# Emergency embolectomy for embolic occlusion of the middle cerebral artery after internal carotid artery balloon test occlusion

Case report

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 $\checkmark$  Balloon test occlusion of the internal carotid artery (ICA) is useful in preoperatively assessing the risk of temporary occlusion or permanent sacrifice of the carotid artery. The incidence of symptomatic complications from this procedure is 1.7%. The case is reported of a 57-year-old woman in whom a balloon test occlusion of the left ICA was attempted. She developed a left ICA dissection/occlusion with subsequent embolization to the left middle cerebral artery, leading to right-sided hemiplegia and expressive aphasia. She was successfully treated by an emergency embolectomy followed by surgical repair of the left ICA, with an excellent outcome. This case represents the most serious complication encountered by the authors in more than 300 balloon test occlusions. Means of avoiding this complication during balloon test occlusion as well as the important factors in managing this problem are emphasized.

KEY WORDS · carotid artery occlusion · balloon occlusion · cavernous sinus · embolization · middle cerebral artery

15-MINUTE clinical test of internal carotid artery (ICA) balloon occlusion followed by an ICAoccluded stable xenon/computerized tomography (Xe/CT) cerebral blood flow (CBF) study has become a standard preoperative protocol at our institution for evaluating the risk of temporary occlusion or permanent sacrifice of the carotid artery.<sup>4,5</sup> While it is generally a safe procedure, occasional complications occur even in experienced hands. We report a case of ICA dissection/occlusion with subsequent embolization to the left middle cerebral artery (MCA); this represents our most serious complication to date resulting from balloon test occlusion. The overall safety of balloon test occlusion, the means of avoiding this complication, and important principles for successfully managing this problem are emphasized.

#### **Case Report**

This 57-year-old right-handed woman presented with a 2-month history of progressive left retro-orbital pain and intermittent left hemispheric headaches.

Examination. Angiography revealed a giant left in-

tracavernous aneurysm extending laterally from the anterior genu of the carotid siphon (Fig. 1). A 1-cm right-sided intracavernous aneurysm and a small right MCA aneurysm were also noted; both of these were asymptomatic. Angiography demonstrated good crossfilling of the left MCA from a right ICA injection via the anterior communicating artery.

The patient's neurological examination was normal. Because of the severity and progressive nature of her retro-orbital pain,<sup>10</sup> and since the aneurysm arose from the anterior genu of the carotid siphon and was therefore at some risk for subarachnoid hemorrhage,<sup>9,10</sup> a decision was made to treat her left intracavernous aneurysm. Magnetic resonance (MR) imaging showed that the aneurysm contained a significant amount of intraluminal thrombus, which could lead to distal embolization if intra-aneurysmal balloon occlusion was attempted. Since the presence of two contralateral aneurysms made carotid sacrifice undesirable, we decided to clip the aneurysm surgically.<sup>11</sup> Preoperative assessment of the patient's ability to tolerate temporary ICA occlusion during surgery was indicated, and she was

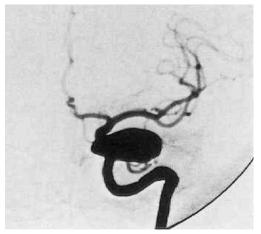


FIG. 1. Left internal carotid angiogram, anteroposterior view, demonstrating a giant left intracavernous aneurysm.

scheduled for a 15-minute clinical test of ICA balloon occlusion followed by an ICA-occluded Xe/CT CBF study.

Test Occlusion. Standard Seldinger technique and local anesthesia were used to insert a No. 5 French double-lumen Swan-Ganz catheter via a No. 6 French sheath into the right femoral artery. The catheter was introduced into the left common ICA and, after injection of a 2000-U bolus of heparin, was directed into the left ICA. Difficulty was encountered in trying to position the catheter at the C-2 vertebral body level for final balloon inflation. The catheter was withdrawn to the level of the carotid bifurcation and contrast medium was injected. A carotid artery dissection with complete occlusion of the ICA at the level of the C-3 vertebral body was noted (Fig. 2A). The ipsilateral superficial temporal artery was quite small.

