Whole-body Diffusion-weighted Imaging: Usefulness for Assessment of M-stage in Lung Cancer Patients as Compared with Standard Whole-body MR Imaging and FDG-PET

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Introduction: Assessment of M-stage is very important for management in lung cancer patients. For this purpose, FDG-PET is widely utilized as whole-body imaging tool for cancer staging with high diagnostic capability (1, 2). Recently, some investigators has suggested that whole-body MR imaging (MRI) has the capability for cancer screening and/ or staging similar to PET (3-5). In addition, whole-body diffusion-weighted image (DWI) has been suggested as useful for assessment of tumor staging and metastases (6). However, no one has directly compared diagnostic accuracy of M-stage in lung cancer among these methods. We hypothesized that whole-body DWI may be useful for improvement of diagnostic accuracy of whole-body MRI and accurately assess M-stage in lung cancer patients similar to PET. The purpose of the present study was to determine the utility of whole-body DWI for accurate assessment of M-stage in lung cancer patients, when directly compared with standard whole-body MRI and PET.

Materials and Methods: Seventy-four consecutive lung cancer patients (48 men, 26 women; mean age 69 years) prospectively underwent standard whole-body MRI, whole-body DW-MRI, FDG-PET, pre-therapeutic standard radiological examinations for diagnosis of M-stage and more than one-year follow-up examinations. Final diagnosis of M-stage in each patient was determined according to the results of standard radiological and follow-up examinations. As whole-body MR imaging, short TI inversion-recovery turbo spin-echo images (TR 3200ms/ TE 60ms/ TI 165ms) and dual-phase T1-weighted gradient-echo images (TR 100ms/ TE 2.3 and 4.6ms/ FA 75°) with and without contrast-media (Gadoteridol, ProHans, Eizai, Japan) were obtained on coronal and sagittal planes by using moving-table system and body coil on a 1.5 T MR scanner (Gyroscan Intera, Philips Medical Systems). Whole-body DWI (TR 5759ms/ TE 70 ms/ TI 180 ms/ ETL 96/ b=1, 1000 sec/mm^2) was also obtained in each patient. Other scan parameters were as follows: 265×530mm field of view, 7 stacks, 128×256matrix, 8mm slice thickness, and 1mm slice gap. All FDG-PET examinations were performed by using standard whole-body PET protocol on a PET scanner (ALLEGRO, Philips Medical Systems). Probabilities of presence of metastases on whole-body DWI, whole-body MRI with or without DWI and PET were evaluated by using 5-point visual scoring systems on a per patient basis. To determine the inter-observer agreement, kappa statistics were performed. Then, ROC-analyses were performed for comparison of diagnostic capabilities among whole-body DWI, whole-body MRI with or without DWI and PET. Sensitivity, specificity and accuracy were also compared among them by using McNemar test on per patient basis.

Results: Representative cases are shown in Figure 1 and 2. Kappa values of whole-body DWI was 0.61, and interobserver agreement was considered as substantial. Kappa values of whole-body MRI without and with DWI and PET were 0.52, 0.56 and 0.57, and inter-observer agreements of these methods were considered as moderate. The results of ROC-analysis were shown in Figure 3. Area under the curve (Az)of whole-body DWI (Az=0.73, $p<0.05$) was significantly lower than that of PET (Az=0.86) and whole-body MRI with (Az=0.82) and without DWI (Az=0.92). Az of whole-body MRI without DWI (Az=0.82, $p<0.05$) was significantly lower than that of whole-body MRI with DWI (Az=0.92). Diagnostic capabilities of all methods are shown in Table 1. Specificity and accuracy of PET, whole-body MRI with and without DWI were higher than those of whole-body DWI ($p<0.05$). Accuracy of whole-body MRI with DWI was significantly higher than that of PET ($p<0.05$) and whole-body MRI without DWI ($p<0.05$).

Conclusion: Whole-body DWI is useful for improvement of diagnostic accuracy of standard whole-body MRI. In addition, whole-body MRI with DWI has potential for more accurate assessment of M-stage in lung cancer patients as compared with standard whole-body MRI without DWI and PET.

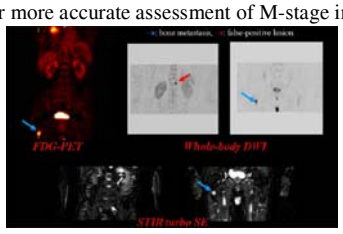

Figure 1. 69-year old male patient with adenocarcinoma and bone metastasis.
PET, whole-body DWI and whole-body MRI demonstrated bone metastasis (blue arrow) as true positive and false-positive lesion (red arrow) was also shown on whole-body DWI.

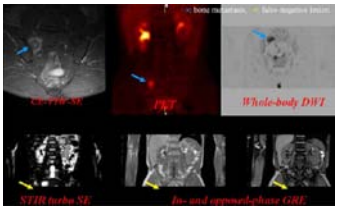

Figure 2. 57-year old male patient with squamous cell carcinoma with bone metastasis.
Conventional contrast-enhanced T1WI, PET, and whole-body DWI clearly showed bone metastasis (blue arrow). On whole-body MRI, this lesion was diagnosed as a false-negative lesion.

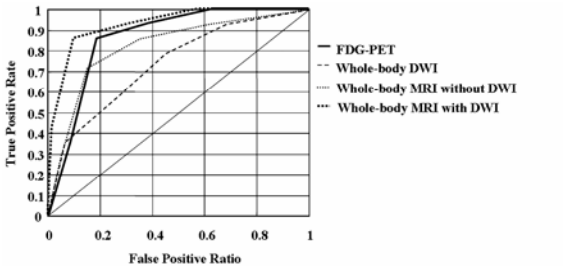

Figure 3. ROC curves of all methods.

Table 1. Diagnostic capabilities of all methods.

	Sensitivity (%)	Specificity (%)	Accuracy (%)
FDG-PET	85.7 (12/14)	81.6 (49/60)*	82.4 (61/74)*, **
Whole-body DWI	92.9 (13/14)	31.7 (19/60)	43.2 (32/74)
Whole-body MRI without DWI	71.4 (10/14)	85.0 (51/60)*	82.4 (61/74)*, **
Whole-body MRI with DWI	85.7 (12/14)	90.0 (54/60)*	89.2 (66/74)*

*: Significant difference with whole-body DWI ($p<0.05$)
**: Significant difference with whole-body MRI with DWI ($p<0.05$)

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