ORIGINAL ARTICLE

PREDICTORS OF OUTCOMES IN ELDERLY ACUTE STROKE PATIENTS UNDERGOING ENDOVASCULAR THROMBECTOMY

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Abstract

Introduction: The aging population is one of the main reasons for the increase in stroke cases.The aim of this study was to evaluate the predictors of 3-month outcomes in patients aged ≥65 years who underwent mechanical thrombectomy for acute ischemic stroke and compare patients aged 65–79 years with those aged ≥80 years in terms of demographic characteristics, workflow, functional outcomes, and complication rates.

Materials and Method: This retrospective cohort study included 169 consecutive patients aged ≥65 years who underwent mechanical thrombectomy for acute ischemic stroke due to large vessel occlusion between April 2020 and May 2023.

Results: Recanalization was successful for 148 (87.57%) patients.According to multivariable logistic regression analysis results, low (≤9) Alberta Stroke Program Early Computed Tomography score (odds ratio: 4.217, 95% confidence interval: 1.209–14.715, and p=0.024), high National Institutes of Health Stroke Scale score at 24th hour (odds ratio: 1.192, 95% confidence interval: 1.087–1.306, and p<0.001), high Acute Physiology and Chronic Health Evaluation score (odds ratio: 1.127, 95% confidence interval: 1.016–1.250, and p=0.023), and intubation need (odds ratio: 15.055, 95% confidence interval: 2.087–108.612, and p=0.007) were independent predictors of poor outcome.

Conclusion: The lack of significant differences in workflow, functional outcomes, and complications among patients >80 years of age indicates that MT is effective in this age group. Considering the aging population, identifying the predictors of 3-month outcomes after mechanical thrombectomy will help predict outcomes, better identify elderly patients who may benefit from the procedure, and guide treatment decisions.

Keywords: Aged; Ischemic Stroke; Endovascular Procedures; Thrombectomy.

INTRODUCTION

With the advancement of healthcare services and technology, the average human lifespan is increasing, which is leading to a rapid rise in the proportion of elderly individuals within the population. Population aging is one of the main reasons for the global increase in the number of stroke cases. According to the World Health Organization, stroke is the second leading cause of death worldwide, with 15 million people suffering from stroke each year. Of these, 5 million die, and 5 million are permanently disabled (1), which creates a burden on families and communities. Approximately 33% of all acute ischemic strokes (AISs) occur in patients aged ≥80 years. According to the projections of the Turkish Statistical Institute, the estimated proportion of elderly people in the total population in Turkey will be 12.9% in 2030, 16.3% in 2040, 22.6% in 2060, and 25.6% in 2080 (2).

The efficacy of mechanical thrombectomy (MT) in AIS due to large vessel occlusion has been demonstrated in selected patients in randomized controlled trials (RCTs) (3). However, the patients in these RCTs were relatively young and maintained good pre-stroke activities of daily living (ADL). The current guidelines provided by the American Heart Association/American Stroke Association indicate that although there is no age limit, the benefits of MT are uncertain in patients with a pre-stroke modified Rankin score (mRS) >1 (4). Conversely, some patients with large vessel occlusion have poor pre-stroke conditions, such as advanced age and poor ADL in the real world(5). In a rapidly aging society, the number of elderly patients undergoing MT is increasing significantly, yet they have been excluded from recent RCTs. It therefore remains unclear whether these patients may benefit from MT for AIS. The availability of data on the incidence and prognosis of stroke in the elderly and information on resource utilization is important for health services planning and the development of treatment strategies.

In this study, we aimed to evaluate the predictors of the 3-month outcomes in patients aged ≥65 years who underwent MT for AIS and to compare the patients aged 65–79 years with those aged ≥80 years in terms of demographic characteristics, workflow, functional outcomes, and complication rates.

