Saudi Journal of Radiology
February 2023
Proceeding of the 13th Radiological Society of Saudi Arabia (RSSA)

EXPERIENCE OF KING ABDULLAH MEDICAL CITY IN BONE METASTASES DETECTION BY DIFFERENT RADIOLOGICAL MODALITIES AND TUMOR MARKER SENSITIVITY

Bashar Babkour[1], Etedal Abdurabuh[2], Aquib Bakhsh[3] and Zeyad G Alharbi[4]

[1]Radiology Department, Alhada Armed Forces Hospital, Taif 26792, Saudi Arabia
[2]Radiology Department, Alnoor Specialist Hospital, Makkah 24241, Saudi Arabia
[3]Radiology Department, King Abdullah Medical City in Holy Capital (KAMC-HC), Makkah 24246, Saudi Arabia
[4]Neurosurgery Department, Alnoor Specialist Hospital, Makkah 24241, Saudi Arabia

ABSTRACT

Objective

The study aims to evaluate the detectability of bone metastases by Computed Tomography (CT) scan in comparison to Bone Scintigraphy (BS) and the sensitivity of tumor markers in different oncological settings for predicting the presence of skeletal metastases.

Methods

Medical information was collected for 299 patients who fit the inclusion criteria from patient files and medical image reports using (AGFA PACS® and Trakcare® systems).

Results

BS detected BM in breast cancer patients in 135 cases, while CT scan detected BM in 122 cases. In prostate cancer patients, the BS detected BM in all 38 cases, while the CT scan detected BM in 32 cases. Regarding Gastro-Intestinal (GI) malignancies, the BS detected BM in 27 cases, while the CT scan detected BM in 23 cases only. Prostate-specific antigen (PSA) was conducted on 40 patients and 28 (70%) of them were elevated. Breast cancer patients showed tumor marker elevation in 46 (38.9%) of 118 patients. GI malignancy revealed the highest rate of tumor markers elevation in 24 (80%) of 30 patients.

Conclusion

Our study showed that BS has higher sensitivity than CT scan in detecting BM for breast, prostate and GI malignancies. Further collaboration is needed to determine the sensitivity of each modality, compare them with other monitoring methods like Magnetic Resonance Imaging (MRI) or positron emission tomography (PET) scan and a computed tomography (CT) to optimize the hospital resources utilization for each type of malignancy and reduce the patient's exposure to unnecessary radiation.

Corresponding Author
Bashar Babkour, Email: Booshabab@gmail.com

Copyright: © 2023 The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

eISSN: 1658-8959

Keywords: Computed tomography, Bone scan, Bone scintigraphy, Bone metastases, Sensitivity, Detectability, Tumor marker

1. INTRODUCTION

Bone is one of the most common sites for metastases. Therefore, cancer patients need to have early screening for bone metastases to start appropriate therapy and predict their prognosis. Bone lesions are divided into two subgroups: osteolytic and osteoblastic bone metastases, which vary in percentage according to tumor type [1].

Tumor markers are a set of biochemicals that are produced by certain neoplastic cells or the body, indicating the presence of a tumor [2]. They are useful in early detection, confirming a diagnosis, following up on the prognosis, and checking for any probable recurrence [3].

Imaging modalities has a role in oncology patients as they help to confirm the diagnosis, assess the extent of the disease and determine whether the management should be medical or surgical [4].

CT scan is the study of choice for staging tumors, assessing response and guiding radiation therapy. It could be beneficial when it comes to evaluating primary tumors or distant metastases [5]. For example, in advanced osteolytic bone lesions, a CT scan shows better focal lesion detection than other modalities due to affection for bone mineral content. In addition, a CT scan determines the extent of osseous damage and measures the constancy of cortical bone and breakage chance [6, 7].

Tc-99m phosphonate-based scintigraphy (bone scan) is one of the fundamental modalities for assessing cortical bone function mainly in cancer patients with osteoblastic skeletal metastases [5]. Accumulation of the radiopharmaceutical shows an illustration of a pathology that indicates cancer [8, 9], making it a useful modality for scanning and excluding skip lesions.

