

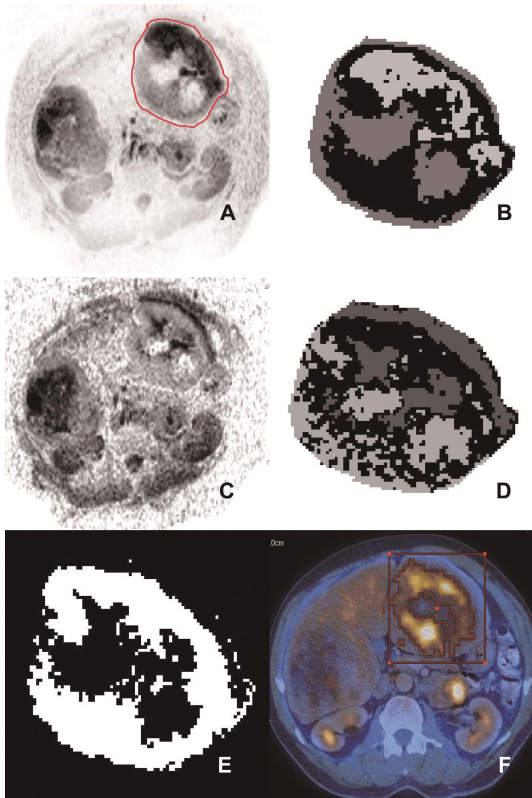
# More accurate volume and ADC measurements of heterogeneous tumor in diffusion-weighted MR imaging: with correlation to PET/CT

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**Target audience:** Those who use diffusion weighted (DW) imaging for diagnosis and treatment response monitoring of tumor.

**Purpose:** To more precisely segment high-cellularity tumor tissues in heterogeneous lesions and therefore more accurately measure volumes and ADCs, we proposed a semi-automatic method based on thresholding both the b0 images and the ADC maps.

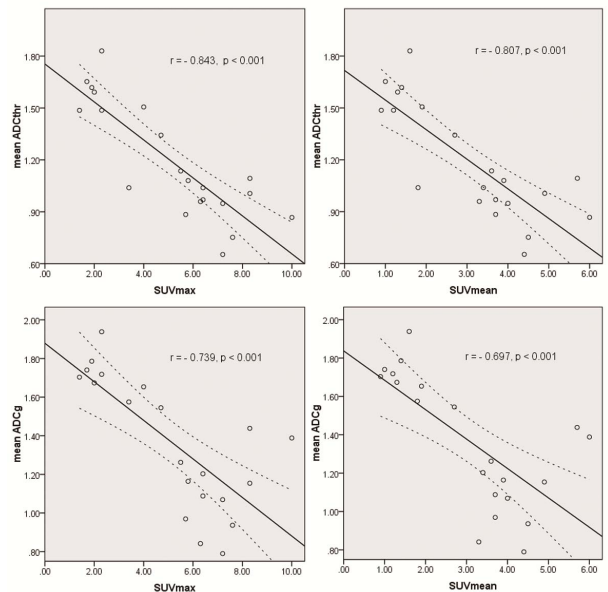


**Fig. 1** One representative case presenting high-cellularity tumor tissues segmented in DW MR images and hyper-metabolic tumor tissue defined in PET/CT. A: b0 image and manually drawn ROI. B: b0 image within ROI was classified into three clusters. C: ADC map. D: ADC map within ROI was classified into three clusters. E: segmented high-cellularity tumor tissue. F: hyper-metabolic tumor tissue selected in PET/CT using 40% maximum SUV as lower threshold.

