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Role of diffusion weighted magnetic resonance imaging in evaluation and differentiation of inflammatory and neoplastic brain lesions

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ABSTRACT

Aim: Role of diffusion weighted magnetic resonance imaging in evaluation and differentiation of inflammatory and neoplastic brain lesions.

Material and methods: This was a prospective study conducted in the Department of Radiodiagnosis, Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh. 50 patients with acute focal neurological deficit and manifestations suggestive of brain lesions which could be neoplastic or inflammatory in nature were included in this study. Data was collected using pre-structured proforma which included details such as name, age, gender, presenting complaints and findings were noted for MRI and DWI imaging.

Results: In our study, sensitivity, specificity of DWI was found to be 47.6% and 50% respectively. The accuracy for DWI for correctly diagnosing benign or malignant lesions on the basis of cut-off value of ADC was found to be 40% with 95% confidence interval of 27.61% to 53.82%. However, diffusion weighted imaging (DWI) was not able to differentiate between inflammatory (benign) and malignant lesions conclusively.

Conclusion: It can be concluded from our study that diffusion weighted imaging (DWI) along with its apparent diffusion coefficient (ADC) values was not able to conclusively differentiate between benign (inflammatory) and malignant (neoplastic) lesions of the brain and further imaging studies such as MR spectroscopy, MR perfusion study etc. can be used to further evaluate lesions and differentiate between them.

Keywords: weighted magnetic resonance imaging, inflammatory, neoplastic , brain lesions

1. INTRODUCTION

The histologically diverse groups of nervous system neoplasms and neoplastic- like lesions can arise from primitive embryologic precursor cells, non-neoplastic normal cellular components, embryologically misplaced tissues, or neoplastic transformation of normal cellular components. These lesions can occur at any site in the brain or its linings.[1] Separating brain tumours from infections in the brain (Cystic or necrotic brain tumour abscesses, and

encephalitis resulting from diffuse glioma) is a crucial clinical issues and treatment techniques for them and their outlook is entirely different.[2]

Unfortunately, both radiologists and neurologists still have trouble diagnosing this distinction. It has been demonstrated that conventional MRI (cMRI) only has 61.4% sensitivity in discriminating between brain abscesses and cystic neoplasms as their primary differential diagnosis.[3] MRI is currently used extensively to determine the tumour extent for planning of surgery and radiotherapy, additionally for post-therapy tumour recurrence monitoring or development. MRI offers a preliminary diagnosis of any tumour. Success rates for cerebral mass lesions range from 30 to 90%. dependent on the type of tumour.[4,5] Yet, biopsy is still used.typically regarded as the benchmark for determining the type of cancer and its malignancy level.[6]

It is possible to evaluate the diffusion characteristics of water molecules in brain tissues that may be significantly affected by illnesses using diffusion-weighted imaging (DWI). True diffusion, according to Fick's law, is the net movement of molecules as a result of a concentration gradient. With MRI, it is impossible to distinguish between molecular motion brought on by pressure gradients, temperature gradients, or ionic interactions. Therefore, only the apparent diffusion coefficient (ADC) may be computed when monitoring molecular mobility with DWI.[7] It has been utilized to research both the healthy brain and a number of illnesses including ischemia, tumours, epilepsy, and white matter problems. [8,9,10]

In order to differentiate and grade brain cancers, computed ADC values from the core of the lesion provided additional information to MRI.[11] DWI can be used to distinguish brain lymphoma from high-grade glioma (astrocytoma) and butterfly glioblastoma multiforme in cases of brain malignancies.[12] Pediatric posterior fossa cancers, especially medulloblastoma, fourth ventricular ependymoma, and juvenile pilocytic astrocytoma, can be distinguished with DWI. When used with MR spectroscopy, DWI can eliminate the necessity for a biopsy.[13] Calculated ADC values can be utilised to recognise brain abscesses and help distinguish them from cystic brain tumours (such as cystic gliomas, brain metastases) and nontumor ring-enhancing brain lesions (such as tumefactive multiple sclerosis).[14] DWI is a great tool for separating epidermoid cysts from arachnoid cysts; cMRI can occasionally make this distinction impossible.[15] Only brain imaging investigations can accurately establish the diagnosis of cerebrovascular stroke and distinguish haemorrhage from ischemia, despite the fact that patient symptoms and clinical examinations may also point to this possibility. DWI has shown advantages in defining ischemic pathophysiology while proving useful in characterizing intracerebral haemorrhage.[16] For the distinction of a wide range of space-occupying brain lesions, DWI is a practical and successful imaging approach. DWI is a fantastic technique for telling epidermoid cysts from arachnoid cysts and brain abscesses from necrotic neoplasms apart.[16] This study is aimed at determining the role of diffusion weighted MR imaging of the brain in the detection, and characterization of brain lesions and to differentiate benign from malignant lesions by using their ADC values. Also, to find out diagnostic efficacy of diffusion weighted MR imaging in differentiating benign from malignant brain lesions by histopathological correlation as gold standard.

