Original Research Article

The role of diffusion-weighted MRI in the evaluation of intra-cranial lesions

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Abstract

Background: Differentiating brain infections from brain tumors (abscesses from necrotic or cystic brain tumors and encephalitis from diffuse gliomas) is a fundamental clinical issue as the strategies for their management and their prognosis differ completely. Unfortunately, this differentiation remains a diagnostic challenge for both neurologists and radiologists. In present study we aimed to study role of diffusion-weighted MRI in the evaluation of intra-cranial lesions. **Material and Methods:** Present study was descriptive study conducted in patients referred to the for MRI brain with diffusion weighted imaging and were detected to have any of these Infarction, infective lesions, Tumors, Demyelination degenerative disorders **Results:** 100 patients underwent DW MRI during study period, most common age group was 51-60 years (36%), followed by 41-50 years (29%). Male patients (67%) were more than female (33%). Majority of patients had infarcts (48%) of which 25 were acute, 10 were chronic 3 were subacute. Other were tumors (32%), intra-axial tumours were 15, which includes GBM (5), Low grade glioma (2), Medulloblastomas (3), Lymphomas (3), anaplastic astrocytoma (1) hemangioblastoma (1). Extra-axial tumours were 17, which includes Meningiomas (10), arachnoid cysts (4) pituitary macroadenoma (3).24% had infective etiology tubercular granulomas (14%), NCC granulomas (3%), Abscesses (4%) Encephalitis (3%) were infective etiologies. 3% had demyelination all had multiple sclerosis. On DW MRI, most common finding was True diffusion restriction - hyperintensity on T2W images hypointensity on ADC images noted in 55 patients. **Conclusion:** Diffuse-weighted imaging should be used routinely as a valuable noninvasive tool besides conventional MRI, whenever available, to reach a definitive final diagnosis.

Keywords: diffusion-weighted MRI, infarct, ADC, True diffusion restriction

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INTRODUCTION

Intracranial cystic lesions may be noninvasively diagnosed using Diffusion weighted imaging (DWI), in vivo Proton magnetic resonance spectroscopy (PMRS), or a combination of DWI and PMRS. Diffusion-weighted imaging has an advantage over PMRS by virtue of its fast acquisition speed and relative ease of analysis.[1] Diffusion-weighted imaging (DWI) is an acceptable technique for studying the movements of water molecules of tissue. In diffusion-weighted imaging we may face with drastically different signals, depending on cell density and the type of tissue. Measuring the diffusion coefficient in brain tumors allows the classification of tumor types and provide a definitive diagnosis of some kinds of tumors.[2] Diffusion-weighted imaging helps in better delineation of brain abscess and tumor cysts by virtue of restricted and facilitated diffusion, respectively.[3] Differentiating brain infections from brain tumors (abscesses from necrotic or cystic brain tumors and encephalitis from diffuse gliomas) is a fundamental clinical issue as the strategies for their management and their prognosis differ completely. Unfortunately, this differentiation remains a diagnostic challenge for both neurologists and radiologists. In present

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study we aimed to study role of diffusion-weighted MRI in the evaluation of intra-cranial lesions.

MATERIAL AND METHODS

Present study was descriptive study conducted in Department of Radio Diagnosis, Dr. Ulhas Patil Medical College, Jalgaon. Study duration was of 1 & half years (from January 2019 to June 2020).

Inclusion criteria:

Patients referred to the for MRI brain with diffusion weighted imaging and were detected
to have any of these Infarction, infective lesions, Tumors, Demyelination degenerative disorders

Exclusion criteria:

Patients with intracranial hemorrhage
contraindication to MRI study such as patients with pacemakers, metallic implants and aneurysmal clips
Study was explained an informed consent was taken from patients/parents /guardians. 100 consecutive patients intracranial lesions suggested on computed tomography or conventional magnetic resonance (MR) imaging, were studied with DWI.

Cranial MR imaging was performed on a whole-body 1.5-T MR system (Signa; General Electric Medical Systems, Milwaukee, Wis) equipped with an actively shielded whole body magnetic field gradient set with a maximal strength of 33 mT/m using a quadrature birdcage head coil for radiofrequency transmission and reception. The routine imaging studies included FSE T2-WI (TR = 4900 milliseconds, TE = 85 milliseconds, n = 3) and SE T1-WI (TR = 650 milliseconds, TE = 14 milliseconds, n = 2). Diffusion-weighted EPI in the axial plane was performed using a single-shot EPI-SE pulse sequence with TR/TE = 10.5 s/110 milliseconds (minimum), field of view = 24 X 24 cm2, n = 2, slice thickness = 5 mm, interslice gap = 0.5 mm, and a matrix size of 128 X 256. Diffusion sensitizing gradients were sequentially applied along the 3 orthogonal directions with the diffusion-weighting factor (b) of b = 0 and 1000 seconds/mm2. Ramp sampling was used to reduce the echo spacing, thereby minimizing the geometric distortion.

Statistical analysis was done using descriptive statistics.

RESULTS

100 patients underwent DW MRI during study period, most common age group was 51-60 years (36%), followed by 41-50 years (29%). Male patients (67%) were more than female (33%).

