Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2026;15(3):1024-31

Evaluation of follow-up brain magnetic resonance imaging in patients with ischemic stroke

Unal Ertem, Asim Kalkan, Ali Saridas

University of Health Science, Prof. Dr. Cemil Taşçıoğlu City Hospital, Clinic of Emergency Medicine, İstanbul, Türkiye

Received 13 January 2026; Accepted 27 April 2026
Available online 20 July 2026 with doi: 10.5455/medscience.2025.12.355

Abstract

This study aimed to assess the diagnostic yield of follow-up diffusion-weighted magnetic resonance imaging (DWI-MRI) in emergency department patients with suspected acute ischemic stroke who had an initial negative scan, and to identify associated risk factors. In this retrospective cross-sectional analysis, we reviewed records of patients presenting between January 2018 and January 2023 who underwent two DWI-MRI scans for suspected stroke. Inclusion required an initial scan without acute ischemic lesions and a follow-up scan within 48 hours. Demographics, symptoms, comorbidities, laboratory data, and imaging intervals were analyzed. Among 171 included patients (mean age 66.0 ± 14.7 years; 58.5% female), follow-up DWI-MRI revealed new ischemic lesions in 25 cases (14.6%). Patients with positive follow-up imaging were significantly older ($p = 0.047$) and more frequently had hyperlipidemia (12.0% vs. 2.1%; $p = 0.041$). In multivariate analysis, hyperlipidemia remained an independent predictor of positive findings (OR = 7.434, 95% CI: 1.369–40.357, $p = 0.020$), whereas age did not retain significance. Approximately one in seven patients with suspected ischemic stroke and an initially normal DWI-MRI show detectable infarction on early follow-up imaging. Hyperlipidemia is a strong independent risk factor for such delayed-appearing lesions, suggesting that repeat MRI should be considered in high-risk patients, particularly those with dyslipidemia, even after an initial negative scan.

Keywords: Emergency department, ischemic stroke, magnetic resonance imaging

Introduction

Stroke ranks among the leading causes of mortality and is a primary source of serious, lasting disability worldwide. The majority of acute stroke cases are ischemic in origin, whereas a smaller proportion results from hemorrhagic events [1]. Due to the considerable health burden associated with stroke—including high rates of morbidity and mortality—timely recognition and management are essential. Diagnosing an acute stroke relies on integrating clinical assessment with findings from appropriate imaging studies [2].

Acute ischemic stroke occurs when cerebral blood flow is abruptly interrupted, typically by a thrombus or embolus, leading to impaired neurological function. The affected brain tissue often comprises a core zone of irreversible infarction surrounded by an ischemic penumbra—a region where cells are functionally compromised but may remain viable with timely reperfusion [2]. Current therapeutic strategies, such as intravenous thrombolysis and endovascular procedures, aim to restore perfusion and have demonstrated improved clinical outcomes in selected patients. These treatments continue to evolve, emphasizing the importance of accurate patient selection [3,4]. Successful implementation depends on rapid clinical evaluation, neuroimaging, and efficient care pathways, as therapeutic efficacy is strongly time-dependent [5].

In clinical settings where acute stroke is suspected, neuroimaging—via non-contrast computed tomography (CT) or magnetic resonance imaging (MRI)—plays a pivotal role in differentiating ischemic from hemorrhagic stroke and informing subsequent treatment decisions [2].

A cornerstone of acute ischemic stroke management is intravenous (IV) thrombolysis using recombinant tissue plasminogen activator (rt-PA), which is approved within a narrow therapeutic

CITATION
Ertem U, Kalkan A, Saridas A. Evaluation of follow-up brain magnetic resonance imaging in patients with ischemic stroke. Med Science. 2026;15(3):1024-31.

Corresponding Author: Unal Ertem, University of Health Science, Prof. Dr. Cemil Taşçıoğlu City Hospital, Clinic of Emergency Medicine, İstanbul, Türkiye
Email: drunalertem@gmail.com

DOI: 10.5455/medscience.2025.12.355

window of 3 to 4.5 hours after symptom onset, contingent on the exclusion of intracranial hemorrhage via neuroimaging. Beyond hemorrhage detection, modern imaging protocols also help identify vessel occlusion amenable to thrombolytic or mechanical thrombectomy interventions and may delineate salvageable tissue at risk of infarction [6].