MATERIALS AND METHOD

A total of 169 consecutive patients aged ≥65 years who underwent MT for AIS caused by large vessel occlusion in our tertiary center between April 2020 and May 2023 were included in the study. Since January 2020, our hospital has had a comprehensive stroke center. The patient data were analyzed retrospectively using prospectively maintained AIS records. The data of the patients aged 65–79 years and ≥80 years who underwent MT were compared in terms of workflow, functional outcomes, and complication rates. Additionally, the predictors of the 3-month outcomes in the patients aged ≥65 years were evaluated. We assessed the patients' medical histories with respect to heart disease, diabetes mellitus, hypertension, hyperlipidemia, cerebrovascular disease, transient ischemic attack, smoking, and alcohol use. To determine the onset of symptoms, we used the time when the symptoms began or when the patient was last observed as healthy.

Recanalization after thrombectomy was evaluated according to the modified thrombolysis in cerebral infarction (mTICI) score (6), and the scores 2b, 2c, and 3 were considered good outcomes. The severity of ischemic stroke was assessed using the National Institutes of Health Stroke Scale (NIHSS) (7). Clinical outcomes were evaluated using the mRS (8).

An mRS score of ≤2 at 3 months was considered a good clinical outcome and a score of 3–6 a poor clinical outcome. The etiological classification of ischemic stroke was determined based on the Trial of Org 10172 in Acute Stroke (TOAST) criteria (9). Symptomatic intracerebral hemorrhage (sICH) was defined according to the European Cooperative Acute Stroke 3 (10).

The occlusion site was classified as anterior or posterior circulation based on neck–brain computed tomography angiography (CTA), neck–brain magnetic resonance angiography (MRA) imaging, or digital subtraction angiography. Each MT procedure was undertaken based on the joint decision-making of neurologists and neurointerventional radiology specialists and was performed using a stent retriever, thrombo-aspiration, or a combination of both. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Bursa City Hospital (Decision date: 07.02.2024, decision no: 2024-1/1).

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The Kolmogorov–Smirnov test was used to determine whether the variables were normally distributed. The descriptive statistics were presented using the median (25th percentile–75th percentile) for the continuous variables, as these were not normally distributed, and frequency (percentage) for the categorical variables. The between-groups analysis of the continuous variables was performed using the Mann–Whitney U test, while the chi-square test, Fisher's exact test, or Fisher–Freeman–Halton test was used for the between-groups analysis of the categorical variables. Logistic regression analyses were performed to determine the independent predictors of a poor outcome in the 3rd month. The variables were analyzed using univariable logistic regression analysis, and statistically significant variables were included in the multivariable logistic regression analysis. Two-tailed p-values less than 0.05 were considered statistically significant.

RESULTS

We included 169 patients (68 men and 101 women) in this study. While their median age was 76 years (interquartile range 70–81 years, range 65–95 years), 114 (67.46%) patients were aged between 65 and 79 years, and 55 (32.54%) patients were 80 years or older. We found no significant differences between the age groups in terms of sex, comorbidities, smoking status, alcohol use, first applied hospital, etiology, Alberta stroke program early CT (ASPECT) scores, affected location, and diffusion MR percentages.

The NIHSS score at the 24th hour was significantly higher in the 80 years and older group than among younger cohort. We found no significant differences between the age groups in terms of the NIHSS scores on admission, changes in NIHSS scores, symptom-to-door time, door-to-neurologist time, door-to-CT time, door-to-CT angiography time, door-to-diffusion MR time, and door-to-groin time.

Recanalization was successful for 148 (87.57%) patients. In addition, 52 (31.90%) patients had hemorrhage, 15 (9.20%) were symptomatic, 37 (22.70%) were asymptomatic, and 56 (33.94%) patients needed intubation/mechanical ventilation. With respect to outcomes, 47 (28.48%) patients had good outcomes at discharge, while 59 (34.91%) patients had good outcomes in the 3rd month. In contrast, 41 (24.85%) patients were exitus in hospital and 55 (32.54%) in the 3rd month. We found no significant differences between the age groups in terms of TICI classification, successful recanalization, acute physiology and chronic health evaluation (APACHE) scores, intubation, duration of intubation, mRS at discharge, outcomes at discharge, mortality in hospital, mRS in the 3rd month, outcomes in the 3rd month, and mortality in the 3rd month (Table 1).

