

Research Paper

Prognostic Impact of NIH Stroke Scale, ASPECTS, and Age in Acute Ischemic Thrombectomy

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ABSTRACT

Introduction: Acute stroke represents a critical medical emergency that demands immediate intervention within the emergency department. The severity of this condition highlights the necessity for rapid medical action to mitigate potential cerebral damage and prevent long-term disabilities or mortality. In cases where ischemic stroke is confirmed, timely therapeutic interventions may include the administration of intravenous thrombolysis (IVT) utilizing tissue plasminogen activator (tPA) or the implementation of mechanical thrombectomy (MT).**Methods:** This cohort study targeted patients diagnosed with acute ischemic stroke (AIS) who were considered suitable candidates for MT. Exclusion criteria included individuals with contraindications to the procedure, those unable to provide informed consent, and patients lacking legal representation for consent purposes. A comprehensive questionnaire was utilized to collect demographic information, medical histories, assessments of stroke severity, and precise documentation of symptom onset times. Furthermore, detailed information regarding the affected arterial pathway, thrombolysis in cerebral infarction (TICI) grading, and patient outcomes at the three-month follow-up, as measured by the modified Rankin scale (MRS), were systematically recorded.**Results:** The cohort consisted of 169 patients, with a mean age of 57.85 years (ranging from 19 to 84 years). Among these participants, 76 individuals (44.7%) were male. The average score on the National Institutes of Health stroke scale (NIHSS) was determined to be 17.92, with scores ranging from 6 to 36. The average duration from symptom onset to the initiation of the thrombectomy procedure was recorded at 5.94 hours. A notable pattern of arterial involvement was predominantly observed in the middle cerebral artery (MCA).**Conclusion:** The study used multivariate logistic regression analysis to elucidate the relationships between various factors and three-month outcomes on the MRS. After controlling for confounding variables, including the time interval from symptom onset and pre-existing medical conditions, the analysis revealed that advanced age and higher NIHSS scores were associated with an increased likelihood of unfavorable MRS outcomes.

Keywords:

Ischemic stroke,
Thrombectomy, Prognosis

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Highlights

- Advanced age and higher baseline NIHSS scores independently predicted unfavorable functional outcomes at 3 months after mechanical thrombectomy.
- Multivariable analysis demonstrated that patient age and initial stroke severity were stronger prognostic factors than time from symptom onset or pre-existing comorbidities.
- Patient age and baseline NIHSS score provide clinically valuable prognostic information for individuals with acute ischemic stroke undergoing mechanical thrombectomy.

Plain Language Summary

A stroke occurs when the blood supply to part of the brain is interrupted, depriving brain cells of the oxygen they need. It is a medical emergency because irreversible brain damage can develop within minutes. Mechanical thrombectomy is one of the most effective treatments for selected patients with acute ischemic stroke. During this procedure, physicians remove a blood clot that is blocking a major artery in the brain. Although mechanical thrombectomy can substantially improve recovery, outcomes vary considerably among patients. Identifying the factors associated with recovery can help physicians make informed clinical decisions and provide patients and their families with more accurate prognostic information. In this study, we followed 169 patients with acute ischemic stroke who underwent mechanical thrombectomy. We collected information on their age, medical history, initial stroke severity, time from symptom onset to treatment, and the location of the blocked artery. Functional recovery was assessed 3 months after treatment using a standardized disability scale. Our findings showed that advanced age and greater stroke severity at hospital admission were the strongest predictors of unfavorable functional outcomes after mechanical thrombectomy. These associations remained significant after adjustment for other potentially influential factors, including pre-existing comorbidities and time from symptom onset to treatment. Most patients in the study had an occlusion of the middle cerebral artery, one of the vessels most commonly affected in acute ischemic stroke. These findings highlight the prognostic value of simple clinical characteristics that can be assessed immediately upon hospital admission. Early identification of patients at increased risk of unfavorable outcomes may help healthcare professionals provide more accurate prognostic information, individualize treatment and follow-up plans, and prioritize rehabilitation services. Ultimately, this information may contribute to improved stroke care and better support patients and their families throughout the recovery process.

