OPTIMIZATION FOR NON-CONTRAST ENHANCED MRA OF RENAL ARTERY AT 3T: EVALUATION OF BBTI WITH CONSIDERATION OF RENAL BLOOD VELOCITY

Yasuhisa Kurata[1], Aki Kido[1], Koji Fujimoto[1], Kayo Kiguchi[1], Kyoko Takakura[1], and Kaori Togashi[1]
[1]*Department of Diagnostic Imaging and Nuclear Medicine, Kyoto University Graduate School of Medicine, Kyoto, Kyoto, Japan*

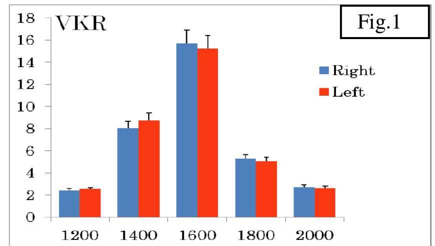
Target Audience: Clinical radiologists and technician who are interested in non-contrast-enhanced MRA or urogenital imaging.

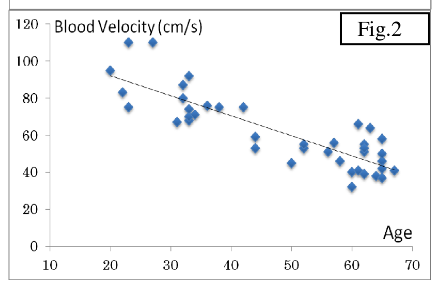
Introduction:

Time-spatial labeling inversion pulse (time-SLIP) is one of the well-known techniques for the non-invasive acquisition of angiogram of the arteries. In this technique, both factors of arterial visualization and background suppression are important for good visualization of MRA image. Black Blood Inversion Time (BBTI) defines these two factors. Optimal BBTI for 1.5T machine was reported to be 1500ms[1], and optimal BBTI for 3.0T machine is thought to be longer because of elongation of T1values at 3.0T. We speculated the age might also affect optimal BBTI since the aging has been known to influence renal blood velocity on US [2]. Hence, we aimed to evaluate the reasonable BBTI for obtaining non-contrast-enhanced MRA of renal artery using time-SLIP technique at 3.0-T. In addition, we also measured blood velocity of abdominal aorta using phase contrast technique, and determined whether optimal BBTI was influenced by age and blood velocity.

Materials and Methods:

Forty healthy volunteers (23 men and 17 women; range 20-67y.o. average 47.9±15.5) were enrolled for the study. MR studies were performed using 3.0-T MR system (Toshiba Medical Systems, Otawara, Japan). Non-contrast enhanced MRA using 3D true SSFP imaging sequence with fat saturation using short time inversion recovery (TI=220) was performed in the coronal plane with the following parameters: TR/TE/FA=4.8ms/2.4ms/120, slice thickness/gap=2/0mm, number of slices=40-54, number of averages=1, field-of-view=330mm×200mm, matrix size=256×128. The final images were reconstructed into an apparent spatial resolution of 1.3mm×1.6mm×5mm. BBTI=1200,1400,1600,1800,2000ms were selected for evaluation. An ECG gating and respiratory triggering was conducted at the beginning of expiration using a bellows wrapped around the abdomen to reduce motion artifact. A selective tagging pulse with a 15cm width was placed above the superior pole of the cranially located kidney. For suppression of the signals of inferior vena cava, an inferior saturation pulse below the tagging pulse was applied. Blood velocity of the abdominal aorta was measured at the level of renal arteries using 2D phase contrast technique.

