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Bone Syntigraphy with ^{99m}Tc-MDP in Breast Cancer Patient

*Amer Hayat Khan[1], Cik Nor Suriana Mohamad Yusof[2], Ashfaq Ahmad[1], Syed Azhar Syed Sulaiman[1]

[1] *Department of Clinical Pharmacy,*
School of Pharmaceutical Sciences Universiti Sains Malaysia, 11800 Penang, Malaysia

[2] *Radio pharmacy Unit, Pharmacy Department,*
Hospital Universiti Sains Malaysia, 16150 Kubeng Kerian, Kelantan, Malaysia

Abstract:

Objectives: The objective of this case report is to emphasize the use of ^{99m} Tc-MDP as a diagnostic tool which is economical, easily available and specific to bone metasis as compared to other diagnostic tool used for the diagnosis of joints, arthritis, fractures and bone metasis.

***Background*:** Throughout World, about 1 in 20 women develop breast cancer in their lifetime. A radiopharmaceutical is a radioactive compound used for the diagnosis and therapeutic treatment of human diseases. Bone metastasis occur in many patients with breast cancer (percentages of up to 85% have been reported). The common site of bony metastasis is the axial skeleton. Bone syntigraphy with ^{99m} Tc-MDP is believed as the best diagnostic tool for bone metastasis as radionuclide bone syntigraphy using 99m Technetium are taken up well by osteoblast. 99mTc-MDP scan allows earlier and more accurate visualization of tumor metastasis in bone with 95% sensitivity and lesions are detected on an average 6 month earlier compared to X-ray studies. This screening is an indirect marker of tumor and metastasis.

Case Presentation: Current report illustrate a case of breast cancer with symptomatic bone metastasis arising in a 71-year-old woman who presented with a breast lump in her left breast for over two years duration and is diagnosed by using bone syntigraphy with ^{99m} Tc-MDP.

Conclusion: The evaluation of breast lesions by current procedure is highly sensitive and specificity, though its comparatively costly but freely availability and the possibility of detecting bone metastases make it prefer choice.

INTRODUCTION:

Breast cancer is the most common cause of cancer deaths worldwide. The rates vary about five-fold around the world. National Cancer Registry of Malaysia provides a data for age-standardize incidence rate (ASR) for 2004 of 46.2 per 100,000 women. World wise, about 1 in 20 women in the world develop breast cancer in their lifetime. The age standardized incidence in Chinese in the highest, with 59.7 per 100,000, followed by the Indians at 55.8 per 100,000 developing breast cancer in their lifetime. The most common age presented with the disease in between 40-49 years, with just over 50% of the case under the age of 50 years, 16.8% below 40 and 2% under 30[1].

A radiopharmaceutical is a radioactive compound used for the diagnosis and therapeutic treatment of human diseases. About 95% of the radiopharmaceuticals are used for diagnostic purposes, while the rest are used for therapeutic treatment. After administration of the radiopharmaceutical, radiations emitted from it are detected by a radiation detector. Thus, the morphologic structure or the physiologic function of the organ can be assessed [2].

More than 80% of radiopharmaceuticals used in nuclear medicine are ^{99m}Tc-labeled compounds. The 6 hours physical half-life and the small amount of electron emission permit the administration of millicurie amounts of ^{99m}Tc radioactivity without significant radiation dose to the patient. It also has a high yield of 140-keV γ rays (90%), which ideal for the current generation of imaging devices in nuclear medicine. ^{99m}Tc is readily available in a sterile, pyrogen-free, and carrier-free state from ^{99}Mo-^{99m}Tc generators. The ^{99}Mo radionuclide has a half-life of 66 hours and decays by β^- emission; 87% decay to the metastable state ^{99m}Tc and the remaining 13% to the ground state ^{99}Tc[2].

CASE DESCRIPTION:

A 71 years old Chinese woman presented with a breast lump in her left breast for over two years duration. She had undergone a simple mastectomy and excision of lymph nodes over lateral aspects last year. The tumor measured was 6 cm x 4 cm and infiltrating pectoralis minor below and extending into axillary vein. Histology revealed infiltrating ductal carcinoma (Bloom-Richardson Grade III) with distant nodal metastasis. Patient X-ray was normal. CT scan was done and she was stages as $T_4N_3M_1$. Patient had completed 6 cycles of chemotherapy of FEC regime which consists of 5-Fluoruracil 500 mg/m^2, Epirubicin 100 mg/m^2 and Cyclophosphamide 500 mg/m^2 given intravenously every 3 weeks. She tolerated this treatment regimen well. Patient also received anastrozole 1 mg once daily and hormonal therapy. The bone scans done and revealed symptomatic bone metastasis.

