Urgent endovascular treatment of acute symptomatic occlusion of the cervical internal carotid artery

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Object. The prognosis of patients with acute symptomatic cervical internal carotid artery (ICA) occlusion is generally considered to be poor. Traditionally, such patients are not considered eligible for urgent thrombolytic/endovascular treatment. Since 1998, an aggressive therapeutic approach with endovascular treatment has been adopted at the authors’ institution. In this report they assess whether aggressive treatment of ICA occlusion is appropriate.

Methods. The clinical characteristics and outcome of six consecutive patients treated urgently with an endovascular approach between 1998 and 2001 are reviewed and summarized.

Recanalization was accomplished in all patients. At a mean follow-up period of 8 months (range 2–14 months), five of six patients had good or excellent outcomes (modified Rankin Scale [mRS] Score 0–1) and one had a poor outcome (mRS Score 4).

Conclusions. With recent advancements in thrombolytic and endovascular treatments, an aggressive endovascular approach in patients with acute symptomatic cervical ICA occlusion may be successful. Further clinical data are required to determine the optimal endovascular approach in these patients.

KEY WORDS • stroke • internal carotid artery • thrombolysis • endovascular therapy • angioplasty

THE prognosis of patients with acute symptomatic cervical ICA occlusion is generally considered to be poor: 16 to 55% will die of complications from infarction, 40 to 69% will be left with a profound deficit, and only 2 to 12% of patients will make a good recovery. The optimal treatment of such patients has not been established and represents a challenging and complex problem. Results of urgent surgical recanalization are not ideal. Despite rapid advancements in thrombolytic/endovascular therapies, there is limited literature on the current therapeutic options for symptomatic acute cervical ICA occlusion. Traditionally, this condition is considered to be an obstacle for urgent intracranial catheter navigation and thrombolytic treatment. Nevertheless, since 1998 we have adopted an aggressive endovascular therapeutic approach in such cases. We report on the results of this approach in six consecutive patients.

Clinical Material and Methods

Between 1998 and 2001, seven consecutive patients presented with acute symptomatic cervical ICA occlusion. Six were treated urgently with an endovascular approach and one was treated with CEA. The medical records of the six patients who received urgent endovascular treatments were reviewed and summarized. Follow-up phone interviews were also conducted and patients were questioned on their current functional status.

Results

Table 1 summarizes the six patients’ overall clinical characteristics, angiographic findings, treatment, and outcome. The patients’ mean age was 61 years (range 41–77 years). None of the six patients had clinical evidence of carotid artery dissection or cardiac embolism. Head CT scans were obtained in all patients at the time of the initial evaluation; none had preintervention acute neuroimaging evidence of frank hypodensity or hemorrhage. A dense MCA sign was present in Cases 2 and 3. Recanalization of the occluded cervical ICA was accomplished in all cases. Navigation through the occluded segment with a guidewire and microcatheter was also successful in all cases. No apparent distal embolization, arterial dissection, or vascular tear/perforation resulted from these maneuvers. In all six patients there were associated distal occlusions in addition to the cervical ICA occlusion. Intraarterial tPA (2–16 mg) was used for intracranial thrombolysis.

After thrombolytic treatment, significant collateral flow was reestablished in all cases except in the patient in Case 4, who had an essentially “isolated” right hemisphere. Par-

Abbreviations used in this paper: CEA = carotid endarterectomy; CT = computerized tomography; ICA = internal carotid artery; MCA = middle cerebral artery; mRS = modified Rankin Scale; OphA = ophthalmic artery; PTA = percutaneous transluminal angioplasty; SAH = subarachnoid hemorrhage; TIA = transient ischemic attack; tPA = tissue plasminogen activator.
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**Table 1**

