Relationships between pulmonary function test parameters and quantitative computed tomography measurements of emphysema in subjects with chronic obstructive pulmonary disease

Virginija Šileikienė[1, 2*],

Marius Urbonas[3],

Mindaugas Matačiūnas[3],

Jolita Norkūnienė[4]

[1] *Centre of Pulmonology and Allergology
of Vilnius University
Hospital Santaros Klinikos,
Vilnius, Lithuania*

[2] *Clinic of Infectious and Chest Diseases,
Dermatovenerology and Allergology
of Vilnius University,
Vilnius, Lithuania*

[3] *Centre of Radiology and Nuclear Medicine
of Vilnius University
Hospital Santaros Klinikos,
Vilnius, Lithuania*

[4] *Department of Mathematical Statistics
of Vilnius Gediminas Technical University,
Vilnius, Lithuania*

Objective. CT is able to precisely define the pathological process in COPD. There are a number of previous articles discussing the distribution of emphysema and its connection with pulmonary function tests. However, the results obtained by the researchers are not identical.

Purpose. To assess relationships between emphysema and pulmonary function test parameters in COPD patients.

Materials and methods. Fifty-nine patients diagnosed to have COPD underwent chest CT examinations and pulmonary function tests.

For the quantitative assessment, percentages of low attenuation volume $LAV_{950\,HU}$ (%) of a both lungs, the right lung, the left lung, and each lobe were obtained. Quantitative CT measurements were compared with forced expiratory volume in 1 s (FEV_1), the ratio of FEV_1 to forced vital capacity (FEV_1/FVC), the diffusing capacity for carbon monoxide (DLco) and total lung capacity (TLC).

Results. Except for the right middle lobe and the right upper lobe, respectively, all the quantitative CT measurements showed weak to moderate negative correlations with diffusing capacity (DLco) ($r = -0.35$ to -0.61, $p < 0.05$) and weak positive correlations with TLC ($r = 0.34$ to 0.44, $p < 0.05$). Group analysis indicated that $LAV_{-950\,HU}$ (%) values of both lungs, right lung, left lung, and each lobe, except for right middle lobe, were increased in patients with GOLD stages 3 and 4 of COPD compared to GOLD stages 1 and 2 ($p < 0.05$).

Conclusion. CT measurements of emphysema are significantly related to pulmonary function tests results, particularly DLco.

Keywords: emphysema, quantitative computed tomography (CT), pulmonary function, COPD

Correspondence to: Virginija Šileikienė, 2 Santariškių St., Vilnius
08661, Lithuania. Email: virginija.sileikiene@santa.lt

INTRODUCTION

Chronic obstructive pulmonary disease (COPD), a common preventable and treatable disease, is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases (1). Airflow limitation is mainly caused by small airway remodelling and/or emphysema, and these pathologic changes directly determine the appropriate management strategy (2, 3). Therefore, differentiation of the two types of pathologic change is clinically important. Spirometry is a well-established method for the diagnosis and assessment of a clinical stage of COPD. However, it is difficult to establish these pathologic changes with this clinical tool, and the regional function and morphological abnormalities cannot be evaluated either. In contrast, imaging examinations have shown great advantages in the assessment of regional morphologic and functional changes in COPD patients. Nonetheless, according to the practise guidelines of GOLD (Global Initiative for Chronic Obstructive Lung Disease), imaging does not play a substantial role in the diagnosis of COPD (1, 4).

