

Surgical Management of Low-Grade Gliomas

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Low-grade gliomas represent a wide spectrum of intra-axial brain tumors with diverse presentations, radiographic and surgical appearances, and prognoses. While there remains a role for biopsy, a growing body of evidence shows that aggressive surgical resection of low-grade gliomas may improve symptoms, extend progression-free survival (PFS), and even cure a select few patients. With the application of preoperative functional imaging, intraoperative navigation, and cortical stimulation, neurosurgeons are able to perform more complete resections while limiting the risk to patients. In this article, we describe the surgical management and current operative techniques used in the treatment of low-grade gliomas. *Semin Oncol* 41:458-467 © 2014 Elsevier Inc. All rights reserved.

Low-grade gliomas represent a wide spectrum of intra-axial brain tumors with diverse presentations, radiographic and surgical appearances and prognoses. By necessity, the goals of surgical treatment of low-grade gliomas are correspondingly wide, from simple biopsy for diagnosis, subtotal resection for relief of presenting symptoms, to attempted surgical cure. We review the indications for surgery, surgical techniques, adjuncts, and surgical goals and limitations. As with most neurosurgical procedures, a judicious balancing of potential risks and benefits, and involvement of the patient in the process is appropriate (Figure 1).

TUMOR CLASSIFICATIONS AND EPIDEMIOLOGY

Gliomas are intrinsic brain tumors arising from the glial cell lines, including astrocytes, ependymal cells, and oligodendrocytes. The current World Health Organization (WHO) classification¹ uses histology to classify tumors and determine grade. The tumors are grouped by the most commonly encountered cell type and graded by the presence or absence of necrosis, mitotic activity, nuclear atypia, and endothelial cell proliferation. Low-grade gliomas are

classified as those with WHO grade I or II. While both WHO grades I and II are considered low grade, the natural history and, therefore, the management of each group of lesions varies greatly. Intracranial WHO grade I gliomas include pilocytic astrocytomas, subependymal giant cell astrocytomas, gangliogliomas, and subependymomas. These lesions may be diffuse but are usually well defined with a benign clinical course. Patients with these lesions are often cured with a successful resection alone. We will focus primarily on the management of WHO grade II astrocytomas, pleomorphic xanthoastrocytomas, oligodendrogliomas, and oligoastrocytomas as these tumors are common in adults and present the greatest clinical challenges.

WHO grade II gliomas have an incidence of 1 to 2 per 100,000 people per year and are most likely to affect young adults.²⁻⁴ The vast majority of patients, up to 80%, present with seizures.⁵ Lesions may be either well-defined, involving two or fewer lobes with clear margins on fluid attenuated inversion recovery (FLAIR), or diffuse, with poorly defined FLAIR borders or involving more than two lobes.

SURGICAL INDICATIONS FOR BIOPSY

When a patient is found to have a lesion consistent with a low-grade glioma, a decision must be made between surgical intervention and observation. In cases where a tissue diagnosis is thought to be useful to direct therapy, stereotactic or open biopsy may be performed. As more and more evidence argues for resection first, biopsy of low-grade gliomas is used in limited scenarios such as when a tumor is inaccessible or diffuse, or when there is a poor functional status or uncertain

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Conflicts of interest: none.

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0093-7754/- see front matter

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<http://dx.doi.org/10.1053/j.seminoncol.2014.06.008>

