ORIGINAL RESEARCH PAPER

Radio-Diagnosis

"ROLE OF ADVANCED MAGNETIC RESONANCE IMAGING (DWI, PERFUSION IMAGING AND MR SPECTROSCOPY) IN INTRACRANIAL TUMORS CORRELATING WITH HISTOPATHOLOGY"

KEY WORDS: MRS, MR perfusion, DWI, meningioma, glioma

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ABSTRACT

Intracranial masses are a significant health problem and present several imaging challenges. The role of imaging is no longer limited to merely providing anatomic details but the advanced MR techniques like DWI, MRS and MR perfusion permit the assessment of the freedom of water molecule movement, the microvascular structure and hemodynamic characteristics, and the chemical makeup of certain metabolites of lesions. In this article, we will discuss the role of the advanced MR imaging techniques, namely perfusion, diffusion.weighted imaging, and MR spectroscopy in the diagnosis and classification of the brain tumors and we will correlate our radiological diagnosis with histopathological diagnosis.

INTRODUCTION

Imaging is crucial in the treatment of brain tumours. For diagnosis, classification, surgical planning, and post-treatment follow-up, magnetic resonance imaging (MRI) is the imaging modality of choice. Conventional gadolinium-based contrast MR imaging provides excellent anatomic or morphologic information of brain tumors[1]. The grading is based on the aggressiveness of brain tumors and evidence of blood-brain barrier breakdown as demonstrated by post-contrast enhancement, edema, tumor infiltration, hemorrhage, necrosis, and mass effect.

Unfortunately, conventional contrast enhanced MR imaging alone cannot differentiate between areas of tumor [2] infiltration from vasogenic edema, as it does not show tumor physiology, which plays a significant role in brain tumor grading. So, often a high-grade brain tumor may be labelled as a low-grade brain tumor due to poor contrast enhancement and absence of necrosis or mass effects. Conversely, low-grade brain tumor with perilesional edema, contrast enhancement, necrosis, and mass effect may be overdiagnosed for a high-grade brain tumor[3].

Diffusion, perfusion, and spectroscopy, three of the most recent MRI techniques, provide more than anatomical information that conventional imaging provides. water displacement within tissue can be measured via diffusion[1,2]. MR perfusion is used to determine brain perfusion. The most extensively utilised perfusion technique is dynamic susceptibility contrast imaging (DSCMRI), which allows for the estimation of relative cerebral blood volume (rCBV) and relative cerebral blood flow (rCBF)[3] . MR spectroscopy can identify metabolites such as Nacetyl aspartate (NAA), cholinecontaining substances (Cho), myoinositol (mI), lactate (Lac), creatine (Cr), and other molecules within tissue using singlevoxel or multivoxel approaches. The diagnostic aim of functional neuroimaging of CNS neoplasms is to optimise tumor characterisation, with an emphasis on improved specificity to separate benign from malignant features. Specific characterisation facilitates planning of the most appropriate treatment. Furthermore, functional neuroimaging of CNS neoplasms can be expanded to the monitoring of ongoing therapy[4].The predictive assessment of therapy response and the monitoring of ongoing therapy to guide therapeutic intervention are major challenges in the current treatment of CNS neoplasms.

Aims & Objectives of the Study

1. To describe the imaging features of various intracranial tumors using advanced MRI techniques (DWI, perfusion imaging, and MR spectroscopy)
2. To compare MRI diagnosis with histopathology

METHODOLOGY

Our study include 35 patients who were referred to MRI with findings suspicious of brain tumors on routine sequences and those who have undergone CT and were seen to have intracranial space occupying leisons. MRS, MRP and DWI imaging were done further, in these patients and radiological diagnosis was derived. This is correlated with histo pathological report.

Imaging Techniques

This study is performed by the and Philips Ingenia 1.5 Tesla MR System with D stream technology using dedicated head coil.

