

The Role of Whole Body MRI With Diffusion Sequence Versus FDGPet/ Ct: A Comparative Study in Pediatric Patients With Hodgkin Lymphoma From Diagnosis to End of Treatment

Lederman, H.M^{1*}, Grassi, DC², Melo, A.C³ and Luisi, F⁴

¹Department of the Diagnostic Imaging Center, Pediatric Oncology Institute (IOP/GRAACC), Federal University of São Paulo (UNIFESP), São Paulo – Brazil.

²Department of Radiologist at the Diagnostic Imaging Center, Pediatric Oncology Institute (IOP/GRAACC), Federal University of São Paulo (UNIFESP), São Paulo – Brazil.

³Department of Radiology Resident at Hospital Heliópolis / Diagnostic Imaging Center, Pediatric Oncology Institute (IOP/GRAACC), Federal University of São Paulo (UNIFESP), São Paulo – Brazil.

⁴Department of Pediatric Oncologist at the Pediatric Oncology Institute (IOP/GRAACC), Federal University of São Paulo (UNIFESP), São Paulo, Brazil.

Corresponding Author: Henrique Lederman, Department of the Diagnostic Imaging Center, Pediatric Oncology Institute (IOP/GRAACC), Federal University of São Paulo (UNIFESP), São Paulo – Brazil.

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Abstract

Background

In pediatric oncology, minimizing exposure to ionizing radiation is crucial due to the potential long-term risks, including the development of secondary malignancies. For pediatric patients with Hodgkin lymphoma, identifying radiation-free imaging methods that can reliably replace conventional techniques is a clinical priority.

Objective

To evaluate the correlation between whole-body magnetic resonance imaging with diffusion-weighted imaging (WB-MRI/ DWI) and 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT) findings in pediatric patients with Hodgkin lymphoma, and to determine whether WB-MRI/DWI can serve as a viable alternative in staging and follow-up protocols.

Materials and Methods

This single-center retrospective study included pediatric patients aged 6.6–17.0 years (mean $\pm$ SD: 14.9 $\pm$ 3.2 years) with histopathological confirmed Hodgkin lymphoma who underwent both WB-MRI/DWI and FDG-PET/CT. Imaging was performed with an average interval of 7.6 $\pm$ 4.9 days, one from the other. Two radiologists independently evaluated all studies, recording the number of sites involved. per exam and adding all of them for a more precise number. Pearson correlation coefficients and Kappa agreement analyses were performed, using FDG-PET/CT as the reference standard.

Results

Among 45 patients (28 male [62,3%], 17 females [37,7%]), 204 sites were positive on FDG-PET/CT and 270 on WB-MRI/DWI. There was a strong correlation between WB-MRI/DWI and FDG-PET/CT for both the number of positive sites ($r = 0.831$, $p < 0.001$). WB-MRI/DWI demonstrated 96% sensitivity, 95% specificity, an overall agreement of 95.2%, and a Kappa index of 0.8004 ($p < 0.001$).

Conclusion

WB-MRI/DWI shows excellent agreement with FDG-PET/CT for the evaluation of Hodgkin lymphoma in pediatric patients and may represent a safe, effective, and radiation-free alternative for staging and follow-up in this population.

Keywords: Whole Body Magnetic Resonance Imaging, Diffusion Magnetic Resonance Imaging, Fluorodeoxyglucose Positron Emission Tomography And Computed Tomography, Hodgkin Disease, Pediatric Neoplasms and Oncology Imaging

1. Introduction

Hodgkin lymphoma is a malignant lymphoid neoplasm that frequently affects pediatric patients, requiring precise imaging for staging, treatment planning, and response assessment. Traditionally, anatomical imaging techniques such as computed tomography (CT) have been the mainstay for evaluating disease extent. However, the cumulative radiation exposure from repeated CT examinations is a significant concern in the developing bodies of pediatric patients. Whole-body magnetic resonance imaging (WB-MRI) with diffusion-weighted imaging (DWI) has emerged as a promising, radiation-free alternative for assessing Hodgkin lymphoma. DWI provides functional information related to tissue cellularity and microstructure, aiding in the detection and characterization of lymphomatous involvement. Meanwhile, 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT) remains the current reference standard for staging and treatment response assessment in Hodgkin lymphoma due to its ability to identify metabolic activity associated with disease. But with high dose of radiation [1-3].

