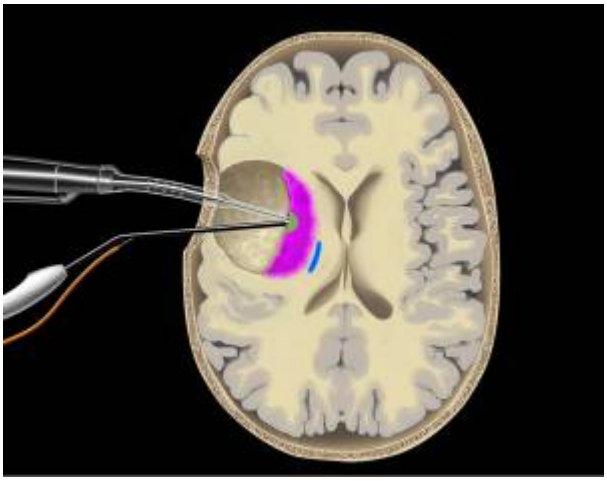
Glioblastoma extent of resection



Increasing the extent of resection (EOR) of glioblastoma is associated with prolonged survival [1) 2)]

Gross total resection of Glioblastoma is associated with a decreased incidence of patient safety indicators (PSIs) and hospital-acquired conditions (HACs), as compared to subtotal resection [3)].

The relationship between the extent of glioblastoma (GB) resection and clinical benefit depends critically on the balance between cytoreduction and avoiding neurologic morbidity. The definition of the extent of tumor resection, how this is best-measured pre- and postoperatively, and its relation to the volume of residual tumor is still discussed. In 2020 Wykes et al. reviewed the literature supporting the extent of resection in GB, highlighting the importance of a standardized definition and measurement of the extent of resection to allow greater collaboration in research projects and trials. Recent developments in neurosurgical techniques and technologies focused on maximizing extent of resection and safety are discussed [4)].

Inoue et al. investigated the relationship of tumor volume between MRI and 11C methionine positron emission tomography and also the relationship between Met uptake index and tumor activity. In ten patients, tumor-to-contralateral normal brain tissue ratio (TNR) was calculated to evaluate metabolic activity of Met uptake areas which were divided into five subareas by the degrees of TNR. In each Glioblastoma, tumor tissue was obtained from subareas showing the positive Met uptake. Immunohistochemistry was performed to examine the tumor proliferative activity and the existence of GSCs. In all patients, the volume of Met uptake area at TNR $\leqq$ 1.4 was larger than that of the Gd-enhanced area. The Met uptake area at TNR 1.4 beyond the Gd-enhanced tumor was much wider in high invasiveness-type Glioblastomas than in those of low invasiveness type, and survival was much shorter in the former than the latter types. Immunohistochemistry revealed the existence of GSCs in the area showing Met uptake at TNR 1.4 and no Gd enhancement. Areas at TNR > 1.4 included active tumor cells with a relatively high Ki-67 labeling index. In addition, it was demonstrated that GSCs could exist beyond the border of the Gd-enhanced tumor. Therefore, to obtain maximum resection of Glioblastomas, including infiltrating GSCs, an aggressive surgical excision that includes the Met-positive area at TNR 1.4 should be considered [5)].

Using volumetric analysis, it is possible to quantify the EOR using MR imaging. Prior studies using semi-automated methods for this purpose found a high interobserver agreement [6) 7)].

However, when manual segmentation is used, a low interobserver agreement in the assessment of tumor resection rates on magnetic resonance imaging (MRI) is described. This applies particularly for post-operative tumor volume and residual tumor volume [8)].

Before the general use of post-operative scanning, intraoperative estimation 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 [9)].

The border zone of different tissues is often the object of discussion, considering that the definition of the border is always ambiguous, especially in cases of tumor. The population of different cells in this area largely depends on the character of those cells in terms of the ability of cell motility and the status of tissue barrier, such as extracellular matrices. Gliomas, especially malignant gliomas, are known to possess a highly invasive nature. The surgical extent of resection is determined by the intraoperative macroscopic appearance, sometimes assisted by the information of a navigation system based on the preoperative images, that is easily influenced by the intraoperative brain shift in many cases. Therefore, the surgery often results in an incomplete resection [10)].

The value of incomplete resection in Glioblastoma surgery remains questionable. If gross total resection (GTR) cannot be safely achieved, biopsy only might be used as an alternative surgical strategy [11)].

Wounded glioma syndrome

see Wounded glioma syndrome.

Contrast-enhancing residual tumor volume (CE-RTV) alone has rarely been analyzed quantitatively to determine if it is a predictor of outcome.

CE-RTV and EOR were found to be significant predictors of survival after Glioblastoma resection. CERTV was the more significant predictor of survival compared with EOR, suggesting that the volume of residual contrast-enhancing tumor may be a more accurate and meaningful reflection of the pathobiology of Glioblastoma [12)].

Difficulties

It is difficult to reproducibly judge EOR in studies due to the lack of reliable tumor segmentation methods, especially for postoperative magnetic resonance imaging (MRI) scans. Therefore, a reliable, easily distributable segmentation method is needed to permit valid comparison, especially across multiple sites.

Cordova et al. report a segmentation method that combines versatile region-of-interest blob generation with automated clustering methods. Applied this to glioblastoma cases undergoing FGS and matched controls to illustrate the method's reliability and accuracy. Agreement and interrater variability between segmentations were assessed using the concordance correlation coefficient, and spatial accuracy was determined using the Dice similarity index and mean Euclidean distance. Fuzzy C-means clustering with three classes was the best performing method, generating volumes with high agreement with manual contouring and high interrater agreement preoperatively and postoperatively. The proposed segmentation method allows tumor volume measurements of contrast-enhanced T 1-weighted images in the unbiased, reproducible fashion necessary for quantifying EOR in multicenter trials [13].

Maximal safe resection

see Glioblastoma Maximal Safe Resection.

Case series

Glioblastoma extent of resection case series.

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