CROSSED CEREBELLAR DIASCHISIS AFTER STROKE: A VASCULAR PHENOMENON?

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Introduction

Crossed cerebellar diaschisis (CCD) in internal carotid artery (ICA) territory stroke refers to a reduction in cerebral blood flow (CBF) and energy metabolism on the contralateral cerebellar hemisphere. (1,2,3) The term “diaschisis” was introduced by Monakow in 1914 (Greek *dia* “in half” and *schizien* “to split”), referring to a remote loss of excitability due to a focal brain lesion, induced by functional disconnection. (4) CCD can often be found in patients with stroke due to large vessel occlusion, however its influence on clinical outcome has been controversial. (5) CCD can be detected with H₂O-PET, contemporary MRI techniques (DSC, ASL), and most recently with BOLD (blood oxygenation-level dependent) functional MRI. (6, 7) However, in patients with ICA occlusion, compensatory hemodynamic factors may also influence perfusion in remote brain areas, including the posterior circulation. (8) Patients with large vessel occlusion tend to have a higher risk of a recurrent ischemia if hemodynamic compensation is insufficient and cerebrovascular reactivity (CVR) is reduced (9). Our goal was to identify potential hemodynamic contributions of CCD in patients with ICA occlusion, using BOLD-CVR imaging and Transcranial Duplex sonography (TCD).

Methods

TCD measurement of flow in the MCA-M1, ACA, PCA and the presence of the four main collateral pathways (8, 9) as well as clinical data (NIHSS and mRS) from 19 stroke patients with unilateral ICA occlusion who underwent BOLD-MRI-CVR assessment were analyzed. The presence of CCD (CCD + or CCD -) was judged quantitatively from BOLD images, based on a cerebellar asymmetry Index cut-off value of > +7% (that means that the CVR of the contralateral cerebellar hemisphere is on average 7% lower then the ipsilateral cerebellar hemisphere). Non-parametric tests were used for group comparisons between CCD+ and CCD - (significance level $p < 0.05$).

Demonstration of supra- and infratentorial BOLD-CVR in a patient with right ICA occlusion. Supratentorially there is reduced CVR of the right hemisphere. (A) shows a CVR reduction of the contralateral cerebellar hemisphere (CCD +) (B) shows no CVR reduction of the contralateral cerebellar hemisphere (CCD -).

Conclusions and Outlook

In patients with stroke due to ICA occlusion, the presence of CCD was associated :

- 1) more severe stroke deficits on admission,
- 2) higher flow in both P2 segments of the PCA and in the **contralateral** P1 segment

The latter is likely to indicate increased compensatory collateral recruitment through leptomeningeal collaterals in CCD+ patients. Our data suggest that in patients with ICA occlusion, there may be an additional hemodynamic contribution to CCD; indicating more severe hemodynamic compromise. Recruitment of more patients as well as consideration of infarct size and location will yield additional information about this phenomenon.

Results			
n(%) or median (IQR)	CCD+ n=10	CCD – n =8	P value
Age	68.8 (23)	66.5 (13)	0.965
sex (female)	3 (33)	2 (25)	0.814
NIHSS @ admission	5 (7)	0 (3)	0.014
NIHSS @ 3 months	1 (1)	0 (0)	0.193
mRS @ 3 months	1 (1)	0 (0)	0.146
CVR supratentorial affected	0.0609 (0.1)	0.0819 (0.12)	0.515
CVR cerebellar ipsilateral	0.1825 (0.17)	0.1713 (0.06)	0.696
CVR cerebellar contralateral	0.1420 (0.18)	0.1646 (0.06)	0.829
Number of coll. (duplex)	2 (1)	2 (0)	0.315
Coll_OA	9 (90)	6 (75)	0.396
Coll_ACA	9 (90)	6 (75)	0.396
Coll_Pcom	1 (10)	3 (38)	0.163
Coll_Lepto	2 (20)	0 (0)	0.180
PSV M1 ipsi (cm/s)	79.5 (56)	80.5 (69)	1
PSV M1 con	103.5 (48)	110 (21)	0.633
PSV ACA ipsi	70 (32)	72.5 (65)	0.633
PSV ACA con	141.5 (115)	97 (70)	0.234
PSV P1 ipsi	84 (39)	68.5 (39)	0.237
PSV P1 con	85 (50)	49 (25)	0.002
PSV P2 ipsi	76 (42)	50 (23)	0.003
PSV P2 con	76 (26)	49 (18)	0.004

Table 1) Patient characteristics, clinical outcome parameters, CVR descriptive parameters, Collaterals (qualitative and quantitative) and peak systolic velocity (PSV) of the ipsi- and contralateral A. cerebri media (M1), A. cerebri anterior (ACA), A. cerebri posterior (P1 Segment, P2-Segment)

A) TCD contralateral to ICAO. Arterial segments: M1: MCA-M1, A1: ACA-A1, P1: PCA- P1, P2: PCA-P2.

B) TCD ipsilateral to ICAO. Same arterial segments and flow profiles as in A) on the affected side are shown. Flow direction in A1 is reversed (AcoA collateral).

Note: Flow values in both PCA are high. From Ref. (8).

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