Case Report

Combined Treatment of Methylprednisolone Pulse and Memantine Hydrochloride Prompts Recovery from Neurological Dysfunction and Cerebral Hypoperfusion in Carbon Monoxide Poisoning: A Case Report

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A 49-year-old healthy man developed sudden unconsciousness under inadequate ventilation. Blood gas analysis showed carboxyhemoglobin of 7.3%. After normobaric oxygen therapy, he recovered completely 7 days later. At 3 weeks after carbon monoxide (CO) exposures, memory and gait disturbances appeared. Neurological examination revealed Mini-Mental State Examination (MMSE) score of 5 of 30 points, leg hyper-reflexia with Babinski signs, and Parkinsonism. Brain fluid-attenuated inversion recovery imaging disclosed symmetric hypointense lesions in the thalamus and the globus pallidus, and hyperintense lesions in the cerebral white matter. Brain single-photon emission tomography (SPECT) scanning with ^{99m}Technesium-ethyl cysteinate dimer displayed marked hypoperfusion in the cerebellum, the thalamus, the basal ganglia, and the entire cerebral cortex. He was diagnosed as CO poisoning and treated with hyperbaric oxygen therapy. The neurological deficits were not ameliorated. At 9 weeks after neurological onset, methylprednisolone (1000 mg/day, intravenous, 3 days) and memantine hydrochloride (20 mg/day, per os) were administered. Three days later, MMSE score was increased from 3 to 20 points. Neurological examination was normal 3 weeks later. Brain SPECT exhibited 20% increase of regional cerebral blood flows in the cerebellum, the thalamus, the basal ganglia, and the entire cerebral cortex. These clinicoradiological changes supported that the treatment with steroid pulse and memantine hydrochloride could prompt recovery from neurological dysfunction and cerebral hypoperfusion. Further clinical trials are warranted whether such combined therapy can attenuate neurological deficits and cerebral hypoperfusion in patients with CO poisoning. **Key Words:** Carbon monoxide poisoning—dementia—Parkinsonism—cerebral blood flow—steroid pulse therapy—memantine hydrochloride.

Carbon monoxide (CO) poisoning is a common fatal event. CO may damage multiple organ systems, particularly the central nervous system. The diagnosis of acute CO poisoning is based on the clinical history and blood carboxyhemoglobin levels. The toxic symptoms are nonspecific and variable.[1] Severe CO exposures cause

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confusion, loss of consciousness, or death. Mild CO exposures induce headache, myalgia, dizziness, and neuropsychological impairment.[2,3] Neurological and neuropsychological sequelae are known to occur after CO poisoning.[1,4,5] Previous studies of brain single-photon emission tomography (SPECT) described cerebral hypoperfusion in patients with CO poisoning.[6-9] However, there were no reports about serial changes of cerebral blood flows (CBFs) using the quantitative comparison of SPECT. We report a patient with CO poisoning who had neuropsychological dysfunction, Parkinsonism, and good recovery from these neurological deficits and reduced CBFs after combined treatment with steroid and memantine hydrochloride.

Case Report

A 49-year-old healthy man developed unconsciousness at the poorly ventilated room next to the kitchen. He was admitted to emergency department of our hospital. Blood gas analysis exhibited pH 7.495, $paCO_2$ 27.7 Torr, paO_2 134 Torr, and carboxyhemoglobin of 7.3% under normobaric oxygen therapy (face mask, 5 L/min). Seven days later, physical and neurological examinations were normal. At 3 weeks after CO exposures, memory and gait disturbances appeared. He visited the neurology department. His consciousness levels were normal. Mental state was apathetic. Mini-Mental State Examination (MMSE) score was 5 of 30 points. Muscle stretch reflexes were increased in the lower extremities with Babinski signs. There were masked face, bradykinesia, Parkinsonian gait, and abnormal righting reflexes.

