Resting and Acetazolamide-Challenged Technetium-99m-ECD SPECT in Transient Global Amnesia

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Regional resting cerebral blood flow and vascular reserve in a patient with transient global amnesia (TGA) were evaluated during and after a TGA episode using ^{99m}Tc-ethyl cysteinate dimer (ECD). The patient had consecutive SPECT studies before and after acetazolamide (ACZ) administration with adjunctive radionuclide angiography using equal-volume-split ^{99m}Tc-ECD. SPECT study during TGA episode showed poor vasodilatory reactivity to ACZ in the left medial temporal region involving the hippocampus and resting hypoperfusion in the regions bilaterally. The resting hypoperfusion with reserved vasodilatory reactivity to ACZ also was seen in the bilateral thalami. Abnormal findings in these regions disappeared on the follow-up SPECT study 15 days after the onset. No previous SPECT evaluation of regional abnormalities of both hemodynamic reserve and resting perfusion during and after an episode of TGA has been reported.

Key Words: transient global amnesia; technetium-99m-ethyl cysteinate dimer; acetazolamide; cerebral blood flow; SPECT

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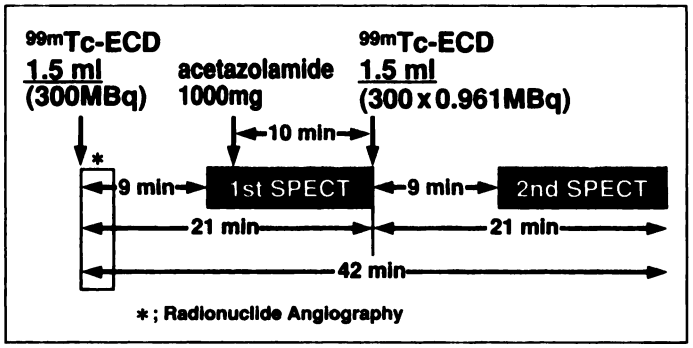

FIGURE 1. Study protocol. Radionuclide angiography was performed immediately after intravenous bolus injection of 1.5 ml (300 MBq) ^{99m}Tc-ECD, followed by baseline SPECT imaging. Acetazolamide was administered during the first SPECT scan, and immediately after completion of the first SPECT acquisition, another 1.5 ml (300 × 0.961 MBq) ^{99m}Tc-ECD was injected. The second SPECT acquisition was started 9 min later.

Transient global amnesia (TGA) is a well-known, reversible neurological disorder characterized by sudden onset of transient impairment of anterograde amnesia with variably graded retrograde amnesia (*1,2*). Although many studies have reported TGA (*3*), only a few reported cerebral perfusion studies using ^{99m}Tc-hexamethylpropylene amine oxime (HMPAO) (*4–8*) because of the brief duration of the episode.

Technetium-99m-ethyl cysteinate dimer (ECD) is superior to ^{99m}Tc-HMPAO after acetazolamide (ACZ) administration in sensitivity of lesion detection and lesion-to-normal contrast (*9*), probably due to lower backdiffusion from the brain to the blood (*10*) and its excellent radiochemical stability (*11*). We have recently advocated a readily accessible double-injection 1-day protocol to measure resting and ACZ-activated regional cerebral blood flow (rCBF) using ^{99m}Tc-ECD without invasive arterial blood sampling (*12*). In this study, we applied this method to the follow-up study of a patient with TGA.

MATERIALS AND METHODS

Because the protocol was described in our previous study (*12*), the method used is briefly summarized in Figure 1. Intravenous radionuclide angiography was performed by bolus injection of 1.5 ml reconstituted ^{99m}Tc-ECD (600 MBq/3 ml). The passage of the tracer from the aortic arch to the brain was monitored on a 128 × 128 matrix (magnification, ×1.0) for 120 sec at 1-sec intervals using a rectangular gamma camera of a two-head SPECT system (Prism 2000 XP; Picker International, Inc., Bedford Heights, OH) equipped with high-resolution, parallel-hole collimators. Regions of interest (ROIs) were placed manually over the aortic arch and bilateral cerebral hemispheres. Time-activity curves of these two ROIs were plotted, and the brain perfusion index (BPI) was determined as described previously (*13*). BPI was converted to mean CBF (mCBF) value (*14*).

