CLINICAL STUDY

Endovascular Stroke Treatment of Acute Tandem Occlusion: A Single-Center Experience

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ABSTRACT

Purpose: To evaluate outcomes and prognostic factors in patients with acute ischemic stroke caused by tandem internal carotid artery/middle cerebral artery occlusion undergoing endovascular treatment.

Materials and Methods: Characteristics of consecutive patients with tandem occlusion (TO) were extracted from a prospective registry. Collateral vessel quality on pretreatment computed tomographic (CT) angiography was evaluated on a 4-point grading scale, and patients were dichotomized as having poor or good collateral flow. Outcome measures included successful reperfusion according to Thrombolysis In Cerebral Infarction score, good outcome at 3 months defined as a modified Rankin scale score $\leq$ 2, symptomatic intracranial hemorrhage (ICH; sICH), and mortality.

Results: A total of 72 patients with TO (mean age, 65.6 y $\pm$ 12.8) were treated. Intravenous thrombolysis was performed in 54.1% of patients, and a carotid stent was inserted in 48.6%. Successful reperfusion was achieved in 64% of patients, and a good outcome was achieved in 32%. sICH occurred in 12.5% of patients, and the overall mortality rate was 32%. Univariate analysis demonstrated that good outcome was associated with good collateral flow ($P = .0001$), successful reperfusion ($P = .001$), and lower rate of any ICH ($P = .02$) and sICH ($P = .04$). On multivariate analysis, good collateral flow (odds ratio [OR], 0.18; 95% confidence interval [CI], 0.04–0.75; $P = .01$) and age (OR, 1.08; 95% CI, 1.01–1.15; $P = .01$) were the only predictors of good outcome. The use of more than one device for thrombectomy was the only predictor of sICH (OR, 10.74; 95% CI, 1.37–84.13; $P = .02$).

Conclusions: Endovascular treatment for TO resulted in good outcomes. Collateral flow and age were independent predictors of good clinical outcomes at 3 months.

ABBREVIATIONS

ASPECTS = Alberta Stroke Program early computed tomography score, CI = confidence interval, ICA = internal carotid artery, ICH = intracranial hemorrhage, mRS = modified Rankin scale, NIHSS = National Institutes of Health Stroke Scale, OR = odds ratio, sICH = symptomatic intracranial hemorrhage, TICI = Thrombolysis In Cerebral Infarction, TO = tandem occlusion

Treatment of tandem internal carotid artery (ICA)/intracranial artery occlusion remains technically challenging. Despite evidence from recent endovascular stroke trials (1–5) that patients with tandem occlusion (TO) benefit from endovascular therapy, a standardized guideline for emergent management of TO has not been

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established. Some of the major randomized trials excluded patients with suspected TO (5), and, despite clinical experience and case series (6,7) of combined angioplasty or stent placement in the ICA with intracranial thrombectomy, the optimal approach to treatment remains uncertain. Given the low recanalization rate and generally poor outcomes reported after intravenous thrombolysis (IVT) in patients with TO (8), more data on contemporary endovascular reperfusion strategies in this subpopulation are needed. The aim of the present study was to report the outcomes and prognostic factors in a large cohort of patients with anterior circulation acute ischemic stroke as a result of TO treated with endovascular therapy.

MATERIALS AND METHODS

Patients

Informed consent to treatment was obtained from all patients or their relatives, and the study was approved by and conducted in accordance with the guidelines of our institutional review board. Consecutive patients with anterior circulation acute ischemic stroke were identified from our prospective endovascular stroke registry (started in August 2009). Patients were selected based on following criteria: (*i*) computed tomographic (CT) angiography documentation of TO (ie, extracranial ICA plus terminal ICA, M1, M2, or A1 segments or a combination of them; intracranial ICA plus M1, M2, or A1 segments or a combination of them) and confirmed as having extracranial ICA occlusion by microcatheter injection at angiography; (*ii*) onset to groin puncture within 5 hours from symptom onset; (*iii*) National Institute of Health Stroke Scale (NIHSS) score $\geq$ 10; (*iv*) modified Rankin scale (mRS) score $\leq$ 2 before stroke; and (*v*) available 3-month mRS score.

