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Diagnostic value of MRI enhancement in determining the degree of malignancy of Brain Tumors in patients

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ABSTRACT

Objective: The present study aimed to evaluate the diagnostic value of MRI enhancement in determining the degree of malignancy of brain tumors. *Materials and Methods:* In this cross-sectional study, a part of the brain tumor was extracted by a neurosurgeon and its malignancy degree was assessed by a pathologist who was unaware of the MRI results. Information about tumors benignancy or malignancy and their malignancy status were recorded on a checklist. Patients whose pathological results were uncertain or undetermined were excluded. Data obtained from the positive and negative results of tumors MRI enhancement and pathology were analyzed in SPSS 20 to determine the sensitivity, specificity, positive and negative likelihood ratio, and AUC. *Results:* The probability value (*p*-value) of greater than 0.05 showed that MRI had no significant positive predictive value in determining the malignancy of brain tumors before and after contrast, but the probability value (*p*-value) of less than 0.05 indicated that enhancement had a positive significant diagnostic value in determining the degree of malignancy in patients with brain tumors, and the most appropriate cutoff point was 1.5 with a sensitivity of 0.77% and a specificity of 85%. *Conclusion:* MRI enhancement has a high diagnostic value for determining the degree of malignancy of brain tumors.

Keywords: Brain tumor, degree of malignancy, magnetic resonance imaging.

1. INTRODUCTION

Brain tumor patients usually have bad prognosis. However, the course of disease progression and mean survival for some patients could be controlled and/or improved by taking some interventional and invasive measures (Weller et al., 2014 and Narita et al., 2015 and Johnson et al., 2016). It is necessary to choose proper treatment for some patients in special settings, and to guide and perform treatment in active tumor site in order to reach best result of patients. Tumor type, grade and volume are the most important factors in evaluating prognosis (Zacharaki et al., 2009 and Kleihues et al., 1993). Using MRI with contrast has been recognized as an essential tool to diagnose primary and secondary tumors. Intra-axial lesions are diagnosed using gadolinium clots based on destroying blood brain barrier and/or vascular lesions letting gadolinium to diffuse the lesion (Abe et al., 2015 and Runge et al., 1985 and Essig et al., 2006). There are many factors affecting improvement grade of signals induced by using gadolinium clots, including magnetic field power, data related to combined parameters used, and the features of the contrast itself (Rohrer et al., 2005 and Runge et al., 2006). However, different studies have demonstrated contradictory results in terms of sensitivity and possibility of predicting tumor malignancy by MRI enhancement. Unlike proper contrast of soft tissues reached by MRI, its sensitivity and specificity for defining tumor type and its grade is limited. This is to some extent due to existing tumoral necrosis which might be misdiagnosed with tumor. The other reason is the diagnosis tool low power to diagnose between tumor, edema, and unspecific treatments effect in high signal area of T2 images (Earnest et al., 1988 and Dean et al., 1990 and Mabray et al., 2015).

In recent decades, there has been an attempt to improve diagnostic methods using new technologies in MRI for malignancy grade of brain tumors. The recent studies results have shown MRI capability in diagnosing tissue grade of the disease (Essig et al., 2006 and Rohrer et al., 2005 and Runge et al., 2006 and Earnest et al., 1988 and Dean et al., 1990). Nowadays, stereotactic sampling methods are used in order to define tumor grade, which is invasive and expensive. Stereotactic sampling is accompanied by complications such as ICH and hemiparesis in %5 of cases (Earnest et al., 1988). If the diagnosing capability of MRI in defining tumor grade is proven, it can be used as a non-invasive cheap method.

This study is designed to investigate diagnostic value of results suggesting malignancy potentials of tumor with results taken from MRI enhancement.

2. METHODS AND MATERIALS

In this cross-sectional study, patients referred to neurosurgery clinic of Kashani hospital and private clinic of Esfahan Sepahan Clinic during 2017-2018, who had brain tumors were included. Inclusion criteria included prior brain surgery, history of prior brain biopsy, contrast intake contraindication (pregnancy, renal dysfunction), and MRI contraindications (metal particles in body, claustrophobia). The sampling was done simply until the sample size of 57 patients was completed.

Before execution, the proposal was studied by research committee of Esfahan Medical Sciences University, and its implementation was initiated after getting code of ethics.

