Positron emission tomography in systemic lupus erythematosus: relation of cerebral vasculitis to PET findings.

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AJNR Am J Neuroradiol 1983, 4 (3) 541-543
http://www.ajnr.org/content/4/3/541

Positron Emission Tomography in Systemic Lupus Erythematosus: Relation of Cerebral Vasculitis to PET Findings

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A 12-year-old Japanese girl with systemic lupus erythematosus is described. Positron emission tomography (PET) showed low attenuation in the right frontotemporal area at relapse, which disappeared at remission. Findings on electroencephalography coincided with those on PET. On x-ray CT there were no specific findings. The PET findings were thought to be due to cerebral vasculitis.

It is well known that neuropsychiatric symptoms are frequently observed in patients with collagenous disease, especially systemic lupus erythematosus (SLE). These symptoms are thought to be due usually to systemic and/or cerebral vasculitis. To strengthen the diagnosis of cerebral vasculitis various techniques are utilized, but these techniques are not sufficient to confirm the diagnosis. We applied positron emission tomography (PET) to a patient with SLE and obtained useful information.

Materials and Methods

PET was performed with a Headtome II (Shimadzu, Japan), designed by Kanno et al. [1]. It produces a hybrid emission tomograph, combining a single-photon emission tomograph and a positron-emission tomograph in one system. It has three detector rings of 64 NaI crystals each, the axial length of which is 30 mm (100 mm total for three rings, including the 5 mm lead shields between the rings [1, 2]). The system sensitivity for positron is 27.5 kcps/μCi/ml for intraring coincidence and 36.5 kcps for interring coincidence. Spatial resolution is 10 mm full width at half maximum at the center of the fields of view. We used ^{11}C-CO_2 and ^{11}C-glucose for circulatory and metabolic tracers in this study. For the ^{11}C-CO_2 inhalation studies, doses were usually 10 mCi and scanning time for three slices was about 100 sec. For ^{11}C-glucose ingestion studies, doses were usually 25 mCi and scanning time for three slices was about 500 sec. Reconstruction time was about 40 sec per slice, and smoothing at reconstruction was performed twice.

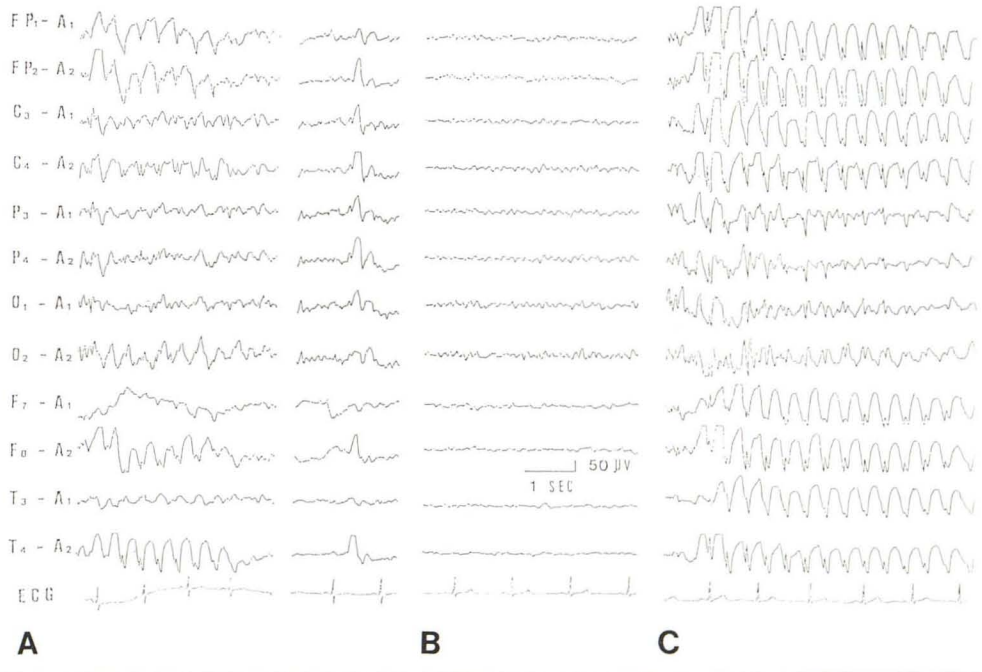

Fig. 1.—EEGs of SLE. **A**, 25 March. Right frontotemporal dominant spike and wave complexes and high-voltage slow waves. **B**, 25 April. Near-normal patterns. **C**, 6 October. Right frontotemporal dominant spike and wave complexes have returned.

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AJNR 4:541-543, May/June 1983 0195-6108/83/0403-0541 $00.00

The Baby Cyclo 105 we used is a product of the Nihon Seikosho Co., Japan. It is a very small cyclotron, occupying only 20 m^2 for setting.