Both chemotherapy and radiotherapy induce microstructural changes in tumor tissue that can be detected on DWI, with apparent diffusion coefficient (ADC) values tending to increase in response to effective therapy (Shapira-Zaltsberg et al., 2020). Previous studies have demonstrated that WB-MRI/DWI can yield results comparable to FDG-PET/CT in pediatric Hodgkin lymphoma and may be a feasible alternative in lymphoma evaluation more broadly [4-7].

The present study aims to build upon this evidence by investigating the correlation between WB-MRI/DWI and FDG-PET/CT in the initial staging and treatment response assessment of pediatric patients with Hodgkin lymphoma, following chemotherapy, with the goal of validating WB-MRI/DWI as a radiation-free alternative in this context.

2. Materials and Methods

2.1. Study Design

This was a single-center, retrospective observational study conducted by the Diagnostic Imaging Center of the Pediatric Institute of Oncology of the Adolescent and Children with Cancer Support Group (IOP/GRAACC). Federal University of São Paulo (UNIFESP). The study was approved by the Institutional Research Ethics Committee, and the requirement for informed consent was waived due to its retrospective nature and the analysis of previously acquired and fully anonymized data [4-7].

2.2. Patients

We included only pediatric patients aged 6.6–17.0 years (mean $\pm$ SD: 14.9 $\pm$ 3.2 years), 45 patients (28 male [62.3%], 17 females [37.7%]), with histopathological confirmed Hodgkin's lymphoma who underwent both 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT) and whole-body magnetic resonance imaging with diffusion-weighted imaging (WB-MRI/DWI) between January 2019 and

December 2025. Imaging was performed with an average interval of 7.6 ± 4.9 days, one from the other. The remainder of the patients of the Institution with Hodgkin's lymphoma were excluded because they lacked histopathological confirmation, had incomplete imaging sequences, or if the interval between FDG-PET/CT and WB-MRI/DWI exceeded the protocol [8,9].

2.3. Diagnosis Confirmation

Hodgkin's lymphoma was confirmed in all cases through histopathological examination of lymph node or extranodal biopsies, performed according to institutional protocols.

2.4. Imaging Protocols

WB-MRI/DWI examinations were performed at IOP/GRAACC using a 1.5 T scanner (Achieva, Philips Healthcare, Best, The Netherlands) with an integrated body coil and maximum gradient strength of 28 mT/m. A coronal T2-weighted short tau inversion recovery (STIR) sequence was acquired with the following parameters: TR/TE, 3133/30 ms; TI, 160 ms; matrix, 220 $\times$ 320; field of view (FOV), 480 mm²; number of excitations (NEX), 4; slice thickness, 5 mm; interslice gap, 1 mm; acquisition time, 35–40 minutes. Subsequently, axial diffusion-weighted imaging with background body signal suppression (DWIBS) was performed using b-values of 0 and 800 s/mm²; TR/TE, 8263/70 ms; matrix, 176 $\times$ 115; FOV, 530 mm²; NEX, 4; slice thickness, 6 mm; interslice gap, –1 mm; acquisition time, 10–15 minutes. Post-processing was performed using Mobi View software (Philips Healthcare, Best, The Netherlands) to obtain coronal maximum intensity projections (MIP). FDG-PET/CT examinations were performed at various external institutions according to their internal protocols. All FDG-PET/CT images were anonymized and imported into the institutional PACS for review [10-13].

