Non-Contrast MRA with FIESTA using IR-IFIS for Selective Visualization the Renal Arteries

T. Masui[1], M. Katayama[1], K. Sato[1], H. Seo[1], K. Ito[1], H. Ikuma[1], M. Sugimura[1], N. Takei[2], M. Miyoshi[2], T. Tsukamoto[2], M. Ishii[1], and A. Kutsuna[1]

[1]Seirei Hamamatsu General Hospital, Hamamatsu, Shizuoka, Japan, [2]Japan Applied Science Laboratory, GEYMS, Hino, Tokyo, Japan

Introduction: Dynamic contrast MR and CT angiography have been used for the evaluation of the vascular diseases in the body, which may replace diagnostic invasive angiography. However, in case of contraindication of use of contrast media including renal insufficiency or allergies, non-contrast MR angiography has an important role. Selective visualization of the arteries is especially required for the evaluation of the renal arteries since the left renal artery and vein courses parallel, causing their overlaps in projection images. Currently, selective visualization of the renal arteries can be performed with 3D fast imaging employing steady state acquisition (FIESTA)(GE, Milwaukee) using Inversion recovery-In Flow Iterative Spatial Saturation pulse (IR-IFIS), based on tagging of the blood in the heart and thoracic aorta, which is flowing through the abdomen, with background suppression by non-selective inversion pulse. The purposes of the current study were to optimize imaging parameters of IR-IFIS for selective visualization of the renal arteries and to apply non-contrast MR angiography with IR-IFIS for the patients with suspected renal tumors compared with contrast MR angiography.

Materials and Methods: *Subjects:* This study consisted of two parts: In the first part of the study, nine volunteers (8 men, 1 woman, mean age 31 years) were studied with non-contrast MR angiography with IR-IFIS for the optimization of the imaging parameters. In the second part, 14 patients (9 men, 5 women, mean age 54 years) suspected with renal tumors were evaluated. *MR imaging:* Pulse sequence-FIESTA with IR-IFIS (Fig 1); Iterative spatial saturation pulses were applied with the interval of 50ms for about 2 second covering the upper abdomen including the heart (Fig2). Non-selective inversion pulse was triggered during respiratory and peripheral gating. After the wait time, the T2 preparation sequence (TE 48msec or longer) was applied followed by the Spec IR fat-sat pulse, and segmented 3D FIESTA. The data were acquired in diastole. All MR imaging was performed on a 1.5T magnet (TwinSpeed HD, GE Milwaukee) with an 8-channel phased array multicoils. After localization, respiratory triggered peripheral gated 3D FIESTA in a coronal plane was obtained using IR-IFIS, with as following parameters; TR/TE/FA/FOV/Matrix/slice thickness/ASSET; 3.8/1.9msec/90°/350×350mm/256×256/2/2 with SpecIR for fat suppression. Evaluated parameters were as follows; 1) Inversion Time (TI, Prep time) 800msec～1200msec, 2) Width of Spatial Saturation 75mm～175mm, 3) Background suppression (Category 0 ~ 4, T2 prep time TE, 48-144ms. In the second part of the study, optimized parameters from the results of the first part were used for 3D FIESTA with IR-IFIS; the same parameters as before except TI of about 1000ms, spatial saturation of 100mm, background suppression of 0 (TE 48ms). Imaging time was approximately 3-4min. Contrast dynamic MRA was obtained with 3D gradient echo sequence (EFGRE) using TR/TE/FA/FOV/Matrix/slice thickness/ZIP/ASSET: 2.9/ 0.9ms/30°/350mm/256x192/2/2, centric k space ordering. After injection of 0.2mmol/kg of gadolinium chelates with injection rate of 0.3ml/sec, smart prep (GE, Milwaukee) was used for triggering of the acquisition. Five seconds after the arrival of the contrast medium, breath-hold 3D EFGRE was obtained in 24 seconds. *Evaluation* In the first part, signal intensities (SIs) of the regions of interest (ROIs), which were placed at various points were measured. Effects of changes of 1) TI or Prep time, 2) Width of Spatial saturation, and 3) TE for T2 prep background suppression were evaluated. In the second part, the number of recognized renal arteries, image quality, artifacts, recognition of the upper and lower aorta, proximal, distal renal arteries, IVC were evaluated with a five-point scale. **Results:** In the first part of the study, the results were summarized in Figs 4. Increase of TI or prep time increased SI of the vascular structures except IVC (Fig4a). Width of Spatial saturation did not affect the SI of the structures (Fig4b). Increase of TE for T2 prep caused stronger background suppression (Fig4c). Thus, optimal parameters for these evaluated features were TI or Prep time of 1000-1000ms, Width of Spatial saturation of 100-1500mm, TE for T2 prep of 48 or 72ms. In the second part, over all image quality was better in contrast MRA than non contrast MRA (C: Non, 4.3:3.3). Lower part of the aorta in contrast MRA was better recognized than in non contrast MRA (4.7:3.0). Visualization of the renal arteries were better in contrast MRA than in non contrast MRA (4.8~3.9: 3.9~1.9). The number of the recognized renal arteries was identical in both MRAs. In the case of three right renal arteries, one of which originated from the right common iliac artery, both MRA visualized all renal arteries (Fig 5).

