pISSN 1738-6586 / eISSN 2005-5013 / J Clin Neurol 2024;20(4):453-455 / https://doi.org/10.3988/jcn.2023.0497

Structural Changes in Brain MRI Versus Functional Alterations in Fluorodeoxyglucose Positron-Emission Tomography Following Carbon Monoxide Intoxication

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Dear Editor,

Brain injury in patients exposed to carbon monoxide (CO) is known to primarily result from hypoxia.[1] It is also known that anterograde amnesia results from bilateral damage to the hippocampus, which is a crucial component of the circuits related to memory formation.[2] Here we present a case report of brain magnetic resonance imaging (MRI) findings for the bilateral hippocampus and globus pallidus after CO intoxication, which reveals discrepancies between the structural changes in brain MRI and the functional changes in fluorodeoxyglucose positron-emission tomography (FDG-PET).

A 50-year-old female visited the emergency room due to decreased consciousness after 4 hours of exposure to CO during a suicide attempt. Upon arrival she was stuporous and intubated due to desaturation. She had no past medical history. She was a social drinker but had never smoked. A neurological examination revealed that her pupil diameter was 3 mm bilaterally with prompt responses. Her vital signs included a blood pressure of 118/64 mm Hg, body temperature of 37.2°C, heart rate of 82 beats/min, and respiration rate of 20 breaths/min. Laboratory tests showed COHb at 41.1%, aspartate aminotransferase at 56 U/L, alanine transaminase at 50 U/L, white blood cells at 252,100/mm^3, lactate dehydrogenase at 303 IU/L, and ammonia elevation at 125 μg/dL. Other routine laboratory findings were normal.

On day 7 of admission, she was extubated after regaining consciousness, but she still showed severe retrograde and anterograde amnesia. The patient was able to correctly report personal information such as her own name, resident registration number, highest level of education, marital status, and whether she had children. However, she was unable to recall recent details such as her current address, current occupation, reasons for the hospitalization, or interactions with her family or physician during the hospitalization. The patient did not show rigidity, dystonia, or bradykinesia.

Radiological findings showed diffusion restriction throughout the bilateral globus pallidus and hippocampus. Fluid-attenuated inversion recovery images indicated high signal intensities in the corresponding areas. FDG-PET revealed diffuse decreases in metabolic activity. Her electroencephalography findings were normal (Fig. 1).

The score in the Mini-Mental Status Examination (MMSE) on the 14th day of illness was 21 out of 30, with scores of 3, 3, 3, 1, and 1 for time orientation, registration, recall, calculation and attention, and visuospatial abilities, respectively. In a detailed neuropsychological assessment, she showed poor performance in the Korean version of the Boston Naming Test (<0.01 percentile), Rey Complex-Figure Test (RCFT) copy (0.02 percentile), Seoul Verbal Learning Test delayed recall (0.03 percentile), RCFT delayed recall (0.2 percentile), Digit Symbol Coding (2.8 percentile), and Controlled Oral Word Association Test (0.8 percentile). However, the patient showed normal abilities in the Digit-Span Test forward and the

