MR imaging of early stage uterine cervical cancer: Diagnostic impact of diffusion-weighted imaging and 3D-dynamic contrast-enhanced MRI at 3T

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[Introduction] MRI is a useful tool for the evaluation of uterine cervical cancer, however, small lesions are occasionally hard to demonstrate on MR examination at 1.5T. In routine MR examination of cervical cancer, T2-weigted imaging is the most useful sequence in tumor depiction and staging. Cervical cancer appears as a high intense mass within low intense cervical stroma on T2-weigted images. In FIGO stage I cancer, the mass is confined to the stroma and low intense stromal ring surrounding high intense mass is completely intact. However, small stage IB1 diseases are often undetectable on usual T2-weighted images, and stage IA cancers are defined as microscopic diseases, which could not be demonstrated on usual MRI. 3T-MRI can offer high-resolution MR images with increased matrix and reduced slice thickness due to increased signal-to-noise ratio (SNR). High-resolution diffusion-weighted imaging (DWI) may be able to detect small hypercellular cancerous foci with decreased apparent diffusion coefficient (ADC). 3D-dynamic contrast-enhanced MRI (3D-DCE-MRI) may reveal hypervascularity of micro-invasive cancer due to angiogenesis of cancer cells. We evaluated the diagnostic impact of 3T-MRI in demonstrating early stage uterine cervical cancer by using DWI and 3D-DCE-MRI.

[Materials and Methods] Pathologically diagnosed 30 small early stage cervical cancers, which are not larger than 4 cm, were retrospectively evaluated. The subjects include 9 microscopic diseases (7 carcinoma in situ (CIS); 1 IA1; 1 IA2) and 21 small visible cancers (18 IB1; 3 IIA1). 9 microscopic diseases include 8 squamous cell carcinomas and 1 adenocarcinoma, whereas 21 small visible cancers include 16 squamous cell carcinomas and 5 adenocarcinomas. MR images were obtained in all subjects on a system with a 3T superconducting units (Signa HDx 3T, General Electric, Milwaukee, WI) with 8ch body-array torso coils. Both axial and sagittal DWI with high b-value (b=800 sec/mm^2; TR/TE=6000/56.1-64 ms; FOV:40cm; matrix:128*192; Slice thickness:3-5 mm; 4 NEX) was performed in all subjects with a spin-echo, single-shot EPI sequence. The parallel image-encoding techniques (the array spatial sensitivity encoding techniques: ASSET) were employed for DWI. Both short-axial and sagittal fast spin-echo T2-weighted images (TR/TE=7000/100 ms; FOV:28cm; matrix:512*288; Slice thickness:2-3mm; 2 NEX) were obtained in all subjects. Axial or sagittal 3D-DCE-MRI (FOV:30cm; matrix:320*192; Slice thickness:4 mm/2mm overlap) was performed in all subjects with a 3D-SPGR sequence with fat suppression (LAVA: Liver Acquisition with Volume Acceleration). Contrast-enhancement of the tumor was divided into 3 types. Type A, nodular enhancement in the early phase; Type B, thickened mucosa-like enhancement in the early phase; Type C, linear enhancement along the mucosa in the early phase. DWI finding of the tumor was divided into 3 types. Type a, very high intense nodule; Type b1, linear very high intensity along the mucosa; Type b2, linear slight high intensity along the mucosa. Contrast-enhancement pattern and DWI finding were visually evaluated by two radiologists. They were blinded to the histopathological types and clinical staging of the lesions. Agreement between the two radiologists was reached in consensus after careful individual evaluation.

[Results] The numbers for each type on 3D-DCE-MRI were as follows: In 21 small visible cancers, Type A, 18; Type B, 3; Type C, 0. 14/16 squamous cell carcinomas (SCC) showed intense contrast-enhancement (CE), and the other 2 SCC showed intermediate CE. Whereas, 2/5 adenocarcinomas (AC) showed intense CE, 2/5 AC showed intermediate CE, and 1/5 AC showed weak CE. In 9 microscopic diseases, Type A, 1; Type B, 0; Type C, 7; no CE, 1. Better CE due to the T1-prolongation and better fat suppression due to the increased separation of the fat and water resonant frequencies can offer high-quality 3D-DCE-MRI at 3T, which can visualize minute cancerous foci as intensely enhancing areas (Type A, B). Triratanachat et al. reported that microvessel densities of CIS and stage Ia cancer were significantly increased than those of control subjects due to angiogenesis of cancer cells (Int J Gynecol Cancer 16, 2006). Although stage Ia cancer and CIS do not form visible mass, 3D-DCE-MRI could demonstrate early CE along the mucosa (Type C) reflecting atypical vascular proliferation in some cases. However, inflammation due to cervicitis or healing process after biopsy may also increase the mucosal vascularity and may show similar appearances on 3D-DCE-MRI. The numbers for each type on DWI were as follows: In 21 small visible cancers, Type a, 21; Type b1, 0; Type b2, 0. In 9 microscopic diseases, Type a, 1; Type b1, 1; Type b2, 4; no signal increase, 1; poor image due to susceptibility artifact, 2. High-resolution DWI can detect small cancers as very high intense areas (Type a). Not only SCC but also AC appeared as high intense areas reflecting their increased cellular density. In some microscopic diseases, DWI could demonstrate signal increase along the cervical mucosa reflecting local hypercellularity due to cancer cell proliferation (Type b1, 2).

[Conclusions] We conclude that 3T-MRI can provide useful information for the diagnosis of early stage uterine cervical cancer, especially in evaluating minute "hard to find" earlier stage lesion by using high-resolution DWI and 3D-DCE-MRI.

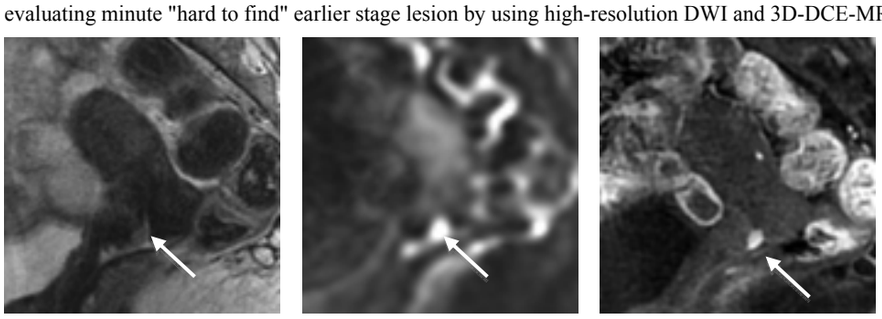

Figure 1: Stage Ib1 cervical cancer: Slight high intense small lesion is visible but not clear on T2-weighted image (left). Very high intense nodule (Type a) is observed on DWI (middle). Intense CE area (Type A) in the early phase of 3D-DCE-MRI (right).