

Non contrast enhanced MRA of the supra-aortic arteries with compressed sensing and parallel imaging

Takayuki Masui¹, Motoyuki Katayama¹, Naoyuki Takei², Kevin F King³, Kimihiko Sato¹, Kei Tsukamoto¹, Kenichi Mizuki¹, Masayoshi Sugimura¹, and Koji Yoneyama¹

¹Radiology, Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan, ²GE Healthcare Japan, Hino, Tokyo, Japan, ³GE Healthcare, Waukesha, Wisconsin, United States

Target audience: Physicians, technologists and scientists who are interested in non-contrast enhanced MR angiography applying to the area of branches of the aortic arch including carotid bifurcation to detect cerebrovascular diseases.

Introduction: Non-contrast enhanced MR Angiography (NC MRA) using an investigational version of Inflow Inversion Recovery technique with 3D FSE (IFIR FSE: GEHC) can be used for evaluation of arteries in the neck with parallel imaging ARC (GEHC) and compressed sensing (CS) at 3T (Fig 1) ¹⁻³. The former study showed reduction of imaging time with ARC and CS². However, excessive reduction of k space data caused degradation of image quality and a 320x320 matrix was at least required. Further optimization IFIR with ARC and CS, reduction of imaging time can be made using a matrix of 256x256. Currently the imaging time of MRA for neck arteries can be reduced to 1 min to 3 minutes with acceleration of approximately 5 to 10 times. Accordingly, the purpose was to evaluate feasibility of NC MRA at 3T in combined use of ARC and CS for the evaluation of the neck arteries as a screening method in a short period of time.

Materials and Methods: Peripheral pulse gated (PG) NC MRA with IFIR FSE was performed in a coronal plane covering the aortic arch to the skull base on a 3T magnet (Discovery MR750, GEHC) with head and neck phased array multicoil. The patients who had a suspicion of cerebrovascular diseases were studied. Total of 37patients (32 men, 5 women, mean age 66.7years ranged from 51 years to 81years), were included in the study. The following parameters for IFIR were used, TR/TE 4000ms~/3.7ms, FOV30cm, matrix 256x256, 1.4mm slice thickness, ARC acceleration 3x2 (Y x Z) or 3x1. For the evaluation of the carotid bifurcation, 3D time of flight (TOF) was obtained for comparison with the parameter of TR/TE 18ms/3/4ms, FOV 16cm, matrix 320x192, slice thick 2mm, overlap 1mm, flip angle 18 degree, number of images 72, and imaging time 2,22 without PG. **Data analysis:** Heart rate and each imaging time for MRA were recorded. Image quality, artifact s and visualization of origins of branches of the aortic arch (brachial cephalic arteries (BCA), common carotid (CCA), subclavian (SA), vertebral (VA) were evaluated in IFIR FSE MRAs with and without CS. And visualization of the distal CCA, proximal internal and external carotid (ICA, ECA) around the carotid bifurcation was also evaluated in IFIR FSE and TOF MRAs.

Results: Imaging time of MRA with ARC3x2 and CS was 59.3sec and 96.2sec for MRA without CS with heart rate of 68bpm in 30 patients (Fig3). Imaging time with ARC3x1 and CS was 134.3sec and 210.7sec without CS with heart rate of 62bpm in seven patients (Fig4). With a matrix of 256x256 using ARC 3x1, image quality of MRA tended to be better than that with ARC 3x2. With CS, MRA with ARC 3x1, 3x2 showed blurring effects proximal part of the neck arteries or signal decrease in distal part of arteries (Fig 3, 4). NC MRA with TOF might have stable image quality in a small imaging coverage (Fig3,4). In the area around the center of FOV; carotid bifurcation, information was maintained in MRA with ARC 3x1 and 3x2 using CS.

Discussion: With ARC and CS, acceleration factor of about 5-10, might be used for noncontrast MRA with IFIR FSE for the neck arteries. Currently, MRA with a matrix of 256x256 and 1.4mm slice thickness can be obtained in approximately less than 2 minutes. With solely ARC 3x2, or ARC 3x1+CS, competitive imaging time for MRA can be made with similar imaging quality. In combination of CS, further improvement of fast imaging can be expected by optimizing IFIR MRA sequences.

Conclusion: Non-contrast enhanced MRA using investigational version of IFIR in combined use of ARC with/without CS can provide information of neck arteries in a short period time. Further optimization of sequence with ARC and CS might be expected to facilitate reduction of imaging time and improvement of imaging quality, thus it is expected to be additionally used for routine clinical study.

Reference (1) Takei N, Miyoshi M, Kabasawa H. J.Magn.Reson.Imaging 2012;35:957-962 (2) Masui T, Takei N, ISMRM, 2013, 3)King KF. ISMRM 2008 1488.

Fig3 No stenotic lesion in the neck artery

ARC3x2, 256x256 CS (+) IFIR FSE CS (-) 3D TOF

Fig4 Stenosis of the right internal carotid artery

ARC 3x1 256x256 CS (+) IFIR-FSE CS (-) 3D TOF

