SUV-ADC mapping of malignant and benign prostate lesions with PET-MRI

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Target audience: Clinicians who are interested in multiple parameter analysis of prostate lesions using PET/MRI

Purpose: 11C-Choline PET/CT has been mainly used for recurrent prostate cancers, and has limitations in primary prostate cancers due to its lower specificity at differentiating malignant lesions from benign ones [1]. Simultaneous PET/MRI offers multiple parameters to address the cellularity, vascularity, and metabolism in a one-stop scan, and is potentially useful for the complete evaluation of prostate lesions including primary and recurrent cancers [2]. However, it is still unclear how to combine those multiple parameters to give a simple indication for malignant and benign lesions. The purpose of this study is to evaluate a SUV-ADC pixelwise mapping method in differentiating malignant and benign lesions.

Methods: Six patients with evaluated prostate specific antigen were firstly scanned with PET/MRI (Biograph mMR, Siemens Healthcare, Erlangen, Germany), and went additionally through standardized ultrasound guided sextant core biopsy or radical prostatectomy (RP). The PET/MRI protocol consists of T1W, T2W, a prototype readout-segmented DWI sequence (RESOLVE) and 15 minutes list mode PET (injection is counted from 0 minute) for the pelvic region, followed by T1W, T2W, single-shot DWI from throat to pelvic region. Lesion's VOI was selected based on suspicious findings in T2W, DWI [3] and high uptake in 11C-Choline PET images, and in total 24 VOIs were included in the analysis. Mean (SUV, ADC and SUV/ADC) of each VOI were tested using unpaired student test (SPSS 13.0). For each VOI, the relative frequency of the SUV and ADC was mapped to the position of corresponding SUV and ADC in a SUV-ADC map.

Results: Among 24 suspicious lesions, 13 were malignant, and 11 were benign ones as confirmed by biopsy or RP. For all the SUV, ADC, and SUV/ADC, there were significant differences between malignant and benign lesions ($P > 0.05$). As shown in Fig. (1 – a, b), when ADC=1.2×10^{-3} mm^2/s was used as a threshold, 2/13 were misdiagnosed as benign lesions while 1/11 was misdiagnosed as malignant lesions; when SUV = 2.5 was used as threshold, 2/11 were misdiagnosed as malignant lesions; SUV/ADC showed clear separation between malignant and benign lesions in the case of SUV/ADC = 2.2. Fig. (2) shows the distribution of benign and malignant lesions in the SUV-ADC map, with a clear 2D curve which completely separates the benign and malignant lesions.

Discussion and Conclusion: The SUV/ADC classification method outperforms the single ADC or SUV in differentiating malignant and benign lesions. A further analysis using the SUV-ADC map indicates that the misdiagnosed 'malignant' lesions (higher SUV uptake) using single SUV have a higher ADC, and the misdiagnosed 'malignant' lesions using single ADC have a lower Choline uptake. It also should be noted that SUV uptake will change with time, and the patterns of benign and malignant lesions will change accordingly. In our case, we are using the SUV obtained 10 – 15 minutes (5 minutes per bed position) after the injection. Although we only have a limited number of cases, the relationship between SUV and ADC for each VOI showed its potential for the differentiation between malignant and benign prostate lesions. Further investigation on the clinical usage of a pixelwise SUV-ADC map evaluation in a larger prostate population is necessary.

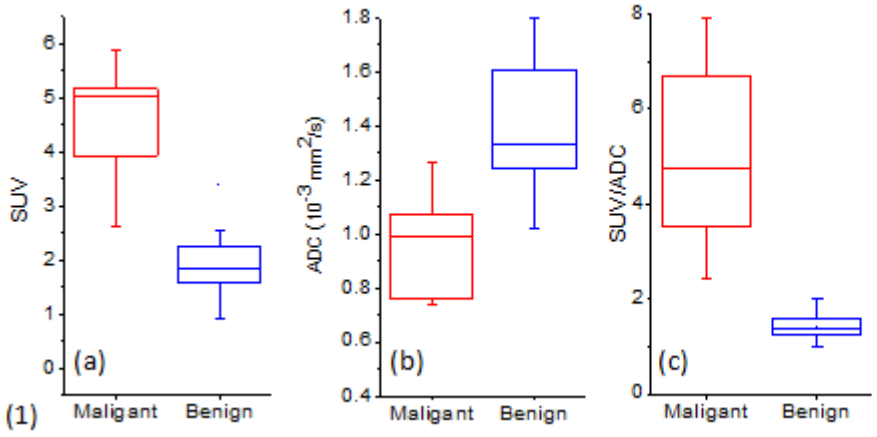

Figure 1: Box plot of mean SUV (a), mean ADC (b) and mean SUV/ADC (c) for malignant and benign lesions.

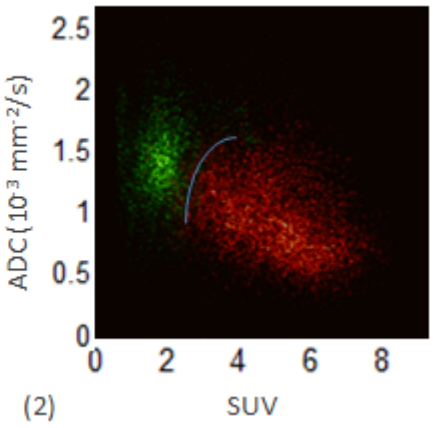

Figure 2: Pixelwise SUV-ADC map of all benign (green dot) and malignant lesions (red dot). The curve (blue) indicates the separation between benign and malignant lesions.

References: [1]. Michael Souvatzoglou, *et al*, Clin Cancer Res, 2011;17:3751-3759; [2]. Wetter A., *et al*, PLoS One. 2014; 9(7); [3]. Jelle O. Barentsz, *et al*, Eur Radiol (2012) 22:746 – 757.