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Should coronary catheter laboratories be used in the treatment of ischemic stroke? Endovascular treatment in acute ischemic stroke performed by interventional cardiologists

I. KOCAYIGIT[1], H. KILIC[1], B.A. ACAR[2], T. ACAR[2], Y.G. ARAS[2], Y. CAN[1], H.A. ERYILMAZ[2], S. BONCUK[2], R. AKDEMIR[1]

[1]Department of Cardiology, Faculty of Medicine, University of Sakarya, Sakarya, Turkey
[2]Department of Neurology, Faculty of Medicine, University of Sakarya, Sakarya, Turkey

Abstract. – OBJECTIVE: The aim of this study was to investigate the technical success and in-hospital outcomes of endovascular thrombectomy (ET) in acute ischemic stroke (AIS) patients performed by interventional cardiologists.

PATIENTS AND METHODS: ET for AIS provides fast, effective and safe recanalization. Insufficient number of catheter laboratories for stroke interventions and experienced interventional neurologists are limiting the widespread application of such a promising treatment method.

RESULTS: 123 patients with AIS and eligible for ET were evaluated retrospectively. 65 patients were female (52.8%) and the mean age of the patients was 71.5 ± 11.9 years. Most of the patients had a middle cerebral artery (MCA) occlusion (112 patients, 91%). Successful recanalization (thrombolysis in cerebral infarction grading 2b or higher) was achieved in 109 patients (88.6%). Access site complication was observed only in 3 patients (2.4%). Intracranial bleeding was observed in 17 patients (13.8%) and only 8 of them were symptomatic (6.5%). In-hospital death occurred in 19 patients (15.4%). The initial National Institutes of Health Stroke Scale (NIHSS) was 16.8±3.3 (median 18) which improved significantly to 10.4±7.2 (median 11) at 24 hours (p<0.001). Dramatic neurologic improvement was observed in 60 of 123 patients (48.8%). The Modified Rankin Score of the patients was significantly lower at discharge compared to admission (4.2±0.7 *vs*. 2.9±2, p<0.001).

CONCLUSIONS: ET in AIS can be performed safely with high success rates by trained interventional cardiologists within the stroke team. Until the number of stroke centers is sufficient, endovascular treatment of AIS can be supported by experienced interventional cardiologists.

Key Words:
Acute ischemic stroke, Endovascular thrombectomy, Interventional cardiologist.

Introduction

Acute ischemic stroke (AIS) is a dysfunction of the central nervous system that results from the sudden occlusion of the intracerebral arteries. AIS is one of the most frequent causes of death and disability worldwide[1]. The majority of all strokes are ischemic in origin, accounting for over 87% of all strokes[2]. Neurologists have two effective treatment modalities to improve outcomes after ischemic stroke: thrombolytic therapy (TT) and endovascular thrombectomy (ET). However, TT has limited success in recanalization of the occluded artery and only a small proportion of stroke patients are eligible for TT[3]. Recent studies[4-10] have shown that ET can achieve fast and effective recanalization of the occluded arteries and improve the prognosis of patients with AIS. Due to the insufficient number of interventional neurologists, other medical specialists, such as radiologists, neurosurgeons and cardiologists, are providing mechanical thrombectomy to patients with AIS[11].

Although their numbers and effectiveness are increasing, interventional neurologists and catheter laboratories for acute stroke interventions are not widely available in many regions. Therefore, until a sufficient number of interventional neurologists are available, interventional cardiologists and catheter laboratories that are available around the clock for ST segment elevation myocardial infarction (STEMI) can support this requirement. Interventional cardiologists spend most of their working hours opening stenosed or occluded arteries and have become increasingly skilled at catheter-based interventions. In our study, we reported the technical success and in-hospital out-

Corresponding Author: Ibrahim Kocayigit, MD; e-mail: ibrahimkocayigit@sakarya.edu.tr

comes of ET in acute stroke patients performed by interventional cardiologists.

