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Role of Magnetic Resonance Imaging Diffusion Weighted and Apparent Diffusion Coeffecient Evaluation in Brain Infarction

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ABSTRACT: *Brain infarction leads to high mortality and morbidity.The quick and precise radiological diagnosis is an important factor when analysing the timing and assessing the stages of brain infarction. Diffusion Weighted Imaging (DWI) has emerged as an important tool in early diagnosis of brain infarction in recent years.The present study is to analyse changes in the values of apparent diffusion coefficient (ADC) and relative ADC (rADC) at various time points after brain infarction as well as multiple brain regions to learn whether the ADC evaluation could be useful in the clinical diagnosis of severity and management of brain infarction.*

Key words: *DWI, rADC, ADC*

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I. Introduction :

One of India's leading causes of death and disability is cerebral infarction. Clinical diagnosis of cerebral infarction can be challenging and therefore the function of MRI is critical. One of the treatment options for acute ischemic stroke is the intravenous tissue plasminogen activator (tPA) given within three hours after the onset of stroke. Less time consuming is a generic MRI diffusion with ADC correlation, which is a highly sensitive imaging test to detect early infarction. Therefore, DWI and ADC correlation with magnetic resonance imaging are important aid in improved patient care and assessing the prognosis.

Previous MRI studies of cerebral infarction are focused on urban population. The research covers the rural population of srikakualm, part of Andhra pradesh state with the goal of determining the MRI diffusion imaging with ADC correlation of patients with cerebral infarction and help in early effective treatment plans and assessing the disease prognosis.

This research can determine the correlation of diffusion weighted MRI and ADC levels in cerebral infarction localization and describe the infarction stages at the time of presentation. This research will help improve cerebral ischemic stroke patient's treatment and provide better insight into the different stages of the disease.

AIM AND OBJECTIVES:

1.Studying that the Apparent Diffusion Coefficient (ADC) in cerebral infarction varies with time and space.
2. Provide evidence to determine the stage of the infarction.

II. Materials And Methods :

Study Design: A cross sectional study conducted on 75 patients referred for MRI brain evaluationDepartment of Radiodiagnosis, Great eastern medical school & hospital, Srikakulam.

INCLUSION CRITERIA:
All patients undergoing MRI brain evaluation during the period of study would be included.
EXCLUSION CRITERIA:
Post trauma, infective or neoplastic etiology.
Un-cooperative, severe claustrophobic patients.
Parameters:
Approximately 75 patients with cerebral infarction (acute, subacute, and chronic) was imaged with both conventional MRI and diffusion weighted imaging. The average ADC values, the relative ADC (rADC) values, and the ADC values or rADC values from the center to the periphery of the lesion will be calculated. All the patients included in the study had arterial infarct and diffusion weighted image was done with b value of 1000.
Method(s)/technique(s)/instrument(s) used: Imaging was done with 1.5 Tesla unit(GE)
Routine MRI was first used to describe T1W1 and T2W1: T1W1 used 350 ms/8 ms TR / TE spin echo sequences (SE); T2W1 used turbo spin echo sequence with TR / TE = 2500 ms/9 ms; the acquisition matrix is 256× 256. Single-time enabled SE-EPI sequences with the following parameters were used for DWI scanning: TR3300 ms, TE94 ms; acquisition matrix 128 / 128, Field of View -230 mm / 230 mm, with diffusion gradient in x, y and z dimensions, and acquisition of images at b value 1000; ADC images were automatically constructed. All scanning sections were 7 mm thick with 2 mm distance to each other.
Procedure: Four regions of interest (ROI) were selected on ADC figures according to T1W1 and T2W1, from the center, near central, edge and near edge of the infarcted area with 5 pixels for each ROI to determine the average ADC value of the entire infarcted region. The rADC value is given by: rADC = (average ADC value in infarcted side/average ADC value in heath side) × 100%. Sulcus and ventricle were avoided in ADC value measurement.

