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# Successful Thrombolysis in the Vertebrobasilar Artery after Endovascular Occlusion of a Recently Ruptured Large Basilar Tip Aneurysm

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**Summary:** The treatment of a patient who had iatrogenic basilar artery thrombosis after endovascular occlusion of a recently ruptured wide-necked basilar apex aneurysm with a nondetachable silicone balloon is described. The rationale for the choice of a nondetachable balloon, the need for anticoagulation in the postoperative period, the timing of thrombolysis, and the choice of thrombolytic agents are discussed.

**Index terms:** Interventional neuroradiology, complications; Iatrogenic disease or disorder; Thrombolysis

As endovascular techniques are being accepted as alternatives to surgery for patients with selected cerebral vascular disease, interventional neuroradiologists are also expected to treat complications associated with these procedures. Two of the most serious complications associated with endovascular therapy are vessel perforation (1, 2) and thromboembolism. With meticulous techniques and systemic anticoagulation, a thromboembolic phenomenon during or after prolonged endovascular procedure is uncommon but can have potentially devastating consequences. The advent of a newer generation of fibrinolytic agents, such as tissue plasminogen activator (3), improves the armamentarium available to endovascular therapists for treating thromboembolic complications. The purpose of this report is to present our anecdotal experience in the management of iatrogenic basilar thrombosis after endovascular occlusion of a recently ruptured large basilar tip aneurysm with a nondetachable silicone balloon.

## Case Report

A 37-year-old woman was in good health until the sudden onset of subarachnoid hemorrhage. Four-vessel an-

giography showed a large basilar tip aneurysm (Fig 1). Both posterior communicating arteries were widely patent on respective internal carotid artery injections. Because of the high morbidity associated with surgical clipping of such a large basilar aneurysm that incorporated both proximal P1 segments into a low-lying neck, we elected to treat this patient with a grade I (Hunt and Hess) aneurysm with endovascular balloon occlusion under systemic heparinization. Two detachable silicone balloons filled with 0.5 mL and 0.4 mL of metrizamide (200 mg I/mL) were individually navigated to and detached within the apex of the basilar aneurysm with a 2F/4F Hieshima coaxial catheter system (Cook, Bloomington, Ind) under digital subtraction angiographic road-mapping technique. Subsequently, a third silicone balloon was inflated across the wide aneurysm neck with a mixture of 0.52 mL of metrizamide and 2-hydroxyethyl methacrylate (HEMA; Polysciences, Warrington, Pa) after a 15-minute noneventful test occlusion with the patient awake. This third balloon was a nondetachable balloon attached to a 2F microcatheter (Interventional Therapeutics, South San Francisco, Calif) which had been navigated through the right vertebral artery. The left posterior cerebral artery was not visualized on a postembolization left vertebral artery angiogram (Fig 2). Left internal carotid injection demonstrated rapid filling of the left posterior cerebral artery via a patent left posterior communicating artery. After HEMA solidification, the hub of the 2F catheter was cut, a knot was tied in the proximal cut end of this catheter, and it was secured extravascularly in the subcutaneous tissue. Hemostasis was obtained by manual compression over the femoral arteries after reversal of circulating heparin with protamine sulfate. The patient left the neuroangiography suite after a normal neurologic examination.

Three hours later, a syndrome of basilar thrombosis with progressive bilateral midbrain and pontine deficits developed. A computed tomogram of the brain was unremarkable. Angiography via the right femoral artery approach demonstrated thrombosis of the right vertebral artery and the distal basilar artery (Fig 3A). The left posterior