RESULTS

The present study was conducted in the Department of Radiodiagnosis GGH ,Kurnool Medical College ,Kurnool .The study population comprised of all the patients who are referred to MRI with findings suspicious of brain tumors on routine sequences and those who have undergone CT and were seen to have intracranial space occupying leisons . A total of 35 cases with intracranial tumors were evaluated using MRI, out of which 17 were males and 18 were females We included all age groups , with range in our study being between 5y to 72y, with mean age of 43.9 y and most of the leisons are in age group of 41 to 60.

Meningiomas constituted about 31.42% of all intracranial tumors in our study. Out of 11 meningiomas 5 were diagnosed as meningiomas on conventional MR imaging On DWI mean ADC value was 1±0.3 ×103. On MRP rCBV values were in range of (8.34 ± 4) Combined technique of DWI, MRS and MRP has sensitivity, specificity, PPV and NPV 100%, 100%, 100%, 100% respectively.

Metastasis constituted about 17.14% of 35 intracranial tumors in our study. out of 6 metastasis, 4 showed correlation with histopathology and 2 did not. Out of 2, 1 came out to be tuberculoma and other as anaplastic meningioma . Out of 6 , 3 leisons were showing restricted diffusion and 3 were not. All had lipid lactate peak with elevted choline, cho/cr ratio > 2.3 ,and cho/NAA ratio >2.2. On perfusion studies, all except one showed increased perfusion. Combined technique of DWI, MRS and MRP has sensitivity, specificity, PPV and NPV 80.00%, 93.3%, 86.60%, 89.66% respectively in diagnosing metastasis

Out of 35 cases 17.14% cases constituted high grade glioma and 14.2% cases, low grade glioma, radiologically. All low grade gliomas did not show restricted diffusion. On MRS 4 out of 5gliomas showed elevated choline with cho/cr ratio < 2.3 and cho/NAA ratio <2.2. on MR perfusion there was no increase in perfusion in all gliomas.one of 4 glioma showed elevated Cho/Cr ratio >2.3. Out of 6 high grade gliomas 5 correlated with histopathology and 1 came out to be metastasis from poorly differentiated carcinoma On diffusion weighted imaging all cases of high grade gliomas showed restricted diffusion in solid part with elevated choline, cho/cr ratio >2.3, cho/NAA >2.2 with lipid lactate peak. rCBV ratios of high-grade gliomas (3.76 ±2.35) were higher than those of low-grade gliomas (0.9 ± 0.52). Combined technique of DWI, MRS and MRP has sensitivity, specificity, PPV and NPV 100%, 96.67%, 94.17%, 100% respectively in diagnosing high grade glioma and 100%,100%,100%,100% respectively in diagnosing low grade glioma.

Medulloblastoma constituted about 8.57% out of 35 cases in our study. Out of 3 medulloblastomas, 2 were histologically confirmed as classical variant of medulloblastoma and 1 came out to be grade II ependymoma. With all medullobalstomas showing elevated choline, Cho/Cr ratio >2.3 and Cho/NAA ratio>2.2 with lipid lactate peak in 2 of leisons in MRS. All the leisons are showing increased perfusion on MRP Combined technique of DWI, MRS and MRP has sensitivity, specificity,PPV and NPV 100%, 96.97%, 94.67%,100% respectively in diagnosing medulloblastoma.

Vestibular schwannomma constituted about 5.7 % of all intracranial tumors in our study. One of the leison is showing restricted diffusion in its solid component and other is not. On MRS there is elevated choline levels with,Cho/Cr ratio >2.3 and Cho/NAA ratio > 2.2. one of the lesions is showing lipid lactate peak with increased perfusion on MRP. Both the lesisons were confirmed histopathologically Combined technique of DWI, MRS and MRP has sensitivity, specificity, PPV and NPV 100%,100%,100%,100% respectively in diagnosing vestibular schwannomma

Pituitary macroadenoma and craniopharyngioma constitute 2.85%each, in our study with macroadenoma demonstrating restricted diffusion , elevated choline with Cho/Cr ratio >2.3 and Cho/NAA ratio> 2.2. On MRP there is increased perfusion.

On the other hand, craniopharyngioma was not showing restricted diffusion. on MRS there is elevated Choline with Cho/Cr ratio < 2.3 and Cho/NAA ratio< 2.2. there was no increase in perfusion.

