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ORIGINAL ARTICLE

Effects of stroke etiology on angiographic success in patients undergoing mechanical thrombectomy

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Abstract

Objective In this study, we investigated the relationship between stroke etiology and recanalization success with endovascular treatment in patients with acute ischemic stroke.

Material and methods A total of 109 patients with anterior circulation stroke who underwent mechanical thrombectomy between August 2017 and June 2019 were included in the study retrospectively. Stroke etiologies of the patients were determined according to the TOAST criteria (Trial of Org 10,172 acute stroke treatment), and the relationship between stroke etiology and successful first-pass recanalization rate with endovascular treatment, total successful recanalization rate, and procedure time was evaluated.

Results The data of 109 patients who presented with anterior circulation stroke and underwent mechanical thrombectomy were retrospectively analyzed. Fifty-five (50.5%) of the patients were female and 54 (49.5%) were male, and mean age was 67.3 ± 12.9. When the stroke etiologies of the patients were evaluated, it was found that 47 (43.1%) were due to large vessel ateherosclerotic disease (LVAD), and 62 (56.9%) were cardioembolic-related. Recanalization success and clinical outcomes did not differ significantly in patients with LVAD and those with cardioembolic etiology ($p > 0.05$). In addition, the number of patients with modified Rankin score (mRS) 6 in the atherosclerotic group was significantly higher than in the cardioembolic group ($p = 0.022$).

Conclusion Recanalization success and clinical outcomes did not differ significantly in patients with LVAD and those with cardioembolic etiology. However, mortality rate was higher in patients with atherosclerotic etiology, due to the complexity of the procedure and the high rate of reocclusion.

Keywords Stroke · Endovascular treatment · Recanalization · Mechanical thrombectomy

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Abbreviations

TOAST	Trial of Org 10,172 acute stroke treatment
LVAD	Large vessel ateherosclerotic disease
mRS	Modified Rankin score

Introduction

In the treatment of patients with acute anterior ischemic stroke with large vessel occlusion, the combination of mechanical thrombectomy with intravenous tissue plasminogen activator (iv tpa) has been shown to have a higher minimal disability rate despite the high bleeding rate than mechanical thrombectomy alone [1]. In a prospective study, 90-day functional independence was evaluated and mechanical thrombectomy was found to be equal or even more effective than combined treatment [2].

Clinical studies and meta-analyses of these studies have shown that the effectiveness of endovascular therapy is limited to the first 6–8 h. Non-randomized studies have shown that patients with proximal artery occlusion may have salvable brain tissue beyond the 6–8-h threshold, and suggest that these patients can benefit from endovascular treatment [3, 4]. However, only a limited number of patients with acute ischemic stroke, possibly in relation with good collateralization, have salvable brain tissue that can be recovered after 6–8 h, and the possibility of clinical success gradually decreases as the reperfusion time is delayed.

It has been stated that the success of the first-pass mechanical thrombectomy, defined as providing complete revascularization to the distal of the occluded vessel with a single pass (first-pass effect), is a predictor of good functional outcome. Therefore, the number of trials and passes and whether the number of passes affect clinical outcome have been investigated in endovascular procedures. It was observed that in 25% of the cases, complete or nearly complete reperfusion was achieved with the first pass, and the clinical outcomes of these patients were better compared to patients who could not be recanalized with the first pass [5, 6]

Although there are different types of approaches to thrombectomy, when evaluating the results of acute ischemic stroke treatment, the time from the onset of symptoms until therapeutic intervention is accepted as a primary factor. However, procedural duration may also affect treatment success; for instance, in a study that attempted to determine the effect of procedural time—rather than the time from onset of symptoms to groin puncture—on outcomes in patients who underwent mechanical thrombectomy, it was reported that procedures longer than 60 min (min) from groin puncture to recanalization led to an increased incidence of complications, increased costs, and worse outcomes [7]. As such, in order to achieve good clinical and angiographic results, effective and fast methods that reduce the duration of the thrombectomy procedure to an average of 30 min have been sought in previous studies [8].