Case Report

A 12-year-old Japanese girl developed normally without specific disorders until she was 9 years old. In August 1980, she complained of arthralgia of both knee joints and gradual weight loss. In October, butterfly erythema appeared on her face. In November, she developed proteinuria. She was admitted to our hospital on 1 December 1980. Laboratory data disclosed leukocytopenia (2,200/mm^3), increased erythrocyte sedimentation rate (89 mm/hr, positive Wassermann reaction, positive C-reactive protein (3+), positive antinuclear antibody, positive anti-DNA antibody, decreased serum CH_{50} (under 20 U/ml), and proteinuria (320 mg/dl). She was diagnosed as having SLE, and corticosteroid therapy with prednisolone (30 mg/day) was begun. On 1 January 1981, she suffered sudden tonic and clonic convulsion with loss of consciousness. Electroencephalographic (EEG) studies showed diffuse 3 cycles/sec spike and wave complexes. X-ray CT and cerebrospinal fluid levels were normal. After 2 months, there were no additional convulsions, and EEG findings were almost normal. Treatment was not with specific anticonvulsants, but with increased doses of prednisolone (60 mg/day). In March 1981, the clinical findings and laboratory data were markedly improved. From April 1981 to January 1982, she was free of the symptoms of SLE, with only the administration of low doses of prednisolone.

In February 1982, she complained of low-grade fever and listlessness, and soon after proteinuria and hematuria appeared. She was readmitted on 25 March. Facial erythema, intention tremor, low-grade fever, and moderate muscle weakness were observed. Laboratory data showed massive proteinuria, leukocytopenia (2,100/mm^3), positive C-reactive protein (2+), positive antinuclear antibody, positive anti-DNA antibody, and decreased serum CH_{50} (under 20 U/ml). She was thought to be in the relapsing stage of SLE. X-ray CT showed moderate ventricular enlargement (fig. 1) perhaps due to the corticosteroid therapy. EEG studies showed right front temporal dominant high-voltage slow-wave activities and spike and wave complexes (fig. 2).

The first PET scan was obtained on 2 April, and revealed a right frontotemporal low attenuation area (LAA) both in ^{11}C-CO_2 inhalation and ^{11}C-glucose ingestion studies (figs. 3A and 3B). She had been taking prednisolone (60 mg/day) for 3 weeks. EEG disclosed marked improvement.

The second PET scan was obtained on 23 April. The right frontotemporal LAA identified on the first scan was now unclear, and in the ^{11}C-glucose study the attenuation of the frontotemporal area was symmetric (figs. 3C and 3D). On 26 April laboratory data were improved. Anti-DNA antibody and antinuclear antibody were negative, and serum CH_{50} was increased (26 U/ml). We thought that this stage was a temporary remission, and that these changes on PET and EEG studies during relapse and remission might represent cerebral vasculitis.

From May to August 1982 she was healthy, but in September 1982, butterfly erythema again appeared on her face, and there was listlessness and mild muscle weakness. EEG studies and PET were performed in October. EEG studies again showed spike and wave complexes, with foci that appeared to be in the right frontotemporal area. In the third PET scan, the right frontotemporal LAA was recognized both in ^{11}C-CO_2 inhalation and ^{11}C-glucose ingestion studies, and resembled that of the first scan (figs. 3E and 3F). She was diagnosed as being in the relapsing stage of cerebral vasculitis.

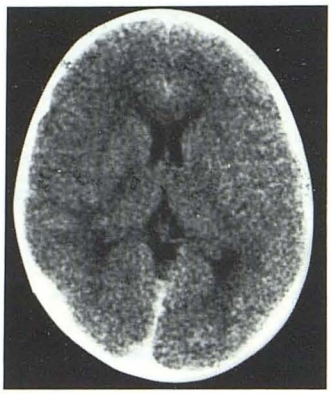

Fig. 2.—X-ray CT. Moderate ventricular enlargement in relapsing stage of SLE.

Discussion

Neuropsychiatric symptoms are often shown in patients with collagenous disease, especially SLE, but there are few reports concerning neurologic manifestations. Bentson et al. [3] reported brain atrophy and the effect of corticosteroid therapy in this disease. In PET, ^{13}N–NH_3 has been popularly used for cerebral circulatory studies and ^{18}F-deoxyglucose (^{18}FDG) for circulatory and metabolic studies. These methods and basis of investigating local cerebral functions were reported first by Sokoloff et al. [4]. We used ^{11}C-CO_2 for circulatory and acid/base balance studies and ^{11}C-glucose for circulatory and metabolic studies. Lockwood and Finn [5] reported ^{11}C-CO_2 had limited usefulness for acid/base study of the brain, because of the low isotope trapping in the brain. In our clinical comparison between normal and critically ill subjects using ^{11}C-CO_2, significant abnormalities were seen in the latter. Inhalation studies were often influenced by pulmonary dysfunction, especially by chronic obstructive lung disorders, but this patient did not have any of these conditions. Instead of ^{18}FDG, we applied ^{11}C-glucose as a metabolic tracer. In the ^{18}FDG study, epileptic foci were sometimes represented as high-attenuation areas, but in ^{11}C-glucose study, these foci were usually represented as LAAs. We hypothesized that this difference resulted from the fact that ^{18}FDG indicated the uptake of glucose in the brain, while ^{11}C-glucose indicated the metabolites from glucose in the brain.

