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Peri- and intraoperative cognitive and language assessment for surgical resection in brain eloquent structures



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ABSTRACT

Neuropsychological care of patients suffering from an infiltrative glioma and candidates for a neurosurgery under awake condition with intraoperative functional mapping is a critical and mandatory stage in therapeutic management. It enables to estimate the functional impact of the tumor and, consequently, the efficacy of functional reorganization typically observed in these patients, not only to better predict surgery outcomes and select appropriate tasks for intraoperative functional mapping, but also to plan efficient and individualized postoperative cognitive rehabilitation strategies. Neuropsychological care management also enables patients to benefit from a solid psychological preparation both to the surgery and its associated transitory functional consequences, as well as provide a personalized psychological and emotional long-term support. Based on their solid experience in the peri-operative care of diffuse low-grade glioma patients, the authors thoroughly describe the different stages of neuropsychological management. Cognitive, emotional and language assessments typically used by the authors around and during surgery are reported, and different possible avenues of improvement are further discussed.

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1. Introduction

Diffuse low-grade glioma (DLGG) is a slow-growing, primary brain tumor mainly occurring in young adults, and most often diagnosed following an inaugural seizure [1]. Although its incidental detection is currently increasing notably due to a broader access to neuroimaging [2]. Given its acknowledged clinical benefits (i.e. increase of overall median survival, time to anaplastic transformation while preserving or even improving quality of life), surgical resection with intraoperative functional monitoring under awake conditions is now recognized as the first-line treatment in the care of DLGG patients [3,4]. However, for this oncofunctional treatment to be truly effective it has to be accompanied by precise and specific neuropsychological care, which has to be administered by a trained neuropsychologist and/or speech therapist, for a number of reasons.

In this chapter, we describe the different steps of the neuropsychological care of DLGG patients. We begin by describing peri-operative cognitive and language assessments in some details. Later, we touch upon the issue of intraoperative cognitive tasks.

2. Rationale of a perioperative functional assessment

First, contrary to what it is sometimes suggested, DLGG patients frequently suffer from neuropsychological disturbances [5], even in the case of incidental discovery [6]. This decrease in cognitive functioning generally concerns attention resources, memory, information processing speed, and more complex cognitive control functions such as dual tasking—all together impacting the quality of life [7]. The observed impairments can be partly explained by a number of socio-demographical factors, such as educational level, and are often exacerbated by anti-epileptic drug therapies [3,8], by fatigue which is recurrent in these patients [9], or by well-comprehensible psychological-related reasons. However, their very origins prior to any oncological/surgical treatment are above all pathophysiological (DLGG) location and size, infiltration or not of white matter pathways [10]. Although DLGG can induce a long-term neuroplasticity, this remains nevertheless limited, especially for certain brain structures (e.g. low plasticity of white matter tracts) [11,12]. Detailed preoperative neuropsychological information is therefore crucial to assess individual limitation in neuroplasticity potential and to subsequently predict postoperative surgical outcomes more precisely.

Second, as awake surgery is a highly unusual clinical situation, patients must be well prepared on both the psychological

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and neuropsychological levels. This optimal preparation entails, not only a very detailed description of the procedure but also a thorough explanation regarding the administration of the cognitive/language/neurological tests that will be performed during surgery (well-trained patients permit to strongly increase the objectivity of the intraoperative assessment). It also allows patients to be prepared for the immediate postoperative phase.

Based on interviews of patients who had undergone awake surgery for DLGG (personal experience), awake surgery itself does not generally constitute a traumatic experience for the patient; the postoperative period is clearly more distressing due to transient impairments (i.e. complete aphasia, akinetic mutism, hemiplegia, spatial neglect, behavioral disinhibition, etc.). This experience can be quite profound for both the patients and their families. It has to be anticipated and clearly explain to patients.

Third, neuropsychological care enables to select appropriate and individualized tasks for intraoperative mapping. Although a set of cognitive/language tasks is typically used depending on cerebral networks damaged by the tumor (see below), the preoperative neuropsychological assessment—allowing to determine which functions are impaired by the tumor and which are the patient's cognitive expertise—permits, if required, to tailor the tasks that will be used during intraoperative functional mapping.