2. MATERIAL AND METHODS

This was a prospective study conducted in the Department of Radiodiagnosis, Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh. 50 patients with acute focal neurological deficit and manifestations suggestive of brain lesions which could be neoplastic or inflammatory in nature were included in this study. Data was collected using pre-

structured proforma which included details such as name, age, gender, presenting complaints and findings were noted for MRI and DWI imaging.

Inclusion Criteria:

- Patients of all ages and sex groups were included who presented to the hospital with acute focal neurological deficits and manifestations of brain lesions after taking written informed consent.
- Patients in which conventional MRI of brain was suggestive of neoplastic or inflammatory brain lesion.

Exclusion Criteria:

- Patient not willing to be part of the study.
- Patients who were claustrophobic.
- Patients with metallic implants or pacemakers.
- Patients with MR incompatible prosthetic heart valves.

3. METHODOLOGY

Patient's clinical history and examination findings were recorded prospectively. This study included 50 patients, presenting to the hospital with acute focal neurological deficit or with manifestations of brain lesions. All these patients were evaluated using conventional MRI and Diffusion weighted MRI, and the ADC values were calculated. Post processing of ADC values, standard mean ADC values were calculated and used to differentiate inflammatory brain lesions from neoplastic brain tumors. Knowledge of exact nature of the lesion helps neurosurgeons in determining the best management, thus reducing morbidity and mortality. The findings of the study were recorded and analyzed statistically, to reach to a differential diagnosis.

Data analysis: Data collected was entered into Microsoft Excel and was analysed using IBM Statistical Package for Social Sciences (SPSS) ver 25. Quantitative data was analyzed and mean, and standard deviation (or median and interquartile range in case of non-normal distribution) were calculated for same. Qualitative variables were expressed in the form of frequency and proportions. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy was calculated for ADC values for DWI for differentiating between benign and malignant lesions.

4. RESULTS

Table 1 Age and Gender distribution of Cases

Age (in years)	Male n (%)	Female n (%)	Total n (%)
01 – 30	09 (29.0)	08 (42.1)	17 (34)
31 – 45	14 (45.2)	07 (36.8)	21 (42)

≥ 46	08 (25.8)	04 (21.1)	12 (24)
Total	31 (100)	19 (100)	50 (100)

Table 1 shows distribution of cases according to age and gender. It can be seen from table that majority of males (45.8%) belonged to age group of 31 to 45 years. Females were distributed almost equally in the age group of 1 to 30 years and 31 to 45 years with former having eight (08) cases and latter having seven (07) cases respectively. Males in the age group of 1 to 30 years were nine (09) while in the age group of ≥ 46 years were eight (08) respectively.

Table 2 Distribution of cases based on diagnosis on histopathological examination

Histopathological diagnosis	**Frequency (n)**	**Percentage (%)**
Abscess	10	20
Neurocysticercosis (NCC)	08	16
Meningioma	06	12
Tuberculoma	05	10
Brain Metastasis	05	10
Diffuse Astrocytoma	03	06
Glioblastoma multiforme	03	06
Pilocytic Astrocytoma	03	06
Schwannoma	03	06
Oligodendroglioma	02	04
Epidermoid Cyst	02	04
Total	50	100

Table 2 shows the distribution of cases on the basis of diagnosis made on the basis of histopathological examination. Abscess was the most common diagnosis made on

histopathological examination accounting for 20% of total cases. Neurocysticercosis and meningioma accounted for 16% and 12% of total cases respectively. Tuberculoma and brain metastasis was histopathological diagnosis made in 10% of total cases each. Other diagnoses which were made on histopathological examination includes – diffuse astrocytoma (6%), glioblastoma multiforme (6%), pilocytic astrocytoma (6%), schwannoma (6%) oligodendroglioma (4%), and epidermoid cyst (4%).

