Impact of vascular risk factors on endovascular mechanical thrombectomy outcomes in patients with stroke

WALAA A. ALDARWISH[1], SHAHID BASHIR[2,3], EMAN MOHAMMED ALI[1,3] and BADER ALENZI[1]

[1]Neurology Department, Neuroscience Center, King Fahad Specialist Hospital-Dammam, Dammam 32253-3202, Saudi Arabia;
[2]Neuroscience Center, King Fahad Specialist Hospital-Dammam, Dammam 32253-3202, Saudi Arabia;
[3]King Salman Center for Disability Research, Riyadh 11614, Saudi Arabia

Received February 11, 2025; Accepted July 2, 2025

DOI: 10.3892/br.2025.2046

Abstract. Endovascular mechanical thrombectomy (MT) is a recommended treatment for acute ischemic stroke due to large vessel occlusion (LVO). The objective of the present study was to evaluate the impact of vascular risk factors on the outcome of MT outcomes in patients with stroke with LVO and to determine the prevalence of structural epilepsy in these patients. This was a retrospective cohort study involving patients with stroke between 20 and 80 years of age with LVO who underwent MT. The clinical outcomes post-MT were assessed using the Modified Thrombolysis in Cerebral Infarction score. A total of 56 individuals were included in the study, with a structural epilepsy prevalence of 14.29%. Patients who received intravenous tissue plasminogen activator (TPA) in addition to MT were less likely to develop structural epilepsy (P=0.041). A substantial number of patients (85.8%, combined Grades 3 and 2B) achieved successful reperfusion. The significant risk factors for hemorrhagic transformation include age [odds ratio (OR), 2.5; 95% CI: 1.8-3.6; P=0.001], hypertension (OR, 3; 95% CI: 2.2-4.1; P<0.001), diabetes (OR, 1.8; 95% CI: 1.2-2.7; P=0.008), heart failure (OR, 1.5; 95% CI: 1.0-2.2; P=0.050) and cardiac thrombus (OR, 2.0; 95% CI: 1.3-3.1; P=0.005). Age was a significant predictor, with patients aged 65 years or younger having an OR of 2.3 (95% CI: 1.5-3.5, P=0.002). In conclusion, the present study provides valuable insights into the impact of vascular risk factors on the outcomes of MT in patients with stroke with LVO and highlights key predictors of post-procedural complications, including structural epilepsy and hemorrhagic transformation.

Correspondence to: Dr Walaa A. Aldarwish, Neurology Department, Neuroscience Center, King Fahad Specialist Hospital-Dammam, 6830 Ammar Bin Thabit Street, Al Merikbat, Dammam 32253-3202, Saudi Arabia
E-mail: walaa.abdulaziz94@gmail.com

Key words: stroke, large vessel occlusion, mechanical thrombectomy, epilepsy, tissue plasminogen activator, thrombolysis in cerebral infarction score, Saudi Arabia

Introduction

Stroke remains one of the leading causes of death and long-term disability worldwide, with large vessel occlusion (LVO) representing one of the most severe subtypes due to the extensive brain regions affected (1). Mechanical thrombectomy (MT) has transformed the management of acute ischemic stroke by enabling rapid reperfusion and significant functional recovery in patients with LVO (2,3). Current guidelines recommend MT based on several criteria: The location of occlusion (typically proximal anterior circulation, such as the internal carotid artery or middle cerebral artery), the time from stroke onset (within 6-24 h), and acceptable infarct burden commonly assessed by an Alberta Stroke Program Early CT Score [ASPECTS]≥6 or infarct volume <50 ml) (4).

MT involves the physical removal of a thrombus using stent retrievers or aspiration devices to restore cerebral perfusion (5). Although MT has been major advance in stroke therapy, clinical outcomes vary, and not all patients benefit equally from the procedure (6). Vascular risk factors such as hypertension, diabetes, hyperlipidemia and smoking are well-established contributors to cerebrovascular pathology and may influence the efficacy and safety of thrombectomy procedures (7). The present study aims to evaluate the impact of these pre-existing vascular conditions on clinical outcomes following MT in patients with LVO, thereby contributing to more personalized and effective treatment strategies. However, functional outcomes following MT vary significantly and are influenced by pretreatment factors such as age and comorbidities (8,9). Numerous pre- and intra-procedural variables have been identified as predictors of clinical outcomes (10).

Although vascular risk factors such as hypertension and diabetes mellitus are widely recognized to influence MT outcomes, their independent prognostic roles remain debated. For instance, the role of diabetes mellitus in predicting poorer recanalization success is controversial, with conflicting evidence in the literature (11). Moreover, the impact of glycemic variability-beyond absolute hyperglycemia-remains underexplored. Existing thresholds for glycemic control (for example, <180 mg/dl.) are derived from heterogeneous clinical protocols, further complicating standardization (11). These ongoing controversies emphasize the need for improved risk

stratification and standardized peri-procedural management strategies.

