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Research Article

The Incidence of Azygos Lobe in Oncology Patients who Underwent ^{18}F-FDG PET/CT Scan

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Abstract

Objectives: AL is most often found incidentally during standard radiography and computed tomography scan. The aim of the present study was to evaluate the incidence of azygos lobe in oncology patients who underwent ^{18}F-FDG PET/CT scan and review the literatüre.

Material and Methods: This is a retrospective, cross-sectional study of 1359 patients (female: 551, male: 808; average age: 58.23 ± 11.60) with malignancy who were referred to ^{18}F-FDG PET/CT scan. All patients underwent ^{18}F-FDG PET/CT scan according to the standard protocol. All image datasets were visually evaluated for detection of AL and quantitatively analyzed by a single nuclear medicine physician.

Results: AL was detected in 9 patients (female: 4, male: 5; average age: 49.55 ± 18.16) who underwent ^{18}F-FDG PET/CT scan and incidence was found to be 0.66%. The cancer diagnoses of patients with AL were as follows in order of frequency: lungs, lymphoma, colorectal, breast, neuroendocrine and sarcoma.

Conclusions: In conclusion, incidence of AL in cancer patients who underwent 18F-FDG PET/CT scan the same as the general population.

Keywords: *Azygos Lobe; ^{18}F-fluorodeoxyglucose; PET/CT; Incidence; Oncology*

Introduction

The azygos lobe (AL) is an anatomical varied that develops during the embryological stages of the right lung upper lobe. AL is formed by a lack in the migration of the azygos vein during the embryonic development and resulting in a lobe detached from the superior-medial portion of the right upper lobe of the lung above the hilum by a fold of parietal pleura containing the azygos vein [1]. AL is most often found incidentally during standard radiography and computed tomography scan. This variant is seen in the right hemithorax and on radiologically represent as the 'comma sign' which corresponds to an azygos fissure [2]. AL has a reported incidence of 0.2% to 1.2% on population, which approximates 0.4% on radiography and 1% on anatomic specimens [3].

AL is a well-known anatomical variation of the right lung but its clinical importance are disregard. Characteristic radiological features of AL are important among clinicians because its confused with an abscess, bulla or masses [4]. The convex line that crosses the upper lobe may confused the appearance of the wall of a bulla or the pleural line seen in a pneumothorax. In addition, consolidation of an AL has been reported and may mimic a lung mass. Primary lung cancer may be arising from an AL [5].

^{18}F-fluorodeoxyglucose (^{18}F-FDG) positron emission tomography combined with computed tomography (PET/CT) is a non-invasive diagnostic nuclear medicine diagnostic tool and clinical indications of PET/CT were in the fields of oncology, neurology and cardiology [6]. ^{18}F-FDG PET/CT is allowing to determinate the localization of increased metabolic activity in tumor tissue. ^{18}F-FDG PET/CT is widely used in routine clinical practice in the management of various types of cancers [7].

Aim of the Study

The aim of the present study was to evaluate the incidence of azygos lobe in oncology patients who underwent ^{18}F-FDG PET/CT scan and review the literatüre.

Material and Method

This is a retrospective, cross-sectional study of patients with malignancy who were referred to ^{18}F-FDG PET/CT scan during the period of January 2016 to December 2017 and 1359 patients (female: 551, male: 808; average age: 58.23 ± 11.60) with metastases or known primary tumor were included in this study. The patients' files with initial diagnosis of malignancy were retrieved from the archive.

All patients underwent ^{18}F-FDG PET/CT scan according to the standard protocol. Patients had fasted for at least 6h and their blood glucose levels were checked before ^{18}F-FDG injection using a finger-stick blood glucose meter. The blood glucose level < 150 mg/dl was ensured. A dose of 0.10 mCi/kg of body weight of ^{18}F-FDG was injected intravenously to each patient under proper glycemic control. Each patient was obliged to drink at least 1L of water. At 60 minutes, whole body PET/CT scan acquisition was performed by a dedicated PET scanner (Siemens Biograph 2, USA) with 3 minutes acquisition for each 8 - 9 bed positions (patient supine, arms on patient's side, vertex to thigh position). Spatial resolution for the PET scanner was 5 mm. Contrast enhanced CT scan was acquired over 1 minute with a low dose of 70 - 120 kVp and tube current 10 - 90 mAs. No intravenous contrast material was used for the CT scans. The CT data were used for attenuation correction of PET images. All image datasets were visually evaluated for detection of AL and quantitatively analyzed by a single nuclear medicine physician.

