Gliomas are “confined” to a named white matter tract: A revolution in understanding gliomas

Observation on the basis of our surgical experience and analysis over the last 4 decades is that gliomas are “disciplined” tumors. Although the general belief is that these tumors are “invasive” and “haphazard” in their extension pattern, our observation is that these tumors have a pattern of growth that confines them into a defined region and space. They arise from a named white fiber tract and extend along its course. The “fencing” formed by adjoining white fiber tracts is “impermeable” and displaced by the growing tumor and is not transgressed or invaded. Like meningiomas and schwannomas, the tumors grow by expansion and are contained in an enclosed space, the borders of which are formed by adjoining white fibers. Both low- and high-grade gliomas have similar pattern of origin, spread, and expansion. The difference between low-grade and high-grade gliomas is only in the growth characteristics and rate of growth but not in their morphological growth pattern. This observation has potential “revolutionary” implications in the understanding of these tumors, designing surgical strategy, and to formulate adjuvant treatment strategy.

Like meningiomas that arise from meninges and grow by expansion and displace adjoining structures, gliomas arise from a named white fiber tract, extend along its course and grow by expansion that involves displacement of adjoining normal tracts. The adjoining fiber tracts are functionally involved by virtue of their displacement and deformation and not due to invasion or destruction. On the surface of the cerebral cortex, the gray matter is thinned out into a thin membrane under the intact cover of pia mater. This information about both low- and high-grade gliomas has allowed us to perform an en-masse surgical resection strategy for these tumors. The consistency, color, and vascularity of these tumors facilitate the development of a well-defined plain of dissection of normal from abnormal allowing radical tumor resection.

Gliomas arising from short arcuate fibers are limited to the involved gyrus/gyri and are called “localized” gliomas. On the other hand gliomas involving other association fibers like the superior longitudinal fasciculus, arcuate fasciculus, uncinate fasciculus, inferior fronto-occipital fasciculus, inferior longitudinal fasciculus and commissural fibers like the corpus callosum involve a relatively longer segment of brain and are called “diffuse” gliomas. Commissural gliomas are typically bilateral. Even these “diffuse” gliomas remain within their confined location and displace adjoining tracts and can be categorized by identifying its growth along the involved fasciculus. Gliomas involving hypothalamus, thalamus, and brainstem form discrete subgroup but have a similar pattern of origin and growth.

The medial extension toward the lateral ventricle of gliomas arising from short arcuate fibers on the lateral aspect of the hemisphere is restricted by the corona radiata and projection fibers that form a firm but reliable compartmentalization. The extension of these tumors (localized gliomas) is from one gyrus to another along the course of the short arcuate fibers. Gray matter is displaced on the surface and underneath the piamater and is thinned out in the form of a membrane. Gliomas arising from the short arcuate white fibers over the entire convexity of the brain including the insula remain similar in configuration, extension, and limitation. Low-grade gliomas have characteristic color, gritty consistency, and low vascularity when compared to the adjoining normal brain. High-grade gliomas are more grayish, relatively soft and necrotic/cystic and more vascular. With experience, it is rather straightforward to develop a surgical plain of dissection using a blunt instrument and resect the tumor en-masse in both low- and high-grade gliomas. The sulcal blood vessels
are essentially *en-passage* normal blood vessels and need to be preserved during surgery.

The surgical technique of *en-masse* resection includes resection of involved gray matter and the involved gyrus. Such resection results in “supratotal” tumor resection. A well-defined surgical plain of dissection can be developed between the tumor and the displaced fiber tract even when the tumor is in vicinity of critical or “eloquent” brain area. As the tumor resection is done in a defined plain of dissection, the dependence on awake craniotomy and neurophysiological monitoring can be limited.

Understanding of anatomy of the involved and displaced white fibers is mandatory to evaluate the tumor suitable for *en-masse* resection. White fiber anatomy can be studied with the help of dedicated MRI sequences and software. Intraoperative use of navigation and ultrasound is helpful to locate the tumor and identify its limits. The identification of tumor from the normal brain by virtue of its color, consistency, and vascularity and the personal ability of developing a plain of dissection around the circumference of the tumor is obviously an important technical requisite. However, it seems that with reasonable experience such a procedure can be effectively and relatively easily performed. Although the methodology of surgical procedure was essentially individual case based and cannot be generalized, the surgical principle was common.

Considering the significance of adjoining critical blood vessels in cases with insular gliomas, the *en-masse* resection should be appropriately tailored and customized and precise and careful. Despite the fact that *en-masse* resection is possible, such form of resection is recommended only in select situations.

Surgery for “diffuse” gliomas also needs to be customized and tailored. Due to the eloquence of the adjoining areas and relationship with critical adjoining vessels, piecemeal resection may be advisable.

In tumors that are in proximity to “functional” or “eloquent” cortical motor area, a tailored customized resection is recommended whenever there is even moderate difficulty in identifying the plain of dissection or when there are negative indicators by neurophysiological monitoring. Neurophysiological monitoring and controlled tumor resection is advocated in gliomas located in the paracentral location, speech area and in the region of angular gyrus. Awake craniotomy and brain mapping is preferably performed in cases where the tumor is located in the proximity of speech area and in the region of angular gyrus.

Thalamic gliomas and brainstem glioma also grow in an expansile fashion by displacing the adjoining critical structures. Radical total resection is possible in both these instances. However, considering the intimacy of critical structures in the vicinity and possible implications of complications can restrict the radicality of resection in both these instances. It is obvious that en-masse resection is not possible in both these situations. Even if *en-masse* resection is not possible, radical resection can be achieved with such surgical strategy.

With experience in resection of tumor in an *en-masse* fashion, dependence on fluorescence dyes to locate residual tumor can be minimized or avoided.

It also appears that understanding the growth characteristics of gliomas that is along the white fibers can allow identification of focused zone for suitability of radiation treatment.

It does seem that the concept that gliomas are localized or contained tumors has the potential of revolutionizing the entire field of surgical treatment and of radiation therapy for these “common” neurosurgical problem.

**Atul Goel**, **Abhidha Shah**, **Saswat Dandpat**, **Survendra Rai**, **Apurva Prasad**

1Department of Neurosurgery, K.E.M. Hospital and Seth G.S. Medical College, 2Lilavati Hospital and Research Centre, 3Department of Neurosurgery, Lilavati Hospital and Research Centre, Mumbai, Maharashtra, India

**Address for correspondence:** Prof. Atul Goel, Department of Neurosurgery, K.E.M. Hospital and Seth G.S. Medical College, Parel, Mumbai - 400 012, Maharashtra, India. E-mail: atulgoel62@hotmail.com

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