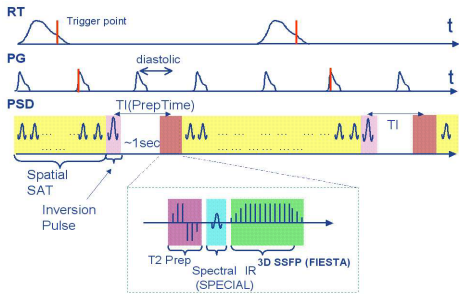

Fig.1. Iterative spatial saturation pulses are used to tag a specific blood and non-selective inversion pulse suppresses background tissues in a non-subtractive fashion. Both respiratory and peripheral triggering (RT, PT) are performed. TI is inversion time equal to preparation time.

Summary and Conclusion: The selective visualization of the renal arteries can be performed with non-contrast MR angiography with respiratory triggered peripheral gated IR-IFIS. In normal volunteers entire abdominal aorta and renal arteries can be demonstrated, which keep adequate high flow velocity in the aorta and renal arteries. Peripheral gating can be used for triggering in stead of ECG gating. In patients with suspected renal diseases, their mean age was higher and slower flow velocities in the arteries were expected. Thus, for visualization of arteries, focus of the interest may be carefully made. However, without use of contrast media, non-contrast MRA using 3D FIESTA with IR-IFIS has potential use of visualization of the vasculatures of interest.

Fig 2 Spatial saturation pulse (Green band). **Fig 3** ROI for SI measurements.

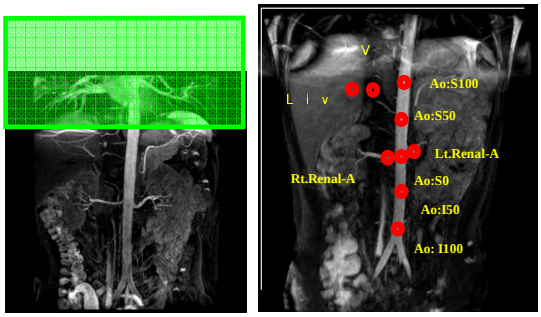

Fig 4a Effects of Increase of TI on SI.

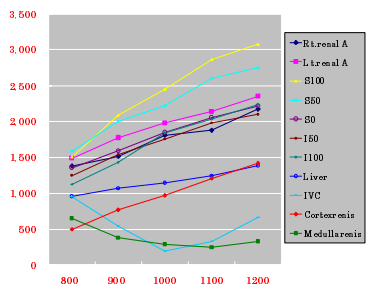

Fig4b Effects of Increase of Width of Sp Sat.

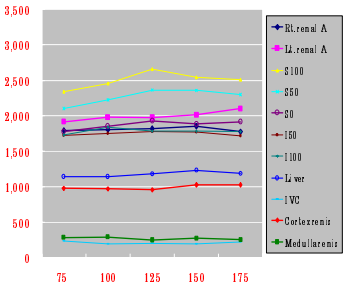

Fig4c Effects of Increase of TE for T2 prep (background sup

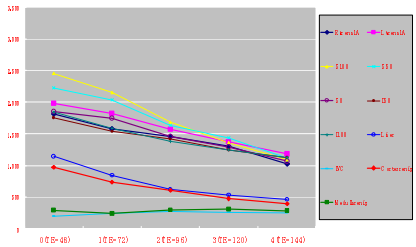

Fig5a Non-contrast MRA with IR-IFIS, **Fig5b** Contrast MRA