Emphysema is defined as a permanent enlargement of air spaces distal to terminal bronchioles accompanied by the destruction of alveolar walls. Emphysema can be centrilobular, panlobular, paraseptal, and bullous. Such pathological changes cannot be assessed by conventional chest radiographs but can be well studied on a computed tomography (CT) scan. Detailed anatomic information about the lung and such morphologic changes as emphysema, bronchial wall thickening and fibrosis can be seen and characterized in a CT scan. Thus, CT is able to precisely define the pathological process in COPD and has been used to differentiate between airway-predominant and emphysema-predominant COPD (5). Various CT techniques are available to quantify emphysema (6) and many studies have addressed the ability of CT to accurately quantify the extent and severity of emphysema. In addition to detailed anatomic structures, CT can make quantitative analysis on the lung volume, airway and lung density. CT is currently considered the method of choice for providing accurate *in vivo* information about pathologic changes in the lung that occur in COPD. A number of studies have been dedicated to *in vivo* quantification of the extent and severity of emphysema.

The extent of emphysema is generally assessed by using CT densitometry parameters such as the relative low-attenuation area (i.e., the proportion of lung parenchyma with attenuation values lower than the predetermined threshold), which can quantitatively assess parenchymal emphysematous destruction of a lung as reflected by reduced CT lung attenuation. Hayhurst et al. were first to quantify the severity of emphysema with CT and showed that Hounsfield units (HU) frequency distribution curves of patients with histologically-proven emphysema differed significantly from patients without emphysema (7). In 1988, the density mask was introduced and is based on pre-defined voxel as a threshold to differentiate between areas of normal attenuation values and low attenuation areas (LAA). Microscopic and macroscopic studies showed that the percentage of the lung area with x-ray attenuation values of less than -950 HU and less than -910 HU can be used to approximate anatomic emphysema on CT scans obtained in inspiration and expiration, respectively.

The percentage of the lung area with CT attenuation values compatible with emphysema has been shown to be related to functional measurements of airflow obstruction (6, 8). However, because CT measurements are not always available, it would be helpful to be able to estimate the presence and severity of emphysema by using functional measurements. An accurate prediction of the percentage of lung area with reduced x-ray attenuation values in CT by using the pulmonary function could be of help to further characterize functional impairment in patients with COPD who are undergoing a routine clinical evaluation or patients' response to therapeutic intervention (3).

We performed this study to determine the capability of quantitative computed tomography to assess pulmonary emphysema and its relationships with pulmonary test parameters in subjects of chronic obstructive pulmonary disease.

MATERIALS AND METHODS

Subjects
The study was approved by the local bioethics committee. Each participants provided a written

informed consent. From February 2009 to April 2012, we recruited 59 non-consecutive patients with COPD (mean age ± standard deviation 68 years ± 11) through the outpatient clinic. There were 52 men and seven women. Of them, 51 subjects were smokers or ex-smokers with a mean smoking exposure of 34.2 pack-years ± 16, and eight subjects were non-smokers. COPD was diagnosed according to the criteria of the GOLD (1). Subjects were drawn for each GOLD stage, resulting in four subjects in GOLD stage 1, 25 in GOLD stage 2, 21 in GOLD stage 3, and six subjects in GOLD stage 4. According to the severity of the disease, the subjects were subsequently divided into two following groups – milder group (GOLD stages 1–2) and more severe group (GOLD stages 3–4).

Pulmonary Function Testing

All patients underwent a complete evaluation of the pulmonary function, including spirometry, body plethysmography, and gas diffusion capacity testing. Pre and post bronchodilator spirometry data, static lung volumes, and single-breath diffusing capacity for carbon monoxide were performed according to the guidelines of the American Thoracic Society (ATS)/European Respiratory Society (ERS). PFT parameters, including FEV_1, FEV_1/FVC ratio, FVC, TLC, VC, RV, and Dlco, were measured using Vmax Encore (Viasys ®Healthcare, US) equipment. The subsequent CT scanning was performed within the interval of less than seven days.

CT Examination

All the subjects underwent volumetric chest CT at the end of inspiratory breath-hold in supine position. Breath-hold training was carried out before each exam. No contrast medium was used. All CT scans were obtained by the same team of diagnostic radiology personnel and with the same CT scanner GE Light Speed VCT 64-slice (GE Healthcare, Milwaukee, Wisconsin, US). CT parameters were as follows: 120 k VP/80 m As, scan range from lung apex to the diaphragm, pitch 0.875, B31f reconstruction kernel, section thickness 5 mm, collimator width 64 × 0.625 mm and a gantry rotation speed of 0.8 s. These CT raw data were reconstructed to 1.25 mm section thicknesses using a standard algorithm.

