Review Article

Role of MRI in Diagnosis and Management of Stroke Cases; A Systematic Review

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Abstract

It is now common practice to use neuroimaging tools, particularly magnetic resonance imaging (MRI), to identify the affected vascular area of a stroke patient's brain and to inform clinical treatment choices. These tools have significantly improved our ability to visualize brain structures. MRI also was known to demonstrate the size and accurate location of the bleeding. The principle of 'time is brain' guides the care of stroke victims. This notion emphasizes the significance of delivering immediate medical attention to stroke victims, which is mostly guided by MRI. We searched PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane library. Rayyan QCRI was used to screen study articles by title and abstract before implementing a full-text assessment. A total of 7 studies with the main topic of MRI's role in stroke diagnosis and management were included in this review. According to the included studies, MRI is the most accurate scanning way in stroke cases. Recent developments in MRI technology have increased its use as an imaging platform in normal clinical stroke treatment.

Keywords: Stroke, Brain scan, Magnetic resonance imaging (MRI), Ischaemic stroke

Introduction

In developed countries, cerebrovascular diseases are the sec ond-leading cause of death for men and the primary cause of death for women [1-3]. Cerebrovascular disease is another major cause of cognitive impairment and dementia [3]. Stroke is the most prevalent cardiovascular illness, accounting for the majority of functional impairment. Neurological sequelae are evident in 90% of stroke patients, with one-third unable to resume daily living activities at their pre-stroke level [1, 2].

Because they can cause disabling symptoms like dysarthria, paralysis, and forgetfulness, cerebral vascular abnormalities can have a negative impact on a person's quality of life [4, 5]. When the blood vessels that supply the brain with oxygen and nutrients become weakened or blocked, a stroke occurs. Typical symptoms include thrombus formation, displacement embolism, cerebral artery stenosis, and brain parenchymal hemorrhage [6]. These occurrences may cause a severe reduction in the amount of blood and oxygen reaching the brain, which may result in a stroke. Stroke is the leading cause of death that is preventable, accounting for more than 10% of fatalities globally [7], with one in five stroke patients dying each year [8]. Many attempts have been undertaken over the last few decades to enhance the result of acute ischemic stroke therapy. But within 3 or 4.5 hours of the onset of symptoms, the only validated treatment for people with an acute ischemic stroke is thrombolytic therapy [9].

The principle of 'time is brain' guides the care of stroke victims. This notion emphasizes the need of delivering immediate medical attention to stroke victims, which is mostly based on neuroimaging [10].

Because brain tissue is destroyed for every minute of delay, a delay in diagnosis might result in permanent damage.

Multimodal magnetic resonance imaging (MRI) is helpful for identifying ischemic stroke and choosing treatment options in the acute phase [11]. Early identification of ischemic stroke and discrimination from stroke mimics are critical in the acute period [12]. MRI sequence imaging data assist reveal stroke causes, which impact prognosis and so play a key role in therapy decisions. By giving information on salvageable

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tissue or ischemic lesion age, MRI lesion mismatch profiles assist us in assessing the possible risks and advantages of thrombolysis [13]. There are several reasons why MRI may be superior to the first CT in stroke patients. Accurate information acquired from MRI concerning stroke subtype, time, or location may lead to better therapy choices [14]. It has been suggested that a clear representation of infarction will enhance patient education and compliance with suggested preventative measures [14].

Materials and Methods

This systematic review was carried out in accordance with the established principles (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, PRISMA).

Study Design

This was a systematic review and meta-analysis.

Study Duration

From July to August 2022.

Study Condition

This review examines the existing research on the function of MRI in the diagnosis of stroke and its involvement in improving case management.

Search Strategy

A thorough search of five major databases, including PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane Library, was conducted to include the relevant literature. Our search was limited to English and adjusted for each database as necessary. "Stroke," "MRI," "imaging," "patients," "MRI role in stroke," "stroke diagnosis," and "stroke cases" were converted into mesh terms in PubMed to identify the qualifying studies. The appropriate keywords were paired with "OR" and "AND" boolean operators. The search results included English-language full-text publications, freely accessible articles, and human trials.

