Journal of Clinical Neuroscience 28 (2016) 157–161

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Technical note

Emergency endovascular revascularization of tandem occlusions: Internal carotid artery dissection and intracranial large artery embolism

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ARTICLE INFO

Article history:
Received 26 November 2015
Accepted 5 December 2015

Keywords:
Closed-cell stent
Internal carotid artery dissection
Ischemic stroke
Stent-assisted revascularization
Stent thrombectomy

ABSTRACT

Internal carotid artery dissection (ICAD) with concomitant occlusive intracranial large artery emboli is an infrequent cause of acute stroke, with poor response to intravenous thrombolysis. Reports on the management of this entity are limited. We present our recent experience in the endovascular management of occlusive ICAD and major intracranial occlusion. Consecutive anterior circulation acute stroke patients meeting Medical Center criteria for endovascular management of ICAD from June 2011 to June 2015 were included. Clinical, imaging, and procedure data were collected retrospectively under Institutional Review Board approval. The endovascular procedure for carotid artery revascularization and intracranial stent thrombectomy is described. Six patients met inclusion criteria (National Institutes of Health Stroke Scale score 12–24, time from symptom onset 2–8 hours). Revascularization of the extracranial carotid dissection and stent thrombectomy were achieved in 5/6 patients, resulting in complete recanalization (Thrombolysis in Myocardial Infarction flow grade 3 in a mean 2.7 hours), and modified Rankin Scale score 0–2 at 90 day follow-up. In one patient, attempts to microcatheterize the true arterial lumen failed and thrombectomy was therefore not feasible. No arterial dissection, arterial rupture or accidental stent detachment occurred, and there was no intracerebral hemorrhage or hemorrhagic transformation. Our preliminary data on this selected subgroup of patients suggest the presented approach is safe, feasible in a significant proportion of patients, and efficacious in achieving arterial recanalization and improving patient outcome. Crossing the dissected segment remains the most important limiting factor in achieving successful ICA recanalization. Further evaluation in larger series is warranted.

1. Introduction

Internal carotid artery dissection (ICAD) causing occlusion or near occlusion with concomitant intracranial large artery emboli is an infrequent but important cause of severe and life-threatening acute stroke [1–3]. In this situation, as in tandem occlusions of atherosclerotic origin, intravenous thrombolysis has had very limited success. Emergency and aggressive endovascular intervention is required, but these procedures are challenging due to the combination of difficult access and the need to revascularize long and complex extracranial carotid lesions that make intracranial mechanical thrombectomy more difficult and time consuming [4–6].

In this article we present our recent experience in the endovascular management of a series of patients with occlusive ICAD and major intracranial occlusions, with a focus on the technical aspects of the intervention.

2. Material and methods

2.1. Patients

Between June 2011 and June 2015, all consecutive anterior circulation acute stroke patients with a National Institutes of Health Stroke Scale (NIHSS) score $\geqslant$10 presenting within 6 hours from symptom onset were triaged on admission for potential endovascular mechanical thrombectomy. Endovascular treatment was also the first choice in patients with a finding of major intracranial occlusion on admission CT angiography (CTA). In addition, endovascular management was considered for patients presenting with a NIHSS score <10 and with clinically fluctuating symptoms or deterioration after admission, as well as for those last seen well beyond the 6 hour threshold who had a mismatch between

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http://dx.doi.org/10.1016/j.jocn.2015.12.003
0967-5868/

neurological deficits and findings on cranial CT scan and/or MRI. Patients considered eligible for intravenous thrombolysis were treated accordingly and independently from the decision for endovascular revascularization procedure, beginning immediately after admission CT scan. Patients with admission CT scan showing cerebral hemorrhage or extensive brain infarction (Alberta Stroke Program Early CT Score [ASPECTS] <6) [7] were excluded from the study.

Clinical and radiological data were collected retrospectively, including time to symptom onset; admission NIHSS; findings at pre and post-treatment CT scan, CTA, and MRI; occlusion site; and extent of collateral supply on CT scan, angiogram, and MRI (when available). Interventional data included anesthesia type, medications during endovascular treatment, endovascular techniques, time-to-recanalization (defined as the interval between introducer sheath placement to first angiographic run showing recanalization), Thrombolysis in Myocardial Infarction flow grade (TIMI) at recanalization, and Thrombolysis in Cerebral Infarction (TICI) grade [8,9].

For the present study, we retrospectively analyzed the subgroup of six patients with ICAD causing occlusion or near occlusion (>90% stenosis) who were found to have a secondary major intracranial artery embolic occlusion (tandem extracranial dissection/intracranial embolic occlusions), and who were managed with extracranial carotid revascularization and intracranial mechanical thrombectomy. Our Institutional Review Board approved this retrospective study with a waiver of informed consent.