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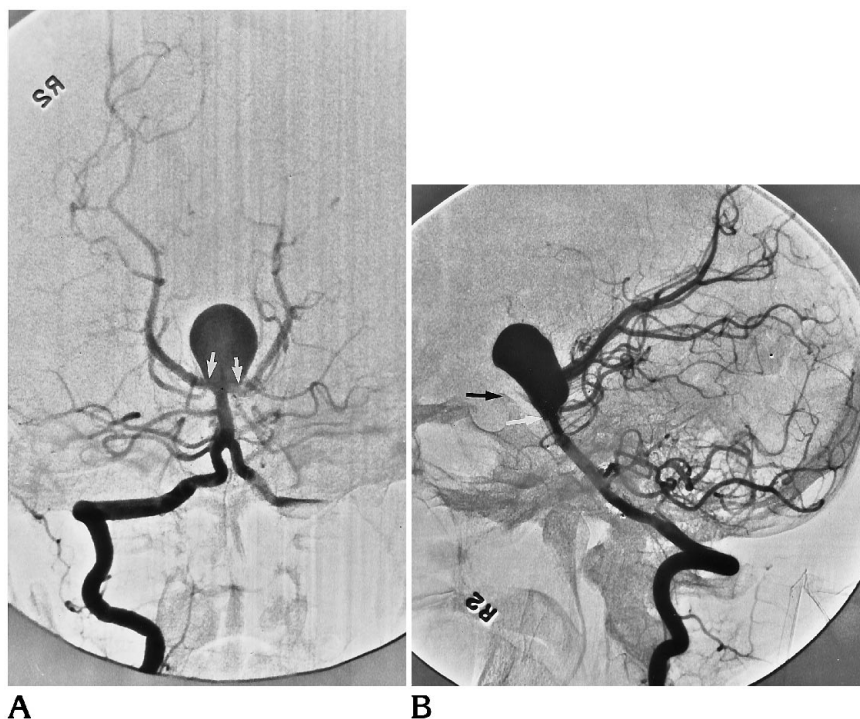
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Fig 1. A, Anteroposterior and B, lateral views of right vertebral angiogram show a wide-necked basilar tip aneurysm. Note both proximal posterior cerebral arteries are incorporated into the aneurysm neck (white arrows). The lateral view (B) is helpful in depicting the relationship of the low-lying aneurysm neck (white arrow) with respect to the dorsum sellae (black arrow).



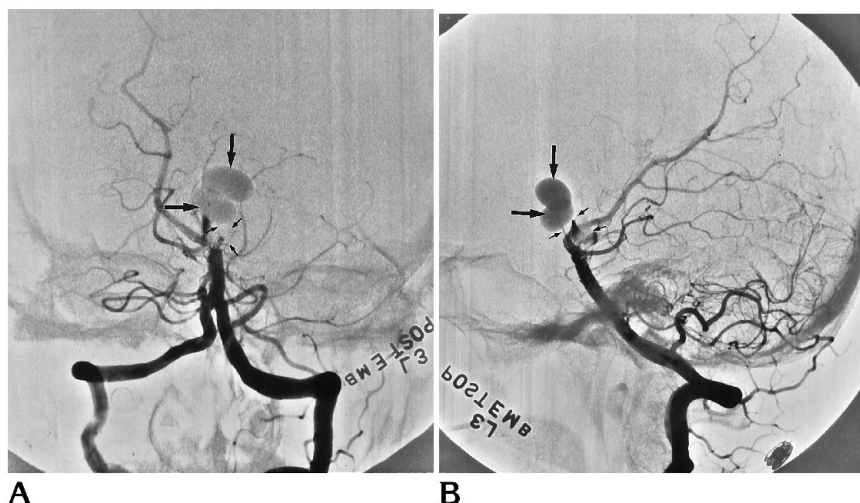
cerebral artery again filled from the left internal carotid artery. There was no caudal migration of the nondetachable balloon. Because of the patient's poor neurologic condition and little hope of spontaneous recovery, we performed intraarterial fibrinolysis with a Tracker-18 microcatheter (Target Therapeutics, Fremont, Calif) navigated via the left vertebral artery and through soft thrombus in the distal basilar artery. Hand injection of contrast material through the microcatheter at the basilar apex demonstrated patency of the right posterior cerebral artery and superior cerebellar artery before fibrinolysis. Local fibrinolytic therapy was initiated 7 hours after onset of the neurologic deficit; urokinase was infused directly into the thrombus for 2 hours at 250 000 U/h followed by 100 000 U/h for another half hour (Fig 3B). The patient's neuro-

logic status fluctuated during treatment; at best she was oriented  $\times 3$  with antigravity (3/5) strength in the left upper and lower extremities and dysarthric speech. As urokinase infusion failed to achieve sustained neurologic improvement and there was concern about crossing the threshold of irreversible brain stem ischemia, tissue plasminogen activator infusion was initiated with alteplase (Genentech, South San Francisco, Calif) (a recombinant tissue plasminogen activator with fibrin specificity) on a compassionate basis. Ten mg of tissue plasminogen activator (5.8 million IU) diluted in 10 mL of sterile water was injected at 1-mg increments into the upper basilar thrombus over 10 minutes. The patient's neurologic status returned to intermittent fluent speech and antigravity strength on the left side. At this time, infusion of tissue plasminogen activator

Fig 2. Left vertebral angiogram after navigation of two detachable balloons (large arrows) and a nondetachable balloon (small arrows) into the basilar tip aneurysm.

