Experience of Endovascular Treatment in Patients with Acute Dissection and Major Vessel Occlusion

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Abstract

Aim: Intravenous thrombolytic therapy is an effective and safe method in the treatment of acute ischemic stroke due to dissection. Our knowledge about the clinical results and reperfusion rates of the endovascular treatment of dissection associated with intracranial vessel occlusion is limited. In our study, we aimed to present our patients with acute dissection in the etiology for which we applied endovascular treatment.

Methods: Patients who underwent endovascular treatment of acute ischemic stroke due to a major vessel occlusion secondary to extracranial or intracranial vessel dissection were extrapolated from Eskisehir Osmangazi Stroke Center Database between January 2015 and May 2020.

Patients' age, gender, symptom time, time of arrival to the emergency room, administration of thrombolytic therapy, admission NIHSS score, ASPECT, etiological diagnoses, thrombectomy method, recanalization rate, post-procedure intracerebral bleeding (SITS-MOST), modified Rankin score at discharge and 3 months later were recorded.

Results: A total of 13 patients with a mean age of 43 ± 9.84 years were included in the study. Of the patients, 46.1% were male (n=6) and 53.8% were female (n=7). Two patients had a history of blunt trauma within the last week. In diagnostic digital subtraction angiography (DSA), it was observed that 12 patients had internal carotid artery dissection. One patient had vertebrobasilar occlusion due to dissection of V4 segment of vertebral artery. TPA was applied to 15% (n=2) of the patients. There were contraindications for tPA in 30% of the patients (n=4). Thromboaspiration method was applied in 46.1% of the patients (n=6) as the first technique in the procedure. Isolated stent was applied in 23% of the patients (n=3) as the first technique. Combined technique was applied in 30% (n=4) of the patients. First pass recanalization rate was found to be 38.4% (n=5). Two or more intracranial procedures had to be performed in 58.3% of the patients (n=7). The rate of complete recanalization (TICI 2b-3) was 92.3% (n=12). Recanalization could not be achieved in one patient. First pass recanalization rate was 38.4% (n=5). Clinical progression and worsening of symptoms due to bleeding (NIHSS> 4) were not observed. The rate of patients who were living independently (mRS ≤2) was 76.9% (n=10).

Conclusions: Endovascular treatment of acute ischemic stroke due to dissection is effective and safe. More studies are needed to evaluate the effectiveness of endovascular therapy and to identify techniques that provide better clinical outcomes.

Keywords: *Interventional neurology; acute stroke; dissection; mechanical thrombectomy*

1. Introduction

Acute ischemic stroke ranks 2nd among causes of death worldwide. Approximately 87% of strokes are due to ischemic events.[1] While the incidence of arterial dissections are rare among all causes of stroke, it is a very common cause of ischemic strokes under the age of 45.[2]

A subintimal tear occurs in the vessel wall in the neck, and dissection occurs between the tunica media and the intima by separating the layers from each other.[3] Dissections are often seen in the extracranial segments of the carotid and vertebral arteries. This region is more mobile than intracranial segments and is more exposed to trauma. The rate of spontaneous dissection in cervical arteries is 2.6 per 100,000 patients, and it constitutes 60% of all dissections. While the rate of spontaneous dissection in the internal carotid artery is 1.7: 100,000, it is 0.97: 100,000 in the vertebral artery.[4]

Neurological findings in dissection of the cervical arteries occur

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due to cerebral ischemia caused by thromboembolism, hypoperfusion or subarachnoid hemorrhage. In addition, cranial neuropathy, pain and Horner syndrome can be seen due to local nerve and vascular compression of the dissection.[5]

Intravenous thrombolytic therapy has been proven to be an effective and safe method in the treatment of acute ischemic stroke due to dissection, and it is applied safely.[6] It has been shown that mechanical thrombectomy in selected patients within the first 6 hours in major vessel occlusions of the anterior system circulation is a safe and effective method. However, our knowledge about the clinical results and reperfusion rates of endovascular treatment in patients with dissection is limited. In our study, we aimed to present our endovascular treatment experience in cervical artery dissections presenting with acute major vessel occlusion.

2. Materials and Methods

Patients who underwent endovascular treatment of acute ischemic stroke due to a major vessel occlusion secondary to extracranial or intracranial vessel dissection were extrapolated from Eskisehir Osmangazi Stroke Center Database between January 2015 and May 2020.

