Case Report

Role of MR perfusion imaging in brain tumors

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Abstract

Introduction: The advancement in surgical treatment and chemotherapy options imaging modalities also need to incorporate advanced neuroimaging modalities for more accurate diagnosis and grading of intracranial masses. This prospective study aimed at characterization of intracranial space occupying lesions using dynamic susceptibility magnetic resonance perfusion. It also attempts to distinguish between high and low grade lesions and gliomas from metastasis and other infective morphologically similar pathologies. **Materials and Methods:** Subjects of all age groups with intra axial lesions diagnosed on conventional imaging were subjected to perfusion on 1.5T Magnetom Siemens Avanto system. Histopathology was gold standard. Data was analysed using statistical package SPSS version 17 and cut off values for rCBV were obtained. Data analysis was done by using correlation coefficient and diagnostic tests (sensitivity, specificity, positive predictive value and negative predictive value). **Results:** By means of this study it was concluded that an intracranial lesion could be said to be high grade if rCBV value was greater than or equal to 2.5(sensitivity- 80%, specificity- 82%) for high grade gliomas .These also aided in solving dilemma faced in distinguishing post treatment changes from residual/recurrence. **Conclusion:** MR perfusion if used wisely can improve diagnostic performance especially where conventional MRI is doubtful.

Keywords: Conventional, Gliomas, Neuroimaging, Recurrence, Residual

Introduction

As conventional MR methods do not have a high sensitivity and specificity it is difficult to precisely diagnose and grade intracranial space occupying by these means alone[1].

Hence such drawbacks have led to further exploration and discovery of newer advanced neuroimaging techniques some of which have found a place in day to day clinical practice while some are still in the phase of research[6].Brain tumours can have many mimickers for example granulomas, abscesses, demyelinating lesions and metastasis particularly when solitary. Even contrast MR imaging can be misleading as it shows enhancement in any lesion associated with disruption of the blood-brain barrier. It is not the true representative of neovascularity or perfusion and does not show true pathological[2].

So the need for other imaging techniques was realized, for example Perfusion MR, which could solve the dilemma commonly faced in characterization of intracranial lesions. In this study it was clearly mentioned that further detailed investigation is needed in this direction as there is inadequate data to enable us to incorporate these methods into regular MRI protocol[2]. The first and the last modality in cross sectional imaging often sought to is MRI as it can give detailed structural information and now we can gain information on tumour perfusion at a cellular level (perfusion-weighted imaging)[7]. Despite such advantages confusion and debate often happen when it comes to grading, confirming invasion into peritumoural area, distinguishing post treatment changes from residual/ recurrence lesion[3,4,5].More studies are needed to quantify these limitations and also to prove use of such newer modalities as complementary diagnostic tools and able to improve preoperative diagnostic accuracy or even obviate stereotactic biopsy.

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Aims

To study the utility of advanced MR imaging characteristics in enabling more accurate diagnosis and grading of intracranial space occupying lesions and to obtain histopathological correlation wherever possible.

Objectives

Role of MR perfusion in

1. To evaluate the role of Magnetic Resonance Perfusion imaging in brain tumors
2. To identify the perfusion patterns in different neoplastic lesions of brain
3 To use the perfusion parameters as a prognostic indicator of brain tumors.

Materials and methods

All patients with intracranial space occupying lesion detected in MRI in AJ Hospital, Mangalore in a time period of 2017-2019 are included in the study and were subjected to contrast enhanced perfusion-weighted MR imaging.

Sample size

minimum 30

(95% confidence level and 85% power and with reference to sensitivity of 70% and specificity of 80%)

Formula used for sample size calculation

$n = Z\alpha 2 \times Sn \times (1 - Sn) / L2 \times P$

[$Z\alpha$ =1-96, 95% confidence level
Sn = Sensitivity
L= Absolute precision (10%),P= Prevalence]

- Study Settings: 1.5 T MRI System – Magnetom Siemens Avanto
- Department Of Radiology
- AJ HOSPITAL MANGALORE
- Study Design: Prospective Study
- Gold Standard: Histopathology/based on clinical response if biopsy is not performed.

