Research Article

Role of perfusion MR imaging in the evaluation of adult intracranial neoplasms

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Abstract

Aim: The aim of the study was to compare the efficacy of MRI perfusion in predicting the histology of intracranial neoplasms and to correlate with WHO grading. **Methods and Materials**: This prospective study was performed in 41 patients with intracranial tumours. The CBV, CBF, MTT and TTP values were calculated within the tumor, the peritumoral region, and the contralateral normal appearing white matter .The ratios were calculated by dividing the maximum value in the tumor and in the peritumoral region by the value in the contralateral normal-appearing white matter. For statistical analysis Student independent t-test and ROC curve analysis was performed. **Results:** The difference in the mean rCBVt, rCBFt, rCBVp, rCBFp, rMTTp ratios of high and low grade gliomas were statistically significant . Among all the parameters rCBVt was the best parameter to identify high-grade gliomas, a cut off > 2.36 for rCBVt yielded 87.5 % sensitivity and 100 % specificity . Similarly the difference in the mean rCBVt, rCBVp and rCBFp of high grade glioma and metastasis were statistically significant.. Among all parameters rCBVp was the best parameter to identify high grade glioma and a cut off > 1.525 for rCBVp yielded 87.5 % sensitivity and 100 % specificity .CONCLUSION: MRI perfusion showed very good diagnostic accuracy in grading glial tumors, as well as in the differentiation of GBM from metastasis.

Keywords: Glioma, Magnetic resonance imaging, Perfusion, Tumour.

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INTRODUCTION

Intracranial tumours are a significant health problem. Imaging plays an integral role in intracranial tumour management. Magnetic resonance (MR) imaging in particular has emerged as the imaging modality most frequently used to evaluate intracranial tumors, and it continues to have an ever expanding multifaceted role. In general, the role of MR imaging in the workup of intraaxial tumors can be broadly divided into tumour diagnosis and classification, treatment planning and post treatment surveillance. In addition to conventional MR imaging techniques, a variety of advanced techniques have found their place in clinical practice or are the subject of intense research. These advanced techniques offer more than the anatomic information provided by the conventional MR imaging sequences. They generate physiologic data and information on chemical composition. The commonly used advanced MR imaging techniques include diffusion-weighted imaging, perfusion weighted imaging and MR spectroscopy. Molecular imaging is largely experimental at this stage. Discrimination of extra-axial and intra-axial brain tumors is relatively easy with only anatomic imaging; however, the major diagnostic challenge is to reliably, noninvasively, and promptly differentiate various histological tumour types to avoid biopsy and follow-

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up imaging studies. Integration of diagnostic information from advanced MR imaging techniques can further improve the classification accuracy of conventional anatomic imaging.[1] Perfusion MRI can be used to evaluate hemodynamic properties of the tumor such as tumor blood volume or blood flow, oxygenation, vessel size, and vascular permeability. This study focuses on the role of the most commonly used advanced MR imaging technique-perfusion-weighted imaging for the diagnosis and classification of the adult intracranial tumours.

MATERIALS AND METHODS

This is a hospital based time bound prospective study, conducted between Oct 2012 to Aug 2014 over a period of 23 months in the Department of Radiodiagnosis and Imaging, Kasturba Medical College, Manipal.

All the patients in whom intracranial neoplasms was suspected and who were conforming to the inclusion criteria were selected for the study.

In each patient, perfusion parameters were calculated and relationship of these parameters with the final diagnosis was correlated.

Inclusion criteria

The study includes those adult patients whose final diagnosis is confirmed by histopathology in case of a tumor / known primary in case of metastasis.

Patients must be previously untreated.

Exclusion criteria

Contraindication to perform MRI.

Histopathology proven non neoplastic lesions.

Statistical analysis

Statistical analysis was performed using SPSS 20 software to obtain the means of the perfusion parameters of various lesions. The means derived were further compared using student independent t-test to check the statistical significance in their difference. Receiver operating characteristic (ROC) curves were generated for the perfusion parameters which showed statistically significant difference to identify the cut off points that maximized the sensitivity and specificity for identifying each condition.

OBSERVATIONS AND RESULTS

The present study sample included 41 patients who suffered from intracranial neoplasms. 27 patients were males and 14 were females.