DISCUSSION:

^{99m} Tc-MDP scan allows earlier and more accurate diagnosis of skeletal metastases then the conventional X-ray. This screening is an indirect marker of tumor and its metastasis. Study done by Citrin, Greig et al.,shows that 50% of patients with known metastases through X-ray have additional lesion or spot not yet visible on the X-ray. 27% with X-ray negative metastases had positive scan [3]. The most common indication for ^{99m}Tc-MDP bone scintigraphy is to diagnose metastatic

disease: it has 95% sensitivity and lesions are detected an average of 6 months earlier than with X-ray studies.

^{99m}Tc-MDP has rapid blood clearance, excellent in vivo chemical stability and a high bone-to-soft tissue ratio, which are ideal for bone imaging [8]. The low energy level of gamma ray makes it safer for use because of the substantially reduced ionization compared with other gamma emitters. The energy of gammas from ^{99m}Tc is about the same as the radiation from a commercial diagnostic X-ray machine

Increase in bone activity (as in increased inosteoblastic activity) causes increase in 99m Tc deposition that particular region of the bone that has metastases. The most common areas where metastases occur is the axial skeleton, the vertebrae, pelvis, proximal parts of the femur, ribs, proximal part of the humerus, and skull [4].

The increase in bone activity which is seen in bone scintigraphy can also be mistaken for other abnormalities at the bone such as metabolic problems (eg, Cushing syndrome), infection, osteomalacia, trauma, arthritis, osteomyelitis, Paget disease, and infarction [5].

About 2 hours are needed after injecting the agent into the patient for performing bone scanning. If imaging at an earlier time post injection is needed to be taken, a radiopharmaceutical with higher affinity for bone, larger uptake ratios of bone-to-soft tissues and more rapid clearance from the blood and soft tissues necessary. Hence, it can be used to diagnose bone disease, assessment of bone and joint pain as well as many forms of arthritis. It also has an important role in detecting infection in bones and joints [6].

Whole body technetium ^{99m}Tc-MDP bone scintigraphy image above revealed hot spot at lumbar vertebrae indicating bone metastases at that particular area of skeletal system from breast cancer. The hot spot seen at patella and tarsal bone is not necessarily metastases. It could be arthritis or any other form of bone abnormalities, therefore further investigation need to be done to confirm the actual diagnosis. According to a report, ^{99m}Tc-MDP can be an alternative to ^{99m}Tc-MIBI in the evaluation of breast lesions because of its high sensitivity and specificity together with its cost, but easy availability and the possibility of detecting bone metastases [7].

From the above image, we notice that there is high back ground against the bone which makes the image of bone slightly blurred. For best results we should get an image of whole skeletal with reduced background. To reduce this error, the scanning process should be performed 2 to 3 hours after injection of ^{99m}Tc-MDP and the patient should drink fluids and avoid urination immediately before imaging so that the bladder activity does not blur the region of image [2].

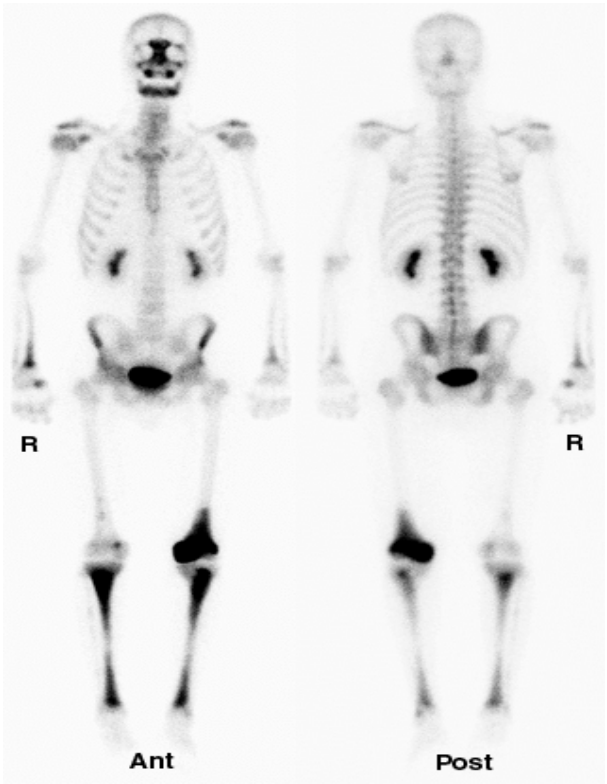

Figure 1. The image above shows a whole body technetium-99m MDP bone scintigraphy of a normal person, which is to be compared with Figure 2