Age, gender, symptom time of all patients, time of admission to the emergency room, administration of thrombolytic therapy, demographic data, National Institute of Health Stroke Scale (NIHSS) score, Alberta Stroke Program Early CT (ASPECT) score, etiological diagnoses, mechanical thrombectomy method, recanalization rate, intracerebral hemorrhage rate (SITS-MOST), Modified Rankin Scale (mRS) score at discharge and 3 months later were recorded.

Baseine National Institute of Health Stroke Scale (NIHSS) of patients were recorded.

In Org 10172 in Acute Stroke (TOAST) classification, patients with ischemic stroke are classified in terms of etiology including large vessel atherosclerosis, cardioembolism, small vessel disease, stroke due to other etiological causes and stroke of unknown etiology.[7]

The patients were diagnosed as having dissection by computed tomography angiography (CT-A) (SIEMENS) imaging and digital subtraction angiography (PHILIPS ALLURA CLARITY).

Alberta Stroke Program Early CT (ASPECT) score is a scoring system in which ischemic areas in the brain tissue in the early period in acute ischemic strokes are evaluated and scored according to topographic classification. ASPECT score was recorded in each patient.[8]

In our protocol, thrombolytic therapy (tPA, alteplase) with a dose of 0.9 mg/kg was given in 60 minutes to the patients who were admitted within the first 4.5 hours after the onset of symptoms prior to mechanical thrombectomy. Patients presented after 4.5 hours of symptom onset were directly underwent mechanical thrombectomy. Patients who presented after 6 hours of symptom onset and patients with unknown stroke onset underwent CTP.

In the course of mechanical thrombectomy procedure; the guiding catheter type was chosen according to the anatomy of the common carotid artery. If the anatomy was good, the balloon guiding catheter was placed, if it is not good like elongation, tortuosity, and the presence of a loop, the guiding sheat was placed. If the dissecting segment was in the internal carotid artery, the occlusion site was reached by passing the dissecting segment with the help of a microwire and entering the true lumen. Middle cerebral artery or distal carotid artery occlusion was intervened with combined aspiration and stent retriever, isolated aspiration or isolated stenting. For basillary occlusion in vertebral V4 dissection, a long guiding sheath was placed in the V2 segment of the left vertebral artery. The lesion was passed under the leadership of microcatheter and microwire with a 6F aspiration catheter, and aspiration was performed with the ADAPT technique.

After mechanical thrombectomy, the evaluation of perfusion in the cerebral angiogram was made according to the Thrombolysis in Cerebral Infarction (TICI) scoring. The classification of post-procedure bleeding was made according to the Safe Implementation of Treatments in Stroke (SITS) Symptomatic Intracerebral Hemorrhage Risk Score.[9]

Ethics committee approval was obtained from Eskisehir Osmangazi University, Faculty of Medicine Ethics Committee for our study.

Table 1

Clinical characteristics of the patients

Mean age ± SD —year		43±9.84
Male gender — no (%)		6 (+46.1)
Medical history	Hypertension	3 (23%)
	Diabetes mellitus	1 (7%)
	Coronary artery disease	1 (7%)
	Atrial fibrillation	0
	Stroke in the past	1 (7%)
	Smoking	2 (15%)
Trauma history	Yes	2 (15%)
	No	11 (84.6%)
NIHSS score at admission	16.53	9-30
Median Systolic Blood Pressure- mm/Hg	144.84	100-180
Median Diastolic Blood Pressure- mm/Hg	88	60-106
Median Glucose Level - mg/dL	142	98-372

Table 2

Locations from where all the admitted patients were transferred

	N	%
Ambulance service	9	69
State hospitals (Eskisehir)	1	7
Bilecik	1	7
Kutahya	2	15
Total	13	100

3. Results

A total of 13 patients with a mean age of 43 ± 9.84 years were included in the study. Of the patients, 46.1% were male (n=6) and 53.8% were female (n=7). Ten of our patients presented within the first 6 hours, but the symptom onset time of 3 was unknown. In all 3 patients, the miss-match area was monitored by conventional CT-perfusion, and endovascular intervention was performed. Two patients had a history of blunt trauma within the last week. The average NIHSS score was 16.53 (9-30) at admission (Table 1). Of the patients, 69.2% (n = 9) were brought to the emergency room by the ambulance service (Table 2).