Therefore, the present study aimed to analyze serial diffusion-weighted MRI (DWI) examinations in patients with suspected ischemic stroke. Specifically, we sought to identify instances where initial DWI was unrevealing but follow-up imaging demonstrated new ischemic lesions, and to evaluate which clinical and demographic factors were associated with such findings.

Material and Methods

Study Design and Ethical Approval

This retrospective, cross sectional analysis was performed at the Emergency Medicine Clinic of a tertiary care city hospital. The study protocol was reviewed and approved by the Non Interventional Ethics Committee of the Health Practice and Research Center at the University of Health Sciences İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital (Approval No: 23012023 369, Date: 23.01.2023). The requirement for individual informed consent was waived due to the retrospective design.

Patient Selection

We screened the records of all patients aged > 18 years who presented with clinical suspicion of acute ischemic stroke and underwent diffusion weighted magnetic resonance imaging (DWI MRI) between January 1, 2018 and January 1, 2023.

Inclusion criteria were:

- Age > 18 years;
- Clinical suspicion of ischemic stroke;
- Availability of an initial DWI MRI without acute ischemic lesions;
- Performance of a follow up control DWI MRI within 48 hours of the first scan.

The clinical indication for performing the second (follow-up) DWI-MRI after an initially negative scan was based on persistent or worsening neurological symptoms despite the negative initial imaging (clinical–radiological mismatch). No institutional protocol mandated repeat imaging; the decision was at the discretion of the treating emergency physician or neurologist.

Exclusion criteria included:

- Age ≤ 18 years;
- Only a single DWI MRI performed;
- History of concomitant trauma;
- Diagnosis of hypoglycemia as the cause of symptoms;
- Pregnancy.

Data Collection

From the eligible cohort, demographic characteristics, presenting symptoms, laboratory results, comorbid conditions, and the time interval between the two DWI MRI examinations were extracted from electronic health records. Additionally, the clinical setting where patients were monitored between the two scans was recorded: patients were followed either in the emergency department observation unit, the neurology ward, or the intensive care unit, depending on their clinical stability and symptom severity. All follow up DWI MRI scans were re evaluated by an experienced neuroradiologist blinded to the clinical data, and the presence, number, and location of any new ischemic lesions were recorded.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25.0. Categorical variables are expressed as counts and percentages, continuous variables as mean ± standard deviation or median (minimum–maximum) depending on distribution. Normality was assessed with the Shapiro–Wilk test. Between group comparisons employed the independent samples t test (normal distribution) or the Mann–Whitney U test (non normal distribution) for continuous variables, and the Pearson chi square or Fisher's exact test for categorical variables. Variables showing a univariate association with pathology on follow up DWI MRI ($p < 0.05$) were entered into a multivariable logistic regression model (enter method) to identify independent predictors. A two tailed p value < 0.05 was considered statistically significant.

Results

A total of 171 patients met the inclusion criteria and were analyzed. The cohort was predominantly female (58.5%). The most common presenting symptoms were dizziness (25.1%), altered consciousness (24.0%), dysarthria (21.6%), and ataxia (18.1%). Electrocardiogram (ECG) data were available for only 19.3% of patients; among these, 5.3% showed atrial fibrillation and 14.0% were in normal sinus rhythm (Table 1).

The mean age of the participants was 66.00 ± 14.68 years. The average interval between the initial and follow-up DWI-MRI was 14.46 ± 12.51 hours. Regarding the clinical follow-up setting, 98 patients (57.3%) were monitored in the emergency department observation unit, 52 (30.4%) in the neurology ward, and 21 (12.3%) in the intensive care unit. There was no significant difference in the rate of positive follow-up imaging across these settings ($p = 0.34$). Relevant laboratory values at presentation are summarized in Table 2.

Comorbid conditions were prevalent, with 88.9% of patients having at least one documented comorbidity. Hypertension (57.9%), diabetes mellitus (32.2%), and coronary artery disease (11.7%) were the most frequent (Table 3).