Composite case definition

Histopathology report to be obtained wherever possible and for all those cases it will be taken as gold standard. However, for cases not undergoing

biopsy, clinical response shall be considered instead of histopathological correlation.

Inclusion criteria

Patients of all age groups with intraaxial brain tumor detected by MR imaging.

Exclusion criteria

• Patients with:

- Intracranial aneurysm clips.
- Intra-orbital metal fragments.
- Any electrically, magnetically or mechanically activated implants (including cardiac pacemakers, biostimulators, neurostimulators, cochlear implants, and hearing aids).

• Patients having claustrophobia.

• Patients with preexisting renal disease / raised creatinine levels.

Method of collection of data

For the patients undergoing conventional MR imaging, with suspected intracranial tumors were judged with MR imaging.

They were subjected for perfusion studies and rCBV will be calculated for all tumours. More than two standard deviations from mean value was considered abnormal.

Protocol used for perfusion imaging consisted following parameters:

- TR/TE 1710/30, Flip angle – 90 degree, Matrix – 128x128
- Section thickness- 5mm and Section gap- 1.5mm
- 10 ml contrast 5ml/s NS 10 ml at 5ml/s- 50 acquisitions 20-22 images after 5 minutes of contrast dose with Pressure injector.
- ROI for perfusion 60/100 mm^2

Statistical analysis

Data analysis was done by using correlation coefficient and diagnostic tests (sensitivity, specificity, positive predictive value and negative predictive value).

A statistical package SPSS version 17 was used to do the analysis.

Analysis

• Comparison of rCBV intracranial lesions and correlation with HPE. (CBV – Cerebral Blood Volume).

Case images

Case 1: Below images represent case of suspected glioblastoma showing high perfusion and was was proven to be same on follow up.

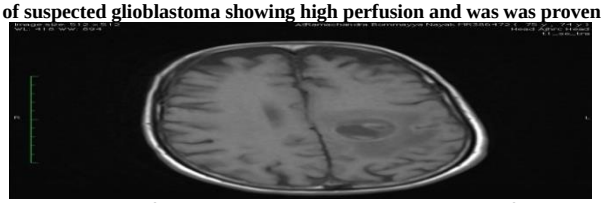


Fig 1: case of suspected glioblastoma showing high perfusion

a. T1 axial sections showing heterogeneous ill-defined lesion with T1 hyperintense areas – s/o haemorrhagic foci involving left high frontal lobe

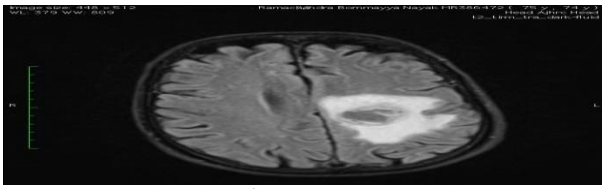


Fig 2: heterogeneous ill-defined lesion with T1 hyperintense areas

b. T2 FLAIR images shows hetrogenous lesion with surrounding edema inleft high frontal lobe

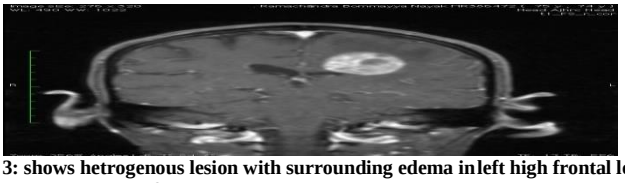


Fig 3: shows hetrogenous lesion with surrounding edema inleft high frontal lobe

c. Post contrast study shows intense enhancement of the lesion.

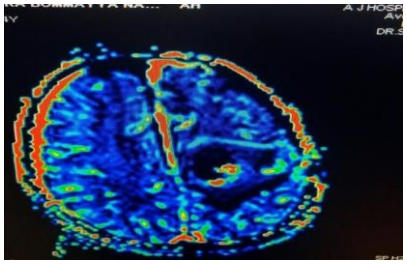


Fig 4:Post contrast study shows intense enhancement of the lesion.

d. Perfusion (rCBV colour map) show areas of increase in perfusion.