In this retrospective study, we sought to investigate the relationships between recanalization success achieved by mechanical thrombectomy and various parameters, such as the time from the onset of symptoms to groin puncture, the number of passes, the procedure time, and the procedure technique. The effects of artery irrigation area, stroke etiology, and stroke risk factors on recanalization success and prognosis were also examined.

Material and methods

Patient selection

In this retrospective study, 109 patients with anterior circulation stroke who applied to the Stroke Unit of the Memorial Hospital, between August 2017 and June 2019, and underwent mechanical thrombectomy were included after obtaining ethical approval for the research. All patients were evaluated by a stroke neurologist using unenhanced brain computed tomography (CT).

Inclusion criteria were as follows: being over 18 years of age, $\leq$ 8-h (h) duration from onset of symptoms to groin puncture, having a stroke severity of $\geq$ 4 according to the National Institutes of Health Stroke Scale (NIHSS) [9], an infarct core area score of $\geq$ 6 according to Alberta Stroke Program Early CT (ASPECT) [10], pre-stroke modified Rankin score (mRS, assessing neurological disability) of $\leq$ 2 [11], lack of intracranial hemorrhage on CT, presence of intracranial large vessel occlusion in computed tomography angiography (CTA), magnetic resonance angiography (MRA) or digital subtraction angiography (DSA), and presence of occlusion in the internal carotid artery (ICA) or in the M1 and M2 segments of the middle cerebral artery (MCA). Patients with posterior circulation stroke, extensive ischemic infarction, intracranial hemorrhage, bleeding coagulation disorder, and pre-stroke mRS of > 2 were excluded from the study.

According to the acute ischemic stroke criteria of the American Heart Association/American Stroke Association (AHA/ASA) guideline, iv tpa was given by the stroke neurologist to patients who were admitted within the first 4.5 h. Stroke onset time is uncertain, onset of symptoms exceeded 4.5 h, systolic blood pressure > 185 mmHg or diastolic blood pressure > 110 mmHg, International Normalized Ratio (INR) > 1.7, thrombocytopenia (< 100 k/mm3), activated partial thromboplastin time (aPTT) > 40 s, and patients receiving new oral anticoagulants were not given iv tpa. Patients without clinical improvement after iv tpa were taken for endovascular treatment [12].

Endovascular procedure

Endovascular procedures were performed under conscious sedation. Routinely 5000 units of bolus heparin were administered after femoral artery groin puncture, if the patient did not receive iv tpa. A triple coaxial system consisting of 6F long sheath, 6F intermediate catheter, and 0.027-in microcatheter was used in 104 of the patients. Briefly, the 6F guiding catheter or 6F long sheath (Neuron MAX, Penumbra Inc., Alameda) was implanted into the common carotid artery (CCA) or ICA. Then, the distal of the occlusion was reached with a 0.027-inner lumen microcatheter over a 0.014-in microwire. The stent was opened distal to the thrombus by passing through the microcatheter and the microcatheter was removed. It was waited for approximately 3 min after stent placement. The stent retriever was then withdrawn, either on its own or together with the 6F intermediate catheter, while applying continuous aspiration to the 6F intermediate catheter and guiding catheter with a 50-ml injector via manual means or pump aspiration. Solitaire (Covidien/ev3 Inc., Irvine, CA, USA) or Trevo (Stryker, Kalamazoo, MI, USA) stents were used. In patients with stenosis or occlusion of the cervical ICA proximal, after successful recanalization of the distal vessel, angioplasty was applied to the proximal ICA. In patients with resistant stenosis despite angioplasty, 600 mg aspirin and 600 mg clopidogrel were administered through the nasogastric tube and a carotid stent was placed.