Introduction

Stroke represents a significant global health challenge, ranking as a leading cause of mortality and morbidity. The number of stroke-related deaths escalated from 4.6 million in 1990 to approximately 6.6 million in 2019, constituting 11.59% of all global fatalities (Phipps & Cronin, 2020). Notably, 87% of deaths and disabilities resulting from stroke occur in low- and middle-income countries (Calvet et al., 2012). Within the Middle East, stroke emerged as the second leading cause of death in 2019, a trend mirrored in Iran, where it similarly ranked as the second leading cause of mortality during the same year (SariAslani et al., 2020). Although the age-standardized incidence rate (ASIR) and age-standardized death rate (ASDR) for stroke are declining nationally in Iran, the absolute number of new stroke cases and related fatali-

ties has risen, primarily attributable to population growth (SariAslani et al., 2020).

Upon presentation to the emergency department (ED), it is imperative for the healthcare team to stabilize the patient's vital signs and evaluate the necessity for expedited brain imaging and therapeutic interventions, including intravenous thrombolysis (IVT) or mechanical thrombectomy (MT) (Lichtman et al., 2010). The current protocol for IVT necessitates administration within a four-and-a-half-hour window from symptom onset. However, this treatment modality carries an inherent risk of bleeding and is only applicable to 2% to 10% of acute ischemic stroke (AIS) cases, demonstrating efficacy in less than 30% of large vessel occlusions. Furthermore, its effectiveness is limited by strict eligibility criteria and the narrow therapeutic window, with bleeding complications remaining a major concern (Katzan et al., 2014).

MT, on the other hand, involves the catheter-based removal of the obstructive blood clot. This procedure is typically performed in conjunction with IVT and is most effective when conducted within six hours of symptom onset; however, it may be executed up to 24 hours post-symptom onset. MT serves as a viable alternative or adjunctive treatment for patients who are ineligible for IVT or who do not exhibit a favorable response to it. It is now considered one of the most significant therapeutic advancements in the management of AIS (Fonarow et al., 2014).

Research indicates that MT markedly enhances patient outcomes, particularly among individuals with major vessel occlusions, leading to reduced disability and improved overall quality of life (Holloway et al., 2014). Furthermore, studies have demonstrated that the incidence of intracerebral hemorrhage and the prevalence of cerebral microbleeds following IVT are more pronounced in Asian populations, thereby underscoring the attractiveness of MT as a treatment option within these demographics (Pishbin et al., 2024). These regional differences reinforce the need to better understand MT outcomes in diverse populations.

The efficacy of MT is contingent upon several factors, including patient selection, the anatomical location of the clot, and the duration since symptom onset. Nonetheless, numerous studies affirm that MT yields superior outcomes compared to standard medical management alone (Almekhlafi et al., 2014). Given the increasing use of MT and the paucity of region-specific outcome data, this study aimed to evaluate the prognosis of patients with AIS undergoing MT.

Materials and Methods

Study design

This cohort study was carried out on patients with AIS who were referred to Ghaem and Razavi Hospitals in Mashhad, which serve as major referral centers for neurological emergencies. We studied patients who underwent MT from April 1, 2018 to February 29, 2019. The study focused on patients aged between 18 and 80 years, presenting with AIS symptoms within a 6-hour window from onset, as confirmed by either magnetic resonance imaging (MRI) or computed tomography (CT) scan. The selection protocol and clinical decision-making for MT were consistently applied across both hospitals. The eligibility criteria for MT were established based on the guidelines outlined by the American Heart Association. Patients with contraindications for MT (such as intracra-

nial hemorrhage or severe comorbidities), those unable to provide informed consent, and individuals lacking a legally authorized representative were excluded from participation (Figure 1). Patients with incomplete medical records or unavailable follow-up data were also excluded to ensure the accuracy of outcome assessment. The determination of the sample size was informed by the complete count of cases over a 12-month period. Thus, a census sampling method was used, including all eligible patients who underwent MT during the study timeframe.

Instrument

A detailed questionnaire specifically designed for this study was utilized to collect relevant data, which included demographic information (age and gender), medical history (notably conditions, such as hypertension, diabetes, and hyperlipidemia), and an evaluation of stroke severity employing the National Institutes of Health stroke scale (NIHSS), the Alberta stroke program early CT (ASPECT) score, and the precise timing of symptom onset. Additionally, patient outcomes were monitored at the three-month follow-up using the modified Rankin scale (MRS).

