ORIGINAL ARTICLE

The Role of Magnetic Resonance Diffusion Weighted Image in Grading of Supratentorial Glioma

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Abstract

Background: ***Gliomas, which arise from glial cells, are the kind of tumors that are most commonly found in the central nervous system (CNS). Gliomas are highly diffusely infiltrative tumors that impact the surrounding brain tissue. The most malignant form of brain tumor is called glioblastoma, whereas the least malignant form is called pilocytic astrocytoma.***

Aim: ***To assess the role of the MRI Diffusion in the assessment of supratentorial gliomas and their different grading.***

Patients and methods: This cross-sectional investigation was conducted on 30 cases with suspected supratentorial glioma that underwent magnetic resonance imaging in the radiology department at Al-Zahraa Hospital throughout the period from Mayo 2023 to Mayo 2024.

Results: ***The diagnostic accuracy for supratentorial glioma by DWI compared to diagnosis by histopathology grades (as a gold standard), there was sensitivity of 94.7%, specificity 90.9%, PPV of 94.7%, NPV% 90.9%; accuracy 93.3%. There was a highly statistically significant increase in grade for histopathology and positive edema, with a p-value (p<0.001).***

Conclusion: ***MRI Diffusion had high diagnostic efficacy in the evaluation of supranational gliomas with different grading as it showed high sensitivity, specificity, and accuracy. In our patients, high pathological grades were associated with higher age, increased glioblastoma multiform, enhancement of contrast, positive hemorrhage in SWI, positive necrosis, positive edema, and diffusion restriction.***

Keywords: Magnetic Resonance Diffusion; Supratentorial Glioma; Edema

1. Introduction

Gliomas, which arise from glial cells, remain the most common type of tumor that affects the central nervous system. Tumors that are extremely diffusely infiltrative and have an impact on the brain tissue that surrounds them are called gliomas. The most dangerous form of brain tumor is called glioblastoma, whereas the least dangerous variety is called pilocytic astrocytoma.[1,2]

In the past, these diffuse gliomas have been categorized into various grades and subtypes depending on histopathology, including diffuse oligodendrogliomas, astrocytomas, and mixed gliomas/oligoastrocytomas. In recent years, molecular and genetic markers have been utilized to classify gliomas.[3,4]

These advances provide for cases with gliomas more specific therapeutic and prognostic benefits. As well as genetic and molecular markers, gliomas are categorized into grades one to four depending on the mitotic index and the existence or absence of necrosis, which indicate the degree of proliferation.[5,6]

The utilization of diffusion-weighted imaging (DWI) is likely to measure the diffusion characteristics of water molecules in brain tissues, which are susceptible to being significantly altered by illnesses. True diffusion is the net motion of molecules as an outcome of a concentration gradient, as per Fick's law. Utilizing magnetic resonance imaging (MRI), it is not possible to differentiate between molecule motion that is generated by concentration gradients and molecular motion that is driven by heat gradients, ionic interactions, or pressure gradients. Consequently, when determining molecular motion with DWI, only the apparent diffusion coefficient (ADC) could be determined. It has been utilized to investigate the normal brain and a variety of pathologies, including ischemia, tumors, epilepsy, and white matter disorders.[7,8]

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The goal of this work was to assess the role of MRI Diffusion in the evaluation of supratentorial gliomas and their different grading.

2. Patients and methods

This cross-sectional investigation has been conducted on 30 cases with suspected supratentorial glioma that underwent magnetic resonance imaging in the radiology department at Al-Zahraa Hospital throughout the period from Mayo 2023 to Mayo 2024.

Inclusion criteria: All patients with supratentorial glioma, if no contraindications for MRI.

Exclusion criteria: Patients with absolute contraindication to MRI examination such as cardiac pacemaker and cochlear implants, claustrophobic and irritable patients, renal impairment, and hypersensitivity to contrast.

Methods:

All patients have been subjected to Full history, taking previous MRI examinations if present.