2.5. Image Analysis And Control Of Observer Subjectivity

All WB-MRI/DWI and FDG-PET/CT images were independently evaluated by two board-certified radiologists with 50 and 10 years of experience in pediatric radiology, blinded to the results of the other modality and to clinical information except for the diagnosis of Hodgkin's lymphoma. Findings considered positive were recorded when lymph nodes showed a short-axis diameter > 1.0 cm, rounded morphology, and high signal intensity on STIR and DWIBS sequences (for WB-MRI/DWI), or increased FDG uptake above background (for FDG-PET/CT). The number of positive Hodgkin lymphoma involvement sites in lymph nodes and extranodal sites detected by both modalities was recorded. Two radiologists independently evaluated all studies, recording the number of involved sites, per exam, and adding all of them for a more precise number. Pearson correlation coefficients and Kappa agreement analyses were performed, using FDG-PET/CT as the reference standard.

2.6. Statistical Analysis

All data were tabulated and analyzed using SPSS® for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). The Pearson correlation coefficient was calculated for the number of positive sites. Agreement between WB-MRI/DWI

and FDG-PET/CT was assessed using the Kappa statistic, with FDG-PET/CT considered the reference standard. Sensitivity, specificity, and overall concordance rates were also calculated, with statistical significance set at $p < 0.05$.

3. Results

A total number of patients with Hodgkin's lymphoma from the Institution only 45 patients (28 male [62,3%], 17 females [37,7%]), that met the initial criteria, including both FDGPET/CT and WB-MRI/DWI, were identified. The ages of the patients at the time of imaging ranged from 6.6 to 17.0 years (mean $\pm$ SD: 14.9 ± 3.2 years).

In total, the number of sites involved. per exam and adding all of them for a more precise number, 204 sites were positive on FDG-PET/CT and 270 on WB-MRI/DWI.

Pearson's correlation analysis demonstrated a strong positive correlation between the two modalities for both the number of involved sites ($r = 0.831$, $p < 0.001$).

Additionally, a comparative analysis using the Kappa concordance coefficient considering FDG-PET/CT as the gold standard—demonstrated high diagnostic agreement, with a sensitivity of 96%, specificity of 95%, overall agreement rate of 95.2%, and a Kappa index of 0.8004 ($p < 0.001$).

4. Discussion

Whole-body MRI (WB-MRI) combined with diffusionweighted imaging (DWI) is consolidating its role as a promising functional alternative to FDG-PET/CT in the staging and follow-up of pediatric lymphoma, with the added benefit of eliminating exposure to ionizing radiation an essential consideration in pediatric imaging protocols. In the present study, the technique demonstrated high diagnostic concordance with FDG-PET/CT, exceeding 95% in the identification of both nodal and extranodal involvement, reinforcing its clinical robustness with a sensitivity of 94.7% and a specificity of 96.1%.

These findings are visually exemplified below, in examples of images pre and post 2 cycles of chemotherapy. (Figures 1 and 2) Recent literature has further strengthened the applicability of WB-MRI/DWI in pediatric lymphoma. In a study conducted by Rosbach et al. (2023), a significant functional correlation between diffusion parameters and cellular metabolism was shown, indicating that lesions with higher metabolic activity tend to exhibit lower water diffusivity, suggesting that mean diffusion values may serve as a reliable functional biomarker for assessing tumor activity. Adding to this evidence, Bhalla et al. (2023), in a systematic meta-analysis, confirmed the high diagnostic performance of WB-MRI in staging pediatric lymphoma, demonstrating high sensitivity for both nodal and extranodal involvement, thereby providing highly accurate staging suitable for longitudinal monitoring without the cumulative risks associated with radiation exposure.

In our cohort, comparative multimodal examples illustrate this diagnostic reliability.

In the present, the Lugano scale in PET/CT remains the standard method for response assessment in lymphoma; it relies on metabolic activity, which may be influenced by residual inflammation or physiological uptake, leading to potential misinterpretations, especially in borderline cases. In such scenarios, diffusion-weight imaging (DWI) emerges as a valuable complementary tool. By indicating directly whether there is restricted diffusion therefore active cellularity it provides a more objective interpretation and reduces interobserver variability, as demonstrated by Latifoltojar et al. (2019a) and Mayerhoefer et al. (2015). This binary approach (positive or negative for restriction) has proven clinically useful, particularly when PET/CT metabolic findings are inconclusive, as noted by Spijkers et al. (2023). Moreover, the absence of ionizing radiation makes DWI especially advantageous for pediatric patients requiring repeated follow-up imaging. In addition, Latifoltojar et al. (2019b) highlighted that whole-body MRI with DWI offers practical applicability even in centers without nuclear medicine infrastructure, reinforcing its role as a safe, accessible, and effective tool for long-term monitoring.