Seven minutes after completion of radionuclide angiography, cerebral SPECT imaging was performed using the Prism 2000 XP with high-resolution fanbeam collimators. The projection data were obtained in a 64 × 64 matrix (magnification, ×1.33) for 30 angles in a 180° arc for each camera head at 20 sec per angle. The time required for SPECT data acquisition was 12 min. One gram of ACZ was administered intravenously 10 min before completion of the first SPECT acquisition. Without any change in the patient's head position, another 1.5 ml ^{99m}Tc-ECD was administered immediately after the first data acquisition. The second SPECT acquisition was performed 9 min later with acquisition conditions identical to those of the first scan. SPECT images were reconstructed by filtered backprojection using a ramp filter followed by postprocessing with a Butterworth filter (order, 8; cutoff 0.28). Attenuation correction was performed using Chang's method (attenuation coefficient, μ = 0.09). To obtain ACZ-activated (post-ACZ) projection data, the first projection data were subtracted from the second SPECT data multiplied by 1.041, which was the correction coefficient for the decay of ^{99m}Tc between the first and second SPECT studies. Then baseline and post-ACZ projection data were reformatted to construct transaxial images parallel to the longitudinal axis of parahippocampal gyrus. The pixel size and slice thickness were 4.5 mm^2 and 4.5 mm, respectively.

For the calculation of post-ACZ mCBF, a transverse slice showing the basal ganglia (slice thickness = 9.0 mm) was

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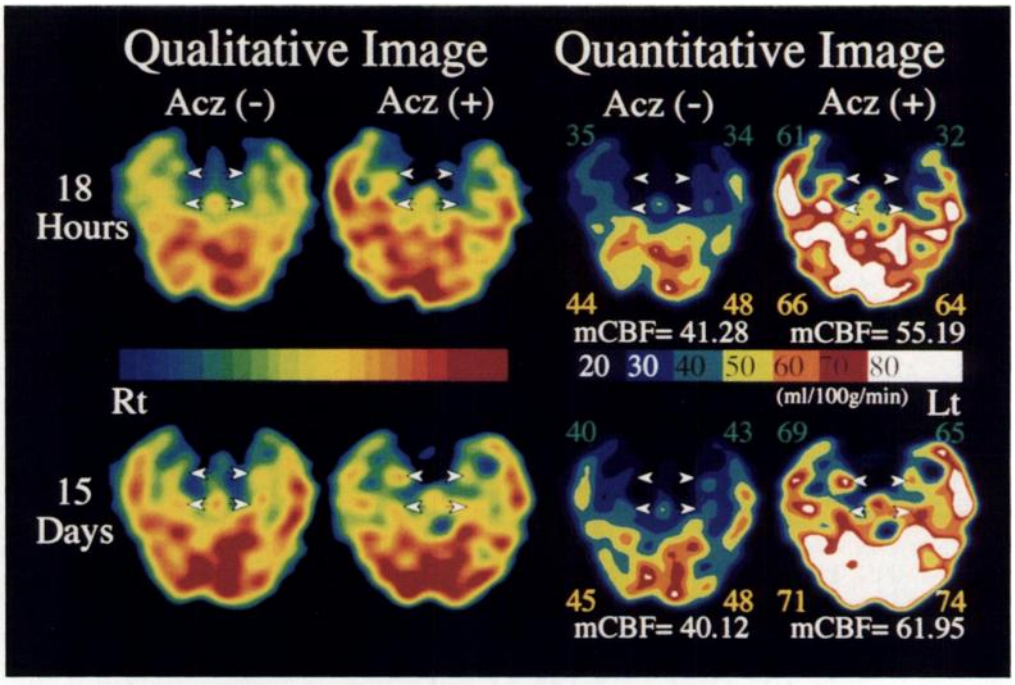

