

Short Communication

Cerebral Hemispheric and Contralateral Cerebellar Hypoperfusion during a Transient Ischemic Attack

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Summary: We studied a 79-year-old woman within 3 h of the onset of a motor aphasia and a right hemiparesis. Single photon emission computed tomography (SPECT) showed a 24% decrease in the perfusion of the left middle cerebral artery territory and a 16% reduction in the perfusion of the right cerebellum. A mild naming difficulty was the neurological deficit at the end of the SPECT ex-

amination, and complete recovery was achieved within 24 h. Repeated SPECT study 10 days later was normal. This is the first report of focal hemispheric and contralateral cerebellar hypoperfusion in transient cerebral ischemia. **Key Words:** Cerebral ischemia—Single photon emission computed tomography—Transient ischemic attack.

The definition of transient ischemic attack (TIA) is a focal neurological deficit that recovers rapidly (maximum duration 24 h) and without residual disability. The inferred pathogenesis is a regional reduction of cerebral blood supply. However, a direct demonstration of this reduction of regional cerebral blood flow (rCBF) during the ischemic attack has not yet been reported. Studies of rCBF in patients with previous TIAs have often demonstrated focal abnormalities of cerebral perfusion (Fieschi et al., 1968; Rees et al., 1970; Skinhoj et al., 1970; Lenzi et al., 1978; Baron et al., 1981; Vorstrup et al., 1983). Only one nontomographic study has been performed so far during the attack (Hartman, 1985).

We report a study of rCBF with single photon emission computerized tomography (SPECT) in a patient with TIA. The rCBF evaluation was performed during the acute transient phase, in presence of neurological symptoms, and it was repeated

10 days later in a follow-up study, with the patient completely normal.

CASE REPORT

A 79-year-old woman was visited about 1 h after the sudden onset of motor aphasia and right hemiparesis. The patient was alert and cooperative, with no problems of comprehension. Carotid auscultation was negative. A computed tomography (CT) scan was normal. A study of cerebral perfusion with SPECT and ^{99m}Tc -hexamethylpropylene-amine-oxime (^{99m}Tc -HM-PAO) (Leonard et al., 1986) was performed immediately after. At the end of the SPECT examination, 3 h after the onset of the neurological symptoms, the patient's only neurological deficit was a mild naming disturbance, which cleared completely over the following hours. Twenty-four hours from the onset of neurological symptoms, the patient's recovery was complete. Doppler sonography of the carotid arteries was normal. Ten days later, a ^{99m}Tc -HM-PAO tomogram and CT scan were repeated.

SPECT STUDY

Regional cerebral blood flow (rCBF) was assessed with SPECT and ^{99m}Tc -HM-PAO using a rotating gamma camera and a dedicated computer. On the 8 reconstructed tomographic axial slices, two pixels thick (1.2 cm), symmetrical regions of interest (ROIs), 4×4 pixels large (2.5×2.5 cm), were chosen on cerebral and cere-

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Abbreviations used: CCD, crossed cerebellar diaschisis; ROI, region of interest; SPECT, single photon emission computed tomography; ^{99m}Tc -HM-PAO, ^{99m}Tc -hexamethylpropylene-amine-oxime; TIC, transient ischemic attack.

bellar areas. The sum of the counts for each ROI in the left side was compared to the symmetrical, contralateral ROI in the right side. In our control group ($n = 17$), the standard deviation of the normalized mean of the left-to-right asymmetry indexes of rCBF were $\pm 7\%$ and $\pm 5\%$ at cerebral and cerebellar levels, respectively.

RESULTS

The first SPECT study showed a significant asymmetry of perfusion between the left and right middle cerebral artery territories, with the rCBF over the left side being decreased by 24% (Fig. 1A). An asymmetry of perfusion, with a reduction of 16%, was also detected over the right cerebellar hemisphere (Fig. 1C). That is, both focal decreases of perfusion were >3 times the range of asymmetry observed in our normal population.

The second SPECT study did not show any perfusion deficit or asymmetry either at the cerebral or at the cerebellar level (Fig. 1B,D).

The CT scans performed on the same days of the SPECT examinations were both normal.

