CLINICAL FEASIBILITY OF ACCELERATED TOF MR ANGIOGRAPHY WITH SPARSE UNDERSAMPLING AND ITERATIVE RECONSTRUCTION: COMPARISON WITH CONVENTIONAL PARALLEL IMAGING

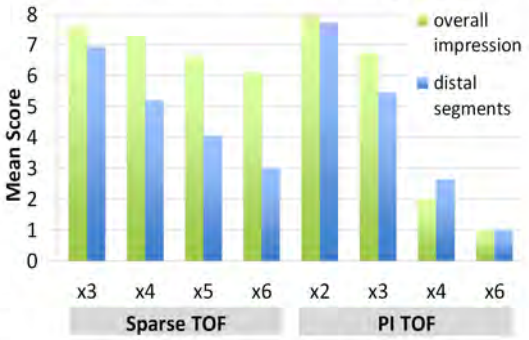
Takayuki YAMAMOTO[1], Koji FUJIMOTO[1], Tomohisa OKADA[1], Yasutaka FUSHIMI[1], Akira YAMAMOTO[1], Aurelien F. STALDER[2], Yutaka NATSUAKI[3], Michaela SCHMIDT[2], and Kaori TOGASHI[1]

[1]Diagnostic Imaging and Nuclear Medicine, Graduate School of Medicine, Kyoto University, Kyoto, Kyoto, Japan, [2]Siemens Healthcare, Erlangen, Germany, [3]Siemens Medical Solutions USA, Inc, Pennsylvania, United States

PURPOSE: MRI application of sparse undersampling and iterative reconstruction with contrast-enhanced MR angiography (MRA) has been widely presented [1]. On the other hand, previous presentation on its non-contrast counterpart (e.g. Time-of-Flight (TOF)) are limited due to their relatively lower CNR. Recent development in the practical sparse MRI for non-contrast MRA application (e.g. sparse TOF [2]) opens an opportunity to introduce this into the clinical settings, and for this proper clinical feasibility study is mandatory. When evaluating the feasibility of sparse TOF, a typical quantitative error measurement such as the normalized mean square error (NMSE) or structural similarity (SSIM) are not appropriate because these do not necessarily correlate with diagnostic information such as visualization of peripheral arteries. Therefore, subjective assessment by radiologists is crucial. We present the results of a subjective evaluation of sparse TOF-MRA in comparison with TOF-MRA accelerated with conventional parallel imaging (PI) technique.

METHODS: Study protocols were approved by the local ethics committee. The Sparse TOF and PI TOF with matched parameters were acquired on healthy volunteers (n=9; mean age, 24.3 years; age range, 22-33 years) at 3.0T scanner with 20-channel head coil (MAGNETOM Skyra, Siemens). TOF-MRA has the following common parameters: TR/TE=21/3.43ms, FA=18°, FOV=199 × 200mm^2, matrix=320×290×204 (interpolated to 640×580×204), and voxel size=0.34×0.34×0.34mm^3. Data were acquired in random orders for each subject using a sparse TOF prototype with acceleration factors of 3,4,5,6 and conventional PI (GRAPPA) with acceleration factors of 2,3,4,6 In this study, we used PI with acceleration factor of 2 (PI ×2) as a gold standard. Reconstruction of sparse TOF was performed at the clinical MR scanner. Image reconstruction for each sparse TOF dataset took about 6 minutes. Maximum intensity projection (MIP) images were created on the scanner and were evaluated by two neuroradiologists with experience of 9 and 17 years. Overall impression and the visualization of distal segments are evaluated based on these MIP images, and were ranked from 8 (best) to 1 (worst) .

RESULTS: The mean score of sparse TOF ×3 was comparable to PI ×2, and superior to PI ×3. Sparse TOF ×4 was also superior or equal to PI ×3, and sparse TOF ×5 was slightly inferior to PI ×3. The image quality of PI declined drastically at ×4 and ×6, whereas the deterioration of sparse TOF was moderate. The acquisition times are displayed on the Table.