Figure 1

Hiperdens artery sign. A- Distal part of the internal carotid artery, B- Middle cerebral artery, C- Middle cerebral artery M2 segment (dot sign), D- Basilar artery

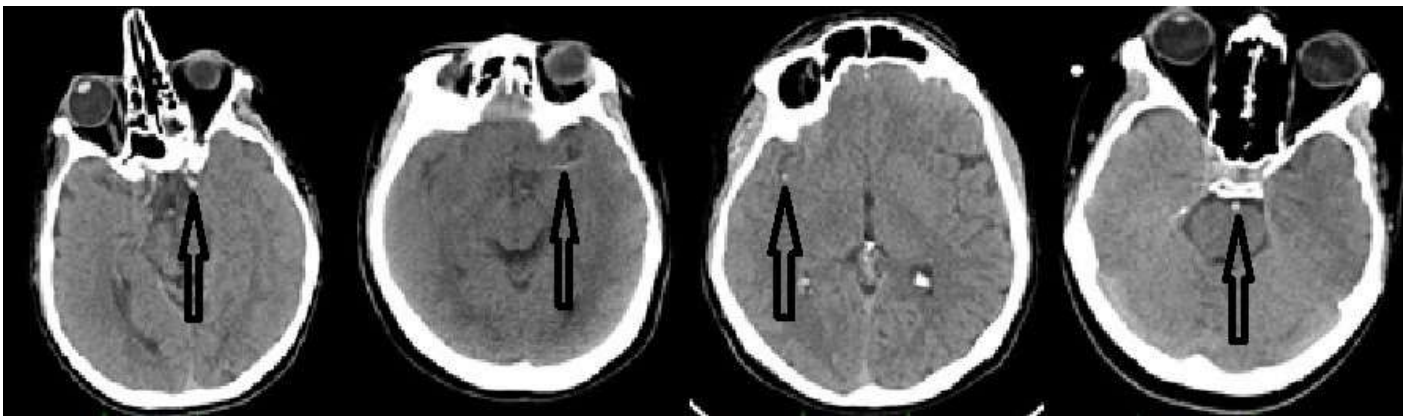
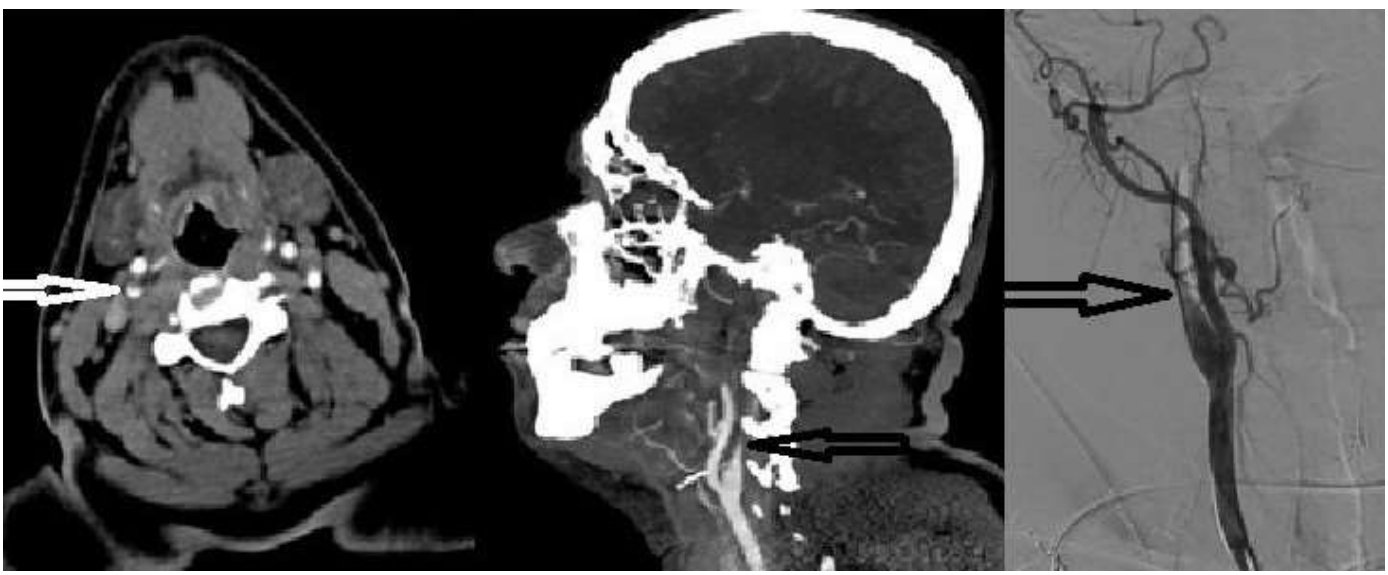