Clinical characteristics, treatment, and outcome in seven patients with acute symptomatic cervical ICA occlusion*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Clinical Presentation</th>
<th>Site of Occlusion</th>
<th>Time From Ictus to Treatment</th>
<th>Treatment</th>
<th>Complications</th>
<th>Outcome†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>77, F</td>
<td>lt hemiparesis, facial droop, &amp; slurred speech</td>
<td>rt cICA; rt M₁</td>
<td>3 hrs 20 mins</td>
<td>manual navigation through rt cICA; 10 mg tPA: complete recanalization at M₁; rt cICA partial interval PTA/stent plc w/ 50% residual stenosis</td>
<td>30-sec asystole w/o clinical consequence during PTA/stent plc; rt small SAH on Day 6 resulting in HA but no additional deficits &amp; requiring no treatment; rt hemispheric TIA in 2 mos w/o restenosis/occlusion &amp; good response to completion of PTA/stent plc leaving no residual stenosis</td>
<td>7 mos: no restenosis; 1 yr: mRS Score 1</td>
</tr>
<tr>
<td>2</td>
<td>53, M</td>
<td>lt hemiparesis &amp; slurred speech</td>
<td>rt cICA; rt M₁,₂; rt A₁,₂</td>
<td>3 hrs 40 mins</td>
<td>manual navigation through rt cICA; 11 mg tPA: complete recanalization at A₁,₂ &amp; partial canalization at M₁,₂; rt cICA PTA/stent plc w/ minimal to no residual stenosis</td>
<td>rt hemispheric TIA in 2 mos w/ rt cICA reocclusion but w/o distal occlusions &amp; w/ good collateral flow from lt hemisphere; good response to more intensive anticoagulation</td>
<td>7 mos: rt cICA &lt;50% stenosis, mRS Score 0</td>
</tr>
<tr>
<td>3</td>
<td>63, M</td>
<td>lt hemiparesis, sensory impairment, ataxia, &amp; facial droop</td>
<td>rt cICA; rt tICA; rt A₁</td>
<td>3 hrs</td>
<td>manual navigation through rt cICA; 16 mg tPA: complete recanalization at A₁/M₁; rt cICA partial interval PTA w/ 50% residual stenosis</td>
<td>rt hemispheric TIA in 2 mos w/ rt cICA reocclusion but w/o distal occlusions &amp; w/ good collateral flow from lt hemisphere; good response to more intensive anticoagulation</td>
<td>14 mos: mRS Score 1</td>
</tr>
<tr>
<td>4</td>
<td>56, F</td>
<td>lt hemiplegia w/ lt gaze deviation</td>
<td>rt cICA; rt tICA; rt A₁</td>
<td>5 hrs 30 mins</td>
<td>manual navigation through rt cICA; 2 mg tPA: complete recanalization at tICA/A₁; rt cICA partial interval PTA w/ 50% residual stenosis</td>
<td>none</td>
<td>3 mos: mRS Score 4</td>
</tr>
<tr>
<td>5</td>
<td>73, M</td>
<td>rt hemiparesis, aphasia, &amp; visual disturbance</td>
<td>lt cICA; lt tICA</td>
<td>w/in 6 hrs</td>
<td>manual navigation through lt cICA; 2 mg tPA: partial canalization at tICA/A₁; rt cICA partial interval PTA w/ 50% residual stenosis; lt CEA at 3 mos</td>
<td>none</td>
<td>8 mos: mRS Score 1</td>
</tr>
<tr>
<td>6</td>
<td>41, F</td>
<td>lt hemiparesis, dysarthria, &amp; facial droop</td>
<td>rt cICA; rt M₁,₂ subocclusive thrombus</td>
<td>6 hrs 30 mins</td>
<td>manual navigation through rt cICA; rt cICA partial interval PTA w/ 40% residual stenosis; rt CEA at 6 wks</td>
<td>none</td>
<td>2 mos: mRS Score 1</td>
</tr>
</tbody>
</table>

† The mRS scores were defined as follows: 0, no symptoms; 1, no significant disability despite symptoms—able to perform usual duties and activities; 2, slight disability—unable to perform all previous activities but able to look after own affairs without assistance; 3, moderate disability—requires some help, but able to walk without assistance; 4, moderately severe disability—unable to walk without assistance and unable to attend to own bodily needs without assistance; 5, severe disability—bedridden, incontinent, and requires constant nursing care and attention.