Follow-up DWI-MRI revealed new ischemic lesions in 25 patients, corresponding to a pathology detection rate of 14.6% (Table 4). The anatomical distribution of these lesions is detailed in the same table.

DOI: 10.5455/medscience.2025.12.355

Comparative analysis between patients with positive (n = 25) and negative (n = 146) follow-up MRI findings revealed no significant differences in gender distribution, presenting symptoms, or ECG findings (p > 0.05 for all; Table 5).

However, patients in the pathology-positive group were significantly older than those without new lesions (70.08 ± 13.86 vs. 65.3 ± 14.75 years; p = 0.047) (Table 6, Figure 1). Laboratory parameters and the time interval between scans did not differ significantly between the groups (p > 0.05).

Regarding comorbidities, hyperlipidemia was significantly more prevalent in patients with positive follow-up imaging (12.0% vs. 2.1%; p = 0.041) (Table 7). No other comorbidity showed a significant association. Notably, 50.0% of patients with hyperlipidemia had pathology on follow-up MRI, compared to 13.3% of those without hyperlipidemia (p = 0.041) (Figure 2).

In multivariate logistic regression analysis which included age and hyperlipidemia as covariates hyperlipidemia remained an independent predictor of positive findings on follow-up DWI-MRI (OR = 7.434, 95% CI: 1.369–40.357, p = 0.020). Age did not retain independent significance in the multivariate model (p = 0.102) (Table 8).

Table 1. Distribution of cases by gender and symptoms

Variables		n	%
Gender	**Male**	71	41.5
	Female	100	58.5
Presenting complaints	**Dizziness**	43	25.1
	Altered consciousness	41	24.0
	Dysarthria	37	21.6
	Motor deficit	31	18.1
	Ataxia	27	15.8
	Sensory deficit	20	11.7
	Aphasia	14	8.2
	Seizure	7	4.1
	Facial paralysis	6	3.5
	Headache	6	3.5
	Visual field issues	5	2.9
	Gaze problems	1	0.6
ECG findings	**Atrial fibrillation**	9	5.3
	Normal sinus rhythm	24	14.0
	Absent	138	80.7

Table 2. Distribution of cases by age, laboratory results, and time interval between two diffusion MRIs

Variables	Mean ± SD	Median (min - max)
Age (years)	66.00 ± 14.68	67 (22 - 99)
Hemoglobin (g/dL)	12.82 ± 1.91	12.9 (6.1 - 17.1)
Leukocytes (x10³/mcL)	9.25 ± 3.39	8.61 (1.18 - 24.25)
Platelets (x10³/mL)	233.28 ± 74.51	233.5 (22 - 507)
Urea (mg/dL)	42.42 ± 24.36	37 (4 - 256)
Creatinine (mg/dL)	1.02 ± 0.75	0.84 (0.37 - 6.46)
Sodium (mEq/L)	137.57 ± 5.43	138 (111 - 167)
Potassium (mEq/L)	4.15 ± 0.55	4.1 (2.12 - 5.61)
ALT (U/L)	22.39 ± 35.57	15 (3 - 383)
AST (U/L)	29.36 ± 36.92	22 (9 - 342)
Time interval between two diffusion MRIs (hours)	14.46 ± 12.51	7 (3.5 - 48)

ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, MRI: Magnetic resonance imaging, SD: Standard deviation