Figure 2

Dissection in axial (A) and sagittal (B) sections of CT- angiography and tandem occlusion in sagittal section; tandem occlusion in diagnostic angiography (C).



Mean symptom-to-door time was 104.63 ± 77.97 minutes (n = 13), and door-imaging time was 18.23 ± 15.87 minutes (n = 13). In the computerized tomography (CT), 92.3% of the patients had hyperdense artery sign (Table 3). In 15% of these patients, the hyperdens artery sign was observed in the distal part of the internal carotid artery (Figure 1A), in 69% in the middle cerebral artery (Figure 1B), in one patient in M2 segment of the middle cerebral artery (dot finding, Figure 1C) and in one patient in the basilar artery (Figure 1D) (Table 2).

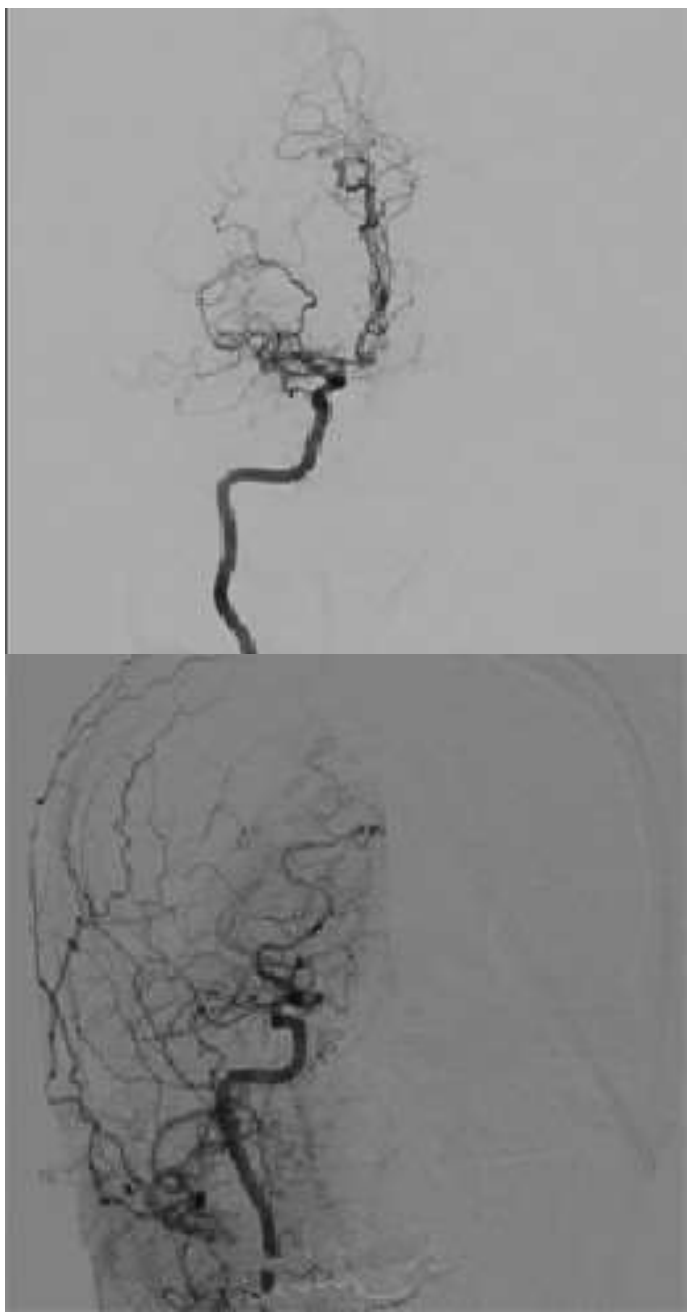
In diagnostic digital subtraction angiography (DSA) ,it was observed that 12 patients had internal carotid artery dissection (Table 4). Nine of the patients with internal carotid artery dissection had middle cerebral artery-internal carotid artery tandem occlusion (Figures 2A, 2B and 2C). In 2 of them the lumen was open even though the internal carotid artery was dissected and there was MCA M1 occlusion (Figure 3A). One patient had a dissected internal carotid artery in stenotic appearance and had a T occlusion (Figure 3B). One patient had vertebrobasilar occlusion due to dissection of V4 segment of vertebral artery (Figure 4). TPA was applied to 15% (n=2) of the patients. There were contraindications for tPA in 30% of the patients (n=4). Of the patients in whom tPA was contraindicated 50% (n=2) had wake-up stroke and one patient's symptom onset time was unknown. One patient had a history of major surgery in the last 3 months.