Factor such as hyperglycemia, advanced age, higher baseline NIHSS score, and failed recanalization increase the risk of unfavorable outcomes at 90 days in patients with acute ischemic stroke treated with MT (12). In addition to preventing complications, optimizing of blood pressure, glucose levels and hemoglobin concentrations represent potentially modifiable factors that merit further investigation (9).

Post-stroke seizures are another frequent complication and are associated with poorer functional outcomes. A systematic review in 2022 reported that 5.8% of patients with stroke undergoing MT developed seizures. However, the relationship between MT and post-stroke seizures remains inconclusive, and the mechanisms linking LVO-related stroke and seizure activity are not yet fully understood (13), Saver *et al* (14) were the first to confirm the significant benefit of MT in patients with LVO, providing the foundational evidence for current clinical guidelines.

Regarding glycemic management during MT, recent studies have clarified the clinical relevance of maintaining intraoperative glucose levels below 180 mg/dl. For example, the study by Janelidze *et al* (15) demonstrated improved outcomes with strict glycemic control, highlighting the importance of real-time glucose monitoring during MT to enhance prognosis.

The present study aims to investigate the impact of vascular risk factors on the clinical outcomes of MT in patients with stroke with LVO. Additionally, it seeks to determine the prevalence of structural epilepsy in this population, a complication that can profoundly affect quality of life and long-term prognosis. By examining this prevalence, the study aims to contribute to more comprehensive post-stroke management strategies, addressing both acute intervention, and long-term complication. Understanding and managing modifiable vascular risk factors will be critical for optimizing MT outcomes and improving patient care.

Patients and methods

Study design. The present study utilizes a retrospective cohort design, focusing on patients who experienced ischemic stroke due to LVO and subsequently underwent endovascular MT.

Study duration and setting. The study was conducted at a single tertiary care center and included medical records reviewed from 2018 to 2023. Data collection began in June 2023 and was completed in December 2023.

Participants. A total of 56 patients (25 women and 31 men) with stroke aged between 20 and 80 years, who underwent MT for LVO during the study period, were included. Patients were identified through hospital medical records. Only those who received MT were eligible; patients who did not undergo the procedure were excluded.

Diagnosis. Post-stroke epilepsy was diagnosed based on the International League Against Epilepsy criteria, requiring at least one unprovoked seizure occurring >24 h after stroke onset, with corroborative electroencephalogram (EEG) or clinical documentation.

Data collection method. Data were collected retrospectively by electronic medical records. The variables gathered included demographic details, vascular comorbidities (for example, hypertension, diabetes), clinical outcomes post-MT, and the incidence of post-stroke (structural) epilepsy.

Outcome assessment. The primary clinical outcome was assessed using the Modified Thrombolysis in Cerebral Infarction (mTICI) scoring system, which measures the degree of reperfusion post-MT.

Sample size justification. A sample size of 56 patients was determined based on the available eligible cases during the study period. While relatively small, this sample was deemed sufficient to provide preliminary insights into the relationship between vascular risk factors and MT outcomes, as well as to estimate the prevalence of post-stroke epilepsy in this population.

Data analysis. Statistical analysis was performed using Stata BE 18 software (2023; StataCorp LLC). Continuous variables were expressed as the mean ± standard deviation, while categorical variables were expressed as percentages. A t-test and a Chi-square test were used. Statistical significance was set at a P-value of less than 0.05. Differences in demographic characteristics and the prevalence of vascular risk factors were examined. Descriptive statistics were calculated for all variables. Pearson's Chi-square test or Fisher's exact test was used to test differences in proportions between groups, where appropriate. Regression analysis was used to determine the extent to which vascular risk factors predict the outcomes of endovascular MT in patients with stroke, considering other patient characteristics and comorbidities.

Ethical considerations. The Institutional Review Board (IRB) of King Fahad Specialist Hospital, approved the study (approval no. NEU0397; Dammam, Saudi Arabia). As an observational, non-interventional study, it posed minimal risk to participants. All patient data were anonymized, and identifying information was removed to ensure confidentiality. The requirement for consent was waived due to the retrospective nature of the data analysis.

Results

A total of 56 individuals with LVO stroke who underwent endovascular MT were included in the study to evaluate the impact of vascular risk factors on MT outcome and to estimate the prevalence of epilepsy.

An overview of participant characteristics of the participants is presented in Table I. Hypertension was the most prevalent comorbidity, identified in 33 (59.0%) followed by diabetes mellitus in 29 patients (51.8%). An additional 29 individuals (51.8%) had other unspecified comorbid conditions. Atrial fibrillation was observed in 15 patients (26.9%), while both smoking and dyslipidemia were reported in 10 patients each (17.9%). Heart failure was present in 7 individuals (12.5%),

Table I. Patient characteristics and vascular risk factors among patients with stroke (n=56).

