Transcranial Doppler Sonography Monitoring of Local Intra-arterial Thrombolysis in Acute Occlusion of the Middle Cerebral Artery

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Background and Purpose: The aim of this study is to report on the use of transcranial Doppler ultrasonography as a noninvasive diagnostic monitoring tool during local intra-arterial thrombolysis in a patient with acute embolic occlusion of the middle cerebral artery.

Case Description: We describe a 41-year-old woman with mitral valve stenosis suffering from embolism of the middle cerebral artery. Local thrombolysis was performed with tissue plasminogen activator at a dosage of 0.05 mg/kg/hr. Progress of the thrombolysis was monitored by transcranial Doppler. The steps of recanalization could be ascertained by transcranial ultrasound showing a hemodynamically relevant residual stenosis after the first 120 minutes and complete patency of the M1 segment of the middle cerebral artery 180 minutes later. One branch of the middle cerebral artery still showed a filling defect.

Conclusions: Our report demonstrates the potential usefulness of transcranial Doppler monitoring during thrombolysis of a proximal occlusion of the middle cerebral artery for guiding the treatment by assessing the reperfusion of the obstructed artery. (Stroke 1992;23:284-287)

Thrombolytic therapy as therapeutic regimen in acute stroke is currently under investigation. The therapeutic efficacy of local or systemic thrombolysis remains unproven, and the benefits and hazards of this therapy are still under discussion. Recent studies have demonstrated favorable clinical outcomes after rapid clot lysis of acute thromboembolic occlusions of the basal cerebral arteries by the administration of various thrombolytic agents. At present, questions concerning initial dosage, duration, and route of administration (local or systemic) remain undecided. It is of particular interest to know the time of reperfusion of the vessel because timing helps to control the duration and dosage of the lytic regimen. So far, only serial angiography has been able to provide these data, but it also has the logistic and medical limitations of any invasive method. It is the aim of this study to report our experience with transcranial Doppler ultrasonography (TCD) as a noninvasive diagnostic monitoring tool during local intra-arterial lysis in a patient with acute embolic occlusion of the middle cerebral artery (MCA).

Case Report

A 41-year-old woman with a known severe mitral valve stenosis was admitted 30 minutes after acute onset of left-sided weakness and speech impairment. On admission, she was somnolent, and neurological examination revealed severe left hemiparesis and speech impairment. Cranial computed tomography was normal. Selective digital subtraction angiography showed an occlusion of the M1 segment of the right MCA (Figure 1). Immediately after angiography, an infusion catheter (Tracker Vascular Access System, Target Therapeutics, Inc., San Jose, Calif.) was advanced through a 5F angiography catheter, using a Taper 0.016-inch steerable guidewire, and placed directly in the right MCA. Intra-arterial thrombolytic therapy with single-chain human tissue plasminogen activator (tPA) (Actilyse; Boehringer Ingelheim, FRG) at 0.05 mg/kg body wt/hr (i.e., 4 mg/hour for the 80-kg patient) was started 90 minutes after the acute onset of symptoms.

At the start of thrombolysis, TCD studies were performed using a transcranial Doppler device (EME, Überlingen, FRG) with a 2-MHz pulsed probe. Frequency spectra of the right MCA and anterior cerebral artery (ACA) insonated by the transtemporal route demonstrated patency of the ACA/MCA junction. The ACA showed a high mean blood flow velocity (78 cm/sec) with a pulsatility index (PTI) of 0.84, whereas mean blood flow veloc-
ity in the MCA at a depth of 60 mm was reduced to 26 cm/sec with a PTI of 1.19. At the same depth, the left MCA showed a mean blood flow velocity of 66 cm/sec with a PTI of 0.88. Approximately 5 mm distally, at an insonation depth of 55 mm, only a faint pathological signal of the right MCA could be detected, which corresponded to the angiographically determined site of the MCA occlusion. The frequency spectra of this weak signal could be recorded only fragmentarily.