Patients entering the study underwent MRI with and without contrast by two experienced radiologists, and the results were studies in a conference between the two radiologists. The two radiologists had consensus on having or not having enhancement, and its pattern. As for the enhancement pattern, being homogenous or heterogeneous, complete or relative, and presence of nodular like enhancement or not were discussed. The images before and after contrast were identically aligned. Then the enhancement amount of tumor with contrast was recorded in checklist. The contrast enhancement ratio (CER) was compared in order to study the difference between low malignancy tumor and anaplastic ones. The formula used for this ratio was *(S-S0)* 100/S0*. In this formula, S was the mean area signal strength showing the largest enhancement in T1 images after contrast. In tumors without visible contrast enhancement, the studied area was the solid part of tumor. The number considered for S0 was the mean signal strength of the area, reached in SE images after T1 contrast. This amount could predict the amount of brain tumor malignancy. MRI was done by a radiologist who was not aware of the pathology result.

A part of brain tumor was expelled out by neurosurgeon, and given to pathologist in order to study malignancy grade. The pathologist was blind to MRI results as well. The data related to tumor being benign or malignant and its malignancy grade was recorded in a checklist. Those patients with indefinite pathology results were excluded from the study.

Then, by entering data in SPSS, version 20, statistical descriptive and analytic analyses to define sensitivity were done based on positive or negative results of tumor enhancement in MRI and tissue pathology. Then there were reports in descriptive part as mean and standard deviation in quantitative variants and percentage (number) for qualitative variants. The sensitivity, specificity, positive likelihood of the two measurement methods was studied. All analyses were done in %5 error level.

Ethical committee approval code

This study was approved by ethical committee of Isfahan University of Medical Sciences with code 397196 2018 April.

3. RESULTS

ROC area under the curve demonstrated the predictive value of MRI before and after contrast, as well as enhancement pattern in diagnosing malignancy grade brain tumors (Diagram 1-3) (Table 1) (Figure 1 and 2).

Table 1 Area under curve (AUC) before and after contrast and enhancement pattern

Variants	%95 confidence interval		P-value	Standard error	Area under curve
	Upper bound	Lower bound			
MRI before contrast	0.713	0.485	0.087	0.058	0.599
MRI after contrast	0.665	0.434	0.396	0.059	0.549
Enhancement pattern	0.925	0.775	0.000	0.038	0.850