Selection Criteria

Our review comprised the studies with the following criteria:

- Mainly cohort and retrospective cohort studies and study designs that provided qualitative or quantitative data about the role of MRI in the diagnosis and management of stroke cases.

Exclusion criteria included the following:

- Studies not conducted in the English language.
- Studies with no free access.

Data Extraction

The search strategy results were examined for duplicate features using Rayyan (QCRI) [9]. The researchers evaluated the pooled search results against a list of inclusion/exclusion criteria to determine the suitability of the titles and abstracts. The reviewers assessed the complete texts of the papers that satisfied the requirements for inclusion. The writers had a discussion to settle any differences. The eligible study was built into a data extraction form. The authors gathered data on the studies' titles, authors, study year, design, population, participant count, gender, incidence, paralytic ileus risk factors, and key findings.

Risk of Bias Assessment

The qualitative data synthesis was performed using the ROBINS-I technique for non-randomized studies [15] in order to evaluate the caliber of the included research. The reviewers found any inconsistencies in the quality assessment and fixed them.

Strategy for Data Synthesis

In order to provide a qualitative overview of the included study components and result data, summary tables with the gathered information from the pertinent studies were created. After the data extraction for this systematic review was complete, decisions were made regarding how to most effectively use the information from the included study articles. Studies that satisfied the full-text inclusion criteria but provided no data on the role of MRI in stroke patients were eliminated.

Results and Discussion

Search Results

The systematic search yielded 220 study papers, after which 53 duplicates were deleted. Twenty studies were removed after being subjected to title and abstract screening. Only 30 items were not retrieved even though 122 reports were searched. Finally, 92 papers were selected for full-text evaluation: 20 research were omitted due to incorrect study outcomes, while 35 studies were discarded due to insufficient data. on the incidence of epileptic seizures, and 39 were excluded for the wrong population type, 7 studies were excluded for the not suitable publishing date. Seven eligible study articles were included in this systematic review.

In this study, we included seven studies from the most recent studies regarding this topic, as we only included studies from 2018 and more to be sure the data is recent and eligible.

Characteristics of the Included Studies

A total of 7 studies were included in this review. The main topic of most of these studies was ranging from MRI's role in the diagnosis and management of stroke cases was included among them. The entire included sample was diagnosed with stroke. All the included studies were conducted regarding the role of MRI in stroke patients and also comparing MRI with the other scanning methods in stroke diagnosis and benefits in management. We estimated the important and effective role of MRI in the early diagnosis of stroke cases and also in recognizing the size and location of bleeding which makes it easier to do the suitable management to the case. We included 3 systematic reviews in this study which enabled us to review

their included data and results. In **Table 1** we included the summary of the included previous studies with their main objectives, key findings, and the year of publication.

Table 1. Summary of characteristics of the included studies.

