Diffusion-weighted MR imaging and MR spectroscopy in the assessment of tumor grade and depth of myometrial invasion in malignant endometrial tumors

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[Introduction] Uterine endometrial carcinoma is the most common gynecologic malignancy. In evaluating endometrial malignancies (endometrial carcinoma and carcinosarcoma) on MRI, the assessment of the depth of myometrial invasion is important because it closely correlates with the patient's prognosis. Histologic tumor grade is also important prognostic factor. In this study we evaluated the relationship between MR biomarkers (ADC value on DWI and metabolite concentration on MRS), and tumor grade and the depth of myometrial invasion of endometrial malignancies.

[Materials and Methods] 76 surgically proven endometrial malignancies were retrospectively evaluated. MRI and MRS were obtained by using 3T (Signa HDx 3T, General Electric) superconducting unit. Spin-echo, single-shot EPI DW images (b=800 sec/mm^2) were obtained in all subjects. The mean ADC values (x 10^{-3} mm^2/seconds) of the tumors were measured in a circular ROI from ADC maps on the workstation. ROI was placed on solid portion of the lesions so as not to contain necrotic or cystic areas as much as possible by referring all MR images. MRS (PRESS, TE = 144ms) was performed in all subjects. Single voxel of interest (VOI=1-8ml) was placed on solid tumoral components. The choline peak (3.2ppm) and lipid peak (1.3 ppm) were evaluated. Quantitative evaluation of the choline and lipid concentration was made by using LCModel (Stephen Provencher Inc.) on the workstation. Mann-Whitney's U test was used to compare the MR biomarkers among low grade tumors and high grade tumors, and among tumors with superficial and deep myometrial invasion. A value of p<0.05 was considered statistically significant. Of these 76 patients, 20 patients who did not fulfill the following criteria were excluded: lesions containing enough solid components for MR spectroscopic measurement, and the choline concentration with a percentage standard deviation (%SD) <20%. 56 endometrial malignancies included 39 low grade tumors (28 G1 endometrioid carcinomas and 11 G2 endometrioid carcinomas) and 17 high grade tumors (3 G3 endometrioid carcinomas, 2 clear cell carcinomas:CCC, 4 serous adenocarcinomas:SAC, and 8 carcinosarcomas:CS). The ages of the 56 patients ranged from 31 to 85 years (mean age: 62 years). The tumor size ranged from 10 to 133 mm (mean; 50 mm) at their maximum diameter.

[Results] The ADCs in 39 low grade tumors and 17 high grade tumors were 0.86+/-0.12 (G1:0.89+/-0.11, G2:0.80+/-0.12), and 0.84+/-0.14 (G3:0.75+/-0.11, CCC:0.97+/-0.16, SAC:0.80+/-0.13, CS:0.87+/-0.14), respectively (p=0.72). The choline concentration in 39 low grade tumors and 17 high grade tumors were 11.27+/-6.26 mM (G1:10.41+/-6.43, G2:13.45+/-5.48) and 9.23+/-6.35 mM (G3:7.74+/-0.88, CCC:22.9+/-8.49, SAC:11.20+/-1.56, CS:5.38+/-2.68), respectively (p=0.13). The lipid peak was observed in 17 of 39 low grade tumors and in all 17 high grade tumors. The lipid concentration in 12 of 17 low grade tumors (5 lesions were excluded because %SD >20%) and 17 high grade tumors were 192.96+/-183.62 and 147.61+/-110.96, respectively (p=0.79). 33 lesions were with no or less than half myometrial invasion (superficial myometrial invasion: SMI), whereas 23 lesions were with equal to or more than half myometrial invasion (deep myometrial invasion: DMI). The ADCs in 33 SMI lesions and 23 DMI lesions were 0.86+/-0.13 and 0.85+/-0.12, respectively (p=0.82). The choline concentration in 33 SMI lesions and 23 DMI lesions were 11.43+/-6.90 and 9.52+/-5.27, respectively (p=0.27). The lipid peak was observed in 14 of 33 SMI lesions (42%) and in all 20/23 DMI lesions (87%).