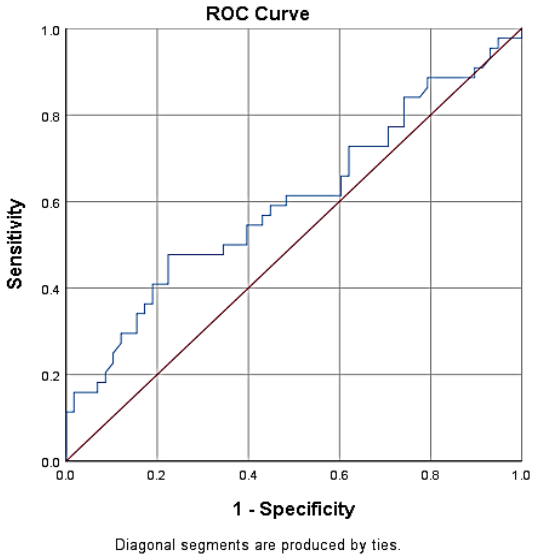

Diagram 1. RAC curve and its AUC before contrast

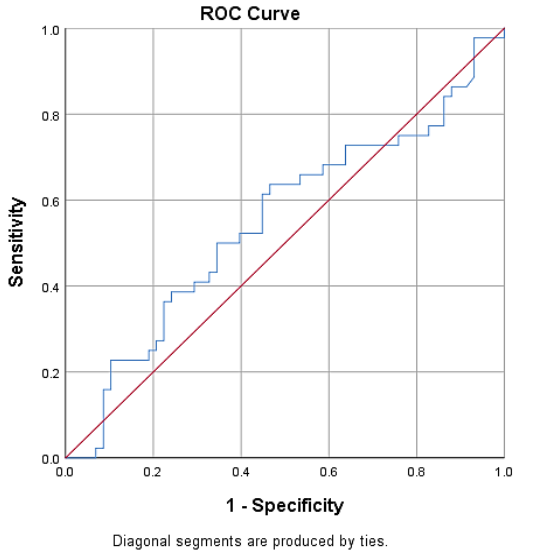

Diagram 2. RAC curve and its AUC after contrast

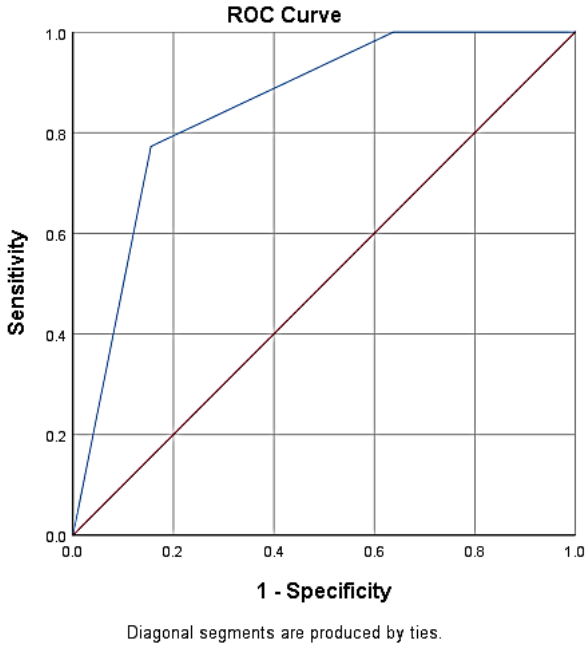

Diagram 3. RAC curve and its AUC in enhancement pattern

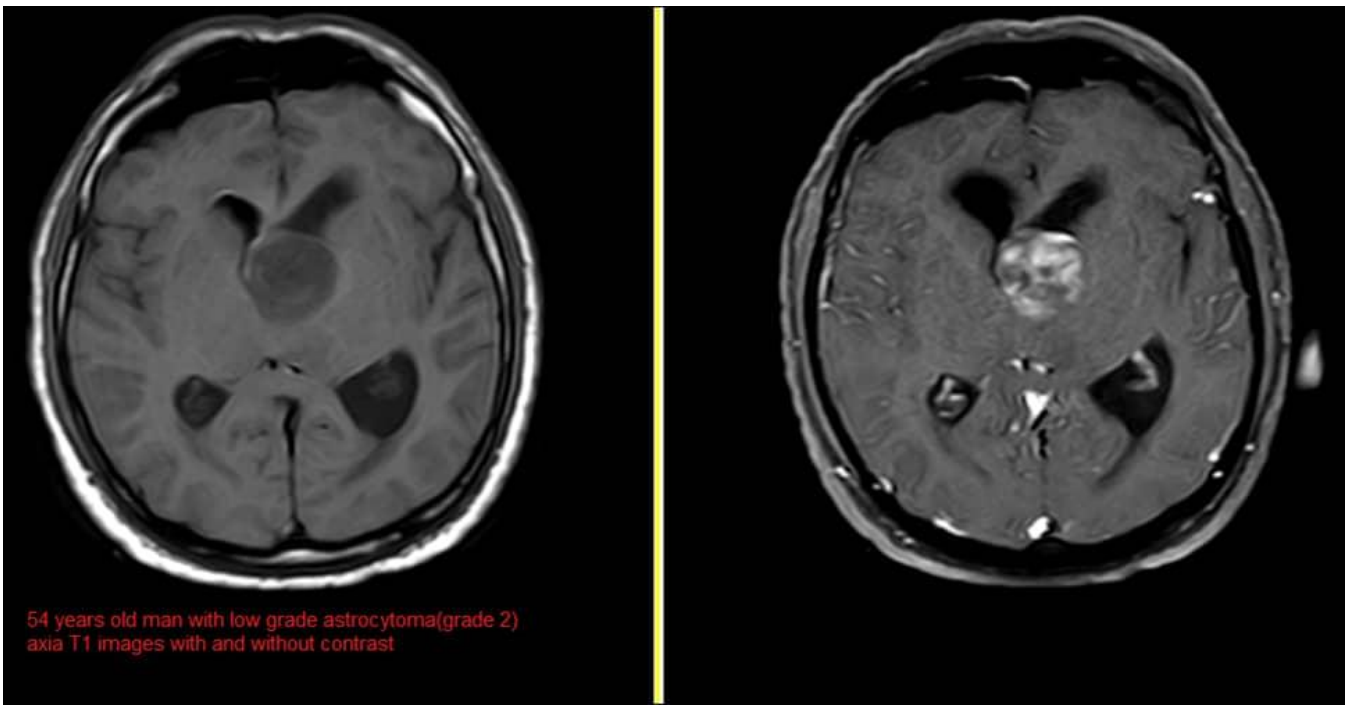

Figure 1 54 years old man with low grade astrosytoma (grade 2) axia T1 image with and without contrast