Study	Study design	District	Study Objective	Total Participants	Key findings
Heitor Cabral Frade, MD., 2022 [14]	A retrospective observational propensity score–matched cohort study	between January 2015 and December 2017 at an academic medical facility	To ascertain whether patients with acute ischemic stroke treated with initial CT alone had better clinical outcomes than patients treated with additional MRI.	1400	An initial CT alone diagnostic imaging strategy was found to be noninferior to an initial CT + additional MRI diagnostic imaging strategy in this propensity score-matched cohort analysis of patients hospitalized with acute ischemic stroke. To determine which hospitalized patients with acute ischemic stroke benefit from MRI, more research is required.
Mohammad Amin Akbarzadeh, *et al*., 2021 [15]	literature review	Updated database collected data.	To evaluate the roles played by various imaging techniques in the diagnosis of acute ischemic stroke and to compare their advantages and disadvantages.	936	MRI is more exact in detecting acute ischemic stroke and more reliable in ruling out cerebral bleeding. CT, on the other hand, is favoured in most healthcare settings because to its availability .and shorter acquisition time
Pragati Kakkar. *et al*. 2021 [16]	literature review	Updated database collected data.	Discover how various imaging techniques are used in the diagnosis, prognosis, and treatment of stroke by examining recent developments in neuroimaging.	1032	However, recent developments in MRI technology have increased its use as an imaging platform in a normal clinical stroke procedure. Multimodal MRI is an useful approach for detecting ischemic stroke and defining the location and size of the infarct region, which is critical information for doctors in deciding suitable therapies and efficiently managing stroke patients.
Takeshi Imura, *et al*., 20210 [17]	Systematic review	Online database	to assemble data on the efficacy of MRIs in predicting gait abilities in stroke patients	80	MRIs are beneficial in predicting stroke patients' walking abilities. We were able to indicate crucial data from an MRI for predicting gait ability. However, due to a lack of quantitative analyses, we cannot draw solid conclusions on the predictive usefulness and impacts of gait prediction using MRI findings.
Hwan Lee, *et al*., 2020 [18]	retrospective study		Researchers looked into whether inpatient brain MRI in patients with acute ischemic stroke is associated with better clinical outcomes to explain its resource requirements.	80	At the cost of slightly longer hospital stays and slightly higher hospital costs, inpatient brain MRI in patients with acute ischemic stroke is associated with a significant decrease in inpatient mortality and sequelae.

Stéphanie Debette, MD, PhD. *et al*. 2019 [19]	A Systematic Review and Meta-analysis	Data were gathered from prospective, longitudinal cohort studies including at least 50 participants.	We must better understand the clinical significance of VBI in order to enhance preventative strategies for the two most prevalent age-related neurological diseases, stroke and dementia.	VBI MRI signals are clinically significant. This study calls for a thorough assessment of the benefit-risk ratio for existing preventative interventions in people with hidden VBI.
Xiao-Hong Zhang, *et al*. 2019 [20]	A Systematic Review and Meta-analysis	The data came from prospective, long-term cohort studies involving at least 50 participants.	The diagnostic efficacy of transcranial Doppler ultrasound (ultrasonography), computed tomography (CT), and magnetic resonance imaging (MRI) in patients with ischemic stroke was investigated using a network meta-analysis.	This network meta-analysis supports the idea that DWI has a better ischemic stroke diagnostic value among MRI methods and CTP has a poor diagnostic value among CT methods, both of which offer therapeutic considerations for managing ischemic stroke.

Stroke is a devastating medical disorder that accounts for more than 5% of all fatalities. Since 20% of stroke patients pass away each year, stroke tops the list of preventable causes of death. When an acute stroke is discovered, there is a window of opportunity to prevent its negative effects for less than an hour. Because neuroimaging is required for stroke diagnosis, appropriate use of neuroimaging might assist save time and design the best therapy for the patient. MRI generates high-resolution images that show the presence, size, and location of a hyperacute cerebral ischemic stroke, but it is important to recognize the case's development and avoid time-consuming procedures [21].

Gradient recalled echo (GRE)-MRI, a multimodal magnetic resonance technology, has been shown to provide comparable results to any other imaging method for the diagnosis of hyperacute hemorrhage in a large body of prior research. GRE pictures have the problem of being susceptible to magnetic field inhomogeneity, which diminishes signal strength and produces artifacts, as demonstrated. These investigations also indicated that MRI is more effective than CT in identifying persistent hemorrhages and cerebral microbleeds. However, because of the prolonged scanning period, MRI is prone to artifacts induced by body movements [22].

