

## Luxury perfusion phenomenon in acute herpes simplex virus encephalitis

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In a patient with acute herpes simplex virus (HSV) encephalitis, positron emission tomography (PET) demonstrated increased cerebral blood flow in the affected temporal lobe accompanied by reduction in the cerebral oxygen extraction fraction and the cerebral metabolic rate of oxygen, i.e., luxury perfusion. Follow-up PET studies showed reduction in cerebral perfusion until it was more closely coupled with oxygen metabolism after the resolution of the acute inflammation. These findings support previous single photon emission computed tomographic data and provide a pathophysiological background for the occurrence of hyperperfusion in HSV encephalitis. This is an interesting example of the luxury perfusion phenomenon occurring in a disease other than cerebral ischemia.

**Key words:** herpes simplex virus encephalitis, luxury perfusion phenomenon, positron emission tomography

### INTRODUCTION

LAUNES ET AL.<sup>1</sup> have reported that the demonstration of increased cerebral blood flow in the affected temporal lobe by single photon emission tomography (SPECT) was helpful in the early diagnosis of herpes simplex virus (HSV) encephalitis, and subsequent clinical experience has supported their observations,<sup>2</sup> but little is known about the changes in cerebral metabolism in acute HSV encephalitis. By means of positron emission tomography (PET), we clearly demonstrated luxury perfusion in the affected temporal lobe of a patient with HSV encephalitis, i.e., a focal increase in cerebral blood flow (CBF) and a marked reduction in the oxygen extraction fraction (OEF) along with a reduced cerebral oxygen metabolic rate (CMRO<sub>2</sub>).<sup>3,4</sup>

### CASE REPORT

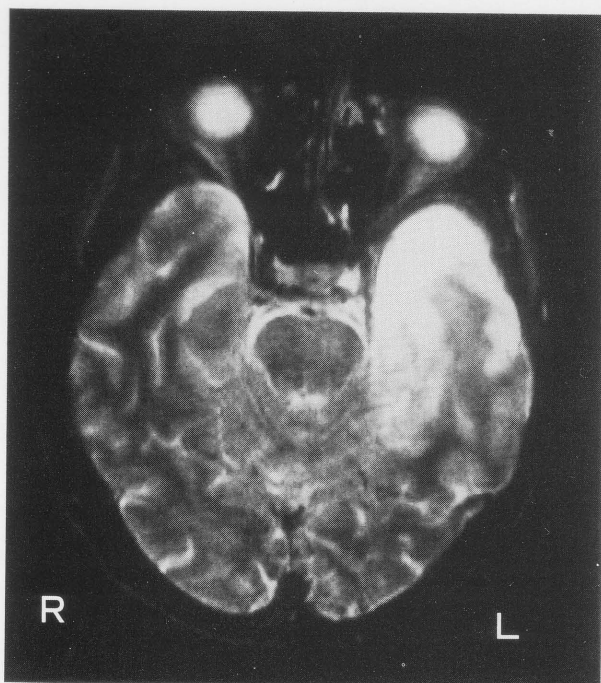
A 42-year-old man was admitted to a local hospital with a 1-week history of fever and clouding of consciousness.

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He was suffering from delusions, was disorientated with respect to time and place, and was unable to recognize his wife. Pleocytosis with a lymphocytic predominance was found on examination of the cerebrospinal fluid (CSF), but HSV antibody was negative in the serum and CSF. He gradually improved over the next two weeks and then was transferred to our hospital for further neurological evaluation.

