# High-grade glioma magnetic resonance imaging

see also Glioma Magnetic resonance imaging.

- Systematic review and epistemic meta-analysis to advance binomial AI-radiomics integration for predicting high-grade glioma progression and enhancing patient management
- Brain tumor classification using MRI images and deep learning techniques
- Congress of neurological surgeons systematic review and evidence-based guidelines for the role of imaging in newly diagnosed WHO grade II diffuse glioma in adults: update
- MRI-based machine learning reveals proteasome subunit PSMB8-mediated malignant glioma phenotypes through activating TGFBR1/2-SMAD2/3 axis
- Maximum Resection of Noncontrast-enhanced Tumor at MRI Is a Favorable Prognostic Factor in IDH Wild-Type Glioblastoma
- Intraoperative superb microvascular ultrasound imaging in glioma: novel quantitative analysis correlates with tumour grade
- Carbon-Encapsulated Iron Nanoparticles Seeking Integrins in Murine Glioma
- Bevacizumab-associated intracerebral hemorrhage in patients with malignant glioma

Magnetic resonance imaging is integral to the care of patients with high-grade gliomas. Anatomic detail can be acquired with conventional structural imaging, but newer approaches also add capabilities to interrogate image-derived physiologic and molecular characteristics of central nervous system neoplasms. These advanced imaging techniques are increasingly employed to generate biomarkers that better reflect tumor burden and therapy response [1].

## T1-weighted images

High-grade glioma T1-weighted images

## T2/FLAIR

T2 weighted images help visualize edema (swelling) around the tumor, which is common in high-grade gliomas.

Hyperintense

Surrounded by vasogenic edema

Flow voids are occasionally seen

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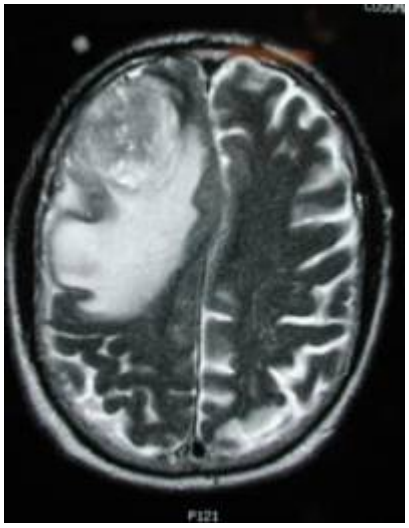
T2 weighted image cannot distinguish between infiltrative tumor growth and other possible causes of non-specific T2-signal increases [2]. Therefore, alternative sequences for the determination of the most malignant tumor parts and the tumor extent are highly desirable.



The T2-weighted image demonstrates the same lesion as in the previous image, with notable edema and midline shift. This finding is consistent with a high-grade or malignant tumor.

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The peritumoral region (PTR) of glioblastoma (Glioblastoma) appears as a T2W-hyperintensity and is composed of microscopic tumor and edema. Infiltrative low-grade glioma (LGG) comprises tumor cells that seem similar to Glioblastoma PTR on MRI. Quantitative analysis of conventional MRI sequences can effectively demarcate Glioblastoma PTR from LGG, which is otherwise indistinguishable from visual estimation [3].

## Dynamic Susceptibility Weighted Contrast-Enhanced Perfusion Imaging

Dynamic Susceptibility Weighted Contrast-Enhanced Perfusion Imaging: This technique measures the passage of contrast through blood vessels, providing information about blood flow and perfusion in the tumor.

susceptibility artifact on T2* from blood products (or occasionally calcification)

low-intensity rim from blood product

incomplete and irregular in 85% when present

mostly located inside the peripheral enhancing component

absent dual rim sign

## DWI/ADC

Diffusion-weighted magnetic resonance imaging:

Apparent Diffusion Coefficient (ADC): DWI measures the random motion of water molecules in tissues. High-grade gliomas often show restricted diffusion, which can be quantified by ADC maps.

solid component

an elevated signal on DWI is common in solid/enhancing component

diffusion restriction is typically intermediate similar to normal white matter, but significantly elevated compared to surrounding vasogenic edema (which has facilitated diffusion)

ADC values in the solid component tend to be similar to normal white matter 745 ± 135 x 10-6 mm2/s

non-enhancing necrotic/cystic component

the vast majority (>90%) have facilitated diffusion (ADC values >1000 x 10-6 mm2/s)

care must be taken in interpreting cavities with blood product

## MR perfusion

rCBV elevated compared to lower grade tumors and normal brain.