Since the patient was clinically asymptomatic, she was hydrated intravenously and was taken to the CT scanner for a Xe/CT CBF study. Despite intravenous hydration and a spontaneous systolic blood pressure of 180 to 190 mm Hg, she suddenly developed expressive aphasia and right-sided hemiplegia during the study although she maintained a normal level of consciousness. The Xe/CT CBF study revealed low blood flow (10 to 18 cc/100 gm/min) in the left MCA territory (Fig. 2B). Distal embolization from the ICA dissection was suspected and the patient was quickly returned to the angiography suite where a right ICA injection demonstrated loss of the previously present collateral crossfilling via the anterior communicating artery. She was taken as an emergency to the operating room, where she was endotracheally intubated and etomidate coma was induced with burst suppression confirmed by electroencephalography. Her systolic blood pressure continued in the 180- to 190-mm Hg range.

Operation. A left frontotemporal craniotomy with orbital osteotomy was performed. After the dura was

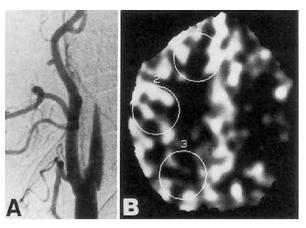


FIG. 2. A: Digital subtraction common carotid angiogram demonstrating an internal carotid artery dissection with lumen occlusion at the level of the C-3 vertebral body. B: A stable xenon/computerized tomography cerebral blood flow study performed after the patient developed right-sided hemiplegia and expressive aphasia. Low blood flow is seen in the left middle cerebral artery distribution (10 to 18 cc/100 gm/ min) compared with normal flow in all other vascular distributions (50 to 55 cc/100 gm/min). The three regions of interest displayed are in the contralateral anterior cerebral artery (1), middle cerebral artery (2), and posterior cerebral artery (3) distributions.

opened and the sylvian fissure split, the supraclinoid carotid artery, the carotid bifurcation, and the proximal anterior cerebral artery were inspected and found to be pulsatile. An embolus was encountered occluding the main branch of the MCA just beyond the carotid bifurcation, and a small clot was seen at the origin of one of the MCA perforating vessels. After proximal and distal temporary clips were placed, an arteriotomy onequarter the circumference of the involved vessel was performed over the embolus (Fig. 3). The distal temporary clip was removed and the distal portion of the embolus "milked" free with good back-bleeding. The same procedure was then repeated for the proximal portion of the embolus. The arteriotomy was then closed with 10-0 nylon interrupted sutures. The perforator clot could not be removed without the sacrifice of that vessel so it was left in place. The total elapsed time from her ictus in the CT scanner until re-establishment of MCA blood flow was  $4\frac{1}{2}$  to 5 hours.

A left cervical carotid exploration was then performed. The carotid bifurcation was free of clot or intimal tear. A second arteriotomy over an area of discoloration 4 cm above the bifurcation revealed a 0.5cm transverse intimal tear. There was no intraluminal clot, but blood clot beneath the intima was removed and the flap tacked down with three 6-0 Prolene sutures. Vigorous back-bleeding from the distal ICA was confirmed and the arteriotomy was closed.

