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This information is current as of July 22, 2025.

*AJNR Am J Neuroradiol* 1990, 11 (5) 878-880  
<http://www.ajnr.org/content/11/5/878.citation>

# Angioplasty of an Atherosclerotic Middle Cerebral Artery Associated with Improvement in Regional Cerebral Blood Flow

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Sundt et al. [1] first described angioplasty of a stenotic basilar artery via an operative approach to the vertebral artery. Since its introduction by Higashida et al. [2, 3] for treatment of intractable vasospasm following subarachnoid hemorrhage, the technique of percutaneous intracranial transluminal angioplasty has been applied by others [4] for that indication. However, there has been a reluctance to apply it more widely to atherosclerotic disease because of uncertainty as to the risk of distal embolization from plaque that might be released during the procedure. Also, the balloon catheters used in the treatment of vasospasm are produced from a silicone elastomer that is somewhat soft (DC .65 catheter, Interventional Therapeutics, San Francisco, CA), causing concern as to its efficacy against hard plaque. We present a case of dilatation of an atherosclerotic middle cerebral artery using the DC .65 catheter, which resulted in improved cerebral perfusion.

## Case Report

A 69-year-old right-handed woman was referred to our hospital for evaluation of a symptomatic left middle cerebral artery stenosis. She had a history of multiple previous strokes, including right parietal, right frontal, and left frontal lacunar infarctions. She was doing well clinically until approximately 3 weeks before admission, when she noted the onset of right leg weakness followed later by weakness of her right arm and face, as well as difficulty speaking. A diagnosis of a left middle cerebral artery cerebrovascular accident was made at her local hospital. An arteriogram showed her to have severe, irregular narrowing of the left middle cerebral artery proximal to its bifurcation and a lack of filling of the anterior branches in the sylvian triangle (Fig. 1). Although the patient improved over the following 2 weeks, she was having recurring neurologic events in spite of aspirin therapy. She was therefore referred for possible angioplasty.

Examination on admission revealed an alert, oriented, 69-year-old right-handed woman. Pertinent findings included a mild expressive dysphasia and left facial weakness. She had 4/5 strength diffusely and was weaker on the right than the left. Her gait was retropulsive and unsteady, but not ataxic.

Cardiologic evaluation revealed no significant arrhythmia or valvular disease. The patient was not a candidate for long-term anticoagulation owing to her recurrent history of vertiginous episodes and falling. Imaging of her regional cerebral blood flow (rCBF) using Tc-99m HMPAO and high-resolution single-photon emission CT (SPECT, PRISM, Ohio Imaging, Inc., Cleveland, OH) showed a significant perfusion defect in the distribution of her left middle cerebral artery (Fig. 2).

Transcranial Doppler studies were performed with a 2-mHz device (TC2-64, Carolina Medical Electronics, Inc., King, NC). Using a standard protocol [5], the left middle cerebral artery velocity was 36 cm/sec and the right middle cerebral artery velocity was 52 cm/sec. After much discussion with the patient regarding the alternatives of treatment, she elected cerebral angioplasty.

The patient's left middle cerebral artery was catheterized under systemic heparinization with a DC .65 balloon catheter. The balloon was inflated and deflated a number of times and digital angiography was performed while the deflated balloon was in place in the middle cerebral artery, revealing enlargement of that vessel over its baseline size. The balloon catheter was removed and formal, cut-film angiography was performed. The arteriogram obtained after catheter removal revealed transient, severe spasm of the left middle cerebral artery, which was observed to resolve without pharmacologic intervention over the ensuing 45 min (Fig. 3). The patient remained asymptomatic during the spasm. At the termination of the angioplasty procedure, Tc-99m HMPAO was administered IV. The patient was taken immediately to the SPECT suite for rCBF imaging. SPECT showed improvement in the flow to her left hemisphere relative to the preoperative scan, with slight residual defect (Fig. 2). The patient was maintained in the intensive care unit with the sheath in her femoral artery and anticoagulated with heparin for the ensuing 48 hr.

At 24 hr after angioplasty, repeat transcranial Doppler revealed that velocity in the right middle cerebral artery remained at 56 cm/sec, while velocity in the left had increased to 154 cm/sec. There was also a 38% decrease in pulsatility, suggesting hyperemia. Her right hemiparesis was improved and she reported an increase in word-finding ability.

At 48 hr postoperatively the heparin was discontinued and a repeat arteriogram (Fig. 4) revealed continued patency of the dilated left middle cerebral artery and filling of two anterior sylvian branches that had not filled on the preoperative study. One posterior sylvian branch

Received July 23, 1989; revision requested August 30, 1989; revision received September 26, 1989; accepted September 28, 1989.

