Original Article

Tc-99m MDP Bone Scan Evaluation in Breast Cancer: A Study on 425 Patients

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Abstract

Breast cancer is the most frequent female cancer, especially in 'developed' countries. 30-85% of metastatic breast cancer patients will develop bone metastases during the course of the disease. The objective of this study was to evaluate the skeletal metastases in breast cancer patients by using Tc-99m MDP bone scan. A retrospective study was conducted on 425 consecutive female breast carcinoma patients referred for bone scan to Institute of Nuclear Medicine and Allied Sciences, Rajshahi from January 2015 to November 2017. Bone scan was performed by an intravenous bolus injection of 20 mCi Tc99m-MDP (technetium 99m methylene-diphosphonate). Bone phase images were taken at three hours after injection of the radiotracer. Out of 425 patients, 290 patients (68.24%) had either normal bone scan or negative for skeletal secondaries and 135 patients (31.76%) were positive for skeletal metastases.Out of 135 positive bone scans 114 (84.44%) patients had multiple sites (two or more) and 21 (15.56%) patients had solitary site of bony involvement. Highest number of skeletal metastases was noted in thoraco-lumbar spine (81.48%). Other sites of metastases were in cervical spine (22.96%), pelvic bones (54.81%), ribs (40.74%), sternum (16.30%), scapula (19.26%), upper extremities (28.15%), lower extremities (36.30%), skull bone (12.60%) and clavicle (13.33%). Tc-99m MDP bone scan is very cost effective in comparison to other imaging modalities (CT, MRI, and PET) and play a major role in early detection of skeletal metastasis in breast cancer patients.

Keywords: Breast Cancer, Tc-99m MDP Bone Scan, Skeletal Metastasis.

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Introduction

Breast cancer is the most frequent female cancer, especially in 'developed' countries. Incidence of breast cancer varies geographically (20-30 cases per 100,000 women in South-Central Asia)[1]. Women with breast cancer are vulnerable to develop metastatic diseases during the early stage. Bone is the most frequent site of distant metastasis from breast cancer. Between 30% and 85% of patients with metastatic breast cancer will develop bone metastases during the course of the disease. Bone also represents the first site of metastasis for 26% to 50% of patients with metastatic breast cancer. The rate of five-year survival will be significantly decreased and severe complications will present following bone metastases in breast cancer patients. In addition, bone metastases are predominant osteolytic in breast cancer. Osteolytic metastases can cause dramatic bone loss, which finally resulted in skeletal related events (SREs), such as pathological fractures, severe pain, bone instability, spinal cord compression and hypercalcemia. These will reduce the quality of patients' life. Therefore, early detection and diagnosis of bone metastasis in patients with breast cancer is helpful for the treatment[2-4].

Bone scan is a traditionally sensitive and efficient method for initial evaluation and follow-up of bone metastases. Many radiopharmaceuticals (radionuclides) have been used in bone scan including technetium-99m bound to methylene diphosphonate. Published sensitivity and specificity rates of bone scan for diagnosis have varied, with sensitivity ranging from 62% to 100% and specificity from 78% to 100%. However, bone scan is generally

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considered sensitive for detecting bone metastases on whole-body images[5-8].

The aim of this study was to evaluate the skeletal metastases in breast cancer patients by using Tc-99m MDP bone scan.

Materials and Methods

A retrospective study was conducted on 425 consecutive female breast carcinoma patients irrespective of clinical stage, menopausal status and pre-operative / post-mastectomy status, referred for bone scan to Institute of Nuclear Medicine and Allied Sciences, Rajshahi from January 2015 to November 2017. The mean age of the patients was 45.2 ± 11.7 years (mean ± SD) with range from 29 to 71 years. Patient's clinical records and bone scan reports were reviewed retrospectively. In our institute we used SPECT (single photon emission computed tomography) digital dual head gamma camera (e-cam series, Siemens from Germany) with a low-energy high resolution parallel-hole collimator. Bone scan was performed by an intravenous bolus injection of 20 mCi Tc99m-MDP (technetium 99m methylene-diphosphonate). Bone phase images were taken at three hours after injection of the radiotracer and the scan time was about 15 minutes for a whole body scan. Whole body scan in anterior and posterior projections were obtained. All scans were interpreted for metastatic deposits by two nuclear medicine physicians.