* cICA = cervical ICA; HA = headache; plc = placement; tICA = terminal ICA.

The patient in Case 1 experienced a headache on Day 2 and 3 months, respectively, after their stroke. The mean follow-up period was 8 months (range 2–14 months). Five of six patients had good or excellent outcomes (mRS Score 0–1), and the other patient (Case 4), who had an essentially “isolated” right hemisphere, had a poor outcome (mRS Score 4).

The patient in Case 1 experienced a headache on Day 2 after intraarterial thrombolyis; a head CT demonstrated a small SAH ipsilateral to the side of treatment. No additional deficits resulted and the patient’s headache resolved uneventfully. Two months after the initial treatment, this patient presented with an ipsilateral hemispheric TIA. The follow-up cerebral angiogram did not demonstrate restenosis or occlusion, and the patient responded well to the completion of PTA/stent placement. At 1-year follow-up review, the patient had no recurrence of symptoms and no significant disability (mRS Score 1).

The patient in Case 3 sought medical attention for ipsilateral hemispheric TIA 2 months after the initial treatment. Repeated cerebral angiograms demonstrated reocclusion of the cervical ICA, but the patient displayed no distal sites of occlusion and had excellent collateral flow to the ipsilateral hemisphere. This patient responded very well to more intensive anticoagulation therapy (aspirin plus warfarin) and was able to perform all activities of daily living at the 14-month follow up (mRS Score 1).

**Illustrative Case**

**Case 1.** This 77-year-old woman presented with right hemisphere TIA that resolved on hospital Day 1. On the 2nd day, however, the patient suffered sudden onset of progressively worsening left-sided weakness with facial palsy and slurred speech. Emergency head CT scans demonstrated no acute evidence of parenchymal injury. A diagnostic cerebral angiogram demonstrated acute occlusion of the cervical ICA, but the patient displayed no distal sites of occlusion and had excellent collateral flow to the ipsilateral hemisphere. This patient responded very well to more intensive anticoagulation therapy (aspirin plus warfarin) and was able to perform all activities of daily living at the 14-month follow up (mRS Score 1).
the right cervical ICA (Fig. 1). There was retrograde filling through the right OphA to the cavernous and petrous ICA (Fig. 2). Left ICA injection angiography demonstrated acute occlusion of the right M1 segment (Fig. 3). At that point, 3 hours and 20 minutes had elapsed since the onset of symptoms. Because the patient’s neurological deficits continued to worsen and there was no significant collateral filling of the right hemisphere, we decided to proceed with emergency intraarterial thrombolysis and balloon angioplasty/stent placement.

A guidewire was successfully negotiated through the occluded right cervical ICA to gain rapid access to the distal ICA, where microcatheter injection demonstrated right-sided M1 occlusion (Fig. 4). After thrombolytic therapy with 10 mg tPA, normal blood flow was reestablished in the right hemisphere (Fig. 5). No residual thrombus was seen in the MCA. The patient experienced immediate, significant functional recovery. Motor function in the left upper and lower extremities improved to at least antigravity by the completion of the thrombolysis. After recanalization was accomplished, PTA/stent placement in the originally occluded ICA was performed. Control angiograms revealed approximately 50% residual stenosis of the right cervical ICA (Fig. 6).

No apparent distal embolization, arterial dissection, or vascular tear/perforation resulted from these procedures. The patient was discharged home on aspirin and Plavix; at the time of discharge, she had only very mild left-sided weakness. Carotid artery Doppler studies demonstrated no evidence of restenosis 7 months later. The patient was able to perform all activities of daily living with only mild neurological symptoms at the 1-year follow-up review (mRS Score 1).

