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Original Article

Whole-body magnetic resonance imaging and FDG-PET/CT for lymphoma staging: Assessment of patient experience

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ABSTRACT

Purpose: To compare patient experience of whole-body MRI and FDG-PET/CT performed for lymphoma staging.
Methods: One-hundred-fifteen patients (59 males, 56 females; 53 Hodgkin, 62 non-Hodgkin; mean age: 43.8 years) with lymphoma underwent whole-body MRI and FDG-PET/CT for staging and filled a questionnaire regarding their experience of the examinations using a 4-point Likert scale (1, very good; 4,very bad). Differences were evaluated using Wilcoxon signed-rank test. Patients were asked to express their preference on both techniques. Preferences were compared on the basis of gender, age, and Ann Arbor stage using the chi-square test. A p-value $\leq .05$ was considered significant.
Results: Most patients found FDG-PET/CT a more burdensome examination than whole-body MRI. Whole-body MRI received a significantly lower score regarding overall satisfaction ($p < .05$), patient experience before ($p < .05$) and after ($p < .05$) scan. No significant difference was found in scan preparation ($p = .207$) and patient experience during scan ($p = .38$). The average Likert scores were <2 in all criteria for both types of scan. 54 patients preferred whole-body MRI, 10 preferred FDG-PET/CT, and 51 had no preference. There was no significant difference in technique preference according to gender ($p = .73$), age ($p = .43$), and stage ($p = 1.00$).
Conclusions: Whole-body MRI and FDG-PET/CT demonstrate high degree of patients' acceptance and tolerance.
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1. Introduction

The staging of newly diagnosed lymphoma includes an accurate imaging evaluation of disease location and extent. ^{18}F-fluorodeoxyglucose-positron emission tomography/computed tomography (FDG-PET/CT) and contrast-enhanced CT are currently the modalities of choice for lymphoma staging [1,2]. FDG-PET/CT provides relevant metabolic information and its reliability in response assessment during treatment and end-of-treatment evaluation is now widely demonstrated [1–4]. However, FDG-PET/CT does leave patients exposed to substantial radiation dose and an increased risk of cancer [5]. Previous studies have demonstrated a high rate of secondary malignancies in patients with lymphoma because of chemo- and radiotherapy [6]. Whole-body magnetic resonance imaging (WB-MRI) with diffusion-weighted imaging (DWI) is a radiation free technique that meets the needs of total body imaging [7] and is already applied in most oncologic fields [8–10]. Several studies have proved the high diagnostic accuracy and usefulness of WB-MRI in staging and follow-up of lymphoma patients [11–17]. It is well known that medical examinations may cause a strong psychological burden in oncologic patients [18,19], with severe discomfort and anxiety that can increase the risk of artefacts during radiological procedures [20].

The aim of our study was to compare patient experience of WB-MRI and FDG-PET/CT performed for staging of newly diagnosed lymphoma.

Abbreviations: FDG-PET/CT, ^{18}F-fluorodeoxyglucose-positron emission tomography/computed tomography; WB-MRI, whole-body magnetic resonance imaging; DWI, diffusion-weighted imaging.

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2. Materials and methods

2.1. Patients

This prospective study included patients with newly diagnosed lymphoma who underwent WB-MRI and FDG-PET/CT for disease staging between November 2013 and January 2016.

Inclusion criteria were: age over 14 years, histological proof of lymphoma, WB-MRI and FDG-PET/CT performed before treatment, and performance status values of ≤ 2 according to the Eastern Cooperative Oncology Group (ECOG) scale.

A total of 135 patients were identified. Twenty were excluded because they refused to complete the questionnaire. Thus, our final population was composed of 115 patients (59 males, 56 females; 53 Hodgkin, 62 Non-Hodgkin; mean age 43.8 years, range 15–82) who underwent both WB-MRI and FDG-PET/CT before treatment. Demographic characteristics, lymphoma histology, and Ann Arbor stage of our study population are shown in Table 1. All WB-MRI scans were of diagnostic quality.

Patients were randomly assigned to get the WB-MRI or FDG-PET/CT first. The mean interval time between WB-MRI and FDG-PET/CT studies was 7.3 days (range 4–10). Institutional review board approval was obtained for this study. All patients provided written informed consent after receiving full explanation of the benefits and risks of the procedure either WB-MRI and PET before examination. All procedures performed in this study were in accordance with the Helsinki declaration and its later amendments or comparable ethical standards.