A, Anteroposterior view shows nonfilling of the left posterior cerebral artery.

B, Lateral view shows small amount of stagnant contrast material in crevices between the nondetachable balloon and the aneurysm.



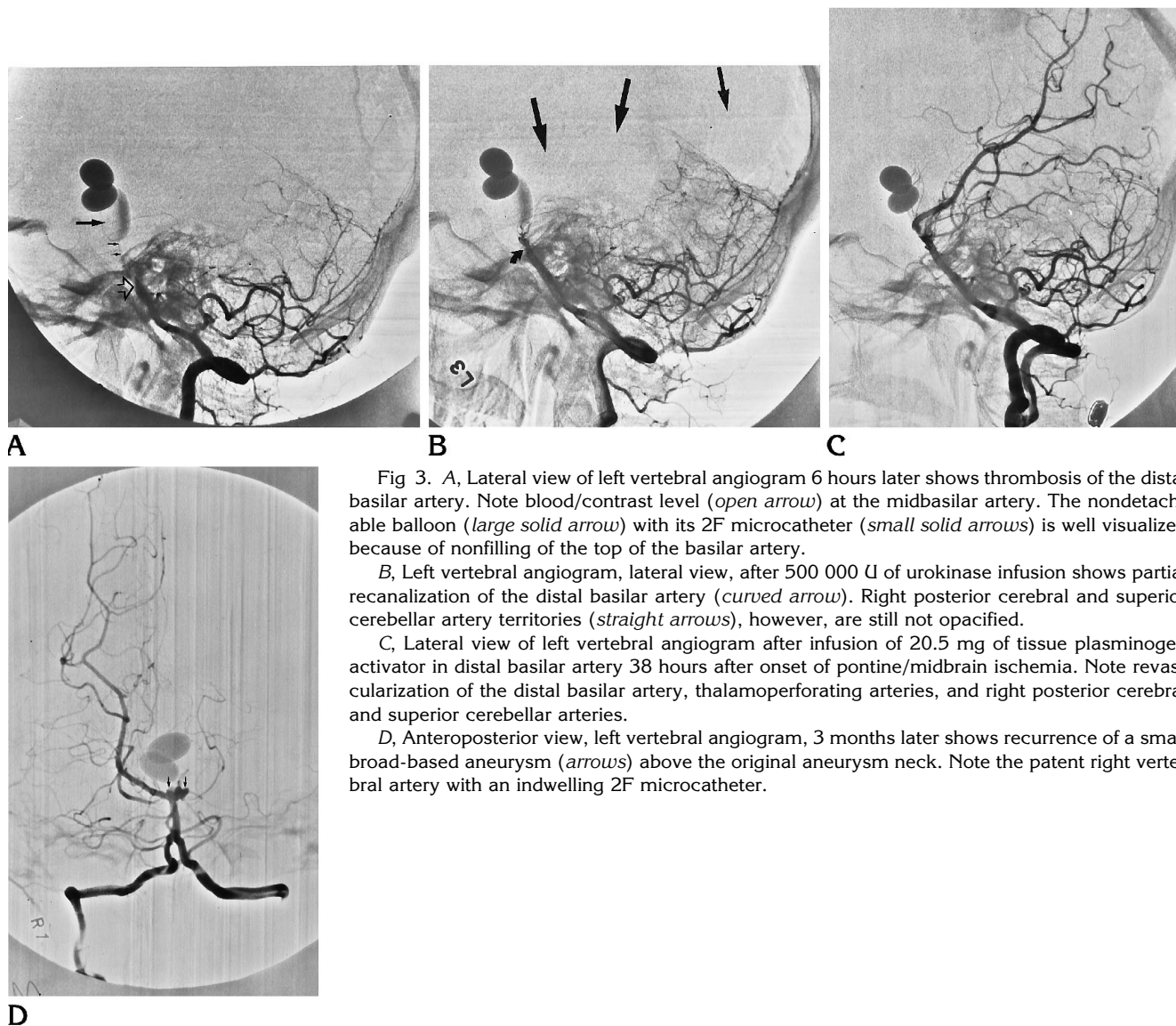


Fig 3. A, Lateral view of left vertebral angiogram 6 hours later shows thrombosis of the distal basilar artery. Note blood/contrast level (*open arrow*) at the midbasilar artery. The nondetachable balloon (*large solid arrow*) with its 2F microcatheter (*small solid arrows*) is well visualized because of nonfilling of the top of the basilar artery.

