

Concurrent Chemoradiotherapy-induced Pelvic Bone Marrow Changes Based on Intravoxel Incoherent Motion MR imaging in Patients with Cervical Cancer: Initial Findings

Jian He¹ and Bin Zhu¹

¹Department of Radiology, Nanjing Drum Tower Hospital, Nanjing, Jiangsu, China

Concurrent Chemoradiotherapy-induced Pelvic Bone Marrow Changes Based on Intravoxel Incoherent Motion MR imaging in Patients with Cervical Cancer: Initial Findings

Target audience:

Gynecologic oncologists, radiation oncologists, radiologists who are interested in bone marrow or clinical application of diffusion weighted imaging as well as intravoxel incoherent motion MR (IVIM) imaging.

Purpose:

To explore the diffusion and perfusion-related changes of pelvic bone marrows in patients with cervical cancer during concurrent chemoradiotherapy (CCRT) by intravoxel incoherent motion (IVIM) MR imaging.

Methods:

Ethics committee approved this study and written consent of each patient was obtained. Sixteen patients with cervical cancers received CCRT. External beam radiotherapy (EBRT) was delivered to the whole pelvis with 15-MV photon beams at a daily dose of 2.0 Gy five times per week for a total dose of 56 Gy. IVIM imaging by using 13 b values (0, 10, 20, 30, 40, 50, 75, 100, 150, 300, 500, 800 and 1,000 s/mm²) were performed on a 3 T MR scanner before, 2 and 4 weeks after start of CCRT. D, f, D* and ADC maps of pelvis were generated by using a bi- and monoexponential algorithms. Regions of interest were drawn within bilateral iliac wings, iliac bodies, acetabulums, sacrum, femoral heads, and gluteus. Dynamic changes of various parameters in different regions of pelvic bone marrows were recorded.

Results:

D values ($\times 10^{-3}$ mm²/s) of bone marrows within the radiation field (bilateral iliac wings, iliac bodies, acetabulum, and sacrum) increased significantly at 2 weeks after start of CCRT compared with baseline values (30.71 \pm 8.52 vs. 49.39 \pm 25.03, P<0.05), and then returned to baseline levels at 4 weeks after CCRT (28.10 \pm 11.04). ADC values showed the same trend as D values. f values (%) of bone marrows within the radiation field increased significantly at 2 weeks compared with baseline levels (13.51 \pm 5.53 vs. 17.58 \pm 6.20, P<0.05), and continued to increase at 4 weeks after start of CCRT (22.13 \pm 5.12). D, ADC and f values of bone marrow outside the radiation field (bilateral femoral heads) remained unchanged (all P > 0.05). There were no significant changes of D* values of bone marrows within and outside the radiation field (all P > 0.05). Parameters of gluteus remained still before and during therapy (all P > 0.05).

Discussion:

During the first 2 weeks of therapy, a dramatic reduction of hematopoietic cells caused enlarged intercellular space and increased D and ADC values consequently.¹ Dependent on the applied dose, the fatty transformation of the bone marrow started around 2 weeks after therapeutic irradiation and continued to regenerate, causing decreased D and ADC values.² In the acute phase, the bone marrow developed edema and vascular congestion, contrast enhanced T1-weighted images show a transiently increased enhancement and a consequent increased f value. Then contrast enhancement decreased gradually. However, the sinusoidal lining was distorted due to irradiation, leading to increased permeability and further increase of f values.³

Conclusion:

IVIM proved a useful and reliable tool to assess both diffusion and perfusion-related changes of pelvic bone marrow in patients with cervical cancer receiving CCRT.

References:

1. Hwang S, Panicek DM. Magnetic resonance imaging of bone marrow in oncology, Part 2. *Skeletal Radiol.* 2007;36(11):1017-1027.
2. Daldrup-Link HE, Henning T, Link TM. MR imaging of therapy-induced changes of bone marrow. *Eur Radiol.* 2007;17(3):743-761.
3. Daldrup-Link HE, Link TM, Rummeny EJ, et al. Assessing permeability alterations of the blood-bone marrow barrier due to total body irradiation: in vivo quantification with contrast enhanced magnetic resonance imaging. *Bone Marrow Transplant.* 2000;25(1):71-78.