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18F Na-F PET/CT BONE SCAN IN EVALUATION OF BONY METASTASIS IN CARCINOMA PATIENTS

Radiology

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ABSTRACT

Aim: To evaluate the diagnostic performance of 18F-NaF PET/CT bone scan in evaluation of bony metastasis in carcinoma patients. **Methods:** Our study included 70 biopsy proven carcinoma patients of both the sexes and age group ranging from 17 to 73 years, who underwent 18F-NaF PET/CT bone scan in SCI, GMC. **Result:** Out of the 70 cases 49(70%) were female and 21(30%) were male patients. The study includes 38(54%) breast cancers, 7 (10%) prostate cancer, 7(10%) lung cancer and 18(26%) patients with other carcinomas. The parameters of sensitivity, specificity, PPV, NPV, and accuracy were 90%, 95%, 97.8%, 79.2%, and 91.4%, respectively in our study. On comparison of NaF PET and CT, NaF PET and CT have a sensitivity of 86.3% and 82.4%, specificity of 94.7% for both, PPV of 97.8% and 97.7%, NPV of 72.0% and 66.7%, and an accuracy of 88.6% and 85.7% respectively. **Conclusion:** 18F NaF PET when it is used in conjunction with anatomical imaging (CT scans), 18F NaF PET/CT yield a high diagnostic performance in detecting bony metastases in all cancer patient.

KEYWORDS

18F-NaF PET/CT, Bones scan, Carcinoma, Diagnostic Performance

INTRODUCTION

Tumour metastasis is the major cause of death in cancer patients. After the liver and the lung, bones are the third most common place for metastasis to occur[1]. The information from PET helps to understand the biochemical and metabolic activity of a tissue and CT helps for better anatomical delineation, combination of these two improves the ability to distinguish between malignant and benign processes. The higher spatial resolution of modern equipment and scanners significantly enhances image quality, multi planar information, and anatomic localization.

METHODS AND METHODOLOGY

This study was conducted after due approval of the Gauhati Medical College and Hospital Ethical Committee (reference no. 190/2007/PT11). A total of 70 biopsy-proven carcinoma patients of both the sexes giving written informed consent were included in the study during the period of December 2020 to July 2022. Our study excluded pregnant and the unwilling patients. Demographic patient data includes age, sex, histopathological diagnosis for the referral. After taking history and clinical examination of the cases, laboratory and previous imaging studies were collected from the patients.

Scanning technique: Patient were kept hydrated before and during the examination and void frequently after I.V. injection. Emission images of the axial skeleton may begin 45 min after administration of radiopharmaceutical. The patient scanned with Siemens Biograph True Point PET/CT machine having 64 slice helical CT scanner. Bone algorithm was set at window level of 600 to 700 HU and width of 2000 HU. Images may be acquired in 2D or 3D mode. The attenuation corrected ^{18}F-NaF PET images and CT images were automatically fused on True D Siemens software. The relevant images were interpreted by radiologists and nuclear medicine specialists.

The optimal gold standard includes biopsies from all the sites of increased NaF uptakes. For obvious practical and ethical reasons, this is not feasible. Instead, a reference standard was established. A region with involvement seen on both PET and CT was regarded as a true positive focus and a site with no suspicious signs on PET and CT was regarded as a true negative. Discrepant findings were assessed using information from clinical data/ laboratory investigations, radiological investigations (USG,CT, PET/CT or MRI) / follow-up examinations[8,9,10,11].

Statistical analysis was performed. Data were statistically described and diagnostic performance was calculated.

RESULTS

The age group of patients in our study ranged from 17 to 73 years with a mean age of 50.5±13.12 years. In our study there were 30% (21) of males and 70% (49) of females were present, showing the prevalence of patients with cancers.

We carried out our study in 70 carcinoma patients constituting 38(54%) breast cancers, 7(10%) prostate cancer, 7(10%) lung cancer and 18(26%) other carcinoma patients.

In our study, ^{18}F-NaF PET/CT detected metastatic lesions in 45 patients in agreement; considered anterior segment true positives, while 19 individuals were considered true negatives as no metastasis detected. Two metastatic lesions in one patient were not consistently picked up by ^{18}F-NaF PET/CT deemed as false negative. Although lesions in five patients showed NaF uptake and CT abnormality simultaneously, these lesions were later confirmed to be benign lesions and were treated as false positives. The results showed that the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 90%, 95%, 97.8%, 79.2%, and 91.4%, respectively.

In our research, ^{18}F-NaF PET/CT discovered metastases in 24 breast cancer patients in concordance; these patients were deemed true positives. 10 people were deemed true negatives because there were no metastases found in them. 2 lesions in one patient that were consistently missed by ^{18}F-NaF PET/CT was classified as false negative. Despite the fact that 3 patients had lesions that simultaneously showed NaF uptake and a CT abnormality, they were considered benign lesions in further evaluation and are false positives. According to the findings, sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 96%, 76.9%, 88.9%, 90.9%, and 89.5% respectively.