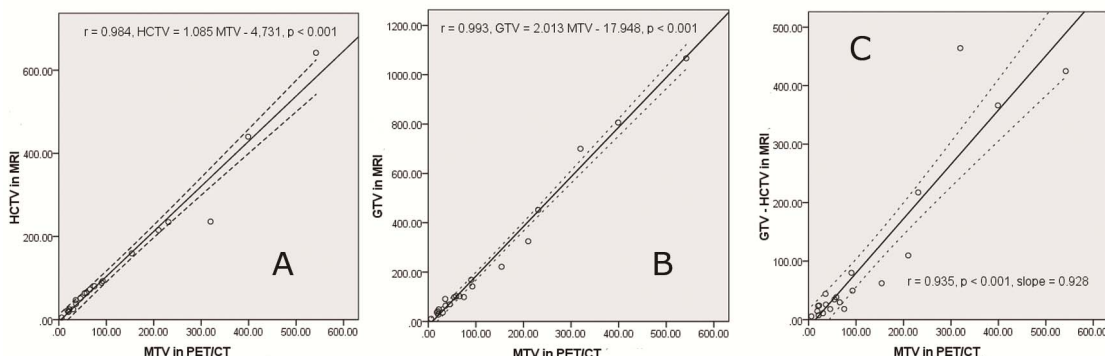
**Methods:** Thirty-seven lesions were found from seven patients with histopathological proof of metastatic gastrointestinal stromal tumor<sup>2</sup> (GIST). According to PET/CT and DW MR images, homogenous lesions and those of smallest dimension lower than 2cm were excluded by two radiologists with consensus. In the remaining twenty-one heterogeneous lesions, gross lesion regions were manually contoured and corresponding lesion volume and ADC were denoted as gross tumor volume (GTV) and gross ADC (ADC<sub>g</sub>). Using k-means clustering algorithm, B0 images and ADC maps in the contoured regions were separately classified into three clusters (with low, intermediate and high value). The pixels with low intensities on b0 images and those with high ADC values on ADC maps were excluded, leaving only the probable high-cellularity tumor tissues<sup>1,3,4</sup> (Fig. 1). The ADC and volume of the high-cellularity tumor tissue were denoted as thresholded ADC (ADC<sub>thr</sub>) and high-cellularity tumor volume (HCTV), respectively. The metabolic tumor volume (MTV) in PET/CT were measured using 40% maximum SUV as lower threshold. The mean SUV (SUV<sub>mean</sub>) and the maximum SUV (SUV<sub>max</sub>) in MTV were also measured.

**Results and Discussion:** HCTV correlated significantly and substantially with MTV:  $HCTV = 1.085 MTV - 4.731$  ( $r = 0.984, p < 0.001$ ), which indicated that MTV and HCTV had nearly perfect concordance. The difference between GTV and HCTV (GTV - HCTV) correlated strongly with MTV (slope = 0.928,  $r = 0.935, p < 0.001$ ), which suggested that GTV were greatly overestimating the tumor volume and the error of GTV increased with the increase of tumor size (Fig. 2).

ADC<sub>thr</sub> correlated significantly and substantially with SUV<sub>mean</sub> ( $r = -0.807, p < 0.001$ ) and SUV<sub>max</sub> ( $r = -0.843, p < 0.001$ ), which were both stronger than the corresponding correlations for ADC<sub>g</sub> (Fig. 3).



**Fig. 3** Linear regressions between ADC values (ADC<sub>thr</sub> and ADC<sub>g</sub>) and SUV values (SUV<sub>max</sub> and SUV<sub>mean</sub>).



**Fig. 2** Linear regressions between HCTV and MTV (A), between GTV and MTV (B), and between (GTV - HCTV) and MTV (C).

**Conclusion:** In DW MR images of GIST, the HCTV measured using the proposed method had perfect concordance with MTV in PET/CT. Furthermore, stronger correlations between ADC values and SUV values were achieved using this method.

**References:** [1] Padhani AR, et al. Neoplasia 2009; 11(2) : 102-125. [2] Gong NJ, et al. NMR Biomed 2012. [3] Padhani AR, et al. Radiology 2011;261(3):700-718. [4] Taouli B, et al. Radiology 2010;254(1):47-66.