However, BS often lacks the exact anatomical localization of the lesion. At the beginning of the disease, lesions could be unseen due to a lack of metabolic activity. Also, tracer could be seen in some degenerative diseases or healing fractures, which can be interpreted as false positive results [1]. Therefore, we aim in this study to compare the sensitivity of both CT scans and BS in the detection of bone metastases.

2. MATERIAL AND METHODS:

This is a retrospective study including all cases that were presented to the Radiology Department at KAMC-HC, Makkah-Saudi Arabia referred from the oncology clinic in the period between January 2013 and December 2021. The research investigators reviewed radiology reports and hospital databases (using AGFA PACS® system and Trakcare® system respectively) for all patients who had proven to have bone metastases and had done both modalities (CT scan and bone scintigraphy). Patients with bone lesions that have proven not to be bone metastases or patients who have bone metastases but have only one modality from the two modalities mentioned above or who have lacked follow-ups were excluded from the study.

The following relevant tumor markers were reviewed: prostate-specific antigen (PSA), CA19-9, CA 15-3, CEA and CA 125.

Ethics and analysis, ethical approval obtained from KAMC-HC IRB (No: 18-409) date of approval 18-Apr-2018. Data were analyzed using a statistical package for social science (SPSS version 21).

3. RESULTS:

Out of 299 patients, 189 (63.21%) of the study samples were females while 110 (36.79%) were males. The study included various types of malignancies. 155 cases (51.84%) of the study sample were breast cancer, which represents more than half of the total population. 45 cases (15.05%) were prostate cancer. 39 cases (13.04%) were GI malignancy, which includes esophageal cancer, gastric cancer, colon cancer, rectal cancer, rectosigmoid cancer, hepatic cancer and pancreatic cancer. Lung cancer was represented in 22 cases (7.36%). Finally, 38 cases (12.71%) represented miscellaneous (Figure 1).

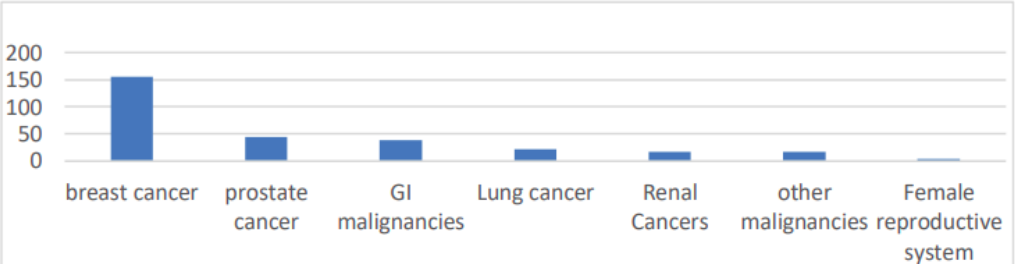

Figure 1 Types of malignancies among study population.

CT scan and BS were done for all 299 patients and we noticed that CT scan detected bone metastasis only in 16 cases (5.35%) (Figure 2). On the other hand, BS detected bone

