The effect of inspiration on airway dimensions measured in CT images from the Danish Lung Cancer Screening Trial

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We retrospectively analysed 40 consecutive patients in CF lung disease. Densi-
tometry may introduce new quantitative and prognostic parameters into severity
chronic CF, which should be considered for new therapeutic approaches. Densi-
tometry on MDCT in cystic fibrosis: radiological evidence for

Methods and Materials: We retrospectively analysed 40 consecutive patients
(mean age 67 ± 13 years) with pulmonary emphysema, no cardiopulmonary comor-
bidities and a DE-CTPA negative for pulmonary embolism. Automated quan-
tification of global and regional pulmonary PBV was performed using the syno
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 PBV showed a moderate but highly significant nega-
tive correlation with residual volume (RV) in % of predicted RV (r=-0.60, 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 PBV values strongly cor-
related with diffusing lung-capacity for carbon monoxide (DLCO, r=0.80, p<0.001,
N=15). Pulmonary PBV values decreased with visual emphysema severity (r=-0.46,
p=0.003, N=40). Moderate negative correlations were found between global PBV
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, parench-ymal density and pulmonary PBV. In patients with pulmonary emphysema, automated quantification of pulmonary PBV in DE-CTPA can be used for a quick, reader-independent estimation of global and regional pulmonary perfusion, which correlates with pulmonary function tests.

Author Disclosures:

Densitometry on MDCT in cystic fibrosis: radiological evidence for emphysema
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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 appli-
cation in chronic obstructive pulmonary disease (COPD). Results were validated
against pulmonary function testing (PFT, 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
related with parallelised FPT (median gap 0d, range 0-73d).

Results: Mean LV was 4681 ml in CF and 3967 ml in NORMAL (n.s). 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 (r=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 (r=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. Densi-
tometry may introduce new quantitative and prognostic parameters into severity
assessment of CF lung disease.

The effect of inspiration on airway dimensions measured in CT images from the Danish Lung Cancer Screening Trial J. Petersen1, M.W. Willer1, L.H. Thomsen1, A. Feragen1, A. Dirksø1, M. de Bruijne1; *Copenhagen/DK, †Heilbronn/DK, ‡Rotterdam/NL (phsp@diku.dk)

Purpose: Airway dimensions measured from CT are increasingly being used to
investigate diseases such as chronic obstructive pulmonary disease (COPD). In
this study, we investigate the effect of differences in inspiration level on such
measurements in voluntary inspiration breathhold scans.

Methods and Materials: We selected from the Danish Lung Cancer Screening
Trial 978 subjects without COPD who were scanned annually for 5 years with low-
dose multi-slice CT. Using in-house developed software, the lungs and airways
were automatically segmented and corresponding airway branches were found in
all scans of the same subject using image registration. Mixed effect models were
used to predict the relative change in lumen diameter (LD) and wall thickness
(WT) in airways of generation 0 (trachea) to 6 based on relative changes in the
segmented total lung volume (TLV).

Results: On average, 1.0, 2.0, 3.9, 7.6, 15.0, 25.0 and 27.3 airways per subject
were included from generations 0, 1, 2, 3, 4, 5 and 6, respectively. Relative changes
in LD were positively related to changes in TLV and coefficients increased with
generation: 0.20 (+0.02), 0.19 (+0.02), 0.21 (+0.01), 0.25 (+0.01), 0.29 (+0.01),
0.34 (+0.01), 0.31 (+0.01). Relative changes in WT were inversely related to changes
in TLV and generation: -0.01 (+0.02), 0.01 (+0.02), -0.02 (+0.01), -0.03
(+0.01), -0.05 (+0.01), -0.09 (+0.00), -0.08 (+0.00).

Conclusion: Subjects who inspire deeper prior to scanning tend to have larger LD
and smaller WT. This effect is more pronounced in higher generation airways. Thus,
adjustment for inspiration level is needed to accurately assess airway dimensions.

Author Disclosures:
M. de Bruijne: Grant Recipient; AstraZeneca.

Deterioration in airway dimensions measured on thin-slice low-dose CT
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Purpose: Chronic bronchitis (CB) is usually caused by smoking and characterised
by chronic inflammation and remodelling of the airway wall, commonly in large air-
ways. The study purpose is to determine differences in airway wall thickness (AWT)
and wall area percentage (WA%) between subjects with and without CB symptoms.

Methods and Materials: 50 heavy smokers with CB symptoms (cough, mucus,
dyspnea and wheezing) and 50 heavy smokers without CB symptoms were randomly
selected from 1,413 participants in a lung cancer screening trial. Airway walls were
measured on images in thin-slice low-dose CT with a dedicated software tool,
for airways with a luminal diameter ≥5 mm in 5 selected bronchi (RB1, RB4,
RB10, LB1+2 and LB10). Differences in measurements between the groups were
assessed by t-test. The association between CB symptoms and AWT and WA% was
analysed using multiple linear regression adjusted for age, body mass index,
smoking habit, amount of emphysema, and lung function.

Results: Mean AWT measured at 5 bronchi was 1.55±0.44 mm and 1.42±0.40 mm
in subjects with and without CB symptoms, respectively (P<0.001). WA% was
47±12% and 43±11%, respectively (P<0.001). With adjustment for confounders,
a significant positive association between both airway wall measurements (AWT
and WA%) and CB symptoms was found for airways with a luminal diameter from
5 to 10 mm (P<0.01). In airways with a luminal diameter ≥10 mm, no significant
association was found (P>0.05).

Conclusion: Patients with chronic bronchitis symptoms have thicker airway walls
of airways between 5 and 10 mm diameter, not in larger diameter.

Value of inspiratory and expiratory lung volume und lung density for detection of bronchiolitis obliterans syndrome (BOS): a feasibility study S. Dettmer1, O. Otten1, C. de Wall1, J.-M. Kuhnigk1, F. Wacker1, H.-O. Shin1; ‡Bremen/DE (sabine-dettmer@t-online.de)

Purpose: To evaluate whether quantitative assessment of lung density and volume
in computed tomography (CT) show differences in patients with and without BOS
after lung transplantation.

Methods and Materials: 210 CT examinations were carried out in lung transplant
patients in full inspiration/expiration using a 64 row MDCT (120 kVp; rotation time
0.8 s; pitch 0.984; collimation 1.25 mm, reconstruction increment 1 mm, standard
reconstruction kernel). 26/184 examinations were performed in patients with with-