Risk factors	Frequency	Percentage, %
Hypertension	33	59.0
Diabetes mellitus	29	51.8
Other comorbidities	29	51.8
Atrial fibrillation	15	26.9
Smoking	10	17.9
Dyslipidemia	10	17.9
Heart failure	7	12.50
Old stroke	6	10.71
Cardiac thrombus	1	1.79
Previous TIA	1	1.79
Body mass index	Mean ± SD	27.2±5.3
Age	Mean ± SD	62±15.2

Table II. Distribution of outcomes based on post-treatment mTICI scores.

mTICI Grade	Frequency (%)
Grade 3	17 (30.4)
Grade 2B	31 (55.4)
Grade 1	4 (7.1)
Grade 0	4 (7.1)
Total	56 (100)

Score 0, no perfusion; 3, full perfusion with filling of all distal branches; 2B, partial perfusion greater than or equal to 50% of the vascular distribution of occluded artery. mTICI, modified thrombolysis in cerebral infarction.

and a history of previous stroke was noted in 6 cases (10.7%). Cardiac thrombus and prior transient ischemic attack (TIA) were the least common, each reported in 1 patient (1.79%).

The mean body mass index (BMI) of the study population was 27.2±5.3, indicating a leaning towards the overweight category. The average age was 62 years (SD ± 15.2), showing a wide age distribution among patients with stroke. These findings suggest that hypertension and diabetes are significant risk factors for stroke in this population, and the presence of multiple comorbidities is common among patients with stroke. The results underscore the need to address a broad spectrum of vascular risk factors in both acute management and long-term prevention strategies for ischemic stroke.

Stroke location distribution. Among the 56 patients, the most common site of stroke was the right middle cerebral artery (Rt MCA) territory, accounting for 28 cases (50%). This was followed by the Left MCA territory 22 patients (39.3%). The remaining stroke locations were less frequent. The data indicates a clear predominance of strokes in the MCA territories, particularly on the right side, with rare occurrences in other specified areas.

Table III. Comparison of mTICI outcomes between patients who received and did not receive TPA (n=56).

	Received TPA		
TICI score	Yes	No	Total
Grade 3	8	9	17
Grade 2B	11	20	31
Grade 1	1	3	4
Grade 0	1	3	4
Total	21	35	56

TPA, tissue plasminogen activator; mTICI, modified thrombolysis in cerebral infarction.

Thrombectomy techniques. As illustrated in Fig. 1, aspiration in combination with stent retrieval was the most commonly employed technique, used in 30 patients (53.6%). Aspiration alone was performed in 26 cases (46.4%), indicating a clear preference for aspiration-based approaches, either alone or in combination.

Reperfusion outcomes (mTICI score). The distribution of mTICI scores following thrombectomy is shown in Table II. Complete reperfusion (Grade 3) was achieved in 17 patients (30.4%), while partial reperfusion (Grade 2B) occurred in 31 cases (55.4%). No patients were classified as Grade 2A. Minimal perfusion (Grade 1) and no perfusion (Grade 0) were each observed in 4 patients (7.1%). Overall, 85.8% of patients (Grades 3 and 2B combined) achieved substantial reperfusion, while 14.2% (Grades 0 and 1) had poor outcomes, underscoring the variability in response to MT.

Effect of TPA on recanalization outcomes. mTICI outcomes between patients who received intravenous tissue plasminogen activator (TPA) and those who did not are compared in Table III. Of the 56 patients, 21 received TPA and 35 did not. Among TPA recipients, 8 (38.1%) achieved Grade 3 and 11 (52.4%) achieved Grade 2B reperfusion. By contrast, 9 (25.7%) non-TPA patients achieved Grade 3 and 20 (57.1%) achieved Grade 2B. Statistical analysis revealed a significant association between TPA administration and higher mTICI scores (Fisher's exact test, P=0.03; likelihood-ratio chi-square, P=0.041). These findings support the beneficial role of TPA in enhancing recanalization outcomes when used adjunctively with MT.