Image analysis

Image analysis was performed on a post-processing workstation AW 4.5 VCAR (GE Healthcare, Milwaukee, Wisconsin, US) using advanced application Thoracic VCAR software. Quantitative CT assessment of lung volumes and the percentage of lung CT voxels below the threshold of –950 HU (as a representative value of the presence of lung emphysema) were performed. The outlining of each lung lobe was performed manually by a radiologist. Percentages of low-attenuation volume $LAV_{-950\,HU}$ (%) were obtained automatically for both lungs, the right lung, the left lung, and each lobe (Figure).

Statistical Analysis

Comparisons between the measurements of a CT scan and PFT parameters were performed. In terms of normally distributed data, analysis of variance Student's t-test were used. Otherwise, statistics were analysed using the Kruskal-Wallis method. Pearson r correlation coefficient was used to evaluate the correlation between the pulmonary function and CT low-attenuation volume $LAV_{-950\,HU}$ (%) parameters in COPD patients. Data analysis and statistical analysis were performed by SPSS version 22.0 (SPSS Inc., Chicago Ill). $P < 0.05$ was considered statistically significant. Continuous data are given as mean ± SD, unless otherwise indicated.

RESULTS

The 59 COPD patients were divided into two groups according to the GOLD stage. Mild/moderate group included GOLD stages 1–2, and severe/very severe group included GOLD stages 3–4. The characteristics of the subjects and PFT parameters are listed in Table 1. Table 2 demonstrates correlation coefficients between $LAV_{-950\,HU}$ (%) of the lobes and PFT results. The $LAV_{-950\,HU}$ (%) of both lungs, the right lung, the left lung, the right middle lobe (RML), the right lower lobe (RLL), the left upper lobe (LUL), and the left lower lobe (LLL) showed weak negative correlations with airflow limitation (FEV_1 and FEV_1/FVC) ($r = -0.30$ to -0.50, $p < 0.031$). The right upper lobe showed no correlation with airflow limitation ($r = -0.20$ to -0.37, $p > 0.05$).