The diagnostic benefits of CT scans and MRI in stroke cases were compared by Heitor Cabral Frade, MD, *et al*. [14] in a retrospective observational, propensity score-matched cohort analysis of patients hospitalized with AIS. They found that, in terms of clinical outcomes, such as death or dependency at hospital discharge or the avoidance of stroke or death one year later, an initial CT alone was not inferior to an initial CT with additional MRI. Two previous studies looked at the effect of MRI on the outcomes of patients with AIS who were hospitalized. In order to determine whether baseline clinical factors and diagnostic investigations carried out during the hospitalization were related to clinical outcomes at 1 year, Hefzy *et al*. [14] examined a prospectively collected sample of 727 patients with a discharge diagnosis of ischemic stroke or transient ischemic attack. Neither CT alone, CT + MRI, magnetic resonance angiography alone, echocardiography, nor transcranial Doppler were significantly associated with clinical outcomes, according to multivariate analysis. These results were refuted by research by Lee *et al*. [19]. The National Inpatient Sample's 94 003 hospitalized patients with an AIS discharge diagnosis and the 1 583 768 patients who did not receive an MRI during their stay were compared. After controlling for comorbidities, MRI was associated with lower inpatient mortality (1.67% vs. 3.09%; adjusted odds ratio [OR], 0.60; 95% CI, 0.53-0.68; P.001).

Takeshi Imura *et al*. [17] conducted a comprehensive review to gather information on the use of MRIs to predict gait abilities in stroke patients. They stated that eight structure- or function-based MRI investigations revealed that MRIs can predict gait ability. They also demonstrated that MRI was the most effective method of scanning stroke site and size, and predicting the patient's gait capacity. MRI is more accurate at excluding cerebral bleeding, and MRI with DWI is more accurate at identifying acute ischemic stroke, claim Mohammad Amin Akbarzadeh *et al*. [15]. Contrarily, CT is preferred in most healthcare settings due to its accessibility and quicker acquisition time.

According to a related study by Pragati Kakkar *et al*. [16], multimodal MRI is a valuable tool for diagnosing ischaemic stroke and identifying the location and size of the infarct area, both of which are crucial details that can help clinicians choose the best interventions and manage stroke patients effectively. In the diagnosis and treatment of stroke, SWI is used to detect cerebral bleeding, PWI to determine the size of the ischemic penumbra, and both PWI and DWI to evaluate stroke.

The diagnostic values of transcranial Doppler ultrasound (ultrasonography), computed tomography (CT), and magnetic resonance imaging (MRI) in patients with ischemic stroke were compared in a further systematic review by Xiao-Hong Zhang *et al*. [20], and it was discovered that MRI is the most efficient technique for stroke diagnosis and management. Among MRI approaches, DWI has been shown

to have a greater diagnostic value for ischemic stroke. MRI, on the other hand, has been reported to have significant clinical importance in stroke diagnosis [19]. MRI clearly shows the size and location of the infarction. Incidental findings on MRI brain scans for various causes include white matter hyperintensities, BI, CMB, and PVS. They have prompted research into severe vs. nonextensive load (with incidences of extensive WMH and PVS burden changing depending on definitions but ranging between 10% and 50%). They affect roughly 10% to 28% of adults 70 years of age or older for BI and CMB and more than 80% for WMH and PVS [23-25]. These underlying cerebral SVD is primarily reflected by these MRI indicators of VBI, which are covert in the vast majority of people, not associated with clinical stroke.

Conclusion

Neuroimaging is an essential diagnostic tool. Its main advantage in diagnosing stroke is that it allows doctors to quickly identify individuals who are likely to benefit from specific therapies, such as thrombolytic drugs and surgical therapy. According to the studies that were considered, MRI is the most accurate scanning method in stroke cases. Recent developments in MRI technology have increased its use as an imaging platform in normal clinical stroke treatment. Multimodal MRI is a useful approach for detecting ischemic stroke and defining the location and size of the infarct region, which is critical information for doctors in deciding suitable therapies and efficiently managing stroke patients. In the diagnosis and treatment of stroke, SWI is used to detect cerebral bleeding, PWI to determine the size of the ischemic penumbra, and both PWI and DWI to evaluate stroke.

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