Case 2: case of high grade glioma showing intense contrast enhancement and also increased perfusion was followed up and proven to be glioblastoma multiforme.

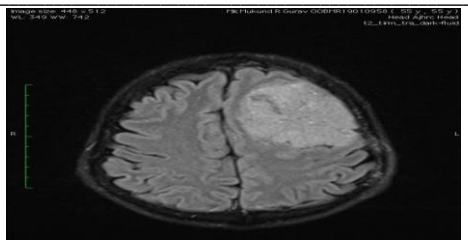


Fig 5: intense contrast enhancement and also increased perfusion was followed up and proven to be glioblastoma multiforme.

a) T2 FLAIR images show altered signal intensity lesion in left high frontal lobe

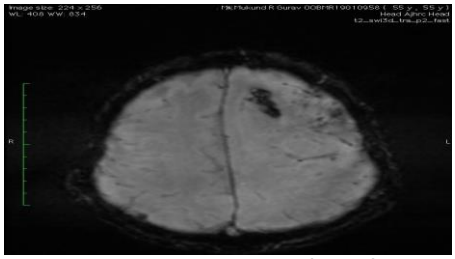


Fig 6: altered signal intensity lesion in left high frontal lobe

b) SWI images shows areas of blooming within the lesion

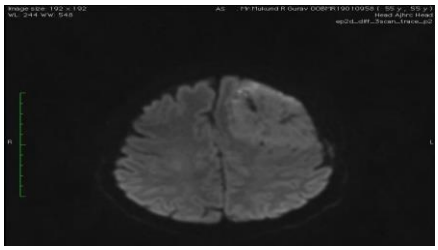


Fig 7: areas of blooming within the lesion

c) diffusion study shows areas of restriction in the lesion

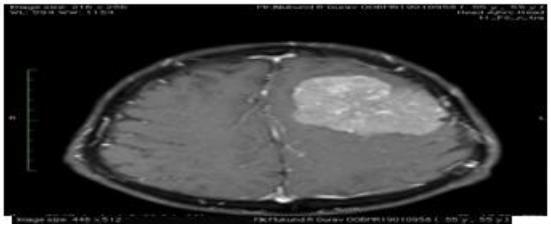


Fig 8: areas of restriction in the lesion

d) Contrast study shows intense enhancement in the lesion

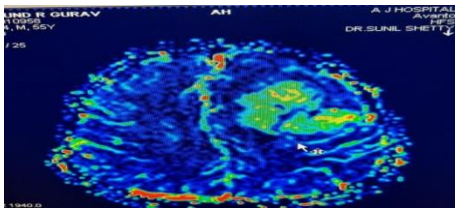


Fig 9: intense enhancement in the lesion

e) Perfusion study show increased perfusion 5 to 6 times

3) **Patient with with peripherally enhancing lesions in left parietooccipital region. No h/o fever, weight loss or systemic complaints. Diagnosis of low grade glioma was given in view of irregular enhancement and perfusion findings. Same was proved on biopsy.**