All statistical analyses were performed using the Statistical Package for the Social Sciences version 15 (Chicago, IL, USA). Quantitative variables were presented as mean ± SD. The incidence of AL was calculated from ^{18}F-FDG PET/CT scans.

Result

According to the ^{18}F-FDG PET/CT scan of 1359 patients, the cancer diagnoses were as follows in order of frequency: lungs (n = 357, 26.3%, female: 36, male: 321; average age: 62.78 ± 9.57), breast (n = 201, 14.8%, female: 189, male: 12; average age: 56.46 ± 11.97), colorectal (n = 183, 13.4%, female: 72, male: 111; average age: 62.06 ± 11.42), head-neck (n = 111, 8.2%, female: 9, male: 102; average age: 57.64 ± 11.7), ovarian-endometrium-cervix (n = 78, 5.7%, female: 78; average age: 60.3 ± 11.12), kidney-ureter-bladder (n = 76, 5.6%, female: 20, male: 56; average age: 65.73 ± 10.39), primer unknown (n = 68, 5%, female: 27, male: 41; average age: 59.75 ± 13.34), stomach (n = 63, 4.6%, female: 21, male: 42; average age: 61.66 ± 10.22), lymphoma (n = 51, 3,7%, female: 39, male: 12; average age: 56.82 ± 16.01), malignant melanoma (n = 48, 3.5%, female: 36, male: 12; average age: 58.66 ± 12.63), testis (n = 18, 1.3%, male: 18; average age: 31 ± 7.56), sarcoma (n = 18, 1,3%, female: 3, male: 15; average age: 58.33 ± 21.47), pleural malignancy (n = 18, 1.3%, male: 18; average age: 62.5 ± 17.82), pancreas (n = 12, 0.9%, female: 6, male: 6; average age: 58.75 ± 2.75), esophagus (n = 12, 0.9%, female: 3, male: 9; average age: 60 ± 8.36), liver-biliary tract (n = 12, 0.9%, male: 12; average age: 61.5 ± 13.07), neuroendocrine (n = 12, 0.9%, female: 6, male: 6; average age: 56 ± 8,86) and others (e.g. thyroid, prostate, primary bone tumor, multiple myeloma, etc.) (n = 21, 1.7%, female: 6, male: 15; average age: 58.12 ± 10.51). The cancer diagnoses of all patient who underwent ^{18}F-FDG PET/CT scan were shown in figure 1.

AL was detected in 9 patients (female: 4, male: 5; average age: 49.55 ± 18.16) who underwent ^{18}F-FDG PET/CT scan and incidence was found to be 0.66%. The cancer diagnoses of patients with AL were as follows in order of frequency: lungs (n = 3, 33.29%, male: 3; average age: 60 ± 8.88), lymphoma (n = 2, 22.23%, female: 1, male: 1; average age: 42.5 ± 14.84), colorectal (n = 1, 11.12%, female: 1; age: 79), breast (n = 1, 11.12%, female: 1; age: 34), neuroendocrine (n = 1, 11.12%, female: 1; age: 45) and sarcoma (n = 1, 11.12%, male: 1; age: 23). The cancer diagnoses of patient with AL were shown in figure 2.

18F-FDG PET/CT scan of thorax confirmed presence of AL. On ^{18}F-FDG PET/CT scan, AL appears as a parenchymal part separated from the upper lobe by a fine line convex to the mediastinum and crosses the anterior part of the right lung's upper lobe. AL is characterized with 'comma sign' on the right paratracheal localization (Figure 3).

