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RESEARCH ARTICLE

LIMITATIONS OF PET SCAN IN THE DETECTION OF DISTAL METASTASES OF BRONCHOPULMONARY CANCER

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Abstract

Introduction: Positron Emission Tomography (PET) scanning has become essential in staging bronchopulmonary cancer, offering superior accuracy in detecting both mediastinal lymph node involvement and distant metastases. However, despite its advantages, PET scanning has notable limitations in detecting distal metastases.

Objective: To highlight the limitations of PET scanning in detecting distal metastases of bronchopulmonary cancer, particularly those located outside the standard acquisition field, through the presentation of two clinical cases.

Methods: We present two cases of bronchopulmonary cancer where PET scanning failed to detect distal bone metastases. The first case involves a tibial metastasis in a patient with squamous cell carcinoma, while the second case presents a humeral metastasis in a patient with small cell carcinoma.

Results: In both cases, PET scanning, which typically covers only from the base of the skull to the upper third of the thighs, missed the distal bone metastases that were later detected through other imaging modalities and confirmed by biopsy or additional testing. These metastases were located outside the standard PET acquisition field.

Conclusion: While PET scanning remains a cornerstone in bronchopulmonary cancer staging, practitioners must be aware of its limitations, thorough clinical examination and patient history remain essential components in the detection of distal metastases.

Introduction:-

The incidence of lung cancer has rapidly increased since the beginning of the 20th century and currently represents the main cause of cancer-related mortality worldwide.

In the staging of lung cancer, Computed Tomography (CT) serves as a cornerstone imaging modality, providing detailed anatomical visualization of disease extent. However, CT's capability to distinguish between benign and malignant processes, whether in organs or lymph nodes, remains limited[1]. In contrast, full-body Positron Emission Tomography (PET) utilizing [18F]fluoro-2-deoxy-D-glucose (FDG) demonstrates superior accuracy in identifying both mediastinal lymph node involvement and distant metastases. The efficacy of FDG-PET has been particularly well-established in non-small cell lung cancer management. Modern PET scanners achieve spatial resolution between 4.5 and 6.0 mm at the axial field's centre, enabling detection of sub-centimetre lesions through their increased glucose uptake[1]. Nevertheless,an important limitation exists: FDG uptake is not cancer-specific, as both

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muscular activity and inflammatory conditions can also accumulate the tracer, potentially leading to diagnostic uncertainty[2].

Despite this limitation, PET-SCAN is the reference examination in the extension assessment of bronchopulmonary cancers with an acquisition extending from the base of the skull to the upper third of the thighs, arms in abduction.

We report the observation of two patients in whom this examination did not detect a distal bone location, as the metastasis was located outside the PET acquisition field.