E

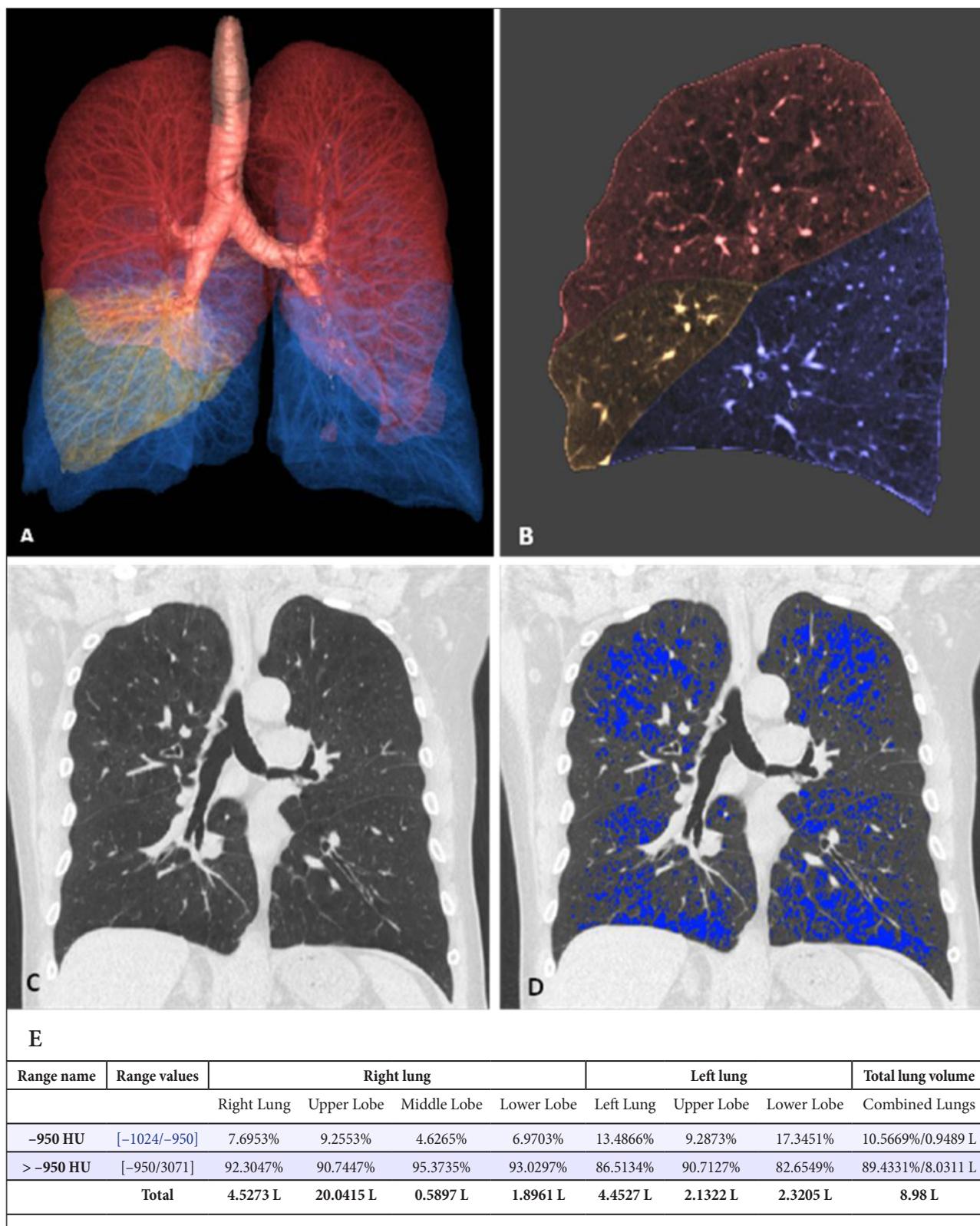| Range name	Range values	Right lung				Left lung			Total lung volume
		Right Lung	Upper Lobe	Middle Lobe	Lower Lobe	Left Lung	Upper Lobe	Lower Lobe	Combined Lungs
−950 HU	[−1024/−950]	7.6953%	9.2553%	4.6265%	6.9703%	13.4866%	9.2873%	17.3451%	10.5669%/0.9489 L
> −950 HU	[−950/3071]	92.3047%	90.7447%	95.3735%	93.0297%	86.5134%	90.7127%	82.6549%	89.4331%/8.0311 L
	Total	**4.5273 L**	**20.0415 L**	**0.5897 L**	**1.8961 L**	**4.4527 L**	**2.1322 L**	**2.3205 L**	**8.98 L**

Figure. Images of the lungs of a 72-year-old male COPD patient with GOLD stage 2 disease. A – the volume rendering (VR) image of the lungs; B – the outline of the right lung lobes; C – a coronal image of the lungs; D – the area of the lungs having a CT value below −950 HU is shown in blue; E – percentages of low-attenuation volume of both lungs, the right lung, the left lung, and each lobe were obtained automatically

Table 1. Clinical data and results of the pulmonary function test of study subjects

Parameter	Value	Mean	SD	Range
No. of patients (male/female)	59 (52/7)			
Age, years	59	68.36	11.13	39–87
Smoking exposure, pack-years	51	34.18	15.96	0–60
FEV$_1$ (%)	56	51.23	17.92	19–106
FEV$_1$/FVC (%)	56	44.02	12.33	21–75
FVC (%)	56	91.68	22.42	45–137
TLC (%)	49	117.31	24.54	67–198
VC (%)	49	90.73	20.69	52–140
RV (%)	49	169.59	61.17	69–381
DLco (%)	47	59.91	21.20	18–100