Table 3 Distribution of cases based on histopathological diagnosis

Histopathological Diagnosis	**Frequency (n)**	**Percentage (%)**
Benign lesions including infections	42	84
Malignant	08	16
Total	50	100

Table 3 shows the distribution of cases based on the histopathological diagnosis. It can be seen from the table that benign lesions (including infections) constituted 84% out of total cases while malignant lesions constituted 16% of total cases.

Table 4 Presenting Complaints of Patients with Benign lesions (including infections)

Presenting Complaints	**Frequency (n)**	**Percentage (%)**
Headache	25	59.5
Fever	15	35.7
Seizures	06	14.3
Ataxia	03	7.1
Vertigo	02	4.8
UL Weakness	02	4.8

Focal seizure	01	2.4
Neck rigidity	01	2.4
Syncope	01	2.4

Table 4 shows the distribution of presenting complaints in patients with benign lesions. Headache was the most common presenting complaint among patients with benign lesion (including infections) and was present in 25 patients out of total patients with benign lesions. Fever was second most common presenting complaint which was seen in 15 patients. Seizures were present in six (06) patients while ataxia as presenting complaint was seen in two (03) patients. Other presenting complaints includes vertigo (02), upper limb weakness (02), focal seizures (01), neck rigidity (01), and syncope (01).

Table 5 Presenting Complaints of Patients with Malignant lesions

Presenting Complaints	Frequency (n)	Percentage (%)
Headache	05	62.5
LL Weakness	01	12.5
None	02	25

Table 5 shows the distribution of presenting complaints in patients with malignant lesions. Headache as seen in patients with benign lesion was also most common presenting complaint in patients with malignant lesions. Other presenting complaints in patients with malignant lesions included lower limb weakness (01). Two patients presented with no complaints.

Table 6 Comparison of Appearance of lesions on T1 Imaging with Histopathological diagnosis

Appearance on T1 Imaging	Histopathological Diagnosis	
	Benign lesions with infections n (%)	Malignant n (%)
Hyperintense	01 (2.4)	01 (12.5)

Hypointense	32 (76.2)	06 (75)
Isointense	09 (21.4)	01 (12.5)
Total	42 (100)	08 (100)

Table 6 shows the comparison between appearance of lesions on T1 imaging with the histopathological diagnosis. Among benign lesions, 76.2% of them were hypointense, 21.4% isointense and 2.4% hyperintense. When compared for malignant lesions, 75% of them were hypointense, 12.5% were isointense and 12.5% hyperintense.

Table 7 Comparison of Appearance of lesions on T2 Imaging with Histopathological diagnosis

Appearance on T2 Imaging	**Histopathological Diagnosis**	
	Benign lesions including infections n (%)	**Malignant n (%)**
Hyperintense	34 (81)	07 (87.5)
Hypointense	02 (4.7)	01 (12.5)
Isointense	06 (14.3)	00 (0)
Total	42 (100)	08 (100)

Table 7 shows the comparison of appearance of lesions on T2 imaging with histopathological diagnosis. On analyzing for benign lesions, it was found that majority of benign lesions (81%) appeared hyperintense while around 14.3% of them appeared isointense. Only 4.7% of benign lesions appeared hypointense on T2 imaging. Coming to appearance of malignant lesions on T2 imaging, majority of lesions appeared hyperintense (87.5%) while only 12.5% (01) appeared hypointense. None of malignant lesions appeared isointense over T2 imaging.

Table 8 Comparison of Appearance of lesions on DWI imaging along with their ADC Values and Histopathological diagnosis

Disease	**DWI**	**ADC Value (X 10^{-3} mm^2 s^{-1})**	**Histopathological Diagnosis**
Infections			

Brain Abscess	High signal seen in the centre of the lesion	0.4 – 0.6	Benign (Infection)
Neurocysticercosis (NCC)	Low signal seen	1.2 – 3.1	Benign (Infection)
Tuberculoma	High signal seen in the core of the lesion	1.1 – 1.3	Benign (Infection)
Malignant lesions (High grade Malignancy)			
Glioblastoma Multiforme	High signal seen in the periphery of lesion; Low signal seen in the centre of the lesion	0.8 – 1.1	Malignant
Brain Metastatic lesions	High signal seen	0.5 – 1.07	Malignant lesions
Benign and low-grade malignant tumors of brain (Intra-axial)			
Pilocytic Astrocytoma	Low signal seen	1.09 – 1.78	Benign
Diffuse Astrocytoma	Low signal seen	1.10 – 1.70	Benign
Oligodendroglioma	Low signal seen	1.00 – 1.70	Benign
Extra-axial Lesions			
Meningioma	Low signal seen	0.70 – 1.10	Benign
Schwannoma	Low signal seen	0.8 – 1.30	Benign
Epidermoid Cyst	Low signal seen	0.70 – 0.98	Benign