Fifteen percent of the patients (n=2) were taken to the neuroangiography unit after intubation. Femoral artery puncture was performed in all patients. Thromboaspiration method was applied in 46.1% of the patients (n=6) as the first technique in the procedure (Figure 4). Isolated stent was applied in 23% of the patients (n=3) as the first technique. Combined technique was applied in 30% (n=4) of the patients. First pass recanalization rate was found to be 38.4% (n=5). Two or more intracranial procedures had to be performed in 58.3% of the patients (n=7). Balloon angioplasty was performed in two patients (15%) as a salvage technique, and in two pa-

tients (15%) a permanent stent was placed in the internal carotid artery during the procedure. Ticagrelor was loaded as an antiaggregant in one patient, tirofibran bolus and infusion therapy was administered in one other patient.

Figure 3

MCA M1 occlusion (A), T occlusion and fetal PCA (B) in DSA



The time between the patient's admission to the emergency department and femoral artery puncture was 97.4 (38-201) minutes. The time between femoral artery puncture and recanalization was 18.23 (4-50) minutes. The rate of complete recanalization (TICI 2b-3) was 92.3% (n=12). Recanalization could not be achieved in one patient. First pass recanalization rate was 38.4% (n=5). Asymptomatic bleeding was observed in 23% (n=3) of the control CT imaging obtained 24 hours after thrombectomy. Two of the patients who had bleeding on CT had subarachnoid hemorrhage and one had type 2 petechial hemorrhage. Clinical progression and worsening of symptoms due to bleeding (NIHSS> 4) were not observed. One patient underwent decompressive hemicraniectomy due to a large hemispheric infarction on control CT imaging and died in postoperative follow-up.

At the end of the third month, 13 patients were evaluated in terms of being able to survive independently. The rate of patients who were living independently (mRS ≤2) was 76.9% (n=10).

Table 3

Hyperdense artery localizations

	n	%
Distal part of the internal carotid artery	2	15
Middle cerebral artery	8	61
Middle cerebral artery M2 segment (dot sign)	1	7
Basilar artery	1	7
Total	12	100

Table 4

Dissection and Occlusion Localizations

Internal Carotid Artery	ICA-MCA tandem	9 (69%)
	Distal ICA- T	1 (7%)
	MCA M1 segment	2 (15%)
Vertebral artery V4	Vertebrobasilar	1 (7%)