B, Left vertebral angiogram, lateral view, after 500 000 U of urokinase infusion shows partial recanalization of the distal basilar artery (*curved arrow*). Right posterior cerebral and superior cerebellar artery territories (*straight arrows*), however, are still not opacified.

C, Lateral view of left vertebral angiogram after infusion of 20.5 mg of tissue plasminogen activator in distal basilar artery 38 hours after onset of pontine/midbrain ischemia. Note revascularization of the distal basilar artery, thalamoperforating arteries, and right posterior cerebral and superior cerebellar arteries.

D, Anteroposterior view, left vertebral angiogram, 3 months later shows recurrence of a small broad-based aneurysm (*arrows*) above the original aneurysm neck. Note the patent right vertebral artery with an indwelling 2F microcatheter.

at the distal basilar artery was changed to 5 mg/h but had to be terminated after one half hour because of sudden hemorrhage from the left femoral artery, which had been punctured on the previous day. Laboratory coagulation profile revealed: partial thromboplastin time, >150 seconds; fibrinogen, 230 mg/mL (normal range, 150 to 400  $\mu$ g/mL); and D-dimer, 0.5 to 2  $\mu$ g/mL (normal range, <0.5  $\mu$ g/mL). Angiography showed partially recanalized right vertebral and distal basilar arteries.

With a right femoral artery sheath in place, the patient was treated with a combination of heparin, volume expansion, and vasopressors over the next 24 hours. Her left motor strength waxed and waned between 1/5 and 3/5; she was somnolent but arousable to loud voice and followed simple commands. Because there was no fixed neurologic deficit, angiography was repeated 40 hours after initial balloon occlusion. This showed a patent right verte-

bral artery and a small amount of residual thrombus below the basilar bifurcation. Another 8 mg of tissue plasminogen activator was infused at 1-mg increments over 20 minutes into the remaining clot. Each 1-mg increment was followed by real-time digital subtraction angiography of the distal basilar artery. Fibrinolytic therapy was terminated when motor strength on the left side returned to antigravity and left vertebral artery injection demonstrated patency of the basilar artery with antegrade filling of the right posterior cerebral and superior cerebellar arteries (Fig 3C). There was no filling of the basilar tip aneurysm. The patient remained heparinized for the next 5 days with resolution of the third cranial nerve palsy and left hemiparesis. Warfarin was then begun and maintained for 3 months. Repeat angiography after 3 months showed a small broad-based aneurysm remnant (Fig 3D). The patient remains neurologically normal.

## Discussion

Treatment of large basilar tip aneurysms is challenging. Current therapeutic options include surgical clipping and endovascular packing with either balloons (4) or thrombogenic coils (5). Each modality has associated morbidity. Whether the approach is surgical or endovascular, best results are reported in aneurysms with narrow necks. The aneurysm in our patient unfortunately had a broad low-lying neck that also incorporated both proximal P1 segments. This aneurysm is not amenable to complete surgical clipping. The primary goal of endovascular therapy, as with surgery, is to eliminate the aneurysm from the circulation completely. This goal cannot be achieved with detachable balloons in a broad-necked aneurysm. In such a situation, the treated aneurysm will undergo rapid regrowth after subtotal balloon occlusion (6). Experimental data from a broad-necked carotid bifurcation aneurysm model after total or subtotal occlusion with silicone or latex detachable balloons also demonstrated similar regrowth tendency (7).