When infections were assessed with diffusion weighted imaging (DWI), brain abscess were seen to have high signal in the centre of lesion with ADC values ranging from 0.4 to 0.6 (X $10^{-3}mm^2s^{-1}$). In case of neurocysticercosis, range of ADC value varied from 1.2 to 3.1 (X $10^{-3}mm^2s^{-1}$) with low signal being seen. In tuberculoma, range of ADC value was found to be 1.1 to 1.3 (X $10^{-3}mm^2s^{-1}$). Assessment of malignant lesions (high grade malignancy) revealed that ADC value for glioblastoma multiforme ranged from 0.8 to 1.1 (X $10^{-3}mm^2s^{-1}$) with high signal in the periphery and low signal seen in the core while for metastatic lesions of brain,

the ADC value were found to be between 0.5 to 1.07 (X 10^{-3} mm^2s^{-1}) with high signal. Intra-axial tumors of brain such as pilocytic astrocytoma, diffuse astrocytoma and oligodendroglioma had ADC values in the range of 1.09 to 1.78, 1.10 to 1.70 and 1.00 to 1.70 (X $10^{-3}mm^2s^{-1}$) respectively while all of them had low signal appearance on DWI. Extra-axial lesions assessment with DWI MRI revealed that low signals were seen on DWI for all the cases of extra-axial lesions of brain such as meningioma, schwannoma and epidermoid cyst. The ADC value for meningioma was found to be 0.70 to 1.10 (X $10^{-3}mm^2s^{-1}$) while for schwannoma, the range varied between 0.8 to 1.30 (X $10^{-3}mm^2s^{-1}$). In cases with epidermoid cyst, the range of ADC value was found to be 0.70 to 0.98 (X $10^{-3}mm^2s^{-1}$).

Table 9 Comparison of appearance of lesions on Contrast Enhanced T1 imaging with histopathological diagnosis

Appearance on Contrast Enhanced T1 imaging	**Histopathological Diagnosis**	
	Benign lesions including infections n (%)	**Malignant n (%)**
Enhancement Seen	33 (78.6)	08 (100)
Enhancement Not Seen	09 (21.4)	00 (0)
Total	42 (100)	18 (100)

Table 9 shows the comparison between appearance of lesions on contrast enhanced T1 imaging with their histopathological diagnosis. Enhancement was seen in around four-fifth (82%) of patients while no enhancement was seen in one-fifth (18%) of patients. Enhancement appeared in 78.6% of patients with benign lesions while in 100% of patients with malignant lesions. No enhancement appeared in 21.4% of patients with benign lesions.

Table 10 Mean ADC values for Brain lesions in comparison to Histopathological diagnosis (Infections and malignancy)

Histopathological Diagnosis	**ADC (X $10^{-3}mm^2s^{-1}$)**	
	Mean	**Standard Deviation**
Infections	1.12	0.54
Malignant	0.90	0.58

Table 10 shows that mean ADC value for infections was found to be 1.12 (X 10^{-3} mm^2s^{-1}) with standard deviation of 0.54 (X $10^{-3}mm^2s^{-1}$) as compared to malignant lesions which had mean ADC value of 0.90 (X $10^{-3}mm^2s^{-1}$) with standard deviation of 0.58 (X $10^{-3}mm^2s^{-1}$). Since the values are nearly overlapping, DWI MRI was not able to clearly differentiate between benign (infections) and malignant lesions.

