Summary. The properties of interstitial fluid in the periventricular white matter in normal pressure hydrocephalus (NPH) were evaluated by measurement of the relaxation times of brain water protons. Patients with NPH were divided into two groups: Shunt responders and shunt non-responders. In the shunt responder group both T1 and T2 values of the periventricular white matter were significantly prolonged compared to those of the controls, and were shortened after shunting. Both T1 and T2 values of the white matter were significantly longer than those of the gray matter, while the reverse relationship was seen in normal controls. However, in the shunt non-responder group, although T1 of the white matter was significantly prolonged, T2 of the same area was not. There was no change in either T1 or T2 of this region after shunting. Both T1 and T2 were almost the same in white and gray matter in shunt non-responders. It is suggested that the periventricular abnormalities seen in various diseases may be distinguished on the basis of the varying relaxation behavior of tissue water.

Keywords: Normal pressure hydrocephalus — Interstitial edema — Water proton relaxation times — Cerebrospinal fluid shunting — Dementia

Introduction

There has been no single investigation to establish the diagnosis of normal pressure hydrocephalus (NPH) or to distinguish patients with NPH from patients with dementia of other causes. Computed tomography (CT) scans and magnetic resonance (MR) images may reveal similar abnormal density or intensity suggesting increased water content in the periventricular white matter not only in NPH patients, but also in other dementia patients.

In the present study, the properties of the interstitial fluid in the white matter in NPH patients were determined by measurement of the relaxation times of brain water protons.
times of the brain water protons. The possibility of distinguishing interstitial edema from other white matter abnormalities was also investigated.

**Materials and Methods**

Twenty one patients with a mean age of 64, diagnosed as having NPH, underwent ventriculoperitoneal shunting. The diagnosis was made on the basis of clinical findings.

Patients were classified into three groups: The first group consisted of 14 patients with true NPH, who responded to shunting, the second consisted of 7 patients with suspected but false NPH, who did not respond to shunting, and the third group consisted of 17 control patients, with a mean age of 64, who had no proven intracranial organic diseases.

The causes of suspected NPH included idiopathic origin in 13 patients, head injury in 5, and intracranial bleeding in 3.

MR imaging was performed on a total of 38 patients for obtaining T1 and T2 images of the brain. A 0.15 tesla, resistive MRI unit was used for the study. The relaxation times were read directly from calculated T1 and T2 images produced from a two-point method by computer algorithms using a combination of two different pulse sequences. The T1 and T2 were measured in the regions of interest; the periventricular white matter and the cortical gray matter. Post-shunt MR imaging was performed, and T1 and T2 measurements were made in the same fashion, on an average of 51 days after ventricular shunting, varying from 15 to 134 days.

**Results**

A comparison between T1 and T2 in both the cortical gray matter and the periventricular white matter was made. Both T1 and T2 were significantly longer in the gray matter than in the white matter in the control group. Conversely, in the true NPH group, however, they were longer in the white matter than in the gray matter. In the false NPH group, there was no significant difference between the gray and the white matter in either T1 or T2.

A comparison of T1 and T2 of the regions of interest among the three groups is shown in Fig. 1.

The preshunt T1 of white matter in the true NPH group was significantly prolonged when compared to that in the controls and in the false NPH group. The T1 of white matter in the false NPH group was also significantly longer than that in the control group. However, there was no difference among the three groups in T1 of the gray matter.

As far as the pre-shunt T2 is concerned, the T2 of white matter in the true NPH group was significantly prolonged when compared to that in the control and false NPH groups. There was no significant difference in T2 of white matter between the false NPH and the control group. However,