Whole-Body Diffusion Imaging with Background Signal Suppression (DWIBS) versus FDG PET/CT in lymphoma patients; Comparative study.

THESIS

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By

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بسم الله الرحمن الرحيم

Abstract

Purpose: We performed a comparison between the diagnostic value of F-18-FDG PET-CT and WB-MRI/DWIBS for detecting nodal and extra-nodal lymphomatous infiltrates.

Patients & Methods: thirty two patients with pathologically proven lymphoma (HL or NHL) underwent both F-18-FDG PET-CT and WB-MRI/DWIBS, to detect nodal and extra-nodal lymphomatous infiltration. Both F-18-FDG PET-CT and WB-MRI/DWIBS were independently interpreted using visual (qualitative) and quantitative analysis in the term of SUV max and ADC mean respectively. Using pathological data and / or combined clinical / radiological follow up as a reference standard, Sensitivity, specificity, PPV, NPV and overall accuracy were estimated for both techniques.

Results: F-18 FDG PET-CT demonstrated clearly higher parameters than WB-MRI/DWIBS. With the latter one showed a limited superiority in the context of bone marrow assessment.

Conclusion: F-18 FDG PET-CT is better than WB-MRI/DWIBS in evaluation of lymphomas. The latter one may play a complementary role especially in assessment of BM infiltration.

Key word: *lymphomas, F-18-FDG PET-CT, WB-MRI, DWIBS*

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CONTENTS

LIST OF ABBREVIATIONS

ADC	apparent diffusion coefficient
ALCL	anaplastic large cell lymphoma
BMB	Bone Marrow Biopsy.
ceCT	Contrast enhanced computerized tomography.
CHL	Classic Hodgkin lymphoma
CMR	Complete metabolic remission
CNS	Central Nervous System
CNS	Central Nervus System
CR	Complete Response
CR	Complete remission
CT	Computerized tomography
DLBCL	Diffuse large B-cell lymphoma.
DW MRI	Diffusion-weighted magnetic resonance imaging
DWI	Diffusion Weighted Imaging
DWIBS	Diffusion Weighted Imaging With Background Signal Suppression
EBV	Epstein-Barr Virus
EPI	Echo Planner Imaging
FDG-PET	Fluorodeoxyglucose Positron emission tomography.
FL	follicular lymphoma
FOV	Field of view
G-CFS	Granulocyte Monocyte Colony Stimulating Facor
GLUT	glucose transport proteins
GTD	Greatest Transverse Diameter.
HD	Hodgkin disease.
HL	Hodgkin lymphoma.
HIV	Human Immune Deficiency Virus
ICML	International Conference on Malignant Lymphoma
IgA	Immunoglobulin A
IHP	International Harmonization Project.
iPET	interim PET-CT

IPI	International Prognostic Index
IPS	International Prognostic System
IWG	International Workshop Group.
IWG	International Working Group
LDCHL	Lymphocyte-depleted HL
LRCHL	Lymphocyte-rich classic HL
MALT	Mucosa Associated Lymphoid Tissue.
MALT	Mucosa-associated Lymphoid Tissue
MCCHL	Mixed cellularity HL
MIP	Maximum Intensity Projection
MPG	Magnetic Pulse Gradient
MPR	multiplanner reformatting
MRI	Magnetic Resonance Imaging
MZL	Marginal Zone Lymphoma.
NHL	Non-Hodgkin Lymphoma
NHL	Non Hodgkin Lymphoma.
NK	Natural Killer
NLPHL	Nodular lymphocyte predominant HL
NPV	Negative predictive Value.
NSCHL	Nodular sclerosis classical HL
PD	Progressive disease.
PET/CT.	Positron emission tomography computerized tomography
PMPL	primary mediastinal large B-cell lymphoma
PPV	Positive Predictive Value.
PR	Partial response
ROC	Receiver operator characteristic
ROI	region of interest
RS	Reed-Sternberg
SEER	Surveillance Epidemiology And End Results.
SLL	Small Lymphocytic Lymphoma.
SLL/CLL	small lymphocytic lymphoma/chronic lymphocytic leukemia
SNR	Signal to noise ratio

