

3D CE-MR Arteriography and Selective Venography of the Upper Extremity Prior to Hemodialysis Access Fistula Surgery

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Introduction

Preoperative assessment of upper extremity arteries and superficial veins can significantly increase early and late patency of arteriovenous fistulae (AVF) for long-term hemodialysis vascular access. For this purpose, physical examination and duplex ultrasonography are widely used in accordance with the recommendations of the Dialysis Outcome Quality Initiative (DOQI) guidelines (1). However, even with the use of these modalities the failure rate for arteriovenous fistula placement remains up to 70% (2). Recently, postoperative CE-MRA of failing AVF has been reported to be successful for detection of stenoses and obstructions along the vascular tree of the upper extremity (3,4). We hypothesize that preoperative CE-MRA is capable of selectively imaging both the arterial and venous vasculature of the entire upper extremity in a single exam. Such an exam could potentially help decrease the AVF failure rate.

Purpose

To develop a new 3D CE-MRA technique for selective visualisation of the proximal and distal upper-extremity arterial tree, distal superficial veins and proximal central veins in the preoperative work-up prior to AVF placement for hemodialysis access.

Materials and Methods

All imaging was done on a 1.5T clinical MR scanner (Gyrosan-NT Intera R9.1, Philips Medical Systems, Best, The Netherlands). Fifteen renal failure patients scheduled for AVF placement underwent CE-MRA of the upper extremity vasculature. Patients were placed in the supine position with the target extremity next to the body. For signal reception, 4-element quadrature phased array (proximal) and rectangular (400 x 100 mm; distal) surface coils were used. Venous access was established in dorsal hand veins on both sides. Imaging consisted of three separate coronal acquisitions. Distal arteries were imaged first by injecting 19 mL of Gd-DTPA contrast medium (Magnevist, Schering, Berlin, Germany) in the canula contralateral to the target extremity. Second, the proximal arteries and central veins were imaged by injection of 15 mL Gd-DTPA. Five dynamic scans were obtained to depict both arteries and veins. The third and last part of the MR exam consisted of selective imaging of distal superficial veins. Via the ipsilateral canula 60 mL of 1:15 diluted Gd-DTPA was injected in the presence of an inflated pressure cuff (60 mmHg) above the elbow. Except for the field-of-view, imaging parameters were: TR/TE/FA: 5.2ms/1.6ms/40°. Acquired voxel size was between 1.0x2.0x1.5-2.5mm³; calculated voxel size was 0.5x1.0x0.75-1.3mm³. Endpoint was successful depiction (defined as being of sufficient quality for surgery without preoperative X-ray arteriography) of aorta, brachiocephalic, subclavian, radial and ulnar arteries, and full opacification and depiction of cephalic, basilic, median cubital, subclavian, jugular and brachiocephalic veins and their connection into the right atrium. One observer, blinded for the outcome of physical examination and duplex ultrasonography subjectively assessed image quality on maximum intensity projections and source images on a 5-point scale (ranging from 0=not visible to 4=very good).

Results

All examinations were performed successfully. Total examination time including patient positioning and post processing was about 40 minutes. In contrast to physical examination and duplex ultrasonography, CE-MRA resulted in high-quality images of proximal and distal arteries in all patients except for one forearm. Proximal arterial and central venous imaging was rated to be of very good quality (mean score 3.5±0.5; composite of proximal arteries and veins and distal arteries in **figure a**). Distal selective venous injection of contrast media by using a proximal inflated cuff resulted in filling and opacification of all superficial veins (inset; **figure b**) with very good image quality (mean 3.9±0.3). Image quality of distal arteries was good (mean score 3.2±0.4).

Discussion and Conclusions

3D CE-MRA can provide high-quality diagnostic images of upper-extremity arteries and veins. The three-step approach as described enables imaging of both arteries and veins in a single session. It remains to be determined if adding CE-MRA to the preoperative workup improves early and long term patency of AVF.

References

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