

**Review Article**

**EFFICACY OF BRAIN MRI AS THE FIRST CHOICE FOR PATIENTS WITH ISCHEMIC STROKE**

Majid Shojaee <sup>1</sup>, Farideh Shariffar <sup>2\*</sup>, Anita Sabzghabaei <sup>3</sup>, Saeed Safari <sup>3</sup>, Hamid Reza Hatam Abadi <sup>1</sup>

<sup>1</sup> Department of Emergency Medicine, Emam Hossein Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>2</sup> Department of Emergency Medicine, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>3</sup> Department of Emergency Medicine, Shohadaye Tajrish Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

\*Corresponding author: Farideh Shariffar, Department of Emergency Medicine, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran  
Email: [Drshariffar2@gmail.com](mailto:Drshariffar2@gmail.com)

Received: 02.12.2019

Revised: 07.01.2020

Accepted: 16.02.2020

**Abstract**

**Introduction:** Stroke is one of the most important causes of disability and death after heart disease and cancer. Using reliable brain imaging, especially MRI, has provided a new window on the pathogenesis, diagnosis and follow-up of ischemic stroke patients. The present study aimed to evaluate the efficacy of brain MRI as the first choice for patients with ischemic stroke.

**Materials and Methods:** This study was performed on 272 patients referred to the emergency department of Imam Hossein Hospital during 2019-2020. First, CT scan and MRI were performed in all patients, then CT scan was considered as a reliable diagnostic method and MRI results were compared with the results of statistical analysis.

**Results:** In this research, 171 males and 101 female patients with mean age of  $53.6 \pm 9.1$  years were studied. History of hypertension (46.3%) was the most frequent risk factor. CT scan showed a sensitivity, specificity, accuracy, positive predictive value, and negative predictive of 10.9%, 97, 13.9%, 99%, and 93%, respectively. MRI also showed a sensitivity, specificity, accuracy, positive predictive value, and negative predictive of 0.89%, 80%, 90.2%, 98.9%, and 27.5%, respectively. MRI results indicated significantly higher performance than CT scan ( $p = 0.01$ ).

**Conclusions:** The results of the present study indicated that MRI has a higher diagnostic power than CT scan. Further studies in larger scale are recommended for more accurate results.

**Keywords:** Ischemic stroke, MRI, CT scan, Stroke.

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DOI: <http://dx.doi.org/10.31838/jcr.07.04.129>

**INTRODUCTION**

Stroke is the third leading cause of death after heart disease and cancer and is the most common cause of chronic disability in adults and the elderly (1-3). It accounts for approximately 50% of neurological disorders in public hospitals and is one of the leading causes of disability and death worldwide (4). Approximately 750,000 strokes occur in the United States annually, 88% of which are ischemic strokes and 8-12% of them lead to death within 30 days (5). The probability of death in the first month after stroke is up to 50% (6).

The economic and social costs of the stroke are enormous, resulting in huge spending on healthcare (7). In the US, it is estimated \$ 41 billion a year. This complication is one of the important causes of physical and brain disabilities, which is of high importance in its timely identification (8). Stroke is associated with weakness, paralysis, numbness, speech disorder, visual field impairment (8).

Ischemic stroke is caused by atherosclerosis of large cerebral arteries and cardioembolism (10 and 9). Lacunar strokes are caused by small cerebral artery occlusion due to the atherosclerosis (11). Regarding risk factors, etiology, and pathogenesis, transient ischemic attacks are similar to cerebral infarction. Also, its diagnostic and etiologic criteria, similar to stroke, are important (12). Accurate and timely diagnosis of ischemic stroke and providing short-term therapeutic interventions are important in reducing subsequent complications (13-13). Although the treatment of acute stroke in all etiologic types is very similar, to prevent recurrence, it is important to determine the etiology of stroke, and that standard diagnostic procedures should be performed in stroke patients (16).