III. Results :

Statistical analysis: The data was expressed in number, percentage, mean and standard deviation. Statistical Package for Social Sciences (SPSS 16.0) version used for analysis. Unpaired t test applied to find the statistical significant. p value less than 0.05 considered statistically significant at 95% confidence interval.

Table1:ComparisonofMRIstagingandrelativeADCvalueofthecenterof infarct

		Centerof theinfarct			Total	Chi-squarevalue
		0.1-0.8	0.8-1.2	>1.2		
RI stagingof infarct	Acute	47	0	1	48	0.000
	Subacute	11	1	0	12	
	Chronic	0	0	15	15	
Total		58	1	16	75	

(p<0.05isconsideredasstatisticallysignificant)

Table-2:ComparisonofMRIstagingandrelativeADCvalueoftheperiphery of infarct

		Peripheryof theinfarct			Total	squarevalue
		0.1-0.8	0.8-1.2	>1.2		
RI stagingofinfarct	Acute	43	1	1	45	0.000
	Subacute	7	4	1	12	
	Chronic	0	3	12	15	
Total		50	8	14	72	

(p<0.05isconsideredasstatisticallysignificant)

Table -3ComparisonoftimesinceinfarctionandrelativeADCvalueoftheperipheryofinfarct

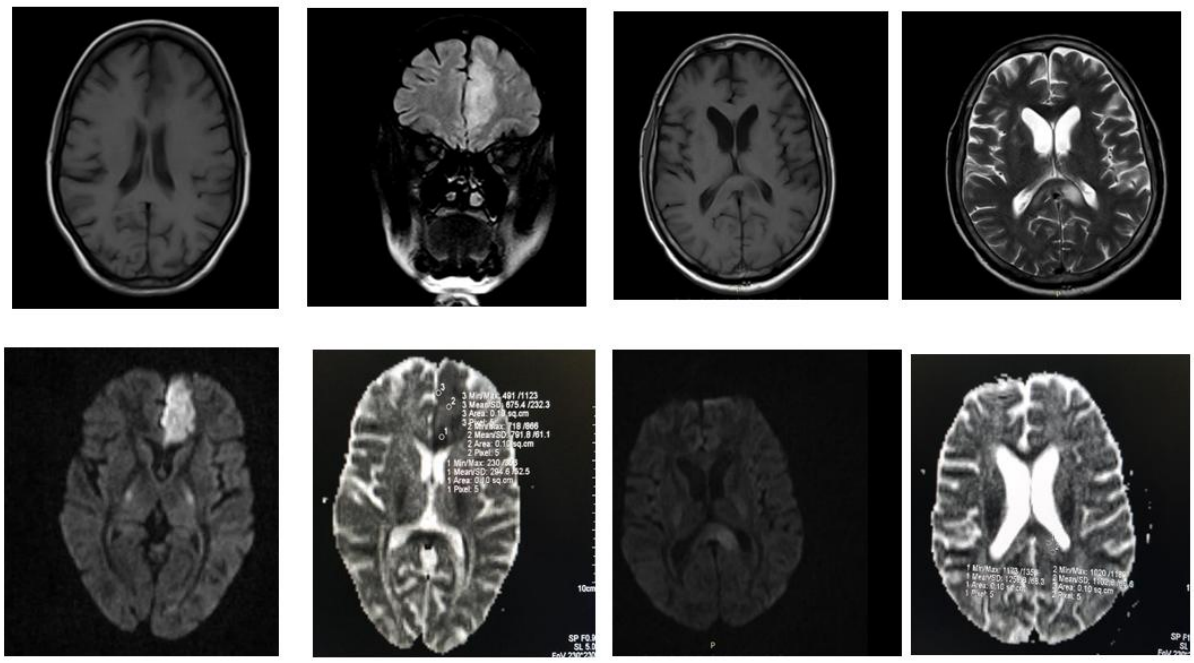
		Peripheryof theinfarct			Total	squarevalue
		0.1-0.8	0.8-1.2	>1.2		
Time sinceinfarction	0-6hrs	2	0	0	2	
	6-72hrs	37	1	1	39	