The P-value > 0.05 means MRI method before contrast does not have positive and significant diagnostic value for diagnosing malignancy grade of patients' brain tumors (p=0.087). Moreover, P-value > 0.05 means MRI after contrast does not have positive and significant diagnostic value for diagnosing malignancy grade of patients' brain tumors (p=0.396). However, P-value < 0.05 means enhancement pattern has positive significant diagnostic value for diagnosing malignancy grade of patients' brain tumors (p=0.000)

Confidence interval for enhancement pattern shows an area under curve (AUC) between % 77.5 and % 92.5 with a % 95 confidence. In other words, if the selected patients are representative of a larger community, the predictive power of enhancement pattern for diagnosing malignancy grade of brain tumors would be % 77.5 at least and % 92.5 at most with % 95 confidence.

The most suitable cut-off point in enhancement pattern is 1.5 with 77% sensitivity and 85% specificity. In this point, enhancement pattern would correctly diagnose the tumor malignancy grade in % 77 of patients. Positive (LR+) and negative (LR-) likelihood ratios in this point are 4.98 and 0.268 respectively.

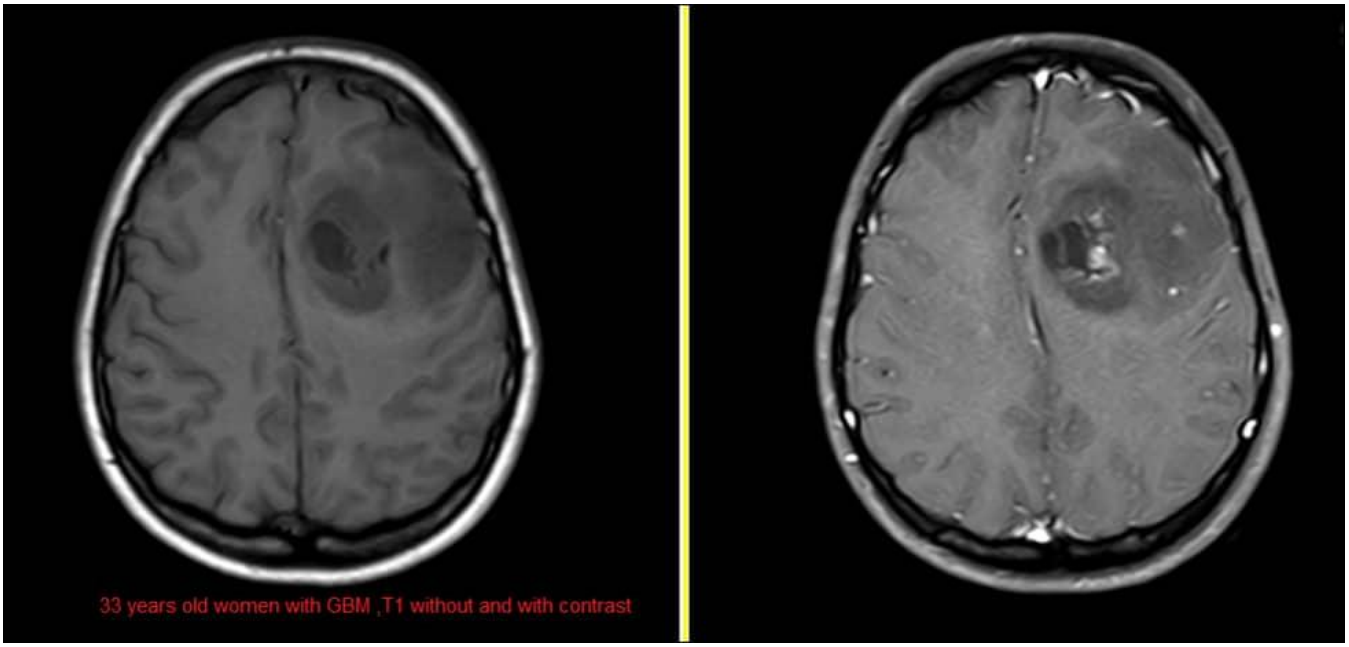

Figure 2 32 years' old women with GBM, T1 without and with contrast

Spearman correlation test results significantly (0.05) showed that enhancement type has a meaningful association with malignancy grade of glioma and meningioma (P-value=0.00), and the strength of such relation would be 0.793 and 0.631 for glioma and meningioma respectively. In other words, if we move from homogeneous to heterogeneous pattern, the malignancy grade of tumor (glioma and meningioma) would increase (table 2). Spearman correlation coefficient between ring enhancement and glioma malignancy grade demonstrated that the two variants have significant association with each other (P-value=0.00, r-spearman=0.627). The malignancy grade in ring enhancement group is significantly higher than other groups.

