradiological parameters. Clinical parameters were: the presence of seizures at onset and presence of paresis/dysesthesias. These deficits were considered regardless they responded or not to steroid administration. Neuroradiological parameters were: 1. morphology of the