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MRI as a Diagnostic Tool for the Determination of Acute Ischaemic Stroke: A Study in a Tertiary Care Hospital

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Abstract

Background: Stroke is a prevalent and potentially fatal medical condition that affects individuals worldwide. Ischemic strokes, caused by arterial blockages, are the most common type, accounting for about 80% of all cases. Hemorrhagic strokes, on the other hand, are less frequent but can have more severe consequences. Accurate and timely diagnosis of stroke is critical for effective treatment and optimal patient outcomes. In this context, diffusion-weighted imaging (DWI) has emerged as a valuable tool for identifying and monitoring ischemic stroke. This article provides an overview of the role of DWI in stroke assessment and management, with a focus on early detection and intervention. The aim of this study is to investigate the reliability of diffusion-weighted MRI (DWI) as an imaging modality in the evaluation of acute ischemic stroke. **Material & Methods:** This prospective cross-sectional study was conducted at the Department of Radiology and Imaging at the Combined Military Hospital (CMH) in Dhaka, Bangladesh, between June 2020 and June 2021. The study aimed to examine 120 patients clinically diagnosed with acute ischemic stroke. Prior to the study, verbal consent was obtained from all patients. The Study subjects were identified in the emergency and casualty department and had undergone an MRI of the brain in the Department of Radiology and Imaging at CMH, Dhaka. . Data were collected on pre-designed forms, and the relevant information was compiled on a master chart for statistical analysis using SPSS software. Descriptive analysis and frequency of results were presented in the form of tables, pie charts, and bar graphs. The ethical clearance of this study was obtained from the Institutional Ethics Committee of CMH, Dhaka, Bangladesh. **Results:** The study included 64 males and 56 females with a mean age of 65.2 ± 7.83 years. The majority of patients had an acute ischemic lesion (88.30%) in the MCA (50.0%) with small-sized lesions (41.7%) and low ADC values (90.0%). The most common clinical presentation was hemiplegia (100%), and diffusion-weighted MRI had a high diagnostic accuracy in detecting acute ischaemic lesions (96.3%). Overall, these findings highlight the importance of MRI in the evaluation of stroke patients and can guide clinical decision-making. **Conclusion:** The present study concluded that DWI in conjunction with ADC map MR imaging is a gold standard diagnostic modality in the evaluation and management of acute ischaemic stroke.

Keywords:- Ischaemic-stroke, MRI, DWI Diffusion, Weighted, Reliable, Modality, evaluation.

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INTRODUCTION

Stroke is the second leading cause of death globally and the second leading cause of lost disability-adjusted life years in high-income nations, after ischemic heart disease. The prevalence of stroke varies by country and exponentially rises with age. Around 80% of strokes in Western countries are brought on by focal cerebral ischemia brought on by artery blockage, with hemorrhages accounting for the other 20%.[1] According to the definition proposed by the World Health Organization in 1970, "stroke is rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer, or leading to death, with no apparent cause other than of vascular origin.[2] Hemorrhagic and ischemic strokes are the two main types. Hemorrhagic strokes are much less frequent than ischemic strokes. Aorto-cardiac embolism, small-vessel blockage, and big vessel atherosclerosis can all cause ischemic strokes. The location, size, and severity of the stroke itself all affect how it will manifest clinically. A head CT or MRI is the most precise diagnostic test available. Early head CT is preferred because it will rule out hemorrhage. While MRI of the brain is helpful for infarction, particularly in the brain stem and cerebellum, CT of the head is favorable for hemorrhage.[3] A type of MR imaging called diffusion-weighted imaging (DWI) gauges the random Brownian motion of water molecules within a tissue voxel. In general, tissues with a high cell density and cellular edema have lower diffusion coefficients. Diffusion is thus particularly helpful in tumor characterization and cerebral ischemia. A technique for evaluating therapy response and tracking illness development, apparent diffusion coefficient (ADC) maps allow for the quantification of DWI signal contrast.[4] The clinical outcomes are predicted by the DWI infarct pattern with ADC mapping and are connected with the pathogenic factors underlying stroke. Hence, clinicians caring for patients with acute ischemic stroke must have a stronger grasp of DWI.[5] In a number of situations, where traditional MR sequences like T2 weighted imaging (T2WI) fail to detect substantial changes in the pictures, DWI is especially helpful. For instance, signal intensity on T2WI does not alter until at least 8 h after the commencement of the stroke and then appears hyper-intense in the stroke region under pathological situations such stroke emerging from ischemia.[6] However, DWI and ADC maps can reveal the alterations in the brain as soon as 30 minutes or even sooner after the commencement of a stroke. On DWI and ADC maps, the signal intensity shifts with time, going from hyper-intense to hypo-intense on DW images and from hypo-intense to hyper-intense on ADC maps, from acute to chronic stage.[7,8] The DWI sequence allows for the early detection of pathological alterations in tissue even when other imaging techniques might not. Consequently, the purpose of this investigation was to determine how diffusion-weighted MR imaging may be used to assess an acute ischemic stroke that was very early in onset and to begin the appropriate treatment as soon as possible to limit future damage and maximize the clinical outcome.

