Insular Gliomas with Exophytic Extension to the Sylvian Cistern: A Glioma Growth Pattern That Has Gone Previously Unnoticed

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BACKGROUND: **An exophytic tumor is defined as a tumor that has its epicenter in the nervous tissue but grows outside the anatomical superficial boundaries of the brain within an adjacent space. Exophytic extension of hemispheric gliomas is extremely rare. The object of this study is to describe the exophytic growth pattern of insular gliomas.**

METHODS: **A series of 28 insular gliomas operated on consecutively were analyzed. The definition of exophytic glioma included these 2 criteria: 1) preoperative magnetic resonance imaging with evidence of exophytic local tumor extension outside the anatomical superficial boundaries of the brain; and 2) surgical identification of piamater and arachnoid invasion, with tumor growth to the adjacent cisterns.**

RESULTS: **A series of 6 exophytic gliomas (21.4%) are reported, among a series of 28 consecutive insular gliomas operated. The exophytic component originated from the posterior portion of the basal frontal lobe, with extension to the sphenoidal compartment of the sylvian cistern, reaching the temporal pole. All exophytic tumors were type 5A in Yasargil classification. The histologic diagnosis was World Health Organization grade II glioma in 3 cases and anaplastic glioma in 3 cases. All patients underwent surgery, and the exophytic component was removed completely.**

CONCLUSIONS: **Radiologic features that define the exophytic growth pattern in insular gliomas are the posterior displacement of the middle cerebral artery and a sharp subarachnoid margin that separates the exophytic tumor from the temporal pole. Contrary to the tumor that infiltrates the anterior perforating substance, the exophytic tumor is amenable for safe and complete resection.**

INTRODUCTION

Gliomas are characterized by an infiltrative pattern of growth, with cellular migration along the white matter fiber tracts,[1,2] which explains the characteristic glioma extension with invasion of adjacent gyri and the diffuse margin with the surrounding normal brain. Insular gliomas are thought to follow the same growth pattern, with extension from the insula to adjacent areas such as the operculi, fronto-orbital, temporopolar, or mesiotemporal areas.[3-5]

An exophytic tumor of the central nervous system is defined as a tumor that has its epicenter in the nervous tissue but grows outside the anatomical superficial boundaries of the brain with extension to an adjacent space.[6] The pia and arachnoid represent a solid barrier for most glioma tumors, which explains why exophytic extension of a hemispheric glioma is extremely rare. In fact, exophytic extension of a insular glioma has not been reported previously.

The present study reports a consecutive series of insular gliomas with exophytic tumor growth and extension to the sylvian cistern. The significance of this tumor growth pattern for planning surgical strategies in insular approaches is discussed.

MATERIALS AND METHODS

Subjects

The patients were selected according to the following criteria: 1) older than 18 years of age; 2) insular tumor location; 3) isolated glioma with no evidence of multicentric extension; 4) histologic

Key words
- Exophytic tumor
- Glioma
- Insula

Abbreviations and Acronyms
FLAIR: Fluid-attenuated inversion recovery
MRI: Magnetic resonance imaging
WHO: World Health Organization

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confirmation of an infiltrative World Health Organization (WHO) grade II glioma or anaplastic glioma; 5) primary craniotomy for tumor resection (no previous craniotomy for tumor resection); and 6) no chemotherapy or radiotherapy before the current surgery. Between January 2005 and September 2014, 28 consecutive patients who were operated on at the Hospital Universitario Marqués de Valdecilla in Santander and Hospital Universitario Central de Asturias in Oviedo met all inclusion criteria and were eligible for the study.

The definition of exophytic glioma included these 2 criteria[6]: 1) preoperative magnetic resonance imaging (MRI) with evidence of exophytic local tumor extension outside the anatomical superficial boundaries of the brain; and 2) surgical identification of pia and arachnoid invasion, with tumor growth through the adjacent cisterns. The tumors with intraventricular exophytic growth were excluded. Six exophytic insular gliomas (21%) were identified according to these criteria.

All participants gave their informed consent to participate in the research; all procedures were approved by the Hospital Universitario Marqués de Valdecilla Committee of Human Research, and all research was conducted according to the Declaration of Helsinki.

