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Positive Findings on Magnetic Resonance Imaging (MRI) of the Patients Diagnosed with Vertebral Metastases on Bone Scintigraphy

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ABSTRACT

Objective: To determine positive findings on Magnetic Resonance Imaging of the patients diagnosed with vertebral metastases on Bone Scintigraphy.

Study Design: Cross-sectional study.

Place and Duration of Study: Study was conducted at Radiology Department of Pakistan Institute of Medical Sciences, Islamabad Pakistan, from May 2019 to May 2020.

Methodology: A total of 30 subjects were recruited for the study. Patients with confirmed diagnosis of cancer who were suspected for spinal metastasis on Tc-99m bone scan were sent for radiologic workup to confirm diagnosis of spine lesions. Patient having spine lesion due to trauma, TB, and infection were excluded from the study. Full spine Magnetic Resonance Imaging of all the patient was performed on 1.5-tesla system using standard protocol. Spine was divided into four regions: cervical, thoracic, lumber and sacral regions. Region-wise bone metastasis was analyzed and compared for bone scan and Magnetic Resonance Imaging. Interpretations were considered concordant if both reports showed positive for metastatic lesions, while discordant if readings differed.

Results: 19(63.3%) of the study population was female. Mean age of the enrolled patients was 59.3±14.9 years. All the lesions of cervical region were concordant. Most of the discordance for Magnetic Resonance Imaging was noted for lumbar region, where 7(26.0%) were reported as negative who were positive on bone scan. In case of bone scintigraphy, 2(7.0%) patients were discordant for thoracic region who were positive on Magnetic Resonance Imaging.

Conclusion: Magnetic Resonance Imaging proved to be an effective imaging tool for detection of spinal metastasis. Very low discordance rate was found to exist among Magnetic Resonance Imaging and bone scan. Magnetic Resonance Imaging provided additional benefits of no radiation dose to the patient and wider availability as compared to the bone scintigraphy.

Keywords: Bone scintigraphy, Magnetic Resonance Imaging, Skeletal metastatic disease.

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INTRODUCTION

Among the patients with primary malignancies, bone is the third most prevalent as well as preferred site for metastatic involvement and vertebral column is the most common site for bony metastasis.[1,2] In a latest research published by Niglas et al; it has been reported that around 40% of living cancer patients are diagnosed with spinal metastasis.[3] Involvement of spine could be a major source of morbidity and mortality in cancer patients. Intractable pain, spinal cord compression and pathological fracture are major complications arising from spinal metastasis that may impose negative impact on quality of life of patient.[4]

Imaging of spinal metastatic disease play a crucial role in the management of malignant disease, as early and accurate diagnosis of metastasis not only alter the grade of disease but it also affects the treatment approach to these patients.[5] Various imaging techniques are practiced to evaluate the vertebral metastasis including plain radiograph, CT, MRI and bone scintigraphy.[6] However, skeletal scintigraphy remains the most preferable and standard imaging investigation by the clinicians, mainly due to its reasonable sensitivity as well as cost-effective evaluation of the whole skeleton in a single imaging examination.[7] However, in cases of aggressive metastatic disease, radioisotope bone scanning can yield higher false-negative results. Moreover, bone scan can also produce false-positive results in case of degenerative changes, healing fracture, and various metabolic disorders such as osteoporosis and osteomalacia.[8] Magnetic resonance imaging (MRI), on the other hand, emerged as a highly sensitive and specific imaging modality for detection of spinal metastatic lesions. MRI has advantage of fast image acquisition, less radiation dose and high resolution over bone scintigraphy.[9] MR imaging of the spine have further advantage of tissue differentiating and the

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multiplanar imaging. That's why, considered to be superior to conventional bone scan imaging for the evaluation of spinal metastatic disease.[10] In a country with low socioeconomic status, where there is bone scan test facility is not easily available to the remote areas as well as the nuclear physicians are not readily available for reporting the bone scan, it is of great importance to explore the utility of other imaging modalities such as MRI for the local population having malignant disease. So, present study is planned to compare the spinal MRI with bone scintigraphy in the detection of vertebralmetastasis.