DOI: 10.5455/medscience.2025.12.355

Table 3. Distribution of comorbid diseases in cases

Comorbid Disease	n	%	Comorbid Disease	n	%
None	19	11.1	**Congestive heart failure**	2	1.2
Present	152	88.9	**Arrhythmia**	2	1.2
Hypertension	99	57.9	**Asthma**	2	1.2
Diabetes mellitus	55	32.2	**Anemia**	1	0.6
Coronary artery disease	20	11.7	**Ankylosing spondylitis**	1	0.6
Malignancy	13	7.6	**Coronary artery bypass surgery**	1	0.6
Epilepsy	12	7.0	**Familial Mediterranean fever**	1	0.6
Chronic kidney failure	9	5.3	**Glaucoma**	1	0.6
Alzheimer's/dementia	9	5.3	**Hepatitis B**	1	0.6
Hyperlipidemia	6	3.5	**Hyperthyroidism**	1	0.6
Chronic obstructive pulmonary disease (COPD)	5	2.9	**Hearing loss**	1	0.6
Hypothyroidism	4	2.3	**Heart valve replacement**	1	0.6
Vertigo	4	2.3	**Multiple sclerosis**	1	0.6
Parkinson's disease	4	2.3	**Obstructive sleep apnea syndrome**	1	0.6
Benign prostatic hyperplasia	3	1.8	**Psychosis**	1	0.6
Migraine	3	1.8	**Thyroiditis**	1	0.6
Bipolar disorder	2	1.2	**Trigeminal neuralgia**	1	0.6

Table 4. Distribution of diffusion MRI findings in cases

Variables		n	%	Variables	n	%
Findings in initial diffusion MRI	**None**	171	100.0	**Right frontoparietal extending to insular cortex**	1	0.6
Findings in follow-up diffusion MRI	**None**	146	85.4	**Right insula**	1	0.6
	Present	25	14.6	**Right corona radiata, left lentiform nucleus**	1	0.6
Regions with pathology identified in diffusion MRI				**Adjacent to right lateral ventricle posterior horn**	1	0.6
Bulbus		2	1.2	**Right lacunar pons**	1	0.6
Left ACA MCA		1	0.6	**Right posterior periventricular white matter (Right PCA)**	1	0.6
Bilateral thalamus		1	0.6	**Left cerebellar hemisphere**	1	0.6
Lacunar in bulbus		1	0.6	**Periventricular white matter adjacent to left lateral ventricle**	1	0.6
Right half of bulbus		1	0.6	**Left MCA**	1	0.6
Cortical multiple lacunar		1	0.6	**Left occipital, left thalamus, left subthalamus PCA**	1	0.6
Mesencephalon		1	0.6	**Left parietal**	1	0.6
Pons		1	0.6	**Left parietooccipital lobe, right frontal lobe**	1	0.6
Left half of pons		1	0.6	**Left cerebellum**	1	0.6
Posterior right bulbus		1	0.6	**Left thalamus**	1	0.6

ACA: Anterior Cerebral Artery, MCA: Middle Cerebral Artery, MRI: Magnetic Resonance Imaging, PCA: Posterior Cerebral Artery

DOI: 10.5455/medscience.2025.12.355

Table 5. Comparison of gender and symptoms in cases based on findings in follow-up diffusion MRI

Variable	No findings (n = 146)	Findings present (n = 25)	p
Gender			
Male	62 (42.5%)	9 (36.0%)	0.544
Female	84 (57.5%)	16 (64.0%)	
Presenting symptoms			
Dizziness	37 (25.3%)	6 (24.0%)	0.886
Confusion	37 (25.3%)	4 (16.0%)	0.312
Dysarthria	31 (21.2%)	6 (24.0%)	0.756
Motor deficit	23 (15.8%)	8 (32.0%)	0.087*
Ataxia	22 (15.1%)	5 (20.0%)	0.555*
Sensory deficit	14 (9.6%)	6 (24.0%)	0.084*
Aphasia	14 (9.6%)	0 (0.0%)	0.227*
Seizure	7 (4.8%)	0 (0.0%)	0.295*
Headache	6 (4.1%)	0 (0.0%)	0.594*
Facial paralysis	5 (3.4%)	1 (4.0%)	1.000*
Visual field defect	4 (2.7%)	1 (4.0%)	0.551*
Gaze disturbance	0 (0.0%)	1 (4.0%)	0.146*
ECG findings			
Atrial fibrillation	8 (5.5%)	1 (4.0%)	0.898
Normal sinus rhythm	21 (14.4%)	3 (12.0%)	
None	117 (80.1%)	21 (84.0%)	

*Fisher's exact test was used for analysis. Chi-square test was used for other comparisons. ECG: Electrocardiography, COPD: Chronic Obstructive Pulmonary Disease, MRI: Magnetic Resonance Imaging

