Pulmonary Computed Tomography findings in patients with chronic aspiration detected by Videofluoroscopic Swallowing Study

Poster No.: C-1579
Congress: ECR 2016
Type: Scientific Exhibit
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Keywords: Thorax, Lung, Respiratory system, CT-High Resolution, CT, Fluoroscopy, Dynamic swallowing studies, Computer Applications-Detection, diagnosis, Swallowing disorders, Atelectasis, Infection

DOI: 10.1594/ecr2016/C-1579

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Aims and objectives

To demonstrate computed tomography (CT) findings in patients with chronic aspiration compared with a control group without aspiration detected by videofluoroscopic swallowing study (VFSS).

*This paper is under current analysis for publishing at a journal.

Methods and materials

Patients and Study design

Adult patients (aged # 18 years) who were consecutively referred to VFSS and undergone chest CT examination for staging extrapulmonary malignancy between May 2010 and October 2014 were retrospectively enrolled in this study. The clinical, imaging, laboratorial data were reviewed by the examination of medical records. The aspiration was confirmed by VFSS realized by a speech-language pathologist and a radiologist with years of experience. Aspiration status was acquired up to 2 months before the computed tomography scan.

This study followed the recommendations of the Declaration of Helsinki and was approved by the regional bioethics review board. All patients referred for VFSS evaluation and confirmed that aspirated and performed chest CT examination because staging lung cancer were included in the study. With the exception of aspiration diagnosis, the exclusion criteria were: any active lung infection (use of antibiotics, documented fever or abnormal white blood cells counts); any type of metastatic neoplasia; lung transplantation, lobectomy, or other pulmonary intervention; confirmed immunosuppression (congenital, HIV or chemotherapy) and any clinical evidence of a diagnosed obstructive or restrictive pulmonary disorder in medical records. Two radiologists with 5 and 7 years of experience in thoracic radiology, respectively, who were blinded to the presence of aspiration, reviewed the CT images for the presence of any abnormalities independently and after, consensus was performed with a third radiologist with 20 years of experience. In addition, inter-observer agreement tests were performed in this study.

Imaging Parameters
Videofluoroscopic Swallowing Study (VFSS): the exams were performed with a Siemens fluoroscopy unit, model Axion Iconos R100, coupled to a computerized image recording system that allowed detailed analysis of the exam. During the realization of VFSS, patients remained seated and image capture was obtained at lateral and anterior-posterior positions, with upper and lower limits ranging from the oral cavity to the stomach. The protocol included functional intake of liquid, pasty and solid consistencies with liquid barium.

Computed Tomography (CT): images were acquired using two commercially available 64-row multi-detector CT scanners (SOMATOM Sensation 64 Systems; Siemens Medical Systems, Forchheim, Germany; and LightSpeed VCT; GE Healthcare, Milwaukee, WI, USA). The examinations performed in the caudal-cranial direction to prevent movement artifacts. The parameters were collimation, 1 mm; rotation time, 0.33 s; pitch, 1.3; dose, 120 kV; and 200 mAs. All CT examinations performed without contrast. All CT images were reconstructed with axial 1-mm slice thickness. Sagittal and coronal reconstruction with and without maximum intensity projection was also performed. The use of automatic exposure control and soft kernel was allowed, and a data matrix of 512 × 512 was used. The scanners were calibrated periodically according to the manufacturers' recommendations.

Statistical Analysis

Excel® software (Microsoft Corporation, Redmond, WA, USA) was used for data tabulation and descriptive analysis. For continuous variables, mean, median, maximum, and minimum values and standard deviations were calculated. For categorical variables, frequencies were expressed as percentages.

Correlative analysis was performed with Stata software (ver.12.1; StataCorp, College Station, TX, USA). The chi-squared test applied to categorical (qualitative) variables, which comprised all measurements cross-tested by the authors. Tests were performed bilaterally with a 0.05 level of significance. These tests were performed separately for each observer. Interobserver agreement was assessed with linearly weighted # statistics for categorical variables and Pearson correlation coefficient for continuous variables. The level of agreement was defined as follows: # = 0 to 0.20, poor agreement; # = 0.21 to 0.40, fair agreement; # = 0.41 to 0.60, moderate agreement; # = 0.61 to 0.80, good agreement; and # = 0.81 to 1.00, very good agreement [13].