After blood biochemical factor examinations (18 and 17), brain CT scan is one of the early diagnostic criteria, though, in the early hours, there is a possibility of error in CT scans and in many cases they are poor in identifying ischemic stroke (19 and 20). In cases of suspected complete extracranial occlusion of the internal carotid artery, to decide whether to have surgery, the possibility of cerebral vasculitis, aneurysm, moyamoya, and fibro-muscular dysplasia, other more accurate imaging techniques, such as MRI, MR Angiography, and CT Angiography are used (21 and 22). Experts generally believe that MRI is superior to CT scan in diagnosing acute stroke, suggesting that changes in acute ischemic injury are more accurately detectable by MRI (23, 24).

In this regard, the present study aimed to evaluate the efficacy of brain MRI as the first choice for patients with ischemic stroke referred to the emergency department of Imam Hossein Hospital during 2019-2020.

**MATERIALS AND METHODS**

**Study population and design**

In this prospective study, all patients with suspected ischemic stroke referred to the emergency department of Imam Hossein Hospital in were entered into the study according to inclusion criteria using simple sampling method.

**Inclusion and exclusion criteria**

Inclusion criteria included patients with suspected ischemic stroke with symptoms such as speech disorder, facial paralysis, urinary and fecal incontinence, sudden decrease in voluntary muscle strength, limb numbness. Exclusion criteria also were patients under 18 years, patients receiving thrombolytic therapy, CT or MRI contraindications, and unwillingness to participate in the study.

**Work process**

After entering patients into the study, their demographic and clinical information were recorded in a checklist. The physician then performed diagnostic examinations and standard treatments for the patients, including MRI and CT scan. Their findings were independently recorded and the final diagnosis was made by a neurologist as the gold standard. Finally, the necessity of CT scan and contributing findings such as cases of brain hemorrhage (ICH, EDH, SDH, SAH) that are more easily diagnosed in CT scan, were recorded. Then, the value of the performed CT scans was compared with the findings and, finally, the question was answered how many of these patients would be at risk of misdiagnosis if they did not perform a CT scan.

**Variables**

Studied variables included age, sex, arterial oxygen saturation, heart rate, blood pressure, level of consciousness, diabetes, dyslipidemia, carotid stenosis, heart disease, history of stroke, atrial fibrillation, and alcohol consumption.

**Ethical considerations**

This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences. Obtaining informed consent from all participants was the first and foremost step in starting this research project. Also, they were assured that their information would be treated as strictly confidential.

**RESULTS**

In this research, 171 males and 101 female patients with mean age of  $53.6 \pm 9.1$  years were studied (Table 1).

The measured blood biochemical factors are presented in Table 2.

**Table 1. Frequency of the studied patients**

Sex	Frequency	Mean age
Male	171 (30.5%)	53.6±9.1
Female	101 (48.5%)	
Total	272	

**Table 2. Measured blood biochemical factors**

Biochemical factors	SPO2	Glucose	HR	RR	ESI	GCS
Value	94.18±9.1	167.2±9.5	84.02±9.5	15.23±1.56	2.96±0.18	14.82±0.89

As shown in Table 3, among the patients with ischemic stroke, history of hypertension (46.3%) was the most frequent risk factor.

**Table 3. Frequency distribution of patients by risk factors**

Risk factors	Hypertension	Smoking	Sweet diabetes	Stroke	Dyslipidemia	Carotid stenosis	Heart disease	Alcohol use	Atrial fibrillation
Percentage	46.3	32.1	26.7	16.2	14.2	13.9	13.2	9.8	1.7

ICT scan results showed 27 true positive and 227 false positive cases, hence a sensitivity of 10.9%. Specificity was 97%, with 10 true negative and 2 false positive cases, and accuracy was calculated to be 13.9%. Also, positive predictive value and negative predictive value was 99% and 93%, respectively (Table 4).