[Conclusion] There was no statistically significant difference in ADC values and choline concentration between tumor grades, or depth of myometrial invasion. Although increasing tumor cellularity may restrict water diffusion and cause ADC decrease, microscopic necrosis or cystic glands may increase ADC values. High metabolic activity of tumor cells may cause high choline concentration, however, the presence of necrosis in VOI may reduce the choline concentration. Necrosis-associated lipid peak is observed in all high grade tumors (100%) but in 17 of 39 low grade tumors (44%). It may be suggested that no lipid peak is suggestive for relatively low grade endometrial tumors.
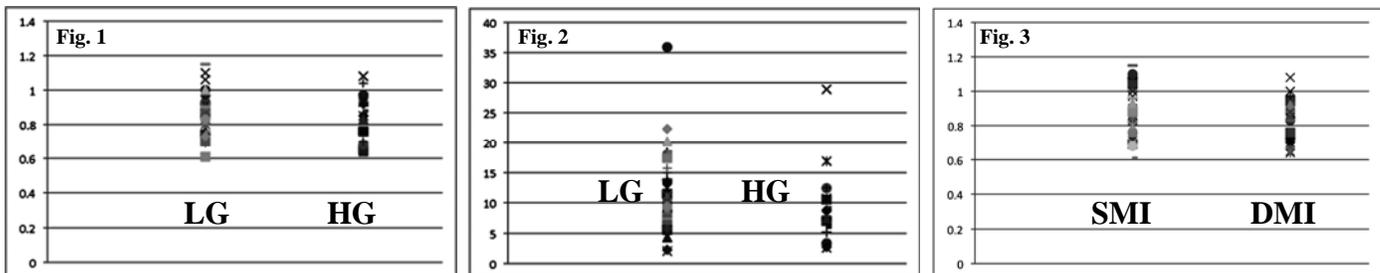
Fig. 1: Scatter plots of ADCs in low grade (LG) tumors and high grade (HG) tumors. **Fig. 2**: Scatter plots of Cho concentration in LG tumors and HG tumors. **Fig. 3**: Scatter plots of ADCs in superficial myometrial invasion (SMI) lesions and deep myometrial invasion (DMI) lesions.
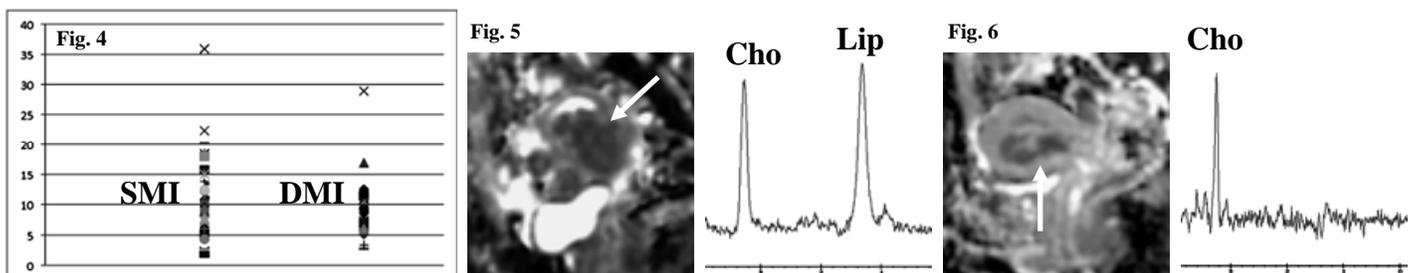
Fig. 4: Scatter plots of Cho concentration in SMI lesions and DMI lesions. **Fig. 5:** ADC map and MRS of high grade tumor (clear cell): ADC 1.08, Cho and Lip peaks.   **Fig. 6.** ADC map and MRS of low grade tumor (G1 endometrioid): ADC 0.90, Cho peak with no Lip peak