On admission, the patient was confused and disorientated with neck stiffness, but there were no focal neurologic deficits. Lumbar puncture showed a raised lymphocyte count (347/ $\mu$ l), a high protein level (1.08 g/l), and positive HSV antibody titers (64 for IgG and 4 for IgM). The serum HSV titers were also high (2816 for IgG and 42 for IgM). Electroencephalography showed diffuse slow background activity. Acyclovir was given intravenously at a dose of 750 mg/day for 14 days. Magnetic resonance imaging at 33 days after the onset showed an area of high signal intensity in the left temporal lobe (Fig. 1). At 46 days, the first PET study was performed by means of the steady state method described previously.<sup>5</sup> It demonstrated increased perfusion, greatly decreased oxygen extraction, and decreased oxygen consumption in the left temporal lobe (Fig. 2). The frontal, parietal, and right temporal cortices generally showed a reduction in CBF and CMRO<sub>2</sub>. He recovered somewhat over the next 2 months, although significant amnesia



**Fig. 1** Magnetic resonance imaging findings. T<sub>2</sub>-weighted spin echo axial image obtained 33 days after the onset of encephalitis, showing an abnormal high signal intensity area in the left temporal lobe.

persisted. At 88 days, the second PET study showed a reduction in CBF, OEF, and CMRO<sub>2</sub> in the left temporal lobe (Fig. 2). Generalized cerebral hypoperfusion and hypometabolism were also noted. At 110 days after the onset when he was discharged from our hospital, mild amnesic aphasia and retrograde amnesia remained. He gradually improved subsequently and returned to his former employment at 20 months after the onset. At that time, a third PET study revealed a left temporal lobe lesion with a reduced OEF surrounded by an area with OEF preservation (Fig. 2). Both CBF and CMRO<sub>2</sub> were markedly reduced in these areas. Mild and generalized hypoperfusion and hypometabolism also persisted.

### DISCUSSION

The first PET study indicated luxury perfusion of the affected temporal lobe characterized by decreased OEF along with an increase or preservation of blood supply in excess of cerebral oxygen demand. This phenomenon is usually observed transiently after cerebral infarction and is related to tissue metabolic acidosis secondary to increased lactic acid production and CO<sub>2</sub> retention or to capillary hyperplasia after ischemic brain injury.<sup>3,4</sup> In the present patient, a similar condition may also have been responsible for hyperperfusion associated with reduced neuronal oxygen demand. With resolution of inflamma-