The left intracavernous aneurysm was explored after radical resection of the anterior clinoid artery and sectioning of the falciform ligament of the optic nerve. A portion of aneurysm neck was visualized in the cli-

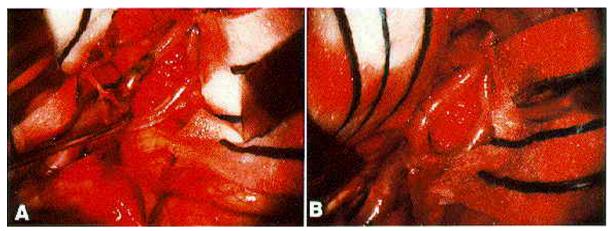


FIG. 3. Intraoperative photographs after splitting the sylvian fissure and exploring the middle cerebral artery. A: An area of discoloration was noted in the main trunk of the middle cerebral artery. After isolating the segment between temporary clips, an arteriotomy was performed and the embolus was delivered from the vessel lumen. B: The arteriotomy was then closed and the temporary clips were removed, restoring blood flow to the middle cerebral artery territory.

noidal space but the majority of the neck and the substance of the aneurysm lay beneath the proximal dural ring. The aneurysm neck was very wide and multiple attempts at clip placement led to ICA occlusion, confirmed by intraoperative angiography. The aneurysm clip was removed and the aneurysm was briefly trapped between temporary aneurysm clips. We then opened the aneurysm, performed a thrombectomy, and reconstituted the ICA with interrupted 7-0 Novofil sutures. A final intraoperative angiogram demonstrated good left ICA flow with exclusion of the intracavernous aneurysm and good filling of the left MCA.

Postoperative Course. Postoperatively, the patient was maintained on a course of subcutaneous heparin, 5000 U twice daily. Her speech was normal and her right hemiplegia had improved, leaving residual mild right arm weakness. She also had a partial left thirdnerve paresis as a result of her cavernous sinus exploration. Follow-up MR images revealed a small area of infarction in the left basal ganglia, presumably from the perforator embolus (Fig. 4A). Her distal MCA territory appeared normal. Follow-up angiography revealed good left ICA flow, exclusion of the left intracavernous aneurysm, and good filling of the left MCA (Fig. 4B). At examination 16 months after surgery, she has returned to homemaking, her speech is normal, and she has no demonstrable cranial nerve deficit or motor weakness on physical examination.

## Discussion

# Balloon Test Occlusion

The 15-minute clinical balloon test occlusion followed by an ICA-occluded Xe/CT CBF study is extremely useful in the preoperative assessment of the risk of temporary occlusion or acute sacrifice of the ICA.<sup>4,5</sup> It has an established role in the preoperative assessment of patients with tumors involving the skull base<sup>16-18</sup> or with vascular lesions below the circle of Willis.<sup>11,17</sup> The balloon test occlusion and Xe/CT CBF study replace the cross-compression angiogram, which is too often unreliable.<sup>6</sup> While the clinical balloon test occlusion has been successfully used by itself for endovascular procedures,<sup>2</sup> the ICA-occluded Xe/CT CBF study identifies an additional subset of patients with marginal CBF reserves who may be at risk for delayed ischemia with long-term ICA occlusion, especially if they experience periods of hypotension or decreased blood volume.

The clinical balloon test occlusion is generally a safe procedure. Of 300 balloon test occlusion procedures performed over the last 5 years at our institution, there were complications in 11 (3.7%).<sup>22</sup> Six (2%) were asymptomatic ICA dissections that did not require surgical intervention; one (0.3%) was an ICA dissection leading to ICA occlusion and distal MCA embolization; and four (1.3%) consisted of neurological deficits that persisted after balloon deflation. Of the latter four, one patient returned to baseline condition within 24 hours. one returned to baseline within 1 week, and two were left with minimal but persistent dysphasia. Since neurological deficits due to decreased blood flow all reverse within minutes after balloon deflation, these four patients most likely sustained small distal emboli from either the catheter tip or an unrecognized dissection, despite full systemic heparinization.