Routine blood laboratory studies were not remarkable. Brain magnetic resonance imaging (MRI) and ^{99m}Technesium-ethyl cysteinate dimmer (^{99m}Tc-ECD) SPECT were performed at 2 weeks after neurological onset. Fluid-attenuated inversion recovery imaging disclosed symmetric hypointense lesions in the thalamus and the globus pallidus. Hyperintense lesions were found in the cerebral white matter. Brain magnetic resonance angiography was normal. Brain ^{99m}Tc-ECD SPECT revealed moderate or severe degree of hypoperfusion in the cerebellum, the basal ganglia, and the entire cerebral cortex (Fig 1). These neurological and radiological findings suggested the diagnosis of CO poisoning. He was treated with hyperbaric oxygen (4 weeks) at 4 weeks after neurological onset. Hyperbaric oxygen therapy did not respond to his neurological deficits, including dementia (MMSE score of 3 points) and Parkinsonism. At 7 weeks after neurological onset, second brain ^{99m}Tc-ECD SPECT displayed slight or mild increase of regional CBFs in the cerebellum, the frontal, the parietal, and the occipital cortex (Fig 2). Methylprednisolone pulse therapy (1000 mg/day, intravenous, 3 days) was performed at 9 weeks after neurological onset. Three days later, MMSE score was

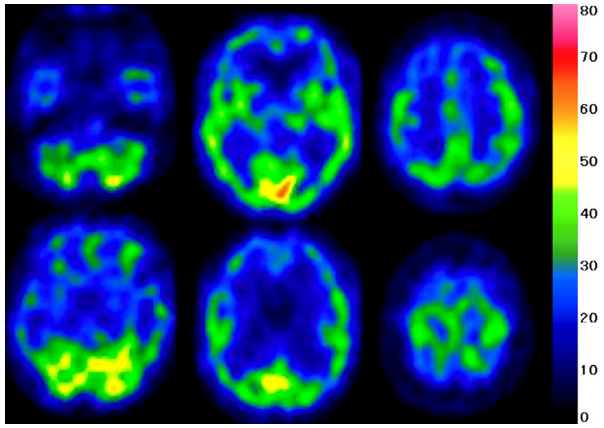

Figure 1. *Brain ^{99m}Tc-ECD SPECT at 2 weeks after neurological onset. Moderate or marked reduction of regional CBFs was found in the cerebellum, the basal ganglia, and the entire cerebral cortex. Abbreviations: CBF, cerebral blood flow; ^{99m}Technesium-ethyl cysteinate dimmer; SPECT, single-photon emission tomography. (Color version of figure is available online.)*

increased to 20 points. Afterward, memantine hydrochloride (20 mg/day, per os) was administered. The study of this medication was approved by the ethical committee of Toho University Omori Medical Center. MMSE score was 30 points at 12 weeks after neurological onset. Remaining neurological examination was also normal, including apathy and Parkinsonism. Follow-up brain MRI showed no changes of abnormal signal intense lesions in the cerebral white matter, the thalamus, and the globus pallidus. Brain SPECT exhibited partial restoration of regional CBFs in the frontal, the temporal, and the parietal cortex (Fig 3). Brain SPECT data were analyzed using the Patlak plot quantitative method.[10] On subtraction imaging between the first and the final scan, regional CBFs were increased at 20% (6-14 mL/100 g/min) in the cerebellum, the thalamus, the basal ganglia, and the cerebral cortex, particularly the frontal cortex (Fig 4). These clinicoradiological changes supported that steroid pulse therapy and subsequent

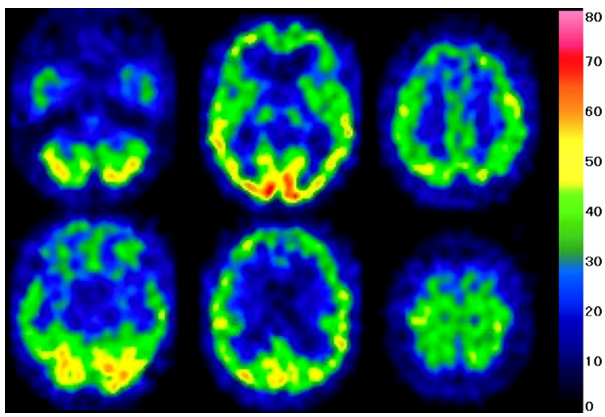

Figure 2. *Brain ^{99m}Tc-ECD SPECT at 7 weeks after neurological onset. Regional CBFs were increased mildly in the cerebellum, the frontal, the parietal, and the occipital cortex compared with the initial scan. Abbreviations: CBF, cerebral blood flow ^{99m}Technesium-ethyl cysteinate dimmer; SPECT, single-photon emission tomography. (Color version of figure is available online.)*