Comparison of the Utility of Whole-Body MRI with and without Quick 3D and Double RF Fat Suppression Techniques, PET/CT and Conventional Examination for Assessment of Recurrence in NSCLC Patients

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Introduction: Recurrence assessment is very important for management of postoperative non-small cell lung cancer (NSCLC) patients.   For several decades, detection of recurrent disease using conventional radiological method was made difficult by the often extensive anatomic abnormalities that exist after definitive treatment.   For this reason, FDG-PET as well as FDG-PET/CT has been found more effective than standard methods for diagnosis in this setting (1).   In addition, it has been suggested in the literature (2, 3) that whole body magnetic resonance imaging (WB-MRI) at 1.5T MR system is at least as accurate as, or more so, as a diagnostic tool for TNM staging in NSCLC patients.   Although increased numbers of 3T MR system will be gradually shifting WB-MRI from 1.5T to 3T MR systems, major drawbacks of WB-MRI at 3T are longer T1 relaxation time and greater B1 inhomogeneity, etc (4).   Under these circumstances, a newly developed quick and segmented 3D T1-weighted gradient echo sequence (Quick 3D) and a double fat suppression RF pulse (DFS) technique for enhancing fat-free capability has proven to be effective in clinical use for improving the diagnostic capability of CE-WB-MRI at 3T in routine clinical practice.   We hypothesized that CE-Quick 3D and DFS could improve the diagnostic performance of CE-WB-MRI using a 3T MR system for recurrence assessment compared with that of a previously reported conventional protocol, and might be at least as effective as FDG-PET/CT and conventional radiological examinations.   The purpose of this study was thus to directly and prospectively compare diagnostic capabilities for assessment of recurrence of CE-WB-MRI with and without Quick 3D and DFS, integrated FDG-PET/CT and conventional radiological examinations.

Materials and Methods: 134 consecutive postoperative NSCLC patients (78 males, 56 females; mean age: 72 years) prospectively underwent standard WB-MRI with and without CE-Quick 3D and DFS, integrated FDG-PET/CT, conventional radiological examination for diagnosis of distant metastasis and/or recurrence, and more than one-year follow-up examinations.   All whole-body 3T MRIs were obtained by using a 3T MR system (Vantage Titan 3T, Toshiba Medical Systems) with multi-channel whole-body coil as having parallel imaging capability (Atlas SPEEDER coil, Toshiba).   Final diagnosis of distant metastasis and/or recurrence in each patient was determined according to the results of conventional radiological and follow-up examinations.   According to the final diagnosis, all patients were divided into two groups as follows: distant metastasis and/or recurrence group (n=24) and non-metastasis and recurrence group (n=110).   All WB-MRI with and without CE-Quick 3D and DFS technique, FDG-PET/CT and conventional radiological examination were prospectively assessed by three different reader groups, which were consisted by two readers.   Probability of recurrence on each method was evaluated by using 5-point visual scoring systems on a per patient basis.   Final diagnosis in each patient was made by consensus of two readers.   A kappa statistic was used to determine the inter-observer agreements for three methods on a per-patient basis. To compare diagnostic capabilities among three methods, ROC analysis was used on a per-patient basis.   This was followed by a statistical comparison of sensitivity, specificity and accuracy by means of McNemar's test.

Results: Representative case is shown in Figure 1.   Interobserver agreement on each method was assessed as substantial (0.76<kappa<0.80).   On ROC analyses of all methods on a per-patient basis, there were no significant difference of area under the curve (Az) among all methods (p>0.05).   Feasible threshold values and compared diagnostic capabilities of three methods are shown in Table 1.   Specificity and accuracy of CE-WB-MRI with Quick 3D and DFS technique was significantly higher than that of PET/CT and conventional radiological examination (p<0.05).   In addition, specificity of WB-MRI without Quick 3D and DFS technique was significantly higher than that of PET/CT and conventional radiological examination (p<0.05).

Conclusion: CE-WB-MRI with CE-Quick 3D and DFS was found to be at least as specific and accurate, or more so, than CE-WB-MRI without CE-Quick 3D and DFS, FDG-PET/CT and conventional radiological examination for recurrence assessment in NSCLC patients.

| Figure 1A | Figure 1B | Figure 1C | Figure 1D |
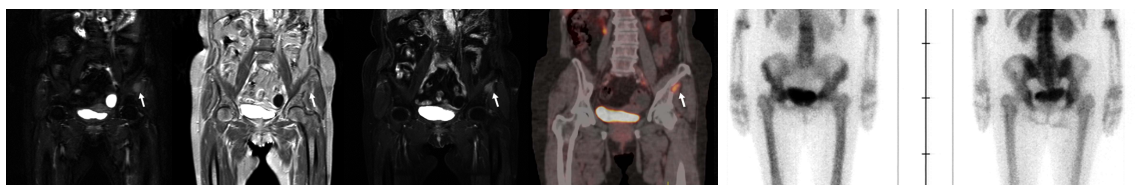
Figure 1. 78-year-old woman with left iliac bone metastasis after surgical resection of adenocarcinoma
A: (L to R: STIR turbo SE imaging to CE-in-phase GRE image) Both images clearly demonstrate bone metastatis (arrow), and this case was scored as 5. WB-MRI without Quick 3D and DFS produced a diagnosis of true-positive.   B: Quick 3D and DFS image clearly shows bone metastasis (arrow), and this case was scored as 5.   WB-MRI with Quick 3D produced a diagnosis of true-positive.   C: FDG-PET/CT clearly demonstrates bone metastasis (arrow), and this case was scored as 5.   FDG-PET/CT produced a diagnosis of true-positive.   D: (L to R: anterior to posterior) Bone scintigraphy as part of conventional radiological examination does not clearly show bone metastasis (arrow), and this case was scored as 1.   Conventional radiological examination produced a diagnosis of false-negative.

Table 1. Comparison of diagnostic performance by four methods for recurrence assessment in postoperative NSCLC patients.

	Az	Threshold value	SE (%)	SP (%)	PPV (%)	NPV (%)	AC (%)
CE-WB-MRI with CE-Quick 3D and DFS	0.96	4	79.2 (19/24)	100 (110/110)	100 (19/19)	95.7 (110/115)	96.3 (129/134)
CE-WB-MRI without CE-Quick 3D and DFS	0.94	4	62.5 (15/24)	100 (110/110)	100 (15/15)	92.4 (110/119)	93.3 (125/134)
FDG-PET/CT	0.92	4	70.8 (17/24)	93.6*, ** (103/110)	70.8 (17/24)	93.6 (103/110)	89.6* (120/134)
Conventional radiological examination	0.92	4	79.2 (19/24)	92.7*, ** (102/110)	70.4 (19/27)	95.3 (102/107)	93.1* (121/134)

SE: sensitivity, SP: specificity, PPV: positive predictive value, NPV: negative predictive value, AC: accuracy
*: Significant difference with CE-WB-MRI wit Quick 3D and DFS (p<0.05).   **: Significant difference without CE-WB-MRI wit Quick 3D and DFS (p<0.05).

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