Investigation on the correlation between the DWI apparent diffusion coefficient and the FDG-PET/CT standardized uptake value in patients with lymphoma

Thomas Kwee[1], Henriëtte Quarles van Ufford[1], Malou Vermoolen[1], Frederik Beek[1], Rob Fijnheer[2], Willem Mali[1], John de Klerk[3], and Rutger-Jan Nievelstein[1]
[1]*Radiology, UMC Utrecht, Utrecht, Netherlands,* [2]*Hematology, Meander MC, Amersfoort, Netherlands,* [3]*Nuclear Medicine, Meander MC, Amersfoort, Netherlands*

Introduction

The lymphomas comprise approximately 5% to 6% of all malignancies and are the fifth most frequently occurring type of cancer in the Western World (1). Whole-body MRI with diffusion-weighted imaging (DWI) is emerging as an alternative to FDG-PET/CT for evaluating lymphoma. DWI is able to quantify the diffusivity of water molecules by means of apparent diffusion coefficient (ADC) measurements. Similar to the SUV in FDG-PET/CT, the ADC may be used as a cancer biomarker for lesion characterization and monitoring response to therapy. However, it is still unknown how the information that is provided by the ADC is related to that of the FDG-PET/CT SUV in lymphoma. The aim of this study was therefore to assess the correlation between the ADC and the FDG-PET/CT SUV in lymphoma.

Subjects and Methods

Twenty consecutive patients with newly diagnosed lymphoma (Hodgkin lymphoma: n=1; non-Hodgkin lymphoma: n=20) prospectively underwent whole-body DWI (using b-values of 0 and 1000 s/mm^2) and FDG-PET/CT. In each patient, the largest lesion that was visible at both DWI and FDG-PET/CT was identified, if possible. ADC measurements were done on all axial slices on which the particular (largest) lesion could be seen, using region of interest analysis. ADC measurements on all axial slices were averaged to obtain a mean ADC (ADC_{mean}). In addition, the lowest ADC of the lesion that was measured was recorded; this minimum ADC (ADC_{min}) was taken into analysis, because this value may well correspond to the tumor area that has the highest cellular density. In each patient, the same lesion was analyzed at FDG-PET/CT, and its maximum SUV (SUV_{max}) (corresponding to the area of highest metabolic activity) was calculated by means of volume of interest analysis. Correlations between ADC_{mean} and SUV_{max}, and between ADC_{min} and SUV_{max} were assessed using Pearson's correlation coefficient (*r)*.

Results

In 9 of 20 patients, there were no lesions that could be seen both at DWI and FDG-PET/CT (no lesions at DWI in 1 case, no pathologic FDG uptake in 5 cases, and no lesions at both modalities in 3 cases), while in the remaining 11 patients, lesions were seen at both modalities. Table 1 shows the locations, volumes, largest diameters, ADC_{mean}, ADC_{min}, and SUV_{max} of the largest lesions that were visualized and analyzed at both DWI and FDG-PET/CT. Mean volume of the largest lesions that were visualized at both DWI and FDG-PET/CT was 373.2 ± 770.2 cm^3 (range, 5.2-2369.6 cm^3) with a mean largest diameter of 8.7 ± 6.1 (range, 3.0-20.1 cm). The mean ADC_{mean} and ADC_{min} (in 10^{-3} mm^2/s) were 0.591 (range, 0.106-0.988) and 0.306 (range, 0.066-0.595), respectively. The mean SUVmax was 16.0 ± 8.8 (range, 6.7-33.9). Pearson's *r* was 0.223 (*P*=0.485) between ADC_{mean} and SUV_{max}, and -0.545 (*P*=0.067) between ADC_{min} and SUV_{max}. Graphs of ADC_{mean} vs. SUV_{max}, and ADC_{min} vs. SUV_{max} are displayed in Figure 1.

Table 1. Locations, volumes (in cm^3), largest diameters (in cm), ADC_{mean} (in 10^{-3} mm^2/s), ADC_{min} (in 10^{-3} mm^2/s), and SUV_{max} of the largest lesions that were visualized and analyzed at both DWI and FDG-PET/CT.

Patient no.	Location Lesion	Tumor volume	Largest diameter	ADC_{mean}	ADC_{min}	SUV_{max}
1	Right axilla	161.9	11.2	0.5450	0.1415	19.5
2	Precardial	33.2	5.5	0.9876	0.5952	13.2
3	Left inguinal	81.0	7.4	0.6076	0.4447	16.4
6	Left axilla	119.9	10.6	0.4988	0.1364	10.4
9	Right axilla	5.2	3.0	0.6087	0.3415	8.3
10	Bladder	2369.6	20.1	0.8759	0.0664	33.9
11	Left axilla	21.4	4.3	0.6349	0.2472	20.9
12	Right upper leg	1590.2	19.8	0.5097	0.2061	30.2
13	Left cervical	59.7	10.5	0.10621	0.4050	14.7
14	Right cervical	7.3	3.1	0.5244	0.3725	7.0
16	Left inguinal	5.2	3.4	0.7063	0.3967	10.2

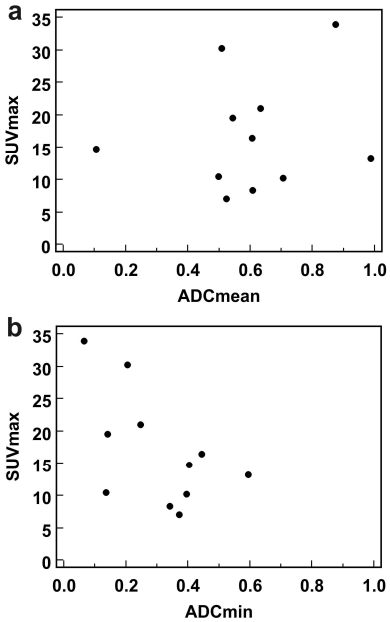

Figure 1. Graphs of ADC_{mean} (in 10^{-3} mm^2/s) vs. SUV_{max} (a), and ADC_{min} (in 10^{-3} mm^2/s) vs. SUV_{max} (b). Pearson's *r* was 0.223 (*P*=0.485) between ADC_{mean} and SUV_{max}, and -0.546 (*P*=0.067) between ADC_{min} and SUV_{max}.

Conclusions

Although no correlation was found between the ADC_{mean} and the SUV_{max}, there was a trend towards a mild negative correlation between the ADC_{min} and the SUV_{max}. This can be explained by the fact that the ADC_{min} better represents the area of lowest cellular density than the ADC_{mean}; thus, lymphomas with higher cellularity tend to have higher glucose metabolism. Further studies are required to investigate the complementary roles of these DWI and FDG-PET/CT metrics with respect to tumor grading and assessment of response to therapy.

References

1. Jemal A, et al. CA Cancer J Clin 2010;60:277-300