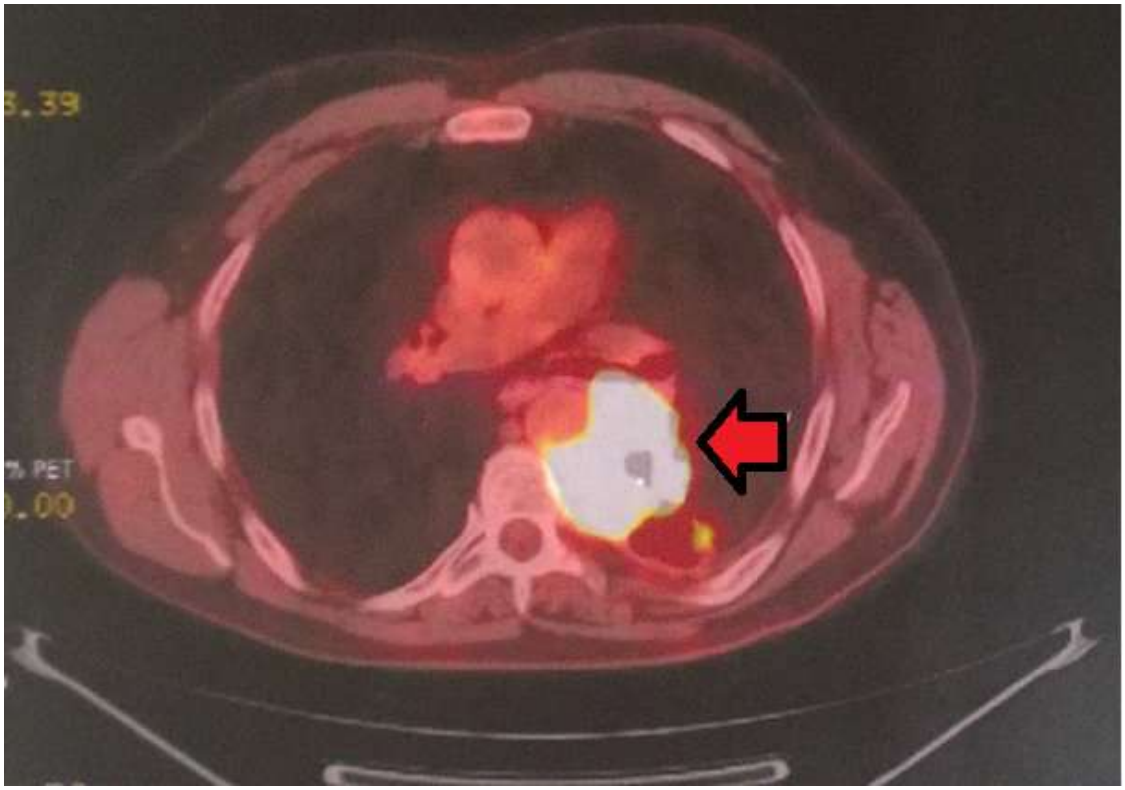
Observation 1:-

A 59-year-old patient, treated for pulmonary tuberculosis in 1979 and a chronic smoker with a 38 pack-year history, had been experiencing hemoptysis for 3 months. Clinical examination was unremarkable. A frontal chest X-ray showed an excavated left basal opacity with a posterior hydroaeric level.

Chest CT revealed a left hilar lymphadenopathy complex encompassing the left pulmonary artery, with middle lobe atelectasis, associated with a middle lobe nodule. Bronchial fibroscopy revealed a lesion at the entrance of the left main bronchus, histologically confirmed as a moderately differentiated, infiltrative squamous cell carcinoma.

The extension work-up included a brain CT scan, which showed no secondary lesions, and a PET scan, which revealed the presence of a small hypermetabolic pulmonary nodule very close to the lymphadenopathy complex in the left hilar region, while the contralateral nodule did not uptake the radioactive tracer (Figure 1-a). The tumor was classified as T3N1M0, corresponding to stage IIIA.

The patient was treated with concurrent chemoradiotherapy. After the second course of chemotherapy, a painful swelling appeared in the left leg. An X-ray of the left leg showed a lytic lesion in the medio-diaphyseal region of the left tibia. Bone scintigraphy showed uptake abnormalities (Figure 1-b). A biopsy confirmed metastatic squamous cell carcinoma of the leg. second-line chemotherapy was initiated along with external fixation of the lytic focus to prevent pathological fractures.