DISCUSSION

The present study has been performed with a technique similar to our previous work on SPECT (Fazio, et al., 1984), utilizing the new radiopharmaceutical ^{99m}Tc -HM-PAO, as reported by Leonard et al. (1986).

In this SPECT study, a focal reduction of perfusion has been demonstrated that is consistent with the neurological deficits during a transient ischemic attack. No hypoperfusion was detected in the second SPECT examination, which was performed after full clinical recovery. At this time, a normal CT scan was also found, showing that the early, transient reduction of rCBF did not result in structural damage detectable by CT scan. In other words, the thresholds for tissue viability were not trespassed (Powers et al., 1985). Nevertheless, the initial depression of neurological function, which is logical to ascribe to the focal transient ischemia, was severe enough to cause remote effects, such as a crossed cerebellar diaschisis (CCD) as measured by rCBF. In fact, the occurrence of CCD during a TIA is quite noteworthy. CCD is frequently reported after supratentorial infarctions (Meneghetti et al., 1984), but its occurrence during or after "transient" neurological deficits is controversial (Pantano et al., 1985).

The absence of brain tissue destruction was also reflected in the absence of the reactive hyperemia that is frequently observed after stroke (Olsen, et al., 1981), even with SPECT (personal data, unpublished). As the patency of the carotid arteries was

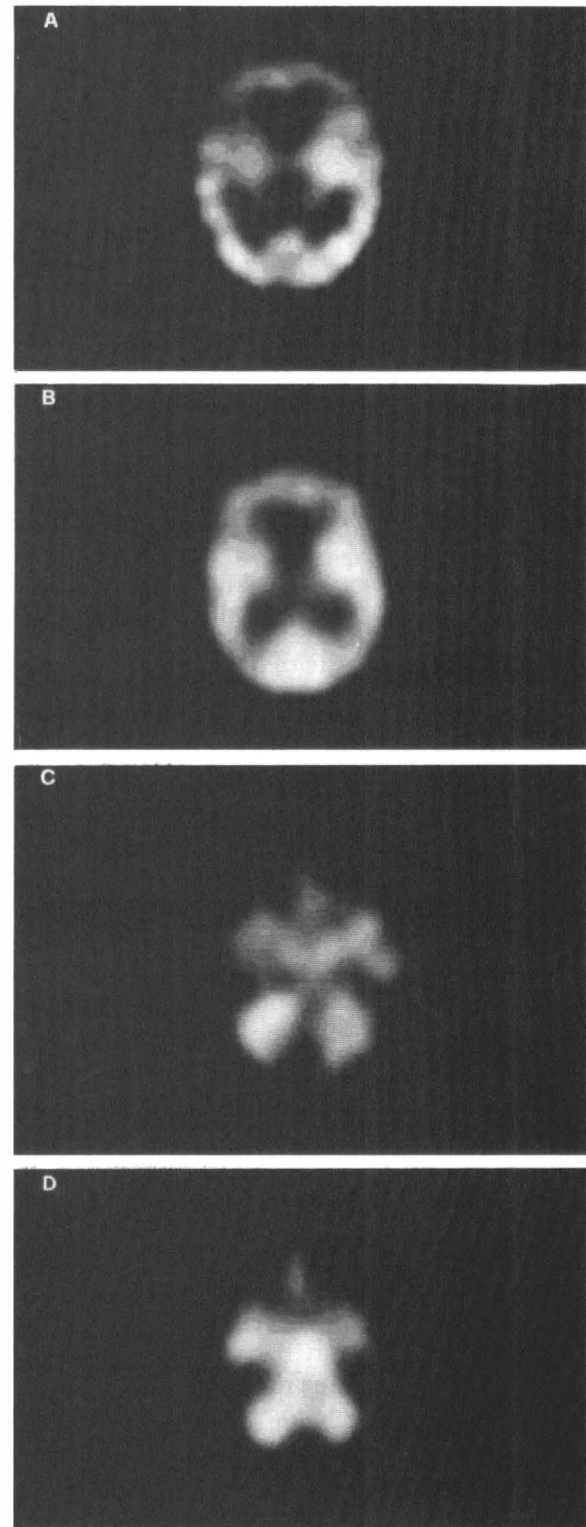


FIG. 1. (A, C) SPECT study during transient ischemic attack: evidence of left frontotemporal hypoperfusion (OM +5.1 cm) and crossed cerebellar diaschisis (OM +0.3 cm). (B, D) Comparable tomographic slices from the follow-up SPECT study:

demonstrated by Doppler sonography, in our patient, the pathogenesis of TIA was most likely related to an embolus originating in the heart, with an early dissolution leading to restoration of the arterial blood flow (Olsen, 1986). This report is a direct demonstration of the ischemic nature of TIAs.