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Table 11 Mean ADC values for Brain lesions in comparison to Histopathological diagnosis (Benign (Intra-axial) and Malignancy)

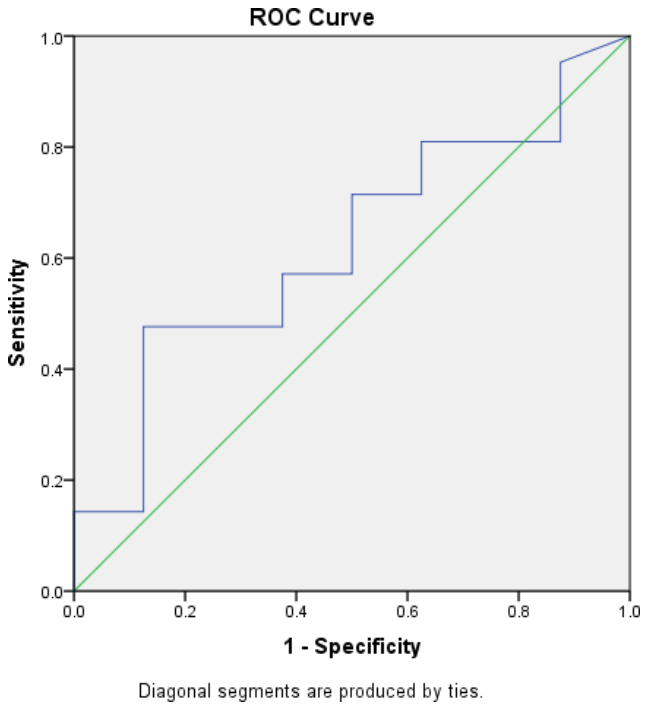
Histopathological Diagnosis	**ADC (X 10^{-3} mm^2s^{-1})**	
	Mean	**Standard Deviation**
Benign (Intra-axial)	1.35	0.57
Malignant	0.90	0.58

When mean ADC value of benign (intra-axial) lesions were compared with malignant lesions of brain, it was found that benign (intra-axial) lesions had mean ADC value of 1.35 (X $10^{-3}mm^2s^{-1}$) while it was 0.90 (X $10^{-3}mm^2s^{-1}$) for malignant lesions. (Table 11)

Table 12 Mean ADC values for Brain lesions in comparison to Histopathological diagnosis (Benign (Extra-axial) and Malignancy)

Histopathological Diagnosis	**ADC (X 10^{-3} mm^2s^{-1})**	
	Mean	**Standard Deviation**
Benign (Extra-axial)	0.96	0.56
Malignant	0.90	0.58

Table 12 shows that mean ADC value for benign (extra-axial) lesion was found to be 0.96 (X $10^{-3}mm^2s^{-1}$) with standard deviation of 0.56 (X $10^{-3}mm^2s^{-1}$) as compared to malignant lesions which had mean ADC value of 0.90 (X $10^{-3}mm^2s^{-1}$) with standard deviation of 0.58 (X $10^{-3}mm^2s^{-1}$). Since the values are nearly overlapping, DWI MRI was not able to clearly differentiate between benign (extra-axial) lesions and malignant lesions of brain.



Graph 1 ROC Curve for ADC (X $10^{-3}mm^2s^{-1}$)

Based on the ROC analysis for ADC (X $10^{-3}mm^2s^{-1}$) [graph 11 and Table 15}, area under ROC curve was found to be 0.622 and cut-off value for differentiating between benign and malignant lesions was 0.95 (x $10^{-3}mm^2s^{-1}$) at which it has sensitivity of 57% and specificity of 50% respectively. The distribution of ADC for differentiating between benign from malignant lesion was not statistically significant (p = 0.278).

Table 13 Distribution of Benign and Malignant lesions above and below calculated cut-off ADC value (0.95 x $10^{-3}mm^2s^{-1}$)

ADC Value (X 10-3mm2s-1)	**Histopathological Diagnosis**		**Total n (%)**
	Benign n (%)	**Malignant n (%)**	
< 0.95	17 (40.5)	04 (50)	21 (42)
≥ 0.95	25 (59.5)	04 (50)	29 (58)
Total	42 (100)	08 (100)	50 (100)

Table 13 shows that on the basis of cut-off value of ADC derived from ROC curve, 17 patients out of 42 patients with benign lesions had ADC value < 0.95 (X $10^{-3}mm^2s^{-1}$) while 21 patients had ADC value of ≥ 0.95 (X $10^{-3}mm^2s^{-1}$). For malignant lesions, ADC value of < 0.95 (X $10^{-3}mm^2s^{-1}$) was found in four (04) patients out of eight (08) patients and four (04) patients had ADC value of ≥ 0.95 (X $10^{-3}mm^2s^{-1}$).