Statistical analysis

Categorical variables were reported as absolute counts and percentages, while quantitative variables were expressed as means and ranges. The analysis included univariate assessments to identify factors associated with favorable functional outcomes, as well as multivariate Cox regression analyses to evaluate factors influencing survival. To assess the survival rate of AIS within the first 90 days, Kaplan-Meier analysis was performed. A $P < 0.05$ was considered statistically significant. Statistical analyses were conducted using SPSS software version 23.

Ethical considerations

The study was conducted in strict adherence to ethical guidelines and received approval from the Organizational Ethics Committee of Mashhad University of Medical Sciences. Throughout the study, rigorous measures were implemented to ensure the confidentiality and privacy of patient information.

Results

In this study, a comprehensive evaluation was conducted involving a cohort of 169 patients, with a mean age of 57.78 ± 13.45 years (range: 19-84). Among the partici-

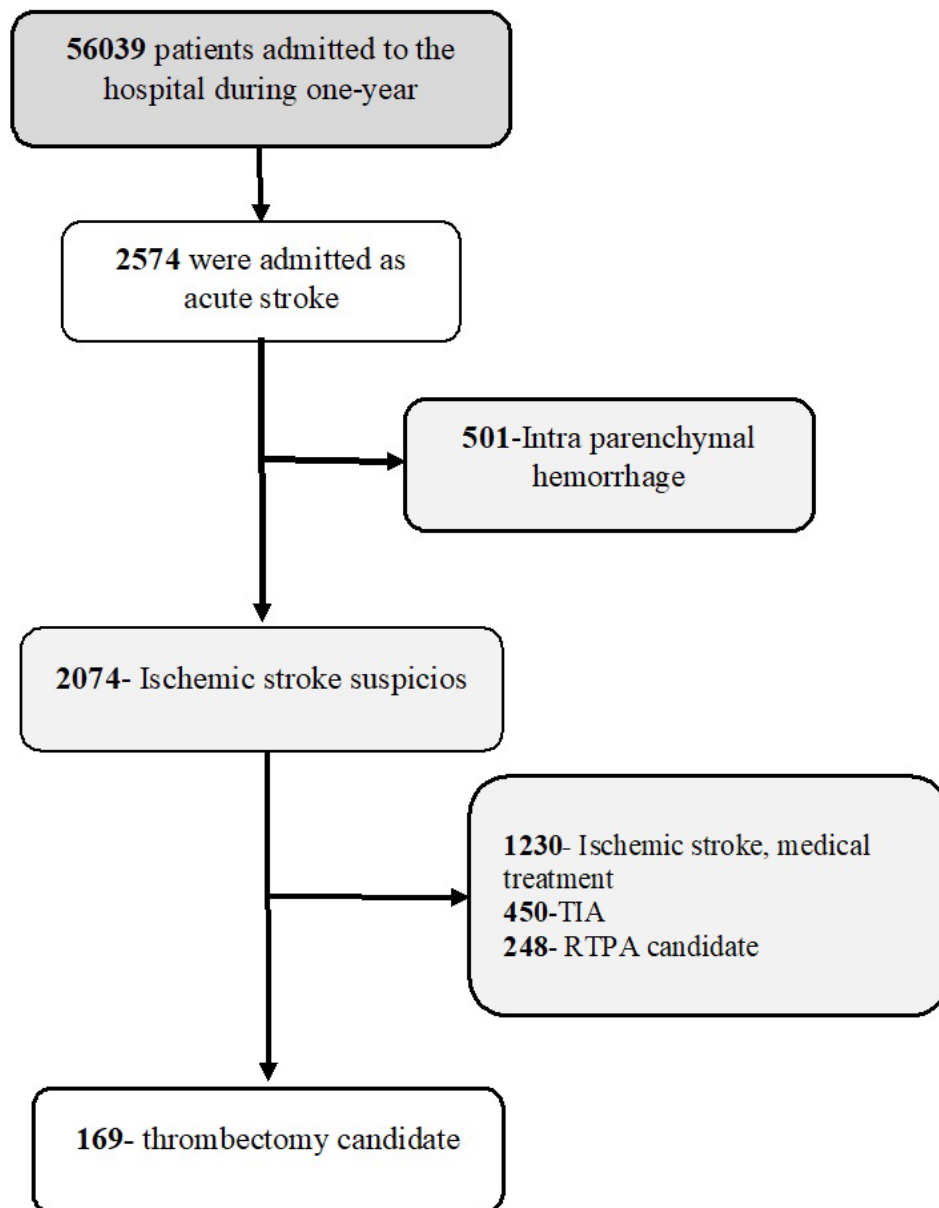


Figure 1. Study protocol

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pants, 95 individuals (56.2%) were male, and a significant majority, 136 patients (87.2%), reported no underlying comorbidities. The baseline mean NIHSS score was recorded at 17.91 ± 14.67 (range: 6-36), while the average interval from symptom onset to thrombectomy was 5.94 hours (range: 2-12 hours).

