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Original Article

## Emergent vs. elective stenting of carotid stenosis with intraluminal carotid thrombus



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### ARTICLE INFO

#### Article history:

Available online 22 March 2017

#### Keywords:

Stenting  
 Acute  
 Elective  
 Carotid stenosis  
 Thrombus

### ABSTRACT

**Background and purpose.** – Carotid stenosis (CS) with intraluminal carotid artery thrombus (ICAT) is rare but ominous finding. The optimal treatment modality is unclear. The aim of this study was to analyze the feasibility and outcome of acute endovascular intervention and delayed elective endovascular therapy after initial anticoagulation in these delicate cases. Moreover, both treatment points were compared and several parameters discussed to facilitate the determination of the optimal time modality in future cases.

**Materials and methods.** – A series of 11 consecutive cases with acute symptomatic CS with ICAT that received endovascular treatment was retrospectively analyzed. General patient data, pre and post-interventional symptoms and imaging were evaluated in an overall mean follow-up of 84 weeks.

**Results.** – Urgent stenting and mechanical thrombectomy was performed in 6 patients. In the remaining 5 cases, elective endovascular treatment was planned after initial anticoagulation therapy with thrombus resolution. One case received secondary urgent treatment due to clinical deterioration. Overall outcome at three months follow-up was excellent (Modified Ranking Scale [mRS] 0–1) in 5 cases, good (mRS 2) in 4 and unfavorable in the remaining 2. Important differences between the two treatment arms were seen in 3 parameters (stenosis degree, thrombus length, and NIHSS score).

**Conclusions.** – This is one of the largest studies analysing endovascular treatment in patients with acute symptomatic CS and additional ICAT only. Both endovascular treatment strategies seem feasible. Parameters such as size of intraluminal thrombus and clinical symptoms should be included in the decision-making process regarding the optimal individual treatment time.

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### Introduction

Carotid artery stenosis (CS) with distally located internal carotid artery thrombus (ICAT) is a rare finding. In the North American Symptomatic Carotid Endarterectomy Trial (NASCET), a frequency of 4.3% was reported in patients with CS of 70–99% [1]. Its presence is ominous. In the NASCET study, patients with intraluminal thrombus were at significantly higher risk for stroke compared to patients without [1]. Moreover, the risk of perioperative stroke or death recorded is double that of patients without thrombus [2].

Higher incidence of stroke or death was also found if these patients only underwent medical therapy [1].

Today, intravenous thrombolysis and mechanical thrombectomy are firmly established for general stroke treatment [3,4]. In the delicate and rare cases of CS with ICAT, urgent mechanical therapy (carotid endarterectomy (CEA), carotid artery stenting (CAS)), or initial medical therapy with anticoagulants or antiplatelets optionally followed by mechanical interventions are available treatment approaches [5–9]. However, randomized controlled studies are inexistent and evidence for supremacy of one of these modalities is lacking.

In this study, we retrospectively analyze the feasibility and outcome of emergent and delayed endovascular treatment in patients with acute symptomatic carotid artery stenosis (sCS) and distal ICAT. Moreover, we evaluate advantages and disadvantages for both time modalities and discuss several parameters to help facilitate the determination of optimal timing of endovascular intervention in these delicate cases.

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## Methods

### Patients included

All patients who underwent carotid artery stenting for sCS at our institution between February 2008 and July 2014 were included in our study, if ICAT was also present. There were no exclusion criteria. An ethical approval has been obtained from the local ethics committee.

### Initial management

All patients underwent baseline investigations including neurological and physical examination, routine blood analysis and 12-lead electrocardiogram (ECG) and personal history was noted. Stroke severity was assessed using the NIHSS score [10] and mRS [11]. Moreover, mRS before ischemic incident was quantified (pre-mRS). Ischemic episode was defined as a TIA in case of symptom remission before admission with neurological deficit lasting  $\leq 24$  h and no radiological signs for acute ischemic lesion. All others were classified as a stroke.

Intravenous thrombolysis with recombinant tissue plasminogen activator (rtPA) (0.9 mg/kg bodyweight (bw)) was performed in all eligible cases. Antiplatelet therapy was given in case of contraindications, except for patients experiencing wake-up stroke (WUS) for unknown reasons.

Patients initially presenting in a peripheral hospital were transferred to our clinic for further treatment. All patients were initially monitored in our intensive care (ICU) or stroke unit, independent of first therapy.