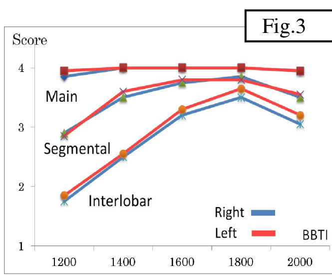


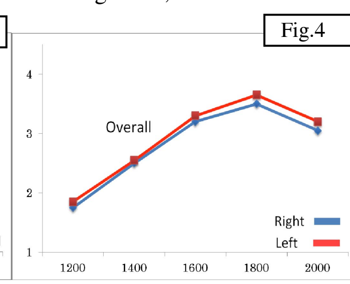


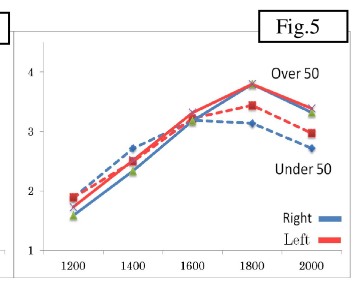
Quantitative evaluation:

The relative signal intensity(SI) of the main renal artery was compared with SI of the renal medulla. These values were used to calculate the relative SI. The vessel to kidney ratio (VKR) was calculated as follows: VKR = {SI(renal artery) - SI(renal medulla)}/SI(renal medulla)

Qualitative evaluation: For visual evaluation, renal arteries were divided into three segments, as follows: main artery, segmental branch, interlobular artery. The image quality of each arterial segment and overall arteries were visually rated (score 1-4) by two radiologists independently. In addition, the relationship between age and blood velocity was assessed. One-way repeated analysis of variance and Friedman's non-parametric test were used for statistical analysis.

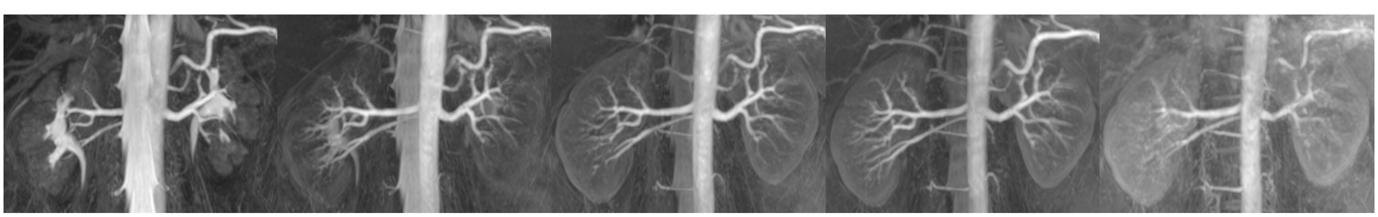






Results: As for the VKR, images with a TI of 1600ms showed the highest ratio bilaterally. Significant differences were noted between all TIs except for the pairs of 1200ms and 2000ms(Fig.1). As for the relation between the ages and blood velocity, strong negative correlation was confirmed (Spearman's coefficient of rank correlation=-0.812, P<0.0001) (Fig.2). The results of qualitative evaluation were shown on figure 3-4. In almost all the segment, image quality in TI of 1200 was significantly poor. In interlobar artery and overall image, image quality in TI of 1800 tended to be better than other TIs. When subjects were divided into two groups (subjects over and under 50y.o.), TI of 1800 tended to show better image quality than others in subjects over 50y.o. In subjects under 50y.o., both TI of 1600 and 1800 tended to show better image quality than other TIs (Fig.5).

Conclusion: The optimal BBTI for visualizing renal arteries by time-SLIP technique at 3.0T was 1600-1800ms regardless of the ages according to qualitative and quantitative analysis. In younger subjects, image quality in TI of 1600ms or 1800ms tended to be better and older subjects in TI of 1800ms, probably due to the difference of blood velocity.



(23y.o. female) TI=1200 TI=1400 TI=1600 TI=1800 TI=2000

References: [1] Takahashi J, Isono S, Miyazaki M, et al. Proc.Intl. Soc. Mag. Reson. 17(2009)
[2] Tetsuka K, Hoshi T, Sumiya T, et al. The influence of aging on renal blood flow in human beings. J Med Ultrasonics 2003; 30:247-251