Risk factors for hemorrhagic transformation. Clinical risk factors associated with hemorrhagic transformation are presented in Table IV. Significant predictors included: Age was identified as a crucial risk factor, with individuals aged 65 and younger having an odds ratio (OR) of 2.5 (95% CI: 1.8-3.6)

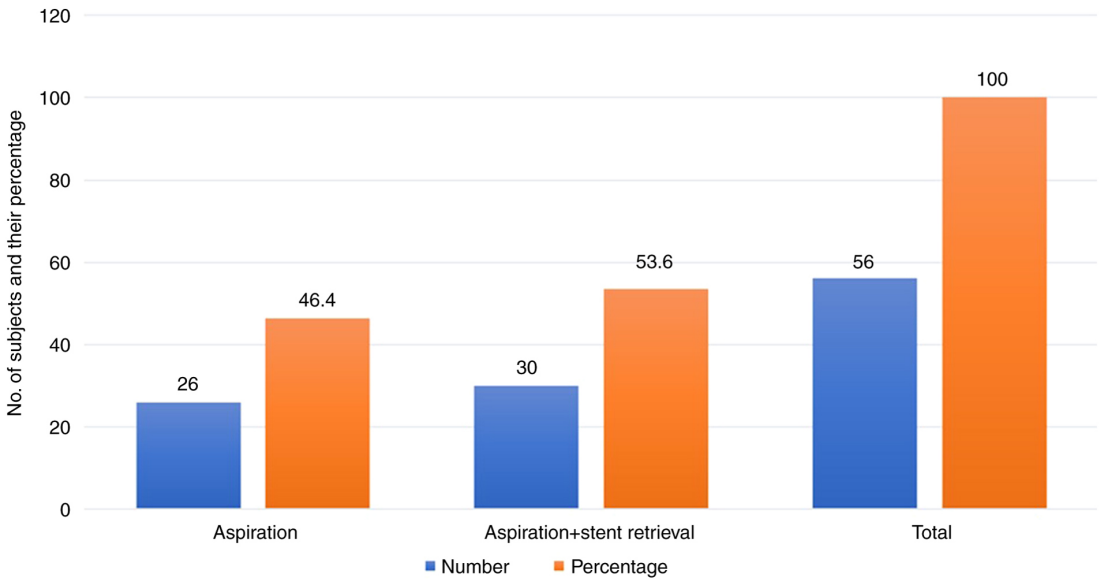

Figure 1. Distribution of thrombectomy techniques performed.

Table IV. Logistic regression analysis of risk factors associated with hemorrhagic transformation.

Risk factor	Odds ratio	95% confidence interval	P-value
Age (less than 65 years)	2.5	1.8-3.6	0.001
Hypertension	3.0	2.2-4.1	<0.001
Diabetes mellitus	1.8	1.2-2.7	0.008
Dyslipidemia	1.2	0.8-1.9	0.300
Smoking	1.0	0.7-1.4	0.900
Sex	1.1	0.8-1.6	0.450
Atrial fibrillation	1.3	0.9-1.9	0.200
Old stroke	1.4	0.9-2.2	0.150
Previous TIA	1.0	0.7-1.5	0.900
Heart Failure	1.5	1.0-2.2	0.050
Cardiac thrombus	2.0	1.3-3.1	0.005
Body mass index	1.1	0.9-1.3	0.450
-cons	0.3	0.08-1.5	0.17

and a P=0.001. This indicates a significant increase in the risk of hemorrhagic transformation among older patients.

Hypertension emerged as the most notable risk factor (OR, 3.0; 95% CI: 2.2-4.1) with a highly significant P<0.001. This suggests that patients with hypertension are three times more likely to experience hemorrhagic transformation compared to those without hypertension.

Diabetes mellitus also showed a significant association with hemorrhagic transformation, with an OR of 1.8 (95% CI: 1.2-2.7) and a P=0.008. This indicates that diabetic patients have an increased risk of hemorrhagic transformation.

Additionally, heart failure was approaching significance with an OR of 1.5 (95% CI: 1.0-2.2) and a P=0.05, while

Table V. Predictors of mechanical thrombectomy outcomes in patients with stroke (n=56).

Predictor	Odds ratio	95% confidence interval	P-value
Age (≥65 years)	2.3	1.5-3.5	0.002
Hypertension	1.0	0.6-1.6	0.900
Diabetes mellitus	0.9	0.5-1.5	0.700
Dyslipidemia	1.1	0.7-1.8	0.400
Smoking	1.2	0.8-1.9	0.600
Sex	1.0	0.6-1.5	0.950
Atrial fibrillation	0.9	0.5-1.4	0.600
Old stroke	1.0	0.6-1.6	0.800
Previous TIA	1.1	0.7-1.8	0.500
Heart failure	1.3	0.8-2.1	0.250
Cardiac thrombus	1.4	0.9-2.2	0.150
Body mass index	1.0	0.9-1.1	0.800

Table VI. Association between seizure occurrence and TPA administration among patients with stroke (n=56).

	Received TPA			
Seizures	Not received TPA, N (%)	Revived TPA N (%)	Total	P-value
No seizures	29 (51.8)	19 (33.9)	48 (85.7)	0.041
Seizures	6 (10.7)	8 (3.6)	8 (14.3)	0.041
Total	35 (62.5)	21 (37.5)	56 (100)	0.046

Likelihood-ration chi-square (2), 0.2543. Pr, 0.0419. Fisher's exact, 0.046. TPA, tissue plasminogen activator.

cardiac thrombus showed a strong significant association with an OR of 2.0 (95% CI: 1.3-3.1) and a P=0.005, suggesting that patients with cardiac thrombi have double the odds of hemorrhagic transformation.