Table 6. Comparison of age, laboratory results, and time between two diffusion MRIs based on findings in follow-up diffusion MRI

Variable	No Findings (n = 146)	Findings Present (n = 25)	p
Age (years)	65.3 ± 14.75 (66)	70.08 ± 13.86 (72)	0.047
Leukocytes (x10³/mcL)	9.43 ± 3.49 (8.83)	8.17 ± 2.47 (8.2)	0.113
Hemoglobin (g/dL)	12.74 ± 1.94 (12.9)	13.28 ± 1.65 (13.6)	0.185
Platelets (x10³/mL)	229.61 ± 76.02 (228)	254.52 ± 62.17 (256)	0.123*
Urea (mg/dL)	42.43 ± 25.64 (37)	42.32 ± 15.34 (42)	0.622
Creatinine (mg/dL)	1.04 ± 0.8 (0.84)	0.88 ± 0.26 (0.79)	0.996
Sodium (mEq/L)	137.79 ± 5.49 (138)	136.32 ± 5.03 (138)	0.343
Potassium (mEq/L)	4.12 ± 0.55 (4.1)	4.3 ± 0.57 (4.16)	0.141*
ALT (U/L)	23.39 ± 38.35 (15)	16.6 ± 6.51 (16)	0.893
AST (U/L)	30.14 ± 39.56 (22)	24.84 ± 13.48 (22)	0.728
Time between two diffusion MRIs (hours)	13.7 ± 11.86 (7)	18.88 ± 15.34 (14)	0.159

*Independent samples (Student's) t-test was used for analysis. Mann-Whitney U test was used for other comparisons. ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, MRI: Magnetic Resonance Imaging, Mean (± Standard Deviation), Median

DOI: 10.5455/medscience.2025.12.355

Table 7. Distribution of comorbidities based on findings in follow-up diffusion MRI

Variable	No findings (n = 146)	Findings present (n = 25)	p
Comorbidities			
None	19 (13.0%)	0 (0.0%)	0.079*
Present	127 (87.0%)	25 (100.0%)	
Hypertension	81 (55.5%)	18 (72.0%)	0.132
Diabetes mellitus	45 (30.8%)	10 (40.0%)	0.364
Coronary artery disease	14 (9.6%)	6 (24.0%)	0.084*
Malignancy	10 (6.8%)	3 (12.0%)	0.409*
Epilepsy	12 (8.2%)	0 (0.0%)	0.218*
Chronic kidney failure	9 (6.2%)	0 (0.0%)	0.760*
Alzheimer's/dementia	9 (6.2%)	0 (0.0%)	0.360*
Hyperlipidemia	3 (2.1%)	3 (12.0%)	**0.041***
COPD	5 (3.4%)	0 (0.0%)	1.000*
Hypothyroidism	4 (2.7%)	0 (0.0%)	1.000*
Vertigo	4 (2.7%)	0 (0.0%)	1.000*
Parkinson's disease	3 (2.1%)	1 (4.0%)	0.472*
Benign prostatic hyperplasia	3 (2.1%)	0 (0.0%)	1.000*
Migraine	3 (2.1%)	0 (0.0%)	1.000*
Bipolar disorder	2 (1.4%)	0 (0.0%)	1.000*
Arrhythmia	2 (1.4%)	0 (0.0%)	1.000*
Asthma	2 (1.4%)	0 (0.0%)	1.000*
Congestive heart failure	1 (0.7%)	1 (4.0%)	0.272*
Anemia	1 (0.7%)	0 (0.0%)	1.000*
Ankylosing spondylitis	1 (0.7%)	0 (0.0%)	1.000*
Glaucoma	1 (0.7%)	0 (0.0%)	1.000*
Hepatitis B	1 (0.7%)	0 (0.0%)	1.000*
Heart valve replacement	1 (0.7%)	0 (0.0%)	1.000*
Multiple sclerosis	1 (0.7%)	0 (0.0%)	1.000*
Obstructive sleep apnea syndrome	1 (0.7%)	0 (0.0%)	1.000*
Psychosis	1 (0.7%)	0 (0.0%)	1.000*
Thyroiditis	1 (0.7%)	0 (0.0%)	1.000*
Trigeminal neuralgia	1 (0.7%)	0 (0.0%)	1.000*
Coronary artery bypass surgery	0 (0.0%)	1 (4.0%)	1.000*
Familial mediterranean fever	0 (0.0%)	1 (4.0%)	1.000*
Hyperthyroidism	0 (0.0%)	1 (4.0%)	1.000*
Hearing loss	0 (0.0%)	1 (4.0%)	1.000*