MRI and Surgical Procedure

All subjects were studied with brain MRI performed on a whole-body 3.0-T scanner (Achieva 3.0T; Philips Healthcare, Best, the Netherlands) with an 8-channel head coil. The imaging protocol includes axial, sagittal, and coronal T1-weighted images (simple and contrast enhanced), T2-weighted images, and fluid-attenuated inversion recovery (FLAIR) images. In the tumoral hemispheres, manual segmentation was performed with region-of-interest analysis to measure tumor volumes (in milliliters) on the basis of FLAIR axial slices.[7] The extent of tumor resection was determined a comparison of MRI scans obtained before the surgery with those obtained 3 months after the surgery. The extent of resection was calculated as: (preoperative tumor volume−postoperative tumor volume)/preoperative tumor volume.

All subjects underwent surgery for tumor resection. Twenty-three patients were operated with direct cortical and subcortical electrical stimulation via a methodology previously described by our group.[8-10] The exophytic portion of the tumor was identified and resected by use of the arachnoid of the cistern as a cleavage plane. Samples of separate tissues were taken from the exophytic component of the tumor in 1 case.

Statistical Analysis

A Mann-Whitney U test was used to determine the relationship between the independent variable (exophytic vs. nonexophytic tumor) and quantitative variables. A Fisher exact test was used to determine the relationship between the independent variable (exophytic vs. nonexophytic tumor) and qualitative variables. A significant level of 5% ($P < 0.05$) was accepted in all cases. SPSS software version 19.0 (SPSS, Armonk, New York, USA) was used for the statistical analysis.

RESULTS

The demographic, radiologic, and pathologic characteristics of the subjects and tumors are listed in Table 1. Preoperative MRI revealed in all cases hyperintens tumors in T2 and FLAIR, without contrast enhancement. The mean preoperative tumor volume was 88 mL (range, 31−174 mL) in nonexophytic tumors, and 103 mL (range, 60−196 mL) in exophytic tumors. Mean preoperative tumor volume of the exophytic portion was 7 mL (range, 3−12 mL). The volume of the exophytic component represented 7% (range, 3%−14%) of the total tumor volume. This difference was not statistically significant ($P > 0.05$).

Insular gliomas in Yasargil the classification are divided into 4 categories: 3A, 3B, 5A, and 5B. 5A tumors differ from type 3A and 3B in that they have a prominent extension to the frontobasal region or the temporal lobe. 5B tumors differ from 5A in that they have temporomesial and/or hipocampal involvement.[3] In the present series, all exophytic tumors were type 5A in Yasargil classification. In contrast, only 6 of 22 cases (27%) were type 5A in nonexophytic tumors. This difference was statistically significant ($P = 0.02$). The prevalence of exophytic tumor growh

Table 1. Radiologic Characteristics and Histology of the 28 Insular Gliomas

	Nonexophitic ($n = 22$)	Exophitic ($n = 6$)	*P* Value
Age, years	44.8 (25.1−66.6)	45,3 (21.9−60.7)	>0.05
Tumor side			
Right	7 (31.8%)	2 (33.3%)	>0.05
Left	15 (68.2%)	4 (66.7%)	>0.05
KPS pre	93 (80−100)	88 (80−100)	>0.05
Berger-Sanai			
I	21 (95.5%)	6 (100%)	>0.05
II	15 (68.2%)	3 (33.3%)	>0.05
III	18 (81.8%)	5 (83.3%)	>0.05
IV	20 (90.9%)	6 (100%)	>0.05
Yasargil			
3A	4 (18.2%)	0 (0%)	>0.05
3B	4 (13.6%)	0 (0%)	>0.05
5A	6 (27.3%)	6 (100%)	**$P = 0.02$**
5B	9 (40.9%)	0 (0%)	>0.05
Preoperative tumor volume, mL	88.1 (31.1−173.8)	103.3 (60−196.1)	>0.05
Postoperative tumor volume, mL	23.9 (4.9−90)	19.6 (6−60)	>0.05
Extent of resection, %	72.4 (33.1−96.1)	84.6 (68.9−92.3)	>0.05
Histology			
Grade II glioma	14 (63.6%)	3 (50%)	>0.05
Anaplastic glioma	8 (36.4%)	3 (50%)	>0.05

P values are derived from univariate Mann-Whitney *U* and Fisher exact tests.
Bold value indicate statistically significant.
KPS pre, preoperative Karnofsky performance scale; Berger-Sanai, Berger-Sanai classification of insular gliomas; Yasargil, Yasargil classification of insular gliomas.