By contrast, dyslipidemia (P=0.300), smoking (P=0.900), sex (P=0.450), atrial fibrillation (P=0.200), old stroke (P=0.150), previous TIA (P=0.900) and BMI (P=0.450) did not show significant associations with hemorrhagic transformation. Their ORs were close to 1.0, indicating that they may not substantially influence the risk of this complication.

The significant risk factors for hemorrhagic transformation include age, hypertension, diabetes, heart failure and cardiac thrombus. This emphasizes the critical need for thorough monitoring and management of these conditions in patients with stroke after endovascular MT, as they are vulnerable to hemorrhagic transformation. Further research is recommended to elucidate the mechanism of these associations and evaluate potential preventive strategies.

Predictors of thrombectomy outcomes. In Table V, logistic regression identified age ≤65 years as a significant predictor of favorable MT outcomes (OR, 2.3; 95% CI: 1.5-3.5; P=0.002). No significant associations were observed with hypertension, diabetes, dyslipidemia, smoking, atrial fibrillation, old stroke, TIA, heart failure, cardiac thrombus, or BMI. For example, hypertension showed no predictive value (OR, 1.0; 95% CI: 0.6-1.6; P=0.900). These findings highlight age as a critical determinant of MT success in this cohort.

Prevalence of post-stroke epilepsy. Of the 56 patients studied, 8 (14.29%) developed post-stroke seizures, while 48 (85.71%) did not. This indicates a seizure prevalence of 14.29% in patients with LVO stroke treated with MT.

Effect of TPA on seizure incidence. The relationship between TPA administration and seizure occurrence is analyzed in Table VI. Among 21 TPA recipients, only 2 (9.5%) developed seizures, while 6 (17.1%) of the 35 non-TPA patients experienced seizures. Statistical analysis revealed a significant association between TPA use and reduced seizure incidence (likelihood-ratio chi-square test, P=0.0419; Fisher's exact test, P=0.046). These results suggest that TPA could benefit patients with stroke with LVO who undergo endovascular MT by reducing the incidence of seizures. However, the evidence could be more substantial, and further research is needed to confirm this finding.

Discussion

The present study examined the impact of vascular risk factors on outcomes following endovascular MT in patients with stroke with LVO and yielded several key findings.

A notable finding was the prevalence of post-stroke epilepsy, observed in 14.29% of patients who underwent MT. This rate is higher than that reported in a 2022 systematic review, which found a cumulative incidence of 9% among patients with stroke treated with MT (13). The increased prevalence in our cohort may reflect the specific focus on LVO strokes, which are associated with more extensive brain tissue damage and, consequently, a higher risk of seizures. This underscores the importance of post-stroke seizure monitoring and early intervention to improve patient quality of life and reduce long-term neurological complications.

Our findings also suggest a potential benefit of TPA in reducing seizure incidence among patients with MT. While prior studies have reported mixed results (14-17), our data support a statistically significant association between TPA administration and reduced seizure risk. Given the potential clinical significance of this finding, further research is warranted to confirm the potential benefit of TPA in reducing seizures. A more extensive, prospective study with a more diverse patient cohort could provide more definitive evidence. Additionally, exploring the mechanisms by which TPA might exert this protective effect could offer insights into the pathophysiology of post-stroke seizures and lead to targeted prevention strategies.

A substantial proportion of patients (85.8%) achieved successful reperfusion (mTICI Grades 2B-3), reinforcing the effectiveness of MT in restoring cerebral perfusion. This aligns with existing evidence from clinical trials and meta-analyses demonstrating MT's efficacy in improving outcomes for LVO stroke (18-21). Future research should focus on identifying predictors of reperfusion success and exploring novel adjunctive therapies that could enhance the efficacy of endovascular MT. Additionally, efforts should be made to optimize patient selection and treatment timing to maximize the chances of successful reperfusion.

TPA administration within the recommended window (3-4.5 h) was associated with improved recanalization outcomes, consistent with current guideline-supported bridging therapy protocols (22-25). This supports the continued use of TPA, both systemically and intra-arterially, as a complement to MT in eligible patients to enhance both short- and long-term recovery.

In terms of complications, hemorrhagic transformation was significantly associated with age, hypertension, diabetes mellitus, heart failure and cardiac thrombus. These results are consistent with previous studies (26-30) and emphasize the need for personalized risk assessment and vigilant monitoring in patients undergoing MT. The consistency of these findings across studies underscores the importance of these risk factors in the clinical management of patients with stroke. These findings emphasize the need for personalized stroke management strategies that consider individual patient risk profiles.

