The effect of inspiration on airway dimensions measured in CT images from the Danish Lung Cancer Screening Trial
Petersen, Jens; Wille, Mathilde; Thomsen, Laura; Feragen, Aasa; Dirksen, Asger; de Bruijne, Marleen

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Assessing pulmonary perfusion in emphysema: automated quantification of perfused blood volume in dual-energy CTPA

F.G. Meinel, A. Graef, S. Herne, F. Barnberg, C. Neurohr, M.F. Reiser, T.R.C. Johnson; Munich/DE (felix.meinel@med.uni-muenchen.de)

Purpose: To determine whether automated quantification of lung perfused blood volume (FBV) in dual-energy computed tomography pulmonary angiography (DE-CTPA) can be used to assess the severity and regional distribution of pulmonary hypoperfusion in emphysema.

Methods and Materials: We retrospectively analysed 40 consecutive patients (mean age 67 ± 13 years) with pulmonary emphysema, no cardiopulmonary comorbidities and a DE-CTPA negative for pulmonary embolism. Automated quantification of global and regional pulmonary FBV was performed using the syngo dual-energy application (Siemens Healthcare). We further quantified the global and regional percentage of voxels with a CT density <-900 HU. Emphysema severity was rated visually and pulmonary function tests were obtained by chart review.

Results: Global pulmonary FBV showed a moderate but highly significant negative correlation with residual volume (RV) in % of predicted RV (r=-0.62, p=0.002, n=23) and a positive correlation with forced expiratory volume in 1 second (FEV1) in % of predicted FEV1 (r=0.67, p<0.001, n=23). Global FBV values strongly correlated with diffusing lung capacity for carbon monoxide (DLCO, r=0.67, p<0.001, n=15). Pulmonary FBV values decreased with visual emphysema severity (r=-0.46, p=0.003, n=40). Moderate negative correlations were found between global FBV values and parenchymal hypodensity in a per-patient (r=0.63, p<0.001, n=40) and per-region analyses (r=0.62, p<0.001, n=40).

Conclusion: DE-CTPA allows simultaneous assessment of lung morphology, parenchymal density and pulmonary FBV. In patients with pulmonary emphysema, automated quantification of pulmonary FBV in DE-CTPA can be used for a quick, reader-independent estimation of global and regional pulmonary perfusion, which correlates with pulmonary function tests.


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Densitometry on MDCT in cystic fibrosis: radiological evidence for emphysema

M.O. Weipuz1, O. Weinheimer2, M. Eichinger1, M. Wiebel1, J. Biederer1, H.U. Kauczor1, C.-P. Heussel1, M.A. Mall1, M. Puderbach2; Heidelberg/DE, Mainz/DE (mark.wielpuz@web.de)

Purpose: The present study was conducted to employ computational densitometry based on multi-detector computed tomography (MDCT) of the chest to characterise and quantify emphysema in cystic fibrosis (CF), identical to its routine clinical application in chronic obstructive pulmonary disease (COPD). Results were validated against pulmonary function testing (PT, i.e. forced expiratory volume in 1 s percent predicted [FEV1%], residual volume [RV] and total lung capacity [TLC]). Patients without lung disease (NORMAL) served as controls.

Methods and Materials: MDCT from n=41 CF (median FEV1%=46, median age 20a) and n=20 NORMAL (FEV1%=102, 30a) were subjected to densitometry. Lung volume (LV) and emphysema volume (EV) were segmented (threshold -950 Hounsfeld units), and the emphysema index was computed (EI). All results were correlated with parallelised PFT (median gap 0d, range 0-73d).

Results: Mean LV was 4681 ml in CF and 3967 ml in NORMAL (ns). Significant EV was found in CF (mean 457 ml) compared to NORMAL (78 ml) (p<0.05). Median EI was elevated to 7% in CF patients, but 1% in NORMAL. EI correlated well with FEV1% in CF (rs=-0.55) and NORMAL (rs=0.67), but with RV (rs=0.69), and RV/TLC (rs=0.47) in CF only (p<0.05). Importantly, EI increased markedly with age in CF (rs=0.67, p<0.001), starting at 13a.

Conclusion: Our results indicate the development of progressive emphysema in chronic CF, which should be considered for new therapeutic approaches. Densitometry may introduce new quantitative and prognostic parameters into severity assessment of CF lung disease.