Care must be taken when positioning the catheter to avoid dissection, as occurred in this case. However, most of the dissections associated with balloon test occlusion have been related to balloon inflation once the balloon is in its final position. Our criterion for adequate occlusion of the ICA with balloon inflation has been to inflate to the point where the balloon just begins to deform from a spherical to cylindrical shape Emergency embolectomy after balloon test occlusion

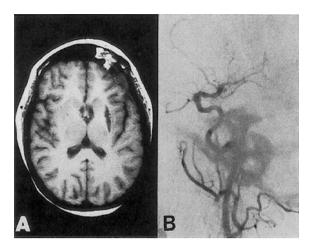


FIG. 4. A: Magnetic resonance image (TR 450 msec, TE 15 msec, 2 excitations), axial view, 11 months after surgery demonstrating a small left basal ganglia infarction, presumably resulting from the embolus in a middle cerebral artery (MCA) perforator which was noted at surgery. The rest of the left MCA distribution appears normal. B: Follow-up angiogram 8 days after surgery demonstrating good left internal carotid artery flow, exclusion of the left intracavernous aneurysm from the circulation, and good filling of the left MCA.

as visualized by fluoroscopy. We are currently investigating whether adequate occlusion might be achieved and confirmed prior to this point in an effort to reduce barotrauma to the intima. Possibilities include inflating just to the point of stasis of the test contrast injection and/or inflating just to the point of blood pressure drop as measured via the distal Swan-Ganz port.<sup>19</sup> An additional safety measure would be to transduce the pressure directly within the catheter balloon to prevent inadvertent overinflation. It is also important to position the catheter so that the balloon inflates in a straight segment of the cervical ICA. If the catheter tip lies within a bend or loop, the tip may impale or abrade the vessel wall upon balloon inflation, leading to intimal damage. Finally, the catheter may have entered the ICA too soon after delivery of the heparin bolus for the patient to have been fully systemically heparinized at the time of vessel injury. This may have contributed to the amount of blood clot that formed in our patient.

Any new neurological deficit that develops during balloon test occlusion and does not quickly clear after balloon deflation should lead one to suspect a distal embolus. Aggressive measures should be taken to identify and treat such emboli. Possibilities for treatment of patients with demonstrable emboli who do not improve following elevation of blood pressure and intravascular volume expansion include intravascular fibrinolytic therapy,<sup>3,13</sup> extracranial-to-intracranial bypass surgery,<sup>24</sup> or emergency embolectomy.<sup>12,14,23</sup>

## Embolectomy

The first report of emergency embolectomy for acute occlusion of the MCA was by Welch<sup>23</sup> in 1956. A review

in 1985 found 24 cases reported in the literature and presented 19 cases from the Mayo Clinic all operated on within 24 hours.<sup>12</sup> Since that time we have identified nine additional reported cases treated within 24 hours.<sup>8,15,21</sup> Embolectomy was chosen in this case because the carotid artery dissection/occlusion prevented catheterization for local fibrinolytic agent infusion and because the patient had a small ipsilateral superficial temporal artery. Since she clinically tolerated ICA occlusion so long as there was collateral flow from the contralateral side, we decided to re-establish MCA flow via contralateral collaterals by performing the embolectomy before proceeding with repair of the carotid artery dissection.

Several factors probably contributed to the successful outcome of this case. It is well known that the likelihood of infarction after ischemia is dependent on both the degree of reduced blood flow and the duration of the ischemia.<sup>7</sup> Experimental evidence suggests that embolectomy after acute MCA occlusion must be performed within 3 to 6 hours in order to have a fair likelihood of success.<sup>1,14,20</sup> The fact that our patient's ictus occurred in a monitored setting allowed us to proceed rapidly and achieve revascularization within 5 hours. Mever, et al.,<sup>12</sup> have shown that fibrin-platelet clots are technically easier to remove successfully than friable atheromatous emboli. Emboli that result from balloon test occlusion are usually fresh fibrin-platelet clots. Finally, optimizing our patient's medical management, including early hydration and volume expansion, maintaining a hypertension state, and placing her in etomidate coma in order to reduce the metabolic demands in the ischemic region, may have limited the amount of damage that was caused during the  $4\frac{1}{2}$  to 5 hours of ischemia or may have enlarged the window of time available to us for successful revascularization with a good outcome.

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