¹⁸F-FDG PET/CT Imaging of Pulmonary Mucinous Cystadenocarcinoma with Signet Ring Cells

Alexandros Kalkanis¹ · Leonidas Palaiodimos^{2,3} · Ifigeneia Klinaki⁴ ·
Dimitrios Karantanis⁵ · Dimitrios Kalkanis⁵

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Abstract A 63-year-old male with a recently diagnosed right lung lesion was referred for staging. F-FDG PET/CT scan revealed a hypodense, cystic-like mass in the right upper lung lobe, which demonstrated low, diffuse ¹⁸F-FDG uptake, likely due to the presence of mucus, as well as intensely hypermetabolic right hilar and right paratracheal lymph nodes. Transbronchial biopsy revealed a primary pulmonary mucinous cystadenocarcinoma with the presence of signet ring cell carcinoma, a co-existence

of two rare variants of lung adenocarcinoma. This case report demonstrates the metabolic phenotype along with the radiographic characteristics of this rare tumor and its metastases.

Keywords Carcinoma, signet ring cell · Cystadenocarcinoma, mucinous · Fluorodeoxyglucose F18 · Imaging · Lung neoplasms · Positron-emission tomography

✉ Leonidas Palaiodimos
palaiodimos@sni.gr

¹ Department of Respiratory Medicine, Army General Hospital, Athens, Greece

² Department of Medicine, Jacobi Medical Center / Albert Einstein College of Medicine, 1955 Williamsbridge Road, Bronx, NY 10461, USA

³ Society of Junior Doctors, Athens, Greece

⁴ Department of Nuclear Medicine, Biotypos Diagnostic Center, Athens, Greece

⁵ Department of Nuclear Medicine, 251 Greek Airforce Hospital, Athens, Greece

Fig. 1 Combined ^{18}F -Fluorodeoxyglucose positron emission tomography and computed tomography (^{18}F -FDG PET/CT) of a 63 year-old male with a recently diagnosed right upper lung mass referred for initial staging. Maximum intensity projection (MIP) image of ^{18}F -FDG PET/CT **a**, axial low-dose, non-intravenous (IV) iodinated contrast CT **b**, axial fused ^{18}F -FDG PET/CT **c**, axial full-dose, IV contrast-enhanced CT, performed 3 months prior **d** and axial ^{18}F -FDG **e** images show a hypodense, cystic-like mass with calcifications in the anterior segment of the right upper pulmonary lobe, which demonstrates low,

diffuse ^{18}F -FDG uptake (SUVmax: 2.8) (white arrows). Multiple intensely hypermetabolic right hilar and right paratracheal lymph nodes were also noted, finding suspicious for metastatic disease (SUVmax: up to 9.3) (white arrowheads). Anatomic and metabolic appearances of the primary lung lesion were consistent with presence of mucus, pointing towards a possible diagnosis of mucinous cystadenocarcinoma, a rare variant of lung adenocarcinoma [1, 2]. Raza et al. have reported another case of mucinous cystadenocarcinoma, which also showed heterogeneous uptake in ^{18}F -FDG PET/CT, but without nodal or pleural involvement [3]

Fig. 2 Axial low-dose, non-IV contrast CT **a**, ^{18}F -FDG PET/CT **b** and ^{18}F -FDG **c** images (*upper row, white arrows*) show multiple right pleural as well as sub-pleural soft tissue lesions, located mostly in the posteromedial right lung base (SUVmax up to 5.4). Pleural extension with adhesion (with or without pleural penetration) and nodal involvement have been reported as common features in mucinous cystadenocarcinoma, and differential diagnosis from pleural mesothelioma may be necessary [4, 5]. Axial non-contrast CT **d**, fused ^{18}F -FDG PET/CT **e** and ^{18}F -FDG PET **f** images (*middle row, white arrows*) show a 18 mm part-solid nodule in the left upper lobe with ground-glass component, which demonstrates faint FDG uptake (SUVmax 1.6). Taking into consideration that these tumors rarely metastasize to the contralateral

hemithorax [6], this finding could be inflammatory in nature, however malignant involvement could not be entirely excluded. There is also a moderate right pleural effusion seen on axial non-contrast CT **g**, fused ^{18}F -FDG PET/CT **h** and ^{18}F -FDG **i** images (*bottom row, white arrows*) (also present on Fig. 1: B and C) which demonstrates faint, diffuse FDG accumulation (SUVmax: 2.3), new finding compared to IV contrast CT performed three months before ^{18}F -FDG PET/CT (Fig. 1: D), suspicious for malignant pleural effusion. Fine needle aspiration of the effusion was positive for malignancy, which concurs with other case reports in the literature [7]. The disease was considered metastatic and only the right upper lung mass was biopsied

Fig. 3 H-EX400 image of the transbronchial biopsy sample from the right upper lung mass: signet ring cells (*simple arrow*), mucinous substrate (*double arrow*). Pathology revealed extensive invasion of bronchial mucosa by mucinous cystadenocarcinoma with the presence of signet-ring cells, a very rare feature of primary lung tumors [8, 9]. Immunohistochemically, the malignant cells were positive for CK7 and CEA and negative for CDX2 and EGFR, concurring with the literature [10]. For treatment purposes, mucinous cystadenocarcinoma has been traditionally considered a non-small cell lung carcinoma (NSCLC). Mucinous cystadenocarcinoma has a much more favorable prognosis than most other forms of adenocarcinoma and most other NSCLC's [10] and radical surgical resection is the treatment of choice. In our case though, due to the extent of the disease, the patient was not eligible for surgical treatment and received 1st line chemotherapy with cisplatin and pemetrexed. Follow-up studies (not available) demonstrated an initial favorable response, however disease progression was documented after the completion of the 1st line treatment. Due to deterioration of the patient's performance status it was decided to proceed only with best supportive care. The patient passed away 10 months after initial diagnosis

Compliance with Ethical Standards

Conflict of Interest Alexandros Kalkanis, Leonidas Palaiodimos, Ifigenia Klinaki, Dimitrios Karantanis, and Dimitrios Kalkanis declare that they have no conflict of interest.

Ethical Statement The study was approved by an institutional review board or equivalent and has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All subjects in the study gave written informed consent or the institutional review board waived the need to obtain informed consent.

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