*Fisher's exact test was used for analysis. Chi-square test was used for other comparisons. COPD: Chronic Obstructive Pulmonary Disease, MRI: Magnetic Resonance Imaging

Table 8. Multivariable logistic regression analysis showing independent risk factors associated with positive findings in follow-up diffusion MRI

Variable	OR [95% CI]	p
Age (years)	1.027 [0.995 - 1.061]	0.102
Hyperlipidemia (+)	**7.434 [1.369 - 40.357]**	**0.020**
(Constant)	0.025	0.002

Dependent variable: Positive findings in follow-up MRI Nagelkerke R^2: 0.072, $p < 0.001$; CI: confidence interval, MRI: magnetic resonance imaging, OR: odds ratio

DOI: 10.5455/medscience.2025.12.355

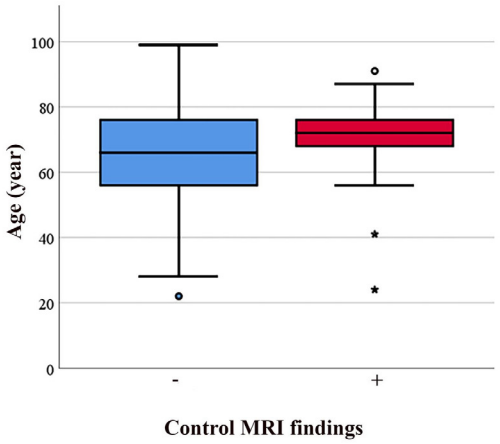

Figure 1. Graphical representation of age distribution based on findings in follow-up diffusion MRI

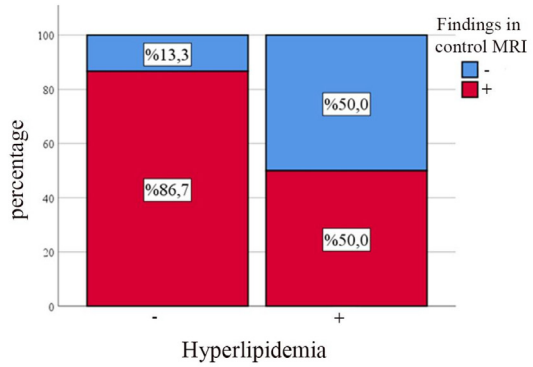

Figure 2. Graphical representation of pathology detection in follow-up diffusion MRI based on presence of hyperlipidemia

Discussion

This retrospective analysis evaluated the utility of follow-up DWI-MRI in emergency department patients with clinically suspected acute ischemic stroke but an initially negative baseline scan. Our principal findings indicate that 14.6% (1 in 7) of such patients demonstrate new ischemic lesions on repeat imaging. Furthermore, hyperlipidemia emerged as an independent predictor of these delayed-appearing lesions, even after adjusting for age.

The critical importance of rapid neuroimaging in acute stroke is well established. While non-contrast computed tomography (CT) remains the initial modality of choice for excluding hemorrhage, its sensitivity for early ischemia is limited [7]. Magnetic resonance imaging (MRI), particularly diffusion-weighted sequences (DWI), offers superior sensitivity for acute infarction and is instrumental in guiding reperfusion therapies [8,9]. However, even DWI can be falsely negative in the hyperacute phase, with reported rates of "DWI-negative" stroke varying from 5% to as high as 25% when imaging is performed very early [10]. Our observed rate of 14.6% aligns with this range and underscores a diagnostic gap where clinical suspicion must override a single negative scan. This reinforces the axiom that "time is brain" [11] and highlights the complementary roles of serial imaging and clinical acumen.

