MRA OF THE CERVICAL ARTERIES: MULTISLAB 3D TOF OR 3D FLASH DURING BOLUS INJECTION OF CONTRAST AGENT

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INTRODUCTION

Magnetic resonance angiography (MRA) of the cervical pre-cerebral arteries is generally performed by a 3D time of flight (TOF) technique based on a FISP acquisition in the transverse plan using a multislab technique with progressive excitation. Recently a new approach using a 3D FLASH technique in the coronal plane with ultra-short TR and TE during the IV injection of a bolus of contrast media has been proposed. Due to their high signal to noise both techniques can be more time efficient with higher resolution by using a zero-filling interpolation in the slice selection phase encoding direction. The goal of this study is to compare the classical 3D TOF multislab technique with the 3D bolus FLASH coronal technique in the depiction and quantification of arterial lesions of the pre-cerebral cervical arteries.

METHODS

58 consecutive patients (40 males, 18 females, mean age: 60 years, range: 18 to 86 years) suspected of cerebro-vascular disease, addressed for an MRI of the brain and for MRA study of the pre-cerebral and cerebral arteries were included in this study. MRI and MRA examinations were performed on a 1.5 T whole body commercial scanner equipped with a high performance field gradient system. Brain MRI and MRA of the cerebral arteries was obtained in a head coil. MRA of the pre-cerebral arteries was obtained in a cervical phased-array 4 elements surface coil. Zero-filling interpolation in the phase encoding slice selection direction was used in both MRA techniques. Details of the sequences used are as follow:

- **3D TOF**: FISP multislab TONE in the transverse orientation, TR 30 ms, TE 6.6 ms, pixel size 0.75x0.39x1 mm, acquisition time 5 min 8 sec.
- **3D bolus**: FLASH in the coronal orientation, TR 3.2 ms, TE 1.2 ms, pixel size 1.71x1.17x0.83 mm, acquisition time 10 sec.

Branches of the aortic arch, cervical and intrapetrous carotids up to the basis of the cavernous sinus and vertebral arteries were compared using both MRA techniques by quantifying vascular lesions, technical quality of the images and the degree of venous opacification with the 3D bolus technique. Intraarterial angiographic correlation was available in 10 cases. Review and classification of the lesions was made by two trained neuroradiologists in agreement.

RESULTS AND DISCUSSION

For the 116 carotid bifurcations included in the study 112 were of diagnostic quality with 3D TOF showing 71 normal bifurcations, 19 stenoses of the internal carotid (IC) in the range of 30-70 %, 12 IC stenosis over 70 %, 8 IC occlusions and 2 IC dissection. All carotid bifurcations were of diagnostic quality with 3D bolus showing 73 normal bifurcations, 20 stenoses of the IC in the range of 30-70 %, 13 IC stenosis over 70 %, 8 IC occlusions and 2 IC dissection. For the distal portion of the IC both 3D TOF and 3D bolus demonstrated 3 additional IC stenoses in the same manner. For the branches of the aortic arch only the 3D bolus was able to diagnose 3 stenoses of the sub-clavian artery. For the V2 to V4 segments of the vertebral arteries 6 stenoses, 1 dissection and 8 occlusions were demonstrated identically by both MRA techniques. 1 stenose of the V4 segment was diagnosed by the 3D TOF only. 1 dissection was diagnosed by the 3D bolus only. 4 stenoses of the ostium of the vertebral artery were recognized only by the 3D bolus technique.

At qualitative evaluation for 231 arterial segments, 3D TOF was superior in 14 cases, 3D bolus was superior in 38 cases and both techniques were equivalent in 179 cases. Patient motion and turbulent flow were the more frequent causes of artifacts. 3D TOF was more sensitive than 3D bolus. Premature opacification of the jugular veins disturbed the analysis of 9 carotid bifurcation out of 116 by 3D bolus.

In conclusion the 3D FLASH bolus technique acquired in the coronal orientation allows similar diagnosis of vascular lesions of the pre-cerebral arteries as the classical transverse 3D TOF technique. Furthermore 3D bolus is able to demonstrate some additional lesions of the proximal supra-aortic vessels.