Transcranial Doppler examinations were repeated every 30 minutes during thrombolysis. Two hours after starting thrombolysis, TCD showed patency of the right MCA, with a marked flow acceleration reaching a mean blood flow velocity of 140 cm/sec and a PTI of 0.54 at an insonation depth of 55 mm (Figure 2). The increase in flow velocity was interpreted as a partial lysis of the embolus, with a hemodynamically relevant residual stenosis. Accordingly, blood flow velocity was markedly reduced in the poststenotic segment of the MCA (32 cm/sec, PTI 0.63) at a depth of 50 mm. The lytic therapy was continued an additional 180 minutes, taking the total tPA dosage to 20 mg. Transcranial Doppler control examinations at that time demonstrated normal frequency spectra of the entire right MCA, with a mean blood flow velocity of 70 cm/sec and a PTI of 0.91 at an insonation depth of 55 mm. At the corresponding depth, the left MCA showed a blood flow velocity of 72 cm/sec with a PTI of 0.83. Control angiography confirmed the TCD findings demonstrating patency of the right MCA with opacification of all its branches (Figure 3). However, one of the MCA branches still showed a significant filling defect, which possibly was caused by embolization of embolus fragments during thrombolysis.

Within 1 hour after recanalization, the patient made a nearly complete recovery. At discharge 2 weeks later, she was free of any neurological symptoms.

**Discussion**

Transcranial Doppler ultrasonography represents a promising monitoring device for continuous or intermittent evaluation of cerebral hemodynamics. The practical usefulness of TCD monitoring has been well documented in situations such as carotid endarterectomy, open-heart surgery, and aortic valvuloplasty.
We used TCD to monitor the local intra-arterial thrombolysis of an acute occlusion of the MCA. In our case, an embolic occlusion in the very proximal part of the MCA and a proper temporal insonation window provided optimal conditions for TCD monitoring. However, a baseline angiogram is mandatory in any case to establish the diagnosis and define the anatomy exactly before starting thrombolytic therapy and TCD studies.

Knowledge of the anatomy is a prerequisite for accurate interpretation of the TCD frequency spectra in this setting. Additionally, the application of TCD in agitated patients requires sound technical expertise. Limitations of TCD monitoring may arise in the absence of a suitable insonation window. Especially in some elderly patients, it may be barely possible to obtain signals through the temporal window. The inability of TCD to define side branch occlusions may limit TCD monitoring to proximal MCA occlusions. In more distally located occlusions, which may be quite common, the technique will approach its limitations. In our patient, a significant filling defect in one branch of the MCA at the end of thrombolytic therapy was not detected by TCD.

The principal conclusion of our observation is that TCD might be a valuable monitoring tool during thrombolysis of acute occlusions of the M1 segment of the MCA. By this method, the time at which recanalization is achieved can be ascertained and hemodynamically relevant residual stenoses disclosed. Evidence of a residual stenosis will modify the duration and dosage of the thrombolytic regimen. Transcranial Doppler monitoring could reduce the need for repeated angiography studies, which can be limited to an initial examination and a concluding one to document the final results. Hence, local intra-arterial thrombolysis can be performed in the intensive-care station. A protracted stay on the angiography table or repeated transportation to the x-ray department is avoided.

Graor and Risius\(^8\) reported on successful local intra-arterial thrombolysis of thrombosed arteries and grafts infusing tPA at a dosage of 0.05 and 0.1 mg/kg body wt/hr, respectively, over 4.7 hours in the mean. Recanalization occurred in 51 of the 55 patients (93%). There was no difference in the incidence of successful thrombus lysis between both dosage regimens. In accordance with these results, we used tPA at a dosage of 0.05 mg/kg/hr. In our patient, partial recanalization was achieved 120 minutes after starting thrombolysis. Infusion time required for complete patency of the M1 segment evaluated by TCD and confirmed by angiography was 5 hours, using a total dosage of 20 mg. The total time of ischemia, defined as the interval from the acute onset of symptoms to partial reperfusion, was 120 minutes.

At present, no study has been undertaken to determine the optimum dosage, rate, and duration of administration of thrombolytic agents. The risk-to-benefit ratio of thrombolytic treatment is still open to discussion. With respect to the hazard of intracerebral hemorrhage, many authors\(^9,10\) recommend that thrombolysis be performed within 5 hours after onset.
of symptoms. However, because it may take several hours before reperfusion is achieved, such advice largely disregards the impact that total time of ischemia is likely to exert on clinical outcome. Continuous or frequent monitoring of intracerebral blood flow velocity by TCD might provide not only missing data on optimum dosage and duration of thrombolytic treatments, but also a better evaluation of benefits and risks of such a regimen with respect to total time of ischemia.

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References

KEY WORDS • embolism • thrombolytic therapy • ultrasonics
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