A key finding of our study was the strong association between hyperlipidemia and the detection of pathology on follow-up DWI-MRI. Patients with hyperlipidemia had over a seven-fold increased odds (OR = 7.434) of having a positive repeat scan. This is consistent with the fundamental role of dyslipidemia in atherosclerosis, a primary mechanism of ischemic stroke [12]. Elevated lipid levels contribute to endothelial dysfunction and plaque formation not only in extracranial vessels but also within the cerebral and coronary circulations, increasing the risk of both atherothrombotic and cardioembolic events [13,14]. While some prior studies, such as that by Zuo et al., did not find an independent link between LDL elevation and DWI-negative stroke in multivariate models [15], our results suggest that hyperlipidemia may influence the temporal visibility of ischemia on DWI, possibly through effects on collateral flow or microvascular integrity. The clinical implication is clear: a history of hyperlipidemia should heighten vigilance and lower the threshold for repeat imaging in patients with persistent symptoms despite an initially normal DWI.

Contrary to the univariate association, age was not an independent risk factor in our multivariate model. This suggests that the correlation between advanced age and positive follow-up imaging may be mediated by the increased prevalence of conditions like hyperlipidemia in older populations [16,17]. Aging is accompanied by progressive vascular changes including endothelial dysfunction and impaired autoregulation that elevate stroke risk [18]. However, our analysis indicates that the presence of specific modifiable risk factors, rather than age alone, may be more directly pertinent to the likelihood of delayed lesion appearance on MRI.

The anatomical distribution of lesions in our cohort was diverse, with the brainstem being the most commonly affected site among positive cases. This observation resonates with literature indicating that posterior circulation infarcts, often presenting with non-specific symptoms like dizziness, are more frequently missed on initial imaging and may exhibit delayed DWI positivity compared to anterior circulation events [19,20]. Interestingly, we found no significant relationship between the scan interval (mean ~14.5 hours) and the yield of follow-up MRI. This contrasts with some reports suggesting that very early initial scanning (within 6-12 hours) is a major factor behind false-negative DWI results [21]. Our null finding may reflect the relatively narrow and clinically dictated imaging window in our cohort.

Limitations

Several limitations warrant consideration. The retrospective, single-center design may introduce selection bias and limits generalizability. Data on certain potential confounders, including detailed lipid subfractions, statin use prior to admission, and precise lesion volumes, were not consistently available. The timing of follow-up MRI was based on clinical discretion rather than a standardized protocol, which may have influenced detection rates. Furthermore, the clinical indication for repeat imaging (persistent symptoms) and the follow-up setting were

DOI: 10.5455/medscience.2025.12.355

not randomized, potentially introducing selection bias. Future prospective, multi-center studies with predefined imaging timepoints and more comprehensive biomarker profiling are needed to validate our findings and better identify which patients benefit most from serial MRI.

Conclusion

This study demonstrates that a substantial minority of emergency department patients with clinically suspected acute ischemic stroke approximately one in seven exhibit visible ischemic lesions on follow-up DWI-MRI despite an initially normal scan. Hyperlipidemia was identified as a strong, independent predictor of such delayed-appearing lesions, underscoring its role not only as a general stroke risk factor but also as a marker for patients who may benefit from serial imaging. In contrast, while advanced age showed a univariate association, it was not an independent risk factor in multivariable analysis.

From a clinical standpoint, these findings advocate for a nuanced imaging strategy. In patients with high pre-test probability of stroke particularly those with known hyperlipidemia a single negative DWI-MRI should not definitively exclude ischemic injury if symptoms persist. Early follow-up imaging in this subset can facilitate timely diagnosis, guide appropriate secondary prevention, and potentially improve long-term outcomes. The results may help refine imaging protocols and highlight patient subgroups most likely to benefit from repeat MRI assessment in emergency practice. Future prospective, multicenter studies are warranted to validate these observations and to refine specific criteria incorporating lipid profiles, vascular imaging, and clinical scores for selecting patients most likely to benefit from repeat MRI evaluation.