Age was a significant predictor of MT outcomes, with patients ≤65 years demonstrating higher odds of favorable recovery. This is consistent with previous studies (31-33) showing that younger patients tend to have improved physiological resilience and post-intervention recovery. This finding suggests that younger patients should be actively considered for endovascular MT when they present with LVO strokes. The potential for favorable outcomes in this age group underscores the importance of timely intervention and access to specialized stroke care (34-36). The age is both statistically robust and clinically significant, reinforcing age as a pivotal factor in MT outcomes. These findings advocate for age-tailored protocols in acute stroke management while highlighting the need for further research to optimize outcomes in older populations.

Additionally, our results suggest that TPA may exert neuroprotective effects beyond its thrombolytic action. Preclinical studies have proposed mechanisms such as modulation of NMDA

receptor trafficking and reduced excitotoxicity (31), which may explain its potential anti-epileptogenic effects. While our study used the standard 0.9 mg/kg dose, emerging evidence suggests that lower doses may be effective in certain populations with reduced bleeding risk. Moreover, the benefit of adjunctive TPA in extended time windows (for example, per DAWN/DEFUSE-3 criteria) remains an area of active investigation, particularly given varying ischemic tolerances and endothelial vulnerability.

To enhance the innovation and clinical applicability of the discussion section, we recommend integrating three key improvements: i) a deeper exploration of the mechanistic links between vascular risk factors and thrombectomy outcomes, including potential biological pathways (for example, endothelial dysfunction, clot composition); ii) the incorporation of predictive modeling approaches (for example, nomograms or machine learning tools) to stratify patients by individualized risk profiles; and iii) a clear translational roadmap outlining how these findings could inform clinical protocols, such as tailored peri-procedural management for high-risk subgroups. These refinements would bridge the gap between observational data and actionable clinical insights. These findings advocate for more personalized protocols, incorporating risk stratification tools (for example, glycemic and BP thresholds) and evaluating novel adjunctive therapies in high-risk patients.

The present study has several limitations. Its retrospective design introduces the potential for selection and information bias due to reliance on medical record documentation. The sample size, though sufficient to detect moderate effect sizes, may limit the statistical power to detect smaller associations. Additionally, being a single-center study, the findings may not be generalizable to broader or more diverse populations. Future research should employ prospective, multicenter designs with larger cohorts to validate and expand upon these findings.

Further research is needed to elucidate the mechanisms underlying this age-dependent effect and to develop targeted strategies for optimizing outcomes in older populations. Future studies should quantify the magnitude of this benefit in real-world clinical settings and explore adjunctive therapies to mitigate age-related disparities.

In conclusion, the present study provides important insights into the impact of vascular risk factors on MT outcomes in patients with stroke with LVO. It highlights the effectiveness of MT in achieving successful reperfusion and suggests potential benefits of adjunctive TPA administration in improving recanalization and reducing seizure risk. The findings reinforce the importance of personalized, risk-based management strategies, especially with regard to age, comorbidities, and hemorrhagic complications. Comprehensive post-stroke care should integrate seizure surveillance and address modifiable vascular risk factors to optimize both acute outcomes and long-term recovery across patient demographics.

Acknowledgements

Not applicable.

Funding

The present study was supported by the King Salman center For Disability Research (grant no. KSRG-2024-307).

Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

WAA contributed to study conception and design, data collection, analysis and interpretation, drafting, and critical revision of the manuscript. SB contributed to study design, data interpretation, manuscript drafting and critical revision for intellectual content. EMA contributed to data collection, data analysis, and initial manuscript drafting. BA contributed to data interpretation, supervision, manuscript review and editing for important intellectual content, and approved the final version. WAA and SB confirm the authenticity of all the raw data. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

The present study was approved by the local ethic committee (approval no. NEU0397) of King Fahad Specialist Hospital Dammam. The requirement for consent was waived due to the retrospective nature of the data analysis.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Use of artificial intelligence tools

During the preparation of this work, artificial intelligence tools were used to improve the readability and language of the manuscript or to generate images, and subsequently, the authors revised and edited the content produced by the artificial intelligence tools as necessary, taking full responsibility for the ultimate content of the present manuscript.

