HIGH-RESOLUTIONAL VISUALIZATION OF THE LENTICULOSTRIATE ARTERY: APPLICATION OF COMPRESSED SENSING FOR FASTER ACQUISITION

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Introduction: Lenticulostriate artery (LSA) gives blood supply to the basal ganglia and the internal capsule, and its occlusion results in infarct at its territory (1). LSA has been well visualized by Time-Of-Flight (TOF)-MRA at 7T (2), but its visualization is not sufficient at 1.5T and 3T (3, 4). At lower static magnetic field, higher spatial resolution better depicts LSA, but it requires fairly long scan time. This can be mitigated by parallel imaging, but its employment reduces signal-to-noise ratio (SNR), especially at the central area where LSA exists. Another option is compressed sensing (CS), which enables accurate reconstruction of sparsely sampled *k*-space data. Moreover, CS has denoising properties and can help to improve SNR (5). For arteries larger than LSA, CS is capable of reducing acquisition time to around 10-20%, but its capability for smaller and lower SNR structure such as LSA has not been much investigated. Therefore, we investigated capability of CS to reduce scan time, while maintaining visualization of LSA.

Method: Eleven volunteers (mean age 29: range 21-34 y.o.) were enrolled under approval of institutional review board with written informed consent. Scan was conducted using a 3T-MR system (Vantage, Toshiba medical systems, Otawara, Japan) with a 32-channel head coil for 3D TOF-MRA (TR/TE 20/3.4ms, FA 15, in-plane resolution 0.41 x 0.41 mm, 0.5 mm-thick 100 slices) placed parallel to the AC-PC line. The *k*-space data was fully sampled in 16 minutes, and this full data was reconstructed as the reference image. The readout was AP direction, and full *k*-space data was resampled in the *kx-kz* plane for 25, 50 and 75 % of data were randomly selected based on a polynomial probability density function (more samples at the central region). The CS reconstruction was conducted with empirically modified NESTA algorithm (6) regularized with combination of L1-norm, wavelet and total variation. The parameters for the combination and reconstruction were determined by preliminary reconstruction trials (data not shown). The reconstructed coronal images were processed with maximum intensity projection of 40 slices in 5 slice-intervals (partial MIPs). The representative slice that best visualized LSA was selected among MIP images reconstructed using fully sampled data. The same position of MIP slices of 25, 50 and 75 % data were used for analysis. Numbers of visualized LSA branches were counted, and the whole length of visualized LSA was measured.

Results: The average numbers of visualized LSAs were 3.3±2.3 (mean ± SD), 4.6±2.3, 5.7±1.4 and 5.8±1.5, and averages of whole length of LSA were 26.1±17.4, 46.7±22.7, 70.0±23.7 and 71.3±18.7 mm, for 25, 50, 75 and 100 % of data, respectively. No significant difference was observed when images were reconstructed with 75% data compared with the full-sampled images, but the measured values were inferior when only 50% or 25% data was used ($p<0.05$). Note good visualization of MCA branches even with 25% data comparable to the full sampling.

Discussions: On the original slices of TOF-MRA, LSA is often visualized as a tiny bright spot of one to several pixel sizes, even using high-spatial resolution and long scan time at 3T. This study showed that undersampling by 25% (i.e. 75% sampling) can be attained by CS without visualization penalty, but scan time of it is still 12 minutes. Small structures may become indistinguishable when *k*-space data is undersampled by 50% or more. In conclusion, CS reconstruction enabled scan time reduction by 25% for TOF-MRA visualization of LSA. Higher contrast between LSA and background (3, 4), as well as improved CS reconstruction, would be required to increase undersampling rate while retaining visualization capability of small arteries such as LSA.

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