A comparison study of Intravoxel Incoherent Motion (IVIM) based DWI and pharmacokinetics analysis based Dynamic Contrast Enhanced MRI in case of cervical cancer

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TARGET AUDIENCE

Anyone who interested in different models within diffusion weighted imaging (DWI) using multi b values or functional MRI to evaluate tumor angiogenesis.

PURPOSE

To investigate the diagnosis significance of intra-voxel incoherent motion (IVIM) model in evaluating tumor angiogenesis in cervical cancer with comparison to the parameters derived from dynamic contrast enhancement (DCE) MRI.

METHODS

20 female patients with surgically proved epithelial cervical cancer underwent pelvic MR exams prior treatment. Consent forms were obtained from all patients prior to the study. There were 4 patients with grade 1 cancer (G1), 12 with G2 and 6 with G3 and the specimens were stained with MVD and VEGF. Diffusion weighted images were acquired in transverse plane with 10 b values (0, 30, 50, 100, 150, 200, 400, 800, 1000, 1500s/mm^2). In DCE exams, T1-weighted LAVA in axial plane was scanned. Bolus injection of Gd-DTPA (0.1mmol/kg at a rate of 2ml/s) was committed after the acquisition of a baseline image. Acquisition of 20 phases of DCE images were performed with a temporal resolution of 9.8s. IVIM parametric maps of fast ADC and perfusion fraction (F) were generated. DCE parametric maps included K^{trans}, K_{ep} and V_e. ROIs encompassed the whole tumor area (ROI_all), tumor edge (ROI_peri) and tumor center (ROI_in) were defined in patient group in DW imaging with b=1500s/mm^2, and then copied to the other maps. Statistic analysis used Chi-square test and Spearman's correlation.

RESULTS

1. Both VEGF expression and MVD count were significantly different among 3 grades of squamous carcinoma (*P*=0.004, 0.006). Pair-wise comparison showed significant differences of MVD between G1/G2 and G3 (*P*<0.05), but not between G1 and G2 (*P*>0.05). Between tumors with mild to moderate expression of VEFG and tumors with high expression, MVD count was significantly different (*P*=0.032).

2. For ROIs at tumor edge and tumor center, as well as the whole tumor area, f and K^{trans} showed mild positive correlation (*r*=0.336, 0.396 and 0.387, respectively, *P*<0.05). f showed no correlation with K_{ep} or V_e. D* showed no correlation with all of the parameters from pharmacokinetic analysis. (Figure 1-3)

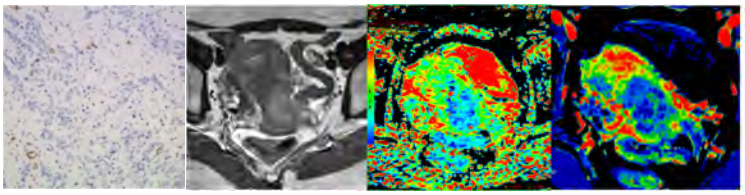

Figure 1 showed an epithelial cervical cancer diagnosed with G1. **A** showed a CD34 stained MVD (8.0 vessels per mm^2). **B.** Axial T_2-Weighted imaging showed hyper intensity area of the tumor. **C.** Function map of perfusion fraction (f_peri=0.18, f_in=0.20). **D.** Functional map of K^{trans} (ktrans_peri=0.13, ktrans_in=0.12).

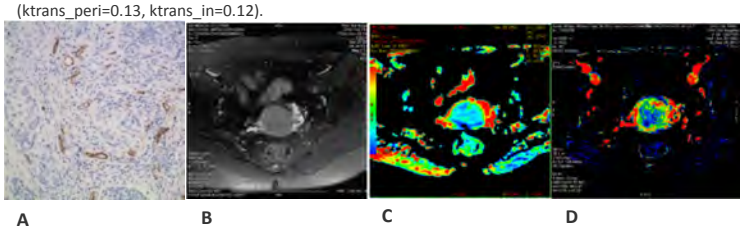

Figure 2 showed anepithelial cervical cancer diagnosed with G2. **A** showed a CD34 stained MVD (17.3 vessels per mm^2). **B.** Axial T_2-Weighted imaging with fat-suppression showed hyper intensity area of the tumor. **C.** Function map of perfusion fraction (f_peri=0.18, f_in=0.17). **D.** Functional map of K^{trans} (ktrans_peri=0.32, ktrans_in=0.24).

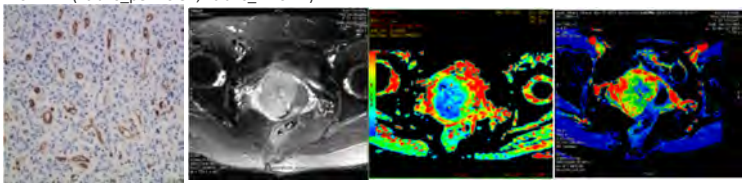

Figure 3 showed an epithelial cervical cancer diagnosed with G3. **A** showed a CD34 stained MVD (48.7 vessels per mm^2). **B.** Axial T_2-Weighted imaging with fat-suppression showed hyper intensity area of the tumor. **C.** Function map of perfusion fraction (f_peri=0.22, f_in=0.15). **D.** Functional map of K^{trans} (ktrans_peri=0.46, ktrans_in=0.29).

3.f_peri and ktrans_peri had positive correlation with MVD count (*r*=0.610 and 0.454, respectively, *P*<0.005) (Figure 4). All of the perfusion parameters, including f and D* from IVIM and all of the parameters derived from pharmacokinetic analysis, were of no difference between tumors with mild to moderate expression of VEFG and tumors with high expression (*P*>0.05).

DISSCUSSION

Both VEGF expression and MVD count showed higher status in poorly differentiated cancer, which demonstrate the relationship between tumor angiogenesis and invasiveness.Both f derived from IVIM and K^{trans}derived from DCE MRI showed ability to assess tumor angiogenesis. Though with different theoretical basement, perfusion parameter of IVIM showed some relationship with pharmacokinetic parameters. Moreover, comparing with K^{trans}, perfusion fraction f had a more compact correlation with MVD, which led to a suspicion of better performance of IVIM other than PK model on analysis of angiogenesis of cervical cancer.

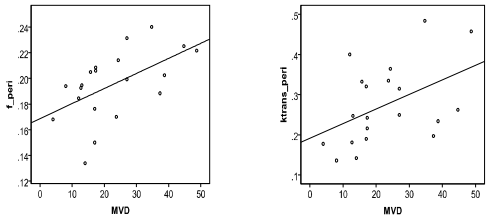

Figure 4.A. Graph shows correlation between f_peri and MVD count(*r*=0.610, *P*=0.004). **B.**correlation between , ktrans_perif_peri and MVD count(*r=0.454, P=0.044*)

CONCLUSION

IVIM could be a viable method for evaluating tumor angiogenesis in cervical cancer and may be used as an alternative to DCE MRI.

REFERENCE

[1] Lee H-J, Rha SY, Chung YE, et al. Tumor perfusion-related parameter of diffusion-weighted magnetic resonance imaging: Correlation with histological microvessel density. Magn Reson Med. 2014 Apr;71(4):1554-8