References

1. Saini V, Guada L and Yavagal DR: Global epidemiology of stroke and access to acute ischemic stroke interventions. Neurology 97 (20 Suppl 2): S6-S16, 2021.
2. Widimsky P, Snyder K, Sulzenko J, Hopkins LN and Stetkarova I: Acute ischaemic stroke: Recent advances in reperfusion treatment. Eur Heart J 44: 1205-1215, 2023.
3. Balami JS, White PM, McMeekin PJ, Ford GA and Buchan AM: Complications of endovascular treatment for acute ischemic stroke: Prevention and management. Int J Stroke 13: 348-361, 2018.
4. Jadhav AP, Desai SM and Jovin TG: Indications for mechanical thrombectomy for acute ischemic stroke: Current guidelines and beyond. Neurology 97 (20 Suppl 2): S126-S136, 2021.
5. Zhu Y, Zhang H, Zhang Y, Wu H, Wei L, Zhou G, Zhang Y, Deng L, Cheng Y, Li M, *et al*: Endovascular metal devices for the treatment of cerebrovascular diseases. Adv Mater 31: e1805452, 2019.
6. Anagnostakou V, Epshtein M, Kühn AL, King RM, Puri A and Gounis MJ: Preclinical modeling of mechanical thrombectomy. J Biomech 130: 110894, 2022.