For MR imaging, a 1.5-T scanner (Signa Explorer; GE Medical Systems) was used. The contrast material utilized in the investigation was gadolinium-DTPA (Magnevist) at a dose of 0.2 milliliters per kilogram body weight, and no reactions were observed following the injection of the contrast material. Contrast studies were occasionally necessary. The receiver coil has been utilized with the slandered head coil. The cMRI examination comprised the following: a precontrast series that comprised axial, sagittal, coronal T1-weighted spin-echo (420/10 [repetition time (TR) msec/echo time (TE) msec]), axial and coronal T2 weighted fast spin-echo (4614/93 [efficient echo time]), and axial fast, fluid attenuation inversion recovery (FLAIR) (5000/90/1852 [inversion time]). A 256×192 matrix, a twenty-three-centimeter field of view, and a five-millimeter slice thickness were the variables of conventional MR imaging. Axial, coronal, and sagittal T1 WI spin echo sequences were involved in the post-contrast series. In conjunction with the presence of bleeding, necrosis, peritumoral edema, mass effect, and contrast enhancement, we assessed the cMRI in terms of lesion signal characteristics. DWI has been conducted in the axial plane for all cases utilizing a single-shot echo-planar spin-echo sequence EPI [7000/104 ms (TR/TE)], a matrix of 128 × 128, a slice thickness of 5 millimeters, and b values of 0, 500, and 1000 in the X, Y, and Z directions.

Statistical analysis:

The statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, United States of America), has been utilized to analyze the data that was gathered. When the distribution of quantitative data was parametric (normal), it was represented as ranges and mean± standard deviation. Conversely, non-parametric parameters have been represented as median with inter-quartile range (IQR). Additionally, qualitative variables have been represented as numbers and percentages. The Shapiro-Wilk Test and Kolmogorov-Smirnov Test have been utilized to examine the normality of the data. The following tests have been carried out: The Fisher's exact and Chi-square test tests have been utilized to compare groups with qualitative data, with the exception of cases where the expected count in any cell was less than five. The specificity, sensitivity, negative and positive predictive values, and accuracy of MRI-DWI were assessed for the grading of supratentorial glioma. Specificity = (true –ve) / [(true –ve) + (false +ve)]. Sensitivity = (true +ve)/ [(true +ve) + (false –ve)]. NPV = (true –ve)/ [(true –ve) + (false –ve)]. PPV = (true +ve) / [(true +ve) + (false +ve)]. Accuracy = (TP+TN)/[FP + TP + FN + TN]. The margin of error accepted was five percent, and the confidence interval was established at ninety-five percent. Consequently, the p-value has been deemed significant as follows: Probability (P-value): A P-value of less than 0.05 has been regarded as significant. A P-value of less than 0.001 has been regarded as highly significant. Insignificant has been defined as a P-value exceeding 0.05.

3. Results

Table (1) describes the distribution of sex and age of total investigation population. Age varied from 15 to 80 years with mean± SD of 43.97±17.65. There were 16 patients (53.3%) were “<50years” and 14 patients (46.7%) were “>50 years”. According to distribution of sex, there was women predominance with 18 women with percentage 60% & 12 men with percentage 40%.

Table 1. General characteristics distribution between investigation group.

DEMOGRAPHIC DATA	NO.	%
AGE "YEARS"		
<50 YEARS	16	53.3%
>50 YEARS	14	46.7%
SEX		
FEMALE	18	60.0%
MALE	12	40.0%

Table 2 showed descriptive statistics regarding patients included in this study; most of them are headaches. 16 patients (53.3%), followed by 6 patients (20%), were fit, then the 3 patients (10%) were weak, and the 2 patients (6.7%) each had sudden loss of vision and paresis.

Table 2. Complain distribution among study group.

COMPLAIN	NO.	%
HEADACHE	16	53.3%
FITS	6	20.0%
WEAKNESS	3	10.0%
PARESIS	2	6.7%
SUDDEN LOSS OF VISION	2	6.7%
BLURRING OF VISION	1	3.3%
DIZZINESS	1	3.3%
DYSARTHRIA	1	3.3%
SUDDEN LOSS OF CONSCIOUSNESS	1	3.3%
TREMORS IN BOTH HAND	1	3.3%
WEIGHT LOSS	1	3.3%

Table 3 shows that the hemorrhage in SWI was 16 patients (53.3%) were negative and 14 patients (46.7%) were negative. The necrosis was 12 patients (40%) were negative necrosis and 18 patients (60%) were negative necrosis. The edema was 25 patients (83.3%) were positive edema and 5 patients (16.7%) were negative edema. The histopathology grades, it was 4 patients (13.3%) were Grade one, 7 cases (23.3%) were Grade two, 5 cases (16.7%) were Grade three and 14 cases (46.7%) were Grade four. Most of patients are gliobastoma multiform 19 cases (63.3%), followed by 7 cases (23.3%) were diffuse astrocytoma and 4 cases (13.3%) were Pilocytic astrocytoma.

Table 3. Hemorrhage in SWI, necrosis, edema and Histopathology type distribution among study group.

