Case Report

Hypertensive Encephalopathy Extending into the Whole Brainstem and Deep Structures

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In patients with hypertensive encephalopathy, brain edema is frequently distributed in the parieto-occipital white matter. We report a patient with high arterial blood pressure of over 300/160 mmHg on admission, who had extensive MRI-documented reversible lesions throughout the whole brain, including the brainstem, thalami, basal ganglia, and cerebellum. Extraordinarily severe acceleration of hypertension may be essential for the breakdown of autoregulation in the deep structures, especially in the brainstem including medulla. (*Hypertens Res* 2002; 25: 797–800)

Key Words: hypertensive encephalopathy, malignant hypertension, brainstem, magnetic resonance imaging, cerebral autoregulation

Introduction

Hypertensive encephalopathy is an acute neurologic syndrome characterized by elevated blood pressure, headache, vomiting, visual changes, altered mental status, seizures, and focal neurologic signs (1–3). The syndrome is usually reversible, but failure to treat hypertension promptly may end in a fatal outcome (4). Recent development of antihypertensive treatments seems to have decreased the incidence and severity of accelerated-malignant hypertension and the resulting organ damage (5–7). Brain edema occurs predominantly in the posterior portions of the white matter (8), and appears to be more accurately visualized by MRI than by CT (9). Extension of the edema into the brainstem, basal ganglia, and cerebellum had been reported to be rare, and is always associated with cortical lesions (10). A recent review stated that edematous changes commonly involve the cerebellum and brainstem (3). To our knowledge, however, the predominant involvement of the brainstem with minimal changes in the supratentorium has only been investigated in the last 2 years (Table 1) (11–13). We here describe a patient with hypertensive encephalopathy who had extensive

MRI-documented reversible lesions throughout the whole brain, including the brainstem, thalami, basal ganglia, and cerebellum.

Case Report

A 73-year-old man presented at our hospital with a complaint of a sudden inability to stand or walk. He reported having a poor memory, had no family history of hypertension, and had not had his blood pressure measured since the age of 60; prior to age 60, his blood pressure had been measured annually and was always within normal range.

Upon arrival, his height was 167 cm, his body weight 50 kg, his systolic arterial pressure over 300 mmHg, his diastolic arterial pressure 160 mmHg, and his pulse rate 100 bpm and regular. He did not have heart murmur or respiratory rate. He was drowsy and disoriented, did not complain of headache or nausea, and did not develop seizure. His retinal arterioles showed acute hypertensive changes (Keith-Wagener III). His cranial nerves, including visual function, were intact. His right arm and leg were paretic with increased deep tendon reflexes and without cerebellar ataxia. Both head CT performed immediately after arrival and MRI

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Table 1. Clinical Features of Patients with Severe Hypertensive Brainstem Encephalopathy

Patient	Age/sex	Original disease*	Blood pressure [†] (mmHg)	Method	Location of brainstem lesions	Location of other lesions
1 (11)	54/F	-	210/144	MRI	bilateral	cerebellum, PVWM
2 (11)	22/F	SLE	213/133	CT	bilateral	none
3 (11)	49/M	-	211/156	MRI	bilateral	cerebellum, PVWM
4 (12)	53/M	-	253/140	MRI	pons, midbrain (partial) medulla (partial)	cerebellum (white matter) PVWM
5 (13)	41/M	-	220/120	MRI	bilateral	PVWM
6 (13)	52/F	-	220/150	MRI	bilateral	PVWM, occipital lobe (mild)

* Other than hypertension. [†] On admission. SLE, systemic lupus erythematosus; PVWM, periventricular white matter.

Fig. 1. A computed tomographic (CT) scanning image taken on admission shows diffuse hypodensity. A tiny hematoma (arrow) can be seen in the left thalamus.

Fig. 2. Axial fluid-attenuated inversion recovery (FLAIR) images of MRI taken on day 2 show extensive edema in the whole brain, including the medulla (a). A tiny hematoma (arrow) can be seen in the left thalamus. Edema was absent on day 21 (b).

performed the next day demonstrated widespread edema in the cerebral white matters and cortices, basal ganglia, thalami, midbrain, pons, medulla, and cerebellum with a tiny hematoma in the left thalamus (Figs. 1, 2a). A fluid-attenuat-

ed inversion recovery (FLAIR) image on MRI detected edema in the brainstem and basal ganglia as clearly as and edema in the cerebral and cerebellar white matters more clearly than a T_2 -weighted image. A T_1 -weighted image on

Fig. 3. Distribution of mean arterial pressure at the symptom onset in patients with hypertensive encephalopathy according to the location of brain edema. Bars show the mean $\pm$ SD. Open circles show the present case.