Broadening its clinical role beyond initial staging, the technique also demonstrated value in differentiating true therapeutic response from residual inflammation, particularly in the context of restaging. In a prospective study, reinforced the utility of WB-MRI/DWI by reporting that the addition of diffusion sequences enhanced the accuracy of residual disease detection. Similarly, highlighted the prognostic value of the technique, demonstrating that increases in diffusion values during therapy correlated positively with progression-free survival, supporting the use of WB-MRI/DWI as a real-time functional biomarker for treatment monitoring, even in cases with borderline metabolic findings. (Figures 3 and 4).

These findings are further supported by De Paepe et al. (2021), who demonstrated that quantitative changes in the apparent diffusion coefficient (ADC) after just one treatment cycle were predictive of clinical outcomes in pediatric patients with aggressive non-Hodgkin lymphoma. Their study also reported a high concordance between WB-DWI and PET/CT, validating the technique as a safe and effective monitoring strategy, particularly suitable for long-term protocols requiring multiple sequential evaluations.

The results of the present study align with those previously described by Schiavon et al. (2019), who also identified significant concordance between WB-MRI with diffusion sequences and FDG-PET/CT in the evaluation of Hodgkin lymphoma in children and adolescents. Their investigation reinforced the diagnostic robustness of WB-MRI/DWI, demonstrating its applicability across diverse clinical contexts as a functional and radiation-free alternative to FDG-PET/CT. (Figures 3 and 4).

Notably, as seen in Figure 5, post-treatment evaluation showed residual hyperintense STIR signal in the mediastinum (Figure 5A), but absence of corresponding hypersignal in the MIP-DWI reconstruction (Figure 5B), indicating non-viable

tissue. These findings were corroborated by the PET/CT scan (Figure 5C), which showed no residual metabolic activity—supporting the interpretation of complete metabolic remission and underlining the technique's utility in treatment monitoring. Based on this robust body of evidence, WB-MRI/

DWI emerges not merely as a promising alternative but as a transformative advance with the potential to reshape diagnostic practices in pediatric oncology, combining high functional performance with comprehensive protection of pediatric health [14,15].



Figure 1 A : Patient JC At Diagnosis. Pet Ct On The Left and Wb-MRI/DWI On The Right

Images show disease on the R side of the neck, enlarged lymph nodes, high uptake on the PET and high signal on WB-MRI/DWI, very similar on comparison.



Figure 1 B : Patient JC Following 2 Cycles Of Chemotherapy Resolution WBMRI on the Left

And Pet CT on the right Images show no signs of uptake on the PET CT no signal on the WBMRI, with complete resolution of the lesions.



Figure 2 A: Patient ACF at Diagnosis, WB-MRI/DWI on The Left And Pet CT on the Right

Images show disease (cervical lymphadenopathy, bilateral axillary and mediastinal mass) with high signal on the WB-MRI/DWI and high uptake on the PET CT (high SUV), equally.



Figure 2 B: Patient ACF Following 2 Cycles Of Chemotherapy, Resolution. WBMRI on the left. and Pet CT on the Right Images Show Resolution Of The Lesions