Note. The data are expressed in terms of means ± standard deviations (SD). Smoking exposure, pack-years – a pack year is defined as twenty cigarettes smoked every day for one year. FEV$_1$ (%) – percentage of predicted forced expiratory volume in 1 s; FVC (%) = percentage of predicted forced vital capacity; TLC (%) – percentage of predicted total lung capacity; VC (%) – percentage of predicted vital capacity; RV (%) – percentage of predicted residual volume; DLco (%) – percentage of predicted diffusing capacity of lung for carbon monoxide.

Table 2. Correlation coefficients between LAV$_{-950\,HU}$ (%)

LAV$_{-950\,HU}$ (%). Mean ± SD	FEV$_1$ (%)		FEV$_1$/FVC (%)		DLco (%)		TLC	
	r	P	r	P	r	P	r	P
Both lungs (10.53 ± 10.65)	–0.39	0.005	–0.50	0.000	–0.59	0.000	0.44	0.003
Right lung (9.86 ± 9.96)	–0.30	0.031	–0.50	0.000	–0.58	0.000	0.40	0.007
Left lung (11.30 ± 12.15)	–0.44	0.001	–0.46	0.001	–0.56	0.000	0.42	0.005
RUL (9.08 ± 11.68)	–0.20	0.169	–0.37	0.007	–0.61	0.000	0.30	0.052
RML (9.32 ± 10.32)	–0.31	0.028	–0.45	0.001	–0.18	0.248	0.34	0.023
RLL (9.51 ± 10.82)	–0.33	0.017	–0.50	0.000	–0.35	0.022	0.35	0.022
LUL (10.16 ± 12.42)	–0.36	0.009	–0.39	0.005	–0.56	0.000	0.35	0.022
LLL (11.49 ± 11.99)	–0.37	0.007	–0.49	0.000	–0.41	0.007	0.36	0.017

Note. The data are Pearson r correlation values. LAV$_{-950\,HU}$ (%) data of anatomic lung part are expressed in terms of means ± standard deviations (SD); FEV$_1$ (%) – percentage of predicted forced expiratory volume in 1 s; FVC (%) = percentage of predicted forced vital capacity; DLco (%) – percentage of predicted diffusing capacity of lung for carbon monoxide; TLC (%) – percentage of predicted total lung capacity.

Except for RUL and RML, all the quantitative CT measurements revealed weak to moderate negative correlations with diffusing capacity (DLco) ($r = -0.35$ to -0.61, $p < 0.022$) and weak positive correlations with total lung capacity (TLC) ($r = 0.34$ to 0.44, $p < 0.023$). RML showed no correlation with DLco ($r = -0.18$, $p > 0.05$) and RUL showed no correlation with TLC ($r = 0.30$, $p > 0.05$).

Table 3 provides patients' characteristics, parameters of the pulmonary function, and quantitative CT measurements in the mild/moderate GOLD stage group and severe/very severe GOLD stage group. The value of LAV$_{-950\,HU}$ (%) of both lungs, right lung, left lung, RUL, RLL, LUL and LLL was increased within GOLD 3–4 group comparing to GOLD 1–2 group

Table 3. Pulmonary function and quantitative CT LAV$_{-950\ HU}$ (%) measurements between GOLD stage 1–2 and GOLD stage 3–4 groups

