Comparison of IVD-HYCR Sampling-Reconstruction with Clinical View-Shared MRA and DSA in Peripheral Vasculature

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INTRODUCTION

X-ray digital subtraction angiography (DSA) is considered the reference standard for assessment of peripheral vascular disease. Recent advances in MR imaging, however, have established MR as a competitive, but far less invasive alternative. View-sharing techniques [1,2], although commonly used, suffer from limited spatial resolution and a broad temporal footprint. In this work, we used a pseudo-randomly undersampled IVD pattern [3] with data-driven parallel imaging [4] and HYCR to acquire high resolution, time-resolved, contrast-enhanced, mask-subtracted angiograms of the peripheral vasculature in a patient population referred for intervention.

METHODS

Twenty-one subjects with known PVD were recruited from our vascular surgery department after IRB approval and obtaining informed consent. Patients were scanned using a 3T system (Discovery MR750, GE Healthcare, Waukesha, WI) and a commercially-available 32 channel body array coil (Necocoil, Pewaukee, WI). HYCR was qualitatively compared to a commercially-available time-resolved contrast enhanced view-shared method [2], and both methods were compared to X-ray DSA (Integriv V system, Philips Medical Systems, Best, The Netherlands).

The MR injection protocol included two separate injections (0.05mmol/kg each) of gadobenate dimeglumine (Multihance, Bracco, Princeton, NJ) followed by a 20 ml saline flush, and all injections were administered at 2.5 ml/s. The MR injection order was randomized in different patients to minimize any related bias. The MR scans were performed prior to the X-ray DSA scans and any interventions. Data-driven parallel imaging [5] was performed for each time-frame. Auto calibration lines were acquired during the mask acquisition and the same lines were used to reconstruct all subsequent time-frames. Sharing the auto calibration lines allowed acquisition of a larger effective central region in each time frame or, alternatively, a reduced view-sharing window necessary to reconstruct a fully-sampled composite image. Figure 1 shows the sampling pattern for the pre-contrast mask and a few subsequent time-frames in the k₁-k₂ plane.

RESULTS

Figures 2-4 show DSA images compared with IVD-HYCR MRA and TRICKs view-shared MRA images of three different patients referred for intervention.

IVD-HYCR imaging parameters include FOV= 48 cm, phase FOV= .75 with matrix size 480 × 360 yielding a 1 mm³ isotropic spatial resolution. True temporal resolution of 6.2 s was matched to the TRICKs image update rate. All the other imaging parameters except for matrix size were also matched to ensure a fair comparison between the two methods. TRICKs had a matrix size of 256 × 192 yielding a 1.9 × 1.9 × 2.2 mm³ resolution. The voxel size was almost 8 times smaller with the IVD-HYCR technique compared to the conventional clinical TRICKs protocol. The higher spatial resolution of the IVD-HYCR technique is apparent in the examples provided here.

CONCLUSION

Combination of the IVD sampling pattern, parallel imaging, and the HYCR sampling pattern provides higher resolution peripheral angiograms, and yields a smaller temporal footprint than the view sharing method used clinically at our institution. Qualitative comparisons with DSA show improved image quality compared to existing clinical practice, reduced artifacts and good diagnostic correlation.

REFERENCES


Figure 1: IVD sampling pattern in the k₁-k₂ plane with data-driven parallel imaging.

Figure 2: X-Ray DSA, IVD-HYCR MRA and conventional TRICKs MRA of a patient with peripheral vascular disease. Male 63 year old patient.

Figure 3: Male 75 year old patient.

Figure 4: Female 70 year old patient.

Figure 5: Segments of the arterial tree that will be graded by two radiologists. The degree of stenosis in each segment is being graded on a 5-point scale (0: normal – 4: occluded). Radiologists are also recording their level of diagnostic confidence on a 4-point scale (0: no confidence – 3: very confident).

DISCUSSION

Two experienced radiologists are grading the severity of stenoses and the diagnostic quality of the IVD-HYCR and view-shared images. The accuracy of the stenosis classification of the two MRA methods will be compared with DSA as the reference. The same two radiologists will also independently determine their overall preferred MRA technique during a separate round of grading.