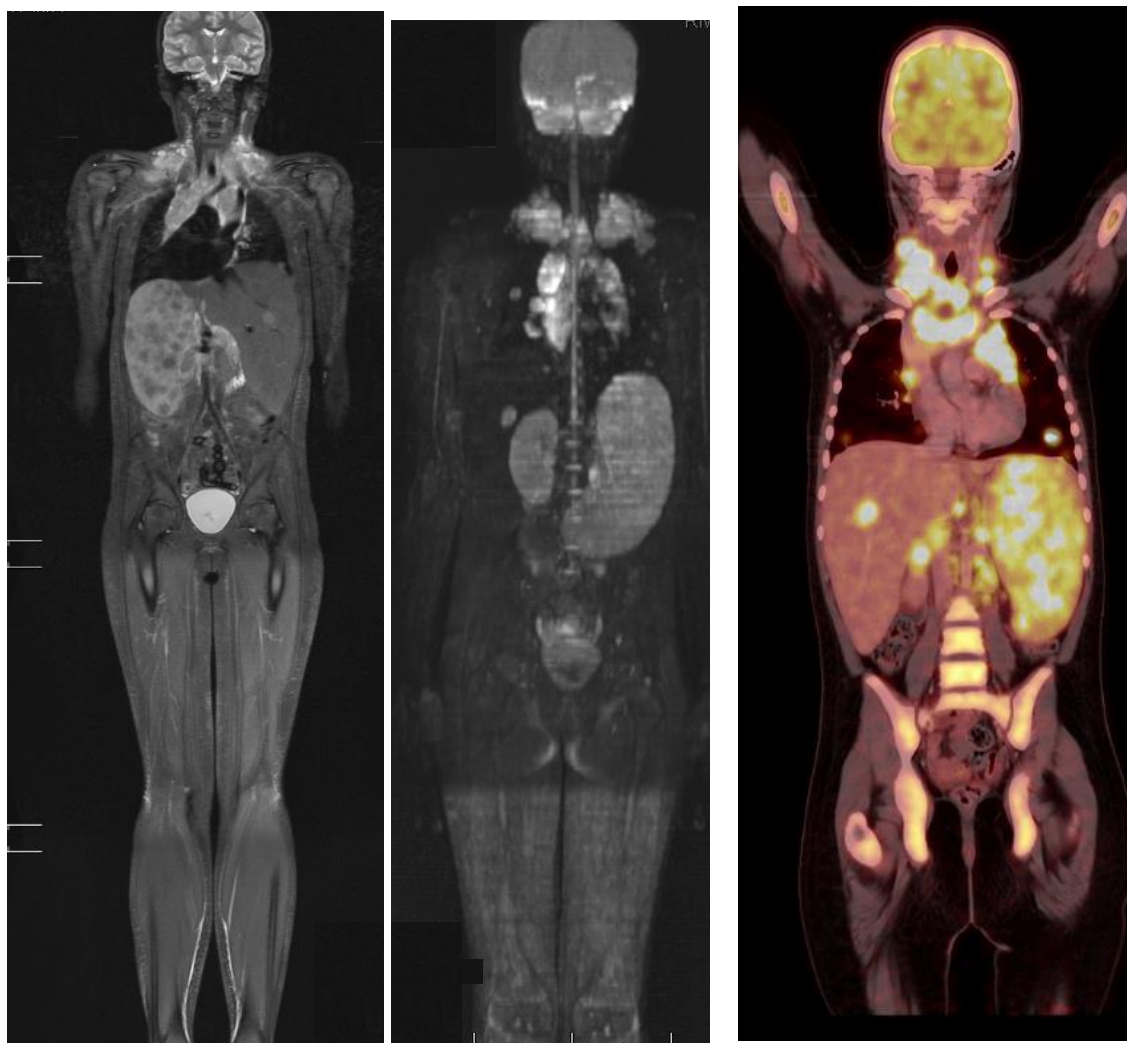


Figure 3 A: Patient JDF at Diagnosis, WB-MRI (Left) and WB-MRI/DWI (Middle) and Pet CT (Right) Show Disease, High Signal On The WB-MRI, Wb-MRI/DWI And High Uptake On the PET CT in the Neck, Mediastinum, Lung, Liver And Spleen, Equally



Figure 3B: Patient JDF Post-Treatment Images Showing Small Lymph Nodes With Residual Mediastinal Involvement on WB-MRI (stir) left. On The Middle WB-MRI/DWI No Signal On The Mediastinum, Without Active Disease. On The Right Fdg-Pet/Ct Confirming Absence Of Pathological Uptake. Marked Improvement On The Spleen, Equally Seen