	GOLD stage 1–2	GOLD stage 3–4
Male/female (*n*)	26/3	24/3
Pulmonary function test		
FEV1 (%)	63.62 ± 15.16†	37.93 ± 8.76†
FEV1/FVC (%)	50.41 ± 10.64†	37.15 ± 10.26†
FVC (%)	99.79 ± 20.79†	82.96 ± 21.12†
TLC (%)	114.48 ± 18.55	120.25 ± 29.66
VC (%)	96.96 ± 18.35†	84.25 ±21.35†
RV (%)	153.64 ± 39.42	186.21 ± 74.98
DLco (%)	69.56 ± 19.02†	48.95 ± 18.29†
CT measurements LAV–950 HU (%)		
Both lungs	6.25 ± 6.88†	15.35 ± 12.44†
Right lung	6.09 ± 7.13†	14.23 ± 11.37†
Left lung	6.50 ± 7.39†	16.52 ± 14.55†
RUL	5.34 ± 8.07†	13.81 ± 14.02†
RML	6.67 ± 7.89	12.60 ± 12.29
RLL	5.97 ± 7.78†	13.07 ± 12.59†
LUL	5.87 ± 6.77†	15.13 ± 15.84†
LLL	7.19 ± 9.40†	15.81 ± 12.96†

Note. † Significant statistical difference between GOLD stage 1–2 and GOLD stage 3-4 groups ($P < 0.05$). Data are expressed in terms of means ± standard deviations (SD). FEV$_1$ (%) = percentage of predicted forced expiratory volume in 1 s, FVC (%) = percentage of predicted forced vital capacity, TLC (%) = percentage of predicted total lung capacity, VC (%) = percentage of predicted vital capacity, RV (%) = percentage of predicted residual volume, *D*Lco (%) = percentage of predicted diffusing capacity of lung for carbon monoxide. RUL = right upper lobe, RML = right middle lobe, RLL = right lower lobe, LUP = left upper lobe, LLL = left lower lobe.

($p < 0.05$), whereas there were no corresponding significant differences between LAV$_{-950\ HU}$ (%) and RML.

DISCUSSION

Airflow limitation in COPD is a complex phenomenon caused by small airway remodelling and emphysema. Pulmonary emphysema results from the destruction of the parenchymal tissue induced by a chronic inflammatory response after inhalation exposure to cigarette smoke and other noxious particles. Our study revealed that quantitative CT measurements of emphysema are significantly related to the nature and severity of the impairment of the pulmonary function.

Quantification of pulmonary emphysema *in vivo* is important for the understanding of the natural history of disease, assessment of

the extent of the disease, and evaluation and follow-up of therapeutic interventions or planning of systemic treatment of COPD. Besides, the detection of early emphysema may prevent the occurrence of obstructive ventilatory impairment as timely appropriate measures such as smoking cessation or a medical intervention may be applied.

The diagnosis of COPD is based on clinical grounds and spirometry. Although spirometry is an essential method for diagnosing COPD, it reflects only the general ventilation function. Measurement of unilateral or regional lung function remains a major challenge in lung function testing (9). Computed tomography allows for early detection of emphysema. It also makes it possible to quantify the total amount of emphysema and provides the precise location of the obstructive ventilatory impairment. It has been reported that the volume of emphysema quantified by CT may

predict the severity of COPD. On CT scans, emphysema is characterised by areas of a lung with reduced attenuation coefficients. Several studies have discussed the threshold of CT analysis. In present study, a semi-automatic method setting the threshold value of –950 HU was applied for the quantitative assessment of the emphysema volume (10, 11). It was first defined on an incremental thin-section CT scan and compared with pathological specimens (11). Zaporozhan et al. reported that the –950 HU threshold data measured on multi-detector-row correlated well with PFTs (12). Several other clinical studies also used the same threshold of –950 HU (13, 14).

Our current study confirms significant correlations between CT measurements of emphysema and airflow obstruction, diffusion capacity, and the parameters of lung volumes. The correlations were in agreement with some expert narrative review and individual studies (2, 8, 15, 16). However, other studies such as the National Emphysema Treatment Trial Study (17) and the International COPD Genetics Network Study (18) reported weaker associations of some PFT parameters. In the National Emphysema Treatment Trial and International COPD Genetics Network, single-slice CT was predominantly used; the reduced strength of the correlations was probably caused by the weak reproducibility and accuracy of single-slice CT (19). Wang et al. reported significant correlations between CT measurements of emphysema and FEV_1, FEV_1/FVC, DLco, and RV/TLC (20). It also demonstrated increased $LAV_{-950\ HU}$ (%) value in GOLD stage 2, 3 and 4 groups as compared with control samples.

