Language mapping for parietal gliomas

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the brain's powerful ability to change itself and adapt

Michael Merzenich
Neuroscientist
The strategy

Temporary perturbation by electrical stimulation
The strategy

Temporary perturbation by electrical stimulation

The strategy

Temporary perturbation by electrical stimulation

1ms, 60 Hz, 2 to 10 mA
Functional exploration

Cortical mapping
Surgery for gliomas involving the left inferior parietal lobule: new insights into the functional anatomy provided by stimulation mapping in awake patients

Clinical article

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Objective. Surgery in the left dominant inferior parietal lobule (IPL) is challenging because of a high density of somatotopic and language structures, both in the cortex and white matter. In the present study, on the basis of the results provided by direct cortical stimulation in awake patients, the authors revisited the anatomo-functional aspects of surgery within the left IPL.

Methods. Fourteen consecutive patients underwent awake craniotomy for a glioma involving the left IPL. Intraoperative motor, sensory, and language mapping was performed before and during the tumor removal, at both the cortical and subcortical levels, to optimize the extent of resection, which was determined based on functional boundaries. Anatomofunctional correlations were performed by combining the results of intraoperative mapping and those provided by pre- and postoperative MRI imaging.

Results. At the cortical level, the primary somatotopic area (intracortical gyrus) limited the resection anteriorly in all cases, at least partially. Less frequently, speech arrest or articulatory problems were observed within the parietal operculum (4 cases). The lateral limit was determined by language sites that were variably distributed. Anoma was the most frequent response (9 cases) at the posterior third of the superior (and/or middle) temporal gyrus. Posteriorly, nonreproducible inconstant language sites were seldom observed in the posterior portion of the angular gyrus (2 cases). At the subcortical level, in addition to somatotopic responses due to stimulation of the thalamocortical pathways, articular defects were induced by stimulation of white matter in the anterior and lateral part of the surgical cavity (11 cases). This tract anatopically corresponds to the horizontal portion of the lateral segment of the superior longitudinal fasciculus (SLF III). Deeply and superficially, phonemic paraphasia was the main language disturbance (12 cases), elicited by stimulation of the posterior septal portion of the arcuate fasciculus. All these eloquent structures were surgically preserved. Despite slight cognitive disorders (working memory, writing, or calculation) in 6 cases, no patient retained a severe or a moderate postoperative deficit (except one with right hemianopia [mean follow-up 48 months]). Resection was total or near total in 9 patients and partial in 5 cases.

Conclusion. To the authors' knowledge, this is the first series dedicated to the surgery of gliomas involving the left IPL. Interestingly, a certain degree of interindividual variability was observed in the distribution of the cortical maps, especially for language. Therefore, it is suggested that no rigid pattern of resection can be considered within the left IPL, and that surgery in this region should be performed in awake patients to adapt the tumor removal to individual functional limits. Nonetheless, several landmarks have been regularly identified, especially at the subcortical levels (SLF III and arcuate fasciculus), a better knowledge of these functional tracts could be helpful to optimize functional outcomes. (DOI: 10.3171/2011.3.JNO112)

Keywords: awake surgery • language mapping • functional anatomy • inferior parietal lobule • temporoparietal junction • glioma • oncology

Surgery within the parietal lobe has rarely been reported in the literature, especially in articles concerning gliomas. Postoperative deficits have nevertheless been observed, in particular unilateral spatial neglect or sensory disturbances. Awake surgery was thus proposed to test spatial cognition and somato-sensory function intraoperatively, at least in the right nondominant hemisphere, with the goal being to minimize morbidity. However, to the best of our knowledge there has been no series specifically dedicated to the resection of gliomas involving the left dominant IPL. It is worth noting that Russell et al. reported on 28 patients in whom the clinical evolution and incidence of
Functional exploration
Cortical and subcortical
Articulatory troubles (n=11)
Phonologic (n=12)
Semantic (n=0)
Does the left superior longitudinal fascicle subserve language semantics? A brain electrostimulation study

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Abstract Recent diffusion tensor imaging (DTI) tractography studies indicate that the supramarginal gyrus (SMG) represents a relay between frontal and temporal language sites. Some authors postulate that pathways connecting SMG to the posterior temporal lobe, i.e., the posterior part of the superior longitudinal fascicle (SLF) subserve semantic aspects of language. However, DTI provides only anatomic but not functional data. Therefore, it is impossible to conclude. Interestingly, intra-operative electrical mapping of cortical and subcortical language structures during tumor surgery is recognized as a reliable technique in functional neuroanatomy research. We mapped the underlying white matter of the SMG, especially the SLF, in 11 patients who underwent awake surgery for a glioma involving the left inferior parietal lobule. Using direct electrostimulation, we investigated the exact role of the SLF in language. Our findings indicate that the white matter under the inferior parietal lobule is highly involved in the dorsal phonological system. First, the SMG, connected to the ventral premotor cortex by horizontal fibers of the SLF, subserves articulatory processing, as demonstrated by dysarthria elicited by stimulation. Second, long axonate fibers, found deeper in the white matter, subserve phonological processing, as supported by phonemic paraphasia induced by electrostimulation. Third, the most important result is that no semantic disturbances were elicited by stimulating the SLF, including its posterior part. Furthermore, no semantic disorders occurred postoperatively. Subcortical brain mapping by direct electrical stimulation does not provide arguments for a possible role of the left SLF in language semantic processing.

Keywords Awake surgery · Language mapping · Superior longitudinal fascicle · Supramarginal gyrus · Semantic processing

Introduction

The cortical organization of language is better understood than its subcortical component. Nevertheless, since the widespread use of diffusion tensor imaging (DTI) tractography, there has been a renewed interest for the subcortical language networks. For instance, recent DTI studies suggest that in the “indirect pathway” participating in the dorsal route, the supramarginal gyrus (SMG) is a relay between the frontal and temporal language sites (Catani and Mesulam 2008; Catani et al. 2005). However, the exact role of such connections in language is poorly known. Some authors postulate that tempo-parietal
Awake phase
Cortical mapping
POST OPERATIVE MRI
POST OPERATIVE MRI
DO-80m WRITTEN

Tambor
Pavão
Telefone
Limão
Avião
Bandeira
Leão
Faca
Vassoura
Conclusions

Take home messages

Go beyond topography – Think *functional*

Go beyond location – Think about the *connections*

Explore *all limits* of the operative cavity

Mapping can increase your volume of *resection*

Keep in mind the *limits of the technique* → patient selection, test selection
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Picture: The American Scientist