**Discussion**

The prognosis of patients with acute symptomatic cervical ICA occlusion has generally been considered to be poor.9 There is no established optimal treatment available for patients with such devastating occlusive infarcts. Results of urgent surgical recanalization are not encouraging.9,15 Meyer, et al.,9 identified two important prognostic factors correlating with poor surgical outcome, that is, the presence of an associated MCA embolus and lack of collateral flow. Unfortunately, concurrent intracranial occlusion of the MCA territory is commonly observed in patients with acute symptomatic occlusion of the cervical ICA.21,13 Furthermore, intracranial occlusion sites often diminish the collateral flow.

Despite the rapid advancement in thrombolytic/endovascular therapies, there is a relative lack of reports in the endovascular literature on this clinical entity. Traditionally, acute cervical ICA occlusion is considered to be an obstacle for urgent intracranial catheter navigation and thrombolytic treatment. Our preliminary experience indicates that
aggressive thrombolytic/endovascular therapy can be a successful way of treating patients with such acute symptomatic cervical ICA occlusion. After a mean follow up of 8 months (range 2–14 months), there were no deaths and five of six patients had good or excellent outcomes (mRS Score 0–1).

**Navigation Through the Occluded Cervical ICA to Gain Rapid Access for Urgent Intracranial Intraarterial Thrombolysis**

In the current literature various authors strongly suggest that clinical improvement with cervical ICA occlusion is determined by the timely reestablishment of collateral flow with intracranial intraarterial thrombolysis. To gain access to the intracranial circulation through the ipsilateral occluded ICA, it is necessary either to recanalize the cervical ICA or navigate directly through the occluded segment. Several recent studies have shown that neither intravenous nor intraarterial thrombolysis is time-efficient and effective for recanalization of the occluded cervical ICA. Higher doses of thrombolytic agents did not seem to correlate with the success rate. Mechanical thrombectomy has been described as technically feasible, with only small expenditures of time. This may serve as an alternative to chemical thrombolysis for ICA recanalization. Nevertheless, navigation through the occluded segment is much more direct and time-efficient.

Navigation through the occluded cervical ICA has been described before in smaller series. Although traversing an occluded vascular segment has been done successfully in the coronary arteries, in bypass grafts, and in the extremities, navigating through an occluded cervical ICA has not been routinely attempted. The major theoretical risks include dislodging thrombi to create more distal emboli, perforation, and dissection. None of these was observed in our patients. Microemboli, however, may be both clinically and angiographically silent. Navigating through the occluded cervical ICA did not seem to result in any of the aforementioned complications reported in prior series either.

Navigation through the occluded cervical ICA was successful in all patients. These patients characteristically had retrograde filling through either the posterior communicating artery or OphA to the supraclinoid ICA, or the cavernous and petrous ICA. This indicated that the cervical ICA thrombus was not extending into the intracranial compartment. In our preliminary experience, such a pattern of retrograde filling may be necessary for successful navigation through occluded cervical ICAs. Our experience provides further support for the idea that navigation directly through the occluded cervical ICA to gain access for intracranial intraarterial thrombolysis is technically feasible, safe, and time-efficient.

**Treatment of the Occluded Cervical ICA After Successful Intracranial Intraarterial Thrombolysis**

Assessment of the adequacy of collateral blood flow after successful intracranial intraarterial thrombolysis is essential in deciding whether to treat the occluded cervical ICA. The exact correlation between angiographic and long-term clinical adequacy of collateral flow is still unknown. Nevertheless, we believe that when it is angiographically apparent that the collateral flow is absent or grossly inadequate, re-
canalization of the occluded cervical ICA should be attempted. The patient in Case 4 in our group had an essentially "isolated" right hemisphere. Despite complete lysis of intracranial thrombi within 6 hours of the onset of symptoms and partial angioplasty of the occluded cervical ICA with 50% residual stenosis, this patient made no clinical improvement and her score remained at 4 on the mRS. This may reflect the crucial importance of collateral flow, along with its correlation with the amount of brain tissue at risk, time of treatment window, and clinical improvement.

