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Depiction of celiac ganglia on positron emission tomography and computed tomography in patients with lung cancer

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ABSTRACT

Objective: To differentiate imaging characteristics of celiac ganglia from metastatic lesion on positron emission tomography–computed tomography (PET-CT) in patients with lung cancer and correlate these findings to postmortem multidetector row computed tomography (MDCT). **Methods:** One hundred twenty-nine patients were included. Imaging characteristics and fluorodeoxyglucose (FDG) avidity of the celiac ganglia were recorded. Postmortem MDCT of 20 subjects were reviewed. **Results:** Celiac ganglia were identified unilaterally in 127 and bilaterally in 108 patients without abnormal FDG uptake. Postmortem images showed celiac ganglia in all cases with no significant difference compared to our patients. **Conclusions:** Familiarity with CT characteristics and FDG-avidity of celiac ganglia enable us to distinguish them from metastatic lesions in their vicinity.

1. Introduction

The celiac plexus, the largest of autonomic fiber plexuses, is located at the level of the upper part of the L1 and is composed of two large ganglia, the celiac ganglia, and a dense network of nerve fibers uniting them together. As described in anatomic studies, the celiac ganglia have nodular morphology similar to lymph nodes and are located one on either side of the midsagittal line anterior to the crura of the diaphragm [1]. The number of ganglia varies from 1 to 5 and reported size ranges from 5 to 45 mm [2].

Celiac ganglia are routinely visualized on cross sectional imaging modalities and on multidetector row computed tomography (MDCT) both the left and right celiac ganglia are identified at the level between the origins of celiac and superior mesenteric arteries, anterior to the crura of the diaphragm. The ability to reliably identify celiac ganglia by CT facilitates invasive procedure like celiac ganglia block and prevent misidentification of celiac ganglion for lymph nodes [3].

Because of similar soft tissue density and morphology, a large celiac ganglion may be easily mistaken for metastatic lymph nodes or retroperitoneal metastatic tumor deposits or metastatic adrenal nodule, thereby affecting patient management [4,5]. However, there are very few published studies highlighting the difference between celiac ganglion and metastatic cancers lesions which is critical for prognosis of malignancies and planning for future interventional procedures.

Lung cancer as the most fatal and second most common cancer in US has a high incidence of adrenal metastasis and may also lead to abdominal lymph node metastasis [6,7]. Because of similarity in location, density, and appearance distinguishing celiac ganglia from metastatic lesions could be challenging and critical for management in patients with primary lung cancer.

In this study in order to better characterize celiac ganglia and distinguish them from any metastatic lesions in its vicinity, we assessed the depiction of celiac ganglia on positron emission tomography-computed tomography (PET-CT) with [^{18}F]-fluorodeoxyglucose (^{18}FDG) in patients with history of lung cancer. We also correlated these finding to postmortem high dose MDCT scans performed in unrelated subjects.

2. Material and methods

Institutional review board approval was obtained for this HIPAA-compliant retrospective study. The correlated postmortem CTs were also performed under an institutional review board study. A total of 129 consecutive patients with lung cancer (70 women and 59 men; mean age, 66.0 years) who underwent PET-CT for staging of tumors from January 2005 to May 2010 at our institution were included. As outlined above, patients with lung cancer were chosen as adrenal metastases and/or upper abdominal lymph nodes metastases can occur in these patients so distinguishing normal celiac ganglia structure from these metastatic lesions could be challenging in some cases. Follow-up MDCT scans until 30 May 2012 for restaging

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of tumor were also obtained to evaluate the changes in the structures during the follow-up. Those patients with no follow-up CT scans 3 months after the initial study were excluded from study.

To better demonstrate the characteristic of celiac ganglia, we also studied 20 postmortem high-dose MDCT scans in unrelated cases and correlated the findings to CT findings in the lung cancer patients.

2.1. PET-CT scans

All PET-CT scans were performed with 64-slice multidetector row PET scanner (LightSpeed, General Electric, Milwaukee, WI, USA) using the following protocol. ^{18}FDG was injected according to patient's body weight. Multiplanar PET images were obtained 60 minutes after injection. Non-contrast CT with 5 mm slice thickness was also obtained. A 100-ml bolus of iohexol (Omnipaque 300; Nycomed-Amersham, Princeton, NJ, USA) was given at 2 ml/s and post-contrast CT with 2.5 mm slice thickness of skull base to pelvis were also obtained after 60 seconds delay.

Follow-up MDCT scans for restaging of tumor were also retrieved until 30 May 2012. The scans were performed after a 100-ml bolus of iohexol at 2 ml/s, and 2.5-mm-slice-thickness scans of thorax to pelvis were also obtained with 64-slice multidetector row CT scanner (LightSpeed, General Electric, Milwaukee, WI) after 60 seconds delay.