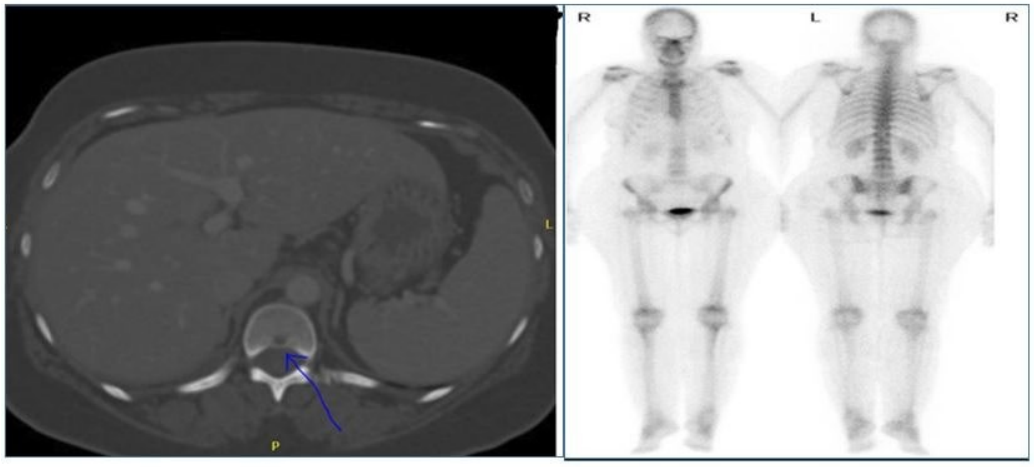

Figure 2 A CT and BS images of same patient shows bone metastases on CT while BS does not.

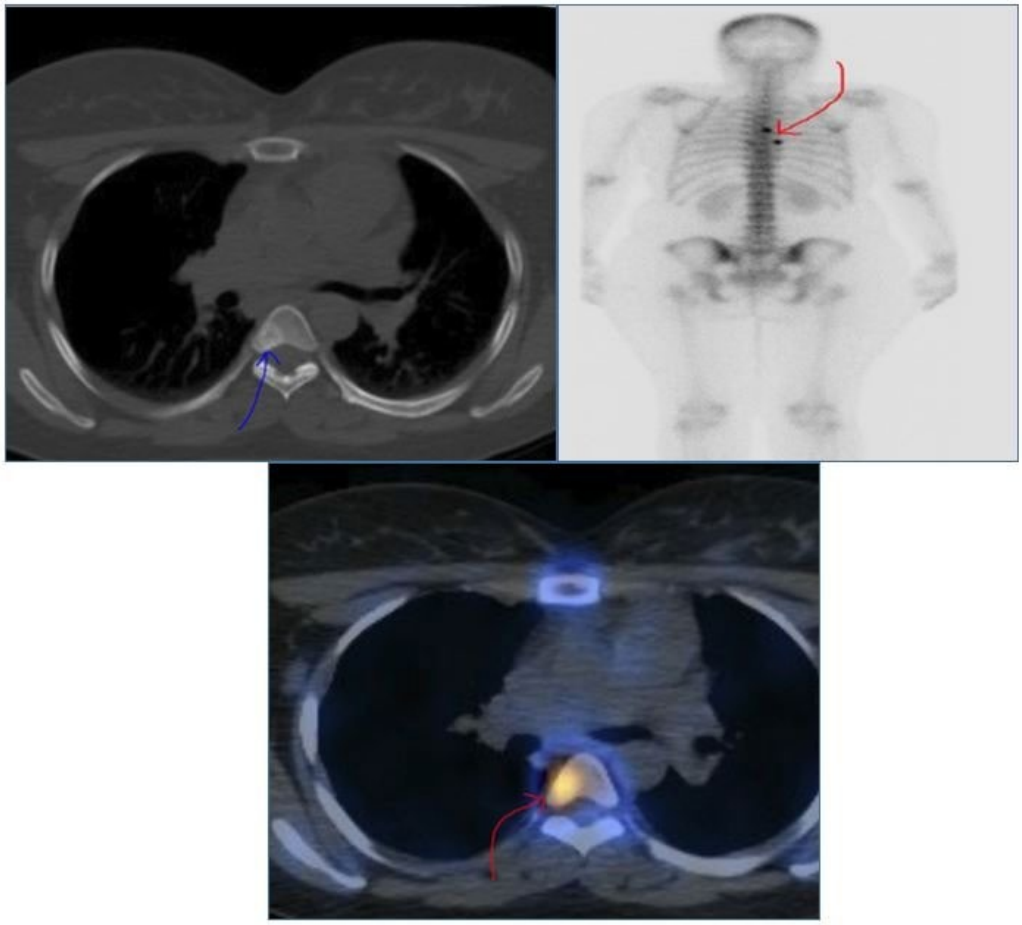

Figure 3 A bone scan image of patient with positive bone scan and negative CT.

