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Whole Body Mr-Dwibs vs. [18F]-FDG-PET/CT in Oncology Patients Coming to Pravara Rural Hospital, Loni

Dr. Prerna Ajwani[1], Dr. Yogendra Pishorilal Sachdev[1*], Dr. Ganesh Vikhe[3], Dr. Manohar Pravin Sachdev[4]

[1]Junior Resident, Department of Radiodiagnosis, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra 413736, India
[2]Professor and HOD, Department of Radiodiagnosis, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra 413736, India
[3]Assistant Professor, Department of Radiodiagnosis, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra 413736, India
[4]Senior Residents in Department of Radiodiagnosis, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Maharashtra 413736, India

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***Corresponding Author:** Dr. Yogendra Pishorilal Sachdev

Abstract

Background*:** Over the past twenty years, advances in our understanding of tumour biology have led to the development of improved treatment strategies for many cancers. As a result, many patients are living longer with metastatic disease and the incidence of metastasis is continuing to rise. Based on post-mortem findings, approximately 70% of patients with breast or prostate cancer have bone metastases. Commensurate with the increased prevalence of bone metastasis, there is potential for significant comorbidities such as pain, limited mobility, hypercalcaemia, spinal cord or nerve root compression, myelosuppression and pathologic fracture. Therefore, early detection of skeletal metastasis is critical for accurate staging and optimal treatment; to allow the implementation of treatment strategies such as surgical fixation, radiotherapy, or bisphosphonate therapy to reduce the risk of complications and improve quality of life. ***Material and methods: The evaluation of diagnostic tests was carried out on50patients in the Department of Radiodiagnosis, Rural medical college, PIMS (D.U) Loni for duration of 2 years (2019-2021). Study population included all patients referred to Department of Radiodiagnosis for DWIB to look for metastases. The ethical clearance was obtained from the Ethics Committee, Rural Medical College and Hospital, Loni. All the patients fulfilling the selection criteria were explained about the purpose of study and a written informed consent was obtained to participate in the study before enrolment. ***Results*:** In our study out of 50 patients, 29 were males and 21 females. The most common age group were of 40 to 50 yrs. The sensitivity of DWIBS was 97.87%, specificity was 100%, positive predictive value of 100%, negative predictive value of 75% and accuracy was 98% in detecting metastases. ***Conclusion*:** Present study concluded that MR-DWIBS is useful in detection of metastases in patients with a low level of suspicion and normal or nonspecific and [18F]-FDG-PET/CT finding. DWIBS is a radiological modality devoid of radiation exposure like with [18F]-FDG-PET/CT. MR-DWIBS is a particularly useful modality in diagnosing metastases due to its high specificity, and accuracy as compared to [18F]-FDG-PET/CT.

Keywords: MR-DWIBS, [18F]-FDG-PET/CT, ONCOLOGY.

INTRODUCTION

Cancer is the second leading cause of death globally, accounting for an estimated 9.6 million deaths, or one in six deaths, in 2018 [1].

Lung, prostate, colorectal, stomach and liver cancer are the most common types of cancer in men, while breast, colorectal, lung, cervical and thyroid cancer are the most common among women. The cancer burden seems to continue exponentially across the world, exerting tremendous physical, emotional and financial strain on individuals, families, communities and health systems. Mean life expectancy seems to be shortened because of the factors related to and contributing to issues with cancer detection, accurate staging, understanding its spread, early detection of metastases and treatment measures. Metastases of various neoplasms not only causes progression of grade of cancer but also affects the overall treatment course

and its outcome. Neoplasms could metastasise to any part of the body with few sites being a predilection.

Over the past twenty years, advances in our understanding of tumour biology have led to the development of improved treatment strategies for many cancers. As a result, many patients are living longer with metastatic disease and the incidence of metastasis is continuing to rise. Based on post-mortem findings, approximately 70% of patients with breast or prostate cancer have bone metastases [2]. Commensurate with the increased prevalence of bone metastasis, there is potential for significant comorbidities such as pain, limited mobility, hypercalcaemia, spinal cord or nerve root compression, myelosuppression and pathologic fracture [3, 4]. Therefore, early detection of skeletal metastasis is critical for [5] accurate staging and optimal treatment [6]; to allow the implementation of treatment strategies such as surgical fixation, radiotherapy, or bisphosphonate therapy to reduce the risk of complications and improve quality of life [7, 8].

