Detection of Crossed-Cerebellar Hypoperfusion in Acute Stroke using perfusion-weighted MRI

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Introduction

Crossed cerebellar diaschisis (CCD), the decrease in blood flow and metabolism in the cerebellar hemisphere contralateral to a supratentorial stroke, is observed relatively frequently using imaging techniques such as PET and SPECT (1). In contrast, curiously, there have been almost no reports of corresponding findings (crossed cerebellar hypoperfusion (CCH)) using magnetic resonance perfusion imaging (PWI) in patients with acute stroke (2). This study was undertaken to determine the frequency of observation of CCH in acute stroke by retrospective review of a research database of acute stroke patients evaluated by diffusion-weighted MRI (DWI) and PWI.

Material and Methods

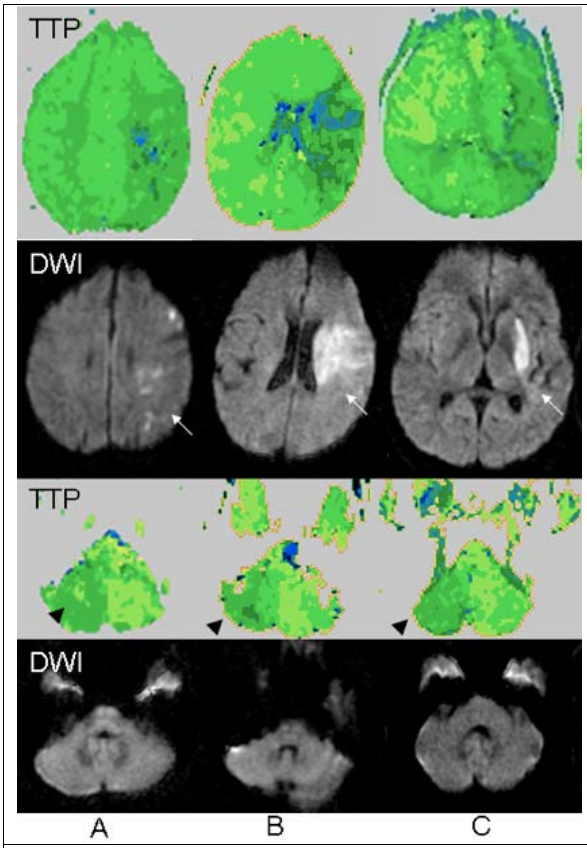

Figure 1. CCH (arrowhead, on TTP maps, row 3) detected in 3 patients with supratentorial infarction (white arrows - top two rows). DWI confirms lack of cerebellar infarction in each case (bottom row).

MRI was performed on 1.5T MRI systems, and consisted of PWI, DWI FLAIR/T_2-weighted sequences and MR angiography. PWI images with whole brain coverage were processed to generate maps of time-to-peak (TTP) and cerebral blood flow (CBF) using the 'Penguin' program (3). PWI and DWI scans from 134 consecutive acute stroke patients, admitted to our stroke service and scanned within 24 hours of symptom onset, were retrospectively reviewed for the presence of cerebellar hypoperfusion contralateral to an acute supratentorial infarct seen on DWI. The presence of hypoperfusion was defined as TTP ≥ 4 seconds compared to the contralateral hemisphere (4), with an absence of cerebellar abnormalities on T2-weighted scans, DWI, or disease of the vertebrobasilar system on MRA.

Results

4 out of 134 cases (2.98%) met the criteria of CCH. Examples of DWI and PWI for 3 of the cases are shown in Figure 1. CCH was best visualized on reconstructed TTP maps, as opposed to CBF, however CBF reductions (contralateral to ipsilateral cerebellar hemisphere) of 29.0%, 26.4%, 56.9% and 30.2% were found in the 4 cases, respectively.

Discussion

The incidence of CCH appears to be lower than that of CCD observed by PET or SPECT (greater than 50% reported in some series (2)). This low incidence could be due to multiple factors, but a major reason may be the relative insensitivity of PWI to detect mild hypoperfusion, particularly if performed at relatively low temporal resolution. With the protocol and selection criteria used here, it is possible that only severe cases of CCD were detected, and that if a lower TTP threshold had been set, more cases would have been included. The value of 4 seconds was chosen here because it represents two time points in the perfusion time course (TR 2 seconds), and is greater than the typical 2 sec time difference seen between gray and white matter. Other reasons that CCH may not have been observed in prior PWI studies include the common use of perfusion protocols that did not have whole brain (i.e. cerebellar) coverage, or failure to generate TTP maps of the posterior fossa. Conversely, the reported incidence of CCD on PET/SPECT may in some cases be over estimated; for instance, in studies which did not also include MRI, it is possible that patients with small supratentorial strokes were missed (if only evaluated with CT and nuclear medicine modalities), or patients with underlying posterior circulation vascular disease were inadvertently included. Both of these factors would lead to increased apparent incidence of CCD in the acute stroke population. In a PET study it has been observed that acute CCD is closely correlated with the volume of supratentoiral hypoperfusion (Sobesky 2005). In our database of 134 acute stroke cases, 38/134 (~28%) ischemic lesions were less than 5 cm^3.

The clinical significance of CCD and its relationship to infarct size and location is controversial; however, with the increasing utilization for MRI for acute stroke evaluation, it is important to establish the ability of MRI to detect CCH. Future studies should include both PET/SPECT and MRI in the same population in order to perform a direct comparison between modalities, and to establish optimum analysis criteria for detection of CCH.

References

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