A preliminary study of multi-b-value DWI in cervical cancer with different pathological features

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Synopsis:

To the best of our knowledge, the capability of multi-b diffusion weighted MR imaging in discrimination of different cervical cancer pathological types has not been investigated. In our pilot study, significant low ADC_{slow} value, high ADC_{fast} and high F_{fast} value were found in cervical squamous cell carcinoma compared with those of adenocarcinoma. Significant ADC_{slow} value differences were shown among low, mediate and high differentiation grades of cervical squamous cell carcinoma, while ADC_{fast} and F_{fast} values showed no significant positive results in the measurements.

Introduction:

Uterine cervical cancer is the second most common female malignancy with a high mortality rate. Cervical squamous cell cancer and cervical adenocarcinoma account for more than 90% of cervical cancer and feature similar clinical symptoms. But the prognostic factors and treatment of these two pathologies are different. Therefore, an early discrimination of these two histological types is necessary. Clinical biopsy remains the "gold standard", but usually loses the consistency with the postoperative pathological findings, due to its limited sampling and the heterogeneity of the tumor tissues. According to NCCN guideline, surgical treatment is not the suggested option for cervical cancer beyond stage IIb. Therefore, no direct comprehensive pathological information can be obtained in this population.

At such circumstance, a method that is capable of indicating the pathological type of cervical cancer is of clinical requirement. Diffusion weighted (DW) MRI techniques, based on the Brownian motions of water molecules between tissues and cells, is considered as an effective, molecular level evaluation method of tumor tissues. To date, few studies have been reported to correlate the ADC values with the pathological features of cervical cancer that did indicate potential correlations. Since the introduction of intra-voxel incoherent motion (IVIM) [1], DW MRI that performs a multiple b-value (multi-b) acquisition has been prevalent and gradually dominated the examinations of tumors with enriched information explored through the application of a bi-exponential mathematic model with the diffusion and perfusion information of the tissue extracted simultaneously. This study intends to investigate the relationship between multi-b-value DWI based on bi-exponential signal decay model and pathological features of cervical cancer.

Methods & Materials:

41 patients (age range: 35-69yrs old) with pathologically confirmed cervical cancer, including 33 cases of squamous cell carcinoma (high-, mid- and low-grade were respectively 6, 20, and 7 cases) and 8 cases of adenocarcinoma, were recruited in the study. All measurements were performed on a 3.0T MR scanner (Discovery 750, GE, Waukesha, USA) using a phased-array body coil. Besides the routine T1WI and T2WI, a multi-b DWI was performed with the parameters as followed: TR/TE:2500/70.2ms; FOV: 26×32cm; matrix: 128×64; slice thickness: 4mm; 13 b values range from 0 to 2000 s/mm^2. ADC_{slow}(slow apparent diffusion coefficient), ADC_{fast} (fast apparent diffusion coefficient) and F_{fast}(Fraction of ADC_{fast}) were obtained after post-procession using a bi-exponential model equipped at an Advantage Workstation (GE, USA) (Fig. 1). The central slice that could manifest the largest part of the tumor was selected, and free-handed regions of interest (ROIs) were positioned within the tumor area avoiding cystic components or hemorrhage inside. All the resulted parameters were statically analyzed by independent samples t-test and one-way ANOVA in different pathological types and differentiation grades using SPSS 18.0 package.

Results &discussion:

As shown in Tab. 1, the ADC_{slow} value of cervical squamous cell carcinoma was found lower than that of cervical adenocarcinoma ($p<0.05$), which indicated the diffusion space in cervical adenocarcinoma was not as restricted as squamous carcinoma. This also agreed with the knowledge that cervical adenocarcinoma cell contains more mucus component. The value of ADC_{fast} and F_{fast} of cervical squamous cell carcinoma were however higher than those of cervical adenocarcinoma with statistically significance ($p<0.05$). It might relate to the dominant vascularity network and rich blood perfusion in squamous cell carcinoma. Significant ADC_{slow} value differences were shown among low, mediate and high differentiation grades of cervical squamous cell carcinoma. Lower ADC_{slow} values in the low differentiation grade tumor correlated with the increased cell density and intracellular organelles in tumors. However, no significant differences in ADC_{fast} and F_{fast} in different pathological grades were observed. So, as previous studies on colorectal cancer and hepatocellular carcinomas shown, the negative correlation between conventional ADC value and histological grade[2,3] was actually mainly originate from the ADC_{slow}.

Thus, perfusion indexes for grad differentiation of cervical squamous cell carcinoma were not significant.

Table 1. ADC values in different pathological types

	Cervical cancer		t	P
	Squamous	Adenocarcinoma		
ADC_{slow}	0.39±0.15	0.73±0.14	5.90	<.0001
ADC_{fast}	52.32±26.11	18.05±11.14	-3.61	0.0009
F_{fast}	0.46±0.13	0.34±0.06	-2.49	0.018

Note: ADC_{slow}、ADC_{fast} unit,$10^{-3}mm^2/s$, F_{fast} unit, %.

Table 2. ADC values in different degree differentiation of cervical squamous cell carcinoma

	High grade	Middle grade	Low grade	F	P
ADC_{slow}	0.57±0.15	0.40±0.10	0.22±0.07	18.01	0.000
ADC_{fast}	46.07±26.18	54.11±28.99	52.56±18.80	0.21	0.81
F_{fast}	0.52±0.15	0.46±0.13	0.42±0.10	1.01	0.38

Note: ADC_{slow}、ADC_{fast} unit,$10^{-3}mm^2/s$, F_{fast} unit, %.

Conclusion: ADC_{slow}, ADC_{fast} and F_{fast} are promising invasive imaging methods that could potentially help identiation of cervical squamous cell carcinoma from cervical adenocarcinoma. ADC_{slow} value of cervical squamous cell carcinoma is positively correlated with the tumor grade.

References: 1. Le Bihan D, et al., Radiology1986; 161(2): 401-407; 2. Curvo-Semedo L, et al. J Magn Reson Imaging, 2012, 35(6):1365-1371; 3. Nishie A, et al. Eur J Radiol, 2011, 80(2):e29-33.