FIGURE 2. Qualitative (left) and paired quantitative (right) SPECT images obtained on June 12 (top) and June 26 (bottom) at the level of the parahippocampal gyrus. To calculate regional cerebral blood flow (rCBF) values of the parahippocampal gyrus (arrows), oval-shaped regions of interest (ROIs) (18 pixels) were manually drawn on each image, but these ROIs are not shown on the images. The green and yellow numerals are the rCBF values of the parahippocampal gyrus and hemispheric mean cerebral blood flow (mCBF) values of each slice, respectively. The white numerals are the total cerebral mCBF values in the respective conditions. The first SPECT examination (top) revealed resting hypoperfusion in the bilateral medial temporal regions involving the hippocampus (ACZ (−), arrows), and limited vasodilatory reactivity to acetazolamide was seen solely in the left medial temporal region (ACZ (+), arrows). The second SPECT study (bottom) showed resolution of the abnormalities (arrows).

produced from the summation of axial SPECT images as the reference slice. Baseline and post-ACZ mean SPECT counts were calculated from ROIs, which were placed manually over all structures composed of gray matter, white matter and ventricle on the reference slice. Post-ACZ mCBF was calculated from baseline mCBF and these SPECT counts using the Lassen's linearization correction algorithm ($\alpha = 2.59$) (*11,15*).

Baseline and post-ACZ ^{99m}Tc-ECD transaxial SPECT images were converted to baseline and post-ACZ quantitative rCBF images using baseline mCBF and post-ACZ mCBF, respectively, by the application of Lassen's linearization correction algorithm ($\alpha = 2.59$) (*14*). Respective rCBF values were calculated from the ROIs positioned on these quantitative slices.

CASE REPORT

A 60-yr-old right-handed man was brought to our hospital around 7 p.m. on June 11, 1997, because of abrupt onset of memory loss. About 4 hr before admission, he started repeating questions about where he was and why he was there. A brain CT scan and electroencephalogram on admission revealed no abnormalities. Verbal expression, comprehension and repetition of sentences were preserved, and neurological examinations were normal. At 9 p.m., the patient was still clearly amnesic, with virtually no retention of new information and no memory of what happened during the past 7 days. By 8 a.m. on June 12, retrograde amnesia was reduced to about 6 hr and the patient was beginning to retain new information. The first SPECT examination was conducted at 9 a.m. on June 12 (18 hr after the onset of amnesia), and the second was on June 26, (15 days after onset).

The first SPECT examination revealed resting hypoperfusion in the bilateral medial temporal regions involving the hippocampus (Fig. 2). Moreover, vasodilatory reactivity to ACZ was limited solely to the left medial temporal region. Resting hypoperfusion in