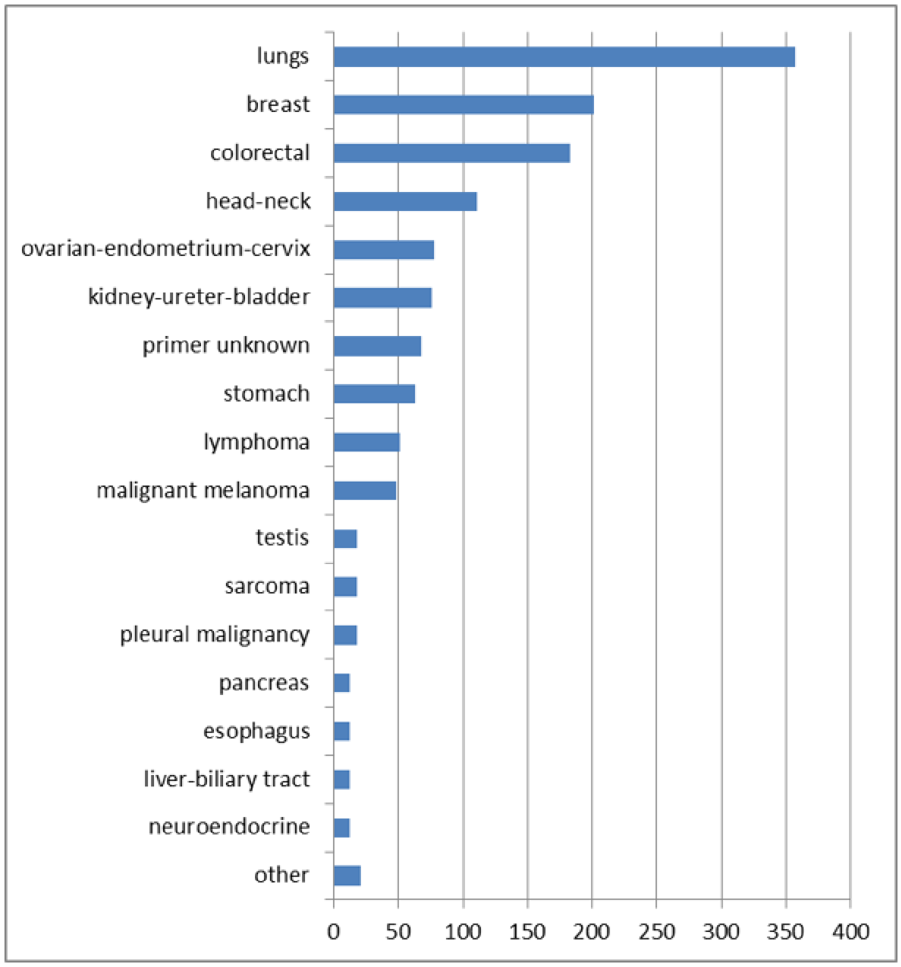

Figure 1: *The cancer diagnoses and number of all patient who underwent ^{18}F-FDG PET/CT scan (N = 1359).*