Patients and Methods

This retrospective study was conducted in the Department of Cardiology and Neurology, Sakarya University School of Medicine, Sakarya, Turkey, between July 2017 and November 2019. The study included 123 patients with AIS who were eligible for endovascular treatment. Eligible patients had the following characteristics: 1) they were 18 years of age; 2) they had an occlusion in the intracranial segment of the internal carotid artery or of the first or proximal second segment of the middle cerebral artery that could be treated within six hours after symptom onset; 3) they had a prestroke functional ability of 1 or less on the modified Rankin scale (ranging from 0 [no symptoms] to 6 [death]); and 4) they had a baseline score of at least 6 points on the National Institutes of Health Stroke Scale (NIHSS), which ranges from 0 to 42, with higher points defining more severe neurologic deficit. The main exclusion criterion was evidence of a large ischemic core on imaging. This was indicated by an Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of less than 7 on computed tomography (the ASPECTS scoring system ranges from 0 to 10, with higher scores defining a smaller infarct zone). Concomitant TT was administered to eligible patients within 4.5 hours after the onset of stroke symptoms, in accordance with current guidelines. Informed written consent was obtained from the participants or their legal representatives, and Ethics committee approval was obtained from the Ethics Committee of Sakarya University before the study began.

The vascular neurologists, in consultation with the interventional cardiologist, determined the patient's eligibility for endovascular treatment. Each interventional cardiologist had performed at least 100 carotid stent procedures. Patients with AIS underwent rapid endovascular treatment. Groin puncture was preferred as the initial entry site. Direct carotid access was used in patients if femoral access was unsuccessful due to the tortuosity of the aorta or an attempt to engage carotid arteries was unsuccessful. First, a cerebral angiogram was performed. Then, a suitable method (contact aspiration alone, stent retriever alone, or a combination of both) was used to achieve reperfusion. All patients underwent neurologic evaluations based on NIHSS performed by a vascular neurologist at admission, at 24 hours, and at discharge. Demographic information, procedural characteristics, NIHSS scores and in-hospital outcomes were collected from our comprehensive stroke centre patient database. The endpoints of the study were successful recanalization, the occurrence of symptomatic intracranial haemorrhage, death, the modified Rankin scores and NIHSS at discharge.

Results

A total of 123 patients underwent endovascular treatment for AIS. Of the total, 65 patients were female (52.8%), and the mean age of the patients was 71.5 ± 11.9 years. The patient characteristics are presented in Table I. Thirty patients (24.4%) received concomitant intravenous TT. The median time from symptom onset to admission to the hospital was 75 (35-125) minutes. The median time from hospital admission to groin puncture for endovascular treatment was 51 (40-75) minutes. Most of the patients had middle cerebral artery occlusion (112 patients, 91%). Distal intracranial internal carotid artery occlusion with middle cerebral artery involvement was detected in eight patients (6.5%). Isolated internal carotid artery occlusion was detected in three patients (5.4%). Successful recanalization (thrombolysis in cerebral infarction grading 2b or higher) was achieved in 109 patients (88.6%; Figure 1).

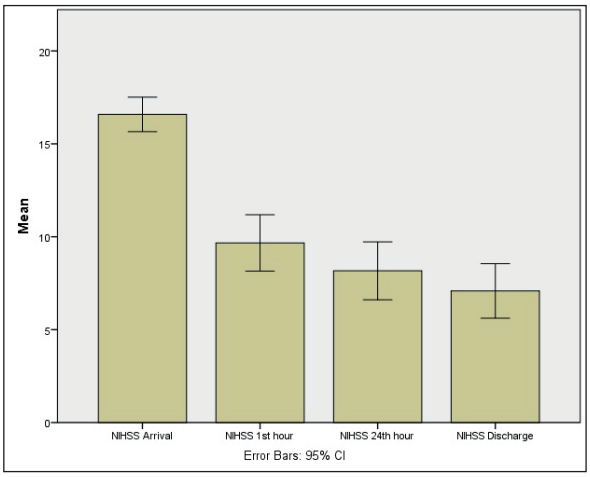

Figure 1. The mean NIHSS scores of the patients. NIHSS: National Institutes of Health Stroke Scale.