We briefly review our current understanding of the biological mechanisms through which tumours metastasise to bone and describes the available imaging methods to diagnose bone metastasis and monitor response to treatment [9]. As the survival time of patients is now longer, accurate detection, and diagnosis of metastatic diseases by whole body (WB) imaging becomes more important [18]. Fluorodeoxyglucose-positron emission tomography/computerized tomography [18] (FDG-PET/CT) is the usual modality for the assessment of metastatic diseases [10].

Diffusion weighted whole-body imaging with back ground signal suppression (MR-DWIBS) VS 18F-fluorodeoxyglucose (FDG)-positron emission tomography (PET)/computed tomography (CT) in metastatic disease [11].

The visualization and measurement of the diffusivity of water molecules in the human body by diffusion-weighted imaging (DWI) actually represents a fingerprint of the cellular characteristics of the tissue. This is because biological tissues are composed of barriers that restrict-free diffusion of water molecules such as cell membranes, fibers, and macromolecules [12].

The major role of DWI in clinical routine is in the early detection of cerebral ischaemia, but changes in tissue water diffusion properties can be helpful for the detection and characterisation of pathological processes, including cancer, in any part of the body [13] DWIBS allows acquisition of volumetric diffusion weighted images of the entire body and also has unique features different from conventional DWI [14, 15]. Diffusion weighted whole-body imaging with back ground signal suppression (MR-DWIBS) VS 18F-fluorodeoxyglucose (FDG)-positron emission tomography (PET)/computed tomography (CT) in metastatic disease [16, 17].

The fact that MR/DWIBS does not require the use of ionizing radiation or contrast agents had advantages; because it means that it is less invasive and more widely available compared to [18] FDG-PET/CT.

DWIBS gives functional information and can be used for the detection and characterization of pathologic processes, including malignant tumors; it may, therefore, be of value in staging and follow-up imaging of malignant tumors. DWIBS techniques coupled with anatomic conventional morphologic techniques allow greater lesion conspicuity and characterization compared with other functional and anatomic imaging modalities.

AIM

To determine the sensitivity, specificity and accuracy of whole body (WB) magnetic resonance diffusion weighted imaging (DWI) with background body signal suppression (MR/DWIBS) in detecting metastatic lesions in oncology patients.

OBJECTIVES

To assess the diagnostic performance of whole body (WB) magnetic resonance diffusion weighted imaging (DWI) with background body signal suppression (MR/DWIBS) compared to 18F-fluorodeoxyglucose-positron emission tomography/computerized tomography (18 FDG-PET/CT) in detecting metastatic lesions in oncology patients.

MATERIALS AND METHODS

The present study was carried out on 50 patients in the department of Radiodiagnosis, Rural medical college, PIMS (D.U), Loni from Oct 2019 to Oct 2021.

- The ethical clearance was obtained from the Ethics Committee, Rural Medical College and Hospital, Loni.
- All the patients fulfilling the selection criteria were explained about the purpose of study and a written informed consent was obtained to participate in the study before enrolment.