METHODOLOGY

A total of 30 patients of both gender having age between 18 to 90 years, with confirmed diagnosis of cancer were selected for the study. Approval was taken from ERB vide letter no F.1-1/2015/ERB/SZABMU/629. World Health Organization (WHO) sample size calculator was used for sample size calculation with 95% confidence interval, 10% absolute precision value and population proportion of 91.5% as identified by the Sohaib SA *et al*.[11] Non-probability consecutive sampling technique was used.

Inclusion criteria: All the patients suspected of having spinal metastasis on Tc-99m bone scan. Patients of spinal metastatic disease confirmed on bone scan fit for MRI.

Exclusion criteria: Patient having spine lesions due to trauma, TB, and infection were excluded from the study. Patient who has hypersensitivity to iodinated contrast were also excluded from the study.

Bone scan reports were obtained from all the patients. MRI of the spine was performed for the region(s) reported as suspected for metastatic on bone scan. MRI was performed on 1.5-tesla system using standard protocol. MRI was read as positive for metastatic osteolytic lesion if a well-defined low T1 and high T2 signal intensity focus with post contrast enhancement was noted. Osteoblastic metastatic lesion was read as low T1/T2 signal intensity lesion with post contrast enhancement. Changes in signal intensity in the bone marrow in conjunction with degenerative changes of the adjacent intervertebral disk were considered to be benign and were distinguished from metastases. Studies were reported by a consultant radiologist with a minimum experience of three years and who was blinded of the bone scan reports. Both the reports were analyzed for spine metastasis. For the purpose of study, spine was divided into four regions: cervical, thoracic, lumber and sacral regions. Region-wise bone metastasis was analyzed and compared for bone scan and MRI.

Interpretations were considered concordant if both reports showed positive for metastatic lesions, while discordant if readings differ. Data was analyzed and compared using SPSS v23 software.Frequency and percentages were determined for qualitative variables like gender and type of cancer while Mean±SD were calculated for quantitative variables like age, number of lesions and study findings.

RESULTS

Among total study population, 19(63.3%) were female with mean age 55.5±13.83 years and 11(36.7%) were male with mean age 65.8±15.02 years. Table-I shows the distribution of type of cancer in the total study sample. A total of 99 bone lesions were reported by the bone scan and 88 lesions were reported by the MRI reports. Region wise distribution of spine metastatic lesions is tabulated in Table-II. Concordance was noted for 100% of patient having cervical spine lesions while discordance was noted for rest of all the regions of spine. One patient that was positive for metastatic sacral lesion reported negative on MRI. Thoracic region of 02 patients while lumber region of 01 patient was also reported as positive for metastatic lesions on MRI that were misdiagnosed on bone scan as negative. On the other hand, thoracic region of 4 patients and lumber region of 07 patients reported as positive for metastatic lesions on bone scan but negative on MRI.

Table-I: Distribution of Type of Cancer in Total Study Sample(n=30)

Type of Cancer	Frequency (%)
Breast Cancer	11(36.7)
Prostate Cancer	5(16.7)
Ovarian Carcinoma	4(13.3)
Lungs Cancer	2(6.7)
Renal Cell Carcinoma	2(6.7)
Unknown primary	2(6.7)
Pancreatic Cancer	1(3.3)
Hepatocellular Carcinoma	1(3.3)
Colorectal Carcinoma	1(3.3)
Adenocarcinoma	1(3.3)

Table-II: Distribution of Metastatic Spine Lesions in Magnetic Resonance Imaging (MRI) and Bone Scintigraphy (n=30)

Regions of spine	Bone scintigraphy	Magnetic Resonance Imaging (MRI)
Cervical	02	02
Thoracic	56	50
Lumber	39	34
Sacral	02	02
Total	99	88