2.2. Endovascular technique

Every procedure was performed under general anesthesia with special care in avoiding hypotension and maintaining baseline arterial pressure >180/120 mmHg. A single dose of 2500 units of intravenous heparin was given immediately after achieving femoral access. Diagnostic angiography was performed to confirm the occlusion pattern and collateral supply. Immediately after angiographic confirmation of ICAD with occlusion or near occlusion, and thus confirmation of the need for stent implant, patients who were not on antiplatelet therapy received 300 mg aspirin per nasogastric tube.

A 90 cm 8–9 French balloon guiding catheter (Cello, ev3/Covidien Neurovascular, Irvine, CA, USA) was placed at the distal common carotid artery ipsilateral to the occluded ICA. The ICA occlusion was crossed with a Synchro/Transend 0.014 inch microguidewire (Boston Scientific, Marlborough, MA, USA) and a Rebar 18 microcatheter (ev3). When possible, the occluded arterial segment was crossed with the aid of a delayed double-contrast road map, as described previously [10], or, alternatively, in the usual "blind" fashion. Angiography was performed through the microcatheter to assess ICA status. The balloon guiding catheter was placed at the proximal ICA and predilation of the cervical lesion was repeatedly performed under proximal occlusion, using a 3.0–3.5 × 30 mm balloon along the full extent of the arterial dissection (from normal-to-normal artery). The angioplasty balloon was then exchanged for a 5 × 30 mm closed-cell carotid stent (Wallstent, Boston Scientific/Target) that was placed as close as possible to the petrocervical junction. In cases of redundant cervical ICA, or when sharp curves, tonsillar loops, or coils precluded navigation of regular carotid stents, low-profile neurostents (Leo stent, Balt, Montmorency, France) were used [11]. Judicious postdilation of the stented segment, including the petrous ICA, which frequently has a significant stenosis, was routinely performed if the stented arterial segment had a residual stenosis of more than 20%.

An intermediate catheter (Fargo, Balt; or Revive IC, Codman Neurovascular/DePuySynthes/Johnson and Johnson, San Jose, CA, USA) was then coaxially navigated across the stented cervical/petrocervical segment and placed at the cavernous ICA, or even further distally if possible. The balloon guiding catheter was preferentially positioned at the stented segment. At this stage, a Rebar 18 microcatheter was navigated across the intracranial occlusion and stent-based thrombectomy (pREset, Phenox, Bochum, Germany; or Solitaire, ev3/Covidien) was performed as usual under proximal ICA occlusion with simultaneous aspiration through the BGC and intermediate catheter. After confirming adequate intracranial recanalization, the intermediate catheter was removed, and, again under proximal occlusion, one or two balloon-expandable stents were implanted at the petrocervical junction, telescoped to the previously implanted Wallstent. In all the cases, we added a second 7 × 30–40 mm Wallstent covering the proximal cervical ICA. Although only subtle changes were usually seen at this point, it was the origin of the dissection in our patients.

A final angiogram was performed to assess revascularization of the ICA and its branches. Heparin was not administered after the procedure. Immediate post-procedural CT scan was obtained to detect hemorrhagic complications or the need for a further surgical procedure. After negative CT scan, clopidogrel was added to the antiplatelet regime (loading dose 300 mg). Patients were kept under a double regimen of antiplatelet agents for 2 months (clopidogrel 75 mg/day plus aspirin 100 mg/day). Clopidogrel was then discontinued and aspirin (100 mg/day) was continued indefinitely.

The technique is illustrated in Figure 1.

3. Results

3.1. Patient demographics and presentation

Six patients with acute stroke after ICAD causing occlusion and secondary major intracranial embolic occlusion were identified (Table 1). The mean age was 32 years (range 16–52); four of six patients were male. Four patients presented with carotid dissection causing complete arterial occlusion and two presented with severe subocclusive (90%) stenosis. All patients presented with concomitant intracranial major occlusions: two patients presented with a "T" ICA occlusion, three patients presented with proximal middle carotid artery (MCA) occlusions, and one presented with an M1–M2 junction occlusion. The cause of dissection was trauma in three cases (fall from a height in two and a motor vehicle accident in one), with trauma-to-stroke latency of 12 hours, 2 days, and 10 days. Dissections were considered non-traumatic in three cases; one patient presented with the carotid dissection after intense afebrile coughing, one patient presented with severe uncontrolled secondary hypertension, and the third after physical exercise. Patients were admitted with NIHSS between 12–24 and time-to-treatment ranging from 2–8 hours.

3.2. ICA dissection

In five out of six patients, successful endovascular revascularization of the occlusive extracranial carotid dissection was achieved; in four of these patients, two cervical Wallstents and one or two petrocervical balloon expandable stents (one stent in four patients, two stents in one) were implanted, and in one patient two telescoped Leo stents were sufficient. In Patient 3 we were not able to microcatheterize the true arterial lumen and ICA revascularization failed.

3.3. Intracranial thrombectomy

In all patients except Patient 3, intracranial stent-assisted thrombectomy was considered successful, achieving complete recanalization (TIMI 3). The mean time-to-therapy was 2.7 hours (range 2–3.3). A mean 2.2 thrombectomy attempts were needed