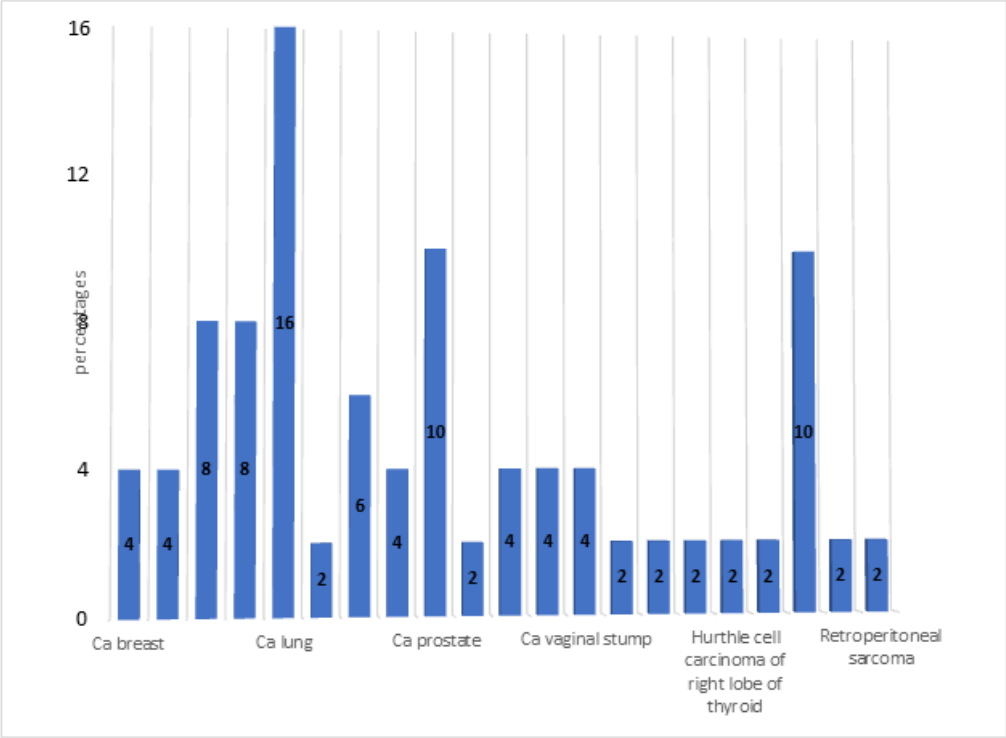
EQUIPMENT

DWIBS was performed on — Philips- Ingenia Elition 3.0 T X scanner.

RESULTS

Table 1: Primary site of malignancy wise distribution of patients with metastases

PRIMARY SITE OF MALIGNANCY	Frequency	Percent
Ca breast	2	4.0
Ca buccal mucosa	2	4.0
Ca cervix	4	8.0
Ca left breast	4	8.0
Ca lung	8	16.0
Ca oesophageal	1	2.0
Ca pancreas	3	6.0
Ca penis	2	4.0
Ca prostate	5	10.0
Ca right breast	1	2.0
Ca stomach	2	4.0
Ca thyroid	2	4.0
Ca vaginal stump	2	4.0
Ca vulva	1	2.0
Germ cell tumour of right testis	1	2.0
Hodgkin's lymphoma	1	2.0
Hurthle cell carcinoma of right lobe of thyroid	1	2.0
Neuroblastoma	1	2.0
Non Hodgkin's lymphoma	5	10.0
Osteosarcoma	1	2.0
Retroperitoneal sarcoma	1	2.0
Total	50	100.0

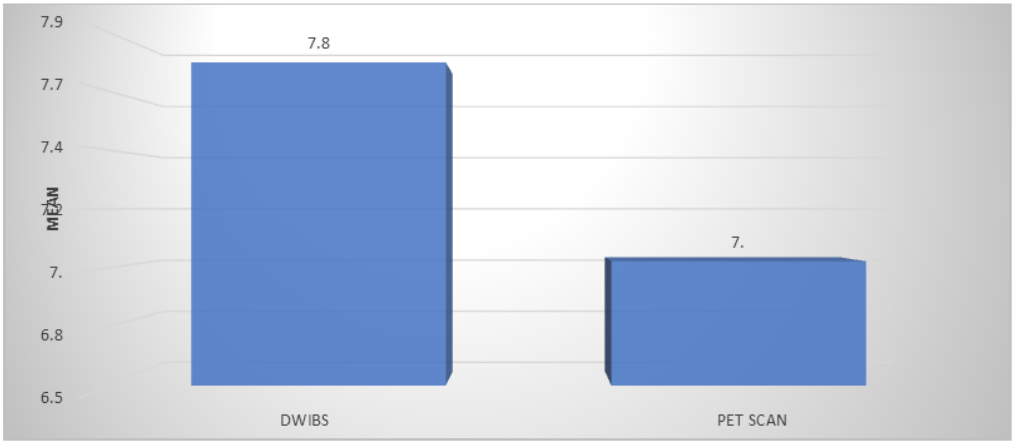


Graph 1: Bar diagram showing Primary site of malignancy wise distribution of patients with metastases

In present study the most common primary site of malignancy encountered was Ca Lung. (8 patients, 16%). Second most common site of primary malignancy Ca Prostate and Non Hodgkin's lymphoma (5 patients, 10 %).

