Extravasation of Contrast Medium from the Lenticulostriate Artery Following Local Intracarotid Fibrinolysis

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Komiyama M, Nishijima Y, Nishio A, Khosla, V. Extravasation of contrast medium from the lenticulostriate artery following local intracarotid fibrinolysis. Surg Neurol 1993;39:315–9.

Two patients with acute embolic occlusion of the intracranial internal carotid artery and the lenticulostriate arteries were treated by local intraarterial fibrinolysis using tissue plasminogen activator. Although fibrinolysis started within 2.5 hours from the ictus, extravasation of the contrast medium from the lenticulostriate arteries occurred in the region of the basal ganglia. Local intraarterial fibrinolysis for acute embolic occlusion of the internal carotid artery may be a high-risk therapeutic intervention even within the ultra-acute stage, especially when the lenticulostriate arteries are occluded by an embolus.

KEY WORDS: Contrast medium; Cerebral embolism; Extravasation; Fibrinolysis; Lenticulostriate artery

Refinement in endovascular techniques have made intraarterial fibrinolytic therapy possible for ultra-acute embolic cerebral vascular occlusions [1,3,10,11]. Its true indications, however, remain unclear. We treated five patients with an embolic occlusion of the internal carotid artery (ICA) by fibrinolysis, during the ultra-acute stage. Whereas recanalization could not be obtained during intervention in three patients, in the two remaining patients extravasation of the contrast medium from the lenticulostriate arteries of the middle cerebral artery occurred. We detail these two patients.

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Received September 15, 1992; accepted October 19, 1992.

Case Presentation

Case 1

A 72-year-old woman developed sudden altered consciousness and left-sided weakness. Her past medical history was not contributory except for cardiac arrhythmia. She was brought to us 1 hour after the ictus. Upon admission, she was stuporous and had left hemiplegia with disconjugate gaze to the right. Electrocardiogram showed marked atrial fibrillation, which suggested that her stroke was of embolic origin. Computerized tomographic (CT) scan did not demonstrate any abnormality. Emergency angiography demonstrated right ICA occlusion immediately distal to the origin of the posterior communicating artery (Figure 1). The left ICA injection showed no collateral flow through the anterior communicating artery to the right anterior cerebral artery. The right cervical ICA was normal. Local fibrinolysis using tissue plasminogen activator (t-PA), which had an osmolality of about 300 mOsm/kg · H_2O, was started 2.5 hours from the onset of her symptoms. The contrast medium used through the microcatheter was ioxaglic acid (Gerbe, S.A., Orne, France), of which osmolality was 665 mOsm/kg · H_2O and was diluted with half the amount of saline, making its osmolality 550 mOsm/kg · H_2O.

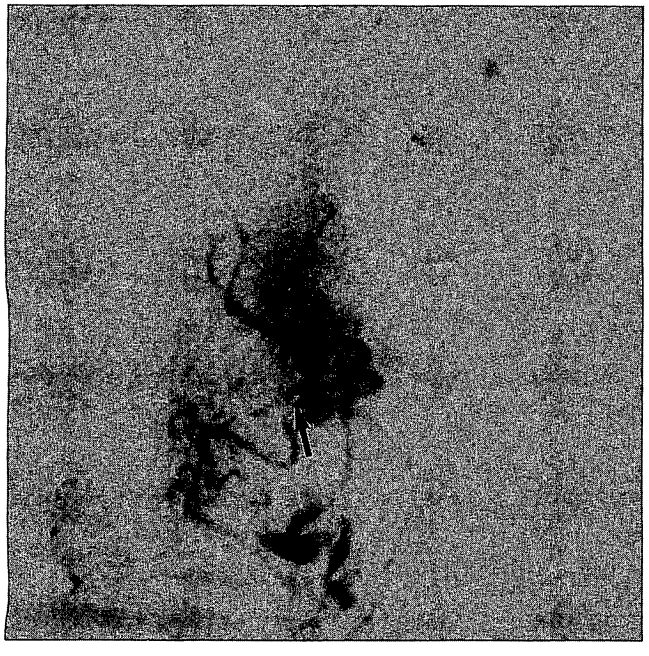
Six million international units (10.3 mg) of t-PA were slowly injected manually for a period of 10 minutes through the tracker-18 catheter (Target Therapeutics, Fremont, CA) with the tip placed within the distal ICA embolus (Figure 2). This resulted in partial recanalization of both the A1 and two-thirds of the M1 portion. The recanalized ICA, A1, and M1 were slightly dilated, but had a smooth intraluminal surface (Figure 3). Another 4 million units of t-PA were slowly injected into the M1 portion. Because extravasation of the contrast medium was strongly suspected as a result of fluoroscopy during this procedure, further treatment was stopped. The entire procedure was finished within 4 hours of onset.