4. Discussion

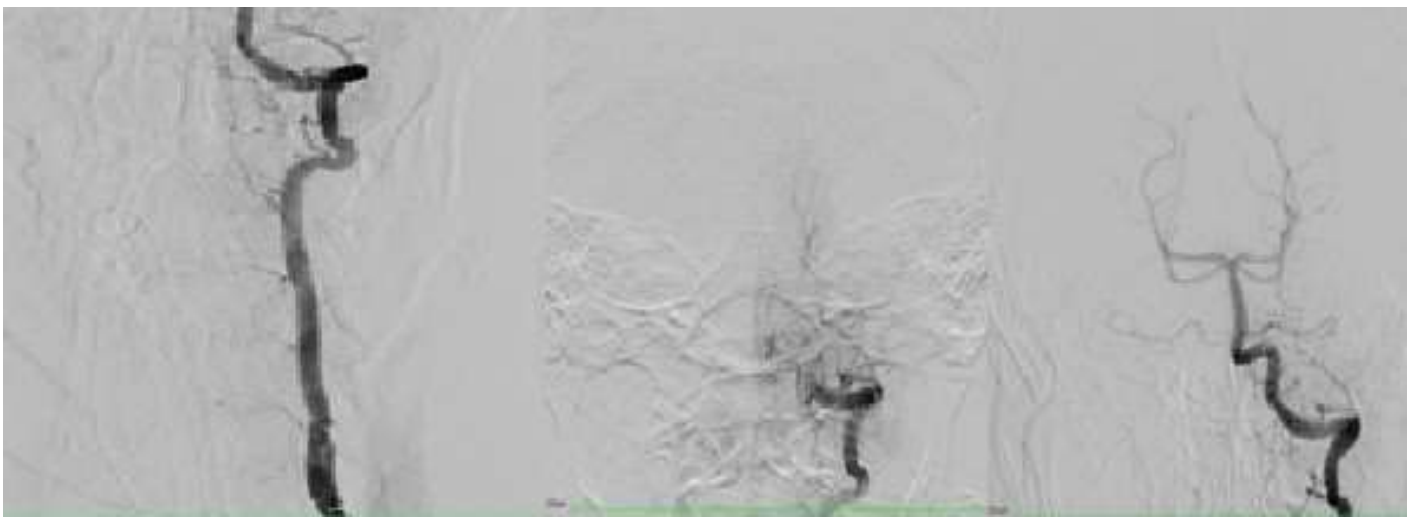
We retrospectively evaluated the data of 13 patients who were admitted to the emergency department of our hospital with major vessel occlusion between 2015 and 2020, who were treated with endovascular treatment (EVT), and whose etiology was dissection. The mean age of our patients was 43±9.84 years, and its frequency at a younger age was consistent with the literature. However, 53.8% of our patients were women and this result was different from previous epidemiological studies.[10]

In the study by Bogousslavsky et al. which was conducted in 1987, it was found that 23% of the patients with carotid dissection died within the first week, and 48% of them had poor functional recovery due to severe neurological deficit.[11] Thrombolytic therapy has been shown to be safe in dissection.[12,13] Nevertheless, although patients with dissection were younger and had less comorbidity, clinical deterioration was found to be higher compared to other patients treated with thrombolytic therapy.[14,15] This is thought to be because dissection patients mostly present with major vessel occlusion.

We selected our patients with computed tomography angiography (CT-A) imaging. However, since the last normal appearance time of our 3 patients was not known (2 patients with wake up stroke, the time in which the patient was last seen normal was unknown in 1 patient), we performed CT-perfusion imaging in these patients and decided for endovascular intervention because there was mismatch. DAWN and DEFUSE-3 showed that the appropriate time interval for mechanical thrombectomy was wider in appropriately selected patients.[16,17]

Figure 4

A 30-year-old female patient was brought in due to a change in consciousness that started 3 hours ago (NIHSS=30). Dissection of the vertebral artery (A) and proximal occlusion of the basilar artery were observed on angiographic imaging (B). Endovascular treatment was performed with the ADAPT technique, and TICI 3 (C) recanalization time was achieved after the procedure. Symptom to recanalization time was 325 min. Discharge mRS was 0.



In the study of Haussen et al., recanalization rate (TICI 2b-3 rate) was 95%. This rate was 92.3% in this study and it was similar to the literature.[18] First pass rate was 38.4% in recanalized patients. Asymptomatic bleeding was present in 23% of our patients. Although asymptomatic bleeding rate was 23%, good survival rate (mRS≤2) was found 76.9%. In the present study the good survival rate was high due to high rate of successful recanalization and the asymptomatic course of intracerebral bleeding.[18]

Since arterial dissections develop suddenly, there is less collateral circulation support in this group of patients compared to patients with occlusion in the atherosclerotic background. The inability of the collateral circulation to provide adequate perfusion support accelerates the transformation of the penumbra tissue into the infarct area.[19] However, although collateral circulation support is less in these patients, younger average age and lower vascular risk factors have a positive effect on good prognosis.[20]

During mechanical thrombectomy, we aimed primarily to open the occlusion in the intracranial segment from a technical point of view. This approach enabled us to achieve faster recanalization in intracranial occlusion without wasting time with revascularization of the internal carotid artery in the cervical segment. Providing early recanalization in intracranial occlusion ensured less final infarct tissue. In addition, dealing with the dissected internal carotid artery might cause re-embolism of new thrombus tissue.[21]