Results

Out of 425 patients, 290 patients (68.24%) had either normal bone scan or negative for skeletal secondaries and 135 patients (31.76%) were positive for skeletal metastases (Figure-1).

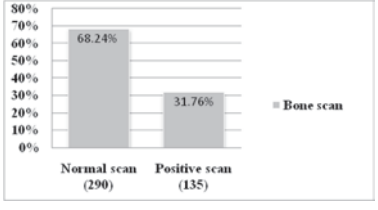

Figure-1: Distribution of bone scan findings in frequency and percentage in the study group (n= 425).

Out of 135 patients with positive skeletal metastases 109 (80.74%) patients were symptomatic or had bone related events and 26 (19.26%) patients were asymptomatic for any bony involvement (Figure-2).

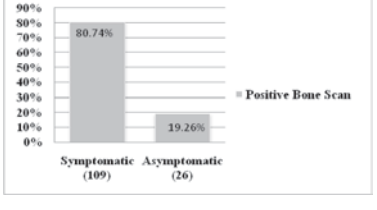

Figure-2: Distribution of bone scan in frequency and percentage by clinical symptoms in the study group (n= 135).

Out of 135 patients with positive bone scan 114 (84.44%) patients had multiple sites (two or more) and 21 (15.56%) patients had solitary site of bony involvement (Figure-3).

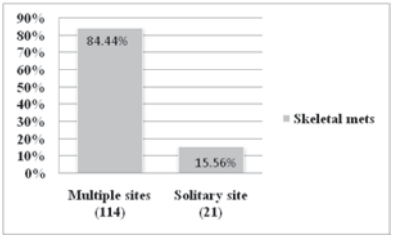

Figure-3: Distribution of skeletal metastases in frequency and percentage by number of site in the study group (n= 135).

Among 135 positive bone scan patients, highest number of skeletal metastases was noted in thoraco-lumbar spine (81.48%). Other sites of metastases were in cervical spine (22.96%), pelvic bones (54.81%), ribs (40.74%), sternum (16.30%), scapula (19.26%), upper extremities (28.15%), lower extremities (36.30%), skull bone (12.60%) and clavicle (13.33%) (Figure-4).

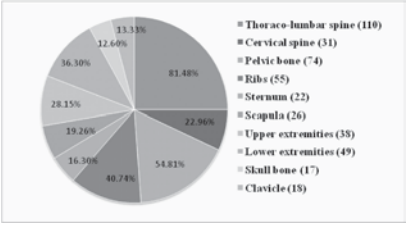

Figure-4: Distribution of skeletal metastases in frequency and percentage by anatomical sites (n= 135).

Discussion

Bone is known to be one of the most common sites of metastasis for breast cancer patients. Several imaging modalities, including plain radiography, computed tomography, magnetic resonance imaging, SPECT-bone scan and positron emission tomography are available to detect bone metastasis. Compared to other modalities, bone scan is characteristic by its high sensitivity, easy accessibility, and providing whole-body imaging of bone metabolism[9,10]. The high sensitivity of this technique is based on physiological basis for preferential uptake of methyl diphosphonate, which identifies as little as 5-15% alteration in local bone turnover. Delineation of a lytic lesion by conventional radiology requires a minimum size of 1cm and a focal loss of at least 50% of bone mineral, while at least 30% increase in bone mineral content is essential to appreciate sclerotic lesion. That's why bone scan may pick up bone metastases up to 18 months earlier than conventional radiology, with an average lead of 4 months. The usual appearance of skeletal metastases on bone scan is focal hot spot; however, rarely focal cold defects are also noted. Therefore, it is more frequently used than the other modalities, and breast cancer patients can benefit from a routine baseline bone scan and a regular follow-up[11,12].