Treatment

Based on current guidelines, IVT was administered (alteplase 0.9 mg/kg; 10% of the dose as a bolus and the remaining infused over 60 min) within 4.5 hours after symptom onset and continued during the endovascular procedure (9,10). After retrograde common femoral access was obtained by using a 10-cm, 6-F introducer sheath (Radifocus Introducer II, Terumo, Tokyo, Japan; n = 23) or, more recently, 80-cm Neuron MAX 088 system (Penumbra, Alameda, California; n = 49), angiography of the ipsilateral common carotid artery was performed to evaluate the extent and likely cause of thrombosis (atherosclerosis, dissection, cardiac embolism). In case of an unstable or near-occlusive atherosclerotic plaque or dissection in the ICA, a stent was placed (Wallstent; Boston Scientific, Marlborough, Massachusetts) without the use of any embolic protection device. Angioplasty was performed after stent placement with a 4.5–5.5-mm balloon catheter (Falcon Grande; Medtronic, Minneapolis, Minnesota) with the use of an embolic protection device in case of a suboptimal angiographic result (ie, residual lumen stenosis > 30%). In patients with stroke of defined cardioembolic origin, (ie, atrial fibrillation or recent myocardial infarction), stent placement was replaced by primary angioplasty to reduce hemorrhagic complications resulting from combined anticoagulant (for secondary stroke prevention) and antiplatelet therapy (for in-stent thrombosis prevention).

Intracranial thrombectomy was performed by using a coaxial system composed of a 6-F guiding catheter (Neuron 070; Penumbra; or Envoy DA; Codman & Shurtleff, Raynham, Massachusetts) or a 6-F, 80-cm sheath (Neuron MAX 88; Penumbra) advanced into the intrapetrous portion of the ICA to increase system stability and an intermediate aspiration catheter (5MAX ACE 64; Penumbra) connected to a dedicated aspiration pump during mechanical thrombectomy, with its distal tip in contact with the thrombus. The choice of device was at the discretion of the neurointerventionalist and consisted of the Penumbra aspiration system (Penumbra; n = 22), stent retriever systems such as Solitaire AB (ev3, Plymouth, Minnesota; n = 4), Revive SE (Codman & Shurtleff; n = 17), or Trevo Retriever (Stryker Neurovascular, Mountain View, California; n = 2), and, more recently, new aspiration devices such as the MAX ACE aspiration system (Penumbra; n = 27) with A Direct Aspiration First Pass Technique (ADAPT) technique (11–15). In case of unsuccessful thromboaspiration, a microcatheter (Rebar 18 [ev3], Prowler Select Plus [Codman & Shurtleff], or Trevo Pro 18 [Stryker Neurovascular]) was advanced over a 0.014-inch microwire (Transend soft tip; Boston Scientific) through the occluded vessel, and a stent retriever was deployed with its distal tip beyond the thrombus. The retrieval of the coaxial system through the carotid stent was performed after the stent retriever was gently withdrawn into the inner lumen of the intermediate catheter under synchronous continuous aspiration, thereby preventing the mesh of the stent retriever and the ICA stent from entangling each other. Postprocedural angiography was then performed to evaluate the result of intracranial thrombus retrieval based on the Thrombolysis In Cerebral Infarction (TICI) score. The choice of general anesthesia or conscious sedation was individualized based on clinical severity, presence of agitation, aspiration risk, or seizures.

Intraprocedural administration of intravenous heparin (range, 1,000–7,000 IU) and/or antiplatelet therapy (lysine acetylsalicylate) was at the discretion of the neurointerventionalist, regardless of previous IVT. Administration of clopidogrel 75 mg and/or aspirin 100 mg within 24 hours after the endovascular procedure was decided by neurointerventionalists and stroke neurologists based on previous IVT, clinical severity, baseline Alberta Stroke Program early CT score (ASPECTS) (16),