MATERIAL AND METHODS

This prospective cross-sectional study was conducted at the Department of Radiology and Imaging at the Combined Military Hospital (CMH) in Dhaka, Bangladesh, between June

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2020 and June 2021. The study aimed to examine 120 patients clinically diagnosed with acute ischemic stroke. Prior to the study, verbal consent was obtained from all patients, and it was emphasized that their information would remain confidential. Study subjects were identified in the emergency and casualty department and had undergone an MRI of the brain in the Department of Radiology and Imaging at CMH, Dhaka. The MRI procedure was explained to the patients, including the potential risks of a contrast examination. Data were collected on pre-designed forms, and the relevant information was compiled on a master chart for statistical analysis using SPSS software. Descriptive analysis and frequency of results were presented in the form of tables, pie charts, and bar graphs. The imaging procedure used was a 3.0-Tesla Magnetic Resonance Imaging Machine, model-GE made in the USA. The MRI protocol for the brain included T1W, T2W, and FLAIR, followed by DWI and ADC map. The findings of T1W, T2W, FLAIR, DW, and ADC map MRI were summarized in different tables. Finally, the imaging findings of the MRI of the brain were compared between routine protocol (T1W, T2W, and FLAIR) and DWI & ADC map. The ethical clearance of this study was obtained from the Institutional Ethics Committee of CMH, Dhaka, Bangladesh

Inclusion Criteria

- Patients clinically diagnosed with acute ischemic stroke
- Patients who underwent an MRI of the brain in the department of Radiology & Imaging
- Patients who provided verbal consent to participate in the study

Exclusion Criteria

- Patients who had a history of hemorrhagic stroke or other neurological disorders
- Patients who had undergone an MRI of the brain within the last 6 months
- Patients who were unable to cooperate with the MRI procedure or unable to provide informed consent.

RESULTS

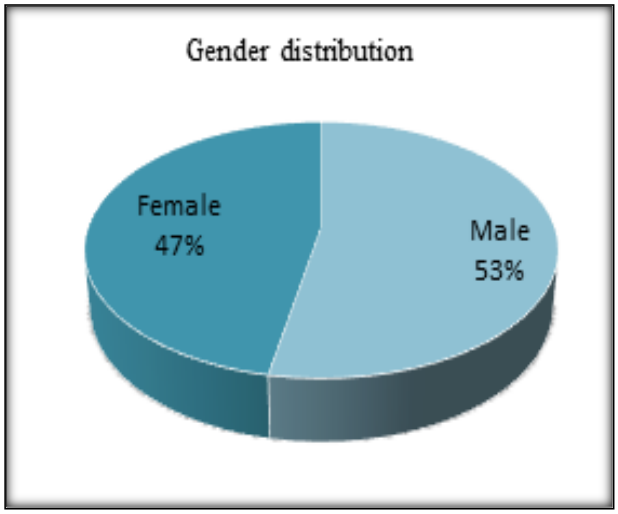

Figure 1: Gender distribution of study subjects (N=120).

According to this figure, out of 60 study subjects, 53% are male and 47% are female.

Table 1: Demographic profile of the patients (N=120).

Age (years)	Sex with frequency		Total
	Male (n= 64)	Female (n= 56)	
30-45	10(15.6%)	4(7.14%)	14(11.6%)

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46-60	20(31.2%)	18(32.14%)	38(31.6%)
61-75	24(37.5%)	28(50.0%)	52(43.3%)
≥75	10(15.6%)	6(10.71%)	16(13.3%)
Mean ± SD	65.2 ± 7.83		

Among the demographic profile of 120 patients, including their age range and sex distribution. The data is presented in a frequency table format, with a breakdown of the number of males and females in each age group. The mean age of the patients is 65.2 ± 7.83 years.

Table 2: Distribution of the study patients according to stroke variables (n=120).

Variables	Frequency	Percentage
Diagnosis of Stroke*		
Non-acute ischaemic lesion	14	11.70%
Acute ischaemic lesion	106	88.30%
Duration of stroke*		
12 Hours	44	36.67
>12 Hours	76	63.33
Ischemic lesions*		
Acute Ischaemic Lesion	108	90.00%
Others lesion	12	10.00%

According to three stroke variables. The first variable is the diagnosis of stroke, which shows that 88.30% of the patients had an acute ischemic lesion, while the remaining 11.70% had a non-acute ischemic lesion. The second variable is the duration of stroke, which indicates that 63.33% of the patients had a stroke duration of more than 12 hours, while 36.67% had a duration of 12 hours or less. The third variable is the type of ischemic lesion, which reveals that 90.00% of the patients had an acute ischemic lesion, while the remaining 10.00% had other types of lesions.