SPD	Sum of Product of Perpendicular Diameters.
SPECT	Single Photon-Emission Computer Tomography
STIR	Short time inversion recovery.
SUV	Standardized uptake value
T	Tesla
TE	Time to Echo
TLG	Total lesion glycolysis
TR	Time of Repetition
US	Ultrasound
WBC	White blood cell
WB-MRI	whole body Magnetic Resonance Imaging
WHO	World Health Organization.

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Introduction

Malignant lymphomas [Hodgkin lymphomas (HL) and non-Hodgkin lymphoma (NHL)] rank third in incidence, of all childhood cancers. Furthermore, in adolescents (aged 15–19 years) the malignant lymphomas are the leading cause of cancer. ***(Kwee et al, 2010).***

The management of both NHL and HL follows well-established guidelines based on the initial staging assessment. An accurate staging is the basis for the selection of an appropriate therapeutic approach in order to prevent over or under treatment as well as to minimize morbidity related to the radio-chemotherapy regimens given. ***(Ferrari C. et al, 2014)***. Once a malignant lymphoma has been diagnosed histologically, extent of the disease has to be assessed (i.e. staging), as this determines treatment planning and prognosis as well as monitoring the effect of therapy. ***(Lin C. et al, 2010)***.

18F-FDG-PET is currently regarded as the reference standard imaging modality in the staging of the majority of lymphoma types, for evaluation of distribution of the disease by providing both functional and anatomic information in a single whole body examination**. *(Ferrari C. et al, 2014).***

Whole body MRI has been proven to be an extremely useful method for multifocal diseases and oncology with the same routine MR contraindications. It should be, respecting the limitations, inherent to any radiology method, accepted as another powerful tool, especially in pediatric oncology, avoiding radiation exposure related disease. ***(Luiz J. et al, 2014)***.

Diffusion weighted MRI does not require the use of ionizing radiation or MR contrast agents and can be easily implemented into a standard MRI protocol ***(Calandriello L. et al, 2013).***

DWI techniques coupled with anatomic conventional morphologic techniques allows greater lesion conspicuity and characterization compared with other functional and anatomic imaging modalities. ***(Attariwala R, et al 2013).***

In 2004, **Takahara et al.** introduced an interesting new concept of DWI, called DWIBS "diffusion-weighted whole-body imaging with background body signal suppression" which made it possible to obtain high quality diffusion images of the whole-body during free breathing ***(Takahara et al 2004).***

The recently introduced concept of (DWIBS) now allows acquisition of volumetric diffusion weighted images of the entire body. This new concept has unique features different from conventional DWI and may play an important role in whole body oncological imaging ***(Kwee, T. C. et al, 2008).***

Whole-body MRI with DWIBS seems a feasible and promising technique for both initial staging and response assessment in patients with lymphoma ***(Lin C. et al, 2012)***.

F-FDG PET/CT remains the reference standard imaging modality for patients affected by HL or aggressive NHL ***(Ferrari C. et al, 2014).*** There are, however, some shortcomings to these techniques, amongst which are patient's exposure to ionizing radiation, contrast and isotope agents. Magnetic resonance imaging (MRI) with its lack of ionizing radiation may be a useful application for tumor detection and staging of malignancies and could overcome the limits of FDG-PET/CT ***(Sumkauskaite, M. et al 2013).***

Aim of the work

The aim of this work is to set a comparison between F-18-FDG PET-CT and whole-body diffusion-weighted imaging MR protocol (DWIBS) for initial staging and post chemotherapy evaluation in patients with pathologically proven lymphoma (Hodgkin and Non-Hodgkin), and to explore the role of the latter one as well as its drawbacks and limitations as an emerging whole body imaging modality.