MRI showed no more than minimal edematous change in any of the visualized regions. On MRA and ultrasonogram, the right vertebral artery was hypoplastic. An echocardiogram showed mild left ventricular hypertrophy. An electrocardiogram also showed a high amplitude suggesting left ventricular hypertrophy. On chest roentgenogram, the cardiothoracic ratio was 49%. Blood urea nitrogen (22.5 mg/dl) and creatinine concentrations (1.9 mg/dl) were elevated, possibly due to hypertensive nephrosclerosis. Blood tests also showed normocytic normochromic anemia (a hemoglobin concentration of 9.9 g/dl and of 28.9%) with a low serum erythropoietin level (9.1 mU/ml), which suggested renal anemia. On urinalysis, protein and occult blood were minimal. Renal CT and MRA revealed renal cell carcinoma with high vascularity, which had not yet been diagnosed before, in the left kidney. Renovascular diseases were negative in a radionuclide renal scan, MRA, and renin sampling. Endocrinologic tests were normal except for temporary elevation of serum catecholamines, renin, and aldosterone on admission. These results indicated that the patient had essential, not secondary, hypertension.

We immediately started intravenous infusion of a calcium channel blocker which lowered his systemic pressure to 140–170/70–90 mmHg, followed by an oral calcium channel blocker and angiotensin-converting enzyme inhibitor on day 5. Ambulatory blood pressure monitoring showed dipper-type alteration. We also administered a hyperosmolar agent intravenously to directly lessen brain edema. He resumed consciousness gradually over a period of 3 days. His Mini-Mental State Examination score increased from 4 at day 3 to 14 at day 14. He moved his right limbs without paresis at day 7. On repeated MRI performed on day 21 (Fig. 2b), his edema was absent and the hematoma in the left thalamus was unclear. The diameter of the vertebrobasilar arteries did not change between the MRIs on day 2 and day 21.

Discussion

The present report had two unique findings not seen in the previous reports on hypertensive encephalopathy. First, the patient had extensive edema throughout the whole brain, and second, his initial blood pressure on admission was extraordinarily high. These two findings appeared to be causally related.

Reversible vasogenic edema is associated with pathophysiological changes of hypertensive encephalopathy. FLAIR images of MRI can detect subtle subcortical and cortical lesions in patients with this disease (14), and diffusion-weighted images are also useful, though to a lesser degree (15, 16). The distribution of edema seems to correlate well with both the severity and duration of high blood pressure. In previous studies, we have examined the correlation between the mean arterial pressure at symptom onset and the distribution of MRI-documented edema (Fig. 3) (8, 9, 11–13, 17, 18). In these studies, mild acceleration of hypertension produced edema in the supratentorial white matter with little or no involvement of the infratentorial compartments. Severe acceleration of hypertension ended in more extensive supratentorial edema and extension into the brainstem, basal ganglia, and cerebellum. And the mean arterial pressure of these patients exceeded 150 mmHg, which also suggests that severe acceleration of hypertension is required for hypertensive brainstem encephalopathy. Compared with these patients, the present one was unique because his lesion expanded into the thalamus, basal ganglia, and whole brainstem, including the midbrain, pons, and medulla.

The difference in the level of arterial pressure for the formation of reversible edema between the cortical or subcortical area and the deep structures may be due to different conditions of autoregulatory adjustment of cerebral blood flow (CBF). In normotensive and spontaneously hypertensive rats, the upper limit of the autoregulatory plateau of CBF in the thalamus has been shown to be higher than that in the cerebral cortex (19). Deep structures such as the thalamus, basal ganglia, and brainstem are fed by the arterioles directly branching from the middle cerebral trunk or basilar artery, and the cortex and subcortex are fed by the terminal branch arteries. The former regions are constantly subjected to higher arterial pressure than the latter ones. Thus, in the deep structures, severe acceleration of hypertension may be necessary for the dysfunction of autoregulation and breakdown of the blood-brain barrier in cases of vasogenic edema.

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