1. Demographic details

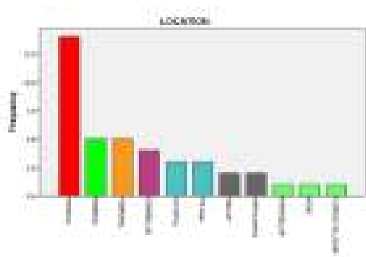
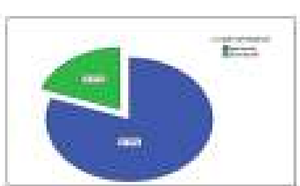
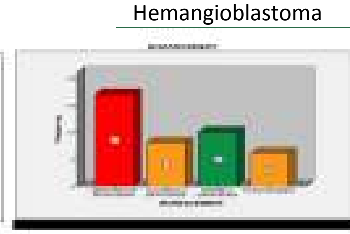
Majority of the patients in the study were in the age group between 30 and 60 yrs age group. Minimum age was 19 yrs, Maximum age was 72 yrs. Mean age was 47.5 yrs. Male patients exceeded the female patients forming 65.9 % of the total population.

2. Frequencies of the lesions

Gliomas constituted the most common intracranial space occupying lesions accounting for 43.9 % of the cases. Out of 18 cases of glioma, 8 had high grade glioma out of which 7 were glioblastomamultiforme (grade IV) and 1 was anaplastic astrocytoma (grade III) and 10 had low grade glioma (WHO grade I andII) which showed minimal to no enhancement after contrast administration. Metastasis was the second most common lesions accounting for a total of 9 cases out of which 4 were secondaries from bronchogenic carcinoma, 3 had breast carcinoma and 2 from the gastrointestinal tract.

Meningiomas were the third most common lesions accounting for a total of 5 cases in which 4 were histopathologically typical meningiomas and 1 was atypical meningiomas.

Diagnosis	Frequency
Low grade glioma	10
High grade glioma	08
Metastasis	09
Meningioma	05
Schwannoma	03
Oligodendroglioma	02
Pituitary macroadenoma	02
Lymphoma	01
Hemangioblastoma	01


3. Morphological Characteristics

34.1% of the lesions were in the frontal lobe followed by 12.2% in parietal and temporal lobe, 7.3% in occipital region and the rest (22.1%) in the locations as shown in the bar chart. Intra-axial lesions constituted the majority accounting to 80.5% of the lesions. 18 out of 41 lesions (41.5 %) showed heterogenous enhancement with majority in this group comprising of gliomas (7 lesions) followed by metastasis (4 lesions). Peripheral enhancement was seen in 24.4% of the cases (10 out of 41 lesions) with the majority in this group constituted by gliomas (5 lesions),followed by metastasis(3 cases). Homogenous enhancement was seen in 19.5% of the cases (08 out of 41 lesions) with majority being meningiomas (03 lesions) and schwannomas (02 lesions). 06 lesions (14.6 %) were non-enhancing and mostly included low grade gliomas(05 lesions) and oligodendroglioma(01 lesion). Calcifications/Hemorrhage was seen in 18 cases (43.9 %) (6 cases of glioma, 4 cases of metastasis, 3 cases each of meningiomas and schwannoma and 1 case each of pituitary macroadenoma and oligodendroglioma). Rest of the lesions 23 cases (56.1 %) showed no calcifications/hemorrhage. 27 cases showed perilesional edema accounting to 65.9 % of the total cases. gliomas (14 cases) formed the majority showing perilesional edema followed by Metastasis (09 cases). 34 cases showed mass effect either in the form of midline shift or effacement of the adjacent sulci or supra/infratentorialherniations. Gliomas (14 -7 low grade and 7 high grade lesions) and metastasis (07 lesions) were among the majority causing the maximum mass effect.

4. Statistical Analysis

Descriptive statistics of the mean, total number of cases (N), standard deviation, minimum and maximum values of rCBVt, rCBVp, rCBFt, rCBFp,rMTTt,rMTTp,rTTPt,rTTPp for various lesions were calculated. Using student independent t-test, a statistical analysis for comparing and characterizing the lesions with respect to the perfusion, diffusion and spectroscopy parameters was performed. The following set of lesions could be compared:

1. High grade and Low grade gliomas
2. High grade gliomas and Metastasis
3. High grade gliomas and Meningiomas
4. High grade gliomas and oligodendroglioma

Receiver operating characteristic (ROC) curves were generated to obtain the sensitivity and specificity for the perfusion, diffusion and spectroscopy parameters showing statistically significant difference in their means.

Statistical comparison of High grade and Low grade gliomas

To identify high grade glioma conventional sequences had a sensitivity of 75 % and specificity of 62.5 %.