CONCLUSION

By conventional MRI, the lesions which had peritumoral edema, mass effect necrosis and hemorrhages were considered to be malignant; 12 were considered benign and 23 as malignant lesions according to this criteria but unfortunately, 9 of them were proved to be benign. All accepted benign lesions were true-positive; 32% sensitivity with 100% specificity was reported for routine MRI without any statistical difference to the exact diagnosis (p>0.05).

By ADC mapping and DWI, the lesions which showed restricted diffusion and lower ADC values than normal brain parenchyma were considered to be malignant; the lesions which were isointense with cerebrospinal fluid (CSF), did not show restricted diffusion and had the same or higher ADC values than normal brain parenchyma were considered to be benign.

So that 13 were malignant and 22 were benign lesions. However 4 of 22 benign leisons, were malignant and 1 out of 13 malignant leisons was benign, with sensitivity 75%, specificity 94.74% for DWI-ADC mapping with significant statistical difference to the correct diagnosis, was revealed (p<0.05). PERCENTAGES sensitivity 100, specificity 100 PPV 100, NPV 100, 81 By MRP, MTT, TTP and CBV values were compared with the measurements of non-pathological brain parenchyma.

The lesions showing increased vascularization and high CBV values were considered to be malignant. Nine of 29 lesions were expressed as malignant and 6 lesions were considered as benign. 13 out of 29 leisons which were considered malignant were benign and 1 out of 6 leisons which were considered to be benign turned out to be malignant one, with sensitivity 94.12%,specificity 27.28% with a significant statistical difference to the correct histopathologic diagnosis (p<0.05). with the measurements of non-pathological brain parenchyma.

According to the metabolite ratios and predominant metabolite peak, the lesions were divided into benign and malignant.The lesions without NAA depression and with the predominant metabolite NAA were considered to be benign. The lesions with NAA depression, with increased Cho/Cr and Cho/NAA ratios, with the predominant metabolite Cho were considered to be malignant.

With Cho/Cr ratio as reference 30 were malignant and 5 were benign.14 out of 30 leisons considered malignant were benign and all accepted benign leisons were true positive, with sensitivity and specificity 100% and 26.18% without any statistical difference to the exact histopathology (p>0.05). since meningiomas and vestibular schwannommas though are benign tumors exhibit increased perfusion and increased CHO/Cr and Cho/NAA ratios specificity for detection of malignant leisons by MRS and MRP is low in our study.

By the combination of DWI and MRP, 19 lesions were classified as benign and 16 lesions were determined as malignant, one of benign considered lesions turned out to be malignant and one of the malignant considered lesion was proved to be benign.

DWI+MRP revealed 93%. 82 sensitivity and 94% specificity with significant statistical differences to the exact histopathology and biopsy (p<0.05). As a whole, conventional MRI had the lowest sensitivities and specificities. By the combination of either DWI and MRS, MRP and MRS or DWI+MRS+MRP revealed 100% sensitivity and 100% specificity.

1. Summary

Objectives of our study were to To describe the imaging features of various intracranial tumors using advanced MRI techniques (DWI, perfusion imaging, and MRS) and To compare MRI diagnosis with histopathology.

Our study included 35 patients, who were referred to department of radiology in view of suspicion of intracranial space occupying leisons. After undergoing MRI brain plain, if there is suspicion of intracranial mass leison , patients were subjected to contrast study along with advanced MRI studies i.e…,DWI, MRS and MRP.

Further the patient is followed up for histopathological correlation. There were 18 females and 16 males in our study with most cases between age group of 41 – 60y. Most common intracranial tumor to occur in our study were meningiomas and gliomas followed by metastasis.

Lowest ADC values were obtained in case of medulloblastoma, in our study with highest ADC values for craniopharyngioma. Lowest perfusion was observed in case of cranio pharyngioma and highest in case of meningioma.