Table 14 Sensitivity and Specificity of DWI

Statistic Parameter	Value	95% CI
Sensitivity	40.48%	27.04% to 55.51%
Specificity	37.5%	13.68% to 69.43%
Positive Predictive Value	77.27%	56.56% to 89.88%
Negative Predictive Value	10.71%	3.71% to 27.2%
Accuracy	40%	27.61% to 53.82%

Table 14 that in our study, sensitivity, specificity of DWI was found to be 47.6% and 50% respectively. The accuracy for DWI for correctly diagnosing benign or malignant lesions on the basis of cut-off value of ADC was found to be 40% with 95% confidence interval of 27.61% to 53.82%. However, diffusion weighted imaging (DWI) was not able to differentiate between inflammatory (benign) and malignant lesions conclusively. Therefore, further imaging studies such as MR spectroscopy, MR perfusion study etc. are required to further differentiate between benign and malignant lesions.

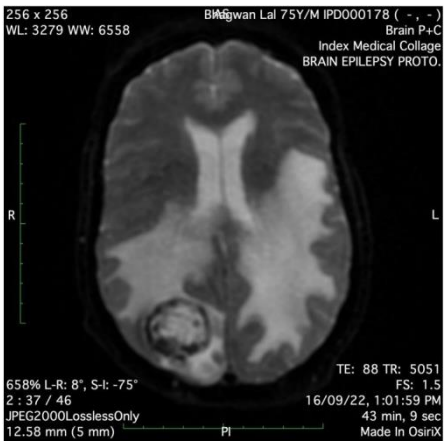


Figure 1- AXIAL DWI
Multiple focal lesions showing high signal on DWI are seen in bilateral cerebral hemispheres, largest seen in right occipital lobe with surrounding perilesional edema

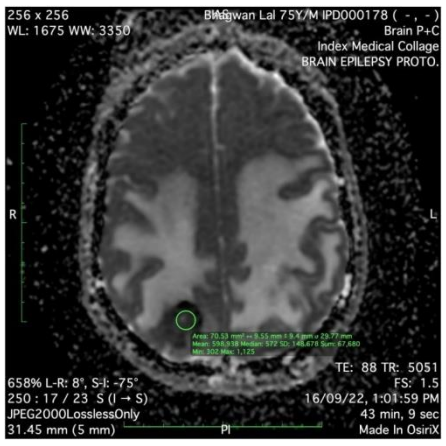


Figure 2- AXIAL ADC maps Lesion gives low ADC values measuring approx. 0.59 (ADC value for cerebral metastatic lesions ranges from 0.5 to 1.07).

5. DISCUSSION

In the present study a total of 50 patients, were a part of this study 62% patients were males and 38% patients were females. 42% patients belonged to the age group of 31 to 45 years,

followed by 34% patients in the age group of 1 to 30 years. Remaining 24% patients were in the age group of ≥ 46 years. In another study by Darweesh AM et al 36 patients participated in a trial. The participants were split into 17 men (47.2%) and 19 women (52.8%), with ages ranging from 17 to 76. Two individuals under the age of 20 (5.56%), 22 patients between the ages of 20 and 50 (61.11%), and 12 patients above the age of 50 were included in the study (33.33%).[4] 75 patients (40 men and 35 women) participated in a study conducted by Baghdady AI et al; their ages ranged from 2 to 72 years, with a mean of 35.5 years. [17]

In the present study most common diagnosis made on histopathological examination was abscess which constituted 20% out of total patients. Other diagnoses made on histopathological examination includes neurocysticercosis (16%), meningioma (12%), tuberculoma and brain metastasis (10% each), diffuse astrocytoma (6%), pilocytic astrocytoma (6%), glioblastoma multiforme (6%), schwannoma (6%), oligodendroglioma (4%) and epidermoid cyst (4%). In a similar study by Baghdady AI et al from the 75 patients who participated in the study, 46 (61.3%) had intracranial neoplastic lesions (group A), 17 (22.6%) had non-neoplastic tumor-like lesions (group B), seven (9.3%) had intracranial suppuration, and five (6.6%) had intracerebral haemorrhage. [17] In another study by Darweesh AM et al Seven cases of low grade glioma (19.44%), five cases of anaplastic astrocytoma (13.88%), eight cases of glioblastoma multiformis (22.25%), eleven cases of metastases (30.55%), and five cases of meningioma (13.88%) were the final histopathology and follow-up findings in 36 patients.[4] In another study by Aydin ZB et al, histopathology confirmed the existence of all eight malignant lesions, including four high-grade gliomas, two glioblastoma multiforme (GBM), a metastasis, and a big cell lymphoma, as well as six benign lesions, including two cavernomas and pilocytic astrocytomas, a central neurocytoma, and hemangioblastoma. The radiologic and clinical follow-up for the additional benign lesions (four meningiomas, five ischemia, an arachnoid cyst, radiation necrosis, abscess-hematoma-encephalomalacia, and cystic extra- axial lesion) was correlated.[18]