0090-3019/93/$6.00

Figure 1. *Case 1. Right carotid injection (frontal view) shows embolic occlusion of the right internal carotid artery immediately distal to the posterior communicating artery. Note the embolus (arrow).*

Neurologically, the patient remained stuporous and the postprocedure computed tomography (CT) showed an extremely high-density lesion in the right basal ganglia, with a CT number of 230, suggesting extravasation of the contrast medium (Figure 4). Subsequently, she developed marked swelling of the right hemisphere with progressive neurological deterioration and died within 8 days.

Figure 2. *Case 1. Selective injection (frontal view) within the embolus through the microcatheter demonstrates the dilated lateral lenticulostriate arteries with capillary blush in the basal ganglia and early venous drainage. Arrow indicates the tip of the microcatheter.*



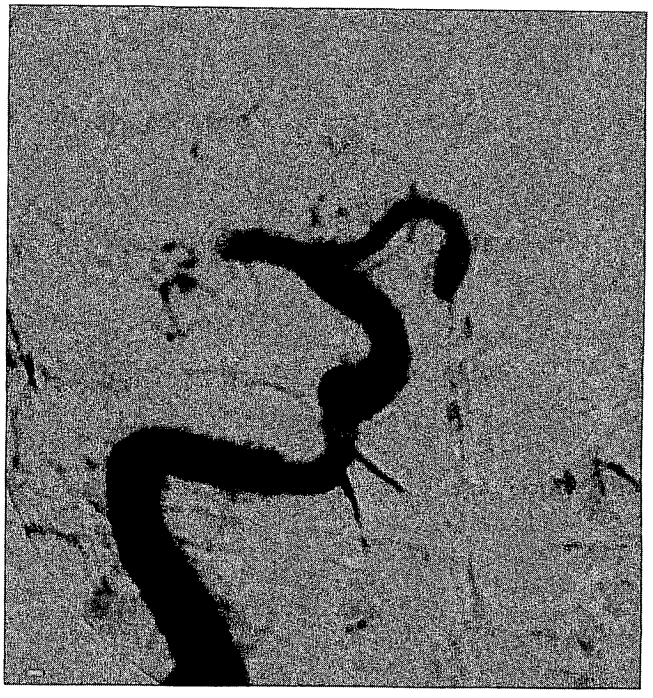


Figure 3. *Case 1. After 6 million units of tissue plasminogen activator infusion, recanalized A1 of the anterior cerebral artery and two-thirds of the M1 of the middle cerebral artery are shown. An embolus is still located in the distal middle cerebral artery.*

Case 2

A 56-year-old man developed sudden right-sided hemiplegia and reached our hospital within 30 minutes of the ictus. Examination revealed a globally aphasic and right hemiplegic patient, with spontaneous eye opening. Aortic and mitral valve replacements were done 5 years previously. He was on 3.5 mg/day of warfarin sodium, which poorly controlled the coagulation to a level of 61.4% (thrombo-test) Electrocardiogram showed a regular sinus rhythm and left ventricular hypertrophy. Immediate CT scan showed no abnormality. Cerebral angiography showed occlusion of the left ICA immediately distal to the origin of the posterior communicating artery with poor collaterals (Figure 5). There was no abnormality in the cervical portion of the left ICA, and a previous history of valve replacement suggested embolic etiology for the stroke. As the time interval between ictus and completion of angiography was 90 minutes, local intraarterial fibrinolysis was attempted. The contrast medium used through the microcatheter was the same as that in case 1.

