N-Stage Assessment in Non-Small Cell Lung Cancer Patients: Comparison of Capability among STIR Turbo SE imaging, Diffusion-Weighted Imaging and FDG-PET/CT

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INTRODUCTION: Assessment of N-stage is very important for management in non-small cell lung cancer (NSCLC) patients. FDG-PET/CT can assess morphological and metabolic information at same time, and widely utilized in this setting. In the last decade, short inversion time inversion recovery (STIR) turbo spin-echo (SE) imaging has been determined at least as valuable as PET/CT for N-stage assessment in non-small cell lung cancer (NSCLC) on 1.5T and 3.0 T systems (1, 2). Recently, diffusion-weighted image (DWI) is suggested as new technique for differentiation of metastatic lymph nodes from non-metastatic lymph nodes by using apparent diffusion coefficient (ADC) measurement and/ or visual assessment (3, 4). However, no direct comparison of capability for N-stage assessment has been made among integrated FDG-PET/CT, STIR turbo SE imaging and DWI in NSCLC patients. We hypothesized that STIR turbo SE imaging can more accurately assess N-stage classification than DWI and integrated FDG-PET/CT in NSCLC patients. The purpose of this study was to prospectively and directly compare capability of N-stage assessment among integrated FDG-PET/CT, STIR turbo SE imaging and DWI in NSCLC patients.

MATERIALS AND METHODS: Sixty-two consecutive NSCLC patients (38 men,14 women; 43-83 years old., mean age 63 years old) who were considered as candidate for surgical therapy were prospectively underwent STIR turbo SE imaging, and DWI. Final diagnosis of N-stage in each patient was determined according to the results of post-operative pathological examinations. All MR studies were performed by using two 1.5 T superconducting magnet (Gyroscan Intera and Achieva, Philips Medical Systems, Best, Netherlands) using a four-channel sensitivity encoding (SENSE) body coil. All STIR turbo SE images were acquired by using a centrically-reordered multi-shot black-blood STIR turbo SE sequence with SENSE (TR = 2-3 <R-R> ms, TEeff = 8 ms, TI = 150 ms, ETL = 8, NEX = 2, 256 × 192 matrix, 512 × 384 reconstruction matrix, field of view = 320 mm, reduction factor = 4). All DWIs were obtained by using a sequentially reordered half-Fourier single shot STIR spin-echo echo-planar imaging sequence (TR = 5759 ms, TE = 70 ms, TI = 180 ms, ETL = 141, NEX= 4, b values 0 and 1000 sec/ mm^2, 256 × 128 matrix, 512 × 256 reconstruction matrix) . All FDG-PET/CT examinations were performed with an integrated PET/CT scanner (Discovery ST; GE Health Care, Milwaukee, WI) by using standard lung cancer protocol, after all patients fasted for at least 6 hours before the intravenous administration of FDG at a rate of 3.3 MBq/kg BW. For quantitative evaluation in each subject, oval region of interests (ROIs) were placed at each lymph node on STIR turbo SE images, DWIs and PET/CT images for signal intensity, ADC, and maximum value of standard uptake value (SUVmax) measurements. For normalization of signal intensity of STIR turbo SE imaging, ROI was also placed at normal muscle in each subject, and lymph node muscle ratio (LMR) of each lymph node was calculated. On comparison of LMR, ADC and SUVmax between metastatic and non-metastatic lymph node, each parameter was compared between two groups by using Student's t-test. To determine the feasible threshold of three methods, ROC-based positive tests were performed on per node basis. Then, sensitivities, specificities, and accuracies were compared on per node basis and per patient basis by using McNemar's test. A p-value less than 0.05 was considered significant difference.

RESULTS: Representative case is shown in Figure 1. On comparison of each index between metastatic and non-metastatic lymph nodes, LMR (1.5 ± 0.6, mean ± standard deviation) and SUVmax (2.6 ± 1.9) of metastatic lymph node were significantly higher than those of non-metastatic lymph node (LMR: 1.0 ± 0.3, $p<0.05$; SUVmax: 1.6 ± 0.5, $p<0.05$). On ROC-based positive test of all indexes, feasible threshold values of ADC, LMR and SUVmax were determined as follows: 0.0025/mm^2, 1.2 and 1.75, respectively. When feasible threshold values were adapted, specificities and accuracies of ADC (specificity: 69.7 [83/119] %, accuracy: 67.7 [90/133] %) and LMR (specificity: 73.1 [87/119] %, $p<0.05$; accuracy: 72.9 [97/133] %) were significantly higher than those of SUVmax (specificity: 51.3 [61/119] %, $p<0.05$; accuracy: 52.6 [70/133] %, $p<0.05$) on a per node basis analyses. In addition, accuracy of LMR was significantly higher than that of ADC ($p<0.05$). Results of compared diagnostic capability on a per patient basis is shown in Table 1. Specificities of ADC (52.8 [28/53] %) and LMR (60.4 [32/53] %) was significantly higher than that of SUVmax (41.5 [22/53] %, $p<0.05$). In addition, accuracy of LMR (62.9 [39/62] %) was significantly higher than that of SUVmax (46.8 [29/62] %, $p<0.05$).

CONCLUSION: STIR turbo SE imaging and DWI were more specific and/ or accurate modalities for N-stage assessment than FDG-PET/CT in NSCLC patients.

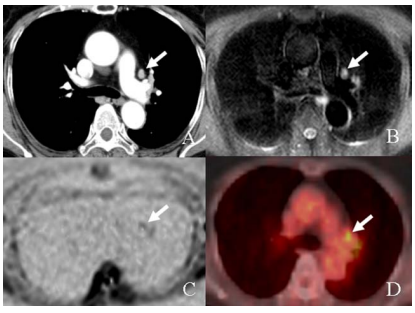

Figure 1. 74-year old NSCLC patient with metastatic lymph node.
A: CT demonstrates subaortic lymph node with 6 mm in the longest diameter. B: LMR was 1.3, and this case was true -positive case on STIR turbo SE imaging. C: ADC was 0.0034/mm^2, and this case was true-positive case on DWI. D: SUVmax was 2.9, and this case was true-positive case on PET/CT.

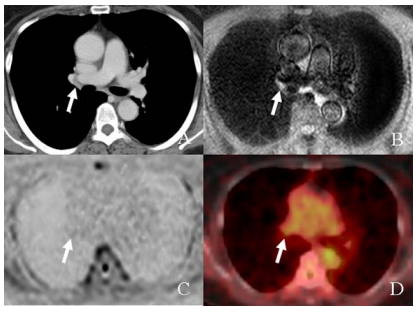

Figure 2. 59-year old NSCLC patient with non-metastatic lymph node.
A: CT demonstrates right hilar lymph nodes with 9 mm in the longest diameter. B: LMR was0.5, and this case was true –negative case on STIR turbo SE imaging. ADC was 0.0022/mm^2, and this case was true-negative case on DWI. D: SUVmax was 2.5, and this case was false-positive case on PET/CT.

Table 1. Diagnostic capability on a per patient basis.

	Sensitivity (%)	Specificity (%)	Accuracy (%)
ADC (/mm^2)	66.7	52.8	54.8
	(6/9)	(28/53)	(34/62)
LMR	77.8	60.4	62.9
	(7/9)	(32/53)	(39/62)
SUVmax	77.8	41.5*, **	46.8**
	(7/9)	(22/53)	(29/62)

*: Significant difference with ADC ($p<0.05$).
**: Significant difference with LMR ($p<0.05$).

References:

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