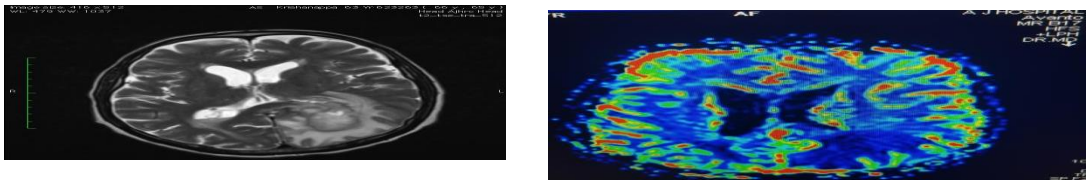


Fig 10: Perfusion study show increased perfusion 5 to 6 times

a) T2 fl flair hyperintense lesion noted in left partoccipal lobe

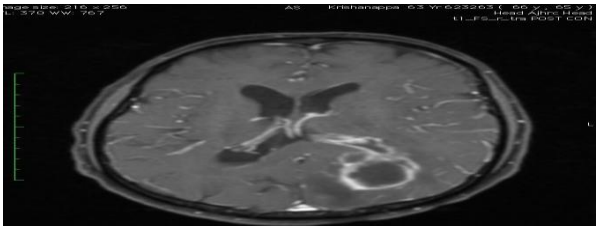


Fig 11: **T2 fl flair hyperintense lesion noted in left partoccipal lobe**

b) Post contrast enhancement shows pheripheral enhancement of lesion

f) Perfusion images (rCBV) shows no significant raised rCBV in periphery of the lesion. Post contrast enhancement shows pheripheral enhancement of lesion Case 4: 53 year old male with history of fall and no antecedent known illness. No systemic complaints. Left frontoparietal mass lesion as shown below with surrounding edema and mass effect. Typical case of glioblastoma multiforme (biopsy proven).

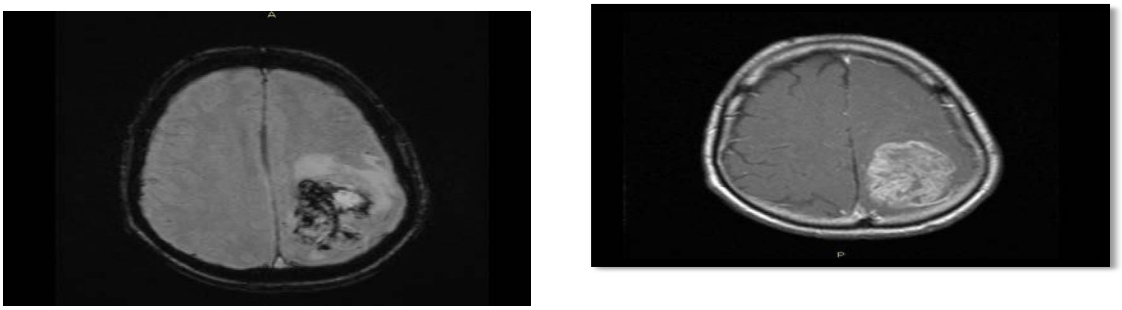


Fig 12: no significant raised rCBV in periphery of the lesion

Axial image shows ill defined heterogenous signal intensity lesion with areas of hyperintensity- s/o haemorrhage. Axial T2 shows heterogeneously hyperintense mass lesion involving left parietal lobe. Areas of blooming on SWI seen in image on right- s/o haemorrhage. Patchy areas of diffusion restriction within the lesion. Post contrast image showing heterogeneous enhancement within the lesion and increased perfusion within lesion and in peritumoural region ~ 5 times.

Case 5) case of glioma of right parital lobe high grade glioma ,biopsy proven as glioblastoma showing areas of increased perfusion .This was followed up and proven to be same

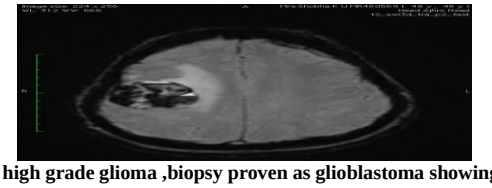
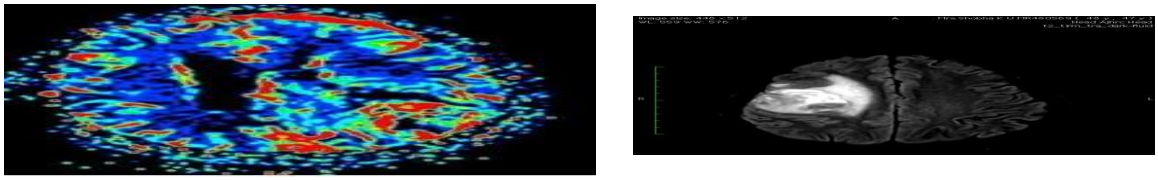


