

## High b-value diffusion-weighted MR images of urothelial cancer

M. Takeuchi<sup>1</sup>, K. Matsuzaki<sup>1</sup>, and H. Nishitani<sup>1</sup>

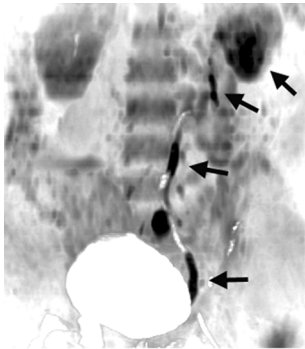
<sup>1</sup>Department of Radiology, University of Tokushima, Tokushima, Tokushima, Japan

**[Introduction]** Urothelial cancers (transitional cell carcinoma) may occur in renal pelvis, ureter, and urinary bladder, and may often appear as multiple lesions with/without urinary tract obstruction. Preoperative detection of all tumors and evaluation of local invasion are helpful for adequate surgical planning. However FDG-PET is useful for malignant tumor detection, it has a limit in evaluating urinary tract cancers because of physiological radiotracer excretion. The purpose of this study is to evaluate urothelial cancers by free-breathing and high b-value diffusion-weighted images (DWI) and corresponding isotropic ADC maps for the tumor detection in the whole urinary tract, and the evaluation of depth of invasion in urinary bladder cancers.

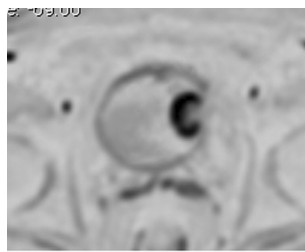
**[Materials and Methods]** Forty five urothelial cancers (two renal pelvic cancers, 15 ureteral cancers and 28 bladder cancers in 39 patients) were evaluated. Free-breathing DWI with high b-value ( $b=800 \text{ sec/mm}^2$ ) was performed in all subjects with a spin-echo, single-shot EPI sequence on a system with a 1.5-T superconducting unit (Signa Excite, General Electric, Milwaukee, WI) with 8ch body-array torso coils. The parallel image-encoding techniques (the array spatial sensitivity encoding techniques: ASSET, General Electric, Milwaukee, WI) were employed. Signal intensity on DWI (black and white inversion) was visually evaluated by two radiologists. The isotropic apparent diffusion coefficients (ADCs) of urothelial cancers, bladder walls and lumens were measured from ADC maps on the workstation (AW 4.2). Static-fluid MR Urography (MRU) based on heavily T2-weighted sequences was also obtained for the evaluation of urinary tract obstruction, and fusion images with maximum intensity projection (MIP) of DWI were reconstructed. The depth of invasion in urinary bladder cancers was evaluated on DWI, T2-weighted images and dynamic contrast-enhanced images (Liver Acquisition with Volume Acceleration: LAVA).

**[Results]** All 45 urothelial cancers showed very high intensity on DWI. The ADC in 45 urothelial cancers was  $1.43 \pm 0.29 \times 10^{-3} \text{ mm}^2/\text{sec.}$ , which was significantly lower than those in bladder walls ( $2.25 \pm 0.35$ ) and lumens ( $3.48 \pm 0.27$ ). MIP of DWI can clearly demonstrate tumor extent, and MRU in combination with DWI (fusion images) provided the three-dimensional entire urinary tract imaging with the extension of tumors. Multiple lesions of urinary tract were well visualized on fusion images (Fig. 1). Hemorrhagic materials in dilated ureter showed high intensity on DWI mimicking cancer, and the lack of contrast-enhancement was diagnostic finding. In bladder cancers, DWI could better visualize hyperintense papillary tumors with hypointense stalks suggesting no invasion (Fig. 2). In bladder cancers with muscular invasion, DWI could clearly demonstrate invasive areas, which were unclear on T2-weighted images because of edematous bladder wall thickening (Fig. 3).

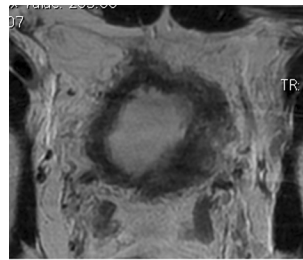
**[Conclusion]** Free-breathing and high b-value DWI may be useful in detecting solitary or multiple urothelial cancers. The fusion images in combination of DWI and MRU are useful in tumor detection and in evaluation of tumor extent in the entire urinary tract. In bladder cancers DWI can provide useful information for the evaluation of depth of invasion. DWI can be obtained without the administration of contrast medium and is suitable for patients with pregnancy, allergic to contrast agents, or renal dysfunction.



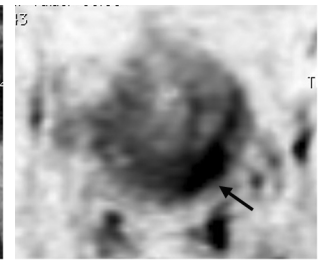
**Fig.1:** Fusion image of DWI and MRU



**Fig.2:** DWI



**Fig.3a:** T2WI



**Fig.3b:** DWI

Fig.1: Multiple left ureteral and renal pelvic cancers (arrows) are well visualized on the fusion image of DWI and MRU.

Fig.2: Papillary non-invasive bladder cancer shows high intensity with hypointense stalk on DWI.

Fig.3: Muscular invasion in edematous thickened wall (arrow) in invasive bladder cancer is well demonstrated on DWI.