MRA of Arteries Supplying the Lower Spinal Cord in TAAA-Patients

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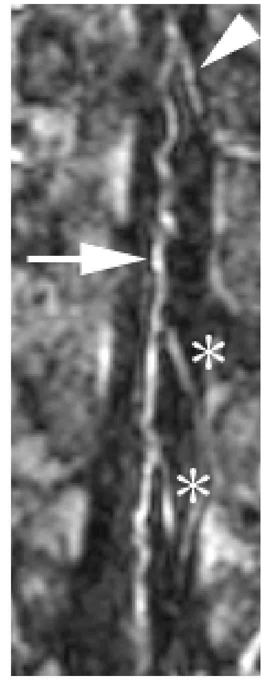
Introduction

Paraplegia is one of the most feared complications during elective replacement of a thoracoabdominal aorta aneurysm (TAAA). To prevent this complication, it is of great interest to visualise the feeding spinal arteries prior to surgery. Ischaemia of the spinal cord can be prevented by re-implanting crucial segmental arteries (SAs) in the prosthetic aorta. In TAAA patients a large number of the SA orifices are occluded due to atherosclerosis. The spinal cord feeding artery that is considered the most important is Adamkiewicz' artery (AKA). This AKA, which is the largest of all anterior radicular arteries (ARA), originates in most cases between vertebral levels T8 and L2. The standard of reference for depiction of feeding spinal arteries is selective intra-arterial digital subtraction angiography (DSA) [1] of SAs. This invasive test is usually avoided because it may lead to neurological deficits, especially in TAAA patients. During selective angiography the catheter is scraped over the inner wall of the aorta and may easily occludes SA orifices with atherosclerotic material, which in turn may cause spinal cord ischaemia. Recently CE-MRA emerged as a possible substitute to visualise the spinal vasculature [2,3]. So far, sensitivities for the detection of the AKA reached however only values of 70 %. This raises the questions whether (i) the applied technique is suboptimal or (ii) the AKA is possibly occluded in a subgroup of TAAA patients. With the current study we aim to demonstrate a CE-MRA technique that is able to consistently visualize feeding spinal cord arteries, which are approximately 1 mm in diameter, in TAAA patients.



Materials and Methods

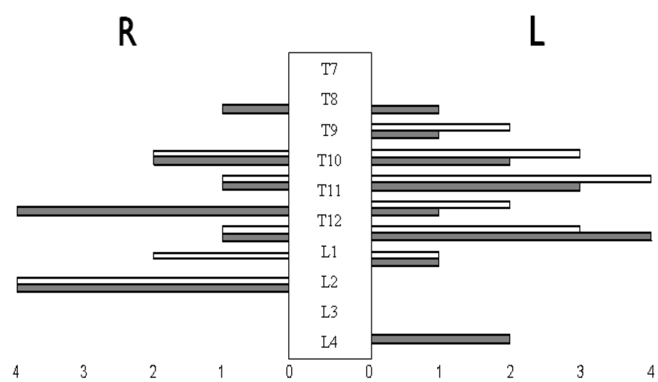
Twenty-five consecutive patients scheduled for elective TAAA repair were included in the current study. All scans were performed on a 1.5T clinical MR system (ACS/NT, Philips Medical Systems, Best) using a quadrature phased-array spine coil. To image the entire aorta, the FOV covered a region from the third thoracic (T3) down to the first sacral vertebra (S1). The scanning protocol consisted of (i) a T2 weighted anatomical scan, (ii) bolus timing, and (iii) CE-MRA. The anatomical scan was carried out to identify the different vertebral levels of the observed SAs. Bolus timing was performed to determine the delay between injection start and enhancement of the aorta. Subsequent dynamic CE-MRA consisted of two scans of 40s each with optimized centric k-space filling [4]. CE-MRA acquisition parameters were TR/TE/FA 5.9 ms/1.9 ms/30° and pixel size was 1.0x1.0mm. Partitions were acquired sagitally with 1.2 mm thickness (interpolated to 0.6 mm); the number of partitions was adapted to the each individual patient. A total of 45 mL Gd-DTPA (Magnevist, Schering, Berlin) was injected at 3 mL/s with a power injector. To visualize the feeding spinal arteries multiplanar reformations (MPR) and maximum intensity projections (MIP) of the CE-MRA scans were evaluated. Vascular structures were considered to be arteries only if they were brightest in the first dynamic phase.

Results

In all 25 patients the ASA, AKA, and the connecting SA were detected. In the **figure** a MIP image of the AKA (arrowhead), ARA (asterisks) and ASA (arrow) can be seen. In 21 cases more than one ARA was found. The distribution of ASA and AKA over different spinal levels and laterality of origination is given in the **graph**. The number of surgically confirmed SAs in the FOV (T3-L5) that directly connected with the aorta was 14 ± 7. The number of SAs occluded at the origin but otherwise patent was 22 ± 4. An extensive collateral system mutually connecting the SAs was observed.

Discussion and Conclusion

Dynamic multiphase CE-MRA is capable of detecting the spinal cord feeding arteries in patients scheduled for elective TAAA repair. The discrepancy between number of observed SAs on CE-MRA images and the number of surgically confirmed SAs directly connected to the aorta can be explained by the presence of the extensive collateral system, that apparently functions as back-up. Although on average many SAs are occluded in TAAA patients, the AKA was still visualized in each patient. The percentage of patients with a diagnosed AKA and the number of ARAs per patient of this study is higher compared to previous studies. The reason for this higher sensitivity is probably the higher arterial contrast agent concentration achieved by (i) a higher injection speed compared to Yamada et al [2] or (ii) the higher dose of contrast agent compared to Yoshioka et al [3]. The use of a optimized centric k-space filling and the temporal separation of enhancement phases may furthermore contribute to the distinction between arteries and veins. This improved CE-MRA protocol is proposed as a reliable alternative to DSA in TAAA patients and now makes pre-operative imaging accessible to possibly reduce the number of ischaemic events in future.



References

[1] Kieffer et al. J Vasc Surg 2002;35:262-268.
[2] Yamada et al. JCAT 2000;24:362-368.
[3] Yoshioka et al. RadioGraphics 2003;23:1215-1225.
[4] Willinek et al. Radiology 2002;225:583-8.