Fig 13: of glioma of right parital lobe high grade glioma ,biopsy proven as glioblastoma showing areas of increased perfusion.

c) SWI shows areas of blooming in the lesion in right parietal lobe

a) **T2 FLAIR axial images shows altered signal lesion in the right high parietal lobe with surrounding edema.**



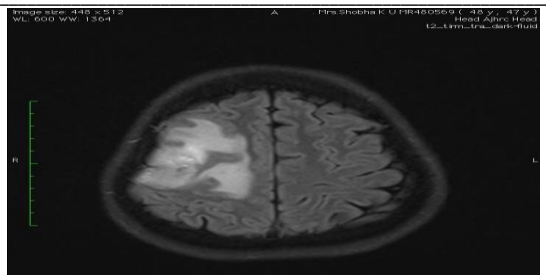
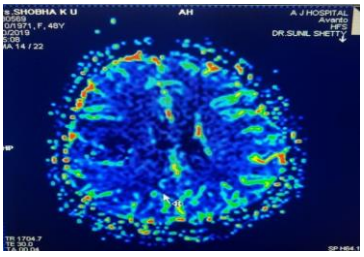


Fig 14: altered signal lesion in the right high parietal lobe with surrounding edema

b) **Post contast study shows areas of subtle enhancement Planning the perfusion dynamic curve, ROI (region of interest) placed with lesion, peri-lesional area, contralateral white matter and vessel.**



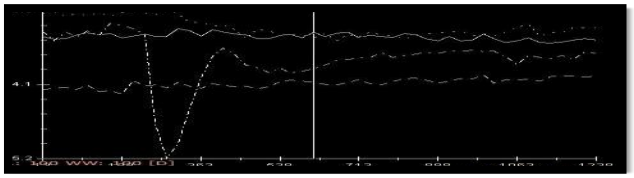


Fig 15: Dynamic perfusion curve- Significant dip in perfusion curve with slow return towards baseline.

Results

In the study group comprising of a mixed population the distribution of types of cases as per location is illustrated in Fig 16.

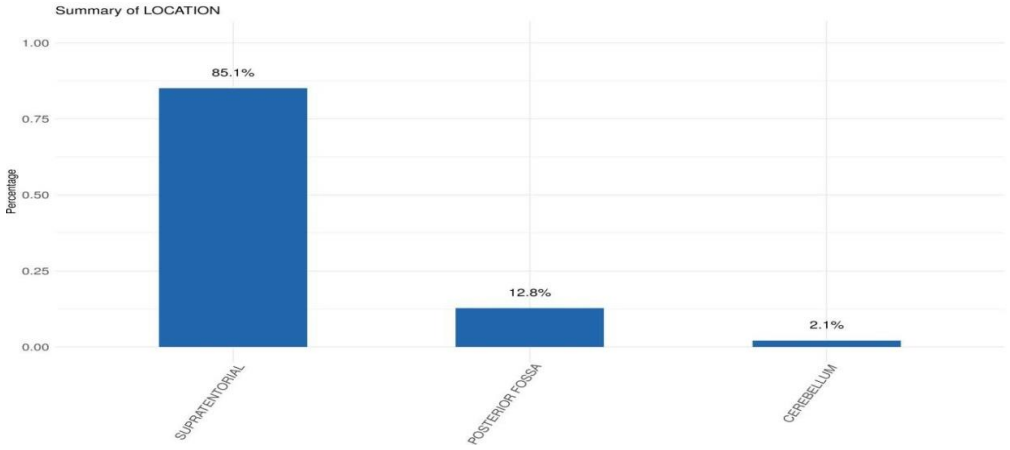
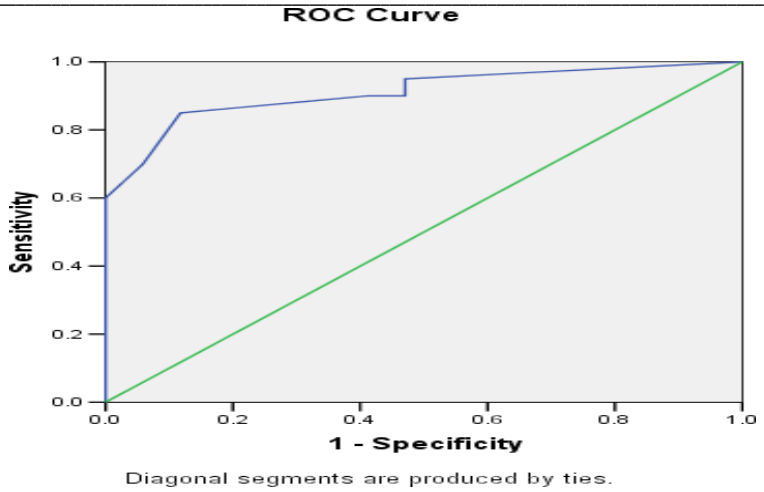


