Evaluation of perforating arteries originating from the posterior communicating artery at 7 Tesla MRI

M. M. Conijn[1], J. Hendrikse[2], J. J. Zwanenburg[3], T. Takahara[2], M. I. Geerlings[4], W. P. Mali[2], and P. R. Luijten[2,3]

[1]Radiology, University Medical Center Utrecht, Utrecht, Utrecht, Netherlands, [2]Radiology, University Medical Center Utrecht, [3]Image Sciences Institute, University Medical Center Utrecht, [4]Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht

Introduction

The presence of a large or a fetal configuration of the posterior communicating artery (PCoA) reduces the risk of white matter lesions in the general population and of borderzone infarcts in patients with carotid occlusions.[1,2] The protective effect of a large PCoA against these ischaemic brain lesions may be explained by the perforating arteries branching from the PCoA, which feed the deep brain structures and deep white matter. Thusfar, these perforating arteries could not be imaged noninvasively. With ultra high field magnetic resonance angiography (MRA) at 7.0 Tesla it is now possible to show deep perforating arteries coming from the circle of Willis without use of contrast agents. In the present study we assessed the ability of time-of-flight MR angiography at 7.0 Tesla to show the penetrating branches of the posterior communicating artery. Furthermore, we assessed the relation between the presence of such perforating branches, the size of the feeding posterior communicating artery and the configuration of the posterior part of the circle of Willis.

Methods

Imaging was performed on 46 healthy subjects on a 7 Tesla whole body system equipped with a volume transmit and 16 channel receive head coil. A time-of-flight angiogram was obtained in each subject using a turbo field echo sequence, with a rest slab positioned superior of the imaging volume to suppress the venous blood. Imaging parameters were: FOV 200x181x68 mm^3, acquired voxel size 0.6 x 0.6 x 0.6 mm^3, acquired matrix size 332 x 294 with 114 slices, TR 23 ms, and TE 2.3 ms. On thin 3mm maximum intensity projections of transversal slabs and sagittal slabs, the diameter of the P1-segment of the posterior cerebral artery, the diameter of the PCoA and the diameter of the perforating artery accompanying the PCoA were measured by taking the full-width-at-half-maximum of the intensity profiles.

Results

Both the PCoA and the accompanying perforating artery were clearly visible on the images (*figure*). Within the left hemisphere a PCoA was present in 39 (85%) of the 46 subjects, of which 23 (59%) PCoA's had a visible accompanying perforating artery. In the right hemisphere a PCoA was present in 42 (91%) of 46 subjects, 29 (69%) with a perforator. The diameter of the PCoA's with accompanying perforator was larger (left 1.22mm, SE 0.07; right 1.24mm, SE 0.07) than of the PCoA's without perforator (left 1.05mm, SE 0.08; right 1.07mm, SE 0.11), although not statistically significant (left p=0.101, right p=0.172). According to the configuration of the posterior part of the circle of Willis, the diameter of the PCoA showed an inverse correlation with the diameter of the P1-segment. A significant positive correlation was found between the left and right sided anatomy of the posterior circulation. Not only both left and right P1 and PCoA were correlated, but also the left and right P1/PCoA ratios were correlated (*table*).

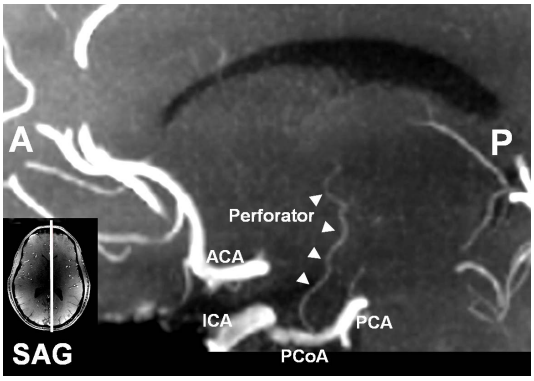

Figure. Perforating artery originating from PCoA

Table. Ipsilateral and contralateral correlation of P1 and PCoA

Correlation ipsilateral between P1 and PCoA		**Coefficient**	**Significance**
P1 left	PCoA left	R = -0.346	P = 0.018
P1 right	PCoA right	R = -0.585	P < 0.001
P1 all	PCoA all	R = -0.482	P < 0.001
Correlation contralateral of P1, PCoA, P1/PCoA		**Coefficient**	**Significance**
P1 left	P1 right	R = 0.409	P < 0.001
PCoA left	PCoA right	R = 0.458	P < 0.001
P1/PCoA left	P1/PCoA right	R = 0.462	P < 0.001

Conclusion

The major findings of the present MRA study at 7 Tesla are three fold. First, we found with 7 Tesla imaging a perforating artery branching from the PCoA in the majority of the PCoA's. Second, we found that the presence of a perforating artery from the PCoA is associated with a larger diameter of the underlying PCoA, although not statistically significant. Third, we found a significant correlation between the left sided and right sided anatomy of the posterior circulation. This is the first study to date that utilized the increased sensitivity of 7T due to increased intrinsic signal-to-noise ratio and prolonged T1 to reliably study the anatomical variability of small, normally non-detectable, arteries in the brain.

[1]*Schomer, D. F., et al. The anatomy of the posterior communicating artery as a risk factor for ischemic cerebral infarction. N.Engl.J.Med. 330.22 (1994): 1565-70.*
[2]*Grond, J van der, et al. A fetal circle of Willis is associated with a decreased deep white matter lesion load. Neurology 63.8 (2004): 1452-56.*