2.2. WB-MRI

All WB-MRI scans were performed at closed 1.5 T MR scanner (Achieva, Philips Healthcare, the Netherlands) without contrast agent administration. The following sequences were used: coronal T1-weighted turbo spin-echo (repetition time, 322 ms; echo time, 18 ms; slice thickness, 6 mm; gap, 1 mm; cranio-caudal coverage, 185.5 cm), coronal short time inversion recovery (repetition time, 1498 ms; echo time, 64 ms; inversion time, 165 ms; slice thickness, 6 mm; gap, 1 mm; cranio-caudal coverage, 185.5 cm), and an axial diffusion-weighted imaging with background body signal suppression (b values = 0 and 800 s/mm^2; repetition time, 3134 ms; echo time, 64 ms; slice thickness, 6 mm; gap, 0 mm; cranio-caudal coverage, 96 cm). We used the built-in body receiver coil. The mean WB-MRI examination time was 35–40 min, including patient positioning.

Table 1
Demographic characteristics, lymphoma histology, and Ann Arbor stage of our study population.

	Hodgkin (53)	Non-Hodgkin (62)
Age		
Mean (range)	31.8 (15–66)	54 (21–86)
Gender		
Male	23	35
Female	30	27
Lymphoma subtype		
Nodular sclerosis	47	
Lymphocite-rich	3	
Mixed cellularity	3	
Diffuse large B-cell		27
Follicular		15
Marginal zone B-cell		7
Mantle cell		7
Lymphoplasmacytic		4
Peripheral T-cell		1
Anaplastic large cell		1
Stage		
I	1	1
II	30	13
III	13	9
IV	9	39

2.3. FDG-PET/CT

FDG-PET/CT scans were performed with two PET/CT scans (Gemini Scan, Philips Medical Solutions and Discovery ST, GE Medical Systems). Before the injection of FDG, the patient blood glucose level was checked and if it was above 200 mg/dl the scan was not performed. The CT images were acquired from the skull base to the proximal thigh and then the PET was obtained. The mean FDG-PET/CT examination time, including the time interval between injection of the radiopharmaceutical and acquisition of PET/CT images, was about one hour and a half.

After a six-hour fasting period, patients were injected with 3.7 MBq/kg body weight of FDG. Blood glucose levels were checked before injection. Following 60 ± 10 min of uptake period. CT was performed from skull base to pelvis by implementing a scout view using 10 mA and 120 kVp scanning parameters, followed by a spiral CT with 80 mA, 140 kVp. After completion of CT, 2D PET emission data (4 min per bed position covering an axial FOV of 15.7 cm with a 3-slice overlap) was obtained. FDG-PET/CT was performed within about 90–100 min, including the period between the injection of FDG and the FDG-PET/CT scan acquisition. CT data was used for attenuation correction. The field of view and pixel size of PET images reconstructed for fusion were 60 cm and 4.7 mm respectively, with a matrix size of 128 by 128.

2.4. Questionnaire

Each patient was asked to fill a questionnaire immediately after the examination. The questionnaire was similar to that used by Adams et al. in a previous study [21] and measured: scan preparation (e.g., insertion of intravenous line); patient experience before the scan (e.g., fear); patient experience during the scan (e.g., fear, discomfort, helplessness); patient experience shortly after the scan (discomfort, emotional distress); overall satisfaction. Evaluation was performed using a 4-point Likert scale (1, very good; 4, very bad). When patients reported a score of 3 or 4, they were asked to explain the reason of their answer. After completing the questionnaires, patients were asked to express their preference on the two techniques.

2.5. Statistical analysis

Data were collected and organized into a statistical database. Differences in experience between WB-MRI and FDG-PET/CT were evaluated using Wilcoxon signed-rank test.

To assess any potential influence of patient-related factors on preference, gender, age (≤ 25 vs. >25 years), and Ann Arbor stage (early; 1–2, vs. advanced; 3–4) were compared between patients who preferred WB-MRI and those who preferred FDG-PET/CT, using the chi-square (χ^2) test.

A p-value of <.05 was considered statistically significant.

Statistical analysis was performed with software (STATA, version 13.1, StataCorp LP, College Station, Texas, USA).

3. Results

3.1. Patient experience

Most patients found FDG-PET/CT a more burdensome examination than WB-MRI. The mean score for WB-MRI overall satisfaction was significantly higher than that of FDG-PET/CT. WB-MRI

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