Fig 16: mixed population the distribution of types of cases as per location



First comparing MR perfusion for characterization of high grade and low grade gliomas, perfusion showed higher specificity (Sensitivity- 80.3%, specificity- 82.5%, PPV- 88.2% and NPV- 85 %).

Table 1: Comparison between PERFUSION and GRADE OF TUMOR

	High Grade	**Percentage**	**LOW GRADE**	**Percentage.1**	**P.value**	**Method**
Decreased	1	3.12	0	0	0.398258	Fisher's Exact Test for Count Data with simulated p-value (based on 1e+06 replicates)
Increased	26	81.25	10	76.6		
No Increase	5	15.62	5	21.33		

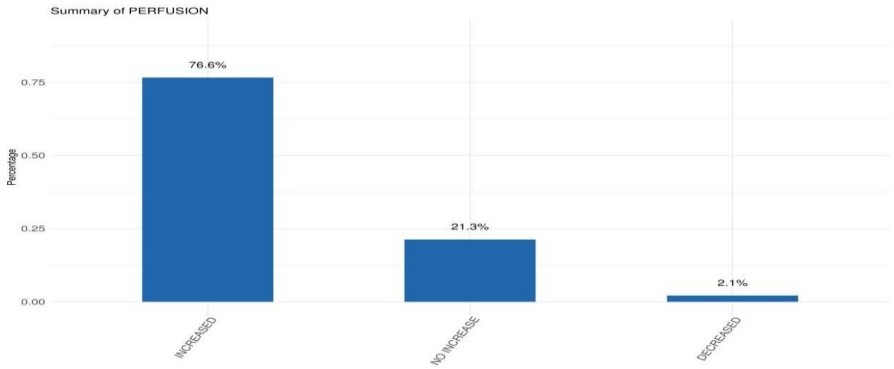


Fig 17:Summary of perfusion

An intracranial lesion could be said to be high grade if rCBV value was greater than or equal to 2.5(sensitivity- 80%, specificity- 82%).The utility of perfusion in this regard is depicted.