HEMORRHAGE IN SWI	NO.	%
NEGATIVE	14	46.7%
POSITIVE	16	53.3%
TOTAL	30	100.0%
NECROSIS		
NEGATIVE	12	40.0%
POSITIVE	18	60.0%
TOTAL	30	100.0%
EDEMA		
NEGATIVE	5	16.7%
POSITIVE	25	83.3%
TOTAL	30	100.0%
HISTOPATHOLOGY GRADES		
GRADE 1	4	13.3%
GRADE 2	7	23.3%
GRADE 3	5	16.7%
GRADE 4	14	46.7%
TOTAL	30	100.0%
HISTOPATHOLOGY TYPE		
GLIOBASTOMA MULTIFORM	19	63.3%
DIFFUSE ASTROCYTOMA	7	23.3%
PILOCYTIC ASTROCYTOMA	4	13.3%
TOTAL	30	100.0%

Table 4 illustrates highly statistically significant increase grade for histopathology and positive necrosis, with p-value (p-value less than 0.001).

Table 4. Comparison between different grading for histopathology according to Necrosis.

NECROSIS		HISTOPATHOLOGY GRADES				TOTAL	TEST VALUE	P-VALUE
		Grade 1	Grade 2	Grade 3	Grade 4			
NEGATIVE	No.	4	6	1	1	12	27.190	0.001**
	%	100.0%	85.7%	20.0%	7.1%	40.0%		
POSITIVE	No.	0	1	4	13	18		
	%	0.0%	14.3%	80.0%	92.9%	60.0%		
TOTAL	No.	4	7	5	14	30		
	%	100.0%	100.0%	100.0%	100.0%	100.0%		

Using: x2: Chi-square test for Number (%) or Fisher's exact test, when appropriate, p-value exceeding 0.05 is insignificant; *p-value below 0.05 is significant; **p-value below 0.001 is highly significant

Table 5 shows highly statistically significant increase grade for histopathology and positive edema, with p-value (p-value less than 0.001).

Table 5. Comparison between different grading for histopathology according to Edema.

EDEMA		HISTOPATHOLOGY GRADES				TOTAL	TEST VALUE	P-VALUE
		Grade 1	Grade 2	Grade 3	Grade 4			
NEGATIVE	No.	2	3	0	0	5	24.600	0.001**
	%	50.0%	42.9%	0.0%	0.0%	16.7%		
POSITIVE	No.	2	4	5	14	25		
	%	50.0%	57.1%	100.0%	100.0%	83.3%		
TOTAL	No.	4	7	5	14	30		
	%	100.0%	100.0%	100.0%	100.0%	100.0%		

Table 6 shows that the diagnostic accuracy for supratentorial glioma by DWI compared to diagnosis by histopathology grades (as a gold standard), there was sensitivity of 94.7%, specificity 90.9%, PPV of 94.7%, NPV% 90.9%; accuracy 93.3%.

Table 6. Diagnostic accuracy between magnetic resonance diffusion weighted image and diagnosis by histopathology grading (as a gold standard) according to supratentorial glioma.

DWI: SIGNAL	HISTOPATHOLOGY GRADES		SENS.%	SPEC.%	PPV%	NPV%	ACCURACY %
	Grade 3-4	Grade 1-2					
DIFFUSION RESTRICTION	18	1	94.7%	90.9%	94.7%	90.9%	93.3%
NO DIFFUSION RESTRICTION	1	10					

NPV: Negative predictive value ,Spec.: Specificity; PPV: Positive predictive value; Sens.: Sensitivity

Case Presentation

Case (1):

34 years old female complaining from convulsion

MRI OF THE BRAIN done with following sequences:

Axial T1, FLAIR & T2 WIs

Sagittal T1 WIs

Diffusion WI axial images

Pre and post contrast study

A small ill-defined focal lesion is observed in the right medial temporal lobe, eliciting bright signal on T2 WI & FLAIER with low signal on T1 and faint post contrast enhancement. with no diffusion restriction. Collectively, the imaging findings are matching with low grade glioma