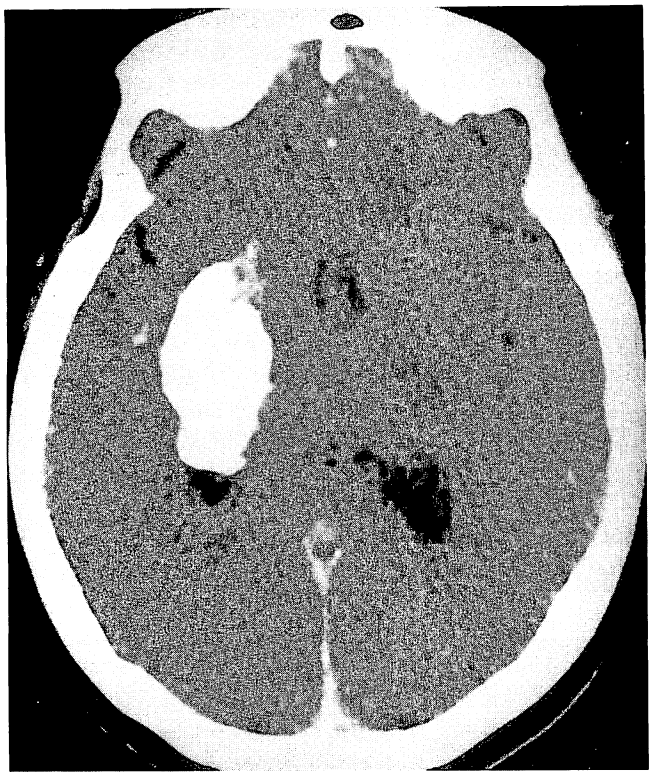
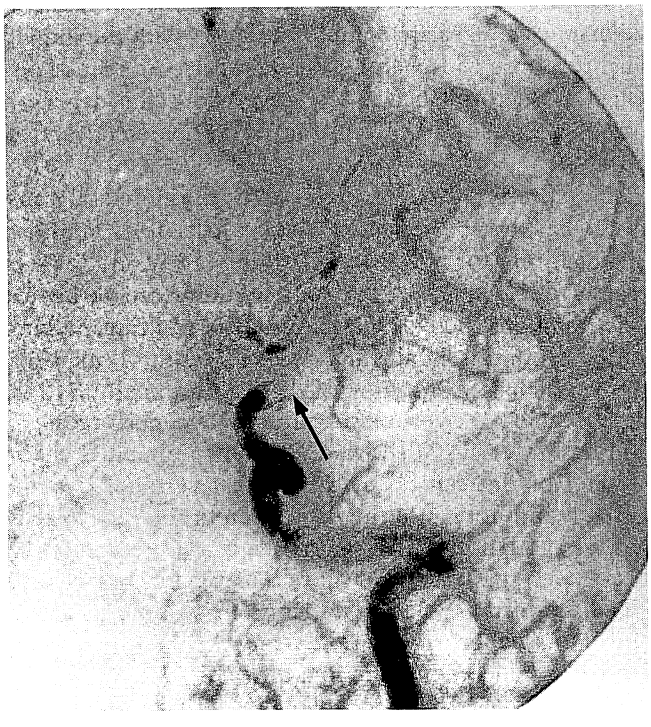


Figure 4. *Case 1. CT scan immediately after fibrinolysis shows high-density area (CT number = 230) at the right basal ganglia, strongly suggestive of the extravasated contrast medium.*

Figure 5. *Case 2. Left internal carotid injection (frontal view) shows embolic occlusion of the internal carotid artery immediately distal to the origin of the posterior communicating artery (arrow).*



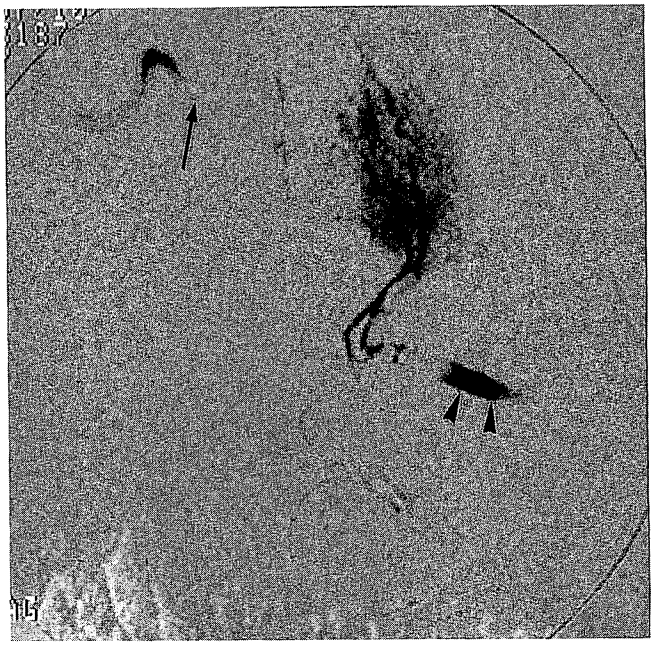


Figure 6. *Case 2. Injection through the microcatheter with the tip placed in the embolus near the origin of the middle cerebral artery (right anterior oblique view). Stagnation of the contrast medium in the M1 portion of the middle cerebral artery (arrowheads) indicates the distal end of the embolus. Markedly enlarged medial lenticulostriate arteries, capillary blush at the basal ganglia, and early venous drainage via the left internal cerebral vein (arrow) are noted.*