The success of recanalization after thrombectomy was measured with the modified thrombolysis in cerebral infarction (mTICI) method [13]. Partial filling in less than 2/3 of the occluded vascular bed was evaluated as TICI 2a, full filling but slow flow was evaluated as TICI 2b and full perfusion was evaluated as TICI 3. Successful recanalization was defined as the presence of TICI 2b + TICI 3. In this study, the time from the onset of symptoms to groin puncture, first pass, number of passes, procedural time—regardless of recanalization success (groin puncture to procedure termination), and recanalization success were recorded. No antiaggregant or anticoagulant was given within the first 24 h after the procedure. Intracranial hemorrhage was classified according to the European Cooperative Acute Stroke Study (ECASS 2) criteria, as intracranial hemorrhage, hemorrhagic infract, or parenchymal hemorrhage, on CT performed after the procedure [14]. Symptomatic hemorrhage was defined by NIHSS $\geq$ 4 neurological deterioration. If no bleeding was observed in the CT performed after 24 h, 100 mg/day aspirin was initiated. In addition, it was also examined whether reocclusion developed with BTA/MRA in patients with clinical worsening.

Clinical evaluation

The clinical evaluation of the patient was made by the stroke neurologist with the NIHSS. Good clinical outcome was defined as 0–2, poor clinical outcome was defined as 3–6 mRS, and mRS 6 was recognized as death. Trial of Org 10,172 Acute Stroke Treatment (TOAST) criteria were used for stroke typing [15]. Patients determined to have stroke in Doppler, CTA, and MRA studies who had severe stenosis (greater than 50%) in ipsilateral ICA on post-procedure assessment were identified as having large vessel atherosclerotic disease (LVAD). Electrocardiogram (ECG), transthoracic echocardiography (TTE), and 24-h Holter monitoring were performed in all patients. Transesophageal echocardiography (TEE) was also performed in patients who were deemed to require TEE after TTE analysis. Etiology was considered to be cardioembolic in patients with rheumatic valvular heart disease, mitral or aortic valve replacement, mild cardiomyopathy (ejection fraction < 40%) or severe cardiomyopathy, nonvalvular atrial fibrillation, infective endocarditis, atrial or ventricular thrombus, cardiac catheterization, cardiac anomaly, but without extracranial and intracranial stenosis.

The demographic data of the patients, stroke risk factors, and stroke etiologies were obtained from the electronic medical file database. Parameters such as the NIHSS scores of the patients at the time of admission to the hospital, whether they received iv tpa, the time from the onset of symptoms to groin puncture, the number of passes, the duration of the procedure, the degree of recanalization, the artery irrigation area, the procedure technique, and procedural complications were recorded.

Statistical methodology

Mean, standard deviation, median, lowest, highest, frequency, and ratio values were used in the descriptive statistics of the data. The distribution characteristics of continuous variables were evaluated with the Kolmogorov–Simonov test. The Mann–Whitney *U* test was used to analyze quantitative independent data. Chi-square test was used in the analysis of qualitative independent data and the Fischer Exact test was used when Pearson chi-square test assumptions were not met. The SPSS version 26.0 program was used for all analyses.

Results

The data of 109 patients who presented with anterior circulation stroke and underwent mechanical thrombectomy were retrospectively analyzed. Fifty-five of the patients were female (50.5%) and 54 were male (49.5%), and mean age was 67.3 ± 12.9 years. When the stroke etiologies of the patients were evaluated, it was found that 47 (43.1%) of them were due to LVAD and 62 (56.9%) of them were cardioembolic. Detailed patient baseline characteristics, procedural parameters, and target vessels are summarized (Table 1).

There was no significant difference in recanalization success in the ICA and MCA irrigation areas ($p > 0.05$). When recanalization success TICI 2b,3 was evaluated with respect to time from the onset of symptoms to groin puncture, it was observed that success was achieved in 42.9% of cases below 4.5 h, 35.2% of cases between 4.5 and 6 h, and 22.0% of cases above 6 h, albeit the differences were not statistically significant. In the group with a pass number of 1, the frequency of achieving TICI 2b,3 recanalization and TICI 3 recanalization was significantly higher than the group with pass number 2 or greater ($p = 0.032$ and $p = 0.001$, respectively). In the group with a pass number of 1, the number of patients with mRS between 0 and 2 was significantly higher compared to the group with greater than 2 passes ($p = 0.046$).