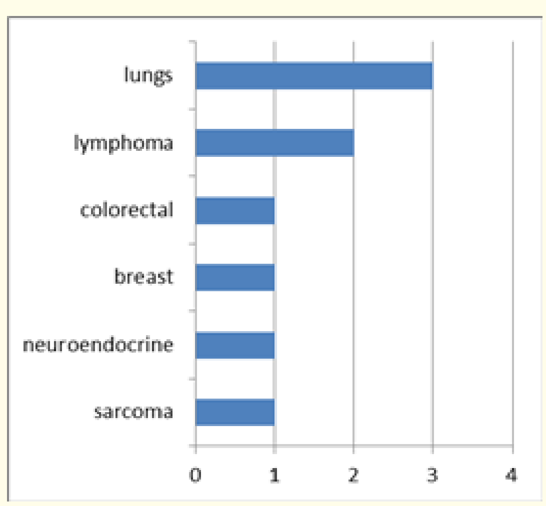

Figure 2: *The cancer diagnoses and number of patient with AL (n= 9).*

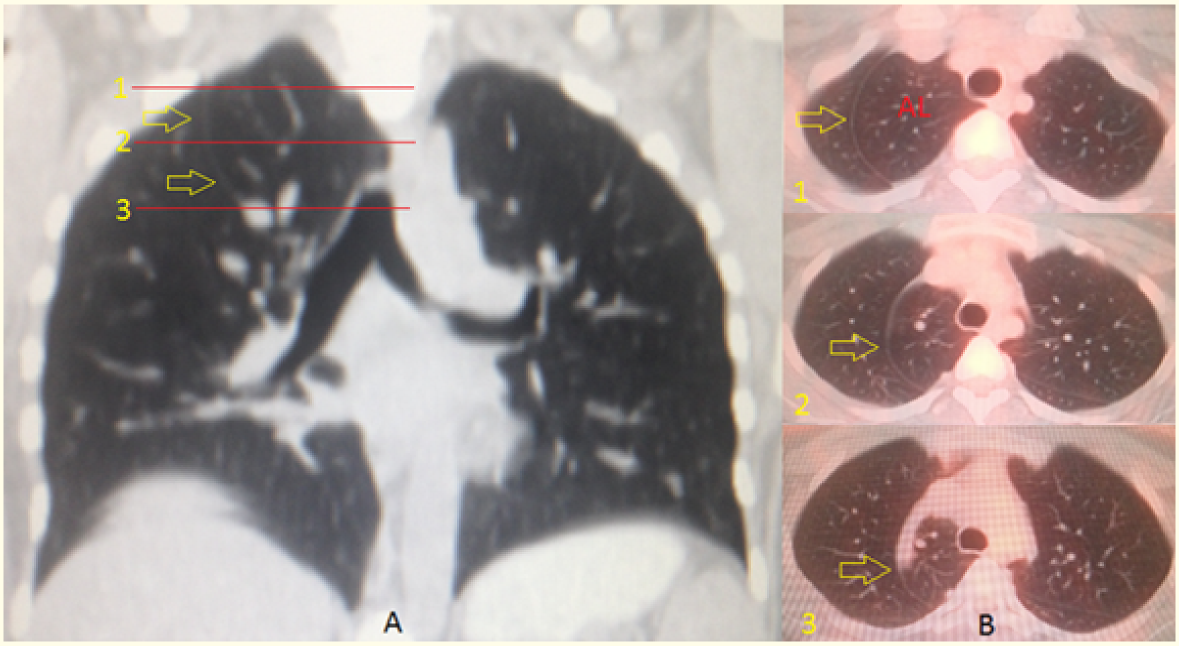

Figure 3: *Coronal image (A) and axial image (B) 18F-FDG PET/CT scan of a 53-year-old man with lung cancer showed an azygos lobe (AL) with well-known characterized 'comma sign' (arrow) on the right upper localization.*

Discussion

AL is a very rare but well-known normal anatomic variant of right upper lobe and first described by Heinrich Wrisberg in 1877 [8]. AL tends to be seen more commonly in men and familial predisposition has been reported [9]. Heineman., *et al.* were presented that the embryological background on AL and azygos vein [10]. When the embryo is approximately 4 weeks old, the lung bud, an outgrowth from the ventral wall of the foregut, expands caudally into the surrounding mesenchyme and bifurcates into right and left bronchial buds. The right bronchial bud then divides into three secondary bronchi while the left bud into two secondary bronchi. Each lung then develops by a process of repeated dichotomous branching of the secondary bronchi. After several generations of branching, bronchopulmonary segments are formed. Defective pulmonary development will give rise to variations as encountered in fissures and lobes [11]. In our study, we found the incidence of AL in cancer patients who underwent ^{18}F-FDG PET/CT scan the same as the normal population and we found that in male patients seem slightly more than women patients.