An analysis of the predominant arterial involvements revealed the following distribution: middle cerebral artery (MCA) involvement was observed in 95 cases (56.2%), followed by internal carotid artery (ICA) involvement in 64 cases (37.9%), and vertebral basilar (VB) involvement in 10 cases (5.9%). Notably, two patients exhibited concurrent ICA and MCA involvement.

Furthermore, it is pertinent to mention that 23 patients received recombinant tissue plasminogen activator (rtPA) prior to undergoing thrombectomy. A comparative analysis of the patients' medical histories between those who survived and those who did not is summarized in [Table 1](#).

The investigation into the prognostic implications of demographic and clinical variables on patient outcomes, as measured by the MRS three months post-thrombectomy, revealed a significant gender-based disparity. Specifically, the distribution of favorable MRS scores (1, 2, and 3, indicative of good recovery) demonstrated a marked contrast between genders, with 32.8% of men achiev-

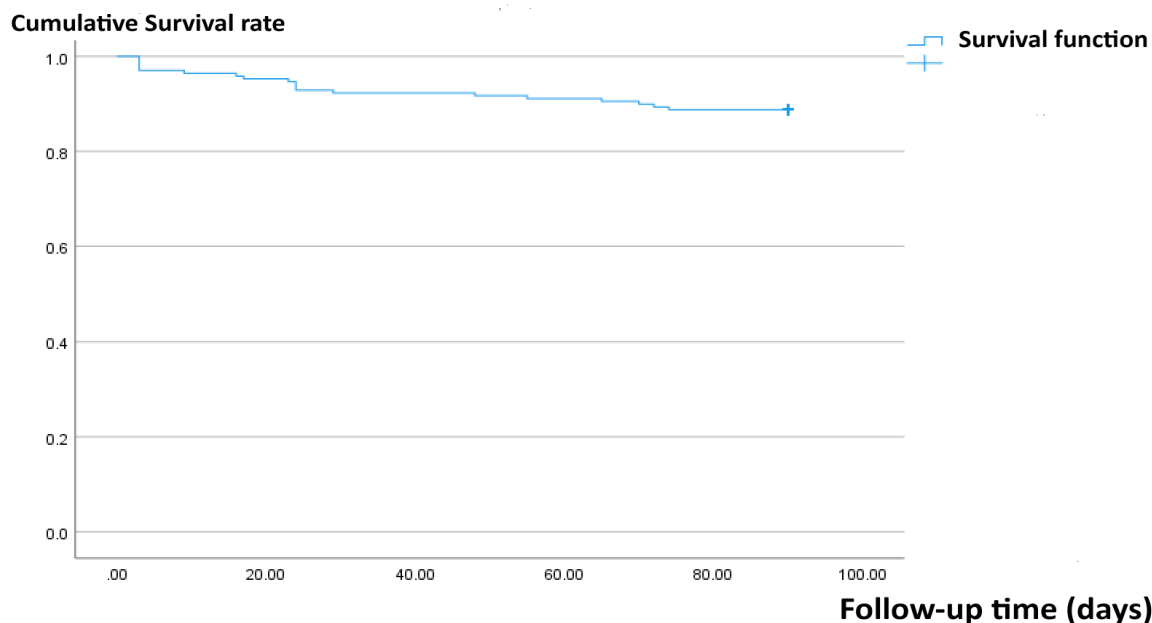


Figure 2. Kaplan-Meier curve for three-month death rate in 169 patients with AIS

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ing these outcomes compared to a more favorable 67.2% among women ($P=0.042$). Conversely, the categorization of MRS scores as 4, 5, or 6, indicative of poor recovery, showed no discernible correlation with underlying diseases. While the majority (60%) of patients exhibiting good recovery displayed MCA involvement, statistical

analysis did not establish a significant association between MRS outcomes and specific arterial involvements ($P=0.31$) (Table 1).

