Extent of resection (EOR)

The extent of resection is the most important prognostic factor following brain glioma surgery. However, conventional structural imaging has failed to accurately delineate glioma margins because of tumor cell infiltration.

Reviewed studies demonstrate that intraoperative adjuncts such as Intraoperative magnetic resonance imaging, Awake craniotomy/GA mapping, fluorescence-guided imaging, and a combination of these modalities improve EOR. However, PFS/OS were underreported. Combining multiple intraoperative modalities seems to have the highest effect compared to each adjunct alone [1).

Eloquent areas within tumors limit the extent of resection and, thus, critically affect outcomes [2).

Before the general use of post-operative scanning, intraoperative estimation by the neurosurgeon was used to determine partial resection, subtotal resection, or total resection. The only study that compared this estimation with the presence of residual tumor mass on an MR image, dates back to 1994 [3).

Classification

Extent of resection classification.

Importance

The extent of tumor resection is a significant predictor of survival in High-grade gliomas. Several authors showed the benefit of intraoperative ultrasound partially matched with magnetic resonance imaging (MRI).

Mounting evidence suggests that a more extensive surgical resection is associated with an improved life expectancy for both Low-grade glioma and high-grade glioma patients. However, radiographically complete resections are not often achieved in many cases because of the lack of sensitivity and specificity of current neurosurgical guidance techniques at the margins of diffuse infiltrative gliomas. Intraoperative fluorescence imaging offers the potential to improve the extent of resection and to investigate the possible benefits of resecting beyond the radiographic margins [4).

A higher extent of resection (EOR) in WHO grade II gliomas (GIIG) is correlated with longer survival. However, the molecular biomarkers also feature prognostic relevance.

Cordier et al., examined whether maximal EOR was related to the genetic profile. They retrospectively investigated the predictive value of 1p19q, IDH1, 53 expression and Ki67 index for the EOR in 200 consecutive GIIGs (2007-2013). Data were modeled in a linear model. The analysis was performed with two statistical methods (arcsin-sqrt and Beta-regression model with logit link). There was no deletion 1p19q in 118 cases, codeletion 1p19q (57 cases), single deletion 1p (4 cases) or19q (16 cases). 155 patients had a mutation of IDH1. p53 was graded in 4 degrees (0:92 cases, 1:52 cases, 2:31 cases, 3:8 cases). Mean Ki67 index was 5.2 % (range 1-20 %). Mean preoperative tumor volume was 60.8 cm3 (range 3.3-250 cm3) and mean EOR was 0.917 (range 0.574-1). The statistical analysis was significant for a lower EOR in patients with codeletion 1p19q (OR 0.738, p = 0.0463) and with a single deletion 19q (OR 0.641, p = 0.0168). There was no significant correlation between IDH1 or p53 and the EOR. Higher Ki67 was marginally associated with higher EOR (p = 0.0603). The study demonstrates in a large cohort of GIIG that a higher EOR is not attributable to favorable genetic markers. This original result supports maximal surgical resection as an important therapeutic factor per se to optimize prognosis, independently of the molecular pattern [5].

In 300 consecutive patients, three sequential groups (groups A, B, C; n=100 each) were compared with respect to time management, complications and technical difficulties to assess improvement in these parameters with experience.

Raheja et al observed a reduction in the number of technical difficulties (p<0.001), time to induction (p<0.001) and total anesthesia time (p=0.007) in sequential groups. Intraoperative magnetic resonance imaging (IOMRI) was performed for neuronavigation guidance (n=252) and intraoperative validation of extent of resection (EOR; n=67). Performing IOMRI increased the EOR over and beyond the primary surgical attempt in 20.5% (29/141) and 18% (11/61) of patients undergoing glioma and pituitary surgery, respectively. Overall, EOR improved in 59.7% of patients undergoing IOMRI (40/67). Intraoperative tractography and real-time navigation using re-uploaded IOMRI images (accounting for brain shift) helps in intraoperative planning to reduce complications. IOMRI is an asset to neurosurgeons, helping to augment the EOR, especially in glioma and pituitary surgery, with no significant increase in morbidity to the patient [6].

Aids

Conventional white matter (WM) imaging approaches, such as diffusion tensor imaging (DTI), have been used to preoperatively identify the location of affected WM tracts in patients with intracranial tumors in order to maximize the extent of resection and potentially reduce postoperative morbidity.

Glioblastoma extent of resection

see Glioblastoma extent of resection

1)
Chanbour H, Chotai S. Review of Intraoperative Adjuncts for Maximal Safe Resection of Gliomas and Its Impact on Outcomes. Cancers (Basel). 2022 Nov 21;14(22):5705. doi: 10.3390/cancers14225705. PMID: 36428797; PMCID: PMC9688206.
2)
Picart T, Herbet G, Moritz-Gasser S, Duffau H. Iterative Surgical Resections of Diffuse Glioma With Awake Mapping: How to Deal With Cortical Plasticity and Connectomal Constraints? Neurosurgery. 2019 Jul 1;85(1):105-116. doi: 10.1093/neuros/nyy218. PMID: 30010996.
3)
Albert FK, Forsting M, Sartor K, Adams HP, Kunze S (1994) Early postoperative magnetic resonance imaging after resection of malignant glioma: objective evaluation of residual tumor and its influence on regrowth and prognosis. Neurosurgery 34:45–60 discussion 60- 41
4)
Liu JT, Meza D, Sanai N. Trends in fluorescence image-guided surgery for gliomas. Neurosurgery. 2014

Jul;75(1):61-71. doi: 10.1227/NEU.0000000000000344. PubMed PMID: 24618801; PubMed Central PMCID: PMC4062574.

5)

Cordier D, Gozé C, Schädelin S, Rigau V, Mariani L, Duffau H. A better surgical resectability of WHO grade II gliomas is independent of favorable molecular markers. J Neurooncol. 2014 Sep 28. [Epub ahead of print] PubMed PMID: 25261925.

6)

Raheja A, Tandon V, Suri A, Sarat Chandra P, Kale SS, Garg A, Pandey RM, Kalaivani M, Mahapatra AK, Sharma BS. Initial experience of using high field strength intraoperative MRI for neurosurgical procedures. J Clin Neurosci. 2015 Aug;22(8):1326-31. doi: 10.1016/j.jocn.2015.02.027. Epub 2015 Jun 12. PubMed PMID: 26077939.