Comparative Study of Diffuse Midline Glioma and Glioblastoma: Magnetic Resonance Imaging in the Characteristics and Demography

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Abstract

Introduction: Diffuse midline glioma and glioblastoma are classified as grade IV CNS tumors (WHO). The entity 'diffuse midline glioma, H3 K27 mutant' was introduced in the 4th revised edition of the 2016 WHO classification of brain tumors; however, there are only a few reports on Magnetic Resonance Imaging of these tumors. Thus, we conducted a retrospective study focused on Magnetic Resonance Imaging features of diffuse midline glioma compared to glioblastoma. This study aims to evaluate and compare the demographic characteristics, anatomic location of lesions, and MRI characteristics of diffuse midline glioma and glioblastoma.

Methods and Materials: We histologically confirmed 30 patients with diffuse midline glioma and 70 patients with glioblastoma were enrolled in this retrospective study.

Pretreatment MRI of each patient was reviewed by a neuroradiology issuing physician and neuroradiology reporting physician for MRI characteristics of tumors. Comparative analysis was performed of the imaging pattern to show differences between diffuse midline glioma and glioblastoma with the p-value.

Results: The age of patients with diffuse midline glioma (mean age =24.7 ±10.4) was significantly lower than in those with glioblastoma (mean age =48.2 ±1). The majority of patients with diffuse midline glioma (56.7%) and glioblastoma (51.4%) were ≤ 25 and ≥ 50 years age group respectively. The most common location of diffuse midline glioma and glioblastoma were the thalamus (73.3%) and frontal lobe (37.1%) respectively. The presence of hydrocephalus, edema, and invasion were statistically significantly differences in patients with diffuse midline glioma (hydrocephalus = 46.7%, edema = 53.3%, and invasion =30%) than in those with glioblastoma (hydrocephalus = 12.9%, edema = 88.6%, and invasion =5.7%) ($P < 0.05$ each).

Conclusions: Despite having similar imaging features, diffuse midline glioma exhibited marked differences in age, edema, invasion, and hydrocephalus in MRI compared to Glioblastoma.

Key words: Diffuse midline glioma (DMG), Glioblastoma (GBM), MRI.

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Introduction

The entity 'diffuse midline glioma, H3 K27M-mutant (DMG)' was introduced in the revised 4th edition of the 2016 WHO classification of brain tumors.[1] However, there are only a few reports on Magnetic Resonance Imaging (MRI) characteristics of these tumors. Thus, we conducted a retrospective study focused on MRI features of DMG compared with GBM.[1, 2] DMG is found throughout the midline structures of the brain and is an aggressive, malignant, and fast-growing tumor with a poor prognosis. DMG is considered a grade IV tumor regardless of histological features by WHO[1, 2, 3, 4, 5]. DMG can spread to other areas of the brain through CSF.

GBM is the most common adult primary intracranial neoplasm, accounting for 50% of all astrocytomas and 15% of all intracranial neoplasms. GBM is a high-grade astrocytoma; it is aggressive, mostly resistant to therapy, and has a poor prognosis.[6] Most (>90%) primary GBMs are *IDH*- wild type. Secondary GBM is continuous

progress from lower grade *IDH-mutant* astrocytomas.[6] GBM tends to spread around condensed white matter tracts including the corticospinal tracts and the corpus callosum involving the contralateral hemisphere.[7] Radiographic features of GBM are typically large tumors at diagnosis. They often have thick, irregularly enhancing margins and a central necrotic core which may also have a hemorrhagic component. GBM is surrounded by vasogenic-type edema which usually contains infiltration by neoplastic cells.[7]

This study aims to compare the demography and MRI characteristics of DMG and GBM.

Methods

This is a retrospective study based on the record of MRI reports from the department of radiology in Nangfang hospital, Southern Medical University, Guangzhou, China. We retrospectively reviewed and compared the imaging features of DMG and GBM from April 17, 2018, through February 19, 2020. An illustration of DMG has been shown in figure 1 and an illustration of GBM has been shown in figure 2. This study includes 30 patients with DMG and 70 patients with GBMs. All patients underwent MRI of the brain on either 1.5T or 3T clinical scanners by using the following protocol: 3-plane localizer, axial T2-weighted (TR/TE, 2500/80 ms), 3D fluid-attenuated inversion recovery (TR/TE/TI, 5500/136/2200 ms), T1-weighted (TR/TE, 10/4 ms) without and with intravenous gadolinium, and axial diffusion-weighted imaging (TR/TE, 7000/60 ms) sequences.