In our small group of prostate cancer patients, 6 patients were labelled as true positives, and 1 person was labelled as a true negative. The criteria for sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were discovered to be 100% according to the results.

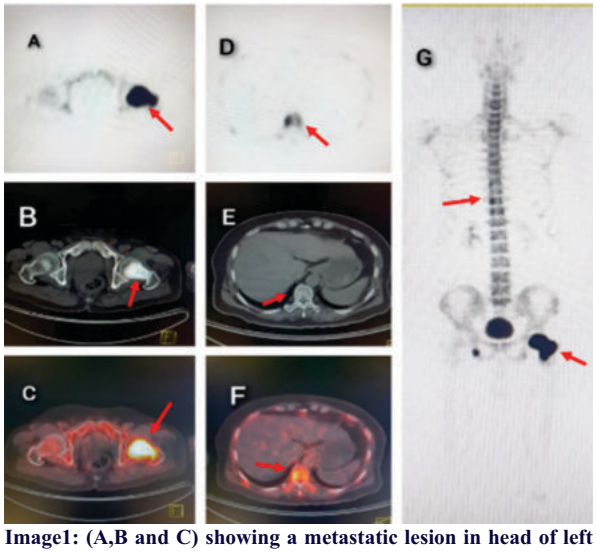

Image1: (A,B and C) showing a metastatic lesion in head of left femur and Figure (D,E and F) showing a metastatic lesion in D10 vertebra.

In the lung cancer patients, ^{18}F-NaF PET/CT identified metastases in 5 lung cancer patients were termed true positives, and 1 person was deemed a true negative. One patient had an abnormality showed both ^{18}F-NaF uptake and CT changes; however, the lesion was declared false positive on follow-up imaging. The research revealed that the criteria for sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 83%, 100%, 100%, 50%, and 85.7%, respectively.

In the remaining 18 other carcinoma patients, ^{18}FNaF PET/CT found metastases in 10 of them, these patients were referred to as true positives, and 7 of them were referred to as true negatives. One patient had both NaF uptake and a CT abnormality, but after comparing the lesion with results from other modalities, the lesion was determined to be false positive. The study found that the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 90.9%, 100%, 100%, 87.5% and 94.4% respectively.

On comparing NaF PET and CT, NaF PET and CT have a sensitivity of 86.3% and 82.4%, specificity of 94.7% for both, positive predictive value of 97.8% and 97.7%, negative predictive value of 72.0% and 66.7%, and an accuracy of 88.6% and 85.7% respectively.

Table1: Diagnostic performance of ^{18}F NaF PET/CT in detection of bony metastasis

Statistic	Breast cancer	Prostate cancer	Lung cancer	Other cancer	All cancers
Sensitivity	96.0%	100.0%	83.3%	90.9%	90.0%
Specificity	76.9%	100.0%	100.0%	100.0%	95.0%
Positive Predictive Value	88.9%	100.0%	100.0%	100.0%	97.8%
Negative Predictive Value	90.9%	100.0%	50.0%	87.5%	79.2%
Accuracy	89.5%	100.0%	85.7%	94.4%	91.4%

DISCUSSION

The age group of patients in our study ranged 17 to 73 years with a mean age of 50.5 + 13.12 years. Sampath et al (2015)[4] studied 75 carcinoma patients ages ranging from 19 to 84 years (average, 57.1 + 15.8 years). Paula Lapa et al (2017)[6], carried out NaF PET/CT scan in detection of bony metastasis in 117 patients of age between 16 to 82 years old with mean of 63 years.

There were 30%(21) of males and 70%(49) of females were present in our study. Paula Lapa et al (2017)[7] used NaF PET/CT in detection of bony metastasis in 117 cancer patients including 68 women and 49 men. Mine Araz et al (2015)[7] studied 37 biopsy proven cancer patients with ^{18}F NaF PET/CT in detection of bony metastasis including 22(59%) male, 15(31%) female.

We carried out our study in 70 biopsy proven carcinoma patients constituting 38(54%) breast cancers, 7(10%) prostate cancer, 7(10%) lung cancer and 18(26%) patients with other carcinomas. Paula Lapa et al (2017)[6], used NaF PET/CT in detection of bony metastasis in 117 patients including 61(52%) of breast carcinoma, 41(35%) prostate carcinoma, 8(7%) of lung cancers and 7(6%) cases of other carcinomas.

CONCLUSION

In conclusion, our study is in agreement with the majority of studies that have been published so far and have indicated that ^{18}F NaF PET/CT has a high sensitivity, specificity, positive predictive value, negative predictive value, and accuracy in detecting bony metastases in all cancer patients.

Therefore, with the availability of ^{18}F NaF PET/CT in the tertiary care hospitals, it can be used as 1st line investigation for evaluation of skeletal metastasis.