When angiographically adequate collateral flow is reestablished after successful intracranial thrombolysis, it is unclear whether recanalization of the occluded cervical ICA offers additional immediate and/or long-term benefits to patients. Unless in the case of an "isolated" hemisphere, symptoms in acute ICA occlusion are often related to distal embolization of the MCA and anterior cerebral artery, or they relate to the direct extension of the thrombus to involve the bifurcation ("T occlusion" of the ICA).

Reestablishment of collateral flow only in the MCA/anterior cerebral artery territory can often result in improvement of the symptoms. Nevertheless, there are several considerations in favor of preservation of the proximal ICA. Overall, a carotid artery is a "bad thing" to lose. This is particularly true in patients with diffuse, coexisting vascular disease. There is also increasing evidence that cognitive dysfunction is associated with chronic reduction in cerebral blood flow.7 Additionally, providing a more direct source of flow may decrease the risk of acute/subacute recoclusion of distal segments. These theoretical benefits, however, must be weighed against the potential complications of acute ICA endovascular recanalization, including reperfusion injury, distal embolization, and acute recoclusion. Nevertheless, our preliminary experience has shown that, with the currently available technology, endovascular recanalization of acute symptomatic cervical ICA occlusion can be performed with an acceptable level of risk and favorable outcomes. Furthermore, continuing refinements of the available devices (catheters, balloons, stents, and so on) and advancements in medical therapies will make such a combined approach even safer in the near future.

We elected to recanalize the occluded cervical ICA with the following procedures: 1) immediate partial PTA/stent placement leaving 40 to 50% residual stenosis, followed by CEA or completion of PTA/stent placement in a delayed fashion; or 2) immediate complete PTA/stent placement leaving no residual stenosis. Most of our patients underwent immediate partial interval PTA/stent placement to minimize reperfusion injury. Nevertheless, two of these patients suffered ipsilateral hemispheric TIAs within 2 months. One experienced recoclusion, but without distal emboli, and responded well to more intensive anticoagulation therapy (aspirin plus warfarin). The other, although there was no evidence of increasing stenosis or recoclusion on the follow-up angiogram, responded very well to the completion of PTA/stent placement, which left no residual stenosis. Had these two patients received follow-up CEA or completion of PTA/stent procedures sooner (within 2 months) after the initial partial recanalization, whether it would have prevented the ipsilateral hemispheric TIA remains speculative. On the other hand, the patient in Case 2...
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underwent immediate complete PTA/stent placement with no residual stenosis. He experienced no significant complications, and had recovered fully by 7 months postoperatively.

In the setting of urgent recanalization of acute symptomatic cervical ICA occlusion, concerns regarding the risk of intracranial hemorrhage remain highly relevant and valid. An SAH occurred in one of our patients (Case 1), but it resulted in no neurological deficits, and the only symptom (headache) resolved spontaneously. Our series is too limited to allow any conclusive remarks. Nevertheless, it is important to stress that in the six patients whose cases we report, the admission head CT revealed no acute evidence of frank hypodensity or hemorrhage. In addition, all of our patients received strict blood pressure control in the intensive care unit once recanalization was established. Furthermore, to minimize the risk of reperfusion injury, most of our patients underwent urgent, intentionally, partial recanalization of the occluded ICA with PTA/stent placement, which left at least 40 to 50% residual stenosis. Complete recanalization of the ICA either with repeated endovascular treatment or surgery (CEA) was performed in a delayed fashion after only 6 to 12 weeks.

Conclusions

The results of our preliminary experience in six patients with acute symptomatic cervical ICA occlusion are encouraging. An aggressive endovascular approach may be a successful way to treat patients in this clinical category. We provide further evidence that navigation through the occluded cervical ICA to gain access for urgent intracranial intraarterial thrombolysis is direct, technically feasible, safe, and time-efficient. The theoretical risks of distal embolism and vascular perforation and/or dissection warrant future studies. Large clinical studies are needed to determine the indications for recanalizing the occluded cervical ICA after successful intracranial intraarterial thrombolysis, the degree of initial recanalization, the timing of completion of recanalization, and the optimal endovascular approach.

References


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