The frequency of TICI 2b,3 recanalization and TICI 3 recanalization was significantly higher in patients with a

Table 1 Baseline characteristics and procedural parameters of all patients

Variables	All patients	Large vessel ateherosclerotic disease (LVAD) ($n=47$)	Cardioembolic ($n=62$)	p
Age, mean	67.3 ± 12.9	62.0 ± 11.7	71.2 ± 12.3	0.001*
Gender, female, n (%)	55 (50.5)	19 (40.4)	36 (58.1)	0.06
NIHSS score on admission, mean	17.0 ± 3.9	16.5 ± 4.4	17.4 ± 3.4	0.28
Vascular risk factors, n (%)				
Coronary artery disease	64 (58.7)	15 (31.9)	49 (79.0)	0.001*
Hypertension	60 (55)	25 (53.2)	35 (56.5)	0.7
Diabetes mellitus	27 (24.8)	14 (29.8)	13 (21.0)	0.29
Atrial fibrillation	46 (42.2)		46 (74.2)	0.001*
Hyperlipidaemia	35 (32.1)	17 (36.2)	18 (29.0)	0.42
Previous ischemic stroke	12 (11)	3 (6.4)	9 (14.5)	0.17
Occlusion zone, n (%)				
Middle cerebral artery	73 (67.0)	31 (66.0)	42 (67.7)	
Anterior cerebral artery	1 (0.9)		1 (1.6)	
Internal carotid artery	17 (15.5)	16 (34)	19 (30.6	
MCA/ICA tandem occlusion	18 (15.5)	10 (21.3)	8 (12.9)	
Onset to groin puncture and recanalization success, n (%)				0.09
0– ≤ 4.5 h	44 (42.9)	22 (46.8)	22 (35.5)	
> 4.5– ≤ 6 h	38 (35.2)	11 (23.4)	27 (43.5)	
> 6 h	27 (22)	14 (29.8)	13 (21.0)	
Successful recanalization (TICI 2B,3), n (%)	91 (83.4)	42 (89.4)	49 (79.0)	0.23
First pass recanalization	32 (29.4)	21 (44.7)	11 (17.7)	
Number of passes, mean	2.1 ± 1.0	1.8 ± 1.0	2.3 ± 0.9	0.002*
Puncture to recanalization, mean	71.0 ± 27.4	61.1 ± 24.6	78.5 ± 27.2	0.001*
IV tpa, n (%)	23 (21.1)	13 (27.7)	10 (16.1)	
İA tpa	3 (2.8)	2 (4.3)	1 (1.6)	
Angioplasty and stenting	12 (11)	10 (21.7)	2 (3.2)	
Outcome, n (%)				0.49
mRS 0–2	47 (43.1)	18 (38.3)	29 (46.8)	
mRS 3–5	48 (44)	19 (40.4)	29 (46.8)	
mRS 6	14 (12.8)	10 (21.3)	4 (6.5)	
Mortality				0.022*
mRS 0–5				
mRS 6				
Symptomatic ICH	3 (2.8)	1 (2.12)	2 (3.22)	
Reocclusion	8 (7.3)	6 (12.7)	2 (3.2)	

Values are mean (SD) or n (%) as appropriate. *:A two-sided p value < 0.05 was considered statistically significant. *NS*, not significant; *NIHSS*, National Institutes of Health Stroke Scale; *MCA*, middle cerebral artery; *ICA*, internal carotid artery; *TICI*, thrombolysis in cerebral infarction; *IV/IA tpa*, intravenous/intraarterial tissue plasminogen activator; *Mrs*, modified Rankin score; *ICH*, intracerebral haemorrhage

procedure time less than 60 min compared to patients with a procedure time longer than 60 min ($p=0.019$ and $p=0.001$, respectively). There was no significant difference in mean mRS values between patients with a procedure time less than 60 min and those with a procedure time exceeding 60 min ($p=0.1$).