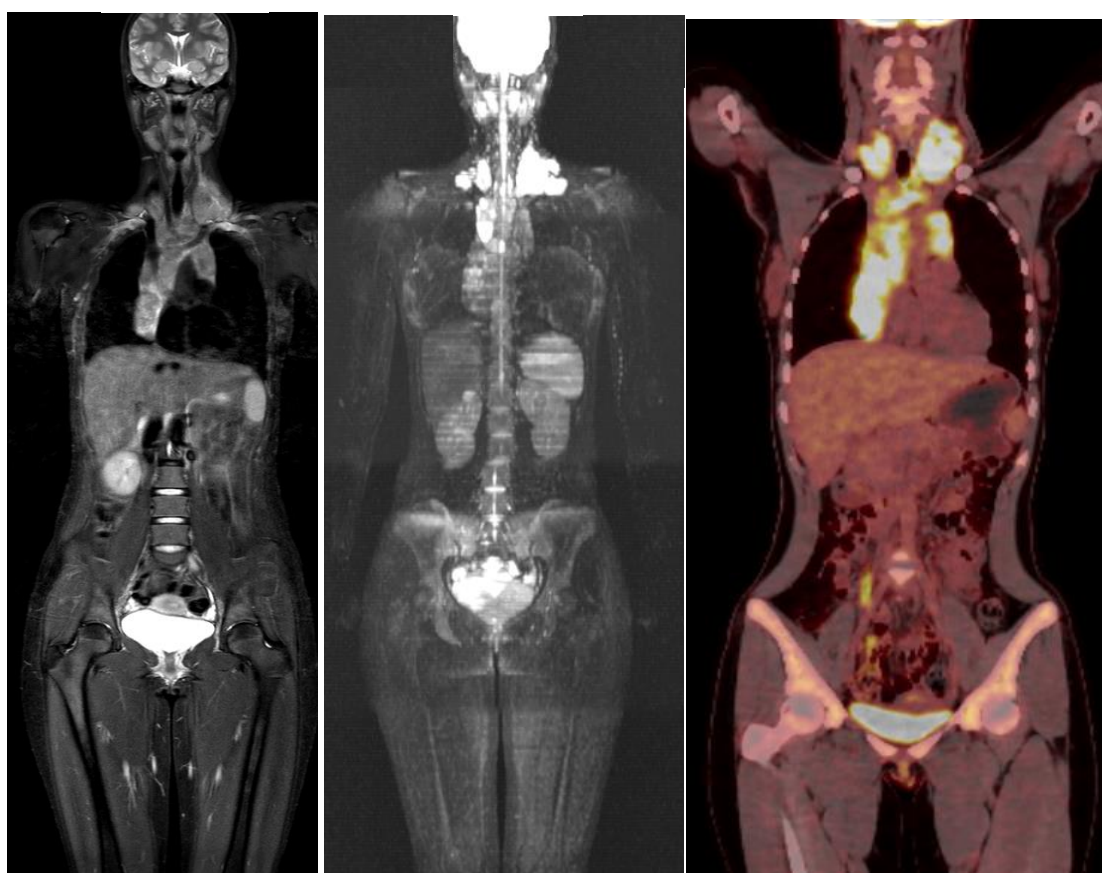


Figure 4A: Patient JRC at Diagnosis, WBMRI (left) and WB-MRI/DWI (middle) and Pet CT (right) Show Disease, High Signal On The WBMRI, WB-MRI/DWI and High Uptake on the PET CT in The Neck, Mediastinum, Equally