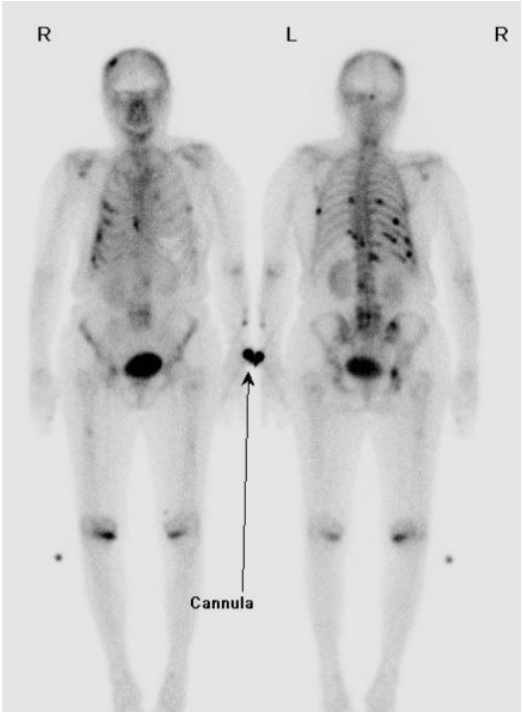

Figure 4 Patient with both bone scan and CT scan positive.

metastases in only 41 (13.71%) of the cases (Figure 3). However, both modalities detected 202 cases (67.56%) (Figure 4) and 40 cases with no bone metastasis were detected with either modality. The detectability of BM in breast cancer patients by BS was 135 cases (87.1%) out of 155, while the CT scan detected BM in 122 cases (78.71%), meaning that BS has higher sensitivity than CT scan for breast cancer. In patients with prostate cancer, the BS detected BM in all 38 cases (84.44%), while the CT scan detected BM in 32 cases (71.11%) only, indicating higher sensitivity of BS for BM in prostate cancer. Regarding GI malignancies, the BS detected BM in 27 cases (69.23.47%), while the CT scan detected BM in 23 cases (58.97%) only, which indicated that BS has higher sensitivity for BM in GI malignancies. BM in patients with lung cancer, renal cancer, female reproductive system and other malignancies was detected by BS 45 (75 %), while the CT scan detected BM in 41 cases (68.33%) only, indicating higher sensitivity of BS for BM in prostate cancer (Table 1).

Of 45 prostate cancer patients, tumor marker tests were conducted on 40 cases, and PSA was elevated in 28 (70 %) cases. Of 155 breast cancer patients, tumor marker tests were conducted on 118 patients, and tumor markers were elevated in 46 patients (38.98%). Of 39 GI malignancy patients, tumor marker tests were conducted on 30 cases, and tumor markers were elevated in 24 cases (80%).

Table 1 Detectability of bone metastases by CT scan vs. bone scintigraphy.

Type of malignancy	CT scan	Bone scintigraphy	Detected by both	No detection	Total
Breast cancer	5	18	117	15	155
Prostate cancer	1	7	31	6	45
GI malignancies	4	8	19	8	39
Other malignancies	6	8	35	11	60

4. DISCUSSION

The sensitivity of bone scan detection of BM varies according to the origin of the tumor. Studies revealed BS showed a higher sensitivity for BM detection than CT scan in different oncological settings [10–12]. Since it has high sensitivity, it became the best modality when it comes to bone metastasis screening and follow-up. Yet, studies proved that it has low specificity for BM [9, 10]. Similarly, some new modalities (SPECT/CT, PET/CT and PET/MRI) show higher sensitivity and specificity than BS. The addition of these modalities improves the early detection of BM [12].

Concerning tumor marker role in BM progression, in a study done from 2006–2015 in China, the researchers found a statistical relation between tumor marker elevation of lung and colorectal cancer with the progression of BM [13].

In another study that was conducted from February 2016 to July 2016 in Shanxi Cancer Hospital in China, the researchers found a correlation between breast cancer and the CEA (77.1%) and CA 15.3 (45.8%) tumor markers [14].

Finally, in a study that was conducted between June 2007 and December 2012 in China, it was found that CA 15.3 levels were an indicator of BM, while CEA elevation indicated metastasis in a non-specific manner [15].