Conflict Of Interest: No conflict of interest to declare.
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Table2: Showing The Comparison Of Diagnostic Performance Of 18 F NaF PET/CT Bone Scan With Other Studies.

Study	Sensitivity	Specificity	PPV	NPV	Accuracy
All cancers					
Our study	90%	95%	97.80%	97.80%	91.41%
Sampath et al (2015)4	97.40%	97.40%			
Breast cancers					
Our study	96%	77%	88.90%	90.90%	89.50%
W. A.M. Broos et al (2017)8	96%	91%	89.00%	97.00%	93.00%
Prostate Cancers					
Our study	100%	100%	100%	100%	100%
Randi F. Fonager et al (2017)5	89%	90%	96%	75%	
Jing Zhou et al (2019)10	96%	97%			
Lung Cancers					
Our study	85%	100%	100%	50%	86%
X. W. et al (2012)11	100%	99%	97%		99%
Liangjun Rao et al (2016)12	100%	99.20%	98%	100%	99.40%
Other Cancers					
Our study	90.90%	100%	100%	87.50%	94.40%
Yin Zhang et al(2018)13	98.30%	65.70%			

REFERENCES

1. Capulli, M., Paone, R., & Rucci, N. (2014). Osteoblast and osteocyte: games without frontiers. Archives of biochemistry and biophysics, 561, 3-12.
2. Yen, R. F., Chen, C. Y., Cheng, M. F., Wu, Y. W., Shiau, Y. C., Wu, K., ... & Yang, R. S. (2010). The diagnostic and prognostic effectiveness of F-18 sodium fluoride PET-CT in detecting bone metastases for hepatocellular carcinoma patients. Nuclear medicine communications, 31(7), 637-645.
3. Sharma, P., Karunanithi, S., Chakraborty, P. S., Kumar, R., Seth, A., Julka, P. K., ... & Kumar, R. (2014). 18F-Fluoride PET/CT for detection of bone metastasis in patients with renal cell carcinoma: a pilot study. Nuclear medicine communications, 35(12), 1247-1253.
4. Sampath, S. C., Sampath, S. C., Mosci, C., Lutz, A. M., Willmann, J. K., Mittra, E. S., ... & Iagaru, A. (2015). Detection of osseous metastasis by 18F-NaF/18F-FDG PET/CT versus CT alone. Clinical Nuclear Medicine, 40(3), e173-e177.
5. Fonager, R. F., Zacho, H. D., Langkilde, N. C., Fledelius, J., Ejlersen, J. A., Haarmark, C., ... & Petersen, L. J. (2017). Diagnostic test accuracy study of 18F-sodium fluoride PET/CT, 99mTc-labelled diphosphonate SPECT/CT, and planar bone scintigraphy for diagnosis of bone metastases in newly diagnosed, high-risk prostate cancer. American journal of nuclear medicine and molecular imaging, 7(5), 218.
6. Lapa, P., Marques, M., Costa, G., Iagaru, A., & Pedroso de Lima, J. (2017). Assessment of skeletal tumour burden on 18F-NaF PET/CT using a new quantitative method. Nuclear Medicine Communications, 38(4), 325-332.
7. Araz, M., Aras, G., & Küçük, Ö. N. (2015). The role of 18F–NaF PET/CT in metastatic

bone disease. Journal of Bone oncology, 4(3), 92-97.
8. Broos, W. A., van der Zant, F. M., Wondergem, M., & Knol, R. J. (2018). Accuracy of 18F-NaF PET/CT in bone metastasis detection and its effect on patient management in patients with breast carcinoma. Nuclear Medicine Communications, 39(4), 325-333.
9. Zhou, J., Gou, Z., Wu, R., Yuan, Y., Yu, G., & Zhao, Y. (2019). Comparison of PSMA-PET/CT, choline-PET/CT, NaF-PET/CT, MRI, and bone scintigraphy in the diagnosis of bone metastases in patients with prostate cancer: a systematic review and meta-analysis. Skeletal Radiology, 48, 1915-1924.
10. Wang, D., Yang, Y., Zeng, Z., Ye, J., Guo, C., Huang, S., ... & Xiao, J. (2022). Comparison of Bone Metastases between 18F-NaF PET/CT, 18F-NaF PET, and Planar 99mTc-MDP Bone Scintigraphy in Patients with Newly Diagnosed Nasopharyngeal Carcinoma. Contrast Media & Molecular Imaging, 2022.
11. Rao, L., Zong, Z., Chen, Z., Wang, X., Shi, X., Yi, C., & Zhang, X. (2016). 18F-labeled NaF PET-CT in detection of bone metastases in patients with preoperative lung cancer. Medicine, 95(16).
12. Zhang, Y., Chen, Y., Huang, Z., Zhang, L., Wan, Q., & Lei, L. (2018). Comparison of 18F-NaF PET/CT and 18F-FDG PET/CT for detection of skull-base invasion and osseous metastases in nasopharyngeal carcinoma. Contrast Media & Molecular Imaging, 2018.