Table 2: Comparison of number of metastases detected on DWIBS and PET scan

Parameter	Minimum	Maximum	Mean	Std. Deviation
DWIBS	0	31	7.76	6.592
PET SCAN	0	20	7.00	4.882

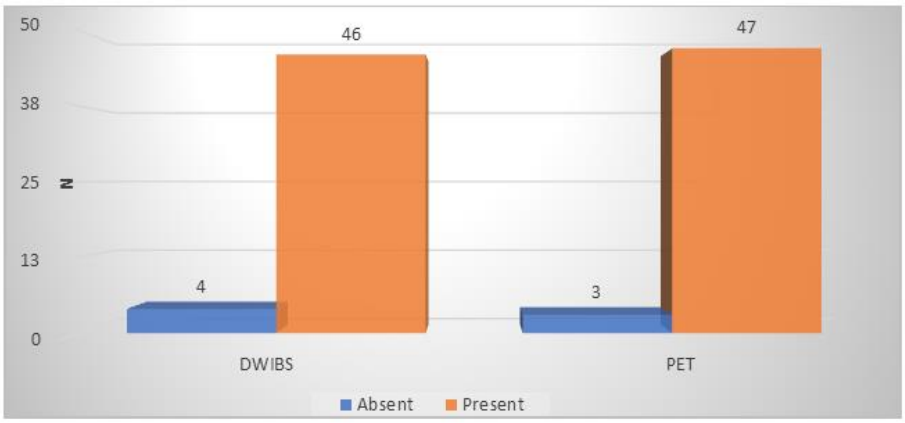


Graph 2: Bar diagram showing comparison of number of metastases detected on DWIBS and PET scan

In the present study, mean number of metastases detected on DWIBS and PET scan are 7.76 and 7.00 respectively.

Table 3: Comparison between presence or absence of metastases on DWIBS and PET scan

Parameter	DWIBS		PET	
	Frequency	Percent	Frequency	Percent
Absent	4	8.0	3	6.0
Present	46	92.0	47	94.0
Total	50	100.0	50	100.0



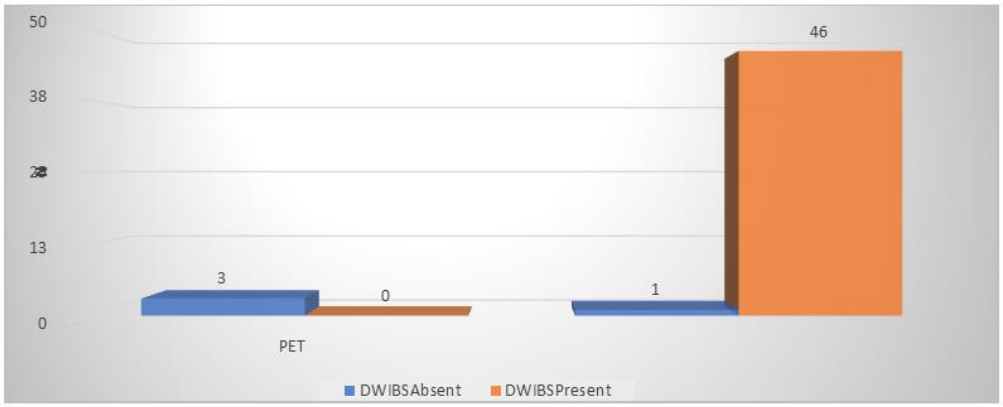
Graph 3: Bar diagram showing comparison of presence or absence of metastases on DWIBS and PET scan

The present study shows no detection of metastases on DWIBS in 4 patients (8%) while PET showed absence of metastases in 3 patients (6%).

Table 4: Comparison between presence or absence of metastases on DWIBS and PET scan

		PET		Total
		Absent	Present	
DWIBS	Absent	3	1	4
	Present	0	46	46
Total		3	47	50

p value=0.001 (S)



Graph 4: Bar diagram showing comparison between presence or absence of metastases on DWIBS and PET scan

The present study shows no detection of metastases on DWIBS in 4 patients (8%) while PET showed presence of metastases in 1 of them. DWIBS detected metastases in 46 patients which were also detected on PET scan in all 46 patients.

Table 5: Diagnostic accuracy

Statistic	Value	95% CI
Sensitivity	97.87%	88.71% to 99.95%
Specificity	100.00%	29.24% to 100.00%
Positive Predictive Value	100.00%	
Negative Predictive Value	75.00%	30.14% to 95.42%
Accuracy	98.00%	89.35% to 99.95%

DISCUSSION

In 2004, Takahara *et al*., [18] perfected the whole-body technique by successfully suppressing the background signal and using specific acquisition software to drastically reduce exam duration [19].