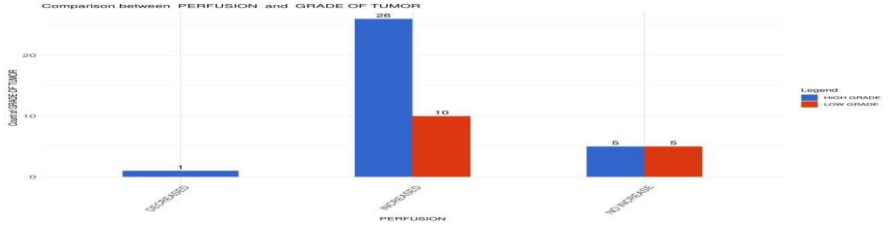


Fig 18: Comparison between perfusion and Grade of tumor

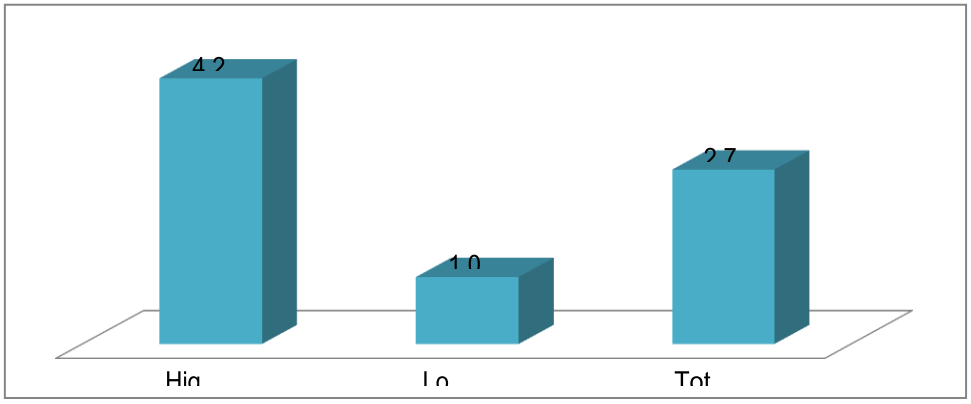


Fig 19: rCBV for High grade and Low grade gliomas

For the follow up cases with known HPE, perfusion showed (Sensitivity- 84.2%, specificity- 100%, PPV- 100% and NPV- 78.6 % for perfusion. Accuracy of perfusion was 75% in diagnosing residual/recurrent lesion.

Discussion

Histopathological analysis sometimes may give false results if the sample is taken from the wrong site or inadequate. For example, the area showing enhancement on conventional MRI may not represent the most aggressive region of the tumour or could actually be the perilesional area. Perfusion MRI gives a measure of volume of blood flowing through microvasculature of a mass of tissue in a unit time hence illustrating tumoral hemodynamics better[8,9].

By means of this prospective study comprising various intracranial lesion types in selected patients, it is clear that although doubted earlier MR perfusion and have a reasonably good sensitivity, specificity and efficacy in characterization of tumours as well as their follow up. As Aprile[10] and his colleagues in 2012 mentioned, the basic MR sequences themselves with or without contrast can help to accomplish diagnosis or probable grading in obvious case such as advanced GBM[11]. Thus by this analysis the best use of these newer methods could be distinguishing among less obvious cases and predicting residual/recurrent disease where post radiation and chemotherapy could produce confusing imaging appearance[12].

Diagnosis of metastasis was aided by assessing the peritumoural region on comparison with post contrast images and thus establishing infiltration by gliomas which was absent in metastasis. Significantly increased perfusion (> 2.5 times rCBV) was seen in most high grade glioma[13].

In few cases there was increased perfusion, beyond the enhancing area on contrast MR images, implying more extensive tumour infiltration and invasiveness. In such cases the surgical planning and resection is helped by this modality. In one of the cases perfusion MRI helped to solve doubt regarding conversion to higher grade lesion where conventional images can be misleading or pick up conversion much later[14].In certain cases DSC perfusion with mean curve analysis was found to be helpful in characterization of tumours like lymphoma, metastasis by studying bolus arrival time, time to peak, area under curve, return to baseline and recirculation effects. However, these have to be interpreted along with other sequences and not in isolation. In cases of extra-axial lesions, pilocytic astrocytoma oligodendroglioma, and lymphoma the rCBV maps can lead to a wrong diagnosis due to lack of typical findings and similarities between few tumour types.Perfusion neuroimaging methods were useful in grading gliomas. Perfusion yielded better results when compared to other advanced sequences particularly in lesions with known histopathology on reimaging after treatment and assessment of progression versus pseudo response[15].However the newer modalities cannot completely replace the existing conventional ones, they have to be used with jurisdiction as problem solving tools. Demyelinating lesions, haemorrhagic fungal granulomas and hypo vascular metastasis are few such examples where above statement holds true.

Conclusion

With proper use of these advanced MR imaging perfusion parameters, superior diagnosis, pre and post operative planning and guidance to biopsy is possible in challenging cases not solved by conventional means. There is also a need for standardization and more criteria to establish cut off perfusion values for uniformity in assessment.

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