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Original Research Paper

Radio-Diagnosis

ROLE OF DIFFUSION-WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MAGNETIC RESONANCE IMAGING FOR THE EVALUATION OF BRAIN INFARCTION

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ABSTRACT

Cerebral infarction is the leading cause of mortality and morbidity worldwide. The time of diagnosis of cerebral infarction plays a crucial role in the treatment and prognosis of the patient. The intravenous tissue plasminogen activator (tPA) given within three hours after the onset of stroke or early revascularization by percutaneous interventions are the early treatment of choices and has good prognostic value. MRI plays a vital role in the diagnosis of cerebral infarction. A less time-consuming MRI sequence like diffusion with ADC correlation is a highly sensitive imaging technique for early detection. During the early stages of brain infarction which is less than 6 hours after the onset of symptoms, MRI sequences such as T1 and T2 showed no changes. Therefore, DWI and ADC correlation with magnetic resonance imaging plays a vital role improved in the early diagnosis and assessing the prognosis of the patient. The present study is a hospital-based prospective, cross-sectional study done in 75 patients, who underwent MRI brain evaluation in the department of radiodiagnosis, at Kona Seema institute of medical sciences, for a period of 12 months. Patients who fulfilled the inclusion and exclusion criteria were selected. ADC and r ADC values are calculated in all patients. The aim of the study is to show that the Apparent Diffusion Coefficient (ADC), diffusion-weighted imaging (DWI) varies with time and space in cerebral infarction and to determine the stage of the infarction using r ADC values, ADC and DWI. In our present study, we proved that the average ADC values and the rADC values change with time and space which helps us to accurately stage the brain infarction in terms of acute, subacute, and chronic cerebral infarction. Combined analysis of DWI with ADC correlation and routine MRI sequences are used for the accurate evaluation of the brain infarction and to assess the progress and treatment plans after brain infarction.

KEYWORDS : MRI, DWI, ADC, r ADC, T1, T2, brain infract, acute, sub-acute, and chronic stages of infarct, duration of infarct.

INTRODUCTION

Brain infarction is the most common neurological condition which has high mortality and morbidity [1,5]. When analyzing the timing and assessing the stages of brain infarction the quick and precise radiological diagnosis is an important factor. Diffusion Weighted plays an important role in the early diagnosis of brain infarction [2]. The present study is to analyze whether changes in the values of apparent diffusion coefficient (ADC) and relative ADC (rADC), DWI at various time points and brain regions after brain infarction could be useful in the clinical diagnosis of severity and management of brain infarction.

AIMS AND OBJECTIVES

To study, the Apparent Diffusion Coefficient (ADC), diffusion-weighted imaging (DWI) varies with time and space in cerebral infarction and to determine the stage of the infarction using r ADC values, ADC and DWI.

MATERIALS AND METHODS

This is a hospital-based prospective, cross-sectional study done in 75 patients, who underwent MRI brain evaluation in the department of radiodiagnosis, at Kona Seema institute of medical sciences, during the period of 12 months. Patients who fulfilled the inclusion and exclusion criteria were selected. Consent is taken from all the patients in the study group. Four regions of interest (ROI) were selected on ADC maps according to T1W1 and T2W images, from the center, near the central, edge, and near the 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 the infarcted side/average ADC value in the health side) × 100%. Sulcus and ventricle were avoided in ADC value measurement.

Inclusion Criteria

1) Co-operative patients.
2) Hemodynamically stable patients.
3) Patients with symptoms of stroke (like weakness, slurring of speech, deviation of the mouth, loss of vision etc).
4) Patients willing to participate.

Exclusion Criteria

1) Non-Co-operative patients.
2) Hemodynamically unstable patients.
3) Patients not willing to participate.

Imaging

ADC DWI

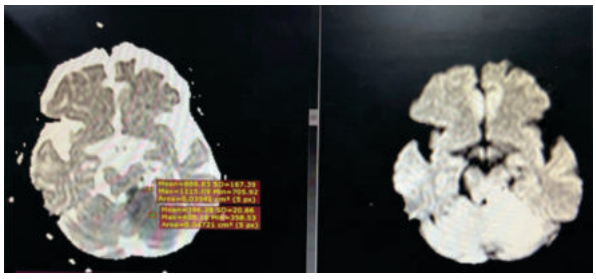


Fig 1: MRI Brain Showing Acute Infarct Involving Left Cerebral Hemisphere And Left Middle Cerebellar Peduncle In Dwi,adc Imaging With Adc Values In The Center And Periphery-

ADC DWI

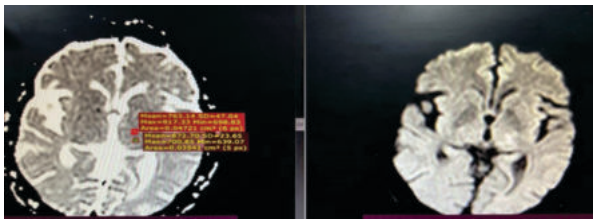


Fig 2: MRI Brain Showing Sub Acute Infarct In The Left

Thalamus In Dwi ,adc Imaging With Adc Values In The Center And Periphery-

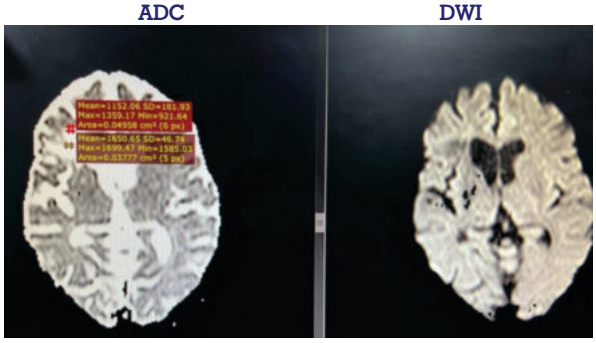


Fig 3: MRI Brain Showing Chronic Infarct In The Right Frontal Lobe In The Periventricular Region In Dwi ,adc Imaging With Adc Values In The Center And Periphery -