To assess the independent effects of statistically significant characteristics observed in the two study groups on survival, a multivariate Cox regression model was

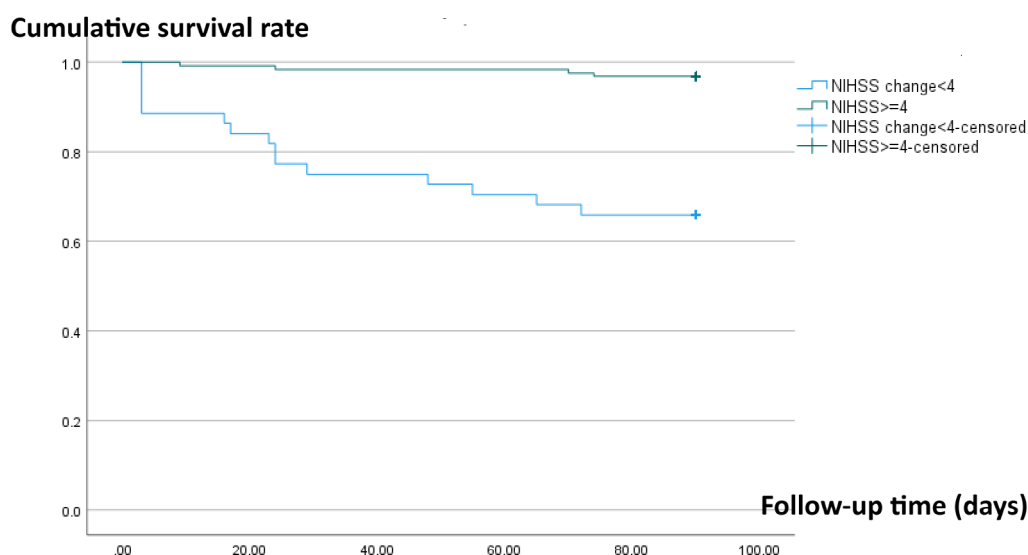


Figure 3. Kaplan-Meier curve for three-month death rate in 169 patients with AIS grouped into two groups based on changes in the NIHSS score (<4 or ≥ 4)

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Table 1. Variables among survived and non-survived patients

Variables		Mean (Range)/No. (%)		P
		Survived (n=152)	Non-survived (n=17)	
A. Demographic variables	Age (y)	57.13 (19-62)	63.65 (48-84)	0.015
	Male gender	83(54.6)	12(70.6)	0.208
B. Past medical history	HLP	15(9.9)	3(17.6)	0.586
	DM	43(28.3)	9(52.9)	0.037
	HTN	38(25)	11(64.7)	0.01
	Smoker	33(21.7)	3(17.6)	0.698
C. Time interval	Time to needle (h)	5.9 (2-13)	7.4 (2-16)	0.67
D. Stroke-related variables	Admission	17.7 (6-29)	19.41(10-36)	
	NIHSS			
	24 h	10.64 (2-26)	19.35 (10-32)	0.04
	72 h	8.07 (0-26)	15.7 (6-21)	
	ASPECT	7.14 (3-10)	6.94 (3-10)	0.01
	Passage number	2.25 (1-6)	3.29 (1-8)	0.02
MRS	Admission	2.74 (1-5)	4.82 (4-5)	0.03
	After 3 months	1.28 (0-5)	-	

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Abbreviations: HLP: Hyperlipidemia; DM: Diabetes mellitus; HTN: Hypertension; H: Hour; NIHSS: National Institutes of Health Stroke scale; ASPECT: Alberta stroke programme early CT score; MRS: Modified Ranking scales.

