Differentiation of benign and malignant solid components of ovarian masses by diffusion-weighted MR imaging with ADC measurement

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[Introduction] Because ovaries are situated deeply in the pelvis, biopsy is not commonly performed for ovarian tumors, and preoperative diagnosis based on imaging is important. The presence of contrast-enhanced solid component may suggest malignancy, however, it is often difficult to differentiate malignancies from benign solid tumor or cystic tumor with benign solid components based on the routine MRI. Various malignant tumors may show high signal intensity on diffusion-weighted imaging (DWI) reflecting hypercellularity of tumor cells. The purpose of this study is to evaluate ovarian tumors by high b-value DWI for the differentiation between benign and malignant ovarian tumors.

[Materials and Methods] Surgically proven 52 ovarian solid masses or solid and cystic masses (36 malignant; 6 borderline malignant; 10 benign) were evaluated. 36 malignant tumors included 32 surface epithelial-stromal tumors, 3 metastatic adenocarcinomas and one germ cell tumor (carcinoid). 6 borderline malignant tumors included 4 surface epithelial-stromal tumors and 2 granulosa cell tumors. 10 benign tumors included 2 surface epithelial-stromal tumors (adenofibromas), 7 sex cord-stromal tumors (3 thecomas and 4 fibromas), and one germ cell tumor (struma ovarii). DWI with high b-value (b=800 sec/mm^2) was performed in all subjects with a spin-echo, single-shot EPI sequence on a system with a 1.5T/3T superconducting units (Signa Excite/Signa Excite HDx 3T, 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 of solid portion of the lesions on DWI was visually evaluated (high; slight high; low). The ADCs (x 10^{-3} mm^2/seconds) of the tumors were measured in a circular ROI from ADC maps on the workstation (AW4.2). ROI was placed on solid portion of the lesions so as not to contain cystic areas as much as possible by referring all MR images. Mann-Whitney's U test was used to compare ADCs among 42 malignant/borderline malignant tumors and 10 benign lesions. A value of $p<0.05$ was considered statistically significant. The ADC cut off value to differentiate benign from malignant/borderline malignant lesions was calculated, with their sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV).

[Results] Solid portion of all 42 malignant/borderline malignant tumors showed homogeneous or heterogeneous high intensity on DWI, whereas 3 benign tumors (3 thecomas) showed high intensity. 2 benign tumors (one adenofibroma and one struma ovarii) showed slight high intensity, and 5 benign tumors (4 fibromas and one adenofibroma) showed low intensity. All 3 thecomas contained low signal intensity almost equal to skeletal muscle on T2-weighted images, which was suggestive for benign fibrous tumors. The ADCs in 42 malignant/borderline malignant tumors and in 10 benign lesions were 1.02 +/- 0.19 and 1.38 +/- 0.30, respectively ($p<0.001$). The ADCs in high intense 3 thecomas on DWI were relatively low (1.08 to 1.20), possibly due to their abundant cellular nature as functioning tumors. Using a cut off ADC value of 1.15 for malignant lesions had a sensitivity of 76%, specificity of 80%, PPV of 94%, and NPV of 44%.

[Conclusions] We conclude that low intensity on DWI with high ADC may suggest benign lesions, however, it may be occasionally difficult to differentiate malignant/borderline malignant lesions from benign lesions only on the basis of signal intensity on DWI with the ADC measurement. Especially benign functioning tumors such as thecomas may mimic malignant tumors on DWI manifestations, however, the presence of low signal intensity on T2-weighted images may be suggestive for its benign nature with dense fibrous stromal proliferation.

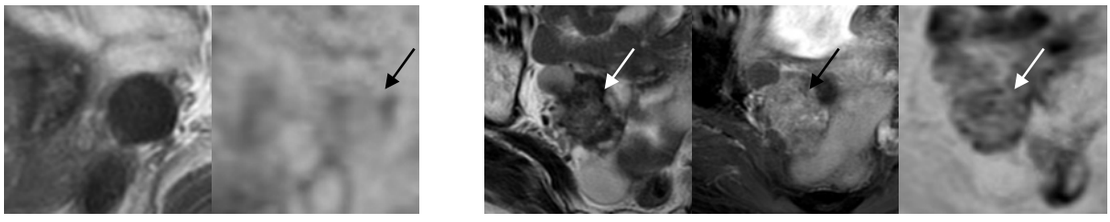

Fig.1: Fibroma: **a.** T2WI; **b.** DWI, Low intense mass on T2WI shows low intensity (arrow) on DWI (ADC: 1.43).

Fig.2: Struma Ovarii: **a.** T2WI; **b.** Gd-fat saturated T1WI; **c.** DWI, Heterogeneous solid and cystic mass (arrow) on T2WI/Gd-fsT1WI. Solid portion (arrow) shows slight high intensity on DWI (ADC: 1.79).

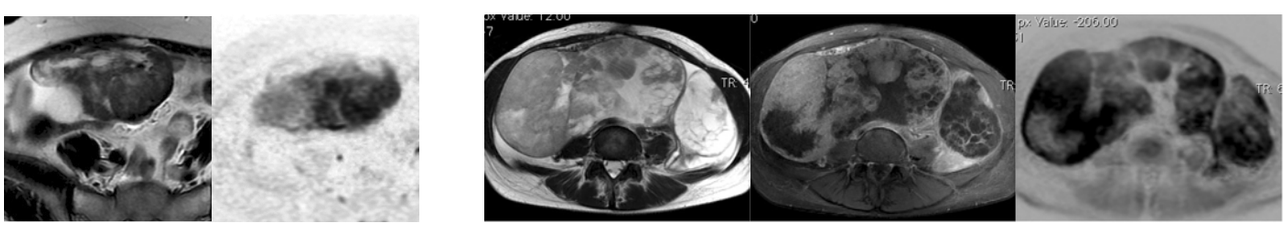

Fig.3: Thecoma: **a.** T2WI; **b.** DWI, Heterogeneous solid mass on T2WI shows high intensity on DWI (ADC: 1.08).

Fig.3: Clear cell adenocarcinoma: **a.** T2WI; **b.** Gd-fsT1WI; **c.** DWI, Heterogeneous solid and cystic mass on T2WI/Gd-fsT1WI. Solid portions show high intensity on DWI (ADC: 0.90).