In the 3rd month, 59 (34.91%) patients had good outcomes (mRS ≤2). According to the results of the multivariable logistic regression analysis, a low (≤9) ASPECT score (OR: 4.217, 95% CI: 1.209–14.715, p=0.024), high NIHSS score at the 24th hour (OR: 1.192, 95% CI: 1.087–1.306, p<0.001), high APACHE score (OR: 1.127, 95% CI: 1.016–1.250, p=0.023), and the need for intubation (OR: 15.055, 95% CI: 2.087–108.612, p=0.007) were independent predictors of a poor outcome (Table 2).

Table 1. Summary of variables with regard to groups

	All patients (n=169)	Age groups		p
		65 - 79 (n=114)	80 or above (n=55)	
Age (n=169)	76 (70 - 81)	72 (68 - 77)	83 (81 - 86)	<0.001
Sex (n=169)				
Male	68 (40.24%)	51 (44.74%)	17 (30.91%)	0.121
Female	101 (59.76%)	63 (55.26%)	38 (69.09%)	
Comorbidities (n=169)				
Heart diseases	105 (62.13%)	75 (65.79%)	30 (54.55%)	0.158
Diabetes mellitus	59 (34.91%)	44 (38.60%)	15 (27.27%)	0.202
Prior cerebrovascular disease	34 (20.12%)	27 (23.68%)	7 (12.73%)	0.144
Prior transient ischemic attack	5 (2.96%)	5 (4.39%)	0 (0.00%)	0.175
Hypertension	130 (76.92%)	88 (77.19%)	42 (76.36%)	1.000
Hyperlipidemia	21 (12.43%)	17 (14.91%)	4 (7.27%)	0.245
Smoking (n=169)	15 (8.88%)	12 (10.53%)	3 (5.45%)	0.390
Alcohol use (n=169)	2 (1.18%)	2 (1.75%)	0 (0.00%)	1.000
Applied hospital (n=169)				
Without stroke center	58 (34.32%)	44 (38.60%)	14 (25.45%)	0.130
With stroke center	111 (65.68%)	70 (61.40%)	41 (74.55%)	
Etiology (n=165)				
Large artery atherosclerosis	46 (27.88%)	35 (31.53%)	11 (20.37%)	0.198
Cardioembolism	74 (44.85%)	49 (44.14%)	25 (46.30%)	
Other determined reasons	1 (0.61%)	0 (0.00%)	1 (1.85%)	
Undetermined reasons	44 (26.67%)	27 (24.32%)	17 (31.48%)	
ASPECT (n=169)	10 (10 - 10)	10 (10 - 10)	10 (9 - 10)	0.065
≤9	36 (21.30%)	19 (16.67%)	17 (30.91%)	0.055
10	133 (78.70%)	95 (83.33%)	38 (69.09%)	
Affected location (n=169)				
Posterior	16 (9.47%)	11 (9.65%)	5 (9.09%)	1.000
Anterior	153 (90.53%)	103 (90.35%)	50 (90.91%)	
Diffusion MR (n=169)	113 (66.86%)	81 (71.05%)	32 (58.18%)	0.136
NIHSS				
Admission (n=169)	15 (10 - 18)	14 (10 - 18)	16 (11 - 19)	0.193
24th hour (n=162)	11 (5 - 18)	9.5 (4 - 16)	13.5 (8 - 19.5)	**0.027**
Change (n=162)	-2 (-6 - 0)	-2 (-8 - 0)	-1 (-4 - 0)	0.129
Symptom to door time, min (n=169)	120 (58 - 210)	120 (58 - 200)	120 (53 - 238)	0.924
Door to neurologist time, min (n=169)	20 (10 - 45)	20 (10 - 45)	24 (9 - 45)	0.972
Door to CT time, min (n=146)	19 (11 - 27)	18 (10 - 26)	21 (13 - 27)	0.218
Door to CT angiography time, min (n=153)	29 (19 - 59)	30 (18 - 60)	27 (20 - 46)	0.872
Door to diffusion MR time, min (n=92)	32 (17.5 - 50)	34 (17.5 - 51.5)	28 (16 - 38.5)	0.225
Door to groin time, min (n=169)	100 (70 - 148)	99 (67 - 150)	100 (71 - 148)	0.633