Table 1: General characteristic

General characteristic	No. of patients = %
Age group	
0-10	6
11–20	9
21–30	5
31–40	4
41–50	29
51–60	36
61–70	11
Gender	
Male	67
Female	33

Majority of patients had infarcts (48%) of which 25 were acute, 10 were chronic 3 were subacute. Other were tumors (32%), intra-axial tumours were 15, which includes GBM (5), Low grade glioma (2), Medulloblastomas (3), Lymphomas (3), anaplastic astrocytoma (1) hemangioblastoma (1). Extra-axial tumours were 17, which includes Meningiomas (10), arachnoid cysts (4) pituitary macroadenoma (3).24% had infective etiology tubercular granulomas (14%), NCC granulomas (3%), Abscesses (4%) Encephalitis (3%) were infective etiologies. 3% had demyelination all had multiple sclerosis.

Table 2: Etiology DW-MRI picture

	Etiology	true diffusion restriction -	no signal change on T2W images	hypointensity on DWI and T2 FLAIR	T2 shine through	T2 washout	total
1	Infarcts						48
A	acute infarcts,.	22	3				25
B	chronic infarcts -			5	5		10
C	subacute infarcts	2			1		3
2	Tumours						32
A	Intra-axial						15
i	GBM	4			1		5
ii	Low grade glioma				1	1	2

iii	Medulloblastomas	3					3
iv	Lymphomas	3					3
v	anaplastic astrocytoma				1		1
vi	hemangioblastoma					1	1
B	Extra-axial						17
i	Meningiomas	6		3	1		10
ii	arachnoid cysts		4				4
iii	pituitary macroadenoma	3					3
3	Infective conditions						24
A	tubercular granulomas	5			2	7	14
B	NCC granulomas					3	3
C	Abscesses	4					4
D	Encephalitis	1			1	1	3
4	Demyelination		2			1	3

On DW MRI, most common finding was True diffusion restriction - hyperintensity on T2W images hypointensity on ADC images noted in 55 patients.

Table 3: Primary finding on DW MRI

Primary finding on DW MRI	No. of patients
True diffusion restriction - hyperintensity on T2W images hypointensity on ADC images	55
No signal change on T2W images	9
Hypointensity on DWI and T2 FLAIR images with hyperintensity on ADC images	8
T2 shine through	13
T2 washout	15

DISCUSSION

DWI explores the molecular characteristic of diffusivity of particles within a region. It is based on the application of two gradients at a set interval of time, in such a way that only a molecule that experiences both gradients at the same position produces signal. Therefore regions of the brain that show "restricted diffusion" are hyperintense on DWI. This restricted diffusion appears as hyperintense area on DWI and needs to be corroborated with computer generated apparent diffusion coefficient (ADC) maps which show corresponding hypointense area. This corroboration rules out T2-shine through effect.[4] Diffusion-weighted imaging (DWI) has a well-defined role in differentiating between important intracranial lesions, namely, brain abscess, arachnoid cyst, cystic/necrotic tumor, and epidermoid tumor. Quantitative analysis allows one to clearly delineate vascular, inflammatory, metabolic, infectious, and nonvascular disorders.[5,6] In a similar study, Pradeep Kumar[7] had infarcts comprised the majority of lesions at 56 cases (50.9% of the total cases studied). Of these acute infarcts constituted 34 cases (60.7%); 19 (33.9%) were chronic infarcts and 3 (5.3%) were subacute infarcts. All cases of acute infarcts and 66.7% of subacute infarcts showed diffusion restriction. Among intra axial tumors true restriction was noted in 7 cases. 75% of glioblastoma multiforme showed true diffusion restriction. 100% of medulloblastomas and 100% of lymphomas showed diffusion restriction. Similar findings were noted in present study. Kamini Gupta[8] studied 67 patients who underwent Conventional MR sequences along with DW and MRS were done after taking localisers in all the three planes. Most common cerebral neoplasms were metastases followed by Glioblastoma Multiforme (GBM). Male: female ratio was 1.5:1. Headache was the most common presenting complaint. Apparent Diffusion Coefficient (ADC) values were similar in GBM and metastases but were higher in low grade gliomas. On MRS, choline levels in the areas of diffusion restriction were higher and NAA levels were lower in cases of GBM, metastases and lymphoma as compared to low grade gliomas. DW imaging with ADC values and MRS in combination with conventional MRI are very useful in detection of brain tumours and distinguishing low grade from high grade tumours. DWI plays an important role in the differentiation of these abscesses from necrotic neoplasms, which usually demonstrate high ADC values within the core. Luthra G *et al.*. observed diffusion restriction with low ADC value in both tubercular and pyogenic abscesses.[9] Bacterial as well as tubercular abscesses show central diffusion restriction due to highly viscous necrotic tissue within.[9] Reddy JS[10] noted a high sensitivity and specificity of DWI for the diagnosis of brain abscess vs nonabscess cystic mass lesions. High specificity and sensitivity of DWI in the present and previously reported studies indicate reproducibility of the DWI over a number of studies High specificity and sensitivity of DWI for differentiation of abscess from nonabscess lesions is due to the difference in the contents of the cavities of both the etiology revealed by differences in macromolecular concentration, cell density, and viscosity of the fluid.[11,12]

CONCLUSION

Diffusion weighted MRI has been proven to be of excellent use in the characterization of infarcts and in the detection of acute infarcts. Diffuse-weighted imaging should be used routinely as a valuable noninvasive tool besides conventional MRI, whenever available, to reach a definitive final diagnosis.

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