Preoperative MRI features of each patient were reviewed by a neuroradiologist for the following tumor characteristics: age, location, multifocality, invasion, contrast enhancement, necrosis, edema, mass effect, and hydrocephalus and border characteristics.

Comparative analysis of the imaging-pattern difference between DMG and GBM with Chi-square test and t-test were performed. A P-value less than 0.05 is considered to be statistically significant. Statistical analysis was performed with the software SPSS 25.

Results

The mean age of the patient was found to be statistically significantly lower in DMG group (mean age =24.7 ±10.4) than in GBM group (mean age =48.2 ±1) (P-value <0.001, Table 1).However there was no significant difference in sex distribution of the two groups in the tumors.

DMG was found to be most commonly located in the thalamus (73.3%) whereas GBM was in the frontal lobes. (37.1%, Table 2)

The presence of hydrocephalus, edema, and invasion were statistically significantly different between the two groups. ($P < 0.05$ each, Table 3).

In contrast, no significant differences were found between two groups in terms of presence of contrast enhancement, necrosis, irregular border, and mass effect ($P > 0.05$ each, Table 3). (An illustration of DMG has been shown in figure 1) (An illustration of DMG has been shown in figure 2)

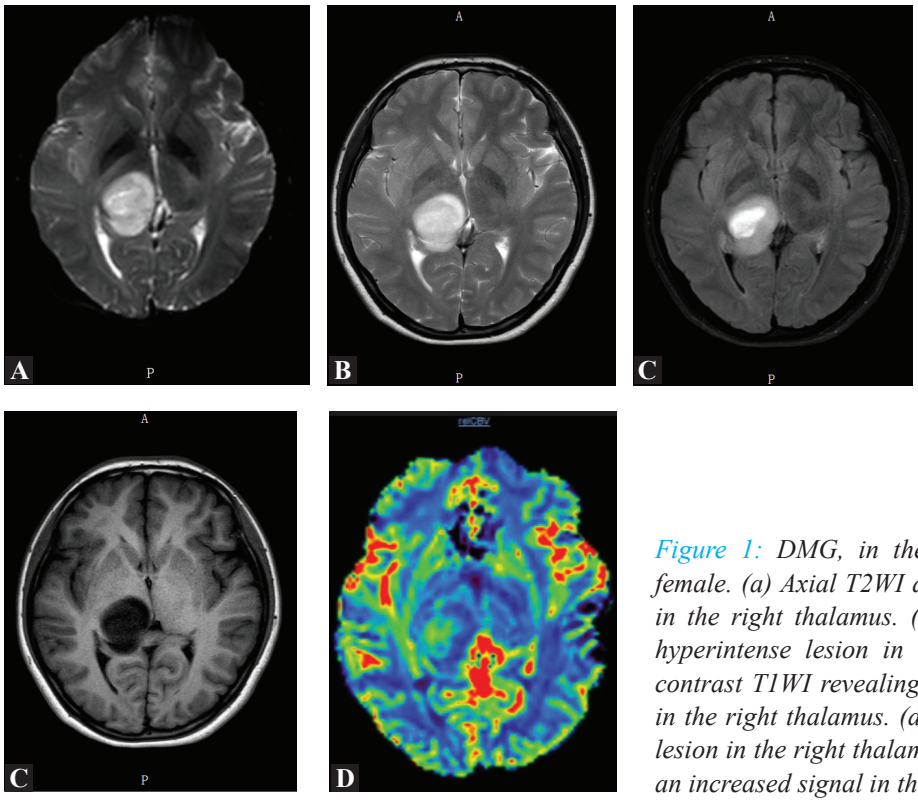

Figure 1: DMG, in the right thalamus in a 19-year-old female. (a) Axial T2WI demonstrating a hyperintense lesion in the right thalamus. (b) Axial FLAIR image revealing a hyperintense lesion in the right thalamus. (c) Axial pre-contrast T1WI revealing homogeneously hypointense lesion in the right thalamus. (d) Axial DWI reveals a hyperintense lesion in the right thalamus. (e) CBV parameter map reveals an increased signal in the right thalamus.