Table 1. *continued...*

TICI (n=169)				
TICI 0	11 (6.51%)	8 (7.02%)	3 (5.45%)	0.531
TICI 1	8 (4.73%)	4 (3.51%)	4 (7.27%)	
TICI 2A	2 (1.18%)	1 (0.88%)	1 (1.82%)	
TICI 2B	30 (17.75%)	21 (18.42%)	9 (16.36%)	
TICI 2C	5 (2.96%)	5 (4.39%)	0 (0.00%)	
TICI 3	113 (66.86%)	75 (65.79%)	38 (69.09%)	
Successful recanalization, TICI≥2b (n=169)	148 (87.57%)	101 (88.60%)	47 (85.45%)	0.740
Hemorrhage (n=163)	52 (31.90%)	37 (33.64%)	15 (28.30%)	0.613
Symptomatic	15 (9.20%)	10 (9.09%)	5 (9.43%)	0.718
Asymptomatic	37 (22.70%)	27 (24.55%)	10 (18.87%)	
APACHE score (n=164)	11 (7 - 15)	11 (7 - 15)	11 (6 - 15)	0.954
Intubation (n=165)	56 (33.94%)	35 (31.53%)	21 (38.89%)	0.446
Duration of intubation, days (n=165)	0 (0 - 4)	0 (0 - 3)	0 (0 - 6)	0.320
mRS, Discharge (n=165)	4 (2 - 5)	4 (1 - 5)	5 (3 - 6)	0.119
Good outcome, mRS≤2, Discharge (n=165)	47 (28.48%)	35 (31.53%)	12 (22.22%)	0.289
Mortality, in hospital (n=165)	41 (24.85%)	23 (20.72%)	18 (33.33%)	0.117
mRS, 3rd month (n=169)	4 (1 - 6)	4 (1 - 6)	5 (2 - 6)	0.118
Good outcome, mRS≤2, 3rd month (n=169)	59 (34.91%)	42 (36.84%)	17 (30.91%)	0.558
Mortality, 3rd month (n=169)	55 (32.54%)	32 (28.07%)	23 (41.82%)	0.107

Descriptive statistics were presented by using median (25th percentile - 75th percentile) for continuous variables due to non-normality of distribution and frequency (percentage) for categorical variables. NIHSS National Institutes of Health Stroke Scale, mTICI modified Thrombolysis in Cerebral Infarction. ASPECTS Alberta Stroke Program Early CT Score. APACHE score Acute Physiology And Chronic Health Evaluation mRS modified Rankin Scale.

Table 2. Odds ratios for bad outcome at 3rd month (MRS>2), logistic regression analysis results

	Univariable		Multivariable	
	OR (95% CI)	**p**	**OR (95% CI)**	**p**
Age, ≥80	1.304 (0.656 - 2.592)	0.449		
Sex, Female	0.923 (0.483 - 1.762)	0.808		
Heart diseases	0.686 (0.353 - 1.335)	0.267		
Diabetes mellitus	1.526 (0.771 - 3.019)	0.225		
Prior cerebrovascular disease	3.016 (1.170 - 7.776)	**0.022**	3.474 (0.850 - 14.193)	0.083
Prior transient ischemic attack	0.799 (0.130 - 4.921)	0.809		
Hypertension	1.619 (0.779 - 3.366)	0.197		
Hyperlipidemia	1.395 (0.511 - 3.809)	0.516		
Smoking	1.080 (0.351 - 3.321)	0.893		
Alcohol use	882527923.409 (0 - N/A)	0.999		
Applied hospital, Without stroke center	1.029 (0.528 - 2.005)	0.933		
Etiology (1)				
Large artery atherosclerosis	1.143 (0.473 - 2.762)	0.767		
Cardioembolism	0.733 (0.338 - 1.591)	0.432		