2.2. Postmortem CT scan

All unenhanced postmortem CT examinations were performed within 12 hours of death on a second generation 64 channel dual source CT scanner (Somatom Definition Flash, Siemens HealthCare, Forchheim, Germany) at two- to threefold higher radiation dose than routine abdomen CT (mean CT dose index of 26.7±4.9 mGy; range, 20–32) with slice thickness of 5 mm and 5-mm increment.

2.3. Image interpretation

The images were reviewed on a picture archiving communication system workstation (Impax; Agfa, Mortsel, Belgium) by an expert radiologist with over 10 years of experience. The frequency of visualization, location, morphologic features, size, enhancement pattern, and FDG avidity of the celiac ganglia were recorded. The location of celiac ganglia was recorded according to the relationship to left adrenal, abdominal aorta, and vertebral level. The bidimensional size of the celiac ganglia was measured in the axial plane. The density was measured by putting a region of interest (ROI). The circular ROI was drawn covering the maximum portion of the ganglia, excluding the edges. The ROIs were placed on two consecutive slices and the average was recorded. The FDG avidity of celiac ganglia was also recorded. On follow-up CT scans, any morphologic change in the celiac ganglia was recorded.

3. Results

Structures consistent with celiac ganglia were identified in 127 cases (98%). The celiac ganglia were observed bilaterally in 108 patients (91% of total patients). The left celiac ganglion was visualized slightly more often than the right ganglion; however, the difference was not significant (P=.74). They appeared as discoid or lobulated structures, with smooth margin (in 68.3% of patients) ranging in short axis from 2 to 22 mm (mean, 7.1 mm) and long axis from 6.9 to 35.3 mm (mean, 19.4 mm). Location of most of these ganglia was at the level of T12-L1 between the adrenal gland and diaphragmatic crura adjacent to the abdominal aorta; two celiac ganglia were found at the level of L2.

The distance from aorta was 1–15.3 mm (mean 4.5 mm) and from ipsilateral adrenal gland was 0–13.2 mm (mean 2.9 mm) (Fig. 1).

On non-contrast scans, the ganglia appeared hypodense with ill-demarcated margin. There was a substantial increase in mean Hounsfield units (HU) in all of the cases on enhanced CT (11 vs. 68, P=.004). There was no evidence of abnormal FDG uptake in the celiac ganglia on PET scans. During follow-up (mean: 20.1 months; range 1.47–73.07 months) the ganglia did not change in size in 123 patients (95% of cases). Celiac ganglia could not be identified in 6 cases on follow up CT (mean follow up 38.9 months; range 26.67-67 months). This was due to the progression of adrenal metastasis in 3

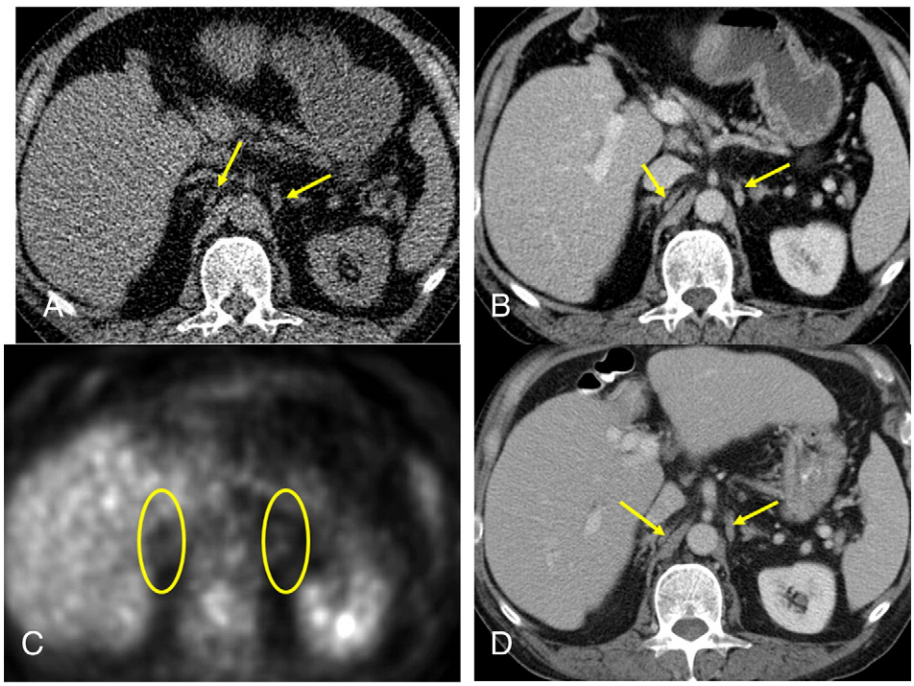

Fig. 1. A 55-year-old male with lung cancer. Axial CT images (A, B) show smooth bilateral celiac ganglia (arrows) in pre- (A) and post-contrast images (B). There is no FDG avidity in the region of ganglia (yellow circles) (C). Follow-up CT after 26 months shows no change in size (D).