Recanalization success did not differ significantly in patients with LVAD and those with cardioembolic etiology (p ˃0.05). In the cardioembolic group, the number of passes and procedural time were significantly higher compared to the atherosclerotic group ($p=0.002$ and $p=0.001$, respectively) (Fig. 1). The mean mRS values did not differ significantly in the cardioembolic and LVAD groups ($p>0.05$) (Fig. 2). However, the number of patients with an mRS of 6 in the group with LVAD was significantly higher than that of the cardioembolic group ($p=0.022$).

The age of the patients in the group with failed recanalization was significantly higher than the group with successful recanalization ($p = 0.027$). In the group with procedure time exceeding 60 min, the rate of hypertension (HT) was significantly higher than the group with procedure time below 60 min ($p = 0.043$).

The number of passes was significantly higher in the tandem occlusion group than in the non-tandem occlusion group ($p = 0.019$). While there was no significant difference between the two groups in terms of procedure time and success of recanalization, the frequency of patients with mRS values of 0–2 was significantly higher in the group without tandem occlusion ($p = 0.026$).

Discussion

Mechanical thrombectomy has become the standard treatment in patients with acute ischemic stroke due to large vessel occlusion [12, 16]. The outcomes of thrombectomy appear to be related to various factors, including the time from the onset of symptoms to groin puncture, first-pass recanalization, recanalization procedure time, and endovascular technique. Additionally, the success of a procedure can be influenced not only by these parameters, but also by stroke etiology, patient-related risk factors, and the type and properties of the occlusion.

In a prior study examining patients who underwent mechanical thrombectomy, the time from the onset of symptoms to groin puncture was examined under 3 groups (less than 3 h, between 3 and 6 h, and over 6 h), and it was found that shorter duration was associated with better clinical outcome—independent of endovascular treatment [17]. In our study, although statistical significance was not found, 42.9% of recanalization procedures were successful in patients who underwent thrombectomy within 4.5 h, and this rate was reduced by half (22%) in patients who underwent thrombectomy after the 6th hour. In addition, it was observed that,

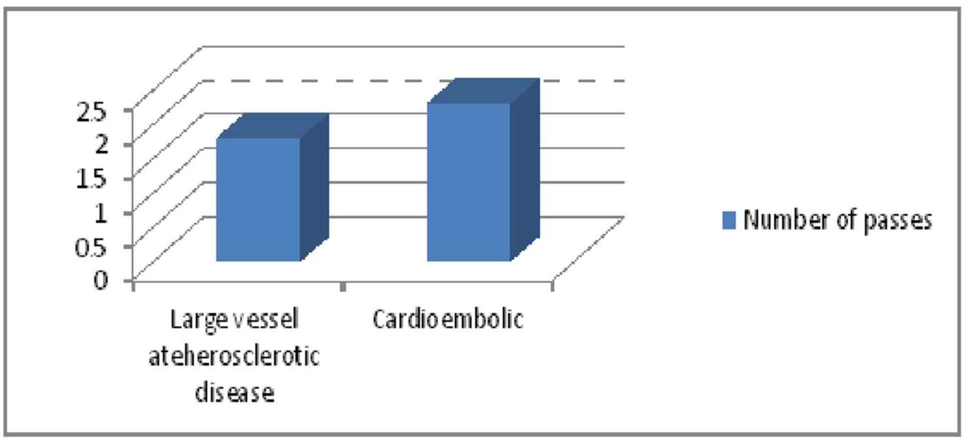

Fig. 1 Number of passes in strokes due to large vessel atherosclerotic disease (LVAD) and cardioembolic etiology