AL is take shaped due to penetration of right posterior cardinal vein into the apex of the lung instead of normal migration over it during embryogenesis. AL is formed during embryological development when the right posterior cardinal vein aberrantly migrates through the upper lobe of the right lung rather than over the apex. As a result, two pleural layers are carried through the right upper lobe creating a fissure known as the azygos fissure. While most of the posterior cardinal veins regress during embryological development, the right-sided supracardinal veins form a portion of the inferior vena cava, the intercostal veins, the hemiazygos vein, and the azygos vein [12]. Change in intrathoracic pressure can result in displacement of the azygos vein from the azygos fissure to the mediastinum, which is termed an empty or vanishing azygous fissure [13].

AL is usually identified incidentally on chest X-ray or CT scan examination. AL is important to radiologists and thoracic surgeons to be aware of the anatomic variations of pulmonary lobes including AL, due to it may affect the surgical plan and decision. Identification of an azygos vein in its normal position at the angle between the trachea and right bronchus on a radiograph can be helpful to rule out an AL. Confirmation of the diagnosis can be done by CT [3]. In our study we used ^{18}F-FDG PET/CT scan for diagnosis of AL.

Clinical importance of AL is that it may be confused with a bulla or abscess, a pulmonary nodule and a consolidated azygos lobe may mimick like a lung mass. Lung tumours, pneumothorax, atelectasis and bronchiectasis has been reported to occur in AL [8]. Spontaneous pneumothorax associated with AL has been reported in both adult and paediatric patients, because AL can be increase the mechanical stress of the lungs [2]. The incidence of spontaneous pneumothorax is more than 7/100.000 men cases and of more than 1/100.000 women cases per annum [12,14]. De Carolis., *et al.* were reported double tracheoesophageal fistula and AL [15]. Deniz., *et al.* were reported a patient with together anterior thoracic meningocele and AL of the lung and both anomalies are related to faulty embryogenesis [16].

Primary lung cancer associated with AL is extremely rare. A few cases of primary lung cancer based on from AL have been reported in the literature [17-22]. Arai., *et al*. were reported a patient primary lung adenocarcinoma associated with the azygos lobe treated by lobectomy with video-assisted thoracoscopic surgery [9]. Pinto., *et al*. were descripted a metastatic osteosarcoma nodule in the AL [23]. Khvastunov., *et al.* were descripted pleural mesothelioma with AL [24]. In our study, all patients with AL were asymptomatic and three patients were diagnosed with lung cancer.

Surgical management was successfully completed using video-assisted thoracoscopic surgery, through resection of the bullae harboring AL, Technical difficulties in thoracoscopic procedures may arise with an AL. Sympathectomies and lobectomies involving AL have commonly been reported [21,25]. Some cardiopulmonary pathologies might be present in patients with AL, therefore it is important to keep this in mind when examining such patients [26]. The operating surgeon should be made aware of this anatomical variant prior to initiating the surgery. Potential complications can be avoided by coordinated surgical management [25]. Detection and knowledge of AL precise anatomical features are important not only to differantiate this anomaly from other pathological conditions, but also to alert the surgeon to potential problems during surgery [20]. In our study, there was no surgical operation for AL in the all patient group.

^{18}F-FDG PET/CT can improve the accuracy of the clinical stage and provides the basis for patients to choose the correct treatment approach, assessment of treatment response as a prognostic factor. PET/CT may improve evaluation of tumor by combining both anatomic information and functional information [27]. ^{18}F-FDG PET/CT scan has the potential to distinguish viable tumor and non-malignant tissue and it is used for the diagnosis and staging of more cancer as well as for the assessment of response to treatment [28]. ^{18}F-FDG PET/CT scan was used in the diagnosis of primary tumor in AL [10,29]. In our study shown that ^{18}F-FDG PET/CT scan is mostly used in lung, breast and colorectal cancer screening.

Conclusion

In conclusion, incidence of AL in cancer patients who underwent ^{18}F-FDG PET/CT scan the same as the general population. ^{18}F-FDG PET/CT scan may be used in the diagnosis of AL.

Conflict of Interest

None.

Financial Support

None.

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