The concern of rapid aneurysm regrowth caused by balloon migration and the associated risks of future rupture (8) led to our choice of a nondetachable silicone balloon placed across the aneurysm neck. We used a large enough balloon inflation volume to occlude the proximal left P1 segment in order to prevent inflow into the aneurysm neck. The nondetachable balloon was attached to a 2F polyethylene microcatheter secured in the subcutaneous tissue adjacent to the left femoral arteriotomy site. The rationale for using this technique is to counter the transmitted pulsation and potential cephalad migration of silicone balloons. The use of nondetachable latex balloons tethered to 1F polyethylene microcatheters has been pioneered and used successfully for permanent vascular occlusion by Merland et al (9, 10). The rationale for choosing metrizamide as the filling medium for the first two balloons was predicated by our choice of the nondetachable balloon system. If the nondetachable balloon system is indeed successful in completely blocking inflow into the wide aneurysm neck and does not migrate, the aneurysm dome would then undergo thrombosis and shrinkage. In such a situation, a balloon filled with contrast material has the potential to deflate slowly, thus decreasing the combined mass effect of balloons and

thrombus. The overall therapeutic approach we took was unconventional and understandably controversial, but we believed it would provide the best chance of blocking the aneurysm neck completely and preventing aneurysm regrowth.

In treating cerebral aneurysms with an endovascular approach, there is no widely accepted consensus on the use of systemic heparinization in the postoperative period. Common sense would suggest the use of systemic heparin in our patient with an indwelling microcatheter in the vertebrobasilar system to prevent thromboembolic complications. However, our patient had recently had a subarachnoid hemorrhage, and the placement of one or more balloons into such an aneurysm could potentially introduce further mechanical trauma to the fragile aneurysm wall, resulting in rehemorrhage. It was on the basis of these concerns that we chose not to heparinize the patient in the immediate postoperative period. In retrospect, this resulted in thrombosis of the right vertebral and distal basilar arteries.

The risk of performing thrombolysis in a recently ruptured large aneurysm is obvious; however, the risk of any therapy has to be measured against the natural history of the disease being treated. The prognosis of most patients with acute basilar artery occlusion is poor; the mortality ranges from 75% to 100% with conventional anticoagulation or antiplatelet therapy (11). For patients who survive acute basilar occlusion, severe disability is common. There are two case reports of posterior circulation thrombosis treated with intraarterial tissue plasminogen activator infusion; both showed beneficial results (12, 13). The overwhelming experience of thrombolysis in the vertebrobasilar artery territory has been obtained with fibrin nonspecific agents. Among 78 patients from the four largest series of patients treated with intraarterial urokinase and streptokinase (14–17), complete or partial recanalization was achieved in 44 (56%). Favorable clinical outcome, defined as survival without severe deficits, was associated with recanalization in 28 of 78 patients; 34 of the 38 deaths occurred in patients without recanalization. Analysis of the data from these four series suggests the interval between onset of symptoms and the start of fibrinolytic therapy is not as critical as that in middle cerebral artery mainstem occlusion, which only has a 4- to 6-hour window of treatment opportunity. In vertebrobasilar thrombosis, the patient's neuro-

logic status before fibrinolysis rather than the absolute duration of ischemia proved to be the most valuable prognostic factor. This prompted us to treat our patient, who had a waxing and waning neurologic status, with a second course of local fibrinolytic therapy 36 hours after initial onset of neurologic deficits.

There are no reports in the literature comparing the efficacy of tissue plasminogen activator versus urokinase in the treatment of intracranial thrombosis. However, data from a randomized controlled trial on the treatment of peripheral arterial or bypass graft occlusion are available (18). Sixteen patients each were randomized to treatment with urokinase or tissue plasminogen activator; thrombolysis consistently occurred more rapidly in the tissue plasminogen activator group. Our decision to switch from urokinase to tissue plasminogen activator when neurologic improvement in our patient could not be sustained was based on these data.

The last issue that needs to be addressed is how much thrombolytic agent can be administered safely to a patient with a recently ruptured basilar aneurysm. Unfortunately, no published data are available. Our strategy was to administer tissue plasminogen activator at 1-mg increments over 1 minute followed immediately by a real-time digital subtraction angiography to assess status of the parent vessel and the aneurysm. The predetermined treatment end points were either (a) when thrombolysis was first noted in the aneurysm lumen or (b) when clinical ischemic symptoms reversed. With this strategy, we hope to achieve good clinical outcome without subjecting patients to the risks of clot lysis within a recently ruptured aneurysm. The margin of safety in achieving thrombolysis of a parent vessel without thrombolysis within a balloon-occluded aneurysm is narrow. The risks and benefits of therapy have to be carefully balanced. Only further experience can answer whether the overall treatment protocol is an optimal one.

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