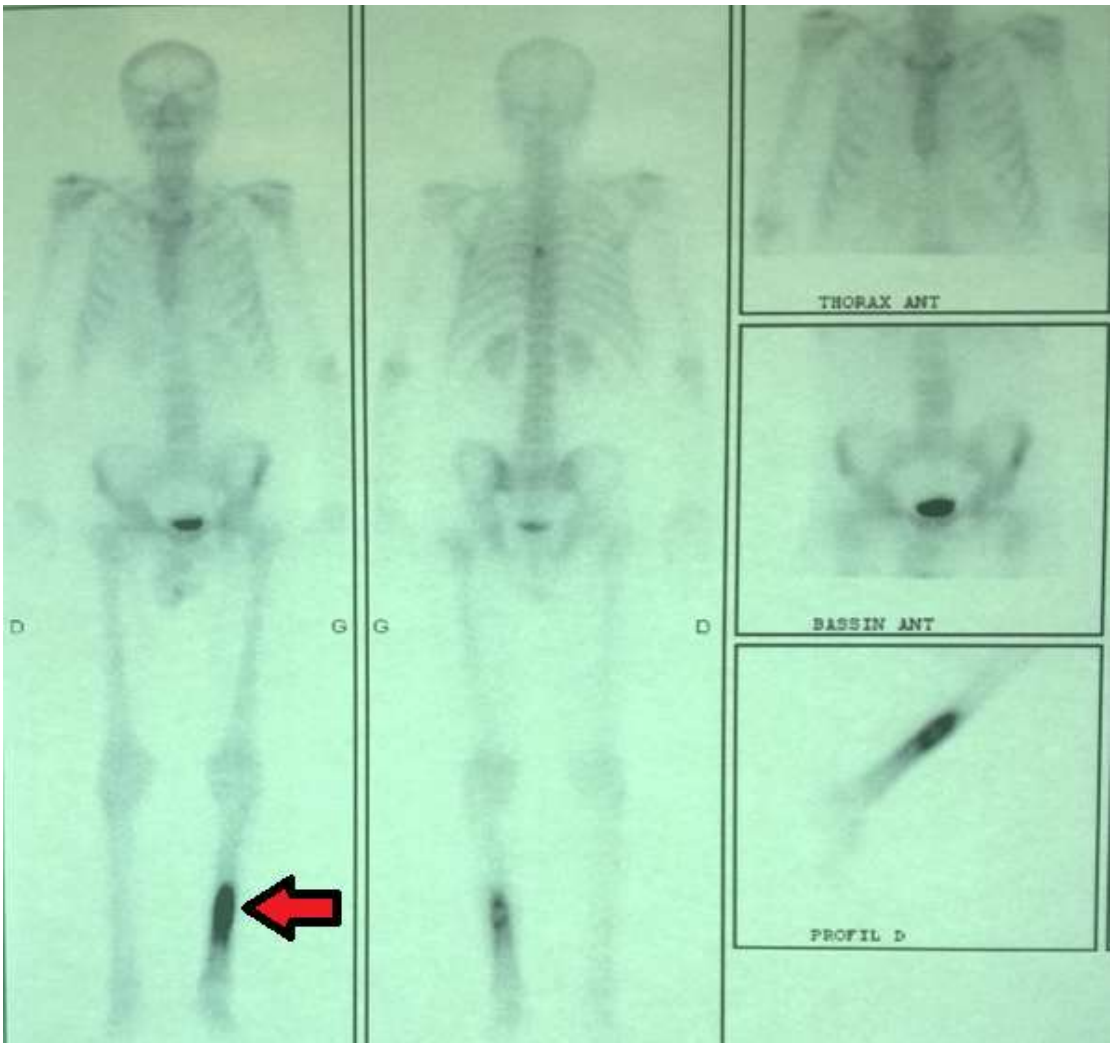
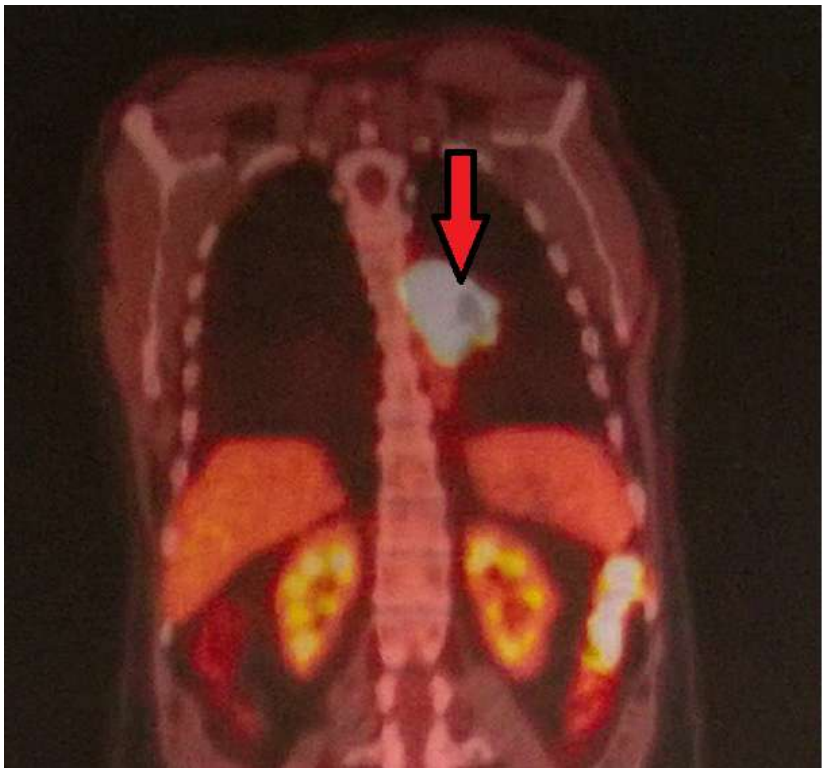