RESULTS

In the present study, we evaluated 75 patients who underwent MRI brain evaluation in our department. Based on the time since infarction the distribution of patients is as follows 6.66%(5 patients) in 0-6 hours, 58.66%(44 patients) in 6-72 hours, and 34.66% (26 patients) in > 72 hours after the onset of symptoms. Based on MRI staging of infarct the distribution of patients is as follows 66.66% (50 patients) in the acute stage, 12% (9 patients) in the subacute stage, and 21.33% (16 patients) in the chronic stage of the infarct. Comparison of time since infarction and relative ADC value of the center and the periphery of the infarct showed low rADC values in the center of the infarct in patients presenting within 6- 72 hours after infarction and high rADC values in the periphery of the infarct when the time of infarction is more than 72 hours at the time of evaluation. Comparison of MRI staging and relative ADC values with the center and periphery showed low rADC values in the center of the infarct during acute stages of infarct and high rADC values in the periphery of the infarct during chronic stages of the infarct.

Table 1: The Below Table Shows The Association Between Distribution Of Patients In Various Time Frames Since The Time Of Infarction.

INFARCTION	NUMBER	PERCENTAGE(%)
0-6 HRS	5	6.66%
6-48 HRS	44	58.66%
MORE THAN 72HRS	26	34.66%

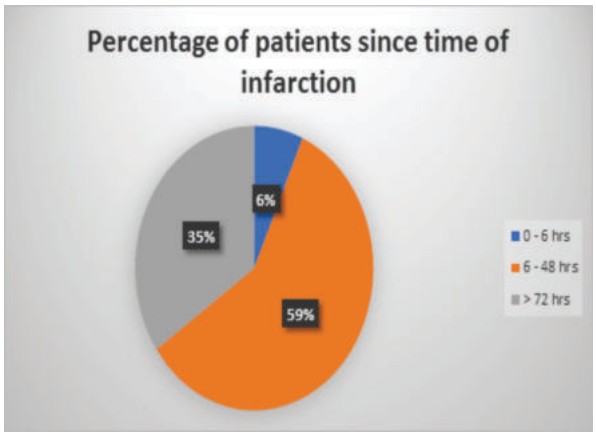
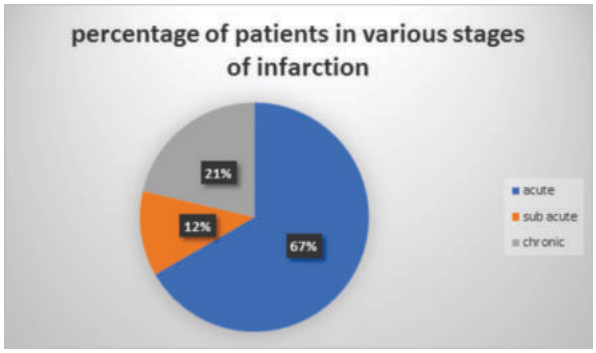


Table 2: The Below Table Shows The Association Between The Distribution Of Patients In Various Stages Of Infarction.

MRI STAGING OF INFARCT	NUMBER	PERCENTAGE (%)
ACUTE	50	66.66%
SUB-ACUTE	9	12%
CHRONIC	16	21.33%



DISCUSSION

In our present study, we proved that the average ADC values and the rADC values change with time and space[3]The speed of diffusion of the water molecules is reflected by the ADC values with high ADC values if the diffusion is fast and low ADC values if the diffusion is slow as it is seen in the region of the infarct. In acute infarction, ADC values are low due to the restricted diffusion of water molecules by cellular injury and edema. In the sub-acute phase, ADC values slightly increased due to enhanced blood-brain barrier permeability which causes free diffusion of water molecules in extracellular space and also cell membrane rupture leading to the release of intracellular water molecules into the extracellular space. In the chronic phase, ADC values are higher and sometimes higher than healthy tissue due to the liquefaction of brain tissues and are slowly replaced by the CSF, which has free movement of water molecules and this is reflected by the steady increase in ADC values and relative ADC values from acute to chronic stages of infarct[4]. We also proved in our study that there is a spatial distribution of ADC and rADC values within the infarcted regions of the brain. In our study, ADC and the rADC values increased from the center to the periphery in the majority of cases, correlating well with the clinical diagnosis of acute infarction.

CONCLUSION

In our study, the average ADC values and relative ADC values of acute infarction were significantly lower than the subacute and chronic infarction lesions. It was demonstrated that the ADC and the relative ADC values increase from low in acute stages to high in subacute and chronic stages of the infarct. Still, we recommend that the combined analysis of routine MRI sequences, Diffusion-weighted imaging with ADC correlation would be important and accurate in the evaluation of the brain infarction and to assess the progression and treatment plans after brain infarction.

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