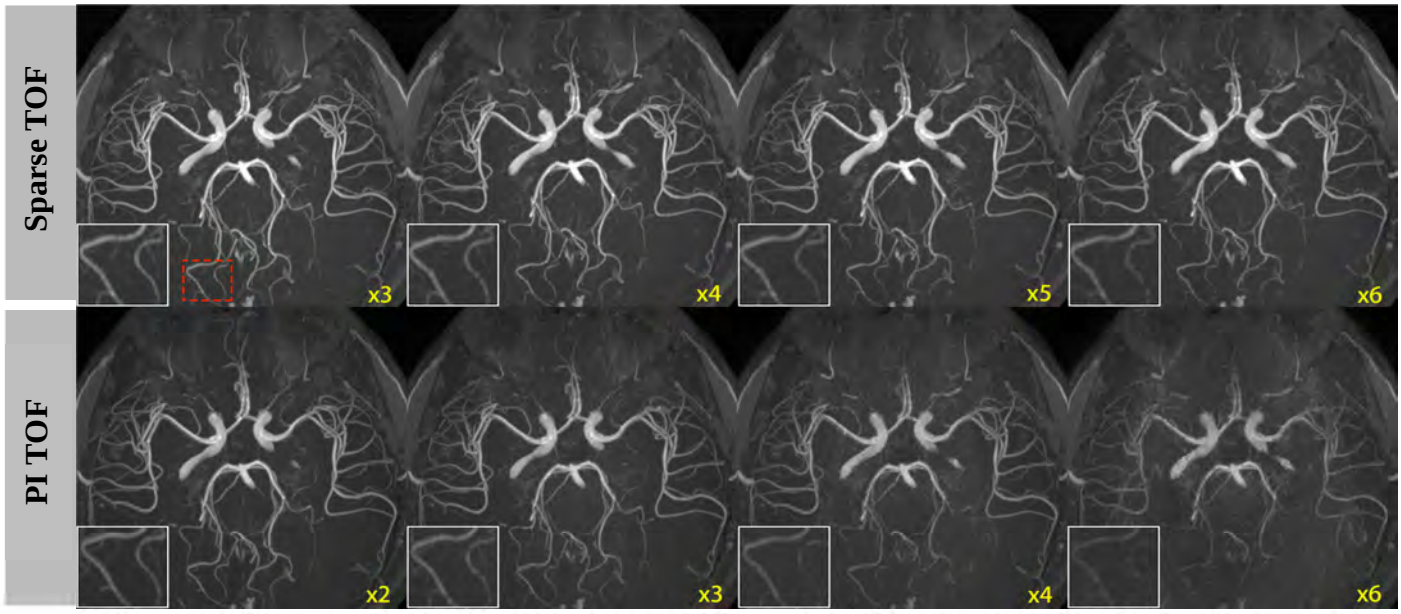
DISCUSSION: There was little difference in quality between sparse TOF ×3 and PI ×2 (gold standard). At 3 or higher acceleration factor, deterioration of images with sparse TOF was moderate while achieving shorter acquisition time. Sparse TOF was not subject to the influence of the g-factor, because incoherent undersampling results in relatively benign artifacts scattered in the whole image. In addition to this advantage, nonlinear reconstruction with the sparse TOF technique effectively removed these artifacts and increased the contrast of the vascular structures.

CONCLUSION: Sparse TOF-MRA achieved higher acceleration while maintaining visual quality and can thus be used in a clinical setting.

Acquisition Time (min)

Acc.	×2	×3	×4	×5	×6
sparse TOF		5:27	4:26	3:41	3:13
PI TOF	8:04	5:54	4:51		3:44

REFERENCES: [1] Lustig, M. et al. Magn. Reson. Med. 58, 1182–1195 (2007). [2] Natsuaki, Y. et. al. ISMRM 2014 #0941



MIP images of Sparse TOF and PI TOF. The view of distal segment of PCA is enlarged (red and white rectangle).