Detection of Bone Metastases in Nasopharyngeal Carcinoma Patients: Accuracy of 3T Whole-body MRI and FDG-PET-CT

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Purpose: To prospectively compare the diagnostic capability for bone metastasis of 3.0-Tesla whole-body magnetic resonance imaging (WB-MRI)[1] and integrated fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET-CT) in nasopharyngeal carcinoma (NPC) patients.

Materials and Methods: The study protocol was approved by the Institutional Review Board at our hospital and written informed consent was obtained from each subject. Between September 2003 and October 2009, a total of 388 patients (295 men, 93 women; mean age 48.90 years) with histologically proven NPC were referred for WB-body MRI and FDG-PET-CT for tumor staging and restaging. WB-MRI and FDG-PET-CT were performed within a time frame of 10 days. WB-MRI was performed on a 3.0-Tesla system (MAGNETOM Trio with Tim, Siemens Medical Solutions, Germany) equipped with movable table platforms and total imaging matrix. Examination protocols were tailored to obtain dedicated locoregional evaluation and adequate distant sites screening (Table 1).FDG-PET-CT imaging was performed using a PET/CT system (Discovery ST 16, GE Healthcare, Milwaukee, USA) consisting of a PET device and a 16-section CT device. Before PET acquisition, helical CT was performed from the head to the proximal thigh. Emission PET images from the head to the proximal thigh were acquired at 50–70 min after injection of 370 MBq of FDG. Images were acquired in two-dimensional mode, 3 min per table position. PET images were reconstructed using CT for attenuation correction. For each method, the probability of bone metastasis was independently assessed by using a 5-point visual scoring system (0: no lesion, 1: definitely benign, 2: probably benign, 3: probably malignant, 4: definitely malignant). On the basis of the pathological results or follow-up period of 12 months data, WB-MRI and FDG-PET-CT results were classified as true-positive, true-negative, false-positive, or false-negative. We calculated the sensitivity, specificity and accuracy of WB-MRI and FDG-PET-CT, and compared their differences with McNemar test. In addition, receiver-operating characteristic (ROC) curve analysis and the area under the ROC curve (AUC) were used to evaluate and compare their diagnostic capabilities.

Table 1 3.0 T WB-MRI protocols for NPC patients (PAT parallel acquisition technique, TSE turbo spin echo, FS fat saturation, STIR short tau inversion recovery, HASTE half-Fourier single-shot turbo spine echo, VIBE volumetric interpolated breath-hold examination)

	Region	Sequence	TR (ms)	TE (ms)	FA	FOV (mm)	Pixel size	PAT	Scan time (min)
Precontrast	Head/neck	Ax T2 TSE FS	6,640	88	140	200	0.7×0.5×4	2	02:21
		Ax T1 TSE	562	10	150	200	0.8×0.6×4	2	02:07
	Whole spine	Sag T1 TSE (2 stations)	500	11	140	440	1.2×0.9×4	2	1:37×2
		Sag STIR (2 stations)	5000	105	130	440	1.6×1.1×4	3	2:22×2
	Whole body	Cor T1 TSE (3 stations)	700	9.1	140	500	1.6×1.3×5	2	2:20×3
		Cor STIR (3 stations)	4800	94	140	500	1.8×1.3×5	3	2:40×3
	Chest	Ax T2 HASTE	1000	95	140	360	1.4×1.1×5	2	00:35
	Abdomen	Ax T2 HASTE	1000	95	140	360	1.4×1.1×5	2	00:35
		Ax T1 VIBE	3.27	1.35	13	350	1.7×1.4×3	2	00:16
P**ost**contrast	Abdomen	Ax T1 VIBE(artery phase)	3.27	1.35	13	350	1.7×1.4×3	2	00:16
		Ax T1 VIBE(portal phase)	3.27	1.35	13	350	1.7×1.4×3	2	00:16
	Chest	Ax T1 VIBE	3.27	1.35	13	350	1.7×1.4×3	2	00:16
	Abdomen	Ax T1 VIBE(equilibrium phase)	3.27	1.35	13	350	1.7×1.4×3	2	00:16
	Pelvis	Ax T1 VIBE	3.27	1.35	13	350	1.7×1.4×3	2	00:16
	Head/neck	Ax T1 FS TSE	550	10	150	200	0.9×0.7×4	2	03:13
		Cor T1 FS TSE	600	10	150	240	0.9×0.8×4	2	02:24

Results: Twenty-four (6.2%) of our 388 patients were diagnosed as having bone metastases. Of these 24 patients, bone metastases were detected by both WB-MRI and FDG-PET-CT in 16, WB-MRI alone in one, and FDG-PET-CT alone in two. In the remaining five patients, bone metastases were missed by both imaging techniques. On a patient-based analysis (Table 2), WB-MRI and FDG-PET-CT showed the similar sensitivity and specificity for bone metastasis (70.8 % vs 75.0 %, P=0.999; 99.5% vs 98.4%, P=0.289, respectively). Their diagnostic capabilities were equal (0.909 vs 0.909).

Table 2 Results of 3T WB-MRI and PET-CT for detecting bone metastasis in NPC patients (FN false-negative, TP true-positive, TN true-negative, FP false-positive, PPV positive predictive value, NPV negative predictive value, AUC area under curve)

	FN	TP	TN	FP	Sensitivity (%)[a]	Specificity (%)[a]	PPV (%)[a]	NPV(%)[a]	Accuracy (%)[a]	AUC
WB-MRI	7	17	362	2	70.8 (48.9-87.4)	99.5 (98.0-99.9)	89.5 (66.9-98.7)	98.1 (96.1-99.2)	97.7 (95.6-98.9)	0.909
PET-CT	6	18	358	6	75.0 (53.3-90.2)	98.4 (96.4-99.4)	75.0 (53.3-90.2)	98.4 (96.4-99.4)	96.9 (94.7-98.4)	0.909

[a]Data in parentheses are 95% confidence intervals

Conclusion: 3T WB-MRI is a feasible technique for the detection of bone metastasis in NPC patients, with similar sensitivity and equal diagnostic capacity to FDG-PET-CT.

References:

1. K. Engelhard et. al. Eur Radiol., 14(1):99-105, 2004.