Table 2. *continued...*

ASPECT, ≤9	2.660 (1.086 - 6.514)	**0.032**	4.217 (1.209 - 14.715)	**0.024**
Affected location, Posterior	2.502 (0.683 - 9.159)	0.166		
Diffusion MR	1.184 (0.608 - 2.307)	0.619		
NIHSS at admission	1.124 (1.054 - 1.198)	**<0.001**	0.980 (0.885 - 1.085)	0.699
NIHSS at 24th hour	1.255 (1.167 - 1.350)	**<0.001**	1.192 (1.087 - 1.306)	**<0.001**
Symptom to door time, min	1.001 (0.999 - 1.004)	0.234		
Door to neurologist time, min	1.000 (0.993 - 1.006)	0.906		
Door to CT time, min	0.997 (0.977 - 1.018)	0.810		
Door to CT angiography time, min	0.995 (0.988 - 1.002)	0.196		
Door to diffusion MR time, min	0.993 (0.982 - 1.003)	0.167		
Door to groin time, min	1.002 (0.997 - 1.008)	0.447		
Recanalization, Unsuccessful	3.652 (1.029 - 12.961)	**0.045**	3.418 (0.603 - 19.379)	0.165
Hemorrhage (2)				
Symptomatic	11.065 (1.406 - 87.078)	**0.022**	6.790 (0.569 - 80.996)	0.130
Asymptomatic	2.459 (1.062 - 5.691)	**0.036**	2.343 (0.753 - 7.288)	0.142
APACHE score	1.215 (1.120 - 1.317)	**<0.001**	1.127 (1.016 - 1.250)	**0.023**
Intubation	18.667 (5.498 - 63.374)	**<0.001**	15.055 (2.087 - 108.612)	**0.007**
Duration of intubation, days	1.119 (1.032 - 1.214)	**0.006**	0.959 (0.898 - 1.024)	0.206
Nagelkerke R2	-		0.607	

OR: Odds ratio, CI: Confidence interval, (1) Reference category is undetermined reasons, (2) Reference category is no hemorrhage

DISCUSSION

In the present study, no significant differences were observed with regard to the demographic characteristics, workflow, functional outcomes, and complication rates between the patients aged 65–79 years and those ≥80 years who presented to the emergency department and underwent MT for AIS. The results showed that MT was effective in the patients aged >65 years. A low (≤9) ASPECT score, high APACHE score, high NIHSS score at 24 hours, and the need for intubation were independent predictors of a poor outcome.

Many studies have focused on the efficacy and safety of MT in elderly patients with AIS. Previous clinical studies have generally focused on the age groups <80 and ≥80 years and have reported that in patients aged ≥80 years who underwent MT for AIS, favorable clinical outcomes were less frequent and mortality rates were higher compared to younger patients.

A systematic review conducted from 2014 to 2019, which comprised 16 studies and 3954 patients, reported that in the patients aged ≥80 years who underwent MT, the functional independence rates were lower and the mortality rates higher compared to the patients aged <80 years (11). In another systematic review that included 26 studies and 9492 patients, the functional independence rates were lower and mortality rates higher in the patients aged ≥80 years who underwent MT compared to those aged <80 years. Furthermore, the rate of functional independence in the patients aged ≥80 years at 90 days after MT was 26.3% (12).

In a nationwide study conducted by Mehta et al. in the United States, 1540 patients aged ≥80 years who underwent MT were compared with 4639 patients aged <80 years who underwent the same procedure. The patients aged ≥80 years had lower good outcome rates (discharge to home or acute rehabilitation center) and higher mortality rates (13).

In the present study, we did not find any significant differences in the mRS scores at discharge or 3 months, in-hospital mortality, and 3-month mortality between the patients aged 65–79 years and ≥80 years who underwent MT. Moreover, 21.07% of the patients who underwent MT were aged ≥80 years, and the rate of functional independence at 3 months in these patients was 30.91%, which is consistent with the results of previous meta-analyses (13-16).

Studies have shown lower revascularization rates in elderly patients than younger patients. In two large meta-analyses conducted by Zhao et al. and Jiang et al. (11,12), the patients aged ≥80 years had lower recanalization rates compared to those aged <80 years. In a study conducted by Kim et al., 20 very elderly (≥80 years) patients and 93 elderly (60–79 years) patients who underwent MT were compared, and the rate of TICI 2b–3 reperfusion in the elderly patients was significantly higher than that in the very elderly group (75.3% versus 40%, respectively; p=0.002) (17).