In the present study on T1 imaging in association with histopathological diagnosis, in benign lesions (including infections), 76.2% of them appeared hypointense, 21.4% isointense and 2.4% hyperintense. Similarly in case of malignant lesions, 75% of them appeared hypointense, 12.5% isointense and 12.5% hyperintense. Comparison of appearance of lesions on T2 imaging, we found that majority of benign lesions (including infections) appeared hyperintense (81%). Isointense and hypointense appearance on imaging was seen in 14.3% and 4.7% of patients with benign lesions (including infections).

Mean ADC value for infections was found to be 1.12 (X $10^{-3}mm^2s^{-1}$) with standard deviation of 0.54 (X $10^{-3}mm^2s^{-1}$) as compared to malignant lesions which had mean ADC value of 0.90 (X $10^{-3}mm^2s^{-1}$) with standard deviation of 0.58 (X $10^{-3}mm^2s^{-1}$). Since the values are nearly overlapping, DWI MRI was not able to clearly differentiate between benign (infections) and malignant lesions. In a similar study by Baghdady AI et al, ADC values between high-grade/low- grade gliomas, abscesses, and intracranial necrotic neoplasms including glioblastoma multiforme, lymphoma/high-grade astrocytoma, medulloblastoma/ ependymoma and pilocytic astrocytoma, and epidermoid/arachnoid cysts were statistically different, according to analysis of calculated ADC.[17]

In the present study area under ROC curve was found to be 0.622 and cut-off value for differentiating between benign and malignant lesions was 0.95 (x $10^{-3}mm^2s^{-1}$) at which it has sensitivity of 57% and specificity of 50% respectively. The distribution of ADC for differentiating between benign from malignant lesion was not statistically significant ($p = 0.278$). In another study by Aydin ZB et al, cut-off values were established using the ROC curve analysis: meaningful findings for ADC and NAA/Cr at long TE were not achieved.

Cut-off values for CBV and CBF were 406.50 and 29.50 respectively. At long TE, Cho/NAA and Cho/Cr ratios were 1.395 and 1.295, respectively. At short TE, NAA/Cr was 3.215, Cho/NAA ratios were 1.345, and Cho/Cr ratios were 1.49. For CBV, we had an 87% sensitivity and an 81% specificity, for CBF, a 75% sensitivity and a 73% specificity, and for all ratios at both TE acquisitions, a 62%-88% sensitivity and a 68%-86% specificity.
In our study, sensitivity, specificity of DWI was found to be 47.6% and 50% respectively. The accuracy for DWI for correctly diagnosing benign or malignant lesions on the basis of cut-off value of ADC was found to be 40% with 95% confidence interval of 27.61% to 53.82%. In another study by Aydin ZB et al CBV and choline/creatine (Cho/Cr) ratio at short echo time (TE) had the highest sensitivity (87%–88%) and Cho/N-acetyl aspartate (NAA) at short TE had the highest specificity (86%), respectively, for differentiating benign from malignant brain lesions. Compared to MRP's 91% sensitivity and 88% specificity and MRS's 77% sensitivity and 63% specificity, DWI's anticipated sensitivity and specificity were both 77% and 75%. Either the DWI and MRS, MRP and MRS, or DWI+MRS+MRP combination exhibited 100% sensitivity and 100% specificity.[18] However, diffusion weighted imaging (DWI) was not able to differentiate between inflammatory (benign) and malignant lesions conclusively. Therefore, further imaging studies such as MR spectroscopy, MR perfusion study etc. are required to further differentiate between benign and malignant lesions.

6. CONCLUSION

It can be concluded from our study that diffusion weighted imaging (DWI) along with its apparent diffusion coefficient (ADC) values was not able to conclusively differentiate between benign (inflammatory) and malignant (neoplastic) lesions of the brain and further imaging studies such as MR spectroscopy, MR perfusion study etc. can be used to further evaluate lesions and differentiate between them.

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