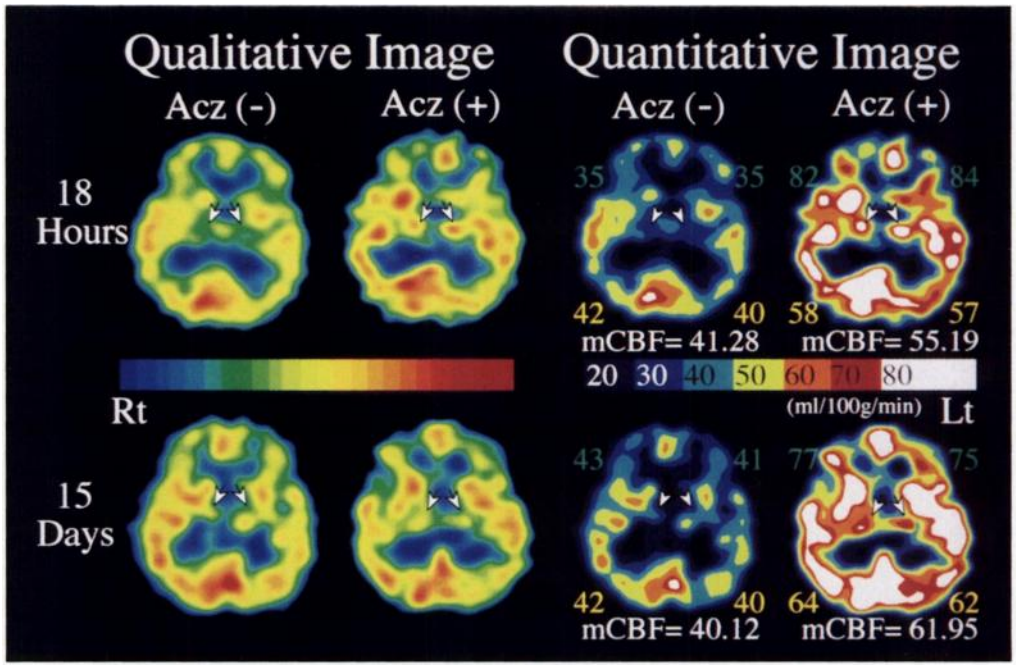

FIGURE 3. Qualitative (left) and paired quantitative (right) SPECT images obtained on June 12 (top) and June 26 (bottom) at the level of the thalamus. To calculate regional cerebral blood flow (rCBF) values of the thalamus (arrows), oval-shaped regions of interest (ROIs) (5 pixels) were drawn manually on each image, but these ROIs are not shown on the images. The green and yellow numerals are the rCBF values of the thalamus and hemispheric mean cerebral blood flow (mCBF) values of each slice, respectively. The white numerals are the total cerebral mCBF values in the respective conditions. The first SPECT examination (top) revealed resting hypoperfusion in the bilateral thalami (ACZ (−), arrows), but vasodilatory potential in the regions were preserved (ACZ (+), arrows). The second SPECT study (bottom) showed resolution of resting hypoperfusion (ACZ (−), arrows).

the bilateral thalami (Fig. 3) also was revealed, but vasodilatory potential was preserved. The above-mentioned abnormalities resolved on the follow-up study (Figs. 2 and 3).

DISCUSSION

Because the duration of TGA episodes is short, the opportunity to test patients during such episodes is rare. Accordingly, SPECT imaging analyzing rCBF during TGA episodes using ^{99m}Tc-HMPAO has been reported in only a few cases. Stillhard et al. (*4*) and Tanabe et al. (*6*) reported cases of TGA with hypoperfusion in the bilateral medial temporal lobes, including the hippocampal formation; Goldenberg et al. (*5*) presented a case of hypoperfusion in bilateral thalami; and Lin et al. (*7*) described a right-handed patient with multiple perfusion defects in both occipital lobes, medial left temporal lobe and the left thalamus. The SPECT studies in these reports were performed 6–7 hr after the onset of the TGA episode. Meanwhile, Hodges (*8*) described a right-handed patient with TGA whose focal hypoperfusion was confined to the left medial temporal lobe, as seen on the SPECT study obtained 24 hr post-TGA, and discussed the probability of identifying bilateral abnormalities if the SPECT study had been performed earlier.

In the present study using ^{99m}Tc-ECD, resting perfusion abnormalities such as hypoperfusion of bilateral medial temporal regions and thalami that coincided with the results from ^{99m}Tc-HMPAO were more easily appreciated using the quantitative SPECT images. Moreover, ACZ-activated quantitative SPECT images clearly showed severe focal impairment of vascular reserve and recovery in the left medial temporal region during and after the TGA episode, respectively. Because vasodilation leading to increased cerebral blood volume is the first response to diminished perfusion pressure in an autoregulation mechanism (*16,17*) and regions with limited vasodilatory potential show less blood flow increase in a vasodilatory challenge test, the focal vascular impairment in this patient suggests that injury to the medial temporal region of the dominant hemisphere may be most pathognomonic in a patient with TGA.

CONCLUSION

Although one of the major causes of TGA is supposed to be a hemodynamic vertebrobasilar transient ischemic attack that is not of atherothromboembolic origin, producing a transient dysfunction of inferomedial parts of the temporal lobes containing the hippocampal area (*2*), cause and location of neuronal dysfunction in TGA have not yet been clarified. Our simplified method that sensitively detects localized impaired cerebrovascular reserve should help elucidate these processes.

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