In the present study, no significant differences were found between the patients aged 65–79 years and ≥80 years in terms of mTICI classification and successful recanalization rates (mTICI 2b–3). Furthermore, 87.57% of the patients aged ≥65 years, 88.60% of the patients aged 65–79 years, and 85.45% of the patients aged ≥80 years had successful recanalization.

No significant difference was found in the rate of intracranial hemorrhage after MT when the patients aged 65–79 years and ≥80 years in our study were compared. While studies such as that of Alawieh et al. (18) have reported a higher incidence of intracranial hemorrhage associated with MT in patients aged ≥80 years, some studies and meta-analyses have not found a difference in the rate of post-MT intracranial hemorrhage between young and elderly patients (12,19).

In our study, the sICH rate in the patients aged ≥80 years was 9.43%. In a study conducted by Zai et al., the rate of sICH in the patients aged ≥80 years was 8.6%, while in a meta-analysis by Jiang et al., which included 8388 patients from 21 studies, this rate was 6.7% (12, 19).

Although we did not find initial stroke severity to be associated with a poor outcome in the patients aged ≥65 years who underwent MT for AIS, some studies have reported a higher NIHSS score on admission as a factor associated with worse outcomes in patients undergoing MT (15, 20, 21).

A high NIHSS score at 24 hours was identified as an independent predictor of a poor clinical outcome after MT in our study. Similarly, Chen et al. reported a higher NIHSS score at 24 hours after MT as a predictor of 30-day mortality (21). Consistent with the results of other studies (19, 22, 23), a low ASPECT score (≤9) was also identified as a predictor of a poor outcome in the present study.

Burke et al. reported a 44% higher risk of death in acute stroke patients who were intubated compared to those who were not (24), while Feng et al. noted that intubation was a factor associated with a poor prognosis in AIS patients undergoing MT (25).In our study, the need for intubation was an independent predictor of a poor outcome at 3 months in the patients aged ≥65 years who underwent MT.

Better functional outcomes have been reported in elderly patients with AIS who underwent MT compared to those who did not undergo MT (3). Recent studies on the outcomes of MT in elderly patients have consistently demonstrated significant rates of successful recanalization and functional independence, thereby supporting the use of MT in this age group.

The present study provides evidence of the outcomes of patients aged 65 years and over treated with MT due to AIS. The data obtained are significant, as they represent one of the two major stroke centers in the Southern Marmara region, serving as a reference for acute stroke patients.

In the present study, we observed that a significant proportion of patients aged 65 years

and over benefited from MT, with a high rate of successful recanalization achieved in those patients. A low ASPECT score (≤9), a high APACHE score, a high NIHSS score at 24 hours, and a need for intubation were associated with poor long-term outcomes. Moreover, MT was as safe and effective for patients aged ≥80 years as for those aged 65–79 years, with the results being similar in regards to workflow, complications, and successful recanalization between the two groups. Additionally, similar mortality rates and functional outcomes were observed between the two groups at the three-month follow-up.

LIMITATIONS

However, this study has some limitations. It is a retrospective, single-center study. Moreover, as some patients were referred to our institution from external centers, the mRS, which indicates the functional status of patients before the stroke and whether they lived independently, was missing in some cases. Therefore, we were unable to include the pre-stroke mRS in our study. Another limitation of the present study is that patients over 65 years of age were not compared with younger patients.

CONCLUSION

In conclusion, to achieve positive outcomes in patients aged 65 years and over, the decision to perform MT should be made on a case-by-case basis, taking into account the ASPECT and APACHE scores. We believe that these patients should not be deprived of MT based solely on their age.

Further prospective and multicenter studies must be performed to identify elderly patients who may benefit from MT, incorporating data on factors such as infarct size, collateral status, pre-MT intravenous thrombolytic therapy, anesthesia and thrombectomy techniques, the number of passes for recanalization, and complications such as pneumonia or urinary tract infections during follow-up.

Considering the aging of the global population, the number of patients aged 65 and over undergoing MT is steadily increasing.Thus, identifying factors associated with long-term outcomes after MT in elderly patients will not only help predict outcomes in these patients, but also guide us in better identifying those who may benefit from MT and assist informed decision-making.

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