The results of our study confirmed the logical assumption that patients with emphysema have deteriorating diffusing lung capacity, increased total lung capacity, the residual volume, and reduced FEV_1. These correlations were in agreement with other studies (20–22). The data of our analysis suggest that the $LAV_{-950\ HU}$ (%) of each lobe, except RML, showed mild to moderate negative correlation with DLco and weak positive correlation – except in the case of RUL – with RV/TLC.

DLco measures the ability of the lungs to transfer gas from inhaled air to the red blood cells in pulmonary capillaries, thus decreased DLco value is caused by the destruction of alveolar walls and results in capillary network reduction and therefore

indirectly reflect the extent of emphysema. These results are not in conformity with the findings of the previous studies. Saitoh et al. found moderate to strong correlations of DLco with the $LAV_{-950\ HU}$ (%) of the right lung, the whole lung, and each upper lobe, whereas the $LAV_{-950\ HU}$ (%) of the left lung and each lower lobe showed no or only weak correlations with DLco (23). They also found moderate correlations of RV/TLC with the $LAV_{-950\ HU}$ (%) of the right lung, left lung, both lungs and each lower lobe, whereas the $LAV_{-950\ HU}$ (%) of each upper lobe showed no or only weak correlations with it. The difference may be partly due to technical factors. Densitometry can be influenced not only by the applied percentile or density threshold, but also by image reconstruction algorithm (22, 24), section thickness (25), inspiration level (26), scanner/study centre (26), gravity (27), and radiation dose (28).

Several studies reported that DLco correlated stronger with emphysema in the upper lobes (23), while, in contrast, there are studies that reported the opposite – that PFT values, especially DLco, correlated stronger in the lower lobes (29). In our study, the moderate negative correlation between the right upper lobe and DLco was the strongest compared with other lobes ($r = –0.61$, $p < 0.000$). Could it be interpreted that emphysema takes place firstly in the RUL? It could be explained that since the right main bronchus is stub and steep, it is easier for the inflammatory agents to reach the right lung. Hoesein et al. reported that heavy (former) smokers with upper-lobe predominant CT-quantified emphysema have a more rapid decrease in lung function than those with lower-lobe predominant CT-quantified emphysema (30). But only more detailed studies could answer if CT-quantified emphysema of RUL better reflects the worsening of the lung function.

By studying the distribution of emphysema between functional groups, we found that the extent of emphysema was greater in severe or very severe COPD patients compared with the group of mild or moderate patients. This observation is in agreement with similar studies (5), where the severity of emphysema varies greatly even among patients with the same stage of COPD. It turns out that in some patients with moderate or severe airway obstruction (moderate to severe COPD stages) emphysema symptoms are hardly present, in contrast to those patients whose lungs are seriously affected

by emphysema yet respiratory function tests are almost normal. The COPD breakdown into functional groups cannot be discretely ascertained by PFT, because FEV_1 value alone cannot objectively reflect the diversity and complexity of structural lung changes and overall clinical presentation. Even within the same GOLD stage, patients will present with differences in the severity of dyspnoea, frequency of acute exacerbations, and their response to inhaled corticosteroids or bronchodilators, partially because of differences in phenotyping not addressed by the GOLD scheme.

Hence performing a thoracic CT scan to and assessing emphysema in the patients with even a mild stage of obstruction is useful for the identification of the phenotype of the disease. Based on CT examination results, it can give a complete clinical picture of the disease of each individual patient and prescribe individual and optimal treatment.