Note: The investigation into the prognostic implications of demographic and clinical variables on patient outcomes, as measured by the MRS three months post-thrombectomy, revealed a significant gender-based disparity. Specifically, the distribution of favorable MRS scores (1, 2, and 3, indicating good recovery) showed a notable contrast between genders, with 32.8% of men achieving these outcomes compared to a more favorable 67.2% among women ($P=0.042$). Conversely, the categorization of MRS scores as 4, 5, or 6, which denote poor recovery, showed no discernible correlation with underlying diseases. While the majority (60%) of patients with good recovery exhibited middle cerebral artery (MCA) involvement, no significant association was found between MCA involvement and recovery outcomes ($P=0.31$).

employed. All variables that demonstrated a $P<0.2$ in univariate analysis were included in the model. Consequently, age, sex, hypertension (HTN), diabetes mellitus (DM), passage number, MRS scores, and changes in NIHSS scores were incorporated into the model. The results of the Cox regression analysis are presented in Table 2. Notably, HTN ($P=0.01$), greater changes in NIHSS scores ($P=0.04$), and MRS scores ($P<0.001$) emerged as statistically significant independent variables influencing survival outcomes (Table 2).

The 90-day follow-up results for patients with AIS are illustrated in the Kaplan-Meier curve presented in Figure 2. In total, 5 patients (26.31%) succumbed within the first three days post-admission, while 8 patients (42.1%) died

during the first month; an additional 6 cases (31.57%) of mortality occurred between days 30 and 90 (Figure 2).

The findings of this study indicated that among the 19 patients who died within the first 90 days of follow-up, in 15 cases (78.9%), the change in NIHSS scores between the first and third day of admission was less than four points. The Kaplan-Meier curve depicting the three-month mortality rate among the 170 patients with AIS is stratified into two groups based on changes in the NIHSS score (<4 or ≥ 4) and is illustrated in Figure 3.

Table 2. Factors affecting survival

	Factors	Hazard Ratio	95% CI	P
Univariate analysis	Age	0.95	0.91, 1	0.06
	Male gender	0.5	0.16, 1.49	0.21
	Hypertension	5.5	1.90, 15.88	0.002
	Diabetes mellitus	2.85	1.03, 7.87	0.04
	Smoking	0.77	0.20, 2.85	0.69
	Passage number	0.61	0.43, 0.86	0.005
	MRS	0.08	0.02, 0.27	<0.001
Multivariate analysis (backward method)	Change in the NIHSS score (admission-72 h) <4	18.97	5.12, 70.29	<0.001
	Hypertension	3.13	1.22, 8.05	0.01
	Change in the NIHSS score (admission-72 h) <4	3.25	1.04, 10.17	0.04
	MRS	4.99	2.19, 11.37	<0.001

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Discussion

Our investigation showed a significant correlation between elevated NIHSS scores at presentation and unfavorable clinical outcomes following thrombectomy procedures. The distinct advantage of the NIHSS lies in its ease of application, facilitating straightforward bedside calculation without the necessity for supplementary clinical imaging. This study further underscores the utility of the NIHSS, not only as a measure of stroke severity but also as a valuable predictor of MT outcomes.

These findings resonate with prior research. Notably, [Almekhlafi et al. \(2014\)](#) explored the impact of age and NIHSS scores on MT outcomes, introducing the SPAN index—a composite measure of age and NIHSS. Their study, which included 196 patients, revealed that reperfusion success among individuals with both elevated age and NIHSS did not significantly differ from those with advanced age and lower NIHSS scores. Consistent with our own results, their work highlighted an association between higher SPAN scores and poorer clinical outcomes.

Additionally, [Pfaff et al. \(2016\)](#) conducted a pertinent investigation into MT outcomes in patients presenting with low NIHSS scores. Their study focused on individuals with an NIHSS score of 5 and reported a 63.6% incidence of favorable clinical outcomes within three months. The authors concluded that favorable MT outcomes were more prevalent in cases of milder strokes,

a conclusion that aligns with our findings and logically follows the premise that patients exhibiting milder symptoms are inherently more responsive to treatment.