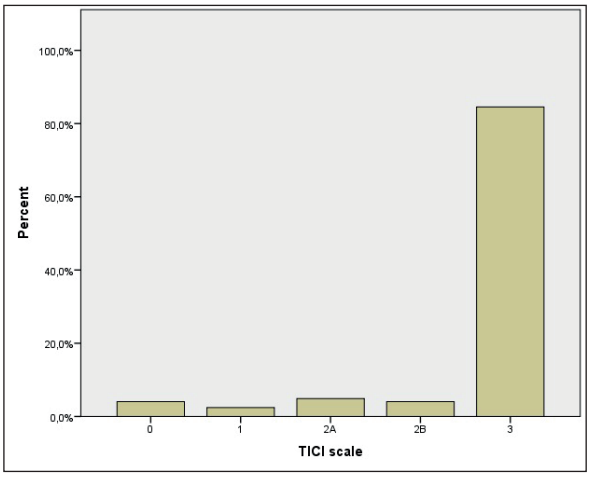

Figure 2. Post-procedural TICI scales of the patients. TICI: Thrombolysis in cerebral infarction.

Stent retrievers were used in 97 of 123 patients (78.9%). The initial entry site was the femoral artery in all patients. In 119 patients (96.7%), the procedure was completed *via* the femoral route. In only four patients (3.2%), crossover to the direct carotid artery puncture was performed due to excessive tortuosity or inability to engage to carotid artery ostium. The procedural characteristics are shown in Table II. Access site complication (hematoma) was observed in only three patients (2.4%). Intracranial bleeding was observed in 17 patients (13.8%), only eight of whom were symptomatic (6.5%). All causes of mortality amounted to 15.4% (19 patients). The in-hospital outcomes are shown in Table III. The baseline NIHSS for patients who underwent endovascular treatment was 16.8 ± 3.3 (median 18), which improved significantly to 10.4 ± 7.2 (median 11) at 24 hours ($p < 0.001$). The mean NIHSS scores of the patients are shown in Figure 2. Dramatic neurologic improvement, which was defined as a reduction of at least 8 points on the NIHSS or a score of 0 to 2 at 24 hours, was observed in 60 of 123 patients (48.8%). The Modified Rankin Scale score of the patients was significantly lower at discharge compared to admission (4.2 ± 0.7 *vs*. 2.9 ± 2, $p < 0.001$).

Table I. Characteristics of the patients.

Number of patients	123
Age	71.5 ± 11.9
Female Gender	65 (52.8%)
BMI	27 ± 4.2
Hypertension	97 (78.9%)
Diabetes Mellitus	38 (30.9%)
Coronary artery disease	41 (33.3%)
Hyperlipidemia	21 (17.1%)
Smoking habitus	
Active	21 (17.1%)
Ex smoker	32 (26%)
Congestive heart failure	22 (17.9%)
Atrial fibrillation	53 (43.1%)
Previous ischemic stroke	21 (17.1%)
Previous hemorrhagic stroke	1 (0.8%)
Admission NIHSS	16.8 ± 3.3
Admission modified Rankin Scale	4.2 ± 0.7

BMI: Body mass index. NIHSS: National Institutes of Health Stroke Scale.

Discussion

In our study, we report the technical success and in-hospital clinical outcomes of endovascular therapy in 123 patients. The therapy was performed by interventional cardiologists studying with vascular neurologists on a stroke team. Successful recanalization was provided in 88.6% (109/123) of the patients. Comparing the results of our study with other large trials assessing endovascular treatment in patients with AIS, higher successful recanalization rates were observed in our study than in the Mr Clean (58.7%), Escape (72.4%), Revascat (65.7) and Resilient (82%) trials[7,8,10,12]. Successful reperfusion rates were similar between Swift Prime (88%), Extend IA (86.2%) and our study[6,9,12]. Goktekin et al[13] reported that successful reperfusion was achieved by interventional cardiologists in 35 of 38 patients (89%) with acute ischemic stroke. As in our study, the rate of successful reperfusion may have been higher because interventional cardiologists have many years of experience opening occluded arteries. Dramatic neurologic improvement was observed in 60 of 123 patients (48.8%); such improvement was defined as a reduction of at least 8 points on the NIHSS or a score of 0 to 2 at 24 hours. The rate of dramatic neurologic improvement at 24 hours was 59% in the Revascat trial and 31.4% in the Resilient trial[7,12]. In the Extend IA trial, dramatic neurologic improvement at 72 hours was observed in 28 of 35 patients (80%)[9]. The clinical outcomes of stroke interventions performed by interventional cardiologists were similar to those achieved by neurointerventional centres.