Histopathology: Diffuse astrocytoma

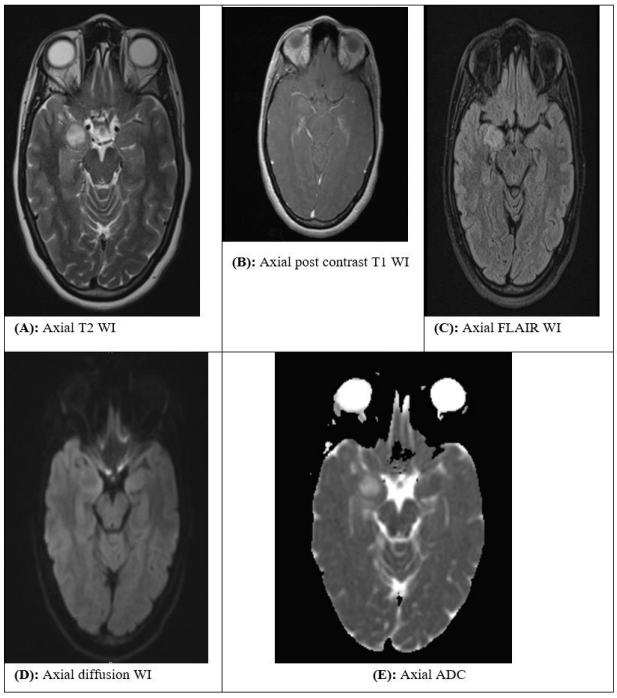

Figure 1. Shows case 1

CASE 2

55 years old female case complaining from sever continues headache

MRI OF THE BRAIN was done with following sequences:

Axial T1, FLAIR & T2 WIs

Sagittal T1 WIs

Diffusion WI axial images

Post contrast T1

There is left frontal intra axial SOL showing heterogeneous MR appearance of mixed signal intensity in all pulse sequences, predominately hyperintense in T2WIs and zone of iso and hyperintensity in FLAIR, in T1 it is predominately hypointense with isointense zones in side, solid component shows diffusion restriction, such lesion shows heterogeneous zones of post contrast enhancement of solid component while the necrotic component show no appreciable enhancement associated moderate perifocal edema is noted compressing left lateral ventricle with midline shift to the right side by about 7.5 mm.

Collectively these images matching with high grade glioma

Histopathology: Glioblastoma multiform.

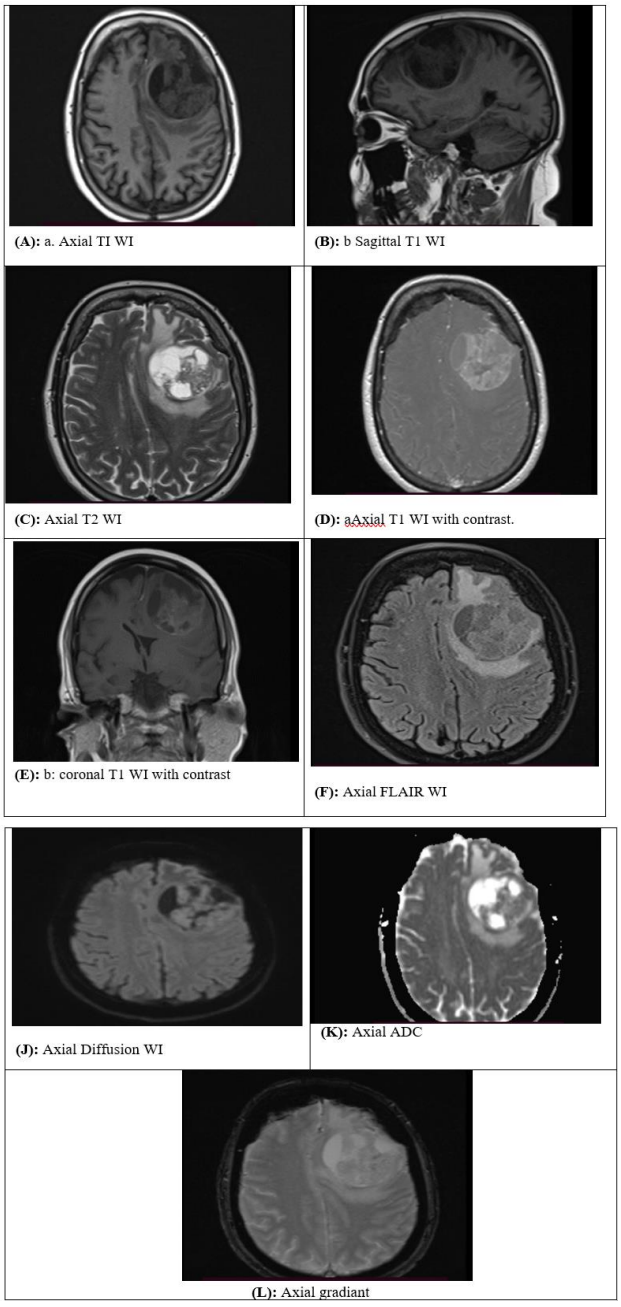

Figure 2. shows case 2

4. Discussion

Age varied from 15 to 80 years with mean± SD of 43.97 ± 17.65. There were 16 patients (53.3%) who were "< 50 years" and 14 patients (46.7%) who were "> 50 years". In terms of gender distribution, there was a female preponderance, with 18 females accounting for 60% and 12 men accounting for 40%.