Figure n°1:- a) PET-SCAN showing a left hilar tumour with a pulmonary nodule
b) Bone scintigraphy showing abnormal left tibial fixation

Observation 2:-

A 56-year-old patient with a 40 pack-year smoking history and COPD was admitted to the hospital with exertional dyspnea, chest pain, and dysphonia. Chest X-ray revealed a left hilar opacity. CT scan showed a locally advanced left mediastinal-hilar tumor mass. Bronchial fiberoscopy revealed left vocal cord paralysis, with infiltration at the entrance of the left lower lobe bronchus, histologically consistent with small cell carcinoma. PET scan, performed as part of the extension work-up, confirmed hypermetabolism of the left mediastinal-hilar complex, with no evidence of distant metastases (Figure 2-a).

During hospitalization, the patient developed right arm pain. A standard X-ray showed subcortical demineralization of the distal right humerus (Figure 2-b), this was also confirmerd by the bone scintigraphy (Figure 2- C), the MRI showed an enhancing bone lesion with minimal soft tissue extension. The patient was treated by chemotherapy.



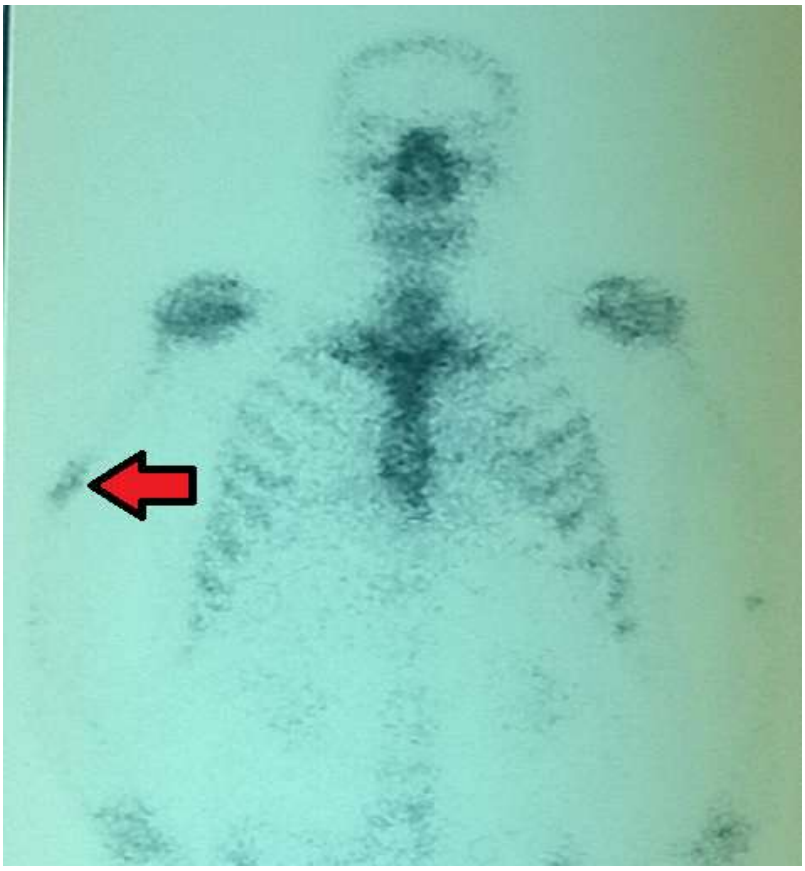


Figure n°2:- a) PETSCAN showing hyperfixation of the left mediastinum-hilar complex
b) A standard radiography showing subcortical demineralisation of the distal end of theright humerus.
c) Bone scintigraphy showing abnormal righthumerus fixation