The routes of skeletal metastasis are direct extension or invasion, lymphatic spread, hematogenous dissemination and intraspinal spread. Skeletal metastases of breast cancer will mainly occur from hematogenous dissemination. The mechanism or a route of venous system dissemination to develop skeletal metastasis was proposed by Batson[13]. He insisted that owing to the extensive communications of this venous system and to the variability of the direction of this blood flow, tumors arising in many sites release cells that could be deposited anywhere along the course of vessels, including the skeleton, even in the absence of pulmonary and hepatic metastasis. Breast carcinoma cells can easy migrate to neighboring ribs and spinal vertebrae via Batson venous plexus, and spread to the sternum via the parasternal lymph nodes[13,14].

In our study, out of 425 patients, 290 patients (68.24%) had either normal bone scan or negative for skeletal secondaries and 135 patients (31.76%) were positive for skeletal metastases. MS Afzal et al.[11] found positive bone scan in 38% patients out of 465 breast cancer patients. Skeletal metastases were seen in 23.42% (241/1029) patients in a study by Doddala S et al[15]. Kotb MH et al.[16] found positive bone scan in 18.2% patients out of 450. Out of 135 patients with positive skeletal metastases 109 (80.74%) patients were symptomatic or had bone related events and 26 (19.26%) patients were asymptomatic for any bony involvement. I Kuchuk et al.[17] found 26.8% patients was asymptomatic for skeletal metastases in breast cancer patients.

In present study, out of 135 patients with positive bone scan 114 (84.44%) patients had multiple sites (two or more) and 21 (15.56%) patients had solitary site of bony involvement. In a study of comparison between solitary and multiple skeletal metastatic lesions of breast cancer patients by M. Koizumi et al.[18] found that out of 703 patients with metastatic bone lesions, 289 (41%) had a solitary bone lesions and 414 (59%) had multiple bone lesions at the time of diagnosis. Boxer et al.[19] found that out of 160 consecutive studied breast cancer patients, 79% were having multiple metastatic lesions. He stated that solitary metastases are much more common in cases of breast cancer, than they are thought to be. Reported incidence of solitary skeletal metastases in breast cancer patients having skeletal metastases ranges from 11% to 21%.

Among 135 positive bone scan patients, highest number of skeletal metastases was noted in thoraco-lumbar spine (81.48%) in our study. Other sites of metastases were in cervical spine (22.96%), pelvic bones (54.81%), ribs (40.74%), sternum (16.30%), scapula (19.26%), upper extremities (28.15%), lower extremities (36.30%), skull bone (12.60%) and clavicle (13.33%). MS Afzal et al.[11] found highest number of bony lesions was in spine (84.5% -most common in thoracolumbar), followed by ribs (55.5%), pelvis (37.3% - most frequent in iliac bone), skull (32%), scapula (27.3%), sternum (26.4%), femur (19.1%), humerus (14.5%), clavicle (3.6%) and tibia (0.9%). In another study of patients with breast cancer conducted by Musat E et al.[20], out of 23 subjects with skeletal metastases, 16 cases were having multiple secondaries; the most involved site was the ribs (18 cases), followed by the spine (in 17 cases), iliac bone (9 cases), the femur (7 cases), the skull (3 cases). In spine, the more frequently involved vertebrae were dorsal (49.23%), followed by lumbosacral (26.13%) and lastly cervical vertebrae (12.3%).

Conclusion

Skeletal metastases are much more common in multiple sites than solitary lesion in breast cancer patients. Thoraco-lumbar spine was the most common site of involvement in our study. Tc-99m MDP bone scan is very cost effective in comparison to other imaging modalities (CT, MRI, and PET) and play a major role in early detection of skeletal metastasis in breast cancer patients.

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