Neuropsychiatric symptoms in SLE have been described by many authors [6–11]; the average incidence has been about 30%. In some cases, these symptoms were caused by therapeutic drugs, such as corticosteroids and immunosuppressants; however, in most cases they were caused by the disease itself, because they usually appeared with the active stage of SLE, and were relieved after corticosteroid therapy.

Pathologic features of the central nervous system in SLE were described by Dubois [12]. He investigated 31 postmortem brains, and indicated that the major findings were microscopic vasculitis and fibrinoids in the arachnoid and the brain. Therefore, the neuropsychiatric symptoms in SLE might be caused by cerebral vasculitis.

In our case, there was a history of steroid-dependent neurologic and EEG changes. The abnormal EEG findings were mainly spike and wave complexes that are often seen in cerebrovascular disorders. The LAA on PET might mean disturbed localized cerebral blood flow and glucose metabolism. We concluded that the findings on PET might well reflect the state of the cerebral vasculitis in this patient, and an application of PET to such a patient is useful to detect the cerebral vasculitis before the appearance of serious neurologic symptoms.

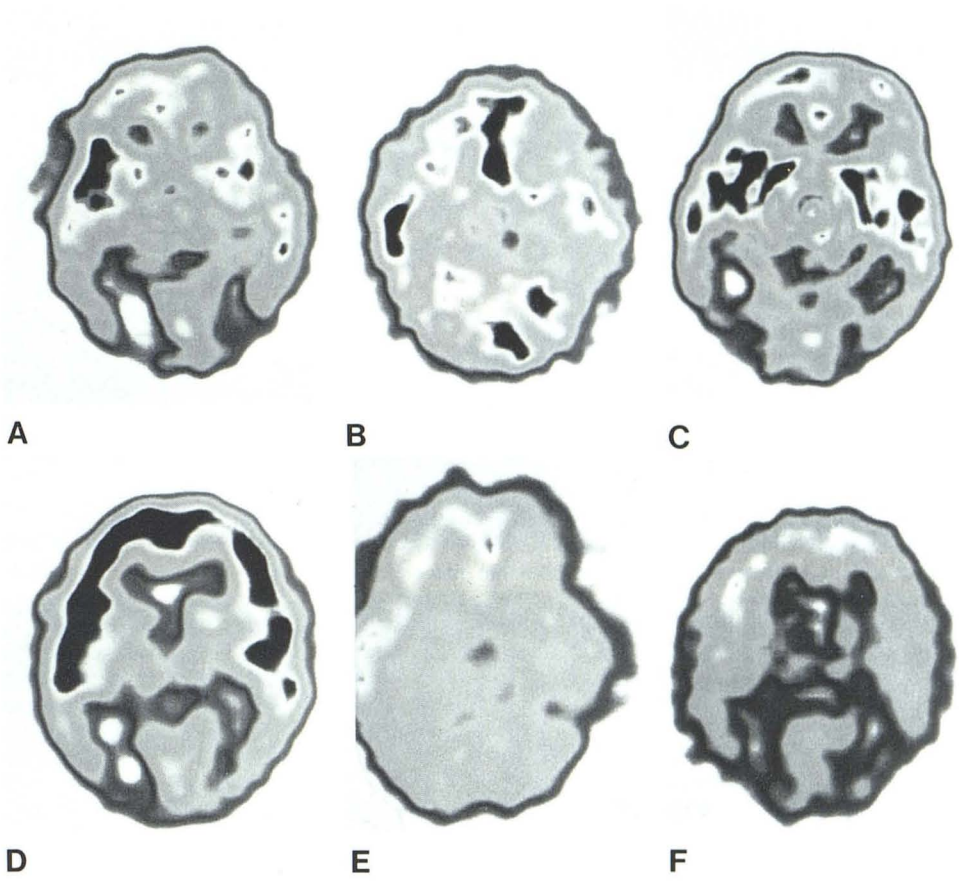

Fig. 3.—PET (all reversed images). **A**, 2 April; ^{11}C-CO_2 study. Right frontotemporal LAA. **B**, 23 April; ^{11}C-glucose study. Similar LAA in right frontotemporal region. **C**, 23 April; ^{11}C-CO_2 study. LAA has disappeared. **D**, 23 April; ^{11}C-glucose study. LAA has disappeared. **E**, 2 October; ^{11}C-CO_2 study. Right frontotemporal LAA has reappeared. **F**, 2 October; ^{11}C-glucose study. Asymmetry of attenuation in frontotemporal area evident.

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