Discussion:-

In patients with newly diagnosed lung cancer, the initial disease staging is a crucial step in selecting the most appropriate therapy and determining the prognosis[3].

A single PET scan can be used to explore the main metastatic sites of bronchopulmonary cancers (lungs, adrenals, brain, skeleton and liver parenchyma). The aim of PET scans is to improve the selection of non-small-cell bronchopulmonary cancers that are candidates for surgery or thoracic radiotherapy, and to avoid heavy treatment, with no expected benefit[4,5,6].

The frequently used term 'whole-body PET' should not obscure the fact that it most frequently involves acquisition from the base of the skull (orbito-meatal line) to the upper third of the thighs. The arms are generally abducted to minimise artefacts due to bony structures, which degrade both transmission and CT images. Peripheral metastases involving soft tissues or the skeleton are not explored by the PET scan because they are located outside the acquisition field[6].

Distal bone sites, located beyond the elbows or knees, are characterised by their rarity, and have the particularity of being rapidly symptomatic, causing pain, swelling, local inflammatory phenomena and functional impotence. According to Beaulieu, they account for an estimated 4% of bone metastases in all cancers. Lung cancer is the leading cause of distal metastases (50% of distal metastases in the upper limb and 30-50% in the lower limb)[7,8].

In the detection of bone metastases from lung cancer, technetium-99m scintigraphy remains the widely adopted imaging modality. However, its diagnostic value is limited by its non-specific nature, as any condition causing increased metabolic activityincluding trauma, arthritis, and degenerative conditions—can produce false-positive

results. Furthermore, the technique may fail to detect lytic and indolent metastases due to their minimal inflammatory response[9].

PET/CT offers comparable sensitivity with superior specificity compared to scintigraphy in detecting bone metastases. However, PET/CT has two significant constraints in bone metastasis evaluation. First, standard imaging protocols typically cover only from the head to the pelvis, potentially missing lesions outside this range. Second, osteoblastic metastases may yield false-negative results due to reduced glucose metabolism within proliferating bone matrix. Additionally, antitumor cytokine production may suppress FDG uptake, further complicating lesion detection[9].

PET scans including the extremities in the pre-therapeutic assessment of pulmonary neoplasia would enable this type of lesion to be detected. These 'whole body' acquisitions are difficult to interpret, would require strict and complete immobilisation of the patient, and would lengthen the examination time. In fact, including the top of the skull and the lower extremities in the acquisition field would lengthen the examination by around 20 minutes [8]. This increase in time would result in a reduction in the number of examinations and longer appointment times, which would further reduce the already poor accessibility of this imaging modality.

However given the low frequency of the problem and current technical restrictions, the systematic use of whole-body PET scans in the assessment of lung cancers does not appear to be justified. This is particularly true as peripheral metastases are often rapidly symptomatic, and can generally be suspected on questioning and clinical examination. However, it is advisable for the doctors ordering and performing the PET scan to ask about any suspicious pain in the limbs. In this case, the PET acquisition field should include the limbs.

Conclusion:-

Integrated PET/CT imaging has emerged as an indispensable diagnostic modality in the radiological evaluation of lung cancer, often supplementing or superseding traditional imaging techniques.

However, interpretation requires careful consideration in specific contexts, While PET/CT has fundamentally transformed the approach to staging and therapeutic planning inlung cancer, practitioners must maintain awareness of potential interpretative pitfalls.

Practitioners must be aware that certain lesions cannot be detected by PET-SCAN, and questioning and clinical examination remain essential.

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