Our findings also show that a temporary suppression of regional function is capable of producing secondary remote effects, such as CCD, which are referred to a deafferentation process. This functional consequence seems to recover with the recovery of the primary neurological deficits.

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REFERENCES

- Baron JC, Boussier MG, Rey A, Guillard A, Comar DD, Castaigne P (1981) Reversal of focal "misery-perfusion syndrome" by extra-intracranial arterial bypass in hemodynamic cerebral ischemia. *Stroke* 12:454-459
- Fazio F, Lenzi GL, Gerundini P, Collice M, Gilardi MC, Colombo R, Taddei G, Del Maschio A, Piacentini M, Kung HF, Blau M (1984) Tomographic assessment of regional cerebral perfusion using intravenous I-123-HIPDM and a rotating gamma-camera. *J Comp Assist Tomogr* 8:911-921
- Fieschi C, Agnoli A, Battistini N (1968) Derangement of regional cerebral blood flow and of its regulatory mechanism in acute cerebrovascular lesions. *Neurology* 18:1166-1179
- Hartman A (1985) Prolonged disturbances of regional cerebral blood flow in transient ischemic attack. *Stroke* 16:932-939
- Lenzi GL, Jones T, McKenzie CG, Moss S (1978) Non-invasive regional study of chronic cerebrovascular disorders using the oxygen-15 inhalation technique. *J Neurol Neurosurg Psychiatry* 41:11-17
- Leonard JP, Nowotnik DP, Neirinckx RD (1986) Technetium-99m-d, I-HM-PAO: a new radiopharmaceutical for imaging regional brain perfusion using SPECT: a comparison with iodine-123 HIPDM. *J Nucl Med* 27:1819-1823
- Meneghetti G, Vorstrup S, Mickey B, Lindewald H, Lassen NA (1984) Crossed cerebellar diaschisis in ischemic stroke: a study of regional cerebral blood flow by ¹³³Xe inhalation and single photon emission computerized tomography. *J Cereb Blood Flow Metabol* 4:235-240
- Olsen ST (1986) Regional cerebral blood flow after occlusion of the middle cerebral artery. *Acta Neurol Scand* 73:321-337
- Olsen ST, Larsen B, Skriver B, Hering M, Enevoldsen E, Lassen NA (1981) Focal cerebral hyperemia in acute stroke. *Stroke* 12:598-600
- Pantano P, Di Piero V, Triulzi F, Fazio F, Savi AR, Lenzi GL, Fieschi C (1985) Crossed cerebellar diaschisis in supratentorial cerebral ischemia: a study with I-123-HIPDM and SPECT. *J Cereb Blood Flow Metabol* 5:15-16
- Powers WJ, Grubb RL, Darrit D, Raichle ME (1985) Cerebral blood flow and cerebral metabolic rate of oxygen requirements for cerebral function and viability in humans. *J Cereb Blood Flow Metabol* 5:600-608
- Rees JE, Bull JWD, Du Boulay GH, Marshall J, Russel RWR, Simon L (1970) Regional cerebral blood flow in transient ischemic attacks. *Lancet* ii:1210-1213
- Skinhoj JE, Hoedt-Rasmussen K, Paulson OB, Lassen NA (1970) Regional cerebral blood flow and its autoregulation in patients with transient local cerebral ischemic attack. *Neurology* 20:485-493
- Vorstrup S, Hemmingsen R, Henriksen L, Lindewald H, Engel HC, Lassen NA (1983) Regional cerebral blood flow in patients with transient ischemic attacks studied by xenon ¹³³ inhalation and emission tomography. *Stroke* 14:903-910