Table 3: Clinical presentation of stroke patient (n=120).

Clinical presentation	Frequency	Percentage (%)
Hemiplegia	120	100.0
Impaired consciousness	36	30.0
Vertigo	16	13.3
Dysphasia	28	23.3
Dysphagia	12	10.0
Headache	26	21.6
Cranial nerve palsy	22	18.3

Among these cases, common clinical hemiplegia was reported in 120 patients, accounting for 100% of the cases. Impaired consciousness was observed in 36 patients, representing 30% of the cases, while vertigo was reported in 16 patients, or 13.3% of the cases. Dysphasia and headache were observed in

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28 (23.3%) and 26 (21.6%) patients, respectively. Dysphagia and cranial nerve palsy were less common, reported in 6 (10%) and 22 (18.3%) patients, respectively.

Table 4: Baseline hemodynamic status of the study subjects (n=120).

Variables	**Frequency**		**p-value**
	M (n=64)	**F (n=56)**	
Vital signs			
Temperature (C)	35.78 ± 1.22	35.72 ± 1.26	1.025^{ns}
Heart rate (b/pm)	96.43 ± 17.35	94.53 ± 16.13	0.857^{ns}
Respiratory rate (breath/min)	24.23 ± 6.23	25.17 ± 7.21	0.502^{ns}
Mean arterial BP (mmHg)	91.80 ± 78.43	92.22 ± 26.20	1.008^{ns}

[Table 4] presents the baseline hemodynamic status of the 120 study subjects, consisting of 64 males and 56 females. The table includes vital signs such as temperature, heart rate, respiratory rate, and mean arterial blood pressure, along with their respective frequencies and p-values. The mean temperature for males and females was 35.78 ± 1.22 and 35.72 ± 1.26°C, respectively, and there was no significant difference between the two genders. Similarly, there were no significant differences in heart rate or respiratory rate between males and females. The mean arterial blood pressure for males and females was 91.80 ± 78.43 and 92.22 ± 26.20 mmHg, respectively, with no significant difference observed between the genders. Overall, the baseline hemodynamic status of the study subjects was similar between males and females.

Table 5: MRI findings of the study population (n=120).

MRI findings	**Frequency**		**Total (%)**
	M (n=64)	**F (n=56)**	
Arterial territory involved			
Middle cerebral artery (MCA)	64(50.0%)	44(39.2%)	108(45.0%)
Anterior cerebral artery (ACA)	32(25.0%)	28(25.0%)	60(25.0%)
Posterior cerebral artery (PCA)	8(12.5%)	14(25.0%)	22(18.3%)
Others (AICA, PICA, or SCA)	8(12.5%)	6(10.71%)	14(11.6%)
Size			
Small sized	24(37.5%)	26(46.4%)	50(41.7%)
Intermediate sized	18(28.1%)	14(25.0%)	32(26.7%)
Large sized	22(34.3%)	16(28.5%)	38(31.7%)
Mass Effect			
Present	12(18.7%)	10(17.8%)	22(18.3%)
Absent	52(81.2%)	46(82.2%)	98(81.7%)
Lesion age (ADC map)			
Low ADC	56(87.5%)	52(92.8%)	108(90.0%)
Normalize to raised ADC	8(12.5%)	4(7.1%)	12(10.0%)

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The table provides information on the MRI findings of 120 patients, including 64 males and 56 females. The arterial territory involved in the majority of cases was the middle cerebral artery (MCA), with a frequency of 50.0%. The next most common arterial territory was the anterior cerebral artery (ACA) at 25.0%. The size of the lesion was categorized into three groups, with small-sized lesions being the most frequent (41.7%), followed by large-sized lesions (31.7%). Mass effect was present in 18.3% of cases. The majority of the lesions (90.0%) had low ADC values, while only 10.0% had normalized to raised ADC values. Overall, the table provides valuable information on the MRI findings of stroke patients and highlights the importance of differentiating between various arterial territories and lesion sizes.

Table 6: Diagnostic accuracy of diffusion-weighted MRI in the evaluation of acute ischaemic stroke (n=120).