There are certain limitations in this study: since it had a relatively small number of subjects, the patients were not divided into four GOLD groups of bronchial obstruction severity. However, we think that division of our subjects into two groups – milder (GOLD 1–2) and more severe (GOLD 3–4) – is quite rational from the practical point of view.

As only inspiratory CT was performed without comparison with expiratory CT, the air trapping phenomenon was not investigated.

CONCLUSIONS

Quantitative CT measurements of emphysema are significantly related to the nature and severity of the impairment of the pulmonary function and therefore provide a useful morphological method to assess the severity of COPD and the impairment of the lung function.

CT measurements of emphysema are significantly related to the results of pulmonary function tests, particularly *D*Lco.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest to disclose.

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Virginija Šileikienė, Marius Urbonas, Mindaugas Matačiūnas, Jolita Norkūnienė

KIEKYBINE KOMPIUTERINE TOMOGRAFIJA ĮVERTINTOS EMFIZEMOS IR KVĖPAVIMO FUNKCIJŲ RODIKLIŲ SĄSAJOS SERGANT LĖTINE OBSTRUKCINE PLAUČIŲ LIGA

Santrauka

Įvadas. Lėtinė obstrukcinė plaučių liga (LOPL) yra diagnozuojama pagal vienintelį kvėpavimo funkcijos rodiklį FEV1, tačiau jis atspindi tik bronchų obstrukciją, o tokie LOPL morfologiniai komponentai kaip emfizema, bronchektazės, fibrozė ar jų deriniai, kurie yra labai svarbūs ligonio fenotipui nustatyti, geriausiai įvertinami atlikus krūtinės ląstos kompiuterinę tomografiją. Pastaruoju metu pasirodė mokslinių darbų, nagrinėjančių struktūrinių plaučių pakitimų ir kvėpavimo funkcijų rodiklių sąsajas, tačiau jų duomenys prieštaringi. Šio tyrimo tikslas – ištirti sąsajas tarp įvairių kvėpavimo funkcijos rodiklių ir plaučių emfizemos ligoniams, sergantiems LOPL.

Metodika. Ištirti 59 įvairių sunkumo stadijų LOPL sergantys ligoniai, jiems atliktas išsamus plaučių funkcijų tyrimas ir krūtinės ląstos kompiuterinė tomografija.

Emfizemos pažeisto plaučių audinio plotui įvertinti buvo apskaičiuotas visų plaučių – atskirai kiekvieno plaučio ir kiekvienos plaučių skilties žemo tankio plotas $LAV_{950\ HU}$ (%). Gauti rodikliai palyginti su kvėpavimo funkcijų rodikliais – forsuotu iškvėpimo tūriu per 1 s (FEV_1), FEV1 ir forsuotos gyvybinės plaučių talpos rodiklio (FVC) santykiu (FEV_1/FVC), anglies monoksido difuzijos geba (DLco) ir bendrąja plaučių talpa (TLC).

Rezultatai. Išskyrus dešiniojo plaučio vidurinę ir viršutinę skiltis, visi KT emfizemos rodikliai neigiamai koreliavo su difuzine geba (DLco) (r = nuo –0,35 iki –0,61, $p < 0,05$) ir teigiamai koreliavo su TLC (r = nuo 0,34 iki 0,44, $p < 0,05$). Grupių analizė atskleidė, kad sunkesne LOPL stadija (GOLD III–IV) sergančių pacientų visų plaučių dalių, išskyrus dešiniąją vidurinę skiltį, $LAV_{-950\ HU}$ (%) buvo didesnis, palyginti su lengvesnės LOPL (GOLD I–II) stadijos pacientų rodikliais ($p < 0,05$).

Išvados. Emfizemos KT išraiška reikšmingai susijusi su kvėpavimo funkcijų rodikliais, ypač DLco.

Raktažodžiai: emfizema, kiekybinė kompiuterinė tomografija (KT), plaučių funkcija, LOPL