Fourth, the immediate postoperative neuropsychological/language assessment in conjunction with the preoperative assessment gives a complete picture of surgery's functional consequences. This critical stage will allow proposing an individualized neuropsychological rehabilitation strategy. We know that early, intensive and individualized care is very beneficial and required to reach or at least to tend towards a full recovery.

Last, neuropsychological and psychological follow-up allows quantifying the recovery, reorienting cognitive/language rehabilitation if required, and providing psychological support.

3. Peri-operative cognitive assessments

The neuropsychological management of DLGG patients should be highly controlled, and structured following the same temporal organization (See Fig. 1). Cognitive and language assessments are administered three times during the peri-operative period: The week before surgery, three to five days after surgery and three months after. It is worth noting here that a language or cognitive rehabilitation is always administered to the patients during this 3-month period (sometimes, an orthoptic rehabilitation is performed when disturbances of visual or visuospatial processes are observed and a physiological rehabilitation is performed when sensorimotor disturbances are observed). Of course, the choice of cognitive and language tasks is individually-based, depending on the therapist and the patient. The matter here is not to impose an assessment protocol but rather to describe a well-tried standard examination (experienced with more than 500 patients). The proposed assessment takes into consideration critical parameters and constraints:

- in our centers, patients come from all over the country, Europe and even parts of the world. As a result, in some cases, it not always possible to see the patients several times before or after surgery. The assessment must then be at the same time sensitive, relevant and comprehensive but not too long;
- moreover, this is justified by the fact that, beyond the possible functional consequences of the lesion/resection, DLGG patients generally suffer from fatigue (inducing reduced concentration and motivation) and take anti-epileptic drugs (inducing concentration disturbances, fatigue and slowdown). If the testing is too

Table 1
Peri-operative cognitive assessment.

Cognitive assessment other than language	
Pre- and 3-month postoperative cognitive assessment	Immediate postoperative cognitive assessment (3/5 days after)
<i>General</i>	
Complaints inventory	Yes
Subjective reports/Questionnaires	No
Handedness	No
<i>Working Memory</i>	
Digit span test [39]	Yes
<i>Information Processing speed</i>	
Digit Symbol (WAIS-IV) [40]	Yes
<i>Verbal and nonverbal long-term memory</i>	
RL/RI 16, Rey's Figure [41]	No
<i>Praxis</i>	
Motor, ideomotor, reflexive, constructive	Yes
<i>Visual gnosis</i>	
V.O.S.P [42]	Yes
<i>Somatognosis and body Schema</i>	
<i>Visuospatial cognition</i>	
The Bells test, line bisection task [43]	Yes
<i>Attention</i>	
T.E.A or D2, PASAT, Baddeley's Dual task [44]	No
<i>Executive functions</i>	
Motor and verbal inhibition (go/no go) [45,46], shifting (TMT), visuospatial planning (Rey's Figure) [47] and auto-generation (Fluency task)	Yes
<i>Social cognition and emotion</i>	
Mentalizing (Comic strips task, Read the Mind in the Eyes Task), basic emotion recognition (Ekman's face) and other personal materials [48]	Only the Read the Mind in the Eyes task
<i>When possible: general intellectual functioning</i>	
Verbal Comprehension, perceptible organization, working memory, processing speed (WAIS-IV)	No
Language assessment	
<i>General</i>	
Complaints inventory	Yes
Subjective reports/Questionnaires	No
Fluency/informativity	Yes
<i>Used Tasks</i>	
Timed naming task [49]	Yes
Fluency Task	Yes
Timed semantic association task [50]	Yes
Timed reading task	Yes
Repetition task	Yes
Lexicality judgment	No
Writing	Yes
Comprehension (Token test) [51]	Yes
Metaphoric/implicit language	Yes
Prosody	No

Note that other more specific tasks are sometimes used such as metacognition or moral cognition tasks. Note also that detailed discussion of the presented tests is in the main body of text.

long, the results will be biased and will not reflect the patient's actual cognitive status;

- most of the assessment must be feasible a few days following surgery;
- the same assessment has to be equally valid for all patients;
- we will describe the peri-operative cognitive and language assessment typically administered to the patients. A complete overview of the core assessment is provided in Table 1.

3.1. Peri-operative assessment: cognitive functions other than language

A comprehensive set of cognitive and emotional tasks is always proposed the week before, three to five days after and three months after surgery. This core assessment includes a measure

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