Similar to Zeumer's method [11], a 7 French, double lumen, balloon catheter (Medi-tech, Watertown, MA) was introduced into the left, cervical ICA, and the balloon was inflated to stop carotid flow. Six million units of t-PA were injected slowly over 30 minues into the ICA using a microinfusion pump. Because the occlusion remained as such, a tracker-18 catheter was navigated through the original balloon catheter up to the proximal part of the embolus. A further 3 million units of t-PA were infused during a 20-minute period with proximal control resulting in a faint visualization of the left anterior cerebral artery. The tracker catheter was further advanced up to the proximal portion of the left middle cerebral artery, and contrast material injection showed a capillary blush around the head of the caudate nucleus which was interpreted as an arteriovenous shunting from the medial lenticulostriate arteries—which were obviously enlarged—to the internal cerebral vein (Figure 6). Another 3 million units of t-PA were infused through the tracker catheter with the tip placed at the same location. During these procedures, pressure injection through the microcatheter was maximally avoided. Because fluoroscopy revealed a discrete extravasation with stasis of the contrast medium in the region of the basal ganglia, further procedure was stopped. The final angiographic picture was no different from the initial

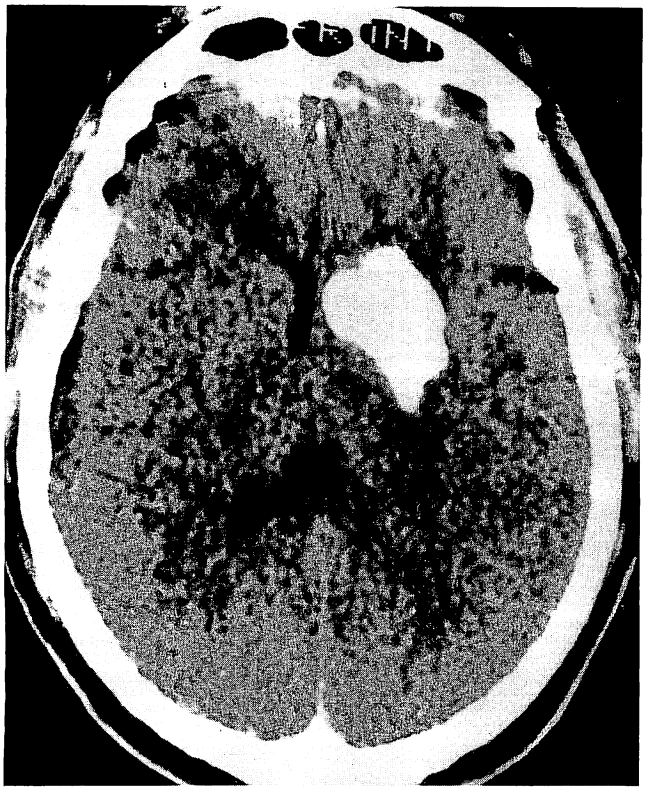


Figure 7. *Case 2. CT scan immediately after the intervention. High-density area, indicating the contrast medium, is located at the head of the left caudate nucleus.*

one. The entire process was finished within 4 hours of the ictus.

Postoperatively, the patient became stuporous and the postprocedure CT showed an extremely high-density area, indicating the extravasated contrast medium in relation to the head of the left caudate nucleus (Figure 7). On the next day, CT showed the same high-density area and a massive left hemispheric infarction. The patient showed progressive neurological deterioration and died a week later.

Discussion

Although the initial work by Fletcher et al [4] on systemic urokinase for acute cerebral infarction was disappointing, recent reports on local intraarterial fibrinolysis are more encouraging, although a 13% incidence of postperfusion hemorrhage is reported [3]. However, the risk of postperfusion hemorrhage and the lack of clear-cut indications make patient selection difficult and confusing. These factors have limited widespread use of local intraarterial fibrinolysis as a treatment modality.