Water motion is a functional and dynamic phenomenon that can vary over time due to many physiological and pathological factors, such as body temperature, oedema and cellular necrosis [20, 21]. Much importance has been paid to determining the sensitivity factor of b values, which expresses diffusion-weighted sequence, in order to better identify lesions in different organs [22, 23]. Many studies have been performed in an attempt to optimise b values, changing them according to the body area examined to improve lesion detection [24, 25].

Our study showed an overall agreement between the two techniques in 18 of 50 patients (36%**)** without selecting a specific tumour histological type. MR-DWIBS detected greater number of lesions in 21 patients as compared to [18F]-FDG-PET/CT. [18F]-FDG-PET/CT detected greater number of lesions in 11 patients as compared to MR-DWIBS. In a preliminary study, Ochiai *et al*., [26] compared MR-DWIBS and [18F]-FDG-PET/CT using qualitative analysis only in primary lesions and lymph-node metastases. They concluded that DWIBS may be a useful diagnostic procedure for detecting and assessing malignant tumours. The non specificity of the MR-DWIBS signal for lesions is related to the variations in the b value, depending on lesion site. There was a high variance in data for lymphnode lesions using the b parameter optimised to identify parenchymal lesions. In bone lesions, an important difference between the two techniques was observed and, in this case, the b parameter may have influenced the identification of bone changes, which were unrelated to malignant neoplasms. This would justify the higher number of lesions observed at MR-DWIBS (380) compared with [18F]-FDG-PET/CT (353). Eighty four lesions were MR-DWIBS positive and [18F]-FDG-PET/CT negative compared with twenty seven lesions were [18F]-FDG-PET/CT positive and MR-DWIBS negative, with agreement in only 36 % cases. Our findings showed that in detecting metastases in patients with malignant tumors, WB DWIBS at 3 T had specificity and accuracy similar to those of FDG PET/CT but had lower sensitivity. The ADCs can be used to distinguish bony benign lesions from malignant lesions and to achieve better specificity. Therefore, WB DWIBS coupled with ADC calculation might be effective for the quantitative and qualitative analysis of WB bone metastases.

Several previous studies have indicated the important role of PET/CT in evaluating suspicious cancer and WB metastases [27-31], and they support our findings that PET/CT has a sensitivity, specificity, and accuracy in detecting bone metastases which is at par with that of MR-DWIBS. However, the main disadvantage of PET/CT is ionizing radiation exposure and cost, which limit the repeatability and feasibility of

using PET/CT for repeated surveillance in clinical practice. On the other hand, PET/CT is insensitive in detecting bone marrow involvement because high cellularity and edema of bone marrow can be misdiagnosed as tumor invasion or can mask tumor FDG uptake [32]. Main influencing factor for false positives on PET scan was bone marrow edema caused by fracture, inflammation, or severe bone degeneration. As we know, PET/CT fusion images provide information not only on tissue metabolism but also on anatomic information. In the present study, one case of Hurthle cell carcinoma of thyroid, post total thyroidectomy, underwent PET scan within 7 days of surgery which revealed residual lesion in operative bed. Patient further underwent DWIBS within 4 days of PET scan. DWIBS revealed areas of STIR hyperintensities with corresponding ares of diffusion restriction DWI images (b-0 value) which did not restrict on DWI(b-800 value) images. On confirmation with ADC value of suspected residual lesion, 3 ROIs were selected with a mean ADC value of 1.9 x 10^{-3} mm^2/s, suggesting benign nature. Hence, it came to be labeled as post operative necrotic tissue. This brings to notice how PET scan could falsely diagnose metastatic lesion in presence of post operative edema. Therefore, to improve the diagnostic accuracy of PET/CT in clinical practice, histomorphologic alterations detected by CT should not be neglected. Over the years, various studies of the diagnostic accuracy of WB DWI for detecting bone metastases have been published, but the results of these studies are drastically diverse because of the differences in DWI protocols and the equipment used in these studies.

CONCLUSION

Present study concluded that MR-DWIBS is useful in detection of metastases in patients with a low level of suspicion and normal or nonspecific and [18F]-FDG-PET/CT finding. DWIBS is a radiological modality devoid of radiation exposure like with [18F]-FDG-PET/CT. MR- DWIBS is a particularly useful modality in diagnosing metastases due to its high specificity, and accuracy as compared to [18F]-FDG-PET/CT. MR-DWIBS also overcomes disadvantage of [18F]-FDG-PET/CT of radiation exposure and false positives due to presence of post operative edema, bone marrow edema secondary to pathological fractures.

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