In line with us, Danilov et al.,[9] included 527 patients with supratentorial gliomas and found that women were predominant (50.4%) while men were 49.6% of all patients. However, the mean age was 39.8 ± 17.9 years, which is younger than ours.

Regarding complaint distribution, most of the patients had headaches (53.3%). Sixteen patients

(53.3%), followed by 6 patients (20%), were fit, then the 3 patients (10%) were weak, and the 2 patients (6.7%) each had sudden loss of vision and paresis. Other complaints were minor.

The findings were in partial agreement with earlier epidemiology investigations conducted by Rasmussen et al.,[10] that stated that some of their prevalent clinical manifestations involve vomiting, seizures, and headache. Vision disturbance, hemiparesis, vertigo or dizziness, and an alteration in personality might also be the presenting features.

In our study, the hemorrhage in susceptibility-weighted imaging (SWI) was sixteen cases (53.3 percent) were negative, and fourteen cases (46.7 percent) were negative. Eighteen cases (60 percent) showed necrosis, while other12 cases (40%) were negative for necrosis. 83.3% of patients had edema, while 16.7% did not show edema.

Regarding histopathology type for patients included in this study, most of them were glioblastoma multiform 19 patients (63.3%), followed by 7 patients (23.3%) were diffuse astrocytoma and 4 patients (13.3%) were Pilocytic astrocytoma.

Similar to previous results, in Haydar et al.[11] cross-sectional studies, 61.5% of cases had glioblastoma multiform, and fifteen patients had astrocytoma (38.5%).

Regarding histopathology grades, it was 4 cases (13.3%) were Grade One, 7 cases (23.3%) were Grade Two, 5 cases (16.7%) were Grade Three, and 14 cases (46.7%) were Grade Four.

Similarly, Danilov et al.,[9] included 527 patients with supratentorial gliomas and found that 25% had low-grade glaucoma, and 75 % of them had high-grade glaucoma.

Hemorrhage in SWI 16 patients (53.3%) were negative, and 14 patients (46.7%) were negative. The necrosis was 12 patients (40%) had negative necrosis, and 18 patients (60%) had negative necrosis. The edema was 25 patients (83.3%) were positive edema, and 5 patients (16.7%) were negative edema.

Also, there was a highly statistically significant elevation grade for histopathology and both positive necrosis and positive edema. And statistically significant increase in grade for histopathology and diffusion restriction.

In accordance with all of the previous significant associations, Haydar et al.,[11] found that high-grade tumors have been associated with the following outcomes: hyperintense FLAIR, with contrast enhancement occurring in cases of grade four complete, all of the cases are heterogeneous, with the exception of one case (homogeneous enhancement).

In addition to accompanying results (edema, hemorrhage, necrosis) were high-grade neoplasm.

For the diagnostic accuracy for supratentorial glioma by DWI compared to diagnosis by histopathology grades (as a gold standard), there was sensitivity of 94.7%, specificity of 90.9%, PPV of 94.7%, NPV% 90.9%; accuracy of 93.3%.

Munir et al.,[12] assessed the diagnostic accuracy of MRI in the identification of intra-axial gliomas in suspected cases, with histopathology acting as the gold standard, in contrast to our diagnostic findings. The sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy of MRI in the identification of intra-axial gliomas were 89.31 percent, 73.91 percent, 95.12 percent, 54.84 percent, and 87.01 percent when histopathology results were used as the gold standard. This variance might be attributed to the fact that the investigation involved intra-axial gliomas, whereas our study involved supranational gliomas.

However, Shoaib et al.[13] determined the specificity, NPV, sensitivity, and PPV of perfusion-weighted MRI in the grading of gliomas into low-high grades. They determined that the overall sensitivity of PWI was 82.6 percent, specificity was 75 percent, PPV was 90.48 percent, and NPV was 60 percent. The total accuracy was 80.65 percent. In contrast to conventional MRI, they still concluded that diffusion and perfusion-weighted MRI had a higher degree of accuracy in evaluating tumor grade.

4. Conclusion

MRI Diffusion had high diagnostic efficacy in the evaluation of supranational gliomas with different grading as it showed high sensitivity, specificity, and accuracy. In our patients, high pathological grades were associated with higher age, increase gliobastoma multiform, enhancement of contrast, positive hemorrhage in SWI, positive necrosis, positive edema, and diffusion restriction.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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