The difference in the mean rCBVt, rCBFt, rCBVp, rCBFp, rMTTp of high grade and low grade gliomas were statistically significant ($P < 0.05$). No statistically significant difference found between the two with respect to mean rMTTt, rTTPt, rTTP

Mrperfusion

To identify high-grade gliomas, a cut off of >**2.36** for rCBVt yielded 87.5 % sensitivity and 100 % specificity and **1.474**> for rCBFt yielded 87.5 % sensitivity and 70 % specificity.

To identify high-grade gliomas, a cut off of >**1.395** forrCBVp yielded 87.5 % sensitivity and 90 % specificity and >**1.21** for rCBFp yielded 87.5 % sensitivity and 70 % specificity.

To identify high-grade gliomas, a cut off of >**1.035** forrMTTp yielded 87.5 % sensitivity and 70 % specificity

Statistical comparison of High grade gliomas and Metastasis

The difference in the mean rCBVt, rCBVp and rCBFp of high grade and metastasis were statistically significant ($P < 0.05$). No statistically significant difference found between the two with respect to mean rCBFt, rMTTt, rMTTp, rTTPt, rTTPp.

MR perfusion

To identify high-grade gliomas, a cut off of **> 1.525** for rCBVp yielded 87.5 % sensitivity and 100 % specificity and **1.145**> for rCBFp yielded 87.5 % sensitivity and 88.9 % specificity.

To identify high-grade gliomas, a cut off of >**2.395** forrCBVt yielded 87.5 % sensitivity and 77.8 % specificity.

Statistical comparison of High grade glioma and Meningiomas

The difference in the mean rCBVp, rCBFp of high grade and meningiomas were statistically significant ($P < 0.05$). No statistically significant difference found between the two with respect to mean rCBVt, rCBFt, rMTTt, rMTTp, rTTPt, rTTPp, was obtained.

MR perfusion

To identify high-grade gliomas, a cut off of >**1.38** for rCBVp yielded 87.5 % sensitivity and 100 % specificity andto identify high-grade gliomas, a cut off of >**1.16** forrCBFp yielded 87.5 % sensitivity and 100 % specificity.

Statistical comparison of High grade glioma and Oligodendroglioma

No significant difference in the perfusion parameters was obtained in our study. Major limitation was the small sample size for oligodendroglioma.

DISCUSSION

Advanced magnetic resonance imaging (MRI) techniques, such as MR spectroscopy, diffusion and perfusion MR imaging techniques can give important in vivo physiologic and metabolic information, complementing morphologic findings from conventional MRI in the clinical setting. The most common perfusion technique is T2* dynamic susceptibility imaging. The

T2* effects of gadolinium result in decreased signal intensity during the passage of gadolinium and the change in signal intensity is plotted against time to form a signal intensity time curve [1,2,3]. The study comprised of 41 cases of intracranial neoplasms of which glioma (43.85%) constituted the most common lesion, followed by metastasis (21.9%) and meningiomas (12.1%). 27 patients were male and 14 were females. Most of the patients were between the age group of 30-60 yrs. Minimum age was 19 yrs, Maximum age was 72 yrs. Mean age was 47.5 yrs. To identify high-grade gliomas, a cut off of > 1.38 for rCBVp yielded 87.5 % sensitivity and 100 % specificity and to identify high-grade gliomas, a cut off of >1.16 forrCBFp yielded 87.5 % sensitivity and 100 % specificity. Consider overlap in the values of rCBVt was noted between high grade gliomas and meningiomas. Meningiomas have shown higher rCBVt values comparable and even higher than high grade neoplasms. rCBVp was more useful parameter to distinguish vasogenic edema surrounding the meningioma from tumour infiltrative edema in high grade gliomas.MTT and TTP was not significant in differentiating high grade gliomas and metastasis. The differentiation of high grade glioma and oligodendroglioma based on Dynamic MR perfusion studies is often difficult because of the higher rCBV and rCBF values observed in oligodendroglioma, of which vast majority are WHO grade II tumours. While some investigators have found increasing CBV with increasing grade in oligodendroglioma,others have found this not to be the case[14,15]with high rCBV often found in low-grade oligodendrogliomas. Our study had a major limitation of small sample size. Only 2 cases of oligodendroglioma were assessed in the study .On case showed increased CBVt andCBFt in agreement with other studies while other study showed only mild increase in CBVt and CBFt. The Bland Altmann test was performed to determine the agreement between the two observers. There was significant agreement between the observers and also within the observer, concluding that there was no significant variation between the values of the perfusion, diffusion and spectroscopy parameters obtained and the values are repeatable and consistent.

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