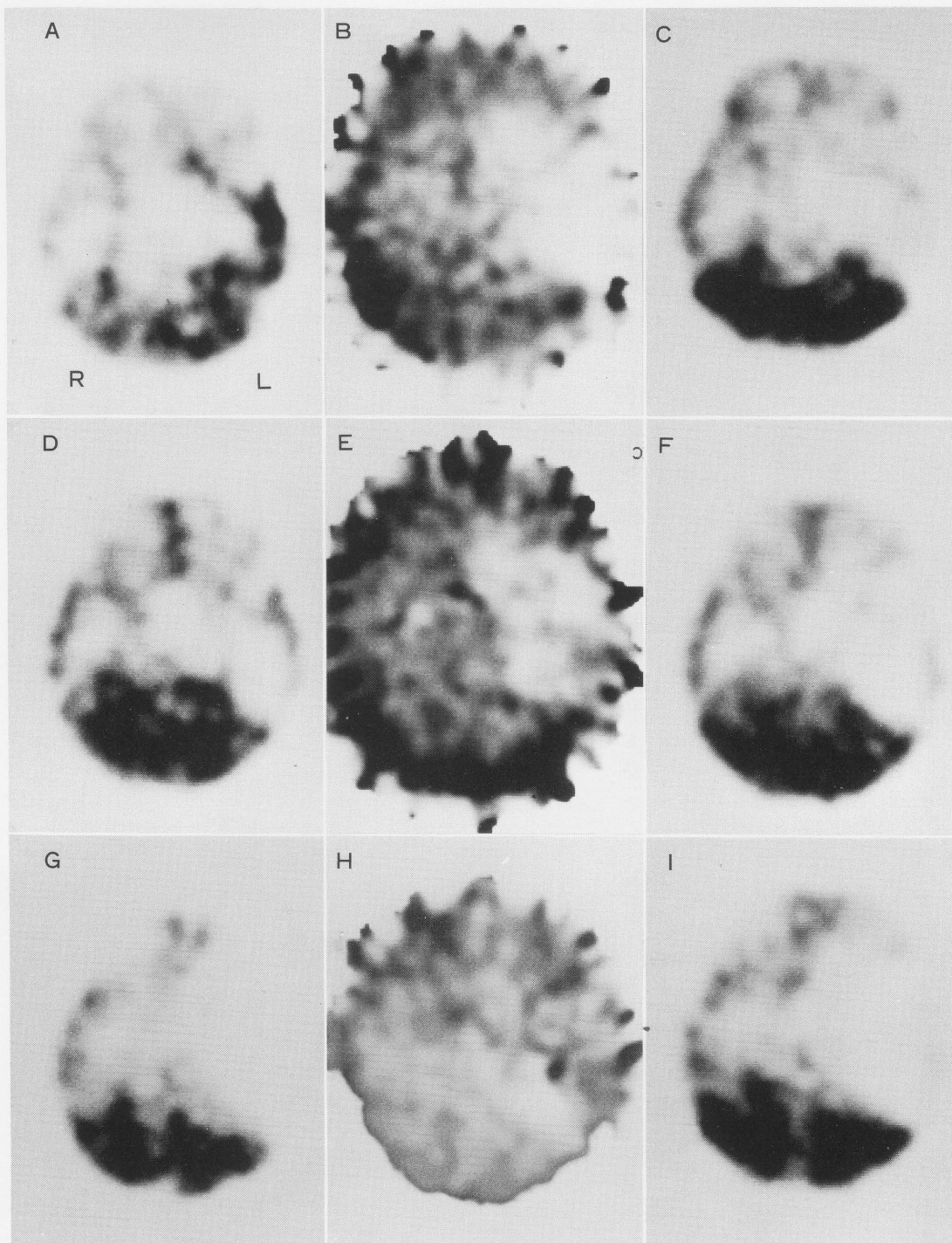
tion, perfusion decreased as shown in the second PET study, until it finally came close to matching oxygen demand as shown in the third PET study. The PET findings obtained in this patient firmly support previous SPECT data and provide a pathophysiological background for the occurrence of hyperperfusion in HSV encephalitis.

Launes et al.<sup>1</sup> used SPECT to detect focal hyperperfusion in all six patients with HSV encephalitis and none of eight patients with non-HSV encephalitis. Increased cerebral blood flow in the affected brain region has subsequently been repeatedly demonstrated by SPECT in acute HSV encephalitis,<sup>2</sup> and the phenomenon may be helpful in the early diagnosis of this illness, but there have been few data on cerebral metabolism in acute HSV encephalitis. Goetting and Haddad<sup>6</sup> reported two patients with severe viral encephalitis, one proven and the other suspected to be due to HSV, in whom the global cerebral oxygen extraction was assessed. They determined OEF by simultaneously sampling arterial and jugular venous blood and found that it was low in both patients throughout the acute period. These authors concluded that cerebral hyperemia was present in their patients.

These observations obtained by SPECT and by OEF determination are unified by our PET finding that cerebral blood flow increases and exceeds oxygen demand in acute HSV encephalitis, resulting in a reduction in OEF. Although this phenomenon is probably due to inflammatory hyperemia, the relationship between CBF, CMRO<sub>2</sub>, and OEF indicates luxury perfusion. This is a new example of the luxury perfusion phenomenon occurring in diseases other than cerebral ischemia.

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**Fig. 2** PET findings. The first PET study at 46 days after the onset of encephalitis (top row) showed increased CBF (A) as well as decreased OEF (B) and decreased  $CMRO_2$  (C) in the left temporal lobe. The second PET study at 88 days after the onset (middle row) showed reduced CBF (D), less reduction in OEF (E) and persistent reduction in  $CMRO_2$  (F). The third PET study at 20 months after the onset (bottom row) revealed that the left temporal lobe region with reduced OEF had decreased in size (H). CBF (G) and  $CMRO_2$  (I) were both markedly reduced.