The results of MRI showed 178 true positive and 21 false negative cases, hence a sensitivity of 0.89%. Specificity was

80%, with 8 true negative and 2 false positive cases. 178 patients had ischemic stroke, and MRI diagnosed 180 patients with abdominal-pelvic injuries, hence a positive predictive value of 98.9%. Eight patients did not have ischemic stroke, but the MRI diagnosed 29 patients as non-ischemic, thus a negative predictive value was calculated to be 27.5%. MRI results indicated significantly higher performance than CT scan ( $p = 0.01$ ).

**Table 4. Evaluation of the two diagnostic methods of ischemic stroke**

Variable	CT scan		MRI		Significance
	Numbers	Percentage	Numbers	Percentage	
Sensitivity	27	10.9	178	89.9	0.01
Specificity	8	83.3	37	80	
Accuracy	35	13.9	186	90.2	
Positive predictive value	30	93.1	178	98.9	
Negative predictive value	33	4.2	38	27.5	

**DISCUSSION**

Timely and accurate identification of ischemic stroke can be important in reducing subsequent complications (5, 12). It is generally believed that MRI is superior to CT scan in diagnosing acute stroke. Also, changes in acute ischemic injury are more quickly detectable with MRI. (24 and 23). In the present study, CT scan showed a sensitivity, specificity, accuracy, positive predictive value, and negative predictive of 10.9%, 97, 13.9%, 99%, and 93%, respectively. MRI also showed sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of 0.89%, 80%, 90.2%, 98.9%, and 27.5%, respectively. MRI results indicated significantly higher performance than CT scan ( $p = 0.01$ ). Also, regarding sensitivity, many studies have confirmed the superiority of MRI over the CT scan (28–25).

In the present study, MRI diagnosed acute ischemic stroke in 178 patients (89.9%). Similarly, a study showed that MRI significantly detected acute stroke, acute ischemic stroke, and chronic hemorrhagic stroke more accurately than CT scan. However, in the diagnosis of acute intracranial hemorrhage, CT and MRI were similar. MRI detected acute ischemic stroke in 164 of 356 patients (46%), while CT scan detected 35 of 356 patients (10%). Compared to the final clinical diagnosis, MRI and CT scan had a sensitivity of 83% (181 of 217 cases) and 26% (56 of 217 cases) in diagnosing acute stroke, respectively (29).

Nevertheless, some contradictory results have been obtained regarding the MRI method. One study has suggested that MRI could be as accurate as CT scan in detecting acute hemorrhage in patients with acute focal stroke symptoms, but is more accurate in diagnosing chronic hemorrhage than CT scan (30).

In another study, Mullins et al. reported sensitivity and specificity of 94% and 97% for MRI, respectively. In evaluations performed in the first 12 hours, MRI was more diagnostic than CT, but after 12 hours, their performance was similar (31).

Our study showed the superiority of MRI over CT scan. A similar study also showed that the lesions recorded by MRI was greater than CT scan. Researchers have suggested that MRI is preferable to CT in the diagnosis of ischemic injuries after transient and minor ischemic strokes (32).

In our study, many important risk factors were identified, one of which was hypertension in ischemic patients. Attention to this issue can be investigated as an important preventive factor in health care and an effective factor in ischemic stroke in future studies.

It is important to pay great attention to the treatment interventions in stroke. Accurate and long-term evaluation and management of stroke patients includes physiotherapy and testing, to determine the exact cause of the event to prevent recurrence. Management varies in different types of acute strokes. Urgent goals include minimizing brain injury, identifying patients quickly and accurately, reducing therapeutic complications, and moving toward pathophysiological recognition with regard to patient symptoms (38-33).

### CONCLUSION

Finding treatment interventions and timely identification of the complication is a critical issue in the health of stroke patients. Early diagnosis and treatment of brain injury can prevent adverse consequences such as disabilities and mortality in stroke patients. Given the weakness of CT scan in the diagnosis of ischemic stroke patients, using MRI as a top priority can save the lives of many patients. Thus, further studies in larger scale are recommended for more accurate results.

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