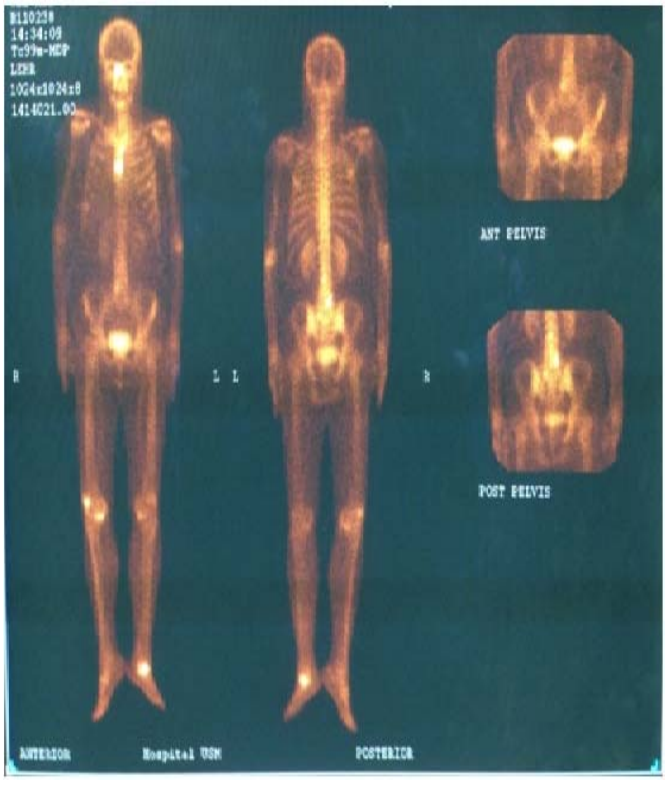

Figure 2. The image above shows a whole body technetium-99m MDP bone scintigraphy of a Patient.

CONCLUSION:

^{99m}Tc-MDP bone scintigraphy gives accurate visualization of tumor metastasis in bone. Besides this bone scanning also can be used to visualize osteomyelitis, fracture, stress fracture, avascular necrosis, osteoporosis, and prosthetic joint evaluation. ^{99m}Tc-MDP bone scintigraphy is a simple diagnostic modality with a low radiation burden, when compared to conventional radiology. Bone scintigraphy is extraordinarily sensitive in detecting any abnormality within living bone. It is far more sensitive that x-ray, CT or even MRI in the detection of fractures and is the most sensitive means of detecting malignant tumor in bone. So objective of this study is well achieved by highlighting the importance and advantages of this radionucleotide over other conventional methods for diagnosis of bone metasis. It is expected that current study will emphasize the use of this nucleotide for specific, early and accurate diagnosis of bone metasis.

COUNSELING:

After patient receiving the injection of ^{99m}Tc-MDP, it is encouraged for the patient:

- To drink fluids and to void immediately before the examination and as often thereafter as possible for the next 4-6 hours. To minimize radiation dose to the bladder.
- Maintaining distance from other persons, including separate sleeping arrangements.
- Minimizing time in public places (e.g., public transportation, grocery stores, shopping centers, theaters, restaurants, sporting events).
- Minimize time with children and pregnant women. Do not hold or cuddle children.
- Breast feeding is not allowed within 24 hours.
- Avoid public transportation.

Radiopharmaceuticals should be used only by physicians who are qualified by training and experience in the safe use and handling of radionuclides and whose experience and training have been approved by the appropriate government agency authorized to license the use of radionuclides. ^{99m}Tc-MDP injection must be handled with care. Once sodium pertechnetate injection is added to the vial, appropriate safety measures should be used to minimize external radiation to clinical occupational personnel. ^{99m}Tc-MDP injection should be inspected visually for particulate matter and discoloration prior to administration whenever solution and container permit. Shielding should be utilized when preparing the technetium ^{99m}Tc-MDP injection. They usually have no pharmacological effects and they were administered in very small amounts as microdoses. Because of this reason, the incidence of adverse reactions to radiopharmaceuticals (ARRPs) is generally minor and rare. However, therapeutic radiopharmaceuticals can cause tissue damage because of high radiation [6-8].

Local or generalized rash with itching and dermal irritation, headache, malaise, edema of the extremities, and arthralgia have also been reported. The time to onset of these symptoms may occur within minutes or be delayed by several hours post-administration of technetium ^{99m}Tc-MDP. If the patient is pregnant she should inform her physician about her condition. Her physician will decide if the drug is applicable for the patient. The negative effects of ^{99m}Tc-MDP on pregnant and its effect on fertility are not known. The ideal time for application in fertile women is the 10 days following the end of the menstruation. Breast-feeding moms are recommended not to feed their children with their milk when ^{99m}Tc-MDP is applied [10]

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