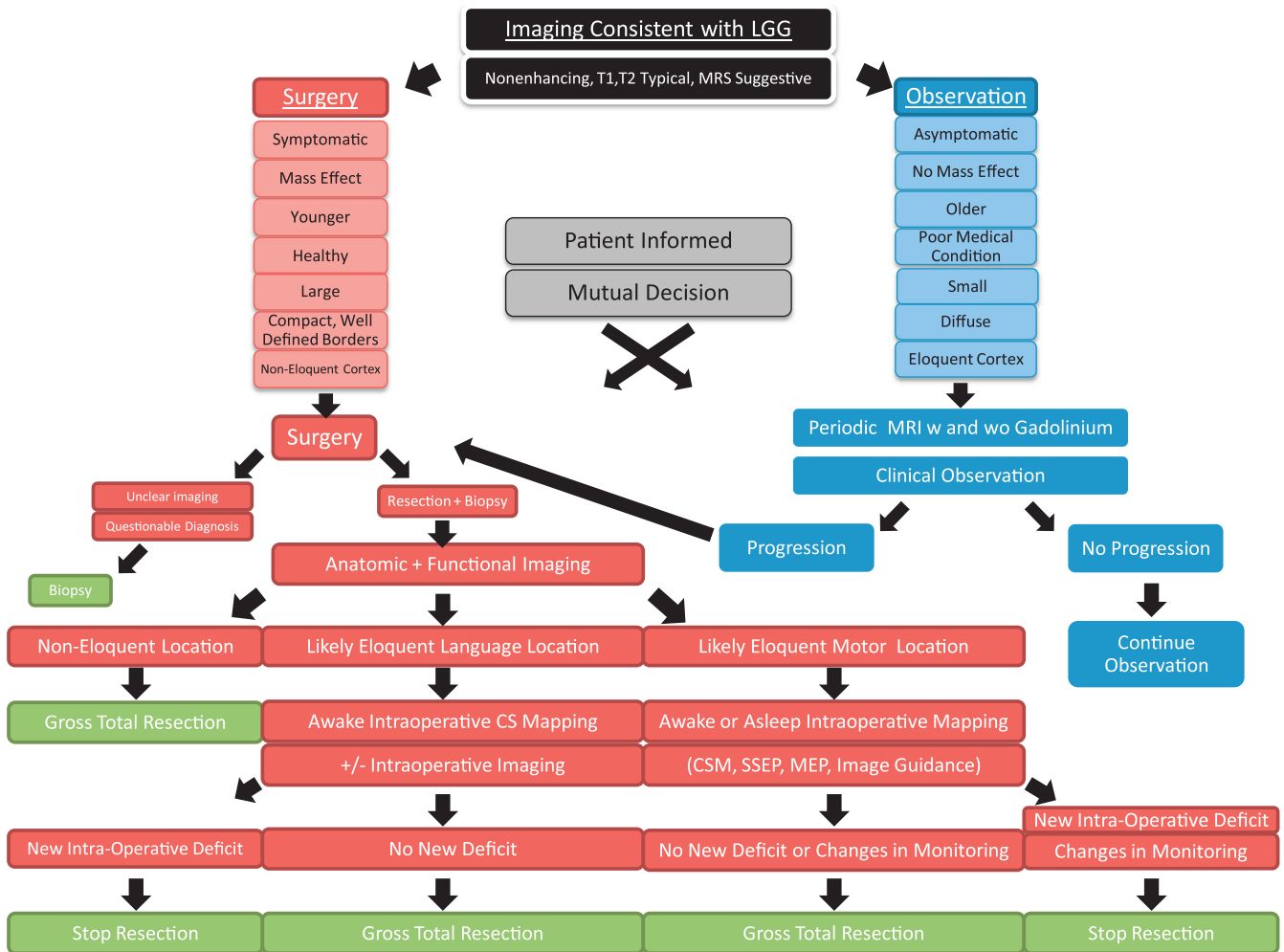


Figure 1. Decision algorithm for surgical intervention in low-grade gliomas.

pathology. Open biopsy with image guidance is appropriate in cases where the lesion approaches or reaches the cortical surface in a safe, accessible area. Stereotactic biopsy is most appropriate for deep-seated or small lesions (Figure 2). Based on the surgeon's experience and comfort with each technique, frame-based or frameless stereotactic biopsy can be performed. Frameless stereotaxy has gained popularity as its reliability has been shown in large series.⁶⁻⁸

TECHNICAL ASPECTS OF STEREOTACTIC AND OPEN BIOPSY

The goal of a biopsy is to acquire sufficient tissue to obtain a diagnosis while minimizing the risk to the patient. Prior to any biopsy, imaging is obtained that will be used for neuronavigation and the stereotactic targeting system in the operating room. The most common study is magnetic resonance imaging (MRI; T2-weighted images and T1-weighted with contrast) 1-mm slices; thin-cut computed tomography (CT)

with contrast also may be used if an MRI cannot be obtained. Once the patient is sedated and positioned, the tumor is localized using neuronavigation and cranial landmarks. Those lesions that arrive at or are close to the surface of the cortex can be accessed with a single 1-cm burr hole or with a small craniotomy. Once the dura is opened, the cortex is inspected for abnormal appearance, and biopsies are taken, then sent for frozen and permanent pathology. If the surgeon is satisfied with the tissue sample, the surgery is complete and the wound is closed. While the goals of a stereotactic biopsy are the same, the technique requires some additional planning. Prior to incision, a plan is defined in the neuronavigation computer, including the entry point and the trajectory of the needle to the target. There are several general principles that are used when making any stereotactic plan whether for stereotactic biopsy or deep brain stimulator (DBS) lead placement. The trajectory should avoid sulci in order to prevent vascular injury and should try not to pass through the ventricle due to the risk of intraventricular hemorrhage and subsequent hydrocephalus.

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