Diffusion-weighted MRI findings	**Types of the lesion (stroke)**	
	Acute ischaemic lesion (n=106)	**Non-acute ischaemic lesion (n=14)**
Ischaemic lesion (n=108)	104	4
Other lesions (n=12)	2	10

[Table 6] provides information about the diagnostic accuracy of diffusion-weighted MRI in the assessment of acute ischaemic stroke. The study included 120 patients, out of which 106 had acute ischaemic lesions, and the remaining 14 had non-acute ischaemic lesions. The table presents the types of lesions identified through diffusion-weighted MRI findings, which were ischaemic lesion and other lesions. Out of the 108 ischaemic lesions detected, 104 were acute ischaemic lesions, and four were non-acute ischaemic lesions. Among the 12 other lesions identified, two were acute ischaemic lesions, and ten were non-acute ischaemic lesions. These findings suggest that diffusion-weighted MRI has a high diagnostic accuracy in detecting acute ischaemic lesions in patients with acute stroke.

DISCUSSION

Acute ischemic stroke is a medical emergency that requires prompt diagnosis and management to prevent long-term disability and mortality. Diffusion-weighted MRI (DW-MRI) is a reliable imaging modality in the evaluation of acute ischemic stroke, as it can detect ischaemic lesions with high sensitivity and specificity.[9] This study included 120 patients with acute stroke, of which 88.3% had an acute ischaemic lesion. Another similar study found that 156 out of 205 patients (76%) had acute ischaemic lesion,[10] and yet another study found that 80.04% of patients had an acute ischaemic lesion.[11] The demographic profile of the patients showed a mean age of 65.2 ± 7.83 years, with a slight male predominance (53%). In contrast, a similar study found a mean age of 49.5 ± 9.8 with a male predominance of 68.6%.[12] Another similar study found that the mean age of the sample was 57.6 ± 5.9 years.[13] The most common clinical presentation of stroke was hemiplegia, reported in 100% of cases, followed by impaired consciousness (30%), vertigo (13.3%), dysphasia (23.3%), headache (21.6%), dysphagia (10%), and cranial nerve palsy (18.3%). A similar study found that hemiparesis was the most common presentation in both hemorrhagic (85%) and

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ischemic (80%) stroke. The second and third common presentations in hemorrhagic stroke were impaired consciousness (80%) and vomiting (75%), while in ischemic stroke, they were diarrhea (60%) and motor dysphasia (58.75%).[14] These findings are consistent with previous studies that have reported similar clinical presentations in patients with acute stroke. This study provides valuable information on the MRI findings of stroke patients, including the arterial territory involved, lesion size, mass effect, and ADC values. The middle cerebral artery (MCA) was the most commonly involved arterial territory, accounting for 50.0% of cases, followed by the anterior cerebral artery (ACA) at 25.0%. The size of the lesion was categorized into three groups, with small-sized lesions being the most frequent (41.7%), followed by large-sized lesions (31.7%). Mass effect was present in 18.3% of cases. The majority of the lesions (90.0%) had low ADC values, indicating restricted diffusion, while only 10.0% had normalized to raised ADC values. In another similar study, the most common arterial territory involved was the middle cerebral artery (MCA), which was seen in 65% of cases. The anterior cerebral artery (ACA) was involved in 22.5% of cases, while the posterior cerebral artery (PCA) was involved in 12.5% of cases.[15] Other study also found similar MRI finding.[16] This information is crucial in understanding the pathophysiology of stroke and its clinical implications. This study also assessed the diagnostic accuracy of DW-MRI in the evaluation of acute ischaemic stroke, where 106 patients had acute ischaemic lesions, and the remaining 14 had non-acute ischaemic lesions. Transient ischemic attack (TIA), subacute ischemia, or chronic lesion denotes a non-acute stroke. The percentage of TIA patients with a DWI lesion increases with increasing total symptom duration,[17] and with an increasing duration between TIA symptom onset and performance of the initial DWI.[18] TIA is defined as a transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia without signs of acute infarction by neuroim.

Limitations of The Study

In this study, the sample size is relatively small, which may affect the generalizability of the results.

CONCLUSIONS

Stroke is one of the foremost causes of morbidity, mortality, and a socioeconomic challenge. This is particularly true for developing countries like Bangladesh, where the health support system including the rehabilitation system is not within the reach of ordinary people. Early detection and risk stratification reduced the burden of stroke. Thus, the present study concludes that DWI in conjunction with ADC map MR imaging is a gold standard diagnostic modality in the evaluation and management of acute ischaemic stroke.

Recommendation

Stroke is a leading cause of death worldwide, and DWI can help detect changes in the brain in its early stages, enabling early treatment and minimizing further damage. The study included 60 patients diagnosed with acute ischemic stroke, and the findings of routine magnetic resonance imaging (MRI) protocol for the brain were compared with DWI and apparent diffusion coefficient (ADC) map MRI.

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The results showed that DWI and ADC maps can detect changes in the brain as early as 30 minutes after the onset of stroke, and are particularly useful in cases where conventional MRI sequences do not show significant changes. The article emphasizes the importance of a deeper understanding of DWI for physicians treating patients with acute ischemic stroke.

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