5. CONCLUSION

Our study shows that BS has higher sensitivity in detecting BM than CT scan in breast, prostate and GI malignancies, considering it was an advanced tertiary referral center experience. We recommend conducting further studies in collaboration with other centers to determine the sensitivity of each modality in BM detection, compare them with other monitoring methods like tumor markers, MRI or PET/CT, optimize the hospital resources utilization for each type of malignancy and reduce the patient's exposure to unnecessary radiation.

CONFLICTS OF INTEREST

All authors declare no conflict of interest

ACKNOWLEDGMENT

The authors acknowledge the valuable help of Mr. Maher Alhazmie MSC from the research center at KAMC-HC for his cooperation in statistical analysis.

REFERENCES

[1] Schmidt GP, Reiser MF, Baur-Melnyk A. Whole-body imaging of bone marrow. Seminars in musculoskeletal radiology. 2009;13(2):120–153.

[2] Malati T. Tumour markers: An overview. Indian Journal of Clinical Biochemistry: IJCB. 2007;22(2):17–31.

[3] Sharma S. Tumor markers in clinical practice: General principles and guidelines. Indian Journal of Medical and Paediatric Oncology. 2009;30(1):1–8.

[4] Barentsz J, Takahashi S, Oyen W, Reznek R et al. Commonly UsedImaging Techniques for Diagnosis and Staging. 2006;24(20):3234–44.

[5] Rosenthal DI. Radiologic diagnosis of bone metastases. Cancer. 1997;80(8):1595–607.

[6] Lecouvet FE, Malghem J, Michaux L, Michaux JL et al. Skeletal survey in advanced multiple myeloma: radiographic versus MR imaging survey. British Journal of Haematology. 1999;106(1):35–9.

[7] Poitout D, Gaujoux G, Lempidakis M, Dulac P et al. [X-ray computed tomography or MRI in the assessment of bone tumor extension]. Chirurgie; memoiresde l'Academie de chirurgie. 1991;117(5-6):488–90.

[8] Roberts JG, Gravelle IH, Leach KG, Hughes LE. Evaluation of radiography and isotopic scintigraphy for detecting skeletal metastases in breast cancer. Lancet (London, England). 1976;1(7953):237–9.

[9] Ketiku KK, Azodo MV. Detection of skeletal metastases in Nigerian breast cancer patients: evaluation of radioisotope bone scan and radiography. West African journal ofmedicine. 1996;15(2):81–4.

[10] Pietrzak AK, Cholewinski W. Detection of the Prostate Cancer Bone Metastases: Is It Feasible to Compare 18F-fluorocholine PET/CT, 18F- fluorodeoxyglucose PET/CT and 99mTc-methyl Diphosphonate Bone Scintigraphy? Urology journal. 2018;15(5):242–7.

[11] Nakajima K, Kaneko G, Shiinah, Ichikawa T et al. Role of bone scan index in the prognosis and effects of therapy on prostate cancer with bone metastasis. International journal of urologyofficial journal of the Japanese Urological Association. 2018;25(5):492–9.

[12] Cook GJ, Goh V. Imaging Bone Metastases in Breast Cancer: Staging and Response Assessment. Journal of nuclear medicine: official publication, Society of Nuclear Medicine. 2016;57(1):27s–33s.

[13] Zhenghong ZZ, Yingjiangshan Z et al. Retrospective study of predictors of bone metastasis in colorectal cancer patients. Journal of Bone Oncology. 2017;9:25–8.

[14] Wang W, Xu X, Tian B, Wang Y, Sun T et al. The diagnostic value of serum tumor markers CEA, CA19-9, CA125, CA15-3, and TPS in metastatic breast cancer. Clinica Chimica Acta; International Journal of Clinical Chemistry. 2017;470:51–5.

[15] Geng B, Liang MM, Ye XB, Zhao WY. Association of CA 15-3 and CEA with clinicopathological parameters in patients with metastatic breast cancer. Molecular and Clinical Oncology. 2015;3(1):232–6.