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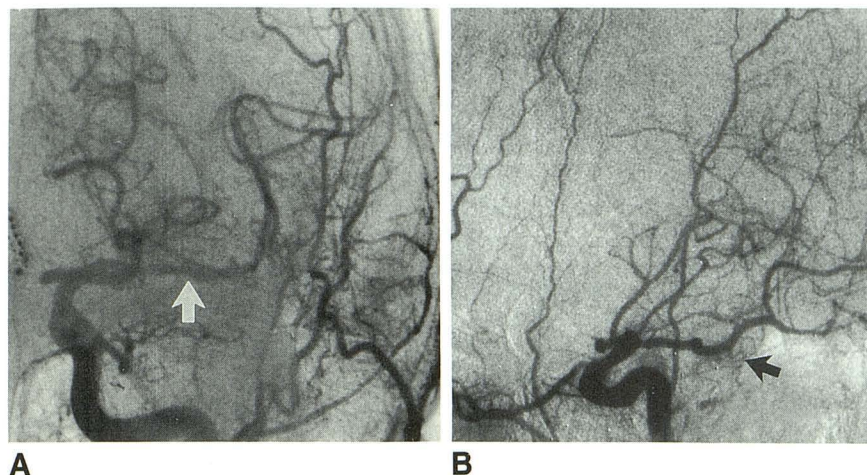


Fig. 1.—A and B, Arteriograms obtained before angioplasty. Anteroposterior (A) and lateral (B) views of left common carotid injection reveal nonfilling of the anterior cerebral artery, a widely patent posterior communicating artery filling the left posterior cerebral artery (arrow in B), and an irregular, diffusely stenotic proximal middle cerebral artery (arrow in A). Also note on lateral view the paucity of vessels in the sylvian triangle, particularly anteriorly.

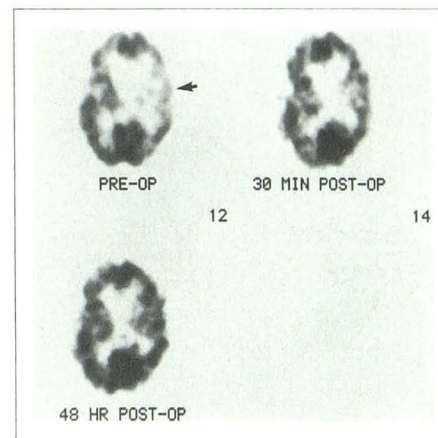


Fig. 2.—Selected images from SPECT study performed 7 days before angioplasty, immediately after angioplasty, and 2 days postoperatively. Note flow defect in left middle cerebral artery distribution (arrow), which is substantially improved immediately after angioplasty and is completely resolved 2 days later.