Ethical Approval
The study protocol was reviewed and approved by the Non Interventional Ethics Committee of the Health Practice and Research Center at the University of Health Sciences İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital (Approval No: 23012023 369, Date: 23.01.2023).

Patient Consent
The requirement for individual informed consent was waived due to the retrospective design.

Conflict of Interest
The authors confirm the absence of any conflicts associated with this work.

Funding
The authors declare that they have received no financial support for the study.

References

1. Roger VL, Go AS, Lloyd-Jones DM, et al.; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics--2012 update: a report from the American Heart Association. Circulation. 2012;125:e2-e220. Erratum in: Circulation. 2012;125:e1002.
2. Phipps MS, Cronin CA. Management of acute ischemic stroke. BMJ. 2020;368:l6983.
3. National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. N Engl J Med. 1995;333:1581-7.
4. Nogueira RG, Jadhav AP, Haussen DC, et al. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. N Engl J Med. 2018;378:11-21.
5. Goyal M, Menon BK, van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. Lancet. 2016;387:1723-31.
6. Mendelson SJ, Prabhakaran S. Diagnosis and management of transient ischemic attack and acute ischemic stroke: a review. JAMA. 2021;325:1088-98.
7. Lin MP, Liebeskind DS. Imaging of ischemic stroke. Continuum (Minneap Minn). 2016;22:1399-423.
8. Campbell BC, Tu HT, Christensen S, et al. Assessing response to stroke thrombolysis: validation of 24-hour multimodal magnetic resonance imaging. Arch Neurol. 2012;69:46-50.
9. Chalela JA, Kang DW, Luby M, et al. Early magnetic resonance imaging findings in patients receiving tissue plasminogen activator predict outcome: insights into the pathophysiology of acute stroke in the thrombolysis era. Ann Neurol. 2004;55:105-12.
10. Newman-Toker DE. Missed stroke in acute vertigo and dizziness: it is time for action, not debate. Ann Neurol. 2016;79:27-31.
11. Kang DW, Kwon JY, Kwon SU, et al. Wake-up or unclear-onset strokes: are they waking up to the world of thrombolysis therapy?. Int J Stroke. 2012;7:311-20.
12. Wang C, Du Z, Ye N, et al. Hyperlipidemia and hypertension have synergistic interaction on ischemic stroke: insights from a general population survey in China. BMC Cardiovasc Disord. 2022;22:47.
13. Camilo O, Goldstein LB. Statewide assessment of hospital-based stroke prevention and treatment services in North Carolina: changes over the last 5 years. Stroke. 2003;34:2945-50.
14. Zeljkovic A, Vekic J, Spasojevic-Kalimanovska V, et al. LDL and HDL subclasses in acute ischemic stroke: prediction of risk and short-term mortality. Atherosclerosis. 2010;210:548-54.
15. Chalela JA, Kidwell CS, Nentwich LM, et al. Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective comparison. Lancet. 2007;369:293-8.
16. Tao WD, Liu M, Fisher M, et al. Posterior versus anterior circulation infarction: how different are the neurological deficits?. Stroke. 2012;43:2060-5.
17. Tarnutzer AA, Lee SH, Robinson KA, et al. ED misdiagnosis of cerebrovascular events in the era of modern neuroimaging: A meta-analysis. Neurology. 2017;88:1468-77.
18. Kitis O, Calli C, Yunten N, et al. Wallenberg's lateral medullary syndrome: diffusion-weighted imaging findings. Acta Radiol. 2004;45:78-84.
19. Caveney AF, Silbergleit R, Frederiksen S, et al. Resource utilization and outcome at a university versus a community teaching hospital in tPA treated stroke patients: a retrospective cohort study. BMC Health Serv Res. 2010;10:44.
20. Kidwell CS, Wintermark M. The role of CT and MRI in the emergency evaluation of persons with suspected stroke. Curr Neurol Neurosci Rep. 2010;10:21-8.
21. Zuo L, Zhang Y, Xu X, et al. A retrospective analysis of negative diffusion-weighted image results in patients with acute cerebral infarction. Sci Rep. 2015;5:8910.