Case – 1: Meningioma

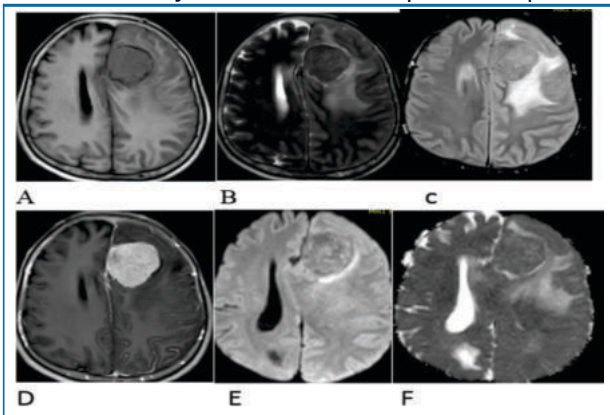

Figure - 1: A) Axial T1 weighted MR image showing well defined extra axial mass leison which is isointense to grey matter with surrounding odema in left frontal lobe B) on T2 weighted MR image the leison is isointense to grey matter C) on FLAIR images the leison is not getting supressed D) on post contrast T1 weighted images the leison is showing intense homogenous post-contrast enhancement E) and F) DWI and ADC the leison is showing restriction similar to brain parenchyma with ADC values 1.1×10^{-3}

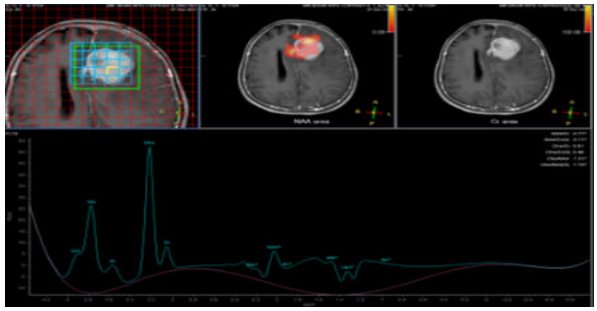

Figure – 2: MRS with long TE in same case : there is elevated choline along with elevated choline creatine ratio measuring 5.11 and choline NAA ratio measuring 2.81.

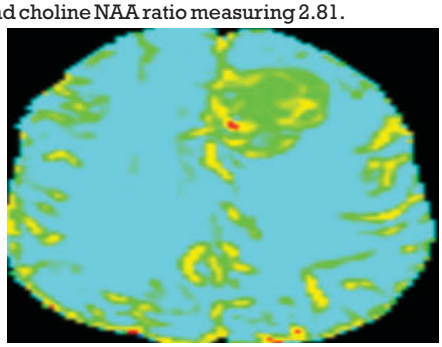

Figure – 3: on MR perfusion the leison is showing increased perfusion with rCBV ratio 3.6.

Case-2: Low Grade Glioma

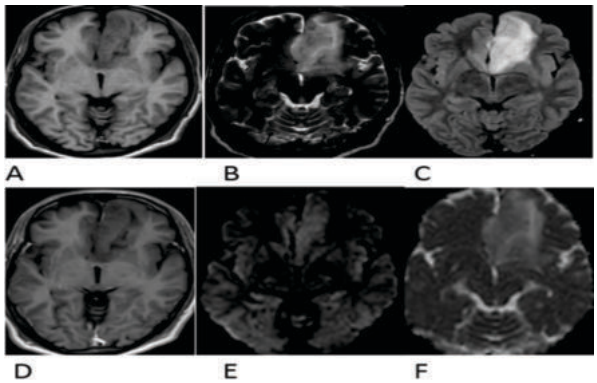

Figure – 4: A)axial T1 weighted MR images showing ill-defined intra axial mass lesion which is hypointense to grey matter noted involving left frontal lobe B) on T2 weighted images the lesion is hyperintense C)on FLAIR sequences the lesion is not getting suppressed and there is no surrounding odema D)on T1 weighted post contrast images there is no enhancement of leison E) and F) on DWI and ADC the lesion is showing T2 shine through with ADC values 1.46×10^{-3}