	>72hrs	11	7	13	31	0.000
Total		50	8	14	72	

Table-4:ComparisonoftimesinceinfarctionandrelativeADCvalueofthe centerofinfarct

		Centerof theinfarct			Total	squarevalue
		0.1-0.8	0.8-1.2	>1.2		
Timesinceinfarction	0-6hrs	4	0	0	4	0.000
	6-72hrs	39	0	1	40	
	>72hrs	15	1	15	31	
Total		58	1	16	75	

ACUTEINFARCT **SUBACUTE INFARCT**



IV. DISCUSSION

In acute cases the diffusionof water molecules are restricted and it can be explained by the cellular edema andthis is reflected as bright signal in trace images and low ADC values in the postprocessingdiffusionweightedimaging.Insomeofthecases(4patients)theconventional imaging sequences (T1WI and T2WI) showed no changes in signalbecause of the relative balance in the total amount of water in the acute phase afterbrain infarction, but diffusion weighted imaging with ADC mapping demonstratedacuteinfarct.

This shows that the accuracy of diagnosing brain infarction using DWI andADC correlation is very high as demonstrated in our study in these 4 patients. Inorder to normalise the ADC values, in our study we measured the ADC values of theunaffected contralateral side to equate the values which is the relative ADC (rADC)whichcan beused in comparativestudies further.

ComparisonofMRIstagingandrelativeADCvalueswiththecenterandperipheryshowed the following results:

AtthecenteroftheinfarcttherADCvalueswereattherangeof0.1-0.8%in48patientsintheacutestage,11patientsinsubacutestageandnilpatientin chronic stage, indicating low rADC values in the centre of the infarct during acutestagesof infarct.

At the periphery of the infarct the rADC values were at the range of > 1.21%in 12 patients in chronic stage, whereas 1 patient in acute stage and 1 patient insubacute stage, indicating high rADC values in the periphery of the infarct duringchronicstages ofinfarct.

Comparison of time since infarction and relative ADC value of the center andtheperiphery ofthe infarct showed thefollowing:

At the centre of the infarct the rADC values were at the range of 0.1-0.8 %in4patientsin0-6hourssinceinfarction,39patientsin6-72hoursand15patientsin more than 72 hours since infarction, indicating low rADC values inthe centre ofthe infarct in patients presenting within 6- 72 hours after infarction. At the peripheryof the infarct the rADC values were at the range of > 1.21% in 13 patients in >72hours after the onset of symptom, whereas 1 patient in 6-72 hours and nil patient in0-6 hours, indicating high rADC values in the periphery of the infarct when the timeofinfarction is morethan72 hours at the timeof evaluation.

In present study the, ADC and the rADC values increased from the centre to theperipheryinmajorityofcases,correlatingwellwiththeclinicaldiagnosisofacu infarction and decreased from the centre to the periphery in chronic stages of infarctas demonstrated in some of our patients. There can be falsenormal phenomena inthe late subacute phase which indicates that reperfusion at this stage may not behelpful. This spatial distribution of the ADC values would be helpful to predict therecovery of infarcted tissue into a normal tissue or will it undergo degeneration aftertherapeuticintervention in thepatients.

V. Conclusion :

In our study the average ADC values and relative ADC values of acuteinfarction lesion was significantly lower than the subacute and chronic infarctionlesions. The ADC values in acute lesions had gradient signs that these lesions
hadincreasedADCvaluesfromthecentertoperiphery.TheADCvaluesinchroniclesionshadadversegradientsignswithdecreasedvaluesfromthecentertotheperiphery.This
suggeststhattheaccuracyofusingADCvaluesindiagnosisofbraininfarctionisveryhighinourstudy.

Therefore the ADC and relative ADC values of infarction lesion follow theevolution rules with time and space, which can be helpful to provide evidence forclinicalstagingandtoguidethetreatmentorjudgingtheprognosisininfarction.

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