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# Accelerated 3D carotid MRI using compressed sensing and parallel imaging

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## Introduction

Imaging of the carotid artery with black-blood MRI can be used to identify plaques that are vulnerable for rupture [1,2]. 3D imaging is particularly interesting to overcome the SNR and volumetric coverage limitations of 2D multi-slice techniques. However, 3D scans are more susceptible to motion artifacts, particularly swallowing-related artifacts, due to the longer acquisition times [3]. Parallel imaging can be used to accelerate the acquisition, but acceleration is limited by noise amplification. An alternative acceleration technique is compressed sensing (CS) [4], where image compressibility can be exploited to undersample k-space without losing image information. 3D imaging is a natural candidate for CS, since higher dimensional data sets increase sparsity. We propose to combine CS and parallel imaging to increase the acceleration rate for 3D carotid imaging.

## Purpose

Evaluate the feasibility of highly-accelerated 3D carotid MRI using CS and parallel imaging.

## Methods

3D carotid MRI was performed in a healthy volunteer on a 3 T scanner (Siemens; Tim-Trio) using a custom 8-channel carotid coil array. Fully-sampled 3D fast spin echo data were acquired with T1-weighting. The relevant imaging parameters include: TE = 12 ms, TR = 800 ms, scan-time = 15 min, FOV = 190 mm ×143 mm × 44 mm, image-resolution = 0.3 mm × 0.3 mm × 2 mm. Acceleration was simulated by decimating the fully-sampled data along the phase-encoding (ky) and partition-encoding (kz) dimensions by factors R = 4, 6 and 8, using a random undersampling pattern to generate the required incoherence for CS. Combination of CS and parallel imaging was performed using a single joint reconstruction algorithm (JOCS: joint CS [5]) by enforcing joint sparsity on the multicoil images in order to exploit k-space redundancy and incoherence along the coil dimension. Finite differences along x, y and z were employed to sparsify the 3D data set. A standard GRAPPA reconstruction with simulated acceleration R = 4(2 × 2) was also performed for comparison purposes.

## Results

Fig. 1 shows reconstructed images in an axial view and Table 1 shows the corresponding root-mean-square-error (RMSE) values. JOCS presented improved image quality over GRAPPA, which yielded more noise. Compared with R = 4, acceleration factors R = 6 and R = 8 presented more blurring and change of contrast in regions with low-value finite-differences, which are challenging for JOCS reconstruction. Fig. 2 shows intensity profiles through a carotid vessel. JOCS with R = 4 and R = 6 presented adequate profiles, whereas for R = 8 the epithelium-tissue border was considerably blurred.

## Conclusion

JOCS enables higher accelerations than GRAPPA for 3D carotid imaging, which may markedly reduce sensitivity to motion. Future work will explore the use of geometrically-oriented wavelets to further improve image sparsity.

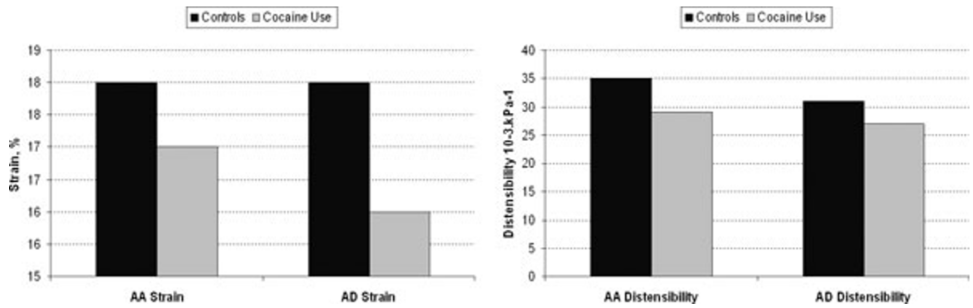


**Figure 1**

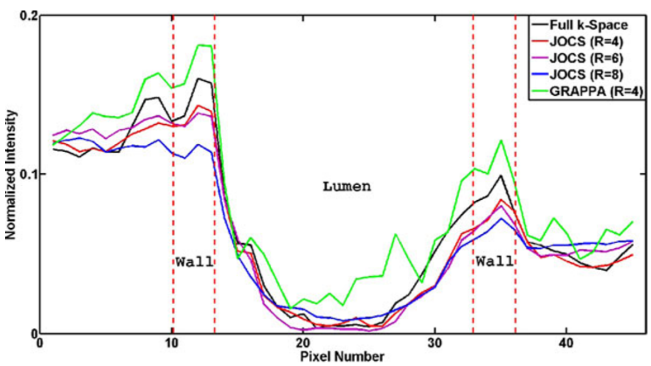


**Fig. 2**: Average of 3 adjacent intensity profiles through a carotid vessel. Red dotted lines denote the vessel wall boundaries.

**Figure 2**
**Average of 3 adjacent intensity profiles through a carotid vessel**. Red dotted lines denote the vessel wall boundaries.

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