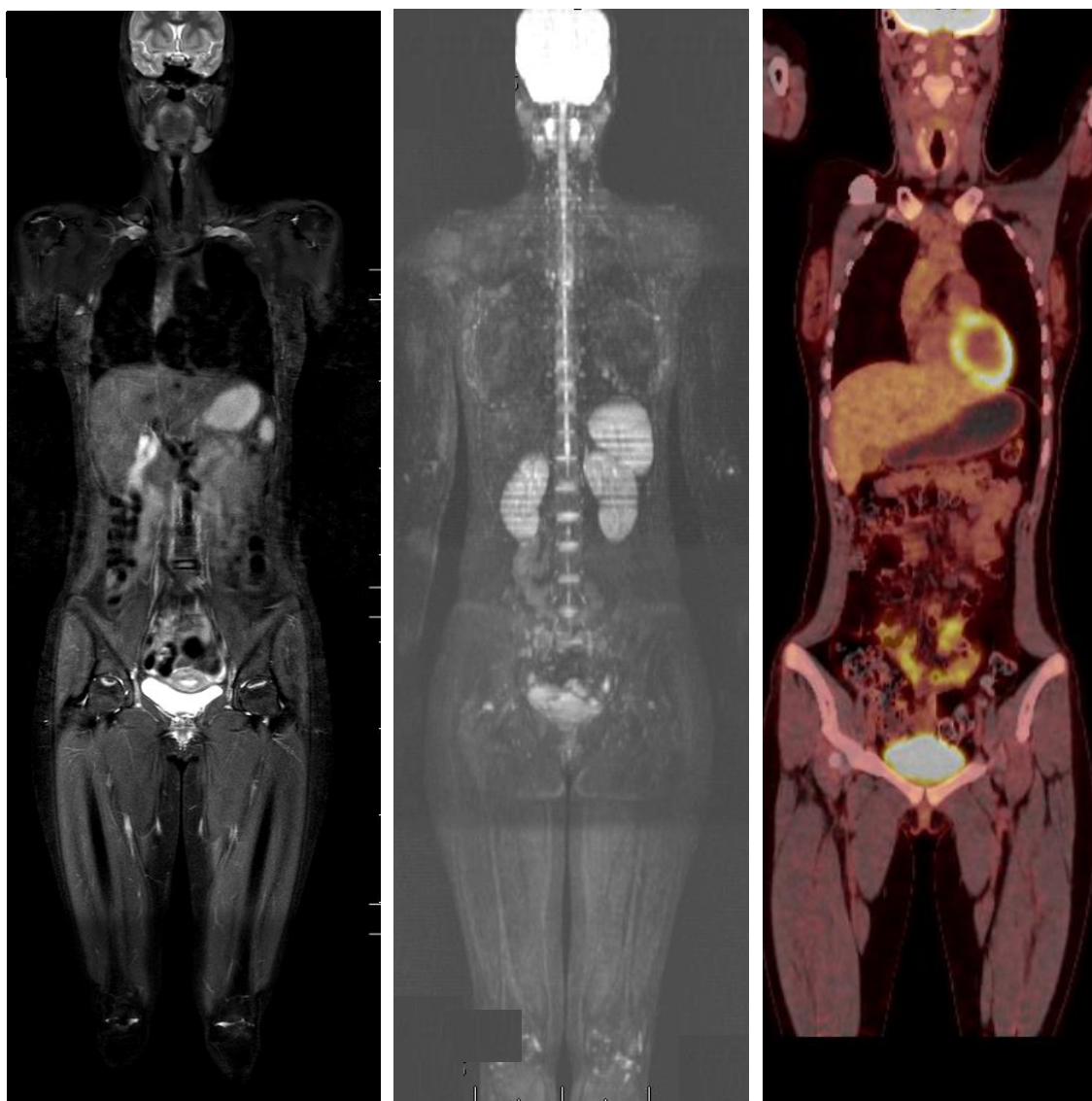


Figure 4b: Patient JRC Following 2 Cycles Of Chemotherapy WBMRI (left) Residual Small Lesion On The Right Mediastinal And WB-MRI/DWI (middle) and Pet CT (right) Does Not Show Disease In The Neck, Mediastinum, Equally

5. Conclusion

Based on the findings of the study, whole-body magnetic resonance imaging with diffusion-weighted imaging is a safe and effective method, demonstrating a very strong correlation and high agreement with fluorodeoxyglucose positron emission tomography combined with computed tomography. This technique represents a viable, radiation-free alternative for the evaluation of pediatric patients with Hodgkin's lymphoma.

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