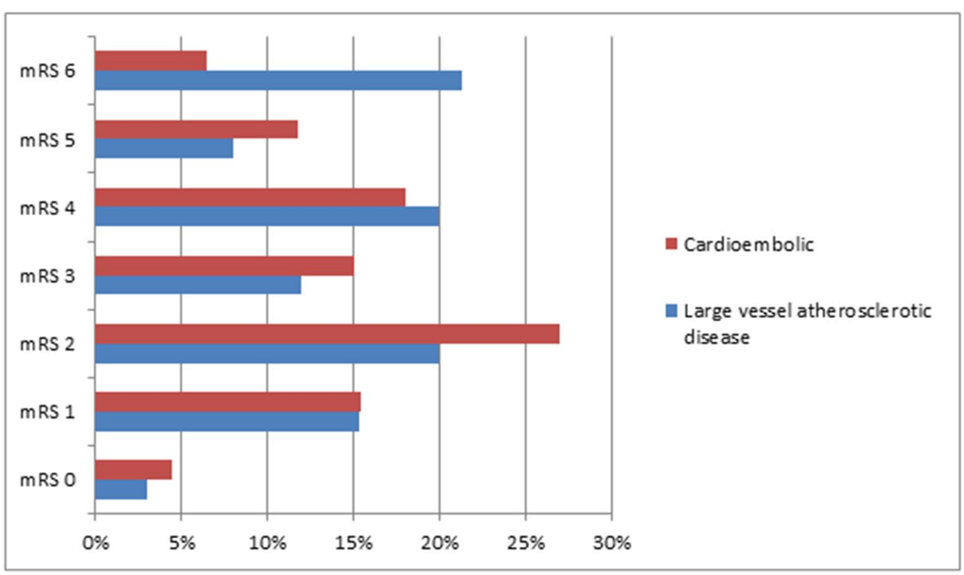

Fig. 2 Distribution of modified Rankin score (mRS) values in patients with large vessel atherosclerotic disease (LVAD) and cardioembolic etiology

in the group where recanalization could not be achieved, 3rd month mRS value was above 2 and most of the patients experienced disability.

Recently, complete recanalization with the least number of passes has been shown to be associated with improved clinical outcomes, as well as intervention in the first 6–8 h, to achieve effective endovascular treatment [18, 19]. In a study in which 472 people were included, good functional outcomes were observed in 44.4% of subjects with 3 passes, 26.3% of subjects with 4 passes, and 14.8% of subjects with 5 or more passes. It was observed that procedural duration was prolonged, success was decreased, and functional outcomes were worse in situations where the number of passes exceeded 3 and when the number of passes increased [20]. Similarly, in our own experience, as the number of passes increased, the success of recanalization decreased and 3rd month mRS scores increased.

Prolongation of procedure time and delayed recanalization adversely affect functional outcome. A 30-min delay in recanalization can increase functional dependence by 11% [21]. In our study, lower recanalization success was determined in cases with a procedure duration exceeding 60 min. We believe that lower recanalization success will evidently translate into worse outcome.

In a meta-analysis, it was shown that the frequency of recanalization success was lower in elderly patients compared to young individuals, and the reason for this was that increased vascular tortuosity decreased the effective use of thrombectomy devices. It has also been reported that diseases such as HT and vascular sclerosis, which are more common in elderly patients, increase the tendency for intracerebral hemorrhage [22, 23]. In our study, recanalization success was significantly lower in patients with HT. Patients' age was also significantly higher in the group with failed recanalization. In conclusion, it is possible to say that HT and advanced age negatively affect the success of recanalization and clinical outcome.

LVAD and cardioembolic etiology are among the main causes of ischemic stroke in acute ischemic stroke, especially in patients with large vessel occlusion requiring endovascular treatment. When evaluating the effect of LVAD and cardioembolic etiologies on the success of recanalization, it may be thought that clinical outcomes may be worse in patients with cardioembolic etiology, since these patients usually have more advanced age and longer endovascular process (the number of passes is higher, the duration of the procedure is longer). As a matter of fact, it was reported in previous publications that the success of recanalization was low and the procedure time was prolonged due to the high white blood cell (WBC) and fibrin/platelet content of thrombi in patients with cardioembolic etiology, and this situation negatively affected the clinical outcome [24]. In another study, it was reported that recanalization rates were similar in embolic or intracranial atherosclerosis-related large artery occlusions; however, in large artery occlusions due to intracranial atherosclerosis, the outcomes were worse because the procedure was complex and the duration of the procedure was prolonged due to the high rate of re-occlusion [25]. Again, in atherosclerotic large artery occlusions, despite the use of angioplasty and stenting as salvage therapy, revascularization rates were observed to be worse than cardioembolic ones [26, 27].