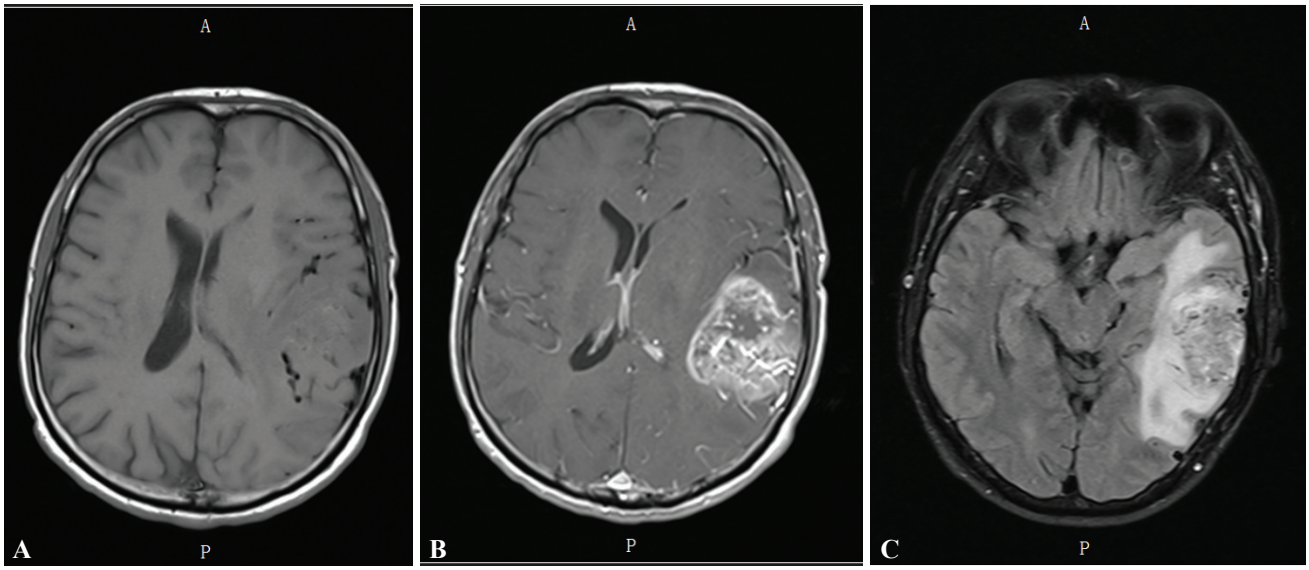

Figure 2: Glioblastoma is the left temporal lobe in a 51-year-old man. (A) Axial pre-contrast T1WI revealing hypointense lesion in the left temporal lobe. (B) Axial FLAIR image reveals a heterogeneous lesion in the left temporal lobe. (C) Axial post-contrast T1WI revealing irregular enhancement in the left temporal lobe.

Characteristics	Descriptions	DMG (*n* = 30)	GBM (*n* = 70)	p-value
Age (years)	Mean (SD)	24.7(10.4)	48.2(14.5)	<0.001
	Range	5-47	17-83	
Age groups (years)	Up to 25	17(56.7%)	5(7.1%)	
	26-50	13 (43.3 %)	29(41.4%)	
	above 50		36(51.4%)	
Gender	Male	16 (53.3 %)	45(64.3 %)	0.303
	Female	14(46.7 %)	25(35.7%)	

Table 1: Patient demographics showing age and sex distribution analyzed by Chi-square test