Results
From an initial sample of 1300 VFSS conducted, 56 had chest CT registration for staging extra-pulmonary cancer. From these, 28 patients show pulmonary aspiration in VFSS. A total of 56 patients with a mean age of 65 (± 15) years and nearly equal sex distribution (29 [52%] men) were included in analysis. All patients were referred to VFSS because symptoms of chronic cough. There are not difference in from 56 patients, 38 have diagnosis of colon cancer, 10 have diagnosis of renal cancer, 5 urinary bladder cancer and 3 have diagnosis of melanoma. There is not statistical difference between groups of cancer and aspiration diagnosis. Also, 32 patients have diagnosis of cerebrovascular disease (21 in aspiration group/11 in non aspiration group) (p<0.05).

The results of the interobserver agreement (# values) were bronchial wall thickening (0.54), air trapping (0.74), atelectasis (0.82), centrilobular nodules (0.84) and bronchiolectasis (0.88), followed by consolidation (0.86) and ground-glass opacities (0.79).

**CT findings**

**Aspiration Group**

The study group comprised 28 participants. The most frequent CT findings (Table 1) were bronchial wall thickening (54%), air trapping (54%), atelectasis (18%), centrilobular nodules (16%) and bronchiolectasis (15%), followed by consolidation (6%) and ground-glass opacities (4%).
Table 1: The control group comprised 28 patients. The most prevalent abnormalities were bronchial wall thickening (53%) and air trapping (53%), followed by centrilobular nodules (4%) and atelectasis (2%; Table 1).

References: Bruno Hochhegger

Control Group

The control group comprised 28 patients. The most prevalent abnormalities (Table 1) were bronchial wall thickening (53%), air trapping (53%), followed by centrilobular nodules (4%) and atelectasis (2%).

Distribution of CT Findings

Bronchial thickening and air trapping were slightly more prevalent in the aspiration group (Figure 1), but these differences between groups were not significant ($P = 0.208$). Bronchiolectasis, centrilobular nodules, ground-glass opacities, atelectasis and consolidation were observed significantly in patients with aspiration than in control subjects (all $P < 0.001$) (Figure 1). The main CT findings in aspiration group were in the left lower lobe and in the right lower lobe ($P < 0.001$) (Figure 2). In both groups, bronchial wall thickening and air trapping occurred in all lung zones ($P =0.208$).
Table 2: Bronchial thickening and air trapping were slightly more prevalent in the aspiration group than in the control group (Table 2), but these differences were not significant \( (P = 0.208) \). Bronchiolectasis, centrilobular nodules, ground-glass opacities, atelectasis, and consolidation were significantly more common in patients with aspiration than in control subjects \( (all \ P < 0.001; \text{Table 2}) \). In the aspiration group, the main CT findings were observed in the left and right lower lobes \( (P < 0.001; \text{Table 2 and Figure 1}) \). Bronchial wall thickening and air trapping occurred in all lung zones \( (P = 0.208) \).

References: Bruno Hochhegger
Fig. 1: A 59-year-old man diagnosed with melanoma 1 year previously, who presented with chronic cough. (a) Sagittal CT demonstrated bronchiolectasis, atelectasis, and areas of ground-glass opacity in the lower lobes.

References: Bruno Hochhegger
Fig. 2: A 59-year-old man diagnosed with melanoma 1 year previously, who presented with chronic cough. (b) Coronal CT provided better visualisation of bronchiectasis in the right lower lobe.

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Images for this section:
Table 1: The control group comprised 28 patients. The most prevalent abnormalities were bronchial wall thickening (53%) and air trapping (53%), followed by centrilobular nodules (4%) and atelectasis (2%; Table 1).

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Table 2: Bronchial thickening and air trapping were slightly more prevalent in the aspiration group than in the control group (Table 2), but these differences were not significant (P = 0.208). Bronchiolectasis, centrilobular nodules, ground-glass opacities, atelectasis, and consolidation were significantly more common in patients with aspiration than in control subjects (all P < 0.001; Table 2). In the aspiration group, the main CT findings were observed in the left and right lower lobes (P < 0.001; Table 2 and Figure 1). Bronchial wall thickening and air trapping occurred in all lung zones (P = 0.208).

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**Fig. 1:** A 59-year-old man diagnosed with melanoma 1 year previously, who presented with chronic cough. (a) Sagittal CT demonstrated bronchiolectasis, atelectasis, and areas of ground-glass opacity in the lower lobes.

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**Fig. 2:** A 59-year-old man diagnosed with melanoma 1 year previously, who presented with chronic cough. (b) Coronal CT provided better visualisation of bronchiectasis in the right lower lobe.

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Conclusion

In summary, we observed significantly different radiological patterns on chest CT between patients with aspiration and a control group. Atelectasis, centrilobular nodules, bronchiolectasis, consolidation and ground-glass opacities occurred more frequently in patients with aspiration, with a pronounced tendency for lower lobes.

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