Received December 6, 2023
Revised February 8, 2024
Accepted February 23, 2024

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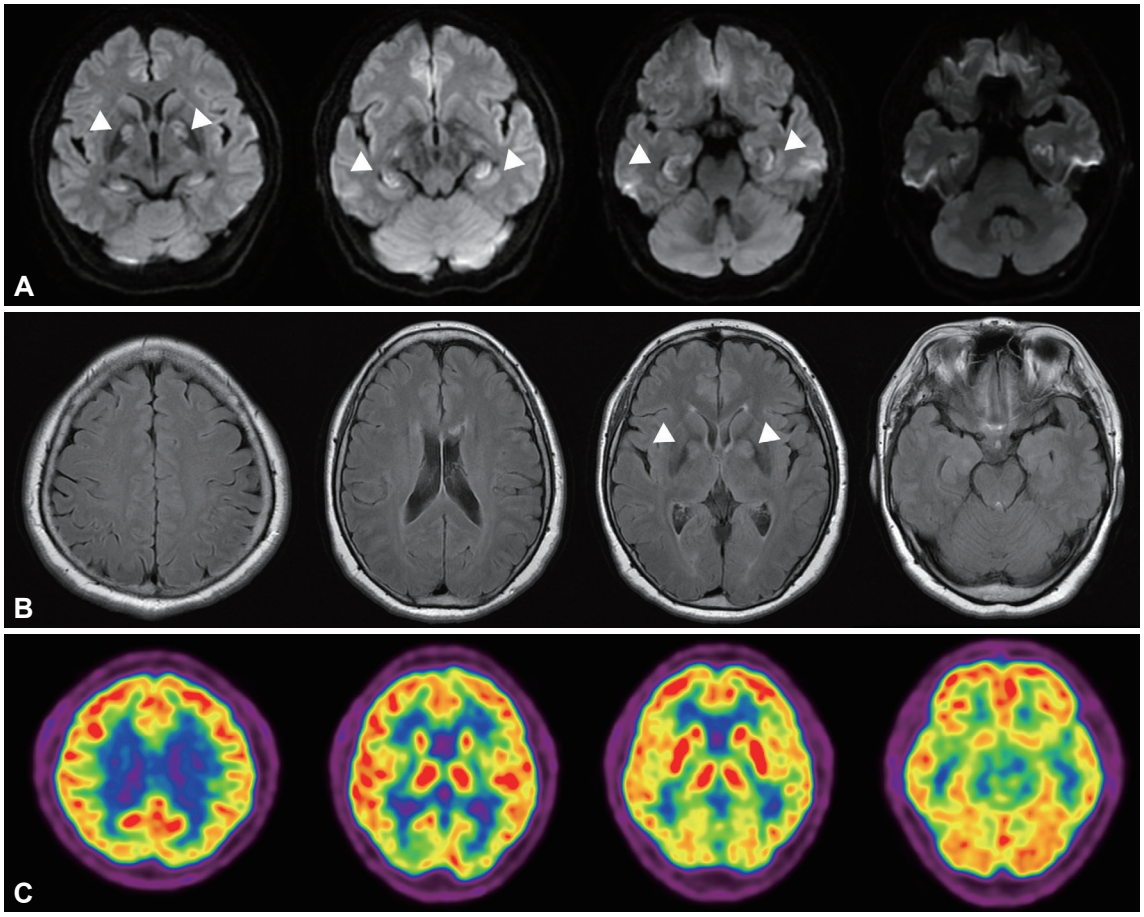

Fig. 1. Radiological findings of the patient. A: Axial diffusion-weighted imaging showed diffusion restriction (arrowheads) bilaterally in the globus pallidus and hippocampus. B: Axial FLAIR imaging showed high signal intensities (arrowheads) bilaterally in the globus pallidus and hippocampus. C: FDG-PET showed diffuse cerebral decreases and slight reductions in basal ganglia glucose uptake. FDG-PET, fluorodeoxyglucose positron-emission tomography; FLAIR, fluid-attenuated inversion recovery.

Korean version of the Trail-Making Test (TMT).

We also experimentally measured procedural memory using part A of the TMT.[3,4] This task requires individuals to use a pencil to connect a series of numbers scattered about a page in order (1–25) as rapidly as possible. As expected, over five trials her time decreased from 67 to 30 sec, indicating that she learned the locations of these numbers. However, she took 53 sec to complete the task 30 min later, suggesting that she had not fully consolidated and retained this new procedural learning ability (Supplementary Fig. 1 in the online-only Data Supplement).

Hypoglycemia, seizures, and infectious encephalitis that might involve the bilateral hippocampus were excluded. Drug abuse or intoxication was also excluded based on her medical history and blood tests.[3,5] The patient was diagnosed as cognitive impairment associated with bilateral hippocampal lesions due to CO intoxication. She received hyperbaric oxygen therapy for 8 days and was discharged on the 15th day of the illness.

The patient's memory had partially recovered 2 months later, with the follow-up MMSE score having improved from 21 to 25 (Supplementary Fig. 2 in the online-only Data Supplement). The patient was now able to go out walking alone and engage in conversations about events that had occurred within the previous few days.

The patient showed mainly anterograde and retrograde amnesia as well as reduced visuospatial and frontal functions in detailed neuropsychological tests, with no motor symptoms. These symptoms were more consistent with the diffuse cerebral decrease and slight reduction in basal ganglia glucose uptake observed in FDG-PET than with the MRI findings, which showed diffusion restriction in the globus pallidus and hippocampus. This suggests that the neurological symptoms were correlated with FDG-PET findings but not with those of MRI. This differs from previous reports of FDG-PET imaging showing hypometabolism in regions such as the prefrontal cortex, basal ganglia, and hippocampus, alongside decreased glucose metabolism in areas similar to where lesions

were evident in MRI.[6] The present case was noteworthy in suggesting that FDG-PET findings are more consistent than MRI findings with neurological manifestations in CO-induced encephalopathy.

Supplementary Materials

The online-only Data Supplement is available with this article at https://doi.org/10.3988/jcn.2023.0497.

Ethics Statement

This study was approved by the Institutional Review Board of Myongji Hospital (2024-02-018). The requirement for participant's consent was waived by the Instituitional Reviwe Board of Myongji Hospital since we used retrospective de-idendified data.

Availability of Data and Material

All data generated or analyzed during the study are included in this published article.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Funding Statement

This study was supported by a faculty grant from the Myongji Hospital (2205-09-01) and a fund from the Korea Centers for Disease Control and Prevention (2023-ER1003-00, 2023-ER1003-01).

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