DMG(*n* = 30)		GBM (*n* = 70)	
Subcallosal	1 (3.3%)	Right thalamus/ cerebral peduncle/ right pontine/midbrain	1 (1.4 %)
Thalamus	22 (73.3 %)	Thalamus	4 (5.7 %)
Midbrain tectum	1 (3.3%)	Frontal lobe	26 (37.1 %)
Pons	2 (6.7 %)	Occipital lobe	7 (10%)
Vermis	3 (10%)	Parietal lobe	10 (14.3 %)
Cervical spine	1 (3.3 %)	Posterior Fossa	1 (1.4 %)
		Temporal lobe	4 (5.7 %)
		Basal ganglia	1 (1.4%)
		Corpus callosum	2 (2.9%)
		Pineal gland	1 (1.4%)
		Frontal /occipital lobe	1 (1.4%)
		Frontal /parietal lobe	7 (10 %)
		Frontal lobe / thalamus	1 (1.4%)
		Occipital/parietal lobe	3 (4.3 %)
		Occipital/temporal lobe	1 (1.4%)

Table 2: Anatomic location and proportion of various lesions of the two groups

	DMG(n = 30)	GBM (n = 70)	p-value
Contrast enhancement	26(86.7%)	65(92.9%)	0.542
Necrosis	1(3.3%)	13(18.6%)	0.09
Edema	16 (53.3%)	62(88.6%)	<0.001
Invasion	9(30.0%)	4(5.7%)	0.003
Mass effect	26 (86.7%)	51(72.9%)	0.213
Irregular border	16 (53.3%)	60(62.9%)	0.373
Hydrocephalus	16 (53.3%)	9(12.9%)	<0.001

Table 3: Various MRI characteristics of lesions of the two groups analyzed by t-test

Discussion

Our study showed that there were statistically significant differences in some areas of demography and MRI features between DMG and GBM.

In this study, patients with DMG) were significantly younger than those with GBM, 24.7 ±10.4 vs 48.2±1 years. This result is similar to that previously reported by other investigators which reported children and younger patients are more prone to DMG (mean age = 27 ± 13.8).[3,8] GBM usually occurs after the age of 40 years. [5, 7, 9,10] This study showed most patients with DMG were of 25 years or below age group, whereas the majority of GBMs were of above 50 years age group.

In this study, both DMG (53.3 %) and GBM (64.3 %) were more common in males which is concordant with previous studies which showed a male preponderance in both DMG (54%)[8] and GBM (56.81%).[3, 12] While previous studies showed that the most common location of DMG is the pons and that of GBM is in the temporal lobe, this study showed that the thalamus and frontal lobe are common locations for DMG and GBMs respectively.[2,4,5,11]

Our study showed DMG (86.7%) and GBM (92.9%) were contrast-enhanced whereas other studies showed contrast enhancement in 12.5% in DMG[2, 8] and 98% in GBM.[10] In this study the contrast enhanced in DMG is not consistent with other study. It may be due to small sample size and histopathological and immunohistochemical diagnosis in DMG.So the further research is necessary.

The presence of hydrocephalus, edema, and invasion were significantly different between the two groups. We observed the presence of edema in DMG (53.3%) in the majority of cases; however it was significantly less than GBM (88.6%). This finding is not consistent with the previous study in DMG (25%).[8] But it is consistent with previous findings in GBM (79%).[8] This study showed that the majority of DMG (53.3%), and GBM (62.9%) had the presence of irregular borders. Our results reveal that most of the DMG (86.7%), as well as GBM (72.9%), had the presence of a mass effect. Our result is consistent with previous studies; DMG, (100%), as well as GBM, (100%), had the presence of a mass effect.[8] In this study, the presence of invasion with DMG (30%) was significantly higher than that with GBM (5.7%). This result is not consistent with the published results of other studies reporting DMG 32/33[4], GBM (94.3%)[10]. This study showed that hydrocephalus in DMG (53.3%) was significantly higher than that in GBM (12.9%).

The main limitation of our study is the big difference in the number of cases between the two groups. We did not have enough number of DMG cases to compare with GBM cases.

Conclusions

This study was the evaluation of demographic characteristics, anatomic location, and MRI features between DMG and GBM. DMG in our study had highly variable features in MRI but exhibited significant differences in age, location, edema, invasion, and hydrocephalus as compared to the GBM.

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