

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

***THESIS***

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Radio-diagnosis***

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# **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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## **LIST OF ABBREVIATIONS**

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

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

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

## ***Introduction***

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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 (*Sumkauskaitė, 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.