The development of treatment methods for acute artery occlusion causing AIS has been parallel to the development of treatment methods for acute myocardial infarction over the years. Selec-

Table II. Procedural characteristics.

Concomittant thrombolytic therapy	30 (24.4%)
Presentation time (min)	75 [35-125]
Time to treatment (min)	51 [40-75]
Access site	
Femoral	119 (96.7%)
Carotid	4 (3.2%)
Occluded artery	
MCA-M1	94 (76.4%)
MCA-M2	18 (14.6%)
Terminal ICA with M1 involvement	8 (6.5%)
Isolated ICA	3 (2.4%)
Retriever stent	97 (78.9%)
Contact aspiration	26 (21.1%)
Successful reperfusion (TICI ≥2B)	109 (88.6%)

Min: minutes; MCA: middle cerebral artery; M1: first segment of MCA; M2: second segment of the MCA; ICA: internal carotid artery. TICI: thrombolysis in cerebral infarction.

Table III. In-hospital outcomes.

Death	19 (15.4%)
Dramatic neurologic improvement*	60 (48.8%)
Intracranial bleeding	17 (13.8%)
Symptomatic intracranial bleeding**	8 (6.5%)
Access site complications (hematoma)	3 (2.4%)

*Dramatic neurologic improvement was defined as a reduction of at least 8 points on the NIHSS or a score of 0 to 2 at 24 hours. **Symptomatic intracranial bleeding was clinically determined.

tion of patients who will benefit from treatment, the prevalence of invasive intervention centres for ischemic stroke and transportation of patients to these centres are the most important difficulties encountered. The treatment of acute ischemic stroke, which starts with TT, progresses towards opening the occluded artery by intervention without delay. This progression is similar to the development of the treatment process for STEMI patients, which is characterised by complete occlusion of the coronary arteries.

Although recanalizing the major artery occlusion seems to be a similar procedure, STEMI and AIS interventions are quite different from one another. Occlusion of the artery in acute myocardial infarction is caused by the rupture and thrombosis of the underlying atherosclerotic plaque; conversely, most of the lesions in acute ischemic stroke originate from heart or carotid artery plaques[14]. While the aim of the intervention in patients with STEMI is to stabilize the ruptured atherosclerotic plaque and stent the lesion, the main goal in AIS is to remove the embolic material and restore the flow rather than stent the lesion. Therefore, retriever stents and aspiration devices are more commonly used in the endovascular treatment of acute ischemic stroke.

An insufficient number of catheter laboratories for stroke interventions and experienced interventional neurologists is limiting the widespread application of such a promising treatment method. It is well known that cardiologists have achieved a similar organisation in the context of acute myocardial infarction in recent years. Cardiologists increasingly perform interventional procedures, so they have become experienced in catheter-based therapies. It is clear that more patients in need of urgent treatment will be reached with increasing cooperation with interventional cardiologists in the treatment of AIS. However, it should be kept in mind that the pathophysiology of acute myocardial infarction and AIS are quite different, so the role of vascular neurologists in all steps of the treatment of AIS should not be ignored.

The study limitations included the fact that the study was conducted in a single centre with a relatively small sample size. The lack of a control group and retrospective design were other limitations.

Conclusions

Endovascular treatment in AIS can be performed safely with high success rates by trained interventional cardiologists on the stroke team. Effective organisation of interventional cardiologists, neurologists and radiologists and a catheterisation laboratory with round-the-clock on-site staffing are essential for a good outcome. Until there is a sufficient number of interventional neurologists, the endovascular treatment of acute ischemic stroke can be supported by experienced interventional cardiologists.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Statement of Authorship

All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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