Table 2 Relation between enhancement type and malignancy grade

Spearman correlation coefficient	p-value	
0.793	0.000	Glioma
0.631	0.000	Meningioma

4. DISCUSSION

The aim of this study was to find the diagnostic value of MRI enhancement in diagnosing malignancy grade of brain tumors in patients referred to kashani hospital and Esfahan Sepahan Clinic in 2017-2018.

Patients with brain tumors have poor treatment prognosis. However, with timely and right diagnosis of the disease as well as tumor grading and sizing, there could be some treatments for patients so to increase their quality of lives as well as their lifespan. MRI is one of the diagnostic methods (Weller et al., 2014 and Narita et al., 2015 and Johnson et al., 2016). Magnetic resonance imaging (MRI) is a common method used in diagnosis and recognizing tumors and malignancies. Sometimes, however, it is not possible to diagnose tumoral tissues from intact ones due to low quality of MRIs; Although MRIs enjoy high quality, they do not have necessary contrast to differentiate between intact and tumoral tissue. However, using increased contrast MRI has been recognized as an essential tool for diagnosing primary and secondary tumors.

Our study results also demonstrated that MRI method before and after contrast does not have positive significant diagnostic value for diagnosing malignancy grade of patients' brain tumors. In this setting in his study which was one with oncologic view, Dr.

Jeremy Rees (2011) stated that contrast factors commonly used have some disadvantages including toxicity, low half-life, and no possibility to have multiple functions. In some studies in contrast, they have recommended using magnetic nanoparticles due to their low toxicity, high half-life, and multiple function, and most importantly better contrast. Using these particles have decreased T1 and T2 time, and increased image contrast (Roberts et al., 2000).

In their study, Heidi CR et al. showed association between MRI enhancement and malignancy grade. Aligned with that, our study significantly (0.05) showed that, enhancement type is associated with malignancy grade of glioma and meningioma. There is association strength of 0.793 and 0.631 for glioma and meningioma, respectively. In other words, if we move from homogeneous pattern to heterogeneous one, the malignancy grade (of glioma and meningioma) would increase.

The results of our current study demonstrated that enhancement pattern has positive significant value for diagnosing malignancy grade of patients' brain tumors. Moreover, the confidence interval for enhancement pattern showed that the area under curve (AUC) is between % 77.5 and % 92.5 with % 95 confidence. In other words, if the selected patients are representative of a larger community, the predictive power of enhancement pattern for diagnosing malignancy grade of brain tumors would be % 77.5 at least and % 92.5 at most with % 95 confidence. The most suitable cut-off point in enhancement pattern is 1.5 with 77% sensitivity and 85% specificity. In this point, enhancement pattern would correctly diagnose the tumor malignancy grade in % 77 of patients. Aligned with this in 2000, Heidi CR et al. studied the role of MRI enhancement in predicting malignancy grade of brain tumors. 22 patients diagnosed as glioma were studied with MRI. one patient with grade one, eight with grade two, seven with grade three, and six patients with grade four were reported. The results of this study demonstrated that MRI enhancement could be used for predicting malignancies (Roberts et al., 2000).

In 2009, however, another study by evangrlia I.Z et al. was done for studying predictive role of MRI in defining malignancy and brain tumor type. They showed in their studies that MRI enhancement is not a suitable method for grading glioma tumor malignancy, and is not capable of differentiating high grade malignant tumors from metastatic ones (Zacharaki et al., 2009).

5. CONCLUSION

This study concludes that the predictive value of MRI with contrast for diagnosing malignancy grade of brain tumors is low, while on the contrary, the power of MRI enhancement diagnostic value to define malignancy grade of brain tumors is of high precision.

Conflicts of interest

There are no conflicts of interest between authors.

Financial resources

There are no financial resources.

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