DISCUSSION

Previously published literature illuminated that imaging modalities visualize different aspects of bone tissues in terms of water content, vascularity, density or metabolic activity.[12] Hence, based on the detection capability for different imaging modalities, appearance of osteolytic, osteoblastic and mixed metastatic activity may also differ considerably.[10] In bone scan, it is difficult to discriminate metastatic lesion from traumatic or degenerative in absence of strong clinical history. Moreover, poor resolution of bone scintigraphy increases the probability of misdiagnosis of a malignant lesion from non-malignant uptake which may leads to false-positive results. However, bone scan is preferred for the baseline screening of suspected spinal metastatic spread, as it has advantage of scanning the whole skeleton with high sensitivity and can play a pivotal role for detection of extra-spinal metastasis as well.[13] On the other hand, conventional MRI, due to its high soft-tissue contrast and high spatial resolution has the capability for differentiating the metastatic lesions that are depicted on bone scintigraphy. But it is relatively less sensitive to detect early metabolic changes to the osseoustissue.[14]

Our study, to the best of our knowledge, is the pioneer in comparing the relative findings of MRI and bone scan for detection of spinal metastatic disease in our local population. Breast cancer was found to be the most common primary malignancy associated with vertebral metastases followed by prostate cancer. Rajesh et al. found similar results in his study conducted in 2019.[15] We found that 81% of the metastatic lesions from breast cancer were located in thoracolumbar spine while M Arif Hossen also reported 81% of the lesions in thoracolumbar spine.[16] We found in our study that bone scan reported more metastatic lesions than MRI because of its highly sensitive nature. On the other hand, we also noted that most of the discordance was noted in lumber and thoracic regions due to the high positive rate for metastatic lesions of bone scan. Gosfield E[17] and colleagues compared the radionuclide bone scan and MRI for detecting spinal metastasis and they reported that maximum number of the positive regions detected in thoracic and minimum in cervical regions that was similar to our study results. As a whole, they found nearly equal positive regions on bone scan and MRI. Contrary to our study results, they found less lumber metastatic lesions on bone scan than by MRI. Concordance for cervical region was noted in 13 patients and discordance was noted for only 4 patients. In our study we found no discordance for this region. Rate of concordance and discordance for thoracic and lumber region was nearly similar to our study results. They didn't compare the metastatic disease in the sacral region. In another study, Kattapuram SV compared the negative scintigraphy with positive MRI findings and they found that 18% of patients showed additional spine metastatic lesions on MRI. Overall discordance rate for bone scintigraphy found to be 23% in their study.[18] Frank *et al.* retrospectively studied the MR and bone scan images and they ruled out that 73(69%) out of 106 patients had the same results of bone scan and MRI showing overall discordance rate of 31%.[19] It is worth mentioning that in patients with known metastatic spinal disease who subsequently develop spinal cord compression, choice of accurate imaging may help in proper diagnosis of underlying cause, since it is not always secondary to the metastatic disease. Rasha Al-Qurainy reported 93% sensitivity of MRI for detection of metastatic spinal cord compression.[20]

In summary, we found that bone scan is sensitive for the detection of spinal metastasis but due to its poor resolution and incompetency in differentiating the underlying cause of increased radiotracer uptake, it can produce false-positive results. On the other hand, MRI found to be relatively more efficient in detecting the spinal metastasis and underlying cause as well as in most of the case vertebral collapse, falsely reported as spine metastasis in our study. Limitation of our study is that the sensitivity and specificity and accuracy of both imaging modalities was not calculated, mainly because due to unavailability of required resources. Secondly, we haven't compared the MRI with advance bone scanning techniques like SPECT. So, further large-scale studies are suggested to overcome these deficiencies.

CONCLUSION

Although bone scan is preferred for the baseline screening of suspected spinal metastatic spread, MRI is an effective imaging tool for detection of spinal metastasis. This study establishes very low discordance rate among MRI and bone scan. MRI provides added benefits of no radiation dose to the patient and fast acquisition. MRI is extremely valuable in clarifying equivocal falsely positive bone scan because of its inherent anatomic details.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SBZ & AIM: Data acquisition, data analysis, critical review, approval of the final version to be published.

JE: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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