In cardioembolic large artery occlusions, the thrombus is loosely contacted to the vessel wall and the lumen is normal, so the guide catheter advances easily without resistance, and in this case, it is possible to remove the thrombus using the stentretriver or aspiration technique. In atherosclerotic large artery occlusions, since the thrombus is tightly contacted to the vessel wall, it is difficult to remove it using the stentretriver or aspiration technique, and residual stenosis is often observed after the procedure. After repeated procedure, reocclusion can also be seen as a result of local thrombosis due to vessel wall damage [28]. In this case, glycoprotein IIb/IIIa inhibitors can be given primarily from the distal access catheter or microcatheter, or balloon angioplasty/stenting treatment and glycoprotein IIb/IIIa inhibitors can be applied in addition [29]. In these patients, control angiograms should be performed after 10–20 min to see if there is reocclusion after successful recanalization. Stentretriver thrombectomy is as effective for first-pass recanalization in acute strokes due to intracranaial atherosclerosis as it is for embolic large artery occlusions. While the contact aspiration method is the same as stentretriver thrombectomy in embolic occlusions, it is less effective in intracranial atherosclerosis. For successful contact aspiration, large-bore catheters require the distal tip to be firmly attached to the occlusive clot. However, due to vascular tortuosity in occlusions due to intracranial atherosclerosis, less firmly engagement occurs than in an embolic clot in a normal vascular structure. As a result, the rate of reocclusion developed by both methods is similar [30]. In cardioembolic strokes, the fact that the clot is large, rich in fibrin, and located more frequently in terminal occlusions [24, 31] causes an increase in the number of passes and therefore a prolongation of the recanalization time. On the other hand, in atherosclerotic strokes, the need for additional procedures such as balloon angioplasty/stenting due to reocclusion, which is common, also causes a prolongation of the recanalization time. In a meta-analysis, it was determined that atrial fibrillation, cardiogenic embolism, long-term use of statins, long-term use of antiplatalet, and target vessel occlusion MCA-M1 prevented reocclusion after mechanical thrombectomy, while a longer time from symptom onset to recanalization increased reocclusion [32]. Due to reocclusion seen in atherosclerotic large artery occlusions, early neurological deterioration and 90-day death rates were observed to be higher, and the probability of a 90-day mRS score of ≤ 2 was also lower [32]. It was also stated that the reocclusion rate after a successful recanalization was between 2 and 20% [33]. In our study, the number of passes was higher in the cardioembolic group, and the procedure time was significantly longer. In the atherosclerotic group, the reocclusion rate detected by CTA/MRA in patients with clinical worsening was higher. There was no significant difference between the two groups in terms of recanalization success and mean mRS values at 3rd month. However, in the large artery atherosclerosis group, the number of patients with mRS 6 was significantly higher than the cardioembolic group. This was associated with a higher reocclusion rate in the atherosclerotic group than in the cardioembolic group.

In atherosclerotic stenosis or occlusion, due to the chronicity of the process, collaterals are more effective than collaterals in a sudden embolic process. This may prolong the reperfusion time in atherosclerotic patients. However, in the absence of severe stenosis, in the presence of an in situ thrombus, and a vulnerable plaque, the change in collateral status is similar to the situation in embolic occlusions [28]. Although collateral circulation can prolong the reperfusion delay time and protect from ischemia in the early period in atherosclerotic strokes, we think that it does not go beyond delaying the clinical worsening after reocclusion, although not in every case. In this case, we can say that mortality may increase in patients with LVAD who have reocclusion.

