

Summary

Aims: The main aim of this study is to analyse the effectiveness, safety and causal relationships of treatment of patients with carotid artery dissection arising spontaneously, due to trauma or from an iatrogenic cause.

Methods: In all patients, we analyzed baseline clinical symptomatology and NIHSS, findings on initial CTA (ev. DSA), selected therapy in the acute phase, follow-up brain imaging, medication at discharge, and clinical findings at 3 months with assessment of NIHSS and mRS with carotid artery imaging by ultrasound or CTA.

The first group consisted of 38 patients with *spontaneous* ICA dissection. Currently asymptomatic patients after a resolved TIA or patients with NIHSS ≤ 3 were treated conservatively with antiplatelet or anticoagulation therapy. Patients with significant neurological deficit (NIHSS ≥ 4) were treated with intravenous thrombolysis, or stent implantation in the neck dissection area, mechanical thrombectomy of the distal emboli, or a combination of all methods.

The second group included 16 patients with *traumatic* ICA dissection diagnosed on whole-body CT scan as part of the post-trauma evaluation. Patients with brain injury or major bleeding lesions were kept without antithrombotic therapy until their condition stabilized with early switch to anticoagulation therapy with low molecular weight heparin at prophylactic dose. After consolidation of the bleeding trauma, acetylsalicylic acid antiplatelet therapy was added to the combination. Patients who developed neurological symptomatology related to ICA dissection were managed on a strictly individual basis with consideration of all potential risks associated with aggressive antithrombotic therapy or stent implantation with necessary dual antiplatelet therapy. All patients with luminal stenosis of ICA underwent follow-up CTA at 2-3 days to exclude severe progression of the lesion. In addition, patients were followed up at 3 months with ultrasound or CTA.

In the third group, patients with severe ICA dissection due to an *iatrogenic* cause were followed up and divided into 2 subgroups and evaluated separately. Five patients developed ICA dissection with significant stenosis during *endovascular treatment of acute iCMP*. Because of the small size of the patient cohort, the final clinical outcome was not evaluated, which would have been burdened by the small cohort error, and we therefore focused only on

estimating the incidence rate. An additional 5 patients developed severe ICA dissection during *elective or semielective catheterization procedures*. Patients with significant neurosymptomatology or neurologically untestable patients under general anesthesia with severe stenosis and graphically verified inadequate collateral circulation were treated with urgent stent implantation. Patients with iatrogenic dissection without neurological deficit were treated conservatively.

Results: 38 patients with *spontaneous* ICA dissection were diagnosed during the study period. Of this cohort, 20 patients were currently asymptomatic or with minor neurological deficit (NIHSS ≤ 3) and were treated conservatively, 13 with antiplatelet and 7 with anticoagulation therapy. The efficacy of the method in the conservative arm in the parameter of absence of any new neurological symptomatology at 3 months was $p = 95$ (73-100) %, and in the parameter of preservation of flow in the affected ICA at the follow-up examination at 3M was also $p = 95$ (73-100) %. The safety of the method in the conservative arm, defined by the absence of any significant treatment-related complication, was $p = 100$ (86-100) %. Eighteen patients were admitted with significant neurological deficit (NIHSS 4-19), one patient was already out of the therapeutic window and was treated conservatively only. The other 17 patients were referred for recanalization therapy. In 14 patients, IVT was initiated with subsequent interventional therapy being considered, 6 of these patients experienced early recovery and further intervention was abandoned. A total of 11 patients were indicated for endovascular treatment, 1x IAT and 1x MT without treatment of the ICA with stent, and 9 times treatment of the cervical segment of ICA with stent, which was combined with mechanical thrombectomy of the intracranial arteries twice and performed 3 times without prior IVT. The efficacy of the method in the recanalization arm in the parameter of achieving good neurological status (NIHSS ≤ 3 , mRS 0-2) was $p = 88$ (64-99) %, and in the parameter of preserving patency of the affected ICA the efficacy was $p = 81$ (54-96) %. The safety of the method in the invasive arm was $p = 94$ (71-100) %. In the group of 9 patients indicated for acute stent implantation, the efficacy of the method in the parameter of achieving good neurological status was 88 %, and in the parameter of preserving patency of the affected ICA, the efficacy was 67 %. The safety of the method of acute stent implantation was $p = 100$ (67-100) %.

There were 16 patients with *traumatic* ICA dissection out of 4145 patients examined on CT after high-energy trauma ($p = 0.4\%$ [0.2-0.6]). In 4 cases, ICA findings were bilateral, 4 times (20%) the artery was closed, 7 times (35%) with stenosis greater than 80%, and 9 times (45%) with stenosis less than 80%. All patients were treated conservatively. As the risk of bleeding gradually decreased, patients were moved to pharmacological treatment by fractionated low molecular weight heparin at prophylactic dose and antiplatelet agents. In total we recorded 3 (19%) neurological complications related to ICA dissection, one (6%) of which was severely disabling.

Iatrogenic ICA dissections resulting from *treatment of severe iCMP* were recorded in 18 of 797 catheterized patients. Thirteen cases ($p = 1.6\%$ [0.9-2.8]) involved a small vessel wall defect without significant stenosis. In 5 cases ($p = 0.6\%$ [0.2 - 1.5]) significant stenosis or ICA occlusion occurred and in only 1 case ($p = 0.1\%$ [0.0 - 0.7]) did the intended MT fail to complete successfully due to occlusive dissection. In the second subset, 5 patients ($p = 0.6\%$ [0.2 - 1.4]) with iatrogenic ICA dissection were evaluated out of a total of 863 patients after ICA catheterization for *diagnostic or elective therapeutic reasons*. Two patients were treated conservatively, and 3 patients underwent acute stent implantation. We observed permanent severe neurological disability in 1 patient at 3M, the other patients were asymptomatic, thus the risk of permanent severe neurodeficit due to iatrogenic ICA dissection during elective procedures was $p = 0.1$ (0.0-0.6) %.

Conclusion: In patients with acute *spontaneous* ICA dissection with less severe neurological symptomatology, conservative management with the need for regular follow-up is generally recommended, and this is supported by our data. From the analysis of our cohort, it can be assumed that recanalization therapy (IVT, stent implantation, and mechanical thrombectomy) is a safe and effective treatment modality in the presence of significant neurological deficit. In patients after high-energy trauma with findings of ICA stenosis up to 80% due to *traumatic* dissection, the risk of neurological complications is generally low, and this is also confirmed by the data from our cohort. In contrast, we can expect permanent neurological disability in 50% of patients with occluded ICA. Treatment must be strictly individualized, considering all potential risks associated with aggressive antithrombotic therapy or stent implantation with the need of dual antiplatelet therapy.

In patients with *iatrogenic* ICA dissection arising during treatment of severe iCMP, we assess the incidence of this major complication below 1% as a satisfactory outcome. Our results are comparable with other published study.

From the analysis of a cohort of patients with iatrogenic ICA dissection arising during elective procedures, we suggest that urgent stent implantation in patients with sudden onset severe neurodeficit due to hemodynamically significant ICA dissection from an iatrogenic cause is a safe and effective treatment strategy.

Key words: carotid artery dissection, neurological symptoms, stent implantation