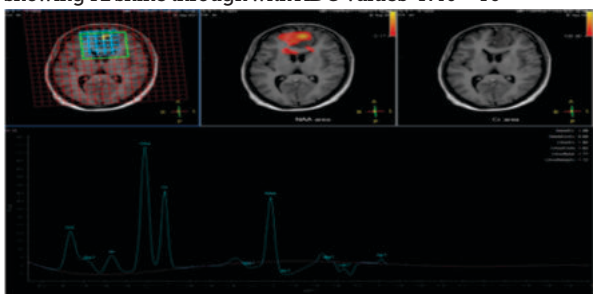

Figure – 5: On multivoxel MRS with long TE there is elevated choline with choline creatine ratio measuring 1.62 and choline NAA ratio measuring 1.77.

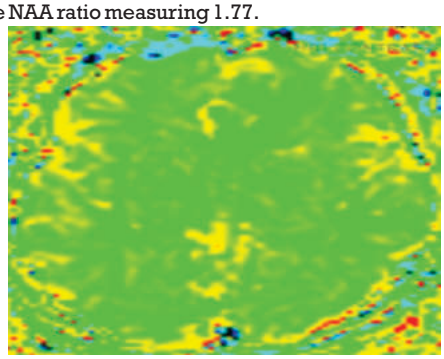

Figure – 6: On MR perfusion there is no increase in perfusion.

Case – 3; Medulloblastoma

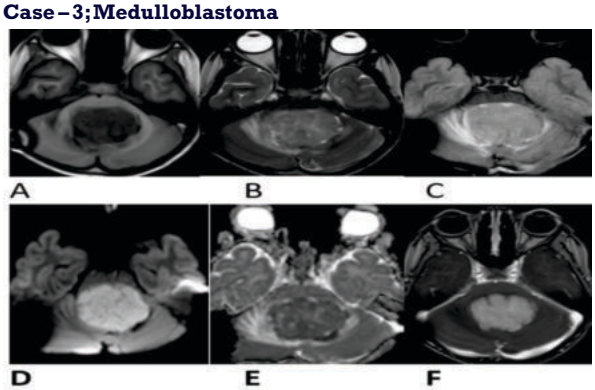

Figure – 7: A) Axial T1 weighted MR images showing well circumscribed hypointense intraaxial mass leison with perileisonal oedema noted arising from 4th ventricle B) leison is heterogeneously hyperintense on T2 weighted images C) on FLAIR images there is no suppression D) on post contrast T1 weighted images there is intense heterogenous post contrast enhancement E) and F) DWI and ADC maps showing diffusion restriction more than brain parenchyma with ADC values 0.6×10^{-3}

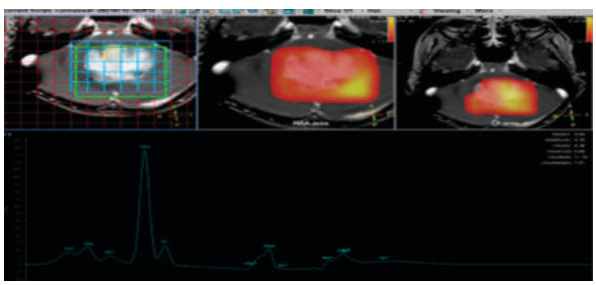

Figure – 8: On multivoxel MRS with long TE there is elevated

choline with choline creatine ratio measuring 6.38 and choline NAA ratio measuring 11.75.

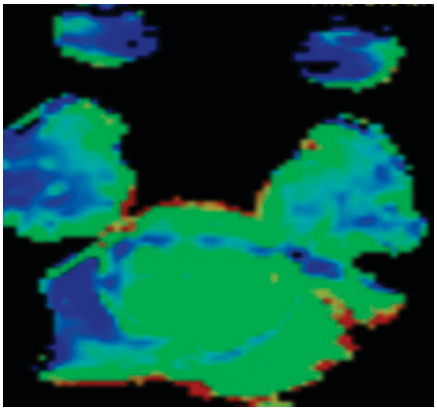

Figure – 9: On MR perfusion there is increased perfusion with rCBV ratio 1.68

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