Evaluation of cerebral vasospasm in patients with subarachnoid hemorrhage using single photon emission computed tomography

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Abstract

Cerebral vasospasm (CVS) occurs as a result of the breakdown in cerebral autoregulation mechanisms. Because cerebral vasospasm can occur after subarachnoid hemorrhage (SAH), it is important to evaluate borderline perfusion. Evaluation of borderline vascular insufficiency is important to reduce ischemic complications. In this study 25 patients with SAH were investigated by somatosensory evoked potentials (SEP), computed tomography (CT), digital subtraction angiography (DSA) and single photon emission computed tomography (SPECT) in order to predict borderline ischemic areas. Clinical grades were also correlated with these investigations. Thirteen patients had symptomatic vasospasm and 15 patients had angiographic vasospasm. SPECT showed hypoperfusion in 22 out of 25 patients. CT predicted CVS in 8 of these 22 patients. Our study shows that brain perfusion SPECT is a non-traumatic, non-invasive, non-allergic, inexpensive method for the prediction of cerebral vasospasm. We conclude that brain SPECT with Tc-99m HM-PAO is an accessible technique that can demonstrate varying degrees of regional tissue hypoperfusion in patients with delayed ischemic deficits due to CVS following SAH.

Keywords: Cerebral vasospasm, SPECT.

1 Introduction

Cerebral vasospasm causing delayed ischemic neurologic deficits complicates SAH in approximately 30% of patients [3]. CVS occurs as result of the breakdown in the cerebral autoregulation mechanisms, which is a protective mechanism against hemorrhage in the acute phase, but becomes a disadvantage in the chronic phase by causing cerebral ischemia and retarding clinical recovery [8]. A wide variety of drugs have been used in the pharmacologic treatment of CVS but haven not been successful until now. The early diagnosis of CVS is very important for its prophylaxis. For prediction and diagnosis of CVS many diagnostic procedures have been used, such as angiography [13], SEP [13, 14, 19, 20], PET [14], transcranial Doppler technique [1], and xenon-enhanced CT blood flow mapping [9, 22].

About six years ago, a new method to investigate changes in the regional cerebral blood flow was introduced: it used SPECT to measure the regional cerebral uptake of intravenously administered technetium-99 M labelled d,l-hexamethylpropylene amine oxime (Tc 99m-HM PAO) [2, 4–7, 10, 12, 15–17, 21]. Several studies have shown that cerebral uptake of Tc 99m-HM PAO reflects cerebral blood flow. Decreased cerebral uptake of Tc 99m-HM PAO in cerebrovascular disease has been shown to correspond well with the results of other methods [2, 4, 21].

In this study, we evaluated the value of Tc 99m-HM PAO brain SPECT, for the early diagnosis and monitoring of CVS and compared it to some other diagnostic methods such as CT, DSA, and
SEP. Although a few studies have reported using SPECT in patients with SAH [6, 7, 15], none have reported studies comparing SPECT, CT, DASA, and SEP.

2 Material and methods

Tc 99m-HM PAO brain SPECT, CT, DSA, and SEP were applied to 25 patients (12 males, 13 females, aged from 9 to 55 years) within 24 to 36 hours after diagnosis.

555 MBq Tc 99m-HM PAO (Ceretec, Amersham Plc, UK) was injected intravenously. SPECT acquisition parameters were: 128 × 128 matrix, 1.00 zoom, 64 view and 30 sec/view using LEAP collimator on a GE 400 ACT/STARCAM system. Reconstruction was performed using Nowak software, and each slice was 1 cm thick.

Patients were graded by Botterel’s system for clinical status, Sano’s system for CT results and according to the distribution of CVS compared with the contralateral vascular diameters for DSA results. In SEP, central conduction time (CCT) was measured in each patient by stimulating Nervus medianus and recording from the contralateral cerebral cortex. The results were compared with those of a control group.

All results were evaluated by a team consisting of radiologist, a neurosurgeon and a nuclear medicine physician.

3 Results

The clinical gradings and the results of the tests were as follows:

Eight grade III and 5 grade IV patients (a total of 13 = 52%) were regarded as having CVS clinically. Eight patients (32%) with SAH were regarded as having CVS in terms of CT findings. Fifteen patients (60%) out of 25 were regarded as having CVS according to the DSA results. Seven patients (28%) showing prolonged CCT were accepted to have CVS according to SEP studies.

Hypo- and/or non-perfused regions were found in 22 (88%) of 25 patients on the basis of the SPECT studies. On the other hand, 8 out of 22 patients with SPECT showing hypoperfusion had significant CT abnormalities, and 15 of these 25 patients had angiographic vasospasm (Figure 1a + b).

Patients 1, 11, and 12, who had normal SPECT findings, also had normal results in all the other correlative tests.

4 Discussion

Several methods have been suggested for early detection of CVS [1, 9, 13, 14, 22]. Definitive

Figure 1. CT and SPECT in case 4. a: While early CT was normal, SPECT shows hypoperfusion on the left frontal lobe. There is an obvious hyperperfusion in the right frontal, left occipital lobe and in the periphery of the stroke area. b: Late CT shows hypodensity on the left frontal lobe.