It has been reported that the majority of patients in large artery occlusions due to intracranaial atherosclerosis are young men. In our study, the age of patients with atherosclerotic disease was lower than those with cardioembolic disease and male gender was dominant. Coronary artery disease was found to be significantly higher in the cardioembolic group. In one study, it was stated that coronary artery disease was not different in both groups, but there were also undiagnosed asymptomatic patients. A cohort of patients with ischemic stroke with no prior history of coronary artery disease was systematically studied, and asymptomatic CAD was identified in 37.5% of patients with CT coronary angiogram [29].

It has been reported that TICI 2b,3 reperfusion is observed at a lower rate in acute tandem strokes with atherosclerotic occlusion of extracranial ICA, but when compared with high-grade extracranial ICA stenoses, they have similar functional outcomes [34]. In our study, the number of passes was significantly higher in 18 patients (16.5%) with tandem occlusion—even though the duration of the procedure and the success of recanalization did not differ significantly between patients with and without tandem occlusion. Therefore, by considering that the number of passes can influence clinical outcome, we can explain the relatively lower frequency of patients with mRS 0–2 in the tandem occlusion group when compared to the non-tandem occlusion group.

This research could only include a low number of patients due single-centeredness, and data was retrospectively obtained (patient and imaging data), which may have caused bias in assessment. Finally, exclusion of strokes due to posterior circulation, and the lack of examination concerning collateral flow and thrombus length or histopathology, can be counted among the limitations of our study.

Conclusion

Thrombolysis given before endovascular treatment is effective in dissolving the residual thrombus or thrombus in the distal vessels that the stentretriver cannot reach. On the other hand, it is known that iv tpa can disintegrate the clot and cause distal emboli and increase the risk of intracranial and extracranial hemorrhage. Because of this situation, in patients with good collaterals, low NIHSS score, multiple infarct areas, difficulty in groin puncture, and more distally located thrombus, the necessity of iv tpa in the treatment window is in favor. In patients with proximal occlusions, use of anticoagulants, unsuitability for thrombolysis, and high bleeding risk, initiation of treatment may be favored by mechanical thrombectomy [1, 2]. Regardless of the etiology, iv tpa and mechanical thrombectomy bridging treatment are recommended in patients with acute stroke, while the etiology should be considered in terms of the mechanical thrombectomy method. The clinical outcome of patients with acute stroke who underwent endovascular treatment may be associated with the etiology of the event. Despite finding higher pass count and longer procedure duration in patients with cardioembolic etiology, recanalization success and clinical outcomes were similar to subjects with atherosclerotic etiology. However, mortality rate was higher in patients with atherosclerotic etiology, due to the complexity of the procedure and the high rate of reocclusion. Therefore, we believe that recanalization rates and clinical success may be improved by determining a strategy taking into consideration the etiology instead of planning the mechanical thrombectomy procedure as a standard approach. Given that the etiology of stroke is directly associated with the histopathology of the clot, the relationship between recanalization and stroke etiology can be better understood. With the advances technology, we believe there is a need for multi-center studies involving a large number of patients on this subject.

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Altunhan, Aslı Yaman Kula, Talip Asil; methodology: Talip Asil, Cigdem Deniz; project administration: Cigdem Deniz, Aslı Yaman Kula, Talip Asil; resources: Cigdem Deniz, Bengu Altunhan, Aslı Yaman Kula, Talip Asil; supervision: Talip Asil; validation: Cigdem Deniz, Talip Asil, Bengu Altunhan; roles/writing—original draft: Cigdem Deniz; writing—review and editing; Cigdem Deniz, Talip Asil.

Data availability The authors take full responsibility for the data, the analysis, and interpretation of the research, and they have full access to all of the data.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval Approval was obtained from the ethics committee of Bezmialem Vakıf University (10.9.2019–16/319). The procedures used in this study adhere to the tenets of the Declaration of Helsinki. All participants gave their written informed consent to participate in the study.

Informed consent statement Informed consent statement was obtained from all participants.

Consent for publication All authors agreed with this final version.

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