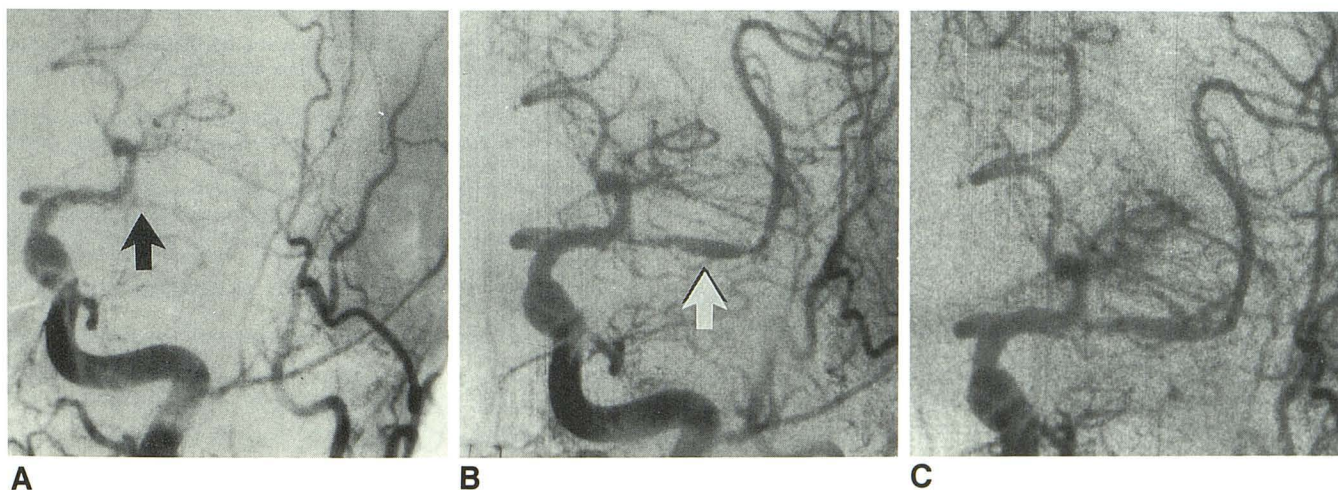


Fig. 3.—A–C, Anteroposterior arteriograms of left common carotid artery injection immediately (A), 15 min (B), and 30 min (C) after balloon withdrawal show left middle cerebral artery in severe spasm (arrow in A), initially producing near occlusion (slow, faint filling was seen on later films). The second study shows opening of the vessel, particularly distally (arrow), with segmentally more severe spasm proximally. The third study shows improvement in the proximal segment.

appeared less prominent than it had previously. Repeat rCBF imaging revealed symmetric flow to both middle cerebral artery distributions, with complete resolution of the flow defect.

Three days after discontinuation of heparinization, the patient developed restenosis, which did not respond to intracarotid nitroglycerin (200  $\mu$ g administered  $\times 2$ ). Attempted repeat angioplasty was unsuccessful. In spite of this, her rCBF studies remain improved and she has had no recurrence of symptoms 2 months after angioplasty.

## Discussion

A difficulty in evaluating angioplasty of the middle cerebral artery is understanding its effects on rCBF. With SPECT

imaging, this is the first demonstration that tissue flow can increase coincidentally with dilatation of the proximal artery. More experience will be necessary to understand whether this represents reactive hyperemia or a true increase in tissue perfusion. This case also demonstrates that dilatation may be possible without clinically significant distal embolization.

Although this technique may offer promise for selected patients, we do not know its complication rate or long-term viability. Only clinical follow-up over time will reveal its value. The occurrence of restenosis in this case may be related to premature discontinuation of heparin. The decision to heparinize for 48 hr was arbitrary and based on discussions with individuals in our institution with experience in coronary and



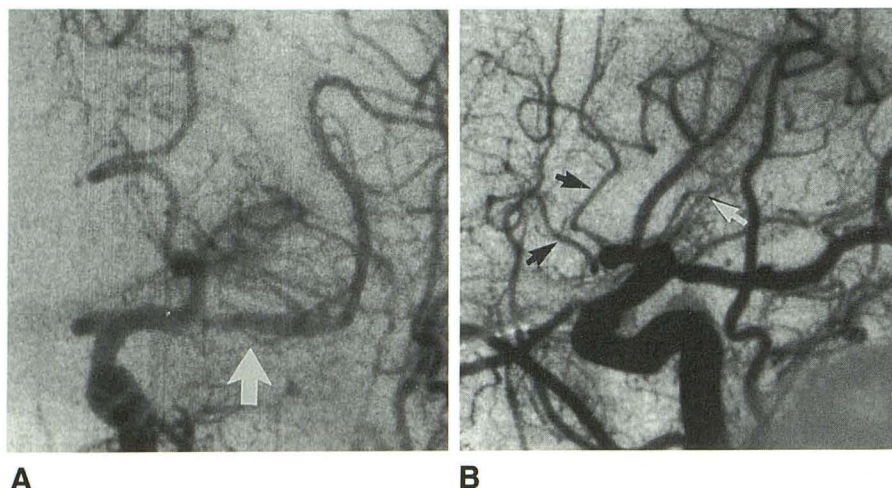


Fig. 4.—A and B, Arteriograms obtained 48 hr postoperatively. Anteroposterior (A) and lateral (B) views show continued wide patency of middle cerebral artery (arrow in A) although it remains somewhat irregular. Also note filling of two anterior sylvian branches (black arrows in B) on lateral view that did not fill preoperatively. There is one posterior sylvian branch (white arrow in B) that fills less well than it did preoperatively.

visceral angioplasty. Much more experience must be accumulated to define the frequency and pathophysiology of restenosis and its possible prevention and treatment. We report this case only to illustrate its technical possibility and rCBF improvement in middle cerebral artery atherosclerosis.

If the technique proves viable, a significant issue is patient selection. The procedure should be reserved for symptomatic patients in whom maximum medical management has failed. We believe rCBF imaging to be beneficial in this selection process.

Transcranial Doppler provides bedside assessment of the altered hemodynamics that can be repeated as often as desired. As such, it is a valuable adjunct. In our case, although the degree of rise in transcranial Doppler velocity and the increase in middle cerebral artery diameter suggested hyperemic flow, normal flow was seen on SPECT studies 24 hr later. Further experience will be necessary to correlate the observed hemodynamic changes.

#### ACKNOWLEDGMENT

We thank William Deaton for his assistance in the performance of this procedure.

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