## Diffusion Tensor Imaging

Diffusion Tensor Imaging (DTI): DTI is used to visualize the white matter tracts in the brain, aiding in surgical planning and preserving critical brain regions.

The joint histograms of decomposed anisotropic and isotropic components of DTI were constructed in both contrast-enhancing and nonenhancing tumor regions. Patient survival was analyzed with joint histogram features and relevant clinical factors. The incremental prognostic values of histogram features were assessed using receiver operating characteristic curve analysis. The correlation between the proportion of diffusion patterns and tumor progression rate was tested using the Pearson's correlation coefficient.

They found that joint histogram features were associated with patient survival and improved survival model performance. Specifically, the proportion of nonenhancing tumor subregion with decreased isotropic diffusion and increased anisotropic diffusion was correlated with tumor progression rate ($P = .010$, $r = 0.35$), affected progression-free survival (hazard ratio = 1.08, $P < .001$), and overall survival (hazard ratio = 1.36, $P < .001$) in multivariate models.

Joint histogram features of DTI showed incremental prognostic values over clinical factors for glioblastoma patients. The nonenhancing tumor subregion with decreased isotropic diffusion and increased anisotropic diffusion may indicate a more infiltrative habitat and potential treatment target [4].

# Magnetic Resonance Spectroscopy

Magnetic Resonance Spectroscopy (MRS):

Metabolite Mapping: MRS can provide information about the chemical composition of tissues, helping to identify specific metabolites associated with tumors. Functional MRI (fMRI):

typical spectroscopic characteristics include

choline: increased

lactate: increased

lipids: increased

NAA: decreased

myoinositol: decreased

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Magnetic resonance imaging (MRI) has become the gold standard for the assessment of intracerebral lesions and is thus the primary tool for glioblastoma diagnosis and follow-up examination. [5].

Within clinical routine, diagnosis of glioblastoma is usually based on T1-weighted gadolinium contrast-enhanced MRI (CE-T1) and T2 weighted images. The limitation of this approach is that CE-T1 images exclusively visualize the disruption of the blood-brain barrier and hence lack identification of non-enhancing tumor portions [6] [7].

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Basic MRI modalities available from any clinical scanner, including native T1-weighted (T1w) and contrast-enhanced (T1CE), T2-weighted (T2w), and T2-fluid-attenuated inversion recovery (T2-FLAIR) sequences, provide critical clinical information about various processes in the tumor environment. In the last decade, advanced MRI modalities are increasingly utilized to further characterize glioblastomas more comprehensively. These include multi-parametric MRI sequences, such as dynamic susceptibility contrast (DSC), dynamic contrast enhancement (DCE), higher order diffusion techniques such as diffusion tensor imaging (DTI), and MR spectroscopy (MRS). Significant efforts are ongoing to implement these advanced imaging modalities into improved clinical workflows and personalized therapy approaches. Functional MRI (fMRI) and tractography are increasingly being used to identify eloquent cortices and important tracts to minimize postsurgical neuro-deficits [8].

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Gadolinium enhancement alone is not a significant predictor of IDH-mutant glioma, but the pattern of enhancement is a significant predictor with ring enhancing lesion, demonstrating high sensitivity and specificity for Glioblastoma, IDH wildtype glioma. Predicting “molecular Glioblastoma” by conventional neuroimaging is difficult. Moreover, Gadolinium enhancement is not a significant factor of survival analyzed with a pattern of enhancement or molecular stratifications. Intratumoral calcification is an

important radiographic finding for predicting molecular diagnosis and survival in glioma patients [9].

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Postoperative assessment of Glioblastoma volume seems to offer high intraobserver agreement, but low interobserver agreement. Using absolute residual tumor volume (RTV) values to relate extent of tumor resection with survival may be unreliable. More research is needed before this method can be used as a valid end point for clinical studies. Computer-assisted tumor volume calculation may increase interobserver agreement in the future [10].

volumetric magnetic resonance imaging [11].

## Early postoperative magnetic resonance imaging in glioblastoma

see Early postoperative magnetic resonance imaging in glioblastoma.

## Magnetic resonance perfusion imaging

see Magnetic resonance perfusion imaging in glioblastoma.

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