In 2019, another study examined the relationship between NIHSS scores and MT outcomes in a cohort of 183 patients with internal carotid artery or MCA occlusions ([Aoki et al. 2019](#)). The findings from this investigation emphasized the independent role of NIHSS as a determinant influencing recanalization success.

Our study corroborates these earlier investigations, reinforcing the pronounced relationship between NIHSS scores and the achievement of recanalization. However, certain discrepancies exist within the literature. [Seker et al. \(2017\)](#) scrutinized a cohort of 104 patients with acute MCA occlusion and found no statistically significant relationship between NIHSS scores and recanalization rates according to the thrombolysis in cerebral infarction (TICI) criteria. Conversely, [Wang et al. \(2021\)](#) identified significant differences in NIHSS scores between patients with successful and unsuccessful recanalization. This divergence is further supported by research conducted by [Rha & Saver \(2007\)](#) which similarly indicates a substantial correlation between NIHSS scores and successful recanalization.

It is plausible that the variation between our findings and those of the aforementioned studies may be attributed to differences in the number of endovascular throm-

bolysis attempts, as multiple passes have been associated with recanalization outcomes. However, this aspect was not incorporated into our study parameters.

Furthermore, our investigation posits age as an independent prognostic determinant of clinical outcomes. Examining the impact of age on post-treatment consequences is of considerable significance, particularly given the substantial representation of elderly individuals within the acute stroke patient population. Studies focusing on geriatric patients have consistently indicated that advanced age correlates with more severe clinical ramifications following intravenous fibrinolysis, with elderly patients experiencing less favorable outcomes compared to their younger counterparts. It is noteworthy that data concerning geriatric patients undergoing endovascular treatment remain limited, primarily due to the frequent exclusion of individuals over 80 years of age from research studies.

In summary, our study contributes to the expanding body of evidence that underscores the centrality of NIHSS scores in predicting outcomes following MT. While our findings are consistent with prior research in principle, they offer nuanced insights regarding recanalization success and emphasize the critical role of age in post-treatment prognostication. Further exploration within larger and more diverse patient cohorts, which includes the examination of variables, such as the frequency of endovascular thrombolysis, could yield a more comprehensive understanding of the intricate interplay between the NIHSS score, age, and clinical outcomes in the context of thrombectomy interventions.

Conclusion

The cumulative body of literature reviewed in this analysis provides substantial support for the efficacy of MT as a leading therapeutic approach for addressing AIS resulting from large vessel occlusion. Evidence of consistently favorable functional outcomes, reduced mortality rates, and sustained benefits in long-term follow-ups affirms the procedure as a reliable intervention. Nonetheless, it is imperative to emphasize the necessity for ongoing research aimed at refining patient selection criteria and enhancing procedural methodologies. By doing so, the potential for optimizing favorable prognoses subsequent to MT can be maximized.

In the context of this investigation, the findings elucidate the influential roles of age and the NIHSS score in predicting three-month outcomes for patients undergoing MT. These identified predictive factors contribute to

a more comprehensive understanding of patient responses to the intervention, thereby providing opportunities for improved patient care and refined treatment strategies. Clinically, these results underscore the importance of early and accurate assessment of stroke severity and baseline characteristics to guide timely decision-making and individualized treatment planning. Future studies should aim to evaluate additional prognostic markers, explore long-term functional and cognitive outcomes, and investigate strategies to improve post-thrombectomy care pathways—particularly in resource-limited settings. Such efforts may help expand access, reduce disparities, and further enhance the overall effectiveness of MT in diverse patient populations.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of [Mashhad University of Medical Sciences](#), Mashhad, Iran (Code: IR.MUMS.MEDICAL.REC.1398.565).

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This study was extracted from the medical practitioner thesis of Amirhosein Naseri, approved by the Faculty of Medicine, [Mashhad University of Medical Sciences](#), Mashhad, Iran.

Authors' contributions

Conceptualization and supervision: Elnaz Vafadar Moradi and Humain Baharvahdat; Methodology, software, validation, and formal analysis: Shabnam Niroumand; Investigation and resources: Elham Pishbin, Zahra Ahmadi, and Amirhosein Naseri; Data curation: Amirhosein Naseri; Writing the original draft: Elnaz Vafadar Moradi and Elham Pishbin; Review and editing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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