Theron et al [10] have classified acute cerebral vascular occlusions into three different groups. In group 1 there is intra/extracranial occlusion of the ICA but the circle of Willis and the lenticulostriate arteries are patent. In group 2 the cortical arteries are occluded but the lenticulostriate vessels are spared, whereas in group 3 the lenticulostriate arteries are involved in the intracerebral arterial occlusions. Because the lenticulostriate arteries are end arteries whose walls become very fragile following prolonged ischemia, group 3 could be at high risk for postperfusion hemorrhage.

Although Theron et al [10] mentioned that local intraarterial fibrinolysis was dangerous after 4–5 hours of ischemia, the safe period for recanalization is not definitely definable. Our two cases are similar to case 12 of Theron et al, but postperfusion hemorrhage resulted even though intraarterial fibrinolysis was started within 2.5 hours, and extravasation of the contrast medium was seen within 4 hours of the ictus. The lateral lenticulostriate arteries, called *Charcot artere de l'hémorrhagie cérébrale,* are notorious for hypertensive bleeding due to associated degenerative changes. Extravasation of the contrast medium may not be attributable to the time of ischemia alone but is the result of interaction of a variety of factors not fully understood presently. The poor collateral flow and the high concentration of the contrast medium may be among them.

In the group-3 type of occlusions of the ICA, if there is no collateral flow through the anterior communicating artery to the anterior cerebral artery, then cerebral ischemia, especially in the region of the basal ganglia, may be extremely severe. Recanalization in the ultra-acute stage may be useful in selected patients, but the time factor currently defies the definition as the hemodynamic changes are complex and vary with the individual response to ischemia. The latter itself depends on a host of factors, such as collateral flow, the degree of atherosclerosis, hypertension, hyperlipidemia, and so on.

We prefer t-PA to urokinase for fibrinolysis because t-PA has the advantages of a short half-life (5 minutes), high affinity for fibrin-bound plasminogen, and low-systemic effect [8]. We think that there are three machanisms for the extravasation of the contrast medium: (1) profound ischemia and recanalization, (2) exposure of the high concentration of the contrast medium to the vessel, and (3) overpressurization of the perforating arteries. Ito et al [7] showed in the experimental animal model of the carotid occlusion that cerebral ischemia usually did not cause the disruption of the blood–brain barrier (BBB) in ultra-acute stage, but recanalization destroyed the BBB after more than 3 hours of ischemia. Damage of the BBB by the contrast medium is caused by (1) its hyperosmolality, causing the endothelial cells to shrink and tight junctions to open [9], and (2) the direct chemical toxity to the endothelial cells due to the

ionic and chemical content of the contrast medium [5]. Rapoport et al [9] reported that various contrast media with an osmolality over 1200 mOsm/kg · H_2O produced the BBB damage, and Hayakawa et al [6] showed that the local BBB injury was induced at the *serum osmolality* of about 370 mOsm/kg · H_2O when the contrast medium was administered intravenously. The stasis of the contrast medium within the vessel before the full recanalization might enhance the adverse effects on the BBB. Although we used diluted ioxaglic acid with an osmolality of 550 mOsm/kg · H_2O, this contrast was ionic and gave a much more severe disturbance on the BBB than did the nonionic contrast media [2]; a local serum osmolality at the occlusion site was higher than 370 mOsm/kg · H_2O, which could cause local BBB damage. Furthermore, even delicate contrast injection through the microcatheter in the occluded artery could result in overpressurization of the perforating arteries and then the rupture of the vessels.

In the local fibrinolysis for the acute embolic occlusion of the ICA and the lenticulostriate artery, the above-mentioned machanisms would result in disruption of the BBB or rupture of the perforating arteries, which lead to the extravasation of the contrast medium to the cerebral parenchyma. To avoid the damage of the BBB, we note fibrinolysis should be completed before the collapse of the BBB, say before 1 hour from the ictus, and the contrast medium (either ionic or hyperosmolar) should not be injected locally; however, this is not clinically feasible.

There is no established treatment for the acute embolic occlusion of the ICA, and its prognosis varies from no deficit to death. When the lenticulostriate arteries are involved, the prognosis is obviously poor. Although there remains some possibility that selected patients may profit from local fibrinolysis in the ultra-acute stage, this treatment may be a high-risk procedure especially when the lenticulostriate arteries are occluded by an embolus.

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