An adjuvant procedure to the internal carotid artery was performed in 4 of our patients during acute procedure. Balloon angioplasty was applied in 2 patients, and self-expandable stent was applied in 2 patients. Ticagrelor was loaded in 1 of the patients we acutely stented, and tirofiban was loaded and then given as infusion in the other patient we acutely stented. In 1 of our patients, the stent was occluded in the acute period, but clinical progression was not observed in the patient. Asymptomatic or symptomatic bleeding was not observed in the control CT imaging in both patients. A total of 15.3% (n=2) of the patients were stented during the acute procedure, and stent was observed to be occluded in 1 patient. A self expandable stent was placed in the carotid artery in 1 of our patients under clopidogrel treatment one week after the incident.

After revascularization was achieved in the intracranial artery occlusion, we did not stent immediately if the internal carotid artery was not opened in the first stage imaging. We were very selective in terms of internal carotid artery stenting, because the dissection in the internal carotid artery could spontaneously resolve, and the implanted stent could be occluded due to increased thrombogenicity in the acute period. After washing with fluid for a while, we punctured the contralateral femoral artery in patients with no flow in the ipsilateral internal carotid artery. In the imaging taken from the contralateral common carotid artery, we terminated our procedure at this stage if flow was observed on the occlusion side via the anterior communicating artery. Collateral circulation support is insufficient in patients with dissection since the event is acute. However, the Willis polygon works better because dissection is seen in a relatively younger patient population.[22] In such patients, it is important to learn that the anterior communicating artery is working and that the middle cerebral artery is filling from the contralateral internal carotid artery by taking images from the opposite common carotid artery. For this reason, it is advantageous to use both groins, to perform a procedure with one groin and to get an image from the other groin. After the middle cerebral artery is fully recanalized, the dissected internal carotid artery can be left occluded without stenting, if there is a passage through the anterior communicant artery from the unaffected internal carotid artery. However, if the communicant arteries are insufficient or hypoplastic, stenting decision can be taken in patients who are suitable for.

The mortality in acute basilar artery occlusion is between 75-91%, and survivors rarely regain functional independence.[23,24] Although recanalization rates are good with thrombolytic therapy, the mortality rate has only decreased to 65-75%. This situation has necessitated different treatment approaches.[25] The most common cause of acute basilar artery dissection in young patients is traumatic vertebral artery dissection.[26] The treatment approach is rescue therapy (first thrombolytic therapy followed by mechanical thrombectomy) and does not have a high level of evidence. Although it may vary depending on the location of the clinical occlusion and

collateral circulation support, it generally has a poor prognosis. Our patient was a 30-year-old woman and a boxer. In the emergency department, Glasgow Coma Score (GCS) was 3, there was basilar artery occlusion in CT-A imaging. Recanalization was achieved with the thromboaspiration technique in the patient who underwent mechanical thrombectomy and she was discharged without any sequelae in the postoperative period. Vertebral artery dissections are frequently seen in the V2-V3 segments. But in our patient, the V4 segment was occluded. Occlusion of the V4 segment did not cause prolongation in our procedure.

Our study had limitations due to its single center, retrospective non-randomized-controlled design and small sample size.

5. Conclusion

Endovascular treatment of acute ischemic stroke due to dissection is effective and safe. Dissection has an important place in the etiology of young patients presenting with ischemic stroke. In patients with major vascular occlusions, this etiology should be kept in the foreground, and mechanical thrombectomy should be applied in appropriate centers along with thrombolytic therapy. It is necessary to decide on the endovascular technique to be applied on a patient basis.

Statement of ethics

Ethics committee approval was obtained from Eskisehir Osmangazi University, Faculty of Medicine Ethics Committee for our study. (E-25403353-050.99-182189 -11)

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

This Data and materials are available to the researchers. This manuscript has been presented orally in 56. National Neurology Congress, 16-21 November, 2019. This study was re-evaluated by adding new patients after the presentation.

Author contributions

FAK: Draft of manuscript, Data collection, Statistical analysis, ZUK: Data collection, Tables, ÖK: Graphic design, supervision, AÖÖ: Conception and design of the manuscript, supervision, review. All authors read and approved the final version of the manuscript.

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