Whole-brain MR-DSA using time-resolved 3D contrast-enhanced MRA and Parallel Imaging

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Introduction

Two-dimensional contrast-enhanced MR projection angiography using complex subtraction (1,2) demonstrates vessel perfusion at a high temporal resolution. This technique, termed time-resolved projection or DSA-MRA has proved to be highly effective to demonstrate neurovascular pathologies (e.g. abnormal connections between cerebral arteries and venous structures- dural arteriovenous fistulae) – that cannot be depicted with alternative MR imaging methods (3), and has become an important adjunctive diagnostic tool for neurovascular imaging (4). Besides the lack of volumetric information, 2D projection MRA is hampered by signal cancellations along the thick slab, which in some cases presents a considerable drawback to evaluate the complex intracranial vascular structures. We hypothesized that whole brain, time-resolved volumetric contrast-enhanced MR with parallel imaging offers the possibility to evaluate with both a high temporal and spatial resolution the intracranial vessels.

Materials and Methods

Temporal resolution of time-resolved 3D DSA-MRA is critical and should be at least 2-3 sec/3D data set. With the use of an eight-channel head coil and GRAPPA-based parallel imaging a complete 3D volume could be acquired within 1.8 to 2.1 sec. TR of the RF-spoiled FLASH sequence was minimized to 2.4 ms using a rapid, non-selective rectangular excitation pulse and optimised gradient timing. An acceleration factor of 3 and 30 reference lines were used for parallel imaging. Reference lines have been acquired only once for the first scan, and subsequently used to reconstruct other acquisitions. Spatial resolution was 2.2 x 1.6 mm^2 in-plane, and 5 mm slice thickness, covering the entire head along sagittal orientation.

Five healthy volunteers have been investigate with whole brain 3D contrast enhanced MRA to optimize imaging parameters with respect to temporal and spatial resolution. Subsequently, three patients with suspected or proved dural arteriovenous fistulae were examined. Injection of contrast agent was synchronized with start of image acquisition. Image analysis in healthy volunteers included the visualization of small arteries and veins and the ability to differentiate the different phases of the cerebral perfusion on subsequent frames.

Results

Time-resolved 3D DSA-MRA proved to be a robust method to visualize the cerebral perfusion from the arterial to the venous phase. The temporal resolution of about 1.8 sec/data set proved to be sufficient to visualize the dural fistulae in all cases, and to characterize the flow dynamics of the injected contrast agent. The identification of small vessels was good, if their course was parallel to the acquisition plane but insufficient if they ran perpendicular to the plane.

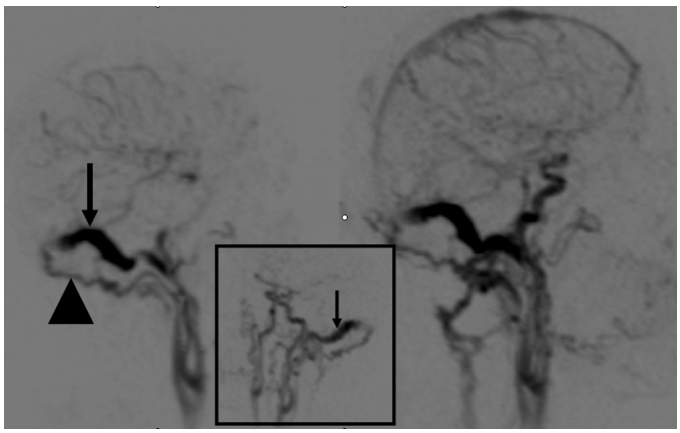

Fig 1. Dural arteriovenous fistula at the right transverse sinus. The temporal resolution of 1.8 s/3D frame allows to visualize the early venous filling (arrow) by the occipital artery (arrowhead) (inlet: oblique projection).

Conclusion

Whole brain 3D contrast enhanced MRA using parallel imaging can provide detailed insight into the cerebral vascular perfusion and has the potential to replace 2D projection angiography for the detection of dural arteriovenous fistulae. 3D time-resolved MRA does not suffer from signal cancellation along slice direction, which represents a major difficulty in 2D projection MRA.

References

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