### Imaging studies

Initially, all patients underwent a cranial computed tomography (CT) scan in our institution or peripheral hospitals to exclude intracranial hemorrhage (ICH). After therapy initiation (acute endovascular therapy or initial anticoagulation), all patients had a follow-up cranial CT or MRI during hospitalization; mostly within 36 h. In case of neurological deterioration, cranial CT was urgently obtained to exclude symptomatic ICH (sICH) or brain edema with beginning herniation. Symptomatic ICH was defined as any new hemorrhage not seen on previous imaging, in conjunction with additional neurological deterioration [12]. Furthermore, ultrasound controls were carried out during hospitalization and at follow-up controls to monitor stent patency. In case of elective carotid artery stenting, control CT-angiographies were performed 8–21 days after initiation of anticoagulation for diagnosis of thrombus resolution.

Thrombus was partially intraluminal and partially adhered to the wall. Its length was measured by board-certified neuroradiologists either on CT (in 2D multiplane reconstruction-mode) or angiographic images. The length of thrombi not aligned in a straight axis was measured by adding the multiple segments together. On angiographic studies, length was determined in four cases with small thrombus. If calibration markers were missing, thrombus length was estimated by assuming the diameter of internal carotid artery above the carotid bulb to be 5.11 mm in men and 4.66 mm in women [15].

### Endovascular therapy

Carotid artery stenting was performed either on an emergency basis or electively after lysis of ICAT, following the interdisciplinary consent of interventional neuro-radiologists, neurologists and vascular surgeons. Generally, patients with a long thrombus tended to be treated in a delayed manner because of high-risk of

distal thrombus migration. On the other hand, patients with high initial NIHSS score were intended to be treated on an emergent basis. Emergent stenting was performed within 6 h of symptom onset or with relevant CT perfusion (CTP) mismatch, defined as a time-to-peak (TTP)/cerebral blood volume (CBV)-area-ratio  $\geq 2$ .

Stenosis degree was defined according to NASCET criteria [13], and a stenosis  $>50\%$  was interpreted as relevant. Cerebral artery recanalization was evaluated by the Thrombolysis In Cerebral Infarction (TICI) score [14]. We defined endovascular reperfusion as TICI  $\geq 2b$ . For order of treatment in primary and secondary emergent endovascular therapy and detailed information about the carotid artery stenting procedure, please see [supplemental material](#). Following the endovascular procedures, treatment with double antiplatelet therapy and thrombosis prophylaxis by heparin was initiated. In one case of atrial fibrillation, oral anticoagulation was administered. GP-IIb/IIIa-receptor antagonist Tirofiban was administered additionally in four primary urgent interventions. Intra-arterial urokinase was administered in one case. In patients treated electively after initial anticoagulation, two were treated with Heparin and antiplatelets, and carotid artery stenting was performed during the same hospitalization after confirmation of thrombus resolution. In the other two patients, antiplatelets were given, oral anticoagulation with heparin bridging initiated, and according to the patients' wish, stenting performed during a second hospital stay.

### Clinical outcome and follow-up

After discharge, patients were regularly followed up after 3 months as outpatients in the Department of Neurology ( $n=9$ ), or by telephone in case of follow-up in other clinics ( $n=2$ ). Clinical outcome was measured by mRS and subdivided into excellent (mRS 0–1), good (mRS 2) and unfavorable outcome (mRS 3–5). New ischemic incidents and mortality were assessed by patient's medical history. There were no regular control-MRI's in case of a follow up with no complications.

### Statistical analysis

Data were analyzed by unpaired *t* test using SPSS 21.0.0.0 software (SPSS, Inc.) to confirm statistical significance of the differences between two groups. A *P* value of  $<0.05$  was considered statistically significant.

## Results

### Patients' demographics

Between February 2008 and July 2014, sCS with ICAT was detected in 11 patients (9 males and 2 females) out of 283 angiographic interventions for acute cerebral ischemic incidents (Table 1). Median age was 70 years (range 52–78). Four patients (36%) had had previous ischemic incidents. All patients had at least one cerebrovascular risk factor (see Table 2; [Supplemental material](#)). On admission, three patients were taking antiplatelet medication, none were on oral anticoagulation. Pre-mRS was 0 in nine patients and 3 in two cases (one with previous ischemic stroke, the other one with metastasized colic cancer under palliative treatment).

### Clinical presentation and time course

All patients presented with acute ischemic stroke (two with wake-up stroke) (Table 1). In five cases, elective stenting was planned. In the remaining six cases, emergency CAS of the stenosis and mechanical thrombectomy was decided (Figs. 1 and 2,

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