7. Ząbczyk M, Ariëns RAS and Undas A: Fibrin clot properties in cardiovascular disease: From basic mechanisms to clinical practice. Cardiovasc Res 119: 94-111, 2023.
8. Almallouhi E, Al Kasab S, Hubbard Z, Bass EC, Porto G, Alawieh A, Chalhoub R, Jabbour PM, Starke RM, Wolfe SQ, *et al*: Outcomes of mechanical thrombectomy for patients with stroke presenting with low alberta stroke program early computed tomography score in the early and extended window. JAMA Netw Open 4: e2137708, 2021.
9. Ganesh A, Ospel JM, Menon BK, Demchuk AM, McTaggart RA, Nogueira RG, Poppe AY, Almekhlafi MA, Hanel RA, Thomalla G, *et al*: Assessment of discrepancies between follow-up infarct volume and 90-day outcomes among patients with ischemic stroke who received endovascular therapy. JAMA Netw Open 4: e2132376, 2021.
10. Jiang S, Fei A, Peng Y, Zhang J, Lu YR, Wang HR, Chen M and Pan S: Predictors of outcome and hemorrhage in patients undergoing endovascular therapy with solitaire stent for acute ischemic stroke. PLoS One 10: e0144452, 2015.
11. Karamchandani RR, Satyanarayana S, Yang H, Rhoten JB, Strong D, Clemente JD, Defilipp G, Patel NM, Bernard JD, Stetler WR, *et al*: Predictors of devastating functional outcome despite successful basilar thrombectomy. Interv Neuroradiol: November 21, 2023 (Epub ahead of print).
12. Wnuk M, Popiela T, Drabik L, Brzegowy P, Lasocha B, Wloch-Kopec D, Pulyk R, Jagiella J, Wiacek M, Kaczorowski R, *et al*: Fasting hyperglycemia and long-term outcome in patients with acute ischemic stroke treated with mechanical thrombectomy. J Stroke Cerebrovasc Dis 29: 104774, 2020.
13. Liu F, Chen D, Fu Y, Wang H and Liu L: Incidence and association of seizures in stroke patients following endovascular treatment: A systematic review and meta-analysis. Eur J Neurol 30: 134-143, 2023.
14. Saver JL, Goyal M, Bonafe A, Diener HC, Levy EI, Pereira VM, Albers GW, Cognard C, Cohen DJ, Hacke W, *et al*: Stent-retriever thrombectomy after intravenous t-PA vs t-PA alone in stroke. N Engl J Med 372: 2285-2295, 2015.
15. Janelidze S, Berron D, Smith R, Strandberg O, Proctor NK, Dage JL, Stomrud E, Palmqvist S, Mattsson-Carlgren N and Hansson O: Associations of plasma phospho-tau217 levels with tau positron emission tomography in early Alzheimer disease. JAMA Neurol 78: 149-156, 2021.
16. Gruber J, Gattringer T, Mayr G, Schwarzenhofer D, Kneihsl M, Wagner J, Sonnberger M, Deutschmann H, Haidegger M, Fandler-Höfler S, *et al*: Frequency and predictors of poststroke epilepsy after mechanical thrombectomy for large vessel occlusion stroke: Results from a multicenter cohort study. J Neurol 270: 6064-6070, 2023.
17. Naylor J, Thevathasan A, Churilov L, Guo R, Xiong Y, Koome M, Chen Z, Chen Z, Liu X, Kwan P and Campbell BCV: Association between different acute stroke therapies and development of post stroke seizures. BMC Neurol 18: 61, 2018.
18. Nesselroth D, Gilad R, Namneh M, Avishay S and Eilam A: Estimation of seizures prevalence in ischemic strokes after thrombolytic therapy. Seizure 62: 91-94, 2018.
19. Lekoubou A, Awoumou JJ and Kengne AP: Incidence of seizure in stroke patients treated with recombinant tissue plasminogen activator: A systematic review and meta-analysis. Int J Stroke 12: 923-931, 2017.
20. Brigo F, Schneider M, Wagenpfeil G, Ragoschke-Schumm A, Fousse M, Holzhoffer C, Nardone R, Faßbender K and Lochner P: Intravenous thrombolysis with tPA and cortical involvement increase the risk of early poststroke seizures: Results of a case-control study. Epilepsy Behav 104: 106312, 2020.
21. Zhao W, Ma P, Zhao W, Yang B, Zhang Y, Song J, Zhang P and Yue X: The safety and efficacy of mechanical thrombectomy in posterior vs anterior emergent large vessel occlusion: A systematic review and meta-analysis. J Stroke Cerebrovasc Dis 29: 104545, 2020.
22. Dargazanli C, Arquizan C, Gory B, Consoli A, Labreuche J, Redjem H, Eker O, Decroix JP, Corlobé A, Mourand I, *et al*: Mechanical thrombectomy for minor and mild stroke patients harboring large vessel occlusion in the anterior circulation: A multicenter cohort study. Stroke 48: 3274-3281, 2017.
23. Alexandre AM, Valente I, Pedicelli A, Pezzullo AM, Colò F, Scarcia L, Romi A, Piano M, Macera A, Gabrieli JD, *et al*: Mechanical thrombectomy in acute ischemic stroke due to large vessel occlusion in the anterior circulation and low baseline national institute of health stroke scale score: A multicenter retrospective matched analysis. Neurol Sci 43: 3105-3112, 2022.
24. Nagel S, Bouslama M, Krause LU, Küpper C, Messer M, Petersen M, Lowens S, Herzberg M, Ringleb PA, Möhlenbruch MA, *et al*: Mechanical thrombectomy in patients with milder strokes and large vessel occlusions. Stroke 49: 2391-2397, 2018.
25. Cheng NT and Kim AS: Intravenous thrombolysis for acute ischemic stroke within 3 h versus between 3 and 4.5 h of symptom onset. Neurohospitalist 5: 101-109, 2015.
26. Song S: Hyperacute management of ischemic stroke. Semin Neurol 33: 427-435, 2023.
27. Del Zoppo GJ, Saver JL, Jauch EC and Adams HP Jr; American Heart Association Stroke Council: Expansion of the time window for treatment of acute ischemic stroke with intravenous tissue plasminogen activator: A science advisory from the American heart association/American stroke association. Stroke 40: 2945-2948, 2009.
28. Nguyen TQ, Truong AL, Phan HT, Nguyen DD, Nguyen KV, Nguyen HTB, Nguyen ATT, Hoang DCB, Tran VT, Nguyen TQ, *et al*: Bridging therapy and direct thrombectomy for acute ischemic stroke: A prospective cohort study. J Stroke Med 3: 124-130, 2020.
29. Kablau M, Kreisel SH, Sauer T, Binder J, Szabo K, Hennerici MG and Kern R: Predictors and early outcome of hemorrhagic transformation after acute ischemic stroke. Cerebrovasc Dis 32: 334-341, 2011.
30. Thomas SE, Plumber N, Venkatapathappa P and Gorantla V: A review of risk factors and predictors for hemorrhagic transformation in patients with acute ischemic stroke. Int J Vasc Med 2021: 4244267, 2021.
31. Kunte H, Busch MA, Trostdorf K, Vollnberg B, Harms L, Mehta RI, Castellani RJ, Mandava P, Kent TA and Simard JM: Hemorrhagic transformation of ischemic stroke in diabetics on sulfonylureas. Ann Neurol 72: 799-806, 2012.
32. Tan S, Wang D, Liu M, Zhang S, Wu B and Liu B: Frequency and predictors of spontaneous hemorrhagic transformation in ischemic stroke and its association with prognosis. J Neurol 261: 905-912, 2014.
33. Yu G, Kim YJ, Jeon SB and Kim WY: Thromboelastography for prediction of hemorrhagic transformation in patients with acute ischemic stroke. Am J Emerg Med 38: 1772-1777, 2020.
34. Bagg S, Pombo AP and Hopman W: Effect of age on functional outcomes after stroke rehabilitation. Stroke 33: 179-185, 2002.
35. Emberson J, Lees KR, Lyden P, Blackwell L, Albers G, Bluhmki E, Brott T, Cohen G, Davis S, Donnan G, *et al*: Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: A meta-analysis of individual patient data from randomised trials. Lancet 384: 1929-1935, 2014.
36. Adcock AK, Schwamm LH, Smith EE, Fonarow GC, Reeves MJ, Xu H, Matsouaka RA, Xian Y and Saver JL: Trends in use, outcomes, and disparities in endovascular thrombectomy in US patients with stroke aged 80 years and older compared with younger patients. JAMA Netw Open 5: e2215869, 2022.

Copyright © 2025 Aldarwish et al. This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) License.